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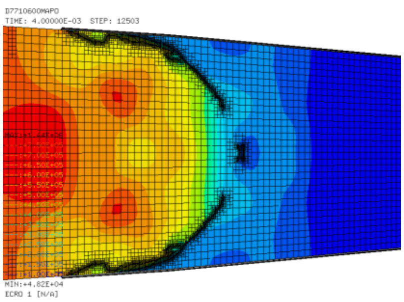
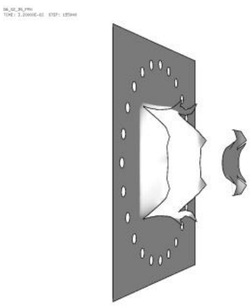
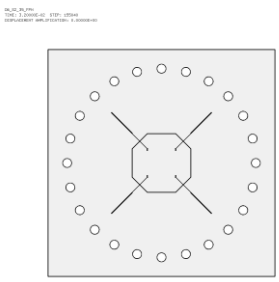
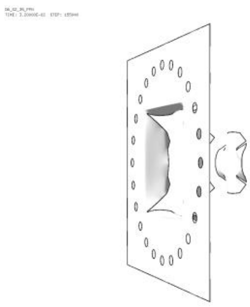

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Simulation of blast-loaded thin steel plates with slits by EUROPLEXUS

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Contents

Abstract

This report presents some EUROPLEXUS [1] simulations of thin steel plates with slits that have been tested in the SIMLab Shock Tube Facility (SSTF) at the Norwegian University of Science and Technology (NTNU) in Trondheim, Norway. The SSTF is able to generate a clean and repeatable blast-like pressure loading without resorting to the use of explosives.

The simulations presented here concern blast-like loading (in the SSTF shock tube) of thin steel plates with pre-formed X-shaped slits. The presence of these initial defects triggers the formation and propagation of cracks, eventually leading to complete failure of the plate (for sufficiently high firing pressures).

Keywords: *Shock tube, Blast loading, Thin plates, Ductile failure, Crack propagation.*

Foreword

This report is part of a large series of scientific-technical documents that are meant to provide essential information and documentation to users and developers of the EUROPLEXUS code. EUROPLEXUS (also abbreviated as EPX) is a computer code jointly developed by the French Commissariat à l'Energie Atomique (CEA DMT Saclay) and by EC-Joint Research Centre (JRC Ispra) within the framework of contractual agreements between the two research bodies.

EPX is a mature, general-purpose Finite Element and Finite Volume explicit code under active development since 1999, for the simulation of fast transient dynamic events in complex fluid-structure systems. It is an evolution of its ancestor PLEXIS-3C, which was also jointly developed by CEA and JRC in the 1980s and early '90s.

The code has been traditionally used in safety studies, ranging from nuclear reactors, to energy plants, to chemical and industrial plants, off-shore structures, car and road barrier crashes, among others. More recently it has proven a very useful tool in providing certified and independent numerical solutions in support of EC policies regarding the security of critical infrastructures and public spaces (like buildings, train and metro stations and carriages, etc.), which may be vulnerable to terrorist attacks or to natural disasters.

While being mainly of technical nature, the information contained in this series of reports is an invaluable source of reference for the users (as a complement to the User's manual) but also in particular for the developers of EPX. New models made available in the code are described in detail from the theoretical viewpoint. Several verification and application examples are also usually provided, in order to illustrate the practical use and to verify the correct functioning of the models.

Usually, at the end of each report an Appendix lists the input files that were used to produce the examples presented in the report. This allows users to re-run the test cases with EPX at any time and to use them as a basis for their own numerical simulations.

A complete list of the reports (produced both at JRC and at CEA) in this series can be found in the Bibliography section of the EPX User's manual [1].

1 Introduction

This report presents some EUROPLEXUS simulations of thin steel plates with slits that have been tested in the SIMLab Shock Tube Facility (SSTF) at the Norwegian University of Science and Technology (NTNU) in Trondheim, Norway. The SSTF is able to generate a clean and repeatable blast-like pressure loading without resorting to the use of explosives.

EUROPLEXUS [1] (also abbreviated as EPX) is a computer code jointly developed by the French Commissariat à l'Energie Atomique (CEA DMT Saclay) and by EC-JRC. The code application domain is the numerical simulation of fast transient phenomena such as explosions, crashes and impacts in complex three-dimensional fluid-structure systems. The Cast3m [2] software from CEA is used as a pre-processor to EPX when it is necessary to generate complex meshes.

The experimental test matrix and results used as a reference for the numerical simulations of this report were published in reference [3].

Over a decade of fruitful collaboration between JRC and NTNU has led to a number of publications documenting the numerical simulations of NTNU experiments carried out by EPX, see e.g. references [4–19]. On one hand, this activity and the availability of accurate and precise experimental records has allowed the calibration of a number of models present in EPX, ranging from fluid-structure interaction (FSI), to structural failure models, to material models. On the other hand, the simulations help the experimental team to design and carry out their experiments, and to interpret the experimental results.

The simulations presented here concern blast-like loading (in the SSTF shock tube) of thin steel plates with pre-formed X-shaped slits. The presence of these initial defects triggers the formation and propagation of cracks, eventually leading to complete failure of the plate (for sufficiently high firing pressures). Some of the main results obtained here, for one of the plates considered (Docol 600 material and 25 bar nonimal firing pressure) have also been communicated at a recent Conference [16]. This report documents exhaustively the simulation procedure and the entire test matrix for this type of plate and will serve as the base for a future journal paper on the subject.

2 Lagrangian (uncoupled) preliminary simulations

We start by re-running some of the simulations from the large test matrix that had been performed around April 2021 as preparatory material for the DYMAT 2021 Conference in Madrid [14]. The test matrix and the results were summarized in the (draft) report [19]. The scope of re-running these tests was primarily to check that the results obtained have not changed following two years of development of the code, and to update the EPX input files if needed, i.e. if the syntax of some commands has changed in the meantime.

The chosen tests are those using a plate with four X-shaped slits, which are labeled S2 in the experimental campaign. The simulations performed (on the EVICOM desktop PC) are summarized in Table 1.

Test	Material	p^* [bar]	Contact	t_{fin} [ms]	Steps	CPU [s]	Eroded	RAM [GB]	Storage [GB]
D6_S2_15	Docol-600DL	15	PINB	5.0	130 760	52 558	60	1.4	10.5
D6_S2_25	Docol-600DL	25	PINB	5.0	131 335	52 558	320	1.4	10.6
D6_S2_35	Docol-600DL	35	PINB	5.0	151 677	156 698	617	1.4	10.9
D14_S2_15	Docol-1400M	15	PINB	5.0	110 787	41 447	609	1.4	10.4
D14_S2_25	Docol-1400M	25	PINB	5.0	128 781	67 450	1 124	1.4	10.5
D14_S2_35	Docol-1400M	35	PINB	5.0	133 246	63 404	1 102	1.4	10.5

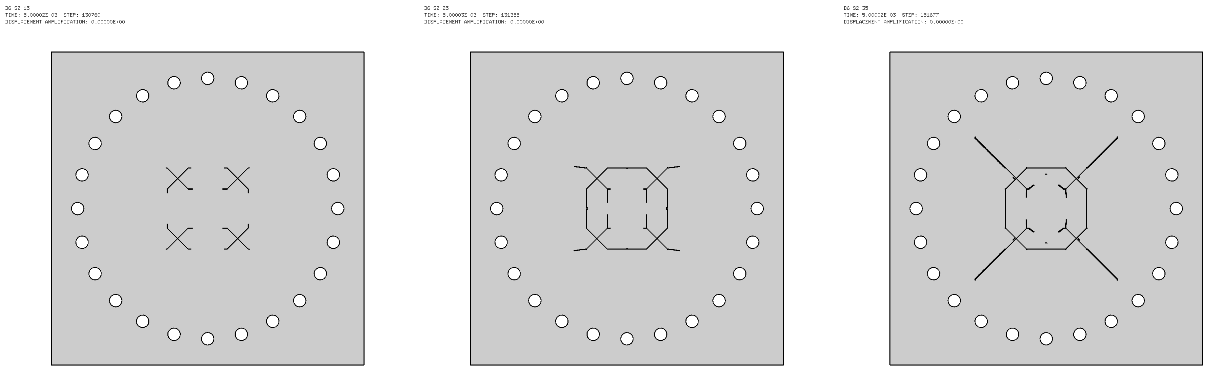
Table 1: Preliminary Lagrangian simulations (repetition of 2021 tests).

The second column shows the material of the plate (either Docol-600DL or Docol-1400M steel), the third one the nominal initial over-pressure in the driver. All pressures are expressed in bar. The fourth column lists the EPX model used to represent the contact between the plate and the clamping system. In [19] two sets of simulations were performed, one using the pinball contact model (PINB) and the other using the sliding surface model (GLIS). As seen from the Table, only the PINB-based simulations were repeated in the present Section.

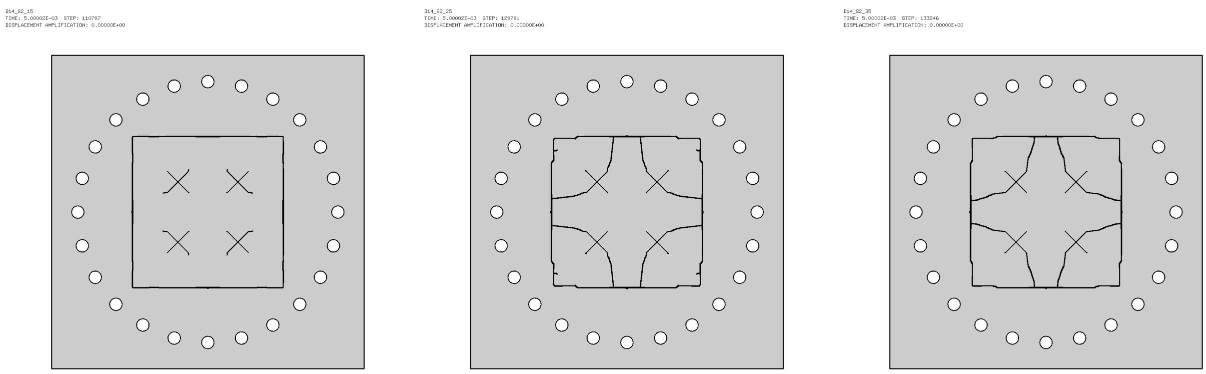
The eighth column shows the number of eroded elements at the end of the simulation, which gives an idea of the damage obtained. However, note that the number includes also the CLxx elements (if any) attached to the eroded structural elements. The last two columns give the peak RAM and the storage (amount of results) produced on the hard disk, in GB. The simulations are contained in separate folders (one per test) of the directory `EVICOM-D:\Users\Folco_Dati\Data\Pdf\2023\COUPLED2023\Full_Paper\PINB`.

From reference [3], we see that experimental results for the S2 specimens are available for the following three nominal firing over-pressures: 10 bar, 15 bar and 25 bar, and this for both materials. In the 2021 report [19], simulations with the S2 plate had been done at nominal firing over-pressures of 15 bar, 25 bar and 35 bar, for both materials (which are the simulations repeated here). No simulations at 10 bar was performed in 2021, therefore these will have to be produced anew, by building the corresponding map file and Eulerian pressure file first.

No corrections in the EPX input files of the simulations in Table 1 were necessary in order to re-run them. The results obtained were virtually identical to those obtained in 2021 and reported in [19]. Figure 1 shows the final plate fracturing (mapped on the initial geometry) for all the above simulations.



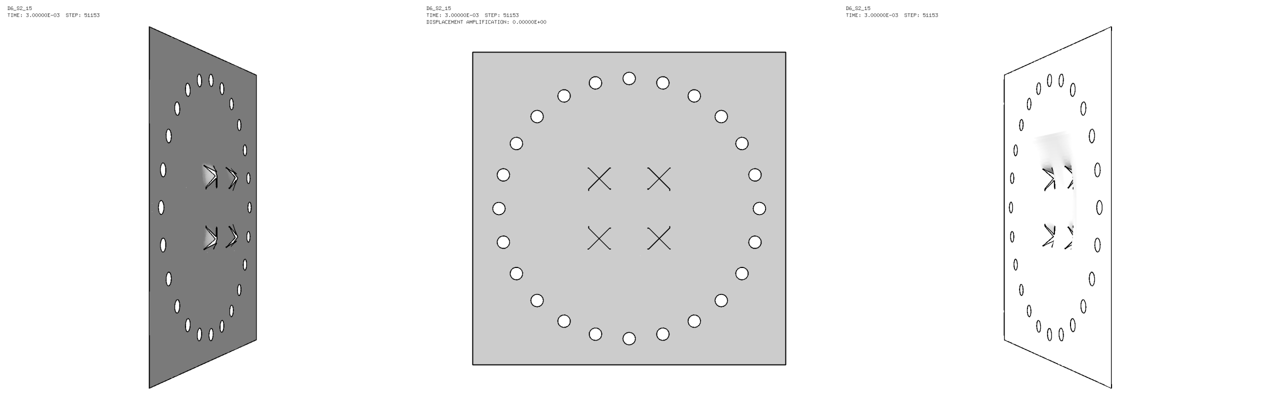
(a) Docol-600DL @ 15 bar (b) Docol-600DL @ 25 bar (c) Docol-600DL @ 35 bar



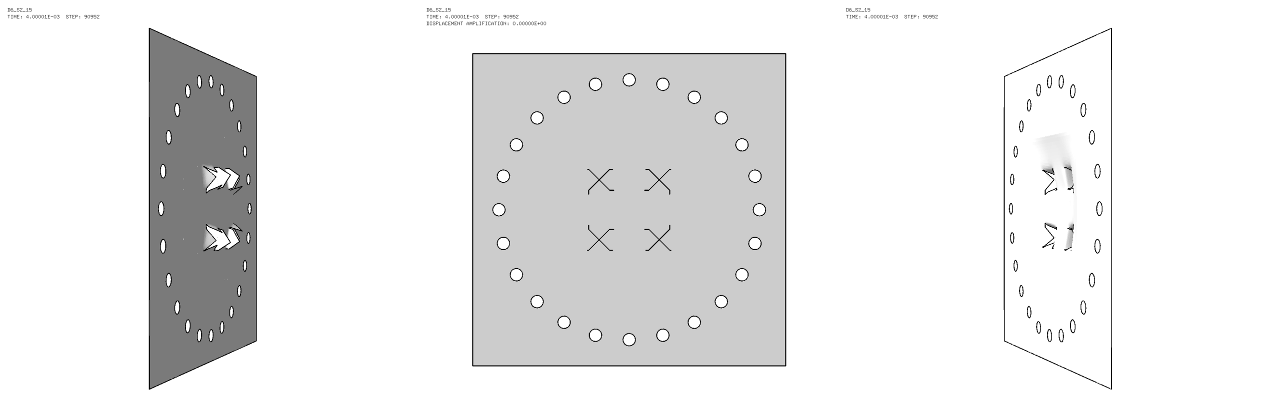
(d) Docol-1400M @ 15 bar (e) Docol-1400M @ 25 bar (f) Docol-1400M @ 35 bar

Figure 1: Final damage in the S2 plate (mapped on the initial geometry).

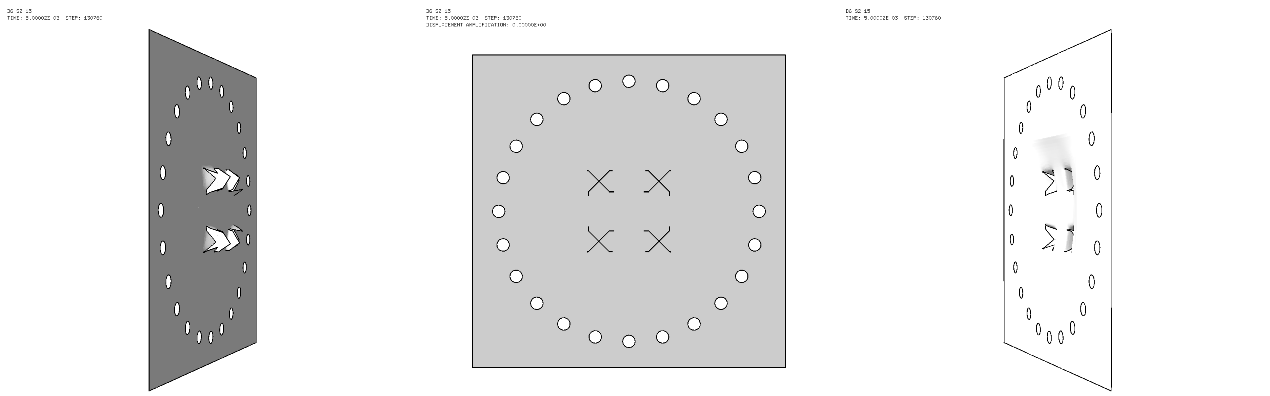
The following Figures 2 to 7 show, for each case separately, the (symmetrized) plate mesh without element outlines at various times (by using different time values, as appropriate for each case), seen from three different eye positions (right, front, left), in order to highlight the opening of the slits. The right and left views show the deformed plate, while the central view shows the undeformed plate, in order to follow the formation and progression of the cracks.



(a) $t = 3.0$ ms (b) Undeformed, $t = 3.0$ ms (c) $t = 3.0$ ms

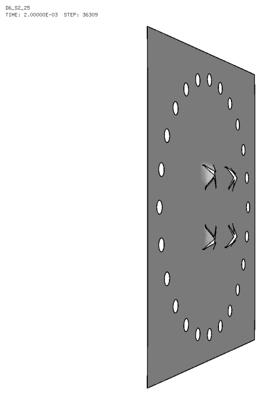


(d) $t = 4.0$ ms (e) Undeformed, $t = 4.0$ ms (f) $t = 4.0$ ms

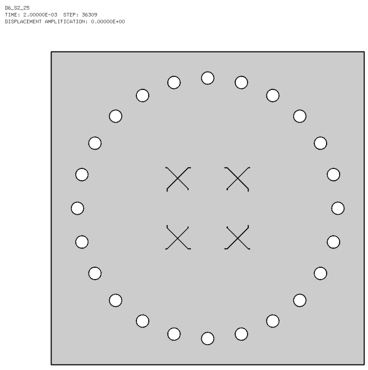


(g) $t = 5.0$ ms (h) Undeformed, $t = 5.0$ ms (i) $t = 5.0$ ms

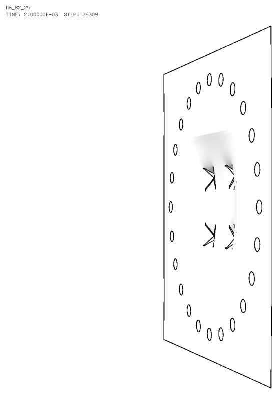
Figure 2: Geometry of the S2 plate at various times in case D6_S2_15.



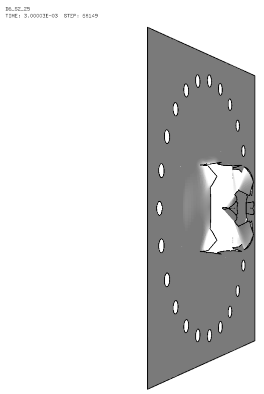
(a) $t = 2.0$ ms



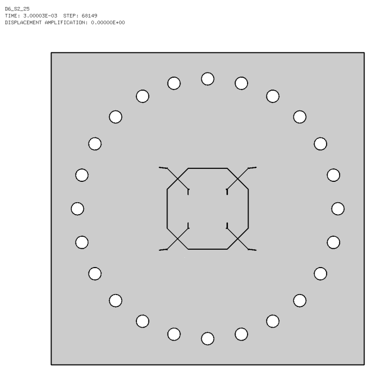
(b) Undeformed, $t = 2.0$ ms



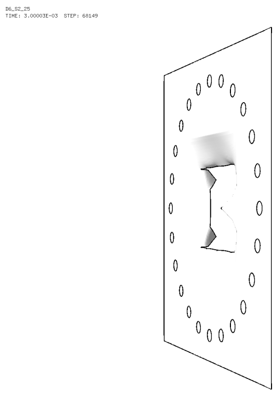
(c) $t = 2.0$ ms



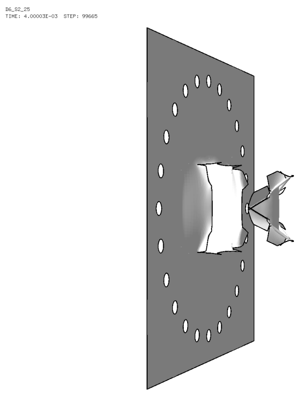
(d) $t = 3.0$ ms



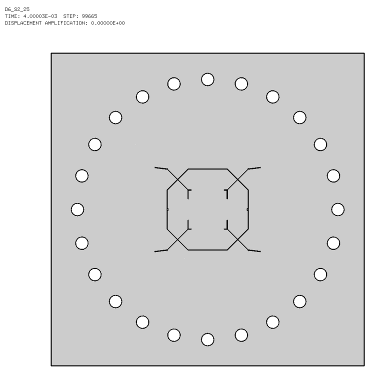
(e) Undeformed, $t = 3.0$ ms



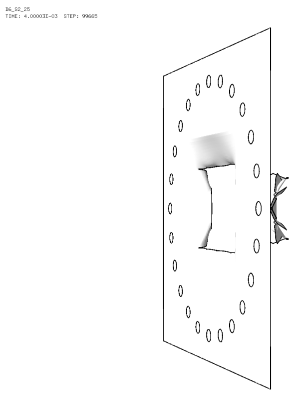
(f) $t = 3.0$ ms



(g) $t = 4.0$ ms

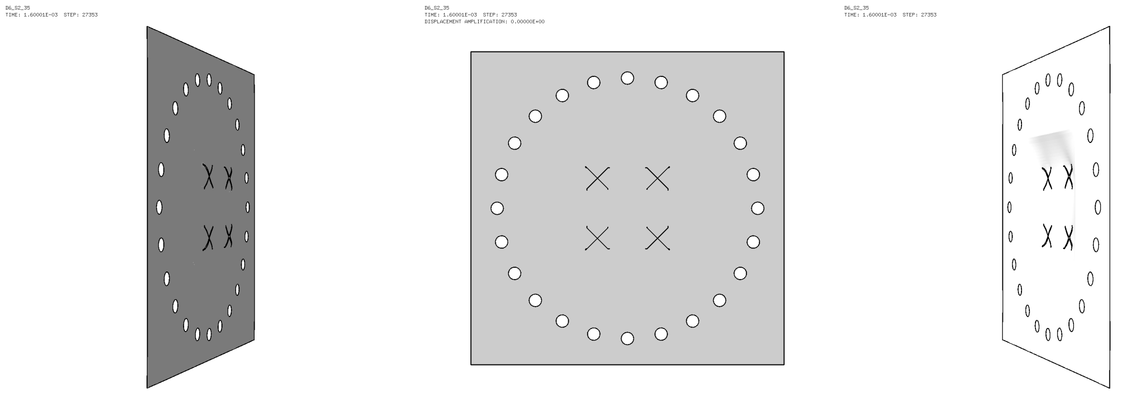


(h) Undeformed, $t = 4.0$ ms

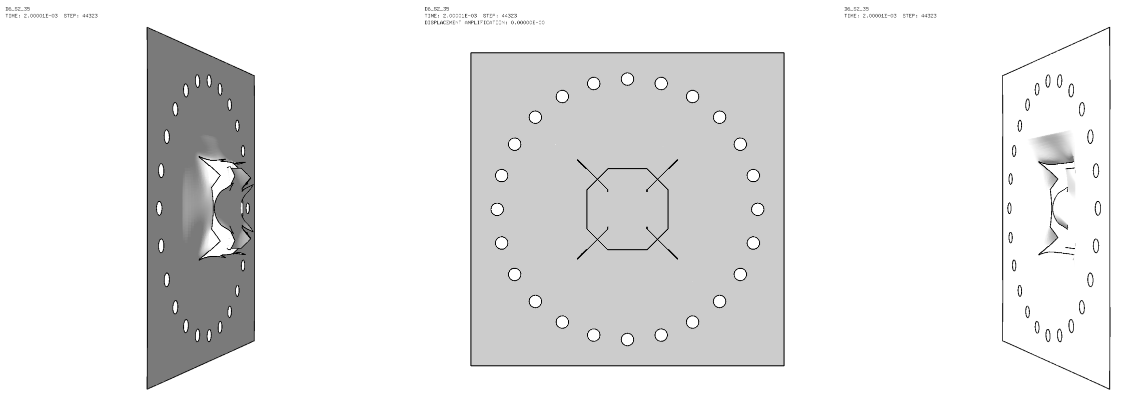


(i) $t = 4.0$ ms

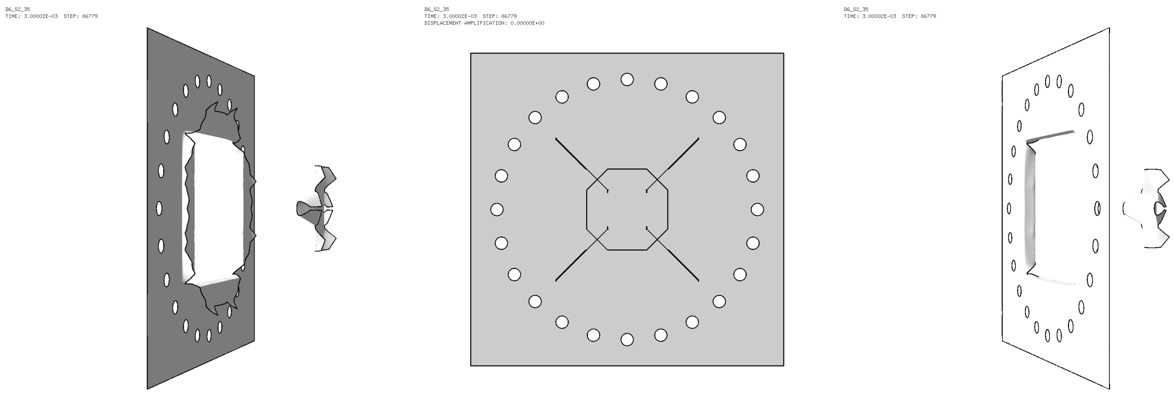
Figure 3: Geometry of the S2 plate at various times in case D6_S2_25.



(a) $t = 1.6$ ms (b) Undeformed, $t = 1.6$ ms (c) $t = 1.6$ ms

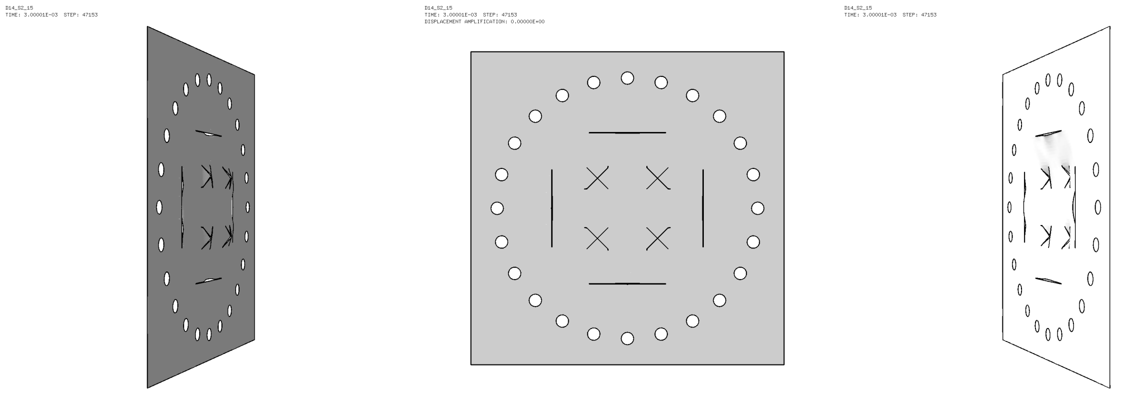


(d) $t = 2.0$ ms (e) Undeformed, $t = 2.0$ ms (f) $t = 2.0$ ms

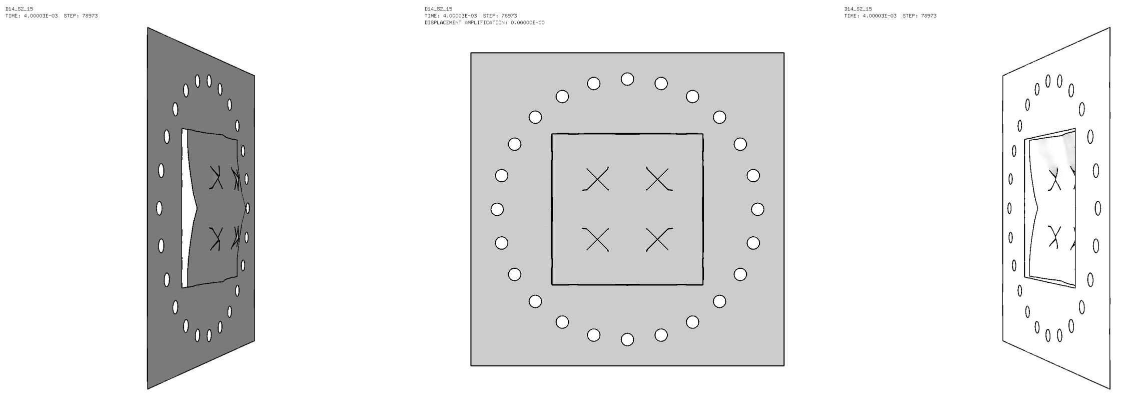


(g) $t = 3.0$ ms (h) Undeformed, $t = 3.0$ ms (i) $t = 3.0$ ms

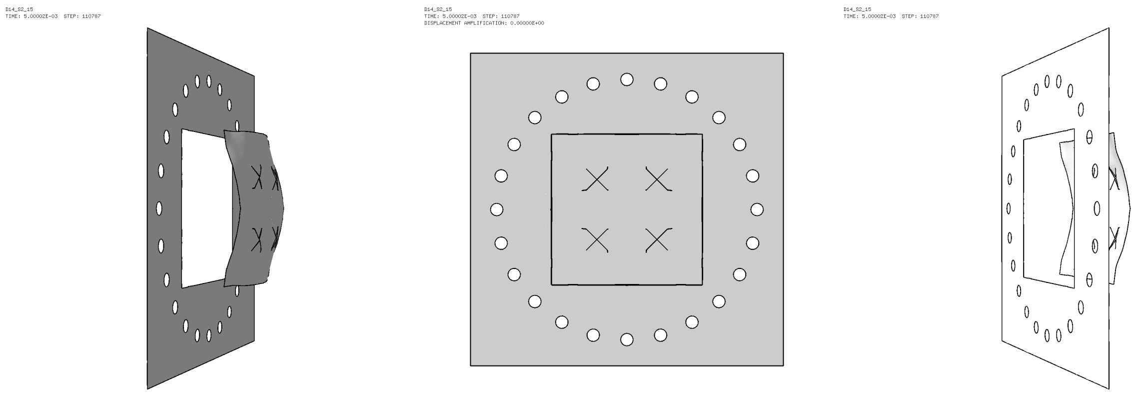
Figure 4: Geometry of the S2 plate at various times in case D6_S2_35.



(a) $t = 3.0$ ms (b) Undeformed, $t = 3.0$ ms (c) $t = 3.0$ ms

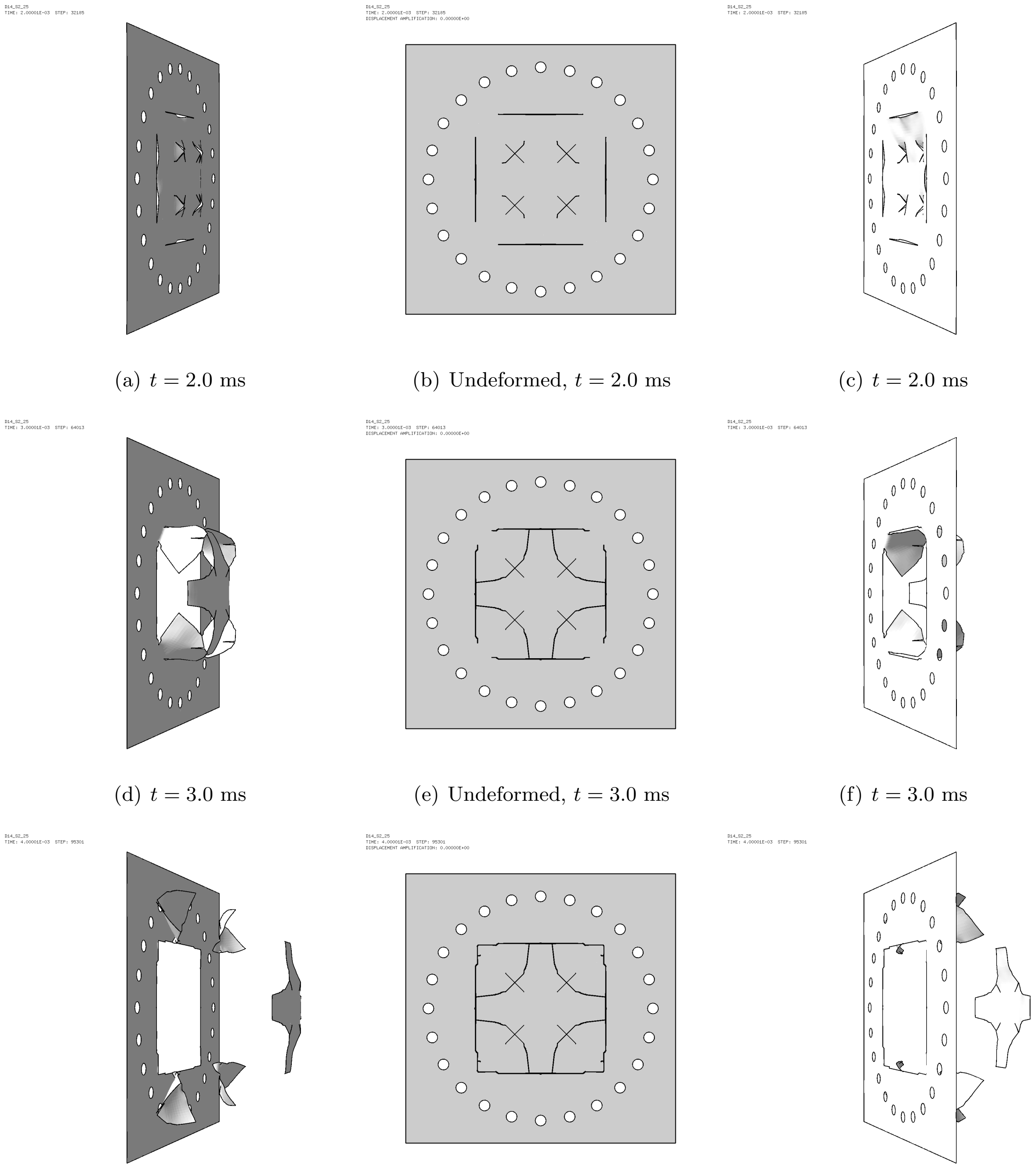


(d) $t = 4.0$ ms (e) Undeformed, $t = 4.0$ ms (f) $t = 4.0$ ms



(g) $t = 5.0$ ms (h) Undeformed, $t = 5.0$ ms (i) $t = 5.0$ ms

Figure 5: Geometry of the S2 plate at various times in case D14_S2_15.

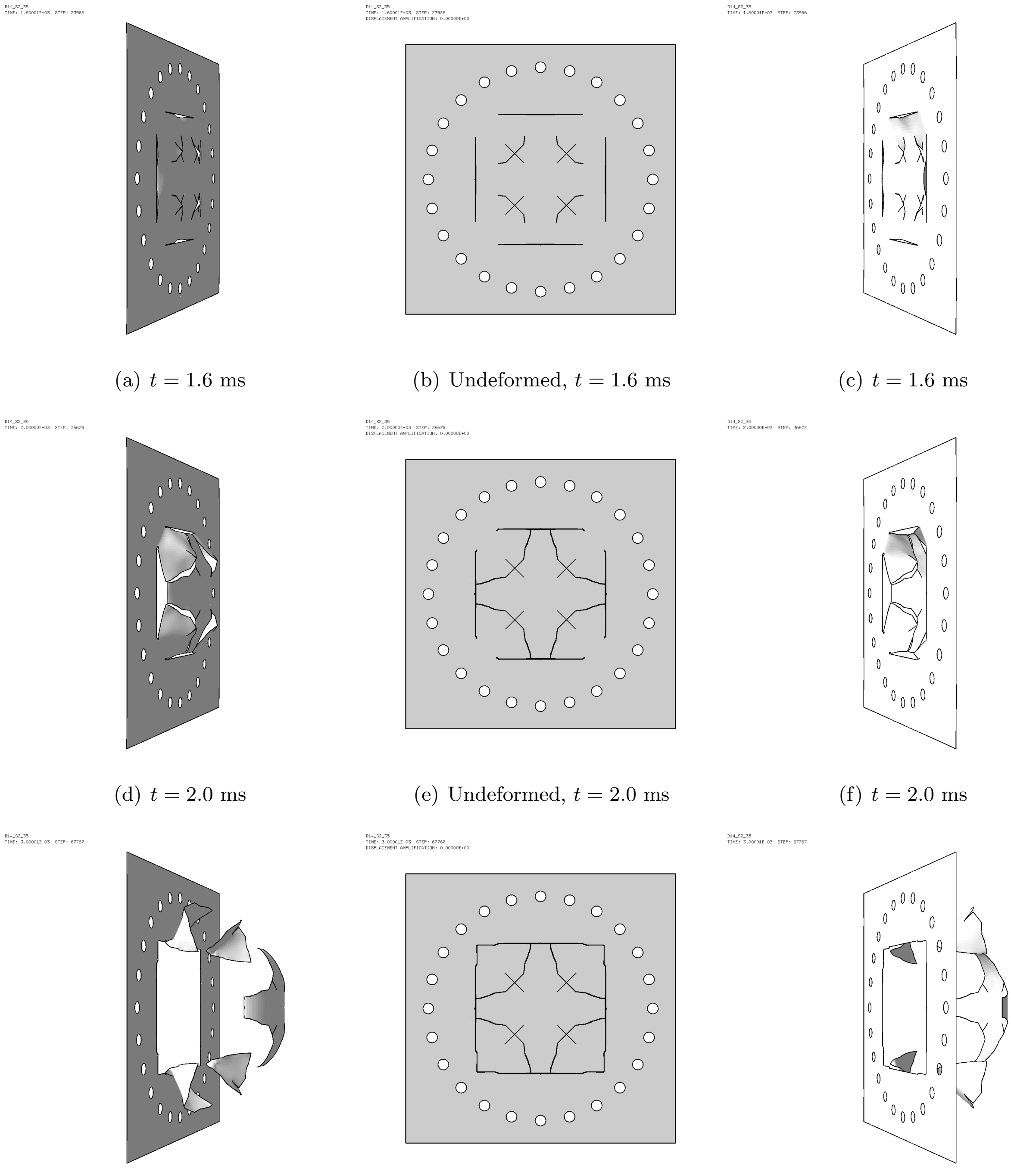


(a) $t = 2.0$ ms (b) Undeformed, $t = 2.0$ ms (c) $t = 2.0$ ms

(d) $t = 3.0$ ms (e) Undeformed, $t = 3.0$ ms (f) $t = 3.0$ ms

(g) $t = 4.0$ ms (h) Undeformed, $t = 4.0$ ms (i) $t = 4.0$ ms

Figure 6: Geometry of the S2 plate at various times in case D14_S2_25.



(a) $t = 1.6$ ms (b) Undeformed, $t = 1.6$ ms (c) $t = 1.6$ ms

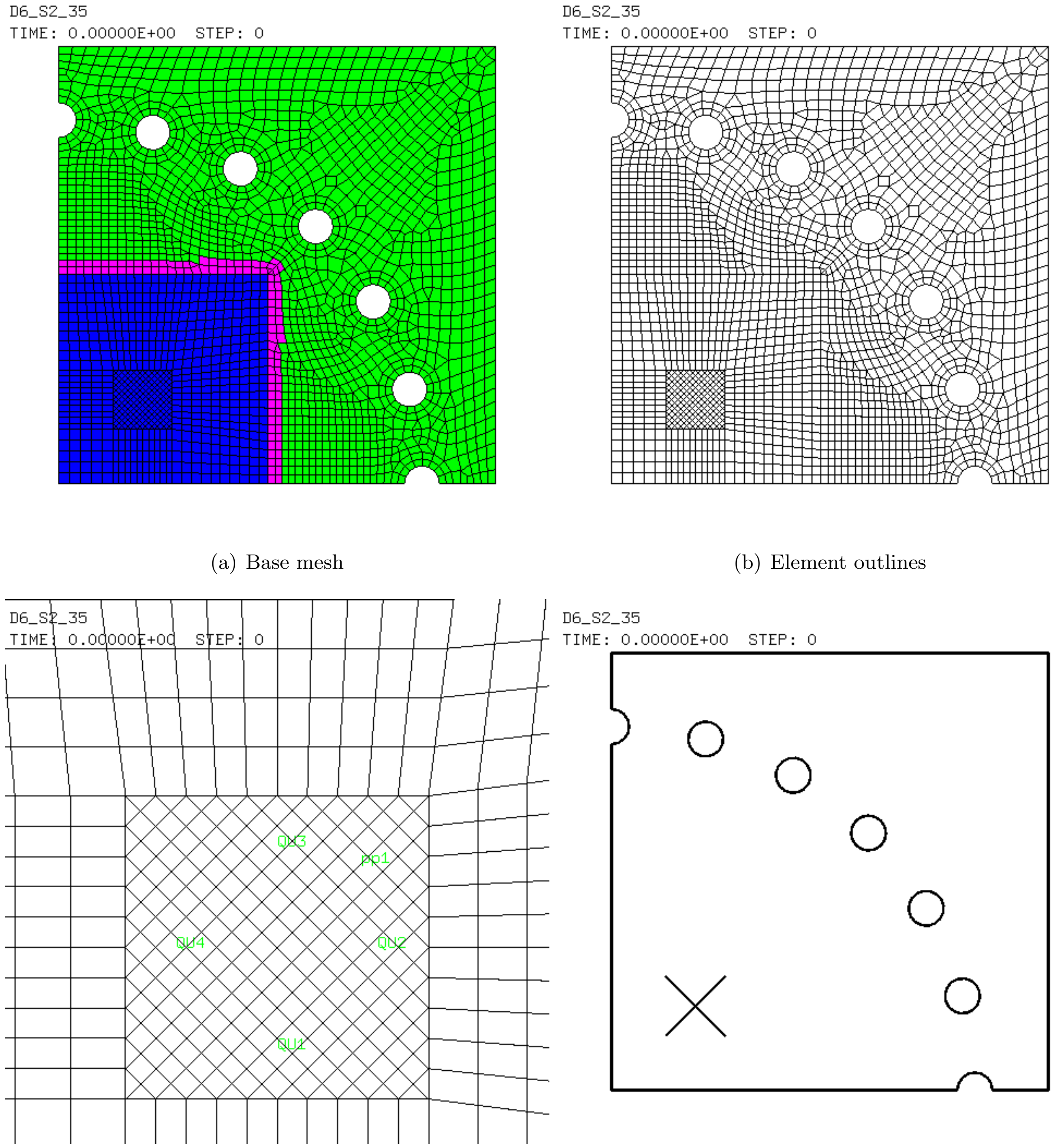
(d) $t = 2.0$ ms (e) Undeformed, $t = 2.0$ ms (f) $t = 2.0$ ms

(g) $t = 3.0$ ms (h) Undeformed, $t = 3.0$ ms (i) $t = 3.0$ ms

Figure 7: Geometry of the S2 plate at various times in case D14_S2_35.

2.1 Characteristics of the S2 plate mesh

The (base) mesh of the S2 plate is shown in Figure 8. Only 1/4 of the plate is represented in the computational model, thanks to symmetry. The zone of the plate exposed to the blast pressure is shown in blue in Figure 8(a). The magenta zone is the first couple of element layers clamped between the frames, while the rest is shown in green.



(a) Base mesh

(b) Element outlines

(c) Detail of slit zone

(d) Free edges

Figure 8: Base mesh of the S2 plate.

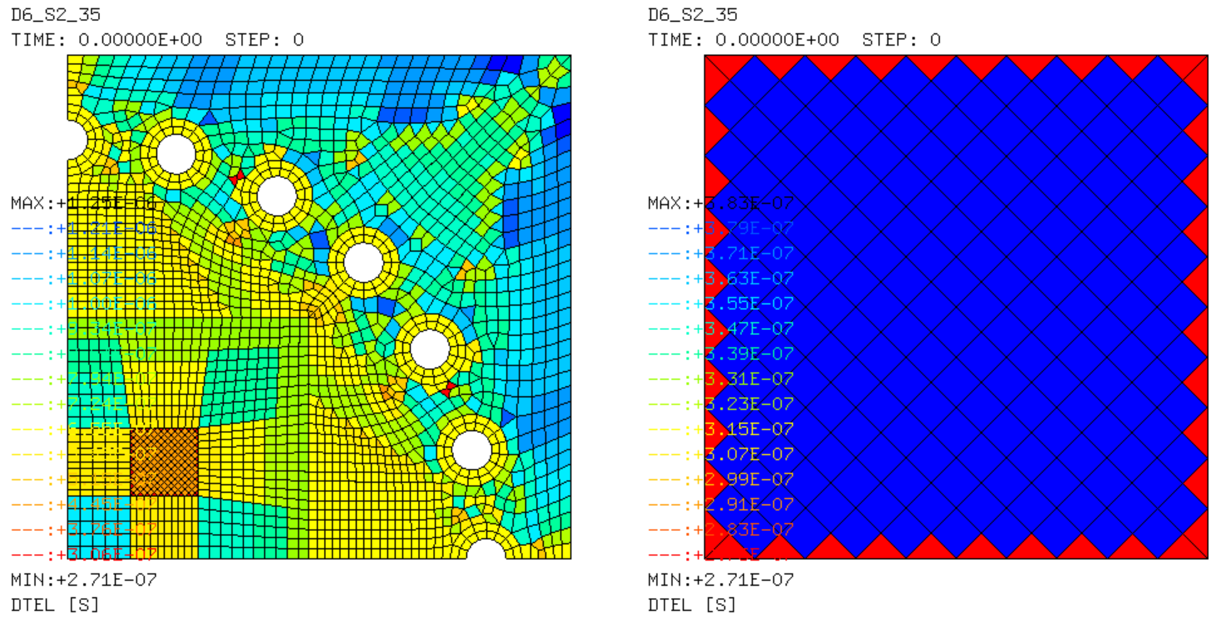
The slit zone is detailed in Figure 8(c). The abrupt change in element size between the slit zone and the surrounding zone is probably not optimal, especially in view of capturing the onset and propagation of cracks, but the model relies on automatic adaptive mesh refinement (AMR) to obtain a more regular mesh during the course of the suimulation.

The presence of triangular elements at the four corners of the slit zone, and their orientation, also might be not optimal as concerns the formation and orientation of the first appearing cracks.

However, again, it is hoped that the correct crack orientation will be captured as they propagate, thanks to AMR.

In the initial (base, i.e. not yet AMR refined) configuration, the most critical element in the entire mesh is element 599, with a stability step $\Delta t_{\text{stab}} = C_s \Delta t_{\text{crit}} = 2.20443 \times 10^{-7}$ s (with C_s the safety coefficient, $C_s = 0.7$ in this case, and $\Delta t_{\text{crit}} \approx L/c$ the critical step, where L is the element's length and c the speed of sound in the element's material). This element is a CUB8 belonging to the lower plate / bolts assembly and will not be refined during the simulation, therefore it will lose its role of most critical element, in favor of some element in the plate, as soon as AMR starts operating.

The "smallest" base element in the plate is element 10522, with a minimum intra-nodal length of 2.39069 mm. A bit surprisingly, this is a Q4GS located near the bolts and has $\Delta t_{\text{stab}} = 3.05428 \times 10^{-7}$ s. The element (and three others all with the same stability step) may be seen depicted in medium red in Figure 9(a), which shows the stability step (DTEL) distribution over the plate in the initial configuration. The color scale is inverted, i.e. the elements with the smallest DTEL are shown in red and those with the largest DTEL are shown in blue. Note that these elements are unlikely to get refined by the AMR process.



(a) DTEL in the whole plate

(b) DTEL in the slit region

Figure 9: Stability step (DTEL) in the plate.

The most critical element(s) in the plate are the triangular elements located along the border of the slit region. These are very small and not clearly visible in Figure 9(a). They appear in full red in Figure 9(b), which uses a different color scale from Figure 9(a), showing a detail of the slit region, and have $\Delta t_{\text{stab}} = 2.71015 \times 10^{-7}$ s. The hypotenuse of these (rectangle, isosceles) triangles measures 4.24264 mm while the cathetus (which is also the side of the square elements in the slit region) measures 3.00000 mm. All the square elements in the slit region, in blue in Figure 9(b), have $\Delta t_{\text{stab}} = 3.83272 \times 10^{-7}$ s.

In these simulations a maximum refinement level $L_{\text{max}} = 4$ is used in the (entire) plate. Therefore, the size of a fully refined element becomes 1/8 of the corresponding base element and the stability step gets reduced accordingly. Therefore, once the plate is (locally) fully refined in and around the slit, we may expect a stability step of the order of $\Delta t_{\text{stab}} \approx 2.71015 \times 10^{-7}/8 = 3.38769 \times 10^{-8}$ s, and this will also probably be the global stability step for (most part of) the simulation.

It is worthwhile to notice that the thickness of the plate is $h = 0.8$ mm. When fully refined, the side of the smallest plate elements in the crack region will become about $L = 3.00000/8 = 0.375$ mm. Since this is below the thickness ($L/h = 0.47$), one might raise some doubts about the shell theory being still valid for the (refined) shell elements. In fact, common engineering practice would suggest having shell elements with a side to thickness ratio L/h larger than 2.

2.2 Pressure time functions

It should be noted that the above simulations were performed by using the so-called "Eulerian" pressures (which in turn used the map files) produced in 2021 for the simulation of non-perforated plates and which were stored in the "NTNU database" at JRC, described in reference [15]. The pressure time functions are shown in Figure 10.

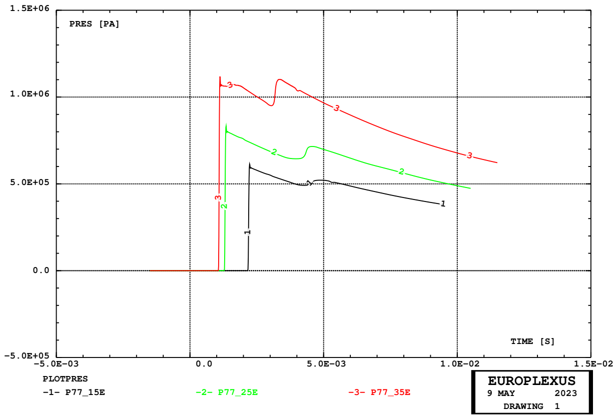


Figure 10: Pressure time functions used in the Lagrangian simulations.

The strategy behind the present simulations, including an explanation of map files, Eulerian, Lagrangian (decoupled) and FSI (coupled) calculations, is presented in references [10, 13].

3 Map file generation simulations

As noted in the previous Section, no simulations at 10 bar nominal firing over-pressure had been performed in 2021. Therefore, the corresponding map file and Eulerian pressure file have to be generated anew. The simulations performed for this purpose are summarized in Table 2 (not in alphabetical order but in the order in which they were actually executed, so note that that case 10g comes before 10f) and are described in detail below. The number of eroded elements reported is at the time t_{fant}, i.e. it includes only the elements eroded by material failure and by neighboring (if any).

Case	Description	p^* [bar]	t_{fire} [ms]	t_{fin} [ms]	Steps	CPU [s]	Ero.	RAM [GB]	Sto. [GB]
D7705600map	Repetition of 2021	5	7.0	44.0	103 728	95 960	468	4.0	12.6
D7710600mapa	See Section 3.2	10	7.0	40.0	92 742	68 127	236	4.0	11.4
D7710600mapb	Reduce ramping period	10	3.0	40.0	94 902	133 774	502	4.1	11.7
D7710600mapc	Multiple map files	10	3.0	40.0	94 902	125 650	502	4.1	12.2
D7710600mapd	Use map trigger	10	3.0	32.2*	77 884	118 562	502	4.1	9.7
D7710600mape	Do not remove membranes	10	3.0	32.2*	125 138	704 043	546	4.3	9.8
D7710600mapg	Idem b, `DERO`, $t_{\text{fin}} = 4$ ms	10	3.0	4.0	12 349	22 039	414	4.1	1.4
D7710600mapf	Idem e, `DERO`, first run	10	3.0	[26.8]	[106 979]	[559 389]	[546]	[4.1]	[7.9]
D7710600mapf	Idem e, `DERO`, second run	10	3.0	[19.2]	[118 824]	[615 928]	[638]	[4.1]	[5.7]
D7710600maph	Idem f, `CENE`, not `NTIL`	10	3.0	[3.1]	[2 781]	[1 533]	—	—	—
D7710600mapi	Idem h, $C_s = 0.25$	10	3.0	[3.1]	[7 754]	[4 164]	—	—	—
D7710600mapj	Idem f, `CENE`, `KMAS 0.75`	10	3.0	32.2*	168 348	994 947	654	4.3	10.0
D7710600mapk	Idem e, `FSCP 0`	10	3.0	[5.7]	[20 002]	[63 332]	[896]	[4.1]	[1.7]
D7710600mapl	Idem e, low-res FSI	10	3.0	[8.2]	[19 056]	[79 266]	[208]	[6.7]	[4.6]
D7710600mapm	Idem l, correct FELCSN_W	10	3.0	[14.0]	[31 510]	[162 887]	[104]	[6.7]	[7.4]
D7710600mapn	Idem m, correct ping-pong	10	3.0	32.1*	71 201	547 779	252	6.7	16.7
D7710600mapo	Idem n, `MAXL 3`	10	3.0	[8.0]	[29 965]	1 235 830	[726]	[37.8]	24.2

*Map trigger

Table 2: Simulations of membrane bursts to generate map files.

The following Table lists the main parameters used in the generation of map files. All simulations were performed in 2021, except the 10 bar cases.

p^* [bar]	N_m	h_{mem} [mm]	p_4 [bar]	p_3 [bar]	p_2 [bar]	p_1 [bar]	p_{imp} [bar]	t_{fire} [ms]	t_{fant} [ms]	t_{map} [ms]	t_{fin} [ms]	t_{quas} [ms]
5	2	0.22–0.29	6.376	1.0050	1.0050	1.0050	2.25	7.0	10.0	38.0	44.0	5.0
10a	2	0.50	11.360	0.9968	0.9968	0.9968	4.20	7.0	8.0	31.0	40.0	7.0
10b	2	0.50	11.360	0.9968	0.9968	0.9968	4.20	3.0	8.0	33.0	40.0	3.0
10c	2	0.50	11.360	0.9968	0.9968	0.9968	4.20	3.0	8.0	31.0-33.0	40.0	3.0
10d	2	0.50	11.360	0.9968	0.9968	0.9968	4.20	3.0	8.0	trigger	[40.0]	3.0
10e	2	0.50	11.360	0.9968	0.9968	0.9968	4.20	3.0	—	trigger	[40.0]	3.0
10g	2	0.50	11.360	0.9968	0.9968	0.9968	4.20	3.0	—	—	4.0	3.0
10f	2	0.50	11.360	0.9968	0.9968	0.9968	4.20	3.0	—	trigger	[40.0]	3.0
10h	2	0.50	11.360	0.9968	0.9968	0.9968	4.20	3.0	—	trigger	[40.0]	3.0
10i	2	0.50	11.360	0.9968	0.9968	0.9968	4.20	3.0	—	trigger	[40.0]	3.0
10j	2	0.50	11.360	0.9968	0.9968	0.9968	4.20	3.0	—	trigger	[40.0]	3.0
10k	2	0.50	11.360	0.9968	0.9968	0.9968	4.20	3.0	—	trigger	[40.0]	3.0
10l	2	0.50	11.360	0.9968	0.9968	0.9968	4.20	3.0	—	trigger	[40.0]	3.0
10m	2	0.50	11.360	0.9968	0.9968	0.9968	4.20	3.0	—	trigger	[40.0]	3.0
10n	2	0.50	11.360	0.9968	0.9968	0.9968	4.20	3.0	—	trigger	[40.0]	3.0
10o	2	0.50	11.360	0.9968	0.9968	0.9968	4.20	3.0	—	trigger	[40.0]	3.0
15	3	0.50	17.160	1.0080	5.6770	1.0080	3.85	3.0	8.0	29.0	40.0	5.0
25	3	1.00	28.110	1.0080	9.8340	1.0080	7.87	3.0	18.0	28.0	40.0	5.0
35	3	1.50	39.140	1.0070	13.7100	1.0070	12.98	3.0	8.0	27.0	40.0	5.0
60	3	2.75	63.070	1.0060	22.0300	1.0060	20.50	3.0	18.0	26.0	40.0	5.0

Table 3: Parameters used in the simulations to generate map files.

It should be noted that the nominally thicker membranes in Table 3 were actually obtained by stacking together several membranes of the two basic thicknesses that were available experimentally, namely 0.25 and 0.5 mm. The setup of membranes in the various experiments is detailed in Figure 11.

Test #	Test name	Length driver [m]	Firing pressure driver [bar]	Combination of membranes	Number of membrane-combinations	Comment
1	P1-25	0.77	25.0	2x0.5	3	Docol 600 DL = complete tearing
2	P1-15	0.77	15.5	0.25 + 0.25	3	Docol 600 DL = crack initiation
3	P1-05	0.77	5.2	0.25	2	Docol 600 DL = no cracks
4	P2-35	0.77	38.0	2x0.25 + 2x0.5	3	Docol 600 DL = complete tearing
5	P2-25	0.77	25.0	2x0.5	3	Docol 600 DL = crack initiation
6	P2-05	0.77	5.2	0.25	2	Docol 600 DL = no cracks
6*	P2-15	0.77	15.5	0.25 + 0.25	3	Docol 600 DL = barely cracking
7	P3-35	0.77	38.0	2x0.25 + 2x0.5	3	Docol 600 DL = complete tearing
8	P3-25	0.77	25.0	2x0.5	3	Docol 600 DL = crack initiation
9	P3-15	0.77	15.5	0.25 + 0.25	3	Docol 600 DL = no cracks
10	S1-15	0.77	15.5	0.25 + 0.25	3	Docol 600 DL = complete tearing
11	S1-10	0.77	10.2	0.25 + 0.25	2	Docol 600 DL = crack initiation
12	S1-05	0.77	5.2	0.25	2	Docol 600 DL = no cracks
13	S2-25	0.77	25.0	2x0.5	3	Docol 600 DL = complete tearing
14	S2-15	0.77	15.5	0.25 + 0.25	3	Docol 600 DL = crack initiation
15	S2-10	0.77	10.2	0.25 + 0.25	2	Docol 600 DL = no cracks
16	S3-25	0.77	25.0	2x0.5	3	Docol 600 DL
17	S3-15	0.77	15.5	0.25 + 0.25	3	Docol 600 DL
18	S3-35	0.77	38.0	2x0.25 + 2x0.5	3	15 vs 05 depends on #16
18*	S3-05	0.77	5.2	0.25	2	Docol 600 DL
19	S3-25	0.77	25.0	2x0.5	3	Docol 1400 M
20	S3-15	0.77	15.5	0.25 + 0.25	3	Docol 1400 M
21	S3-35	0.77	38.0	2x0.25 + 2x0.5	3	Same pressure as in #18
21	S3-05	0.77	5.2	0.25	2	Docol 1400 M

Figure 11: Setup of membranes in the various experiments.

3.1 Case D7705600map

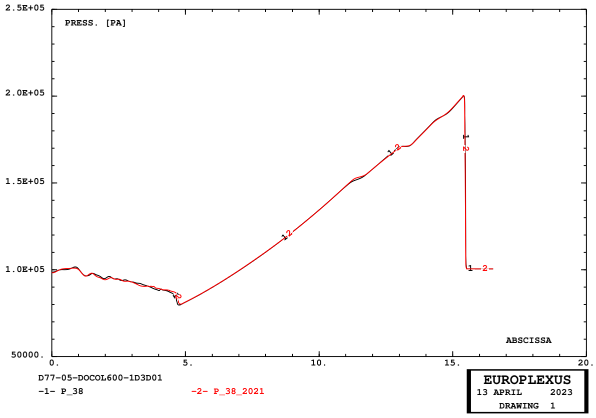
This is a repetition of the homonym test that had been run in 2021, in order to check that the results of the code have not changed after two years of development. Figure 12 compares the 2021 map file (red curves) with the current one (black curves).

As it can be seen, the solutions differ somewhat in the initial part of the shock tube (firing section), where the membranes are located. However, the final and most significant parts of the curves (near the specimen) are nearly identical, so the differences should not have an impact on the results as the specimen is concerned.

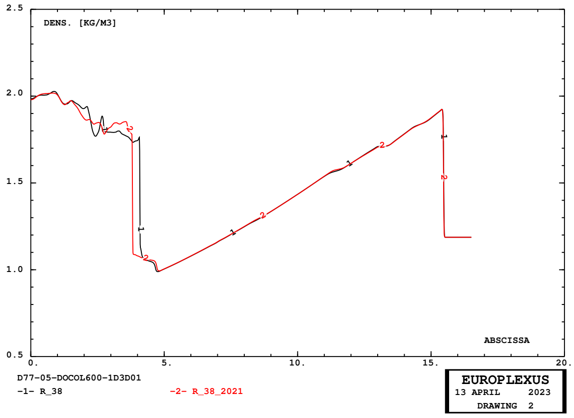
Figure 13 shows the inflation and progressive failure of the firing membranes.

Figure 14 shows the fluid mesh FSI-driven refinement and the fluid pressure.

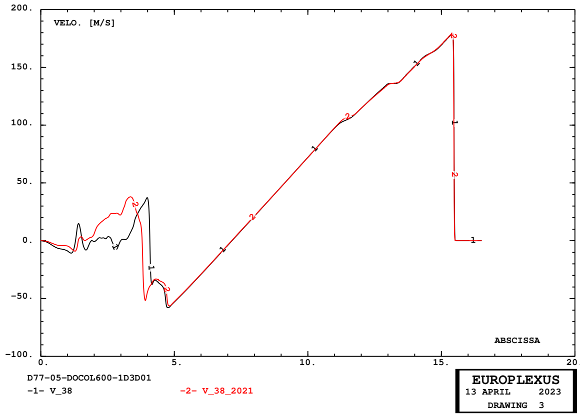
Figure 15 shows the failure patterns of the firing membranes.



(a) Pressure

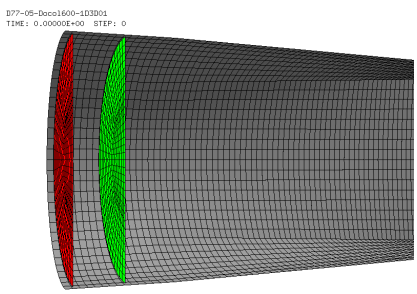


(b) Density

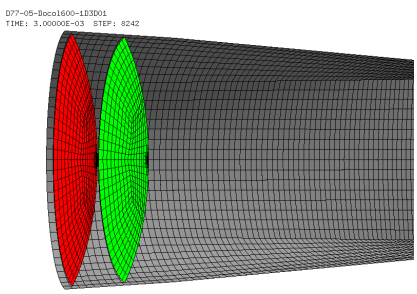


(c) Velocity

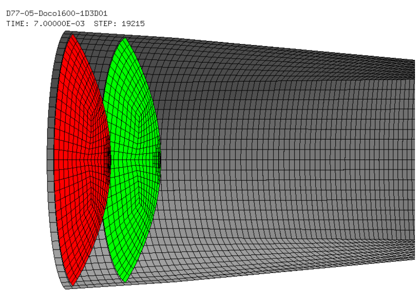
Figure 12: Comparison of map file curves between 2021 solution and current one.



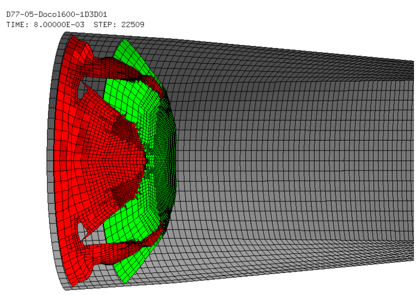
(a) $t = 0$



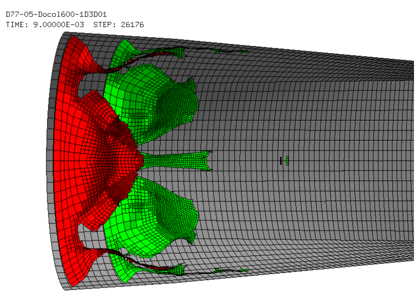
(b) $t = 3$ ms



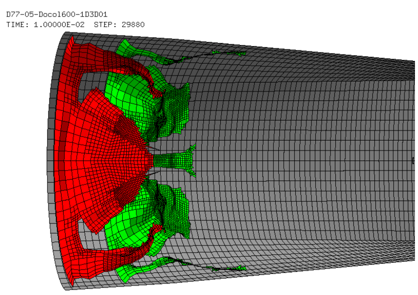
(c) $t = 7$ ms



(d) $t = 8$ ms

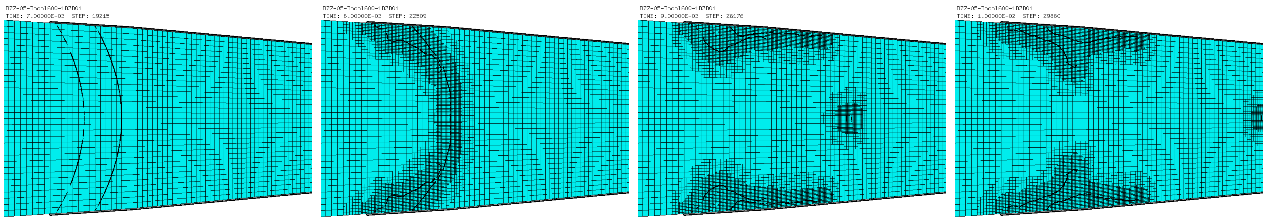


(e) $t = 9$ ms

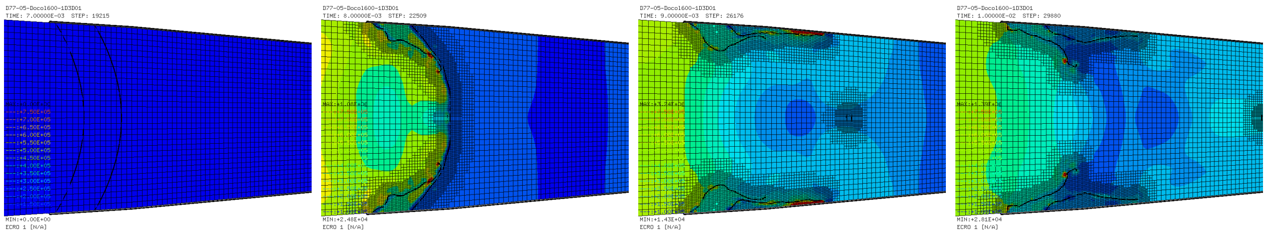


(f) $t = 10$ ms

Figure 13: Inflation and progressive failure of the firing membranes in test D7705600map.

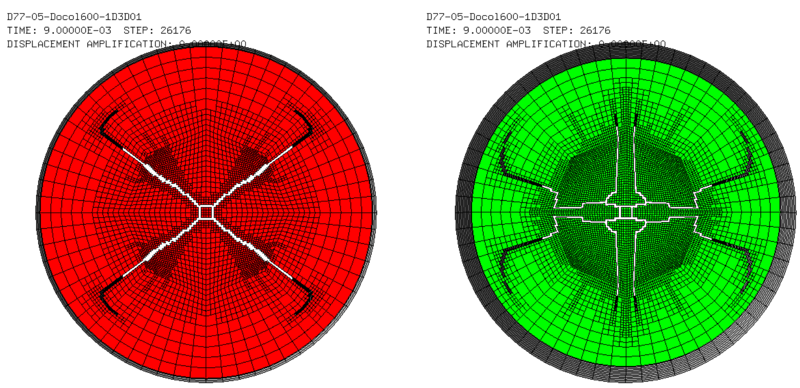


(a) $t = 7$ ms (b) $t = 8$ ms (c) $t = 9$ ms (d) $t = 10$ ms



(e) $t = 7$ ms (f) $t = 8$ ms (g) $t = 9$ ms (h) $t = 10$ ms

Figure 14: Fluid mesh FSI-driven refinement and the fluid pressure in test D7705600map.



(a) First membrane (b) Second membrane

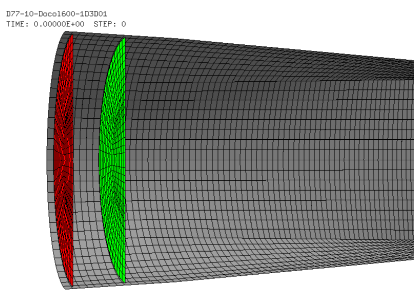
Figure 15: Failure patterns of the firing membranes in test D7705600map.

3.2 Case D7710600mapa

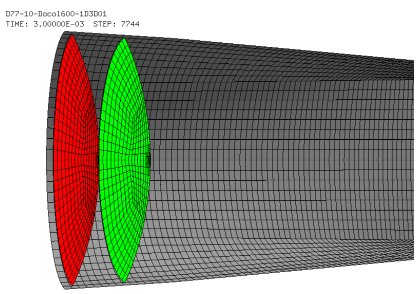
This is a first attempt at obtaining a map file for the nominal 10 bar firing pressure. The mesh file is identical to that of the 5 bar case presented above. The EPX input file differs in the following points:

- The membrane thickness is constant and equal to 0.5 mm instead of passing from 0.22 to 0.25 and to 0.29 mm.
- The constitutive law for the membranes material (Melinex) is different. Two such laws were characterized at NTNU, one for membrane thicknesses less than 0.5 mm (only case 5 bar) and the other for membrane thicknesses equal to or greater than 0.5 mm (all other cases).
- This test used two membranes, like the 5 bar case, while all other tests used three membranes. The pressures in the firing chambers p_1, p_2, p_3, p_4, as well as the initially imposed pressure p_{imp} acting on the membranes, were modified with respect to the 5 bar case, according to the values listed in Table 3.
- The time of production of the map file t_{map} was tentatively reduced from 38.0 to 31.0 ms. It is difficult to estimate this time exactly in a first calculation like this one. This value will likely have to be adjusted upon repeating the simulation.
- The time of removal of the membranes t_{fant} was reduced from 10.0 to 8.0 ms, i.e. to the value used in all higher-pressure tests except 25 and 60 bar nominal pressure cases which used 18 ms in the 2021 simulations. The use of such different and apparently random times seems hard to justify, other than by empirical arguments, and will have to be investigated.
- The time at which the quasi-static damping is removed t_{quas} was increased from 5.0 to 7.0 ms, in order to make it equal to the firing time. Again, it seems hard to justify why the damping should act over a different period of time than the initial pressure ramping time. Note from Table 3 that the map files from 2021 for 15 bar and higher used a t_{map} of 5.0 ms, larger than t_{fire}, which also seems a bit strange. All these value will have to be justified and possibly made more uniform.

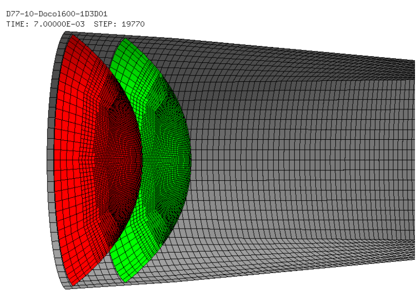
Figure 16 shows the inflation and progressive failure of the firing membranes.



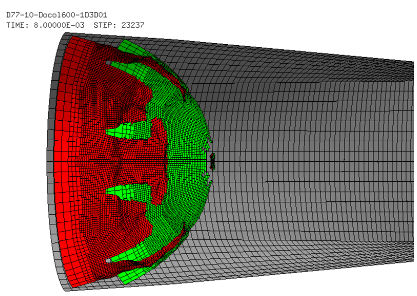
(a) $t = 0$



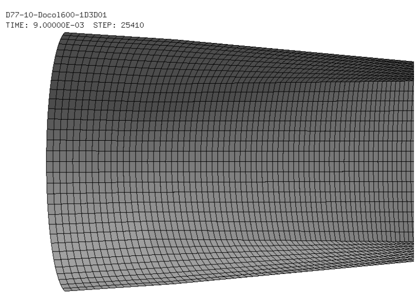
(b) $t = 3$ ms



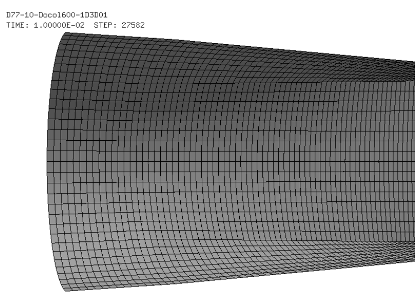
(c) $t = 7$ ms



(d) $t = 8$ ms



(e) $t = 9$ ms

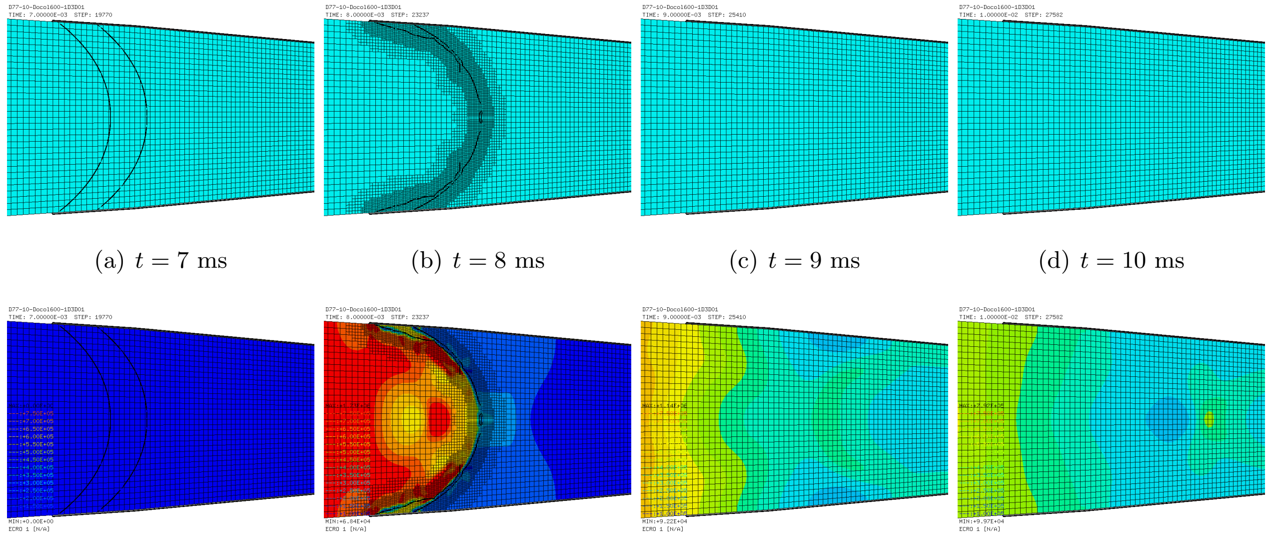


(f) $t = 10$ ms

Figure 16: Inflation and progressive failure of the firing membranes in test D7710600mapa.

Figure 17 shows the fluid mesh FSI-driven refinement and the fluid pressure.

Figure 18 shows the failure patterns of the firing membranes at $t = 8$ ms (t_{fant}). As it can be seen, the removal of the membranes is done too early, since the second membrane has not failed completely

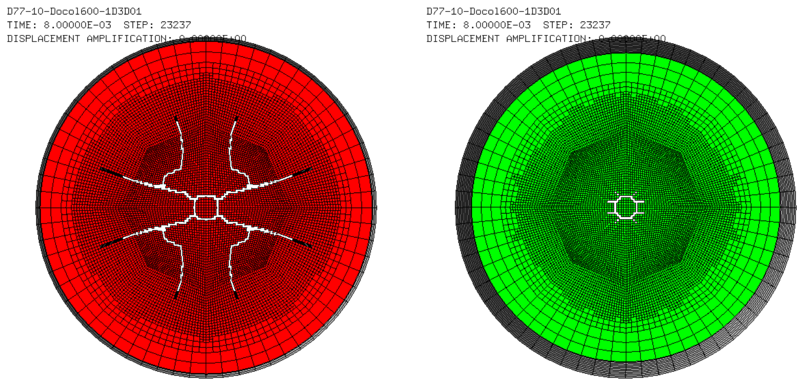


(a) $t = 7$ ms (b) $t = 8$ ms (c) $t = 9$ ms (d) $t = 10$ ms

(e) $t = 7$ ms (f) $t = 8$ ms (g) $t = 9$ ms (h) $t = 10$ ms

Figure 17: Fluid mesh FSI-driven refinement and the fluid pressure in test D7710600mapa.

yet.



(a) First membrane (b) Second membrane

Figure 18: Failure patterns of the firing membranes in test D7710600mapa.

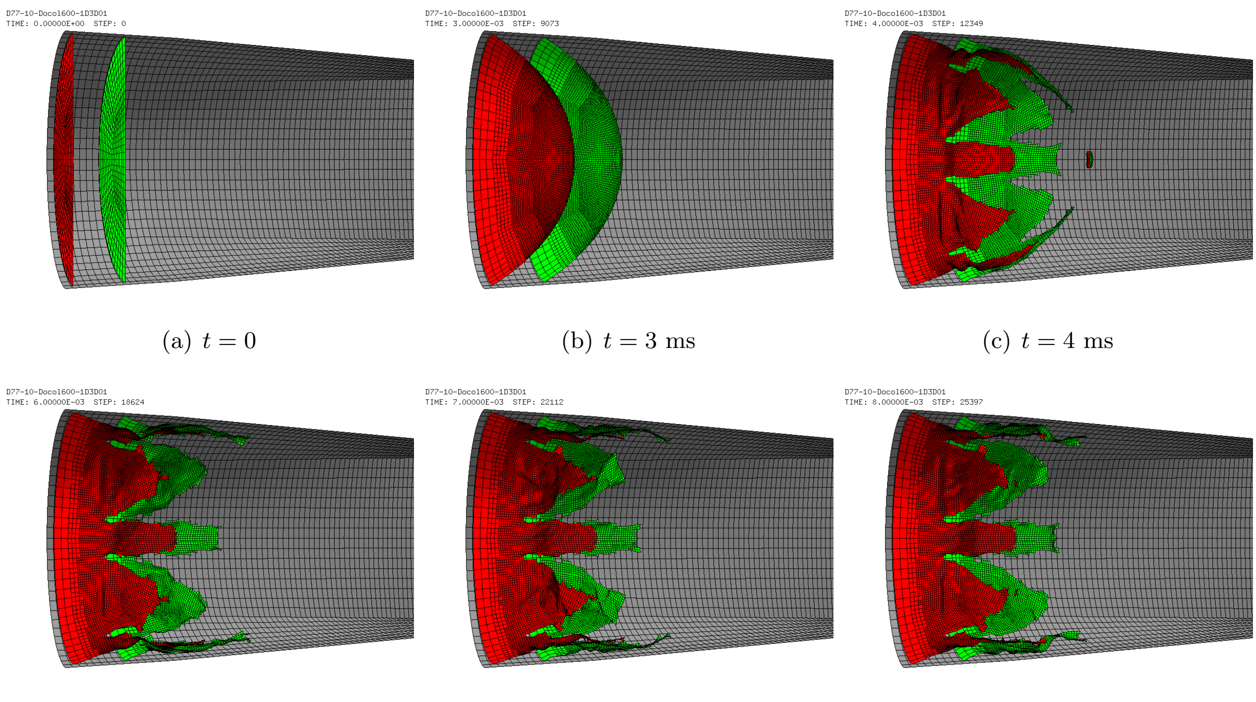
3.3 Case D7710600mapb

The test presented in the previous Section is repeated with the following modifications:

- Four pressure sensors `e4`, `e3`, `e2` and `e1` are added to track the fluid pressure in the driver and in the three chambers and thus be able to follow the loading and firing process. Tentatively, the first three sensors are placed on the internal wall of the pipe, close to (directly upstream) the membranes, while the last one (`e1`) is located directly downstream the third (last) membrane, in the driven section.
- The ramping period of the initial membrane pressurization (firing time t_{fire}) is reduced from 7.0 to 3.0 ms, i.e. it is made equal to that of the higher-pressure tests. Note that this time is usually, in all tests performed so far, the same as the time of fluid material re-initialization in the pressure chambers t_{imat} (`INIT IMAT` directive) and the same as the time until which CCFV calculations are skipped t_{skip} (`INIT SKIP` directive).
- The time in the (`INIT SKIP` and `INIT IMAT` directives is reduced from 5.0 to 3.0 ms to make it equal to the firing time t_{fire}.
- The map time t_{map}, i.e. the time at which the map file is produced, is increased from 31 ms to 33 ms.
- The time of removal of the quasi-static damping t_{quas} is reduced from 7.0 to 3.0 ms to make it equal to the firing time t_{fire}.

The CPU cost of this simulation becomes roughly double that of the previous one, mainly due to the shortening of t_{skip} mentioned above.

Figure 19 shows the inflation and progressive failure of the firing membranes.



(a) $t = 0$ (b) $t = 3$ ms (c) $t = 4$ ms

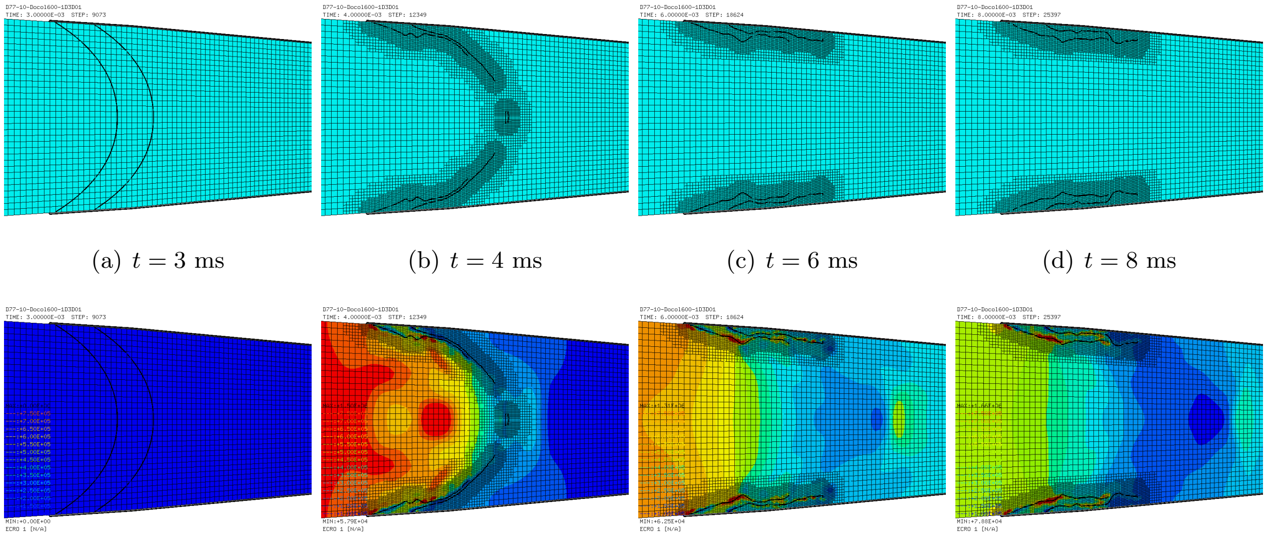
(d) $t = 6$ ms (e) $t = 7$ ms (f) $t = 8$ ms

Figure 19: Inflation and progressive failure of the firing membranes in test D7710600mapb.

Figure 20 shows the fluid mesh FSI-driven refinement and the fluid pressure.

Figure 21 shows the failure patterns of the firing membranes at $t = 8$ ms (t_{fant}). As it can be seen, the removal of the membranes seems to have been done at about the right time, since they both look completely failed at $t = 8$ ms.

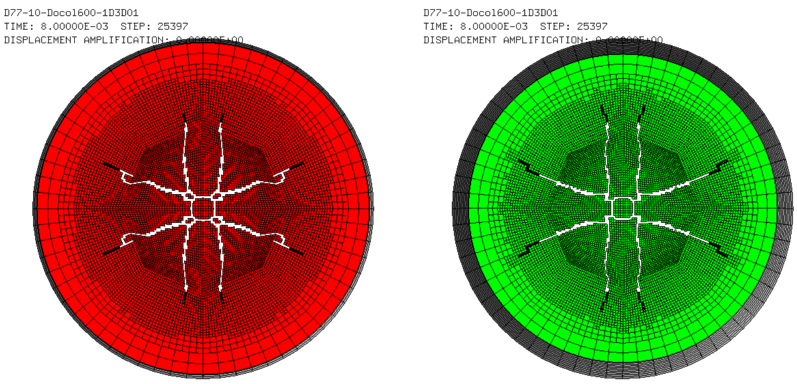
Figure 22 compares the map file curves from tests D7710600mapa (red curves) and D7710600mapb (black curves). It immediately appears that the map time t_{map} for the (b) solution, 33 ms, is too large, since the blast has already hit the right end of the model. Therefore, this simulation will have to be repeated, by taking as map time an intermediate value between cases (a), 31 ms, and (b), 33



(a) $t = 3$ ms (b) $t = 4$ ms (c) $t = 6$ ms (d) $t = 8$ ms

(e) $t = 3$ ms (f) $t = 4$ ms (g) $t = 6$ ms (h) $t = 8$ ms

Figure 20: Fluid mesh FSI-driven refinement and the fluid pressure in test D7710600mapb.

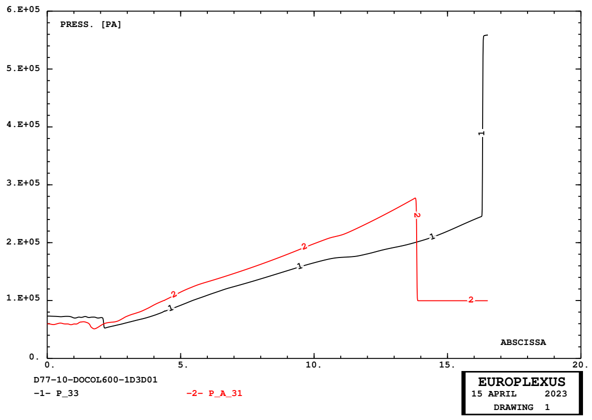


(a) First membrane (b) Second membrane

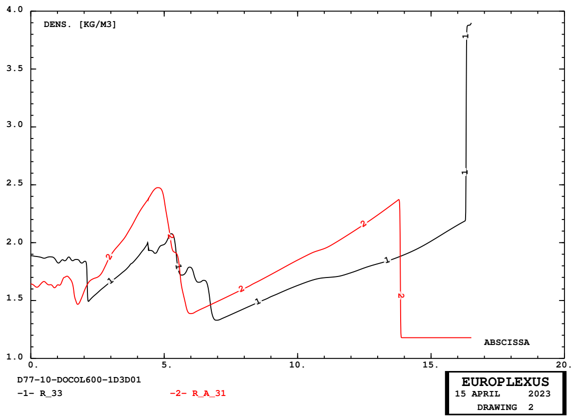
Figure 21: Failure patterns of the firing membranes in test D7710600mapb.

ms, by taking for example $t_{\text{map}} = 32$ ms.

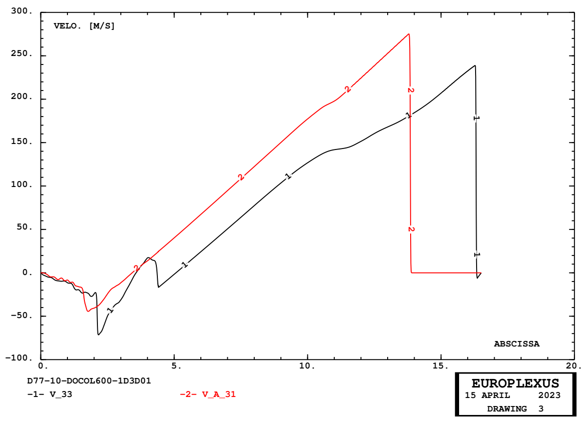
Finally, Figure 23 compares the space curves at the same time $t = 31$ ms from tests D7710600mapa (red curves) and D7710600mapb (black curves). This allows to directly appreciate the effect of the different modeling of the membranes in the two solutions.



(a) Pressure

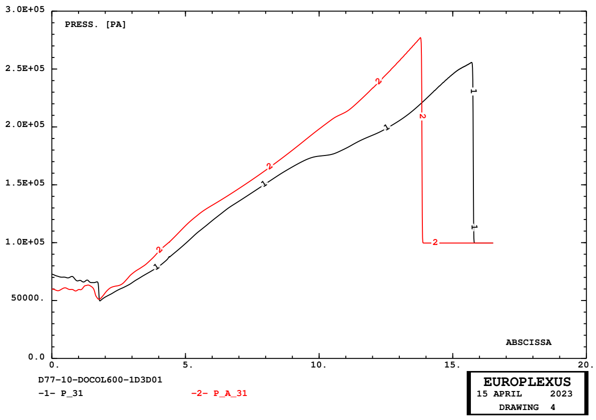


(b) Density

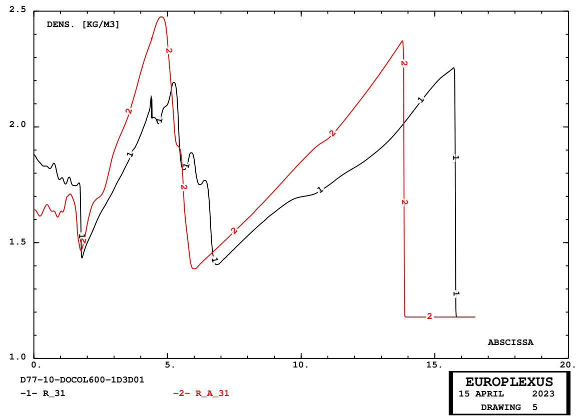


(c) Velocity

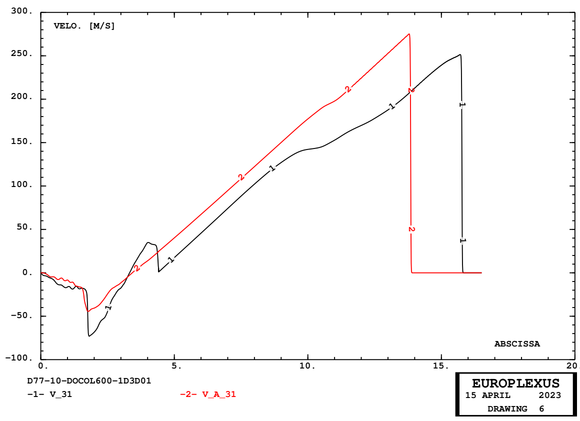
Figure 22: Comparison of map file curves between solutions D7710600mapa and D7710600mapb.



(a) Pressure



(b) Density



(c) Velocity

Figure 23: Comparison of curves at $t = 31$ ms between solutions D7710600mapa and D7710600mapb.

3.4 Producing a map file from a results file?

We explore the possibility of generating a map file from a results file, instead of having to re-run the simulation. The ALIC file is chosen because it is the one containing the largest subset of code data.

We tentatively use the following EPX input file, trying to generate a map file from the results of test D7710600mapb at 33 ms (if this works then one could use the same technique to generate a map file at 31 or 32 ms since ALIC data are available at those times):

```
D7710600MAPBM
ECHO
!CONV WIN
RESU SPLI ALIC 'D7710600mapb.ali' GARD PSCR
SORT ARRE NSTO 34 ! TEMP 33.0E-3
ECRI FICH FORM MAPP OBJE LECT flui3d tubelp1 TERM
                   TIME PROG 32.99E-3 TERM ! 33.0E-3 TERM
FIN
```

We use the `ARRE` keyword of the `SORT` directive to position ourselves at the selected ALIC storage (`NSTO 34` i.e. the 34-th storage, corresponding here to $t = 33$ ms). Using the time (`TEMP`) instead of `NSTO` could be more problematic due to the imprecision of floating point values. Then we use the `ECRI` ... `MAPP` directive to generate a map file at the desired time. Note that we use `TIME PROG 32.99E-3`, i.e. a slightly lower value than the nominal one, in order to be sure that the map file will be triggered at the chosen `ARRE` time, again to avoid problems with floating point imprecisions.

The map file writing routine M_MAPPING::WRITE_MAPPING is invoked. However, it fails writing the file because some arrays are not allocated: CONV_VFCC, CONV_VFCC_1D, SOLU_VFCC, SOLU_VFCC_1D. In fact, these arrays are not stored in the ALIC file.

Adding such arrays in the ALIC file would probably increase too much the size of the file itself, and is probably unjustified just to make it compatible with a possible (future, hypothetic) need of producing a map file from the ALIC data. Therefore, this strategy is abandoned.

3.5 Producing multiple map files

We therefore resort to a less elegant and less powerful strategy, which consists in generating multiple map files, at a series of selected times, when running the simulation. After inspecting the solution, the user can select the best map file and perhaps discard the remaining ones. Of course, this technique cannot be applied with an already existing simulation, but it requires re-running it (hopefully just once).

A few simple modifications are introduced in subroutines ECRITU and M_MAPPING::WRITE_MAPPING in order to activate this possibility. When reading the MAPP command, the corresponding file unit is not opened immediately in ECRITU, but only the (basic) file name is built. Then, during the simulation, the map file writing routine can be called several times. Each time, a unique file name is generated by appending an automatic suffix `_nn` to the base file name, where `nn` is the counter of map files produced in the current run (01, 02 etc.). The writing routine opens the file anew, writes it and finally closes it at each mapping station.

The simulations performed are summarized in Table 4 and are described in detail below.

Test	Mesh	Description	t_{fin} [ms]	Steps	CPU [s]
MAMU01	100 Q4VF	Generate two map files	80.0	69	0.1

Table 4: Simulations to generate multiple map files.

3.5.1 Test MAMU01

As an example of this new possibility, consider test MAMU01. This test is similar to MAPP01 from reference [11], but we ask for the production of two map files, one at 50 ms and the other at 60 ms:

```
MAMU01
  . . .
ECRI . . .
```

```
    FICH FORM MAPP OBJE LECT tous TERM TIME PROG 50.E-3 60.E-3 TERM
 . . .
FIN
```

Indeed, after running the test, the following map files are found in the current directory: mamu01_01.map and mamu01_02.map.

3.6 Triggering the map file production

As an alternative to specifying multiple map files, a new possibility is developed which uses a trigger in order to activate the map file production. The mechanism is similar to the strategy used to trigger adaptive mesh refinement, see directives `OPTI ADAP TRIG`, `OPTI NOCR TRIG` and `LINK TBLO ... TRIG` described in [1], and the input syntax is also similar.

The idea is to activate the map file writing when a certain physical quantity, monitored at a certain location (element or node) in the mesh, reaches a certain threshold. A typical example of monitored quantity would be the fluid pressure upstream the specimen in the shock tube.

A new `TRIG` sub-directory is allowed in the `ECRI FICH MAPP` directive, as an alternative to specifying one or more map times explicitly via `/CTIM/`:

```
"ECRI" "FICH" ...
    "MAPP" <"FORM"> <nmapp> "OBJE" /LECT/
           $[ /CTIM/ ;
              TRIG |[ CONT icon ; ECRO iecr ; EPST ieps ;
                    DEPL idep ; VITE ivit ; ACCE iacc ; VCVI ivcv ]|
                    <TSTO> TVAL tval /LECT/ ]$ ;
```

The `TSTO` optional keyword stops the simulation immediately after generating the (triggered) map file. The other keywords have the same meaning as for the `OPTI ADAP TRIG` directive, see [1] for details.

If a results file of type ALIC (full) is specified in the simulation, then an ALIC storage is automatically generated at the MAPP trigger time, in addition to the other storages specified in the EPX input file.

The simulations performed are summarized in Table 5 and are described in detail below.

Test	Mesh	Description	t_{fin} [ms]	Steps	CPU [s]
MATR01	100 Q4VF	Use trigger to generate map file	80.0	69	0.1
MATR02	100 Q4VF	Idem 01, add `TSTO`	[54.9]	46	0.1
MATR03	100 Q4VF	Idem 02, no ALIC file	[54.9]	46	0.1
MATR04	100 Q4VF	Idem 03 but ALIC after MAPP in .EPX	[54.9]	46	0.1

Table 5: Simulations to trigger map file generation.

3.6.1 Case MATR01

This test is similar to MAPP01 from reference [11], but we use the `TRIG` keyword to generate the map file when the pressure exceeds a given value in a monitored Finite Volume near the right end of the tube:

```
MATR01
 . . .
COMP GROU 3 'hp' LECT  1 PAS 1  50 TERM
            'lp' LECT 51 PAS 1 100 TERM
            'trigger' LECT 81 TERM
 . . .
ECRI VFCC TFRE 10.E-3
    FICH ALIC TFRE 10.E-3
    FICH FORM MAPP OBJE LECT tous TERM
                TRIG ECRO 1 TVAL 1.1E5 LECT trigger TERM
 . . .
FIN
```

The trigger is activated at step 46, $t = 54.9$ ms and a map file (MATR01_01.map) is written.. The simulation continues until $t_{\text{fin}} = 80.0$ ms because the `TSTO` optional keyword is not set.

3.6.2 Case MATR02

This test is similar to MATR01 but we add the TSTO keyword. The siumulation is stopped as soon as the map file is generated. The run continues after the SUIT command. An ALIC storage is automatically written at the trigger time (step 46).

3.6.3 Case MATR03

This test is similar to MATR02 but there is no ALIC file output, so no ALIC storage is automatically written at the trigger time (step 46). The ALIC file is specified before the MAPP file in the EPX input file.

3.6.4 Case MATR04

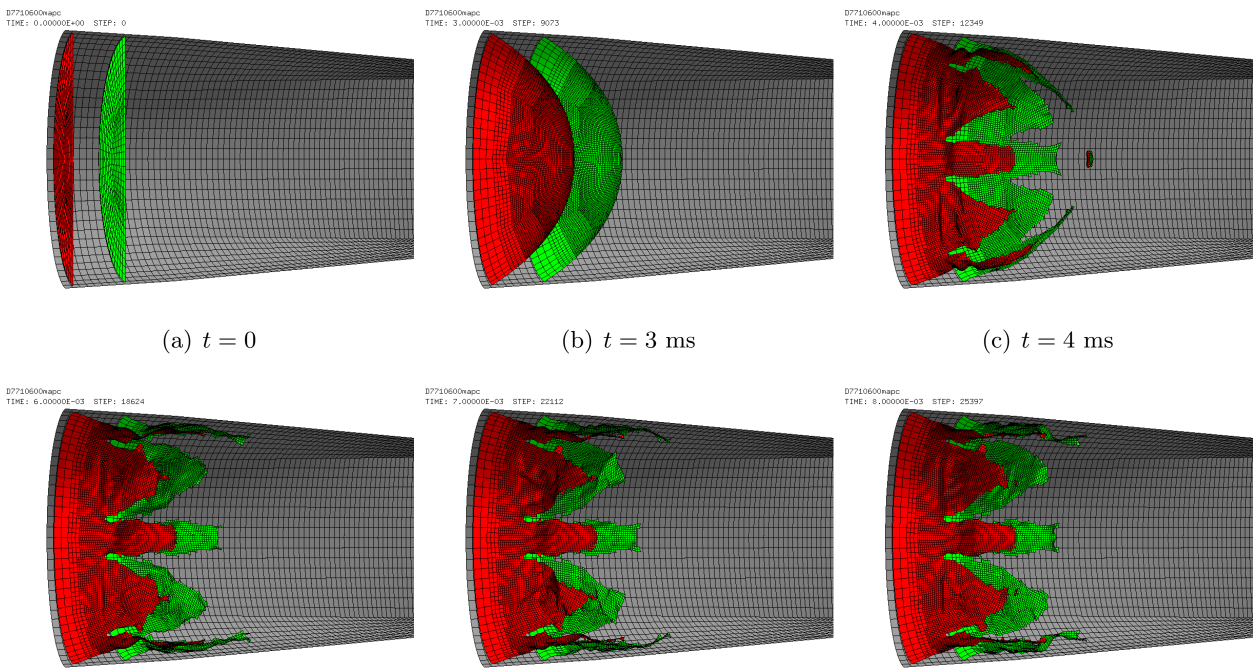
This test is similar to MATR03 but the ALIC file is specified after the MAPP file in the EPX input file. The program behaviour is identical to MAPP03, as it should be.

3.7 Case D7710600mapc

This is a repetition of case D7710600mapb where we produce a map file every 0.5 ms from $t = 31$ ms to $t = 33$ ms. Therefore, we expect five map files to be generated, named D7710600mapc_01.map to D7710600mapc_05.map. The syntax of the map command becomes:

```
D7710600mapc
 . . .
ECRI . . .
     FICH FORM MAPP OBJE LECT flui3d tubelp1 TERM
                    TIME PROG 31.0E-3 PAS 0.5E-3 33.0E-3 TERM
 . . .
FIN
```

Figure 24 shows the inflation and progressive failure of the firing membranes.



(a) $t = 0$ (b) $t = 3$ ms (c) $t = 4$ ms

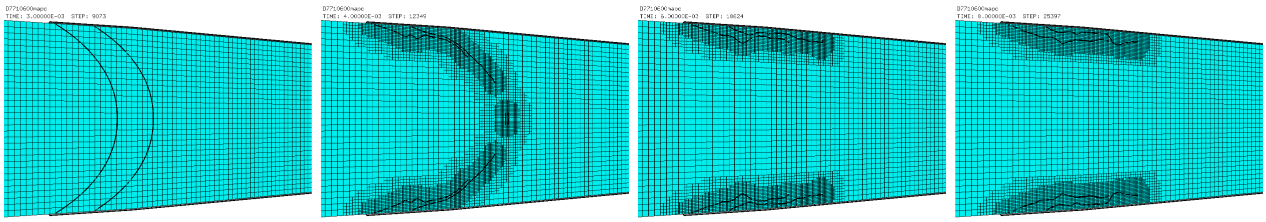
(d) $t = 6$ ms (e) $t = 7$ ms (f) $t = 8$ ms

Figure 24: Inflation and progressive failure of the firing membranes in test D7710600mapc.

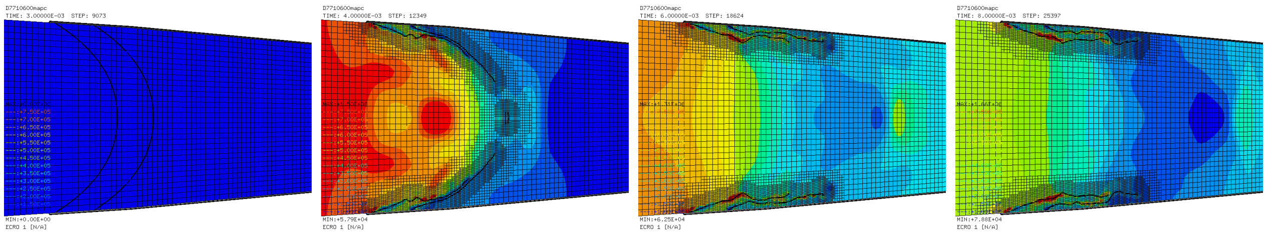
Figure 25 shows the fluid mesh FSI-driven refinement and the fluid pressure.

Figure 26 shows the failure patterns of the firing membranes at $t = 8$ ms (t_{fant}). As it can be seen, the removal of the membranes seems to have been done at about the right time, since they both look completely failed at $t = 8$ ms.

Figure 27 compares the map file curves at 31, 32 and 33 ms. Note that those at 31.5 and 32.5 ms cannot be drawn from the ALIC file because data were stored only at full-millisecond time stations. They could be drawn from the map files themselves, but this is more complicated since it would require reading back the map file and mapping it onto a fluid mesh (like in an Eulerian simulation, for example). The map files at 32 and 33 ms look too "late" since the blast wave is either already too close to the right extremity of the model, or it has even already been reflected. The map file at 31 ms might be a little bit too early. So it seems that the map file at 31.5 ms (the second one produced in this simulation, i.e. file D7710600MAPC_02.map) might be the best one to be used in successive Eulerian or FSI simulations

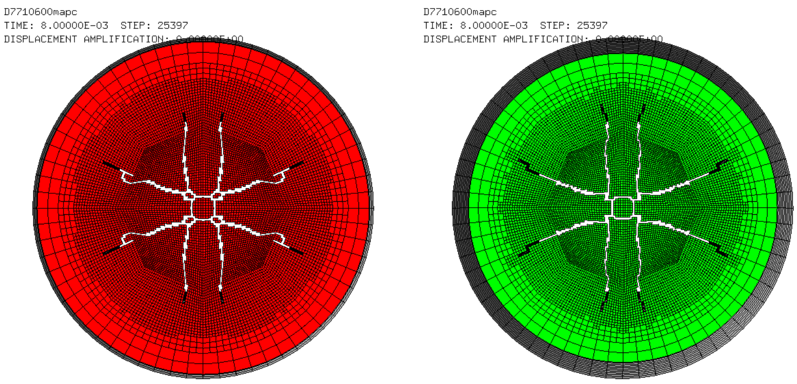


(a) $t = 3$ ms (b) $t = 4$ ms (c) $t = 6$ ms (d) $t = 8$ ms



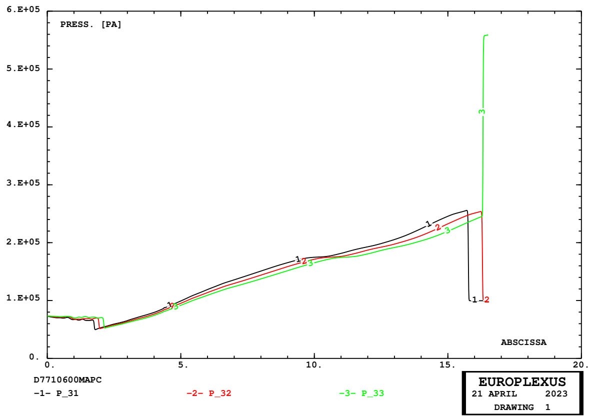
(e) $t = 3$ ms (f) $t = 4$ ms (g) $t = 6$ ms (h) $t = 8$ ms

Figure 25: Fluid mesh FSI-driven refinement and the fluid pressure in test D7710600mapc.

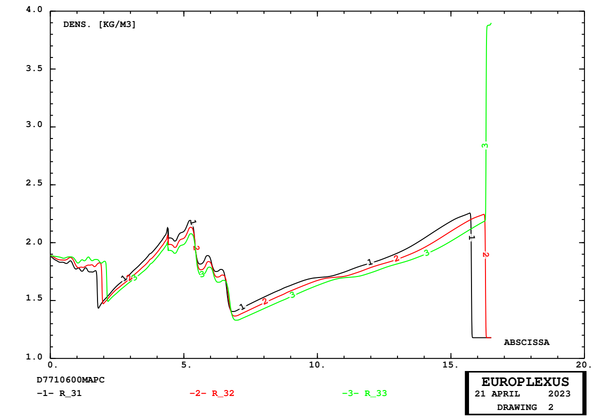


(a) First membrane (b) Second membrane

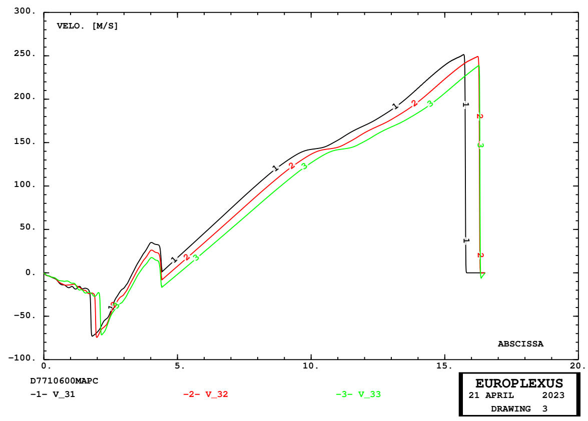
Figure 26: Failure patterns of the firing membranes in test D7710600mapc.



(a) Pressure



(b) Density



(c) Velocity

Figure 27: Comparison of map file curves at 31, 32 and 33 ms in test D7710600mapc.

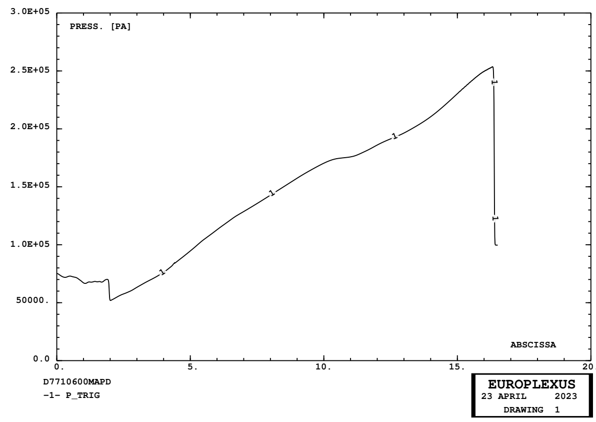
3.8 Case D7710600mapd

This is a repetition of test D7710600mapc by using the trigger mechanism to produce the map file instead of prescribing the map time(s) explicitly:

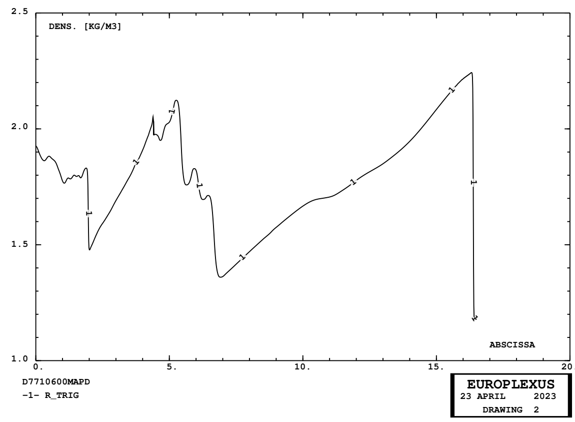
```
D7710600mapd
 . . .
COMP . . .
     GROU 22  . . .
            'trigger' LECT tube TERM COND NEAR POIN -0.70 0 0
 . . .
ECRI . . .
     FICH FORM MAPP OBJE LECT flui3d tubelp1 TERM
                    TRIG ECRO 1 TSTO TVAL 1.02E5 LECT trigger TERM
 . . .
FIN
```

Since the TSTO keyword is specified, the simulation is expected to stop right after creating the map file. And, since an ALIC file is prescribed, an ALIC storage is expected to automatically occur at the trigger time. Both such conditions are indeed respected.

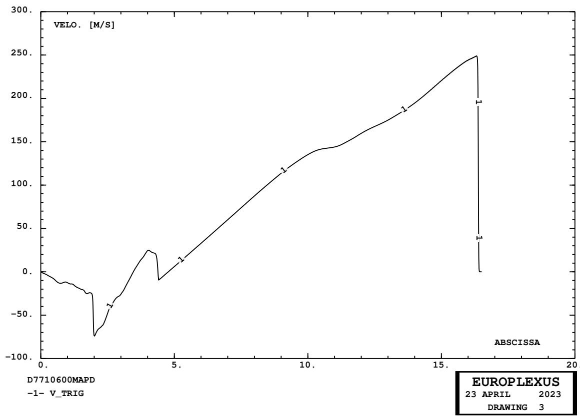
In this simulation the map trigger gets activated at $t_{\text{trig}} = 32.2$ ms. Figure 28 shows the map file curves at the trigger time.



(a) Pressure



(b) Density



(c) Velocity

Figure 28: Map file curves at $t_{\text{trig}} = 32.2$ ms in test D7710600mapd.

Other results of this simulation were of course identical to those presented in Figures 24, 25 and 26 for test D7710600mapc, and are not presented for brevity.

3.9 Case D7710600mape

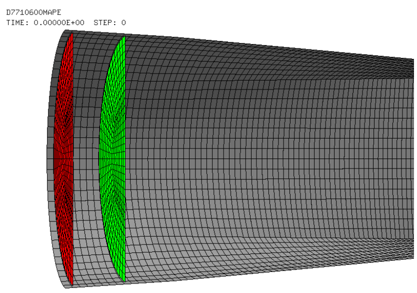
This is a repetition of test D7710600mapd without removing the membranes by the `FANT` directive at $t_{\mathrm{fant}} = 8.0$ ms. Therefore, the simulation becomes very long in terms of CPU. The scope is to obtain a reference solution to which solutions with various values of t_{fant} can be compared in order to assess the equivalence of the map file obtained.

Upon first running, this simulation had to be stopped due to physical displacement of the EVICOM PC on which it was running, when it had reached about 28.5 ms instead of the expected trigger time of about 32.2 ms (*fide* case D7710600mapd). So it had to be re-run to complete the simulation. The trigger got activated at $t = 32.1668$ ms, after 125 138 time steps and 704 043 s (8.2 days) of CPU time, and the simulation was automatically stopped after writing the map file.

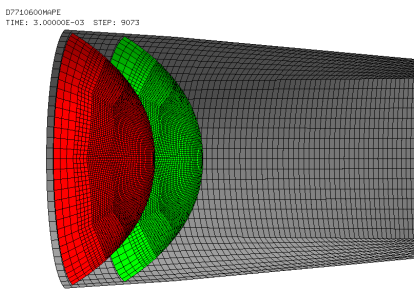
The automatically produced map file is named D7710600mape_01.map and has a size of 85 042 848 bytes. On the first line, it contains the creation date 01/05/2023. Note that this is not the date the file was actually written (10/05/2023 at 17:29), but the date at which the job had been started.

An ALIC file storage (number 34) was automatically written at the map time just before stopping the job. However, results were not automatically written on the listing at the map time. This will have to be corrected, since a printout at the map time might be useful, among other things, to get the final list of eroded elements etc.

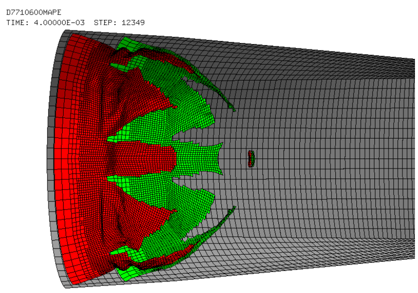
Figure 29 shows the inflation and progressive failure of the firing membranes. The pressurization phase ends at 3 ms. At 4 ms both membranes are already largely damaged. At 8 ms the failure process has substantially terminated (so that the membranes could probably be removed). Very little occurs in the membranes configuration beyond 8 ms, except near the very end of the simulation ($t > 27$ ms) when the membranes bounce slightly back, possibly due to a re-pressurization wave which brings some gas from the driven section back into the driver.



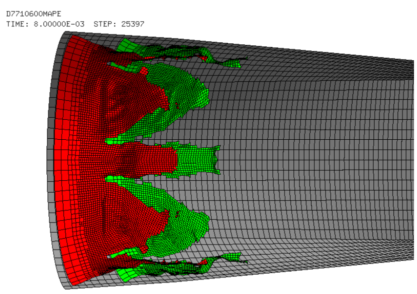
(a) $t = 0$



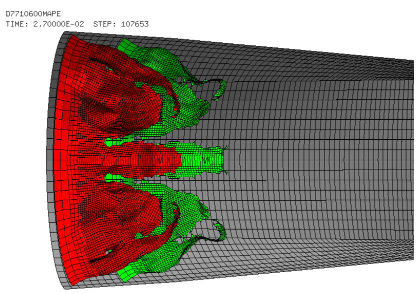
(b) $t = 3$ ms



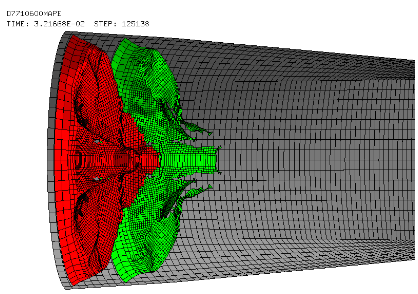
(c) $t = 4$ ms



(d) $t = 8$ ms



(e) $t = 27$ ms

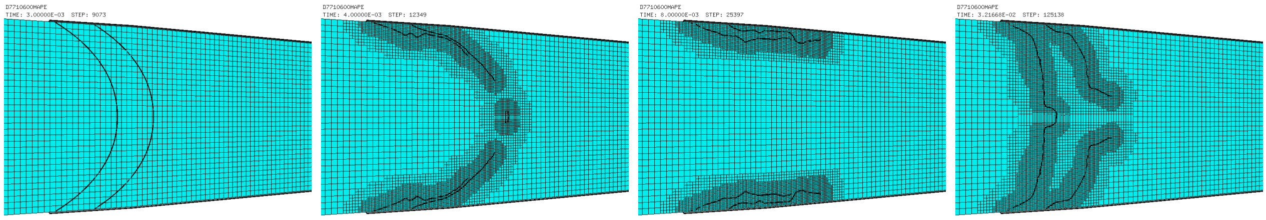


(f) $t = 32.2$ ms

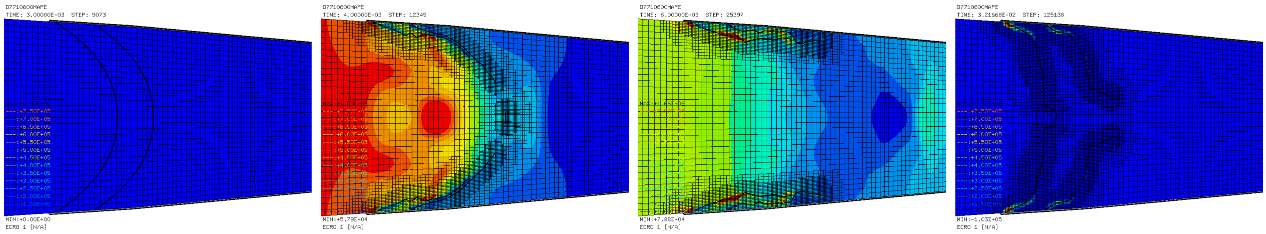
Figure 29: Inflation and progressive failure of the firing membranes in test D7710600mape.

Figure 30 shows the fluid mesh FSI-driven refinement and the fluid pressure.

Figure 31 shows the failure patterns of the firing membranes at various times. As it can be seen, at 8 ms both membranes are already completely failed. Very few additional erosions take place between 8 and 32.2 ms. In fact, of the total 273 shell elements eroded (due to material failure) at $t = 32.2$ ms, 251 (i.e. 92%) had already been eroded at $t = 8.0$ ms. Note that in this model, whenever a shell element gets eroded (here only due to material failure), the attached CLXX element used to initially



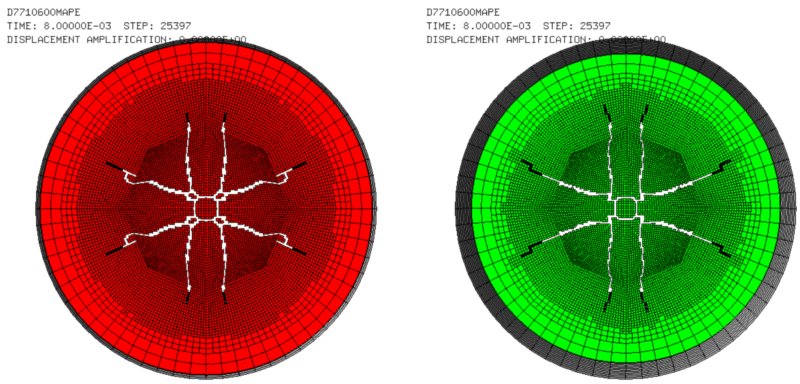
(a) $t = 3$ ms (b) $t = 4$ ms (c) $t = 8$ ms (d) $t = 32.2$ ms



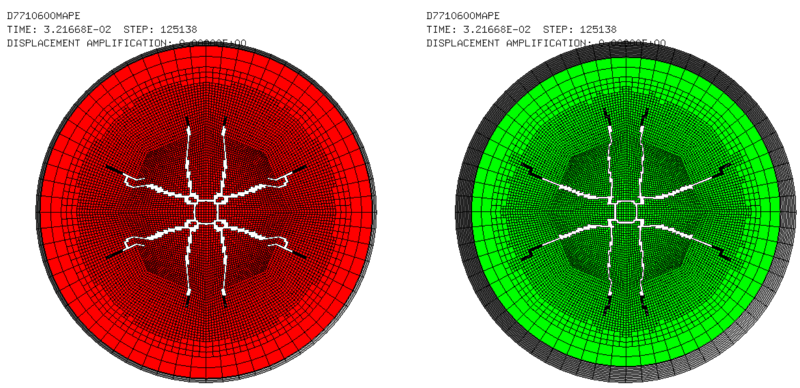
(e) $t = 3$ ms (f) $t = 4$ ms (g) $t = 8$ ms (h) $t = 32.2$ ms

Figure 30: Fluid mesh FSI-driven refinement and the fluid pressure in test D7710600mape.

pressurize the membranes also gets eroded, so that the total number of eroded elements reported by EPX by ATTENTION messages in the listing (and in Table 2) is the double of what is physically interesting.



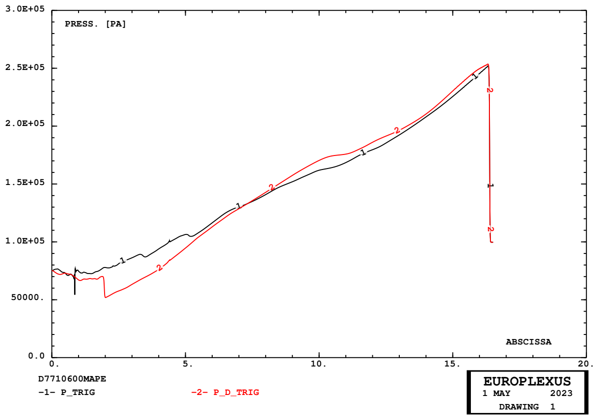
(a) First membrane @ $t = 8$ ms (b) Second membrane @ $t = 8$ ms



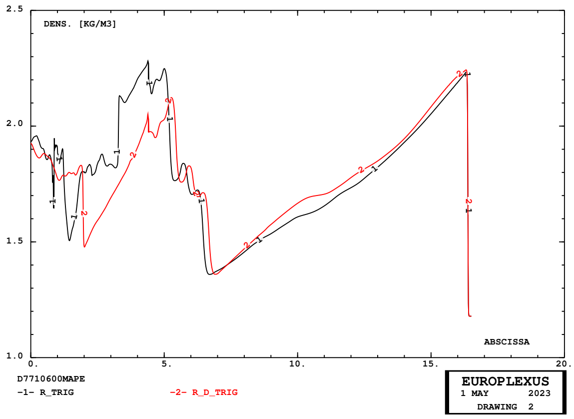
(c) First membrane @ $t = 32.2$ ms (d) Second membrane @ $t = 32.2$ ms

Figure 31: Failure patterns of the firing membranes in test D7710600mape.

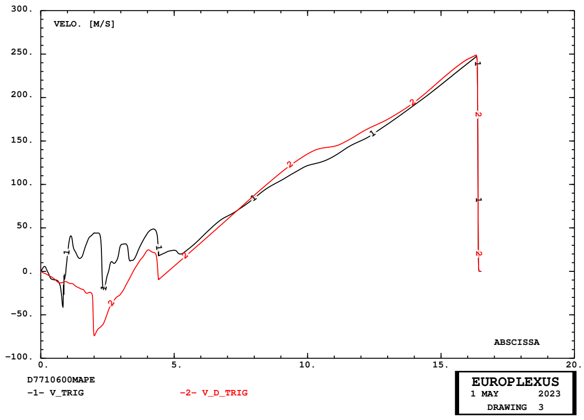
Figure 32 shows the map file (space) curves at the trigger time (in black) compared with the same curves for case D7710600mapd (in red). The difference between the two cases is that in D7710600mapd the membranes were removed at $t = 8$ ms, while in case D7710600mapd they are kept until the final (map trigger) time.



(a) Pressure



(b) Density



(c) Velocity

Figure 32: Comparison of map file curves in tests D7710600mapd and D7710600mape.

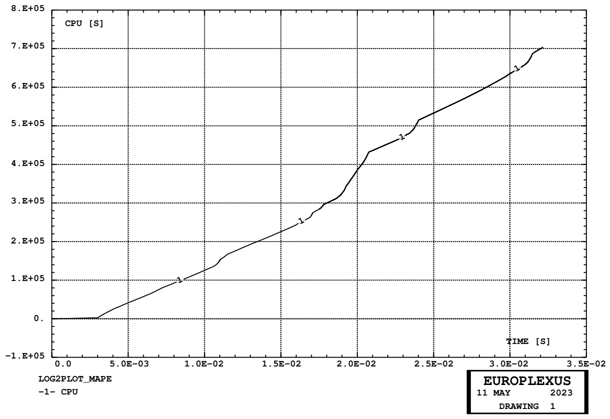
The curves differ somewhat in the initial (left) part of the tube, due to the presence of the membranes in the black case, and their absence in the red case. However, the central and final (rightmost) parts of the curves, say for $x > 5$ m (where the abscissa x in the drawings of Figure 32 is measured from the left extremity of the tube) are very similar. This confirms the fact that removing the membranes once they are completely failed is a legitimate process. In fact, experience shows that the specimen (placed at the right extremity of the tube) usually fails completely just a few ms after the first impact of the blast wave.

A finer inspection shows that the curves obtained by removing the membranes (in red) are slightly higher than those obtained by keeping the membranes (in black). This appears plausible, since the (largely failed) membranes, if not removed, continue to exert a (very little) containment effect upon the discharge of the high-pressure gas from the driver into the driven section of the tube.

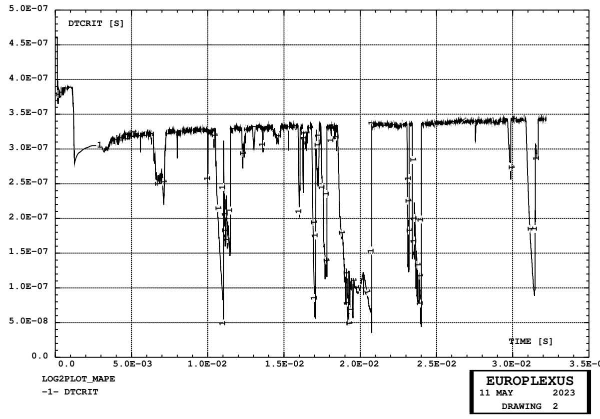
The quasi-equality of the map curves over a distance of about $L_{\mathrm{eq}} = 11$ m in the right part of the tube warrants an "unperturbed" period t_{unpert} for the experiment which can be estimated as follows. The last membrane (mem2 in this case) is located at $X_{\mathrm{m2}} = -16.265$ m in the model, while the map trigger is located at $X_{\mathrm{trig}} = -0.7$ m. The blast wave starts being released at approximately $t_{\mathrm{fire}} = 3.0$ ms and reaches the map trigger at $t_{\mathrm{trig}} = 32.2$ ms. Therefore, the average propagation speed of the blast wave front along the tube is: $v^{\mathrm{ave}}_{\mathrm{blast}} = (X_{\mathrm{trig}} - X_{\mathrm{m2}})/(t_{\mathrm{trig}} - t_{\mathrm{fire}}) = (-0.7 + 16.265)/(32.2 - 3.0) = 0.533$ m/ms. From this we obtain $t_{\mathrm{unpert}} \approx L_{\mathrm{eq}}/v^{\mathrm{ave}}_{\mathrm{blast}} = 11.0/0.533 = 20.6$ ms (i.e. 533 m/s), which is largely sufficient to simulate the specimen behavior up to (its possible) failure.

In the experiments with larger nominal firing pressures (15, 25 and 35 bar), the average propagation speed of the blast wave front $v_{\mathrm{blast}}^{\mathrm{ave}}$ will most likely be higher than in this case (10 bar), resulting in smaller values of t_{unpert}. However, also the blast pressure levels will result higher, so that the (possible) failure of the specimen will occur in a shorter time, i.e. the experiment duration will be shorter. Therefore, the above conclusion on the adequacy of t_{unpert} should continue to hold also for the tests with higher firing pressures (to be checked and confirmed).

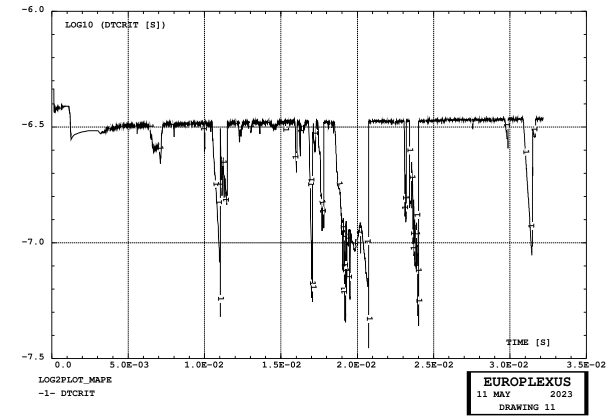
Figure 33 shows the CPU time, the stability step and the (norm of) the maximum velocity during the simulation.



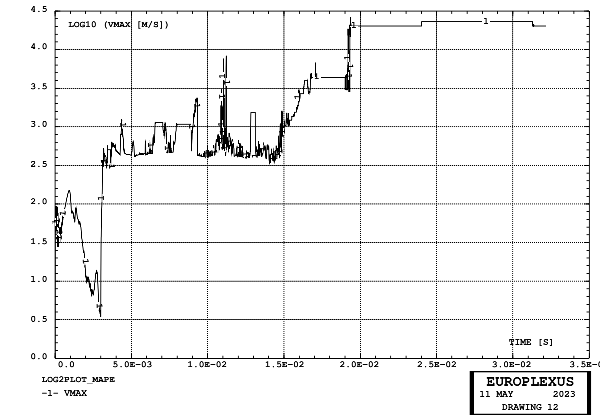
(a) CPU time



(b) Δt



(c) Δt (log scale)



(d) $v_{\max}$ (log scale)

Figure 33: CPU time, stability time step and maximum velocity in test D7710600mape.

3.10 A new form of displacement-driven erosion

In the simulations performed so far it was observed that small fragments detached from the membranes and traveling freely through the shock tube were not eroded until the entire membranes were eventually removed by the FANT command at time t_{fant}.

This might cause a degradation of performance in the simulation, if such small fragments happen to be critical as far as stability is concerned. Besides, retaining such fragments even after they have exited the 3D fluid region of the model makes no sense and has no influence on the results.

Therefore, a method is sought to remove such fragments from the simulation. One possibility would be to remove membrane elements once they have exited the 3D fluid region, so that they can no longer contribute to FSI. However, some inspection of the code reveals that achieving this goal might be relatively complicated and error-prone.

Therefore, it is preferred resorting to a simpler and safer alternative strategy. Any membrane elements should be removed from the calculation (eroded) when they have displaced more than a prescribed amount from their initial position. The norm of the displacement is used, for the sake of simplicity in the implementation. This is yet another type of displacement-driven erosion, similar but not identical to the one used in safety glass windows blast studies, see the COMP FAIL DISP or AUTO directive in [1].

The new displacement-driven erosion model is activated by the COMP DERO DISP directive, see [1]:

```
COMP ...   DERO ( DISP disp /LECT/ )
```

The simulations performed to check the new model are summarized in Table 6 and are described in detail below.

Test	Mesh	Description	t_{fin} [ms]	Steps	CPU [s]
DERO00	5 Q41L	Case without adaptivity	30.0	7	—
DERO01	5 Q41L	Case with adaptivity	30.0	12	—
DERO02	5 Q4GS	Idem 01 but 3D	30.0	11	—
DERO03	5 Q4GS 5 CL3D	Idem 02 but add CL3D	30.0	11	—

Table 6: Simulations to check displacement-driven erosion.

3.10.1 Case DERO00

This is a simple test to verify the new COMP DERO DISP directive in the absence of adaptivity.

A bar made of 5 Q41L square elements has an initial velocity. We want to erode elements 4 and 5 after a displacement of 0.1 m and elements 2 and 3 after a displacement of 0.2 m. The input reads:

```
DERO00
ECHO
!CONV WIN
EROS 1.0
LAGR DPLA
GEOM LIBR POIN 12 Q41L 5 TERM
  0 0  1 0  2 0  3 0  4 0  5 0
  0 1  1 1  2 1  3 1  4 1  5 1
  1 2 8 7
  2 3 9 8
  3 4 10 9
  4 5 11 10
  5 6 12 11
COMP EPAI 1. LECT tous TERM
     DERO DISP 0.1 LECT 4 5 TERM
          DISP 0.2 LECT 2 3 TERM
MATE VM23 RO 8000. YOUN 2.D8 NU 0.3 ELAS 2.D8
          TRAC 1 2.D8 1.0
          LECT tous TERM
INIT VITE 1 10 LECT tous TERM
ECRI FREQ 100
OPTI PAS AUTO NOTE LOG 1
CALC TINI 0. TEND 0.03D0
FIN
```

This results in the following erosions:

```
** ATTENTION       1 IN PUT_FAILED_ELEM : STEP        3 T = 1.30826E-02 ELEMENT        4 BECOMES ERODED (COMP DERO DISP)
** ATTENTION       2 IN PUT_FAILED_ELEM : STEP        3 T = 1.30826E-02 ELEMENT        5 BECOMES ERODED (COMP DERO DISP)
** ATTENTION       3 IN PUT_FAILED_ELEM : STEP        5 T = 2.18043E-02 ELEMENT        2 BECOMES ERODED (COMP DERO DISP)
** ATTENTION       4 IN PUT_FAILED_ELEM : STEP        5 T = 2.18043E-02 ELEMENT        3 BECOMES ERODED (COMP DERO DISP)
```

3.10.2 Case DERO01

This test is similar to DERO00 but we add adaptivity. We initially refine elements 3 and 5 once by the INIT ADAP SPLI directive:

```
DERO01
ECHO
!CONV WIN
EROS 1.0
LAGR DPLA
DIME ADAP NPOI 10 Q41l 8 ENDA TERM
GEOM LIBR POIN 12 Q41L 5 TERM
  0 0  1 0  2 0  3 0  4 0  5 0
  0 1  1 1  2 1  3 1  4 1  5 1
  1 2 8 7
  2 3 9 8
  3 4 10 9
  4 5 11 10
  5 6 12 11
COMP EPAI 1. LECT 1 PAS 1 5 TERM
     DERO DISP 0.1 LECT 4 5 TERM
          DISP 0.2 LECT 2 3 TERM
MATE VM23 RO 8000. YOUN 2.D8 NU 0.3 ELAS 2.D8
          TRAC 1 2.D8 1.0
          LECT 1 PAS 1 5 TERM
LINK COUP
INIT VITE 1 10.0 LECT 1 PAS 1 12 TERM
     ADAP SPLI LEVE 2 LECT 3 5 TERM
ECRI FREQ 100
OPTI PAS AUTO NOTE LOG 1
CALC TINI 0. TEND 0.03D0
FIN
```

This results in the following erosions:

```
** ATTENTION       1 IN PUT_FAILED_ELEM : STEP       5 T = 1.09022E-02 ELEMENT       4 BECOMES ERODED (COMP DERO DISP)
** ATTENTION       2 IN PUT_FAILED_ELEM : STEP       5 T = 1.09022E-02 ELEMENT      10 BECOMES ERODED (COMP DERO DISP)
** ATTENTION       3 IN PUT_FAILED_ELEM : STEP       5 T = 1.09022E-02 ELEMENT      11 BECOMES ERODED (COMP DERO DISP)
** ATTENTION       4 IN PUT_FAILED_ELEM : STEP       5 T = 1.09022E-02 ELEMENT      12 BECOMES ERODED (COMP DERO DISP)
** ATTENTION       5 IN PUT_FAILED_ELEM : STEP       5 T = 1.09022E-02 ELEMENT      13 BECOMES ERODED (COMP DERO DISP)
** ATTENTION       6 IN PUT_FAILED_ELEM : STEP      10 T = 2.18043E-02 ELEMENT       2 BECOMES ERODED (COMP DERO DISP)
** ATTENTION       7 IN PUT_FAILED_ELEM : STEP      10 T = 2.18043E-02 ELEMENT       6 BECOMES ERODED (COMP DERO DISP)
** ATTENTION       8 IN PUT_FAILED_ELEM : STEP      10 T = 2.18043E-02 ELEMENT       7 BECOMES ERODED (COMP DERO DISP)
** ATTENTION       9 IN PUT_FAILED_ELEM : STEP      10 T = 2.18043E-02 ELEMENT       8 BECOMES ERODED (COMP DERO DISP)
** ATTENTION      10 IN PUT_FAILED_ELEM : STEP      10 T = 2.18043E-02 ELEMENT       9 BECOMES ERODED (COMP DERO DISP)
```

3.10.3 Case DERO02

This test is similar to DERO01 but in 3D, using Q4GS shell elements. The erosion pattern coincides with that of DERO01, as expected:

```
** ATTENTION       1 IN PUT_FAILED_ELEM : STEP       5 T = 1.20665E-02 ELEMENT       4 BECOMES ERODED (DERO DISP (DISPLACEMENT))
** ATTENTION       2 IN PUT_FAILED_ELEM : STEP       5 T = 1.20665E-02 ELEMENT      10 BECOMES ERODED (DERO DISP (DISPLACEMENT))
** ATTENTION       3 IN PUT_FAILED_ELEM : STEP       5 T = 1.20665E-02 ELEMENT      11 BECOMES ERODED (DERO DISP (DISPLACEMENT))
** ATTENTION       4 IN PUT_FAILED_ELEM : STEP       5 T = 1.20665E-02 ELEMENT      12 BECOMES ERODED (DERO DISP (DISPLACEMENT))
** ATTENTION       5 IN PUT_FAILED_ELEM : STEP       5 T = 1.20665E-02 ELEMENT      13 BECOMES ERODED (DERO DISP (DISPLACEMENT))
** ATTENTION       6 IN PUT_FAILED_ELEM : STEP       9 T = 2.17197E-02 ELEMENT       2 BECOMES ERODED (DERO DISP (DISPLACEMENT))
** ATTENTION       7 IN PUT_FAILED_ELEM : STEP       9 T = 2.17197E-02 ELEMENT       6 BECOMES ERODED (DERO DISP (DISPLACEMENT))
** ATTENTION       8 IN PUT_FAILED_ELEM : STEP       9 T = 2.17197E-02 ELEMENT       7 BECOMES ERODED (DERO DISP (DISPLACEMENT))
** ATTENTION       9 IN PUT_FAILED_ELEM : STEP       9 T = 2.17197E-02 ELEMENT       8 BECOMES ERODED (DERO DISP (DISPLACEMENT))
** ATTENTION      10 IN PUT_FAILED_ELEM : STEP       9 T = 2.17197E-02 ELEMENT       9 BECOMES ERODED (DERO DISP (DISPLACEMENT))
```

3.10.4 Case DERO03

This test is similar to DERO03 but we attach CL3D boundary condition elements to the Q4GS shell elements. The CL3D elements are eroded as soon as the matching shell elements are eroded, as expected:

```
** ATTENTION       1 IN PUT_FAILED_ELEM : STEP       5 T = 1.20665E-02 ELEMENT       4 BECOMES ERODED (DERO DISP (DISPLACEMENT))
** ATTENTION       2 IN PUT_FAILED_ELEM : STEP       5 T = 1.20665E-02 ELEMENT      15 BECOMES ERODED (DERO DISP (DISPLACEMENT))
** ATTENTION       3 IN PUT_FAILED_ELEM : STEP       5 T = 1.20665E-02 ELEMENT      16 BECOMES ERODED (DERO DISP (DISPLACEMENT))
** ATTENTION       4 IN PUT_FAILED_ELEM : STEP       5 T = 1.20665E-02 ELEMENT      17 BECOMES ERODED (DERO DISP (DISPLACEMENT))
** ATTENTION       5 IN PUT_FAILED_ELEM : STEP       5 T = 1.20665E-02 ELEMENT      18 BECOMES ERODED (DERO DISP (DISPLACEMENT))
** ATTENTION       6 IN PUT_FAILED_ELEM : STEP       5 T = 1.20665E-02 ELEMENT       9 BECOMES ERODED (NEIGHBOUR WAS ERODED)
** ATTENTION       7 IN PUT_FAILED_ELEM : STEP       5 T = 1.20665E-02 ELEMENT      23 BECOMES ERODED (NEIGHBOUR WAS ERODED)
** ATTENTION       8 IN PUT_FAILED_ELEM : STEP       5 T = 1.20665E-02 ELEMENT      24 BECOMES ERODED (NEIGHBOUR WAS ERODED)
** ATTENTION       9 IN PUT_FAILED_ELEM : STEP       5 T = 1.20665E-02 ELEMENT      25 BECOMES ERODED (NEIGHBOUR WAS ERODED)
** ATTENTION      10 IN PUT_FAILED_ELEM : STEP       5 T = 1.20665E-02 ELEMENT      26 BECOMES ERODED (NEIGHBOUR WAS ERODED)
** ATTENTION      11 IN PUT_FAILED_ELEM : STEP       9 T = 2.17197E-02 ELEMENT       2 BECOMES ERODED (DERO DISP (DISPLACEMENT))
** ATTENTION      12 IN PUT_FAILED_ELEM : STEP       9 T = 2.17197E-02 ELEMENT      11 BECOMES ERODED (DERO DISP (DISPLACEMENT))
** ATTENTION      13 IN PUT_FAILED_ELEM : STEP       9 T = 2.17197E-02 ELEMENT      12 BECOMES ERODED (DERO DISP (DISPLACEMENT))
** ATTENTION      14 IN PUT_FAILED_ELEM : STEP       9 T = 2.17197E-02 ELEMENT      13 BECOMES ERODED (DERO DISP (DISPLACEMENT))
** ATTENTION      15 IN PUT_FAILED_ELEM : STEP       9 T = 2.17197E-02 ELEMENT      14 BECOMES ERODED (DERO DISP (DISPLACEMENT))
** ATTENTION      16 IN PUT_FAILED_ELEM : STEP       9 T = 2.17197E-02 ELEMENT       7 BECOMES ERODED (NEIGHBOUR WAS ERODED)
** ATTENTION      17 IN PUT_FAILED_ELEM : STEP       9 T = 2.17197E-02 ELEMENT      19 BECOMES ERODED (NEIGHBOUR WAS ERODED)
** ATTENTION      18 IN PUT_FAILED_ELEM : STEP       9 T = 2.17197E-02 ELEMENT      20 BECOMES ERODED (NEIGHBOUR WAS ERODED)
** ATTENTION      19 IN PUT_FAILED_ELEM : STEP       9 T = 2.17197E-02 ELEMENT      21 BECOMES ERODED (NEIGHBOUR WAS ERODED)
** ATTENTION      20 IN PUT_FAILED_ELEM : STEP       9 T = 2.17197E-02 ELEMENT      22 BECOMES ERODED (NEIGHBOUR WAS ERODED)
```

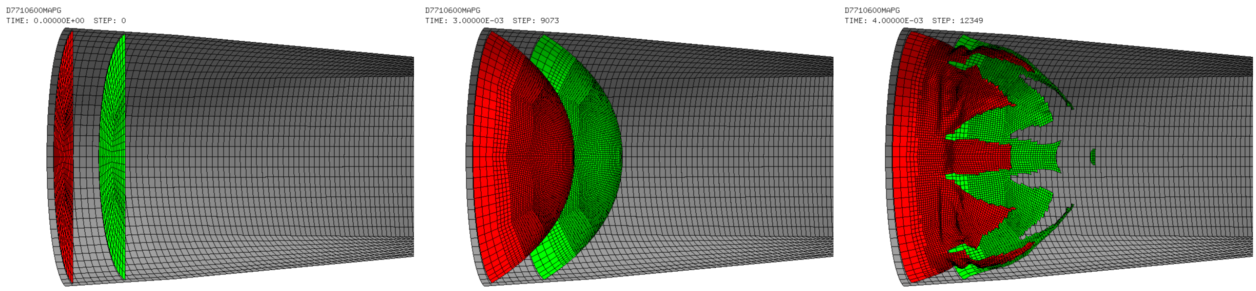
3.11 Case D7710600mapg

This test was meant to verify the DERO command on the real shock tube model rather than the small academic tests described in Section 3.10. The model is identical to that of case D7710600mapb, but we add the COMP DERO keyword for the first membrane (mem1), set at a displacement of just 0.2 m to activate the erosion as early as possible, and we reduce the final time to just 4.0 ms to speed up the simulation.

```
D7710600MAPG
 . . .
COMP . . .
    DERO DISP 0.20 LECT mem1 TERM
 . . .
CALC TINI 0 TEND 4.0E-3
FIN
```

At $t = 4.0$ ms, 30 elements had been eroded by the DERO mechanism, thus confirming the correct functioning of the new directive.

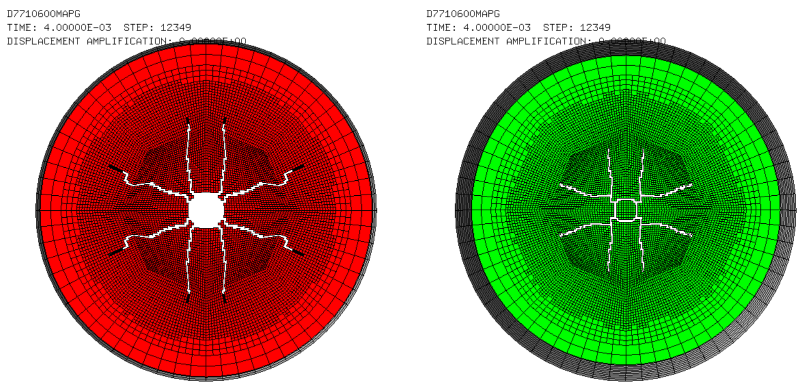
Figure 34 shows the inflation and progressive failure of the firing membranes.



(a) $t = 0$ (b) $t = 3$ ms (c) $t = 4$ ms

Figure 34: Inflation and progressive failure of the firing membranes in test D7710600mapg.

Figure 35 shows the failure patterns of the firing membranes. Note that the central part of the first membrane (the red one) gets eroded by the DERO mechanism. The same does not apply to the second membrane (the green one), since the DERO command is not applied to it.



(a) First membrane (b) Second membrane

Figure 35: Failure patterns of the firing membranes in test D7710600mapg.

3.12 Case D7710600mapf

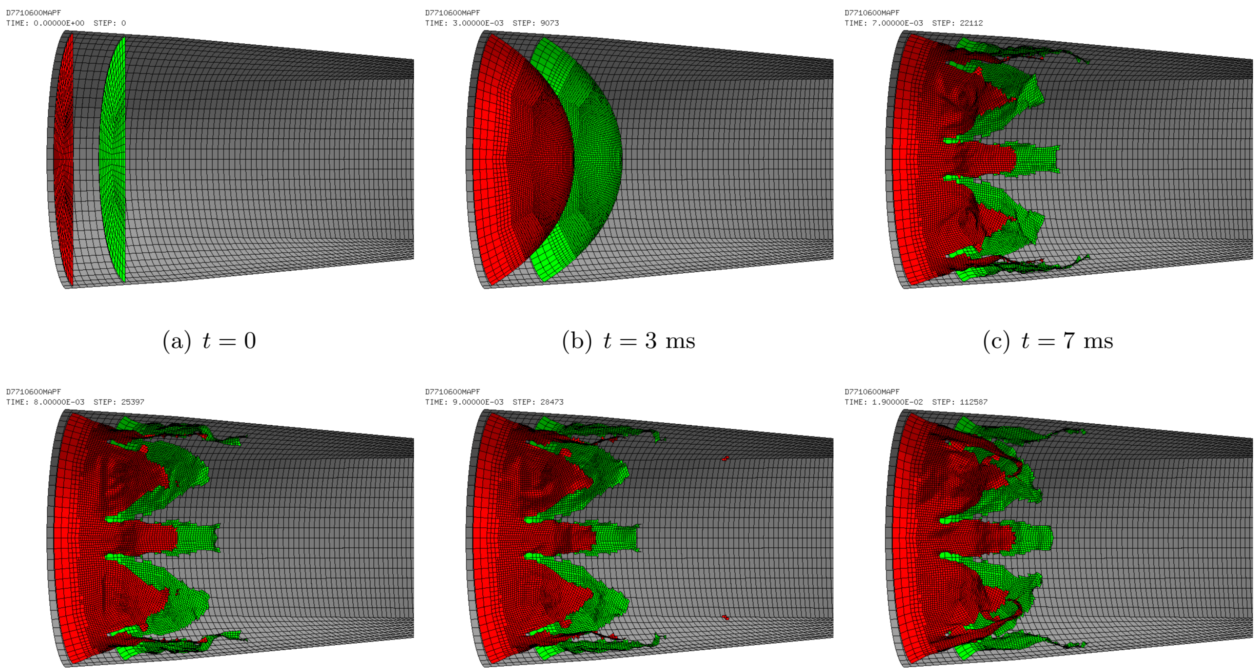
This is a repetition of test D7710600mape of Section 3.9 by adding the `COMP DERO DISP` directive (after testing it on case D7710600mapg presented in the previous Section) in order to erode membrane fragments once they have exited the 3D fluid domain:

```
D7710600mapf
 . . .
COMP . . .
     GROU 22  . . .
            'trigger' LECT tube TERM COND NEAR POIN -0.70 0 0
     . . .
     DERO DISP 1.230 LECT mem1 TERM
          DISP 1.160 LECT mem2 TERM
 . . .
ECRI . . .
     FICH FORM MAPP OBJE LECT flui3d tubelp1 TERM
                    TRIG ECRO 1 TSTO TVAL 1.02E5 LECT trigger TERM
 . . .
FIN
```

Upon first running, this simulation had to be stopped due to physical displacement of the EVICOM PC on which it was running, when it had reached about 26.8 ms instead of the expected trigger time of about 32.2 ms (*fide* case D7710600mapd). So it had to be re-run to complete the simulation. However, it was also noticed that the `DERO DISP` directive was not working and the central fragments of the membranes were not eroded after the specified displacement. This was due to a bug in the `DERO DISP` model, which was fixed in an evolution of 2 May 2023.

Then the test was re-run and the `DERO DISP` model did work (causing 34 erosions) but, quite surprisingly, the simulation became extremely slow ($\Delta t = 2 \times 10^{-11}$) at around $t = 19.3$ ms, i.e. much earlier than the time reached during the first run (26.8 ms), with huge velocities (10^8 m/s) in some Finite Volumes, so that the simulation had to be intentionally stopped. It is not known (and considered unlikely) whether this phenomenon is due to the `DERO DISP` model. Actually, one would expect that removing possibly weird membrane fragments from the calculation would help stability rather than compromising it. So, the subject will have to be further investigated.

Some results are presented, until the last storage station which was at $t = 19.0$ ms. Figure 36 shows the inflation and progressive failure of the firing membranes.

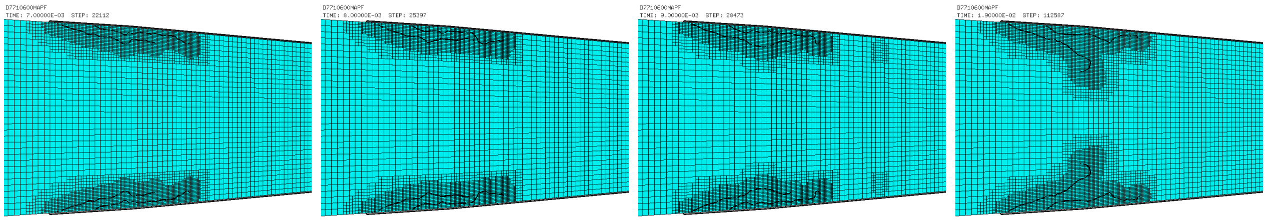


(a) $t = 0$ (b) $t = 3$ ms (c) $t = 7$ ms

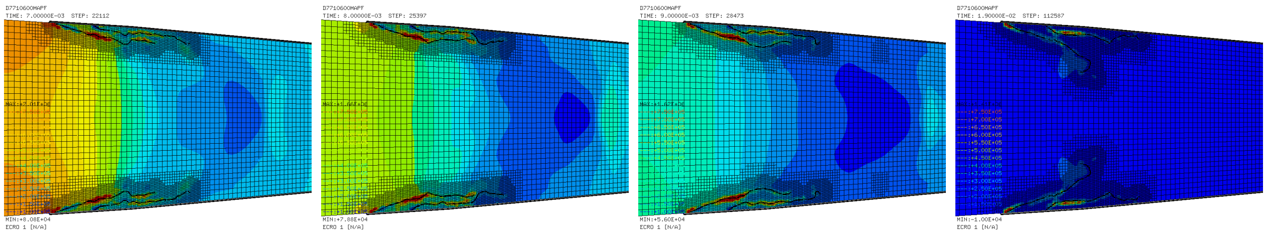
(d) $t = 8$ ms (e) $t = 9$ ms (f) $t = 19$ ms

Figure 36: Inflation and progressive failure of the firing membranes in test D7710600mapf.

Figure 37 shows the fluid mesh FSI-driven refinement and the fluid pressure.



(a) $t = 7$ ms (b) $t = 8$ ms (c) $t = 9$ ms (d) $t = 19$ ms



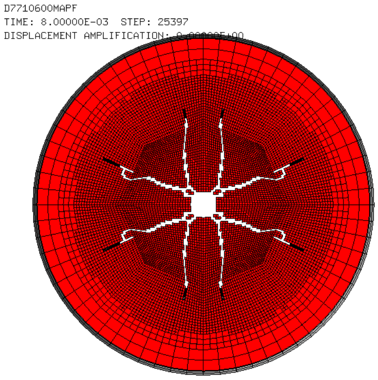
(e) $t = 7$ ms (f) $t = 8$ ms (g) $t = 9$ ms (h) $t = 19$ ms

Figure 37: Fluid mesh FSI-driven refinement and the fluid pressure in test D7710600mapf.

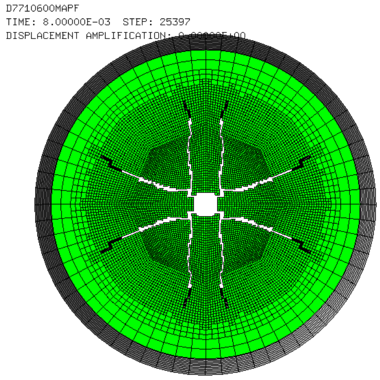
Figure 38 shows the failure patterns of the firing membranes at various times. As it can be seen, at 8 ms both membranes are already completely failed, including the central part which flies away as a small fragment and gets eroded by the `DERO DISP` mechanism. Very few additional erosions take place between 8 and 19 ms.

Figure 39 shows the fluid velocities in the 3D part of the model (driver and first part of the driven section) at 19 ms. A huge (non-physical) velocity appears in a volume near the partially failed membranes, where the pressure should be quite low at this time. By zooming in the pressure maps in Figure 37, one sees that relatively high pressures remain “trapped” in the influence domain of the membranes, probably due to the fact that numerical fluxes are blocked between FVs within said domain.

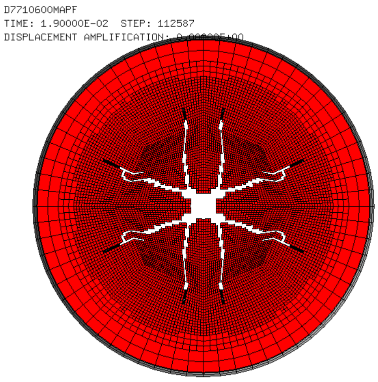
Although such phenomenon has probably no influence on the pressure distribution along the tube (the fluid pressures and velocities in the 1D part of the fluid model are perfectly physical), they might produce a local instability or imprecision, which might be the source of the numerical difficulties observed in the simulation (excessive drop of the stability step).



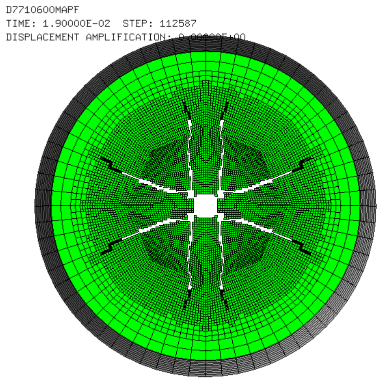
(a) First membrane @ $t = 8$ ms



(b) Second membrane @ $t = 8$ ms

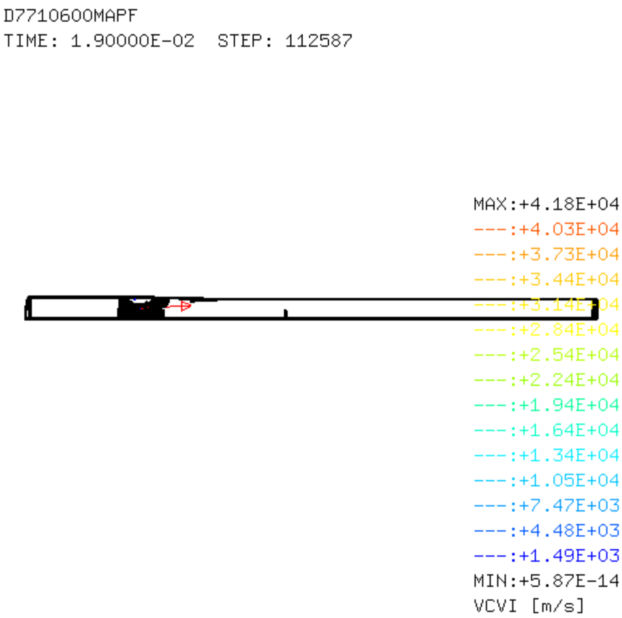


(c) First membrane @ $t = 19$ ms

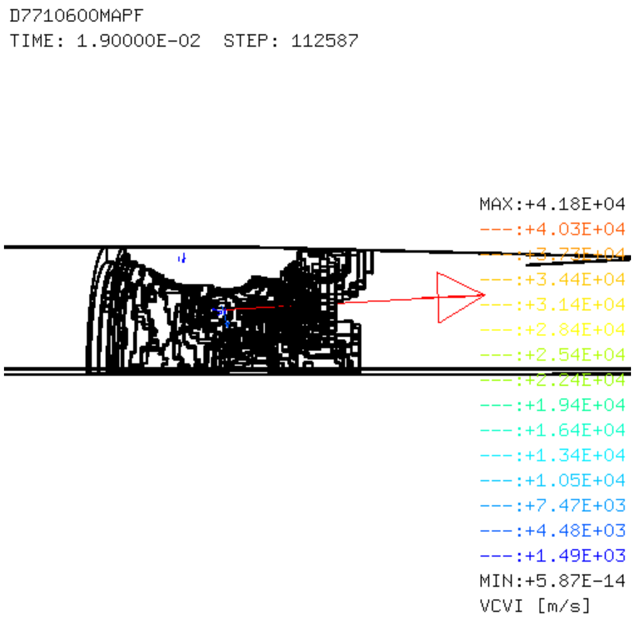


(d) Second membrane @ $t = 19$ ms

Figure 38: Failure patterns of the firing membranes in test D7710600mapf.



(a) $t = 19$ ms

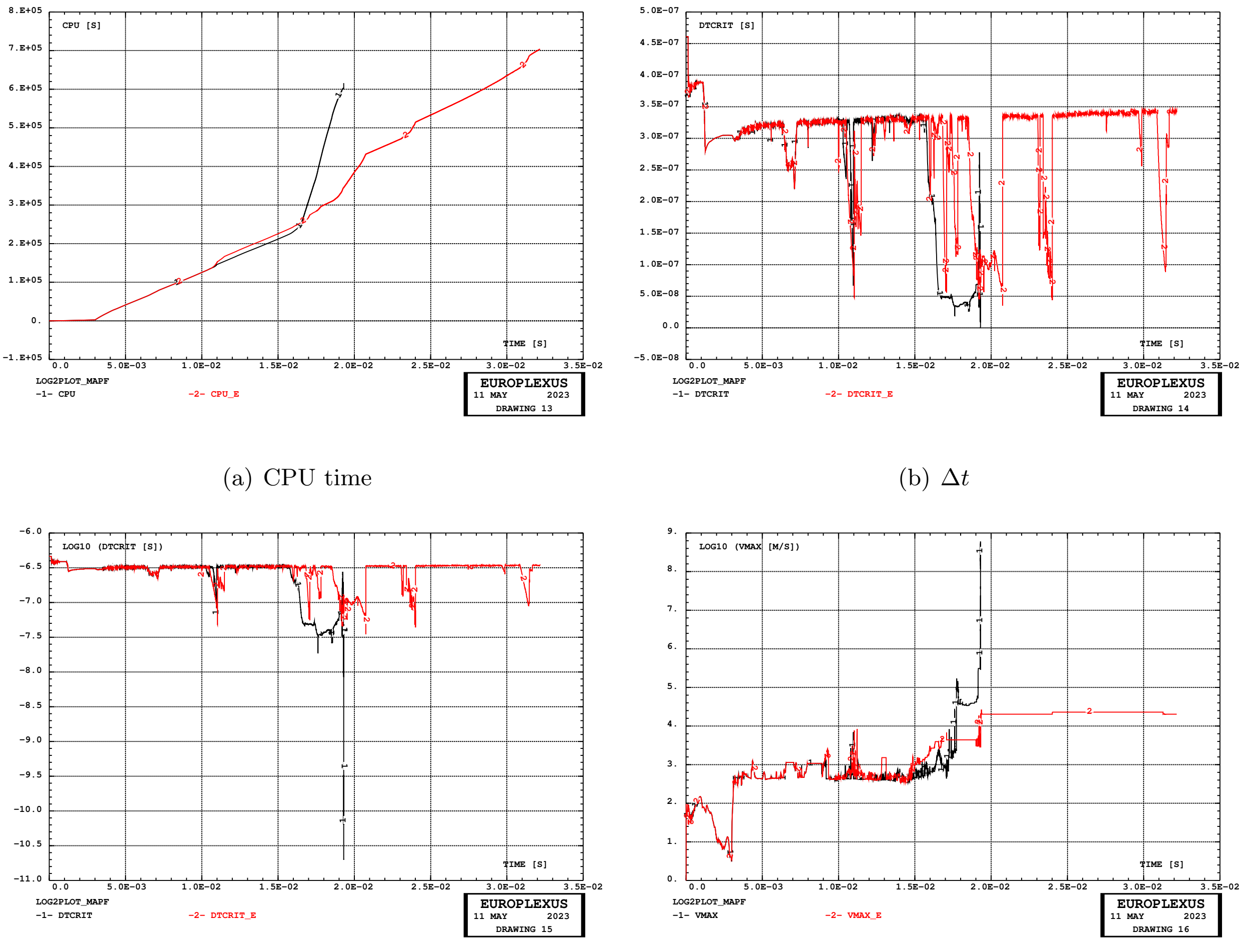


(b) Detail

Figure 39: Fluid velocity in the 3D part of the fluid model at $t = 19$ ms in test D7710600mapf.

Figure 40 shows the CPU time, the stability step and the (norm of) the maximum velocity during the simulation. The curves from the present simulation are drawn in black, while the corresponding ones from case D7710600mape are drawn in red, for comparison. The stability step is relatively constant in the first part of the simulation ($\Delta t \approx 3 \times 10^{-7}$), apart from two localized drops at around 7 and 11 ms, from which it recovers relatively promptly. However, from about 17 ms onward the step drops down to a much lower value of about 5×10^{-8} until, at about 19.3 ms, it becomes too small for the simulation to advance, prompting for interruption of the calculation.

The maximum velocity remains of the order of 1000 m/s (which is physical) until about 17 ms. Then it starts increasing very rapidly and this has a deleterious effect on the stability time step of the fluid Finite Volumes, and eventually on the overall cost of the simulation.



(a) CPU time

(b) Δt

(c) Δt (log scale)

(d) $v_{\max}$ (log scale)

Figure 40: CPU, stability step and maximum velocity in tests D7710600mape and D7710600mapf.

Table 7 presents some data related to stability at various times. For $t \geq 17$ ms the critical elements are fluid ones at the maximum refinement level (3) in the second firing chamber (fir2). Since the fluid part of the model is Eulerian, the size of these elements does not change and the drop in their stability seems due to the high local velocities in the volumes themselves.

Time [ms]	Step	Δt_{stab} [s] $\cdot 10^{-7}$	El. crit.	Level	Base el.	Type	Mat.	Belongs to
0.0	0	4.61	406	1	406	Q4GS	VM23	pinbcm
5.0	15 501	3.19	92 556	3	185	Q4GS	VM23	mem1, memc1d
7.0	22 112	2.55	108 566	3	20 013	CUVF	GAZP	fir2, flui3d, fcoup1
10.0	31 532	3.27	92 556	3	185	Q4GS	VM23	mem1, memc1d
11.0	35 397	3.22	92 556	3	185	Q4GS	VM23	mem1, memc1d
15.0	47 578	3.29	92 556	3	185	Q4GS	VM23	mem1, memc1d
17.0	63 857	0.48	226 045	3	19 850	CUVF	GAZP	fir2, flui3d, fcoup1
18.0	88 761	0.36	226 031	3	19 850	CUVF	GAZP	fir2, flui3d, fcoup1
19.0	112 587	0.67	226 031	3	19 850	CUVF	GAZP	fir2, flui3d, fcoup1

Table 7: Some stability-related data in test D7710600mapf.

3.13 Case D7710600maph

This is basically a repetition of test D7710600mapf by activating the `CENE` option (`OPTI VFCC CENE`) of the CCFV. According to the Users' manual [1], this option (which has only effect in second-order in space simulations like the present one) should apply a correction to the gradients in such a way that the internal energy stays always positive. Therefore, the `NTIL` option, which had been used in the previous simulations, is removed since it should become redundant (to be checked). The hope is that `CENE` would eliminate or reduce the instabilities observed.

Other minor model changes are also applied with respect to case D7710600mapf, so that the complete set of modifications can be listed as follows:

- Replace option `NTIL` by option `CENE` (as already explained above).
- Replace `CSTA 0.25` by `CSTA 0.7 CSVF 0.471`, in this way hoping to speed up the simulation. The structural elements, which should be the most critical ones, will be integrated with a much larger step while the CCFV will have a safety coefficient $C_s = 0.7 \cdot 0.471 = 0.33$, which is (slightly) higher that the one used previously (0.25) but still below the theoretical limit of 1/3 for a 3D calculation.
- The pinbcm object composed of Q4GS elements is no longer used. This represented the (rigid) structure placed around the 3D driven section in the model in order to prevent the membranes or fragments thereof from exiting the tube radially (while axial motion is left free). Since pseudo-nodal pinballs (npincm) were (and still are) used for the contact, the shell elements are simply not needed. Note that these shells were initially the most critical elements in the model (due to steel-like material and to the fact that they had not been declared `NOCR`, despite being completely blocked in translation). Therefore, it is hoped to gain something in the simulation speed in the initial phase, before the membranes get refined by adaptivity and become the most critical ones.
- We add the command `TFAI 6.0E-7` in an attempt to erode membrane fragments that would become so distorted as to slow down the simulation. The value chosen is based on the fact that the stability step of the membranes (in the initial, unrefined configuration) is $\Delta t_{\text{stab}} = 2.84 \times 10^{-6}$. Since a maximum refinement level of 3 is prescribed in the membranes, the stability step will become 1/4 of the initial value, i.e. about 7.1×10^{-7}. By applying some extra safety to account for possible element deformation, we obtain the value indicated above of 6.0×10^{-7}.
- Upon preliminary running, it was noticed that spurious contact forces were generated in the initial configuration between the perimeter of the membranes and the containing structure mentioned above. This generated spurious in-plane forces in the membrane due to the penalty-based contact model adopted (`PINB PENA`). Although such forces had probably only minor effects, it is preferred to get rid of them by removing from the contact declaration the pseudo-nodal pinballs involved in these spurious contacts, now identifies as two additional element groups named npmem1 and npmem2.
- Finally, an initial small value of the time increment `PAS1 1.E-8` is prescribed to give the model a better chance to start the simulation in an smooth and equilibrated manner.

Upon first running, the simulation failed violently (access violation) as soon as the CCFV calculation was activated at t_{fire} (3.0 ms here). This was due to an evident bug in module M_REC_VFCC_1D, subroutine BOUCLE_RECONS_GRADIENT_VFCC_1D. The quantity NBRFACELE must be computed *before* calling CALL_LIMIT_EINT_VFCC_1D, if the `CENE` option is active.

After correcting this bug, the simulation was re-run, but this time it stopped only slightly later, at $t \approx 3.1$ ms, with a nonsense message (BAD_LENGTH in M_ALLOCATION). Inspection revealed that the maximum velocity passes from a physically plausible value to a huge value (10^{16}) in just one step, which is probably the indirect cause of the mentioned message.

Therefore, it is suspected that the correction mentioned before is not the only one needed. The fact that the bug mentioned above was present seems to indicate that the `CENE` option, despite having apparently been programmed, had never been tested in a case containing 1D VFCC elements (while there are several non-regression tests using it with 3D VFCC elements). The advice and intervention of CEA, authors of the `CENE` option, will have to be requested.

3.14 Case D7710600mapi

This was a repetition of case D7710600mapi described in the previous Section, by returning to the original (stricter) stability step of the previous simulations, thus hoping to avoid the instability (sudden increase of the velocity) observed in the previous simulation. The modifications were:

- The `CSTA 0.7 CSVF 0.471` is rolled back to `CSTA 0.25`.
- Consequently, the value of `TFAI` must be modified, because now the time increment used will be smaller. We set it to $6.0 \times 10^{-7} \cdot (0.25/0.70)$, i.e. `TFAI 2.15E-7`.

However, upon running we obtain the same error message, at the same time as in the previous simulation, and the huge velocity has the same value. This might indicate that the problem is not a numerical instability, but just (another) bug in the so-far untested `CENE` model when applied to a 1D VFCC mesh. However, this hypothesis will have to be checked.

3.15 Checking CENE with a mixed 3D-1D CCFV mesh

In order to check whether the CENE option can be used in the presence of 1D CCFV elements (together with 3D CCFV elements) we conduct some simple tests. We revisit the test 1D3D14 from reference [5]. In this test, two 3D fluid domains are connected by a 1D part. The conditions are those typical of a shock tube test, so the numerical solutions can be compared against the analytical one.

The simulations performed are summarized in Table 8 and are described in detail below.

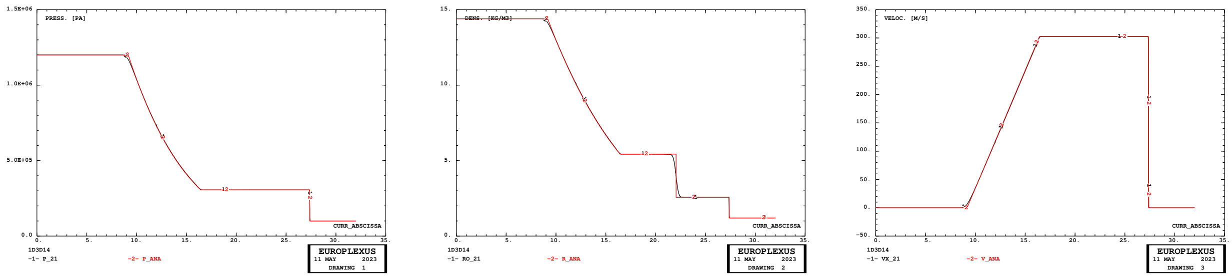
Test	Mesh	Description	t_{fin} [ms]	Steps	CPU [s]
1D3D14	2200 CUVF 1000 TUVF	Repeated from [5]	20.0	1 896	12.8
1D3D24	2200 CUVF 1000 TUVF	Idem 14, add RECO 1	20.0	1 897	18.6
1D3D34	2200 CUVF 1000 TUVF	Idem 24, add CENE	20.0	1 899	19.5

Table 8: Simulations to check the use of CENE with 1D CCFV.

3.15.1 Case 1D3D14

This is simply a repetition of the test from [5], to check that the input is still valid after a few years have passed. The OTPS option is modified into STPS to comply with the intervened syntax changes. The test uses ORDR 2 STPS 2 but the reconstruction RECO is not activated, since at the moment the test was constructed (2015) the 1D part of the model did not accept it. Therefore, the formulation was actually first order in space.

The test runs correctly, and some results are presented next. Figure 41 compares the numerical solution (in black) against the analytical reference (in red), showing excellent agreement (for a first-order model).



(a) Pressure (b) Density (c) Sound speed

Figure 41: Some results of test 1D3D14.

3.15.2 Case 1D3D24

We repeat case 1D3D14 by activating the RECO 1 option, which is now available also for 1D volumes. The model becomes full second-order in space.

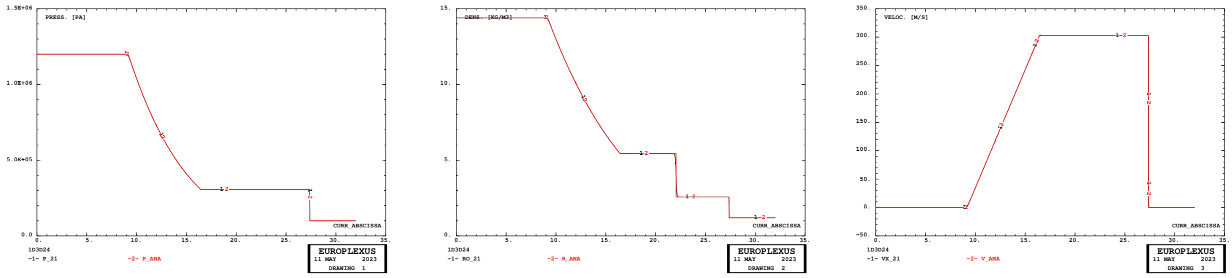
Figure 42 compares the numerical solution (in black) against the analytical reference (in red), showing even better agreement than in the pevious case (thanks to the second-order in space formulation).

3.15.3 Case 1D3D34

Finally, we repeat case 1D3D24 (second order in space) by adding the CENE option.

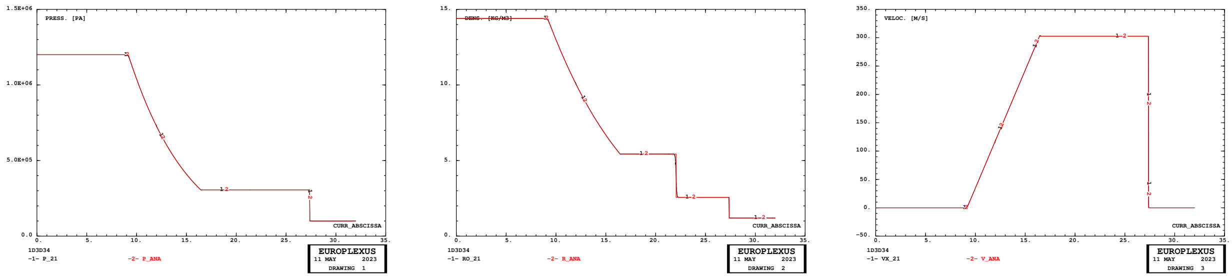
The simulation runs smoothly and delivers the same result as case 1D3D24 (no difference on the .ps file), as shown in Figure 42.

The conclusion from these tests seems to be that in principle CENE can be used in second-order VFCC simulations containing a mix of 3D and 1D volumes (after the correction that was described in



(a) Pressure (b) Density (c) Sound speed

Figure 42: Some results of test 1D3D24.



(a) Pressure (b) Density (c) Sound speed

Figure 43: Some results of test 1D3D34.

one of the previous cases). Therefore, the difficulties observed in the previous shock tube simulations must have a different origin.

3.16 Case D7710600mapj

This was a repetition of case D7710600mapf described in Section 3.12 with the following modifications:

- The CENE option for the VFCC is used in place of NFAI, like in cases 10h and 10i.
- The Dubois parameters for mass, momentum and energy KMAS, KQDM and KENE are set to 0.75 instead of the default value 0.5. In addition, the Dubois limiters are explicitly chosen by setting LMAS, LQDM and LENE to 3, but this is the default and so they had been already used in the previous simulations.
- The stability coefficient is left to the setting used in case 10f (CSTA 0.25), unlike in case 10h.

Note that the chosen values (0.75) of the Dubois limiter parameters are those used in the recent very successful simulations of explosions (confined detonation of solid charges in air) inside pipes performed at NTNU, see [17, 18]. However, in that case the pressures and pressure gradients were probably higher than in the present shock tube tests. The default values (0.50) of the Dubois limiter parameters had been used in all simulations of the shock tube so far, see e.g. [10, 15].

Upon first running, the simulation stopped due to TILT at step 11384, $t = 3.69711$ ms, having used 16 543 s of CPU and after the erosion of 224 elements (half of which due to material failure and the rest due to neighbor failure). The reason for the stop was negative internal energy across VFCC interface 832 913, right element 283 223, a CUVF element whose base element is 21 451. The last printed $v_{\max}$ on the log file was still physical (703 m/s).

We attempt to re-run the same identical simulation by adding the NTIL option (although this should in theory be redundant, since the CENE option is also active). This time the simulation successfully reaches the map trigger time, which happens to be at $t_{\text{map}} = 32.157$ ms, although using an even larger amount of CPU time (11.6 days) than in case D7710600mape.

During the entire simulation, 291 elements are eroded due to material failure and 36 due to the DERO mechanims.

Figure 44 shows the inflation and progressive failure of the firing membranes. The pressurization phase ends at 3 ms. At 4 ms both membranes are already largely damaged. At 8 ms the failure process has substantially terminated (so that the membranes could probably be removed). Very little occurs in the membranes configuration beyond 8 ms, except near the very end of the simulation ($t > 27$ ms) when the membranes bounce slightly back, possibly due to a re-pressurization wave which brings some gas from the driven section back into the driver.

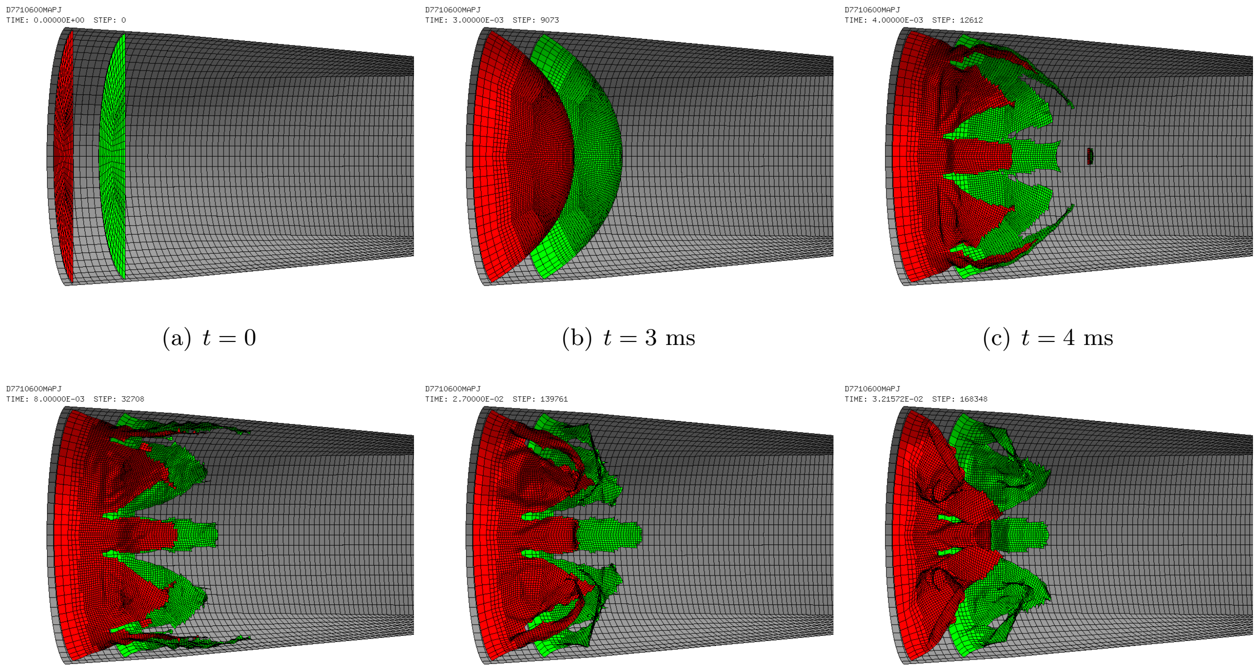
Figure 45 shows the fluid mesh FSI-driven refinement and the fluid pressure. From the fluid pressure maps it can be seen that the tendency for some high pressure to remain “trapped” near the partially failed membranes is somewhat higher than in the previous simulations, cfr. case D7710600mape, Figure 30.

Figure 46 shows the failure patterns of the firing membranes at various times. As it can be seen, at 8 ms both membranes are already completely failed. Very few additional erosions take place between 8 and 32.2 ms.

Figure 47 shows the map file (space) curves at the trigger time (in green) compared with the same curves for case D7710600mapd (in red) and with those for case D7710600mape (in black). The colors chosen are the same as in Figure 32, to allow direct comparison. The difference between the three cases is that in D7710600mapd the membranes were removed at $t = 8$ ms, while in the other two cases they are kept until the final (map trigger) time. The difference between D7710600mape and D7710600mapj is that the latter uses more aggressive values of the Dubois parameters, the CENE option in place of NFAI and the DERO erosion mechanism.

As it can be seen, the black (case e) and green (present case j) map curves are almost identical in the significant part of the tube, say for $x > 7$ m.

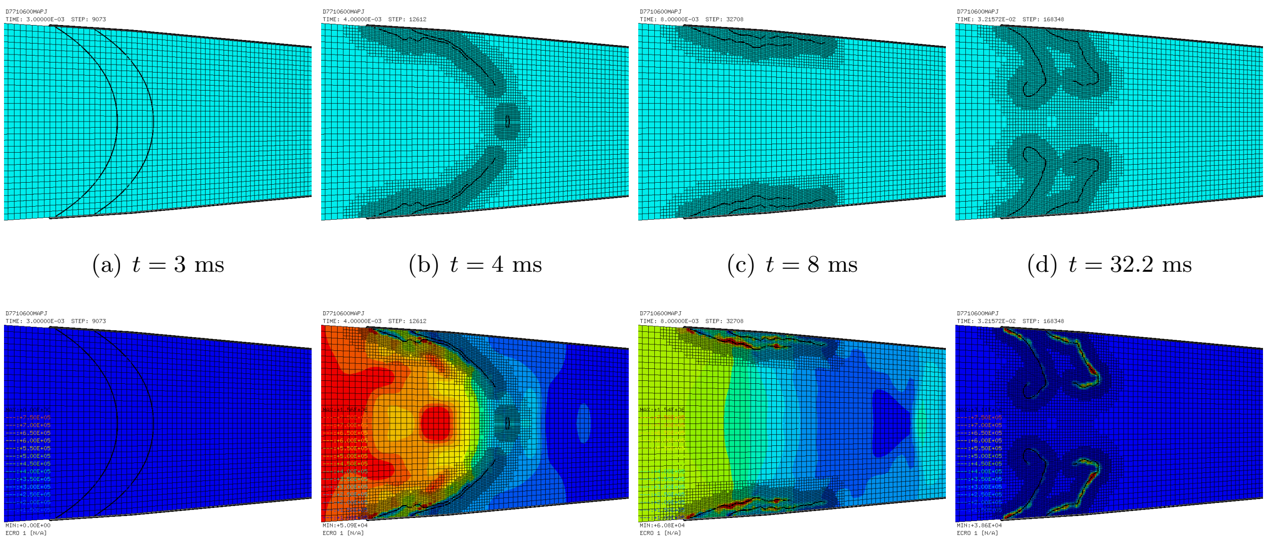
Figure 48 shows the CPU time, the stability step and the (norm of) the maximum velocity during the simulation.



(a) $t = 0$ (b) $t = 3$ ms (c) $t = 4$ ms

(d) $t = 8$ ms (e) $t = 27$ ms (f) $t = 32.2$ ms

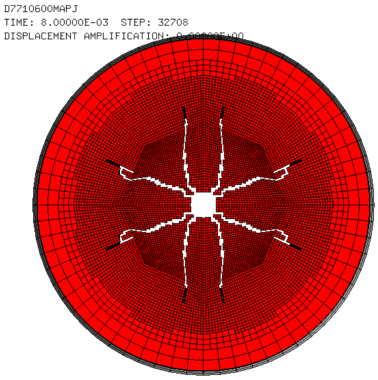
Figure 44: Inflation and progressive failure of the firing membranes in test D7710600mapj.



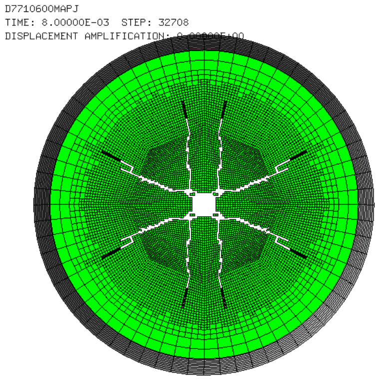
(a) $t = 3$ ms (b) $t = 4$ ms (c) $t = 8$ ms (d) $t = 32.2$ ms

(e) $t = 3$ ms (f) $t = 4$ ms (g) $t = 8$ ms (h) $t = 32.2$ ms

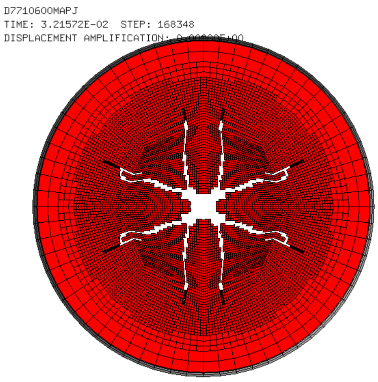
Figure 45: Fluid mesh FSI-driven refinement and the fluid pressure in test D7710600mapj.



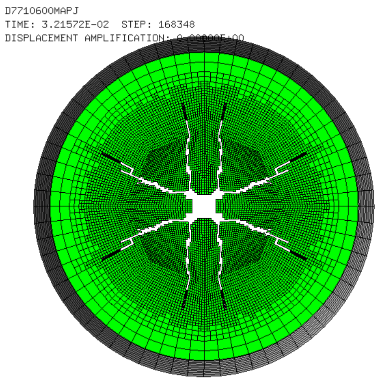
(a) First membrane @ $t = 8$ ms



(b) Second membrane @ $t = 8$ ms

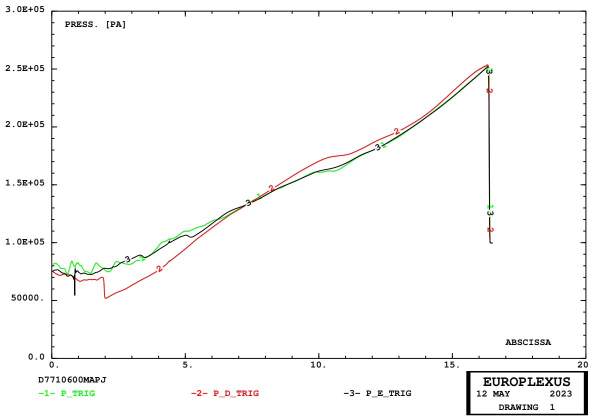


(c) First membrane @ $t = 32.2$ ms

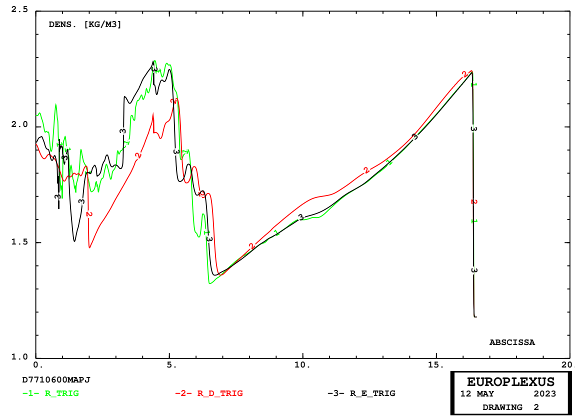


(d) Second membrane @ $t = 32.2$ ms

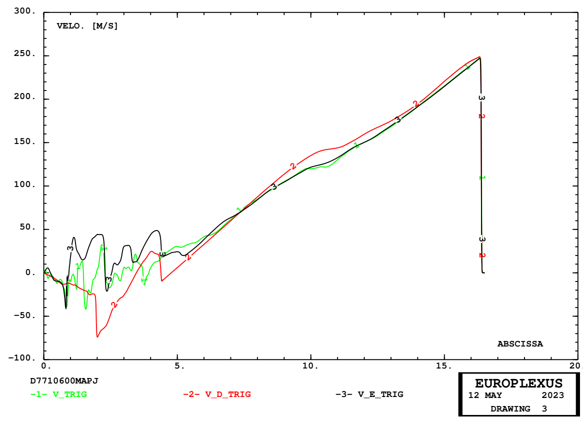
Figure 46: Failure patterns of the firing membranes in test D7710600mapj.



(a) Pressure

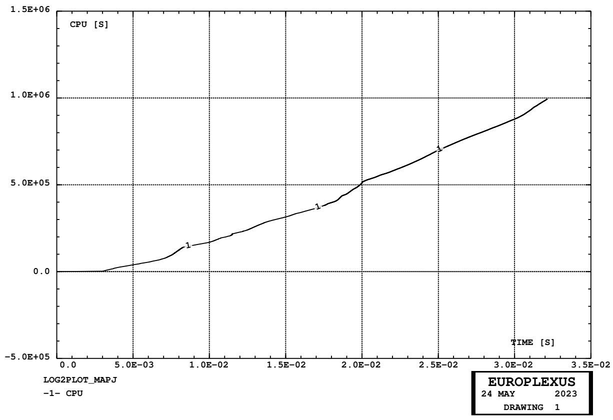


(b) Density

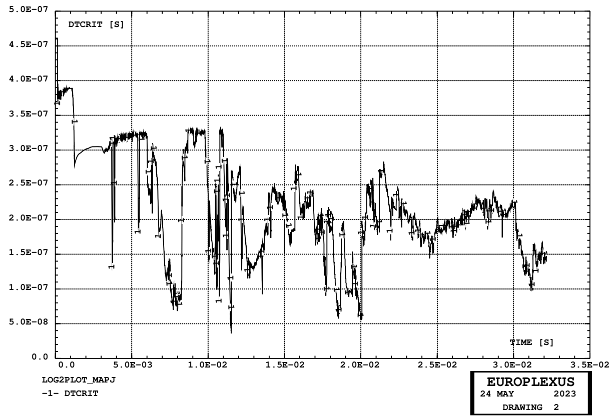


(c) Velocity

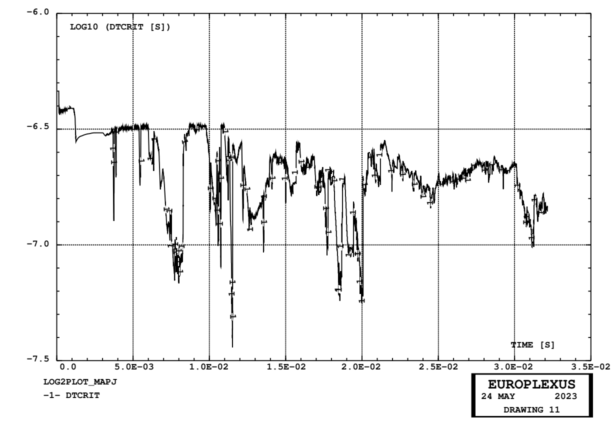
Figure 47: Comparison of map file curves in tests D7710600mapd, D7710600mape and D7710600mapj.



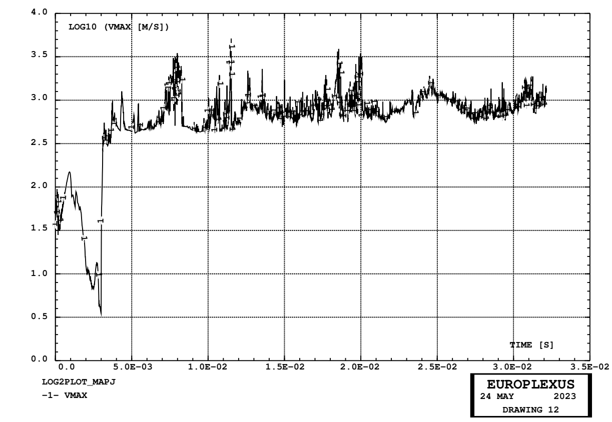
(a) CPU time



(b) Δt



(c) Δt (log scale)



(d) $v_{\max}$ (log scale)

Figure 48: CPU time, stability time step and maximum velocity in test D7710600mapj.

3.17 Checking alternative reconstruction/limiter on a mixed 3D-1D CCFV mesh

After being informed of the numerical difficulties encountered in the simulations, CEA's experts (P. Galon, A. Beccantini) have suggested trying alternative settings of the CCFV parameters:

- Try first order in space. Unfortunately, this is considered unsuitable for the present application because we need a high-accuracy solution due to the length of the shock tube. Nevertheless, a first-order test will be conducted to find out whether all the instabilities come from the second-order formulation.
- Try out `RECO 2` instead of `RECO 1`. In this way, the reconstruction is based on the internal specific energy rather than on the conservative variables. The internal energy should therefore remain strictly positive by construction and there should be no need to use the `CENE` option. A doubt is raised that `RECO 2` is available also in the 1D case. The existence of some benchmarks using it (e.g. BM_VFCC_1D_TCHOC_OE2OT2_PRIM) seems to indicate that this is the case, but a test will be carried out to verify this (see below).
- Use the Barth-Jespersen (B-J) limiter, which is more diffusive but also more robust than the Dubois limiter. To this end it is suggested to set: `LMAS 2 LQDM 2 LENE 2` but also `LVEL 2` and `LPRE 2`. It is not clear, and will have to be ascertained, whether `LVEL` and `LPRE` are used only for the CDEM material (as written in the listing), or also in the present case of GAZP material (as written in the Users' manual [1]). The B-J limiter uses an additional parameter (actually, a switch) K_{Bar}. By default it is $K_{\text{Bar}} = 0$ which activates the standard version of the limiter. Setting $K_{\text{Bar}} = 1$ (`KBAR 1`) activates a modified version of the limiter which is more robust for the calculation of shock waves. So in the present case it is advised to use `KBAR 1`.

To check the above mentioned settings, we first perform some quick tests by using the 1D-3D shock tube model of Section 3.15. This model is probably too simple and does not present real 3D phenomena unlike in the shock tube application near the membranes. However, the scope here is mainly to see whether the code accepts the new proposed setting of the parameters in a case involving a mixed 1D-3D CCFV mesh. The simulations performed are summarized in Table 9 and are described in detail below.

Test	Mesh	Description	t_{fin} [ms]	Steps	CPU [s]
1D3D44	2200 CUVF 1000 TUVF	Idem 24, `RECO 2`	20.0	1 897	19.1
1D3D54	2200 CUVF 1000 TUVF	Idem 24, B-J limiter	20.0	1 900	19.1
1D3D64	2200 CUVF 1000 TUVF	`RECO 2`, B-J limiter	20.0	1 900	19.1

Table 9: Simulations to check the use of alternative reconstruction and limiter.

3.17.1 Case 1D3D44

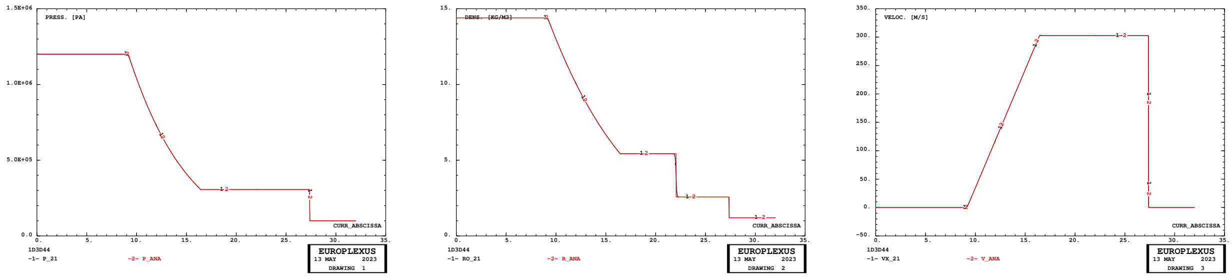
This case is similar to test 1D3D24 of Section 3.15.2 but we use `RECO 2` (specific internal energy) instead of `RECO 1` (conservative variables) for the reconstruction.

The calculation succeeded. Results are visually very similar (although not identical, according to diff on the .PS curves) to those of case 1D3D24. They are shown in Figure 49. These results confirm that `RECO 2` can indeed be used in 1D VFCC models.

3.17.2 Case 1D3D54

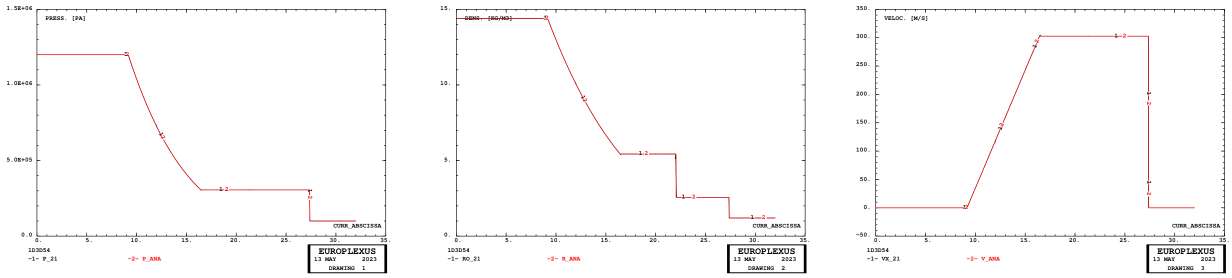
This case is similar to test 1D3D24 of Section 3.15.2 (`RECO 1`) but we use the B-J limiter: `LMAS 2`, `LQDM 2`, `LENE 2`, but also `LVEL 2` and `LPRE 2`, plus `KBAR 1`.

The calculation succeeded. Results are visually very similar (although not identical, according to diff on the .PS curves) to those of case 1D3D24. They are shown in Figure 50. These results confirm that the B-J limiter can indeed be used in 1D VFCC models.



(a) Pressure (b) Density (c) Sound speed

Figure 49: Some results of test 1D3D44.



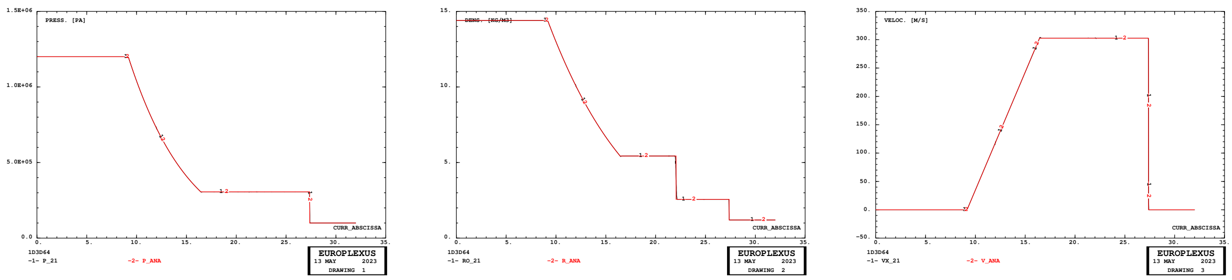
(a) Pressure (b) Density (c) Sound speed

Figure 50: Some results of test 1D3D54.

3.17.3 Case 1D3D64

This case is similar to test 1D3D44 (`RECO 2`) but we use the B-J limiter like in case 1D3D54, thus combining all suggested parameter modifications.

The calculation succeeded. Results are visually very similar (although not identical, according to diff on the .PS curves) to those of case 1D3D24. They are shown in Figure 51. These results confirm that the `RECO 2` combined with the B-J limiter can indeed be used in 1D VFCC models.



(a) Pressure (b) Density (c) Sound speed

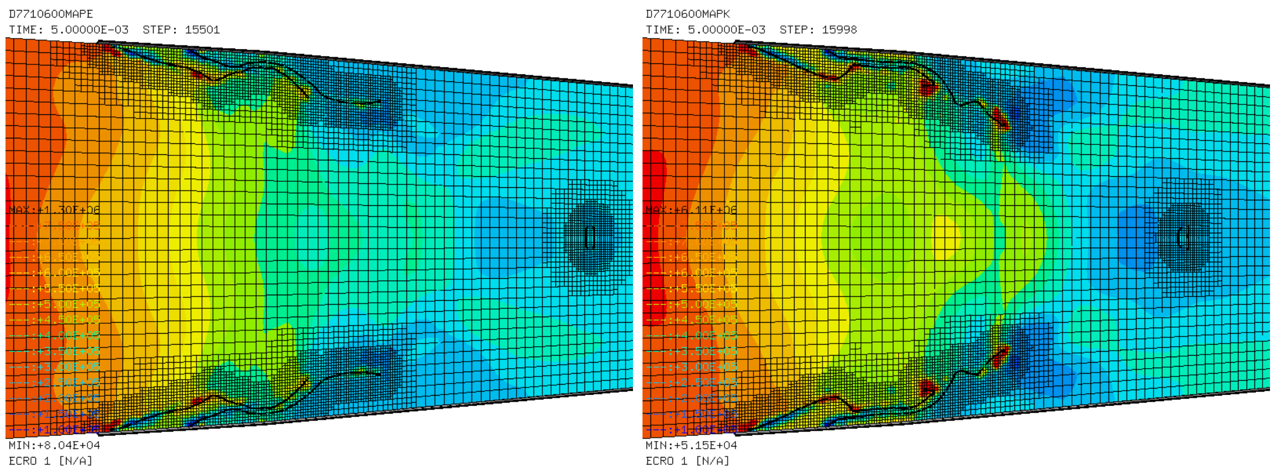
Figure 51: Some results of test 1D3D64.

3.18 Case D7710600mapk

This is a repetition of case D7710600mape described in Section 3.9 by using `FSCP 0` instead of `FSCP 1` in the FLSW model of FSI. This means that CCFV numerical fluxes will be blocked only along the direction normal to the structure, rather than along all spatial directions. Consequently, the fluid will be free to slide along the membranes, thus hopefully reducing the probability for high-pressure pockets to be trapped in the vicinity of the membranes.

Unfortunately, the simulation stopped at $t = 5.73$ ms due to the onset of an enormous velocity (10^{32}) occurring in just one step on a shell node (101 135). At the immediately previous steps the maximum velocity was about 9000 m/s in some fluid volumes. The last storage station in the ALIC file was at 5.0 ms.

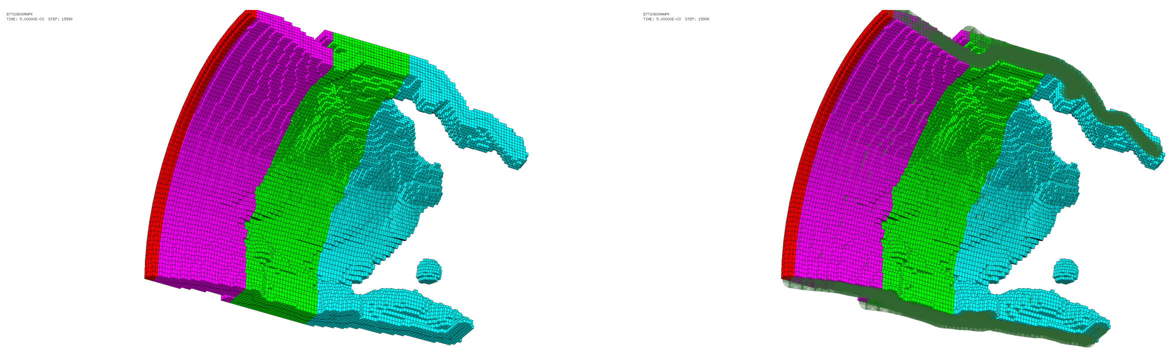
Figure 52 compares the fluid pressures near the partially failed membranes at $t = 5.0$ ms between cases D7710600mape (`FSCP 1`) and D7710600mapk (`FSCP 0`). It can be seen that even larger high-pressure pockets are formed than in the reference case. Therefore, setting `FSCP` to `0` does not solve the problem.



(a) D7710600mape (`FSCP 1`) (b) D7710600mapk (`FSCP 0`)

Figure 52: Comparison of fluid pressures at 5 ms in tests D7710600mape and D7710600mapk.

Figure 53 shows the coupled fluid and the structural influence domain of the partially failed membranes at $t = 5.0$ ms.



(a) Coupled fluid (b) Idem plus influence domain

Figure 53: Coupled fluid and structural influence domain at 5 ms in test D7710600mapk.

By inspection, it appears evident that the thickness of the coupled fluid layer is excessive. This may perhaps contribute to the formation of the observed high-pressure pockets, since fluid fluxes are blocked (either directionally or completely) within the coupled fluid layer (structural influence domain).

3.19 Case D7710600mapl

Following the disappointing results of test D7710600mapk, it is decided to revise the FSI coupling parameters, as well as the related AMR settings, used in the simulations so far. As already observed in the previous test case, the thickness of the coupled fluid layer (i.e. the thickness of the membranes influence domain) appears excessive. Besides possibly contributing to the persistence of high-pressure pockets, this penalizes the CPU time of the solution due to an excessive number of small fluid elements generated (also due to the scaling factor `SCAL 2` used in the `FLSW ADAP` command).

Furthermore, the size of the (fully refined) fluid mesh seems inappropriate, namely too large, with respect to the (fully refined) structural mesh in the central part of the membranes. Recall in fact that, in theory, a (much) finer fluid mesh than the structural mesh is required for an embedded-type FSI algorithm such as FLSW to work properly. This said, in several applications excessively large fluid meshes were used in the past, in order to reduce the cost of the simulation which is dominated by the number of fluid volumes, with acceptable results. But this might not be true in the present application.

Closer inspection of the present case shows that this (i.e. the simulation of the membranes) is a particularly tough situation. Already the base structural mesh is very non-uniform, namely finer near the center of the membranes (from where cracks are expected to start) and coarser near the outer perimeter. And the (base) fluid mesh is also correspondingly uneven, since it is build by following the same logic.

Therefore, using a constant thickness of the influence domain (i.e. a constant influence radius `R 0.025` in the `FLSW` directive) might be inappropriate here. It might be better to prescribe a variable radius, by using the `GAMM` keyword instead of `R`, see [1]. In this way, the local radius is computed based on the size of the local fluid mesh. This requires an extra search over the fluid elements, and therefore the computational cost is increased with respect to the case of constant `R`, but one might perhaps save something in the total number of refined fluid elements.

In order to check out this setting relatively rapidly, this test provisionally uses low-resolution FSI. That is, the maximum refinement level of the membranes is reduced from 3 to 2 (`ADAP THRS MAXL 2`). This is inappropriate for a precise detection of the membrane cracks, but will give at least an approximate solution.

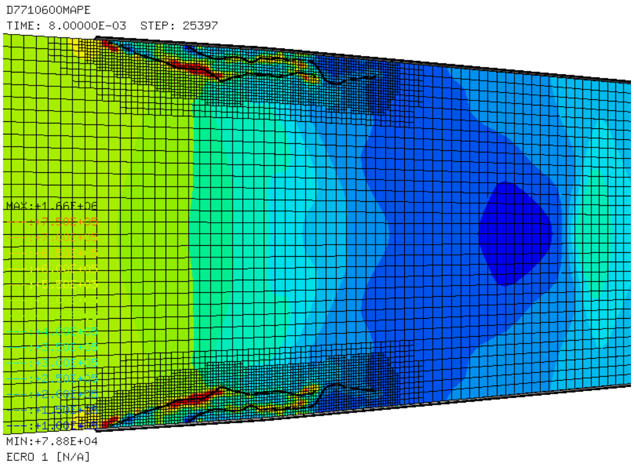
The changes in the present case with respect to case D7710600mape can be summarized as follows:

- Reduce the structural refinement (`MAXL`) from level 3 to level 2.
- Use a variable radius of the structural influence domain by setting `GAMM 1.1` instead of `R 0.025` in the `FLSW ADAP` directive.
- Use an automatically computed grid size instead of a user-specified grid size for the main fast search grid, namely `DELE 1.1` instead of `HGRI 0.016`. In this way, the grid size is computed by EPX based on the size of the largest coupled structural element.
- Use a lower scaling factor for the determination of fluid elements to be refined, `SCAL 1.5` instead of `2.0`.

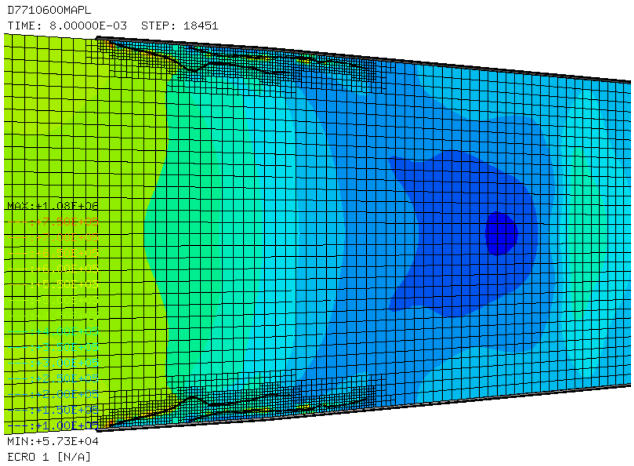
The simulation stopped at $t = 8.27$ ms with an error message in BUILD_FELCSN_W saying that "there are FLSW nodes outside the fast search grid". This problem will have to be investigated.

Figure 54 compares the fluid pressures near the partially failed membranes at $t = 8.0$ ms between cases D7710600mape (`R 0.025`) and D7710600mapl (`GAMM 1.1`). The thickness of the coupled fluid layer is much smaller and the high-pressure pockets seem reduced with respect to the reference.

The differences in the overall solutions (pressure levels, position of the membranes) are attributed to the fact that this is a low-resolution FSI solution. See e.g. the failure patterns of the membranes at 8.0 ms, which are compared against the reference in Figure 55. A full-resolution test will have to be conducted next.

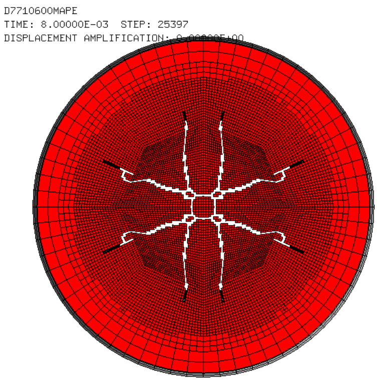


(a) D7710600mape (`R 0.025`)

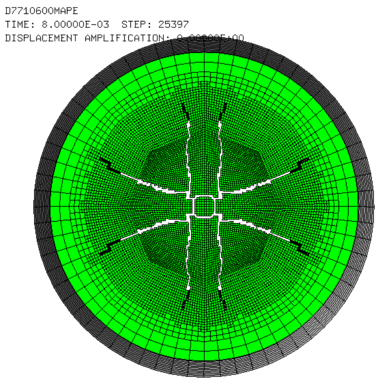


(b) D7710600mapl (`GAMM 1.1`)

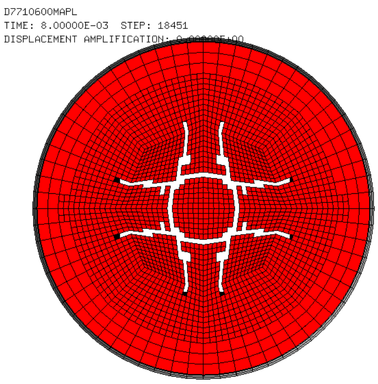
Figure 54: Comparison of fluid pressures at 8 ms in tests D7710600mape and D7710600mapl.



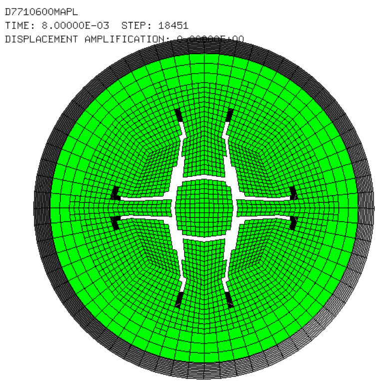
(a) First membrane, test 10e



(b) Second membrane, test 10e



(c) First membrane, test 10l



(d) Second membrane, test 10l

Figure 55: Comparison of membranes erosion at 8 ms in tests D7710600mape and D7710600mapl.

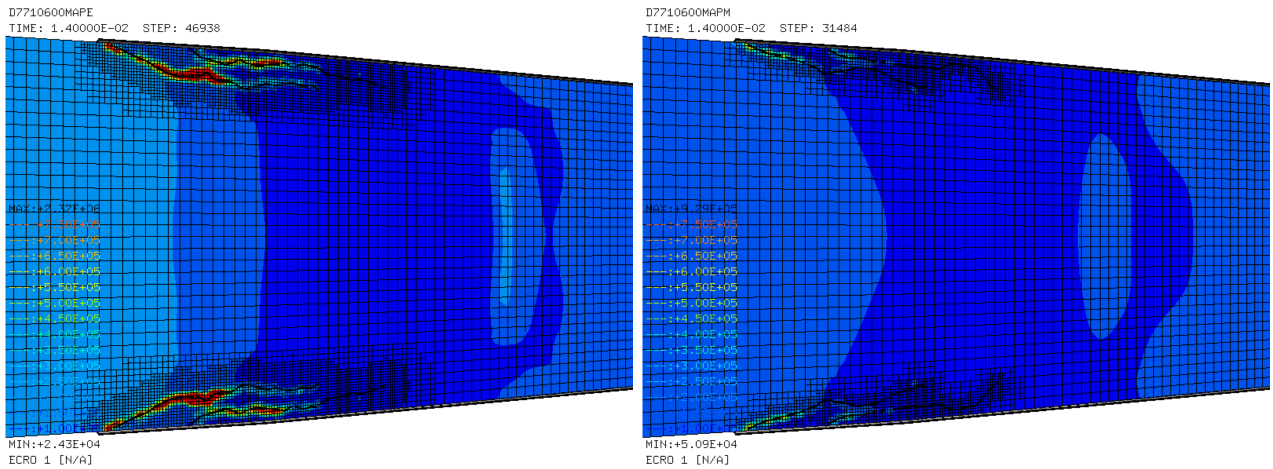
3.20 Case D7710600mapm

After inspection of BUILD_FELCSN_W, it was decided to simply transform the error message into an attention message (with a limit of 10 messages) and let the calculation go on. In fact, it may happen that some structure nodes initially lie outside of the coupled fluid domain, or (like in this case) move outside that domain during the simulation. Therefore, some structure node might end up finding itself outside the fast search grid. In that case, we tentatively assume that simply no FSI coupling should occur on those nodes.

This test is a repetition of case D7710600mapl with the corrected executable. Unfortunately, the simulation stopped at about $t = 14.0$ ms with an error message saying:

```
ERROR   1 *** ADAPT_FLSW *** PING-PONG DUE TO RCON
```

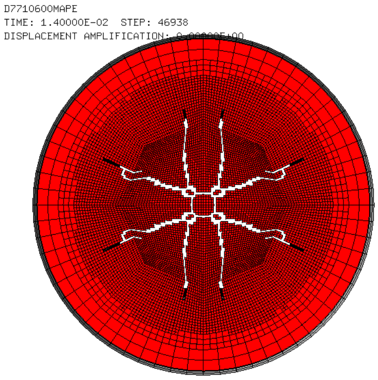
Figure 56 compares the fluid pressures near the partially failed membranes at $t = 14.0$ ms between cases D7710600mape (`R 0.025`) and D7710600mapm (`GAMM 1.1`). The thickness of the coupled fluid layer is much smaller and the high-pressure pockets seem reduced with respect to the reference.



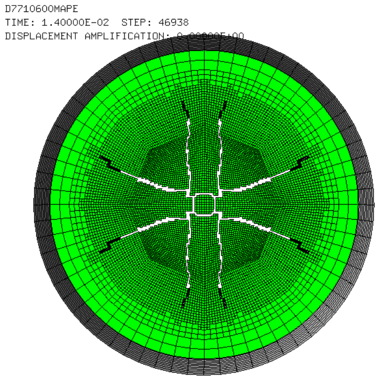
(a) D7710600mape (`R 0.025`) (b) D7710600mapm (`GAMM 1.1`)

Figure 56: Comparison of fluid pressures at 14 ms in tests D7710600mape and D7710600mapm.

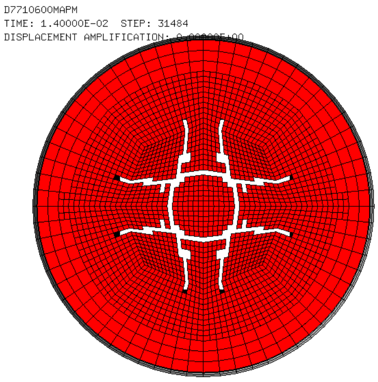
The differences in the overall solutions (pressure levels, position of the membranes) are attributed to the fact that this is a low-resolution FSI solution. See e.g. the failure patterns of the membranes at 8.0 ms, which are compared against the reference in Figure 57. A full-resolution test will have to be conducted next.



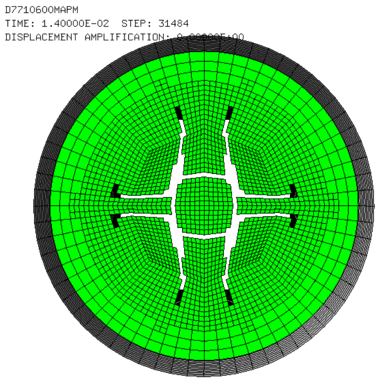
(a) First membrane, test 10e



(b) Second membrane, test 10e



(c) First membrane, test 10l



(d) Second membrane, test 10l

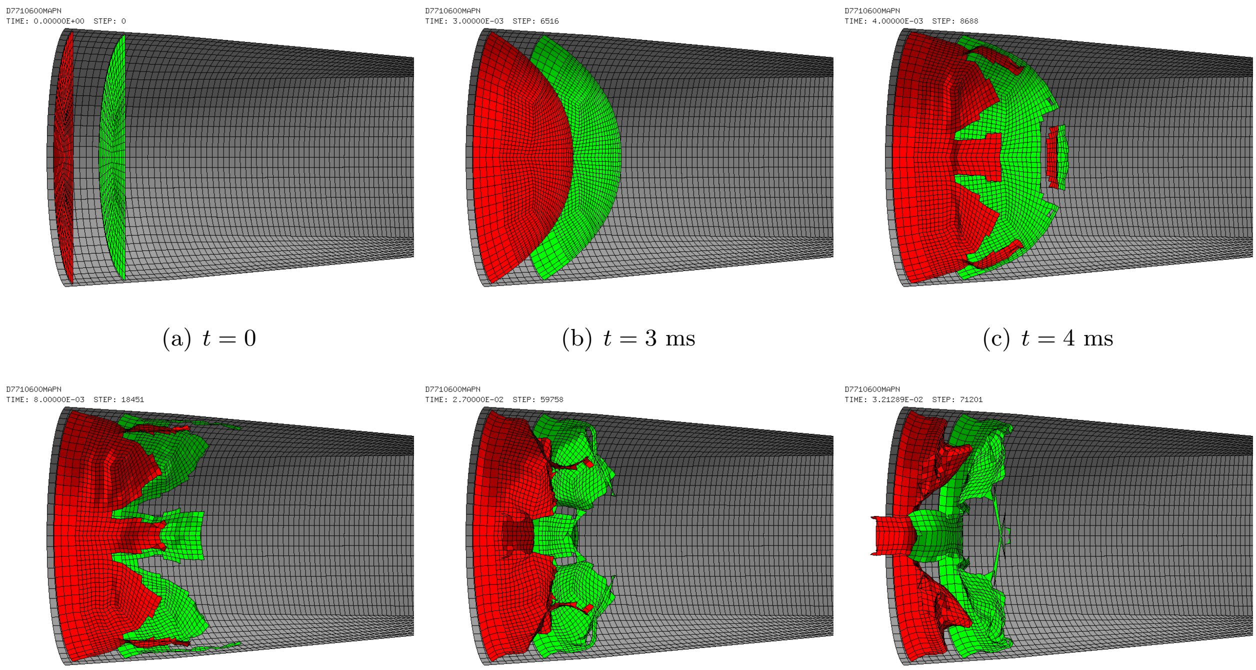
Figure 57: Comparison of membranes erosion at 14 ms in tests D7710600mape and D7710600mapm.

3.21 Case D7710600mapn

After inspection of subroutine ADAPT_FLSW from module M_LINK_FLSW, it was decided to simply transform the error message into an attention message (with a limit of 10 messages) and let the calculation go on. The same is done also in subroutine ADAPT_FLSR from module M_LINK_FLSR, for uniformity. Note that the same correction (concerning PING-PONG due to RCON) had been done some time ago also in subroutine ADAPT_PINB from module M_PINS_ADAP.

This test is a repetition of case D7710600mapm with the corrected executable. The map file production trigger is activated, and the simulation is automatically stopped, at $t_{\mathrm{map}} = 32.129$ ms, after about 6.3 days of CPU time.

Figure 58 shows the inflation and progressive failure of the firing membranes. The pressurization phase ends at 3 ms. At 4 ms both membranes are already largely damaged. At 8 ms the failure process has substantially terminated (so that the membranes could probably be removed). Very little occurs in the membranes configuration beyond 8 ms, except near the very end of the simulation ($t > 27$ ms) when the membranes bounce slightly back, possibly due to a re-pressurization wave which brings some gas from the driven section back into the driver.

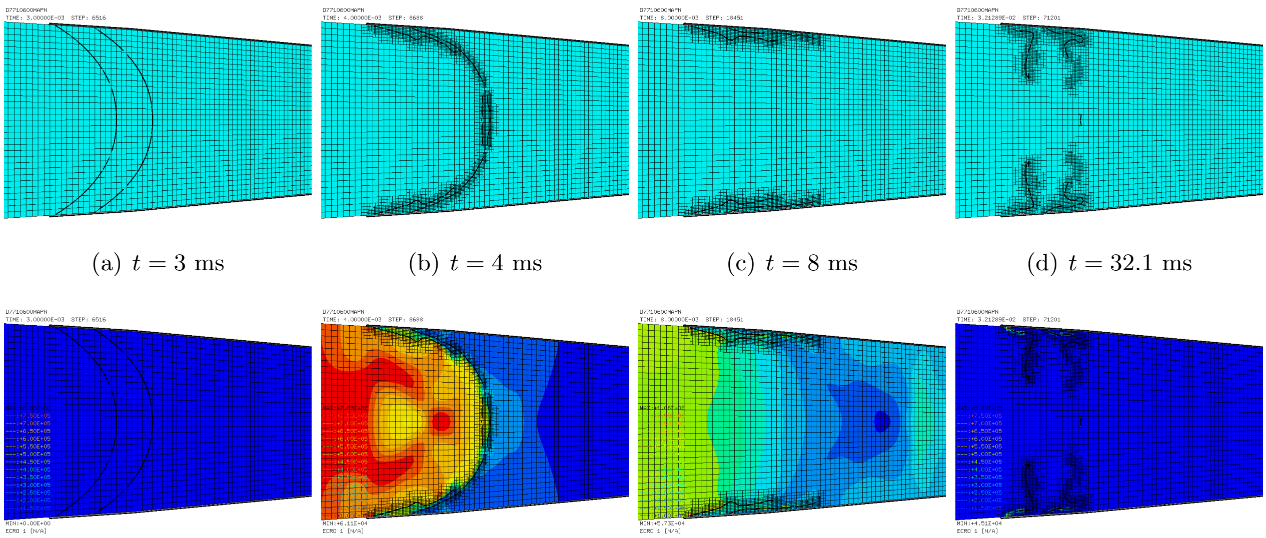


(a) $t = 0$ (b) $t = 3$ ms (c) $t = 4$ ms

(d) $t = 8$ ms (e) $t = 27$ ms (f) $t = 32.1$ ms

Figure 58: Inflation and progressive failure of the firing membranes in test D7710600mapn.

Figure 59 shows the fluid mesh FSI-driven refinement and the fluid pressure.

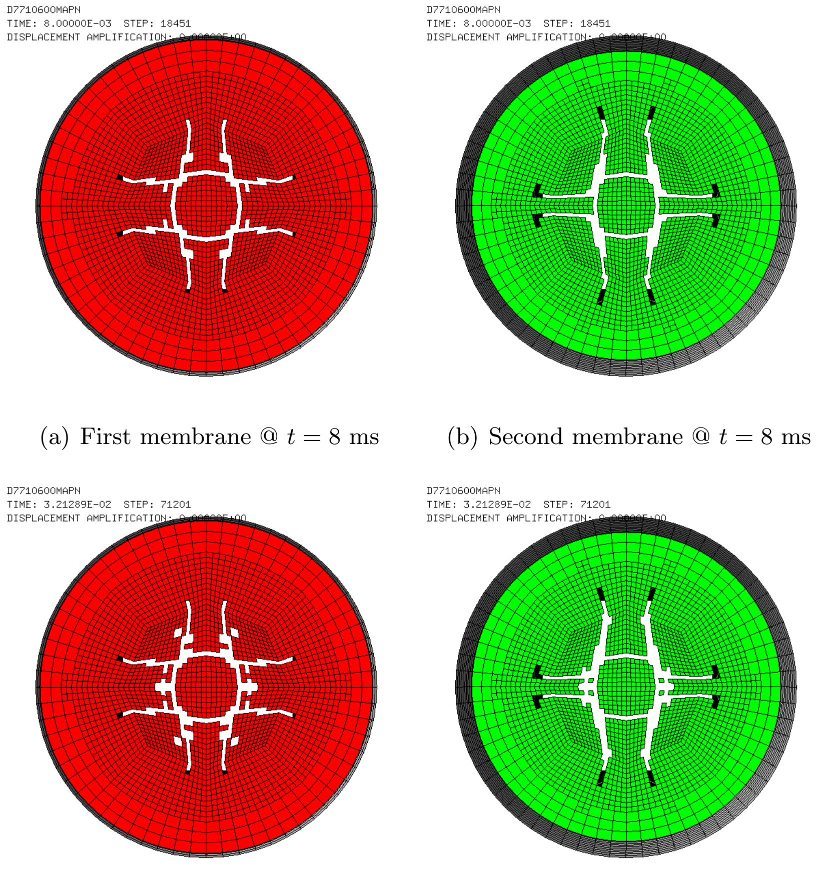


(a) $t = 3$ ms (b) $t = 4$ ms (c) $t = 8$ ms (d) $t = 32.1$ ms

(e) $t = 3$ ms (f) $t = 4$ ms (g) $t = 8$ ms (h) $t = 32.1$ ms

Figure 59: Fluid mesh FSI-driven refinement and the fluid pressure in test D7710600mapn.

Figure 60 shows the failure patterns of the firing membranes at various times. As it can be seen, at 8 ms both membranes are already completely failed. Very few additional erosions take place between 8 and 32.2 ms.

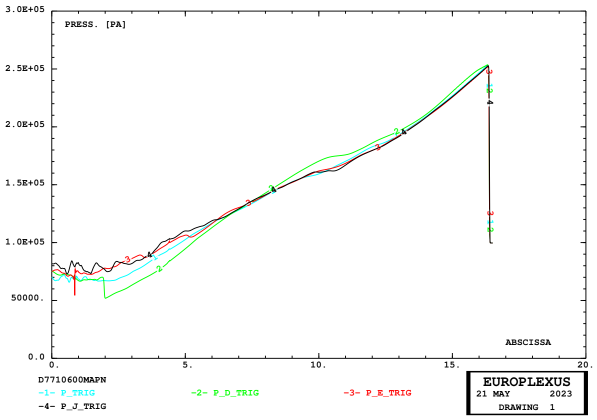


(a) First membrane @ $t = 8$ ms (b) Second membrane @ $t = 8$ ms

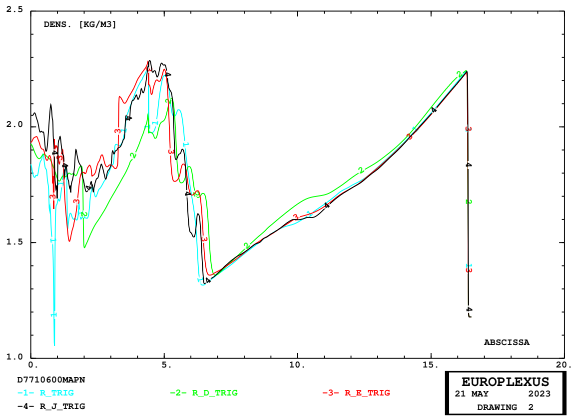
(c) First membrane @ $t = 32.1$ ms (d) Second membrane @ $t = 32.1$ ms

Figure 60: Failure patterns of the firing membranes in test D7710600mapn.

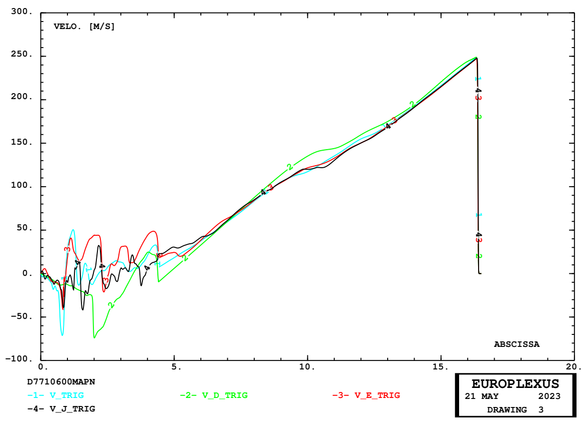
Figure 61 shows the map file (space) curves at the trigger time (in cyan), compared with the same curves for case D7710600mapd (in red), with those for case D7710600mape (in black) and those for case D7710600mapj (in green). The colors chosen are the same as in Figure 47, to allow direct comparison. The difference between the four cases is that in D7710600mapd the membranes were removed at $t = 8$ ms, while in the other three cases they are kept until the final (map trigger) time. The difference between D7710600mape and D7710600mapj is that the latter uses more aggressive values of the Dubois parameters, the `CENE` option in place of `NFAI` and the `DERO` erosion mechanism.



(a) Pressure



(b) Density

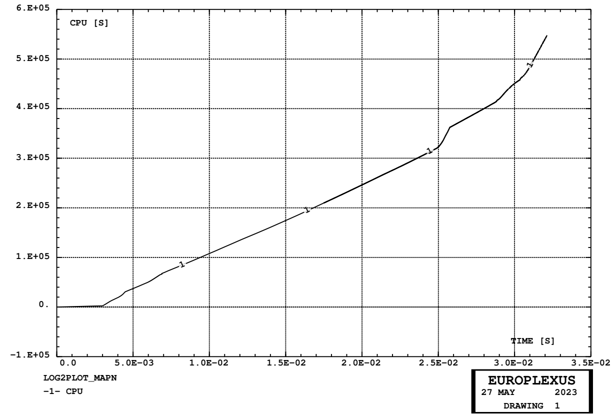


(c) Velocity

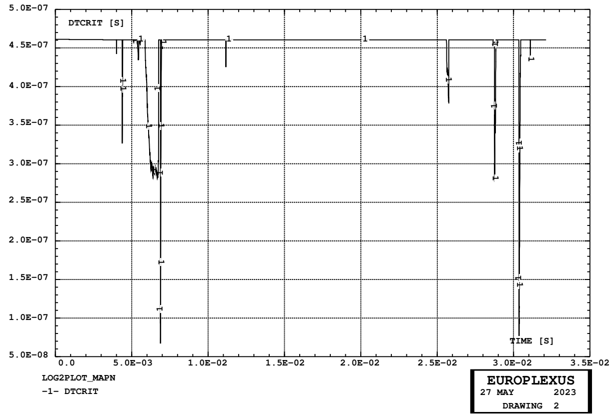
Figure 61: Comparison of map file curves in tests D7710600mapd, mape, mapj and mapn.

As it can be seen, the black (case e), green (case j) and cyan (present case n) map curves are almost identical in the significant part of the tube, say for $x > 7$ m.

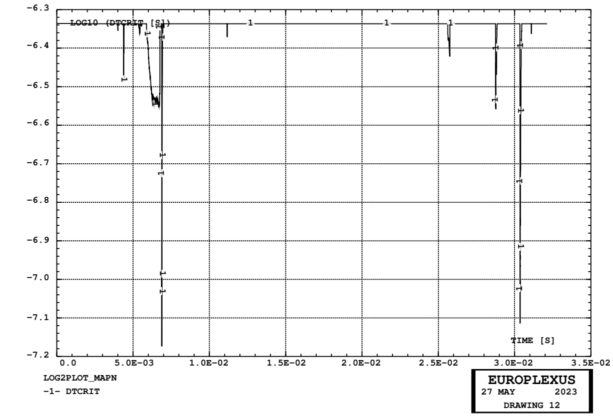
Figure 62 shows the CPU time, the stability step, the (norm of) the maximum velocity and the CPU time per step during the simulation.



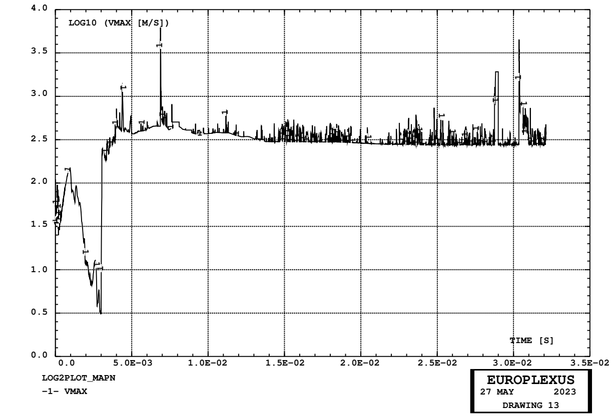
(a) CPU time



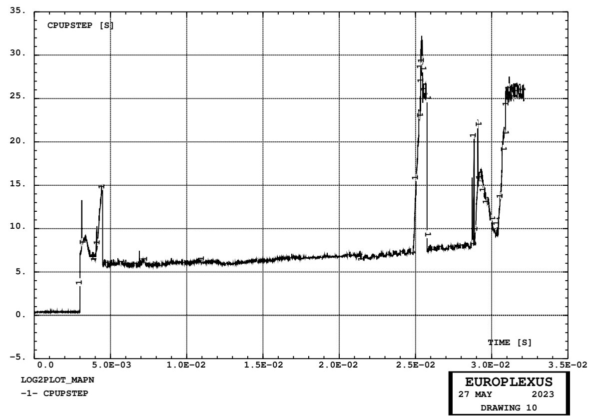
(b) Δt



(c) Δt (log scale)



(d) $v_{\max}$ (log scale)



(e) CPU time per step

Figure 62: CPU time, stability time step and maximum velocity in test D7710600mapn.

From Figure 62(e) it can be observed that the CPU cost per step of the simulation has some unexpected (and sometimes persistent) spikes after about 25 ms, which penalize the overall cost of the simulation. This behavior is surprising since the cost of the simulation *per step* should not vary so much, since it has nothing to do with the step size which, on the other hand, might drop thus pebalizing the efficiency of the calculation. But the latter does not vary too much in this example.

There are some sudden drops, but the normal value is recovered rapidly.

This behavior will have to be investigated. A possible (suspect) candidate for the large increase of the per step cost observed could be the (supposedly fast) search of the fluid element containing each structural node, which is only carried on when the `GAMM` parameter (not `R`) is used, like in the present case.

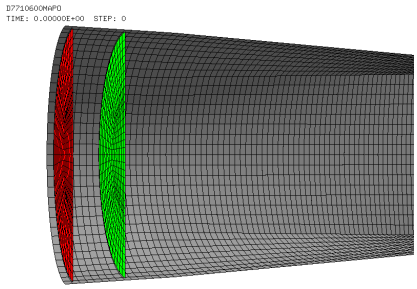
In this regard, it should be observed that in this simulation the membrane fragments are not eroded according to the displacement criterion (`DERO`) and therefore, if they fly a long distance away, they could cause the abnormal extension of the fast search domain (fast search grid).

3.22 Case D7710600mapo

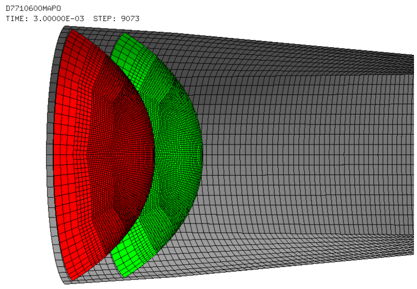
This test is similar to D7710600mapl/m/n but we restore membranes refinement to level 3 (`ADAP THRS MAXL` 3). In the `FLSW ADAP` directive we use `GAMM` 1.1, `DELE` 1.1, `LMAX` 4 and `SCAL` 1.2.

The simulation was very slow (as it could have been expected) and took about 14.3 days of CPU to reach the first 8 ms.

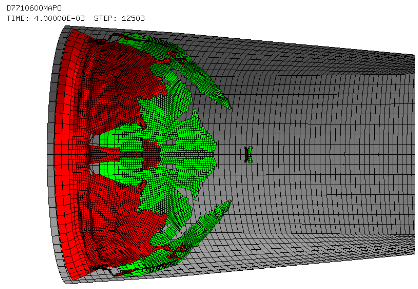
Figure 63 shows the inflation and progressive failure of the firing membranes. The pressurization phase ends at 3 ms. At 4 ms both membranes are already largely damaged. At 8 ms the failure process has substantially terminated (so that the membranes could probably be removed).



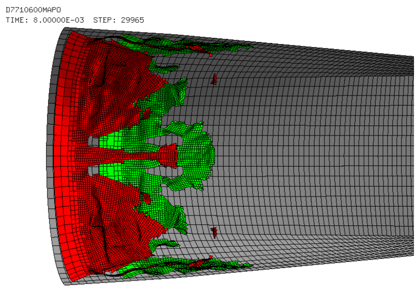
(a) $t = 0$



(b) $t = 3$ ms



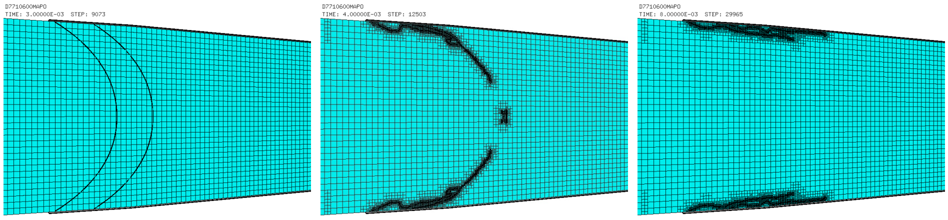
(c) $t = 4$ ms



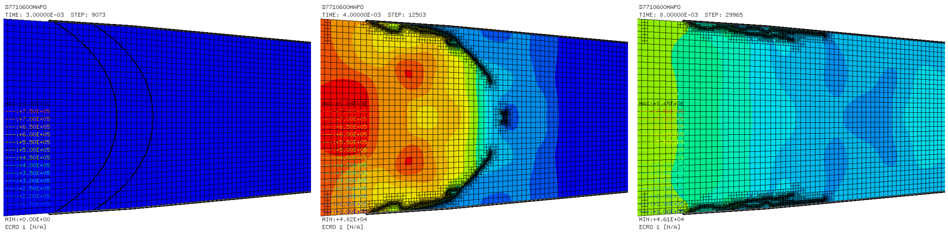
(d) $t = 8$ ms

Figure 63: Inflation and progressive failure of the firing membranes in test D7710600mapo.

Figure 64 shows the fluid mesh FSI-driven refinement and the fluid pressure. The fully refined fluid zone near the structure is very narrow.



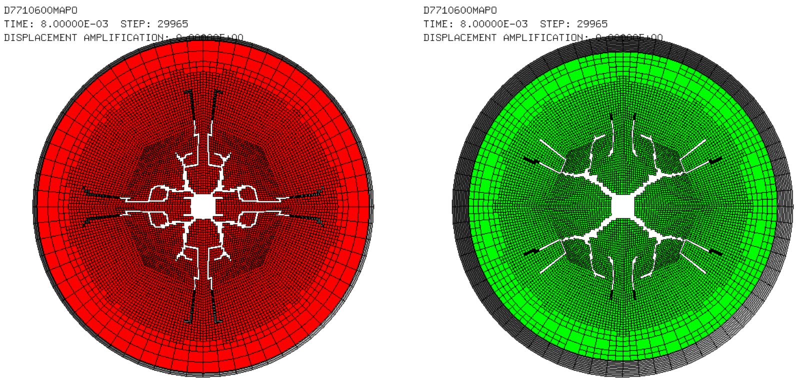
(a) $t = 3$ ms (b) $t = 4$ ms (c) $t = 8$ ms



(d) $t = 3$ ms (e) $t = 4$ ms (f) $t = 8$ ms

Figure 64: Fluid mesh FSI-driven refinement and the fluid pressure in test D7710600mapo.

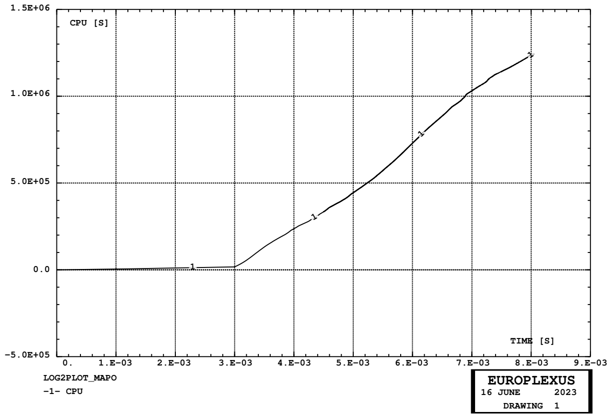
Figure 65 shows the failure patterns of the firing membranes at various times. As it can be seen, at 8 ms both membranes are already completely failed.



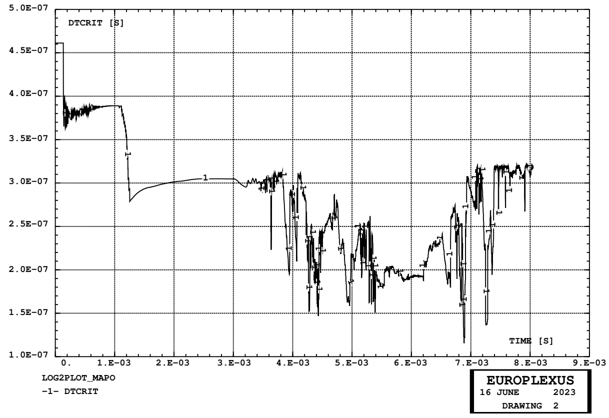
(a) First membrane @ $t = 8$ ms (b) Second membrane @ $t = 8$ ms

Figure 65: Failure patterns of the firing membranes in test D7710600mapo.

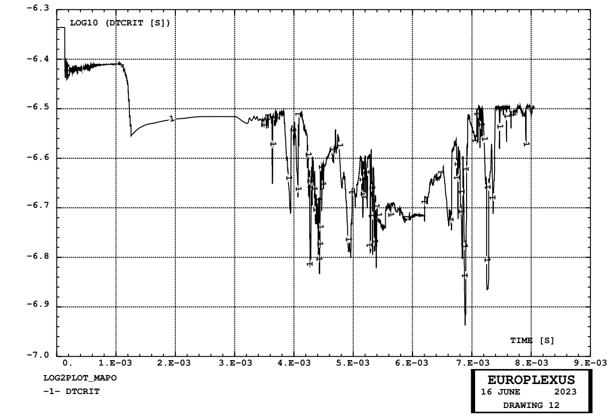
Figure 66 shows the CPU time, the stability step, the (norm of) the maximum velocity and the CPU time per step during the simulation.



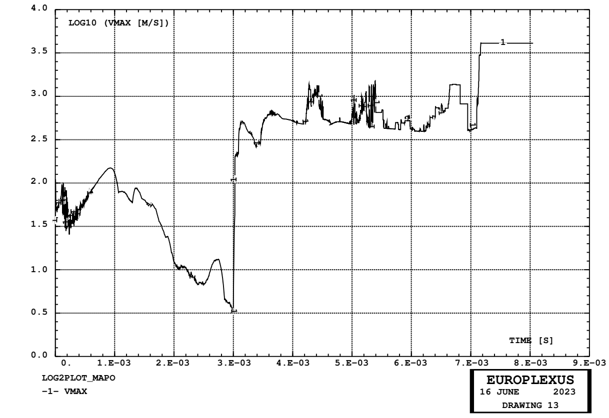
(a) CPU time



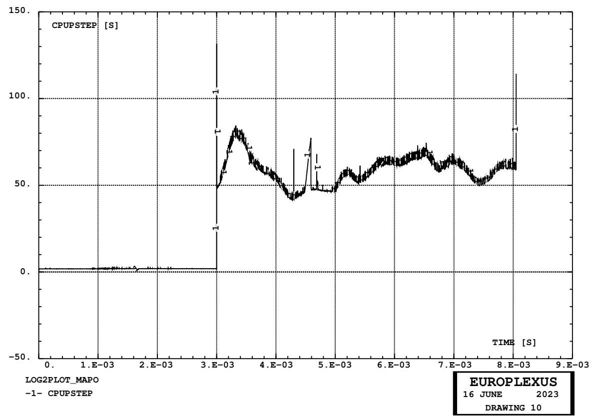
(b) Δt



(c) Δt (log scale)



(d) $v_{\max}$ (log scale)



(e) CPU time per step

Figure 66: CPU time, stability time step and maximum velocity in test D7710600mapo.

4 Eulerian simulations

In this Section we use some of the map files obtained in Section 3 in order to run Eulerian simulations aimed at producing the pressure time curves that will be used in the successive set of Lagrangain (uncoupled) simulations to be described in Section 5. The strategy behind this procedure is explained in references [10, 15].

In the Eulerian simulations, only the fluid is represented. The model consists of the 3D fluid domain from the mapping simulations (without the membranes), the 1D fluid domain from the said simulations, plus an extra 3D fluid domain which extends until the nominal position of the specimen (plate) to be tested. The plate is not included, and the right end of the model represents a rigid wall, i.e. a rigid plate.

The scope is to measure the blast pressure acting on the final wall, at nine different sampling positions spread over the cross section, from which one can obtain a single time signal (called the Eulerian pressure history in the following), representing the average pressure that would act on an ideal perfectly rigid plate placed at the end of the shock tube. Experience has shown that the nine signals obtained are almost identical in practice, see [15], since the pressure is evenly distributed over the ideally rigid plate. Therefore, it makes sense to use a single pressure signal (the average one) in order to (uniformly) load the test deformable plate in the successive Lagrangian simulations.

The Eulerian simulations performed are summarized in Table 10.

Case	Map file	Map date (start)	p^* [bar]	t_{map} [ms]	t_{fin} [ms]	Steps	CPU [s]	RAM [GB]	Sto. [GB]
ST_EUL_10	D7710600mape_01.map	01/05/23	10	32.2	44.0	4 638	4 317	2.1	1.5

Table 10: Eulerian simulations.

4.1 Case ST_EUL_10

This test uses as a basis the Eulerian mesh from the 2021 Eulerian simulation at 5 bar nominal pressure (case ST_EUL_05 from the NTNU database [15]). The initial fluid material properties (`MATE` directive) are updated so they correspond to those of the 10 bar case, see Table 3. The initial state of the fluid in the mapped parts of the fluid domain is read back from the map file produced in case D7710600mape of Section 3.9, named D7710600mape_01.map. The modified parts of the input file with respect to the 5 bar case (from 2021) are marked in red below:

```
ST_EUL_10
ECHO
!CONV win
CAST mesh
TRID EULE
!EROS 1.0
DIME
     JONC 1180 ! Total n. of nodes in a TUBM juncton
     NALE 1 NBLE 1
     TERM
GEOM ! T3GS fake
     CUVF flui3d tubelp3 ! tank
     TUVF tubelp1
     CL3D face3d stub3d ! pre
     TUBM rac3d1d raclp
TERM
COMP ! EPAI 3.00E-3 LECT fake TERM
     DIAM DROI 0.1692568 LECT tubelp1 TERM
     RACC TUBM LECT rac3d1d  TERM
          NTUB LECT p1a   TERM DTUB 0.1692568
          FACE LECT face3d TERM COEF 1.0
     RACC TUBM LECT raclp  TERM
          NTUB LECT p1d3   TERM DTUB 0.1692568
          FACE LECT stub3d TERM COEF 1.0
! Attention: the TUBM element (raclp) is NOT included
! in the "mesh" object (although it IS indeed passed in from Cast3m).
! For this reason we must add it explicitly in the GROU directive below
! if we want to have it in the extracted element groups.
     GROU 17 'endtube' LECT tube TERM COND XB GT -0.6
            'trigger' LECT tube TERM COND NEAR POIN -0.1501 0 0
            'frefine' LECT flui TERM COND XB GT -0.3
                                     COND XB LT  1.0
            'S1' LECT tube TERM COND NEAR POIN 0 0 0.12
            'S2' LECT tube TERM COND NEAR POIN 0 0 0.06
            'S3' LECT tube TERM COND NEAR POIN 0 0 0
            'S4' LECT tube TERM COND NEAR POIN 0 0.06 0.12
            'S5' LECT tube TERM COND NEAR POIN 0 0.06 0.06
            'S6' LECT tube TERM COND NEAR POIN 0 0.06 0
            'S7' LECT tube TERM COND NEAR POIN 0 0.12 0.12
            'S8' LECT tube TERM COND NEAR POIN 0 0.12 0.06
            'S9' LECT tube TERM COND NEAR POIN 0 0.12 0
            'S01' LECT tube TERM COND NEAR POIN -0.245 0 0.15
            'S02' LECT tube TERM COND NEAR POIN -0.345 0 0.15
            'epar1' LECT tubelp1 TERM COND NEAR NODE LECT p1a TERM
            'epar2' LECT tubelp1 TERM COND NEAR NODE LECT p1d3 TERM
            'tubelpp' LECT tubelp1 DIFF epar1 epar2 TERM
     NGRO 1 'pt0' LECT tube TERM COND NEAR POIN -16.19999 0.0 0.0
     COUL TURQ LECT tube tra lp3xl TERM
          VERT LECT fir2 TERM
          ROSE LECT fir1 TERM
          ROUG LECT driver TERM
         ROSE LECT S1 S2 S3 S4 S5 S6 S7 S8 S9 S01 S02 TERM
MATE
    !LOI 2
     GAZP RO 13.445 GAMM 1.4 CV 719.286 PINI 11.36E5 PREF 9.968E4
          LECT none TERM
    !LOI 3
     GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
          LECT none TERM
    !LOI 4
     GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
          LECT none TERM
    !LOI 5
     GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
          LECT flui3d TERM ! _cuvf TERM
     GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
          LECT epar1 epar2 TERM
     GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
          LECT rac3d1d raclp tubelpp TERM
     PARO PSIL 0.02
          LECT tubelpp TERM
     MULT 6 7 LECT tubelpp TERM
! In order to obtain a printout at least of the 3D VFCCs I am obliged
! to use a different material for tubelp3 and other 3D parts, but with
```

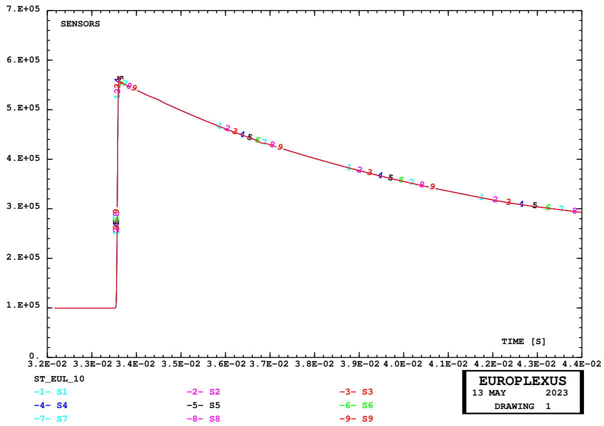
```
! the same characteristics as the material used for tubelp1
     GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
          LECT tubelp3 _cuvf TERM ! tank _cuvf TERM
INIT MAPP FORM 'D7710600mape_01.map' MATC OBJE LECT flui3d tubelp1 TERM
ECRI DEPL VITE ECRO FAIL TFRE 0.25E-3
          POIN LECT pt0 TERM
          ELEM LECT S1 TERM
     FICH ALIC TEMP TFRE 1.e-5
!      FICH ALIT './D7710600eule.alt' FREQ 0 TFRE 0.D0
!      FICH ALIT FREQ 0 TFRE 0.D0
!         TIME PROG 0.D0 PAS 0.5D-3 22.D-3 PAS 0.01D-3 60.D-3
!         PAS 1.D-3 120.D-3
          POIN LECT pt0 TERM
          ELEM LECT S1 S2 S3 S4 S5 S6 S7 S8 S9 S01 S02 TERM
!    FICH PVTK './D7710600eule.pvd' FREQ 0 TFRE 0.D0
!    Fichier PVTK  TFREQ  10.0e-3
!        GROU AUTO
!        VARI DEPL VITE FAIL ACCE VCVI CONT ECRO FLIA
     FICH SPLI ALIC TFRE 0.5E-3
OPTI NOTE CSTA 0.25
     LOG 1
     VFCC FCON 6 ! hllc solver
          ORDR 2 ! order in space
          STPS 2 ! order in time
          RECO 1
          NTIL
CALC TINI 0 TEND 44.0E-3
FIN
```

Once run the simulation, the input file ST_EUL_10p is used to obtain the pressure curves. Again, the differences with respect to the 5 bar case are highlighted in red. The plot limits `XMIN`, `XMAX`, the time shift (`MOVE`) and the ambient pressure are adjusted to values appropriate for the 10 bar case:

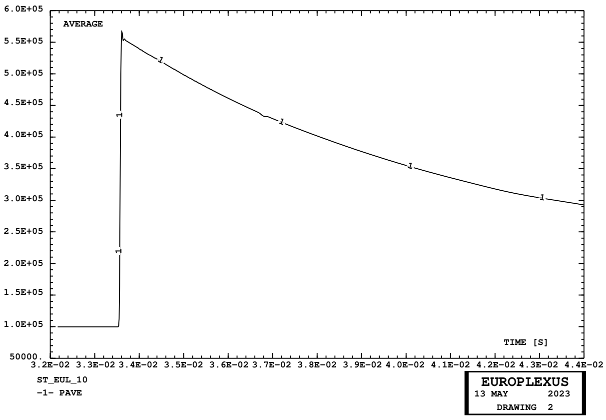
```
ST_EUL_10p
ECHO
RESU SPLI ALIC TEMP 'ST_EUL_10.alt' GARD PSCR
SORT GRAP
AXTE 1.0 'Time [s]'
COUR 1 'S1' ECRO COMP 1 LECT S1 TERM ! Sensors 1 to 0
COUR 2 'S2' ECRO COMP 1 LECT S2 TERM
COUR 3 'S3' ECRO COMP 1 LECT S3 TERM
COUR 4 'S4' ECRO COMP 1 LECT S4 TERM
COUR 5 'S5' ECRO COMP 1 LECT S5 TERM
COUR 6 'S6' ECRO COMP 1 LECT S6 TERM
COUR 7 'S7' ECRO COMP 1 LECT S7 TERM
COUR 8 'S8' ECRO COMP 1 LECT S8 TERM
COUR 9 'S9' ECRO COMP 1 LECT S9 TERM
TRAC 1 2 3 4 5 6 7 8 9 AXES 1.0 'Sensors'
     XMIN 32.E-3 XMAX 44.E-3 NX 12 YZER
     COLO turq rose roug bleu noir vert turq rose roug
     THIC 0.8 0.8 0.8 0.8 0.8 0.8 0.8 0.8 0.8
COUR 10 'Pave' MEAN 9 1 2 3 4 5 6 7 8 9 ! Take the average
TRAC 10 AXES 1.0 'Average'
     XMIN 32.E-3 XMAX 44.E-3 NX 12 YZER
COUR 11 'Sub' SUBC 10 0.9968e5          ! Subtract ambient pressure
COUR 12 'Pressure' MOVE 11 -32.0e-3     ! Shift in time
TRAC 12 AXES 1.0 'Pres [Pa]' YZER       ! This is the final result
     COLO BLEU
     THIC 0.8
LIST 12 AXES 1.0 'Pres [Pa]' YZER
QUAL COUR 12 REFE  0.00000E+00 TOLE 1.E-2
FIN
```

Figure 67 shows the nine raw pressure signals obtained (which are nearly identical as expected), the average pressure signal and the overpressure signal.

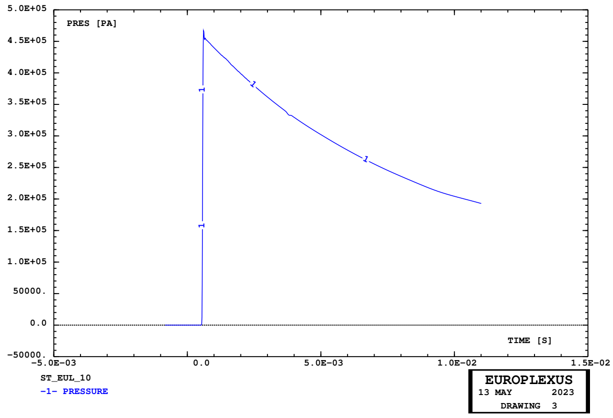
The final obtained pressure (overpressure) time function for 10 bar nominal firing pressure is shown in cyan in Figure 68, where it is compared with the other pressures time functions that had been presented in Figure 10 (note that these signals are not synchronized in time).



(a) Raw pressures



(b) Average pressure



(c) Overpressure

Figure 67: Some results of test ST_EUL_10.

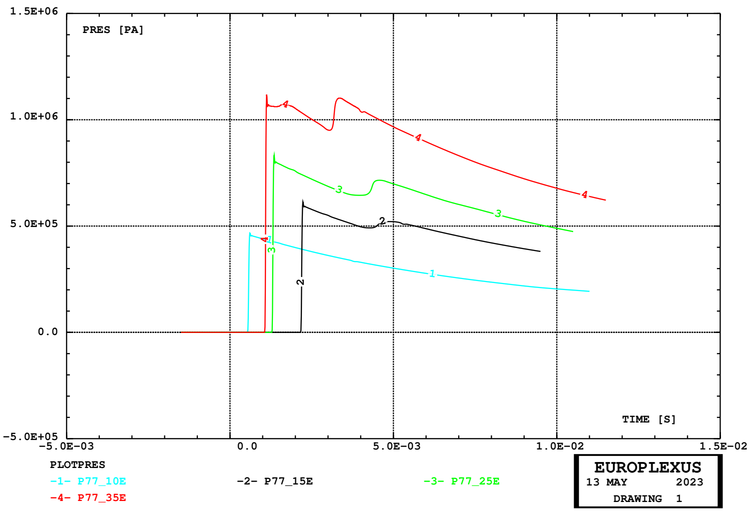


Figure 68: Pressure time functions to be used in the Lagrangian simulations.

5 Lagrangian simulations

By using the 10 bar Eulerian pressure signal obtained in Section 4, we are now able to run the 10 bar nominal Lagrangian simulations (for the two materials considered in this study, i.e. tests D6_S2_10 and D14_S2_10) and thus to complete the Lagrangian test matrix that was introduced in Section 2 (see Table 1).

The complete test matrix is detailed in Table 11. The output disk space includes both ALIC and PVTK results files.

Test	Material	p^* [bar]	Contact	t_{fin} [ms]	Steps	CPU [s]	Eroded	RAM [GB]	Storage [GB]
D6_S2_10	Docol-600DL	10	PINB	5.0	170 745	61 792	22	1.4	10.5
D6_S2_15	Docol-600DL	15	PINB	5.0	130 760	52 558	60	1.4	10.5
D6_S2_25	Docol-600DL	25	PINB	5.0	131 335	52 558	320	1.4	10.6
D6_S2_35	Docol-600DL	35	PINB	5.0	151 677	156 698	617	1.4	10.9
D14_S2_10	Docol-600DL	10	PINB	5.0	142 561	35 621	12	1.4	10.3
D14_S2_15	Docol-1400M	15	PINB	5.0	110 787	41 447	609	1.4	10.4
D14_S2_25	Docol-1400M	25	PINB	5.0	128 781	67 450	1 124	1.4	10.5
D14_S2_35	Docol-1400M	35	PINB	5.0	133 246	63 404	1 102	1.4	10.5

Table 11: Complete set of Lagrangian simulations of the S2 plate.

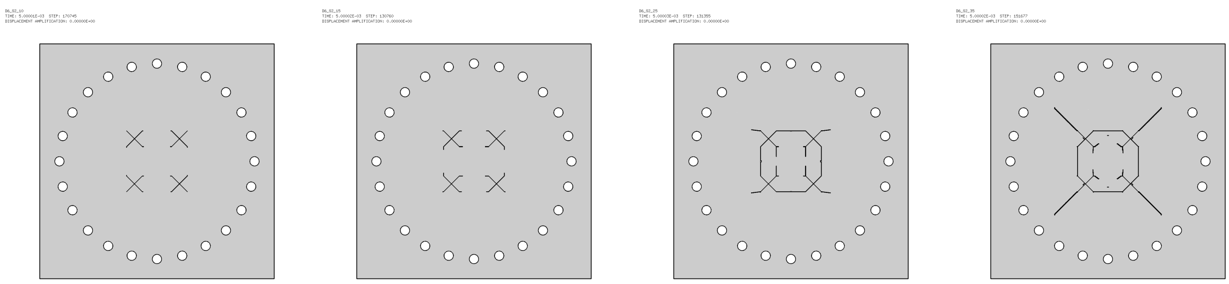
5.1 Case D6_S2_10

The simulation runs correctly until the final time.

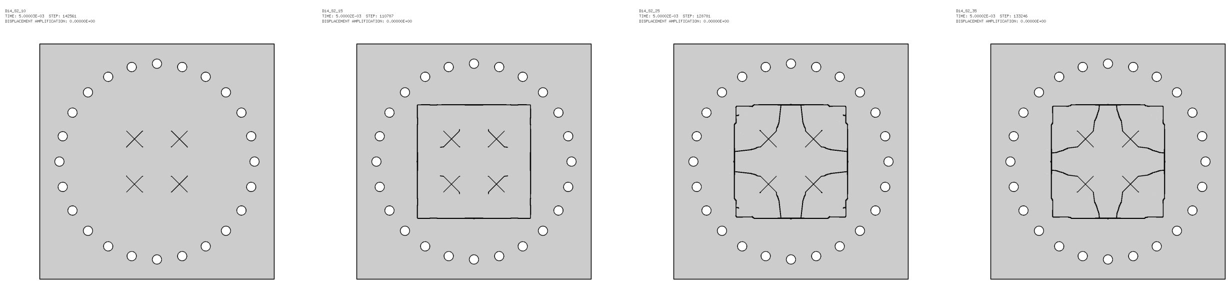
5.2 Case D14_S2_10

The simulation runs correctly until the final time.

Figure 69 shows the final plate fracturing (mapped on the initial geometry) for all the Lagrangian simulations.



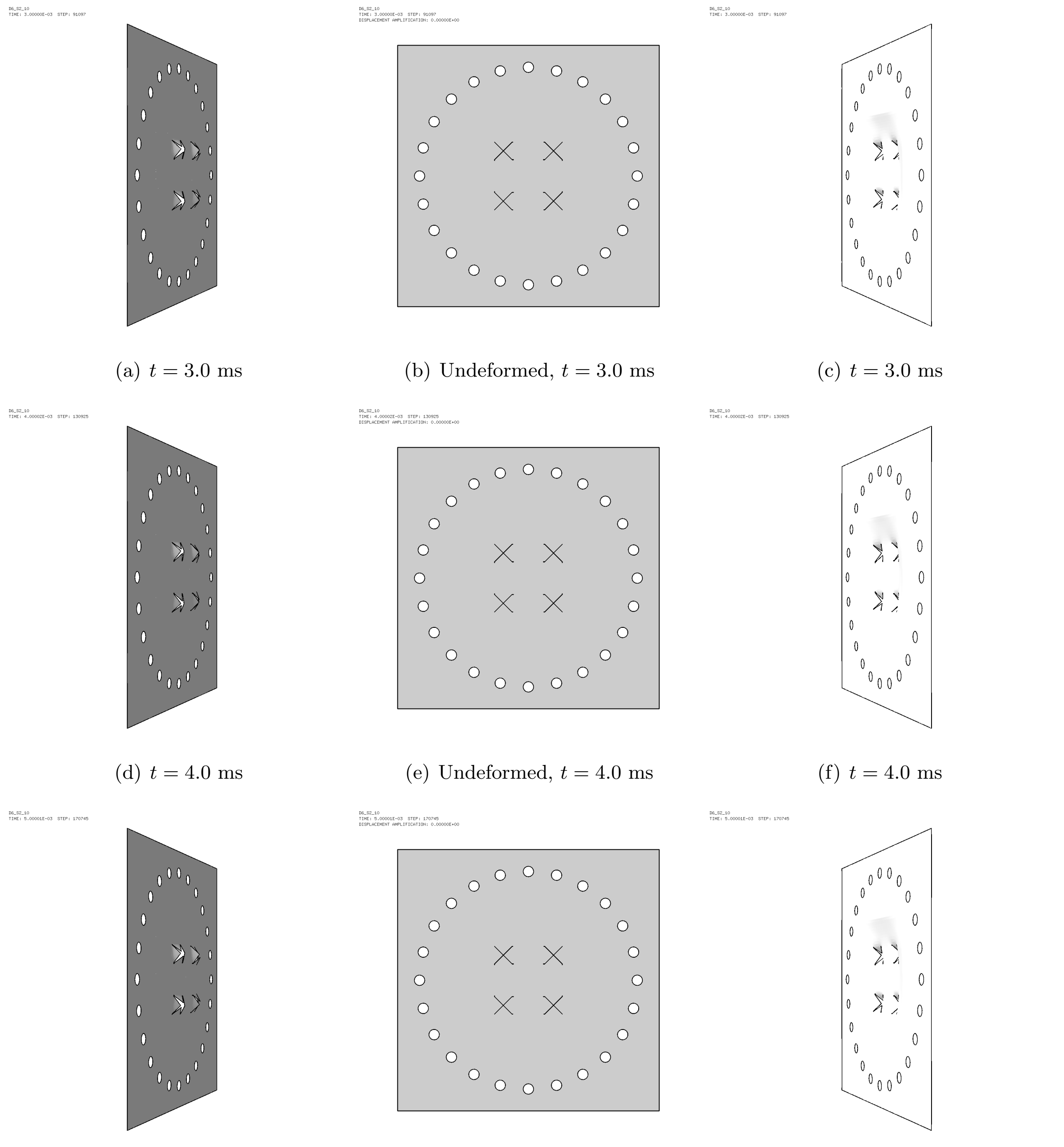
(a) Docol-600DL @ 10 bar (b) Docol-600DL @ 15 bar (c) Docol-600DL @ 25 bar (d) Docol-600DL @ 35 bar



(e) Docol-1400M @ 10 bar (f) Docol-1400M @ 15 bar (g) Docol-1400M @ 25 bar (h) Docol-1400M @ 35 bar

Figure 69: Final damage in the Lagrangian S2 plate (mapped on the initial geometry).

The following Figures 70 and 71 show, for each case separately, the (symmetrized) plate mesh without element outlines at various times (by using different time values, as appropriate for each case), seen from three different eye positions (right, front, left), in order to highlight the opening of the slits. The right and left views show the deformed plate, while the central view shows the undeformed plate, in order to follow the formation and progression of the cracks.

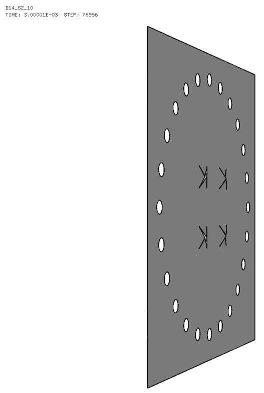


(a) $t = 3.0$ ms (b) Undeformed, $t = 3.0$ ms (c) $t = 3.0$ ms

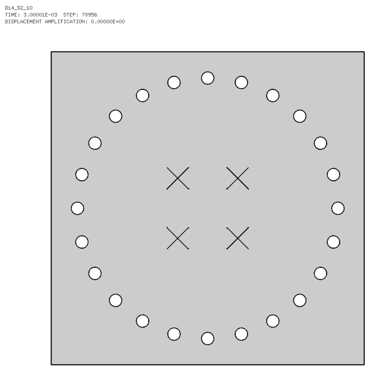
(d) $t = 4.0$ ms (e) Undeformed, $t = 4.0$ ms (f) $t = 4.0$ ms

(g) $t = 5.0$ ms (h) Undeformed, $t = 5.0$ ms (i) $t = 5.0$ ms

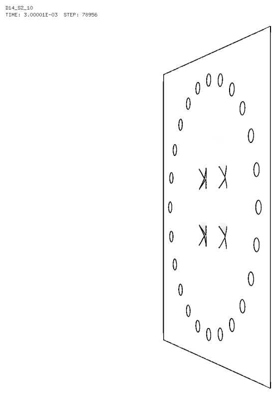
Figure 70: Geometry of the S2 plate at various times in case D6_S2_10.



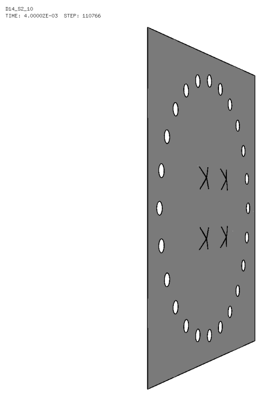
(a) $t = 3.0$ ms



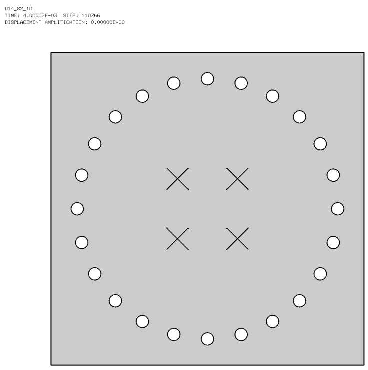
(b) Undeformed, $t = 3.0$ ms



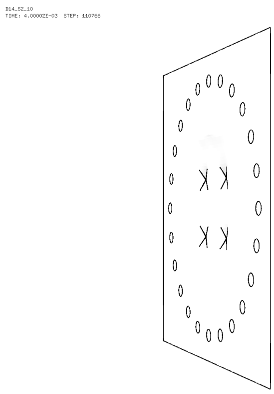
(c) $t = 3.0$ ms



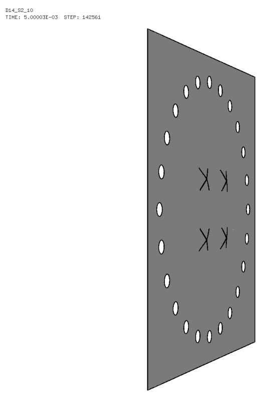
(d) $t = 4.0$ ms



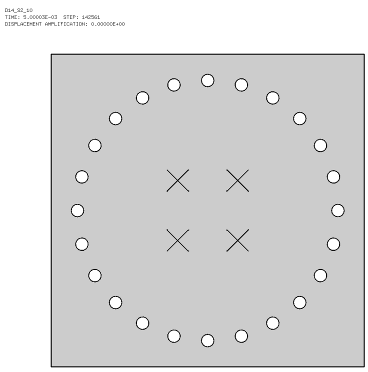
(e) Undeformed, $t = 4.0$ ms



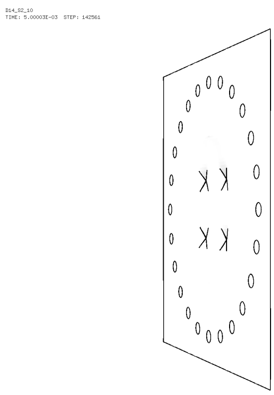
(f) $t = 4.0$ ms



(g) $t = 5.0$ ms



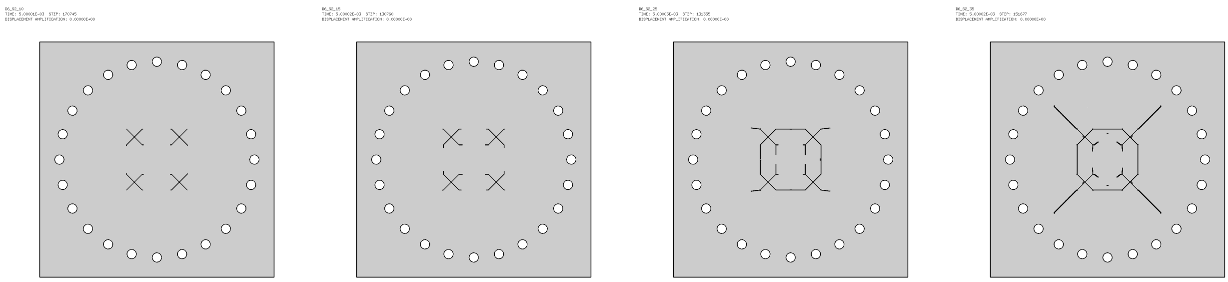
(h) Undeformed, $t = 5.0$ ms



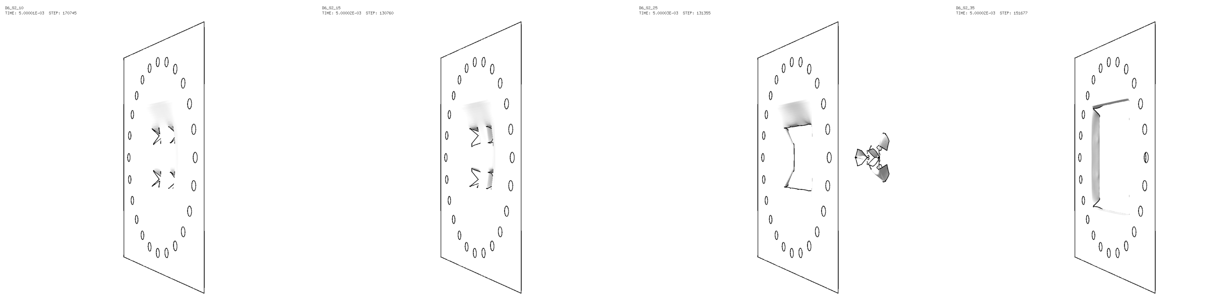
(i) $t = 5.0$ ms

Figure 71: Geometry of the S2 plate at various times in case D14_S2_10.

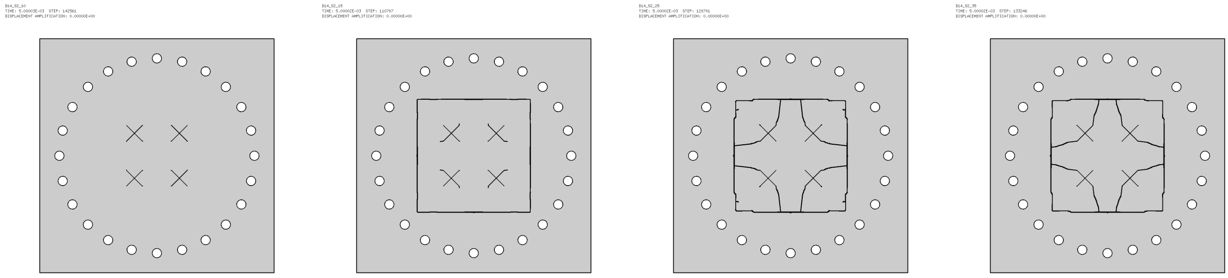
Finally, Figure 72 summarizes and compares among them all the main results of the Lagrangian calculations performed so far. For each case, the final (at $t = 5.0$ ms) plate damage (cracks) in both the initial (un-deformed) and the deformed geometry is shown.



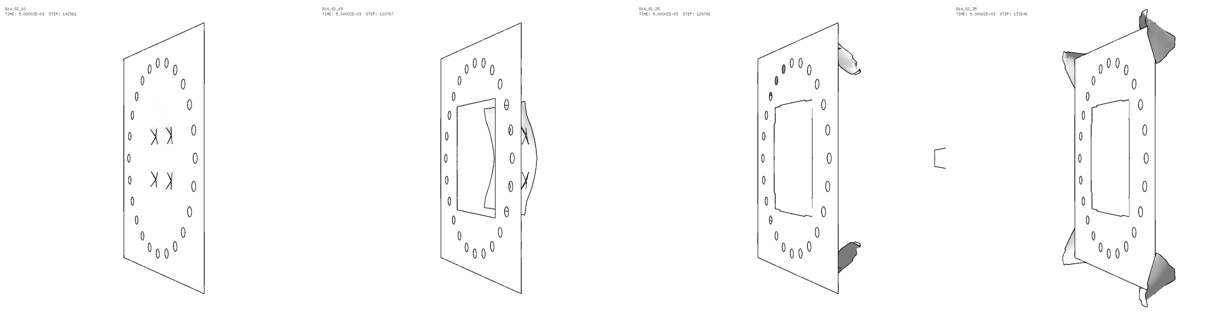
(a) Docol-600DL @ 10 bar (b) Docol-600DL @ 15 bar (c) Docol-600DL @ 25 bar (d) Docol-600DL @ 35 bar



(e) Docol-600DL @ 10 bar (f) Docol-600DL @ 15 bar (g) Docol-600DL @ 25 bar (h) Docol-600DL @ 35 bar



(i) Docol-1400M @ 10 bar (j) Docol-1400M @ 15 bar (k) Docol-1400M @ 25 bar (l) Docol-1400M @ 35 bar



(m) Docol-1400M @ 10 bar (n) Docol-1400M @ 15 bar (o) Docol-1400M @ 25 bar (p) Docol-1400M @ 35 bar

Figure 72: Final damage in the Lagrangian S2 plate, on the initial and on the deformed geometry.

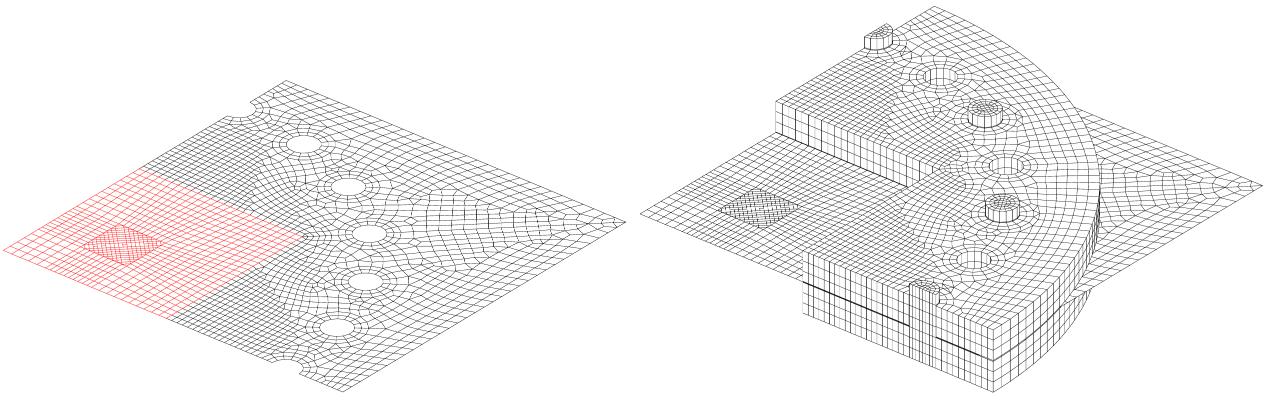
6 FSI (coupled) preliminary simulations

This Section presents some preliminary FSI (coupled) simulations of the S2 plates. The simulations performed are summarized in Table 12 and are described in detail below.

Test	Description	p^* [bar]	Cont.	t_{fin} [ms]	Steps	CPU [s]	Ero.	RAM [GB]	Sto. [GB]
D6_S2_35_FG	FSI simulation	35	GLIS	32.0	83 207	217 487	1061	5.2	5.7
D6_S2_35_FP	Idem but with PINB	35	PINB	32.0	83 106	223 180	1500	5.3	5.9
D6_S2_35_FG2	GLIS ADAP SYME	35	GLIS	32.0	83 021	224 298	1058	5.2	5.7
D6_S2_35_FG_C	FG + TFAI 1.143E-08	35	GLIS	32.0	153 726	417 774	228	5.2	5.9
D6_S2_35_FP_C	FP + TFAI 1.143E-08	35	PINB	32.0	153 829	451 618	222	5.3	6.0
D6_S2_35_FG2_C	FG2 + TFAI 1.143E-08	35	GLIS	32.0	155 657	455 530	222	5.2	5.8
D6_S2_35_FG_CSVF	FG + CSVF 0.571	35	GLIS	32.0	73 871	206 380	203	5.2	5.7

Table 12: FSI (coupled) preliminary simulations of the S2 plates.

All these FSI simulations used the ST_MAP3_35.map map file from the NTNU DataBase [15], that had been generated at a physical time $t_{\text{map}} = 27.0$ ms on 21/02/2021. So all these simulations start at 27.0 ms. The mesh of the S2 plate, with 4 X-shaped slits, and of the clamping system (of which only 1/4 is included in the model, thanks to symmetry) was generated by running Cast3m on the input file S2.dgibi, producing S2.msh, see Figure 73.

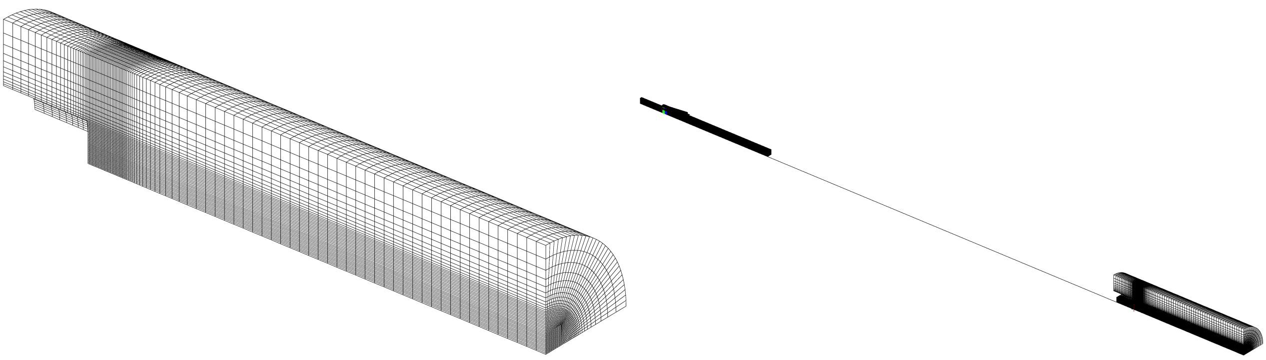


(a) Plate

(b) Plate assembly

Figure 73: Mesh of the S2 plate and clamping system.

Next, the full FSI model, including also the shock tube (but without the membranes) was obtained by running Cast3m on the input file S2_FSI.dgibi, which reads back S2.msh and produces S2_FSI.msh by embedding the structural assembly into the fluid mesh, see Figure 74.



(a) Tank

(b) Complete FSI model

Figure 74: Mesh of the FSI model with embedded S2 plate and clamping system.

6.1 Case D6_S2_35_FG

This simulation used the GLIS directive to model the contact (with friction) between the plate and the clamping system. In this model (and in the two following ones) the same value of TFAI ($t_{\text{fail}} = 2.0 \times 10^{-8}$ s) was tentatively used as in the Lagrangian (uncoupled) simulations presented in Section 2. Recall that TFAI is used in order to get rid of (erode) plate elements that might become too distorted in the deformation process without arriving at complete material failure, thereby possibly penalizing the overall stability step of the simulation.

However, after running the test it was noted that, on a total of 1061 eroded elements, only 213 were removed due to material failure, while as many as 848 were eroded due to TFAI, i.e. for having reached a too small stability step. By comparison, in the Lagrangian simulation D6_S2_35 of Section 2, which used exactly the same mesh for the plate, only one element had been eroded due to TFAI.

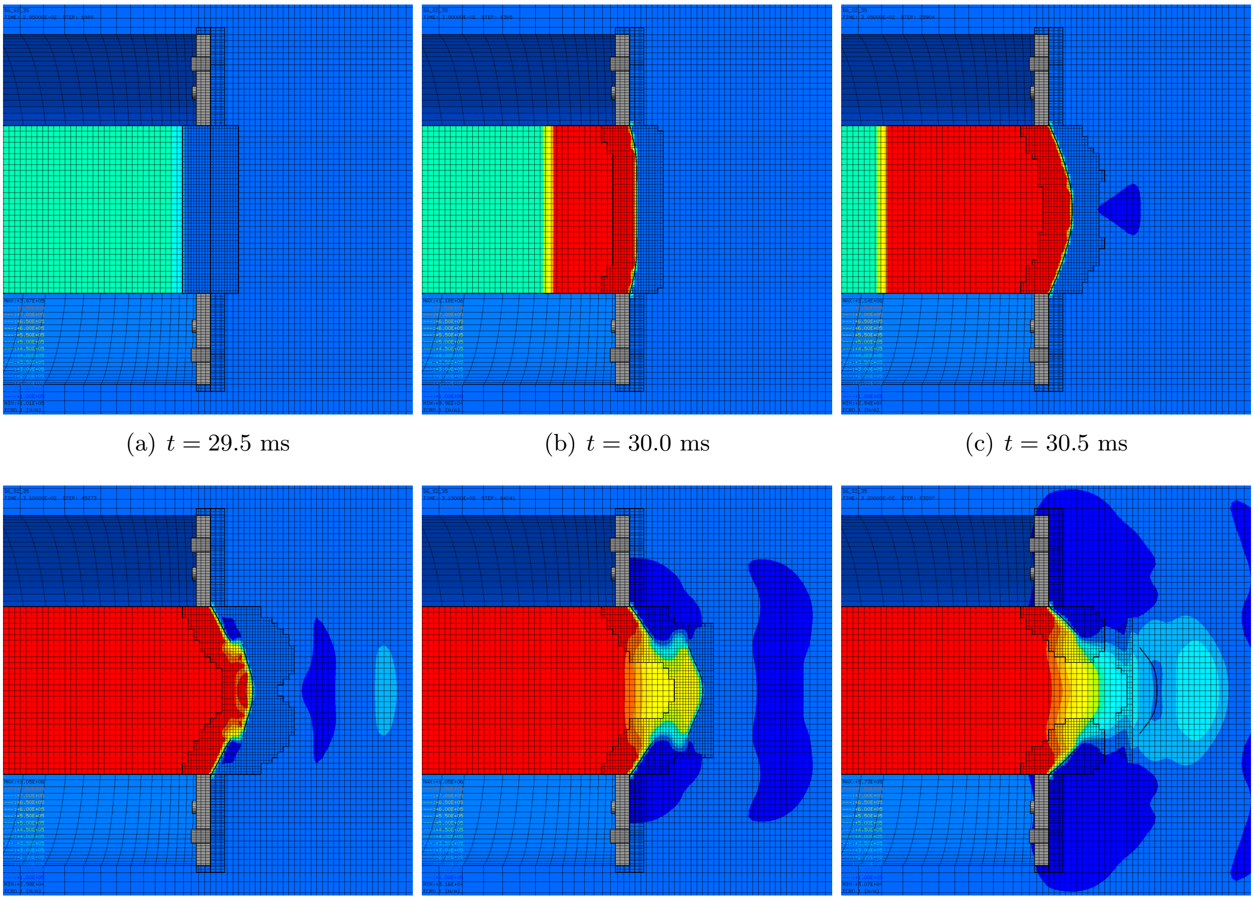
After some investigation, the reason for this evident discrepancy was determined. The two calculations used different values of the safety stability coefficient CSTA, namely $C_s^{\text{Lag}} = 0.7$ in the Lagrangian case and $C_s^{\text{ALE}} = 0.4$ in the FSI (ALE) case. The smaller value used in the second case is due to the fact that the fluid is present and the CCFV require smaller stability coefficients, especially in 3D.

The problem observed comes from the fact that EPX uses the same C_s for all elements (both structure and fluid). Therefore, in order to reproduce the same conditions as in the Lagrangian case, one should in the FSI case use:

$$t_{\text{fail}}^{\text{ALE}} = t_{\text{fail}}^{\text{Lag}} \cdot \frac{C_s^{\text{ALE}}}{C_s^{\text{Lag}}} = 2.0 \times 10^{-8} \cdot \frac{0.4}{0.7} = 1.143 \times 10^{-8} \text{ s} \tag{1}$$

So this simulation and the two following ones are probably incorrect since the plate failure is over-estimated, and will have to be repeated. Nevertheless, some results are presented below. A more appropriate solution of this problem will require a small development in EPX, e.g. introducing a separate (or an additional) stability safety coefficient for the CCFV, in order to avoid having to resort to relatively obscure calculations such as eq. (1).

Figure 75 shows the (symmetrized) fluid pressure in the test region at various times.

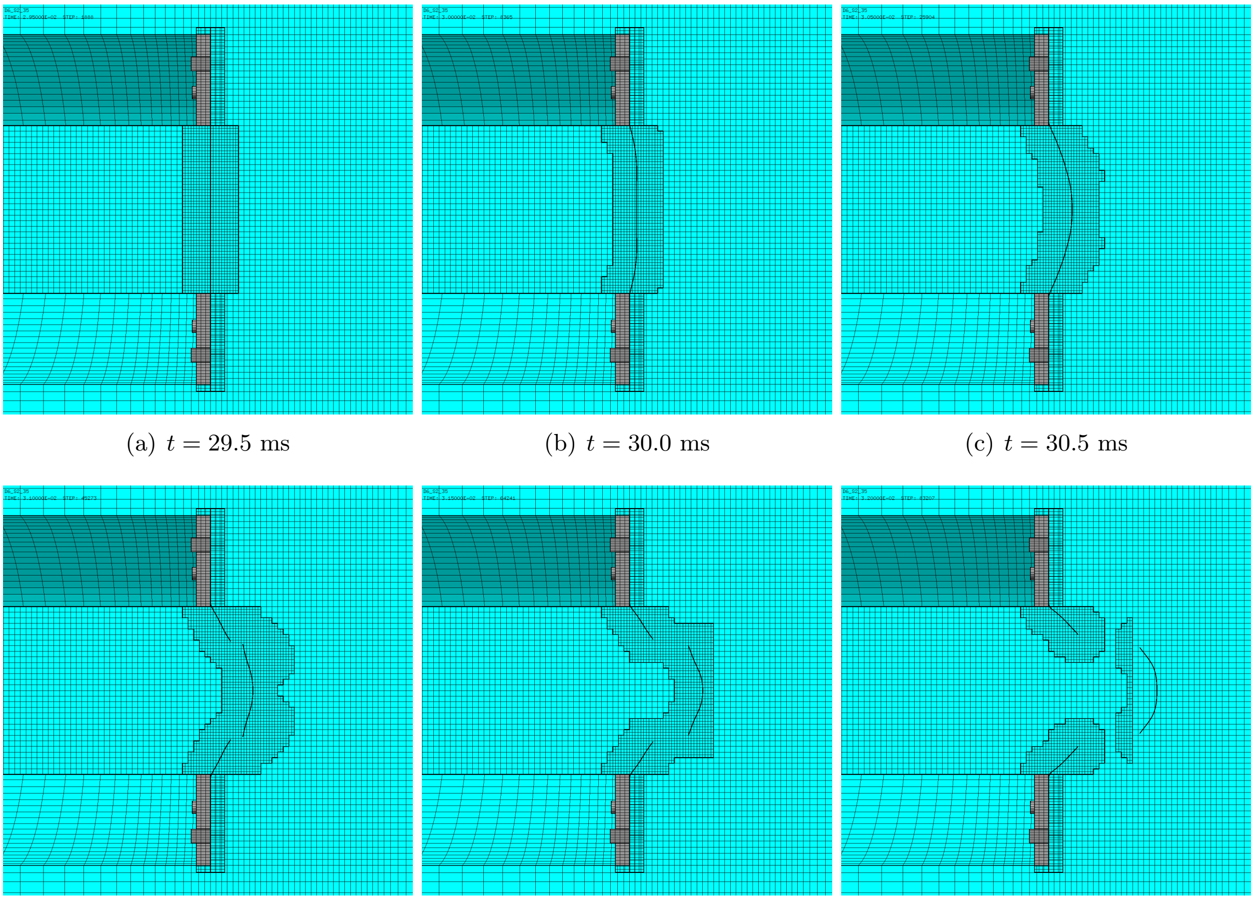


(a) $t = 29.5$ ms (b) $t = 30.0$ ms (c) $t = 30.5$ ms

(d) $t = 31.0$ ms (e) $t = 31.5$ ms (f) $t = 32.0$ ms

Figure 75: Fluid pressure in the test region in simulation D6_S2_35_FG.

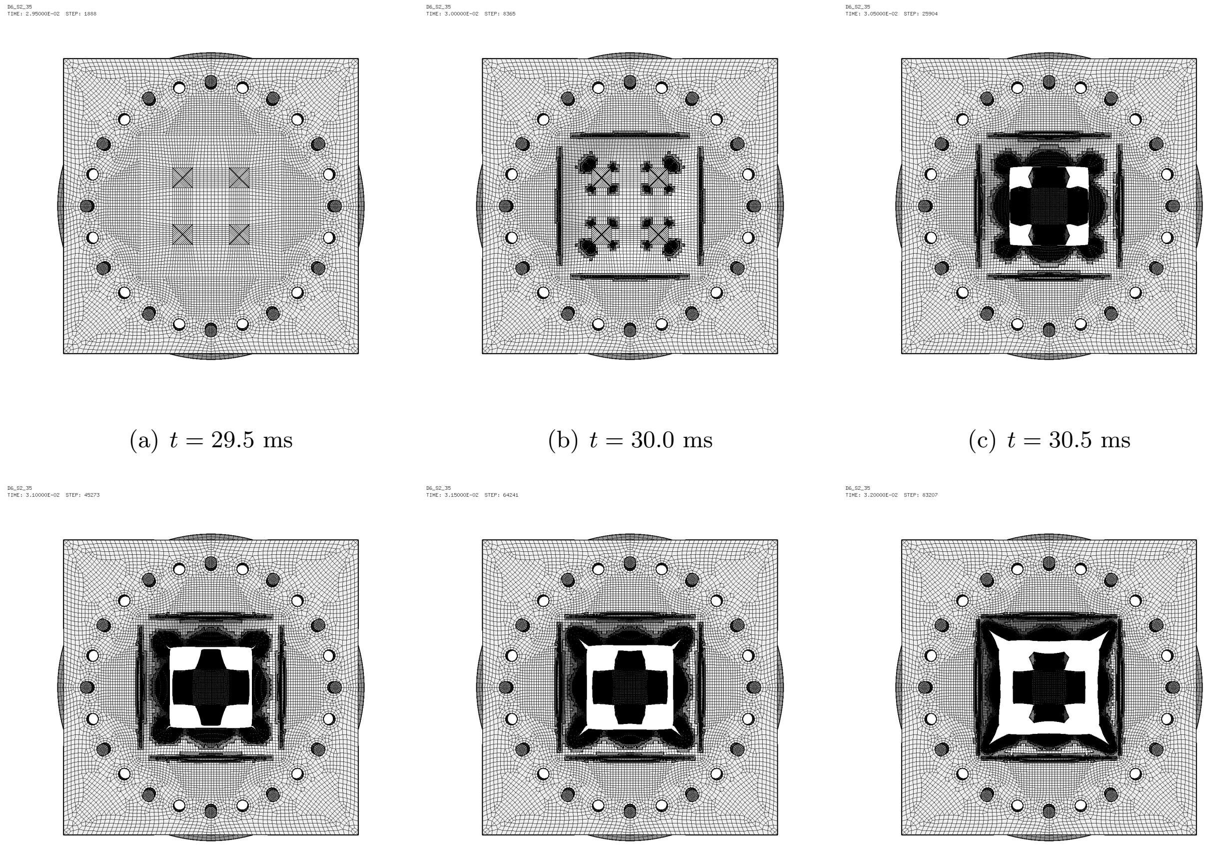
Figure 76 shows the (symmetrized) mesh in the test region at various times.



(a) $t = 29.5$ ms
(b) $t = 30.0$ ms
(c) $t = 30.5$ ms
(d) $t = 31.0$ ms
(e) $t = 31.5$ ms
(f) $t = 32.0$ ms

Figure 76: Mesh in the test region in simulation D6_S2_35_FG.

Figure 77 shows the (symmetrized) plate mesh at various times. The element outlines are included, in order to appreciate the adaptive mesh refinement taking place in the plate.

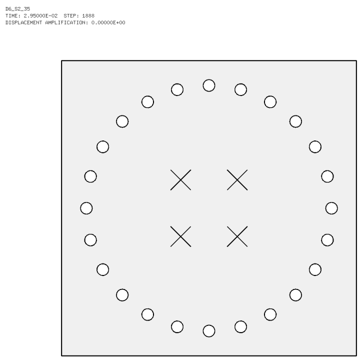


(a) $t = 29.5$ ms (b) $t = 30.0$ ms (c) $t = 30.5$ ms

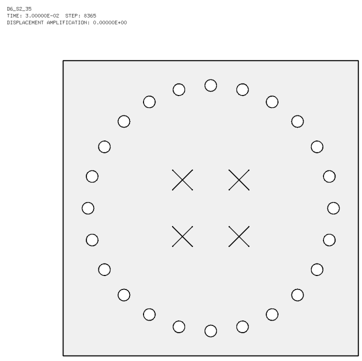
(d) $t = 31.0$ ms (e) $t = 31.5$ ms (f) $t = 32.0$ ms

Figure 77: Plate mesh in simulation D6_S2_35_FG.

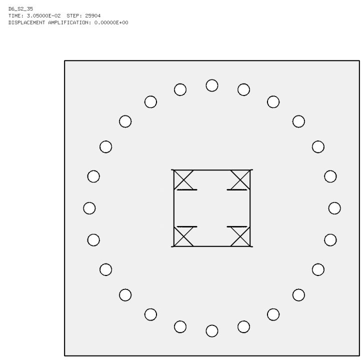
Figure 78 shows the (symmetrized) plate mesh without element outlines at various times. The geometry is mapped onto the initial configuration, by using the `DEFO AMPD 0.0` keywords. The `ADAP` keyword of the `TRAC` directive is used to allow for correct visualization of free edges and sharp corners. This allows to appreciate the progressive growth of the cracks.



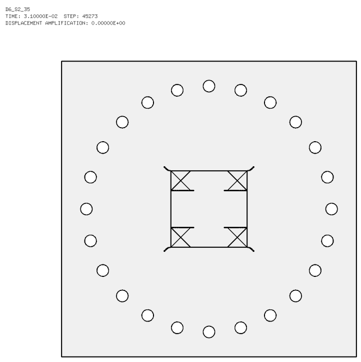
(a) $t = 29.5$ ms



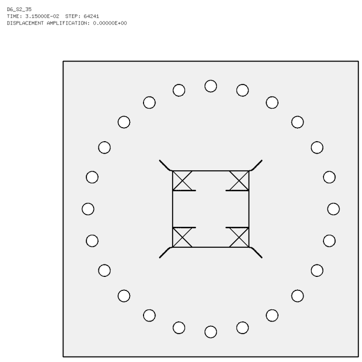
(b) $t = 30.0$ ms



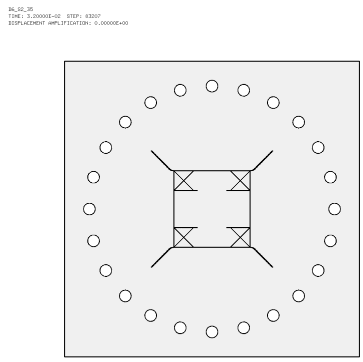
(c) $t = 30.5$ ms



(d) $t = 31.0$ ms



(e) $t = 31.5$ ms



(f) $t = 32.0$ ms

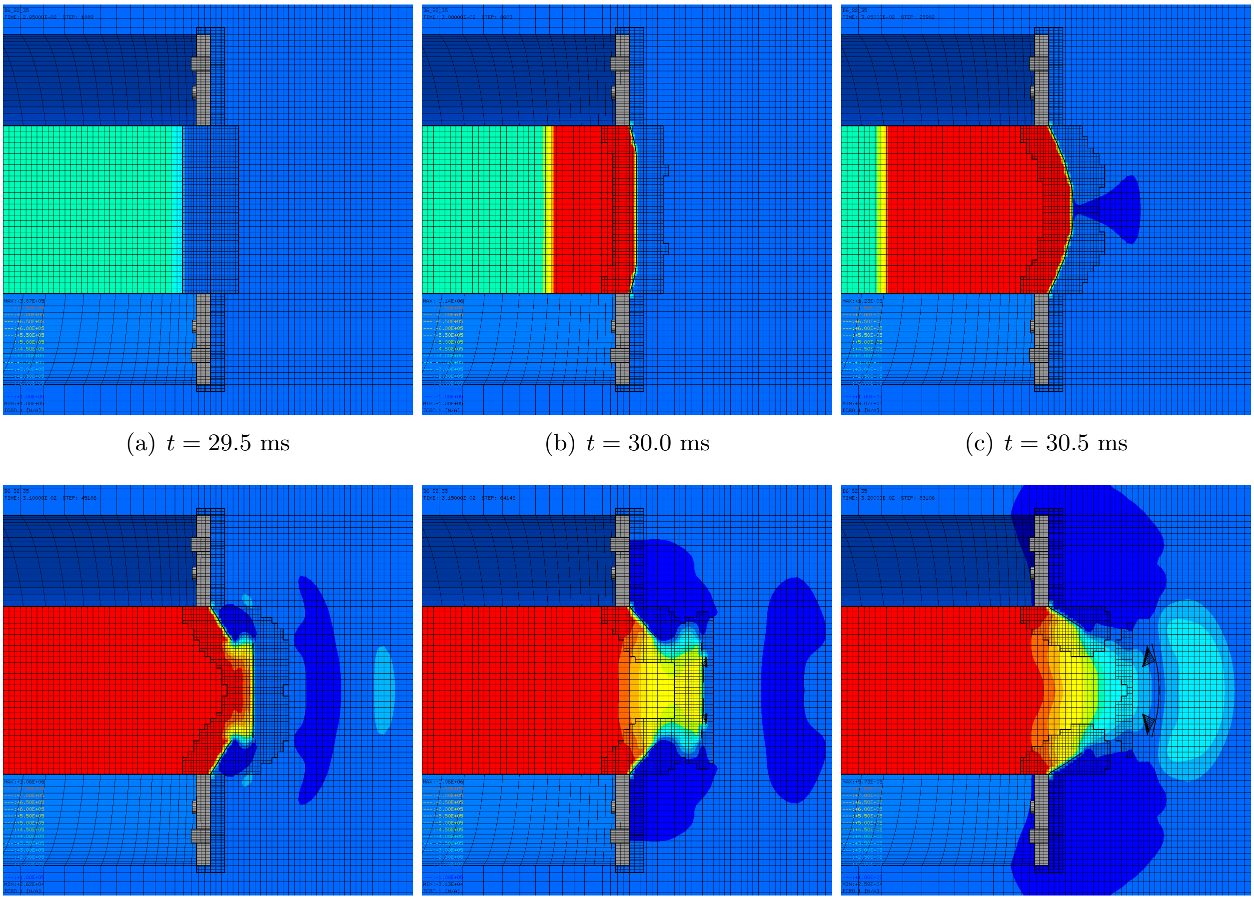
Figure 78: Undeformed plate mesh (without element outlines) in simulation D6_S2_35_FG.

Most damage in the plate occurs between 30.0 and 30.5 ms. The central part of the plate is teared off and flies away. X-shaped cracks continue to grow thereafter in the exposed part of the plate still attached to the clamping system.

6.2 Case D6_S2_35_FP

This simulation was similar to D6_S2_35_FG but used the PINB directive to model the contact (with friction) between the plate and the clamping system.

Figure 79 shows the (symmetrized) fluid pressure in the test region at various times.

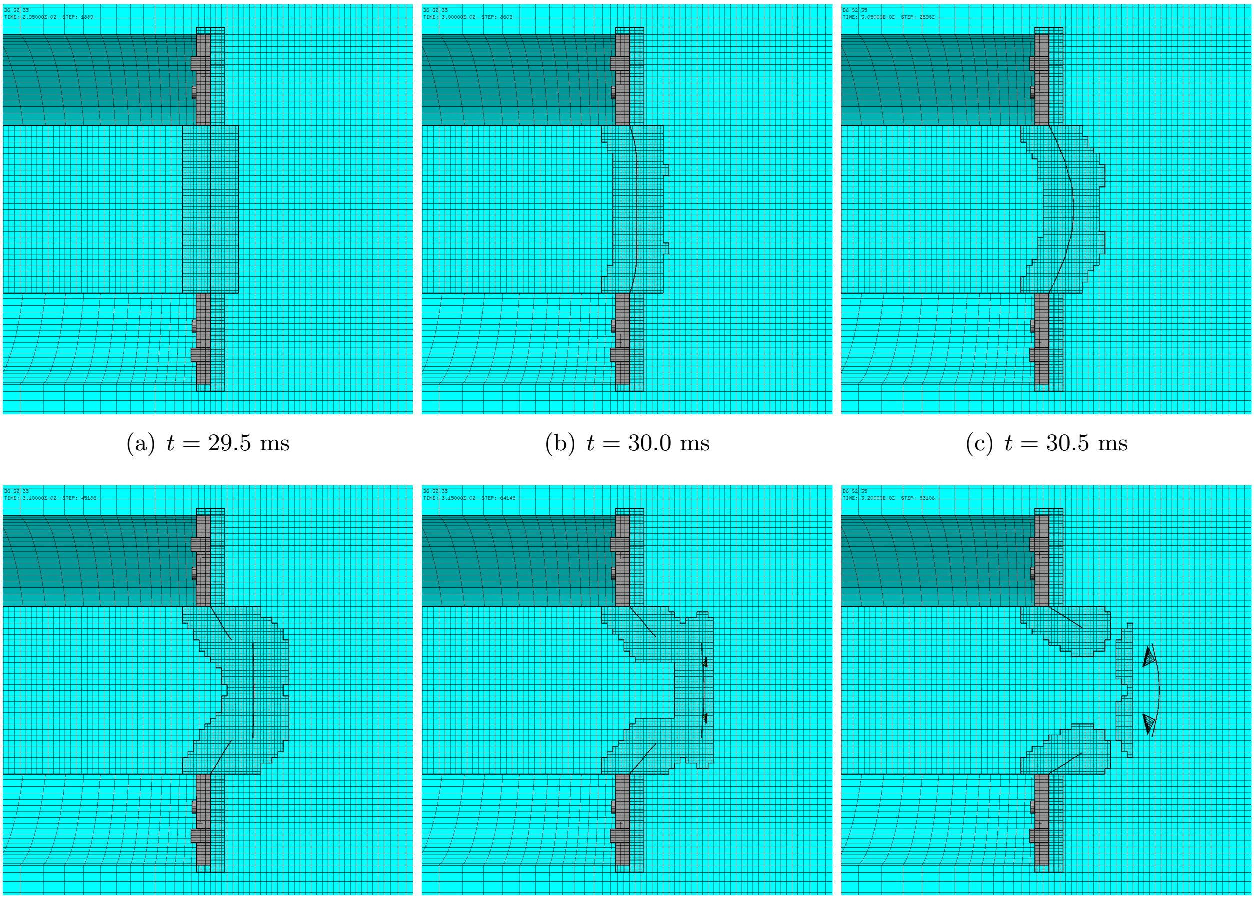


(a) $t = 29.5$ ms (b) $t = 30.0$ ms (c) $t = 30.5$ ms

(d) $t = 31.0$ ms (e) $t = 31.5$ ms (f) $t = 32.0$ ms

Figure 79: Fluid pressure in the test region in simulation D6_S2_35_FP.

Figure 80 shows the (symmetrized) mesh in the test region at various times.

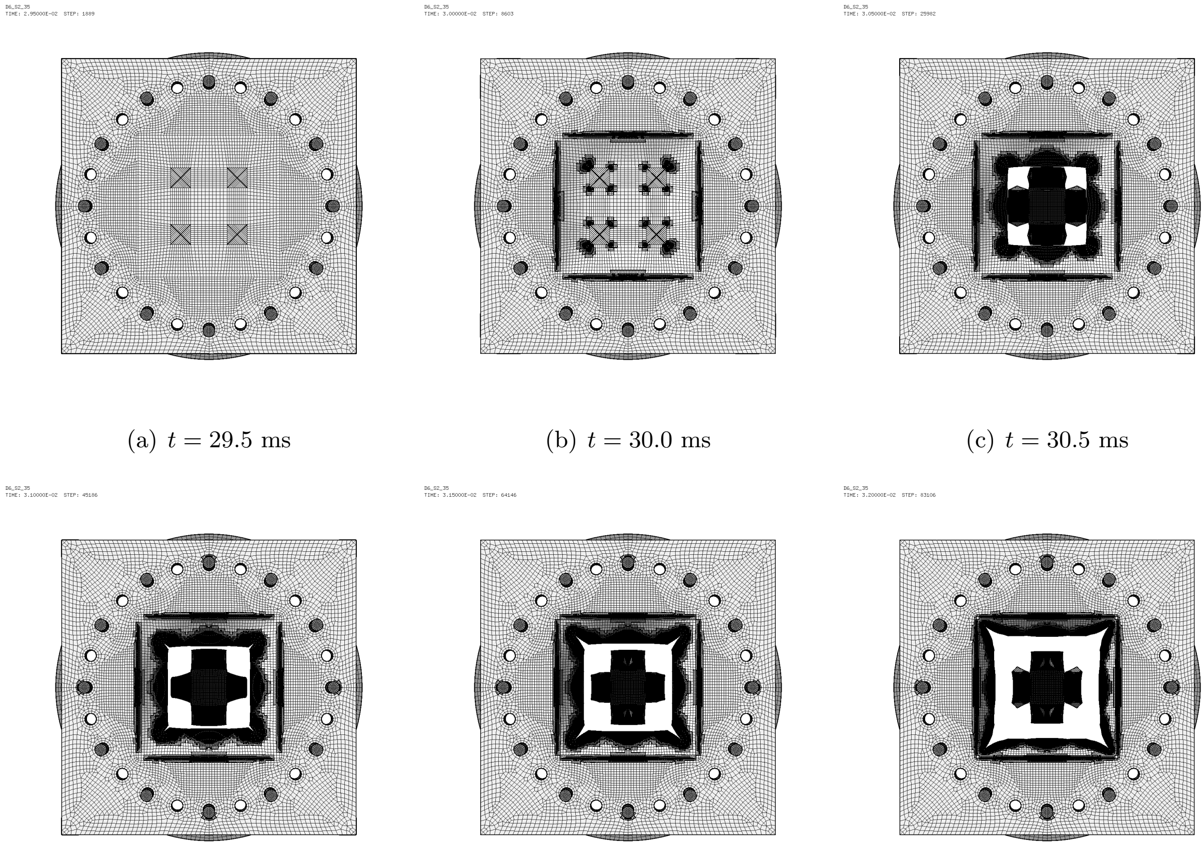


(a) $t = 29.5$ ms (b) $t = 30.0$ ms (c) $t = 30.5$ ms

(d) $t = 31.0$ ms (e) $t = 31.5$ ms (f) $t = 32.0$ ms

Figure 80: Mesh in the test region in simulation D6_S2_35_FP.

Figure 81 shows the (symmetrized) plate mesh at various times. The element outlines are included, in order to appreciate the adaptive mesh refinement taking place in the plate.

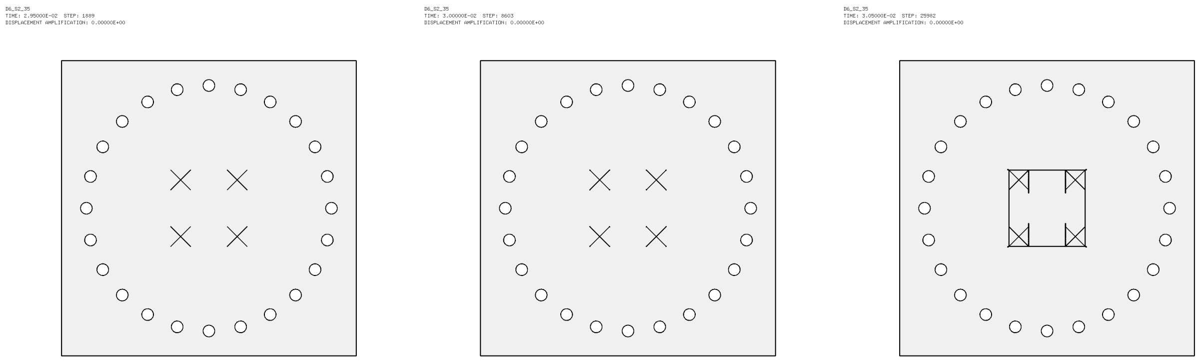


(a) $t = 29.5$ ms (b) $t = 30.0$ ms (c) $t = 30.5$ ms

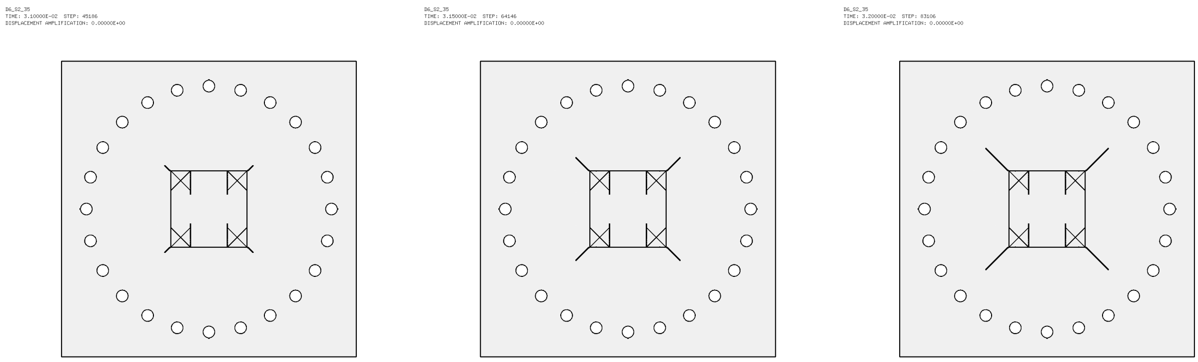
(d) $t = 31.0$ ms (e) $t = 31.5$ ms (f) $t = 32.0$ ms

Figure 81: Plate mesh in simulation D6_S2_35_FP.

Figure 82 shows the (symmetrized) plate mesh without element outlines at various times. The geometry is mapped onto the initial configuration, by using the DEFO AMPD 0.0 keywords. The ADAP keyword of the TRAC directive is used to allow for correct visualization of free edges and sharp corners. This allows to appreciate the progressive growth of the cracks.



(a) $t = 29.5$ ms (b) $t = 30.0$ ms (c) $t = 30.5$ ms



(d) $t = 31.0$ ms (e) $t = 31.5$ ms (f) $t = 32.0$ ms

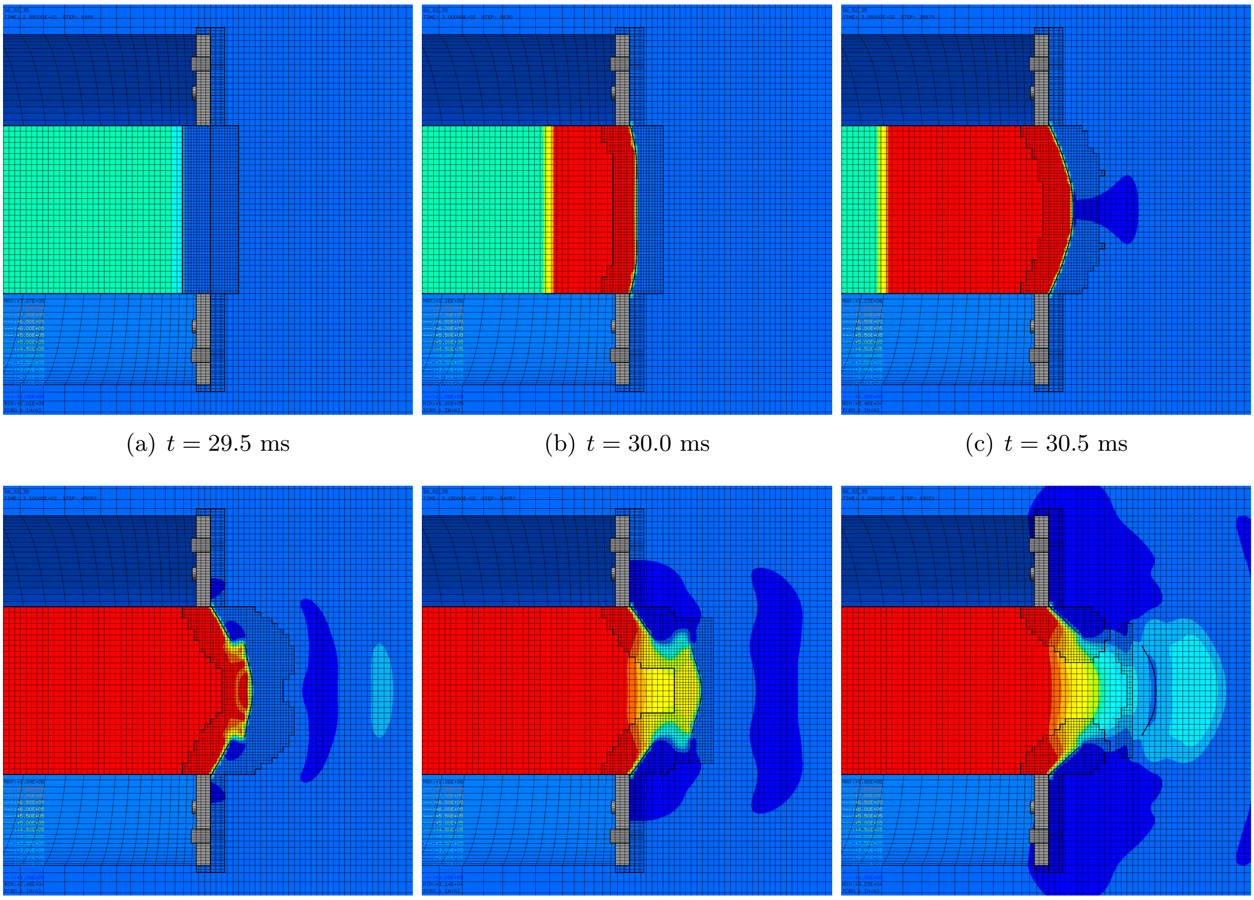
Figure 82: Undeformed plate mesh (without element outlines) in simulation D6_S2_35_FP.

6.3 Case D6_S2_35_FG2

This was a repetition of test D6_S2_35_FG by adding the `GLIS ADAP SYME` option.

According to [1], the `ADAP` keyword combines sliding surfaces (GLIS) with adaptivity. This means that the sliding surfaces data structure is updated whenever the mesh is adaptively refined or unrefined. The `SYME` keyword combines sliding surfaces (GLIS) with symmetries. This is currently implemented only in the coupled version of the links (`LINK COUP`). The combination should prevent the appearance of unsymmetric contact forces (which could break the symmetry of the model), especially in case of friction.

Figure 83 shows the (symmetrized) fluid pressure in the test region at various times.

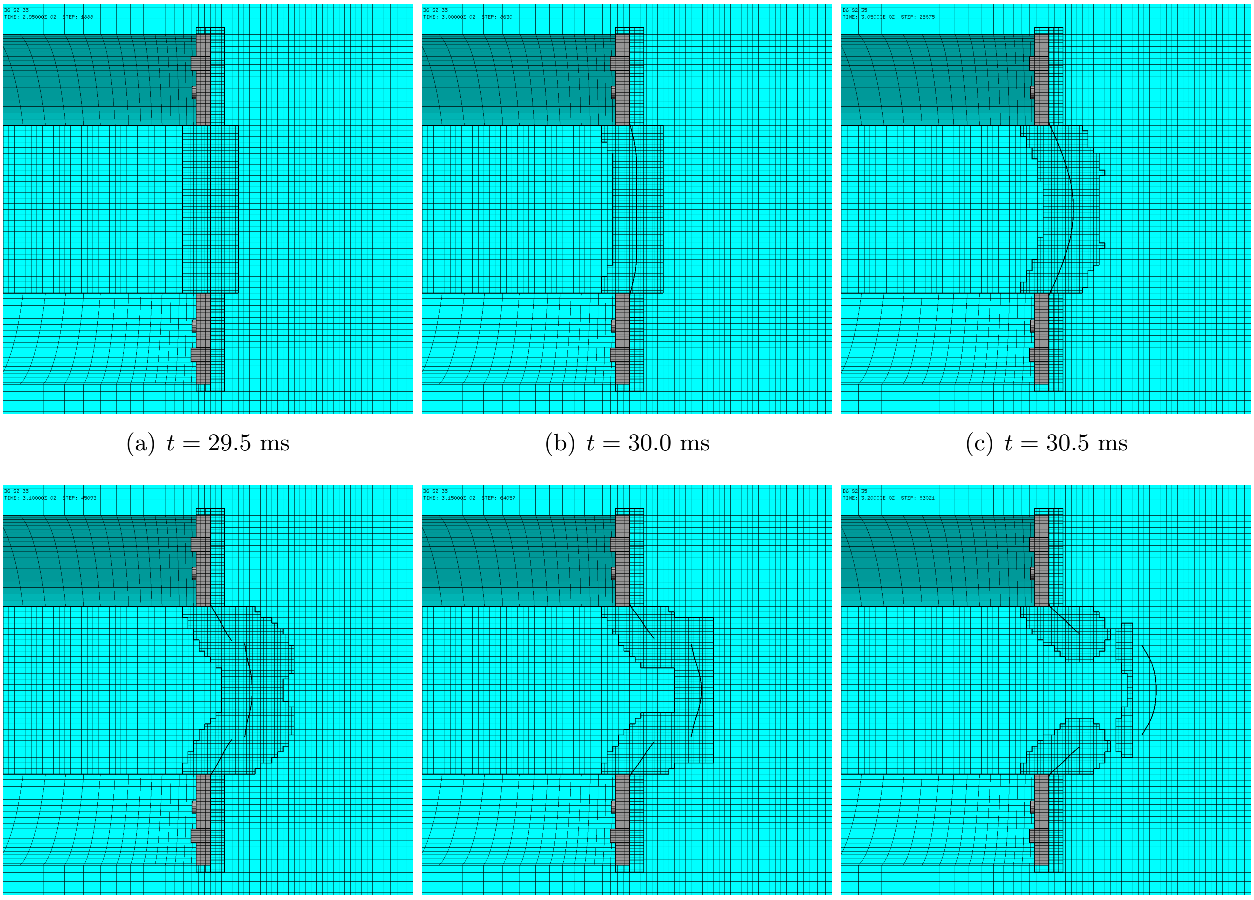


(a) $t = 29.5$ ms (b) $t = 30.0$ ms (c) $t = 30.5$ ms

(d) $t = 31.0$ ms (e) $t = 31.5$ ms (f) $t = 32.0$ ms

Figure 83: Fluid pressure in the test region in simulation D6_S2_35_FG2.

Figure 84 shows the (symmetrized) mesh in the test region at various times.

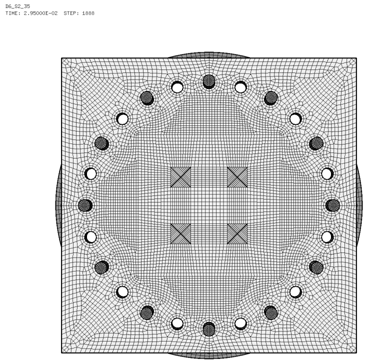


(a) $t = 29.5$ ms (b) $t = 30.0$ ms (c) $t = 30.5$ ms

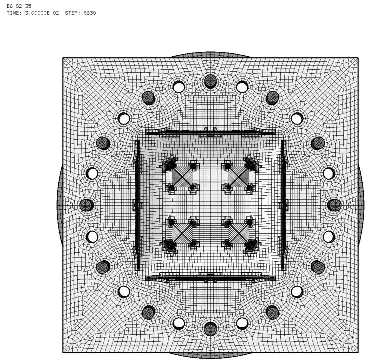
(d) $t = 31.0$ ms (e) $t = 31.5$ ms (f) $t = 32.0$ ms

Figure 84: Mesh in the test region in simulation D6_S2_35_FG2.

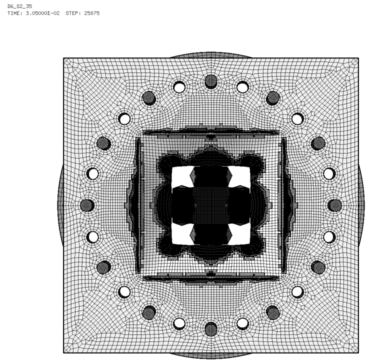
Figure 85 shows the (symmetrized) plate mesh at various times. The element outlines are included, in order to appreciate the adaptive mesh refinement taking place in the plate.



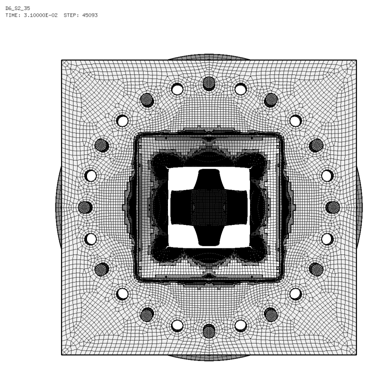
(a) $t = 29.5$ ms



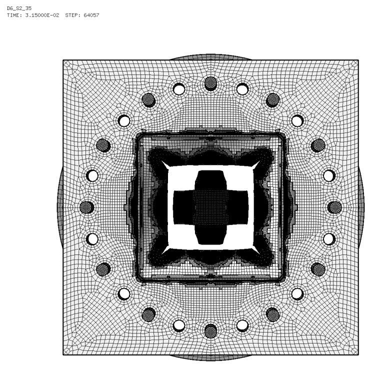
(b) $t = 30.0$ ms



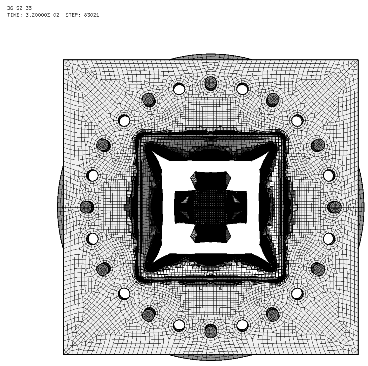
(c) $t = 30.5$ ms



(d) $t = 31.0$ ms



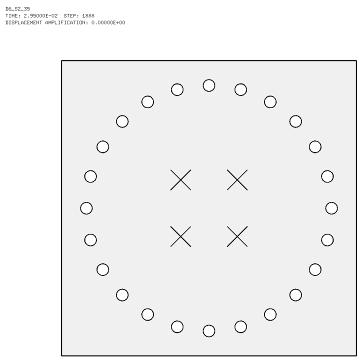
(e) $t = 31.5$ ms



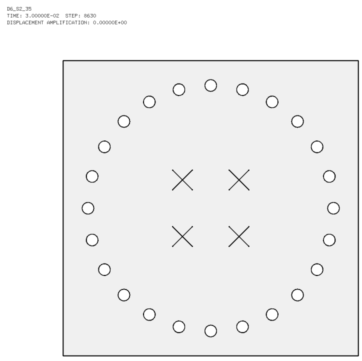
(f) $t = 32.0$ ms

Figure 85: Plate mesh in simulation D6_S2_35_FG2.

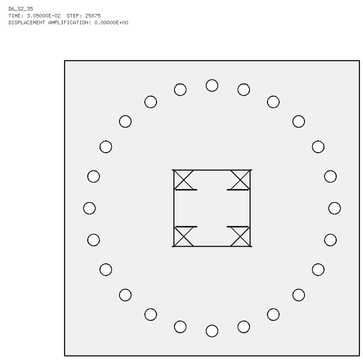
Figure 86 shows the (symmetrized) plate mesh without element outlines at various times. The geometry is mapped onto the initial configuration, by using the `DEFO AMPD 0.0` keywords. The `ADAP` keyword of the `TRAC` directive is used to allow for correct visualization of free edges and sharp corners. This allows to appreciate the progressive growth of the cracks.



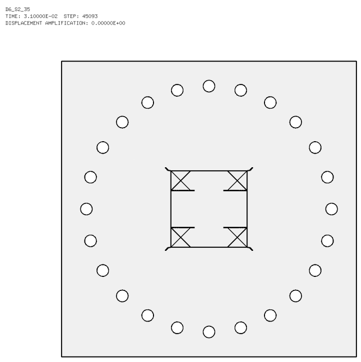
(a) $t = 29.5$ ms



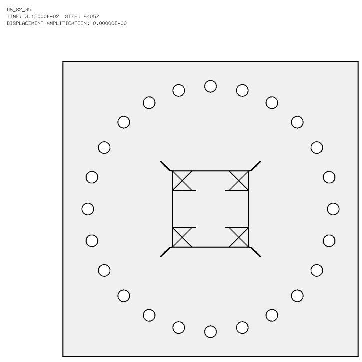
(b) $t = 30.0$ ms



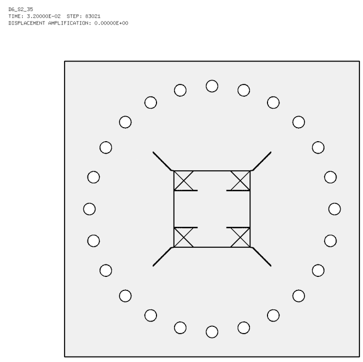
(c) $t = 30.5$ ms



(d) $t = 31.0$ ms



(e) $t = 31.5$ ms



(f) $t = 32.0$ ms

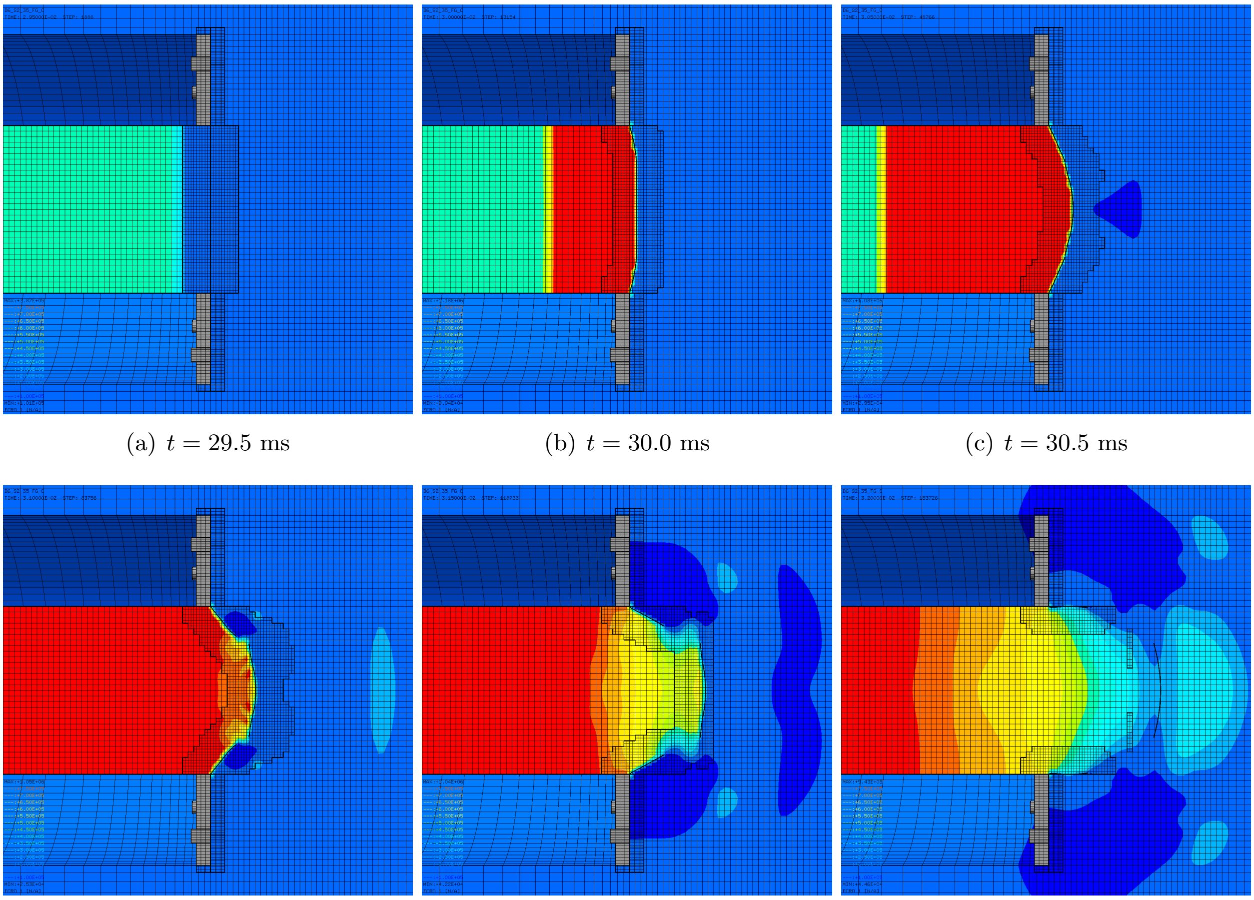
Figure 86: Undeformed plate mesh (without element outlines) in simulation D6_S2_35_FG2.

6.4 Case D6_S2_35_FG_C

This is a repetition of case D6_S2_35_FG by correcting the value of t_{fail} according to eq. (1), i.e. by setting `TFAI 1.143E-8`.

Upon first run, this simulation had to be stopped due to physical displacement of the EVICOM PC on which it was running, when it had reached about 31.1 ms instead of the planned 32.0 ms. So it had to be re-run to complete the simulation. Some results are shown below.

Figure 87 shows the (symmetrized) fluid pressure in the test region at various times.

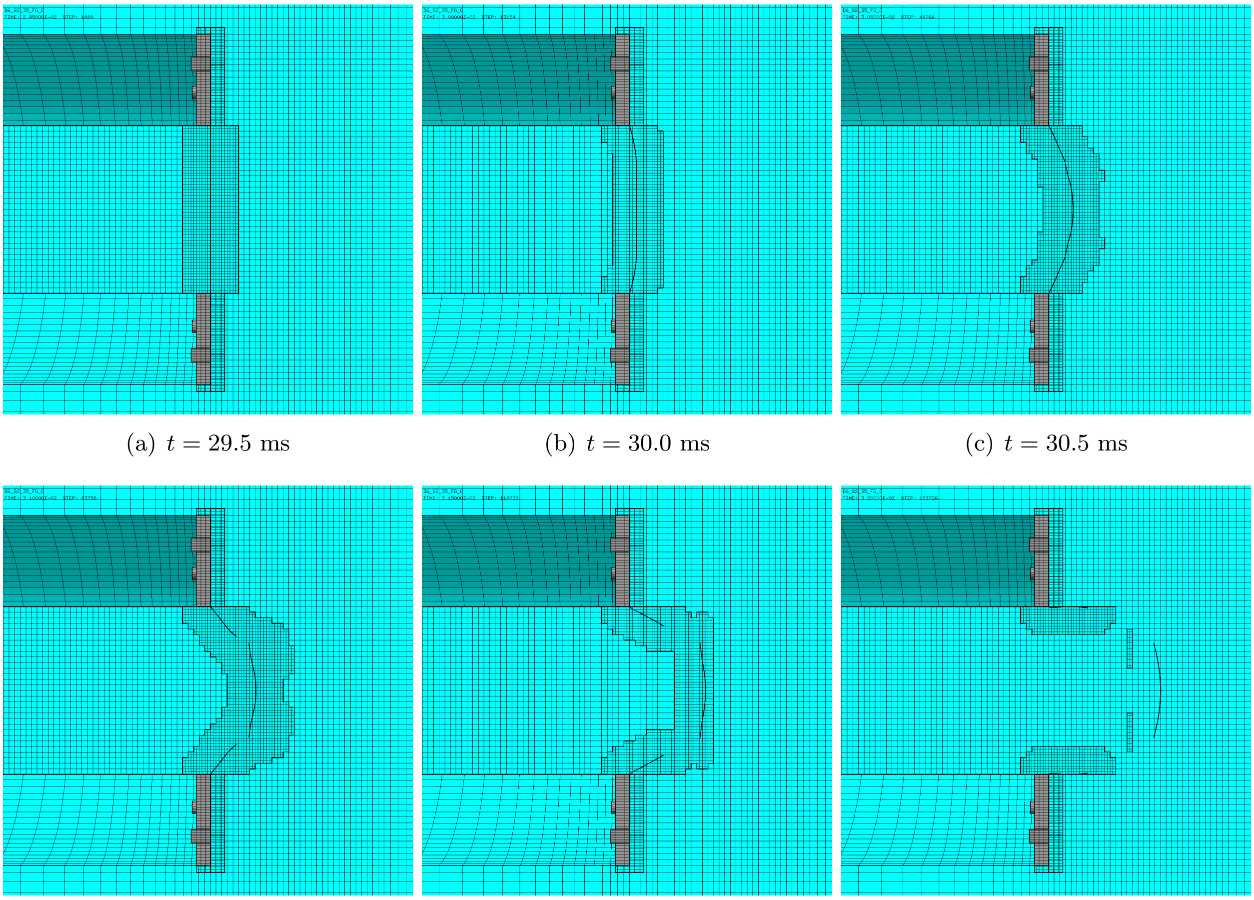


(a) $t = 29.5$ ms (b) $t = 30.0$ ms (c) $t = 30.5$ ms

(d) $t = 31.0$ ms (e) $t = 31.5$ ms (f) $t = 32.0$ ms

Figure 87: Fluid pressure in the test region in simulation D6_S2_35_FG_C.

Figure 88 shows the (symmetrized) mesh in the test region at various times.

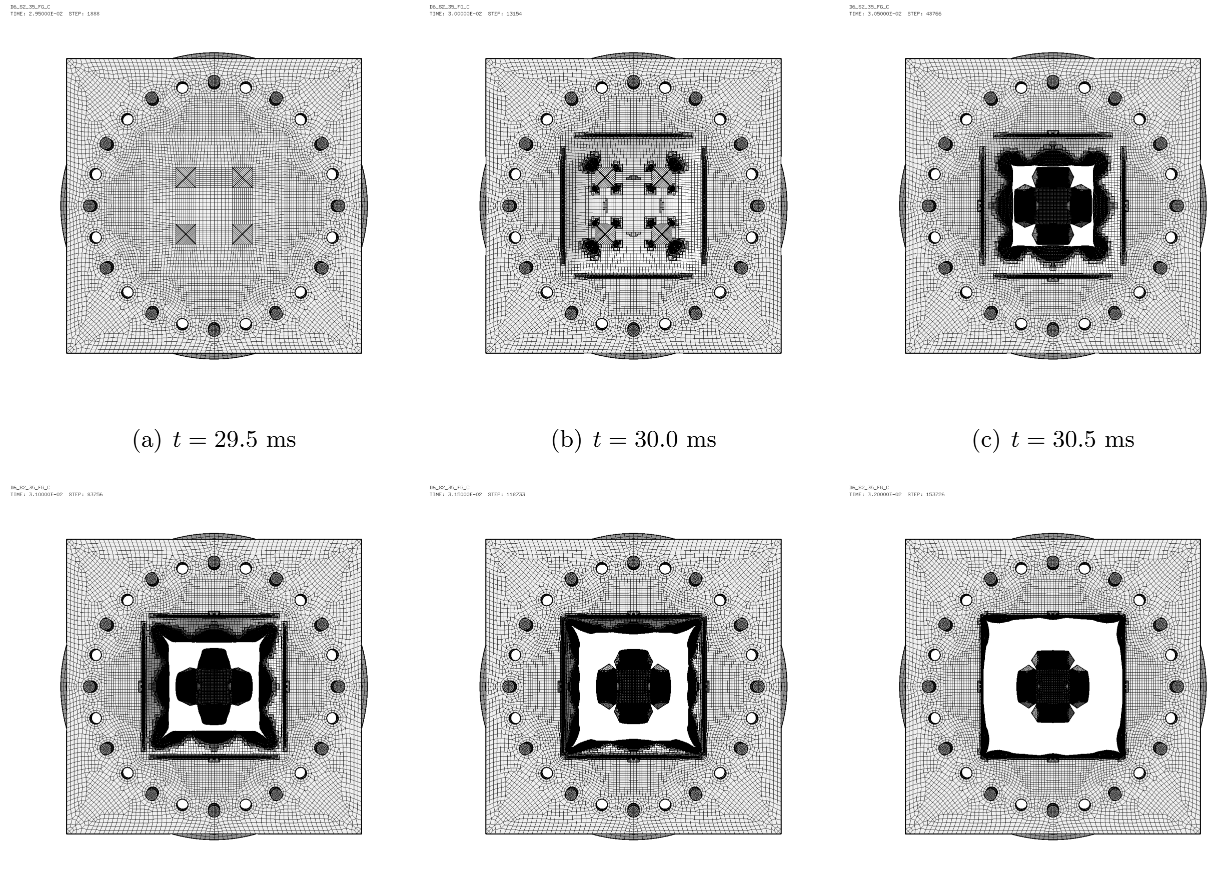


(a) $t = 29.5$ ms (b) $t = 30.0$ ms (c) $t = 30.5$ ms

(d) $t = 31.0$ ms (e) $t = 31.5$ ms (f) $t = 32.0$ ms

Figure 88: Mesh in the test region in simulation D6_S2_35_FG_C.

Figure 89 shows the (symmetrized) plate mesh at various times. The element outlines are included, in order to appreciate the adaptive mesh refinement taking place in the plate.

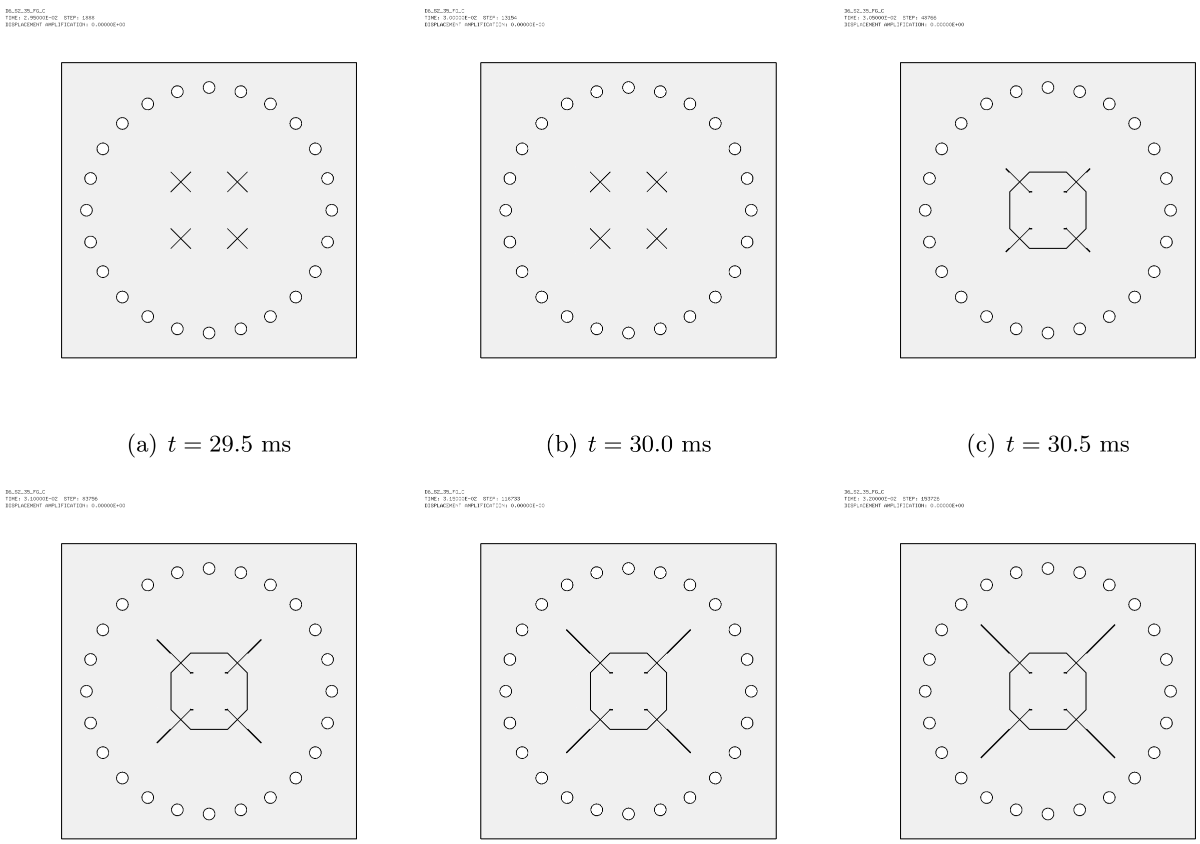


(a) $t = 29.5$ ms (b) $t = 30.0$ ms (c) $t = 30.5$ ms

(d) $t = 31.0$ ms (e) $t = 31.5$ ms (f) $t = 32.0$ ms

Figure 89: Plate mesh in simulation D6_S2_35_FG_C.

Figure 90 shows the (symmetrized) plate mesh without element outlines at various times. The geometry is mapped onto the initial configuration, by using the `DEFO AMPD 0.0` keywords. The `ADAP` keyword of the `TRAC` directive is used to allow for correct visualization of free edges and sharp corners. This allows to appreciate the progressive growth of the cracks.



(a) $t = 29.5$ ms (b) $t = 30.0$ ms (c) $t = 30.5$ ms

(d) $t = 31.0$ ms (e) $t = 31.5$ ms (f) $t = 32.0$ ms

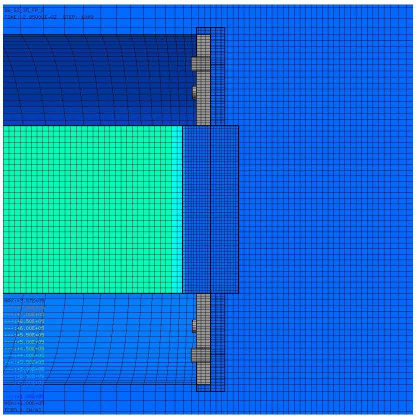
Figure 90: Undeformed plate mesh (without element outlines) in simulation D6_S2_35_FG_C.

6.5 Case D6_S2_35_FP_C

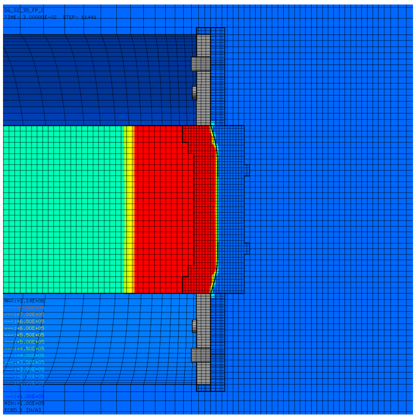
This is a repetition of case D6_S2_35_FP by correcting the value of t_{fail} according to eq. (1), i.e. by setting `TFAI 1.143E-8`.

Upon first run, this simulation had to be stopped due to physical displacement of the EVICOM PC on which it was running, when it had reached about 31.1 ms instead of the planned 32.0 ms. So it had to be re-run to complete the simulation. Some results are shown below.

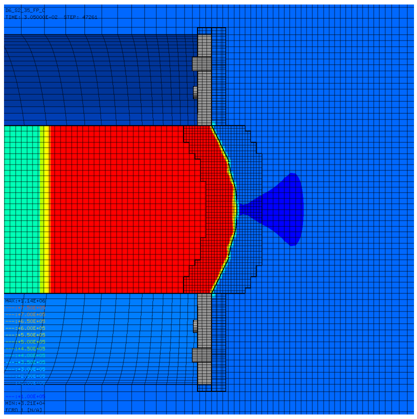
Figure 91 shows the (symmetrized) fluid pressure in the test region at various times.



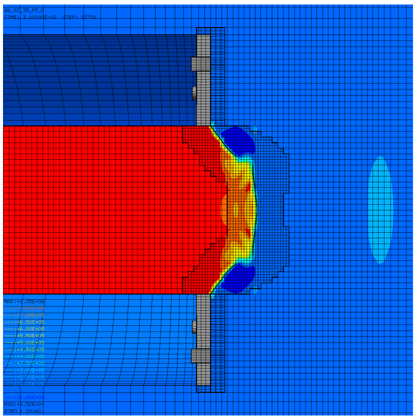
(a) $t = 29.5$ ms



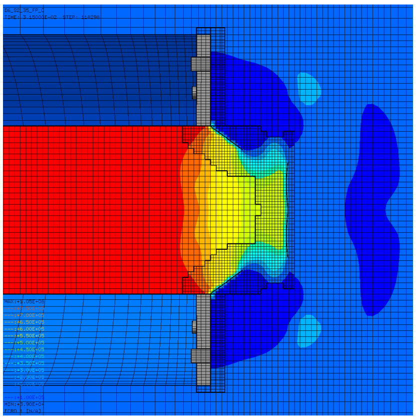
(b) $t = 30.0$ ms



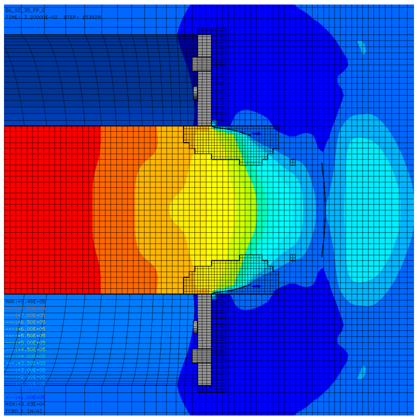
(c) $t = 30.5$ ms



(d) $t = 31.0$ ms



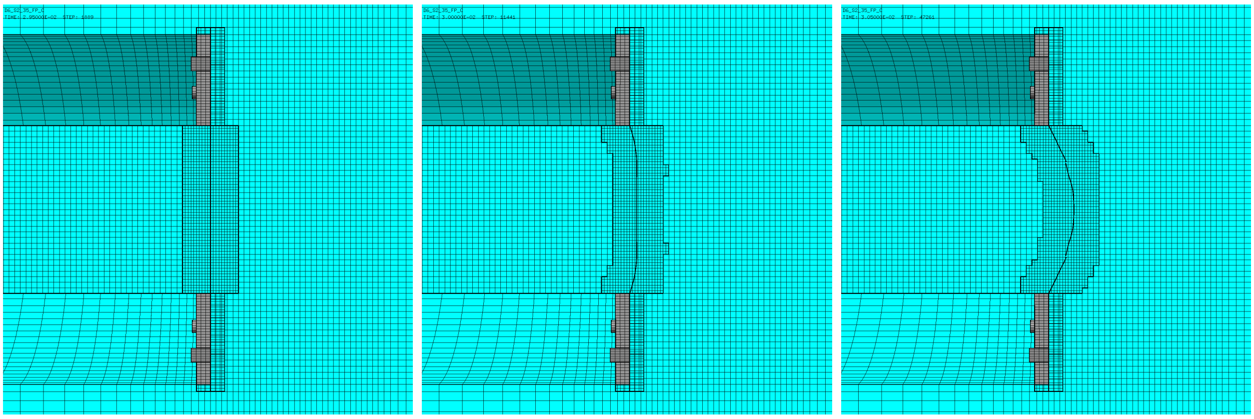
(e) $t = 31.5$ ms



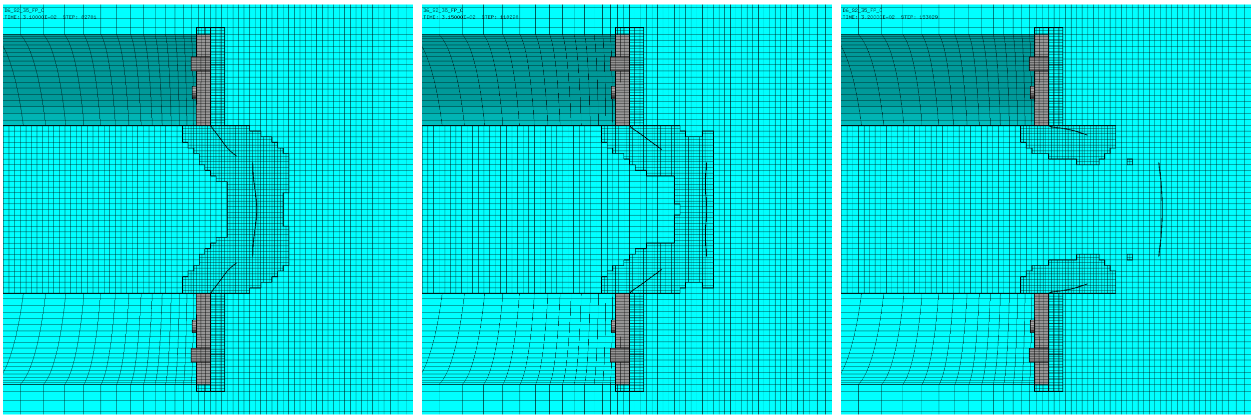
(f) $t = 32.0$ ms

Figure 91: Fluid pressure in the test region in simulation D6_S2_35_FP_C.

Figure 92 shows the (symmetrized) mesh in the test region at various times.



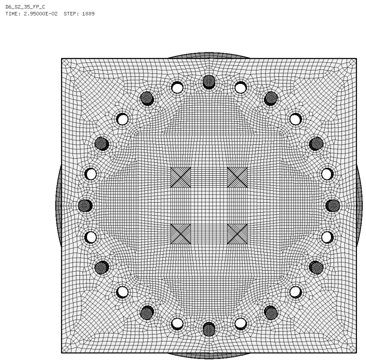
(a) $t = 29.5$ ms (b) $t = 30.0$ ms (c) $t = 30.5$ ms



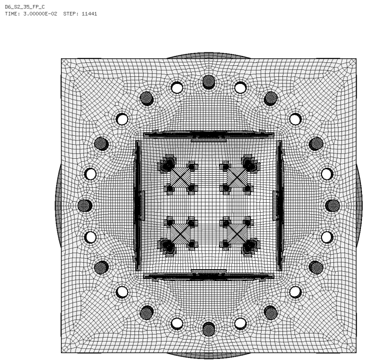
(d) $t = 31.0$ ms (e) $t = 31.5$ ms (f) $t = 32.0$ ms

Figure 92: Mesh in the test region in simulation D6_S2_35_FP_C.

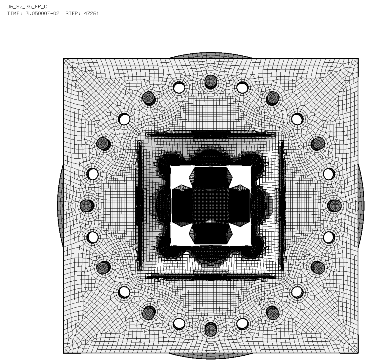
Figure 93 shows the (symmetrized) plate mesh at various times. The element outlines are included, in order to appreciate the adaptive mesh refinement taking place in the plate.



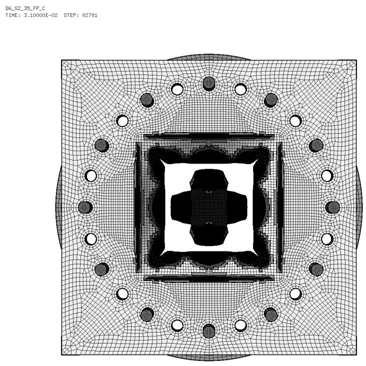
(a) $t = 29.5$ ms



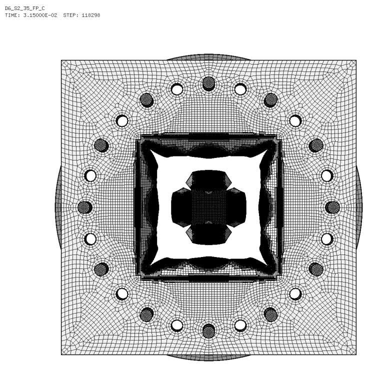
(b) $t = 30.0$ ms



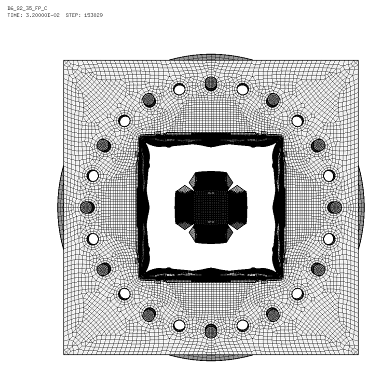
(c) $t = 30.5$ ms



(d) $t = 31.0$ ms



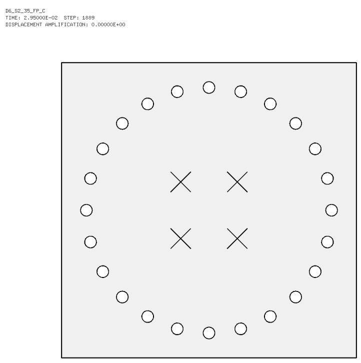
(e) $t = 31.5$ ms



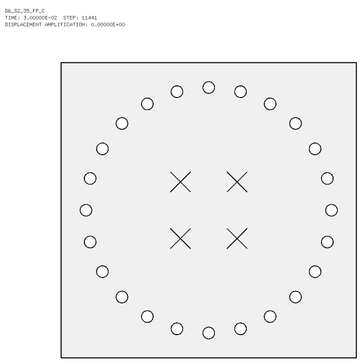
(f) $t = 32.0$ ms

Figure 93: Plate mesh in simulation D6_S2_35_FP_C.

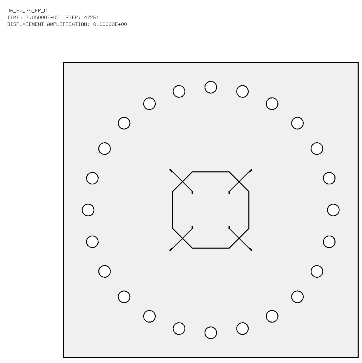
Figure 94 shows the (symmetrized) plate mesh without element outlines at various times. The geometry is mapped onto the initial configuration, by using the `DEFO AMPD 0.0` keywords. The `ADAP` keyword of the `TRAC` directive is used to allow for correct visualization of free edges and sharp corners. This allows to appreciate the progressive growth of the cracks.



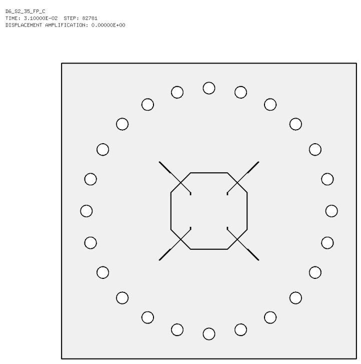
(a) $t = 29.5$ ms



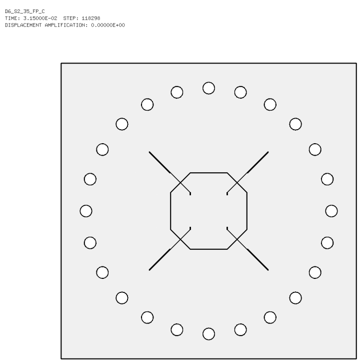
(b) $t = 30.0$ ms



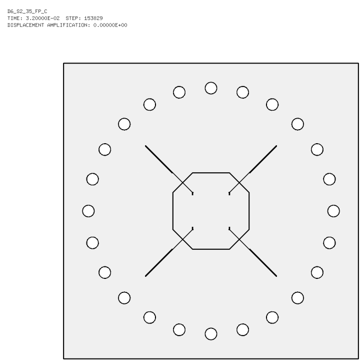
(c) $t = 30.5$ ms



(d) $t = 31.0$ ms



(e) $t = 31.5$ ms



(f) $t = 32.0$ ms

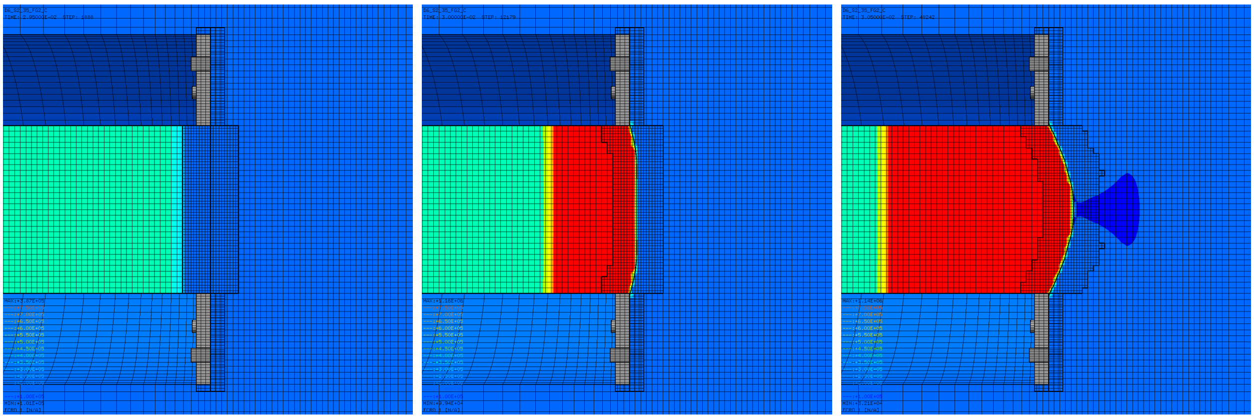
Figure 94: Undeformed plate mesh (without element outlines) in simulation D6_S2_35_FP_C.

6.6 Case D6_S2_35_FG2_C

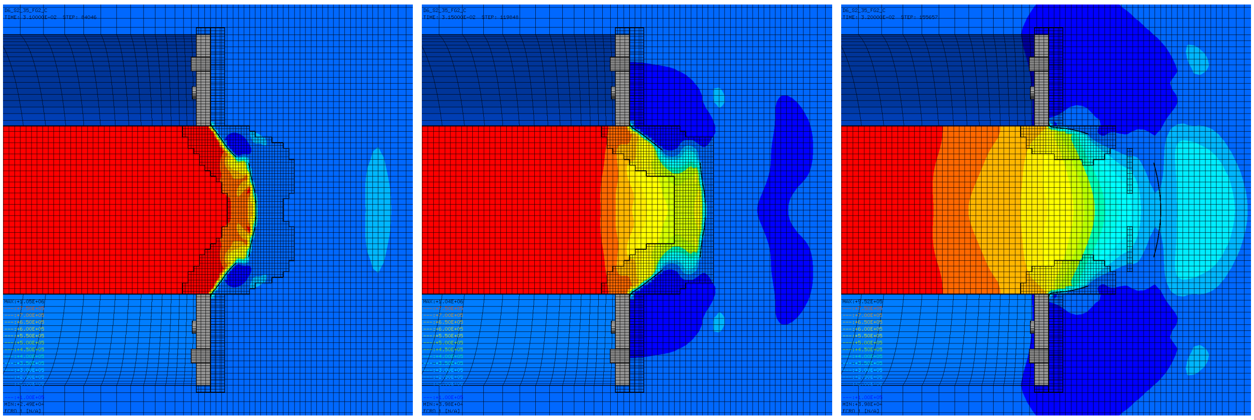
This is a repetition of case D6_S2_35_FG2 by correcting the value of t_{fail} according to eq. (1), i.e. by setting `TFAI 1.143E-8`.

Upon first run, this simulation had to be stopped due to physical displacement of the EVICOM PC on which it was running, when it had reached about 31.1 ms instead of the planned 32.0 ms. So it had to be re-run to complete the simulation. Some results are shown below.

Figure 95 shows the (symmetrized) fluid pressure in the test region at various times.



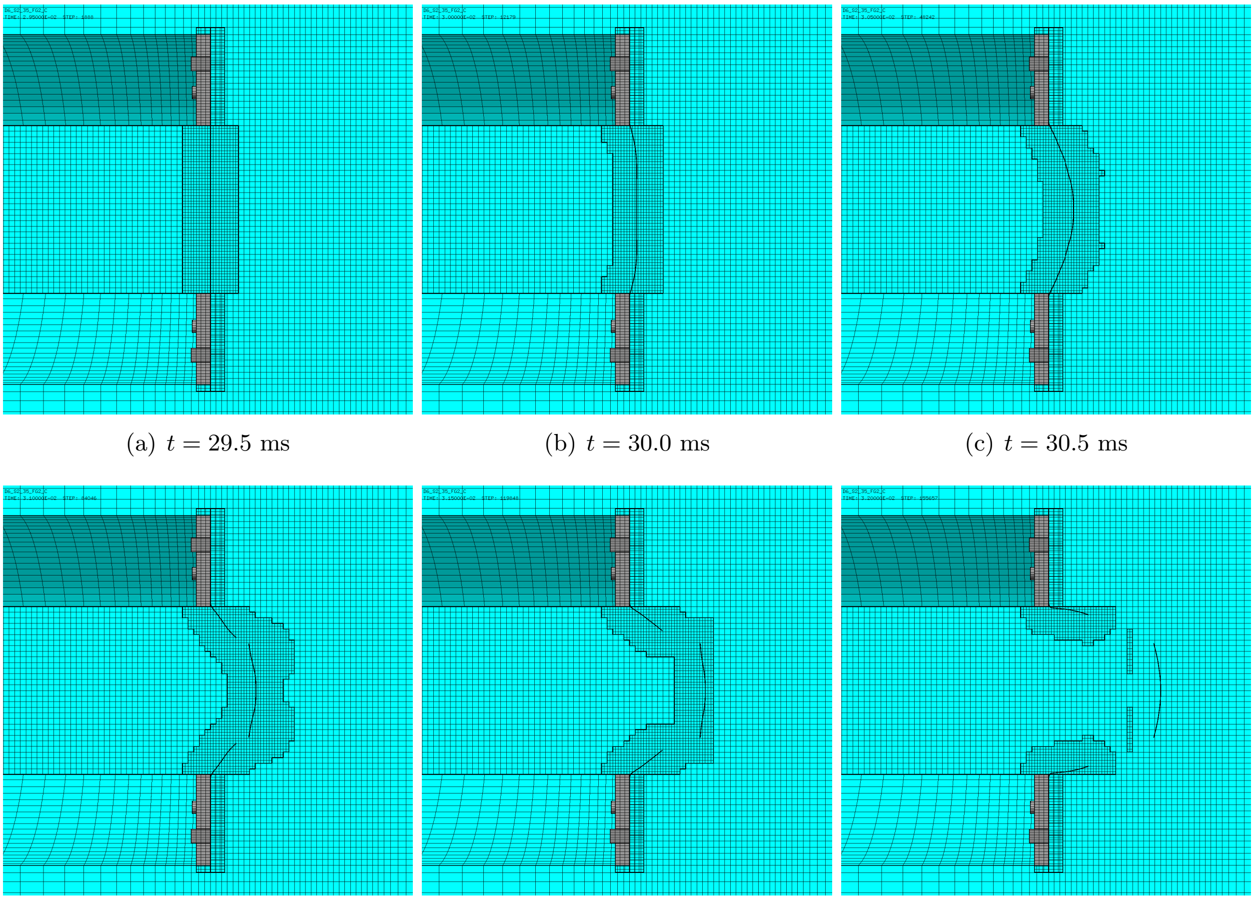
(a) $t = 29.5$ ms (b) $t = 30.0$ ms (c) $t = 30.5$ ms



(d) $t = 31.0$ ms (e) $t = 31.5$ ms (f) $t = 32.0$ ms

Figure 95: Fluid pressure in the test region in simulation D6_S2_35_FG2_C.

Figure 96 shows the (symmetrized) mesh in the test region at various times.

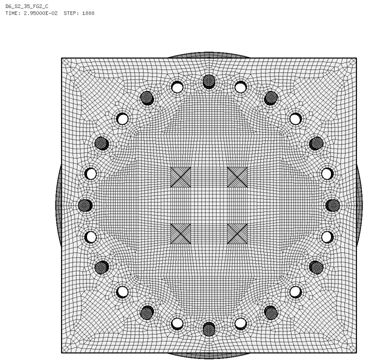


(a) $t = 29.5$ ms (b) $t = 30.0$ ms (c) $t = 30.5$ ms

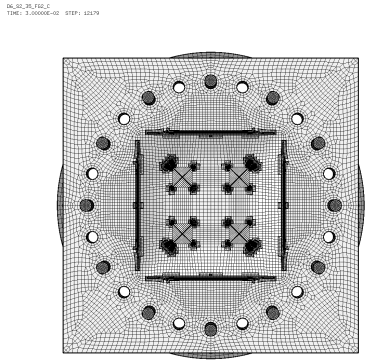
(d) $t = 31.0$ ms (e) $t = 31.5$ ms (f) $t = 32.0$ ms

Figure 96: Mesh in the test region in simulation D6_S2_35_FG2_C.

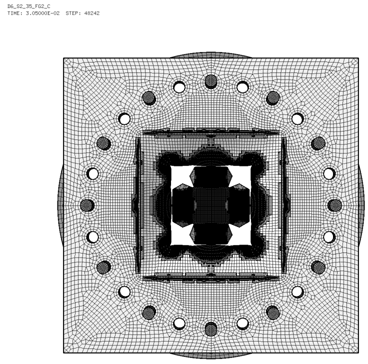
Figure 97 shows the (symmetrized) plate mesh at various times. The element outlines are included, in order to appreciate the adaptive mesh refinement taking place in the plate.



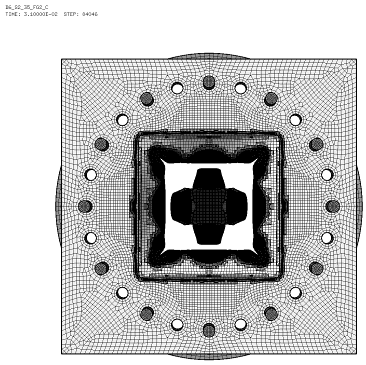
(a) $t = 29.5$ ms



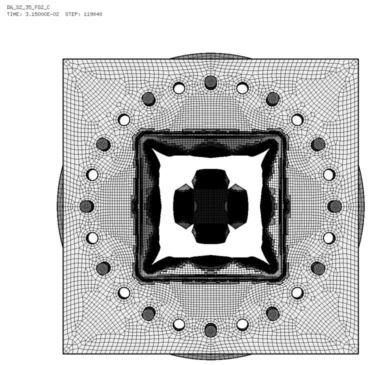
(b) $t = 30.0$ ms



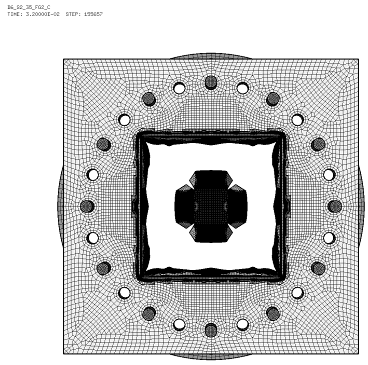
(c) $t = 30.5$ ms



(d) $t = 31.0$ ms



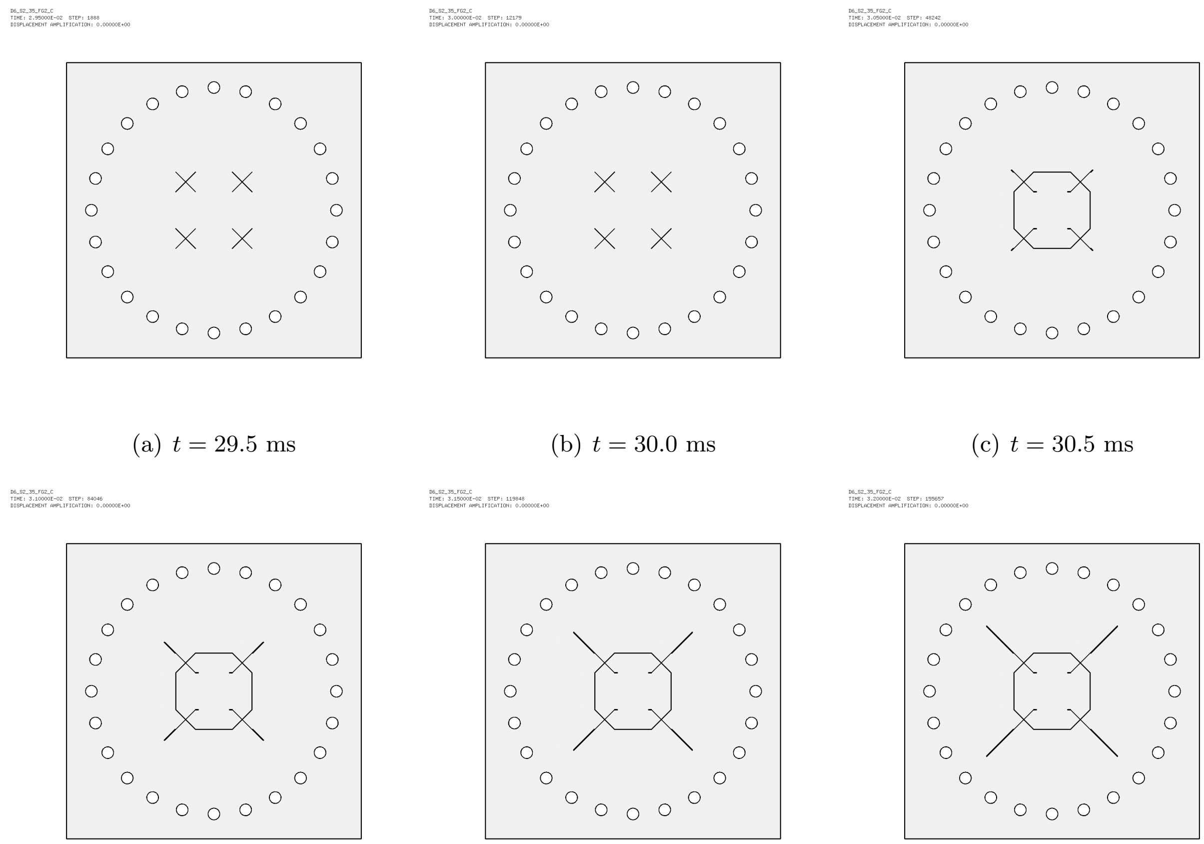
(e) $t = 31.5$ ms



(f) $t = 32.0$ ms

Figure 97: Plate mesh in simulation D6_S2_35_FG2_C.

Figure 98 shows the (symmetrized) plate mesh without element outlines at various times. The geometry is mapped onto the initial configuration, by using the `DEFO AMPD 0.0` keywords. The `ADAP` keyword of the `TRAC` directive is used to allow for correct visualization of free edges and sharp corners. This allows to appreciate the progressive growth of the cracks.



(a) $t = 29.5$ ms (b) $t = 30.0$ ms (c) $t = 30.5$ ms

(d) $t = 31.0$ ms (e) $t = 31.5$ ms (f) $t = 32.0$ ms

Figure 98: Undeformed plate mesh (without element outlines) in simulation D6_S2_35_FG2_C.

6.7 Additional stability safety coefficient (CSVF) for the CCFV

Following the observations raised in Section 6.1 when dealing with case D6_S2_35_FG, we introduce an additional stability safety coefficient C_s^{VF} (new option `OPTI CSVF csvf`) for the Cell-Centered Finite Volumes (CCFV). In an FSI simulation, where both the structure (FE) and the fluid (CCFV) are present, this should allow to compute each type of element with a Δt closer to its actual stability limit, while at the same time (hopefully) saving some CPU in the overall calculation.

To illustrate this, consider for example the FSI (ALE) case D6_S2_35_FC of Section 6.1. The model is 3D and, to be on the safe side, the CCFV fluid requires a stability safety coefficient C_s of 0.4. In fact, theoretically one should use $1/D$, where D is the space dimension, so $C_s = 0.33$ in 3D. However, the corresponding Lagrangian (structure only) calculation D6_S2_35 presented in Section 2 used a much larger safety factor $C_s = 0.7$, without showing any sign of instability.

Furthermore, in the plate simulations considered in the present report, the critical part of the model is the structure since, on one hand, the sound speed in the metal is typically higher than in the fluid (air) and, on the other hand, the mesh size in the structure h_S (after adaptive refinement) is smaller than that in the fluid h_F (also after adaptive refinement).

Actually, the latter condition ($h_s < h_F$) is the opposite to the one recommended to achieve optimal accuracy in FSI calculations using embedded methods such as the FLSW algorithm used here. However, the reason for refining the structure so much is that we want to faithfully capture the formation and propagation of cracks in the plate. Refining also the fluid accordingly would lead to a much higher number of fluid elements, since the fluid is a 3D volume and not a 3D surface, and this could unacceptably penalize the CPU cost of the simulation.

Prior to the present development, in EPX the *stability step* of an element was the *critical step* Δt_{crit} estimated by the code (roughly the element length L divided by the speed of sound c in the element material) multiplied by the *safety coefficient* C_s (`CSTA`, by default 0.8):

$$\Delta t_{\mathrm{stab}} = C_s \Delta t_{\mathrm{crit}} \approx C_s \frac{L}{c} \tag{2}$$

The same equation applied to all elements, i.e. to both FE and CCFV.

We now introduce an additional safety coefficient C_s^{VF}, which can be prescribed by the option:

```
OPTI CSVF csvf
```

By default, the code assumes $C_s^{\mathrm{VF}} = 1.0$, so that results of older models should not be affected. For a Cell-Centered Finite Volume, the value of the stability step obtained by eq. (2) is further multiplied by C_s^{VF}, obtaining:

$$\begin{aligned} \Delta t_{\mathrm{stab}}^{\mathrm{FE}} &= C_s \Delta t_{\mathrm{crit}} \approx C_s \frac{L}{c} \qquad \text{for a FE} \\ \Delta t_{\mathrm{stab}}^{\mathrm{VF}} &= C_s^{\mathrm{VF}} C_s \Delta t_{\mathrm{crit}} \approx C_s^{\mathrm{VF}} C_s \frac{L}{c} \qquad \text{for a CCFV} \end{aligned} \tag{3}$$

Thus, instead of correcting the test D6_S2_35_FG of Section 6.1 by reducing the failure time step t_{fail} according to eq. (1) as done in case D6_S2_35_FG_C of Section 6.4, one can more simply proceed as follows:

- Set the global safety coefficient to the same value as that used in the Lagrangian failure time step t_{fail} simulation, i.e. $C_s = 0.7$ (`OPTI CSTA 0.7`).
- Set the additional safety coefficient in such a way that a final value of 0.4 is obtained for the fluid part of the model, i.e. $C_s^{\mathrm{VF}} = 0.4/0.7 = 0.571$.
- Set the failure time step to the same value used in the Lagrangian (structure only) simulation, $t_{\mathrm{fail}} = 2.0 \times 10^{-8}$ s. Since the fluid part of the model is not erodible, the value of t_{fail} has no effect on it.

Thus, the only modification in order to pass from a Lagrangian to a FSI simulation is the added setting of C_s^{VF}, in such a way that the desired overall safety coefficient (0.4 in this example) is obtained for the fluid part of the model.

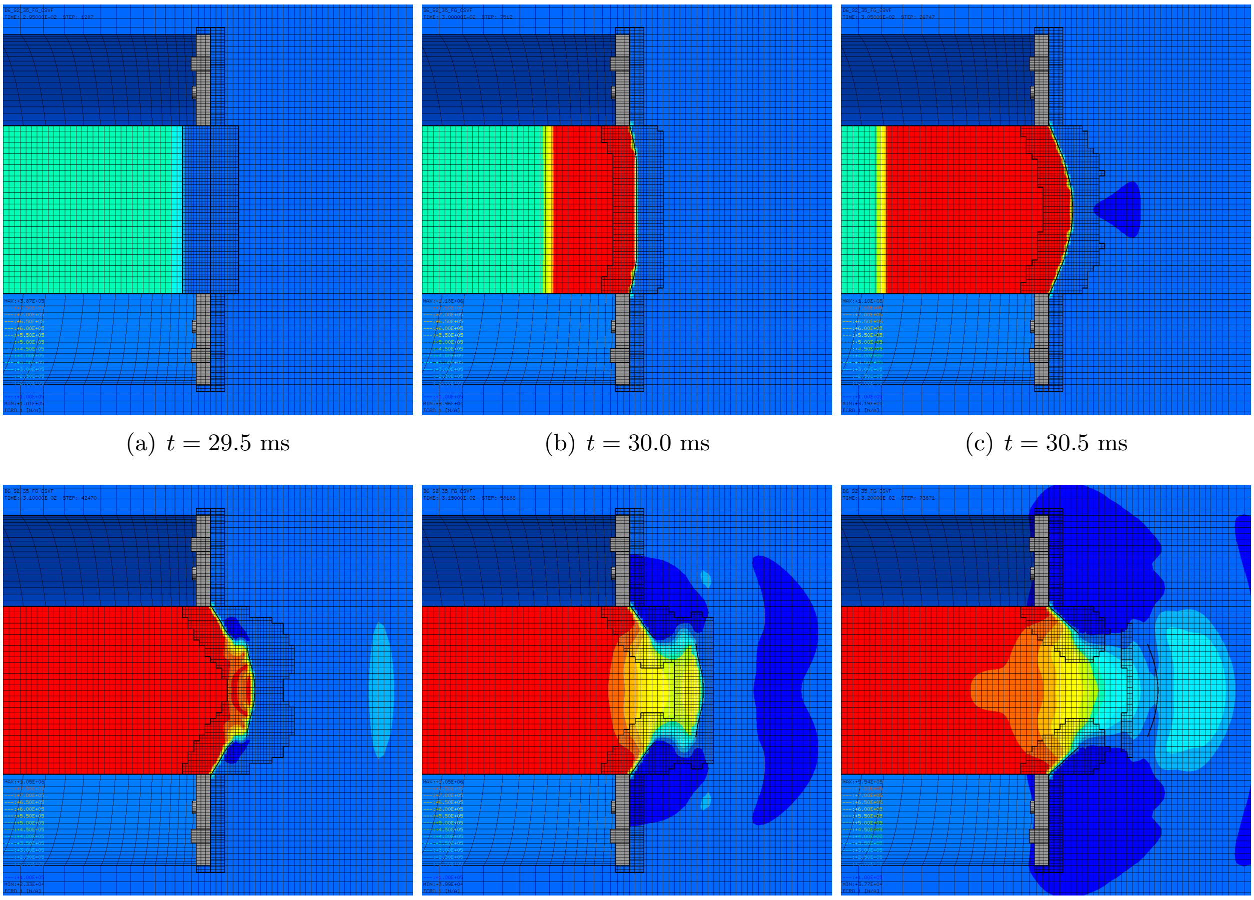
6.8 Case D6_S2_35_FG_CSVF

This is a repetition of case D6_S2_35_FG of Section 6.1 by using the new option `OPTI CSVF` as explained in Section 6.7. The relevant parts of the input file read:

```
D6_S2_35_FG_CSVF
 . . .
OPTI NOTE CSTA 0.7 CSVF 0.571 ! (so that CSTA*CSVF=0.4 for the VFCC)
 . . .
CALC TINI 0 TEND 32.0E-3 TFAI 2.0E-8
FIN
```

This solution was considerably faster than the other “corrected” solutions, using just about half the number of steps and half the CPU time. Some results are shown below.

Figure 99 shows the (symmetrized) fluid pressure in the test region at various times.

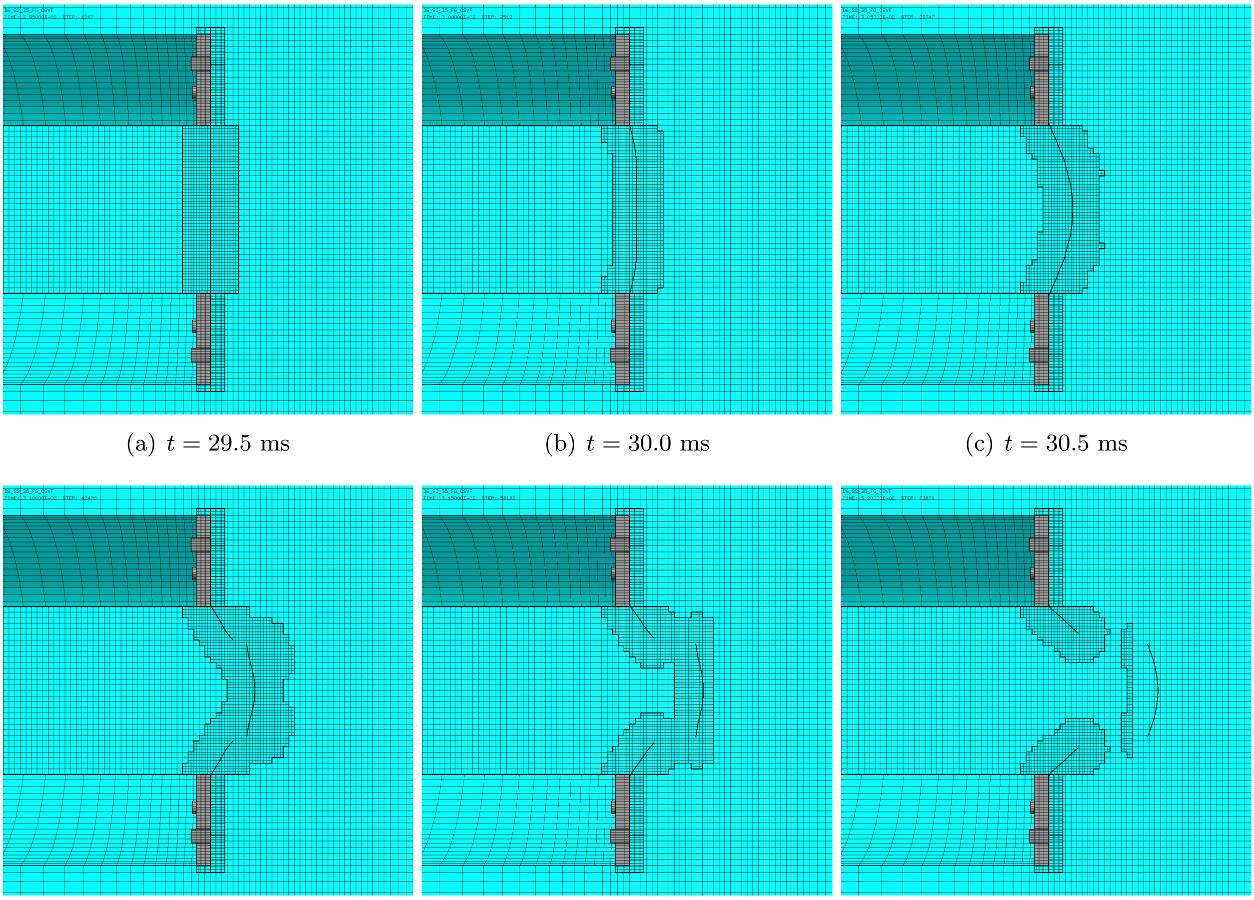


(a) $t = 29.5$ ms (b) $t = 30.0$ ms (c) $t = 30.5$ ms

(d) $t = 31.0$ ms (e) $t = 31.5$ ms (f) $t = 32.0$ ms

Figure 99: Fluid pressure in the test region in simulation D6_S2_35_FG_CSVF.

Figure 100 shows the (symmetrized) mesh in the test region at various times.

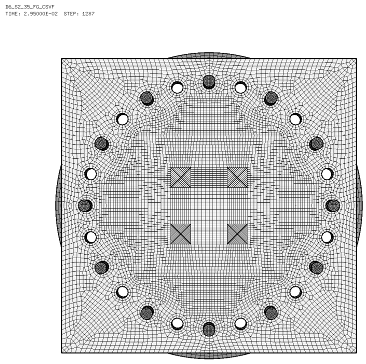


(a) $t = 29.5$ ms (b) $t = 30.0$ ms (c) $t = 30.5$ ms

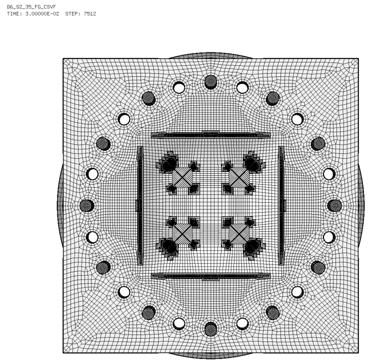
(d) $t = 31.0$ ms (e) $t = 31.5$ ms (f) $t = 32.0$ ms

Figure 100: Mesh in the test region in simulation D6_S2_35_FG_CSVF.

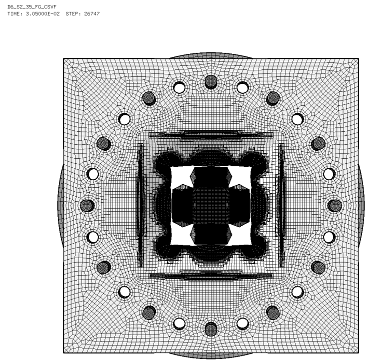
Figure 101 shows the (symmetrized) plate mesh at various times. The element outlines are included, in order to appreciate the adaptive mesh refinement taking place in the plate.



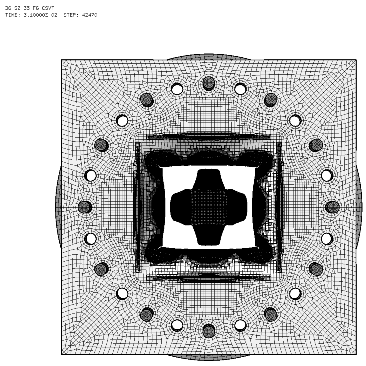
(a) $t = 29.5$ ms



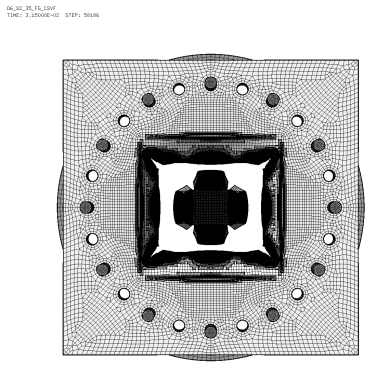
(b) $t = 30.0$ ms



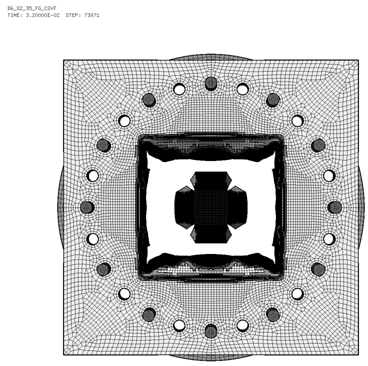
(c) $t = 30.5$ ms



(d) $t = 31.0$ ms



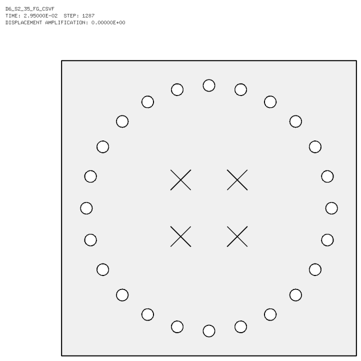
(e) $t = 31.5$ ms



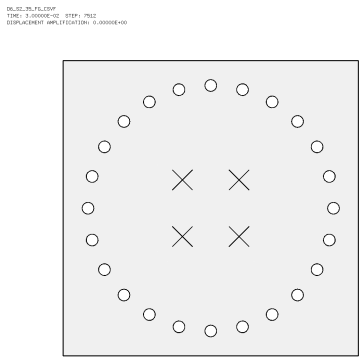
(f) $t = 32.0$ ms

Figure 101: Plate mesh in simulation D6_S2_35_FG_CSVF.

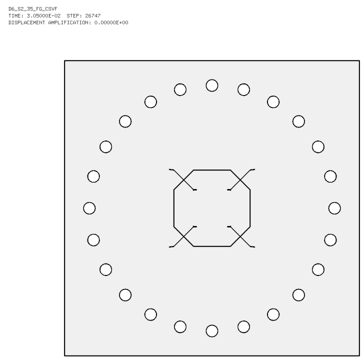
Figure 102 shows the (symmetrized) plate mesh without element outlines at various times. The geometry is mapped onto the initial configuration, by using the `DEFO AMPD 0.0` keywords. The `ADAP` keyword of the `TRAC` directive is used to allow for correct visualization of free edges and sharp corners. This allows to appreciate the progressive growth of the cracks.



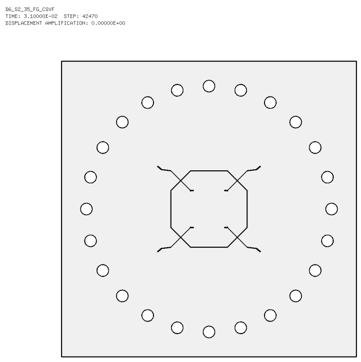
(a) $t = 29.5$ ms



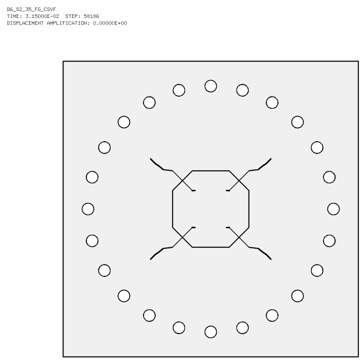
(b) $t = 30.0$ ms



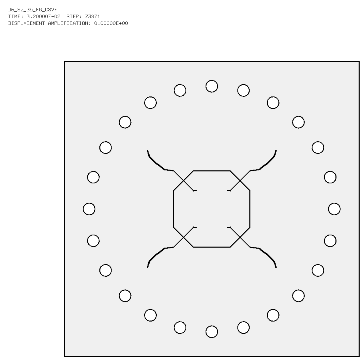
(c) $t = 30.5$ ms



(d) $t = 31.0$ ms



(e) $t = 31.5$ ms



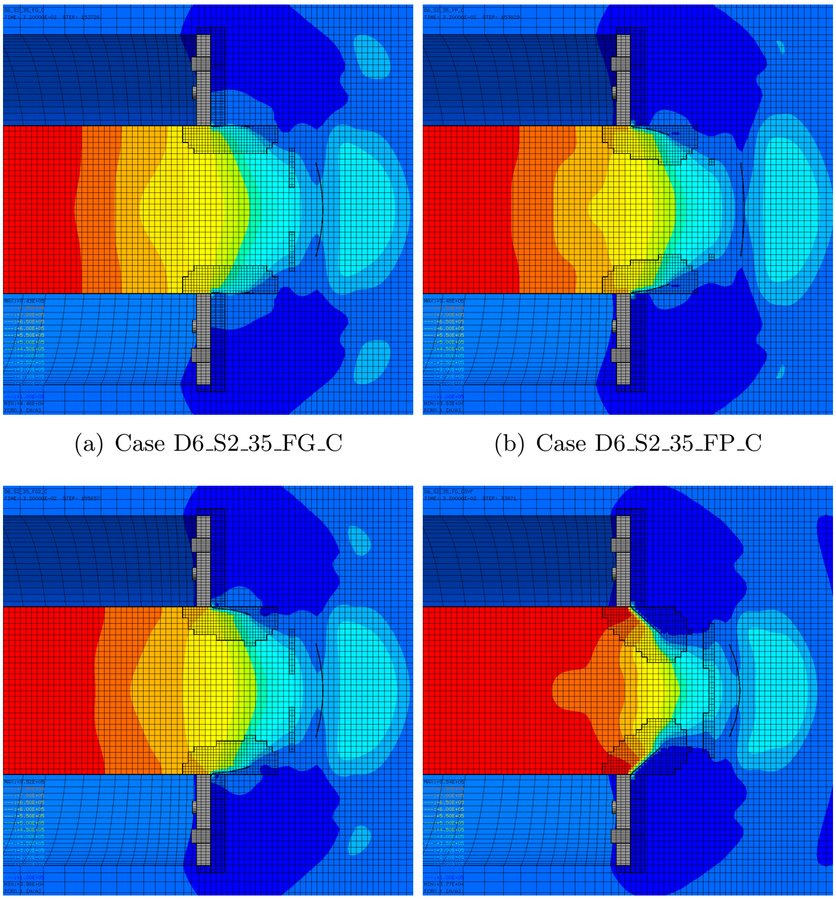
(f) $t = 32.0$ ms

Figure 102: Undeformed plate mesh (without element outlines) in simulation D6_S2_35_FG2_CSVF.

6.9 Comparison of FSI simulations

In this Section we compare the 35-bar FSI solutions obtained so far. Only the four "corrected" cases are considered, namely cases D6_S2_35_FG_C, D6_S2_35_FG_P, D6_S2_35_FG2_C and D6_S2_35_FG_CSVF from Table 12.

Figure 103 compares the (symmetrized) fluid pressures in the test region at $t = 32.0$ ms.

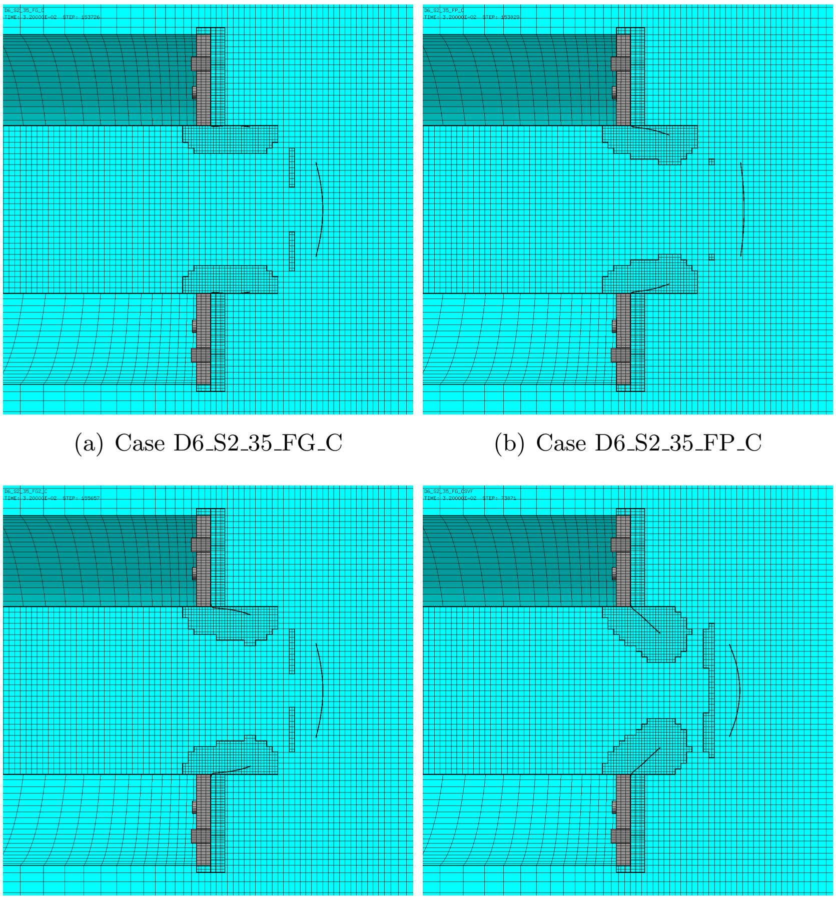


(a) Case D6_S2_35_FG_C (b) Case D6_S2_35_FP_C

(c) Case D6_S2_35_FG2_C (d) Case D6_S2_35_FG_CSVF

Figure 103: Final fluid pressures in the test region in preliminary FSI simulations at 35 bar.

Figure 104 compares the (symmetrized) meshes in the test region at $t = 32.0$ ms.

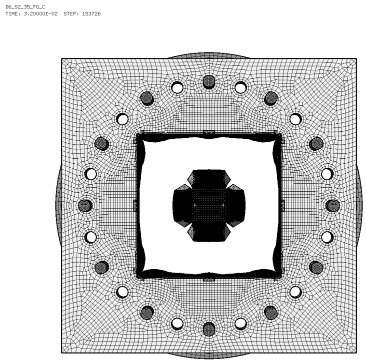


(a) Case D6_S2_35_FG_C (b) Case D6_S2_35_FP_C

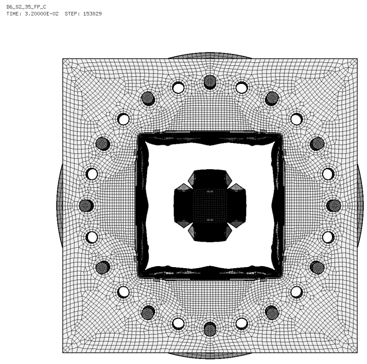
(c) Case D6_S2_35_FG2_C (d) Case D6_S2_35_FG_CSVF

Figure 104: Final meshes in the test region in preliminary FSI simulations at 35 bar.

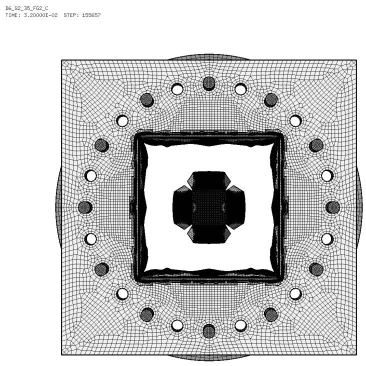
Figure 105 compares the (symmetrized) plate meshes at $t = 32.0$ ms. The element outlines are included, in order to appreciate the adaptive mesh refinement taking place in the plate.



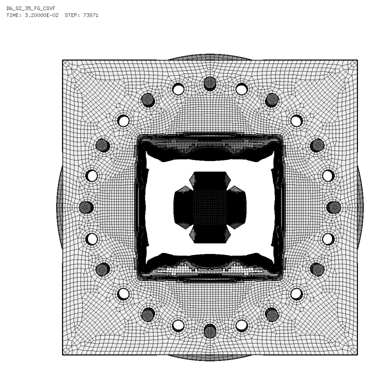
(a) Case D6_S2_35_FG_C



(b) Case D6_S2_35_FP_C



(c) Case D6_S2_35_FG2_C

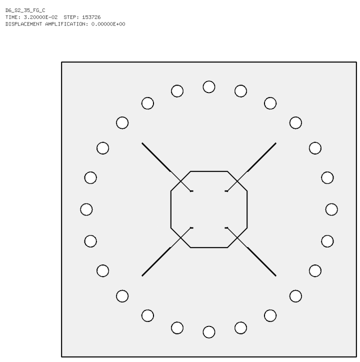


(d) Case D6_S2_35_FG_CSVF

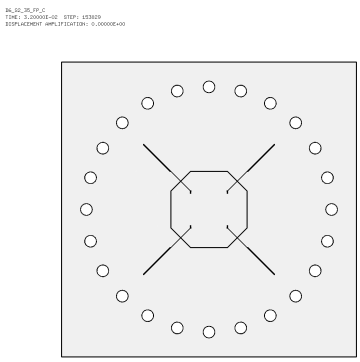
Figure 105: Final plate meshes in preliminary FSI simulations at 35 bar.

Figure 106 shows the (symmetrized) plate mesh without element outlines at various times. The geometry is mapped onto the initial configuration, by using the `DEFO AMPD 0.0` keywords. The `ADAP` keyword of the `TRAC` directive is used to allow for correct visualization of free edges and sharp corners. This allows to appreciate the progressive growth of the cracks.

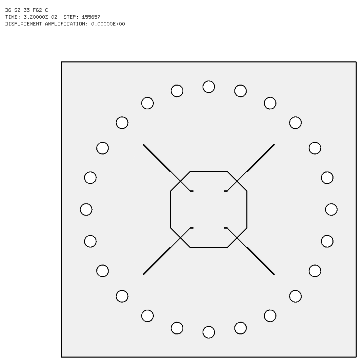
The Lagrangian solution of case D6_S2_35 from Section 2 is also included as the last one in the Figure, in order to allow direct comparison with the FSI solutions.



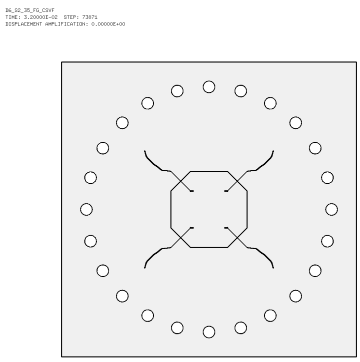
(a) Case D6_S2_35_FG_C



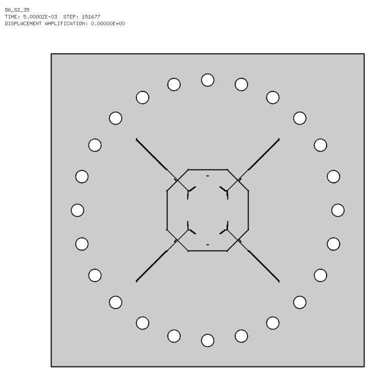
(b) Case D6_S2_35_FP_C



(c) Case D6_S2_35_FG2_C



(d) Case D6_S2_35_FG_CSVF



(e) Case D6_S2_35 (Lagrangian)

Figure 106: Final undeformed plate meshes in preliminary FSI simulations at 35 bar.

From the above Figures, one might conclude that the first three FSI solutions look very similar, indicating that the choice of the contact model (either `GLIS` or `PINB`) does not play a big role in this application. Also, the use of additional `ADAP` keyword in the `GLIS` model seems to have little influence here.

The last FSI solution, using `CSFV`, shows some differences with respect to the other three (especially in the form of the radial cracks which are less straight), but it remains very similar and might even be considered equivalent from an engineering viewpoint. Altogether, the differences observed are reasonable, considering that this solution was twice faster than the previous ones.

The Lagrangian solution is similar to the FSI solutions as far as the general shape and orientation of the cracks is concerned, but the cracks are slightly more pronounced, especially towards the center of the plate, showing additional crack bifurcations not present in the FSI solutions.

7 FSI simulations

This Section presents a set of FSI simulations with each of the nominal firing pressures of interset for the S2 plate, namely 10, 15 and 25 bar. Simulations at 35 bar are also included, although no experiment was conducted on the S2 plate at that firing pressure. All tests use the PINB model for the contact between the plate and the mounting frames.

The simulations performed are summarized in Table 13 and are described in detail below.

Test	p^* [bar]	Map file	Date	t_{map} [ms]	t_{fin} [ms]	Steps	CPU [s]	Ero.	RAM [GB]	Sto. [GB]
D6_S2_10_FP	10	D7710600mape_01.map	01/05/23	32.2*	38.2	278 122	603 259	7	4.9	6.9
D6_S2_15_FP	15	D7715600map.map	03/03/21	29.0	36.0	202 006	480 804	20	5.0	7.8
D6_S2_25_FP	25	D7725600map.map	03/03/21	28.0	34.0	180 679	479 251	61	5.1	6.8
D6_S2_35_FPN	35	D7735600map.map	15/03/21	27.0	32.0	155 040	488 320	222	5.3	5.9
D14_S2_10_FP	10	D7710600mape_01.map	01/05/23	32.2*	38.2	252 736	430 743	4	4.9	6.9
D14_S2_15_FP	15	D7715600map.map	03/03/21	29.0	36.0	166 856	330 494	490	4.9	7.8
D14_S2_25_FP	25	D7725600map.map	03/03/21	28.0	34.0	154 131	341 940	677	5.0	6.8
D14_S2_35_FPN	35	D7735600map.map	15/03/21	27.0	32.0	119 550	270 415	1 099	5.0	5.8

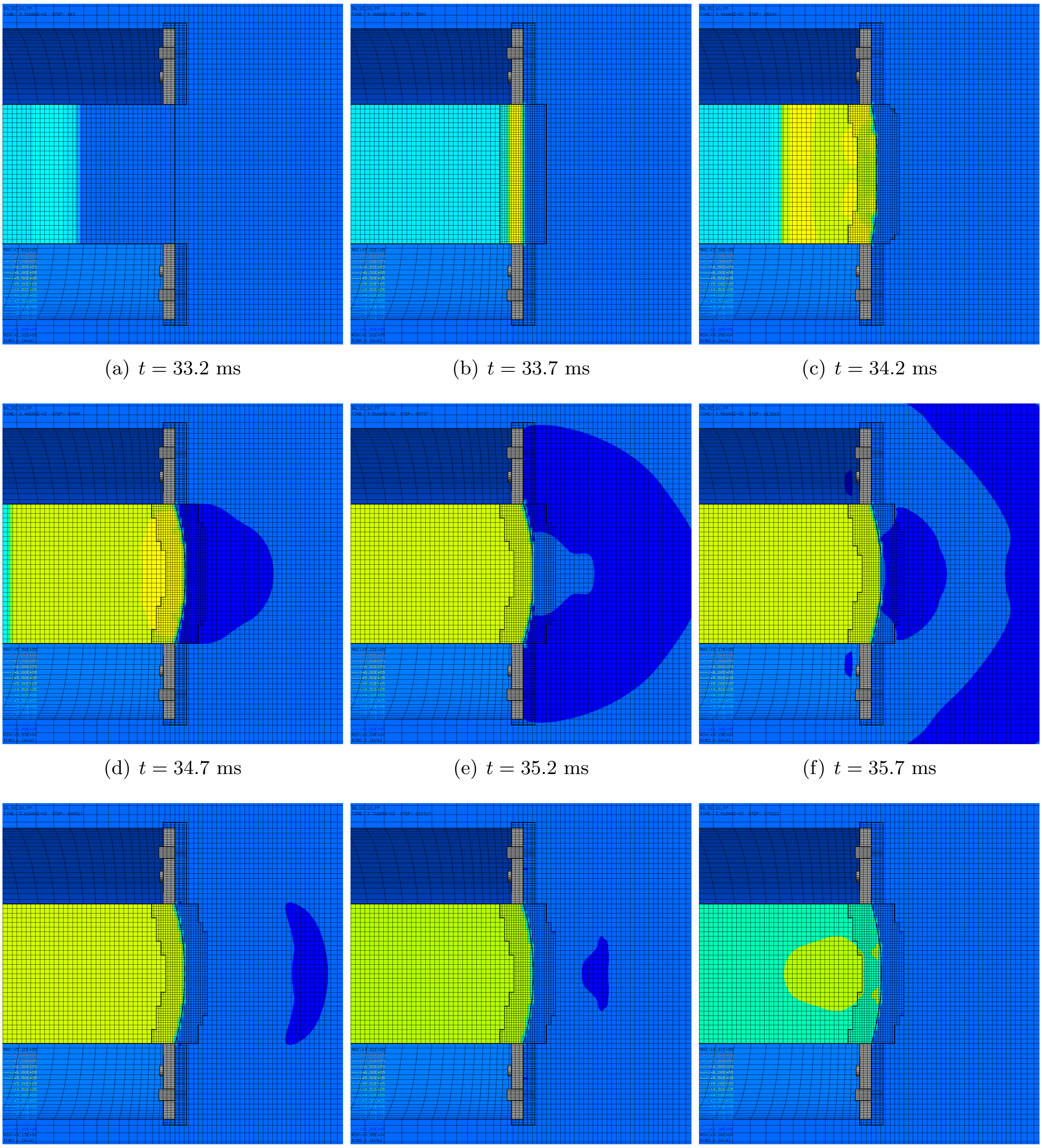
*Map trigger

Table 13: FSI (coupled) simulations of the S2 plates.

7.1 Case D6_S2_10_FP

This test is an FSI simulation at a nominal firing pressure of 10 bar. The model is derived from that of case D6_S2_35_FP_C presented in the previous Section, but uses the 10-bar map file D7710600mape_01.-map obtained in Section 3.9, generated at t_{map} = 32.2 ms on 01/05/2023. The plate material is Docol-600DL. Some results are shown below.

Figure 107 shows the (symmetrized) fluid pressure in the test region at various times.



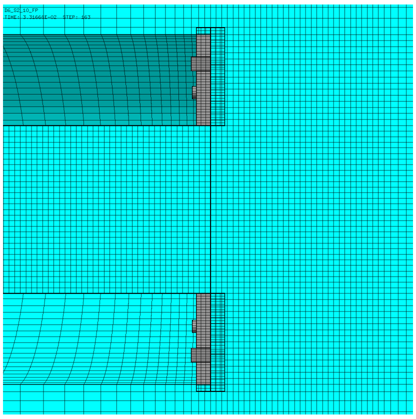
(a) $t = 33.2$ ms (b) $t = 33.7$ ms (c) $t = 34.2$ ms

(d) $t = 34.7$ ms (e) $t = 35.2$ ms (f) $t = 35.7$ ms

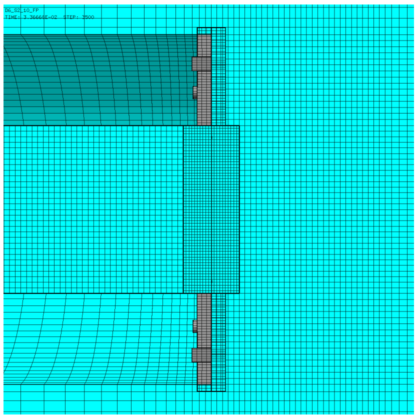
(g) $t = 36.2$ ms (h) $t = 37.2$ ms (i) $t = 38.2$ ms

Figure 107: Fluid pressure in the test region in simulation D14_S2_10_FP.

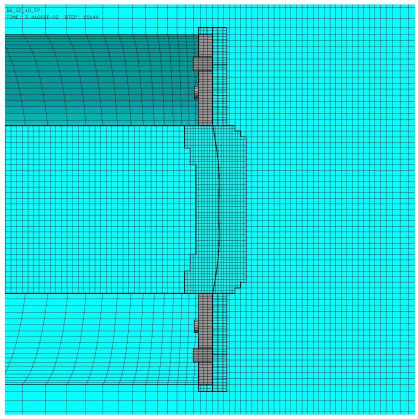
Figure 108 shows the (symmetrized) mesh in the test region at various times.



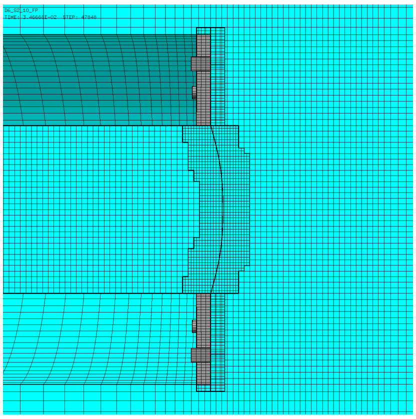
(a) $t = 33.2$ ms



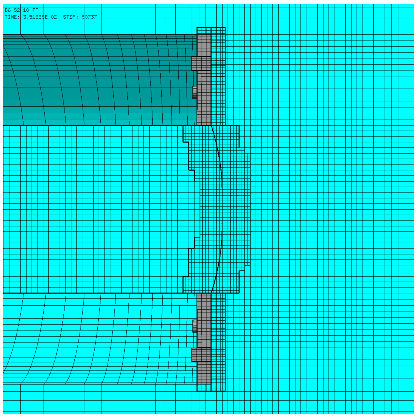
(b) $t = 33.7$ ms



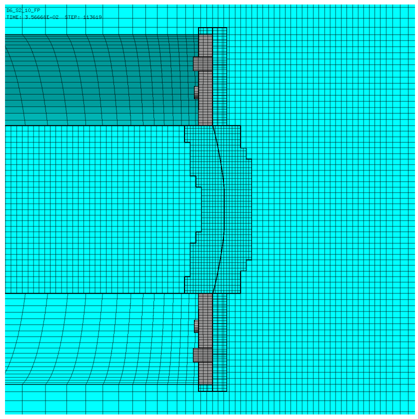
(c) $t = 34.2$ ms



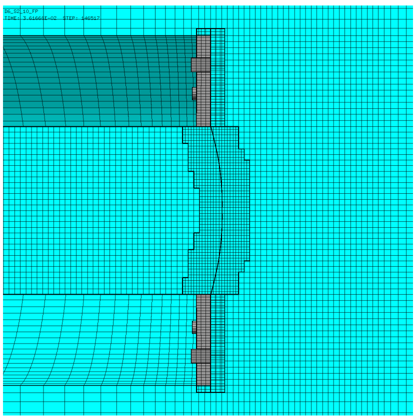
(d) $t = 34.7$ ms



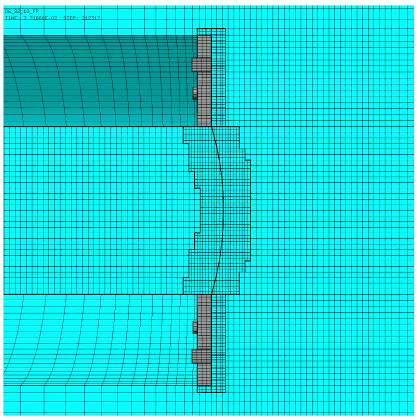
(e) $t = 35.2$ ms



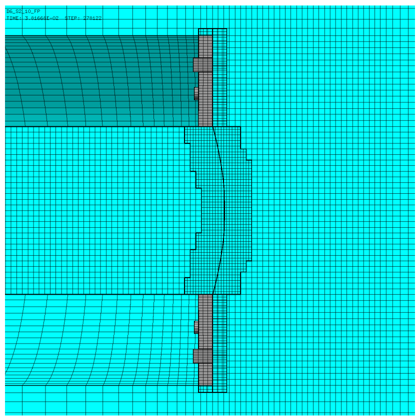
(f) $t = 35.7$ ms



(g) $t = 36.2$ ms



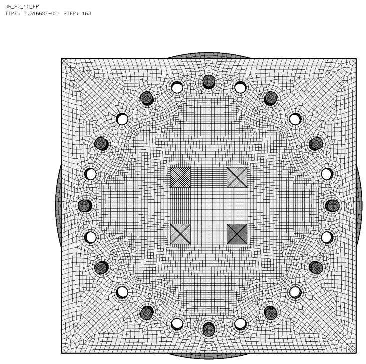
(h) $t = 37.2$ ms



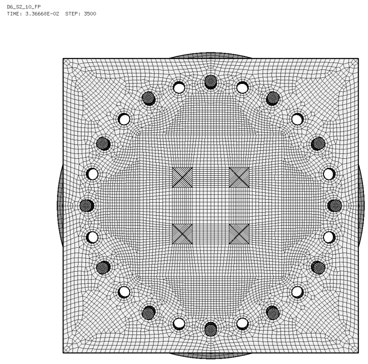
(i) $t = 38.2$ ms

Figure 108: Mesh in the test region in simulation D6_S2_10_FP.

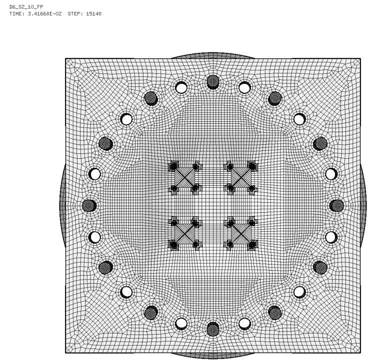
Figure 109 shows the (symmetrized) plate mesh at various times. The element outlines are included, in order to appreciate the adaptive mesh refinement taking place in the plate.



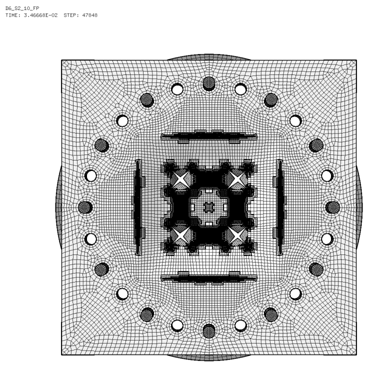
(a) $t = 33.2$ ms



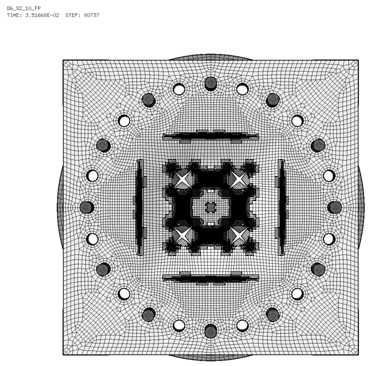
(b) $t = 33.7$ ms



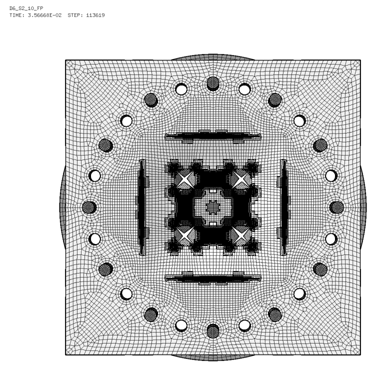
(c) $t = 34.2$ ms



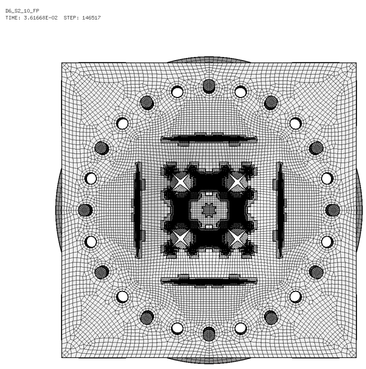
(d) $t = 34.7$ ms



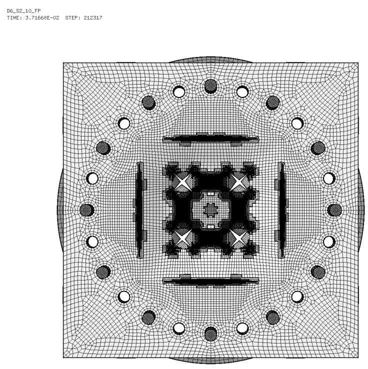
(e) $t = 35.2$ ms



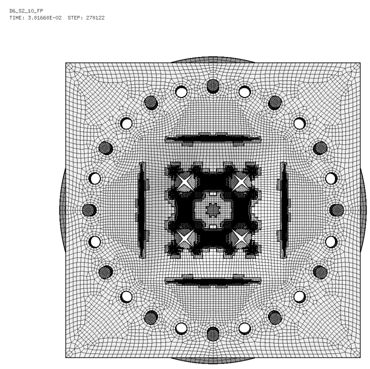
(f) $t = 35.7$ ms



(g) $t = 36.2$ ms



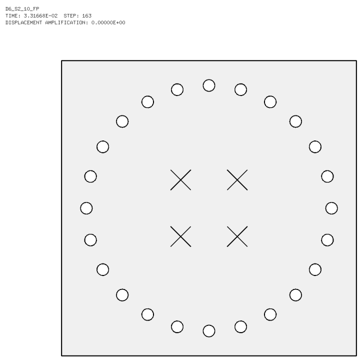
(h) $t = 37.2$ ms



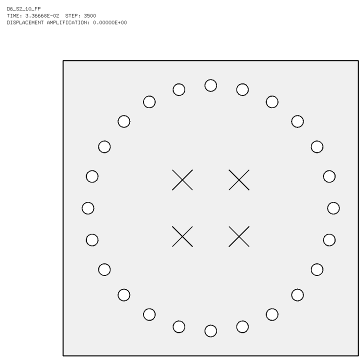
(i) $t = 38.2$ ms

Figure 109: Plate mesh in simulation D6_S2_10_FP.

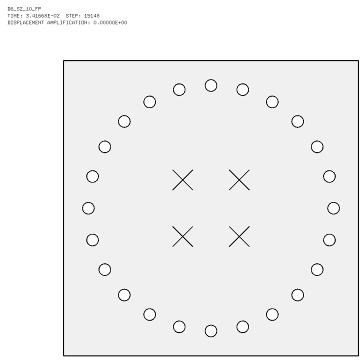
Figure 110 shows the (symmetrized) plate mesh without element outlines at various times. The geometry is mapped onto the initial configuration, by using the `DEFO AMPD 0.0` keywords. The `ADAP` keyword of the `TRAC` directive is used to allow for correct visualization of free edges and sharp corners. This allows to appreciate the progressive growth of the cracks.



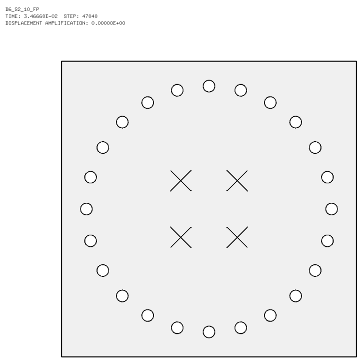
(a) $t = 33.2$ ms



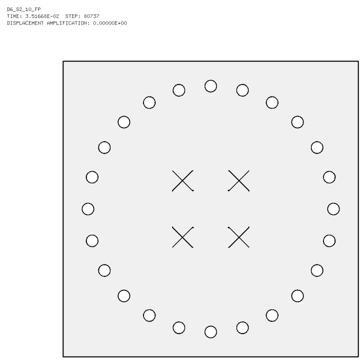
(b) $t = 33.7$ ms



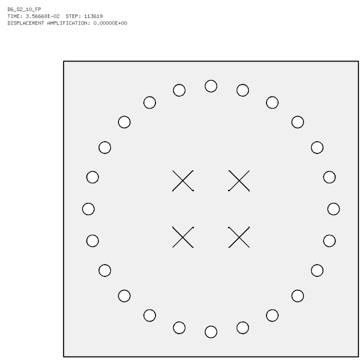
(c) $t = 34.2$ ms



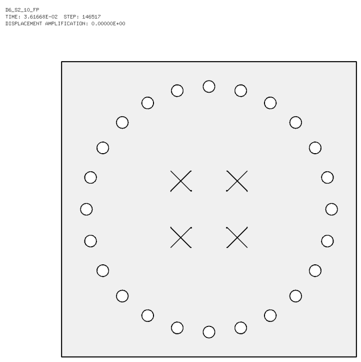
(d) $t = 34.7$ ms



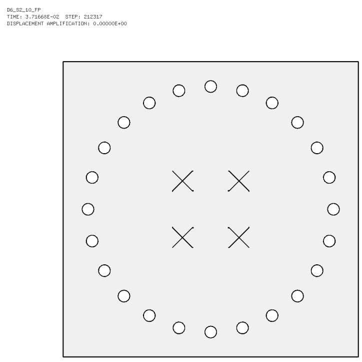
(e) $t = 35.2$ ms



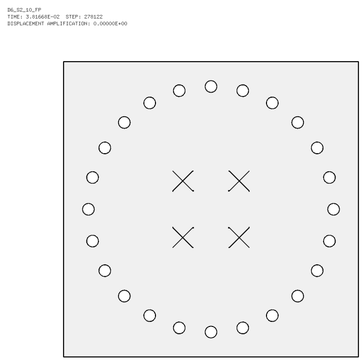
(f) $t = 35.7$ ms



(g) $t = 36.2$ ms



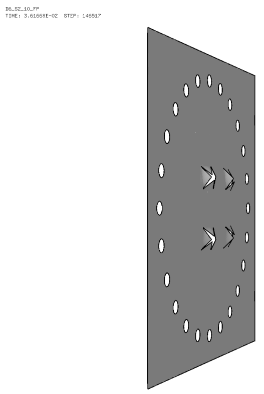
(h) $t = 37.2$ ms



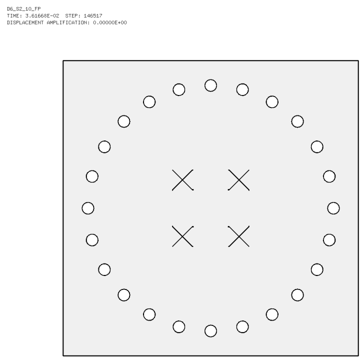
(i) $t = 38.2$ ms

Figure 110: Undeformed plate mesh (without element outlines) in simulation D6_S2_10_FP.

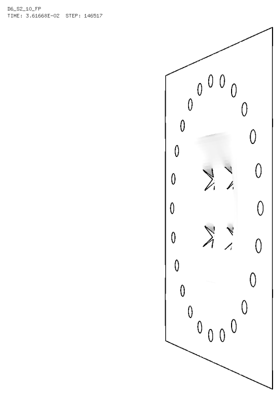
Figure 111 shows the (symmetrized) plate mesh without element outlines at various times, from three different eye positions (right, front, left), in order to highlight the opening of the slits. The right and left views show the deformed plate, while the central view shows the undeformed plate, like in the previous Figure, in order to highlight the cracks.



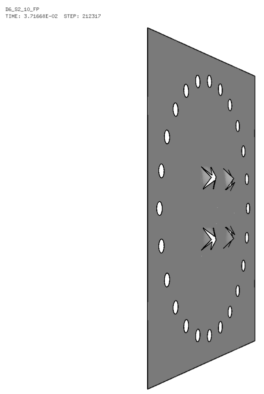
(a) $t = 36.2$ ms



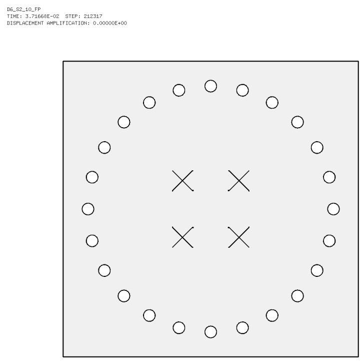
(b) Undeformed, $t = 36.2$ ms



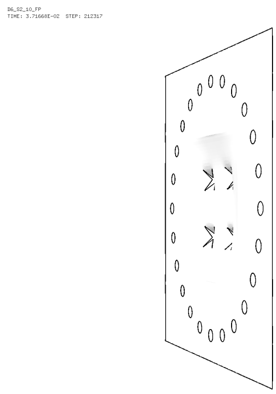
(c) $t = 36.2$ ms



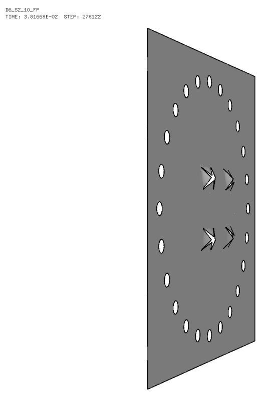
(d) $t = 372.$ ms



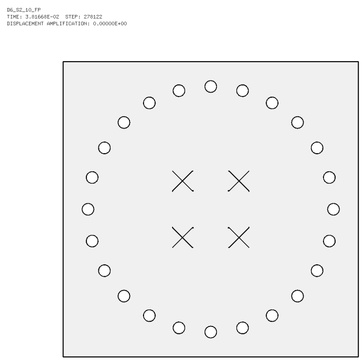
(e) Undeformed, $t = 37.2$ ms



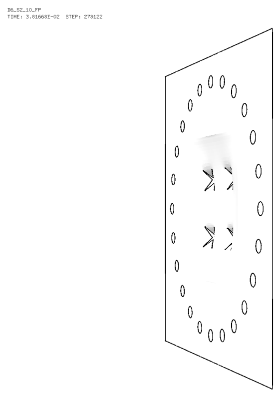
(f) $t = 37.2$ ms



(g) $t = 38.2$ ms



(h) Undeformed, $t = 38.2$ ms



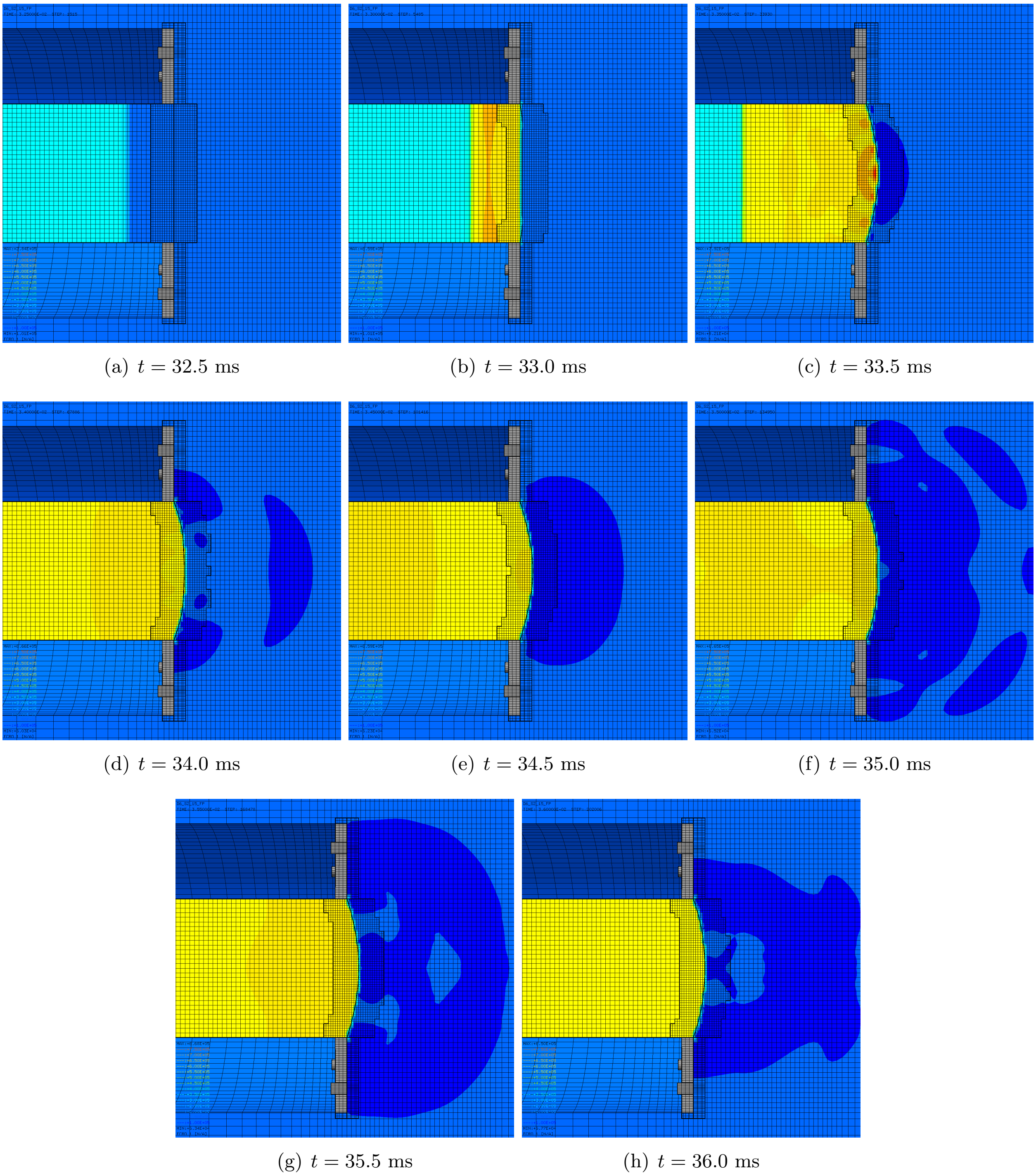
(i) $t = 38.2$ ms

Figure 111: Plate mesh (without element outlines) in simulation D6_S2_10_FP.

7.2 Case D6_S2_15_FP

This test is similar to case D6_S2_10_FP but uses the 15-bar map file from 2021, D7715600map.map from the NTNU DataBase [15], that had been generated at a physical time of $t_{\text{map}} = 29.0$ ms on 03/03/2021. Some results are shown below.

Figure 112 shows the (symmetrized) fluid pressure in the test region at various times.



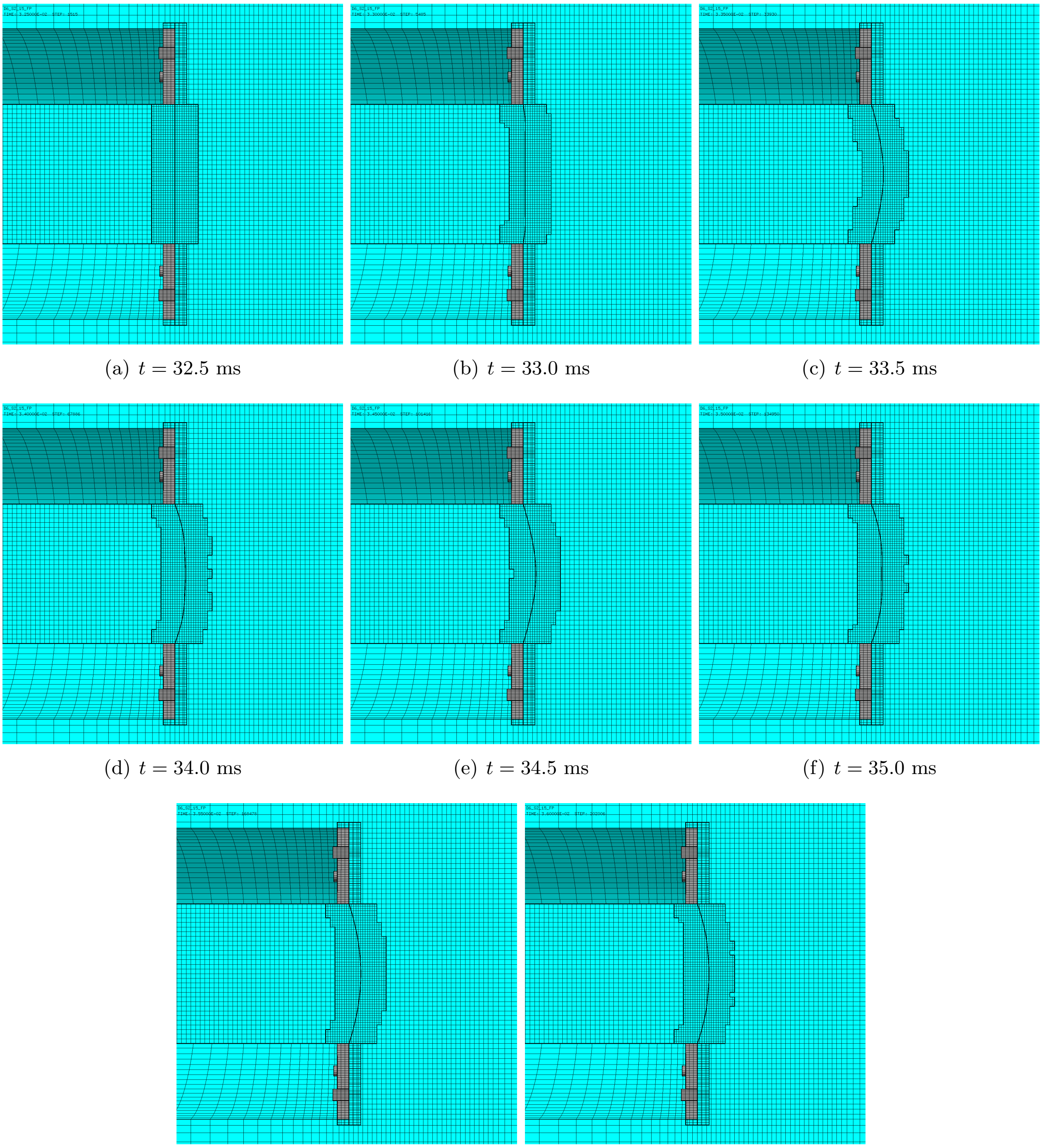
(a) $t = 32.5$ ms (b) $t = 33.0$ ms (c) $t = 33.5$ ms

(d) $t = 34.0$ ms (e) $t = 34.5$ ms (f) $t = 35.0$ ms

(g) $t = 35.5$ ms (h) $t = 36.0$ ms

Figure 112: Fluid pressure in the test region in simulation D6_S2_15_FP.

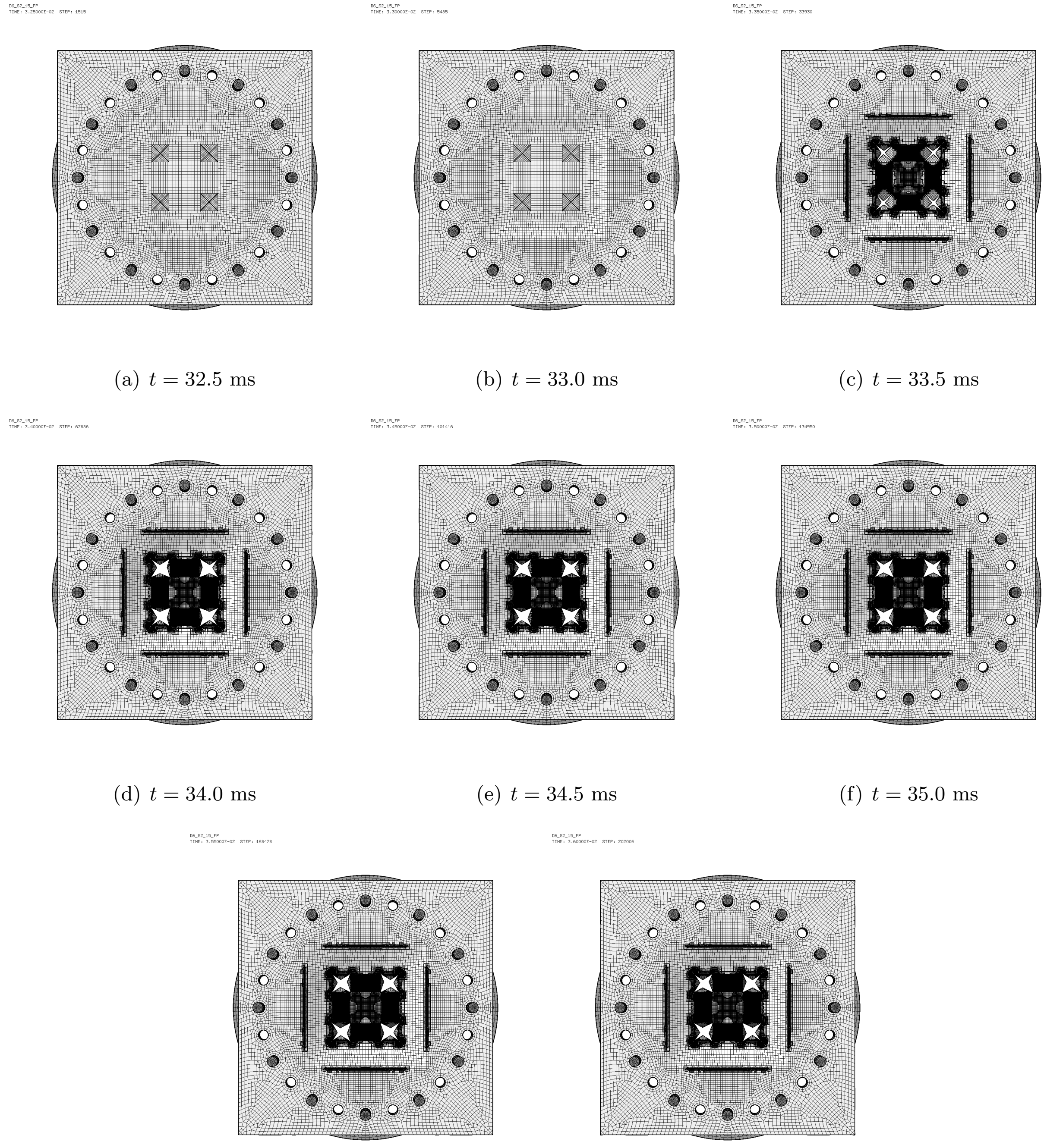
Figure 113 shows the (symmetrized) mesh in the test region at various times.



(a) $t = 32.5$ ms
(b) $t = 33.0$ ms
(c) $t = 33.5$ ms
(d) $t = 34.0$ ms
(e) $t = 34.5$ ms
(f) $t = 35.0$ ms
(g) $t = 35.5$ ms
(h) $t = 36.0$ ms

Figure 113: Mesh in the test region in simulation D6_S2_15_FP.

Figure 114 shows the (symmetrized) plate mesh at various times. The element outlines are included, in order to appreciate the adaptive mesh refinement taking place in the plate.



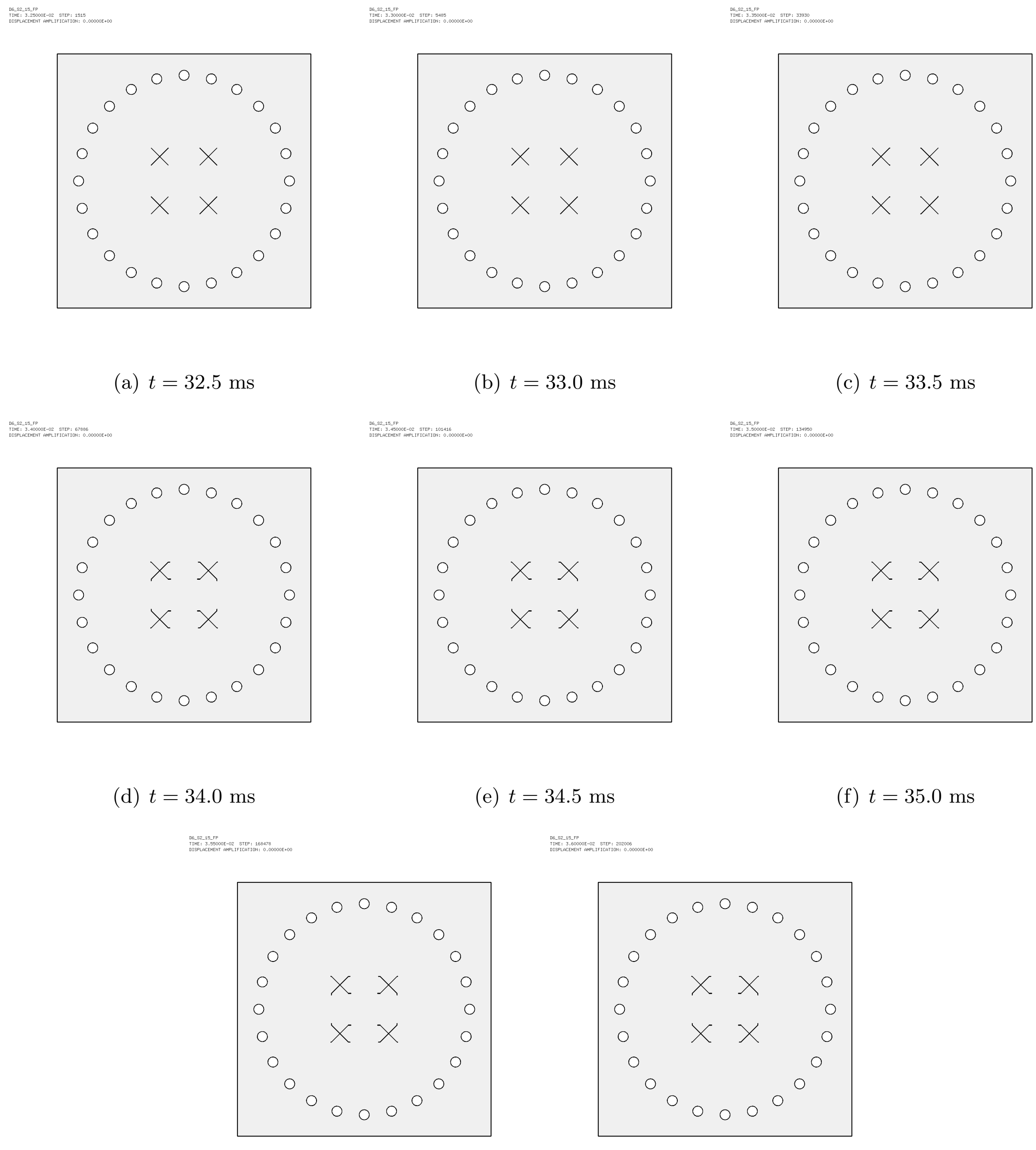
(a) $t = 32.5$ ms (b) $t = 33.0$ ms (c) $t = 33.5$ ms

(d) $t = 34.0$ ms (e) $t = 34.5$ ms (f) $t = 35.0$ ms

(g) $t = 35.5$ ms (h) $t = 36.0$ ms

Figure 114: Plate mesh in simulation D6_S2_15_FP.

Figure 115 shows the (symmetrized) plate mesh without element outlines at various times. The geometry is mapped onto the initial configuration, by using the `DEFO AMPD 0.0` keywords. The `ADAP` keyword of the `TRAC` directive is used to allow for correct visualization of free edges and sharp corners. This allows to appreciate the progressive growth of the cracks.



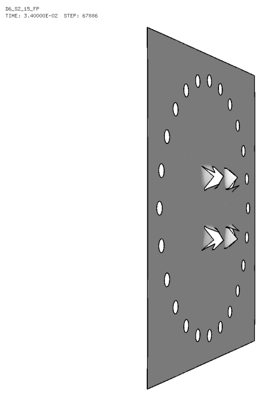
(a) $t = 32.5$ ms (b) $t = 33.0$ ms (c) $t = 33.5$ ms

(d) $t = 34.0$ ms (e) $t = 34.5$ ms (f) $t = 35.0$ ms

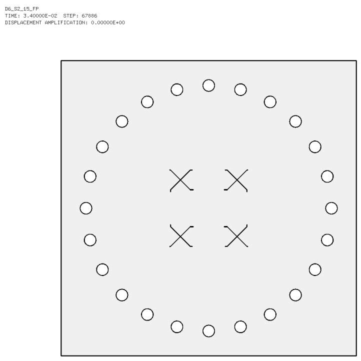
(g) $t = 35.5$ ms (h) $t = 36.0$ ms

Figure 115: Undeformed plate mesh (without element outlines) in simulation D6_S2_15_FP.

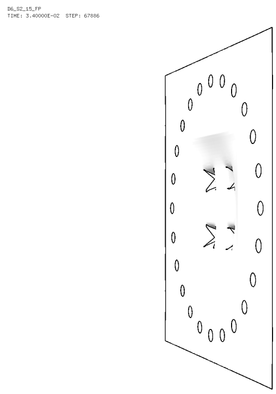
Figure 116 shows the (symmetrized) plate mesh without element outlines at various times, from three different eye positions (right, front, left), in order to highlight the opening of the slits. The right and left views show the deformed plate, while the central view shows the undeformed plate, like in the previous Figure, in order to highlight the cracks.



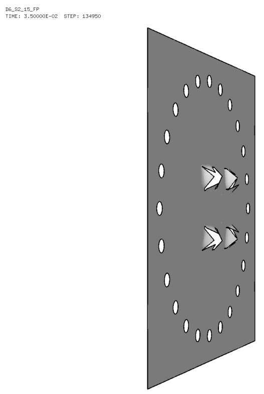
(a) $t = 34.0$ ms



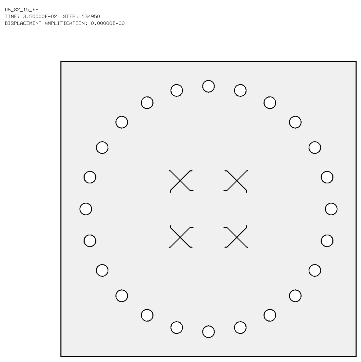
(b) Undeformed, $t = 34.0$ ms



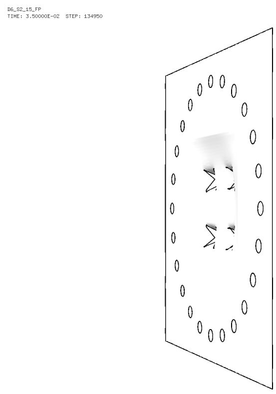
(c) $t = 34.0$ ms



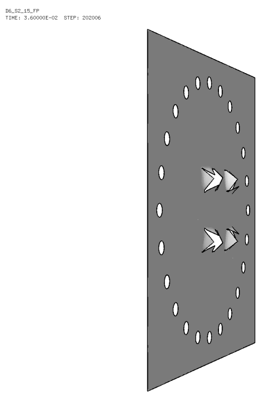
(d) $t = 35.0$ ms



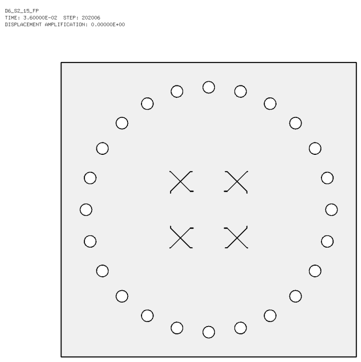
(e) Undeformed, $t = 35.0$ ms



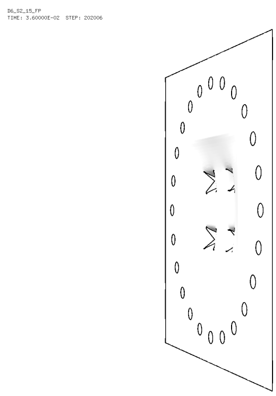
(f) $t = 35.0$ ms



(g) $t = 36.0$ ms



(h) Undeformed, $t = 36.0$ ms



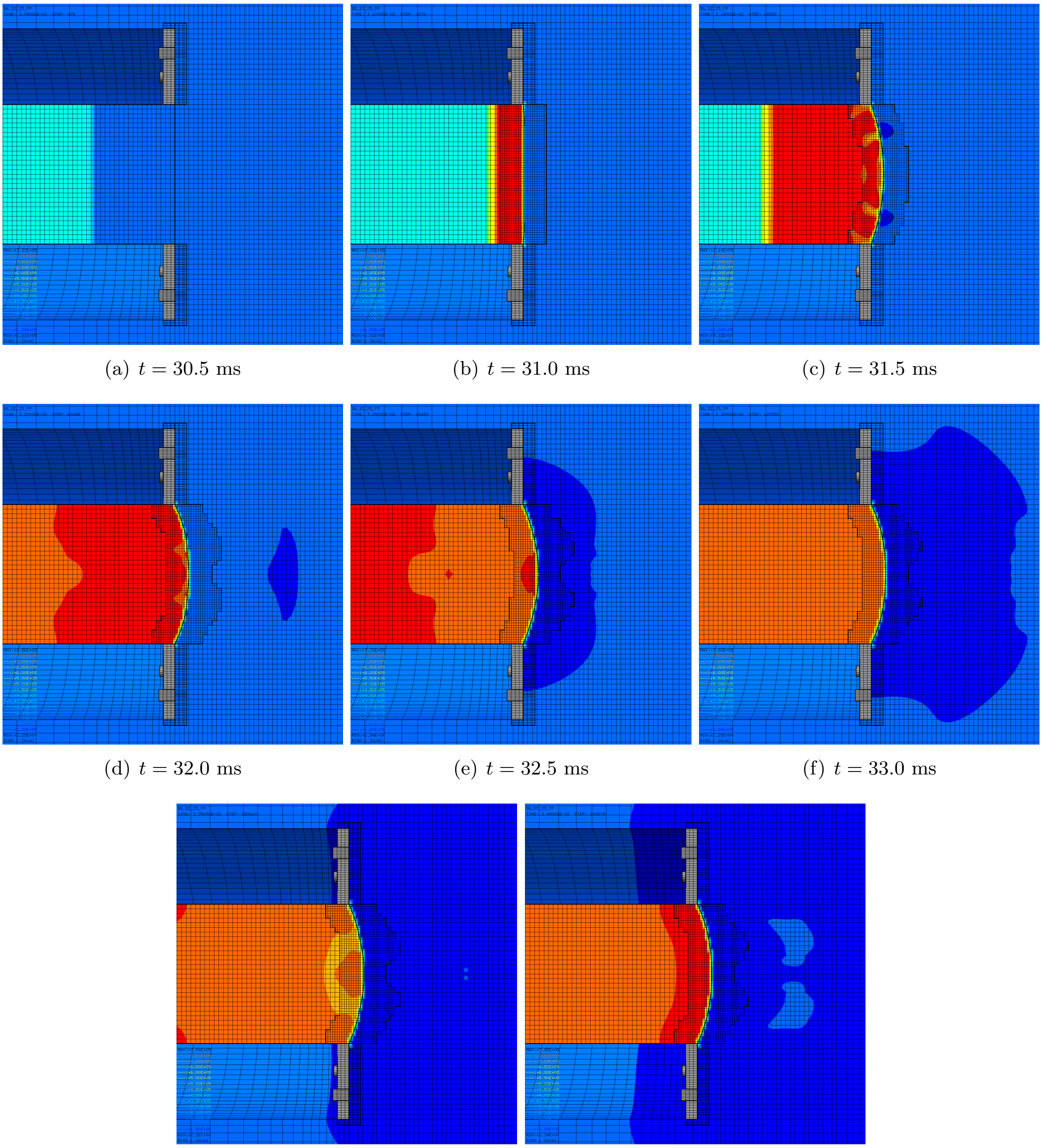
(i) $t = 36.0$ ms

Figure 116: Plate mesh (without element outlines) in simulation D6_S2_15_FP.

7.3 Case D6_S2_25_FP

This test is similar to case D6_S2_10_FP but uses the 25-bar map file from 2021, D7725600map.map from the NTNU DataBase [15], that had been generated at a physical time of $t_{map} = 28.0$ ms on 03/03/2021. Some results are shown below.

Figure 117 shows the (symmetrized) fluid pressure in the test region at various times.



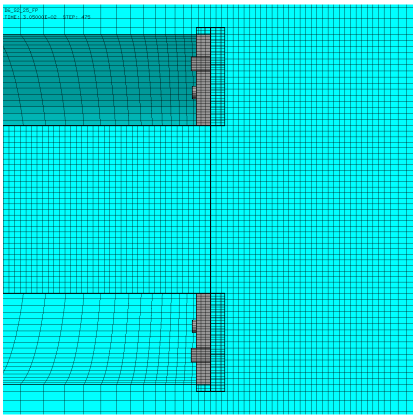
(a) $t = 30.5$ ms (b) $t = 31.0$ ms (c) $t = 31.5$ ms

(d) $t = 32.0$ ms (e) $t = 32.5$ ms (f) $t = 33.0$ ms

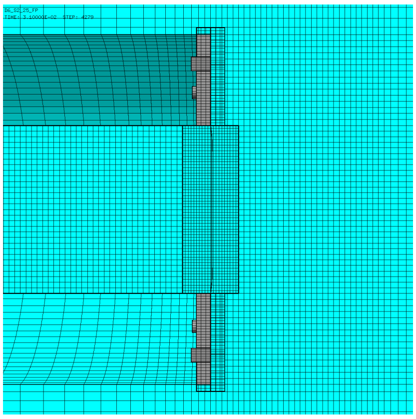
(g) $t = 33.5$ ms (h) $t = 34.0$ ms

Figure 117: Fluid pressure in the test region in simulation D6_S2_25_FP.

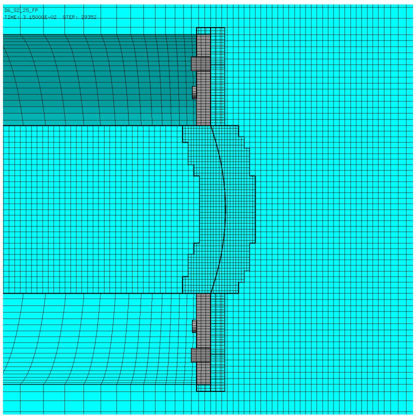
Figure 118 shows the (symmetrized) mesh in the test region at various times.



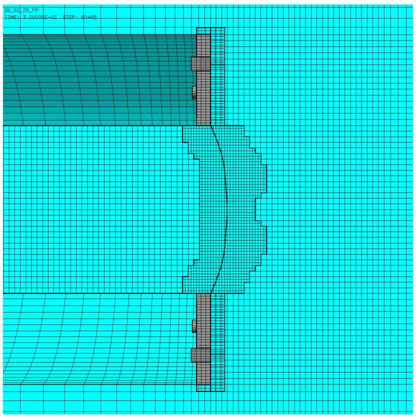
(a) $t = 30.5$ ms



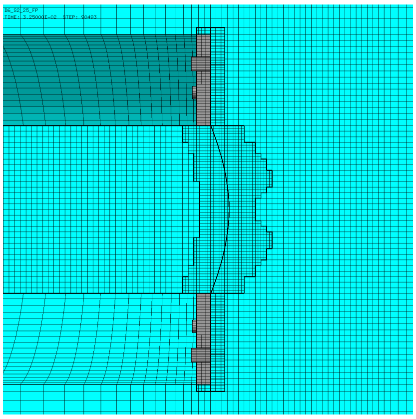
(b) $t = 31.0$ ms



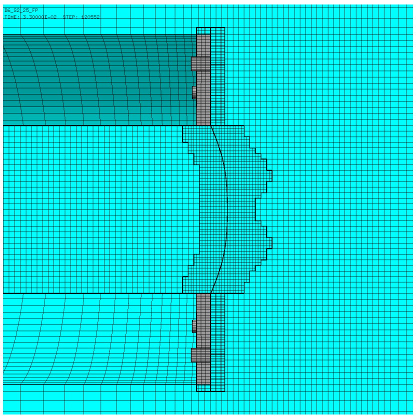
(c) $t = 31.5$ ms



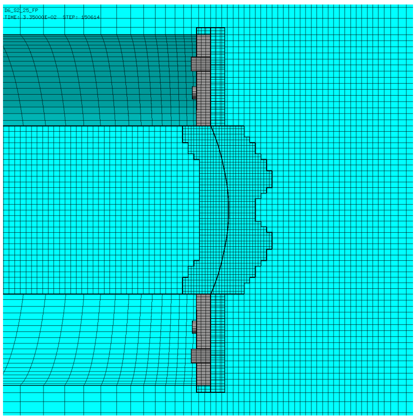
(d) $t = 32.0$ ms



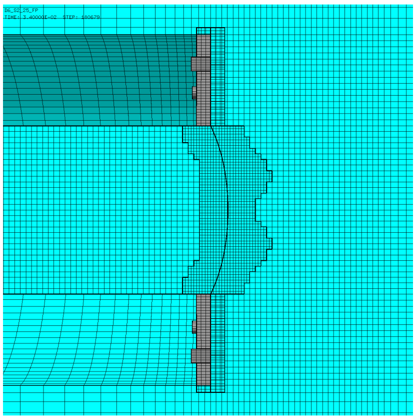
(e) $t = 32.5$ ms



(f) $t = 33.0$ ms



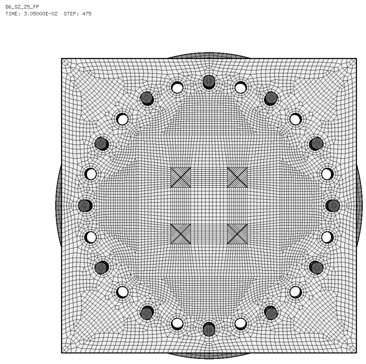
(g) $t = 33.5$ ms



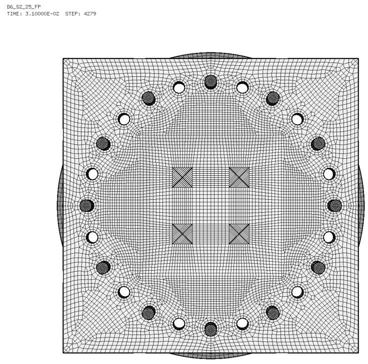
(h) $t = 34.0$ ms

Figure 118: Mesh in the test region in simulation D6_S2_25_FP.

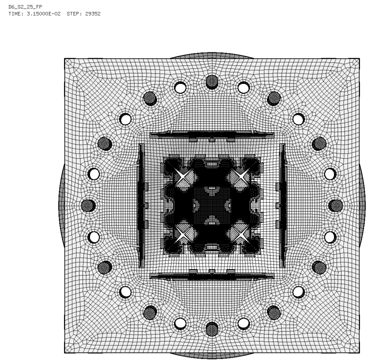
Figure 119 shows the (symmetrized) plate mesh at various times. The element outlines are included, in order to appreciate the adaptive mesh refinement taking place in the plate.



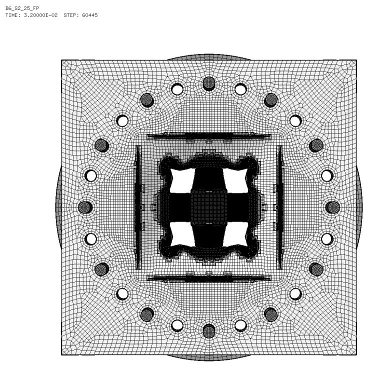
(a) $t = 30.5$ ms



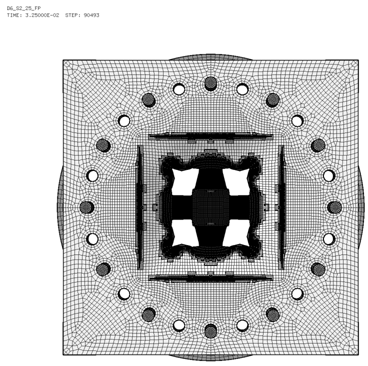
(b) $t = 31.0$ ms



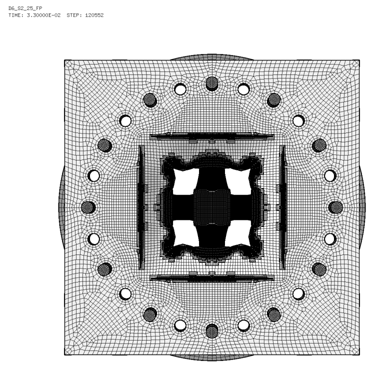
(c) $t = 31.5$ ms



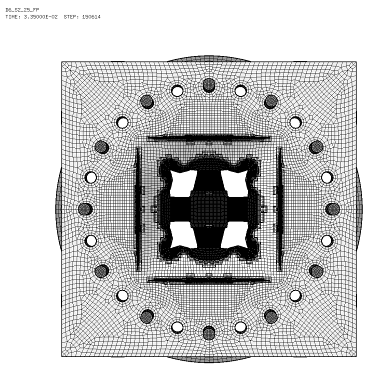
(d) $t = 32.0$ ms



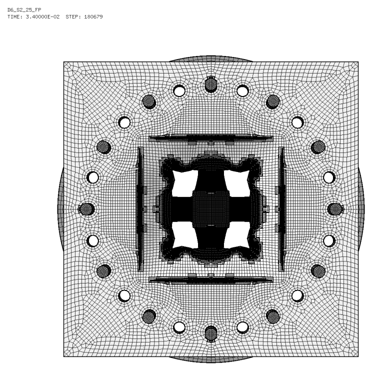
(e) $t = 32.5$ ms



(f) $t = 33.0$ ms



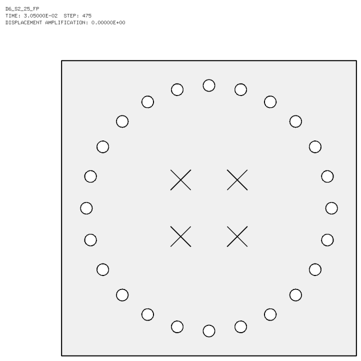
(g) $t = 33.5$ ms



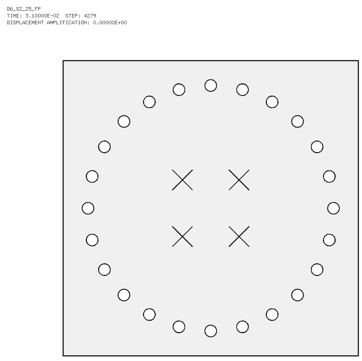
(h) $t = 34.0$ ms

Figure 119: Plate mesh in simulation D6_S2_25_FP.

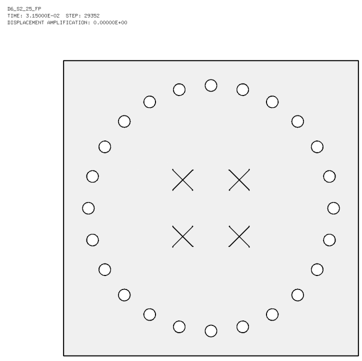
Figure 120 shows the (symmetrized) plate mesh without element outlines at various times. The geometry is mapped onto the initial configuration, by using the `DEFO AMPD 0.0` keywords. The `ADAP` keyword of the `TRAC` directive is used to allow for correct visualization of free edges and sharp corners. This allows to appreciate the progressive growth of the cracks.



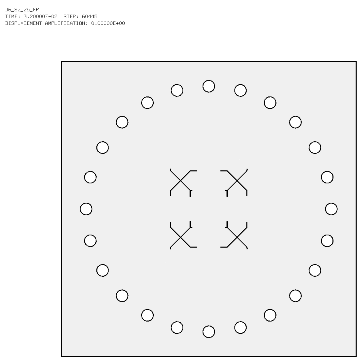
(a) $t = 30.5$ ms



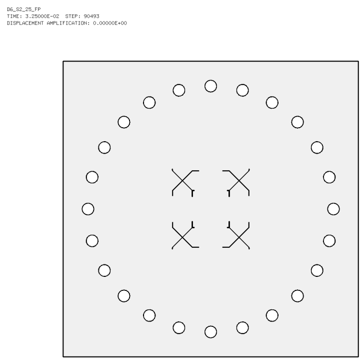
(b) $t = 31.0$ ms



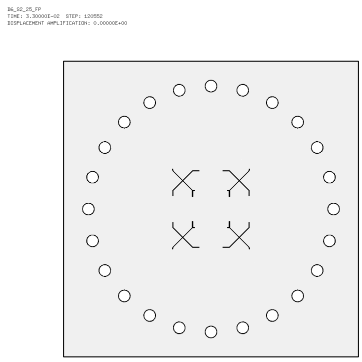
(c) $t = 31.5$ ms



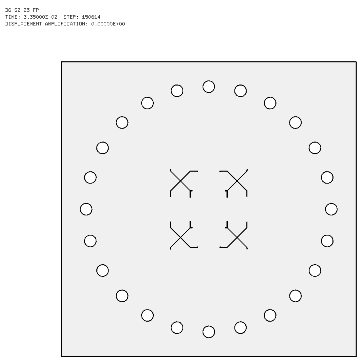
(d) $t = 32.0$ ms



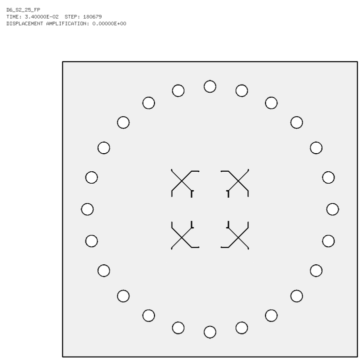
(e) $t = 32.5$ ms



(f) $t = 33.0$ ms



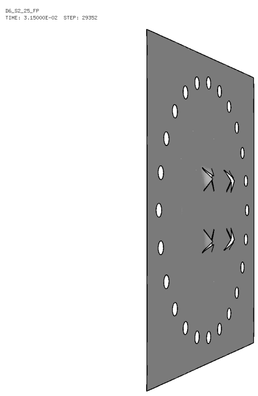
(g) $t = 33.5$ ms



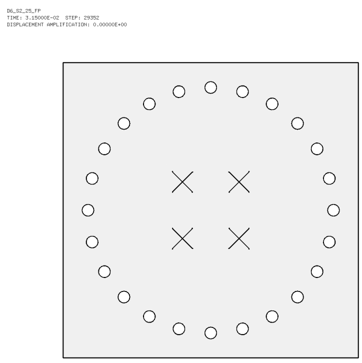
(h) $t = 34.0$ ms

Figure 120: Undeformed plate mesh (without element outlines) in simulation D6_S2_25_FP.

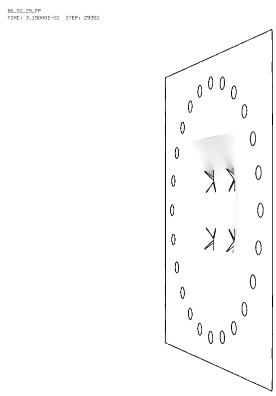
Figure 121 shows the (symmetrized) plate mesh without element outlines at various times, from three different eye positions (right, front, left), in order to highlight the opening of the slits. The right and left views show the deformed plate, while the central view shows the undeformed plate, like in the previous Figure, in order to highlight the cracks.



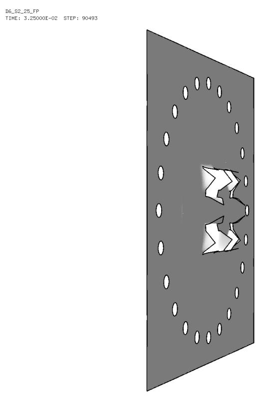
(a) $t = 31.5$ ms



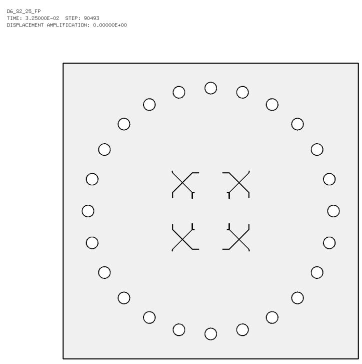
(b) Undeformed, $t = 31.5$ ms



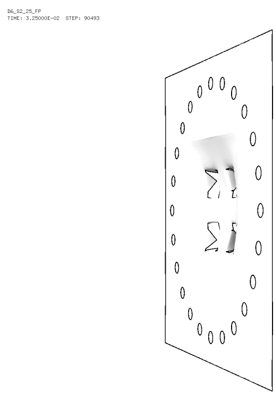
(c) $t = 31.5$ ms



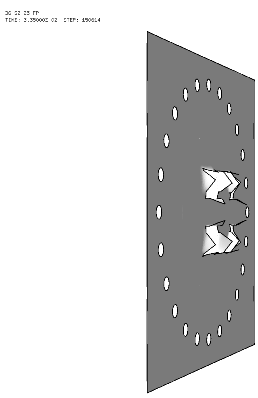
(d) $t = 32.5$ ms



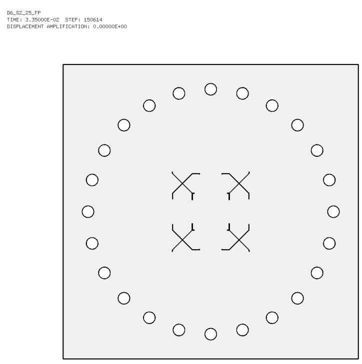
(e) Undeformed, $t = 32.5$ ms



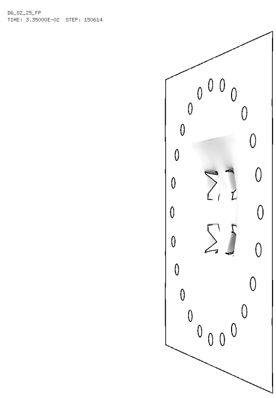
(f) $t = 32.5$ ms



(g) $t = 33.5$ ms



(h) Undeformed, $t = 33.5$ ms



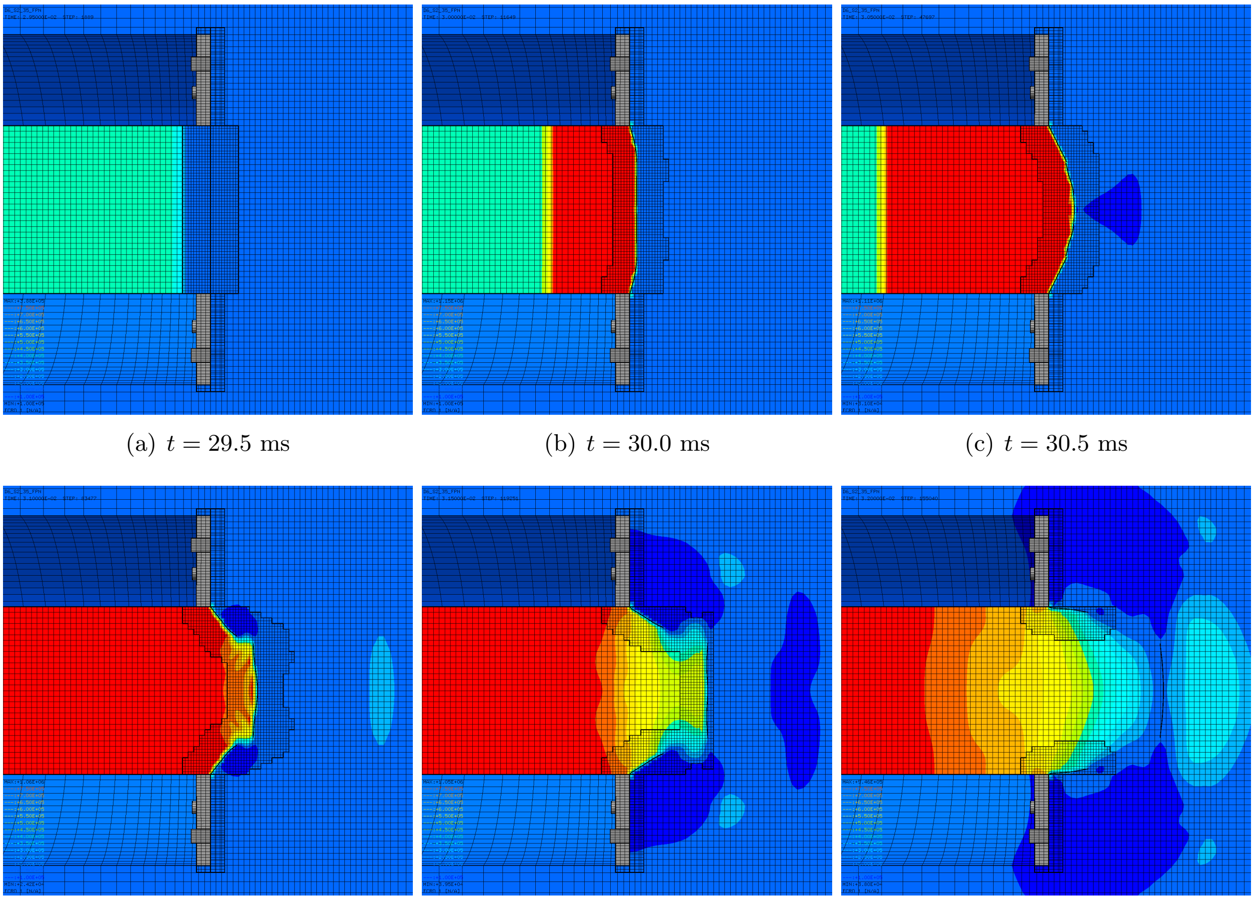
(i) $t = 33.5$ ms

Figure 121: Plate mesh (without element outlines) in simulation D6_S2_25_FP.

7.4 Case D6_S2_35_FPN

This test is similar to case D6_S2_10_FP and to preliminary FSI case D6_S2_35_FP_C presented in Section 6.5 but uses the 2021 map file D7735600map.map, instead of ST_MAP3_35.map (also from 2021), for uniformity with the 15 bar and 25 bar cases. Some results are shown below.

Figure 122 shows the (symmetrized) fluid pressure in the test region at various times.

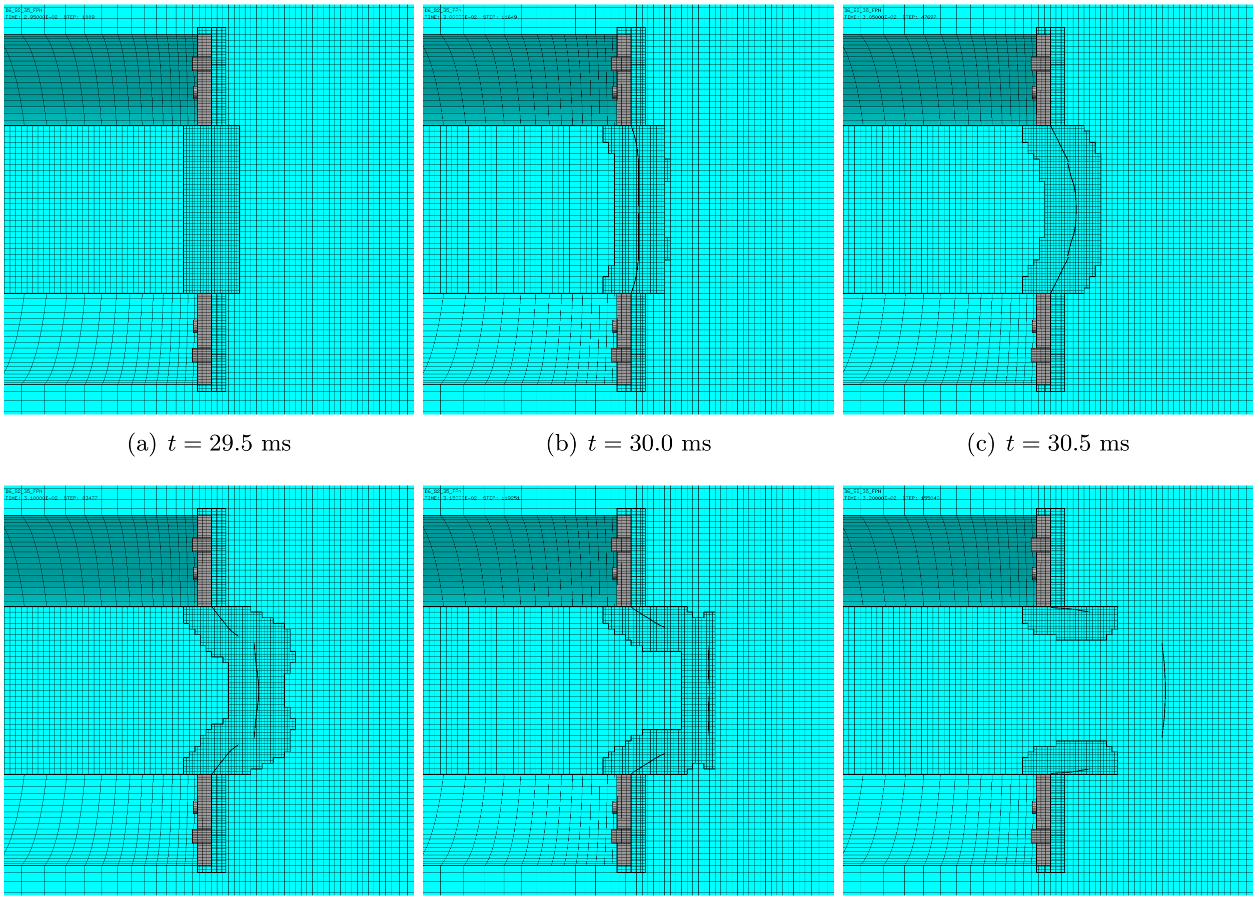


(a) $t = 29.5$ ms (b) $t = 30.0$ ms (c) $t = 30.5$ ms

(d) $t = 31.0$ ms (e) $t = 31.5$ ms (f) $t = 32.0$ ms

Figure 122: Fluid pressure in the test region in simulation D6_S2_35_FPN.

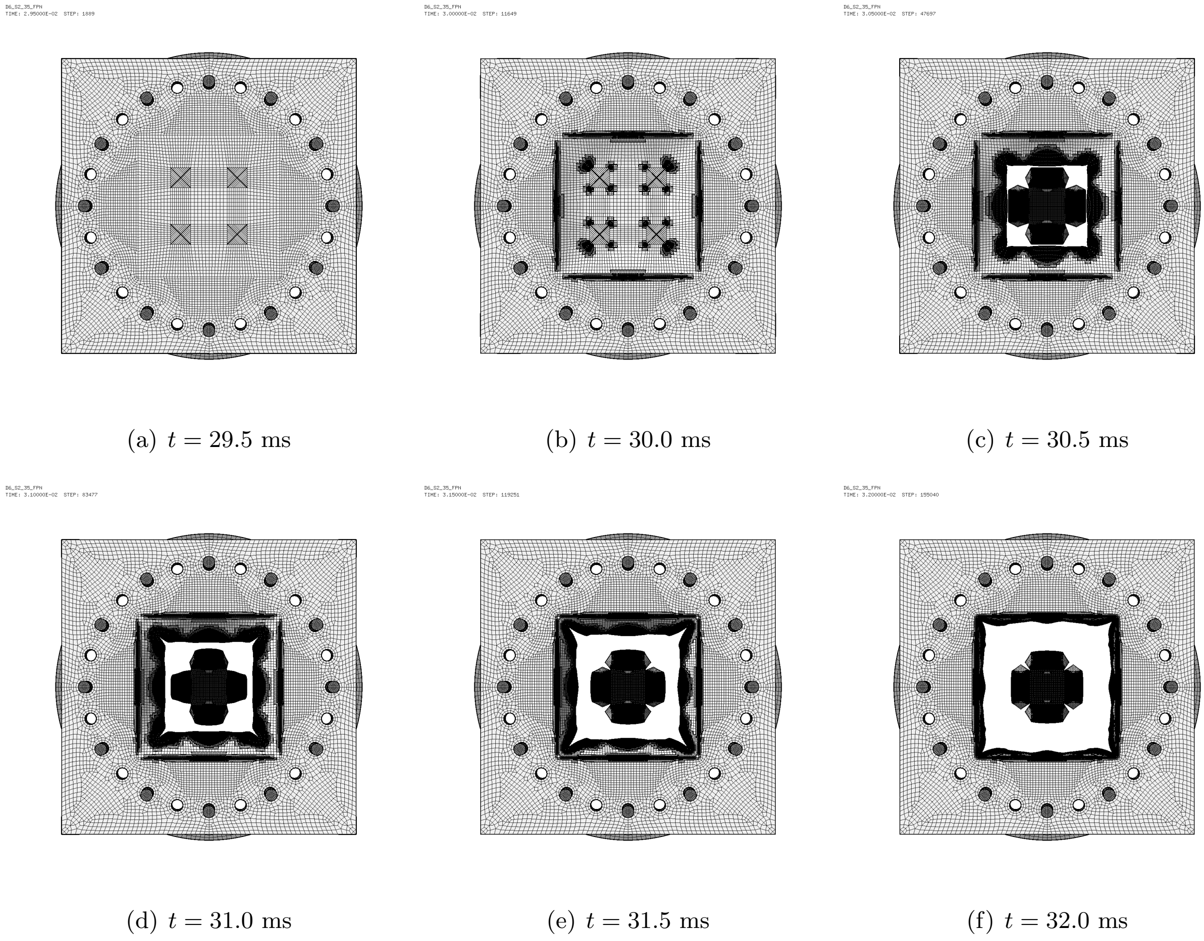
Figure 123 shows the (symmetrized) mesh in the test region at various times.



(a) $t = 29.5$ ms
(b) $t = 30.0$ ms
(c) $t = 30.5$ ms
(d) $t = 31.0$ ms
(e) $t = 31.5$ ms
(f) $t = 32.0$ ms

Figure 123: Mesh in the test region in simulation D6_S2_35_FPN.

Figure 124 shows the (symmetrized) plate mesh at various times. The element outlines are included, in order to appreciate the adaptive mesh refinement taking place in the plate.

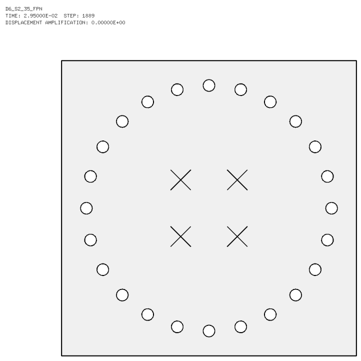


(a) $t = 29.5$ ms (b) $t = 30.0$ ms (c) $t = 30.5$ ms

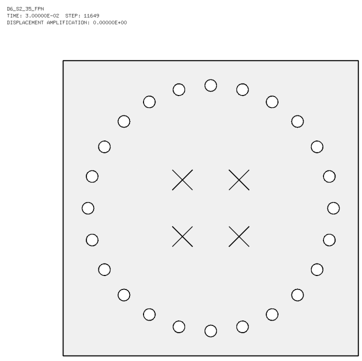
(d) $t = 31.0$ ms (e) $t = 31.5$ ms (f) $t = 32.0$ ms

Figure 124: Plate mesh in simulation D6_S2_35_FPN.

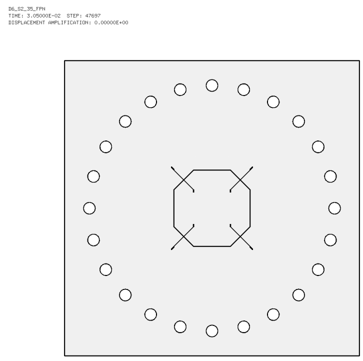
Figure 125 shows the (symmetrized) plate mesh without element outlines at various times. The geometry is mapped onto the initial configuration, by using the `DEFO AMPD 0.0` keywords. The `ADAP` keyword of the `TRAC` directive is used to allow for correct visualization of free edges and sharp corners. This allows to appreciate the progressive growth of the cracks.



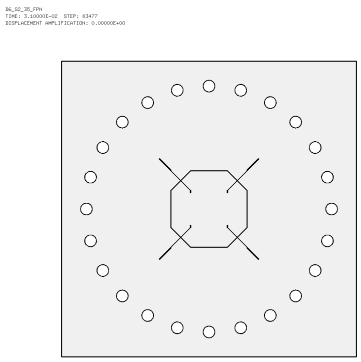
(a) $t = 29.5$ ms



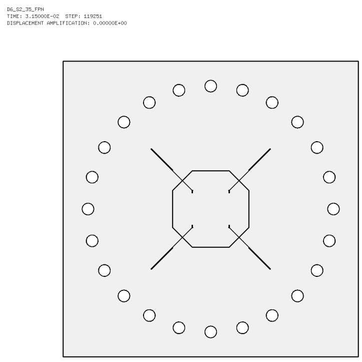
(b) $t = 30.0$ ms



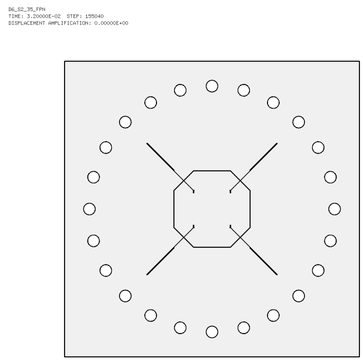
(c) $t = 30.5$ ms



(d) $t = 31.0$ ms



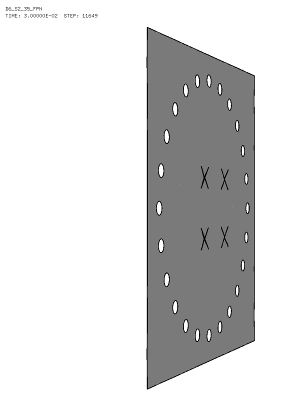
(e) $t = 31.5$ ms



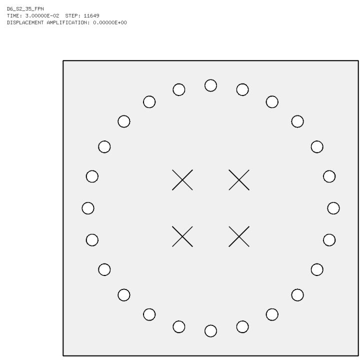
(f) $t = 32.0$ ms

Figure 125: Undeformed plate mesh (without element outlines) in simulation D6_S2_35_FPN.

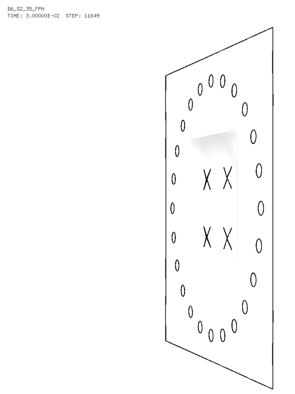
Figure 126 shows the (symmetrized) plate mesh without element outlines at various times, from three different eye positions (right, front, left), in order to highlight the opening of the slits. The right and left views show the deformed plate, while the central view shows the undeformed plate, like in the previous Figure, in order to highlight the cracks.



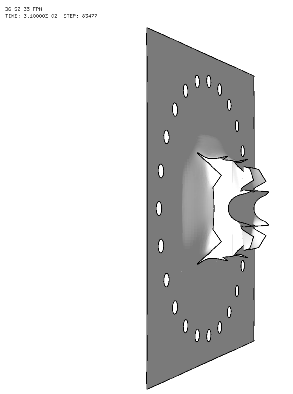
(a) $t = 30.0$ ms



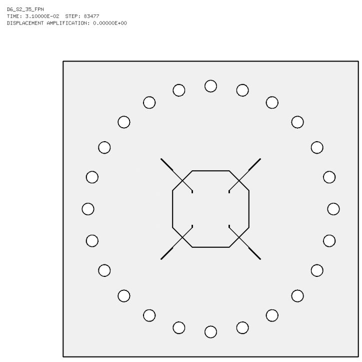
(b) Undeformed, $t = 30.0$ ms



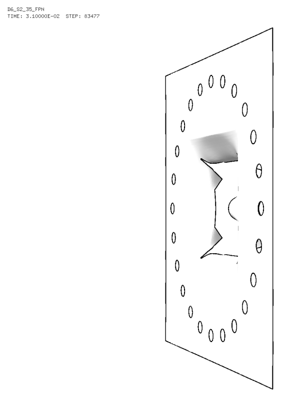
(c) $t = 30.0$ ms



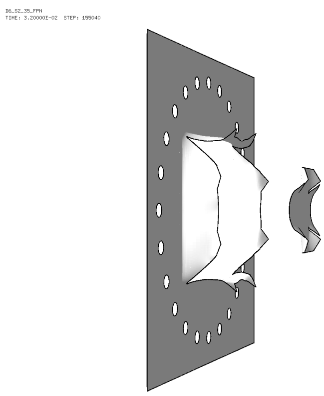
(d) $t = 31.0$ ms



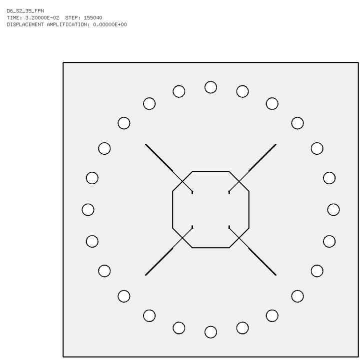
(e) Undeformed, $t = 31.0$ ms



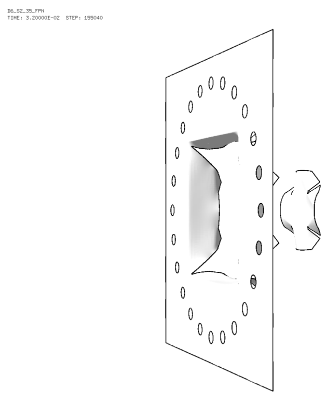
(f) $t = 31.0$ ms



(g) $t = 32.0$ ms



(h) Undeformed, $t = 32.0$ ms



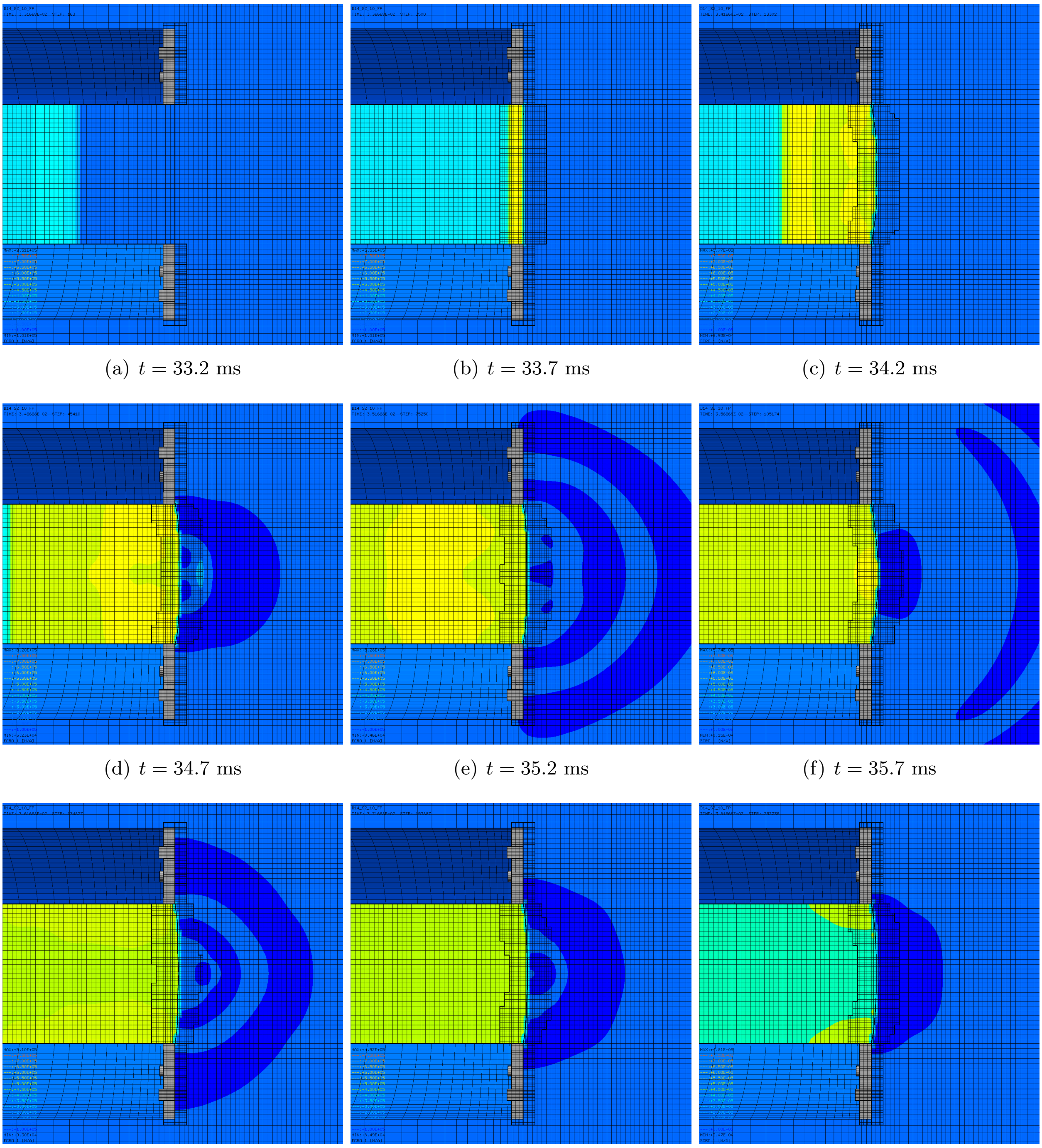
(i) $t = 32.0$ ms

Figure 126: Plate mesh (without element outlines) in simulation D6_S2_35_FPN.

7.5 Case D14_S2_10_FP

This test is identical to D6_S2_10_FP but the material of the plate is Docol-1400M. Some results are shown below.

Figure 127 shows the (symmetrized) fluid pressure in the test region at various times.



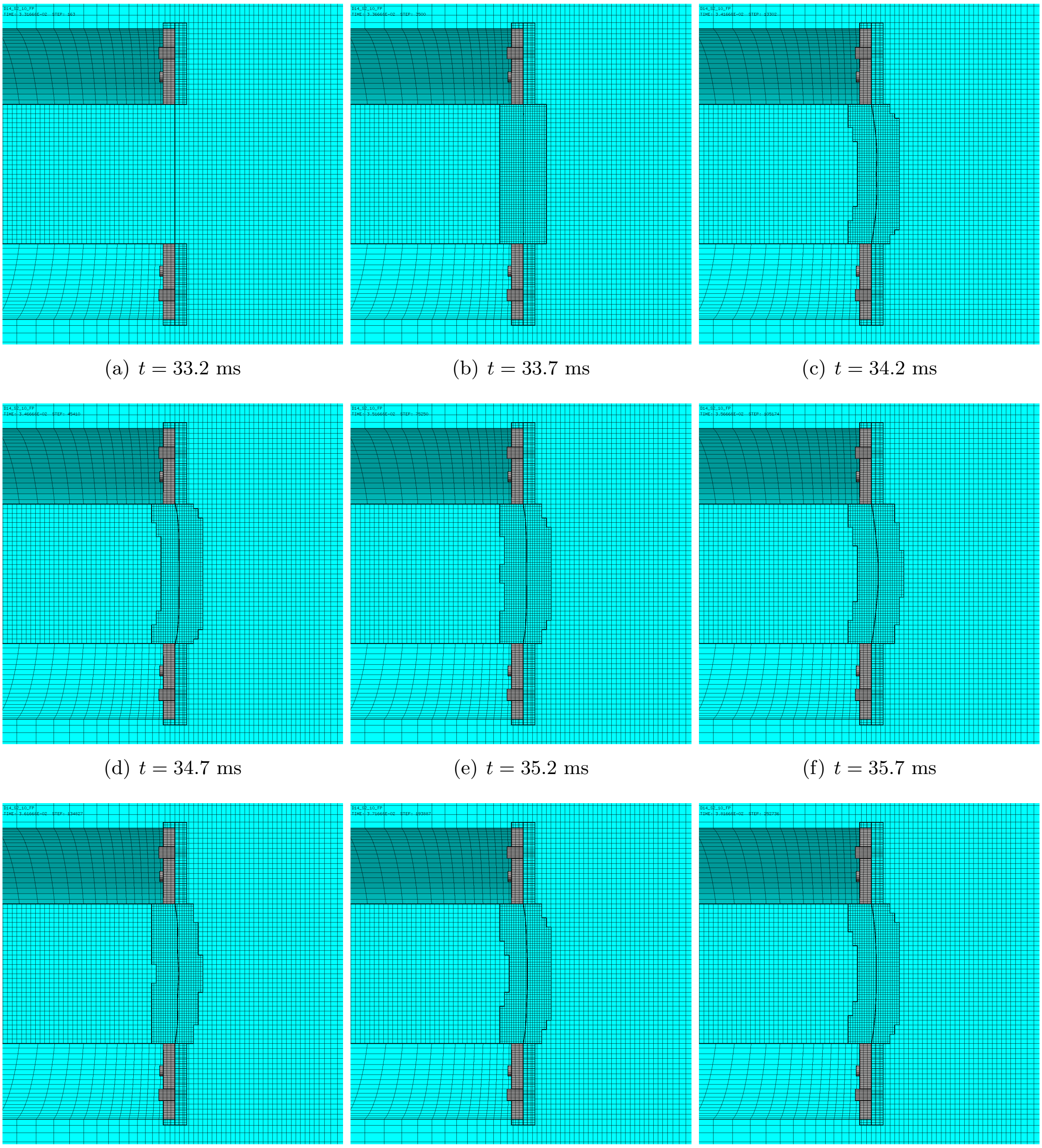
(a) $t = 33.2$ ms (b) $t = 33.7$ ms (c) $t = 34.2$ ms

(d) $t = 34.7$ ms (e) $t = 35.2$ ms (f) $t = 35.7$ ms

(g) $t = 36.2$ ms (h) $t = 37.2$ ms (i) $t = 38.2$ ms

Figure 127: Fluid pressure in the test region in simulation D14_S2_10_FP.

Figure 128 shows the (symmetrized) mesh in the test region at various times.



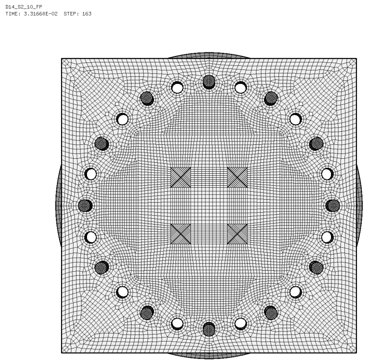
(a) $t = 33.2$ ms (b) $t = 33.7$ ms (c) $t = 34.2$ ms

(d) $t = 34.7$ ms (e) $t = 35.2$ ms (f) $t = 35.7$ ms

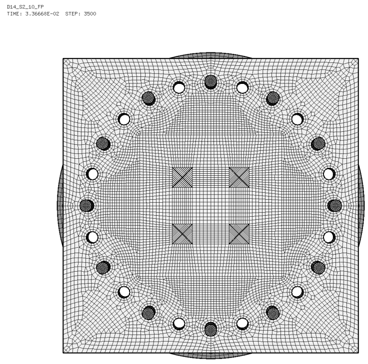
(g) $t = 36.2$ ms (h) $t = 37.2$ ms (i) $t = 38.2$ ms

Figure 128: Mesh in the test region in simulation D14_S2_10_FP.

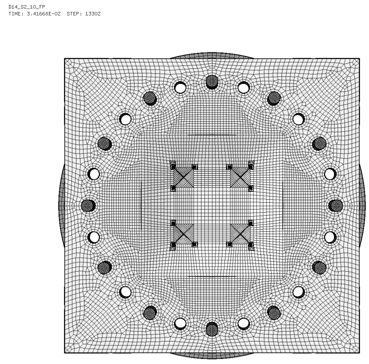
Figure 129 shows the (symmetrized) plate mesh at various times. The element outlines are included, in order to appreciate the adaptive mesh refinement taking place in the plate.



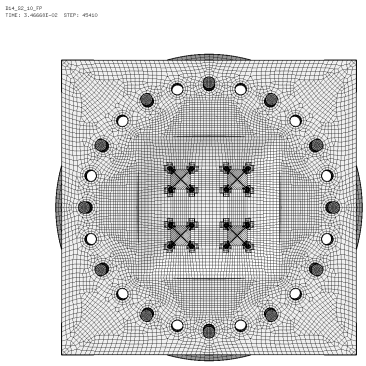
(a) $t = 33.2$ ms



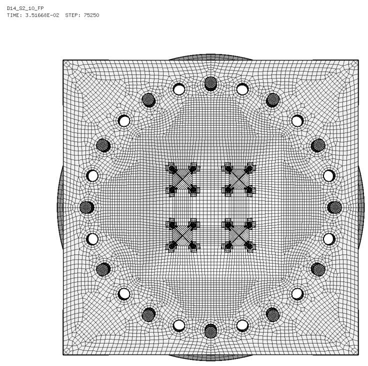
(b) $t = 33.7$ ms



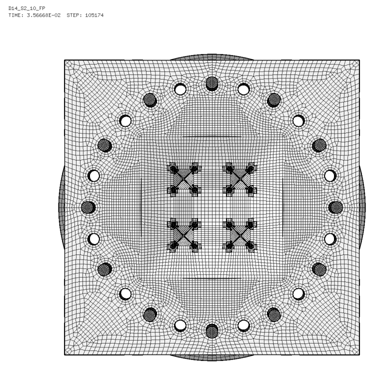
(c) $t = 34.2$ ms



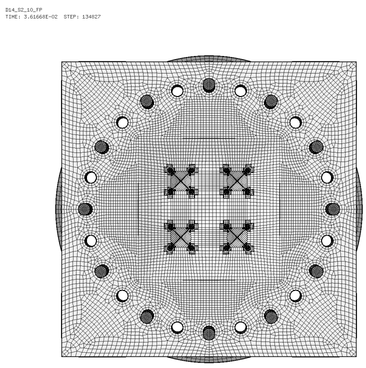
(d) $t = 34.7$ ms



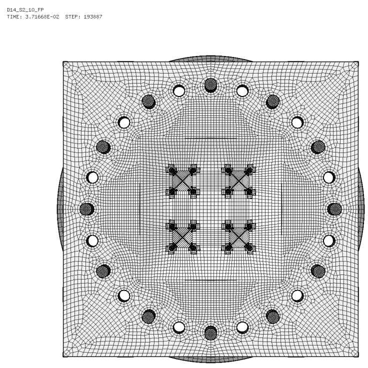
(e) $t = 35.2$ ms



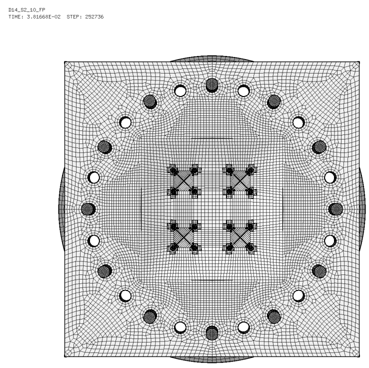
(f) $t = 35.7$ ms



(g) $t = 36.2$ ms



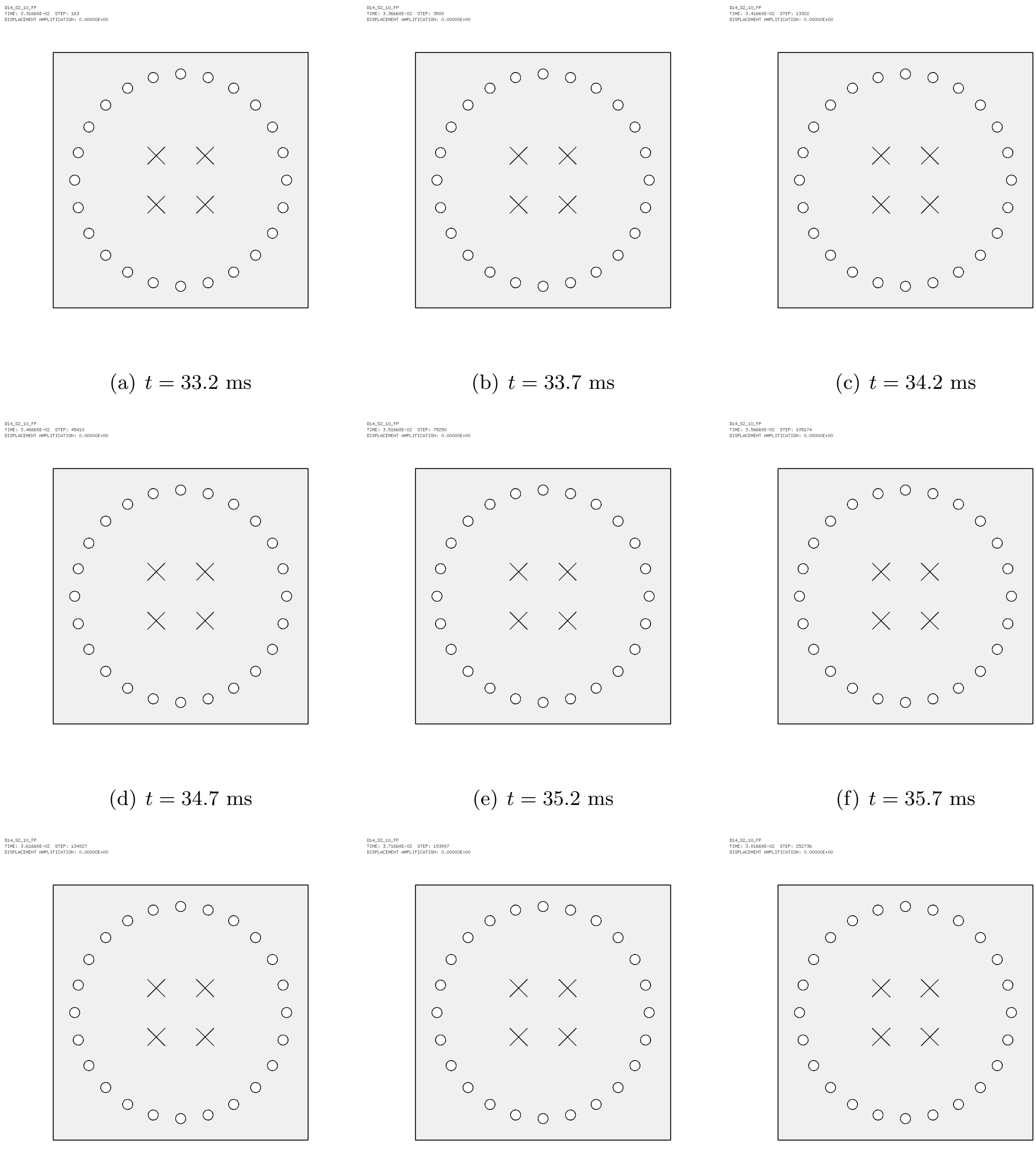
(h) $t = 37.2$ ms



(i) $t = 38.2$ ms

Figure 129: Plate mesh in simulation D14_S2_10_FP.

Figure 130 shows the (symmetrized) plate mesh without element outlines at various times. The geometry is mapped onto the initial configuration, by using the `DEFO AMPD 0.0` keywords. The `ADAP` keyword of the `TRAC` directive is used to allow for correct visualization of free edges and sharp corners. This allows to appreciate the progressive growth of the cracks.



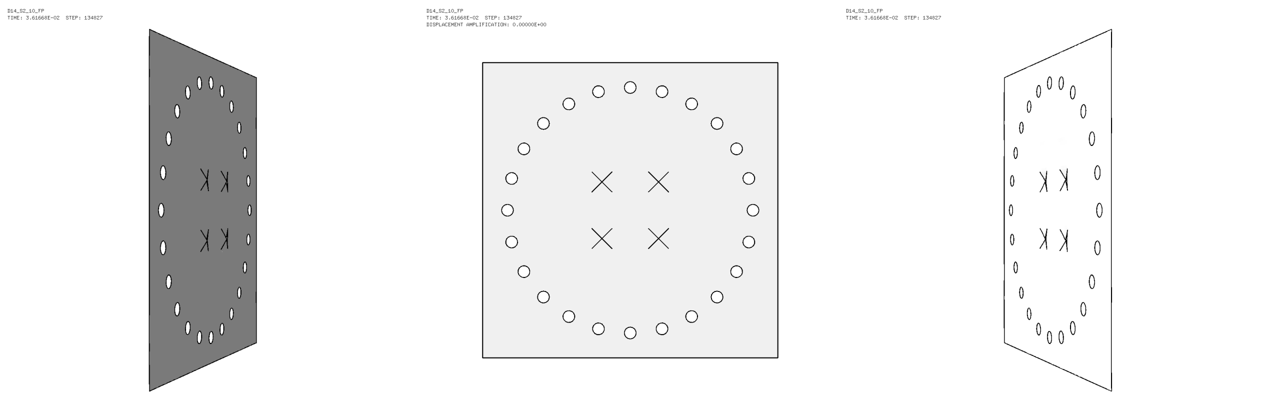
(a) $t = 33.2$ ms (b) $t = 33.7$ ms (c) $t = 34.2$ ms

(d) $t = 34.7$ ms (e) $t = 35.2$ ms (f) $t = 35.7$ ms

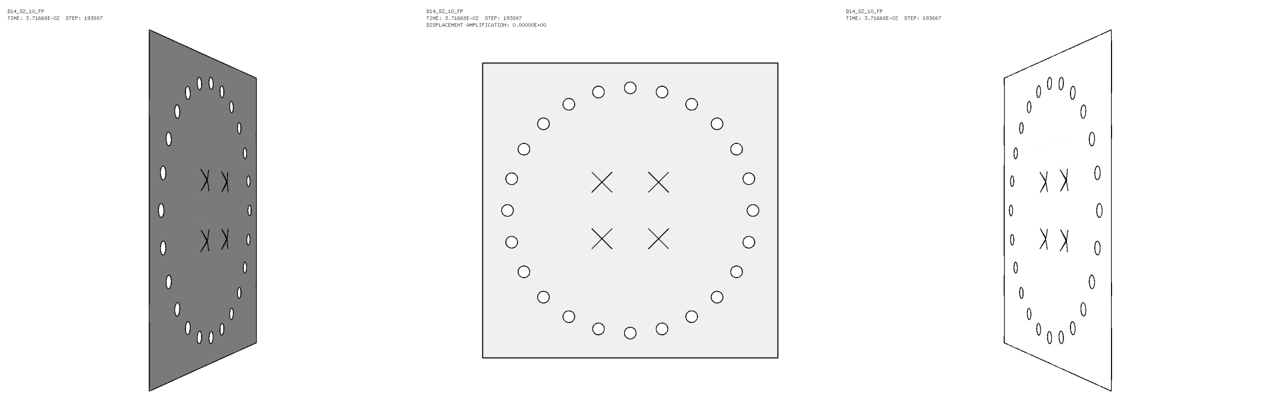
(g) $t = 36.2$ ms (h) $t = 37.2$ ms (i) $t = 38.2$ ms

Figure 130: Undeformed plate mesh (without element outlines) in simulation D14_S2_10_FP.

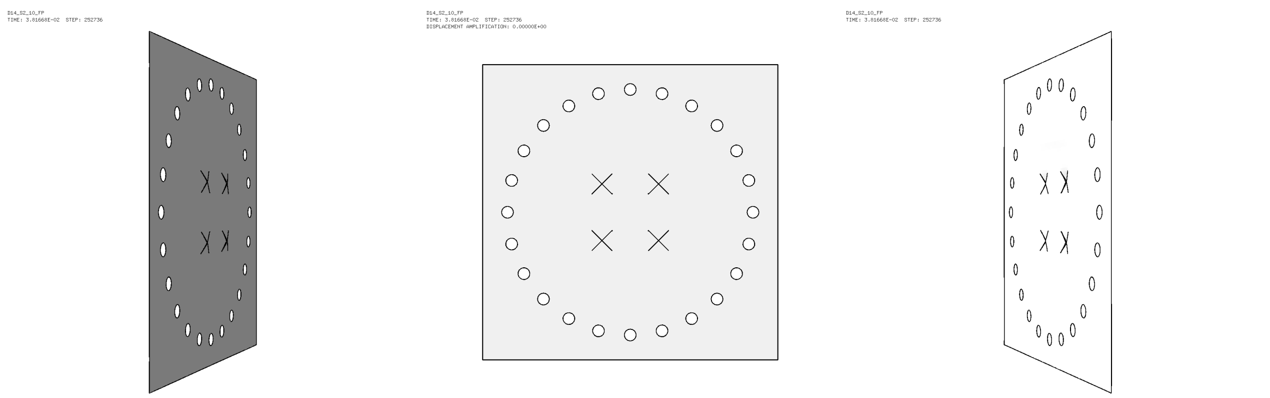
Figure 131 shows the (symmetrized) plate mesh without element outlines at various times, from three different eye positions (right, front, left), in order to highlight the opening of the slits. The right and left views show the deformed plate, while the central view shows the undeformed plate, like in the previous Figure, in order to highlight the cracks.



(a) $t = 36.2$ ms (b) Undeformed, $t = 36.2$ ms (c) $t = 36.2$ ms



(d) $t = 372.$ ms (e) Undeformed, $t = 37.2$ ms (f) $t = 37.2$ ms



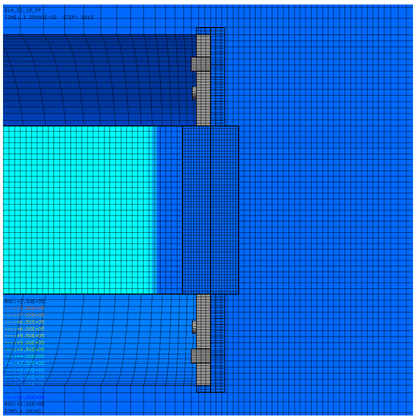
(g) $t = 38.2$ ms (h) Undeformed, $t = 38.2$ ms (i) $t = 38.2$ ms

Figure 131: Plate mesh (without element outlines) in simulation D14_S2_10_FP.

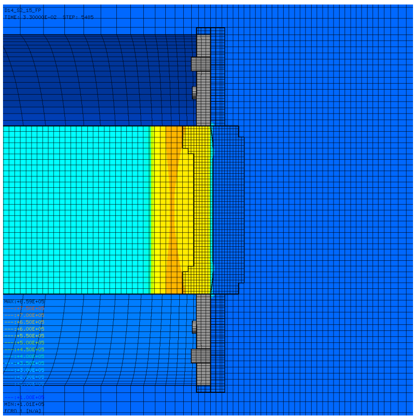
7.6 Case D14_S2_15_FP

This test is identical to D6_S2_15_FPN but the material of the plate is Docol-1400M. Some results are shown below.

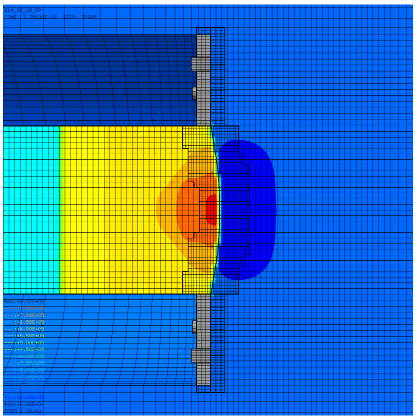
Figure 132 shows the (symmetrized) fluid pressure in the test region at various times.



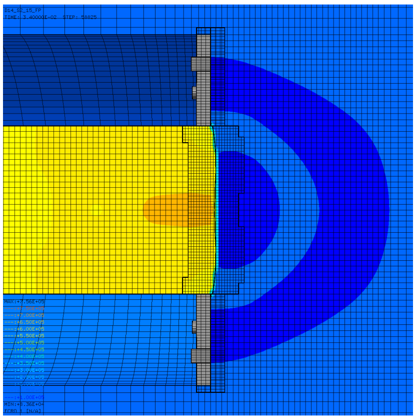
(a) $t = 32.5$ ms



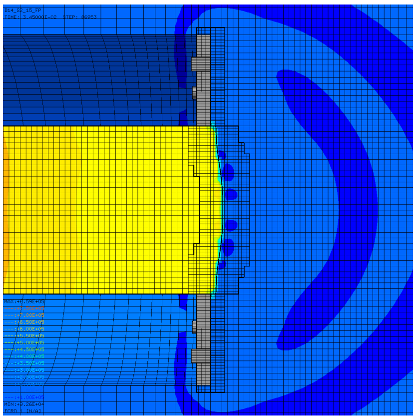
(b) $t = 33.0$ ms



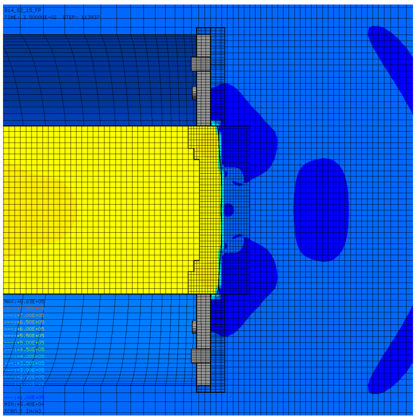
(c) $t = 33.5$ ms



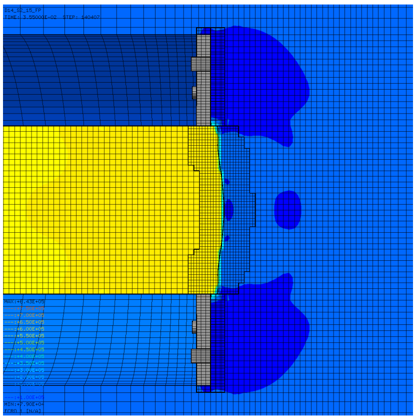
(d) $t = 34.0$ ms



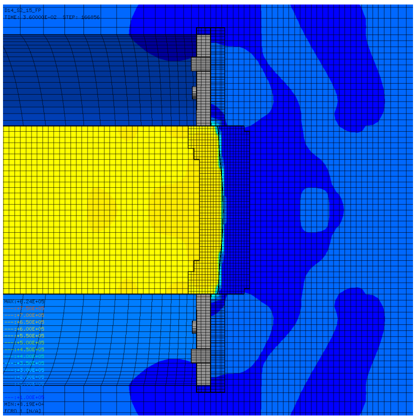
(e) $t = 34.5$ ms



(f) $t = 35.0$ ms



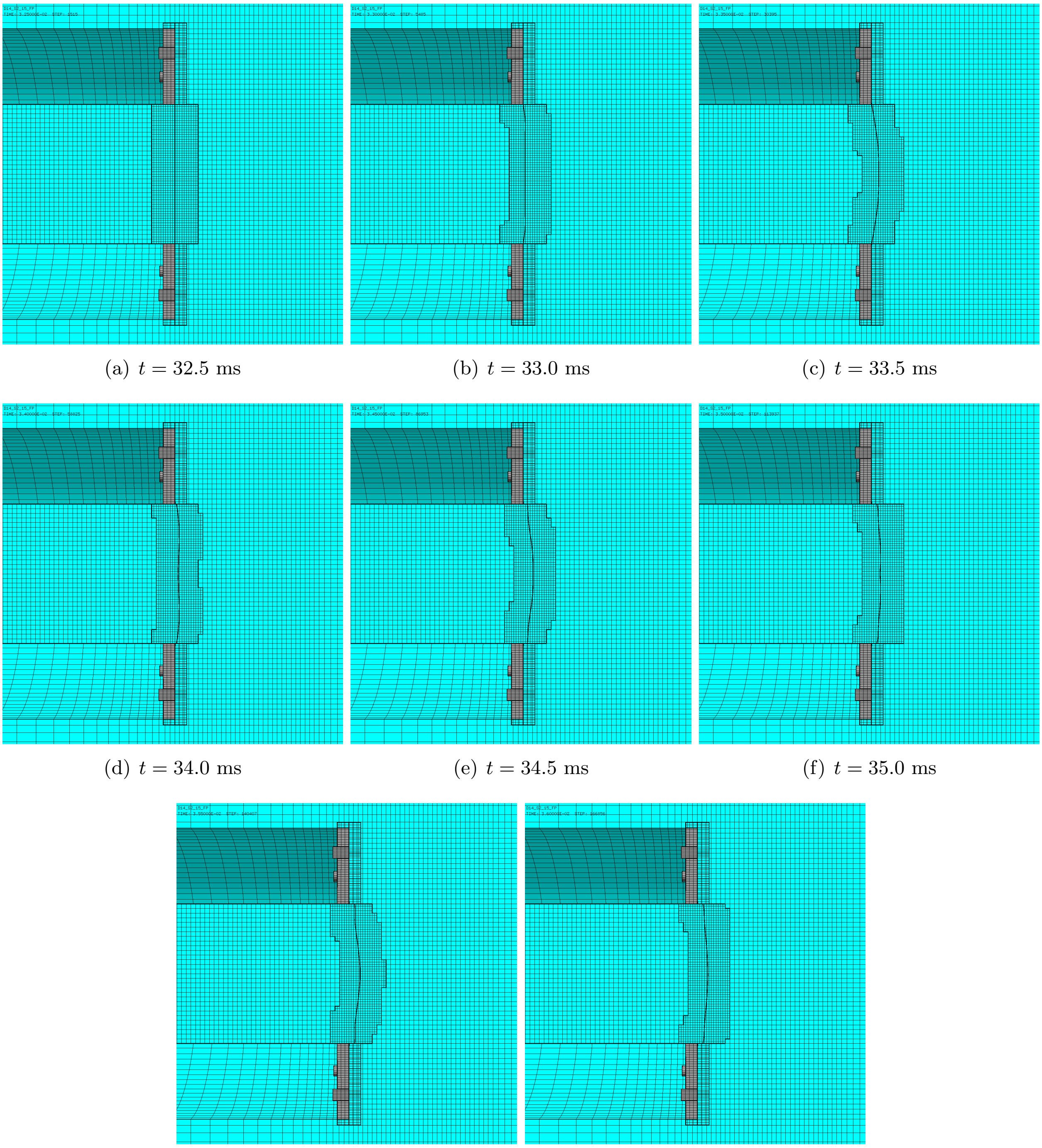
(g) $t = 35.5$ ms



(h) $t = 36.0$ ms

Figure 132: Fluid pressure in the test region in simulation D14_S2_15_FP.

Figure 133 shows the (symmetrized) mesh in the test region at various times.



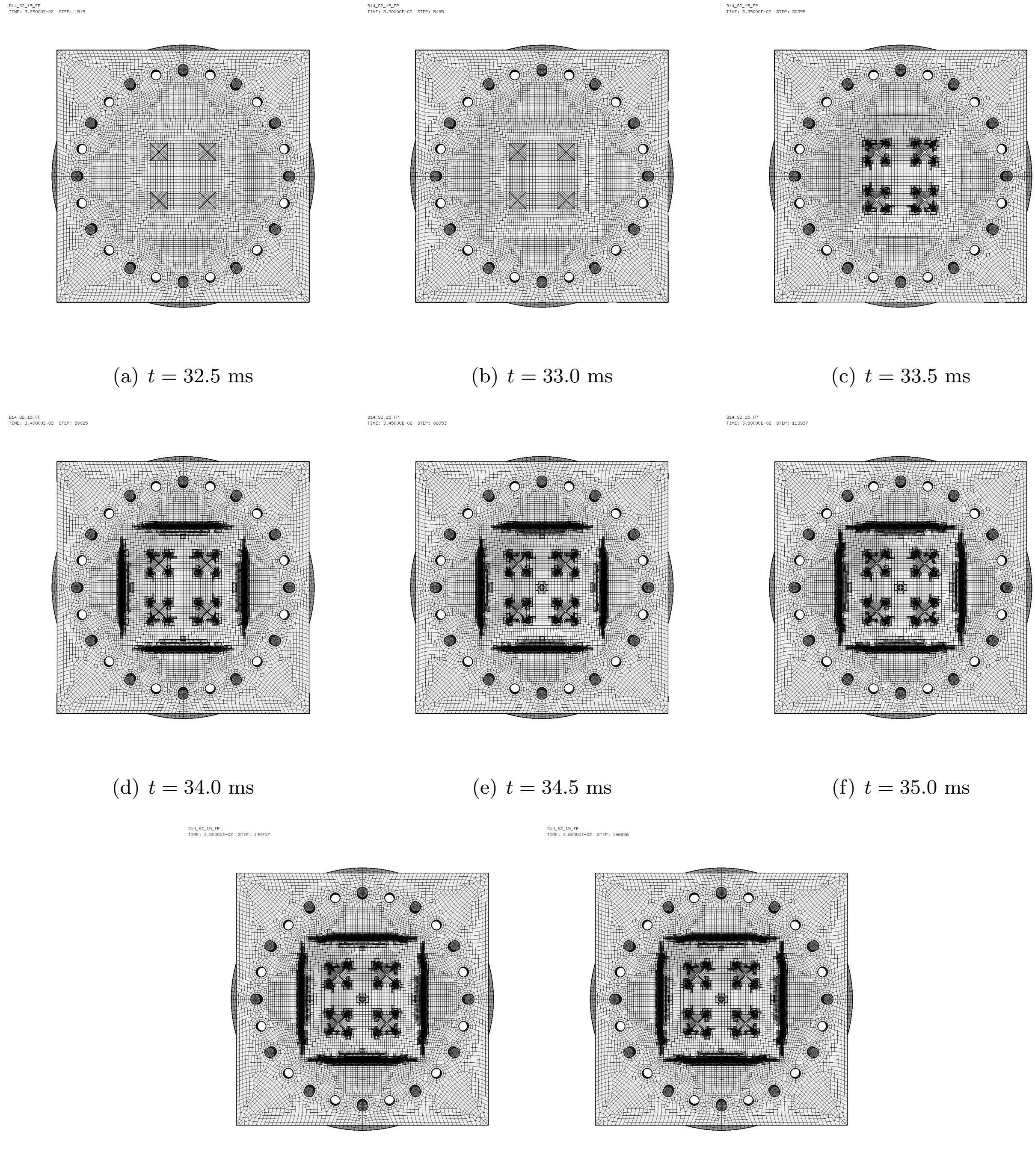
(a) $t = 32.5$ ms (b) $t = 33.0$ ms (c) $t = 33.5$ ms

(d) $t = 34.0$ ms (e) $t = 34.5$ ms (f) $t = 35.0$ ms

(g) $t = 35.5$ ms (h) $t = 36.0$ ms

Figure 133: Mesh in the test region in simulation D14_S2_15_FP.

Figure 134 shows the (symmetrized) plate mesh at various times. The element outlines are included, in order to appreciate the adaptive mesh refinement taking place in the plate.



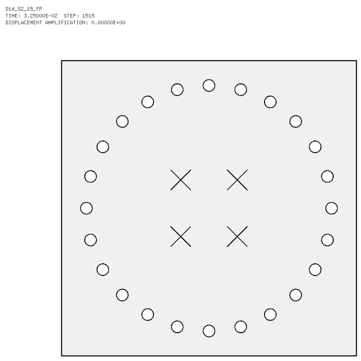
(a) $t = 32.5$ ms (b) $t = 33.0$ ms (c) $t = 33.5$ ms

(d) $t = 34.0$ ms (e) $t = 34.5$ ms (f) $t = 35.0$ ms

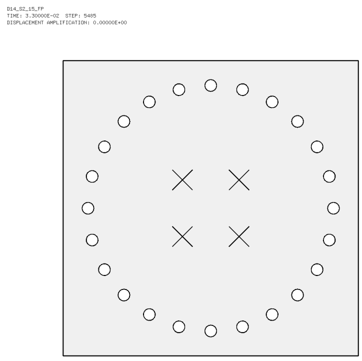
(g) $t = 35.5$ ms (h) $t = 36.0$ ms

Figure 134: Plate mesh in simulation D14_S2_15_FP.

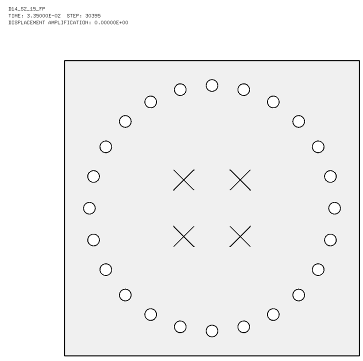
Figure 135 shows the (symmetrized) plate mesh without element outlines at various times. The geometry is mapped onto the initial configuration, by using the `DEFO AMPD 0.0` keywords. The `ADAP` keyword of the `TRAC` directive is used to allow for correct visualization of free edges and sharp corners. This allows to appreciate the progressive growth of the cracks.



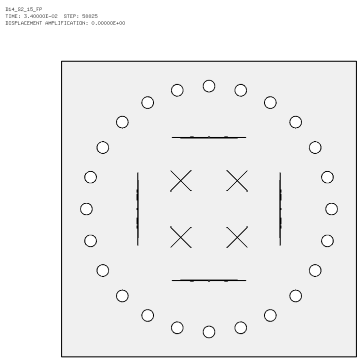
(a) $t = 32.5$ ms



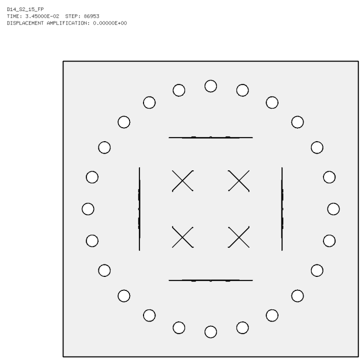
(b) $t = 33.0$ ms



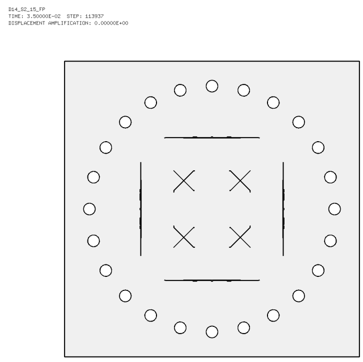
(c) $t = 33.5$ ms



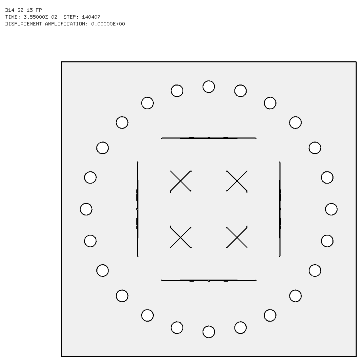
(d) $t = 34.0$ ms



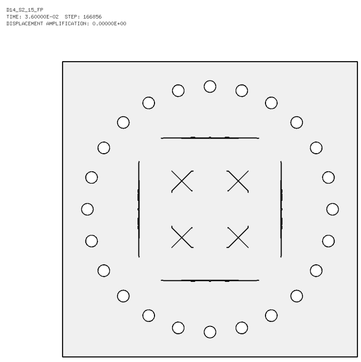
(e) $t = 34.5$ ms



(f) $t = 35.0$ ms



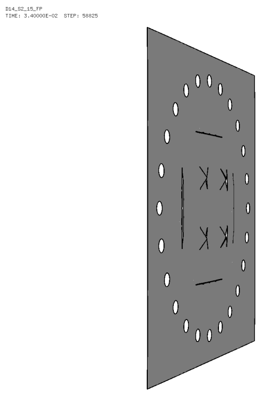
(g) $t = 35.5$ ms



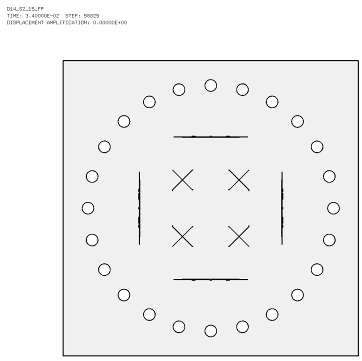
(h) $t = 36.0$ ms

Figure 135: Undeformed plate mesh (without element outlines) in simulation D14_S2_15_FP.

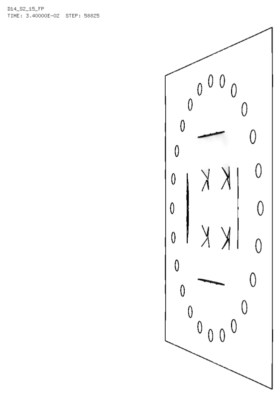
Figure 136 shows the (symmetrized) plate mesh without element outlines at various times, from three different eye positions (right, front, left), in order to highlight the opening of the slits. The right and left views show the deformed plate, while the central view shows the undeformed plate, like in the previous Figure, in order to highlight the cracks.



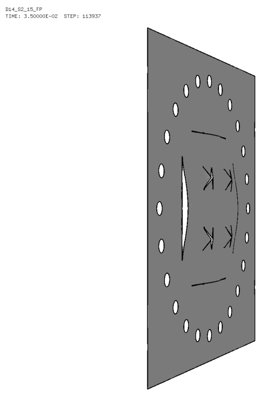
(a) $t = 34.0$ ms



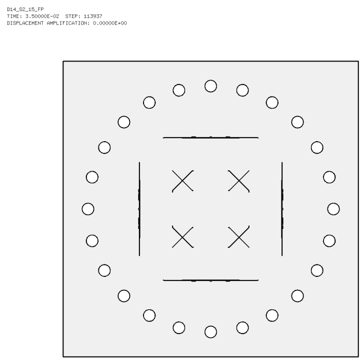
(b) Undeformed, $t = 34.0$ ms



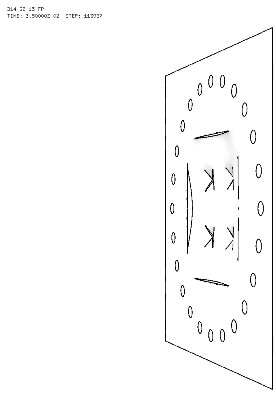
(c) $t = 34.0$ ms



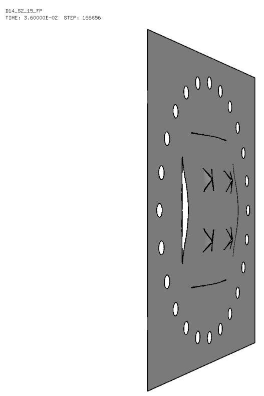
(d) $t = 35.0$ ms



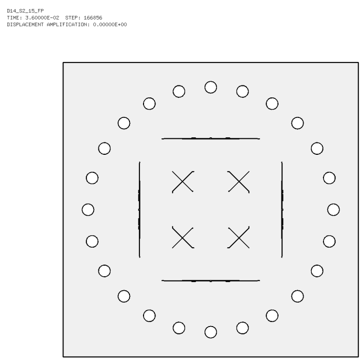
(e) Undeformed, $t = 35.0$ ms



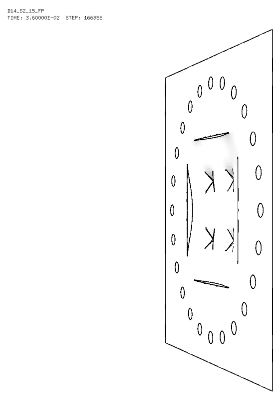
(f) $t = 35.0$ ms



(g) $t = 36.0$ ms



(h) Undeformed, $t = 36.0$ ms



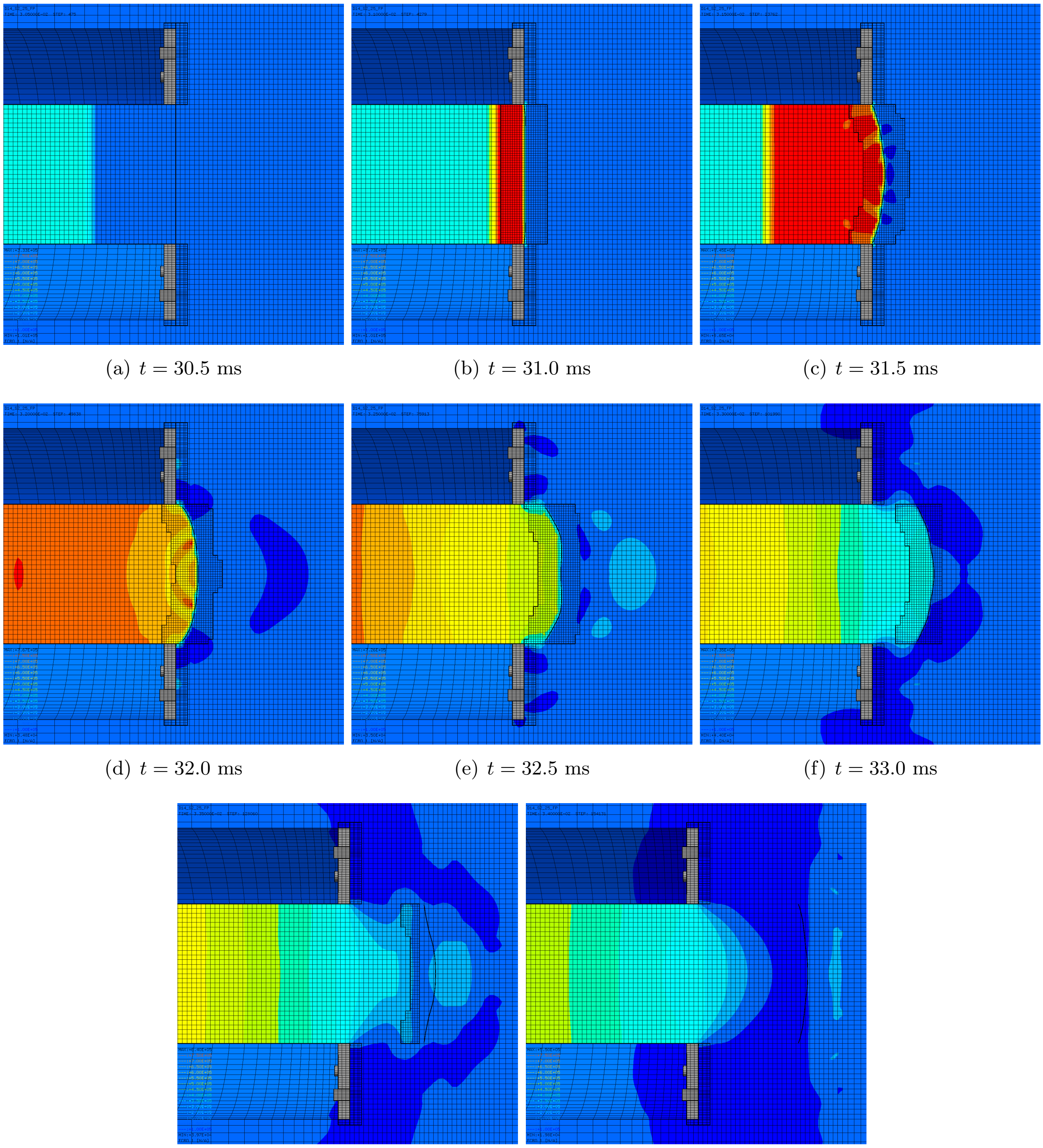
(i) $t = 36.0$ ms

Figure 136: Plate mesh (without element outlines) in simulation D14_S2_15_FP.

7.7 Case D14_S2_25_FP

This test is identical to D6_S2_25_FP but the material of the plate is Docol-1400M. Some results are shown below.

Figure 137 shows the (symmetrized) fluid pressure in the test region at various times.



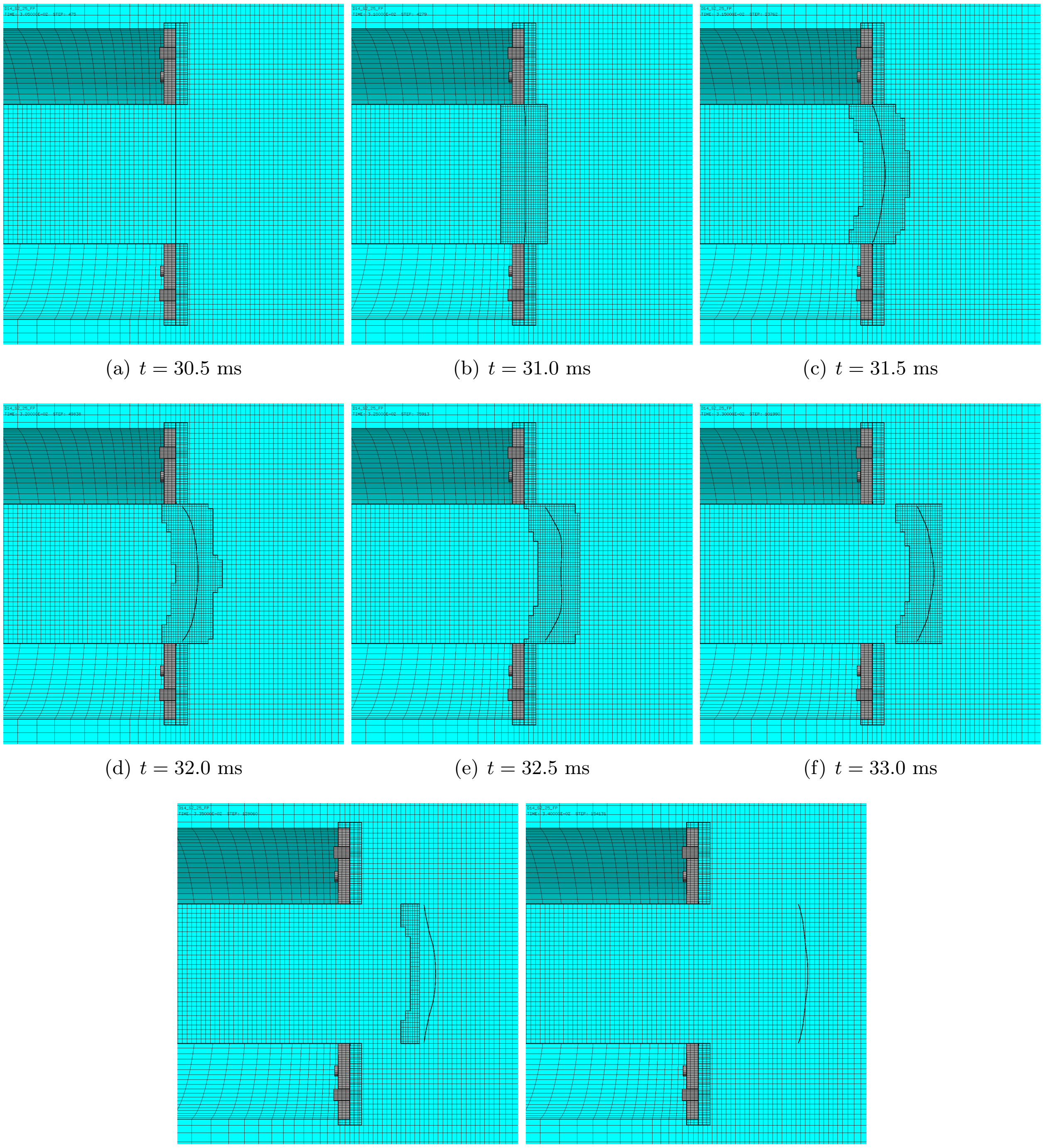
(a) $t = 30.5$ ms (b) $t = 31.0$ ms (c) $t = 31.5$ ms

(d) $t = 32.0$ ms (e) $t = 32.5$ ms (f) $t = 33.0$ ms

(g) $t = 33.5$ ms (h) $t = 34.0$ ms

Figure 137: Fluid pressure in the test region in simulation D14_S2_25_FP.

Figure 138 shows the (symmetrized) mesh in the test region at various times.



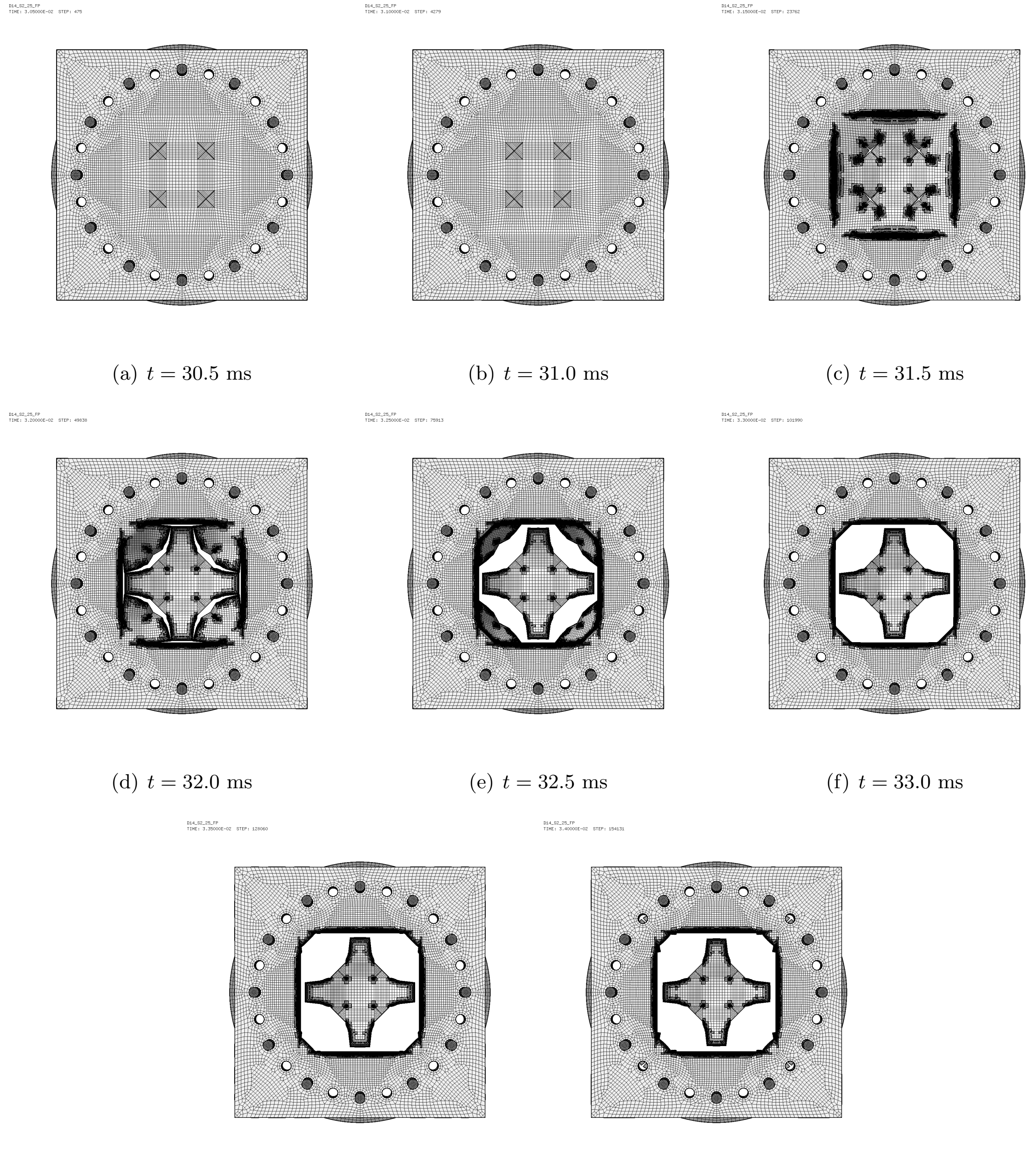
(a) $t = 30.5$ ms (b) $t = 31.0$ ms (c) $t = 31.5$ ms

(d) $t = 32.0$ ms (e) $t = 32.5$ ms (f) $t = 33.0$ ms

(g) $t = 33.5$ ms (h) $t = 34.0$ ms

Figure 138: Mesh in the test region in simulation D14_S2_25_FP.

Figure 139 shows the (symmetrized) plate mesh at various times. The element outlines are included, in order to appreciate the adaptive mesh refinement taking place in the plate.



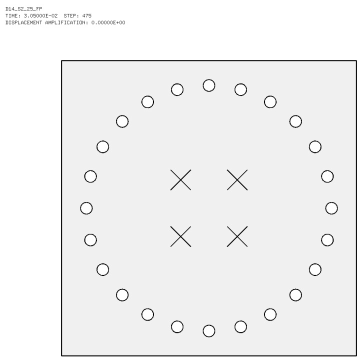
(a) $t = 30.5$ ms (b) $t = 31.0$ ms (c) $t = 31.5$ ms

(d) $t = 32.0$ ms (e) $t = 32.5$ ms (f) $t = 33.0$ ms

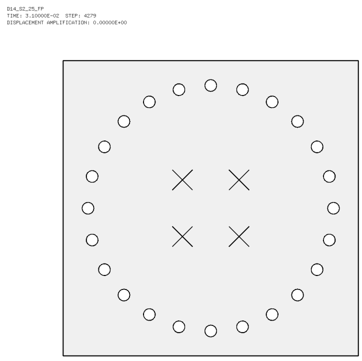
(g) $t = 33.5$ ms (h) $t = 34.0$ ms

Figure 139: Plate mesh in simulation D14_S2_25_FP.

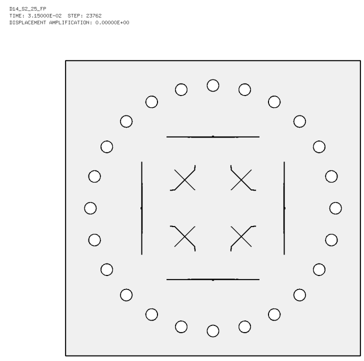
Figure 140 shows the (symmetrized) plate mesh without element outlines at various times. The geometry is mapped onto the initial configuration, by using the `DEFO AMPD 0.0` keywords. The `ADAP` keyword of the `TRAC` directive is used to allow for correct visualization of free edges and sharp corners. This allows to appreciate the progressive growth of the cracks.



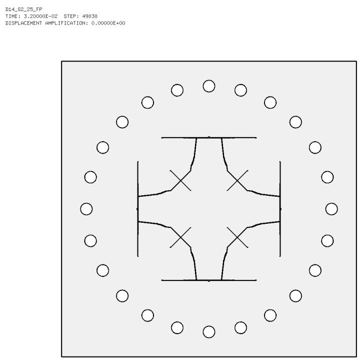
(a) $t = 30.5$ ms



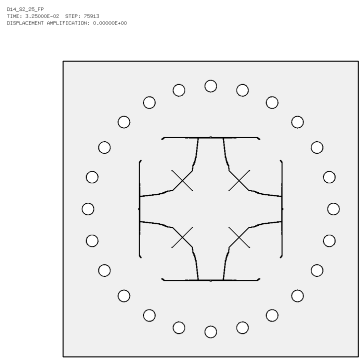
(b) $t = 31.0$ ms



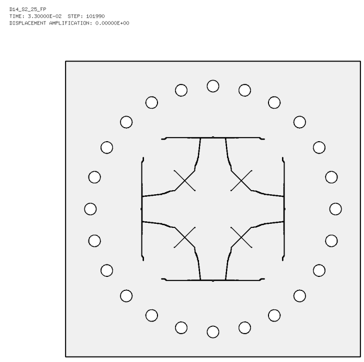
(c) $t = 31.5$ ms



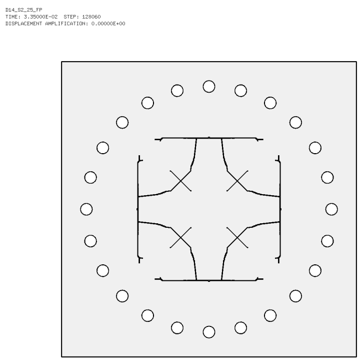
(d) $t = 32.0$ ms



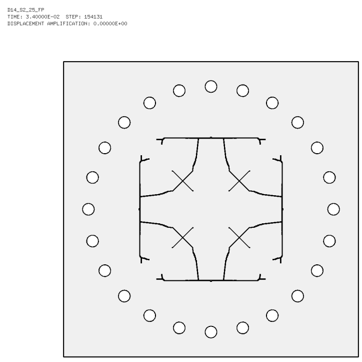
(e) $t = 32.5$ ms



(f) $t = 33.0$ ms



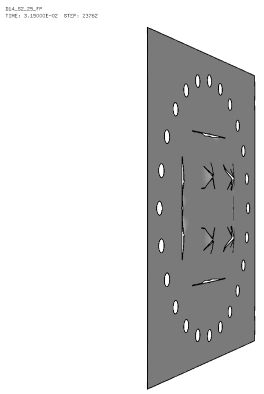
(g) $t = 33.5$ ms



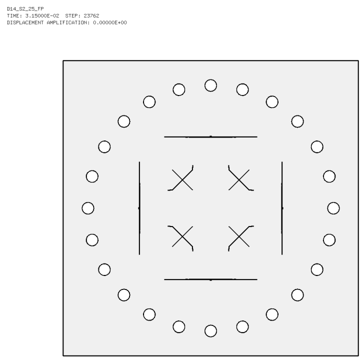
(h) $t = 34.0$ ms

Figure 140: Undeformed plate mesh (without element outlines) in simulation D14_S2_25_FP.

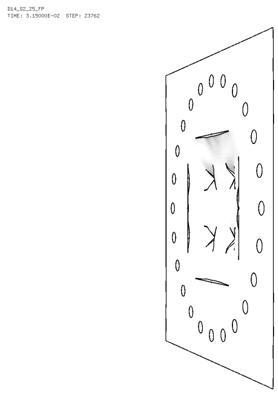
Figure 141 shows the (symmetrized) plate mesh without element outlines at various times, from three different eye positions (right, front, left), in order to highlight the opening of the slits. The right and left views show the deformed plate, while the central view shows the undeformed plate, like in the previous Figure, in order to highlight the cracks.



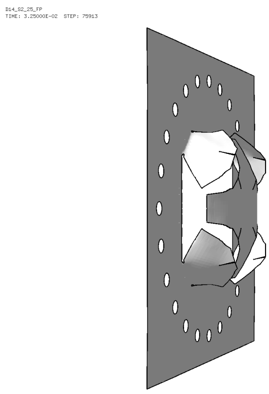
(a) $t = 31.5$ ms



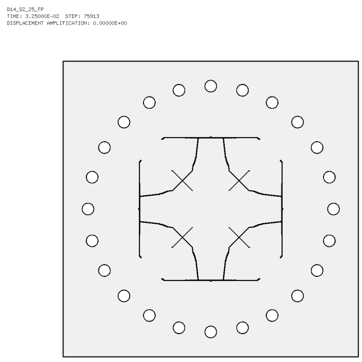
(b) Undeformed, $t = 31.5$ ms



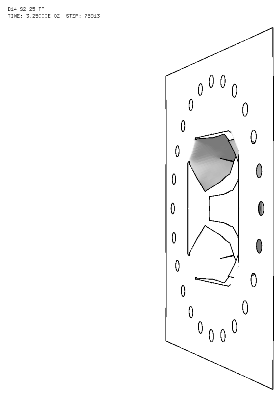
(c) $t = 31.5$ ms



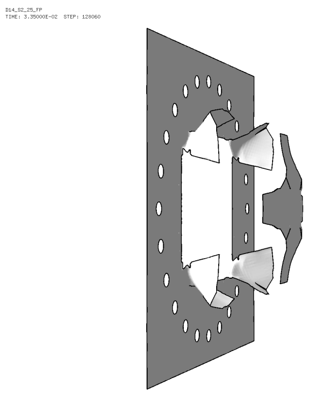
(d) $t = 32.5$ ms



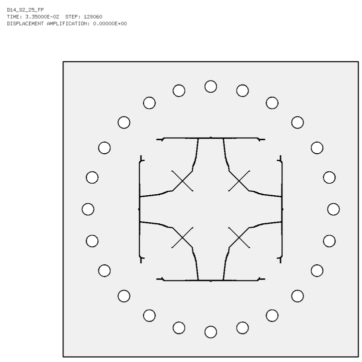
(e) Undeformed, $t = 32.5$ ms



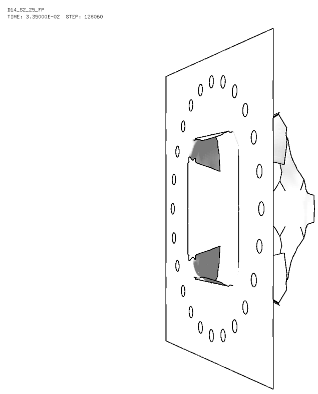
(f) $t = 32.5$ ms



(g) $t = 33.5$ ms



(h) Undeformed, $t = 33.5$ ms



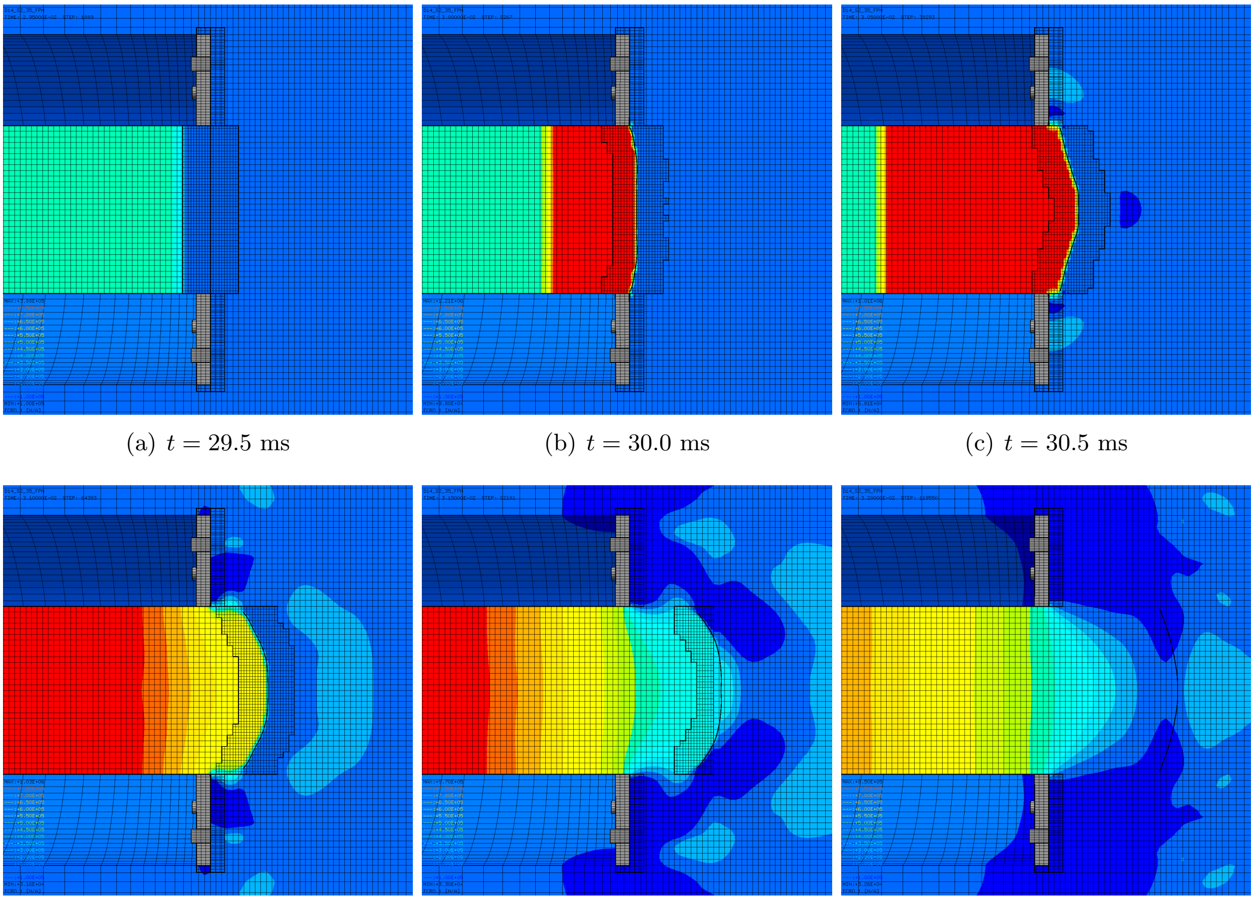
(i) $t = 33.5$ ms

Figure 141: Plate mesh (without element outlines) in simulation D14_S2_25_FP.

7.8 Case D14_S2_35_FPN

This test is identical to D6_S2_35_FP but the material of the plate is Docol-1400M. Some results are shown below.

Figure 142 shows the (symmetrized) fluid pressure in the test region at various times.

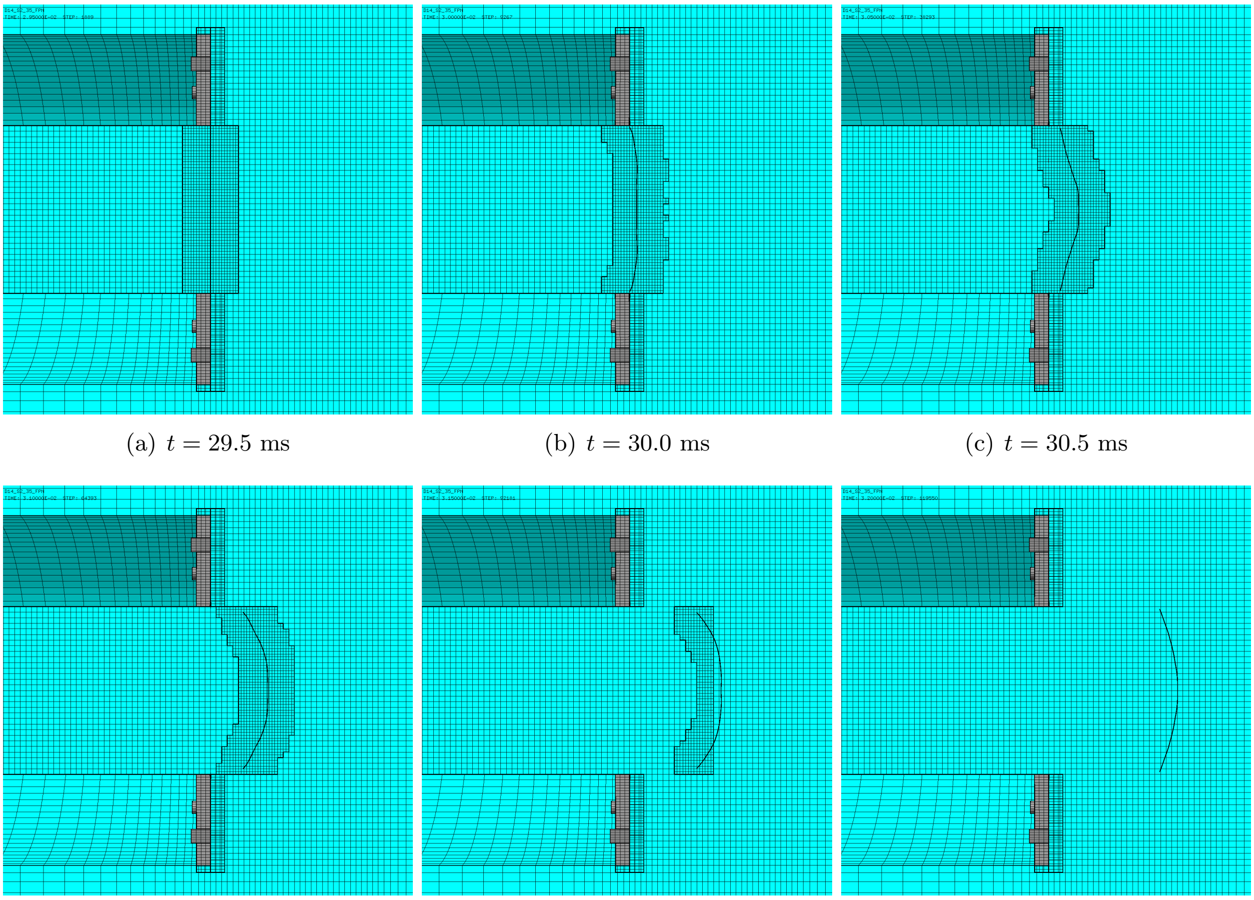


(a) $t = 29.5$ ms (b) $t = 30.0$ ms (c) $t = 30.5$ ms

(d) $t = 31.0$ ms (e) $t = 31.5$ ms (f) $t = 32.0$ ms

Figure 142: Fluid pressure in the test region in simulation D14_S2_35_FPN.

Figure 143 shows the (symmetrized) mesh in the test region at various times.

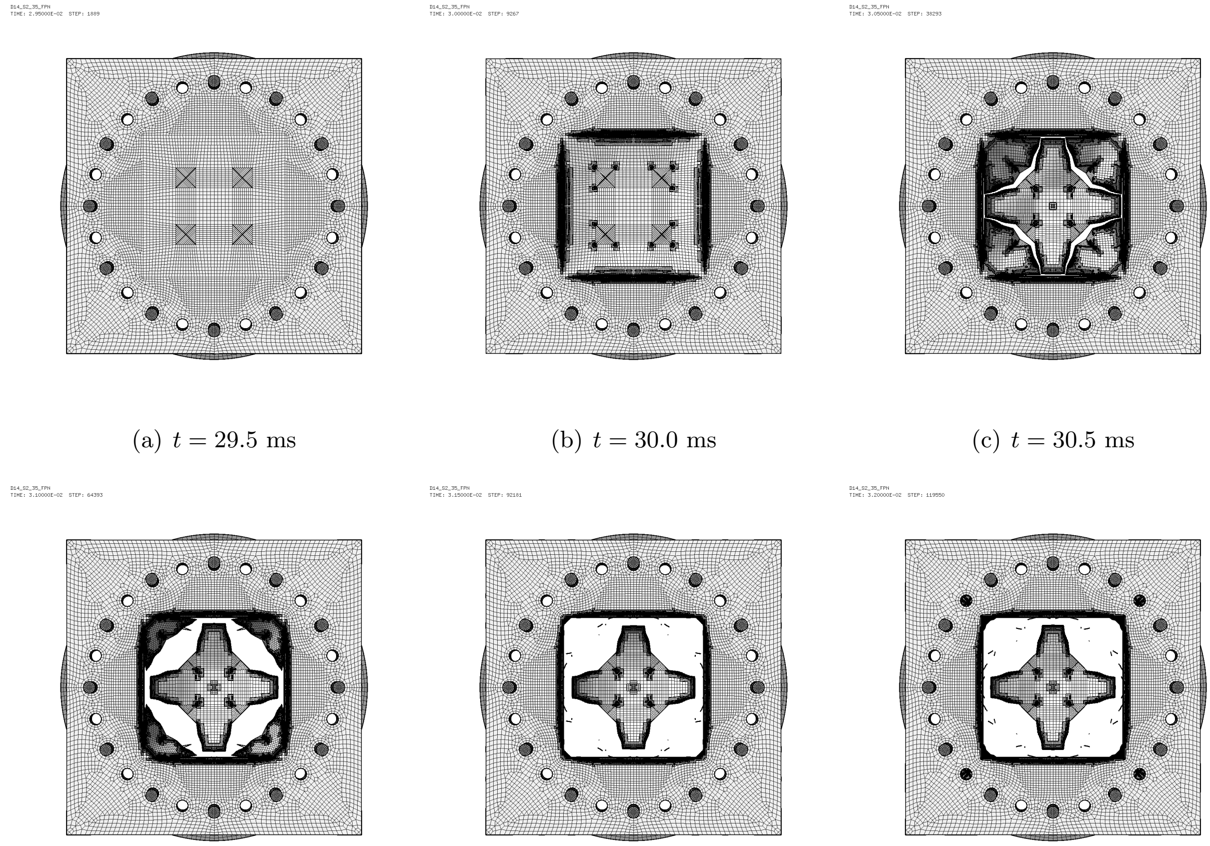


(a) $t = 29.5$ ms (b) $t = 30.0$ ms (c) $t = 30.5$ ms

(d) $t = 31.0$ ms (e) $t = 31.5$ ms (f) $t = 32.0$ ms

Figure 143: Mesh in the test region in simulation D14_S2_35_FPN.

Figure 144 shows the (symmetrized) plate mesh at various times. The element outlines are included, in order to appreciate the adaptive mesh refinement taking place in the plate.

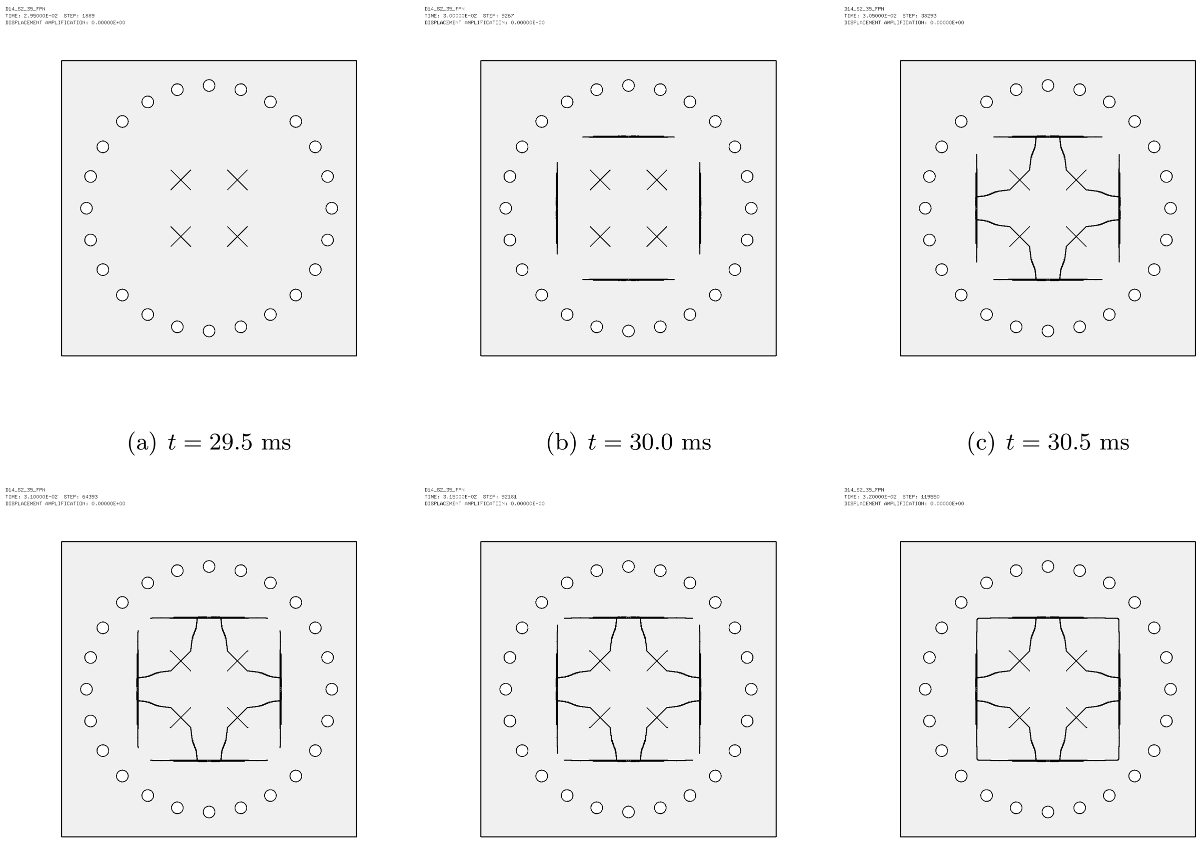


(a) $t = 29.5$ ms (b) $t = 30.0$ ms (c) $t = 30.5$ ms

(d) $t = 31.0$ ms (e) $t = 31.5$ ms (f) $t = 32.0$ ms

Figure 144: Plate mesh in simulation D14_S2_35_FPN.

Figure 145 shows the (symmetrized) plate mesh without element outlines at various times. The geometry is mapped onto the initial configuration, by using the `DEFO AMPD 0.0` keywords. The `ADAP` keyword of the `TRAC` directive is used to allow for correct visualization of free edges and sharp corners. This allows to appreciate the progressive growth of the cracks.

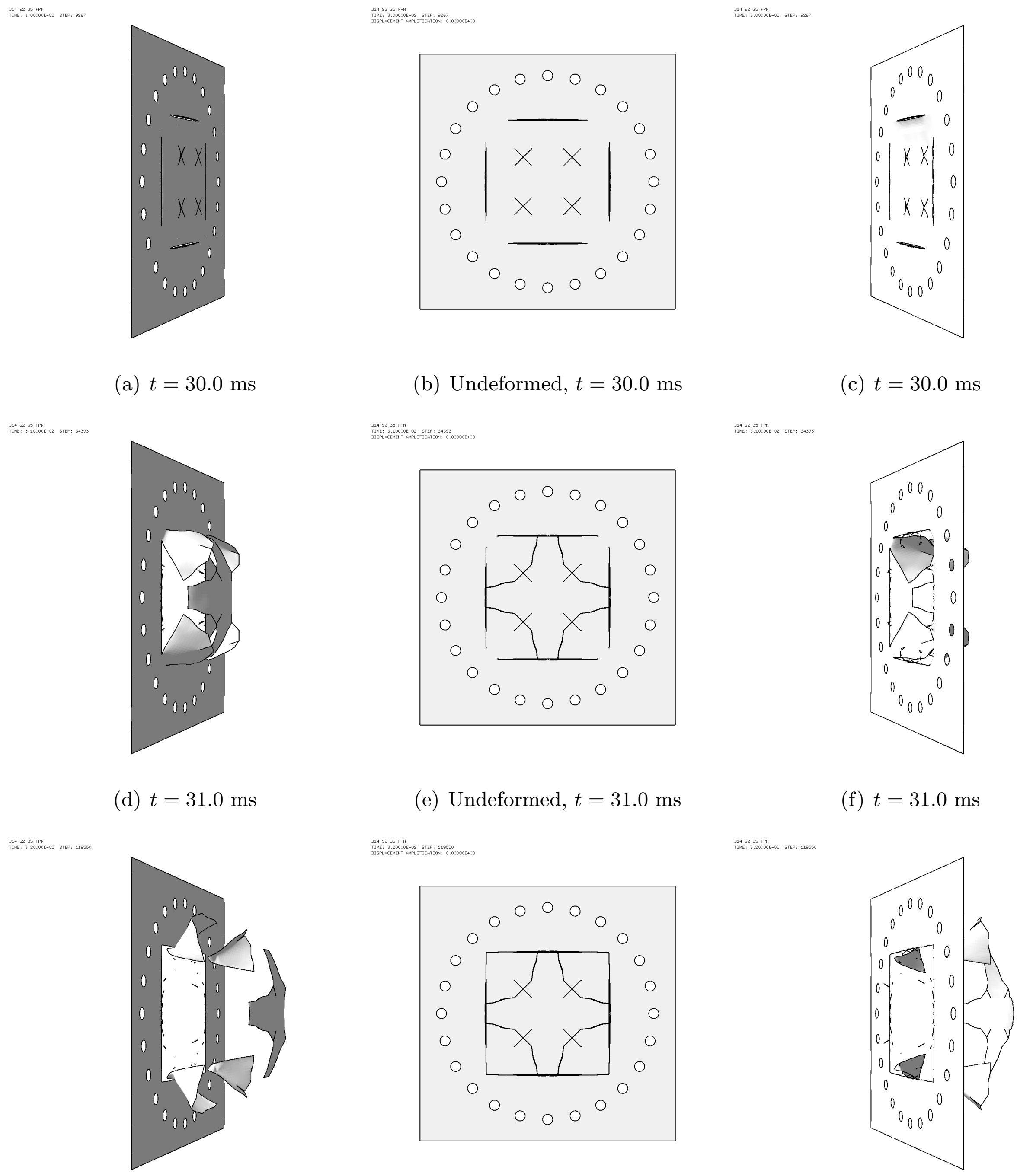


(a) $t = 29.5$ ms (b) $t = 30.0$ ms (c) $t = 30.5$ ms

(d) $t = 31.0$ ms (e) $t = 31.5$ ms (f) $t = 32.0$ ms

Figure 145: Undeformed plate mesh (without element outlines) in simulation D14_S2_35_FPN.

Figure 146 shows the (symmetrized) plate mesh without element outlines at various times, from three different eye positions (right, front, left), in order to highlight the opening of the slits. The right and left views show the deformed plate, while the central view shows the undeformed plate, like in the previous Figure, in order to highlight the cracks.



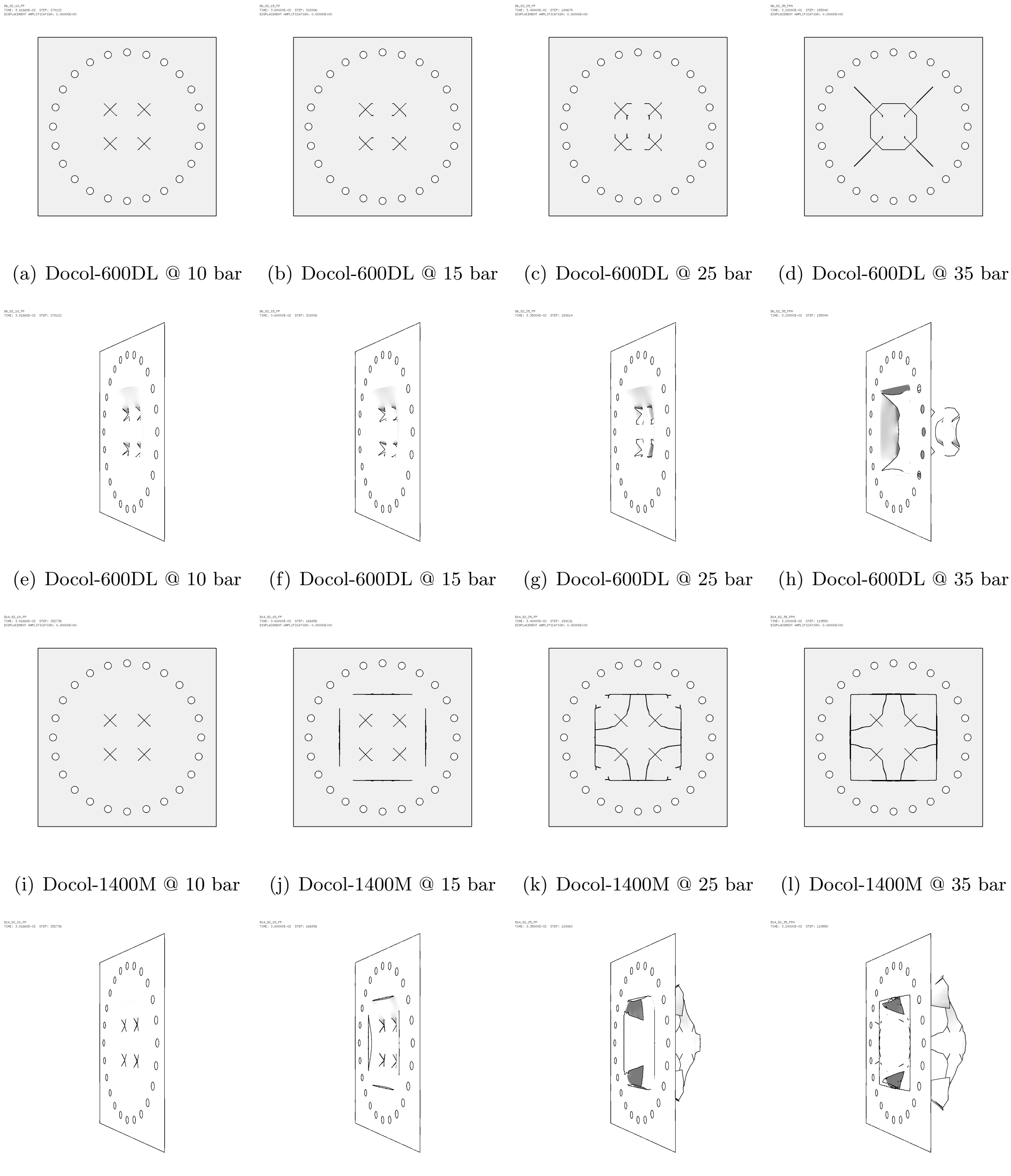
(a) $t = 30.0$ ms (b) Undeformed, $t = 30.0$ ms (c) $t = 30.0$ ms

(d) $t = 31.0$ ms (e) Undeformed, $t = 31.0$ ms (f) $t = 31.0$ ms

(g) $t = 32.0$ ms (h) Undeformed, $t = 32.0$ ms (i) $t = 32.0$ ms

Figure 146: Plate mesh (without element outlines) in simulation D14_S2_35_FPN.

Finally, Figure 147 summarizes and compares among them all the main results of the FSI calculations performed so far. For each case, the final plate damage (cracks) in both the initial (un-deformed) and the deformed geometry is shown. The final time varies case by case, see Table 13.



(a) Docol-600DL @ 10 bar (b) Docol-600DL @ 15 bar (c) Docol-600DL @ 25 bar (d) Docol-600DL @ 35 bar

(e) Docol-600DL @ 10 bar (f) Docol-600DL @ 15 bar (g) Docol-600DL @ 25 bar (h) Docol-600DL @ 35 bar

(i) Docol-1400M @ 10 bar (j) Docol-1400M @ 15 bar (k) Docol-1400M @ 25 bar (l) Docol-1400M @ 35 bar

(m) Docol-1400M @ 10 bar (n) Docol-1400M @ 15 bar (o) Docol-1400M @ 25 bar (p) Docol-1400M @ 35 bar

Figure 147: Final damage in the FSI S2 plate, on the initial and on the deformed geometry.

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424 -- Pdf/2023/COUPLED2023/Full_Paper/As_Submitted/
ECCOMAS_PROCEEDINGS_COUPLED2023_IS31_Aune_Valsamos_Casadei.pdf

[17] F. Casadei, G. Valsamos, M. Larcher, M. Kristoffersen. *Numerical simulation of blasts in steel and concrete pipes with EUROPLEXUS.* JRC Technical Report, PUBSY No. JRC132490, 2023.
427 -- Pdf/2021/Martin_Kristoffersen_2021/Report/Front/Req_JRC132490.pdf

[18] M. Kristoffersen, F. Casadei, G. Valsamos, M. Larcher, K.O. Hauge, A. Minoretti, T. Børvik. *Confined blast loading: Experiments and simulations of internal detonations.* Paper submitted to Computers and Structures, 2023.
430 -- Pdf/2022/MK_2022_Paper/As_Submitted/Confined_blast_loading.pdf

[19] F. Casadei, G. Valsamos, M. Larcher, V. Aune. *EUROPLEXUS simulations of steel plates witout and with pre-formed holes tested in the NTNU SIMlab Shock Tube Facility.* JRC Technical Report, PUBSY No. JRCxxxxxx, in preparation.
704 -- Pdf/2021/DYMAT_Madrid_Evicom/Report/DYMAT_Madrid.pdf

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List of abbreviations and definitions

CEA	Commissariat à l'Energie Atomique
EC	European Commission
EPX	EUROPLEXUS software [1]
JRC	Joint Research Centre
NTNU	Norwegian University of Science and Technology, Trondheim
SSTF	SIMLab Shock Tube Facility, Trondheim

Appendix I — Input files

All the input files used in the previous Sections are listed below.

1d3d14.dgibi

```
opti echo 1;
opti dime 3 elem cub8;
opti trac psc ftra '1d3d14_mesh.ps';
opti sauv form '1d3d14.msh';
*
lhp3d = 12.0;
lhp1d = 4.0;
llp1d = 6.0;
llp3d = 10.0;
nhp3d = 1200;
nhp1d = 400;
nlp1d = 600;
nlp3d = 1000;
h = lhp3d / nhp3d;
tol = h / 10;
*
p0 = 0 0 0;
p1 = 0 h 0;
p2 = 0 h h;
p3 = 0 0 h;
bashp3d = manu qua4 p0 p1 p2 p3;
hp3d = bashp3d volu tran nhp3d (lhp3d 0 0);
baslp3d = bashp3d plus ((lhp3d+lhp1d+llp1d) 0 0);
lp3d = baslp3d volu tran nlp3d (llp3d 0 0);
p1d1 = p0 plus (lhp3d 0 0);
p1d2 = p1d1 plus (lhp1d 0 0);
p1d3 = p1d2 plus (llp1d 0 0);
hp1d = p1d1 d nhp1d p1d2;
lp1d = p1d2 d nlp1d p1d3;
hp = hp3d et hp1d;
lp = lp3d et lp1d;
flui = hp et lp;
*
* raccords 3d-1d
*
facehp = bashp3d plus (lhp3d 0 0);
pfacehp = chan poi1 facehp;
elim tol (pfacehp et hp3d);
facelp = baslp3d;
pfacelp = chan poi1 facelp;
rachp = manu supe (p1d1 et facehp);
raclp = manu supe (p1d3 et facelp);
*
mesh = flui et facehp et facelp et rachp et raclp;
*
tass mesh noop;
sauv form mesh;
trac cach qual mesh;
*
fin;
```

1d3d14.epx

```
1D3D14
ECHO
!CONV win
CAST mesh
TRID EULE
DIME JONC 10 TERM ! Total n. of nodes in a TUBM juncton
GEOM CUVF hp3d lp3d TUVF hp1d lp1d CL3D facehp facelp
     TUBM rachp raclp TERM
COMP DIAM DROI 0.011283792 LECT hp1d lp1d TERM
     RACC TUBM LECT rachp  TERM
          NTUB LECT p1d1   TERM DTUB 0.011283792
          FACE LECT facehp TERM COEF 1.0
     RACC TUBM LECT raclp  TERM
          NTUB LECT p1d3   TERM DTUB 0.011283792
          FACE LECT facelp TERM COEF 1.0
! Attention: the TUBM elements (rachp and raclp) are NOT included
! in the "mesh" object (although they ARE indeed passed in from Cast3m).
! For this reason we must add them explicitly in the GROU directive below
! if we want to have them in the extracted element groups.
     GROU 2 'nrachp' LECT mesh rachp raclp TERM
                     COND XB GT 11.99 COND XB LT 12.01
            'nraclp' LECT mesh rachp raclp TERM
                     COND XB GT 21.99 COND XB LT 22.01
     COUL ROUG LECT hp TERM
  TURQ LECT lp TERM
          VERT LECT rachp raclp TERM
MATE GAZP RO 14.4 GAMM 1.4 CV 720 PINI 12.E5 PREF 1.E5
          LECT hp TERM
     GAZP RO 1.20 GAMM 1.4 CV 720 PINI 1.0E5 PREF 1.E5
          LECT lp TERM
! In order to obtain a printout at least of the 3D VFCCs I am obliged
! to use a different material for rachp and raclp, but with the
! same characteristics as the materials used for hp and lp, respectively
     GAZP RO 14.4 GAMM 1.4 CV 720 PINI 12.E5 PREF 1.E5
          LECT rachp TERM
     GAZP RO 1.20 GAMM 1.4 CV 720 PINI 1.0E5 PREF 1.E5
          LECT raclp TERM
ECRI ECRO VFCC TFRE 1.E-3
!    NOPO NOEL
     FICH ALIC TFRE 1.E-3
OPTI NOTE CSTA 0.75
     LOG 1
     VFCC FCON 6 ! hllc solver
          ORDR 2 ! order in space
          STPS 2 ! order in time
!         RECO 1 ! Not accepted by CAL_VFCC_1D in 2015
CALC TINI 0 TEND 20.E-3
FIN
```

1d3d14p.epx

```
Post-treatment (space curves from alice file)
ECHO
OPTI PRIN
RESU ALIC '1d3d14.ali' GARD PSCR
COMP NGRO 1 'xaxo' LECT flui TERM
                   COND LINE X1 0 Y1 0 Z1 0 X2 32 Y2 0 Z2 0 TOL 0.0001
SORT GRAP
PERF '1d3d14.pun'
AXTE 1.0 'Time [s]'
SCOU 61 'p_21'  NSTO 21 SAXE 1.0 'curr_abscissa' LECT xaxo TERM
                        ECRO COMP 1
SCOU 62 'ro_21' NSTO 21 SAXE 1.0 'curr_abscissa' LECT xaxo TERM
                        ECRO COMP 2
SCOU 65 'vx_21' NSTO 21 SAXE 1.0 'curr_abscissa' LECT xaxo TERM
                        VCVI COMP 1
DCOU 71 'p_ana' SHTU GAMM 1.4 ROM 14.4 ROP 1.2 EINT 2.08333E5
                     LENM 16 LENP 16
                     TIME 20.E-3 NRAR 30 VARI 1
DCOU 72 'r_ana' SHTU GAMM 1.4 ROM 14.4 ROP 1.2 EINT 2.08333E5
                     LENM 16 LENP 16
                     TIME 20.E-3 NRAR 30 VARI 2
DCOU 75 'v_ana' SHTU GAMM 1.4 ROM 14.4 ROP 1.2 EINT 2.08333E5
                     LENM 16 LENP 16
                     TIME 20.E-3 NRAR 30 VARI 5
TRAC 61 71 AXES 1.0 'PRESS. [PA]'
COLO NOIR ROUG
LIST 61 AXES 1.0 'PRESS. [PA]'
TRAC 62 72 AXES 1.0 'DENS. [KG/M3]'
COLO NOIR ROUG
LIST 62 AXES 1.0 'DENS. [KG/M3]'
TRAC 65 75 AXES 1.0 'VELOC. [M/S]'
COLO NOIR ROUG
LIST 65 AXES 1.0 'VELOC. [M/S]'
FIN
```

1d3d24.dgibi

```
opti echo 1;
opti dime 3 elem cub8;
opti trac psc ftra '1d3d24_mesh.ps';
opti sauv form '1d3d24.msh';
*
lhp3d = 12.0;
lhp1d = 4.0;
llp1d = 6.0;
llp3d = 10.0;
nhp3d = 1200;
nhp1d = 400;
nlp1d = 600;
nlp3d = 1000;
h = lhp3d / nhp3d;
tol = h / 10;
*
p0 = 0 0 0;
p1 = 0 h 0;
p2 = 0 h h;
p3 = 0 0 h;
bashp3d = manu qua4 p0 p1 p2 p3;
hp3d = bashp3d volu tran nhp3d (lhp3d 0 0);
baslp3d = bashp3d plus ((lhp3d+lhp1d+llp1d) 0 0);
lp3d = baslp3d volu tran nlp3d (llp3d 0 0);
p1d1 = p0 plus (lhp3d 0 0);
p1d2 = p1d1 plus (lhp1d 0 0);
p1d3 = p1d2 plus (llp1d 0 0);
hp1d = p1d1 d nhp1d p1d2;
lp1d = p1d2 d nlp1d p1d3;
hp = hp3d et hp1d;
lp = lp3d et lp1d;
flui = hp et lp;
*
* raccords 3d-1d
*
facehp = bashp3d plus (lhp3d 0 0);
pfacehp = chan poi1 facehp;
elim tol (pfacehp et hp3d);
facelp = baslp3d;
pfacelp = chan poi1 facelp;
rachp = manu supe (p1d1 et facehp);
raclp = manu supe (p1d3 et facelp);
*
```

```
mesh = flui et facehp et facelp et rachp et raclp;
*
tass mesh noop;
sauv form mesh;
trac cach qual mesh;
*
fin;
```

1d3d24.epx

```
1D3D24
ECHO
!CONV win
CAST mesh
TRID EULE
DIME JONC 10 TERM ! Total n. of nodes in a TUBM juncton
GEOM CUVF hp3d lp3d TUVF hp1d lp1d CL3D facehp facelp
     TUBM rachp raclp TERM
COMP DIAM DROI 0.011283792 LECT hp1d lp1d TERM
     RACC TUBM LECT rachp  TERM
          NTUB LECT p1d1   TERM DTUB 0.011283792
          FACE LECT facehp TERM COEF 1.0
     RACC TUBM LECT raclp  TERM
          NTUB LECT p1d3   TERM DTUB 0.011283792
          FACE LECT facelp TERM COEF 1.0
! Attention: the TUBM elements (rachp and raclp) are NOT included
! in the "mesh" object (although they ARE indeed passed in from Cast3m).
! For this reason we must add them explicitly in the GROU directive below
! if we want to have them in the extracted element groups.
     GROU 2 'nrachp' LECT mesh rachp raclp TERM
                     COND XB GT 11.99 COND XB LT 12.01
            'nraclp' LECT mesh rachp raclp TERM
                     COND XB GT 21.99 COND XB LT 22.01
     COUL ROUG LECT hp TERM
  TURQ LECT lp TERM
          VERT LECT rachp raclp TERM
MATE GAZP RO 14.4 GAMM 1.4 CV 720 PINI 12.E5 PREF 1.E5
          LECT hp TERM
     GAZP RO 1.20 GAMM 1.4 CV 720 PINI 1.0E5 PREF 1.E5
          LECT lp TERM
! In order to obtain a printout at least of the 3D VFCCs I am obliged
! to use a different material for rachp and raclp, but with the
! same characteristics as the materials used for hp and lp, respectively
     GAZP RO 14.4 GAMM 1.4 CV 720 PINI 12.E5 PREF 1.E5
          LECT rachp TERM
     GAZP RO 1.20 GAMM 1.4 CV 720 PINI 1.0E5 PREF 1.E5
          LECT raclp TERM
ECRI ECRO VFCC TFRE 1.E-3
!    NOPO NOEL
     FICH ALIC TFRE 1.E-3
OPTI NOTE CSTA 0.75
     LOG 1
     VFCC FCON 6 ! hllc solver
          ORDR 2 ! order in space
          STPS 2 ! order in time
          RECO 1 ! Reconstruction on the conserved variables
CALC TINI 0 TEND 20.E-3
FIN
```

1d3d24p.epx

```
Post-treatment (space curves from alice file)
ECHO
OPTI PRIN
RESU ALIC '1d3d24.ali' GARD PSCR
COMP NGRO 1 'xaxo' LECT flui TERM
                   COND LINE X1 0 Y1 0 Z1 0 X2 32 Y2 0 Z2 0 TOL 0.0001
SORT GRAP
PERF '1d3d24.pun'
AXTE 1.0 'Time [s]'
SCOU 61 'p_21'  NSTO 21 SAXE 1.0 'curr_abscissa' LECT xaxo TERM
                    ECRO COMP 1
SCOU 62 'ro_21' NSTO 21 SAXE 1.0 'curr_abscissa' LECT xaxo TERM
                    ECRO COMP 2
SCOU 65 'vx_21' NSTO 21 SAXE 1.0 'curr_abscissa' LECT xaxo TERM
                    VCVI COMP 1
DCOU 71 'p_ana' SHTU GAMM 1.4 ROM 14.4 ROP 1.2 EINT 2.08333E5
                   LENM 16 LENP 16
                   TIME 20.E-3 NRAR 30 VARI 1
DCOU 72 'r_ana' SHTU GAMM 1.4 ROM 14.4 ROP 1.2 EINT 2.08333E5
                   LENM 16 LENP 16
                   TIME 20.E-3 NRAR 30 VARI 2
DCOU 75 'v_ana' SHTU GAMM 1.4 ROM 14.4 ROP 1.2 EINT 2.08333E5
                   LENM 16 LENP 16
                   TIME 20.E-3 NRAR 30 VARI 5
TRAC 61 71 AXES 1.0 'PRESS. [PA]'
COLO NOIR ROUG
LIST 61 AXES 1.0 'PRESS. [PA]'
TRAC 62 72 AXES 1.0 'DENS. [KG/M3]'
COLO NOIR ROUG
LIST 62 AXES 1.0 'DENS. [KG/M3]'
TRAC 65 75 AXES 1.0 'VELOC. [M/S]'
COLO NOIR ROUG
LIST 65 AXES 1.0 'VELOC. [M/S]'
FIN
```

1d3d34.dgibi

```
opti echo 1;
opti dime 3 elem cub8;
opti trac psc ftra '1d3d34_mesh.ps';
opti sauv form '1d3d34.msh';
*
lhp3d = 12.0;
lhp1d = 4.0;
llp1d = 6.0;
llp3d = 10.0;
nhp3d = 1200;
nhp1d = 400;
nlp1d = 600;
nlp3d = 1000;
h = lhp3d / nhp3d;
tol = h / 10;
*
p0 = 0 0 0;
p1 = 0 h 0;
p2 = 0 h h;
p3 = 0 0 h;
bashp3d = manu qua4 p0 p1 p2 p3;
hp3d = bashp3d volu tran nhp3d (lhp3d 0 0);
baslp3d = bashp3d plus ((lhp3d+lhp1d+llp1d) 0 0);
lp3d = baslp3d volu tran nlp3d (llp3d 0 0);
p1d1 = p0 plus (lhp3d 0 0);
p1d2 = p1d1 plus (lhp1d 0 0);
p1d3 = p1d2 plus (llp1d 0 0);
hp1d = p1d1 d nhp1d p1d2;
lp1d = p1d2 d nlp1d p1d3;
hp = hp3d et hp1d;
lp = lp3d et lp1d;
flui = hp et lp;
*
* raccords 3d-1d
*
facehp = bashp3d plus (lhp3d 0 0);
pfacehp = chan poi1 facehp;
elim tol (pfacehp et hp3d);
facelp = baslp3d;
pfacelp = chan poi1 facelp;
rachp = manu supe (p1d1 et facehp);
raclp = manu supe (p1d3 et facelp);
*
mesh = flui et facehp et facelp et rachp et raclp;
*
tass mesh noop;
sauv form mesh;
trac cach qual mesh;
*
fin;
```

1d3d34.epx

```
1D3D34
ECHO
!CONV win
CAST mesh
TRID EULE
DIME JONC 10 TERM ! Total n. of nodes in a TUBM juncton
GEOM CUVF hp3d lp3d TUVF hp1d lp1d CL3D facehp facelp
     TUBM rachp raclp TERM
COMP DIAM DROI 0.011283792 LECT hp1d lp1d TERM
     RACC TUBM LECT rachp  TERM
          NTUB LECT p1d1   TERM DTUB 0.011283792
          FACE LECT facehp TERM COEF 1.0
     RACC TUBM LECT raclp  TERM
          NTUB LECT p1d3   TERM DTUB 0.011283792
          FACE LECT facelp TERM COEF 1.0
! Attention: the TUBM elements (rachp and raclp) are NOT included
! in the "mesh" object (although they ARE indeed passed in from Cast3m).
! For this reason we must add them explicitly in the GROU directive below
! if we want to have them in the extracted element groups.
     GROU 2 'nrachp' LECT mesh rachp raclp TERM
                     COND XB GT 11.99 COND XB LT 12.01
            'nraclp' LECT mesh rachp raclp TERM
                     COND XB GT 21.99 COND XB LT 22.01
     COUL ROUG LECT hp TERM
  TURQ LECT lp TERM
          VERT LECT rachp raclp TERM
MATE GAZP RO 14.4 GAMM 1.4 CV 720 PINI 12.E5 PREF 1.E5
          LECT hp TERM
     GAZP RO 1.20 GAMM 1.4 CV 720 PINI 1.0E5 PREF 1.E5
          LECT lp TERM
! In order to obtain a printout at least of the 3D VFCCs I am obliged
! to use a different material for rachp and raclp, but with the
! same characteristics as the materials used for hp and lp, respectively
     GAZP RO 14.4 GAMM 1.4 CV 720 PINI 12.E5 PREF 1.E5
          LECT rachp TERM
     GAZP RO 1.20 GAMM 1.4 CV 720 PINI 1.0E5 PREF 1.E5
          LECT raclp TERM
ECRI ECRO VFCC TFRE 1.E-3
!    NOPO NOEL
     FICH ALIC TFRE 1.E-3
OPTI NOTE CSTA 0.75
     LOG 1
     VFCC FCON 6 ! hllc solver
          ORDR 2 ! order in space
          STPS 2 ! order in time
          RECO 1 ! Reconstruction on the conserved variables
          CENE   ! Keep specific internal energy strictly positive
CALC TINI 0 TEND 20.E-3
FIN
```

1d3d34p.epx

```
Post-treatment (space curves from alice file)
ECHO
OPTI PRIN
RESU ALIC '1d3d34.ali' GARD PSCR
COMP NGRO 1 'xaxo' LECT flui TERM
                  COND LINE X1 0 Y1 0 Z1 0 X2 32 Y2 0 Z2 0 TOL 0.0001
SORT GRAP
PERF '1d3d34.pun'
AXTE 1.0 'Time [s]'
SCOU 61 'p_21'  NSTO 21 SAXE 1.0 'curr_abscissa' LECT xaxo TERM
                       ECRO COMP 1
SCOU 62 'ro_21' NSTO 21 SAXE 1.0 'curr_abscissa' LECT xaxo TERM
                       ECRO COMP 2
SCOU 65 'vx_21' NSTO 21 SAXE 1.0 'curr_abscissa' LECT xaxo TERM
                       VCVI COMP 1
DCOU 71 'p_ana' SHTU GAMM 1.4 ROM 14.4 ROP 1.2 EINT 2.08333E5
                  LENM 16 LENP 16
                  TIME 20.E-3 NRAR 30 VARI 1
DCOU 72 'r_ana' SHTU GAMM 1.4 ROM 14.4 ROP 1.2 EINT 2.08333E5
                  LENM 16 LENP 16
                  TIME 20.E-3 NRAR 30 VARI 2
DCOU 75 'v_ana' SHTU GAMM 1.4 ROM 14.4 ROP 1.2 EINT 2.08333E5
                  LENM 16 LENP 16
                  TIME 20.E-3 NRAR 30 VARI 5
TRAC 61 71 AXES 1.0 'PRESS. [PA]'
COLO NOIR ROUG
LIST 61 AXES 1.0 'PRESS. [PA]'
TRAC 62 72 AXES 1.0 'DENS. [KG/M3]'
COLO NOIR ROUG
LIST 62 AXES 1.0 'DENS. [KG/M3]'
TRAC 65 75 AXES 1.0 'VELOC. [M/S]'
COLO NOIR ROUG
LIST 65 AXES 1.0 'VELOC. [M/S]'
FIN
```

1d3d44.dgibi

```
opti echo 1;
opti dime 3 elem cub8;
opti trac psc ftra '1d3d44_mesh.ps';
opti sauv form '1d3d44.msh';
*
lhp3d = 12.0;
lhp1d = 4.0;
llp1d = 6.0;
llp3d = 10.0;
nhp3d = 1200;
nhp1d = 400;
nlp1d = 600;
nlp3d = 1000;
h = lhp3d / nhp3d;
tol = h / 10;
*
p0 = 0 0 0;
p1 = 0 h 0;
p2 = 0 h h;
p3 = 0 0 h;
bashp3d = manu qua4 p0 p1 p2 p3;
hp3d = bashp3d volu tran nhp3d (lhp3d 0 0);
baslp3d = bashp3d plus ((lhp3d+lhp1d+llp1d) 0 0);
lp3d = baslp3d volu tran nlp3d (llp3d 0 0);
p1d1 = p0 plus (lhp3d 0 0);
p1d2 = p1d1 plus (lhp1d 0 0);
p1d3 = p1d2 plus (llp1d 0 0);
hp1d = p1d1 d nhp1d p1d2;
lp1d = p1d2 d nlp1d p1d3;
hp = hp3d et hp1d;
lp = lp3d et lp1d;
flui = hp et lp;
*
* raccords 3d-1d
*
facehp = bashp3d plus (lhp3d 0 0);
pfacehp = chan poi1 facehp;
elim tol (pfacehp et hp3d);
facelp = baslp3d;
pfacelp = chan poi1 facelp;
rachp = manu supe (p1d1 et facehp);
raclp = manu supe (p1d3 et facelp);
*
mesh = flui et facehp et facelp et rachp et raclp;
*
tass mesh noop;
sauv form mesh;
trac cach qual mesh;
*
fin;
```

1d3d44.epx

```
1D3D44
ECHO
!CONV win
CAST mesh
TRID EULE
DIME JONC 10 TERM ! Total n. of nodes in a TUBM juncton
GEOM CUVF hp3d lp3d TUVF hp1d lp1d CL3D facehp facelp
     TUBM rachp raclp TERM
COMP DIAM DROI 0.011283792 LECT hp1d lp1d TERM
     RACC TUBM LECT rachp  TERM
          NTUB LECT p1d1   TERM DTUB 0.011283792
          FACE LECT facehp TERM COEF 1.0
     RACC TUBM LECT raclp  TERM
          NTUB LECT p1d3   TERM DTUB 0.011283792
          FACE LECT facelp TERM COEF 1.0
! Attention: the TUBM elements (rachp and raclp) are NOT included
! in the "mesh" object (although they ARE indeed passed in from Cast3m).
! For this reason we must add them explicitly in the GROU directive below
! if we want to have them in the extracted element groups.
     GROU 2 'nrachp' LECT mesh rachp raclp TERM
                     COND XB GT 11.99 COND XB LT 12.01
            'nraclp' LECT mesh rachp raclp TERM
                     COND XB GT 21.99 COND XB LT 22.01
     COUL ROUG LECT hp TERM
  TURQ LECT lp TERM
          VERT LECT rachp raclp TERM
MATE GAZP RO 14.4 GAMM 1.4 CV 720 PINI 12.E5 PREF 1.E5
          LECT hp TERM
     GAZP RO 1.20 GAMM 1.4 CV 720 PINI 1.0E5 PREF 1.E5
          LECT lp TERM
! In order to obtain a printout at least of the 3D VFCCs I am obliged
! to use a different material for rachp and raclp, but with the
! same characteristics as the materials used for hp and lp, respectively
     GAZP RO 14.4 GAMM 1.4 CV 720 PINI 12.E5 PREF 1.E5
          LECT rachp TERM
     GAZP RO 1.20 GAMM 1.4 CV 720 PINI 1.0E5 PREF 1.E5
          LECT raclp TERM
ECRI ECRO VFCC TFRE 1.E-3
!    NOPO NOEL
     FICH ALIC TFRE 1.E-3
OPTI NOTE CSTA 0.75
     LOG 1
     VFCC FCON 6 ! hllc solver
          ORDR 2 ! order in space
          STPS 2 ! order in time
          RECO 2 ! Reconstruction based on internal specific energy
CALC TINI 0 TEND 20.E-3
FIN
```

1d3d44p.epx

```
Post-treatment (space curves from alice file)
ECHO
OPTI PRIN
RESU ALIC '1d3d44.ali' GARD PSCR
COMP NGRO 1 'xaxo' LECT flui TERM
                  COND LINE X1 0 Y1 0 Z1 0 X2 32 Y2 0 Z2 0 TOL 0.0001
SORT GRAP
PERF '1d3d44.pun'
AXTE 1.0 'Time [s]'
SCOU 61 'p_21'  NSTO 21 SAXE 1.0 'curr_abscissa' LECT xaxo TERM
                       ECRO COMP 1
SCOU 62 'ro_21' NSTO 21 SAXE 1.0 'curr_abscissa' LECT xaxo TERM
                       ECRO COMP 2
SCOU 65 'vx_21' NSTO 21 SAXE 1.0 'curr_abscissa' LECT xaxo TERM
                       VCVI COMP 1
DCOU 71 'p_ana' SHTU GAMM 1.4 ROM 14.4 ROP 1.2 EINT 2.08333E5
                  LENM 16 LENP 16
                  TIME 20.E-3 NRAR 30 VARI 1
DCOU 72 'r_ana' SHTU GAMM 1.4 ROM 14.4 ROP 1.2 EINT 2.08333E5
                  LENM 16 LENP 16
                  TIME 20.E-3 NRAR 30 VARI 2
DCOU 75 'v_ana' SHTU GAMM 1.4 ROM 14.4 ROP 1.2 EINT 2.08333E5
                  LENM 16 LENP 16
                  TIME 20.E-3 NRAR 30 VARI 5
TRAC 61 71 AXES 1.0 'PRESS. [PA]'
COLO NOIR ROUG
LIST 61 AXES 1.0 'PRESS. [PA]'
TRAC 62 72 AXES 1.0 'DENS. [KG/M3]'
COLO NOIR ROUG
LIST 62 AXES 1.0 'DENS. [KG/M3]'
TRAC 65 75 AXES 1.0 'VELOC. [M/S]'
COLO NOIR ROUG
LIST 65 AXES 1.0 'VELOC. [M/S]'
FIN
```

1d3d54.dgibi

```
opti echo 1;
opti dime 3 elem cub8;
opti trac psc ftra '1d3d54_mesh.ps';
opti sauv form '1d3d54.msh';
*
lhp3d = 12.0;
lhp1d = 4.0;
llp1d = 6.0;
llp3d = 10.0;
nhp3d = 1200;
nhp1d = 400;
nlp1d = 600;
nlp3d = 1000;
h = lhp3d / nhp3d;
tol = h / 10;
*
p0 = 0 0 0;
```

```
p1 = 0 h 0;
p2 = 0 h h;
p3 = 0 0 h;
bashp3d = manu qua4 p0 p1 p2 p3;
hp3d = bashp3d volu tran nhp3d (lhp3d 0 0);
baslp3d = bashp3d plus ((lhp3d+lhp1d+llp1d) 0 0);
lp3d = baslp3d volu tran nlp3d (llp3d 0 0);
p1d1 = p0 plus (lhp3d 0 0);
p1d2 = p1d1 plus (lhp1d 0 0);
p1d3 = p1d2 plus (llp1d 0 0);
hp1d = p1d1 d nhp1d p1d2;
lp1d = p1d2 d nlp1d p1d3;
hp = hp3d et hp1d;
lp = lp3d et lp1d;
flui = hp et lp;
*
* raccords 3d-1d
*
facehp = bashp3d plus (lhp3d 0 0);
pfacehp = chan poi1 facehp;
elim tol (pfacehp et hp3d);
facelp = baslp3d;
pfacelp = chan poi1 facelp;
rachp = manu supe (p1d1 et facehp);
raclp = manu supe (p1d3 et facelp);
*
mesh = flui et facehp et facelp et rachp et raclp;
*
tass mesh noop;
sauv form mesh;
trac cach qual mesh;
*
fin;
```

1d3d54.epx

```
1D3D54
ECHO
!CONV win
CAST mesh
TRID EULE
DIME JONC 10 TERM ! Total n. of nodes in a TUBM juncton
GEOM CUVF hp3d lp3d TUVF hp1d lp1d CL3D facehp facelp
     TUBM rachp raclp TERM
COMP DIAM DROI 0.011283792 LECT hp1d lp1d TERM
     RACC TUBM LECT rachp  TERM
          NTUB LECT p1d1   TERM DTUB 0.011283792
          FACE LECT facehp TERM COEF 1.0
     RACC TUBM LECT raclp  TERM
          NTUB LECT p1d3   TERM DTUB 0.011283792
          FACE LECT facelp TERM COEF 1.0
! Attention: the TUBM elements (rachp and raclp) are NOT included
! in the "mesh" object (although they ARE indeed passed in from Cast3m).
! For this reason we must add them explicitly in the GROU directive below
! if we want to have them in the extracted element groups.
     GROU 2 'nrachp' LECT mesh rachp raclp TERM
                     COND XB GT 11.99 COND XB LT 12.01
            'nraclp' LECT mesh rachp raclp TERM
                     COND XB GT 21.99 COND XB LT 22.01
     COUL ROUG LECT hp TERM
  TURQ LECT lp TERM
          VERT LECT rachp raclp TERM
MATE GAZP RO 14.4 GAMM 1.4 CV 720 PINI 12.E5 PREF 1.E5
          LECT hp TERM
     GAZP RO 1.20 GAMM 1.4 CV 720 PINI 1.0E5 PREF 1.E5
          LECT lp TERM
! In order to obtain a printout at least of the 3D VFCCs I am obliged
! to use a different material for rachp and raclp, but with the
! same characteristics as the materials used for hp and lp, respectively
     GAZP RO 14.4 GAMM 1.4 CV 720 PINI 12.E5 PREF 1.E5
          LECT rachp TERM
     GAZP RO 1.20 GAMM 1.4 CV 720 PINI 1.0E5 PREF 1.E5
          LECT raclp TERM
ECRI ECRO VFCC TFRE 1.E-3
!    NOPO NOEL
     FICH ALIC TFRE 1.E-3
OPTI NOTE CSTA 0.75
     LOG 1
     VFCC FCON 6 ! hllc solver
          ORDR 2 ! order in space
          STPS 2 ! order in time
          RECO 1 ! Reconstruction on the conserved variables
          LMAS 2 ! Barth-Jespersen limiter (not Dubois)
          LQDM 2
          LENE 2
          LVEL 2
          LPRE 2
          KBAR 1 ! Use version of B-J best suited for shock waves
CALC TINI 0 TEND 20.E-3
FIN
```

1d3d54p.epx

```
Post-treatment (space curves from alice file)
ECHO
OPTI PRIN
RESU ALIC '1d3d54.ali' GARD PSCR
COMP NGRO 1 'xaxo' LECT flui TERM
                    COND LINE X1 0 Y1 0 Z1 0 X2 32 Y2 0 Z2 0 TOL 0.0001
SORT GRAP
PERF '1d3d54.pun'
AXTE 1.0 'Time [s]'
SCOU 61 'p_21'  NSTO 21 SAXE 1.0 'curr_abscissa' LECT xaxo TERM
                         ECRO COMP 1
SCOU 62 'ro_21' NSTO 21 SAXE 1.0 'curr_abscissa' LECT xaxo TERM
                         ECRO COMP 2
SCOU 65 'vx_21' NSTO 21 SAXE 1.0 'curr_abscissa' LECT xaxo TERM
                         VCVI COMP 1
DCOU 71 'p_ana' SHTU GAMM 1.4 ROM 14.4 ROP 1.2 EINT 2.08333E5
                     LENM 16 LENP 16
                     TIME 20.E-3 NRAR 30 VARI 1
DCOU 72 'r_ana' SHTU GAMM 1.4 ROM 14.4 ROP 1.2 EINT 2.08333E5
                     LENM 16 LENP 16
                     TIME 20.E-3 NRAR 30 VARI 2
DCOU 75 'v_ana' SHTU GAMM 1.4 ROM 14.4 ROP 1.2 EINT 2.08333E5
                     LENM 16 LENP 16
                     TIME 20.E-3 NRAR 30 VARI 5
TRAC 61 71 AXES 1.0 'PRESS. [PA]'
COLO NOIR ROUG
LIST 61 AXES 1.0 'PRESS. [PA]'
TRAC 62 72 AXES 1.0 'DENS. [KG/M3]'
COLO NOIR ROUG
LIST 62 AXES 1.0 'DENS. [KG/M3]'
TRAC 65 75 AXES 1.0 'VELOC. [M/S]'
COLO NOIR ROUG
LIST 65 AXES 1.0 'VELOC. [M/S]'
FIN
```

1d3d64.dgibi

```
opti echo 1;
opti dime 3 elem cub8;
opti trac psc ftra '1d3d64_mesh.ps';
opti sauv form '1d3d64.msh';
*
lhp3d = 12.0;
lhp1d = 4.0;
llp1d = 6.0;
llp3d = 10.0;
nhp3d = 1200;
nhp1d = 400;
nlp1d = 600;
nlp3d = 1000;
h = lhp3d / nhp3d;
tol = h / 10;
*
p0 = 0 0 0;
p1 = 0 h 0;
p2 = 0 h h;
p3 = 0 0 h;
bashp3d = manu qua4 p0 p1 p2 p3;
hp3d = bashp3d volu tran nhp3d (lhp3d 0 0);
baslp3d = bashp3d plus ((lhp3d+lhp1d+llp1d) 0 0);
lp3d = baslp3d volu tran nlp3d (llp3d 0 0);
p1d1 = p0 plus (lhp3d 0 0);
p1d2 = p1d1 plus (lhp1d 0 0);
p1d3 = p1d2 plus (llp1d 0 0);
hp1d = p1d1 d nhp1d p1d2;
lp1d = p1d2 d nlp1d p1d3;
hp = hp3d et hp1d;
lp = lp3d et lp1d;
flui = hp et lp;
*
* raccords 3d-1d
*
facehp = bashp3d plus (lhp3d 0 0);
pfacehp = chan poi1 facehp;
elim tol (pfacehp et hp3d);
facelp = baslp3d;
pfacelp = chan poi1 facelp;
rachp = manu supe (p1d1 et facehp);
raclp = manu supe (p1d3 et facelp);
*
mesh = flui et facehp et facelp et rachp et raclp;
*
tass mesh noop;
sauv form mesh;
trac cach qual mesh;
*
fin;
```

1d3d64.epx

```
1D3D64
ECHO
!CONV win
CAST mesh
TRID EULE
DIME JONC 10 TERM ! Total n. of nodes in a TUBM juncton
GEOM CUVF hp3d lp3d TUVF hp1d lp1d CL3D facehp facelp
     TUBM rachp raclp TERM
COMP DIAM DROI 0.011283792 LECT hp1d lp1d TERM
     RACC TUBM LECT rachp  TERM
          NTUB LECT p1d1   TERM DTUB 0.011283792
          FACE LECT facehp TERM COEF 1.0
     RACC TUBM LECT raclp  TERM
          NTUB LECT p1d3   TERM DTUB 0.011283792
          FACE LECT facelp TERM COEF 1.0
! Attention: the TUBM elements (rachp and raclp) are NOT included
! in the "mesh" object (although they ARE indeed passed in from Cast3m).
```

```
! For this reason we must add them explicitly in the GROU directive below
! if we want to have them in the extracted element groups.
     GROU 2 'nrachp' LECT mesh rachp raclp TERM
                     COND XB GT 11.99 COND XB LT 12.01
            'nraclp' LECT mesh rachp raclp TERM
                     COND XB GT 21.99 COND XB LT 22.01
     COUL ROUG LECT hp TERM
  TURQ LECT lp TERM
          VERT LECT rachp raclp TERM
MATE GAZP RO 14.4 GAMM 1.4 CV 720 PINI 12.E5 PREF 1.E5
          LECT hp TERM
     GAZP RO 1.20 GAMM 1.4 CV 720 PINI 1.0E5 PREF 1.E5
          LECT lp TERM
! In order to obtain a printout at least of the 3D VFCCs I am obliged
! to use a different material for rachp and raclp, but with the
! same characteristics as the materials used for hp and lp, respectively
     GAZP RO 14.4 GAMM 1.4 CV 720 PINI 12.E5 PREF 1.E5
          LECT rachp TERM
     GAZP RO 1.20 GAMM 1.4 CV 720 PINI 1.0E5 PREF 1.E5
          LECT raclp TERM
ECRI ECRO VFCC TFRE 1.E-3
!    NOPO NOEL
     FICH ALIC TFRE 1.E-3
OPTI NOTE CSTA 0.75
     LOG 1
     VFCC FCON 6 ! hllc solver
          ORDR 2 ! order in space
          STPS 2 ! order in time
          RECO 2 ! Reconstruction based on internal specific energy
          LMAS 2 ! Barth-Jespersen limiter (not Dubois)
          LQDM 2
          LENE 2
          LVEL 2
          LPRE 2
          KBAR 1 ! Use version of B-J best suited for shock waves
CALC TINI 0 TEND 20.E-3
FIN
```

1d3d64p.epx

```
Post-treatment (space curves from alice file)
ECHO
OPTI PRIN
RESU ALIC '1d3d64.ali' GARD PSCR
COMP NGRO 1 'xaxo' LECT flui TERM
                   COND LINE X1 0 Y1 0 Z1 0 X2 32 Y2 0 Z2 0 TOL 0.0001
SORT GRAP
PERF '1d3d64.pun'
AXTE 1.0 'Time [s]'
SCOU 61 'p_21'  NSTO 21 SAXE 1.0 'curr_abscissa' LECT xaxo TERM
                        ECRO COMP 1
SCOU 62 'ro_21' NSTO 21 SAXE 1.0 'curr_abscissa' LECT xaxo TERM
                        ECRO COMP 2
SCOU 65 'vx_21' NSTO 21 SAXE 1.0 'curr_abscissa' LECT xaxo TERM
                        VCVI COMP 1
DCOU 71 'p_ana' SHTU GAMM 1.4 ROM 14.4 ROP 1.2 EINT 2.08333E5
                   LENM 16 LENP 16
                   TIME 20.E-3 NRAR 30 VARI 1
DCOU 72 'r_ana' SHTU GAMM 1.4 ROM 14.4 ROP 1.2 EINT 2.08333E5
                   LENM 16 LENP 16
                   TIME 20.E-3 NRAR 30 VARI 2
DCOU 75 'v_ana' SHTU GAMM 1.4 ROM 14.4 ROP 1.2 EINT 2.08333E5
                   LENM 16 LENP 16
                   TIME 20.E-3 NRAR 30 VARI 5
TRAC 61 71 AXES 1.0 'PRESS. [PA]'
COLO NOIR ROUG
LIST 61 AXES 1.0 'PRESS. [PA]'
TRAC 62 72 AXES 1.0 'DENS. [KG/M3]'
COLO NOIR ROUG
LIST 62 AXES 1.0 'DENS. [KG/M3]'
TRAC 65 75 AXES 1.0 'VELOC. [M/S]'
COLO NOIR ROUG
LIST 65 AXES 1.0 'VELOC. [M/S]'
FIN
```

D14_S2_10.epx

```
D14_S2_10
ECHO
!CONV win
CAST 'S2.msh' spec
EROS 1.0 CROI
TRID LAGR
DIME ADAP NPOI 100000
          Q4GS 100000
          CL3D 100000
          T3GS 20000
          CL3T 20000
          PMAT 50000
          NPIN 50000
     ENDA
TERM
GEOM CUB8 ecub8
     PR6  epri6
     Q4GS equa4
     T3GS etri3
     PMAT nplate
     CL3D presur ppqua4
     CL3T pptri3
TERM
COMP EPAI 0.8E-3 LECT plate nplate TERM
     GROU 5 'pp1'     LECT plate TERM
                      COND BOX X0 0.0 Y0 0.0  Z0 0.0
                               DX 0.1 DY 0.15 DZ 0.15
            'plaEdg'  LECT plate DIFF pp1 TERM
                      COND YB LT 0.16
                      COND ZB LT 0.16
            'nplatmp' LECT nplate  TERM
                      COND YB LT 0.16
                      COND ZB LT 0.16
            'nplalim' LECT nplate DIFF nplatmp TERM
            'prec'    LECT preplat TERM
                      COND NEAR POIN 0.0 0.0 0.0
     NGRO 4 'blox' LECT lframeb TERM COND X GT 0.0253
            'symy' LECT spec TERM COND Y LT 0.0001
            'symz' LECT spec TERM COND Z LT 0.0001
            'cen'  LECT plate TERM COND NEAR POIN 0.0 0.0 0.0
     COUL TURQ LECT lframeb TERM
          VERT LECT plate TERM
          ROSE LECT plaEdg TERM
          ROUG LECT nplalim TERM
          BLEU LECT uframe pp1 TERM
     ORIE INVE LECT preplat TERM
INCLUDE 'p77_10e.txt'
ADAP THRS ECRO 11 TMIN 0.01 TMAX 0.02 MAXL 4 CRIT 1
          LECT plate TERM
MATE VPJC RO 7850.0 YOUN 2.1E11 NU 0.33 ELAS 3.257E8 MXIT 100
          QR1 2.348E8 CR1 56.2 QR2 4.457E8 CR2 4.7
          PDOT 5.E-4 C 1.E-2 TQ 0.9 CP 452.0
          TM 1800.0 M 1.0 DC 1.0 WC 555.0E6
          RESI 1
          LECT lframeb TERM
     VPJC RO 7850.0 YOUN 2.1E11 NU 0.33 ELAS 3.257E8 MXIT 100
          QR1 2.348E8 CR1 56.2 QR2 4.457E8 CR2 4.7
          PDOT 5.E-4 C 1.E-2 TQ 0.9 CP 452.0
          TM 1800.0 M 1.0 DC 1.0 WC 555.0E6
          RESI 1
          LECT uframe TERM
     VPJC RO 7850.0 YOUN 2.1E11 NU 0.33 ELAS 11.50E8 MXIT 50 ! Docol 1400M
          QR1 2.410E8 CR1 610.9 QR2 1.641E8 CR2 95.8
          PDOT 5.E-4 C 4.E-3 TQ 0.9 CP 452.0
          TM 1800.0 M 1.0 DC 1.0 WC 741.0E6
          RESI 1
          LECT plate TERM
     MASS 0.0 YOUN 2.1E11 NU 0.33
          LECT nplate TERM
     IMPE PIMP RO 7850.0 PRES 43.9e6 PREF 0.0
          LECT presur TERM
     IMPE PIMP RO 7850 PRES 1.0 PREF 0.0 FONC 1
          LECT preplat TERM
OPTI PINS ASN
LINK COUP SPLT NONE
     BLOQ 123 LECT blox TERM
     CONT SPLA NX 0 NY 1 NZ 0 LECT symy TERM
     CONT SPLA NX 0 NY 0 NZ 1 LECT symz TERM
LINK DECO
     PINB PENA SFAC 1.0
          BODY FROT MUST 0.5 MUDY 0.5 GAMM 0 DMIN 0.0004
               LECT lframeb TERM
          BODY FROT MUST 0.5 MUDY 0.5 GAMM 0 DMIN 0.0004
               LECT uframe TERM
          BODY FROT MUST 0.5 MUDY 0.5 GAMM 0 DIAM 0.0004 ADNP
               LECT nplate TERM
          EXCL PAIR 1 2
ECRI DEPL VITE ECRO FAIL TFRE 0.2E-3
          POIN LECT cen TERM
          NOELEM
     FICH ALIT TFRE 0.1E-4
          POIN LECT cen symy TERM
          ELEM LECT prec TERM
     FICH PVTK TFRE  0.1e-3
          GROU AUTO
          VARI ECRO CONT FAIL DEPL VITE FLIA
     FICH SPLI ALIC TFRE 2.0E-4
OPTI NOTE CSTA 0.7
     LOG 1
     JAUM
     LMST
     ADAP RCON WHAN
     PINS GRID DPIN 1.01
     QUASI STATIQUE 1000. 0.7 FROM 0.0 UPTO 0.5e-3
CALC TINI 0 TEND 5.0E-3 TFAI 2.0E-8
FIN
```

D14_S2_10_FP.epx

```
D14_S2_10_FP
ECHO
!CONV win
CAST 'S2_FSI.msh' mesh
TRID ALE
EROS 1.0 CROI
DIME ADAP NPOI 200000
          CUVF 200000
          Q4GS 60000
          T3GS 10000
          NVFI 600000
          PMAT 50000
          NPIN 50000
```

```
    ENDA
    JONC 475 ! Total n. of nodes in a TUBM juncton
    NALE 1 NBLE 1
    TERM
GEOM CUB8 ecub8
    PR6  epri6
    Q4GS equa4 ! mems pinbcm
    T3GS etri3
    CUVF flui3d tubelp3 tank
    TUVF tubelp1
    PMAT nplate
    CL3D face3d presur abso stub3d ! pre
    TUBM rac3d1d raclp
TERM
COMP EPAI 0.8e-3 LECT plate nplate TERM
    DIAM DROI 0.1692568 LECT tubelp1 TERM
    RACC TUBM LECT rac3d1d  TERM
         NTUB LECT p1a   TERM DTUB 0.1692568
         FACE LECT face3d TERM COEF 1.0
    RACC TUBM LECT raclp  TERM
         NTUB LECT p1d3   TERM DTUB 0.1692568
         FACE LECT stub3d TERM COEF 1.0
! Attention: the TUBM element (raclp) is NOT included
! in the "mesh" object (although it IS indeed passed in from Cast3m).
! For this reason we must add it explicitly in the GROU directive below
! if we want to have it in the extracted element groups.
    GROU 21 'endtube' LECT tube TERM COND XB GT -0.6
          'trigger' LECT tube TERM COND NEAR POIN -0.1501 0 0
          'frefine' LECT flui TERM COND XB GT -0.3
                                   COND XB LT  1.0
          'pp1'    LECT plate TERM
                   COND BOX X0 0.0 Y0 0.0  Z0 0.0
                            DX 0.1 DY 0.15 DZ 0.15
          'pp2'    LECT plate TERM
                   COND BOX X0 0.0 Y0 0.0  Z0 0.0
                            DX 0.1 DY 0.165 DZ 0.165
          'fcoup'  LECT flui  TERM COND XB GT -0.05
                                   COND XB LT 0.150
                                   COND YB LT 0.150
                                   COND ZB LT 0.150
          'scoup'  LECT plate TERM COND YB LT 0.150
                                   COND ZB LT 0.150
          'lfrb2' LECT lframeb TERM
                   COND XB LT -0.865E-2
          'lfrb1' LECT lframeb DIFF lfrb2 TERM
          'uframe2'    LECT uframe DIFF presur TERM
          'S1' LECT tube TERM COND NEAR POIN -0.345 0.0 0.15
          'S2' LECT tube TERM COND NEAR POIN -0.245 0.0 0.15
          'S16' LECT flui3d TERM COND NEAR POIN -15.225 0 0.15
          'S15' LECT flui3d TERM COND NEAR POIN -15.125 0 0.15
          'S12' LECT tube TERM COND NEAR POIN -12.495 0 0.15
          'S11' LECT tube TERM COND NEAR POIN -12.395 0 0.15
          'S6' LECT tube TERM COND NEAR POIN -5.685 0 0.15
          'S5' LECT tube TERM COND NEAR POIN -5.585 0 0.15
          'epar1' LECT tubelp1 TERM COND NEAR NODE LECT p1a TERM
          'epar2' LECT tubelp1 TERM COND NEAR NODE LECT p1d3 TERM
          'tubelpp' LECT tubelp1 DIFF epar1 epar2 TERM
    NGRO 13 'blox'  LECT lframeb TERM COND !X LT -0.0253
                                            X GT 0.0253
          'symy'  LECT plate TERM    COND Y LT 0.0001
          'symz'  LECT plate TERM    COND Z LT 0.0001
          'pt0' LECT tube TERM COND NEAR POIN -16.19999 0.0 0.0
          'cen' LECT plate TERM COND NEAR POIN 0.0 0.0 0.0
          'axis1'   LECT plate TERM COND Y LT 0.0001
          'axis2'   LECT plate TERM COND Z LT 0.0001
          'csymy' LECT uframe lframeb TERM COND Y LT 0.0001
          'csymz' LECT uframe lframeb TERM COND Z LT 0.0001
          'elfb'  LECT lframeb TERM COND ENVE
          'nlfb'  LECT elfb    TERM COND X GT -0.01
                                    COND X LT  0.001
          'nbad1' LECT nlfb TERM
                  COND CONE X1 -0.009 Y1 0.260 Z1 0
                            X2  0.001 Y2 0.260 Z2 0
                            R1  0.009 R2 0.009
          'nbad2' LECT nlfb TERM
                  COND CONE X1 -0.009 Y1 0 Z1 0.260
                            X2  0.001 Y2 0 Z2 0.260
                            R1  0.009 R2 0.009
    COUL TURQ LECT tube tra lp3xl TERM
         VERT LECT plate fir2 TERM
         ROSE LECT fir1 TERM
         ROUG LECT driver TERM
        ROSE LECT S1 S2 S5 S6 S11 S12 S15 S16 TERM
ADAP THRS ECRO 11 TMIN 0.01 TMAX 0.02 MAXL 4 CRIT 1 ! NOUN
         LECT plate TERM
!         LECT pp2 TERM
GRIL LAGR LECT spec TERM
MATE
   !LOI 1
    GAZP RO 20.310 GAMM 1.4 CV 719.286 PINI 17.16E5 PREF 100.8E3
         LECT none TERM
   !LOI 2
    GAZP RO 1.193 GAMM 1.4 CV 719.286 PINI 100.8E3 PREF 100.8E3
         LECT none TERM
   !LOI 3
   GAZP RO 6.720 GAMM 1.4 CV 719.286 PINI 5.677E5 PREF 100.8E3
         LECT none TERM
   !LOI 4
    GAZP RO 1.193 GAMM 1.4 CV 719.286 PINI 100.8E3 PREF 100.8E3
         LECT flui3d TERM ! _cuvf TERM
    GAZP RO 1.193 GAMM 1.4 CV 719.286 PINI 100.8E3 PREF 100.8E3
         LECT epar1 epar2 TERM
    GAZP RO 1.193 GAMM 1.4 CV 719.286 PINI 100.8E3 PREF 100.8E3
         LECT rac3d1d raclp tubelpp TERM
    PARO PSIL 0.02
         LECT tubelpp TERM
    MULT 6 7 LECT tubelpp TERM
! In order to obtain a printout at least of the 3D VFCCs I am obliged
! to use a different material for tubelp3 and other 3D parts, but with
! the same characteristics as the material used for tubelp1
   GAZP RO 1.193 GAMM 1.4 CV 719.286 PINI 100.8E3 PREF 100.8E3
         LECT tubelp3 tank _cuvf TERM
    CLVF ABSO RO 1.187
         LECT abso TERM
    VPJC RO 7850.0 YOUN 2.1E11 NU 0.33 ELAS 3.257E8 MXIT 100
         QR1 2.348E8 CR1 56.2 QR2 4.457E8 CR2 4.7
         PDOT 5.E-4 C 1.E-2 TQ 0.9 CP 452.0
         TM 1800.0 M 1.0 DC 1.0 WC 555.0E6
         RESI 1
         LECT lframeb TERM
    VPJC RO 7850.0 YOUN 2.1E11 NU 0.33 ELAS 3.257E8 MXIT 100
         QR1 2.348E8 CR1 56.2 QR2 4.457E8 CR2 4.7
         PDOT 5.E-4 C 1.E-2 TQ 0.9 CP 452.0
         TM 1800.0 M 1.0 DC 1.0 WC 555.0E6
         RESI 1
         LECT uframe TERM
    VPJC RO 7850.0 YOUN 2.1E11 NU 0.33 ELAS 11.50E8 MXIT 50 ! Docol 1400M
         QR1 2.410E8 CR1 610.9 QR2 1.641E8 CR2 95.8
         PDOT 5.E-4 C 4.E-3 TQ 0.9 CP 452.0
         TM 1800.0 M 1.0 DC 1.0 WC 741.0E6
         RESI 1
         LECT plate TERM
    MASS 0.0 YOUN 2.1E11 NU 0.33
         LECT nplate TERM
    IMPE PIMP RO 7850.0 PRES 44.0011e6 PREF 1.011E5 !fc To be checked
         LECT presur TERM ! _cl3d TERM
OPTI PINS ASN
LINK COUP SPLT NONE
    BLOQ 123 LECT blox TERM
!    GLIS 2
!              FROT MUST 0.5 MUDY 0.5 GAMM 0
!              PGAP 0.4E-3
!            ! MAIT LECT lframeb TERM
!              MAIT NODE LECT nlfb DIFF nbad1 nbad2 TERM
!              PESC LECT plate TERM
*
!              FROT MUST 0.5 MUDY 0.5 GAMM 0
!              PGAP 0.4E-3
!              MAIT LECT uframe TERM
!              PESC LECT plate TERM
LINK DECO BLOQ 246 LECT symy TERM
         BLOQ 345 LECT symz TERM
         BLOQ 2 LECT csymy TERM
         BLOQ 3 LECT csymz TERM
    PINB PENA SFAC 1.0
         BODY FROT MUST 0.5 MUDY 0.5 GAMM 0 DMIN 0.0004
              LECT lframeb TERM
         BODY FROT MUST 0.5 MUDY 0.5 GAMM 0 DMIN 0.0004
              LECT uframe TERM
         BODY FROT MUST 0.5 MUDY 0.5 GAMM 0 DIAM 0.0004 ADNP
              LECT nplate TERM
         EXCL PAIR 1 2
    FLSW STRU LECT scoup TERM
         FLUI LECT fcoup TERM
         R 0.0087    ! 0.014
         HGRI 0.00606 ! 0.016
         DGRI
         FACE
         BFLU 2 ! block if at least one node is in influence domain
         FSCP 1 ! couple in all directions
         ADAP LMAX 2 SCAL 6
    TBLO 123    TRIG LECT lframeb uframe TERM
         123456 TRIG LECT plate TERM
INIT MAPP FORM 'D7710600mape_01.map' MATC OBJE LECT flui3d tubelp1 TERM
ECRI DEPL VITE ECRO FAIL TFRE 0.25E-3
         POIN LECT cen axis1 axis2 TERM
         ELEM LECT S1 TERM
     FICH ALIT FREQ 0 TFRE 0.D0
         TIME PROG 0.D0 PAS 0.5D-3 22.D-3 PAS 0.01D-3 80.D-3
         POIN LECT cen axis1 axis2 TERM
         ELEM LECT S1 S2 S5 S6 S11 S12 S15 S16 TERM
!    FICH PVTK FREQ 0 TFRE 0.D0
!        TIME PROG 0.D0 PAS 0.5D-3 28.D-3 PAS 0.1D-3 40.D-3
!        PAS 1.D-3 50.D-3
!        GROU AUTO
!        VARI DEPL VITE FAIL ACCE VCVI CONT ECRO FLIA
    FICH SPLI ALIC TFRE 0.5E-3
OPTI NOTE CSTA 0.4
    GLIS NORM ELEM
    STEP IO
    LOG 1
    JAUM
    LMST
    PINS GRID DPIN 1.01
    VFCC FCON 6 ! hllc solver
         ORDR 2 ! order in space
         STPS 2 ! order in time
         RECO 1
         NTIL
    ADAP RCON WHAN
    ADAP RCON TRIG ECRO 1 TVAL 1.05E5 LECT trigger TERM
    NOCR TRIG LECT plate lframeb uframe TERM
    FLS  CUB8 2 ! For the inverse mapping
CALC TINI 0 TEND 40.0E-3 TFAI 1.143E-8 ! 2.0E-8
FIN
```

D14_S2_10_FPw.epx

```
D14_S2_10_FPW
ECHO
!CONV WIN
RESU SPLI ALIC 'D14_S2_10_FP.ali' GARD PSCR
COMP COUL VERT LECT plate TERM
          GR50 LECT lframeb uframe TERM
          TURQ LECT tubelp3 tank TERM
SORT VISU NSTO 1
*=======================================================================
PLAY
*-----------------------------------------------------------------------
CAME   1 EYE  -4.60000E-03 -7.47801E-10 -1.66049E+00
!        Q    -2.05103E-10 -1.00000E+00 -6.46235E-26  2.77556E-16
         VIEW  5.55112E-16  4.10207E-10  1.00000E+00
         RIGH  1.00000E+00  1.53918E-26 -5.55112E-16
         UP    2.43102E-25 -1.00000E+00  4.10207E-10
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER : -4.60000E-03  0.00000E+00  1.62500E-01
!RSPHERE:  3.64597E-01
!RADIUS :  1.82299E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.31529E+00
!FAR    :  2.04449E+00
SCEN GEOM NAVI FREE
          LINE SFRE SSHA
     ISO  FILL FIEL ECRO 1 SCAL USER PROG 1.001E5 PAS 0.5E5 7.501E5 TERM
          SUPP LECT tubelp3 tank TERM
     LIMA ON
SLER CAM1 1 NFRA 1
FREQ 1
TRAC OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate lframeb uframe tubelp3 tank TERM ! SYXY
                                   SYXZ
                                   TOLS 1.E-3 NFAI REND
GOTR LOOP 16 OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate lframeb uframe tubelp3 tank TERM ! SYXY
                                   SYXZ
                                   TOLS 1.E-3 NFAI REND
ENDPLAY
*=======================================================================
SUIT
Post-treatment (make avi file from bitmaps)
ECHO
RESU SPLI ALIC 'D14_S2_10_FP.ali' GARD PSCR
*=================================================================
SORT VISU NSTO 1
*=================================================================
PLAY
MAVI FPS 5 KFRE 5 COMP -1 REND
ENDPLAY
*=================================================================
FIN
```

D14_S2_10_FPx.epx

```
D14_S2_10_FPX
ECHO
!CONV WIN
RESU SPLI ALIC 'D14_S2_10_FP.ali' GARD PSCR
COMP COUL VERT LECT plate TERM
          GR50 LECT lframeb uframe TERM
          TURQ LECT tubelp3 tank TERM
SORT VISU NSTO 1
*=======================================================================
PLAY
*-----------------------------------------------------------------------
CAME   1 EYE  -4.60000E-03 -7.47801E-10 -1.66049E+00
!        Q    -2.05103E-10 -1.00000E+00 -6.46235E-26  2.77556E-16
         VIEW  5.55112E-16  4.10207E-10  1.00000E+00
         RIGH  1.00000E+00  1.53918E-26 -5.55112E-16
         UP    2.43102E-25 -1.00000E+00  4.10207E-10
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER : -4.60000E-03  0.00000E+00  1.62500E-01
!RSPHERE:  3.64597E-01
!RADIUS :  1.82299E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.31529E+00
!FAR    :  2.04449E+00
SCEN GEOM NAVI FREE
          LINE SFRE SSHA
     LIMA ON
SLER CAM1 1 NFRA 1
FREQ 1
TRAC OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate lframeb uframe tubelp3 tank TERM ! SYXY
                                   SYXZ
                                   TOLS 1.E-3 NFAI REND
GOTR LOOP 16 OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate lframeb uframe tubelp3 tank TERM ! SYXY
                                   SYXZ
                                   TOLS 1.E-3 NFAI REND
ENDPLAY
*=======================================================================
SUIT
Post-treatment (make avi file from bitmaps)
ECHO
RESU SPLI ALIC 'D14_S2_10_FP.ali' GARD PSCR
*=================================================================
SORT VISU NSTO 1
*=================================================================
PLAY
MAVI FPS 5 KFRE 5 COMP -1 REND
ENDPLAY
*=================================================================
FIN
```

D14_S2_10_FPy.epx

```
D14_S2_10_FPY
ECHO
!CONV WIN
RESU SPLI ALIC 'D14_S2_10_FP.ali' GARD PSCR
COMP COUL GR80 LECT plate TERM
          GR50 LECT lframeb uframe TERM
SORT VISU NSTO 1
*=======================================================================
PLAY
CAME   1 EYE  -1.97046E+00  0.00000E+00 -4.08169E-10
!        Q     7.07107E-01  0.00000E+00 -7.07107E-01  0.00000E+00
         VIEW  1.00000E+00  0.00000E+00  2.05103E-10
         RIGH -2.05103E-10  0.00000E+00  1.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  1.96000E-02  0.00000E+00  0.00000E+00
!RSPHERE:  4.42236E-01
!RADIUS :  1.99006E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.54783E+00
!FAR    :  2.87454E+00
*-----------------------------------------------------------------------
SCEN GEOM NAVI FREE
          LINE SFRE SSHA
     LIMA ON
SLER CAM1 1 NFRA 1
TRAC OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate lframeb TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
FREQ 1
GOTR LOOP 16 OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate lframeb TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
ENDPLAY
*=======================================================================
SUIT
Post-treatment (make avi file from bitmaps)
ECHO
RESU SPLI ALIC 'D14_S2_10_FP.ali' GARD PSCR
*=================================================================
SORT VISU NSTO 1
*=================================================================
PLAY
MAVI FPS 5 KFRE 5 COMP -1 REND
ENDPLAY
*=================================================================
FIN
```

D14_S2_10_FPyy.epx

```
D14_S2_10_FPYY
ECHO
!CONV WIN
RESU SPLI ALIC 'D14_S2_10_FP.ali' GARD PSCR
COMP COUL GR80 LECT plate TERM
          GR50 LECT lframeb uframe TERM
SORT VISU NSTO 1
*=======================================================================
PLAY
CAME   1 EYE  -1.97046E+00  0.00000E+00 -4.08169E-10
!        Q     7.07107E-01  0.00000E+00 -7.07107E-01  0.00000E+00
         VIEW  1.00000E+00  0.00000E+00  2.05103E-10
         RIGH -2.05103E-10  0.00000E+00  1.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  1.96000E-02  0.00000E+00  0.00000E+00
!RSPHERE:  4.42236E-01
!RADIUS :  1.99006E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.54783E+00
!FAR    :  2.87454E+00
*-----------------------------------------------------------------------
SCEN GEOM NAVI FREE
          LINE HEOU SFRE SSHA
     LIMA ON
SLER CAM1 1 NFRA 1
TRAC OFFS SIZE 1200 1200 FICH BMP DEFO AMPD 0.0
     OBJE LECT plate TERM SYXY SYXZ TOLS 1.E-3 NFAI ADAP REND
FREQ 1
GOTR LOOP 16 OFFS SIZE 1200 1200 FICH BMP DEFO AMPD 0.0
     OBJE LECT plate TERM SYXY SYXZ TOLS 1.E-3 NFAI ADAP REND
ENDPLAY
*=======================================================================
SUIT
Post-treatment (make avi file from bitmaps)
ECHO
RESU SPLI ALIC 'D14_S2_10_FP.ali' GARD PSCR
*=================================================================
SORT VISU NSTO 1
*=================================================================
```

```
PLAY
MAVI FPS 5 KFRE 5 COMP -1 REND
ENDPLAY
*================================================================
FIN
```

D14_S2_10_FPz1.epx

```
D14_S2_10_FPZ1
ECHO
 CONV WIN
RESU SPLI ALIC 'D14_S2_10_FP.ali' GARD PSCR
COMP COUL GR80 LECT plate TERM
SORT VISU NSTO 1
*======================================================================
PLAY
CAME   1 EYE   6.49959E-01  0.00000E+00  1.78574E+00
!         Q    -9.84808E-01  0.00000E+00 -1.73648E-01  0.00000E+00
         VIEW -3.42021E-01  0.00000E+00 -9.39692E-01
         RIGH  9.39692E-01  0.00000E+00 -3.42021E-01
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  9.56724E-18  0.00000E+00  0.00000E+00
!RSPHERE:  4.41942E-01
!RADIUS :  1.90035E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.45841E+00
!FAR    :  2.78423E+00
CAME   2 EYE  -6.49959E-01  0.00000E+00  1.78574E+00
!         Q    -9.84808E-01  0.00000E+00  1.73648E-01  0.00000E+00
         VIEW  3.42021E-01  0.00000E+00 -9.39692E-01
         RIGH  9.39692E-01  0.00000E+00  3.42021E-01
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  9.56724E-18  0.00000E+00  0.00000E+00
!RSPHERE:  4.41942E-01
!RADIUS :  1.90035E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.45841E+00
!FAR    :  2.78423E+00
*----------------------------------------------------------------------
SCEN GEOM NAVI FREE
          FACE SBAC
          LINE HEOU SFRE SSHA
     LIMA ON
SLER CAM1 1 NFRA 1
TRAC OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate TERM SYXY SYXZ TOLS 1.E-3 NFAI ADAP REND
FREQ 1
GOTR LOOP 16 OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate TERM SYXY SYXZ TOLS 1.E-3 NFAI ADAP REND
ENDPLAY
*======================================================================
SUIT
Post-treatment (make avi file from bitmaps)
ECHO
RESU SPLI ALIC 'D14_S2_10_FP.ali' GARD PSCR
*================================================================
SORT VISU NSTO 1
*================================================================
PLAY
MAVI FPS 5 KFRE 5 COMP -1 REND
ENDPLAY
*================================================================
FIN
```

D14_S2_10_FPz2.epx

```
D14_S2_10_FPZ2
ECHO
 CONV WIN
RESU SPLI ALIC 'D14_S2_10_FP.ali' GARD PSCR
COMP COUL GR80 LECT plate TERM
SORT VISU NSTO 1
*======================================================================
PLAY
CAME   1 EYE   6.49959E-01  0.00000E+00  1.78574E+00
!         Q    -9.84808E-01  0.00000E+00 -1.73648E-01  0.00000E+00
         VIEW -3.42021E-01  0.00000E+00 -9.39692E-01
         RIGH  9.39692E-01  0.00000E+00 -3.42021E-01
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  9.56724E-18  0.00000E+00  0.00000E+00
!RSPHERE:  4.41942E-01
!RADIUS :  1.90035E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.45841E+00
!FAR    :  2.78423E+00
CAME   2 EYE  -6.49959E-01  0.00000E+00  1.78574E+00
!         Q    -9.84808E-01  0.00000E+00  1.73648E-01  0.00000E+00
         VIEW  3.42021E-01  0.00000E+00 -9.39692E-01
         RIGH  9.39692E-01  0.00000E+00  3.42021E-01
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  9.56724E-18  0.00000E+00  0.00000E+00
!RSPHERE:  4.41942E-01
!RADIUS :  1.90035E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.45841E+00
!FAR    :  2.78423E+00
*----------------------------------------------------------------------
SCEN GEOM NAVI FREE
          FACE SBAC
          LINE HEOU SFRE SSHA
     LIMA ON
SLER CAM1 2 NFRA 1
TRAC OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate TERM SYXY SYXZ TOLS 1.E-3 NFAI ADAP REND
FREQ 1
GOTR LOOP 16 OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate TERM SYXY SYXZ TOLS 1.E-3 NFAI ADAP REND
ENDPLAY
*======================================================================
SUIT
Post-treatment (make avi file from bitmaps)
ECHO
RESU SPLI ALIC 'D14_S2_10_FP.ali' GARD PSCR
*================================================================
SORT VISU NSTO 1
*================================================================
PLAY
MAVI FPS 5 KFRE 5 COMP -1 REND
ENDPLAY
*================================================================
FIN
```

D14_S2_10_z1.epx

```
D14_S2_10_Z1
ECHO
 CONV WIN
RESU SPLI ALIC 'D14_S2_10.ali' GARD PSCR
COMP COUL GR80 LECT plate TERM
SORT VISU NSTO 1
*======================================================================
PLAY
CAME   1 EYE   6.49959E-01  0.00000E+00  1.78574E+00
!         Q    -9.84808E-01  0.00000E+00 -1.73648E-01  0.00000E+00
         VIEW -3.42021E-01  0.00000E+00 -9.39692E-01
         RIGH  9.39692E-01  0.00000E+00 -3.42021E-01
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  9.56724E-18  0.00000E+00  0.00000E+00
!RSPHERE:  4.41942E-01
!RADIUS :  1.90035E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.45841E+00
!FAR    :  2.78423E+00
CAME   2 EYE  -6.49959E-01  0.00000E+00  1.78574E+00
!         Q    -9.84808E-01  0.00000E+00  1.73648E-01  0.00000E+00
         VIEW  3.42021E-01  0.00000E+00 -9.39692E-01
         RIGH  9.39692E-01  0.00000E+00  3.42021E-01
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  9.56724E-18  0.00000E+00  0.00000E+00
!RSPHERE:  4.41942E-01
!RADIUS :  1.90035E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.45841E+00
!FAR    :  2.78423E+00
*----------------------------------------------------------------------
SCEN GEOM NAVI FREE
          FACE SBAC
          LINE HEOU SFRE SSHA
     LIMA ON
SLER CAM1 1 NFRA 1
TRAC OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate TERM SYXY SYXZ TOLS 1.E-3 NFAI ADAP REND
FREQ 1
GOTR LOOP 25 OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate TERM SYXY SYXZ TOLS 1.E-3 NFAI ADAP REND
ENDPLAY
*======================================================================
SUIT
Post-treatment (make avi file from bitmaps)
ECHO
RESU SPLI ALIC 'D14_S2_10.ali' GARD PSCR
*================================================================
SORT VISU NSTO 1
*================================================================
PLAY
MAVI FPS 5 KFRE 5 COMP -1 REND
ENDPLAY
*================================================================
FIN
```

D14_S2_10_z2.epx

```
D14_S2_10_Z2
ECHO
 CONV WIN
RESU SPLI ALIC 'D14_S2_10.ali' GARD PSCR
COMP COUL GR80 LECT plate TERM
SORT VISU NSTO 1
*======================================================================
```

```
PLAY
CAME   1 EYE   6.49959E-01  0.00000E+00  1.78574E+00
!        Q    -9.84808E-01  0.00000E+00 -1.73648E-01  0.00000E+00
         VIEW -3.42021E-01  0.00000E+00 -9.39692E-01
         RIGH  9.39692E-01  0.00000E+00 -3.42021E-01
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  9.56724E-18  0.00000E+00  0.00000E+00
!RSPHERE:  4.41942E-01
!RADIUS :  1.90035E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.45841E+00
!FAR    :  2.78423E+00
CAME   2 EYE  -6.49959E-01  0.00000E+00  1.78574E+00
!        Q    -9.84808E-01  0.00000E+00  1.73648E-01  0.00000E+00
         VIEW  3.42021E-01  0.00000E+00 -9.39692E-01
         RIGH  9.39692E-01  0.00000E+00  3.42021E-01
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  9.56724E-18  0.00000E+00  0.00000E+00
!RSPHERE:  4.41942E-01
!RADIUS :  1.90035E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.45841E+00
!FAR    :  2.78423E+00
*-------------------------------------------------------------------------
SCEN GEOM NAVI FREE
          FACE SBAC
          LINE HEOU SFRE SSHA
     LIMA ON
SLER CAM1 2 NFRA 1
TRAC OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate TERM SYXY SYXZ TOLS 1.E-3 NFAI ADAP REND
FREQ 1
GOTR LOOP 25 OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate TERM SYXY SYXZ TOLS 1.E-3 NFAI ADAP REND
ENDPLAY
*=========================================================================
SUIT
Post-treatment (make avi file from bitmaps)
ECHO
RESU SPLI ALIC 'D14_S2_10.ali' GARD PSCR
*=================================================================
SORT VISU NSTO 1
*=================================================================
PLAY
MAVI FPS 5 KFRE 5 COMP -1 REND
ENDPLAY
*=================================================================
FIN
```

D14_S2_10f.epx

```
D14_S2_10F
ECHO
!CONV WIN
RESU SPLI ALIC 'D14_S2_10.ali' GARD PSCR
COMP COUL GR80 LECT plate TERM
SORT VISU NSTO 1
PLAY
CAME   1 EYE  -1.85740E+00  2.10571E-03  2.10571E-03
!        Q     7.07107E-01  0.00000E+00 -7.07107E-01  0.00000E+00
         VIEW  1.00000E+00  0.00000E+00  2.05103E-10
         RIGH -2.05103E-10  0.00000E+00  1.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER : -2.25515E-03  2.10571E-03  2.10571E-03
!RSPHERE:  4.63787E-01
!RADIUS :  1.85515E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.39136E+00
!FAR    :  2.78272E+00
SCEN GEOM NAVI FREE
          LINE HEOU SFRE
SLER CAM1 1 NFRA 1
FREQ 1
TRAC DEFO AMPD 0.0 OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate TERM
     SYXY SYXZ ! TOLS 1.E-2
     NFAI ADAP REND
GOTR LOOP 25 DEFO AMPD 0.0 OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate TERM
     SYXY SYXZ ! TOLS 1.E-2
     NFAI ADAP REND
ENDPLAY
*=========================================================================
SUIT
Post-treatment (make avi file from bitmaps)
ECHO
RESU SPLI ALIC 'D14_S2_10.ali' GARD PSCR
*=================================================================
SORT VISU NSTO 1
*=================================================================
PLAY
MAVI FPS 5 KFRE 5 COMP -1 REND
ENDPLAY
*=================================================================
FIN
```

D14_S2_15.epx

```
D14_S2_15
ECHO
!CONV win
CAST 'S2.msh' spec
EROS 1.0 CROI
TRID LAGR
DIME ADAP NPOI 100000
          Q4GS 100000
          CL3D 100000
          T3GS 20000
          CL3T 20000
          PMAT 50000
          NPIN 50000
     ENDA
TERM
GEOM CUB8 ecub8
     PR6  epri6
     Q4GS equa4
     T3GS etri3
     PMAT nplate
     CL3D presur ppqua4
     CL3T pptri3
TERM
COMP EPAI 0.8E-3 LECT plate nplate TERM
     GROU 5 'pp1'     LECT plate TERM
                      COND BOX X0 0.0 Y0 0.0  Z0 0.0
                               DX 0.1 DY 0.15 DZ 0.15
            'plaEdg'  LECT plate DIFF pp1 TERM
                      COND YB LT 0.16
                      COND ZB LT 0.16
            'nplatmp' LECT nplate  TERM
                      COND YB LT 0.16
                      COND ZB LT 0.16
            'nplalim' LECT nplate DIFF nplatmp TERM
            'prec'    LECT preplat TERM
                      COND NEAR POIN 0.0 0.0 0.0
     NGRO 4 'blox' LECT lframeb TERM COND X GT 0.0253
            'symy' LECT spec TERM COND Y LT 0.0001
            'symz' LECT spec TERM COND Z LT 0.0001
            'cen'  LECT plate TERM COND NEAR POIN 0.0 0.0 0.0
     COUL TURQ LECT lframeb TERM
          VERT LECT plate TERM
          ROSE LECT plaEdg TERM
          ROUG LECT nplalim TERM
          BLEU LECT uframe pp1 TERM
     ORIE INVE LECT preplat TERM
INCLUDE 'p77_15e.txt'
ADAP THRS ECRO 11 TMIN 0.01 TMAX 0.02 MAXL 4 CRIT 1
          LECT plate TERM
MATE VPJC RO 7850.0 YOUN 2.1E11 NU 0.33 ELAS 3.257E8 MXIT 100
          QR1 2.348E8 CR1 56.2 QR2 4.457E8 CR2 4.7
          PDOT 5.E-4 C 1.E-2 TQ 0.9 CP 452.0
          TM 1800.0 M 1.0 DC 1.0 WC 555.0E6
          RESI 1
          LECT lframeb TERM
     VPJC RO 7850.0 YOUN 2.1E11 NU 0.33 ELAS 3.257E8 MXIT 100
          QR1 2.348E8 CR1 56.2 QR2 4.457E8 CR2 4.7
          PDOT 5.E-4 C 1.E-2 TQ 0.9 CP 452.0
          TM 1800.0 M 1.0 DC 1.0 WC 555.0E6
          RESI 1
          LECT uframe TERM
     VPJC RO 7850.0 YOUN 2.1E11 NU 0.33 ELAS 11.50E8 MXIT 50 ! Docol 1400M
          QR1 2.410E8 CR1 610.9 QR2 1.641E8 CR2 95.8
          PDOT 5.E-4 C 4.E-3 TQ 0.9 CP 452.0
          TM 1800.0 M 1.0 DC 1.0 WC 741.0E6
          RESI 1
          LECT plate TERM
     MASS 0.0 YOUN 2.1E11 NU 0.33
          LECT nplate TERM
     IMPE PIMP RO 7850.0 PRES 43.9e6 PREF 0.0
          LECT presur TERM
     IMPE PIMP RO 7850 PRES 1.0 PREF 0.0 FONC 1
          LECT preplat TERM
OPTI PINS ASN
LINK COUP SPLT NONE
     BLOQ 123 LECT blox TERM
     CONT SPLA NX 0 NY 1 NZ 0 LECT symy TERM
     CONT SPLA NX 0 NY 0 NZ 1 LECT symz TERM
LINK DECO
     PINB PENA SFAC 1.0
          BODY FROT MUST 0.5 MUDY 0.5 GAMM 0 DMIN 0.0004
               LECT lframeb TERM
          BODY FROT MUST 0.5 MUDY 0.5 GAMM 0 DMIN 0.0004
               LECT uframe TERM
          BODY FROT MUST 0.5 MUDY 0.5 GAMM 0 DIAM 0.0004 ADNP
               LECT nplate TERM
          EXCL PAIR 1 2
ECRI DEPL VITE ECRO FAIL TFRE 0.2E-3
          POIN LECT cen TERM
          NOELEM
     FICH ALIT TFRE 0.1E-4
          POIN LECT cen symy TERM
          ELEM LECT prec TERM
     FICH PVTK TFRE  0.1e-3
          GROU AUTO
          VARI ECRO CONT FAIL DEPL VITE FLIA
     FICH SPLI ALIC TFRE 2.0E-4
OPTI NOTE CSTA 0.7
     LOG 1
     JAUM
```

```
     LMST
     ADAP RCON WHAN
     PINS GRID DPIN 1.01
     QUASI STATIQUE 1000. 0.7 FROM 0.0 UPTO 0.5e-3
CALC TINI 0 TEND 5.0E-3 TFAI 2.0E-8
FIN
```

D14_S2_15_FP.epx

```
D14_S2_15_FP
ECHO
!CONV win
CAST 'S2_FSI.msh' mesh
TRID ALE
EROS 1.0 CROI
DIME ADAP NPOI 200000
          CUVF 200000
          Q4GS 60000
          T3GS 10000
          NVFI 600000
          PMAT 50000
          NPIN 50000
     ENDA
     JONC 475 ! Total n. of nodes in a TUBM juncton
     NALE 1 NBLE 1
     TERM
GEOM CUB8 ecub8
     PR6  epri6
     Q4GS equa4 ! mems pinbcm
     T3GS etri3
     CUVF flui3d tubelp3 tank
     TUVF tubelp1
     PMAT nplate
     CL3D face3d presur abso stub3d ! pre
     TUBM rac3d1d raclp
TERM
COMP EPAI 0.8e-3 LECT plate nplate TERM
     DIAM DROI 0.1692568 LECT tubelp1 TERM
     RACC TUBM LECT rac3d1d  TERM
          NTUB LECT p1a   TERM DTUB 0.1692568
          FACE LECT face3d TERM COEF 1.0
     RACC TUBM LECT raclp  TERM
          NTUB LECT p1d3   TERM DTUB 0.1692568
          FACE LECT stub3d TERM COEF 1.0
! Attention: the TUBM element (raclp) is NOT included
! in the "mesh" object (although it IS indeed passed in from Cast3m).
! For this reason we must add it explicitly in the GROU directive below
! if we want to have it in the extracted element groups.
     GROU 21 'endtube' LECT tube TERM COND XB GT -0.6
            'trigger' LECT tube TERM COND NEAR POIN -0.1501 0 0
            'frefine' LECT flui TERM COND XB GT -0.3
                                     COND XB LT  1.0
            'pp1'    LECT plate TERM
                     COND BOX X0 0.0 Y0 0.0  Z0 0.0
                              DX 0.1 DY 0.15 DZ 0.15
            'pp2'    LECT plate TERM
                     COND BOX X0 0.0 Y0 0.0  Z0 0.0
                              DX 0.1 DY 0.165 DZ 0.165
            'fcoup'  LECT flui  TERM COND XB GT -0.05
                                     COND XB LT 0.150
                                     COND YB LT 0.150
                                     COND ZB LT 0.150
            'scoup'  LECT plate TERM COND YB LT 0.150
                                     COND ZB LT 0.150
            'lfrb2' LECT lframeb TERM
                     COND XB LT -0.865E-2
            'lfrb1' LECT lframeb DIFF lfrb2 TERM
            'uframe2'    LECT uframe DIFF presur TERM
            'S1' LECT tube TERM COND NEAR POIN -0.345 0.0 0.15
            'S2' LECT tube TERM COND NEAR POIN -0.245 0.0 0.15
            'S16' LECT flui3d TERM COND NEAR POIN -15.225 0 0.15
            'S15' LECT flui3d TERM COND NEAR POIN -15.125 0 0.15
            'S12' LECT tube TERM COND NEAR POIN -12.495 0 0.15
            'S11' LECT tube TERM COND NEAR POIN -12.395 0 0.15
            'S6' LECT tube TERM COND NEAR POIN -5.685 0 0.15
            'S5' LECT tube TERM COND NEAR POIN -5.585 0 0.15
            'epar1' LECT tubelp1 TERM COND NEAR NODE LECT p1a TERM
            'epar2' LECT tubelp1 TERM COND NEAR NODE LECT p1d3 TERM
            'tubelpp' LECT tubelp1 DIFF epar1 epar2 TERM
     NGRO 13 'blox'  LECT lframeb TERM COND !X LT -0.0253
                                            X GT 0.0253
            'symy'  LECT plate TERM    COND Y LT 0.0001
            'symz'  LECT plate TERM    COND Z LT 0.0001
            'pt0' LECT tube TERM COND NEAR POIN -16.19999 0.0 0.0
            'cen' LECT plate TERM COND NEAR POIN 0.0 0.0 0.0
            'axis1'   LECT plate TERM COND Y LT 0.0001
            'axis2'   LECT plate TERM COND Z LT 0.0001
            'csymy' LECT uframe lframeb TERM COND Y LT 0.0001
            'csymz' LECT uframe lframeb TERM COND Z LT 0.0001
            'elfb'  LECT lframeb TERM COND ENVE
            'nlfb'  LECT elfb    TERM COND X GT -0.01
                                      COND X LT  0.001
            'nbad1' LECT nlfb TERM
                    COND CONE X1 -0.009 Y1 0.260 Z1 0
                              X2  0.001 Y2 0.260 Z2 0
                              R1  0.009 R2 0.009
            'nbad2' LECT nlfb TERM
                    COND CONE X1 -0.009 Y1 0 Z1 0.260
                              X2  0.001 Y2 0 Z2 0.260
                              R1  0.009 R2 0.009
     COUL TURQ LECT tube tra lp3x1 TERM
          VERT LECT plate fir2 TERM
          ROSE LECT fir1 TERM
          ROUG LECT driver TERM
         ROSE LECT S1 S2 S5 S6 S11 S12 S15 S16 TERM
ADAP THRS ECRO 11 TMIN 0.01 TMAX 0.02 MAXL 4 CRIT 1 ! NOUN
          LECT plate TERM
!          LECT pp2 TERM
GRIL LAGR LECT spec TERM
MATE
    !LOI 1
     GAZP RO 20.310 GAMM 1.4 CV 719.286 PINI 17.16E5 PREF 100.8E3
          LECT none TERM
    !LOI 2
     GAZP RO 1.193 GAMM 1.4 CV 719.286 PINI 100.8E3 PREF 100.8E3
          LECT none TERM
    !LOI 3
    GAZP RO 6.720 GAMM 1.4 CV 719.286 PINI 5.677E5 PREF 100.8E3
          LECT none TERM
    !LOI 4
     GAZP RO 1.193 GAMM 1.4 CV 719.286 PINI 100.8E3 PREF 100.8E3
          LECT flui3d TERM ! _cuvf TERM
     GAZP RO 1.193 GAMM 1.4 CV 719.286 PINI 100.8E3 PREF 100.8E3
          LECT epar1 epar2 TERM
     GAZP RO 1.193 GAMM 1.4 CV 719.286 PINI 100.8E3 PREF 100.8E3
          LECT rac3d1d raclp tubelpp TERM
     PARO PSIL 0.02
          LECT tubelpp TERM
     MULT 6 7 LECT tubelpp TERM
! In order to obtain a printout at least of the 3D VFCCs I am obliged
! to use a different material for tubelp3 and other 3D parts, but with
! the same characteristics as the material used for tubelp1
    GAZP RO 1.193 GAMM 1.4 CV 719.286 PINI 100.8E3 PREF 100.8E3
          LECT tubelp3 tank _cuvf TERM
     CLVF ABSO RO 1.187
          LECT abso TERM
     VPJC RO 7850.0 YOUN 2.1E11 NU 0.33 ELAS 3.257E8 MXIT 100
          QR1 2.348E8 CR1 56.2 QR2 4.457E8 CR2 4.7
          PDOT 5.E-4 C 1.E-2 TQ 0.9 CP 452.0
          TM 1800.0 M 1.0 DC 1.0 WC 555.0E6
          RESI 1
          LECT lframeb TERM
     VPJC RO 7850.0 YOUN 2.1E11 NU 0.33 ELAS 3.257E8 MXIT 100
          QR1 2.348E8 CR1 56.2 QR2 4.457E8 CR2 4.7
          PDOT 5.E-4 C 1.E-2 TQ 0.9 CP 452.0
          TM 1800.0 M 1.0 DC 1.0 WC 555.0E6
          RESI 1
          LECT uframe TERM
     VPJC RO 7850.0 YOUN 2.1E11 NU 0.33 ELAS 11.50E8 MXIT 50 ! Docol 1400M
          QR1 2.410E8 CR1 610.9 QR2 1.641E8 CR2 95.8
          PDOT 5.E-4 C 4.E-3 TQ 0.9 CP 452.0
          TM 1800.0 M 1.0 DC 1.0 WC 741.0E6
          RESI 1
          LECT plate TERM
     MASS 0.0 YOUN 2.1E11 NU 0.33
          LECT nplate TERM
     IMPE PIMP RO 7850.0 PRES 44.0011e6 PREF 1.011E5 !fc To be checked
          LECT presur TERM ! _cl3d TERM
OPTI PINS ASN
LINK COUP SPLT NONE
     BLOQ 123 LECT blox TERM
!    GLIS 2
!              FROT MUST 0.5 MUDY 0.5 GAMM 0
!              PGAP 0.4E-3
!            ! MAIT LECT lframeb TERM
!              MAIT NODE LECT nlfb DIFF nbad1 nbad2 TERM
!              PESC LECT plate TERM
*
!              FROT MUST 0.5 MUDY 0.5 GAMM 0
!              PGAP 0.4E-3
!              MAIT LECT uframe TERM
!              PESC LECT plate TERM
LINK DECO BLOQ 246 LECT symy TERM
          BLOQ 345 LECT symz TERM
          BLOQ 2 LECT csymy TERM
          BLOQ 3 LECT csymz TERM
     PINB PENA SFAC 1.0
          BODY FROT MUST 0.5 MUDY 0.5 GAMM 0 DMIN 0.0004
               LECT lframeb TERM
          BODY FROT MUST 0.5 MUDY 0.5 GAMM 0 DMIN 0.0004
               LECT uframe TERM
          BODY FROT MUST 0.5 MUDY 0.5 GAMM 0 DIAM 0.0004 ADNP
               LECT nplate TERM
          EXCL PAIR 1 2
     FLSW STRU LECT scoup TERM
          FLUI LECT fcoup TERM
          R 0.0087    ! 0.014
          HGRI 0.00606 ! 0.016
          DGRI
          FACE
          BFLU 2 ! block if at least one node is in influence domain
          FSCP 1 ! couple in all directions
          ADAP LMAX 2 SCAL 6
     TBLO 123    TRIG LECT lframeb uframe TERM
          123456 TRIG LECT plate TERM
INIT MAPP FORM 'D7715600map.map' MATC OBJE LECT flui3d tubelp1 TERM
ECRI DEPL VITE ECRO FAIL TFRE 0.25E-3
          POIN LECT cen axis1 axis2 TERM
          ELEM LECT S1 TERM
      FICH ALIT FREQ 0 TFRE 0.D0
          TIME PROG 0.D0 PAS 0.5D-3 22.D-3 PAS 0.01D-3 80.D-3
          POIN LECT cen axis1 axis2 TERM
          ELEM LECT S1 S2 S5 S6 S11 S12 S15 S16 TERM
```

```
!    FICH PVTK FREQ 0 TFRE 0.D0
!         TIME PROG 0.D0 PAS 0.5D-3 28.D-3 PAS 0.1D-3 40.D-3
!         PAS 1.D-3 50.D-3
!         GROU AUTO
!         VARI DEPL VITE FAIL ACCE VCVI CONT ECRO FLIA
     FICH SPLI ALIC TFRE 0.5E-3
OPTI NOTE CSTA 0.4
     GLIS NORM ELEM
     STEP IO
     LOG 1
     JAUM
     LMST
     PINS GRID DPIN 1.01
     VFCC FCON 6 ! hllc solver
          ORDR 2 ! order in space
          STPS 2 ! order in time
          RECO 1
          NTIL
     ADAP RCON WHAN
     ADAP RCON TRIG ECRO 1 TVAL 1.05E5 LECT trigger TERM
     NOCR TRIG LECT plate lframeb uframe TERM
     FLS  CUB8 2 ! For the inverse mapping
CALC TINI 0 TEND 36.0E-3 TFAI 1.143E-8 ! 2.0E-8
FIN
```

D14_S2_15_FPw.epx

```
D14_S2_15_FPW
ECHO
!CONV WIN
RESU SPLI ALIC 'D14_S2_15_FP.ali' GARD PSCR
COMP COUL VERT LECT plate TERM
          GR50 LECT lframeb uframe TERM
          TURQ LECT tubelp3 tank TERM
SORT VISU NSTO 1
*========================================================================
PLAY
*------------------------------------------------------------------------
CAME   1 EYE  -4.60000E-03 -7.47801E-10 -1.66049E+00
!        Q    -2.05103E-10 -1.00000E+00 -6.46235E-26  2.77556E-16
         VIEW  5.55112E-16  4.10207E-10  1.00000E+00
         RIGH  1.00000E+00  1.53918E-26 -5.55112E-16
         UP    2.43102E-25 -1.00000E+00  4.10207E-10
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER : -4.60000E-03  0.00000E+00  1.62500E-01
!RSPHERE:  3.64597E-01
!RADIUS :  1.82299E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.31529E+00
!FAR    :  2.04449E+00
SCEN GEOM NAVI FREE
          LINE SFRE SSHA
     ISO  FILL FIEL ECRO 1 SCAL USER PROG 1.001E5 PAS 0.5E5 7.501E5 TERM
          SUPP LECT tubelp3 tank TERM
     LIMA ON
SLER CAM1 1 NFRA 1
FREQ 1
TRAC OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate lframeb uframe tubelp3 tank TERM ! SYXY
                               SYXZ
                               TOLS 1.E-3 NFAI REND
GOTR LOOP 14 OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate lframeb uframe tubelp3 tank TERM ! SYXY
                               SYXZ
                               TOLS 1.E-3 NFAI REND
!TRAC OFFS SIZE 1200 1200 FICH BMP
!     OBJE LECT plate lframeb TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
!*------------------------------------------------------------------------
!SCEN GEOM NAVI FREE
!         LINE HEOU SFRE SSHA
!     LIMA ON
!SLER CAM1 1 NFRA 1
!TRAC OFFS SIZE 1200 1200 FICH BMP
!     OBJE LECT plate lframeb TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
ENDPLAY
*========================================================================
FIN
```

D14_S2_15_FPx.epx

```
D14_S2_15_FPX
ECHO
!CONV WIN
RESU SPLI ALIC 'D14_S2_15_FP.ali' GARD PSCR
COMP COUL VERT LECT plate TERM
          GR50 LECT lframeb uframe TERM
          TURQ LECT tubelp3 tank TERM
SORT VISU NSTO 1
*========================================================================
PLAY
*------------------------------------------------------------------------
CAME   1 EYE  -4.60000E-03 -7.47801E-10 -1.66049E+00
!        Q    -2.05103E-10 -1.00000E+00 -6.46235E-26  2.77556E-16
         VIEW  5.55112E-16  4.10207E-10  1.00000E+00
         RIGH  1.00000E+00  1.53918E-26 -5.55112E-16
         UP    2.43102E-25 -1.00000E+00  4.10207E-10
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER : -4.60000E-03  0.00000E+00  1.62500E-01
!RSPHERE:  3.64597E-01
!RADIUS :  1.82299E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.31529E+00
!FAR    :  2.04449E+00
SCEN GEOM NAVI FREE
          LINE SFRE SSHA
     LIMA ON
SLER CAM1 1 NFRA 1
FREQ 1
TRAC OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate lframeb uframe tubelp3 tank TERM ! SYXY
                               SYXZ
                               TOLS 1.E-3 NFAI REND
GOTR LOOP 14 OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate lframeb uframe tubelp3 tank TERM ! SYXY
                               SYXZ
                               TOLS 1.E-3 NFAI REND
!TRAC OFFS SIZE 1200 1200 FICH BMP
!     OBJE LECT plate lframeb TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
!*------------------------------------------------------------------------
!SCEN GEOM NAVI FREE
!         LINE HEOU SFRE SSHA
!     LIMA ON
!SLER CAM1 1 NFRA 1
!TRAC OFFS SIZE 1200 1200 FICH BMP
!     OBJE LECT plate lframeb TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
ENDPLAY
*========================================================================
FIN
```

D14_S2_15_FPy.epx

```
D14_S2_15_FPY
ECHO
!CONV WIN
RESU SPLI ALIC 'D14_S2_15_FP.ali' GARD PSCR
COMP COUL GR80 LECT plate TERM
          GR50 LECT lframeb uframe TERM
SORT VISU NSTO 1
*========================================================================
PLAY
CAME   1 EYE  -1.97046E+00  0.00000E+00 -4.08169E-10
!        Q     7.07107E-01  0.00000E+00 -7.07107E-01  0.00000E+00
         VIEW  1.00000E+00  0.00000E+00  2.05103E-10
         RIGH -2.05103E-10  0.00000E+00  1.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  1.96000E-02  0.00000E+00  0.00000E+00
!RSPHERE:  4.42236E-01
!RADIUS :  1.99006E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.54783E+00
!FAR    :  2.87454E+00
*------------------------------------------------------------------------
SCEN GEOM NAVI FREE
          LINE SFRE SSHA
     LIMA ON
SLER CAM1 1 NFRA 1
TRAC OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate lframeb TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
FREQ 1
GOTR LOOP 14 OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate lframeb TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
ENDPLAY
*========================================================================
FIN
```

D14_S2_15_FPyy.epx

```
D14_S2_15_FPYY
ECHO
!CONV WIN
RESU SPLI ALIC 'D14_S2_15_FP.ali' GARD PSCR
COMP COUL GR80 LECT plate TERM
          GR50 LECT lframeb uframe TERM
SORT VISU NSTO 1
*========================================================================
PLAY
CAME   1 EYE  -1.97046E+00  0.00000E+00 -4.08169E-10
!        Q     7.07107E-01  0.00000E+00 -7.07107E-01  0.00000E+00
         VIEW  1.00000E+00  0.00000E+00  2.05103E-10
         RIGH -2.05103E-10  0.00000E+00  1.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  1.96000E-02  0.00000E+00  0.00000E+00
!RSPHERE:  4.42236E-01
!RADIUS :  1.99006E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.54783E+00
!FAR    :  2.87454E+00
*------------------------------------------------------------------------
SCEN GEOM NAVI FREE
          LINE HEOU SFRE SSHA
     LIMA ON
SLER CAM1 1 NFRA 1
TRAC OFFS SIZE 1200 1200 FICH BMP DEFO AMPD 0.0
```

```
     OBJE LECT plate TERM SYXY SYXZ TOLS 1.E-3 NFAI ADAP REND
FREQ 1
GOTR LOOP 14 OFFS SIZE 1200 1200 FICH BMP DEFO AMPD 0.0
     OBJE LECT plate TERM SYXY SYXZ TOLS 1.E-3 NFAI ADAP REND
ENDPLAY
*======================================================================
FIN
```

D14_S2_15_FPz1.epx

```
D14_S2_15_FPZ1
ECHO
 CONV WIN
RESU SPLI ALIC 'D14_S2_15_FP.ali' GARD PSCR
COMP COUL GR80 LECT plate TERM
SORT VISU NSTO 1
*======================================================================
PLAY
CAME   1 EYE   6.49959E-01  0.00000E+00  1.78574E+00
!        Q    -9.84808E-01  0.00000E+00 -1.73648E-01  0.00000E+00
         VIEW -3.42021E-01  0.00000E+00 -9.39692E-01
         RIGH  9.39692E-01  0.00000E+00 -3.42021E-01
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  9.56724E-18  0.00000E+00  0.00000E+00
!RSPHERE:  4.41942E-01
!RADIUS :  1.90035E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.45841E+00
!FAR    :  2.78423E+00
CAME   2 EYE  -6.49959E-01  0.00000E+00  1.78574E+00
!        Q    -9.84808E-01  0.00000E+00  1.73648E-01  0.00000E+00
         VIEW  3.42021E-01  0.00000E+00 -9.39692E-01
         RIGH  9.39692E-01  0.00000E+00  3.42021E-01
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  9.56724E-18  0.00000E+00  0.00000E+00
!RSPHERE:  4.41942E-01
!RADIUS :  1.90035E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.45841E+00
!FAR    :  2.78423E+00
*----------------------------------------------------------------------
SCEN GEOM NAVI FREE
          FACE SBAC
          LINE HEOU SFRE SSHA
     LIMA ON
SLER CAM1 1 NFRA 1
TRAC OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate TERM SYXY SYXZ TOLS 1.E-3 NFAI ADAP REND
FREQ 1
GOTR LOOP 14 OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate TERM SYXY SYXZ TOLS 1.E-3 NFAI ADAP REND
ENDPLAY
*======================================================================
SUIT
Post-treatment (make avi file from bitmaps)
ECHO
RESU SPLI ALIC 'D14_S2_15_FP.ali' GARD PSCR
*================================================================
SORT VISU NSTO 1
*================================================================
PLAY
MAVI FPS 5 KFRE 5 COMP -1 REND
ENDPLAY
*================================================================
FIN
```

D14_S2_15_FPz2.epx

```
D14_S2_15_FPZ2
ECHO
 CONV WIN
RESU SPLI ALIC 'D14_S2_15_FP.ali' GARD PSCR
COMP COUL GR80 LECT plate TERM
SORT VISU NSTO 1
*======================================================================
PLAY
CAME   1 EYE   6.49959E-01  0.00000E+00  1.78574E+00
!        Q    -9.84808E-01  0.00000E+00 -1.73648E-01  0.00000E+00
         VIEW -3.42021E-01  0.00000E+00 -9.39692E-01
         RIGH  9.39692E-01  0.00000E+00 -3.42021E-01
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  9.56724E-18  0.00000E+00  0.00000E+00
!RSPHERE:  4.41942E-01
!RADIUS :  1.90035E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.45841E+00
!FAR    :  2.78423E+00
CAME   2 EYE  -6.49959E-01  0.00000E+00  1.78574E+00
!        Q    -9.84808E-01  0.00000E+00  1.73648E-01  0.00000E+00
         VIEW  3.42021E-01  0.00000E+00 -9.39692E-01
         RIGH  9.39692E-01  0.00000E+00  3.42021E-01
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  9.56724E-18  0.00000E+00  0.00000E+00
!RSPHERE:  4.41942E-01
!RADIUS :  1.90035E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.45841E+00
!FAR    :  2.78423E+00
*----------------------------------------------------------------------
SCEN GEOM NAVI FREE
          FACE SBAC
          LINE HEOU SFRE SSHA
     LIMA ON
SLER CAM1 2 NFRA 1
TRAC OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate TERM SYXY SYXZ TOLS 1.E-3 NFAI ADAP REND
FREQ 1
GOTR LOOP 14 OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate TERM SYXY SYXZ TOLS 1.E-3 NFAI ADAP REND
ENDPLAY
*======================================================================
SUIT
Post-treatment (make avi file from bitmaps)
ECHO
RESU SPLI ALIC 'D14_S2_15_FP.ali' GARD PSCR
*================================================================
SORT VISU NSTO 1
*================================================================
PLAY
MAVI FPS 5 KFRE 5 COMP -1 REND
ENDPLAY
*================================================================
FIN
```

D14_S2_15_z1.epx

```
D14_S2_15_Z1
ECHO
 CONV WIN
RESU SPLI ALIC 'D14_S2_15.ali' GARD PSCR
COMP COUL GR80 LECT plate TERM
SORT VISU NSTO 1
*======================================================================
PLAY
CAME   1 EYE   6.49959E-01  0.00000E+00  1.78574E+00
!        Q    -9.84808E-01  0.00000E+00 -1.73648E-01  0.00000E+00
         VIEW -3.42021E-01  0.00000E+00 -9.39692E-01
         RIGH  9.39692E-01  0.00000E+00 -3.42021E-01
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  9.56724E-18  0.00000E+00  0.00000E+00
!RSPHERE:  4.41942E-01
!RADIUS :  1.90035E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.45841E+00
!FAR    :  2.78423E+00
CAME   2 EYE  -6.49959E-01  0.00000E+00  1.78574E+00
!        Q    -9.84808E-01  0.00000E+00  1.73648E-01  0.00000E+00
         VIEW  3.42021E-01  0.00000E+00 -9.39692E-01
         RIGH  9.39692E-01  0.00000E+00  3.42021E-01
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  9.56724E-18  0.00000E+00  0.00000E+00
!RSPHERE:  4.41942E-01
!RADIUS :  1.90035E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.45841E+00
!FAR    :  2.78423E+00
*----------------------------------------------------------------------
SCEN GEOM NAVI FREE
          FACE SBAC
          LINE HEOU SFRE SSHA
     LIMA ON
SLER CAM1 1 NFRA 1
TRAC OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate TERM SYXY SYXZ TOLS 1.E-3 NFAI ADAP REND
FREQ 1
GOTR LOOP 25 OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate TERM SYXY SYXZ TOLS 1.E-3 NFAI ADAP REND
ENDPLAY
*======================================================================
SUIT
Post-treatment (make avi file from bitmaps)
ECHO
RESU SPLI ALIC 'D14_S2_15.ali' GARD PSCR
*================================================================
SORT VISU NSTO 1
*================================================================
PLAY
MAVI FPS 5 KFRE 5 COMP -1 REND
ENDPLAY
*================================================================
FIN
```

D14_S2_15_z2.epx

```
D14_S2_15_Z2
ECHO
 CONV WIN
RESU SPLI ALIC 'D14_S2_15.ali' GARD PSCR
```

```
COMP COUL GR80 LECT plate TERM
SORT VISU NSTO 1
*=======================================================================
PLAY
CAME   1 EYE   6.49959E-01  0.00000E+00  1.78574E+00
!        Q    -9.84808E-01  0.00000E+00 -1.73648E-01  0.00000E+00
         VIEW -3.42021E-01  0.00000E+00 -9.39692E-01
         RIGH  9.39692E-01  0.00000E+00 -3.42021E-01
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  9.56724E-18  0.00000E+00  0.00000E+00
!RSPHERE:  4.41942E-01
!RADIUS :  1.90035E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.45841E+00
!FAR    :  2.78423E+00
CAME   2 EYE  -6.49959E-01  0.00000E+00  1.78574E+00
!        Q    -9.84808E-01  0.00000E+00  1.73648E-01  0.00000E+00
         VIEW  3.42021E-01  0.00000E+00 -9.39692E-01
         RIGH  9.39692E-01  0.00000E+00  3.42021E-01
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  9.56724E-18  0.00000E+00  0.00000E+00
!RSPHERE:  4.41942E-01
!RADIUS :  1.90035E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.45841E+00
!FAR    :  2.78423E+00
*-----------------------------------------------------------------------
SCEN GEOM NAVI FREE
          FACE SBAC
          LINE HEOU SFRE SSHA
     LIMA ON
SLER CAM1 2 NFRA 1
TRAC OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate TERM SYXY SYXZ TOLS 1.E-3 NFAI ADAP REND
FREQ 1
GOTR LOOP 25 OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate TERM SYXY SYXZ TOLS 1.E-3 NFAI ADAP REND
ENDPLAY
*=======================================================================
SUIT
Post-treatment (make avi file from bitmaps)
ECHO
RESU SPLI ALIC 'D14_S2_15.ali' GARD PSCR
*=================================================================
SORT VISU NSTO 1
*=================================================================
PLAY
MAVI FPS 5 KFRE 5 COMP -1 REND
ENDPLAY
*=================================================================
FIN
```

D14_S2_15f.epx

```
D14_S2_15F
ECHO
!CONV WIN
RESU SPLI ALIC 'D14_S2_15.ali' GARD PSCR
COMP COUL GR80 LECT plate TERM
SORT VISU NSTO 1
PLAY
CAME   1 EYE  -1.85740E+00  2.10571E-03  2.10571E-03
!        Q     7.07107E-01  0.00000E+00 -7.07107E-01  0.00000E+00
         VIEW  1.00000E+00  0.00000E+00  2.05103E-10
         RIGH -2.05103E-10  0.00000E+00  1.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER : -2.25515E-03  2.10571E-03  2.10571E-03
!RSPHERE:  4.63787E-01
!RADIUS :  1.85515E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.39136E+00
!FAR    :  2.78272E+00
SCEN GEOM NAVI FREE
          LINE HEOU SFRE
SLER CAM1 1 NFRA 1
FREQ 1
TRAC DEFO AMPD 0.0 OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate TERM
     SYXY SYXZ ! TOLS 1.E-2
     NFAI ADAP REND
GOTR LOOP 25 DEFO AMPD 0.0 OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate TERM
     SYXY SYXZ ! TOLS 1.E-2
     NFAI ADAP REND
ENDPLAY
*=======================================================================
SUIT
Post-treatment (make avi file from bitmaps)
ECHO
RESU SPLI ALIC 'D14_S2_15.ali' GARD PSCR
*=================================================================
SORT VISU NSTO 1
*=================================================================
PLAY
MAVI FPS 5 KFRE 5 COMP -1 REND
ENDPLAY
*=================================================================
FIN
```

D14_S2_25.epx

```
D14_S2_25
ECHO
!CONV win
CAST 'S2.msh' spec
EROS 1.0 CROI
TRID LAGR
DIME ADAP NPOI 100000
          Q4GS 100000
          CL3D 100000
          T3GS 20000
          CL3T 20000
          PMAT 50000
          NPIN 50000
     ENDA
TERM
GEOM CUB8 ecub8
     PR6  epri6
     Q4GS equa4
     T3GS etri3
     PMAT nplate
     CL3D presur ppqua4
     CL3T pptri3
TERM
COMP EPAI 0.8E-3 LECT plate nplate TERM
     GROU 5 'pp1'     LECT plate TERM
                      COND BOX X0 0.0 Y0 0.0  Z0 0.0
                               DX 0.1 DY 0.15 DZ 0.15
            'plaEdg'  LECT plate DIFF pp1 TERM
                      COND YB LT 0.16
                      COND ZB LT 0.16
            'nplatmp' LECT nplate  TERM
                      COND YB LT 0.16
                      COND ZB LT 0.16
            'nplalim' LECT nplate DIFF nplatmp TERM
            'prec'    LECT preplat TERM
                      COND NEAR POIN 0.0 0.0 0.0
     NGRO 4 'blox' LECT lframeb TERM COND X GT 0.0253
            'symy' LECT spec TERM COND Y LT 0.0001
            'symz' LECT spec TERM COND Z LT 0.0001
            'cen'  LECT plate TERM COND NEAR POIN 0.0 0.0 0.0
     COUL TURQ LECT lframeb TERM
          VERT LECT plate TERM
          ROSE LECT plaEdg TERM
          ROUG LECT nplalim TERM
          BLEU LECT uframe pp1 TERM
     ORIE INVE LECT preplat TERM
INCLUDE 'p77_25e.txt'
ADAP THRS ECRO 11 TMIN 0.01 TMAX 0.02 MAXL 4 CRIT 1
          LECT plate TERM
MATE VPJC RO 7850.0 YOUN 2.1E11 NU 0.33 ELAS 3.257E8 MXIT 100
          QR1 2.348E8 CR1 56.2 QR2 4.457E8 CR2 4.7
          PDOT 5.E-4 C 1.E-2 TQ 0.9 CP 452.0
          TM 1800.0 M 1.0 DC 1.0 WC 555.0E6
          RESI 1
          LECT lframeb TERM
     VPJC RO 7850.0 YOUN 2.1E11 NU 0.33 ELAS 3.257E8 MXIT 100
          QR1 2.348E8 CR1 56.2 QR2 4.457E8 CR2 4.7
          PDOT 5.E-4 C 1.E-2 TQ 0.9 CP 452.0
          TM 1800.0 M 1.0 DC 1.0 WC 555.0E6
          RESI 1
          LECT uframe TERM
     VPJC RO 7850.0 YOUN 2.1E11 NU 0.33 ELAS 11.50E8 MXIT 50 ! Docol 1400M
          QR1 2.410E8 CR1 610.9 QR2 1.641E8 CR2 95.8
          PDOT 5.E-4 C 4.E-3 TQ 0.9 CP 452.0
          TM 1800.0 M 1.0 DC 1.0 WC 741.0E6
          RESI 1
          LECT plate TERM
     MASS 0.0 YOUN 2.1E11 NU 0.33
          LECT nplate TERM
     IMPE PIMP RO 7850.0 PRES 43.9e6 PREF 0.0
          LECT presur TERM
     IMPE PIMP RO 7850 PRES 1.0 PREF 0.0 FONC 1
          LECT preplat TERM
OPTI PINS ASN
LINK COUP SPLT NONE
     BLOQ 123 LECT blox TERM
     CONT SPLA NX 0 NY 1 NZ 0 LECT symy TERM
     CONT SPLA NX 0 NY 0 NZ 1 LECT symz TERM
LINK DECO
     PINB PENA SFAC 1.0
          BODY FROT MUST 0.5 MUDY 0.5 GAMM 0 DMIN 0.0004
               LECT lframeb TERM
          BODY FROT MUST 0.5 MUDY 0.5 GAMM 0 DMIN 0.0004
               LECT uframe TERM
          BODY FROT MUST 0.5 MUDY 0.5 GAMM 0 DIAM 0.0004 ADNP
               LECT nplate TERM
          EXCL PAIR 1 2
ECRI DEPL VITE ECRO FAIL TFRE 0.2E-3
          POIN LECT cen TERM
          NOELEM
     FICH ALIT TFRE 0.1E-4
          POIN LECT cen symy TERM
          ELEM LECT prec TERM
     FICH PVTK TFRE  0.1e-3
```

```
        GROU AUTO
        VARI ECRO CONT FAIL DEPL VITE FLIA
    FICH SPLI ALIC TFRE 2.0E-4
OPTI NOTE CSTA 0.7
    LOG 1
    JAUM
    LMST
    ADAP RCON WHAN
    PINS GRID DPIN 1.01
    QUASI STATIQUE 1000. 0.7 FROM 0.0 UPTO 0.5e-3
CALC TINI 0 TEND 5.0E-3 TFAI 2.0E-8
FIN
```

D14_S2_25_FP.epx

```
D14_S2_25_FP
ECHO
!CONV win
CAST 'S2_FSI.msh' mesh
TRID ALE
EROS 1.0 CROI
DIME ADAP NPOI 200000
        CUVF 200000
        Q4GS 60000
        T3GS 10000
        NVFI 600000
        PMAT 50000
        NPIN 50000
    ENDA
    JONC 475 ! Total n. of nodes in a TUBM juncton
    NALE 1 NBLE 1
    TERM
GEOM CUB8 ecub8
    PR6  epri6
    Q4GS equa4 ! mems pinbcm
    T3GS etri3
    CUVF flui3d tubelp3 tank
    TUVF tubelp1
    PMAT nplate
    CL3D face3d presur abso stub3d ! pre
    TUBM rac3d1d raclp
TERM
COMP EPAI 0.8e-3 LECT plate nplate TERM
    DIAM DROI 0.1692568 LECT tubelp1 TERM
    RACC TUBM LECT rac3d1d  TERM
        NTUB LECT p1a   TERM DTUB 0.1692568
        FACE LECT face3d TERM COEF 1.0
    RACC TUBM LECT raclp  TERM
        NTUB LECT p1d3   TERM DTUB 0.1692568
        FACE LECT stub3d TERM COEF 1.0
! Attention: the TUBM element (raclp) is NOT included
! in the "mesh" object (although it IS indeed passed in from Cast3m).
! For this reason we must add it explicitly in the GROU directive below
! if we want to have it in the extracted element groups.
    GROU 21 'endtube' LECT tube TERM COND XB GT -0.6
           'trigger' LECT tube TERM COND NEAR POIN -0.1501 0 0
           'frefine' LECT flui TERM COND XB GT -0.3
                                    COND XB LT  1.0
           'pp1'    LECT plate TERM
                    COND BOX X0 0.0 Y0 0.0  Z0 0.0
                            DX 0.1 DY 0.15 DZ 0.15
           'pp2'    LECT plate TERM
                    COND BOX X0 0.0 Y0 0.0  Z0 0.0
                            DX 0.1 DY 0.165 DZ 0.165
           'fcoup'  LECT flui  TERM COND XB GT -0.05
                                    COND XB LT 0.150
                                    COND YB LT 0.150
                                    COND ZB LT 0.150
           'scoup'  LECT plate TERM COND YB LT 0.150
                                    COND ZB LT 0.150
           'lfrb2' LECT lframeb TERM
                    COND XB LT -0.865E-2
           'lfrb1' LECT lframeb DIFF lfrb2 TERM
           'uframe2'    LECT uframe DIFF presur TERM
           'S1' LECT tube TERM COND NEAR POIN -0.345 0.0 0.15
           'S2' LECT tube TERM COND NEAR POIN -0.245 0.0 0.15
           'S16' LECT flui3d TERM COND NEAR POIN -15.225 0 0.15
           'S15' LECT flui3d TERM COND NEAR POIN -15.125 0 0.15
           'S12' LECT tube TERM COND NEAR POIN -12.495 0 0.15
           'S11' LECT tube TERM COND NEAR POIN -12.395 0 0.15
           'S6' LECT tube TERM COND NEAR POIN -5.685 0 0.15
           'S5' LECT tube TERM COND NEAR POIN -5.585 0 0.15
           'epar1' LECT tubelp1 TERM COND NEAR NODE LECT p1a TERM
           'epar2' LECT tubelp1 TERM COND NEAR NODE LECT p1d3 TERM
           'tubelpp' LECT tubelp1 DIFF epar1 epar2 TERM
    NGRO 13 'blox'  LECT lframeb TERM COND !X LT -0.0253
                                          X GT 0.0253
           'symy'  LECT plate TERM    COND Y LT 0.0001
           'symz'  LECT plate TERM    COND Z LT 0.0001
           'pt0' LECT tube TERM COND NEAR POIN -16.19999 0.0 0.0
           'cen' LECT plate TERM COND NEAR POIN 0.0 0.0 0.0
           'axis1'   LECT plate TERM COND Y LT 0.0001
           'axis2'   LECT plate TERM COND Z LT 0.0001
           'csymy' LECT uframe lframeb TERM COND Y LT 0.0001
           'csymz' LECT uframe lframeb TERM COND Z LT 0.0001
           'elfb'  LECT lframeb TERM COND ENVE
           'nlfb'  LECT elfb    TERM COND X GT -0.01
                                     COND X LT  0.001
           'nbad1' LECT nlfb TERM
                   COND CONE X1 -0.009 Y1 0.260 Z1 0
                             X2  0.001 Y2 0.260 Z2 0
                             R1  0.009 R2 0.009
           'nbad2' LECT nlfb TERM
                   COND CONE X1 -0.009 Y1 0 Z1 0.260
                             X2  0.001 Y2 0 Z2 0.260
                             R1  0.009 R2 0.009
    COUL TURQ LECT tube tra lp3xl TERM
         VERT LECT plate fir2 TERM
         ROSE LECT fir1 TERM
         ROUG LECT driver TERM
        ROSE LECT S1 S2 S5 S6 S11 S12 S15 S16 TERM
ADAP THRS ECRO 11 TMIN 0.01 TMAX 0.02 MAXL 4 CRIT 1 ! NOUN
         LECT plate TERM
!         LECT pp2 TERM
GRIL LAGR LECT spec TERM
MATE
    !LOI 1
     GAZP RO 20.310 GAMM 1.4 CV 719.286 PINI 17.16E5 PREF 100.8E3
         LECT none TERM
    !LOI 2
     GAZP RO 1.193 GAMM 1.4 CV 719.286 PINI 100.8E3 PREF 100.8E3
         LECT none TERM
    !LOI 3
    GAZP RO 6.720 GAMM 1.4 CV 719.286 PINI 5.677E5 PREF 100.8E3
         LECT none TERM
    !LOI 4
     GAZP RO 1.193 GAMM 1.4 CV 719.286 PINI 100.8E3 PREF 100.8E3
         LECT flui3d TERM ! _cuvf TERM
     GAZP RO 1.193 GAMM 1.4 CV 719.286 PINI 100.8E3 PREF 100.8E3
         LECT epar1 epar2 TERM
     GAZP RO 1.193 GAMM 1.4 CV 719.286 PINI 100.8E3 PREF 100.8E3
         LECT rac3d1d raclp tubelpp TERM
     PARO PSIL 0.02
         LECT tubelpp TERM
     MULT 6 7 LECT tubelpp TERM
! In order to obtain a printout at least of the 3D VFCCs I am obliged
! to use a different material for tubelp3 and other 3D parts, but with
! the same characteristics as the material used for tubelp1
    GAZP RO 1.193 GAMM 1.4 CV 719.286 PINI 100.8E3 PREF 100.8E3
         LECT tubelp3 tank _cuvf TERM
     CLVF ABSO RO 1.187
         LECT abso TERM
     VPJC RO 7850.0 YOUN 2.1E11 NU 0.33 ELAS 3.257E8 MXIT 100
         QR1 2.348E8 CR1 56.2 QR2 4.457E8 CR2 4.7
         PDOT 5.E-4 C 1.E-2 TQ 0.9 CP 452.0
         TM 1800.0 M 1.0 DC 1.0 WC 555.0E6
         RESI 1
         LECT lframeb TERM
     VPJC RO 7850.0 YOUN 2.1E11 NU 0.33 ELAS 3.257E8 MXIT 100
         QR1 2.348E8 CR1 56.2 QR2 4.457E8 CR2 4.7
         PDOT 5.E-4 C 1.E-2 TQ 0.9 CP 452.0
         TM 1800.0 M 1.0 DC 1.0 WC 555.0E6
         RESI 1
         LECT uframe TERM
     VPJC RO 7850.0 YOUN 2.1E11 NU 0.33 ELAS 11.50E8 MXIT 50 ! Docol 1400M
         QR1 2.410E8 CR1 610.9 QR2 1.641E8 CR2 95.8
         PDOT 5.E-4 C 4.E-3 TQ 0.9 CP 452.0
         TM 1800.0 M 1.0 DC 1.0 WC 741.0E6
         RESI 1
         LECT plate TERM
     MASS 0.0 YOUN 2.1E11 NU 0.33
         LECT nplate TERM
     IMPE PIMP RO 7850.0 PRES 44.0011e6 PREF 1.011E5 !fc To be checked
         LECT presur TERM ! _cl3d TERM
OPTI PINS ASN
LINK COUP SPLT NONE
     BLOQ 123 LECT blox TERM
!    GLIS 2
!              FROT MUST 0.5 MUDY 0.5 GAMM 0
!              PGAP 0.4E-3
!            ! MAIT LECT lframeb TERM
!              MAIT NODE LECT nlfb DIFF nbad1 nbad2 TERM
!              PESC LECT plate TERM
*
!              FROT MUST 0.5 MUDY 0.5 GAMM 0
!              PGAP 0.4E-3
!              MAIT LECT uframe TERM
!              PESC LECT plate TERM
LINK DECO BLOQ 246 LECT symy TERM
         BLOQ 345 LECT symz TERM
         BLOQ 2 LECT csymy TERM
         BLOQ 3 LECT csymz TERM
     PINB PENA SFAC 1.0
         BODY FROT MUST 0.5 MUDY 0.5 GAMM 0 DMIN 0.0004
              LECT lframeb TERM
         BODY FROT MUST 0.5 MUDY 0.5 GAMM 0 DMIN 0.0004
              LECT uframe TERM
         BODY FROT MUST 0.5 MUDY 0.5 GAMM 0 DIAM 0.0004 ADNP
              LECT nplate TERM
         EXCL PAIR 1 2
     FLSW STRU LECT scoup TERM
         FLUI LECT fcoup TERM
         R 0.0087    ! 0.014
         HGRI 0.00606 ! 0.016
         DGRI
         FACE
         BFLU 2 ! block if at least one node is in influence domain
         FSCP 1 ! couple in all directions
         ADAP LMAX 2 SCAL 6
     TBLO 123    TRIG LECT lframeb uframe TERM
         123456 TRIG LECT plate TERM
INIT MAPP FORM 'D7725600map.map' MATC OBJE LECT flui3d tubelp1 TERM
ECRI DEPL VITE ECRO FAIL TFRE 0.25E-3
```

```
        POIN LECT cen axis1 axis2 TERM
        ELEM LECT S1 TERM
     FICH ALIT FREQ 0 TFRE 0.D0
        TIME PROG 0.D0 PAS 0.5D-3 22.D-3 PAS 0.01D-3 80.D-3
        POIN LECT cen axis1 axis2 TERM
        ELEM LECT S1 S2 S5 S6 S11 S12 S15 S16 TERM
!    FICH PVTK FREQ 0 TFRE 0.D0
!       TIME PROG 0.D0 PAS 0.5D-3 28.D-3 PAS 0.1D-3 40.D-3
!       PAS 1.D-3 50.D-3
!       GROU AUTO
!       VARI DEPL VITE FAIL ACCE VCVI CONT ECRO FLIA
    FICH SPLI ALIC TFRE 0.5E-3
OPTI NOTE CSTA 0.4
    GLIS NORM ELEM
    STEP IO
    LOG 1
    JAUM
    LMST
    PINS GRID DPIN 1.01
    VFCC FCON 6 ! hllc solver
        ORDR 2 ! order in space
        STPS 2 ! order in time
        RECO 1
        NTIL
    ADAP RCON WHAN
    ADAP RCON TRIG ECRO 1 TVAL 1.05E5 LECT trigger TERM
    NOCR TRIG LECT plate lframeb uframe TERM
    FLS  CUB8 2 ! For the inverse mapping
CALC TINI 0 TEND 34.0E-3 TFAI 1.143E-8 ! 2.0E-8
FIN
```

D14_S2_25_FPw.epx

```
D14_S2_25_FPW
ECHO
!CONV WIN
RESU SPLI ALIC 'D14_S2_25_FP.ali' GARD PSCR
COMP COUL VERT LECT plate TERM
        GR50 LECT lframeb uframe TERM
        TURQ LECT tubelp3 tank TERM
SORT VISU NSTO 1
*=======================================================================
PLAY
*-----------------------------------------------------------------------
CAME   1 EYE  -4.60000E-03 -7.47801E-10 -1.66049E+00
!        Q    -2.05103E-10 -1.00000E+00 -6.46235E-26  2.77556E-16
         VIEW  5.55112E-16  4.10207E-10  1.00000E+00
         RIGH  1.00000E+00  1.53918E-26 -5.55112E-16
         UP    2.43102E-25 -1.00000E+00  4.10207E-10
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER : -4.60000E-03  0.00000E+00  1.62500E-01
!RSPHERE:  3.64597E-01
!RADIUS :  1.82299E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.31529E+00
!FAR    :  2.04449E+00
SCEN GEOM NAVI FREE
        LINE SFRE SSHA
    ISO  FILL FIEL ECRO 1 SCAL USER PROG 1.001E5 PAS 0.5E5 7.501E5 TERM
        SUPP LECT tubelp3 tank TERM
    LIMA ON
SLER CAM1 1 NFRA 1
FREQ 1
TRAC OFFS SIZE 1200 1200 FICH BMP
    OBJE LECT plate lframeb uframe tubelp3 tank TERM ! SYXY
                              SYXZ
                              TOLS 1.E-3 NFAI REND
GOTR LOOP 12 OFFS SIZE 1200 1200 FICH BMP
    OBJE LECT plate lframeb uframe tubelp3 tank TERM ! SYXY
                              SYXZ
                              TOLS 1.E-3 NFAI REND
ENDPLAY
*=======================================================================
FIN
```

D14_S2_25_FPx.epx

```
D14_S2_25_FPX
ECHO
!CONV WIN
RESU SPLI ALIC 'D14_S2_25_FP.ali' GARD PSCR
COMP COUL VERT LECT plate TERM
        GR50 LECT lframeb uframe TERM
        TURQ LECT tubelp3 tank TERM
SORT VISU NSTO 1
*=======================================================================
PLAY
*-----------------------------------------------------------------------
CAME   1 EYE  -4.60000E-03 -7.47801E-10 -1.66049E+00
!        Q    -2.05103E-10 -1.00000E+00 -6.46235E-26  2.77556E-16
         VIEW  5.55112E-16  4.10207E-10  1.00000E+00
         RIGH  1.00000E+00  1.53918E-26 -5.55112E-16
         UP    2.43102E-25 -1.00000E+00  4.10207E-10
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER : -4.60000E-03  0.00000E+00  1.62500E-01
!RSPHERE:  3.64597E-01
!RADIUS :  1.82299E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.31529E+00
!FAR    :  2.04449E+00
SCEN GEOM NAVI FREE
        LINE SFRE SSHA
    LIMA ON
SLER CAM1 1 NFRA 1
FREQ 1
TRAC OFFS SIZE 1200 1200 FICH BMP
    OBJE LECT plate lframeb uframe tubelp3 tank TERM ! SYXY
                              SYXZ
                              TOLS 1.E-3 NFAI REND
GOTR LOOP 12 OFFS SIZE 1200 1200 FICH BMP
    OBJE LECT plate lframeb uframe tubelp3 tank TERM ! SYXY
                              SYXZ
                              TOLS 1.E-3 NFAI REND
ENDPLAY
*=======================================================================
FIN
```

D14_S2_25_FPy.epx

```
D14_S2_25_FPY
ECHO
!CONV WIN
RESU SPLI ALIC 'D14_S2_25_FP.ali' GARD PSCR
COMP COUL GR80 LECT plate TERM
        GR50 LECT lframeb uframe TERM
SORT VISU NSTO 1
*=======================================================================
PLAY
CAME   1 EYE  -1.97046E+00  0.00000E+00 -4.08169E-10
!        Q     7.07107E-01  0.00000E+00 -7.07107E-01  0.00000E+00
         VIEW  1.00000E+00  0.00000E+00  2.05103E-10
         RIGH -2.05103E-10  0.00000E+00  1.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  1.96000E-02  0.00000E+00  0.00000E+00
!RSPHERE:  4.42236E-01
!RADIUS :  1.99006E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.54783E+00
!FAR    :  2.87454E+00
*-----------------------------------------------------------------------
SCEN GEOM NAVI FREE
        LINE SFRE SSHA
    LIMA ON
SLER CAM1 1 NFRA 1
TRAC OFFS SIZE 1200 1200 FICH BMP
    OBJE LECT plate lframeb TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
FREQ 1
GOTR LOOP 12 OFFS SIZE 1200 1200 FICH BMP
    OBJE LECT plate lframeb TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
ENDPLAY
*=======================================================================
FIN
```

D14_S2_25_FPyy.epx

```
D14_S2_25_FPYY
ECHO
!CONV WIN
RESU SPLI ALIC 'D14_S2_25_FP.ali' GARD PSCR
COMP COUL GR80 LECT plate TERM
        GR50 LECT lframeb uframe TERM
SORT VISU NSTO 1
*=======================================================================
PLAY
CAME   1 EYE  -1.97046E+00  0.00000E+00 -4.08169E-10
!        Q     7.07107E-01  0.00000E+00 -7.07107E-01  0.00000E+00
         VIEW  1.00000E+00  0.00000E+00  2.05103E-10
         RIGH -2.05103E-10  0.00000E+00  1.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  1.96000E-02  0.00000E+00  0.00000E+00
!RSPHERE:  4.42236E-01
!RADIUS :  1.99006E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.54783E+00
!FAR    :  2.87454E+00
*-----------------------------------------------------------------------
SCEN GEOM NAVI FREE
        LINE HEOU SFRE SSHA
    LIMA ON
SLER CAM1 1 NFRA 1
TRAC OFFS SIZE 1200 1200 FICH BMP DEFO AMPD 0.0
    OBJE LECT plate TERM SYXY SYXZ TOLS 1.E-3 NFAI ADAP REND
FREQ 1
GOTR LOOP 12 OFFS SIZE 1200 1200 FICH BMP DEFO AMPD 0.0
    OBJE LECT plate TERM SYXY SYXZ TOLS 1.E-3 NFAI ADAP REND
ENDPLAY
*=======================================================================
FIN
```

D14_S2_25_FPz1.epx

```
D14_S2_25_FPZ1
ECHO
 CONV WIN
RESU SPLI ALIC 'D14_S2_25_FP.ali' GARD PSCR
COMP COUL GR80 LECT plate TERM
SORT VISU NSTO 1
*=======================================================================
PLAY
CAME   1 EYE   6.49959E-01  0.00000E+00  1.78574E+00
!        Q    -9.84808E-01  0.00000E+00 -1.73648E-01  0.00000E+00
         VIEW -3.42021E-01  0.00000E+00 -9.39692E-01
         RIGH  9.39692E-01  0.00000E+00 -3.42021E-01
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  9.56724E-18  0.00000E+00  0.00000E+00
!RSPHERE:  4.41942E-01
!RADIUS :  1.90035E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.45841E+00
!FAR    :  2.78423E+00
CAME   2 EYE  -6.49959E-01  0.00000E+00  1.78574E+00
!        Q    -9.84808E-01  0.00000E+00  1.73648E-01  0.00000E+00
         VIEW  3.42021E-01  0.00000E+00 -9.39692E-01
         RIGH  9.39692E-01  0.00000E+00  3.42021E-01
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  9.56724E-18  0.00000E+00  0.00000E+00
!RSPHERE:  4.41942E-01
!RADIUS :  1.90035E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.45841E+00
!FAR    :  2.78423E+00
*-----------------------------------------------------------------------
SCEN GEOM NAVI FREE
          FACE SBAC
          LINE HEOU SFRE SSHA
     LIMA ON
SLER CAM1 1 NFRA 1
TRAC OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate TERM SYXY SYXZ TOLS 1.E-3 NFAI ADAP REND
FREQ 1
GOTR LOOP 12 OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate TERM SYXY SYXZ TOLS 1.E-3 NFAI ADAP REND
ENDPLAY
*=======================================================================
SUIT
Post-treatment (make avi file from bitmaps)
ECHO
RESU SPLI ALIC 'D14_S2_25_FP.ali' GARD PSCR
*=================================================================
SORT VISU NSTO 1
*=================================================================
PLAY
MAVI FPS 5 KFRE 5 COMP -1 REND
ENDPLAY
*=================================================================
FIN
```

D14_S2_25_FPz2.epx

```
D14_S2_25_FPZ2
ECHO
 CONV WIN
RESU SPLI ALIC 'D14_S2_25_FP.ali' GARD PSCR
COMP COUL GR80 LECT plate TERM
SORT VISU NSTO 1
*=======================================================================
PLAY
CAME   1 EYE   6.49959E-01  0.00000E+00  1.78574E+00
!        Q    -9.84808E-01  0.00000E+00 -1.73648E-01  0.00000E+00
         VIEW -3.42021E-01  0.00000E+00 -9.39692E-01
         RIGH  9.39692E-01  0.00000E+00 -3.42021E-01
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  9.56724E-18  0.00000E+00  0.00000E+00
!RSPHERE:  4.41942E-01
!RADIUS :  1.90035E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.45841E+00
!FAR    :  2.78423E+00
CAME   2 EYE  -6.49959E-01  0.00000E+00  1.78574E+00
!        Q    -9.84808E-01  0.00000E+00  1.73648E-01  0.00000E+00
         VIEW  3.42021E-01  0.00000E+00 -9.39692E-01
         RIGH  9.39692E-01  0.00000E+00  3.42021E-01
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  9.56724E-18  0.00000E+00  0.00000E+00
!RSPHERE:  4.41942E-01
!RADIUS :  1.90035E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.45841E+00
!FAR    :  2.78423E+00
*-----------------------------------------------------------------------
SCEN GEOM NAVI FREE
          FACE SBAC
          LINE HEOU SFRE SSHA
     LIMA ON
SLER CAM1 2 NFRA 1
TRAC OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate TERM SYXY SYXZ TOLS 1.E-3 NFAI ADAP REND
FREQ 1
GOTR LOOP 12 OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate TERM SYXY SYXZ TOLS 1.E-3 NFAI ADAP REND
ENDPLAY
*=======================================================================
SUIT
Post-treatment (make avi file from bitmaps)
ECHO
RESU SPLI ALIC 'D14_S2_25_FP.ali' GARD PSCR
*=================================================================
SORT VISU NSTO 1
*=================================================================
PLAY
MAVI FPS 5 KFRE 5 COMP -1 REND
ENDPLAY
*=================================================================
FIN
```

D14_S2_25_z1.epx

```
D14_S2_25_Z1
ECHO
 CONV WIN
RESU SPLI ALIC 'D14_S2_25.ali' GARD PSCR
COMP COUL GR80 LECT plate TERM
SORT VISU NSTO 1
*=======================================================================
PLAY
CAME   1 EYE   6.49959E-01  0.00000E+00  1.78574E+00
!        Q    -9.84808E-01  0.00000E+00 -1.73648E-01  0.00000E+00
         VIEW -3.42021E-01  0.00000E+00 -9.39692E-01
         RIGH  9.39692E-01  0.00000E+00 -3.42021E-01
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  9.56724E-18  0.00000E+00  0.00000E+00
!RSPHERE:  4.41942E-01
!RADIUS :  1.90035E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.45841E+00
!FAR    :  2.78423E+00
CAME   2 EYE  -6.49959E-01  0.00000E+00  1.78574E+00
!        Q    -9.84808E-01  0.00000E+00  1.73648E-01  0.00000E+00
         VIEW  3.42021E-01  0.00000E+00 -9.39692E-01
         RIGH  9.39692E-01  0.00000E+00  3.42021E-01
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  9.56724E-18  0.00000E+00  0.00000E+00
!RSPHERE:  4.41942E-01
!RADIUS :  1.90035E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.45841E+00
!FAR    :  2.78423E+00
*-----------------------------------------------------------------------
SCEN GEOM NAVI FREE
          FACE SBAC
          LINE HEOU SFRE SSHA
     LIMA ON
SLER CAM1 1 NFRA 1
TRAC OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate TERM SYXY SYXZ TOLS 1.E-3 NFAI ADAP REND
FREQ 1
GOTR LOOP 25 OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate TERM SYXY SYXZ TOLS 1.E-3 NFAI ADAP REND
ENDPLAY
*=======================================================================
SUIT
Post-treatment (make avi file from bitmaps)
ECHO
RESU SPLI ALIC 'D14_S2_25.ali' GARD PSCR
*=================================================================
SORT VISU NSTO 1
*=================================================================
PLAY
MAVI FPS 5 KFRE 5 COMP -1 REND
ENDPLAY
*=================================================================
FIN
```

D14_S2_25_z2.epx

```
D14_S2_25_Z2
ECHO
 CONV WIN
RESU SPLI ALIC 'D14_S2_25.ali' GARD PSCR
COMP COUL GR80 LECT plate TERM
SORT VISU NSTO 1
*=======================================================================
PLAY
CAME   1 EYE   6.49959E-01  0.00000E+00  1.78574E+00
!        Q    -9.84808E-01  0.00000E+00 -1.73648E-01  0.00000E+00
         VIEW -3.42021E-01  0.00000E+00 -9.39692E-01
         RIGH  9.39692E-01  0.00000E+00 -3.42021E-01
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
```

```
!CENTER :  9.56724E-18  0.00000E+00  0.00000E+00
!RSPHERE:  4.41942E-01
!RADIUS :  1.90035E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.45841E+00
!FAR    :  2.78423E+00
CAME   2 EYE  -6.49959E-01  0.00000E+00  1.78574E+00
!        Q    -9.84808E-01  0.00000E+00  1.73648E-01  0.00000E+00
         VIEW  3.42021E-01  0.00000E+00 -9.39692E-01
         RIGH  9.39692E-01  0.00000E+00  3.42021E-01
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  9.56724E-18  0.00000E+00  0.00000E+00
!RSPHERE:  4.41942E-01
!RADIUS :  1.90035E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.45841E+00
!FAR    :  2.78423E+00
*-----------------------------------------------------------------------
SCEN GEOM NAVI FREE
          FACE SBAC
          LINE HEOU SFRE SSHA
     LIMA ON
SLER CAM1 2 NFRA 1
TRAC OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate TERM SYXY SYXZ TOLS 1.E-3 NFAI ADAP REND
FREQ 1
GOTR LOOP 25 OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate TERM SYXY SYXZ TOLS 1.E-3 NFAI ADAP REND
ENDPLAY
*=======================================================================
SUIT
Post-treatment (make avi file from bitmaps)
ECHO
RESU SPLI ALIC 'D14_S2_25.ali' GARD PSCR
*=================================================================
SORT VISU NSTO 1
*=================================================================
PLAY
MAVI FPS 5 KFRE 5 COMP -1 REND
ENDPLAY
*=================================================================
FIN
```

D14_S2_25f.epx

```
D14_S2_25F
ECHO
!CONV WIN
RESU SPLI ALIC 'D14_S2_25.ali' GARD PSCR
COMP COUL GR80 LECT plate TERM
SORT VISU NSTO 1
PLAY
CAME   1 EYE  -1.85740E+00  2.10571E-03  2.10571E-03
!        Q     7.07107E-01  0.00000E+00 -7.07107E-01  0.00000E+00
         VIEW  1.00000E+00  0.00000E+00  2.05103E-10
         RIGH -2.05103E-10  0.00000E+00  1.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER : -2.25515E-03  2.10571E-03  2.10571E-03
!RSPHERE:  4.63787E-01
!RADIUS :  1.85515E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.39136E+00
!FAR    :  2.78272E+00
SCEN GEOM NAVI FREE
          LINE HEOU SFRE
SLER CAM1 1 NFRA 1
FREQ 1
TRAC DEFO AMPD 0.0 OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate TERM
     SYXY SYXZ ! TOLS 1.E-2
     NFAI ADAP REND
GOTR LOOP 25 DEFO AMPD 0.0 OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate TERM
     SYXY SYXZ ! TOLS 1.E-2
     NFAI ADAP REND
ENDPLAY
*=======================================================================
SUIT
Post-treatment (make avi file from bitmaps)
ECHO
RESU SPLI ALIC 'D14_S2_25.ali' GARD PSCR
*=================================================================
SORT VISU NSTO 1
*=================================================================
PLAY
MAVI FPS 5 KFRE 5 COMP -1 REND
ENDPLAY
*=================================================================
FIN
```

D14_S2_35.epx

```
D14_S2_35
ECHO
!CONV win
CAST 'S2.msh' spec
EROS 1.0 CROI
TRID LAGR
DIME ADAP NPOI 100000
          Q4GS 100000
          CL3D 100000
          T3GS 20000
          CL3T 20000
          PMAT 50000
          NPIN 50000
     ENDA
TERM
GEOM CUB8 ecub8
     PR6  epri6
     Q4GS equa4
     T3GS etri3
     PMAT nplate
     CL3D presur ppqua4
     CL3T pptri3
TERM
COMP EPAI 0.8E-3 LECT plate nplate TERM
     GROU 5 'pp1'     LECT plate TERM
                      COND BOX X0 0.0 Y0 0.0  Z0 0.0
                               DX 0.1 DY 0.15 DZ 0.15
            'plaEdg'  LECT plate DIFF pp1 TERM
                      COND YB LT 0.16
                      COND ZB LT 0.16
            'nplatmp' LECT nplate  TERM
                      COND YB LT 0.16
                      COND ZB LT 0.16
            'nplalim' LECT nplate DIFF nplatmp TERM
            'prec'    LECT preplat TERM
                      COND NEAR POIN 0.0 0.0 0.0
     NGRO 4 'blox' LECT lframeb TERM COND X GT 0.0253
            'symy' LECT spec TERM COND Y LT 0.0001
            'symz' LECT spec TERM COND Z LT 0.0001
            'cen'  LECT plate TERM COND NEAR POIN 0.0 0.0 0.0
     COUL TURQ LECT lframeb TERM
          VERT LECT plate TERM
          ROSE LECT plaEdg TERM
          ROUG LECT nplalim TERM
          BLEU LECT uframe pp1 TERM
     ORIE INVE LECT preplat TERM
INCLUDE 'p77_35e.txt'
ADAP THRS ECRO 11 TMIN 0.01 TMAX 0.02 MAXL 4 CRIT 1
          LECT plate TERM
MATE VPJC RO 7850.0 YOUN 2.1E11 NU 0.33 ELAS 3.257E8 MXIT 100
          QR1 2.348E8 CR1 56.2 QR2 4.457E8 CR2 4.7
          PDOT 5.E-4 C 1.E-2 TQ 0.9 CP 452.0
          TM 1800.0 M 1.0 DC 1.0 WC 555.0E6
          RESI 1
          LECT lframeb TERM
     VPJC RO 7850.0 YOUN 2.1E11 NU 0.33 ELAS 3.257E8 MXIT 100
          QR1 2.348E8 CR1 56.2 QR2 4.457E8 CR2 4.7
          PDOT 5.E-4 C 1.E-2 TQ 0.9 CP 452.0
          TM 1800.0 M 1.0 DC 1.0 WC 555.0E6
          RESI 1
          LECT uframe TERM
     VPJC RO 7850.0 YOUN 2.1E11 NU 0.33 ELAS 11.50E8 MXIT 50 ! Docol 1400M
          QR1 2.410E8 CR1 610.9 QR2 1.641E8 CR2 95.8
          PDOT 5.E-4 C 4.E-3 TQ 0.9 CP 452.0
          TM 1800.0 M 1.0 DC 1.0 WC 741.0E6
          RESI 1
          LECT plate TERM
     MASS 0.0 YOUN 2.1E11 NU 0.33
          LECT nplate TERM
     IMPE PIMP RO 7850.0 PRES 43.9e6 PREF 0.0
          LECT presur TERM
     IMPE PIMP RO 7850 PRES 1.0 PREF 0.0 FONC 1
          LECT preplat TERM
OPTI PINS ASN
LINK COUP SPLT NONE
     BLOQ 123 LECT blox TERM
     CONT SPLA NX 0 NY 1 NZ 0 LECT symy TERM
     CONT SPLA NX 0 NY 0 NZ 1 LECT symz TERM
LINK DECO
     PINB PENA SFAC 1.0
          BODY FROT MUST 0.5 MUDY 0.5 GAMM 0 DMIN 0.0004
               LECT lframeb TERM
          BODY FROT MUST 0.5 MUDY 0.5 GAMM 0 DMIN 0.0004
               LECT uframe TERM
          BODY FROT MUST 0.5 MUDY 0.5 GAMM 0 DIAM 0.0004 ADNP
               LECT nplate TERM
          EXCL PAIR 1 2
ECRI DEPL VITE ECRO FAIL TFRE 0.2E-3
          POIN LECT cen TERM
          NOELEM
     FICH ALIT TFRE 0.1E-4
          POIN LECT cen symy TERM
          ELEM LECT prec TERM
     FICH PVTK TFRE  0.1e-3
          GROU AUTO
          VARI ECRO CONT FAIL DEPL VITE FLIA
     FICH SPLI ALIC TFRE 2.0E-4
OPTI NOTE CSTA 0.7
     LOG 1
     JAUM
     LMST
     ADAP RCON WHAN
     PINS GRID DPIN 1.01
     QUASI STATIQUE 1000. 0.7 FROM 0.0 UPTO 0.5e-3
CALC TINI 0 TEND 5.0E-3 TFAI 2.0E-8
```

```
FIN
```

D14_S2_35_FPN.epx

```
D14_S2_35_FPN
ECHO
!CONV win
CAST 'S2_FSI.msh' mesh
TRID ALE
EROS 1.0 CROI
DIME ADAP NPOI 200000
          CUVF 200000
          Q4GS 60000
          T3GS 10000
          NVFI 600000
          PMAT 50000
          NPIN 50000
     ENDA
     JONC 475 ! Total n. of nodes in a TUBM juncton
     NALE 1 NBLE 1
     TERM
GEOM CUB8 ecub8
     PR6  epri6
     Q4GS equa4 ! mems pinbcm
     T3GS etri3
     CUVF flui3d tubelp3 tank
     TUVF tubelp1
     PMAT nplate
     CL3D face3d presur abso stub3d ! pre
     TUBM rac3d1d raclp
TERM
COMP EPAI 0.8e-3 LECT plate nplate TERM
     DIAM DROI 0.1692568 LECT tubelp1 TERM
     RACC TUBM LECT rac3d1d  TERM
          NTUB LECT p1a   TERM DTUB 0.1692568
          FACE LECT face3d TERM COEF 1.0
     RACC TUBM LECT raclp  TERM
          NTUB LECT p1d3   TERM DTUB 0.1692568
          FACE LECT stub3d TERM COEF 1.0
! Attention: the TUBM element (raclp) is NOT included
! in the "mesh" object (although it IS indeed passed in from Cast3m).
! For this reason we must add it explicitly in the GROU directive below
! if we want to have it in the extracted element groups.
     GROU 21 'endtube' LECT tube TERM COND XB GT -0.6
            'trigger' LECT tube TERM COND NEAR POIN -0.1501 0 0
            'frefine' LECT flui TERM COND XB GT -0.3
                                     COND XB LT  1.0
            'pp1'    LECT plate TERM
                    COND BOX X0 0.0 Y0 0.0  Z0 0.0
                             DX 0.1 DY 0.15 DZ 0.15
            'pp2'    LECT plate TERM
                    COND BOX X0 0.0 Y0 0.0  Z0 0.0
                             DX 0.1 DY 0.165 DZ 0.165
            'fcoup'  LECT flui  TERM COND XB GT -0.05
                                     COND XB LT 0.150
                                     COND YB LT 0.150
                                     COND ZB LT 0.150
            'scoup'  LECT plate TERM COND YB LT 0.150
                                     COND ZB LT 0.150
            'lfrb2' LECT lframeb TERM
                    COND XB LT -0.865E-2
            'lfrb1' LECT lframeb DIFF lfrb2 TERM
            'uframe2'    LECT uframe DIFF presur TERM
            'S1' LECT tube TERM COND NEAR POIN -0.345 0.0 0.15
            'S2' LECT tube TERM COND NEAR POIN -0.245 0.0 0.15
            'S16' LECT flui3d TERM COND NEAR POIN -15.225 0 0.15
            'S15' LECT flui3d TERM COND NEAR POIN -15.125 0 0.15
            'S12' LECT tube TERM COND NEAR POIN -12.495 0 0.15
            'S11' LECT tube TERM COND NEAR POIN -12.395 0 0.15
            'S6' LECT tube TERM COND NEAR POIN -5.685 0 0.15
            'S5' LECT tube TERM COND NEAR POIN -5.585 0 0.15
            'epar1' LECT tubelp1 TERM COND NEAR NODE LECT p1a TERM
            'epar2' LECT tubelp1 TERM COND NEAR NODE LECT p1d3 TERM
            'tubelpp' LECT tubelp1 DIFF epar1 epar2 TERM
     NGRO 13 'blox'  LECT lframeb TERM COND !X LT -0.0253
                                            X GT 0.0253
            'symy'  LECT plate TERM    COND Y LT 0.0001
            'symz'  LECT plate TERM    COND Z LT 0.0001
            'pt0' LECT tube TERM COND NEAR POIN -16.19999 0.0 0.0
            'cen' LECT plate TERM COND NEAR POIN 0.0 0.0 0.0
            'axis1'   LECT plate TERM COND Y LT 0.0001
            'axis2'   LECT plate TERM COND Z LT 0.0001
            'csymy' LECT uframe lframeb TERM COND Y LT 0.0001
            'csymz' LECT uframe lframeb TERM COND Z LT 0.0001
            'elfb'  LECT lframeb TERM COND ENVE
            'nlfb'  LECT elfb    TERM COND X GT -0.01
                                      COND X LT  0.001
            'nbad1' LECT nlfb TERM
                    COND CONE X1 -0.009 Y1 0.260 Z1 0
                              X2  0.001 Y2 0.260 Z2 0
                              R1  0.009 R2 0.009
            'nbad2' LECT nlfb TERM
                    COND CONE X1 -0.009 Y1 0 Z1 0.260
                              X2  0.001 Y2 0 Z2 0.260
                              R1  0.009 R2 0.009
     COUL TURQ LECT tube tra lp3xl TERM
          VERT LECT plate fir2 TERM
          ROSE LECT fir1 TERM
          ROUG LECT driver TERM
         ROSE LECT S1 S2 S5 S6 S11 S12 S15 S16 TERM
ADAP THRS ECRO 11 TMIN 0.01 TMAX 0.02 MAXL 4 CRIT 1 ! NOUN
          LECT plate TERM
!          LECT pp2 TERM
GRIL LAGR LECT spec TERM
MATE
    !LOI 1
     GAZP RO 20.310 GAMM 1.4 CV 719.286 PINI 17.16E5 PREF 100.8E3
          LECT none TERM
    !LOI 2
     GAZP RO 1.193 GAMM 1.4 CV 719.286 PINI 100.8E3 PREF 100.8E3
          LECT none TERM
    !LOI 3
    GAZP RO 6.720 GAMM 1.4 CV 719.286 PINI 5.677E5 PREF 100.8E3
          LECT none TERM
    !LOI 4
     GAZP RO 1.193 GAMM 1.4 CV 719.286 PINI 100.8E3 PREF 100.8E3
          LECT flui3d TERM ! _cuvf TERM
     GAZP RO 1.193 GAMM 1.4 CV 719.286 PINI 100.8E3 PREF 100.8E3
          LECT epar1 epar2 TERM
     GAZP RO 1.193 GAMM 1.4 CV 719.286 PINI 100.8E3 PREF 100.8E3
          LECT rac3d1d raclp tubelpp TERM
     PARO PSIL 0.02
          LECT tubelpp TERM
     MULT 6 7 LECT tubelpp TERM
! In order to obtain a printout at least of the 3D VFCCs I am obliged
! to use a different material for tubelp3 and other 3D parts, but with
! the same characteristics as the material used for tubelp1
    GAZP RO 1.193 GAMM 1.4 CV 719.286 PINI 100.8E3 PREF 100.8E3
          LECT tubelp3 tank _cuvf TERM
     CLVF ABSO RO 1.187
          LECT abso TERM
     VPJC RO 7850.0 YOUN 2.1E11 NU 0.33 ELAS 3.257E8 MXIT 100
          QR1 2.348E8 CR1 56.2 QR2 4.457E8 CR2 4.7
          PDOT 5.E-4 C 1.E-2 TQ 0.9 CP 452.0
          TM 1800.0 M 1.0 DC 1.0 WC 555.0E6
          RESI 1
          LECT lframeb TERM
     VPJC RO 7850.0 YOUN 2.1E11 NU 0.33 ELAS 3.257E8 MXIT 100
          QR1 2.348E8 CR1 56.2 QR2 4.457E8 CR2 4.7
          PDOT 5.E-4 C 1.E-2 TQ 0.9 CP 452.0
          TM 1800.0 M 1.0 DC 1.0 WC 555.0E6
          RESI 1
          LECT uframe TERM
     VPJC RO 7850.0 YOUN 2.1E11 NU 0.33 ELAS 11.50E8 MXIT 50 ! Docol 1400M
          QR1 2.410E8 CR1 610.9 QR2 1.641E8 CR2 95.8
          PDOT 5.E-4 C 4.E-3 TQ 0.9 CP 452.0
          TM 1800.0 M 1.0 DC 1.0 WC 741.0E6
          RESI 1
          LECT plate TERM
     MASS 0.0 YOUN 2.1E11 NU 0.33
          LECT nplate TERM
     IMPE PIMP RO 7850.0 PRES 44.0011e6 PREF 1.011E5 !fc To be checked
          LECT presur TERM ! _cl3d TERM
OPTI PINS ASN
LINK COUP SPLT NONE
     BLOQ 123 LECT blox TERM
!    GLIS 2
!              FROT MUST 0.5 MUDY 0.5 GAMM 0
!              PGAP 0.4E-3
!            ! MAIT LECT lframeb TERM
!              MAIT NODE LECT nlfb DIFF nbad1 nbad2 TERM
!              PESC LECT plate TERM
*
!              FROT MUST 0.5 MUDY 0.5 GAMM 0
!              PGAP 0.4E-3
!              MAIT LECT uframe TERM
!              PESC LECT plate TERM
LINK DECO BLOQ 246 LECT symy TERM
          BLOQ 345 LECT symz TERM
          BLOQ 2 LECT csymy TERM
          BLOQ 3 LECT csymz TERM
     PINB PENA SFAC 1.0
          BODY FROT MUST 0.5 MUDY 0.5 GAMM 0 DMIN 0.0004
               LECT lframeb TERM
          BODY FROT MUST 0.5 MUDY 0.5 GAMM 0 DMIN 0.0004
               LECT uframe TERM
          BODY FROT MUST 0.5 MUDY 0.5 GAMM 0 DIAM 0.0004 ADNP
               LECT nplate TERM
          EXCL PAIR 1 2
     FLSW STRU LECT scoup TERM
          FLUI LECT fcoup TERM
          R 0.0087    ! 0.014
          HGRI 0.00606 ! 0.016
          DGRI
          FACE
          BFLU 2 ! block if at least one node is in influence domain
          FSCP 1 ! couple in all directions
          ADAP LMAX 2 SCAL 6
     TBLO 123    TRIG LECT lframeb uframe TERM
          123456 TRIG LECT plate TERM
INIT MAPP FORM 'D7735600map.map' MATC OBJE LECT flui3d tubelp1 TERM
ECRI DEPL VITE ECRO FAIL TFRE 0.25E-3
          POIN LECT cen axis1 axis2 TERM
          ELEM LECT S1 TERM
      FICH ALIT FREQ 0 TFRE 0.D0
          TIME PROG 0.D0 PAS 0.5D-3 22.D-3 PAS 0.01D-3 80.D-3
          POIN LECT cen axis1 axis2 TERM
          ELEM LECT S1 S2 S5 S6 S11 S12 S15 S16 TERM
!    FICH PVTK FREQ 0 TFRE 0.D0
!         TIME PROG 0.D0 PAS 0.5D-3 28.D-3 PAS 0.1D-3 40.D-3
!         PAS 1.D-3 50.D-3
!         GROU AUTO
!         VARI DEPL VITE FAIL ACCE VCVI CONT ECRO FLIA
```

```
     FICH SPLI ALIC TFRE 0.5E-3
OPTI NOTE CSTA 0.4
     GLIS NORM ELEM
     STEP IO
     LOG 1
     JAUM
     LMST
     PINS GRID DPIN 1.01
     VFCC FCON 6 ! hllc solver
          ORDR 2 ! order in space
          STPS 2 ! order in time
          RECO 1
          NTIL
     ADAP RCON WHAN
     ADAP RCON TRIG ECRO 1 TVAL 1.05E5 LECT trigger TERM
     NOCR TRIG LECT plate lframeb uframe TERM
     FLS  CUB8 2 ! For the inverse mapping
CALC TINI 0 TEND 32.0E-3 TFAI 1.143E-8 ! 2.0E-8
FIN
```

D14_S2_35_FPNw.epx

```
D14_S2_35_FPNW
ECHO
!CONV WIN
RESU SPLI ALIC 'D14_S2_35_FPN.ali' GARD PSCR
COMP COUL VERT LECT plate TERM
          GR50 LECT lframeb uframe TERM
          TURQ LECT tubelp3 tank TERM
SORT VISU NSTO 1
*=======================================================================
PLAY
*-----------------------------------------------------------------------
CAME   1 EYE  -4.60000E-03 -7.47801E-10 -1.66049E+00
!        Q    -2.05103E-10 -1.00000E+00 -6.46235E-26  2.77556E-16
         VIEW  5.55112E-16  4.10207E-10  1.00000E+00
         RIGH  1.00000E+00  1.53918E-26 -5.55112E-16
         UP    2.43102E-25 -1.00000E+00  4.10207E-10
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER : -4.60000E-03  0.00000E+00  1.62500E-01
!RSPHERE:  3.64597E-01
!RADIUS :  1.82299E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.31529E+00
!FAR    :  2.04449E+00
SCEN GEOM NAVI FREE
          LINE SFRE SSHA
     ISO  FILL FIEL ECRO 1 SCAL USER PROG 1.001E5 PAS 0.5E5 7.501E5 TERM
          SUPP LECT tubelp3 tank TERM
     LIMA ON
SLER CAM1 1 NFRA 1
FREQ 1
TRAC OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate lframeb uframe tubelp3 tank TERM ! SYXY
                                  SYXZ
                                  TOLS 1.E-3 NFAI REND
GOTR LOOP 10 OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate lframeb uframe tubelp3 tank TERM ! SYXY
                                  SYXZ
                                  TOLS 1.E-3 NFAI REND
!TRAC OFFS SIZE 1200 1200 FICH BMP
!     OBJE LECT plate lframeb TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
!*-----------------------------------------------------------------------
!SCEN GEOM NAVI FREE
!          LINE HEOU SFRE SSHA
!     LIMA ON
!SLER CAM1 1 NFRA 1
!TRAC OFFS SIZE 1200 1200 FICH BMP
!     OBJE LECT plate lframeb TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
ENDPLAY
*=======================================================================
FIN
```

D14_S2_35_FPNx.epx

```
D14_S2_35_FPNX
ECHO
!CONV WIN
RESU SPLI ALIC 'D14_S2_35_FPN.ali' GARD PSCR
COMP COUL VERT LECT plate TERM
          GR50 LECT lframeb uframe TERM
          TURQ LECT tubelp3 tank TERM
SORT VISU NSTO 1
*=======================================================================
PLAY
*-----------------------------------------------------------------------
CAME   1 EYE  -4.60000E-03 -7.47801E-10 -1.66049E+00
!        Q    -2.05103E-10 -1.00000E+00 -6.46235E-26  2.77556E-16
         VIEW  5.55112E-16  4.10207E-10  1.00000E+00
         RIGH  1.00000E+00  1.53918E-26 -5.55112E-16
         UP    2.43102E-25 -1.00000E+00  4.10207E-10
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER : -4.60000E-03  0.00000E+00  1.62500E-01
!RSPHERE:  3.64597E-01
!RADIUS :  1.82299E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.31529E+00
!FAR    :  2.04449E+00
SCEN GEOM NAVI FREE
          LINE SFRE SSHA
     LIMA ON
SLER CAM1 1 NFRA 1
FREQ 1
TRAC OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate lframeb uframe tubelp3 tank TERM ! SYXY
                                  SYXZ
                                  TOLS 1.E-3 NFAI REND
GOTR LOOP 10 OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate lframeb uframe tubelp3 tank TERM ! SYXY
                                  SYXZ
                                  TOLS 1.E-3 NFAI REND
!TRAC OFFS SIZE 1200 1200 FICH BMP
!     OBJE LECT plate lframeb TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
!*-----------------------------------------------------------------------
!SCEN GEOM NAVI FREE
!          LINE HEOU SFRE SSHA
!     LIMA ON
!SLER CAM1 1 NFRA 1
!TRAC OFFS SIZE 1200 1200 FICH BMP
!     OBJE LECT plate lframeb TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
ENDPLAY
*=======================================================================
FIN
```

D14_S2_35_FPNy.epx

```
D14_S2_35_FPNY
ECHO
!CONV WIN
RESU SPLI ALIC 'D14_S2_35_FPN.ali' GARD PSCR
COMP COUL GR80 LECT plate TERM
          GR50 LECT lframeb uframe TERM
SORT VISU NSTO 1
*=======================================================================
PLAY
CAME   1 EYE  -1.97046E+00  0.00000E+00 -4.08169E-10
!        Q     7.07107E-01  0.00000E+00 -7.07107E-01  0.00000E+00
         VIEW  1.00000E+00  0.00000E+00  2.05103E-10
         RIGH -2.05103E-10  0.00000E+00  1.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  1.96000E-02  0.00000E+00  0.00000E+00
!RSPHERE:  4.42236E-01
!RADIUS :  1.99006E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.54783E+00
!FAR    :  2.87454E+00
*-----------------------------------------------------------------------
SCEN GEOM NAVI FREE
          LINE SFRE SSHA
     LIMA ON
SLER CAM1 1 NFRA 1
TRAC OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate lframeb TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
FREQ 1
GOTR LOOP 10 OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate lframeb TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
ENDPLAY
*=======================================================================
FIN
```

D14_S2_35_FPNyy.epx

```
D14_S2_35_FPNYY
ECHO
!CONV WIN
RESU SPLI ALIC 'D14_S2_35_FPN.ali' GARD PSCR
COMP COUL GR80 LECT plate TERM
          GR50 LECT lframeb uframe TERM
SORT VISU NSTO 1
*=======================================================================
PLAY
CAME   1 EYE  -1.97046E+00  0.00000E+00 -4.08169E-10
!        Q     7.07107E-01  0.00000E+00 -7.07107E-01  0.00000E+00
         VIEW  1.00000E+00  0.00000E+00  2.05103E-10
         RIGH -2.05103E-10  0.00000E+00  1.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  1.96000E-02  0.00000E+00  0.00000E+00
!RSPHERE:  4.42236E-01
!RADIUS :  1.99006E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.54783E+00
!FAR    :  2.87454E+00
*-----------------------------------------------------------------------
SCEN GEOM NAVI FREE
          LINE HEOU SFRE SSHA
     LIMA ON
SLER CAM1 1 NFRA 1
TRAC OFFS SIZE 1200 1200 FICH BMP DEFO AMPD 0.0
     OBJE LECT plate TERM SYXY SYXZ TOLS 1.E-3 NFAI ADAP REND
FREQ 1
GOTR LOOP 10 OFFS SIZE 1200 1200 FICH BMP DEFO AMPD 0.0
```

```
    OBJE LECT plate TERM SYXY SYXZ TOLS 1.E-3 NFAI ADAP REND
ENDPLAY
*======================================================================
FIN
```

D14_S2_35_FPNz1.epx

```
D14_S2_35_FPNZ1
ECHO
 CONV WIN
RESU SPLI ALIC 'D14_S2_35_FPN.ali' GARD PSCR
COMP COUL GR80 LECT plate TERM
SORT VISU NSTO 1
*======================================================================
PLAY
CAME   1 EYE   6.49959E-01  0.00000E+00  1.78574E+00
!        Q    -9.84808E-01  0.00000E+00 -1.73648E-01  0.00000E+00
         VIEW -3.42021E-01  0.00000E+00 -9.39692E-01
         RIGH  9.39692E-01  0.00000E+00 -3.42021E-01
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  9.56724E-18  0.00000E+00  0.00000E+00
!RSPHERE:  4.41942E-01
!RADIUS :  1.90035E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.45841E+00
!FAR    :  2.78423E+00
CAME   2 EYE  -6.49959E-01  0.00000E+00  1.78574E+00
!        Q    -9.84808E-01  0.00000E+00  1.73648E-01  0.00000E+00
         VIEW  3.42021E-01  0.00000E+00 -9.39692E-01
         RIGH  9.39692E-01  0.00000E+00  3.42021E-01
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  9.56724E-18  0.00000E+00  0.00000E+00
!RSPHERE:  4.41942E-01
!RADIUS :  1.90035E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.45841E+00
!FAR    :  2.78423E+00
*----------------------------------------------------------------------
SCEN GEOM NAVI FREE
          FACE SBAC
          LINE HEOU SFRE SSHA
     LIMA ON
SLER CAM1 1 NFRA 1
TRAC OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate TERM SYXY SYXZ TOLS 1.E-3 NFAI ADAP REND
FREQ 1
GOTR LOOP 10 OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate TERM SYXY SYXZ TOLS 1.E-3 NFAI ADAP REND
ENDPLAY
*======================================================================
SUIT
Post-treatment (make avi file from bitmaps)
ECHO
RESU SPLI ALIC 'D14_S2_35_FPN.ali' GARD PSCR
*================================================================
SORT VISU NSTO 1
*================================================================
PLAY
MAVI FPS 5 KFRE 5 COMP -1 REND
ENDPLAY
*================================================================
FIN
```

D14_S2_35_FPNz2.epx

```
D14_S2_35_FPNZ2
ECHO
 CONV WIN
RESU SPLI ALIC 'D14_S2_35_FPN.ali' GARD PSCR
COMP COUL GR80 LECT plate TERM
SORT VISU NSTO 1
*======================================================================
PLAY
CAME   1 EYE   6.49959E-01  0.00000E+00  1.78574E+00
!        Q    -9.84808E-01  0.00000E+00 -1.73648E-01  0.00000E+00
         VIEW -3.42021E-01  0.00000E+00 -9.39692E-01
         RIGH  9.39692E-01  0.00000E+00 -3.42021E-01
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  9.56724E-18  0.00000E+00  0.00000E+00
!RSPHERE:  4.41942E-01
!RADIUS :  1.90035E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.45841E+00
!FAR    :  2.78423E+00
CAME   2 EYE  -6.49959E-01  0.00000E+00  1.78574E+00
!        Q    -9.84808E-01  0.00000E+00  1.73648E-01  0.00000E+00
         VIEW  3.42021E-01  0.00000E+00 -9.39692E-01
         RIGH  9.39692E-01  0.00000E+00  3.42021E-01
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  9.56724E-18  0.00000E+00  0.00000E+00
!RSPHERE:  4.41942E-01
!RADIUS :  1.90035E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.45841E+00
!FAR    :  2.78423E+00
*----------------------------------------------------------------------
SCEN GEOM NAVI FREE
          FACE SBAC
          LINE HEOU SFRE SSHA
     LIMA ON
SLER CAM1 2 NFRA 1
TRAC OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate TERM SYXY SYXZ TOLS 1.E-3 NFAI ADAP REND
FREQ 1
GOTR LOOP 10 OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate TERM SYXY SYXZ TOLS 1.E-3 NFAI ADAP REND
ENDPLAY
*======================================================================
SUIT
Post-treatment (make avi file from bitmaps)
ECHO
RESU SPLI ALIC 'D14_S2_35_FPN.ali' GARD PSCR
*================================================================
SORT VISU NSTO 1
*================================================================
PLAY
MAVI FPS 5 KFRE 5 COMP -1 REND
ENDPLAY
*================================================================
FIN
```

D14_S2_35_z1.epx

```
D14_S2_35_Z1
ECHO
 CONV WIN
RESU SPLI ALIC 'D14_S2_35.ali' GARD PSCR
COMP COUL GR80 LECT plate TERM
SORT VISU NSTO 1
*======================================================================
PLAY
CAME   1 EYE   6.49959E-01  0.00000E+00  1.78574E+00
!        Q    -9.84808E-01  0.00000E+00 -1.73648E-01  0.00000E+00
         VIEW -3.42021E-01  0.00000E+00 -9.39692E-01
         RIGH  9.39692E-01  0.00000E+00 -3.42021E-01
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  9.56724E-18  0.00000E+00  0.00000E+00
!RSPHERE:  4.41942E-01
!RADIUS :  1.90035E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.45841E+00
!FAR    :  2.78423E+00
CAME   2 EYE  -6.49959E-01  0.00000E+00  1.78574E+00
!        Q    -9.84808E-01  0.00000E+00  1.73648E-01  0.00000E+00
         VIEW  3.42021E-01  0.00000E+00 -9.39692E-01
         RIGH  9.39692E-01  0.00000E+00  3.42021E-01
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  9.56724E-18  0.00000E+00  0.00000E+00
!RSPHERE:  4.41942E-01
!RADIUS :  1.90035E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.45841E+00
!FAR    :  2.78423E+00
*----------------------------------------------------------------------
SCEN GEOM NAVI FREE
          FACE SBAC
          LINE HEOU SFRE SSHA
     LIMA ON
SLER CAM1 1 NFRA 1
TRAC OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate TERM SYXY SYXZ TOLS 1.E-3 NFAI ADAP REND
FREQ 1
GOTR LOOP 25 OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate TERM SYXY SYXZ TOLS 1.E-3 NFAI ADAP REND
ENDPLAY
*======================================================================
SUIT
Post-treatment (make avi file from bitmaps)
ECHO
RESU SPLI ALIC 'D14_S2_35.ali' GARD PSCR
*================================================================
SORT VISU NSTO 1
*================================================================
PLAY
MAVI FPS 5 KFRE 5 COMP -1 REND
ENDPLAY
*================================================================
FIN
```

D14_S2_35_z2.epx

```
D14_S2_35_Z2
ECHO
 CONV WIN
RESU SPLI ALIC 'D14_S2_35.ali' GARD PSCR
COMP COUL GR80 LECT plate TERM
SORT VISU NSTO 1
```

```
*=======================================================================
PLAY
CAME   1 EYE   6.49959E-01  0.00000E+00  1.78574E+00
!        Q    -9.84808E-01  0.00000E+00 -1.73648E-01  0.00000E+00
         VIEW -3.42021E-01  0.00000E+00 -9.39692E-01
         RIGH  9.39692E-01  0.00000E+00 -3.42021E-01
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  9.56724E-18  0.00000E+00  0.00000E+00
!RSPHERE:  4.41942E-01
!RADIUS :  1.90035E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.45841E+00
!FAR    :  2.78423E+00
CAME   2 EYE  -6.49959E-01  0.00000E+00  1.78574E+00
!        Q    -9.84808E-01  0.00000E+00  1.73648E-01  0.00000E+00
         VIEW  3.42021E-01  0.00000E+00 -9.39692E-01
         RIGH  9.39692E-01  0.00000E+00  3.42021E-01
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  9.56724E-18  0.00000E+00  0.00000E+00
!RSPHERE:  4.41942E-01
!RADIUS :  1.90035E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.45841E+00
!FAR    :  2.78423E+00
*-----------------------------------------------------------------------
SCEN GEOM NAVI FREE
          FACE SBAC
          LINE HEOU SFRE SSHA
     LIMA ON
SLER CAM1 2 NFRA 1
TRAC OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate TERM SYXY SYXZ TOLS 1.E-3 NFAI ADAP REND
FREQ 1
GOTR LOOP 25 OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate TERM SYXY SYXZ TOLS 1.E-3 NFAI ADAP REND
ENDPLAY
*=======================================================================
SUIT
Post-treatment (make avi file from bitmaps)
ECHO
RESU SPLI ALIC 'D14_S2_35.ali' GARD PSCR
*=================================================================
SORT VISU NSTO 1
*=================================================================
PLAY
MAVI FPS 5 KFRE 5 COMP -1 REND
ENDPLAY
*=================================================================
FIN
```

D14_S2_35f.epx

```
D14_S2_35F
ECHO
!CONV WIN
RESU SPLI ALIC 'D14_S2_35.ali' GARD PSCR
COMP COUL GR80 LECT plate TERM
SORT VISU NSTO 1
PLAY
CAME   1 EYE  -1.85740E+00  2.10571E-03  2.10571E-03
!        Q     7.07107E-01  0.00000E+00 -7.07107E-01  0.00000E+00
         VIEW  1.00000E+00  0.00000E+00  2.05103E-10
         RIGH -2.05103E-10  0.00000E+00  1.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER : -2.25515E-03  2.10571E-03  2.10571E-03
!RSPHERE:  4.63787E-01
!RADIUS :  1.85515E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.39136E+00
!FAR    :  2.78272E+00
SCEN GEOM NAVI FREE
          LINE HEOU SFRE
SLER CAM1 1 NFRA 1
FREQ 1
TRAC DEFO AMPD 0.0 OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate TERM
     SYXY SYXZ ! TOLS 1.E-2
     NFAI ADAP REND
GOTR LOOP 25 DEFO AMPD 0.0 OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate TERM
     SYXY SYXZ ! TOLS 1.E-2
     NFAI ADAP REND
ENDPLAY
*=======================================================================
SUIT
Post-treatment (make avi file from bitmaps)
ECHO
RESU SPLI ALIC 'D14_S2_35.ali' GARD PSCR
*=================================================================
SORT VISU NSTO 1
*=================================================================
PLAY
MAVI FPS 5 KFRE 5 COMP -1 REND
ENDPLAY
*=================================================================
FIN
```

D6_S2_10.epx

```
D6_S2_10
ECHO
!CONV win
CAST 'S2.msh' spec
EROS 1.0 CROI
TRID LAGR
DIME ADAP NPOI 100000
          Q4GS 100000
          CL3D 100000
          T3GS 20000
          CL3T 20000
          PMAT 50000
          NPIN 50000
     ENDA
TERM
GEOM CUB8 ecub8
     PR6  epri6
     Q4GS equa4
     T3GS etri3
     PMAT nplate
     CL3D presur ppqua4
     CL3T pptri3
TERM
COMP EPAI 0.8E-3 LECT plate nplate TERM
     GROU 5 'pp1'     LECT plate TERM
                      COND BOX X0 0.0 Y0 0.0  Z0 0.0
                               DX 0.1 DY 0.15 DZ 0.15
            'plaEdg'  LECT plate DIFF pp1 TERM
                      COND YB LT 0.16
                      COND ZB LT 0.16
            'nplatmp' LECT nplate  TERM
                      COND YB LT 0.16
                      COND ZB LT 0.16
            'nplalim' LECT nplate DIFF nplatmp TERM
            'prec'    LECT preplat TERM
                      COND NEAR POIN 0.0 0.0 0.0
     NGRO 4 'blox' LECT lframeb TERM COND X GT 0.0253
            'symy' LECT spec TERM COND Y LT 0.0001
            'symz' LECT spec TERM COND Z LT 0.0001
            'cen'  LECT plate TERM COND NEAR POIN 0.0 0.0 0.0
     COUL TURQ LECT lframeb TERM
          VERT LECT plate TERM
          ROSE LECT plaEdg TERM
          ROUG LECT nplalim TERM
          BLEU LECT uframe pp1 TERM
     ORIE INVE LECT preplat TERM
INCLUDE 'p77_10e.txt'
ADAP THRS ECRO 11 TMIN 0.01 TMAX 0.02 MAXL 4 CRIT 1
          LECT plate TERM
MATE VPJC RO 7850.0 YOUN 2.1E11 NU 0.33 ELAS 3.257E8 MXIT 100
          QR1 2.348E8 CR1 56.2 QR2 4.457E8 CR2 4.7
          PDOT 5.E-4 C 1.E-2 TQ 0.9 CP 452.0
          TM 1800.0 M 1.0 DC 1.0 WC 555.0E6
          RESI 1
          LECT lframeb TERM
     VPJC RO 7850.0 YOUN 2.1E11 NU 0.33 ELAS 3.257E8 MXIT 100
          QR1 2.348E8 CR1 56.2 QR2 4.457E8 CR2 4.7
          PDOT 5.E-4 C 1.E-2 TQ 0.9 CP 452.0
          TM 1800.0 M 1.0 DC 1.0 WC 555.0E6
          RESI 1
          LECT uframe TERM
     VPJC RO 7850.0 YOUN 2.1E11 NU 0.33 ELAS 3.257E8 MXIT 100 ! Docol 600
          QR1 2.348E8 CR1 56.2 QR2 4.457E8 CR2 4.7
          PDOT 5.E-4 C 1.E-2 TQ 0.9 CP 452.0
          TM 1800.0 M 1.0 DC 1.0 WC 555.0E6
          RESI 1
          LECT plate TERM
     MASS 0.0 YOUN 2.1E11 NU 0.33
          LECT nplate TERM
     IMPE PIMP RO 7850.0 PRES 43.9e6 PREF 0.0
          LECT presur TERM
     IMPE PIMP RO 7850 PRES 1.0 PREF 0.0 FONC 1
          LECT preplat TERM
OPTI PINS ASN
LINK COUP SPLT NONE
     BLOQ 123 LECT blox TERM
     CONT SPLA NX 0 NY 1 NZ 0 LECT symy TERM
     CONT SPLA NX 0 NY 0 NZ 1 LECT symz TERM
LINK DECO
     PINB PENA SFAC 1.0
          BODY FROT MUST 0.5 MUDY 0.5 GAMM 0 DMIN 0.0004
               LECT lframeb TERM
          BODY FROT MUST 0.5 MUDY 0.5 GAMM 0 DMIN 0.0004
               LECT uframe TERM
          BODY FROT MUST 0.5 MUDY 0.5 GAMM 0 DIAM 0.0004 ADNP
               LECT nplate TERM
          EXCL PAIR 1 2
ECRI DEPL VITE ECRO FAIL TFRE 0.2E-3
          POIN LECT cen TERM
          NOELEM
     FICH ALIT TFRE 0.1E-4
          POIN LECT cen symy TERM
          ELEM LECT prec TERM
     FICH PVTK TFRE  0.1e-3
          GROU AUTO
          VARI ECRO CONT FAIL DEPL VITE FLIA
```

```
     FICH SPLI ALIC TFRE 2.0E-4
OPTI NOTE CSTA 0.7
     LOG 1
     JAUM
     LMST
     ADAP RCON WHAN
     PINS GRID DPIN 1.01
     QUASI STATIQUE 1000. 0.7 FROM 0.0 UPTO 0.5e-3
CALC TINI 0 TEND 5.0E-3 TFAI 2.0E-8
FIN
```

D6_S2_10_FP.epx

```
D6_S2_10_FP
ECHO
!CONV win
CAST 'S2_FSI.msh' mesh
TRID ALE
EROS 1.0 CROI
DIME ADAP NPOI 200000
          CUVF 200000
          Q4GS 60000
          T3GS 10000
          NVFI 600000
          PMAT 50000
          NPIN 50000
     ENDA
     JONC 475 ! Total n. of nodes in a TUBM juncton
     NALE 1 NBLE 1
     TERM
GEOM CUB8 ecub8
     PR6  epri6
     Q4GS equa4 ! mems pinbcm
     T3GS etri3
     CUVF flui3d tubelp3 tank
     TUVF tubelp1
     PMAT nplate
     CL3D face3d presur abso stub3d ! pre
     TUBM rac3d1d raclp
TERM
COMP EPAI 0.8e-3 LECT plate nplate TERM
     DIAM DROI 0.1692568 LECT tubelp1 TERM
     RACC TUBM LECT rac3d1d  TERM
          NTUB LECT p1a   TERM DTUB 0.1692568
          FACE LECT face3d TERM COEF 1.0
     RACC TUBM LECT raclp  TERM
          NTUB LECT p1d3   TERM DTUB 0.1692568
          FACE LECT stub3d TERM COEF 1.0
! Attention: the TUBM element (raclp) is NOT included
! in the "mesh" object (although it IS indeed passed in from Cast3m).
! For this reason we must add it explicitly in the GROU directive below
! if we want to have it in the extracted element groups.
     GROU 21 'endtube' LECT tube TERM COND XB GT -0.6
            'trigger' LECT tube TERM COND NEAR POIN -0.1501 0 0
            'frefine' LECT flui TERM COND XB GT -0.3
                                     COND XB LT  1.0
            'pp1'    LECT plate TERM
                     COND BOX X0 0.0 Y0 0.0  Z0 0.0
                              DX 0.1 DY 0.15 DZ 0.15
            'pp2'    LECT plate TERM
                     COND BOX X0 0.0 Y0 0.0  Z0 0.0
                              DX 0.1 DY 0.165 DZ 0.165
            'fcoup'  LECT flui  TERM COND XB GT -0.05
                                     COND XB LT 0.150
                                     COND YB LT 0.150
                                     COND ZB LT 0.150
            'scoup'  LECT plate TERM COND YB LT 0.150
                                     COND ZB LT 0.150
            'lfrb2' LECT lframeb TERM
                    COND XB LT -0.865E-2
            'lfrb1' LECT lframeb DIFF lfrb2 TERM
            'uframe2'    LECT uframe DIFF presur TERM
            'S1' LECT tube TERM COND NEAR POIN -0.345 0.0 0.15
            'S2' LECT tube TERM COND NEAR POIN -0.245 0.0 0.15
            'S16' LECT flui3d TERM COND NEAR POIN -15.225 0 0.15
            'S15' LECT flui3d TERM COND NEAR POIN -15.125 0 0.15
            'S12' LECT tube TERM COND NEAR POIN -12.495 0 0.15
            'S11' LECT tube TERM COND NEAR POIN -12.395 0 0.15
            'S6' LECT tube TERM COND NEAR POIN -5.685 0 0.15
            'S5' LECT tube TERM COND NEAR POIN -5.585 0 0.15
            'epar1' LECT tubelp1 TERM COND NEAR NODE LECT p1a TERM
            'epar2' LECT tubelp1 TERM COND NEAR NODE LECT p1d3 TERM
            'tubelpp' LECT tubelp1 DIFF epar1 epar2 TERM
     NGRO 13 'blox'  LECT lframeb TERM COND !X LT -0.0253
                                             X GT 0.0253
            'symy'  LECT plate TERM    COND Y LT 0.0001
            'symz'  LECT plate TERM    COND Z LT 0.0001
            'pt0' LECT tube TERM COND NEAR POIN -16.19999 0.0 0.0
            'cen' LECT plate TERM COND NEAR POIN 0.0 0.0 0.0
            'axis1'   LECT plate TERM COND Y LT 0.0001
            'axis2'   LECT plate TERM COND Z LT 0.0001
            'csymy' LECT uframe lframeb TERM COND Y LT 0.0001
            'csymz' LECT uframe lframeb TERM COND Z LT 0.0001
            'elfb'  LECT lframeb TERM COND ENVE
            'nlfb'  LECT elfb    TERM COND X GT -0.01
                                      COND X LT  0.001
            'nbad1' LECT nlfb TERM
                    COND CONE X1 -0.009 Y1 0.260 Z1 0
                              X2  0.001 Y2 0.260 Z2 0
                              R1  0.009 R2 0.009
            'nbad2' LECT nlfb TERM
                    COND CONE X1 -0.009 Y1 0 Z1 0.260
                              X2  0.001 Y2 0 Z2 0.260
                              R1  0.009 R2 0.009
     COUL TURQ LECT tube tra lp3xl TERM
          VERT LECT plate fir2 TERM
          ROSE LECT fir1 TERM
          ROUG LECT driver TERM
         ROSE LECT S1 S2 S5 S6 S11 S12 S15 S16 TERM
ADAP THRS ECRO 11 TMIN 0.01 TMAX 0.02 MAXL 4 CRIT 1 ! NOUN
          LECT plate TERM
!          LECT pp2 TERM
GRIL LAGR LECT spec TERM
MATE
    !LOI 1
     GAZP RO 20.310 GAMM 1.4 CV 719.286 PINI 17.16E5 PREF 100.8E3
          LECT none TERM
    !LOI 2
     GAZP RO 1.193 GAMM 1.4 CV 719.286 PINI 100.8E3 PREF 100.8E3
          LECT none TERM
    !LOI 3
    GAZP RO 6.720 GAMM 1.4 CV 719.286 PINI 5.677E5 PREF 100.8E3
          LECT none TERM
    !LOI 4
     GAZP RO 1.193 GAMM 1.4 CV 719.286 PINI 100.8E3 PREF 100.8E3
          LECT flui3d TERM ! _cuvf TERM
     GAZP RO 1.193 GAMM 1.4 CV 719.286 PINI 100.8E3 PREF 100.8E3
          LECT epar1 epar2 TERM
     GAZP RO 1.193 GAMM 1.4 CV 719.286 PINI 100.8E3 PREF 100.8E3
          LECT rac3d1d raclp tubelpp TERM
     PARO PSIL 0.02
          LECT tubelpp TERM
     MULT 6 7 LECT tubelpp TERM
! In order to obtain a printout at least of the 3D VFCCs I am obliged
! to use a different material for tubelp3 and other 3D parts, but with
! the same characteristics as the material used for tubelp1
    GAZP RO 1.193 GAMM 1.4 CV 719.286 PINI 100.8E3 PREF 100.8E3
          LECT tubelp3 tank _cuvf TERM
     CLVF ABSO RO 1.187
          LECT abso TERM
     VPJC RO 7850.0 YOUN 2.1E11 NU 0.33 ELAS 3.257E8 MXIT 100
          QR1 2.348E8 CR1 56.2 QR2 4.457E8 CR2 4.7
          PDOT 5.E-4 C 1.E-2 TQ 0.9 CP 452.0
          TM 1800.0 M 1.0 DC 1.0 WC 555.0E6
          RESI 1
          LECT lframeb TERM
     VPJC RO 7850.0 YOUN 2.1E11 NU 0.33 ELAS 3.257E8 MXIT 100
          QR1 2.348E8 CR1 56.2 QR2 4.457E8 CR2 4.7
          PDOT 5.E-4 C 1.E-2 TQ 0.9 CP 452.0
          TM 1800.0 M 1.0 DC 1.0 WC 555.0E6
          RESI 1
          LECT uframe TERM
     VPJC RO 7850.0 YOUN 2.1E11 NU 0.33 ELAS 3.257E8 MXIT 100 ! Docol 600
          QR1 2.348E8 CR1 56.2 QR2 4.457E8 CR2 4.7
          PDOT 5.E-4 C 1.E-2 TQ 0.9 CP 452.0
          TM 1800.0 M 1.0 DC 1.0 WC 555.0E6
          RESI 1
          LECT plate TERM
     MASS 0.0 YOUN 2.1E11 NU 0.33
          LECT nplate TERM
     IMPE PIMP RO 7850.0 PRES 44.0011e6 PREF 1.011E5 !fc To be checked
          LECT presur TERM ! _cl3d TERM
OPTI PINS ASN
LINK COUP SPLT NONE
     BLOQ 123 LECT blox TERM
!    GLIS 2
!              FROT MUST 0.5 MUDY 0.5 GAMM 0
!              PGAP 0.4E-3
!            ! MAIT LECT lframeb TERM
!              MAIT NODE LECT nlfb DIFF nbad1 nbad2 TERM
!              PESC LECT plate TERM
*
!              FROT MUST 0.5 MUDY 0.5 GAMM 0
!              PGAP 0.4E-3
!              MAIT LECT uframe TERM
!              PESC LECT plate TERM
LINK DECO BLOQ 246 LECT symy TERM
          BLOQ 345 LECT symz TERM
          BLOQ 2 LECT csymy TERM
          BLOQ 3 LECT csymz TERM
     PINB PENA SFAC 1.0
          BODY FROT MUST 0.5 MUDY 0.5 GAMM 0 DMIN 0.0004
               LECT lframeb TERM
          BODY FROT MUST 0.5 MUDY 0.5 GAMM 0 DMIN 0.0004
               LECT uframe TERM
          BODY FROT MUST 0.5 MUDY 0.5 GAMM 0 DIAM 0.0004 ADNP
               LECT nplate TERM
          EXCL PAIR 1 2
     FLSW STRU LECT scoup TERM
          FLUI LECT fcoup TERM
          R 0.0087    ! 0.014
          HGRI 0.00606 ! 0.016
          DGRI
          FACE
          BFLU 2 ! block if at least one node is in influence domain
          FSCP 1 ! couple in all directions
          ADAP LMAX 2 SCAL 6
     TBLO 123    TRIG LECT lframeb uframe TERM
          123456 TRIG LECT plate TERM
INIT MAPP FORM 'D7710600mape_01.map' MATC OBJE LECT flui3d tubelp1 TERM
ECRI DEPL VITE ECRO FAIL TFRE 0.25E-3
          POIN LECT cen axis1 axis2 TERM
          ELEM LECT S1 TERM
```

```
     FICH ALIT FREQ 0 TFRE 0.D0
         TIME PROG 0.D0 PAS 0.5D-3 22.D-3 PAS 0.01D-3 80.D-3
         POIN LECT cen axis1 axis2 TERM
         ELEM LECT S1 S2 S5 S6 S11 S12 S15 S16 TERM
!    FICH PVTK FREQ 0 TFRE 0.D0
!        TIME PROG 0.D0 PAS 0.5D-3 28.D-3 PAS 0.1D-3 40.D-3
!        PAS 1.D-3 50.D-3
!        GROU AUTO
!        VARI DEPL VITE FAIL ACCE VCVI CONT ECRO FLIA
     FICH SPLI ALIC TFRE 0.5E-3
OPTI NOTE CSTA 0.4
     GLIS NORM ELEM
     STEP IO
     LOG 1
     JAUM
     LMST
     PINS GRID DPIN 1.01
     VFCC FCON 6 ! hllc solver
          ORDR 2 ! order in space
          STPS 2 ! order in time
          RECO 1
          NTIL
     ADAP RCON WHAN
     ADAP RCON TRIG ECRO 1 TVAL 1.05E5 LECT trigger TERM
     NOCR TRIG LECT plate lframeb uframe TERM
     FLS  CUB8 2 ! For the inverse mapping
CALC TINI 0 TEND 40.0E-3 TFAI 1.143E-8 ! 2.0E-8
FIN
```

D6_S2_10_FPw.epx

```
D6_S2_10_FPW
ECHO
!CONV WIN
RESU SPLI ALIC 'D6_S2_10_FP.ali' GARD PSCR
COMP COUL VERT LECT plate TERM
          GR50 LECT lframeb uframe TERM
          TURQ LECT tubelp3 tank TERM
SORT VISU NSTO 1
*=======================================================================
PLAY
*-----------------------------------------------------------------------
CAME   1 EYE  -4.60000E-03 -7.47801E-10 -1.66049E+00
!        Q    -2.05103E-10 -1.00000E+00 -6.46235E-26  2.77556E-16
         VIEW  5.55112E-16  4.10207E-10  1.00000E+00
         RIGH  1.00000E+00  1.53918E-26 -5.55112E-16
         UP    2.43102E-25 -1.00000E+00  4.10207E-10
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER : -4.60000E-03  0.00000E+00  1.62500E-01
!RSPHERE:  3.64597E-01
!RADIUS :  1.82299E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.31529E+00
!FAR    :  2.04449E+00
SCEN GEOM NAVI FREE
         LINE SFRE SSHA
     ISO  FILL FIEL ECRO 1 SCAL USER PROG 1.001E5 PAS 0.5E5 7.501E5 TERM
         SUPP LECT tubelp3 tank TERM
     LIMA ON
SLER CAM1 1 NFRA 1
FREQ 1
TRAC OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate lframeb uframe tubelp3 tank TERM ! SYXY
                                SYXZ
                                TOLS 1.E-3 NFAI REND
GOTR LOOP 12 OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate lframeb uframe tubelp3 tank TERM ! SYXY
                                SYXZ
                                TOLS 1.E-3 NFAI REND
ENDPLAY
*=======================================================================
SUIT
Post-treatment (make avi file from bitmaps)
ECHO
RESU SPLI ALIC 'D6_S2_10_FP.ali' GARD PSCR
*=================================================================
SORT VISU NSTO 1
*=================================================================
PLAY
MAVI FPS 5 KFRE 5 COMP -1 REND
ENDPLAY
*=================================================================
FIN
```

D6_S2_10_FPx.epx

```
D6_S2_10_FPX
ECHO
!CONV WIN
RESU SPLI ALIC 'D6_S2_10_FP.ali' GARD PSCR
COMP COUL VERT LECT plate TERM
          GR50 LECT lframeb uframe TERM
          TURQ LECT tubelp3 tank TERM
SORT VISU NSTO 1
*=======================================================================
PLAY
*-----------------------------------------------------------------------
CAME   1 EYE  -4.60000E-03 -7.47801E-10 -1.66049E+00
!        Q    -2.05103E-10 -1.00000E+00 -6.46235E-26  2.77556E-16
         VIEW  5.55112E-16  4.10207E-10  1.00000E+00
         RIGH  1.00000E+00  1.53918E-26 -5.55112E-16
         UP    2.43102E-25 -1.00000E+00  4.10207E-10
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER : -4.60000E-03  0.00000E+00  1.62500E-01
!RSPHERE:  3.64597E-01
!RADIUS :  1.82299E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.31529E+00
!FAR    :  2.04449E+00
SCEN GEOM NAVI FREE
         LINE SFRE SSHA
     LIMA ON
SLER CAM1 1 NFRA 1
FREQ 1
TRAC OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate lframeb uframe tubelp3 tank TERM ! SYXY
                                SYXZ
                                TOLS 1.E-3 NFAI REND
GOTR LOOP 12 OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate lframeb uframe tubelp3 tank TERM ! SYXY
                                SYXZ
                                TOLS 1.E-3 NFAI REND
ENDPLAY
*=======================================================================
SUIT
Post-treatment (make avi file from bitmaps)
ECHO
RESU SPLI ALIC 'D6_S2_10_FP.ali' GARD PSCR
*=================================================================
SORT VISU NSTO 1
*=================================================================
PLAY
MAVI FPS 5 KFRE 5 COMP -1 REND
ENDPLAY
*=================================================================
FIN
```

D6_S2_10_FPy.epx

```
D6_S2_10_FPY
ECHO
!CONV WIN
RESU SPLI ALIC 'D6_S2_10_FP.ali' GARD PSCR
COMP COUL GR80 LECT plate TERM
          GR50 LECT lframeb uframe TERM
SORT VISU NSTO 1
*=======================================================================
PLAY
CAME   1 EYE  -1.97046E+00  0.00000E+00 -4.08169E-10
!        Q     7.07107E-01  0.00000E+00 -7.07107E-01  0.00000E+00
         VIEW  1.00000E+00  0.00000E+00  2.05103E-10
         RIGH -2.05103E-10  0.00000E+00  1.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  1.96000E-02  0.00000E+00  0.00000E+00
!RSPHERE:  4.42236E-01
!RADIUS :  1.99006E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.54783E+00
!FAR    :  2.87454E+00
*-----------------------------------------------------------------------
SCEN GEOM NAVI FREE
         LINE SFRE SSHA
     LIMA ON
SLER CAM1 1 NFRA 1
TRAC OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate lframeb TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
FREQ 1
GOTR LOOP 12 OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate lframeb TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
ENDPLAY
*=======================================================================
SUIT
Post-treatment (make avi file from bitmaps)
ECHO
RESU SPLI ALIC 'D6_S2_10_FP.ali' GARD PSCR
*=================================================================
SORT VISU NSTO 1
*=================================================================
PLAY
MAVI FPS 5 KFRE 5 COMP -1 REND
ENDPLAY
*=================================================================
FIN
```

D6_S2_10_FPyy.epx

```
D6_S2_10_FPYY
ECHO
!CONV WIN
RESU SPLI ALIC 'D6_S2_10_FP.ali' GARD PSCR
COMP COUL GR80 LECT plate TERM
          GR50 LECT lframeb uframe TERM
SORT VISU NSTO 1
*=======================================================================
PLAY
```

```
CAME   1 EYE  -1.97046E+00  0.00000E+00 -4.08169E-10
!        Q     7.07107E-01  0.00000E+00 -7.07107E-01  0.00000E+00
         VIEW  1.00000E+00  0.00000E+00  2.05103E-10
         RIGH -2.05103E-10  0.00000E+00  1.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  1.96000E-02  0.00000E+00  0.00000E+00
!RSPHERE:  4.42236E-01
!RADIUS :  1.99006E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.54783E+00
!FAR    :  2.87454E+00
*-----------------------------------------------------------------------
SCEN GEOM NAVI FREE
          LINE HEOU SFRE SSHA
     LIMA ON
SLER CAM1 1 NFRA 1
TRAC OFFS SIZE 1200 1200 FICH BMP DEFO AMPD 0.0
     OBJE LECT plate TERM SYXY SYXZ TOLS 1.E-3 NFAI ADAP REND
FREQ 1
GOTR LOOP 12 OFFS SIZE 1200 1200 FICH BMP DEFO AMPD 0.0
     OBJE LECT plate TERM SYXY SYXZ TOLS 1.E-3 NFAI ADAP REND
ENDPLAY
*=======================================================================
SUIT
Post-treatment (make avi file from bitmaps)
ECHO
RESU SPLI ALIC 'D6_S2_10_FP.ali' GARD PSCR
*=================================================================
SORT VISU NSTO 1
*=================================================================
PLAY
MAVI FPS 5 KFRE 5 COMP -1 REND
ENDPLAY
*=================================================================
FIN
```

D6_S2_10_FPz1.epx

```
D6_S2_10_FPZ1
ECHO
 CONV WIN
RESU SPLI ALIC 'D6_S2_10_FP.ali' GARD PSCR
COMP COUL GR80 LECT plate TERM
SORT VISU NSTO 1
*=======================================================================
PLAY
CAME   1 EYE   6.49959E-01  0.00000E+00  1.78574E+00
!        Q    -9.84808E-01  0.00000E+00 -1.73648E-01  0.00000E+00
         VIEW -3.42021E-01  0.00000E+00 -9.39692E-01
         RIGH  9.39692E-01  0.00000E+00 -3.42021E-01
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  9.56724E-18  0.00000E+00  0.00000E+00
!RSPHERE:  4.41942E-01
!RADIUS :  1.90035E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.45841E+00
!FAR    :  2.78423E+00
CAME   2 EYE  -6.49959E-01  0.00000E+00  1.78574E+00
!        Q    -9.84808E-01  0.00000E+00  1.73648E-01  0.00000E+00
         VIEW  3.42021E-01  0.00000E+00 -9.39692E-01
         RIGH  9.39692E-01  0.00000E+00  3.42021E-01
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  9.56724E-18  0.00000E+00  0.00000E+00
!RSPHERE:  4.41942E-01
!RADIUS :  1.90035E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.45841E+00
!FAR    :  2.78423E+00
*-----------------------------------------------------------------------
SCEN GEOM NAVI FREE
          FACE SBAC
          LINE HEOU SFRE SSHA
     LIMA ON
SLER CAM1 1 NFRA 1
TRAC OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate TERM SYXY SYXZ TOLS 1.E-3 NFAI ADAP REND
FREQ 1
GOTR LOOP 12 OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate TERM SYXY SYXZ TOLS 1.E-3 NFAI ADAP REND
ENDPLAY
*=======================================================================
SUIT
Post-treatment (make avi file from bitmaps)
ECHO
RESU SPLI ALIC 'D6_S2_10_FP.ali' GARD PSCR
*=================================================================
SORT VISU NSTO 1
*=================================================================
PLAY
MAVI FPS 5 KFRE 5 COMP -1 REND
ENDPLAY
*=================================================================
FIN
```

D6_S2_10_FPz2.epx

```
D6_S2_10_FPZ2
ECHO
 CONV WIN
RESU SPLI ALIC 'D6_S2_10_FP.ali' GARD PSCR
COMP COUL GR80 LECT plate TERM
SORT VISU NSTO 1
*=======================================================================
PLAY
CAME   1 EYE   6.49959E-01  0.00000E+00  1.78574E+00
!        Q    -9.84808E-01  0.00000E+00 -1.73648E-01  0.00000E+00
         VIEW -3.42021E-01  0.00000E+00 -9.39692E-01
         RIGH  9.39692E-01  0.00000E+00 -3.42021E-01
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  9.56724E-18  0.00000E+00  0.00000E+00
!RSPHERE:  4.41942E-01
!RADIUS :  1.90035E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.45841E+00
!FAR    :  2.78423E+00
CAME   2 EYE  -6.49959E-01  0.00000E+00  1.78574E+00
!        Q    -9.84808E-01  0.00000E+00  1.73648E-01  0.00000E+00
         VIEW  3.42021E-01  0.00000E+00 -9.39692E-01
         RIGH  9.39692E-01  0.00000E+00  3.42021E-01
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  9.56724E-18  0.00000E+00  0.00000E+00
!RSPHERE:  4.41942E-01
!RADIUS :  1.90035E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.45841E+00
!FAR    :  2.78423E+00
*-----------------------------------------------------------------------
SCEN GEOM NAVI FREE
          FACE SBAC
          LINE HEOU SFRE SSHA
     LIMA ON
SLER CAM1 2 NFRA 1
TRAC OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate TERM SYXY SYXZ TOLS 1.E-3 NFAI ADAP REND
FREQ 1
GOTR LOOP 12 OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate TERM SYXY SYXZ TOLS 1.E-3 NFAI ADAP REND
ENDPLAY
*=======================================================================
SUIT
Post-treatment (make avi file from bitmaps)
ECHO
RESU SPLI ALIC 'D6_S2_10_FP.ali' GARD PSCR
*=================================================================
SORT VISU NSTO 1
*=================================================================
PLAY
MAVI FPS 5 KFRE 5 COMP -1 REND
ENDPLAY
*=================================================================
FIN
```

D6_S2_10_z1.epx

```
D6_S2_10_Z1
ECHO
 CONV WIN
RESU SPLI ALIC 'D6_S2_10.ali' GARD PSCR
COMP COUL GR80 LECT plate TERM
SORT VISU NSTO 1
*=======================================================================
PLAY
CAME   1 EYE   6.49959E-01  0.00000E+00  1.78574E+00
!        Q    -9.84808E-01  0.00000E+00 -1.73648E-01  0.00000E+00
         VIEW -3.42021E-01  0.00000E+00 -9.39692E-01
         RIGH  9.39692E-01  0.00000E+00 -3.42021E-01
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  9.56724E-18  0.00000E+00  0.00000E+00
!RSPHERE:  4.41942E-01
!RADIUS :  1.90035E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.45841E+00
!FAR    :  2.78423E+00
CAME   2 EYE  -6.49959E-01  0.00000E+00  1.78574E+00
!        Q    -9.84808E-01  0.00000E+00  1.73648E-01  0.00000E+00
         VIEW  3.42021E-01  0.00000E+00 -9.39692E-01
         RIGH  9.39692E-01  0.00000E+00  3.42021E-01
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  9.56724E-18  0.00000E+00  0.00000E+00
!RSPHERE:  4.41942E-01
!RADIUS :  1.90035E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.45841E+00
!FAR    :  2.78423E+00
*-----------------------------------------------------------------------
SCEN GEOM NAVI FREE
          FACE SBAC
          LINE HEOU SFRE SSHA
```

```
     LIMA ON
SLER CAM1 1 NFRA 1
TRAC OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate TERM SYXY SYXZ TOLS 1.E-3 NFAI ADAP REND
FREQ 1
GOTR LOOP 25 OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate TERM SYXY SYXZ TOLS 1.E-3 NFAI ADAP REND
ENDPLAY
*=======================================================================
SUIT
Post-treatment (make avi file from bitmaps)
ECHO
RESU SPLI ALIC 'D6_S2_10.ali' GARD PSCR
*=================================================================
SORT VISU NSTO 1
*=================================================================
PLAY
MAVI FPS 5 KFRE 5 COMP -1 REND
ENDPLAY
*=================================================================
FIN
```

D6_S2_10_z2.epx

```
D6_S2_10_Z2
ECHO
 CONV WIN
RESU SPLI ALIC 'D6_S2_10.ali' GARD PSCR
COMP COUL GR80 LECT plate TERM
SORT VISU NSTO 1
*=======================================================================
PLAY
CAME   1 EYE   6.49959E-01  0.00000E+00  1.78574E+00
!        Q    -9.84808E-01  0.00000E+00 -1.73648E-01  0.00000E+00
         VIEW -3.42021E-01  0.00000E+00 -9.39692E-01
         RIGH  9.39692E-01  0.00000E+00 -3.42021E-01
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  9.56724E-18  0.00000E+00  0.00000E+00
!RSPHERE:  4.41942E-01
!RADIUS :  1.90035E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.45841E+00
!FAR    :  2.78423E+00
CAME   2 EYE  -6.49959E-01  0.00000E+00  1.78574E+00
!        Q    -9.84808E-01  0.00000E+00  1.73648E-01  0.00000E+00
         VIEW  3.42021E-01  0.00000E+00 -9.39692E-01
         RIGH  9.39692E-01  0.00000E+00  3.42021E-01
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  9.56724E-18  0.00000E+00  0.00000E+00
!RSPHERE:  4.41942E-01
!RADIUS :  1.90035E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.45841E+00
!FAR    :  2.78423E+00
*-----------------------------------------------------------------------
SCEN GEOM NAVI FREE
          FACE SBAC
          LINE HEOU SFRE SSHA
     LIMA ON
SLER CAM1 2 NFRA 1
TRAC OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate TERM SYXY SYXZ TOLS 1.E-3 NFAI ADAP REND
FREQ 1
GOTR LOOP 25 OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate TERM SYXY SYXZ TOLS 1.E-3 NFAI ADAP REND
ENDPLAY
*=======================================================================
SUIT
Post-treatment (make avi file from bitmaps)
ECHO
RESU SPLI ALIC 'D6_S2_10.ali' GARD PSCR
*=================================================================
SORT VISU NSTO 1
*=================================================================
PLAY
MAVI FPS 5 KFRE 5 COMP -1 REND
ENDPLAY
*=================================================================
FIN
```

D6_S2_10f.epx

```
D6_S2_10F
ECHO
!CONV WIN
RESU SPLI ALIC 'D6_S2_10.ali' GARD PSCR
COMP COUL GR80 LECT plate TERM
SORT VISU NSTO 1
PLAY
CAME   1 EYE  -1.85740E+00  2.10571E-03  2.10571E-03
!        Q     7.07107E-01  0.00000E+00 -7.07107E-01  0.00000E+00
         VIEW  1.00000E+00  0.00000E+00  2.05103E-10
         RIGH -2.05103E-10  0.00000E+00  1.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER : -2.25515E-03  2.10571E-03  2.10571E-03
!RSPHERE:  4.63787E-01
!RADIUS :  1.85515E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.39136E+00
!FAR    :  2.78272E+00
SCEN GEOM NAVI FREE
          LINE HEOU SFRE
SLER CAM1 1 NFRA 1
FREQ 1
TRAC DEFO AMPD 0.0 OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate TERM
     SYXY SYXZ ! TOLS 1.E-2
     NFAI ADAP REND
GOTR LOOP 25 DEFO AMPD 0.0 OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate TERM
     SYXY SYXZ ! TOLS 1.E-2
     NFAI ADAP REND
ENDPLAY
*=======================================================================
SUIT
Post-treatment (make avi file from bitmaps)
ECHO
RESU SPLI ALIC 'D6_S2_10.ali' GARD PSCR
*=================================================================
SORT VISU NSTO 1
*=================================================================
PLAY
MAVI FPS 5 KFRE 5 COMP -1 REND
ENDPLAY
*=================================================================
FIN
```

D6_S2_15.epx

```
D6_S2_15
ECHO
!CONV win
CAST 'S2.msh' spec
EROS 1.0 CROI
TRID LAGR
DIME ADAP NPOI 100000
          Q4GS 100000
          CL3D 100000
          T3GS 20000
          CL3T 20000
          PMAT 50000
          NPIN 50000
     ENDA
TERM
GEOM CUB8 ecub8
     PR6  epri6
     Q4GS equa4
     T3GS etri3
     PMAT nplate
     CL3D presur ppqua4
     CL3T pptri3
TERM
COMP EPAI 0.8E-3 LECT plate nplate TERM
     GROU 5 'pp1'     LECT plate TERM
                      COND BOX X0 0.0 Y0 0.0  Z0 0.0
                               DX 0.1 DY 0.15 DZ 0.15
            'plaEdg'  LECT plate DIFF pp1 TERM
                      COND YB LT 0.16
                      COND ZB LT 0.16
            'nplatmp' LECT nplate  TERM
                      COND YB LT 0.16
                      COND ZB LT 0.16
            'nplalim' LECT nplate DIFF nplatmp TERM
            'prec'    LECT preplat TERM
                      COND NEAR POIN 0.0 0.0 0.0
     NGRO 4 'blox' LECT lframeb TERM COND X GT 0.0253
            'symy' LECT spec TERM COND Y LT 0.0001
            'symz' LECT spec TERM COND Z LT 0.0001
            'cen'  LECT plate TERM COND NEAR POIN 0.0 0.0 0.0
     COUL TURQ LECT lframeb TERM
          VERT LECT plate TERM
          ROSE LECT plaEdg TERM
          ROUG LECT nplalim TERM
          BLEU LECT uframe pp1 TERM
     ORIE INVE LECT preplat TERM
INCLUDE 'p77_15e.txt'
ADAP THRS ECRO 11 TMIN 0.01 TMAX 0.02 MAXL 4 CRIT 1
          LECT plate TERM
MATE VPJC RO 7850.0 YOUN 2.1E11 NU 0.33 ELAS 3.257E8 MXIT 100
          QR1 2.348E8 CR1 56.2 QR2 4.457E8 CR2 4.7
          PDOT 5.E-4 C 1.E-2 TQ 0.9 CP 452.0
          TM 1800.0 M 1.0 DC 1.0 WC 555.0E6
          RESI 1
          LECT lframeb TERM
     VPJC RO 7850.0 YOUN 2.1E11 NU 0.33 ELAS 3.257E8 MXIT 100
          QR1 2.348E8 CR1 56.2 QR2 4.457E8 CR2 4.7
          PDOT 5.E-4 C 1.E-2 TQ 0.9 CP 452.0
          TM 1800.0 M 1.0 DC 1.0 WC 555.0E6
          RESI 1
          LECT uframe TERM
     VPJC RO 7850.0 YOUN 2.1E11 NU 0.33 ELAS 3.257E8 MXIT 100 ! Docol 600
          QR1 2.348E8 CR1 56.2 QR2 4.457E8 CR2 4.7
          PDOT 5.E-4 C 1.E-2 TQ 0.9 CP 452.0
```

```
        TM 1800.0 M 1.0 DC 1.0 WC 555.0E6
        RESI 1
        LECT plate TERM
    MASS 0.0 YOUN 2.1E11 NU 0.33
        LECT nplate TERM
    IMPE PIMP RO 7850.0 PRES 43.9e6 PREF 0.0
        LECT presur TERM
    IMPE PIMP RO 7850 PRES 1.0 PREF 0.0 FONC 1
        LECT preplat TERM
OPTI PINS ASN
LINK COUP SPLT NONE
    BLOQ 123 LECT blox TERM
    CONT SPLA NX 0 NY 1 NZ 0 LECT symy TERM
    CONT SPLA NX 0 NY 0 NZ 1 LECT symz TERM
LINK DECO
    PINB PENA SFAC 1.0
        BODY FROT MUST 0.5 MUDY 0.5 GAMM 0 DMIN 0.0004
            LECT lframeb TERM
        BODY FROT MUST 0.5 MUDY 0.5 GAMM 0 DMIN 0.0004
            LECT uframe TERM
        BODY FROT MUST 0.5 MUDY 0.5 GAMM 0 DIAM 0.0004 ADNP
            LECT nplate TERM
        EXCL PAIR 1 2
ECRI DEPL VITE ECRO FAIL TFRE 0.2E-3
        POIN LECT cen TERM
        NOELEM
    FICH ALIT TFRE 0.1E-4
        POIN LECT cen symy TERM
        ELEM LECT prec TERM
    FICH PVTK TFRE  0.1e-3
        GROU AUTO
        VARI ECRO CONT FAIL DEPL VITE FLIA
    FICH SPLI ALIC TFRE 2.0E-4
OPTI NOTE CSTA 0.7
    LOG 1
    JAUM
    LMST
    ADAP RCON WHAN
    PINS GRID DPIN 1.01
    QUASI STATIQUE 1000. 0.7 FROM 0.0 UPTO 0.5e-3
CALC TINI 0 TEND 5.0E-3 TFAI 2.0E-8
FIN
```

D6_S2_15_FP.epx

```
D6_S2_15_FP
ECHO
!CONV win
CAST 'S2_FSI.msh' mesh
TRID ALE
EROS 1.0 CROI
DIME ADAP NPOI 200000
        CUVF 200000
        Q4GS 60000
        T3GS 10000
        NVFI 600000
        PMAT 50000
        NPIN 50000
    ENDA
    JONC 475 ! Total n. of nodes in a TUBM juncton
    NALE 1 NBLE 1
    TERM
GEOM CUB8 ecub8
    PR6  epri6
    Q4GS equa4 ! mems pinbcm
    T3GS etri3
    CUVF flui3d tubelp3 tank
    TUVF tubelp1
    PMAT nplate
    CL3D face3d presur abso stub3d ! pre
    TUBM rac3d1d raclp
TERM
COMP EPAI 0.8e-3 LECT plate nplate TERM
    DIAM DROI 0.1692568 LECT tubelp1 TERM
    RACC TUBM LECT rac3d1d  TERM
        NTUB LECT p1a   TERM DTUB 0.1692568
        FACE LECT face3d TERM COEF 1.0
    RACC TUBM LECT raclp  TERM
        NTUB LECT p1d3   TERM DTUB 0.1692568
        FACE LECT stub3d TERM COEF 1.0
! Attention: the TUBM element (raclp) is NOT included
! in the "mesh" object (although it IS indeed passed in from Cast3m).
! For this reason we must add it explicitly in the GROU directive below
! if we want to have it in the extracted element groups.
    GROU 21 'endtube' LECT tube TERM COND XB GT -0.6
          'trigger' LECT tube TERM COND NEAR POIN -0.1501 0 0
          'frefine' LECT flui TERM COND XB GT -0.3
                                   COND XB LT  1.0
          'pp1'    LECT plate TERM
                   COND BOX X0 0.0 Y0 0.0  Z0 0.0
                            DX 0.1 DY 0.15 DZ 0.15
          'pp2'    LECT plate TERM
                   COND BOX X0 0.0 Y0 0.0  Z0 0.0
                            DX 0.1 DY 0.165 DZ 0.165
          'fcoup'  LECT flui  TERM COND XB GT -0.05
                                   COND XB LT 0.150
                                   COND YB LT 0.150
                                   COND ZB LT 0.150
          'scoup'  LECT plate TERM COND YB LT 0.150
                                   COND ZB LT 0.150
          'lfrb2' LECT lframeb TERM
                  COND XB LT -0.865E-2
          'lfrb1' LECT lframeb DIFF lfrb2 TERM
          'uframe2'    LECT uframe DIFF presur TERM
          'S1' LECT tube TERM COND NEAR POIN -0.345 0.0 0.15
          'S2' LECT tube TERM COND NEAR POIN -0.245 0.0 0.15
          'S16' LECT flui3d TERM COND NEAR POIN -15.225 0 0.15
          'S15' LECT flui3d TERM COND NEAR POIN -15.125 0 0.15
          'S12' LECT tube TERM COND NEAR POIN -12.495 0 0.15
          'S11' LECT tube TERM COND NEAR POIN -12.395 0 0.15
          'S6' LECT tube TERM COND NEAR POIN -5.685 0 0.15
          'S5' LECT tube TERM COND NEAR POIN -5.585 0 0.15
          'epar1' LECT tubelp1 TERM COND NEAR NODE LECT p1a TERM
          'epar2' LECT tubelp1 TERM COND NEAR NODE LECT p1d3 TERM
          'tubelpp' LECT tubelp1 DIFF epar1 epar2 TERM
    NGRO 13 'blox'  LECT lframeb TERM COND !X LT -0.0253
                                          X GT 0.0253
          'symy'  LECT plate TERM    COND Y LT 0.0001
          'symz'  LECT plate TERM    COND Z LT 0.0001
          'pt0' LECT tube TERM COND NEAR POIN -16.19999 0.0 0.0
          'cen' LECT plate TERM COND NEAR POIN 0.0 0.0 0.0
          'axis1'   LECT plate TERM COND Y LT 0.0001
          'axis2'   LECT plate TERM COND Z LT 0.0001
          'csymy' LECT uframe lframeb TERM COND Y LT 0.0001
          'csymz' LECT uframe lframeb TERM COND Z LT 0.0001
          'elfb'  LECT lframeb TERM COND ENVE
          'nlfb'  LECT elfb    TERM COND X GT -0.01
                                    COND X LT  0.001
          'nbad1' LECT nlfb TERM
                  COND CONE X1 -0.009 Y1 0.260 Z1 0
                            X2  0.001 Y2 0.260 Z2 0
                            R1  0.009 R2 0.009
          'nbad2' LECT nlfb TERM
                  COND CONE X1 -0.009 Y1 0 Z1 0.260
                            X2  0.001 Y2 0 Z2 0.260
                            R1  0.009 R2 0.009
    COUL TURQ LECT tube tra lp3xl TERM
        VERT LECT plate fir2 TERM
        ROSE LECT fir1 TERM
        ROUG LECT driver TERM
       ROSE LECT S1 S2 S5 S6 S11 S12 S15 S16 TERM
ADAP THRS ECRO 11 TMIN 0.01 TMAX 0.02 MAXL 4 CRIT 1 ! NOUN
        LECT plate TERM
!        LECT pp2 TERM
GRIL LAGR LECT spec TERM
MATE
    !LOI 1
    GAZP RO 20.310 GAMM 1.4 CV 719.286 PINI 17.16E5 PREF 100.8E3
        LECT none TERM
    !LOI 2
    GAZP RO 1.193 GAMM 1.4 CV 719.286 PINI 100.8E3 PREF 100.8E3
        LECT none TERM
    !LOI 3
   GAZP RO 6.720 GAMM 1.4 CV 719.286 PINI 5.677E5 PREF 100.8E3
        LECT none TERM
    !LOI 4
    GAZP RO 1.193 GAMM 1.4 CV 719.286 PINI 100.8E3 PREF 100.8E3
        LECT flui3d TERM ! _cuvf TERM
    GAZP RO 1.193 GAMM 1.4 CV 719.286 PINI 100.8E3 PREF 100.8E3
        LECT epar1 epar2 TERM
    GAZP RO 1.193 GAMM 1.4 CV 719.286 PINI 100.8E3 PREF 100.8E3
        LECT rac3d1d raclp tubelpp TERM
    PARO PSIL 0.02
        LECT tubelpp TERM
    MULT 6 7 LECT tubelpp TERM
! In order to obtain a printout at least of the 3D VFCCs I am obliged
! to use a different material for tubelp3 and other 3D parts, but with
! the same characteristics as the material used for tubelp1
   GAZP RO 1.193 GAMM 1.4 CV 719.286 PINI 100.8E3 PREF 100.8E3
        LECT tubelp3 tank _cuvf TERM
    CLVF ABSO RO 1.187
        LECT abso TERM
    VPJC RO 7850.0 YOUN 2.1E11 NU 0.33 ELAS 3.257E8 MXIT 100
        QR1 2.348E8 CR1 56.2 QR2 4.457E8 CR2 4.7
        PDOT 5.E-4 C 1.E-2 TQ 0.9 CP 452.0
        TM 1800.0 M 1.0 DC 1.0 WC 555.0E6
        RESI 1
        LECT lframeb TERM
    VPJC RO 7850.0 YOUN 2.1E11 NU 0.33 ELAS 3.257E8 MXIT 100
        QR1 2.348E8 CR1 56.2 QR2 4.457E8 CR2 4.7
        PDOT 5.E-4 C 1.E-2 TQ 0.9 CP 452.0
        TM 1800.0 M 1.0 DC 1.0 WC 555.0E6
        RESI 1
        LECT uframe TERM
    VPJC RO 7850.0 YOUN 2.1E11 NU 0.33 ELAS 3.257E8 MXIT 100 ! Docol 600
        QR1 2.348E8 CR1 56.2 QR2 4.457E8 CR2 4.7
        PDOT 5.E-4 C 1.E-2 TQ 0.9 CP 452.0
        TM 1800.0 M 1.0 DC 1.0 WC 555.0E6
        RESI 1
        LECT plate TERM
    MASS 0.0 YOUN 2.1E11 NU 0.33
        LECT nplate TERM
    IMPE PIMP RO 7850.0 PRES 44.0011e6 PREF 1.011E5 !fc To be checked
        LECT presur TERM ! _cl3d TERM
OPTI PINS ASN
LINK COUP SPLT NONE
    BLOQ 123 LECT blox TERM
!   GLIS 2
!             FROT MUST 0.5 MUDY 0.5 GAMM 0
!             PGAP 0.4E-3
!           ! MAIT LECT lframeb TERM
!             MAIT NODE LECT nlfb DIFF nbad1 nbad2 TERM
!             PESC LECT plate TERM
```

```
*
!               FROT MUST 0.5 MUDY 0.5 GAMM 0
!               PGAP 0.4E-3
!               MAIT LECT uframe TERM
!               PESC LECT plate TERM
LINK DECO BLOQ 246 LECT symy TERM
          BLOQ 345 LECT symz TERM
          BLOQ 2 LECT csymy TERM
          BLOQ 3 LECT csymz TERM
     PINB PENA SFAC 1.0
          BODY FROT MUST 0.5 MUDY 0.5 GAMM 0 DMIN 0.0004
               LECT lframeb TERM
          BODY FROT MUST 0.5 MUDY 0.5 GAMM 0 DMIN 0.0004
               LECT uframe TERM
          BODY FROT MUST 0.5 MUDY 0.5 GAMM 0 DIAM 0.0004 ADNP
               LECT nplate TERM
          EXCL PAIR 1 2
     FLSW STRU LECT scoup TERM
          FLUI LECT fcoup TERM
          R 0.0087    ! 0.014
          HGRI 0.00606 ! 0.016
          DGRI
          FACE
          BFLU 2 ! block if at least one node is in influence domain
          FSCP 1 ! couple in all directions
          ADAP LMAX 2 SCAL 6
     TBLO 123    TRIG LECT lframeb uframe TERM
          123456 TRIG LECT plate TERM
INIT MAPP FORM 'D7715600map.map' MATC OBJE LECT flui3d tubelp1 TERM
ECRI DEPL VITE ECRO FAIL TFRE 0.25E-3
          POIN LECT cen axis1 axis2 TERM
          ELEM LECT S1 TERM
      FICH ALIT FREQ 0 TFRE 0.D0
          TIME PROG 0.D0 PAS 0.5D-3 22.D-3 PAS 0.01D-3 80.D-3
          POIN LECT cen axis1 axis2 TERM
          ELEM LECT S1 S2 S5 S6 S11 S12 S15 S16 TERM
!    FICH PVTK FREQ 0 TFRE 0.D0
!         TIME PROG 0.D0 PAS 0.5D-3 28.D-3 PAS 0.1D-3 40.D-3
!         PAS 1.D-3 50.D-3
!         GROU AUTO
!         VARI DEPL VITE FAIL ACCE VCVI CONT ECRO FLIA
     FICH SPLI ALIC TFRE 0.5E-3
OPTI NOTE CSTA 0.4
     GLIS NORM ELEM
     STEP IO
     LOG 1
     JAUM
     LMST
     PINS GRID DPIN 1.01
     VFCC FCON 6 ! hllc solver
          ORDR 2 ! order in space
          STPS 2 ! order in time
          RECO 1
          NTIL
     ADAP RCON WHAN
     ADAP RCON TRIG ECRO 1 TVAL 1.05E5 LECT trigger TERM
     NOCR TRIG LECT plate lframeb uframe TERM
     FLS  CUB8 2 ! For the inverse mapping
CALC TINI 0 TEND 36.0E-3 TFAI 1.143E-8 ! 2.0E-8
FIN
```

D6_S2_15_FPw.epx

```
D6_S2_15_FPW
ECHO
!CONV WIN
RESU SPLI ALIC 'D6_S2_15_FP.ali' GARD PSCR
COMP COUL VERT LECT plate TERM
          GR50 LECT lframeb uframe TERM
          TURQ LECT tubelp3 tank TERM
SORT VISU NSTO 1
*=======================================================================
PLAY
*-----------------------------------------------------------------------
CAME   1 EYE  -4.60000E-03 -7.47801E-10 -1.66049E+00
!        Q    -2.05103E-10 -1.00000E+00 -6.46235E-26  2.77556E-16
         VIEW  5.55112E-16  4.10207E-10  1.00000E+00
         RIGH  1.00000E+00  1.53918E-26 -5.55112E-16
         UP    2.43102E-25 -1.00000E+00  4.10207E-10
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER : -4.60000E-03  0.00000E+00  1.62500E-01
!RSPHERE:  3.64597E-01
!RADIUS :  1.82299E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.31529E+00
!FAR    :  2.04449E+00
SCEN GEOM NAVI FREE
          LINE SFRE SSHA
     ISO  FILL FIEL ECRO 1 SCAL USER PROG 1.001E5 PAS 0.5E5 7.501E5 TERM
          SUPP LECT tubelp3 tank TERM
     LIMA ON
SLER CAM1 1 NFRA 1
FREQ 1
TRAC OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate lframeb uframe tubelp3 tank TERM ! SYXY
                                 SYXZ
                                 TOLS 1.E-3 NFAI REND
GOTR LOOP 14 OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate lframeb uframe tubelp3 tank TERM ! SYXY
                                 SYXZ
                                 TOLS 1.E-3 NFAI REND
ENDPLAY
*=======================================================================
FIN
```

D6_S2_15_FPx.epx

```
D6_S2_15_FPX
ECHO
!CONV WIN
RESU SPLI ALIC 'D6_S2_15_FP.ali' GARD PSCR
COMP COUL VERT LECT plate TERM
          GR50 LECT lframeb uframe TERM
          TURQ LECT tubelp3 tank TERM
SORT VISU NSTO 1
*=======================================================================
PLAY
*-----------------------------------------------------------------------
CAME   1 EYE  -4.60000E-03 -7.47801E-10 -1.66049E+00
!        Q    -2.05103E-10 -1.00000E+00 -6.46235E-26  2.77556E-16
         VIEW  5.55112E-16  4.10207E-10  1.00000E+00
         RIGH  1.00000E+00  1.53918E-26 -5.55112E-16
         UP    2.43102E-25 -1.00000E+00  4.10207E-10
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER : -4.60000E-03  0.00000E+00  1.62500E-01
!RSPHERE:  3.64597E-01
!RADIUS :  1.82299E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.31529E+00
!FAR    :  2.04449E+00
SCEN GEOM NAVI FREE
          LINE SFRE SSHA
     LIMA ON
SLER CAM1 1 NFRA 1
FREQ 1
TRAC OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate lframeb uframe tubelp3 tank TERM ! SYXY
                                 SYXZ
                                 TOLS 1.E-3 NFAI REND
GOTR LOOP 14 OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate lframeb uframe tubelp3 tank TERM ! SYXY
                                 SYXZ
                                 TOLS 1.E-3 NFAI REND
ENDPLAY
*=======================================================================
FIN
```

D6_S2_15_FPy.epx

```
D6_S2_15_FPY
ECHO
!CONV WIN
RESU SPLI ALIC 'D6_S2_15_FP.ali' GARD PSCR
COMP COUL GR80 LECT plate TERM
          GR50 LECT lframeb uframe TERM
SORT VISU NSTO 1
*=======================================================================
PLAY
CAME   1 EYE  -1.97046E+00  0.00000E+00 -4.08169E-10
!        Q     7.07107E-01  0.00000E+00 -7.07107E-01  0.00000E+00
         VIEW  1.00000E+00  0.00000E+00  2.05103E-10
         RIGH -2.05103E-10  0.00000E+00  1.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  1.96000E-02  0.00000E+00  0.00000E+00
!RSPHERE:  4.42236E-01
!RADIUS :  1.99006E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.54783E+00
!FAR    :  2.87454E+00
*-----------------------------------------------------------------------
SCEN GEOM NAVI FREE
          LINE SFRE SSHA
     LIMA ON
SLER CAM1 1 NFRA 1
TRAC OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate lframeb TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
FREQ 1
GOTR LOOP 14 OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate lframeb TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
ENDPLAY
*=======================================================================
FIN
```

D6_S2_15_FPyy.epx

```
D6_S2_15_FPYY
ECHO
!CONV WIN
RESU SPLI ALIC 'D6_S2_15_FP.ali' GARD PSCR
COMP COUL GR80 LECT plate TERM
          GR50 LECT lframeb uframe TERM
SORT VISU NSTO 1
*=======================================================================
PLAY
CAME   1 EYE  -1.97046E+00  0.00000E+00 -4.08169E-10
```

```
!       Q     7.07107E-01  0.00000E+00 -7.07107E-01  0.00000E+00
        VIEW  1.00000E+00  0.00000E+00  2.05103E-10
        RIGH -2.05103E-10  0.00000E+00  1.00000E+00
        UP    0.00000E+00  1.00000E+00  0.00000E+00
        FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  1.96000E-02  0.00000E+00  0.00000E+00
!RSPHERE:  4.42236E-01
!RADIUS :  1.99006E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.54783E+00
!FAR    :  2.87454E+00
*-----------------------------------------------------------------------
SCEN GEOM NAVI FREE
         LINE HEOU SFRE SSHA
    LIMA ON
SLER CAM1 1 NFRA 1
TRAC OFFS SIZE 1200 1200 FICH BMP DEFO AMPD 0.0
    OBJE LECT plate TERM SYXY SYXZ TOLS 1.E-3 NFAI ADAP REND
FREQ 1
GOTR LOOP 14 OFFS SIZE 1200 1200 FICH BMP DEFO AMPD 0.0
    OBJE LECT plate TERM SYXY SYXZ TOLS 1.E-3 NFAI ADAP REND
ENDPLAY
*=======================================================================
FIN
```

D6_S2_15_FPz1.epx

```
D6_S2_15_FPZ1
ECHO
 CONV WIN
RESU SPLI ALIC 'D6_S2_15_FP.ali' GARD PSCR
COMP COUL GR80 LECT plate TERM
SORT VISU NSTO 1
*=======================================================================
PLAY
CAME   1 EYE   6.49959E-01  0.00000E+00  1.78574E+00
!       Q    -9.84808E-01  0.00000E+00 -1.73648E-01  0.00000E+00
        VIEW -3.42021E-01  0.00000E+00 -9.39692E-01
        RIGH  9.39692E-01  0.00000E+00 -3.42021E-01
        UP    0.00000E+00  1.00000E+00  0.00000E+00
        FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  9.56724E-18  0.00000E+00  0.00000E+00
!RSPHERE:  4.41942E-01
!RADIUS :  1.90035E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.45841E+00
!FAR    :  2.78423E+00
CAME   2 EYE  -6.49959E-01  0.00000E+00  1.78574E+00
!       Q    -9.84808E-01  0.00000E+00  1.73648E-01  0.00000E+00
        VIEW  3.42021E-01  0.00000E+00 -9.39692E-01
        RIGH  9.39692E-01  0.00000E+00  3.42021E-01
        UP    0.00000E+00  1.00000E+00  0.00000E+00
        FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  9.56724E-18  0.00000E+00  0.00000E+00
!RSPHERE:  4.41942E-01
!RADIUS :  1.90035E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.45841E+00
!FAR    :  2.78423E+00
*-----------------------------------------------------------------------
SCEN GEOM NAVI FREE
         FACE SBAC
         LINE HEOU SFRE SSHA
    LIMA ON
SLER CAM1 1 NFRA 1
TRAC OFFS SIZE 1200 1200 FICH BMP
    OBJE LECT plate TERM SYXY SYXZ TOLS 1.E-3 NFAI ADAP REND
FREQ 1
GOTR LOOP 14 OFFS SIZE 1200 1200 FICH BMP
    OBJE LECT plate TERM SYXY SYXZ TOLS 1.E-3 NFAI ADAP REND
ENDPLAY
*=======================================================================
SUIT
Post-treatment (make avi file from bitmaps)
ECHO
RESU SPLI ALIC 'D6_S2_15_FP.ali' GARD PSCR
*=================================================================
SORT VISU NSTO 1
*=================================================================
PLAY
MAVI FPS 5 KFRE 5 COMP -1 REND
ENDPLAY
*=================================================================
FIN
```

D6_S2_15_FPz2.epx

```
D6_S2_15_FPZ2
ECHO
 CONV WIN
RESU SPLI ALIC 'D6_S2_15_FP.ali' GARD PSCR
COMP COUL GR80 LECT plate TERM
SORT VISU NSTO 1
*=======================================================================
PLAY
CAME   1 EYE   6.49959E-01  0.00000E+00  1.78574E+00
!       Q    -9.84808E-01  0.00000E+00 -1.73648E-01  0.00000E+00
        VIEW -3.42021E-01  0.00000E+00 -9.39692E-01
        RIGH  9.39692E-01  0.00000E+00 -3.42021E-01
        UP    0.00000E+00  1.00000E+00  0.00000E+00
        FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  9.56724E-18  0.00000E+00  0.00000E+00
!RSPHERE:  4.41942E-01
!RADIUS :  1.90035E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.45841E+00
!FAR    :  2.78423E+00
CAME   2 EYE  -6.49959E-01  0.00000E+00  1.78574E+00
!       Q    -9.84808E-01  0.00000E+00  1.73648E-01  0.00000E+00
        VIEW  3.42021E-01  0.00000E+00 -9.39692E-01
        RIGH  9.39692E-01  0.00000E+00  3.42021E-01
        UP    0.00000E+00  1.00000E+00  0.00000E+00
        FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  9.56724E-18  0.00000E+00  0.00000E+00
!RSPHERE:  4.41942E-01
!RADIUS :  1.90035E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.45841E+00
!FAR    :  2.78423E+00
*-----------------------------------------------------------------------
SCEN GEOM NAVI FREE
         FACE SBAC
         LINE HEOU SFRE SSHA
    LIMA ON
SLER CAM1 2 NFRA 1
TRAC OFFS SIZE 1200 1200 FICH BMP
    OBJE LECT plate TERM SYXY SYXZ TOLS 1.E-3 NFAI ADAP REND
FREQ 1
GOTR LOOP 14 OFFS SIZE 1200 1200 FICH BMP
    OBJE LECT plate TERM SYXY SYXZ TOLS 1.E-3 NFAI ADAP REND
ENDPLAY
*=======================================================================
SUIT
Post-treatment (make avi file from bitmaps)
ECHO
RESU SPLI ALIC 'D6_S2_15_FP.ali' GARD PSCR
*=================================================================
SORT VISU NSTO 1
*=================================================================
PLAY
MAVI FPS 5 KFRE 5 COMP -1 REND
ENDPLAY
*=================================================================
FIN
```

D6_S2_15_z1.epx

```
D6_S2_15_Z1
ECHO
 CONV WIN
RESU SPLI ALIC 'D6_S2_15.ali' GARD PSCR
COMP COUL GR80 LECT plate TERM
SORT VISU NSTO 1
*=======================================================================
PLAY
CAME   1 EYE   6.49959E-01  0.00000E+00  1.78574E+00
!       Q    -9.84808E-01  0.00000E+00 -1.73648E-01  0.00000E+00
        VIEW -3.42021E-01  0.00000E+00 -9.39692E-01
        RIGH  9.39692E-01  0.00000E+00 -3.42021E-01
        UP    0.00000E+00  1.00000E+00  0.00000E+00
        FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  9.56724E-18  0.00000E+00  0.00000E+00
!RSPHERE:  4.41942E-01
!RADIUS :  1.90035E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.45841E+00
!FAR    :  2.78423E+00
CAME   2 EYE  -6.49959E-01  0.00000E+00  1.78574E+00
!       Q    -9.84808E-01  0.00000E+00  1.73648E-01  0.00000E+00
        VIEW  3.42021E-01  0.00000E+00 -9.39692E-01
        RIGH  9.39692E-01  0.00000E+00  3.42021E-01
        UP    0.00000E+00  1.00000E+00  0.00000E+00
        FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  9.56724E-18  0.00000E+00  0.00000E+00
!RSPHERE:  4.41942E-01
!RADIUS :  1.90035E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.45841E+00
!FAR    :  2.78423E+00
*-----------------------------------------------------------------------
SCEN GEOM NAVI FREE
         FACE SBAC
         LINE HEOU SFRE SSHA
    LIMA ON
SLER CAM1 1 NFRA 1
TRAC OFFS SIZE 1200 1200 FICH BMP
    OBJE LECT plate TERM SYXY SYXZ TOLS 1.E-3 NFAI ADAP REND
FREQ 1
GOTR LOOP 25 OFFS SIZE 1200 1200 FICH BMP
    OBJE LECT plate TERM SYXY SYXZ TOLS 1.E-3 NFAI ADAP REND
ENDPLAY
*=======================================================================
```

```
SUIT
Post-treatment (make avi file from bitmaps)
ECHO
RESU SPLI ALIC 'D6_S2_15.ali' GARD PSCR
*=================================================================
SORT VISU NSTO 1
*=================================================================
PLAY
MAVI FPS 5 KFRE 5 COMP -1 REND
ENDPLAY
*=================================================================
FIN
```

D6_S2_15_z2.epx

```
D6_S2_15_Z2
ECHO
 CONV WIN
RESU SPLI ALIC 'D6_S2_15.ali' GARD PSCR
COMP COUL GR80 LECT plate TERM
SORT VISU NSTO 1
*=======================================================================
PLAY
CAME   1 EYE   6.49959E-01  0.00000E+00  1.78574E+00
!        Q    -9.84808E-01  0.00000E+00 -1.73648E-01  0.00000E+00
         VIEW -3.42021E-01  0.00000E+00 -9.39692E-01
         RIGH  9.39692E-01  0.00000E+00 -3.42021E-01
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  9.56724E-18  0.00000E+00  0.00000E+00
!RSPHERE:  4.41942E-01
!RADIUS :  1.90035E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.45841E+00
!FAR    :  2.78423E+00
CAME   2 EYE  -6.49959E-01  0.00000E+00  1.78574E+00
!        Q    -9.84808E-01  0.00000E+00  1.73648E-01  0.00000E+00
         VIEW  3.42021E-01  0.00000E+00 -9.39692E-01
         RIGH  9.39692E-01  0.00000E+00  3.42021E-01
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  9.56724E-18  0.00000E+00  0.00000E+00
!RSPHERE:  4.41942E-01
!RADIUS :  1.90035E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.45841E+00
!FAR    :  2.78423E+00
*-----------------------------------------------------------------------
SCEN GEOM NAVI FREE
          FACE SBAC
          LINE HEOU SFRE SSHA
     LIMA ON
SLER CAM1 2 NFRA 1
TRAC OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate TERM SYXY SYXZ TOLS 1.E-3 NFAI ADAP REND
FREQ 1
GOTR LOOP 25 OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate TERM SYXY SYXZ TOLS 1.E-3 NFAI ADAP REND
ENDPLAY
*=======================================================================
SUIT
Post-treatment (make avi file from bitmaps)
ECHO
RESU SPLI ALIC 'D6_S2_15.ali' GARD PSCR
*=================================================================
SORT VISU NSTO 1
*=================================================================
PLAY
MAVI FPS 5 KFRE 5 COMP -1 REND
ENDPLAY
*=================================================================
FIN
```

D6_S2_15f.epx

```
D6_S2_15F
ECHO
!CONV WIN
RESU SPLI ALIC 'D6_S2_15.ali' GARD PSCR
COMP COUL GR80 LECT plate TERM
SORT VISU NSTO 1
PLAY
CAME   1 EYE  -1.85740E+00  2.10571E-03  2.10571E-03
!        Q     7.07107E-01  0.00000E+00 -7.07107E-01  0.00000E+00
         VIEW  1.00000E+00  0.00000E+00  2.05103E-10
         RIGH -2.05103E-10  0.00000E+00  1.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER : -2.25515E-03  2.10571E-03  2.10571E-03
!RSPHERE:  4.63787E-01
!RADIUS :  1.85515E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.39136E+00
!FAR    :  2.78272E+00
SCEN GEOM NAVI FREE
          LINE HEOU SFRE
SLER CAM1 1 NFRA 1
FREQ 1
TRAC DEFO AMPD 0.0 OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate TERM
     SYXY SYXZ ! TOLS 1.E-2
     NFAI ADAP REND
GOTR LOOP 25 DEFO AMPD 0.0 OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate TERM
     SYXY SYXZ ! TOLS 1.E-2
     NFAI ADAP REND
ENDPLAY
*=======================================================================
SUIT
Post-treatment (make avi file from bitmaps)
ECHO
RESU SPLI ALIC 'D6_S2_15.ali' GARD PSCR
*=================================================================
SORT VISU NSTO 1
*=================================================================
PLAY
MAVI FPS 5 KFRE 5 COMP -1 REND
ENDPLAY
*=================================================================
FIN
```

D6_S2_25.epx

```
D6_S2_25
ECHO
!CONV win
CAST 'S2.msh' spec
EROS 1.0 CROI
TRID LAGR
DIME ADAP NPOI 100000
          Q4GS 100000
          CL3D 100000
          T3GS 20000
          CL3T 20000
          PMAT 50000
          NPIN 50000
     ENDA
TERM
GEOM CUB8 ecub8
     PR6  epri6
     Q4GS equa4
     T3GS etri3
     PMAT nplate
     CL3D presur ppqua4
     CL3T pptri3
TERM
COMP EPAI 0.8E-3 LECT plate nplate TERM
     GROU 5 'pp1'     LECT plate TERM
                      COND BOX X0 0.0 Y0 0.0  Z0 0.0
                               DX 0.1 DY 0.15 DZ 0.15
            'plaEdg'  LECT plate DIFF pp1 TERM
                      COND YB LT 0.16
                      COND ZB LT 0.16
            'nplatmp' LECT nplate  TERM
                      COND YB LT 0.16
                      COND ZB LT 0.16
            'nplalim' LECT nplate DIFF nplatmp TERM
            'prec'    LECT preplat TERM
                      COND NEAR POIN 0.0 0.0 0.0
     NGRO 4 'blox' LECT lframeb TERM COND X GT 0.0253
            'symy' LECT spec TERM COND Y LT 0.0001
            'symz' LECT spec TERM COND Z LT 0.0001
            'cen'  LECT plate TERM COND NEAR POIN 0.0 0.0 0.0
     COUL TURQ LECT lframeb TERM
          VERT LECT plate TERM
          ROSE LECT plaEdg TERM
          ROUG LECT nplalim TERM
          BLEU LECT uframe pp1 TERM
     ORIE INVE LECT preplat TERM
INCLUDE 'p77_25e.txt'
ADAP THRS ECRO 11 TMIN 0.01 TMAX 0.02 MAXL 4 CRIT 1
          LECT plate TERM
MATE VPJC RO 7850.0 YOUN 2.1E11 NU 0.33 ELAS 3.257E8 MXIT 100
          QR1 2.348E8 CR1 56.2 QR2 4.457E8 CR2 4.7
          PDOT 5.E-4 C 1.E-2 TQ 0.9 CP 452.0
          TM 1800.0 M 1.0 DC 1.0 WC 555.0E6
          RESI 1
          LECT lframeb TERM
     VPJC RO 7850.0 YOUN 2.1E11 NU 0.33 ELAS 3.257E8 MXIT 100
          QR1 2.348E8 CR1 56.2 QR2 4.457E8 CR2 4.7
          PDOT 5.E-4 C 1.E-2 TQ 0.9 CP 452.0
          TM 1800.0 M 1.0 DC 1.0 WC 555.0E6
          RESI 1
          LECT uframe TERM
     VPJC RO 7850.0 YOUN 2.1E11 NU 0.33 ELAS 3.257E8 MXIT 100 ! Docol 600
          QR1 2.348E8 CR1 56.2 QR2 4.457E8 CR2 4.7
          PDOT 5.E-4 C 1.E-2 TQ 0.9 CP 452.0
          TM 1800.0 M 1.0 DC 1.0 WC 555.0E6
          RESI 1
          LECT plate TERM
     MASS 0.0 YOUN 2.1E11 NU 0.33
          LECT nplate TERM
     IMPE PIMP RO 7850.0 PRES 43.9e6 PREF 0.0
          LECT presur TERM
     IMPE PIMP RO 7850 PRES 1.0 PREF 0.0 FONC 1
          LECT preplat TERM
OPTI PINS ASN
LINK COUP SPLT NONE
```

```
     BLOQ 123 LECT blox TERM
     CONT SPLA NX 0 NY 1 NZ 0 LECT symy TERM
     CONT SPLA NX 0 NY 0 NZ 1 LECT symz TERM
LINK DECO
     PINB PENA SFAC 1.0
          BODY FROT MUST 0.5 MUDY 0.5 GAMM 0 DMIN 0.0004
               LECT lframeb TERM
          BODY FROT MUST 0.5 MUDY 0.5 GAMM 0 DMIN 0.0004
               LECT uframe TERM
          BODY FROT MUST 0.5 MUDY 0.5 GAMM 0 DIAM 0.0004 ADNP
               LECT nplate TERM
          EXCL PAIR 1 2
ECRI DEPL VITE ECRO FAIL TFRE 0.2E-3
          POIN LECT cen TERM
          NOELEM
     FICH ALIT TFRE 0.1E-4
          POIN LECT cen symy TERM
          ELEM LECT prec TERM
     FICH PVTK TFRE  0.1e-3
          GROU AUTO
          VARI ECRO CONT FAIL DEPL VITE FLIA
     FICH SPLI ALIC TFRE 2.0E-4
OPTI NOTE CSTA 0.7
     LOG 1
     JAUM
     LMST
     ADAP RCON WHAN
     PINS GRID DPIN 1.01
     QUASI STATIQUE 1000. 0.7 FROM 0.0 UPTO 0.5e-3
CALC TINI 0 TEND 5.0E-3 TFAI 2.0E-8
FIN
```

D6_S2_25_FP.epx

```
D6_S2_25_FP
ECHO
!CONV win
CAST 'S2_FSI.msh' mesh
TRID ALE
EROS 1.0 CROI
DIME ADAP NPOI 200000
          CUVF 200000
          Q4GS 60000
          T3GS 10000
          NVFI 600000
          PMAT 50000
          NPIN 50000
     ENDA
     JONC 475 ! Total n. of nodes in a TUBM juncton
     NALE 1 NBLE 1
     TERM
GEOM CUB8 ecub8
     PR6  epri6
     Q4GS equa4 ! mems pinbcm
     T3GS etri3
     CUVF flui3d tubelp3 tank
     TUVF tubelp1
     PMAT nplate
     CL3D face3d presur abso stub3d ! pre
     TUBM rac3d1d raclp
TERM
COMP EPAI 0.8e-3 LECT plate nplate TERM
     DIAM DROI 0.1692568 LECT tubelp1 TERM
     RACC TUBM LECT rac3d1d  TERM
          NTUB LECT p1a   TERM DTUB 0.1692568
          FACE LECT face3d TERM COEF 1.0
     RACC TUBM LECT raclp  TERM
          NTUB LECT p1d3   TERM DTUB 0.1692568
          FACE LECT stub3d TERM COEF 1.0
! Attention: the TUBM element (raclp) is NOT included
! in the "mesh" object (although it IS indeed passed in from Cast3m).
! For this reason we must add it explicitly in the GROU directive below
! if we want to have it in the extracted element groups.
     GROU 21 'endtube' LECT tube TERM COND XB GT -0.6
            'trigger' LECT tube TERM COND NEAR POIN -0.1501 0 0
            'frefine' LECT flui TERM COND XB GT -0.3
                                     COND XB LT  1.0
            'pp1'    LECT plate TERM
                     COND BOX X0 0.0 Y0 0.0  Z0 0.0
                              DX 0.1 DY 0.15 DZ 0.15
            'pp2'    LECT plate TERM
                     COND BOX X0 0.0 Y0 0.0  Z0 0.0
                              DX 0.1 DY 0.165 DZ 0.165
            'fcoup'  LECT flui  TERM COND XB GT -0.05
                                     COND XB LT 0.150
                                     COND YB LT 0.150
                                     COND ZB LT 0.150
            'scoup'  LECT plate TERM COND YB LT 0.150
                                     COND ZB LT 0.150
            'lfrb2' LECT lframeb TERM
                    COND XB LT -0.865E-2
            'lfrb1' LECT lframeb DIFF lfrb2 TERM
            'uframe2'    LECT uframe DIFF presur TERM
            'S1' LECT tube TERM COND NEAR POIN -0.345 0.0 0.15
            'S2' LECT tube TERM COND NEAR POIN -0.245 0.0 0.15
            'S16' LECT flui3d TERM COND NEAR POIN -15.225 0 0.15
            'S15' LECT flui3d TERM COND NEAR POIN -15.125 0 0.15
            'S12' LECT tube TERM COND NEAR POIN -12.495 0 0.15
            'S11' LECT tube TERM COND NEAR POIN -12.395 0 0.15
            'S6' LECT tube TERM COND NEAR POIN -5.685 0 0.15
            'S5' LECT tube TERM COND NEAR POIN -5.585 0 0.15
            'epar1' LECT tubelp1 TERM COND NEAR NODE LECT p1a TERM
            'epar2' LECT tubelp1 TERM COND NEAR NODE LECT p1d3 TERM
            'tubelpp' LECT tubelp1 DIFF epar1 epar2 TERM
     NGRO 13 'blox'  LECT lframeb TERM COND !X LT -0.0253
                                              X GT 0.0253
            'symy'  LECT plate TERM    COND Y LT 0.0001
            'symz'  LECT plate TERM    COND Z LT 0.0001
            'pt0' LECT tube TERM COND NEAR POIN -16.19999 0.0 0.0
            'cen' LECT plate TERM COND NEAR POIN 0.0 0.0 0.0
            'axis1'   LECT plate TERM COND Y LT 0.0001
            'axis2'   LECT plate TERM COND Z LT 0.0001
            'csymy' LECT uframe lframeb TERM COND Y LT 0.0001
            'csymz' LECT uframe lframeb TERM COND Z LT 0.0001
            'elfb'  LECT lframeb TERM COND ENVE
            'nlfb'  LECT elfb    TERM COND X GT -0.01
                                      COND X LT  0.001
            'nbad1' LECT nlfb TERM
                    COND CONE X1 -0.009 Y1 0.260 Z1 0
                              X2  0.001 Y2 0.260 Z2 0
                              R1  0.009 R2 0.009
            'nbad2' LECT nlfb TERM
                    COND CONE X1 -0.009 Y1 0 Z1 0.260
                              X2  0.001 Y2 0 Z2 0.260
                              R1  0.009 R2 0.009
     COUL TURQ LECT tube tra lp3xl TERM
          VERT LECT plate fir2 TERM
          ROSE LECT fir1 TERM
          ROUG LECT driver TERM
         ROSE LECT S1 S2 S5 S6 S11 S12 S15 S16 TERM
ADAP THRS ECRO 11 TMIN 0.01 TMAX 0.02 MAXL 4 CRIT 1 ! NOUN
          LECT plate TERM
!          LECT pp2 TERM
GRIL LAGR LECT spec TERM
MATE
    !LOI 1
     GAZP RO 20.310 GAMM 1.4 CV 719.286 PINI 17.16E5 PREF 100.8E3
          LECT none TERM
    !LOI 2
     GAZP RO 1.193 GAMM 1.4 CV 719.286 PINI 100.8E3 PREF 100.8E3
          LECT none TERM
    !LOI 3
    GAZP RO 6.720 GAMM 1.4 CV 719.286 PINI 5.677E5 PREF 100.8E3
          LECT none TERM
    !LOI 4
     GAZP RO 1.193 GAMM 1.4 CV 719.286 PINI 100.8E3 PREF 100.8E3
          LECT flui3d TERM ! _cuvf TERM
     GAZP RO 1.193 GAMM 1.4 CV 719.286 PINI 100.8E3 PREF 100.8E3
          LECT epar1 epar2 TERM
     GAZP RO 1.193 GAMM 1.4 CV 719.286 PINI 100.8E3 PREF 100.8E3
          LECT rac3d1d raclp tubelpp TERM
     PARO PSIL 0.02
          LECT tubelpp TERM
     MULT 6 7 LECT tubelpp TERM
! In order to obtain a printout at least of the 3D VFCCs I am obliged
! to use a different material for tubelp3 and other 3D parts, but with
! the same characteristics as the material used for tubelp1
    GAZP RO 1.193 GAMM 1.4 CV 719.286 PINI 100.8E3 PREF 100.8E3
          LECT tubelp3 tank _cuvf TERM
     CLVF ABSO RO 1.187
          LECT abso TERM
     VPJC RO 7850.0 YOUN 2.1E11 NU 0.33 ELAS 3.257E8 MXIT 100
          QR1 2.348E8 CR1 56.2 QR2 4.457E8 CR2 4.7
          PDOT 5.E-4 C 1.E-2 TQ 0.9 CP 452.0
          TM 1800.0 M 1.0 DC 1.0 WC 555.0E6
          RESI 1
          LECT lframeb TERM
     VPJC RO 7850.0 YOUN 2.1E11 NU 0.33 ELAS 3.257E8 MXIT 100
          QR1 2.348E8 CR1 56.2 QR2 4.457E8 CR2 4.7
          PDOT 5.E-4 C 1.E-2 TQ 0.9 CP 452.0
          TM 1800.0 M 1.0 DC 1.0 WC 555.0E6
          RESI 1
          LECT uframe TERM
     VPJC RO 7850.0 YOUN 2.1E11 NU 0.33 ELAS 3.257E8 MXIT 100 ! Docol 600
          QR1 2.348E8 CR1 56.2 QR2 4.457E8 CR2 4.7
          PDOT 5.E-4 C 1.E-2 TQ 0.9 CP 452.0
          TM 1800.0 M 1.0 DC 1.0 WC 555.0E6
          RESI 1
          LECT plate TERM
     MASS 0.0 YOUN 2.1E11 NU 0.33
          LECT nplate TERM
     IMPE PIMP RO 7850.0 PRES 44.0011e6 PREF 1.011E5 !fc To be checked
          LECT presur TERM ! _cl3d TERM
OPTI PINS ASN
LINK COUP SPLT NONE
     BLOQ 123 LECT blox TERM
!    GLIS 2
!              FROT MUST 0.5 MUDY 0.5 GAMM 0
!              PGAP 0.4E-3
!            ! MAIT LECT lframeb TERM
!              MAIT NODE LECT nlfb DIFF nbad1 nbad2 TERM
!              PESC LECT plate TERM
*
!              FROT MUST 0.5 MUDY 0.5 GAMM 0
!              PGAP 0.4E-3
!              MAIT LECT uframe TERM
!              PESC LECT plate TERM
LINK DECO BLOQ 246 LECT symy TERM
          BLOQ 345 LECT symz TERM
          BLOQ 2 LECT csymy TERM
          BLOQ 3 LECT csymz TERM
     PINB PENA SFAC 1.0
          BODY FROT MUST 0.5 MUDY 0.5 GAMM 0 DMIN 0.0004
```

```
            LECT lframeb TERM
          BODY FROT MUST 0.5 MUDY 0.5 GAMM 0 DMIN 0.0004
            LECT uframe TERM
          BODY FROT MUST 0.5 MUDY 0.5 GAMM 0 DIAM 0.0004 ADNP
            LECT nplate TERM
          EXCL PAIR 1 2
     FLSW STRU LECT scoup TERM
          FLUI LECT fcoup TERM
          R 0.0087    ! 0.014
          HGRI 0.00606 ! 0.016
          DGRI
          FACE
          BFLU 2 ! block if at least one node is in influence domain
          FSCP 1 ! couple in all directions
          ADAP LMAX 2 SCAL 6
     TBLO 123    TRIG LECT lframeb uframe TERM
          123456 TRIG LECT plate TERM
INIT MAPP FORM 'D7725600map.map' MATC OBJE LECT flui3d tubelp1 TERM
ECRI DEPL VITE ECRO FAIL TFRE 0.25E-3
          POIN LECT cen axis1 axis2 TERM
          ELEM LECT S1 TERM
      FICH ALIT FREQ 0 TFRE 0.D0
          TIME PROG 0.D0 PAS 0.5D-3 22.D-3 PAS 0.01D-3 80.D-3
          POIN LECT cen axis1 axis2 TERM
          ELEM LECT S1 S2 S5 S6 S11 S12 S15 S16 TERM
!    FICH PVTK FREQ 0 TFRE 0.D0
!         TIME PROG 0.D0 PAS 0.5D-3 28.D-3 PAS 0.1D-3 40.D-3
!         PAS 1.D-3 50.D-3
!         GROU AUTO
!         VARI DEPL VITE FAIL ACCE VCVI CONT ECRO FLIA
     FICH SPLI ALIC TFRE 0.5E-3
OPTI NOTE CSTA 0.4
     GLIS NORM ELEM
     STEP IO
     LOG 1
     JAUM
     LMST
     PINS GRID DPIN 1.01
     VFCC FCON 6 ! hllc solver
          ORDR 2 ! order in space
          STPS 2 ! order in time
          RECO 1
          NTIL
     ADAP RCON WHAN
     ADAP RCON TRIG ECRO 1 TVAL 1.05E5 LECT trigger TERM
     NOCR TRIG LECT plate lframeb uframe TERM
     FLS  CUB8 2 ! For the inverse mapping
CALC TINI 0 TEND 34.0E-3 TFAI 1.143E-8 ! 2.0E-8
FIN
```

D6_S2_25_FPw.epx

```
D6_S2_25_FPW
ECHO
!CONV WIN
RESU SPLI ALIC 'D6_S2_25_FP.ali' GARD PSCR
COMP COUL VERT LECT plate TERM
          GR50 LECT lframeb uframe TERM
          TURQ LECT tubelp3 tank TERM
SORT VISU NSTO 1
*=====================================================================
PLAY
*---------------------------------------------------------------------
CAME   1 EYE  -4.60000E-03 -7.47801E-10 -1.66049E+00
!        Q    -2.05103E-10 -1.00000E+00 -6.46235E-26  2.77556E-16
         VIEW  5.55112E-16  4.10207E-10  1.00000E+00
         RIGH  1.00000E+00  1.53918E-26 -5.55112E-16
         UP    2.43102E-25 -1.00000E+00  4.10207E-10
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER : -4.60000E-03  0.00000E+00  1.62500E-01
!RSPHERE:  3.64597E-01
!RADIUS :  1.82299E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.31529E+00
!FAR    :  2.04449E+00
SCEN GEOM NAVI FREE
          LINE SFRE SSHA
     ISO  FILL FIEL ECRO 1 SCAL USER PROG 1.001E5 PAS 0.5E5 7.501E5 TERM
          SUPP LECT tubelp3 tank TERM
     LIMA ON
SLER CAM1 1 NFRA 1
FREQ 1
TRAC OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate lframeb uframe tubelp3 tank TERM ! SYXY
                                  SYXZ
                                  TOLS 1.E-3 NFAI REND
GOTR LOOP 12 OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate lframeb uframe tubelp3 tank TERM ! SYXY
                                  SYXZ
                                  TOLS 1.E-3 NFAI REND
ENDPLAY
*=====================================================================
FIN
```

D6_S2_25_FPx.epx

```
D6_S2_25_FPX
ECHO
!CONV WIN
RESU SPLI ALIC 'D6_S2_25_FP.ali' GARD PSCR
COMP COUL VERT LECT plate TERM
          GR50 LECT lframeb uframe TERM
          TURQ LECT tubelp3 tank TERM
SORT VISU NSTO 1
*=====================================================================
PLAY
*---------------------------------------------------------------------
CAME   1 EYE  -4.60000E-03 -7.47801E-10 -1.66049E+00
!        Q    -2.05103E-10 -1.00000E+00 -6.46235E-26  2.77556E-16
         VIEW  5.55112E-16  4.10207E-10  1.00000E+00
         RIGH  1.00000E+00  1.53918E-26 -5.55112E-16
         UP    2.43102E-25 -1.00000E+00  4.10207E-10
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER : -4.60000E-03  0.00000E+00  1.62500E-01
!RSPHERE:  3.64597E-01
!RADIUS :  1.82299E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.31529E+00
!FAR    :  2.04449E+00
SCEN GEOM NAVI FREE
          LINE SFRE SSHA
     LIMA ON
SLER CAM1 1 NFRA 1
FREQ 1
TRAC OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate lframeb uframe tubelp3 tank TERM ! SYXY
                                  SYXZ
                                  TOLS 1.E-3 NFAI REND
GOTR LOOP 12 OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate lframeb uframe tubelp3 tank TERM ! SYXY
                                  SYXZ
                                  TOLS 1.E-3 NFAI REND
ENDPLAY
*=====================================================================
FIN
```

D6_S2_25_FPy.epx

```
D6_S2_25_FPY
ECHO
!CONV WIN
RESU SPLI ALIC 'D6_S2_25_FP.ali' GARD PSCR
COMP COUL GR80 LECT plate TERM
          GR50 LECT lframeb uframe TERM
SORT VISU NSTO 1
*=====================================================================
PLAY
CAME   1 EYE  -1.97046E+00  0.00000E+00 -4.08169E-10
!        Q     7.07107E-01  0.00000E+00 -7.07107E-01  0.00000E+00
         VIEW  1.00000E+00  0.00000E+00  2.05103E-10
         RIGH -2.05103E-10  0.00000E+00  1.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  1.96000E-02  0.00000E+00  0.00000E+00
!RSPHERE:  4.42236E-01
!RADIUS :  1.99006E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.54783E+00
!FAR    :  2.87454E+00
*---------------------------------------------------------------------
SCEN GEOM NAVI FREE
          LINE SFRE SSHA
     LIMA ON
SLER CAM1 1 NFRA 1
TRAC OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate lframeb TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
FREQ 1
GOTR LOOP 12 OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate lframeb TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
ENDPLAY
*=====================================================================
FIN
```

D6_S2_25_FPyy.epx

```
D6_S2_25_FPYY
ECHO
!CONV WIN
RESU SPLI ALIC 'D6_S2_25_FP.ali' GARD PSCR
COMP COUL GR80 LECT plate TERM
          GR50 LECT lframeb uframe TERM
SORT VISU NSTO 1
*=====================================================================
PLAY
CAME   1 EYE  -1.97046E+00  0.00000E+00 -4.08169E-10
!        Q     7.07107E-01  0.00000E+00 -7.07107E-01  0.00000E+00
         VIEW  1.00000E+00  0.00000E+00  2.05103E-10
         RIGH -2.05103E-10  0.00000E+00  1.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  1.96000E-02  0.00000E+00  0.00000E+00
!RSPHERE:  4.42236E-01
!RADIUS :  1.99006E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.54783E+00
```

```
!FAR    :  2.87454E+00
*-----------------------------------------------------------------------
SCEN GEOM NAVI FREE
          LINE HEOU SFRE SSHA
     LIMA ON
SLER CAM1 1 NFRA 1
TRAC OFFS SIZE 1200 1200 FICH BMP DEFO AMPD 0.0
     OBJE LECT plate TERM SYXY SYXZ TOLS 1.E-3 NFAI ADAP REND
FREQ 1
GOTR LOOP 12 OFFS SIZE 1200 1200 FICH BMP DEFO AMPD 0.0
     OBJE LECT plate TERM SYXY SYXZ TOLS 1.E-3 NFAI ADAP REND
ENDPLAY
*=======================================================================
FIN
```

D6_S2_25_FPz1.epx

```
D6_S2_25_FPZ1
ECHO
 CONV WIN
RESU SPLI ALIC 'D6_S2_25_FP.ali' GARD PSCR
COMP COUL GR80 LECT plate TERM
SORT VISU NSTO 1
*=======================================================================
PLAY
CAME   1 EYE   6.49959E-01  0.00000E+00  1.78574E+00
!         Q    -9.84808E-01  0.00000E+00 -1.73648E-01  0.00000E+00
         VIEW -3.42021E-01  0.00000E+00 -9.39692E-01
         RIGH  9.39692E-01  0.00000E+00 -3.42021E-01
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  9.56724E-18  0.00000E+00  0.00000E+00
!RSPHERE:  4.41942E-01
!RADIUS :  1.90035E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.45841E+00
!FAR    :  2.78423E+00
CAME   2 EYE  -6.49959E-01  0.00000E+00  1.78574E+00
!         Q    -9.84808E-01  0.00000E+00  1.73648E-01  0.00000E+00
         VIEW  3.42021E-01  0.00000E+00 -9.39692E-01
         RIGH  9.39692E-01  0.00000E+00  3.42021E-01
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  9.56724E-18  0.00000E+00  0.00000E+00
!RSPHERE:  4.41942E-01
!RADIUS :  1.90035E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.45841E+00
!FAR    :  2.78423E+00
*-----------------------------------------------------------------------
SCEN GEOM NAVI FREE
          FACE SBAC
          LINE HEOU SFRE SSHA
     LIMA ON
SLER CAM1 1 NFRA 1
TRAC OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate TERM SYXY SYXZ TOLS 1.E-3 NFAI ADAP REND
FREQ 1
GOTR LOOP 12 OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate TERM SYXY SYXZ TOLS 1.E-3 NFAI ADAP REND
ENDPLAY
*=======================================================================
SUIT
Post-treatment (make avi file from bitmaps)
ECHO
RESU SPLI ALIC 'D6_S2_25_FP.ali' GARD PSCR
*=================================================================
SORT VISU NSTO 1
*=================================================================
PLAY
MAVI FPS 5 KFRE 5 COMP -1 REND
ENDPLAY
*=================================================================
FIN
```

D6_S2_25_FPz2.epx

```
D6_S2_25_FPZ2
ECHO
 CONV WIN
RESU SPLI ALIC 'D6_S2_25_FP.ali' GARD PSCR
COMP COUL GR80 LECT plate TERM
SORT VISU NSTO 1
*=======================================================================
PLAY
CAME   1 EYE   6.49959E-01  0.00000E+00  1.78574E+00
!         Q    -9.84808E-01  0.00000E+00 -1.73648E-01  0.00000E+00
         VIEW -3.42021E-01  0.00000E+00 -9.39692E-01
         RIGH  9.39692E-01  0.00000E+00 -3.42021E-01
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  9.56724E-18  0.00000E+00  0.00000E+00
!RSPHERE:  4.41942E-01
!RADIUS :  1.90035E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.45841E+00
!FAR    :  2.78423E+00
CAME   2 EYE  -6.49959E-01  0.00000E+00  1.78574E+00
!         Q    -9.84808E-01  0.00000E+00  1.73648E-01  0.00000E+00
         VIEW  3.42021E-01  0.00000E+00 -9.39692E-01
         RIGH  9.39692E-01  0.00000E+00  3.42021E-01
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  9.56724E-18  0.00000E+00  0.00000E+00
!RSPHERE:  4.41942E-01
!RADIUS :  1.90035E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.45841E+00
!FAR    :  2.78423E+00
*-----------------------------------------------------------------------
SCEN GEOM NAVI FREE
          FACE SBAC
          LINE HEOU SFRE SSHA
     LIMA ON
SLER CAM1 2 NFRA 1
TRAC OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate TERM SYXY SYXZ TOLS 1.E-3 NFAI ADAP REND
FREQ 1
GOTR LOOP 12 OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate TERM SYXY SYXZ TOLS 1.E-3 NFAI ADAP REND
ENDPLAY
*=======================================================================
SUIT
Post-treatment (make avi file from bitmaps)
ECHO
RESU SPLI ALIC 'D6_S2_25_FP.ali' GARD PSCR
*=================================================================
SORT VISU NSTO 1
*=================================================================
PLAY
MAVI FPS 5 KFRE 5 COMP -1 REND
ENDPLAY
*=================================================================
FIN
```

D6_S2_25_z1.epx

```
D6_S2_25_Z1
ECHO
 CONV WIN
RESU SPLI ALIC 'D6_S2_25.ali' GARD PSCR
COMP COUL GR80 LECT plate TERM
SORT VISU NSTO 1
*=======================================================================
PLAY
CAME   1 EYE   6.49959E-01  0.00000E+00  1.78574E+00
!         Q    -9.84808E-01  0.00000E+00 -1.73648E-01  0.00000E+00
         VIEW -3.42021E-01  0.00000E+00 -9.39692E-01
         RIGH  9.39692E-01  0.00000E+00 -3.42021E-01
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  9.56724E-18  0.00000E+00  0.00000E+00
!RSPHERE:  4.41942E-01
!RADIUS :  1.90035E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.45841E+00
!FAR    :  2.78423E+00
CAME   2 EYE  -6.49959E-01  0.00000E+00  1.78574E+00
!         Q    -9.84808E-01  0.00000E+00  1.73648E-01  0.00000E+00
         VIEW  3.42021E-01  0.00000E+00 -9.39692E-01
         RIGH  9.39692E-01  0.00000E+00  3.42021E-01
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  9.56724E-18  0.00000E+00  0.00000E+00
!RSPHERE:  4.41942E-01
!RADIUS :  1.90035E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.45841E+00
!FAR    :  2.78423E+00
*-----------------------------------------------------------------------
SCEN GEOM NAVI FREE
          FACE SBAC
          LINE HEOU SFRE SSHA
     LIMA ON
SLER CAM1 1 NFRA 1
TRAC OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate TERM SYXY SYXZ TOLS 1.E-3 NFAI ADAP REND
FREQ 1
GOTR LOOP 25 OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate TERM SYXY SYXZ TOLS 1.E-3 NFAI ADAP REND
ENDPLAY
*=======================================================================
SUIT
Post-treatment (make avi file from bitmaps)
ECHO
RESU SPLI ALIC 'D6_S2_25.ali' GARD PSCR
*=================================================================
SORT VISU NSTO 1
*=================================================================
PLAY
MAVI FPS 5 KFRE 5 COMP -1 REND
ENDPLAY
*=================================================================
FIN
```

D6_S2_25_z2.epx

```
D6_S2_25_Z2
ECHO
 CONV WIN
RESU SPLI ALIC 'D6_S2_25.ali' GARD PSCR
COMP COUL GR80 LECT plate TERM
SORT VISU NSTO 1
*======================================================================
PLAY
CAME   1 EYE   6.49959E-01  0.00000E+00  1.78574E+00
!        Q    -9.84808E-01  0.00000E+00 -1.73648E-01  0.00000E+00
         VIEW -3.42021E-01  0.00000E+00 -9.39692E-01
         RIGH  9.39692E-01  0.00000E+00 -3.42021E-01
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  9.56724E-18  0.00000E+00  0.00000E+00
!RSPHERE:  4.41942E-01
!RADIUS :  1.90035E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.45841E+00
!FAR    :  2.78423E+00
CAME   2 EYE  -6.49959E-01  0.00000E+00  1.78574E+00
!        Q    -9.84808E-01  0.00000E+00  1.73648E-01  0.00000E+00
         VIEW  3.42021E-01  0.00000E+00 -9.39692E-01
         RIGH  9.39692E-01  0.00000E+00  3.42021E-01
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  9.56724E-18  0.00000E+00  0.00000E+00
!RSPHERE:  4.41942E-01
!RADIUS :  1.90035E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.45841E+00
!FAR    :  2.78423E+00
*----------------------------------------------------------------------
SCEN GEOM NAVI FREE
          FACE SBAC
          LINE HEOU SFRE SSHA
     LIMA ON
SLER CAM1 2 NFRA 1
TRAC OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate TERM SYXY SYXZ TOLS 1.E-3 NFAI ADAP REND
FREQ 1
GOTR LOOP 25 OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate TERM SYXY SYXZ TOLS 1.E-3 NFAI ADAP REND
ENDPLAY
*======================================================================
SUIT
Post-treatment (make avi file from bitmaps)
ECHO
RESU SPLI ALIC 'D6_S2_25.ali' GARD PSCR
*=================================================================
SORT VISU NSTO 1
*=================================================================
PLAY
MAVI FPS 5 KFRE 5 COMP -1 REND
ENDPLAY
*=================================================================
FIN
```

D6_S2_25f.epx

```
D6_S2_25F
ECHO
!CONV WIN
RESU SPLI ALIC 'D6_S2_25.ali' GARD PSCR
COMP COUL GR80 LECT plate TERM
SORT VISU NSTO 26
PLAY
CAME   1 EYE  -1.85740E+00  2.10571E-03  2.10571E-03
!        Q     7.07107E-01  0.00000E+00 -7.07107E-01  0.00000E+00
         VIEW  1.00000E+00  0.00000E+00  2.05103E-10
         RIGH -2.05103E-10  0.00000E+00  1.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER : -2.25515E-03  2.10571E-03  2.10571E-03
!RSPHERE:  4.63787E-01
!RADIUS :  1.85515E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.39136E+00
!FAR    :  2.78272E+00
SCEN GEOM NAVI FREE
          LINE HEOU SFRE
SLER CAM1 1 NFRA 1
FREQ 1
TRAC DEFO AMPD 0.0 OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate TERM
     SYXY SYXZ ! TOLS 1.E-2
     NFAI ADAP REND
ENDPLAY
FIN
```

D6_S2_35.epx

```
D6_S2_35
ECHO
!CONV win
CAST 'S2.msh' spec
EROS 1.0 CROI
TRID LAGR
DIME ADAP NPOI 100000
          Q4GS 100000
          CL3D 100000
          T3GS 20000
          CL3T 20000
          PMAT 50000
          NPIN 50000
     ENDA
TERM
GEOM CUB8 ecub8
     PR6  epri6
     Q4GS equa4
     T3GS etri3
     PMAT nplate
     CL3D presur ppqua4
     CL3T pptri3
TERM
COMP EPAI 0.8E-3 LECT plate nplate TERM
     GROU 5 'pp1'     LECT plate TERM
                      COND BOX X0 0.0 Y0 0.0  Z0 0.0
                               DX 0.1 DY 0.15 DZ 0.15
            'plaEdg'  LECT plate DIFF pp1 TERM
                      COND YB LT 0.16
                      COND ZB LT 0.16
            'nplatmp' LECT nplate  TERM
                      COND YB LT 0.16
                      COND ZB LT 0.16
            'nplalim' LECT nplate DIFF nplatmp TERM
            'prec'    LECT preplat TERM
                      COND NEAR POIN 0.0 0.0 0.0
     NGRO 4 'blox' LECT lframeb TERM COND X GT 0.0253
            'symy' LECT spec TERM COND Y LT 0.0001
            'symz' LECT spec TERM COND Z LT 0.0001
            'cen'  LECT plate TERM COND NEAR POIN 0.0 0.0 0.0
     COUL TURQ LECT lframeb TERM
          VERT LECT plate TERM
          ROSE LECT plaEdg TERM
          ROUG LECT nplalim TERM
          BLEU LECT uframe pp1 TERM
     ORIE INVE LECT preplat TERM
INCLUDE 'p77_35e.txt'
ADAP THRS ECRO 11 TMIN 0.01 TMAX 0.02 MAXL 4 CRIT 1
          LECT plate TERM
MATE VPJC RO 7850.0 YOUN 2.1E11 NU 0.33 ELAS 3.257E8 MXIT 100
          QR1 2.348E8 CR1 56.2 QR2 4.457E8 CR2 4.7
          PDOT 5.E-4 C 1.E-2 TQ 0.9 CP 452.0
          TM 1800.0 M 1.0 DC 1.0 WC 555.0E6
          RESI 1
          LECT lframeb TERM
     VPJC RO 7850.0 YOUN 2.1E11 NU 0.33 ELAS 3.257E8 MXIT 100
          QR1 2.348E8 CR1 56.2 QR2 4.457E8 CR2 4.7
          PDOT 5.E-4 C 1.E-2 TQ 0.9 CP 452.0
          TM 1800.0 M 1.0 DC 1.0 WC 555.0E6
          RESI 1
          LECT uframe TERM
     VPJC RO 7850.0 YOUN 2.1E11 NU 0.33 ELAS 3.257E8 MXIT 100 ! Docol 600
          QR1 2.348E8 CR1 56.2 QR2 4.457E8 CR2 4.7
          PDOT 5.E-4 C 1.E-2 TQ 0.9 CP 452.0
          TM 1800.0 M 1.0 DC 1.0 WC 555.0E6
          RESI 1
          LECT plate TERM
     MASS 0.0 YOUN 2.1E11 NU 0.33
          LECT nplate TERM
     IMPE PIMP RO 7850.0 PRES 43.9e6 PREF 0.0
          LECT presur TERM
     IMPE PIMP RO 7850 PRES 1.0 PREF 0.0 FONC 1
          LECT preplat TERM
OPTI PINS ASN
LINK COUP SPLT NONE
     BLOQ 123 LECT blox TERM
     CONT SPLA NX 0 NY 1 NZ 0 LECT symy TERM
     CONT SPLA NX 0 NY 0 NZ 1 LECT symz TERM
LINK DECO
     PINB PENA SFAC 1.0
          BODY FROT MUST 0.5 MUDY 0.5 GAMM 0 DMIN 0.0004
               LECT lframeb TERM
          BODY FROT MUST 0.5 MUDY 0.5 GAMM 0 DMIN 0.0004
               LECT uframe TERM
          BODY FROT MUST 0.5 MUDY 0.5 GAMM 0 DIAM 0.0004 ADNP
               LECT nplate TERM
          EXCL PAIR 1 2
ECRI DEPL VITE ECRO FAIL TFRE 0.2E-3
          POIN LECT cen TERM
          NOELEM
     FICH ALIT TFRE 0.1E-4
          POIN LECT cen symy TERM
          ELEM LECT prec TERM
     FICH PVTK TFRE  0.1e-3
          GROU AUTO
          VARI ECRO CONT FAIL DEPL VITE FLIA
     FICH SPLI ALIC TFRE 2.0E-4
OPTI NOTE CSTA 0.7
     LOG 1
     JAUM
     LMST
     ADAP RCON WHAN
     PINS GRID DPIN 1.01
```

```
    QUASI STATIQUE 1000. 0.7 FROM 0.0 UPTO 0.5e-3
CALC TINI 0 TEND 5.0E-3 TFAI 2.0E-8
FIN
```

D6_S2_35_FG.epx

```
D6_S2_35_FG
ECHO
!CONV win
CAST 'S2_FSI.msh' mesh
TRID ALE
EROS 1.0 CROI
DIME ADAP NPOI 200000
          CUVF 200000
          Q4GS 60000
          T3GS 10000
          NVFI 600000
     ENDA
     JONC 475 ! Total n. of nodes in a TUBM juncton
     NALE 1 NBLE 1
     TERM
GEOM CUB8 ecub8
     PR6  epri6
     Q4GS equa4 ! mems pinbcm
     T3GS etri3
     CUVF flui3d tubelp3 tank
     TUVF tubelp1
     CL3D face3d presur abso stub3d ! pre
     TUBM rac3d1d raclp
TERM
COMP EPAI 0.8e-3 LECT plate TERM
     DIAM DROI 0.1692568 LECT tubelp1 TERM
     RACC TUBM LECT rac3d1d  TERM
          NTUB LECT p1a   TERM DTUB 0.1692568
          FACE LECT face3d TERM COEF 1.0
     RACC TUBM LECT raclp  TERM
          NTUB LECT p1d3   TERM DTUB 0.1692568
          FACE LECT stub3d TERM COEF 1.0
! Attention: the TUBM element (raclp) is NOT included
! in the "mesh" object (although it IS indeed passed in from Cast3m).
! For this reason we must add it explicitly in the GROU directive below
! if we want to have it in the extracted element groups.
     GROU 21 'endtube' LECT tube TERM COND XB GT -0.6
            'trigger' LECT tube TERM COND NEAR POIN -0.1501 0 0
            'frefine' LECT flui TERM COND XB GT -0.3
                                     COND XB LT  1.0
            'pp1'    LECT plate TERM
                     COND BOX X0 0.0 Y0 0.0  Z0 0.0
                              DX 0.1 DY 0.15 DZ 0.15
            'pp2'    LECT plate TERM
                     COND BOX X0 0.0 Y0 0.0  Z0 0.0
                              DX 0.1 DY 0.165 DZ 0.165
            'fcoup'  LECT flui  TERM COND XB GT -0.05
                                     COND XB LT 0.150
                                     COND YB LT 0.150
                                     COND ZB LT 0.150
            'scoup'  LECT plate TERM COND YB LT 0.150
                                     COND ZB LT 0.150
            'lfrb2' LECT lframeb TERM
                    COND XB LT -0.865E-2
            'lfrb1' LECT lframeb DIFF lfrb2 TERM
            'uframe2'    LECT uframe DIFF presur TERM
            'S1' LECT tube TERM COND NEAR POIN -0.345 0.0 0.15
            'S2' LECT tube TERM COND NEAR POIN -0.245 0.0 0.15
            'S16' LECT flui3d TERM COND NEAR POIN -15.225 0 0.15
            'S15' LECT flui3d TERM COND NEAR POIN -15.125 0 0.15
            'S12' LECT tube TERM COND NEAR POIN -12.495 0 0.15
            'S11' LECT tube TERM COND NEAR POIN -12.395 0 0.15
            'S6' LECT tube TERM COND NEAR POIN -5.685 0 0.15
            'S5' LECT tube TERM COND NEAR POIN -5.585 0 0.15
            'epar1' LECT tubelp1 TERM COND NEAR NODE LECT p1a TERM
            'epar2' LECT tubelp1 TERM COND NEAR NODE LECT p1d3 TERM
            'tubelpp' LECT tubelp1 DIFF epar1 epar2 TERM
     NGRO 13 'blox'  LECT lframeb TERM COND !X LT -0.0253
                                          X GT 0.0253
            'symy'  LECT plate TERM    COND Y LT 0.0001
            'symz'  LECT plate TERM    COND Z LT 0.0001
            'pt0' LECT tube TERM COND NEAR POIN -16.19999 0.0 0.0
            'cen' LECT plate TERM COND NEAR POIN 0.0 0.0 0.0
            'axis1'   LECT plate TERM COND Y LT 0.0001
            'axis2'   LECT plate TERM COND Z LT 0.0001
            'csymy' LECT uframe lframeb TERM COND Y LT 0.0001
            'csymz' LECT uframe lframeb TERM COND Z LT 0.0001
            'elfb'  LECT lframeb TERM COND ENVE
            'nlfb'  LECT elfb    TERM COND X GT -0.01
                                      COND X LT  0.001
            'nbad1' LECT nlfb TERM
                    COND CONE X1 -0.009 Y1 0.260 Z1 0
                              X2  0.001 Y2 0.260 Z2 0
                              R1  0.009 R2 0.009
            'nbad2' LECT nlfb TERM
                    COND CONE X1 -0.009 Y1 0 Z1 0.260
                              X2  0.001 Y2 0 Z2 0.260
                              R1  0.009 R2 0.009
     COUL TURQ LECT tube tra lp3xl TERM
          VERT LECT plate fir2 TERM
          ROSE LECT fir1 TERM
          ROUG LECT driver TERM
         ROSE LECT S1 S2 S5 S6 S11 S12 S15 S16 TERM
ADAP THRS ECRO 11 TMIN 0.01 TMAX 0.02 MAXL 4 CRIT 1 ! NOUN
          LECT plate TERM
!           LECT pp2 TERM
GRIL LAGR LECT spec TERM
MATE
    !LOI 1
     GAZP RO 20.310 GAMM 1.4 CV 719.286 PINI 17.16E5 PREF 100.8E3
          LECT none TERM
    !LOI 2
     GAZP RO 1.193 GAMM 1.4 CV 719.286 PINI 100.8E3 PREF 100.8E3
          LECT none TERM
    !LOI 3
    GAZP RO 6.720 GAMM 1.4 CV 719.286 PINI 5.677E5 PREF 100.8E3
          LECT none TERM
    !LOI 4
     GAZP RO 1.193 GAMM 1.4 CV 719.286 PINI 100.8E3 PREF 100.8E3
          LECT flui3d TERM ! _cuvf TERM
     GAZP RO 1.193 GAMM 1.4 CV 719.286 PINI 100.8E3 PREF 100.8E3
          LECT epar1 epar2 TERM
     GAZP RO 1.193 GAMM 1.4 CV 719.286 PINI 100.8E3 PREF 100.8E3
          LECT rac3d1d raclp tubelpp TERM
     PARO PSIL 0.02
          LECT tubelpp TERM
     MULT 6 7 LECT tubelpp TERM
! In order to obtain a printout at least of the 3D VFCCs I am obliged
! to use a different material for tubelp3 and other 3D parts, but with
! the same characteristics as the material used for tubelp1
    GAZP RO 1.193 GAMM 1.4 CV 719.286 PINI 100.8E3 PREF 100.8E3
          LECT tubelp3 tank _cuvf TERM
     CLVF ABSO RO 1.187
          LECT abso TERM
     VPJC RO 7850.0 YOUN 2.1E11 NU 0.33 ELAS 3.257E8 MXIT 100
          QR1 2.348E8 CR1 56.2 QR2 4.457E8 CR2 4.7
          PDOT 5.E-4 C 1.E-2 TQ 0.9 CP 452.0
          TM 1800.0 M 1.0 DC 1.0 WC 555.0E6
          RESI 1
          LECT lframeb TERM
     VPJC RO 7850.0 YOUN 2.1E11 NU 0.33 ELAS 3.257E8 MXIT 100
          QR1 2.348E8 CR1 56.2 QR2 4.457E8 CR2 4.7
          PDOT 5.E-4 C 1.E-2 TQ 0.9 CP 452.0
          TM 1800.0 M 1.0 DC 1.0 WC 555.0E6
          RESI 1
          LECT uframe TERM
     VPJC RO 7850.0 YOUN 2.1E11 NU 0.33 ELAS 3.257E8 MXIT 100 ! Docol 600
          QR1 2.348E8 CR1 56.2 QR2 4.457E8 CR2 4.7
          PDOT 5.E-4 C 1.E-2 TQ 0.9 CP 452.0
          TM 1800.0 M 1.0 DC 1.0 WC 555.0E6
          RESI 1
          LECT plate TERM
     IMPE PIMP RO 7850.0 PRES 44.0011e6 PREF 1.011E5
          LECT presur TERM ! _cl3d TERM
LINK COUP SPLT NONE
     BLOQ 123 LECT blox TERM
     GLIS 2
                FROT MUST 0.5 MUDY 0.5 GAMM 0
                PGAP 0.4E-3
              ! MAIT LECT lframeb TERM
                MAIT NODE LECT nlfb DIFF nbad1 nbad2 TERM
                PESC LECT plate TERM
*
                FROT MUST 0.5 MUDY 0.5 GAMM 0
                PGAP 0.4E-3
                MAIT LECT uframe TERM
                PESC LECT plate TERM
!     GLIS 2
!               FROT MUST 0.5 MUDY 0.5 GAMM 0
!               PGAP 0.4E-3
!               MAIT LECT lframeb TERM
!               PESC LECT plate TERM
!*
!               FROT MUST 0.5 MUDY 0.5 GAMM 0
!               PGAP 0.4E-3
!               MAIT LECT uframe TERM
!               PESC LECT plate TERM
!*
LINK DECO BLOQ 246 LECT symy TERM
          BLOQ 345 LECT symz TERM
          BLOQ 2 LECT csymy TERM
          BLOQ 3 LECT csymz TERM
     FLSW STRU LECT scoup TERM
          FLUI LECT fcoup TERM
          R 0.0087    ! 0.014
          HGRI 0.00606 ! 0.016
          DGRI
          FACE
          BFLU 2 ! block if at least one node is in influence domain
          FSCP 1 ! couple in all directions
          ADAP LMAX 2 SCAL 6
     TBLO 123    TRIG LECT lframeb uframe TERM
          123456 TRIG LECT plate TERM
INIT MAPP FORM 'ST_MAP3_35.map' MATC OBJE LECT flui3d tubelp1 TERM
ECRI DEPL VITE ECRO FAIL TFRE 0.25E-3
          POIN LECT cen axis1 axis2 TERM
          ELEM LECT S1 TERM
      FICH ALIT FREQ 0 TFRE 0.D0
          TIME PROG 0.D0 PAS 0.5D-3 22.D-3 PAS 0.01D-3 80.D-3
          POIN LECT cen axis1 axis2 TERM
          ELEM LECT S1 S2 S5 S6 S11 S12 S15 S16 TERM
!    FICH PVTK FREQ 0 TFRE 0.D0
!         TIME PROG 0.D0 PAS 0.5D-3 28.D-3 PAS 0.1D-3 40.D-3
!         PAS 1.D-3 50.D-3
!         GROU AUTO
!         VARI DEPL VITE FAIL ACCE VCVI CONT ECRO FLIA
     FICH SPLI ALIC TFRE 0.5E-3
OPTI NOTE CSTA 0.4
```

```
     GLIS NORM ELEM
     STEP IO
     LOG 1
     JAUM
     LMST
     PINS GRID DPIN 1.01
     VFCC FCON 6 ! hllc solver
          ORDR 2 ! order in space
          STPS 2 ! order in time
          RECO 1 ! Not accepted by CAL_VFCC_1D
          NTIL
     ADAP RCON WHAN
     ADAP RCON TRIG ECRO 1 TVAL 1.05E5 LECT trigger TERM
     NOCR TRIG LECT plate lframeb uframe TERM
     FLS  CUB8 2 ! For the inverse mapping
CALC TINI 0 TEND 32.0E-3 TFAI 2.0E-8
FIN
```

D6_S2_35_FG2.epx

```
D6_S2_35_FG2
ECHO
!CONV win
CAST 'S2_FSI.msh' mesh
TRID ALE
EROS 1.0 CROI
DIME ADAP NPOI 200000
          CUVF 200000
          Q4GS 60000
          T3GS 10000
          NVFI 600000
     ENDA
     JONC 475 ! Total n. of nodes in a TUBM juncton
     NALE 1 NBLE 1
     TERM
GEOM CUB8 ecub8
     PR6  epri6
     Q4GS equa4 ! mems pinbcm
     T3GS etri3
     CUVF flui3d tubelp3 tank
     TUVF tubelp1
     CL3D face3d presur abso stub3d ! pre
     TUBM rac3d1d raclp
TERM
COMP EPAI 0.8e-3 LECT plate TERM
     DIAM DROI 0.1692568 LECT tubelp1 TERM
     RACC TUBM LECT rac3d1d  TERM
          NTUB LECT p1a   TERM DTUB 0.1692568
          FACE LECT face3d TERM COEF 1.0
     RACC TUBM LECT raclp  TERM
          NTUB LECT p1d3   TERM DTUB 0.1692568
          FACE LECT stub3d TERM COEF 1.0
! Attention: the TUBM element (raclp) is NOT included
! in the "mesh" object (although it IS indeed passed in from Cast3m).
! For this reason we must add it explicitly in the GROU directive below
! if we want to have it in the extracted element groups.
     GROU 21 'endtube' LECT tube TERM COND XB GT -0.6
            'trigger' LECT tube TERM COND NEAR POIN -0.1501 0 0
            'frefine' LECT flui TERM COND XB GT -0.3
                                     COND XB LT  1.0
            'pp1'    LECT plate TERM
                     COND BOX X0 0.0 Y0 0.0  Z0 0.0
                              DX 0.1 DY 0.15 DZ 0.15
            'pp2'    LECT plate TERM
                     COND BOX X0 0.0 Y0 0.0  Z0 0.0
                              DX 0.1 DY 0.165 DZ 0.165
            'fcoup'  LECT flui  TERM COND XB GT -0.05
                                     COND XB LT 0.150
                                     COND YB LT 0.150
                                     COND ZB LT 0.150
            'scoup'  LECT plate TERM COND YB LT 0.150
                                     COND ZB LT 0.150
            'lfrb2' LECT lframeb TERM
                    COND XB LT -0.865E-2
            'lfrb1' LECT lframeb DIFF lfrb2 TERM
            'uframe2'    LECT uframe DIFF presur TERM
            'S1' LECT tube TERM COND NEAR POIN -0.345 0.0 0.15
            'S2' LECT tube TERM COND NEAR POIN -0.245 0.0 0.15
            'S16' LECT flui3d TERM COND NEAR POIN -15.225 0 0.15
            'S15' LECT flui3d TERM COND NEAR POIN -15.125 0 0.15
            'S12' LECT tube TERM COND NEAR POIN -12.495 0 0.15
            'S11' LECT tube TERM COND NEAR POIN -12.395 0 0.15
            'S6' LECT tube TERM COND NEAR POIN -5.685 0 0.15
            'S5' LECT tube TERM COND NEAR POIN -5.585 0 0.15
            'epar1' LECT tubelp1 TERM COND NEAR NODE LECT p1a TERM
            'epar2' LECT tubelp1 TERM COND NEAR NODE LECT p1d3 TERM
            'tubelpp' LECT tubelp1 DIFF epar1 epar2 TERM
     NGRO 13 'blox'  LECT lframeb TERM COND !X LT -0.0253
                                        X GT 0.0253
            'symy'  LECT plate TERM    COND Y LT 0.0001
            'symz'  LECT plate TERM    COND Z LT 0.0001
            'pt0' LECT tube TERM COND NEAR POIN -16.19999 0.0 0.0
            'cen' LECT plate TERM COND NEAR POIN 0.0 0.0 0.0
            'axis1'   LECT plate TERM COND Y LT 0.0001
            'axis2'   LECT plate TERM COND Z LT 0.0001
            'csymy' LECT uframe lframeb TERM COND Y LT 0.0001
            'csymz' LECT uframe lframeb TERM COND Z LT 0.0001
            'elfb'  LECT lframeb TERM COND ENVE
            'nlfb'  LECT elfb    TERM COND X GT -0.01
                                      COND X LT  0.001
            'nbad1' LECT nlfb TERM
                    COND CONE X1 -0.009 Y1 0.260 Z1 0
                              X2  0.001 Y2 0.260 Z2 0
                              R1  0.009 R2 0.009
            'nbad2' LECT nlfb TERM
                    COND CONE X1 -0.009 Y1 0 Z1 0.260
                              X2  0.001 Y2 0 Z2 0.260
                              R1  0.009 R2 0.009
     COUL TURQ LECT tube tra lp3xl TERM
          VERT LECT plate fir2 TERM
          ROSE LECT fir1 TERM
          ROUG LECT driver TERM
         ROSE LECT S1 S2 S5 S6 S11 S12 S15 S16 TERM
ADAP THRS ECRO 11 TMIN 0.01 TMAX 0.02 MAXL 4 CRIT 1 ! NOUN
          LECT plate TERM
!          LECT pp2 TERM
GRIL LAGR LECT spec TERM
MATE
    !LOI 1
     GAZP RO 20.310 GAMM 1.4 CV 719.286 PINI 17.16E5 PREF 100.8E3
          LECT none TERM
    !LOI 2
     GAZP RO 1.193 GAMM 1.4 CV 719.286 PINI 100.8E3 PREF 100.8E3
          LECT none TERM
    !LOI 3
    GAZP RO 6.720 GAMM 1.4 CV 719.286 PINI 5.677E5 PREF 100.8E3
          LECT none TERM
    !LOI 4
     GAZP RO 1.193 GAMM 1.4 CV 719.286 PINI 100.8E3 PREF 100.8E3
          LECT flui3d TERM ! _cuvf TERM
     GAZP RO 1.193 GAMM 1.4 CV 719.286 PINI 100.8E3 PREF 100.8E3
          LECT epar1 epar2 TERM
     GAZP RO 1.193 GAMM 1.4 CV 719.286 PINI 100.8E3 PREF 100.8E3
          LECT rac3d1d raclp tubelpp TERM
     PARO PSIL 0.02
          LECT tubelpp TERM
     MULT 6 7 LECT tubelpp TERM
! In order to obtain a printout at least of the 3D VFCCs I am obliged
! to use a different material for tubelp3 and other 3D parts, but with
! the same characteristics as the material used for tubelp1
    GAZP RO 1.193 GAMM 1.4 CV 719.286 PINI 100.8E3 PREF 100.8E3
          LECT tubelp3 tank _cuvf TERM
     CLVF ABSO RO 1.187
          LECT abso TERM
     VPJC RO 7850.0 YOUN 2.1E11 NU 0.33 ELAS 3.257E8 MXIT 100
          QR1 2.348E8 CR1 56.2 QR2 4.457E8 CR2 4.7
          PDOT 5.E-4 C 1.E-2 TQ 0.9 CP 452.0
          TM 1800.0 M 1.0 DC 1.0 WC 555.0E6
          RESI 1
          LECT lframeb TERM
     VPJC RO 7850.0 YOUN 2.1E11 NU 0.33 ELAS 3.257E8 MXIT 100
          QR1 2.348E8 CR1 56.2 QR2 4.457E8 CR2 4.7
          PDOT 5.E-4 C 1.E-2 TQ 0.9 CP 452.0
          TM 1800.0 M 1.0 DC 1.0 WC 555.0E6
          RESI 1
          LECT uframe TERM
     VPJC RO 7850.0 YOUN 2.1E11 NU 0.33 ELAS 3.257E8 MXIT 100 ! Docol 600
          QR1 2.348E8 CR1 56.2 QR2 4.457E8 CR2 4.7
          PDOT 5.E-4 C 1.E-2 TQ 0.9 CP 452.0
          TM 1800.0 M 1.0 DC 1.0 WC 555.0E6
          RESI 1
          LECT plate TERM
     IMPE PIMP RO 7850.0 PRES 44.0011e6 PREF 1.011E5
          LECT presur TERM ! _cl3d TERM
LINK COUP SPLT NONE
     BLOQ 123 LECT blox TERM
     GLIS 2
              FROT MUST 0.5 MUDY 0.5 GAMM 0
              PGAP 0.4E-3
            ! MAIT LECT lframeb TERM
              MAIT NODE LECT nlfb DIFF nbad1 nbad2 TERM
              PESC LECT plate TERM
*
              FROT MUST 0.5 MUDY 0.5 GAMM 0
              PGAP 0.4E-3
              MAIT LECT uframe TERM
              PESC LECT plate TERM
!     GLIS 2
!               FROT MUST 0.5 MUDY 0.5 GAMM 0
!               PGAP 0.4E-3
!               MAIT LECT lframeb TERM
!               PESC LECT plate TERM
!*
!               FROT MUST 0.5 MUDY 0.5 GAMM 0
!               PGAP 0.4E-3
!               MAIT LECT uframe TERM
!               PESC LECT plate TERM
!*
LINK DECO BLOQ 246 LECT symy TERM
          BLOQ 345 LECT symz TERM
          BLOQ 2 LECT csymy TERM
          BLOQ 3 LECT csymz TERM
     FLSW STRU LECT scoup TERM
          FLUI LECT fcoup TERM
          R 0.0087    ! 0.014
          HGRI 0.00606 ! 0.016
          DGRI
          FACE
          BFLU 2 ! block if at least one node is in influence domain
          FSCP 1 ! couple in all directions
          ADAP LMAX 2 SCAL 6
     TBLO 123    TRIG LECT lframeb uframe TERM
          123456 TRIG LECT plate TERM
```

```
INIT MAPP FORM 'ST_MAP3_35.map' MATC OBJE LECT flui3d tubelp1 TERM
ECRI DEPL VITE ECRO FAIL TFRE 0.25E-3
          POIN LECT cen axis1 axis2 TERM
          ELEM LECT S1 TERM
      FICH ALIT FREQ 0 TFRE 0.D0
          TIME PROG 0.D0 PAS 0.5D-3 22.D-3 PAS 0.01D-3 80.D-3
          POIN LECT cen axis1 axis2 TERM
          ELEM LECT S1 S2 S5 S6 S11 S12 S15 S16 TERM
!    FICH PVTK FREQ 0 TFRE 0.D0
!         TIME PROG 0.D0 PAS 0.5D-3 28.D-3 PAS 0.1D-3 40.D-3
!         PAS 1.D-3 50.D-3
!         GROU AUTO
!         VARI DEPL VITE FAIL ACCE VCVI CONT ECRO FLIA
     FICH SPLI ALIC TFRE 0.5E-3
OPTI NOTE CSTA 0.4
     GLIS NORM ELEM ADAP SYME
     STEP IO
     LOG 1
     JAUM
     LMST
     PINS GRID DPIN 1.01
     VFCC FCON 6 ! hllc solver
          ORDR 2 ! order in space
          STPS 2 ! order in time
          RECO 1 ! Not accepted by CAL_VFCC_1D
          NTIL
     ADAP RCON WHAN
     ADAP RCON TRIG ECRO 1 TVAL 1.05E5 LECT trigger TERM
     NOCR TRIG LECT plate lframeb uframe TERM
     FLS  CUB8 2 ! For the inverse mapping
CALC TINI 0 TEND 32.0E-3 TFAI 2.0E-8
FIN
```

D6_S2_35_FG2_C.epx

```
D6_S2_35_FG2_C
ECHO
!CONV win
CAST 'S2_FSI.msh' mesh
TRID ALE
EROS 1.0 CROI
DIME ADAP NPOI 200000
          CUVF 200000
          Q4GS 60000
          T3GS 10000
          NVFI 600000
     ENDA
     JONC 475 ! Total n. of nodes in a TUBM juncton
     NALE 1 NBLE 1
     TERM
GEOM CUB8 ecub8
     PR6  epri6
     Q4GS equa4 ! mems pinbcm
     T3GS etri3
     CUVF flui3d tubelp3 tank
     TUVF tubelp1
     CL3D face3d presur abso stub3d ! pre
     TUBM rac3d1d raclp
TERM
COMP EPAI 0.8e-3 LECT plate TERM
     DIAM DROI 0.1692568 LECT tubelp1 TERM
     RACC TUBM LECT rac3d1d  TERM
          NTUB LECT p1a   TERM DTUB 0.1692568
          FACE LECT face3d TERM COEF 1.0
     RACC TUBM LECT raclp  TERM
          NTUB LECT p1d3   TERM DTUB 0.1692568
          FACE LECT stub3d TERM COEF 1.0
! Attention: the TUBM element (raclp) is NOT included
! in the "mesh" object (although it IS indeed passed in from Cast3m).
! For this reason we must add it explicitly in the GROU directive below
! if we want to have it in the extracted element groups.
     GROU 21 'endtube' LECT tube TERM COND XB GT -0.6
            'trigger' LECT tube TERM COND NEAR POIN -0.1501 0 0
            'frefine' LECT flui TERM COND XB GT -0.3
                                     COND XB LT  1.0
            'pp1'    LECT plate TERM
                     COND BOX X0 0.0 Y0 0.0  Z0 0.0
                              DX 0.1 DY 0.15 DZ 0.15
            'pp2'    LECT plate TERM
                     COND BOX X0 0.0 Y0 0.0  Z0 0.0
                              DX 0.1 DY 0.165 DZ 0.165
            'fcoup'  LECT flui  TERM COND XB GT -0.05
                                     COND XB LT 0.150
                                     COND YB LT 0.150
                                     COND ZB LT 0.150
            'scoup'  LECT plate TERM COND YB LT 0.150
                                     COND ZB LT 0.150
            'lfrb2' LECT lframeb TERM
                    COND XB LT -0.865E-2
            'lfrb1' LECT lframeb DIFF lfrb2 TERM
            'uframe2'    LECT uframe DIFF presur TERM
            'S1' LECT tube TERM COND NEAR POIN -0.345 0.0 0.15
            'S2' LECT tube TERM COND NEAR POIN -0.245 0.0 0.15
            'S16' LECT flui3d TERM COND NEAR POIN -15.225 0 0.15
            'S15' LECT flui3d TERM COND NEAR POIN -15.125 0 0.15
            'S12' LECT tube TERM COND NEAR POIN -12.495 0 0.15
            'S11' LECT tube TERM COND NEAR POIN -12.395 0 0.15
            'S6' LECT tube TERM COND NEAR POIN -5.685 0 0.15
            'S5' LECT tube TERM COND NEAR POIN -5.585 0 0.15
            'epar1' LECT tubelp1 TERM COND NEAR NODE LECT p1a TERM
            'epar2' LECT tubelp1 TERM COND NEAR NODE LECT p1d3 TERM
            'tubelpp' LECT tubelp1 DIFF epar1 epar2 TERM
     NGRO 13 'blox'  LECT lframeb TERM COND !X LT -0.0253
                                          X GT 0.0253
            'symy'  LECT plate TERM    COND Y LT 0.0001
            'symz'  LECT plate TERM    COND Z LT 0.0001
            'pt0' LECT tube TERM COND NEAR POIN -16.19999 0.0 0.0
            'cen' LECT plate TERM COND NEAR POIN 0.0 0.0 0.0
            'axis1'   LECT plate TERM COND Y LT 0.0001
            'axis2'   LECT plate TERM COND Z LT 0.0001
            'csymy' LECT uframe lframeb TERM COND Y LT 0.0001
            'csymz' LECT uframe lframeb TERM COND Z LT 0.0001
            'elfb'  LECT lframeb TERM COND ENVE
            'nlfb'  LECT elfb    TERM COND X GT -0.01
                                      COND X LT  0.001
            'nbad1' LECT nlfb TERM
                    COND CONE X1 -0.009 Y1 0.260 Z1 0
                              X2  0.001 Y2 0.260 Z2 0
                              R1  0.009 R2 0.009
            'nbad2' LECT nlfb TERM
                    COND CONE X1 -0.009 Y1 0 Z1 0.260
                              X2  0.001 Y2 0 Z2 0.260
                              R1  0.009 R2 0.009
     COUL TURQ LECT tube tra lp3xl TERM
          VERT LECT plate fir2 TERM
          ROSE LECT fir1 TERM
          ROUG LECT driver TERM
         ROSE LECT S1 S2 S5 S6 S11 S12 S15 S16 TERM
ADAP THRS ECRO 11 TMIN 0.01 TMAX 0.02 MAXL 4 CRIT 1 ! NOUN
          LECT plate TERM
!          LECT pp2 TERM
GRIL LAGR LECT spec TERM
MATE
    !LOI 1
     GAZP RO 20.310 GAMM 1.4 CV 719.286 PINI 17.16E5 PREF 100.8E3
          LECT none TERM
    !LOI 2
     GAZP RO 1.193 GAMM 1.4 CV 719.286 PINI 100.8E3 PREF 100.8E3
          LECT none TERM
    !LOI 3
    GAZP RO 6.720 GAMM 1.4 CV 719.286 PINI 5.677E5 PREF 100.8E3
          LECT none TERM
    !LOI 4
     GAZP RO 1.193 GAMM 1.4 CV 719.286 PINI 100.8E3 PREF 100.8E3
          LECT flui3d TERM ! _cuvf TERM
     GAZP RO 1.193 GAMM 1.4 CV 719.286 PINI 100.8E3 PREF 100.8E3
          LECT epar1 epar2 TERM
     GAZP RO 1.193 GAMM 1.4 CV 719.286 PINI 100.8E3 PREF 100.8E3
          LECT rac3d1d raclp tubelpp TERM
     PARO PSIL 0.02
          LECT tubelpp TERM
     MULT 6 7 LECT tubelpp TERM
! In order to obtain a printout at least of the 3D VFCCs I am obliged
! to use a different material for tubelp3 and other 3D parts, but with
! the same characteristics as the material used for tubelp1
    GAZP RO 1.193 GAMM 1.4 CV 719.286 PINI 100.8E3 PREF 100.8E3
          LECT tubelp3 tank _cuvf TERM
     CLVF ABSO RO 1.187
          LECT abso TERM
     VPJC RO 7850.0 YOUN 2.1E11 NU 0.33 ELAS 3.257E8 MXIT 100
          QR1 2.348E8 CR1 56.2 QR2 4.457E8 CR2 4.7
          PDOT 5.E-4 C 1.E-2 TQ 0.9 CP 452.0
          TM 1800.0 M 1.0 DC 1.0 WC 555.0E6
          RESI 1
          LECT lframeb TERM
     VPJC RO 7850.0 YOUN 2.1E11 NU 0.33 ELAS 3.257E8 MXIT 100
          QR1 2.348E8 CR1 56.2 QR2 4.457E8 CR2 4.7
          PDOT 5.E-4 C 1.E-2 TQ 0.9 CP 452.0
          TM 1800.0 M 1.0 DC 1.0 WC 555.0E6
          RESI 1
          LECT uframe TERM
     VPJC RO 7850.0 YOUN 2.1E11 NU 0.33 ELAS 3.257E8 MXIT 100 ! Docol 600
          QR1 2.348E8 CR1 56.2 QR2 4.457E8 CR2 4.7
          PDOT 5.E-4 C 1.E-2 TQ 0.9 CP 452.0
          TM 1800.0 M 1.0 DC 1.0 WC 555.0E6
          RESI 1
          LECT plate TERM
     IMPE PIMP RO 7850.0 PRES 44.0011e6 PREF 1.011E5
          LECT presur TERM ! _cl3d TERM
LINK COUP SPLT NONE
     BLOQ 123 LECT blox TERM
     GLIS 2
                FROT MUST 0.5 MUDY 0.5 GAMM 0
                PGAP 0.4E-3
              ! MAIT LECT lframeb TERM
                MAIT NODE LECT nlfb DIFF nbad1 nbad2 TERM
                PESC LECT plate TERM
*
                FROT MUST 0.5 MUDY 0.5 GAMM 0
                PGAP 0.4E-3
                MAIT LECT uframe TERM
                PESC LECT plate TERM
!     GLIS 2
!                FROT MUST 0.5 MUDY 0.5 GAMM 0
!                PGAP 0.4E-3
!                MAIT LECT lframeb TERM
!                PESC LECT plate TERM
!*
!                FROT MUST 0.5 MUDY 0.5 GAMM 0
!                PGAP 0.4E-3
!                MAIT LECT uframe TERM
!                PESC LECT plate TERM
!*
```

```
LINK DECO BLOQ 246 LECT symy TERM
          BLOQ 345 LECT symz TERM
          BLOQ 2 LECT csymy TERM
          BLOQ 3 LECT csymz TERM
     FLSW STRU LECT scoup TERM
          FLUI LECT fcoup TERM
          R 0.0087    ! 0.014
          HGRI 0.00606 ! 0.016
          DGRI
          FACE
          BFLU 2 ! block if at least one node is in influence domain
          FSCP 1 ! couple in all directions
          ADAP LMAX 2 SCAL 6
     TBLO 123    TRIG LECT lframeb uframe TERM
          123456 TRIG LECT plate TERM
INIT MAPP FORM 'ST_MAP3_35.map' MATC OBJE LECT flui3d tubelp1 TERM
ECRI DEPL VITE ECRO FAIL TFRE 0.25E-3
          POIN LECT cen axis1 axis2 TERM
          ELEM LECT S1 TERM
      FICH ALIT FREQ 0 TFRE 0.D0
          TIME PROG 0.D0 PAS 0.5D-3 22.D-3 PAS 0.01D-3 80.D-3
          POIN LECT cen axis1 axis2 TERM
          ELEM LECT S1 S2 S5 S6 S11 S12 S15 S16 TERM
!    FICH PVTK FREQ 0 TFRE 0.D0
!         TIME PROG 0.D0 PAS 0.5D-3 28.D-3 PAS 0.1D-3 40.D-3
!         PAS 1.D-3 50.D-3
!         GROU AUTO
!         VARI DEPL VITE FAIL ACCE VCVI CONT ECRO FLIA
     FICH SPLI ALIC TFRE 0.5E-3
OPTI NOTE CSTA 0.4
     GLIS NORM ELEM ADAP SYME
     STEP IO
     LOG 1
     JAUM
     LMST
     PINS GRID DPIN 1.01
     VFCC FCON 6 ! hllc solver
          ORDR 2 ! order in space
          STPS 2 ! order in time
          RECO 1 ! Not accepted by CAL_VFCC_1D
          NTIL
     ADAP RCON WHAN
     ADAP RCON TRIG ECRO 1 TVAL 1.05E5 LECT trigger TERM
     NOCR TRIG LECT plate lframeb uframe TERM
     FLS  CUB8 2 ! For the inverse mapping
CALC TINI 0 TEND 32.0E-3 TFAI 1.143E-8 ! TFAI 2.0E-8
FIN
```

D6_S2_35_FG2_Cw.epx

```
D6_S2_35_FG2_CW
ECHO
!CONV WIN
RESU SPLI ALIC 'D6_S2_35_FG2_C.ali' GARD PSCR
COMP COUL VERT LECT plate TERM
          GR50 LECT lframeb uframe TERM
          TURQ LECT tubelp3 tank TERM
SORT VISU NSTO 1
*=======================================================================
PLAY
*-----------------------------------------------------------------------
CAME   1 EYE  -4.60000E-03 -7.47801E-10 -1.66049E+00
!        Q    -2.05103E-10 -1.00000E+00 -6.46235E-26  2.77556E-16
         VIEW  5.55112E-16  4.10207E-10  1.00000E+00
         RIGH  1.00000E+00  1.53918E-26 -5.55112E-16
         UP    2.43102E-25 -1.00000E+00  4.10207E-10
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER : -4.60000E-03  0.00000E+00  1.62500E-01
!RSPHERE:  3.64597E-01
!RADIUS :  1.82299E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.31529E+00
!FAR    :  2.04449E+00
SCEN GEOM NAVI FREE
          LINE SFRE SSHA
     ISO  FILL FIEL ECRO 1 SCAL USER PROG 1.001E5 PAS 0.5E5 7.501E5 TERM
          SUPP LECT tubelp3 tank TERM
     LIMA ON
SLER CAM1 1 NFRA 1
FREQ 1
TRAC OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate lframeb uframe tubelp3 tank TERM ! SYXY
                              SYXZ
                              TOLS 1.E-3 NFAI REND
GOTR LOOP 10 OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate lframeb uframe tubelp3 tank TERM ! SYXY
                              SYXZ
                              TOLS 1.E-3 NFAI REND
!TRAC OFFS SIZE 1200 1200 FICH BMP
!     OBJE LECT plate lframeb TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
!*-----------------------------------------------------------------------
!SCEN GEOM NAVI FREE
!         LINE HEOU SFRE SSHA
!    LIMA ON
!SLER CAM1 1 NFRA 1
!TRAC OFFS SIZE 1200 1200 FICH BMP
!     OBJE LECT plate lframeb TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
ENDPLAY
*=======================================================================
FIN
```

D6_S2_35_FG2_Cx.epx

```
D6_S2_35_FG2_CX
ECHO
!CONV WIN
RESU SPLI ALIC 'D6_S2_35_FG2_C.ali' GARD PSCR
COMP COUL VERT LECT plate TERM
          GR50 LECT lframeb uframe TERM
          TURQ LECT tubelp3 tank TERM
SORT VISU NSTO 1
*=======================================================================
PLAY
*-----------------------------------------------------------------------
CAME   1 EYE  -4.60000E-03 -7.47801E-10 -1.66049E+00
!        Q    -2.05103E-10 -1.00000E+00 -6.46235E-26  2.77556E-16
         VIEW  5.55112E-16  4.10207E-10  1.00000E+00
         RIGH  1.00000E+00  1.53918E-26 -5.55112E-16
         UP    2.43102E-25 -1.00000E+00  4.10207E-10
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER : -4.60000E-03  0.00000E+00  1.62500E-01
!RSPHERE:  3.64597E-01
!RADIUS :  1.82299E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.31529E+00
!FAR    :  2.04449E+00
SCEN GEOM NAVI FREE
          LINE SFRE SSHA
     LIMA ON
SLER CAM1 1 NFRA 1
FREQ 1
TRAC OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate lframeb uframe tubelp3 tank TERM ! SYXY
                              SYXZ
                              TOLS 1.E-3 NFAI REND
GOTR LOOP 10 OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate lframeb uframe tubelp3 tank TERM ! SYXY
                              SYXZ
                              TOLS 1.E-3 NFAI REND
!TRAC OFFS SIZE 1200 1200 FICH BMP
!     OBJE LECT plate lframeb TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
!*-----------------------------------------------------------------------
!SCEN GEOM NAVI FREE
!         LINE HEOU SFRE SSHA
!    LIMA ON
!SLER CAM1 1 NFRA 1
!TRAC OFFS SIZE 1200 1200 FICH BMP
!     OBJE LECT plate lframeb TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
ENDPLAY
*=======================================================================
FIN
```

D6_S2_35_FG2_Cy.epx

```
D6_S2_35_FG2_CY
ECHO
!CONV WIN
RESU SPLI ALIC 'D6_S2_35_FG2_C.ali' GARD PSCR
COMP COUL GR80 LECT plate TERM
          GR50 LECT lframeb uframe TERM
SORT VISU NSTO 1
*=======================================================================
PLAY
CAME   1 EYE  -1.97046E+00  0.00000E+00 -4.08169E-10
!        Q     7.07107E-01  0.00000E+00 -7.07107E-01  0.00000E+00
         VIEW  1.00000E+00  0.00000E+00  2.05103E-10
         RIGH -2.05103E-10  0.00000E+00  1.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  1.96000E-02  0.00000E+00  0.00000E+00
!RSPHERE:  4.42236E-01
!RADIUS :  1.99006E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.54783E+00
!FAR    :  2.87454E+00
*-----------------------------------------------------------------------
SCEN GEOM NAVI FREE
          LINE SFRE SSHA
     LIMA ON
SLER CAM1 1 NFRA 1
TRAC OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate lframeb TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
FREQ 1
GOTR LOOP 10 OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate lframeb TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
ENDPLAY
*=======================================================================
FIN
```

D6_S2_35_FG2_Cyy.epx

```
D6_S2_35_FG2_CYY
ECHO
!CONV WIN
RESU SPLI ALIC 'D6_S2_35_FG2_C.ali' GARD PSCR
COMP COUL GR80 LECT plate TERM
```

```
         GR50 LECT lframeb uframe TERM
SORT VISU NSTO 1
*=======================================================================
PLAY
CAME   1 EYE  -1.97046E+00  0.00000E+00 -4.08169E-10
!        Q     7.07107E-01  0.00000E+00 -7.07107E-01  0.00000E+00
         VIEW  1.00000E+00  0.00000E+00  2.05103E-10
         RIGH -2.05103E-10  0.00000E+00  1.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  1.96000E-02  0.00000E+00  0.00000E+00
!RSPHERE:  4.42236E-01
!RADIUS :  1.99006E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.54783E+00
!FAR    :  2.87454E+00
*-----------------------------------------------------------------------
SCEN GEOM NAVI FREE
         LINE HEOU SFRE SSHA
     LIMA ON
SLER CAM1 1 NFRA 1
TRAC OFFS SIZE 1200 1200 FICH BMP DEFO AMPD 0.0
     OBJE LECT plate TERM SYXY SYXZ TOLS 1.E-3 NFAI ADAP REND
FREQ 1
GOTR LOOP 10 OFFS SIZE 1200 1200 FICH BMP DEFO AMPD 0.0
     OBJE LECT plate TERM SYXY SYXZ TOLS 1.E-3 NFAI ADAP REND
ENDPLAY
*=======================================================================
FIN
```

D6_S2_35_FG2w.epx

```
D6_S2_35_FG2W
ECHO
!CONV WIN
RESU SPLI ALIC 'D6_S2_35_FG2.ali' GARD PSCR
COMP COUL VERT LECT plate TERM
          GR50 LECT lframeb uframe TERM
          TURQ LECT tubelp3 tank TERM
SORT VISU NSTO 1
*=======================================================================
PLAY
*-----------------------------------------------------------------------
CAME   1 EYE  -4.60000E-03 -7.47801E-10 -1.66049E+00
!        Q    -2.05103E-10 -1.00000E+00 -6.46235E-26  2.77556E-16
         VIEW  5.55112E-16  4.10207E-10  1.00000E+00
         RIGH  1.00000E+00  1.53918E-26 -5.55112E-16
         UP    2.43102E-25 -1.00000E+00  4.10207E-10
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER : -4.60000E-03  0.00000E+00  1.62500E-01
!RSPHERE:  3.64597E-01
!RADIUS :  1.82299E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.31529E+00
!FAR    :  2.04449E+00
SCEN GEOM NAVI FREE
          LINE SFRE SSHA
     ISO  FILL FIEL ECRO 1 SCAL USER PROG 1.001E5 PAS 0.5E5 7.501E5 TERM
          SUPP LECT tubelp3 tank TERM
     LIMA ON
SLER CAM1 1 NFRA 1
FREQ 1
TRAC OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate lframeb uframe tubelp3 tank TERM ! SYXY
                                   SYXZ
                                   TOLS 1.E-3 NFAI REND
GOTR LOOP 10 OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate lframeb uframe tubelp3 tank TERM ! SYXY
                                   SYXZ
                                   TOLS 1.E-3 NFAI REND
!TRAC OFFS SIZE 1200 1200 FICH BMP
!    OBJE LECT plate lframeb TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
!*-----------------------------------------------------------------------
!SCEN GEOM NAVI FREE
!         LINE HEOU SFRE SSHA
!    LIMA ON
!SLER CAM1 1 NFRA 1
!TRAC OFFS SIZE 1200 1200 FICH BMP
!    OBJE LECT plate lframeb TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
ENDPLAY
*=======================================================================
FIN
```

D6_S2_35_FG2x.epx

```
D6_S2_35_FG2X
ECHO
!CONV WIN
RESU SPLI ALIC 'D6_S2_35_FG2.ali' GARD PSCR
COMP COUL VERT LECT plate TERM
          GR50 LECT lframeb uframe TERM
          TURQ LECT tubelp3 tank TERM
SORT VISU NSTO 1
*=======================================================================
PLAY
*-----------------------------------------------------------------------
CAME   1 EYE  -4.60000E-03 -7.47801E-10 -1.66049E+00
!        Q    -2.05103E-10 -1.00000E+00 -6.46235E-26  2.77556E-16
         VIEW  5.55112E-16  4.10207E-10  1.00000E+00
         RIGH  1.00000E+00  1.53918E-26 -5.55112E-16
         UP    2.43102E-25 -1.00000E+00  4.10207E-10
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER : -4.60000E-03  0.00000E+00  1.62500E-01
!RSPHERE:  3.64597E-01
!RADIUS :  1.82299E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.31529E+00
!FAR    :  2.04449E+00
SCEN GEOM NAVI FREE
          LINE SFRE SSHA
     LIMA ON
SLER CAM1 1 NFRA 1
FREQ 1
TRAC OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate lframeb uframe tubelp3 tank TERM ! SYXY
                                   SYXZ
                                   TOLS 1.E-3 NFAI REND
GOTR LOOP 10 OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate lframeb uframe tubelp3 tank TERM ! SYXY
                                   SYXZ
                                   TOLS 1.E-3 NFAI REND
!TRAC OFFS SIZE 1200 1200 FICH BMP
!    OBJE LECT plate lframeb TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
!*-----------------------------------------------------------------------
!SCEN GEOM NAVI FREE
!         LINE HEOU SFRE SSHA
!    LIMA ON
!SLER CAM1 1 NFRA 1
!TRAC OFFS SIZE 1200 1200 FICH BMP
!    OBJE LECT plate lframeb TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
ENDPLAY
*=======================================================================
FIN
```

D6_S2_35_FG2y.epx

```
D6_S2_35_FG2Y
ECHO
!CONV WIN
RESU SPLI ALIC 'D6_S2_35_FG2.ali' GARD PSCR
COMP COUL GR80 LECT plate TERM
          GR50 LECT lframeb uframe TERM
SORT VISU NSTO 1
*=======================================================================
PLAY
CAME   1 EYE  -1.97046E+00  0.00000E+00 -4.08169E-10
!        Q     7.07107E-01  0.00000E+00 -7.07107E-01  0.00000E+00
         VIEW  1.00000E+00  0.00000E+00  2.05103E-10
         RIGH -2.05103E-10  0.00000E+00  1.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  1.96000E-02  0.00000E+00  0.00000E+00
!RSPHERE:  4.42236E-01
!RADIUS :  1.99006E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.54783E+00
!FAR    :  2.87454E+00
*-----------------------------------------------------------------------
SCEN GEOM NAVI FREE
          LINE SFRE SSHA
     LIMA ON
SLER CAM1 1 NFRA 1
TRAC OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate lframeb TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
FREQ 1
GOTR LOOP 10 OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate lframeb TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
ENDPLAY
*=======================================================================
FIN
```

D6_S2_35_FG2yy.epx

```
D6_S2_35_FG2YY
ECHO
!CONV WIN
RESU SPLI ALIC 'D6_S2_35_FG2.ali' GARD PSCR
COMP COUL GR80 LECT plate TERM
          GR50 LECT lframeb uframe TERM
SORT VISU NSTO 1
*=======================================================================
PLAY
CAME   1 EYE  -1.97046E+00  0.00000E+00 -4.08169E-10
!        Q     7.07107E-01  0.00000E+00 -7.07107E-01  0.00000E+00
         VIEW  1.00000E+00  0.00000E+00  2.05103E-10
         RIGH -2.05103E-10  0.00000E+00  1.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  1.96000E-02  0.00000E+00  0.00000E+00
!RSPHERE:  4.42236E-01
!RADIUS :  1.99006E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.54783E+00
!FAR    :  2.87454E+00
*-----------------------------------------------------------------------
```

```
SCEN GEOM NAVI FREE
          LINE HEOU SFRE SSHA
     LIMA ON
SLER CAM1 1 NFRA 1
TRAC OFFS SIZE 1200 1200 FICH BMP DEFO AMPD 0.0
     OBJE LECT plate TERM SYXY SYXZ TOLS 1.E-3 NFAI ADAP REND
FREQ 1
GOTR LOOP 10 OFFS SIZE 1200 1200 FICH BMP DEFO AMPD 0.0
     OBJE LECT plate TERM SYXY SYXZ TOLS 1.E-3 NFAI ADAP REND
ENDPLAY
*=======================================================================
FIN
```

D6_S2_35_FG_C.epx

```
D6_S2_35_FG_C
ECHO
!CONV win
CAST 'S2_FSI.msh' mesh
TRID ALE
EROS 1.0 CROI
DIME ADAP NPOI 200000
          CUVF 200000
          Q4GS 60000
          T3GS 10000
          NVFI 600000
     ENDA
     JONC 475 ! Total n. of nodes in a TUBM juncton
     NALE 1 NBLE 1
     TERM
GEOM CUB8 ecub8
     PR6  epri6
     Q4GS equa4 ! mems pinbcm
     T3GS etri3
     CUVF flui3d tubelp3 tank
     TUVF tubelp1
     CL3D face3d presur abso stub3d ! pre
     TUBM rac3d1d raclp
TERM
COMP EPAI 0.8e-3 LECT plate TERM
     DIAM DROI 0.1692568 LECT tubelp1 TERM
     RACC TUBM LECT rac3d1d  TERM
          NTUB LECT p1a   TERM DTUB 0.1692568
          FACE LECT face3d TERM COEF 1.0
     RACC TUBM LECT raclp  TERM
          NTUB LECT p1d3   TERM DTUB 0.1692568
          FACE LECT stub3d TERM COEF 1.0
! Attention: the TUBM element (raclp) is NOT included
! in the "mesh" object (although it IS indeed passed in from Cast3m).
! For this reason we must add it explicitly in the GROU directive below
! if we want to have it in the extracted element groups.
     GROU 21 'endtube' LECT tube TERM COND XB GT -0.6
            'trigger' LECT tube TERM COND NEAR POIN -0.1501 0 0
            'frefine' LECT flui TERM COND XB GT -0.3
                                     COND XB LT  1.0
            'pp1'    LECT plate TERM
                     COND BOX X0 0.0 Y0 0.0  Z0 0.0
                              DX 0.1 DY 0.15 DZ 0.15
            'pp2'    LECT plate TERM
                     COND BOX X0 0.0 Y0 0.0  Z0 0.0
                              DX 0.1 DY 0.165 DZ 0.165
            'fcoup'  LECT flui  TERM COND XB GT -0.05
                                     COND XB LT 0.150
                                     COND YB LT 0.150
                                     COND ZB LT 0.150
            'scoup'  LECT plate TERM COND YB LT 0.150
                                     COND ZB LT 0.150
            'lfrb2' LECT lframeb TERM
                    COND XB LT -0.865E-2
            'lfrb1' LECT lframeb DIFF lfrb2 TERM
            'uframe2'    LECT uframe DIFF presur TERM
            'S1' LECT tube TERM COND NEAR POIN -0.345 0.0 0.15
            'S2' LECT tube TERM COND NEAR POIN -0.245 0.0 0.15
            'S16' LECT flui3d TERM COND NEAR POIN -15.225 0 0.15
            'S15' LECT flui3d TERM COND NEAR POIN -15.125 0 0.15
            'S12' LECT tube TERM COND NEAR POIN -12.495 0 0.15
            'S11' LECT tube TERM COND NEAR POIN -12.395 0 0.15
            'S6' LECT tube TERM COND NEAR POIN -5.685 0 0.15
            'S5' LECT tube TERM COND NEAR POIN -5.585 0 0.15
            'epar1' LECT tubelp1 TERM COND NEAR NODE LECT p1a TERM
            'epar2' LECT tubelp1 TERM COND NEAR NODE LECT p1d3 TERM
            'tubelpp' LECT tubelp1 DIFF epar1 epar2 TERM
     NGRO 13 'blox'  LECT lframeb TERM COND !X LT -0.0253
                                             X GT 0.0253
            'symy'  LECT plate TERM    COND Y LT 0.0001
            'symz'  LECT plate TERM    COND Z LT 0.0001
            'pt0' LECT tube TERM COND NEAR POIN -16.19999 0.0 0.0
            'cen' LECT plate TERM COND NEAR POIN 0.0 0.0 0.0
            'axis1'   LECT plate TERM COND Y LT 0.0001
            'axis2'   LECT plate TERM COND Z LT 0.0001
            'csymy' LECT uframe lframeb TERM COND Y LT 0.0001
            'csymz' LECT uframe lframeb TERM COND Z LT 0.0001
            'elfb'  LECT lframeb TERM COND ENVE
            'nlfb'  LECT elfb    TERM COND X GT -0.01
                                      COND X LT  0.001
            'nbad1' LECT nlfb TERM
                    COND CONE X1 -0.009 Y1 0.260 Z1 0
                              X2  0.001 Y2 0.260 Z2 0
                              R1  0.009 R2 0.009
            'nbad2' LECT nlfb TERM
                    COND CONE X1 -0.009 Y1 0 Z1 0.260
                              X2  0.001 Y2 0 Z2 0.260
                              R1  0.009 R2 0.009
     COUL TURQ LECT tube tra lp3xl TERM
          VERT LECT plate fir2 TERM
          ROSE LECT fir1 TERM
          ROUG LECT driver TERM
         ROSE LECT S1 S2 S5 S6 S11 S12 S15 S16 TERM
ADAP THRS ECRO 11 TMIN 0.01 TMAX 0.02 MAXL 4 CRIT 1 ! NOUN
          LECT plate TERM
!          LECT pp2 TERM
GRIL LAGR LECT spec TERM
MATE
    !LOI 1
     GAZP RO 20.310 GAMM 1.4 CV 719.286 PINI 17.16E5 PREF 100.8E3
          LECT none TERM
    !LOI 2
     GAZP RO 1.193 GAMM 1.4 CV 719.286 PINI 100.8E3 PREF 100.8E3
          LECT none TERM
    !LOI 3
    GAZP RO 6.720 GAMM 1.4 CV 719.286 PINI 5.677E5 PREF 100.8E3
          LECT none TERM
    !LOI 4
     GAZP RO 1.193 GAMM 1.4 CV 719.286 PINI 100.8E3 PREF 100.8E3
          LECT flui3d TERM ! _cuvf TERM
     GAZP RO 1.193 GAMM 1.4 CV 719.286 PINI 100.8E3 PREF 100.8E3
          LECT epar1 epar2 TERM
     GAZP RO 1.193 GAMM 1.4 CV 719.286 PINI 100.8E3 PREF 100.8E3
          LECT rac3d1d raclp tubelpp TERM
     PARO PSIL 0.02
          LECT tubelpp TERM
     MULT 6 7 LECT tubelpp TERM
! In order to obtain a printout at least of the 3D VFCCs I am obliged
! to use a different material for tubelp3 and other 3D parts, but with
! the same characteristics as the material used for tubelp1
    GAZP RO 1.193 GAMM 1.4 CV 719.286 PINI 100.8E3 PREF 100.8E3
          LECT tubelp3 tank _cuvf TERM
     CLVF ABSO RO 1.187
          LECT abso TERM
     VPJC RO 7850.0 YOUN 2.1E11 NU 0.33 ELAS 3.257E8 MXIT 100
          QR1 2.348E8 CR1 56.2 QR2 4.457E8 CR2 4.7
          PDOT 5.E-4 C 1.E-2 TQ 0.9 CP 452.0
          TM 1800.0 M 1.0 DC 1.0 WC 555.0E6
          RESI 1
          LECT lframeb TERM
     VPJC RO 7850.0 YOUN 2.1E11 NU 0.33 ELAS 3.257E8 MXIT 100
          QR1 2.348E8 CR1 56.2 QR2 4.457E8 CR2 4.7
          PDOT 5.E-4 C 1.E-2 TQ 0.9 CP 452.0
          TM 1800.0 M 1.0 DC 1.0 WC 555.0E6
          RESI 1
          LECT uframe TERM
     VPJC RO 7850.0 YOUN 2.1E11 NU 0.33 ELAS 3.257E8 MXIT 100 ! Docol 600
          QR1 2.348E8 CR1 56.2 QR2 4.457E8 CR2 4.7
          PDOT 5.E-4 C 1.E-2 TQ 0.9 CP 452.0
          TM 1800.0 M 1.0 DC 1.0 WC 555.0E6
          RESI 1
          LECT plate TERM
     IMPE PIMP RO 7850.0 PRES 44.0011e6 PREF 1.011E5
          LECT presur TERM ! _cl3d TERM
LINK COUP SPLT NONE
     BLOQ 123 LECT blox TERM
     GLIS 2
             FROT MUST 0.5 MUDY 0.5 GAMM 0
             PGAP 0.4E-3
           ! MAIT LECT lframeb TERM
             MAIT NODE LECT nlfb DIFF nbad1 nbad2 TERM
             PESC LECT plate TERM
*
             FROT MUST 0.5 MUDY 0.5 GAMM 0
             PGAP 0.4E-3
             MAIT LECT uframe TERM
             PESC LECT plate TERM
!     GLIS 2
!             FROT MUST 0.5 MUDY 0.5 GAMM 0
!             PGAP 0.4E-3
!             MAIT LECT lframeb TERM
!             PESC LECT plate TERM
!*
!             FROT MUST 0.5 MUDY 0.5 GAMM 0
!             PGAP 0.4E-3
!             MAIT LECT uframe TERM
!             PESC LECT plate TERM
!*
LINK DECO BLOQ 246 LECT symy TERM
          BLOQ 345 LECT symz TERM
          BLOQ 2 LECT csymy TERM
          BLOQ 3 LECT csymz TERM
     FLSW STRU LECT scoup TERM
          FLUI LECT fcoup TERM
          R 0.0087    ! 0.014
          HGRI 0.00606 ! 0.016
          DGRI
          FACE
          BFLU 2 ! block if at least one node is in influence domain
          FSCP 1 ! couple in all directions
          ADAP LMAX 2 SCAL 6
     TBLO 123    TRIG LECT lframeb uframe TERM
          123456 TRIG LECT plate TERM
INIT MAPP FORM 'ST_MAP3_35.map' MATC OBJE LECT flui3d tubelp1 TERM
ECRI DEPL VITE ECRO FAIL TFRE 0.25E-3
          POIN LECT cen axis1 axis2 TERM
          ELEM LECT S1 TERM
      FICH ALIT FREQ 0 TFRE 0.D0
```

```
        TIME PROG 0.D0 PAS 0.5D-3 22.D-3 PAS 0.01D-3 80.D-3
        POIN LECT cen axis1 axis2 TERM
        ELEM LECT S1 S2 S5 S6 S11 S12 S15 S16 TERM
!    FICH PVTK FREQ 0 TFRE 0.D0
!        TIME PROG 0.D0 PAS 0.5D-3 28.D-3 PAS 0.1D-3 40.D-3
!        PAS 1.D-3 50.D-3
!        GROU AUTO
!        VARI DEPL VITE FAIL ACCE VCVI CONT ECRO FLIA
     FICH SPLI ALIC TFRE 0.5E-3
OPTI NOTE CSTA 0.4
     GLIS NORM ELEM
     STEP IO
     LOG 1
     JAUM
     LMST
     PINS GRID DPIN 1.01
     VFCC FCON 6 ! hllc solver
          ORDR 2 ! order in space
          STPS 2 ! order in time
          RECO 1 ! Not accepted by CAL_VFCC_1D
          NTIL
     ADAP RCON WHAN
     ADAP RCON TRIG ECRO 1 TVAL 1.05E5 LECT trigger TERM
     NOCR TRIG LECT plate lframeb uframe TERM
     FLS  CUB8 2 ! For the inverse mapping
CALC TINI 0 TEND 32.0E-3 TFAI 1.143E-8 ! 2.0E-8
FIN
```

D6_S2_35_FG_CSVF.epx

```
D6_S2_35_FG_CSVF
ECHO
!CONV win
CAST 'S2_FSI.msh' mesh
TRID ALE
EROS 1.0 CROI
DIME ADAP NPOI 200000
          CUVF 200000
          Q4GS 60000
          T3GS 10000
          NVFI 600000
     ENDA
     JONC 475 ! Total n. of nodes in a TUBM juncton
     NALE 1 NBLE 1
     TERM
GEOM CUB8 ecub8
     PR6  epri6
     Q4GS equa4 ! mems pinbcm
     T3GS etri3
     CUVF flui3d tubelp3 tank
     TUVF tubelp1
     CL3D face3d presur abso stub3d ! pre
     TUBM rac3d1d raclp
TERM
COMP EPAI 0.8e-3 LECT plate TERM
     DIAM DROI 0.1692568 LECT tubelp1 TERM
     RACC TUBM LECT rac3d1d  TERM
          NTUB LECT p1a   TERM DTUB 0.1692568
          FACE LECT face3d TERM COEF 1.0
     RACC TUBM LECT raclp  TERM
          NTUB LECT p1d3   TERM DTUB 0.1692568
          FACE LECT stub3d TERM COEF 1.0
! Attention: the TUBM element (raclp) is NOT included
! in the "mesh" object (although it IS indeed passed in from Cast3m).
! For this reason we must add it explicitly in the GROU directive below
! if we want to have it in the extracted element groups.
     GROU 21 'endtube' LECT tube TERM COND XB GT -0.6
            'trigger' LECT tube TERM COND NEAR POIN -0.1501 0 0
            'frefine' LECT flui TERM COND XB GT -0.3
                                     COND XB LT  1.0
            'pp1'    LECT plate TERM
                     COND BOX X0 0.0 Y0 0.0  Z0 0.0
                              DX 0.1 DY 0.15 DZ 0.15
            'pp2'    LECT plate TERM
                     COND BOX X0 0.0 Y0 0.0  Z0 0.0
                              DX 0.1 DY 0.165 DZ 0.165
            'fcoup'  LECT flui  TERM COND XB GT -0.05
                                     COND XB LT 0.150
                                     COND YB LT 0.150
                                     COND ZB LT 0.150
            'scoup'  LECT plate TERM COND YB LT 0.150
                                     COND ZB LT 0.150
            'lfrb2' LECT lframeb TERM
                    COND XB LT -0.865E-2
            'lfrb1' LECT lframeb DIFF lfrb2 TERM
            'uframe2'    LECT uframe DIFF presur TERM
            'S1' LECT tube TERM COND NEAR POIN -0.345 0.0 0.15
            'S2' LECT tube TERM COND NEAR POIN -0.245 0.0 0.15
            'S16' LECT flui3d TERM COND NEAR POIN -15.225 0 0.15
            'S15' LECT flui3d TERM COND NEAR POIN -15.125 0 0.15
            'S12' LECT tube TERM COND NEAR POIN -12.495 0 0.15
            'S11' LECT tube TERM COND NEAR POIN -12.395 0 0.15
            'S6' LECT tube TERM COND NEAR POIN -5.685 0 0.15
            'S5' LECT tube TERM COND NEAR POIN -5.585 0 0.15
            'epar1' LECT tubelp1 TERM COND NEAR NODE LECT p1a TERM
            'epar2' LECT tubelp1 TERM COND NEAR NODE LECT p1d3 TERM
            'tubelpp' LECT tubelp1 DIFF epar1 epar2 TERM
     NGRO 13 'blox'  LECT lframeb TERM COND !X LT -0.0253
                                            X GT 0.0253
            'symy'  LECT plate TERM    COND Y LT 0.0001
            'symz'  LECT plate TERM    COND Z LT 0.0001
            'pt0' LECT tube TERM COND NEAR POIN -16.19999 0.0 0.0
            'cen' LECT plate TERM COND NEAR POIN 0.0 0.0 0.0
            'axis1'   LECT plate TERM COND Y LT 0.0001
            'axis2'   LECT plate TERM COND Z LT 0.0001
            'csymy' LECT uframe lframeb TERM COND Y LT 0.0001
            'csymz' LECT uframe lframeb TERM COND Z LT 0.0001
            'elfb'  LECT lframeb TERM COND ENVE
            'nlfb'  LECT elfb    TERM COND X GT -0.01
                                      COND X LT  0.001
            'nbad1' LECT nlfb TERM
                   COND CONE X1 -0.009 Y1 0.260 Z1 0
                             X2  0.001 Y2 0.260 Z2 0
                             R1  0.009 R2 0.009
            'nbad2' LECT nlfb TERM
                   COND CONE X1 -0.009 Y1 0 Z1 0.260
                             X2  0.001 Y2 0 Z2 0.260
                             R1  0.009 R2 0.009
     COUL TURQ LECT tube tra lp3xl TERM
          VERT LECT plate fir2 TERM
          ROSE LECT fir1 TERM
          ROUG LECT driver TERM
         ROSE LECT S1 S2 S5 S6 S11 S12 S15 S16 TERM
ADAP THRS ECRO 11 TMIN 0.01 TMAX 0.02 MAXL 4 CRIT 1 ! NOUN
          LECT plate TERM
!          LECT pp2 TERM
GRIL LAGR LECT spec TERM
MATE
    !LOI 1
     GAZP RO 20.310 GAMM 1.4 CV 719.286 PINI 17.16E5 PREF 100.8E3
          LECT none TERM
    !LOI 2
     GAZP RO 1.193 GAMM 1.4 CV 719.286 PINI 100.8E3 PREF 100.8E3
          LECT none TERM
    !LOI 3
    GAZP RO 6.720 GAMM 1.4 CV 719.286 PINI 5.677E5 PREF 100.8E3
          LECT none TERM
    !LOI 4
     GAZP RO 1.193 GAMM 1.4 CV 719.286 PINI 100.8E3 PREF 100.8E3
          LECT flui3d TERM ! _cuvf TERM
     GAZP RO 1.193 GAMM 1.4 CV 719.286 PINI 100.8E3 PREF 100.8E3
          LECT epar1 epar2 TERM
     GAZP RO 1.193 GAMM 1.4 CV 719.286 PINI 100.8E3 PREF 100.8E3
          LECT rac3d1d raclp tubelpp TERM
     PARO PSIL 0.02
          LECT tubelpp TERM
     MULT 6 7 LECT tubelpp TERM
! In order to obtain a printout at least of the 3D VFCCs I am obliged
! to use a different material for tubelp3 and other 3D parts, but with
! the same characteristics as the material used for tubelp1
    GAZP RO 1.193 GAMM 1.4 CV 719.286 PINI 100.8E3 PREF 100.8E3
          LECT tubelp3 tank _cuvf TERM
     CLVF ABSO RO 1.187
          LECT abso TERM
     VPJC RO 7850.0 YOUN 2.1E11 NU 0.33 ELAS 3.257E8 MXIT 100
          QR1 2.348E8 CR1 56.2 QR2 4.457E8 CR2 4.7
          PDOT 5.E-4 C 1.E-2 TQ 0.9 CP 452.0
          TM 1800.0 M 1.0 DC 1.0 WC 555.0E6
          RESI 1
          LECT lframeb TERM
     VPJC RO 7850.0 YOUN 2.1E11 NU 0.33 ELAS 3.257E8 MXIT 100
          QR1 2.348E8 CR1 56.2 QR2 4.457E8 CR2 4.7
          PDOT 5.E-4 C 1.E-2 TQ 0.9 CP 452.0
          TM 1800.0 M 1.0 DC 1.0 WC 555.0E6
          RESI 1
          LECT uframe TERM
     VPJC RO 7850.0 YOUN 2.1E11 NU 0.33 ELAS 3.257E8 MXIT 100 ! Docol 600
          QR1 2.348E8 CR1 56.2 QR2 4.457E8 CR2 4.7
          PDOT 5.E-4 C 1.E-2 TQ 0.9 CP 452.0
          TM 1800.0 M 1.0 DC 1.0 WC 555.0E6
          RESI 1
          LECT plate TERM
     IMPE PIMP RO 7850.0 PRES 44.0011e6 PREF 1.011E5
          LECT presur TERM ! _cl3d TERM
LINK COUP SPLT NONE
     BLOQ 123 LECT blox TERM
     GLIS 2
                FROT MUST 0.5 MUDY 0.5 GAMM 0
                PGAP 0.4E-3
              ! MAIT LECT lframeb TERM
                MAIT NODE LECT nlfb DIFF nbad1 nbad2 TERM
                PESC LECT plate TERM
*
                FROT MUST 0.5 MUDY 0.5 GAMM 0
                PGAP 0.4E-3
                MAIT LECT uframe TERM
                PESC LECT plate TERM
!     GLIS 2
!                FROT MUST 0.5 MUDY 0.5 GAMM 0
!                PGAP 0.4E-3
!                MAIT LECT lframeb TERM
!                PESC LECT plate TERM
!*
!                FROT MUST 0.5 MUDY 0.5 GAMM 0
!                PGAP 0.4E-3
!                MAIT LECT uframe TERM
!                PESC LECT plate TERM
!*
LINK DECO BLOQ 246 LECT symy TERM
          BLOQ 345 LECT symz TERM
          BLOQ 2 LECT csymy TERM
          BLOQ 3 LECT csymz TERM
     FLSW STRU LECT scoup TERM
```

```
         FLUI LECT fcoup TERM
         R 0.0087    ! 0.014
         HGRI 0.00606 ! 0.016
         DGRI
         FACE
         BFLU 2 ! block if at least one node is in influence domain
         FSCP 1 ! couple in all directions
         ADAP LMAX 2 SCAL 6
     TBLO 123    TRIG LECT lframeb uframe TERM
         123456 TRIG LECT plate TERM
INIT MAPP FORM 'ST_MAP3_35.map' MATC OBJE LECT flui3d tubelp1 TERM
ECRI DEPL VITE ECRO FAIL TFRE 0.25E-3
         POIN LECT cen axis1 axis2 TERM
         ELEM LECT S1 TERM
      FICH ALIT FREQ 0 TFRE 0.D0
         TIME PROG 0.D0 PAS 0.5D-3 22.D-3 PAS 0.01D-3 80.D-3
         POIN LECT cen axis1 axis2 TERM
         ELEM LECT S1 S2 S5 S6 S11 S12 S15 S16 TERM
!    FICH PVTK FREQ 0 TFRE 0.D0
!        TIME PROG 0.D0 PAS 0.5D-3 28.D-3 PAS 0.1D-3 40.D-3
!        PAS 1.D-3 50.D-3
!        GROU AUTO
!        VARI DEPL VITE FAIL ACCE VCVI CONT ECRO FLIA
     FICH SPLI ALIC TFRE 0.5E-3
OPTI NOTE CSTA 0.7 CSVF 0.571 ! (so that CSTA*CSVF=0.4 for the VFCC)
     GLIS NORM ELEM
     STEP IO
     LOG 1
     JAUM
     LMST
     PINS GRID DPIN 1.01
     VFCC FCON 6 ! hllc solver
         ORDR 2 ! order in space
         STPS 2 ! order in time
         RECO 1 ! Not accepted by CAL_VFCC_1D
         NTIL
     ADAP RCON WHAN
     ADAP RCON TRIG ECRO 1 TVAL 1.05E5 LECT trigger TERM
     NOCR TRIG LECT plate lframeb uframe TERM
     FLS  CUB8 2 ! For the inverse mapping
CALC TINI 0 TEND 32.0E-3 TFAI 2.0E-8
FIN
```

D6_S2_35_FG_CSVFw.epx

```
D6_S2_35_FG_CSVFW
ECHO
!CONV WIN
RESU SPLI ALIC 'D6_S2_35_FG_CSVF.ali' GARD PSCR
COMP COUL VERT LECT plate TERM
         GR50 LECT lframeb uframe TERM
         TURQ LECT tubelp3 tank TERM
SORT VISU NSTO 1
*=======================================================================
PLAY
*-----------------------------------------------------------------------
CAME   1 EYE  -4.60000E-03 -7.47801E-10 -1.66049E+00
!        Q    -2.05103E-10 -1.00000E+00 -6.46235E-26  2.77556E-16
         VIEW  5.55112E-16  4.10207E-10  1.00000E+00
         RIGH  1.00000E+00  1.53918E-26 -5.55112E-16
         UP    2.43102E-25 -1.00000E+00  4.10207E-10
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER : -4.60000E-03  0.00000E+00  1.62500E-01
!RSPHERE:  3.64597E-01
!RADIUS :  1.82299E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.31529E+00
!FAR    :  2.04449E+00
SCEN GEOM NAVI FREE
         LINE SFRE SSHA
     ISO  FILL FIEL ECRO 1 SCAL USER PROG 1.001E5 PAS 0.5E5 7.501E5 TERM
         SUPP LECT tubelp3 tank TERM
     LIMA ON
SLER CAM1 1 NFRA 1
FREQ 1
TRAC OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate lframeb uframe tubelp3 tank TERM ! SYXY
                                   SYXZ
                                   TOLS 1.E-3 NFAI REND
GOTR LOOP 10 OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate lframeb uframe tubelp3 tank TERM ! SYXY
                                   SYXZ
                                   TOLS 1.E-3 NFAI REND
!TRAC OFFS SIZE 1200 1200 FICH BMP
!     OBJE LECT plate lframeb TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
!*-----------------------------------------------------------------------
!SCEN GEOM NAVI FREE
!         LINE HEOU SFRE SSHA
!     LIMA ON
!SLER CAM1 1 NFRA 1
!TRAC OFFS SIZE 1200 1200 FICH BMP
!     OBJE LECT plate lframeb TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
ENDPLAY
*=======================================================================
FIN
```

D6_S2_35_FG_CSVFx.epx

```
D6_S2_35_FG_CSVFX
ECHO
!CONV WIN
RESU SPLI ALIC 'D6_S2_35_FG_CSVF.ali' GARD PSCR
COMP COUL VERT LECT plate TERM
         GR50 LECT lframeb uframe TERM
         TURQ LECT tubelp3 tank TERM
SORT VISU NSTO 1
*=======================================================================
PLAY
*-----------------------------------------------------------------------
CAME   1 EYE  -4.60000E-03 -7.47801E-10 -1.66049E+00
!        Q    -2.05103E-10 -1.00000E+00 -6.46235E-26  2.77556E-16
         VIEW  5.55112E-16  4.10207E-10  1.00000E+00
         RIGH  1.00000E+00  1.53918E-26 -5.55112E-16
         UP    2.43102E-25 -1.00000E+00  4.10207E-10
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER : -4.60000E-03  0.00000E+00  1.62500E-01
!RSPHERE:  3.64597E-01
!RADIUS :  1.82299E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.31529E+00
!FAR    :  2.04449E+00
SCEN GEOM NAVI FREE
         LINE SFRE SSHA
     LIMA ON
SLER CAM1 1 NFRA 1
FREQ 1
TRAC OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate lframeb uframe tubelp3 tank TERM ! SYXY
                                   SYXZ
                                   TOLS 1.E-3 NFAI REND
GOTR LOOP 10 OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate lframeb uframe tubelp3 tank TERM ! SYXY
                                   SYXZ
                                   TOLS 1.E-3 NFAI REND
!TRAC OFFS SIZE 1200 1200 FICH BMP
!     OBJE LECT plate lframeb TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
!*-----------------------------------------------------------------------
!SCEN GEOM NAVI FREE
!         LINE HEOU SFRE SSHA
!     LIMA ON
!SLER CAM1 1 NFRA 1
!TRAC OFFS SIZE 1200 1200 FICH BMP
!     OBJE LECT plate lframeb TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
ENDPLAY
*=======================================================================
FIN
```

D6_S2_35_FG_CSVFy.epx

```
D6_S2_35_FG_CSVFY
ECHO
!CONV WIN
RESU SPLI ALIC 'D6_S2_35_FG_CSVF.ali' GARD PSCR
COMP COUL GR80 LECT plate TERM
         GR50 LECT lframeb uframe TERM
SORT VISU NSTO 1
*=======================================================================
PLAY
CAME   1 EYE  -1.97046E+00  0.00000E+00 -4.08169E-10
!        Q     7.07107E-01  0.00000E+00 -7.07107E-01  0.00000E+00
         VIEW  1.00000E+00  0.00000E+00  2.05103E-10
         RIGH -2.05103E-10  0.00000E+00  1.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  1.96000E-02  0.00000E+00  0.00000E+00
!RSPHERE:  4.42236E-01
!RADIUS :  1.99006E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.54783E+00
!FAR    :  2.87454E+00
*-----------------------------------------------------------------------
SCEN GEOM NAVI FREE
         LINE SFRE SSHA
     LIMA ON
SLER CAM1 1 NFRA 1
TRAC OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate lframeb TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
FREQ 1
GOTR LOOP 10 OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate lframeb TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
!*-----------------------------------------------------------------------
!     VISU NSTO 1
!*-----------------------------------------------------------------------
!SCEN GEOM NAVI FREE
!         LINE HEOU SFRE SSHA
!     LIMA ON
!SLER CAM1 1 NFRA 1
!TRAC OFFS SIZE 1200 1200 FICH BMP
!     OBJE LECT plate lframeb TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
!FREQ 1
!GOTR LOOP 10 OFFS SIZE 1200 1200 FICH BMP
!     OBJE LECT plate lframeb TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
ENDPLAY
*=======================================================================
FIN
```

D6_S2_35_FG_CSVFyy.epx

```
D6_S2_35_FG_CSVFYY
ECHO
!CONV WIN
RESU SPLI ALIC 'D6_S2_35_FG_CSVF.ali' GARD PSCR
COMP COUL GR80 LECT plate TERM
          GR50 LECT lframeb uframe TERM
SORT VISU NSTO 1
*=======================================================================
PLAY
*-----------------------------------------------------------------------
CAME   1 EYE  -1.97046E+00  0.00000E+00 -4.08169E-10
!        Q     7.07107E-01  0.00000E+00 -7.07107E-01  0.00000E+00
         VIEW  1.00000E+00  0.00000E+00  2.05103E-10
         RIGH -2.05103E-10  0.00000E+00  1.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  1.96000E-02  0.00000E+00  0.00000E+00
!RSPHERE:  4.42236E-01
!RADIUS :  1.99006E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.54783E+00
!FAR    :  2.87454E+00
*-----------------------------------------------------------------------
SCEN GEOM NAVI FREE
          LINE HEOU SFRE SSHA
     LIMA ON
SLER CAM1 1 NFRA 1
TRAC OFFS SIZE 1200 1200 FICH BMP DEFO AMPD 0.0
     OBJE LECT plate TERM SYXY SYXZ TOLS 1.E-3 NFAI ADAP REND
FREQ 1
GOTR LOOP 10 OFFS SIZE 1200 1200 FICH BMP DEFO AMPD 0.0
     OBJE LECT plate TERM SYXY SYXZ TOLS 1.E-3 NFAI ADAP REND
ENDPLAY
*=======================================================================
FIN
```

D6_S2_35_FG_Cw.epx

```
D6_S2_35_FG_CW
ECHO
!CONV WIN
RESU SPLI ALIC 'D6_S2_35_FG_C.ali' GARD PSCR
COMP COUL VERT LECT plate TERM
          GR50 LECT lframeb uframe TERM
          TURQ LECT tubelp3 tank TERM
SORT VISU NSTO 1
*=======================================================================
PLAY
*-----------------------------------------------------------------------
CAME   1 EYE  -4.60000E-03 -7.47801E-10 -1.66049E+00
!        Q    -2.05103E-10 -1.00000E+00 -6.46235E-26  2.77556E-16
         VIEW  5.55112E-16  4.10207E-10  1.00000E+00
         RIGH  1.00000E+00  1.53918E-26 -5.55112E-16
         UP    2.43102E-25 -1.00000E+00  4.10207E-10
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER : -4.60000E-03  0.00000E+00  1.62500E-01
!RSPHERE:  3.64597E-01
!RADIUS :  1.82299E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.31529E+00
!FAR    :  2.04449E+00
SCEN GEOM NAVI FREE
          LINE SFRE SSHA
     ISO  FILL FIEL ECRO 1 SCAL USER PROG 1.001E5 PAS 0.5E5 7.501E5 TERM
          SUPP LECT tubelp3 tank TERM
     LIMA ON
SLER CAM1 1 NFRA 1
FREQ 1
TRAC OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate lframeb uframe tubelp3 tank TERM ! SYXY
                                 SYXZ
                                 TOLS 1.E-3 NFAI REND
GOTR LOOP 10 OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate lframeb uframe tubelp3 tank TERM ! SYXY
                                 SYXZ
                                 TOLS 1.E-3 NFAI REND
!TRAC OFFS SIZE 1200 1200 FICH BMP
!     OBJE LECT plate lframeb TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
!*-----------------------------------------------------------------------
!SCEN GEOM NAVI FREE
!          LINE HEOU SFRE SSHA
!     LIMA ON
!SLER CAM1 1 NFRA 1
!TRAC OFFS SIZE 1200 1200 FICH BMP
!     OBJE LECT plate lframeb TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
ENDPLAY
*=======================================================================
FIN
```

D6_S2_35_FG_Cx.epx

```
D6_S2_35_FG_CX
ECHO
!CONV WIN
RESU SPLI ALIC 'D6_S2_35_FG_C.ali' GARD PSCR
COMP COUL VERT LECT plate TERM
          GR50 LECT lframeb uframe TERM
          TURQ LECT tubelp3 tank TERM
SORT VISU NSTO 1
*=======================================================================
PLAY
*-----------------------------------------------------------------------
CAME   1 EYE  -4.60000E-03 -7.47801E-10 -1.66049E+00
!        Q    -2.05103E-10 -1.00000E+00 -6.46235E-26  2.77556E-16
         VIEW  5.55112E-16  4.10207E-10  1.00000E+00
         RIGH  1.00000E+00  1.53918E-26 -5.55112E-16
         UP    2.43102E-25 -1.00000E+00  4.10207E-10
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER : -4.60000E-03  0.00000E+00  1.62500E-01
!RSPHERE:  3.64597E-01
!RADIUS :  1.82299E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.31529E+00
!FAR    :  2.04449E+00
SCEN GEOM NAVI FREE
          LINE SFRE SSHA
     LIMA ON
SLER CAM1 1 NFRA 1
FREQ 1
TRAC OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate lframeb uframe tubelp3 tank TERM ! SYXY
                                 SYXZ
                                 TOLS 1.E-3 NFAI REND
GOTR LOOP 10 OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate lframeb uframe tubelp3 tank TERM ! SYXY
                                 SYXZ
                                 TOLS 1.E-3 NFAI REND
!TRAC OFFS SIZE 1200 1200 FICH BMP
!     OBJE LECT plate lframeb TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
!*-----------------------------------------------------------------------
!SCEN GEOM NAVI FREE
!          LINE HEOU SFRE SSHA
!     LIMA ON
!SLER CAM1 1 NFRA 1
!TRAC OFFS SIZE 1200 1200 FICH BMP
!     OBJE LECT plate lframeb TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
ENDPLAY
*=======================================================================
FIN
```

D6_S2_35_FG_Cy.epx

```
D6_S2_35_FG_CY
ECHO
!CONV WIN
RESU SPLI ALIC 'D6_S2_35_FG_C.ali' GARD PSCR
COMP COUL GR80 LECT plate TERM
          GR50 LECT lframeb uframe TERM
SORT VISU NSTO 1
*=======================================================================
PLAY
CAME   1 EYE  -1.97046E+00  0.00000E+00 -4.08169E-10
!        Q     7.07107E-01  0.00000E+00 -7.07107E-01  0.00000E+00
         VIEW  1.00000E+00  0.00000E+00  2.05103E-10
         RIGH -2.05103E-10  0.00000E+00  1.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  1.96000E-02  0.00000E+00  0.00000E+00
!RSPHERE:  4.42236E-01
!RADIUS :  1.99006E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.54783E+00
!FAR    :  2.87454E+00
*-----------------------------------------------------------------------
SCEN GEOM NAVI FREE
          LINE SFRE SSHA
     LIMA ON
SLER CAM1 1 NFRA 1
TRAC OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate lframeb TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
FREQ 1
GOTR LOOP 10 OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate lframeb TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
!*-----------------------------------------------------------------------
!     VISU NSTO 1
!*-----------------------------------------------------------------------
!SCEN GEOM NAVI FREE
!          LINE HEOU SFRE SSHA
!     LIMA ON
!SLER CAM1 1 NFRA 1
!TRAC OFFS SIZE 1200 1200 FICH BMP
!     OBJE LECT plate lframeb TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
!FREQ 1
!GOTR LOOP 10 OFFS SIZE 1200 1200 FICH BMP
!     OBJE LECT plate lframeb TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
ENDPLAY
*=======================================================================
FIN
```

D6_S2_35_FG_Cyy.epx

```
D6_S2_35_FG_CYY
ECHO
!CONV WIN
RESU SPLI ALIC 'D6_S2_35_FG_C.ali' GARD PSCR
COMP COUL GR80 LECT plate TERM
```

```
         GR50 LECT lframeb uframe TERM
SORT VISU NSTO 1
*=====================================================================
PLAY
CAME   1 EYE  -1.97046E+00  0.00000E+00 -4.08169E-10
!        Q     7.07107E-01  0.00000E+00 -7.07107E-01  0.00000E+00
         VIEW  1.00000E+00  0.00000E+00  2.05103E-10
         RIGH -2.05103E-10  0.00000E+00  1.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  1.96000E-02  0.00000E+00  0.00000E+00
!RSPHERE:  4.42236E-01
!RADIUS :  1.99006E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.54783E+00
!FAR    :  2.87454E+00
*---------------------------------------------------------------------
SCEN GEOM NAVI FREE
         LINE HEOU SFRE SSHA
     LIMA ON
SLER CAM1 1 NFRA 1
TRAC OFFS SIZE 1200 1200 FICH BMP DEFO AMPD 0.0
     OBJE LECT plate TERM SYXY SYXZ TOLS 1.E-3 NFAI ADAP REND
FREQ 1
GOTR LOOP 10 OFFS SIZE 1200 1200 FICH BMP DEFO AMPD 0.0
     OBJE LECT plate TERM SYXY SYXZ TOLS 1.E-3 NFAI ADAP REND
ENDPLAY
*=====================================================================
FIN
```

D6_S2_35_FGw.epx

```
D6_S2_35_FGW
ECHO
!CONV WIN
RESU SPLI ALIC 'D6_S2_35_FG.ali' GARD PSCR
COMP COUL VERT LECT plate TERM
          GR50 LECT lframeb uframe TERM
          TURQ LECT tubelp3 tank TERM
SORT VISU NSTO 1
*=====================================================================
PLAY
*---------------------------------------------------------------------
CAME   1 EYE  -4.60000E-03 -7.47801E-10 -1.66049E+00
!        Q    -2.05103E-10 -1.00000E+00 -6.46235E-26  2.77556E-16
         VIEW  5.55112E-16  4.10207E-10  1.00000E+00
         RIGH  1.00000E+00  1.53918E-26 -5.55112E-16
         UP    2.43102E-25 -1.00000E+00  4.10207E-10
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER : -4.60000E-03  0.00000E+00  1.62500E-01
!RSPHERE:  3.64597E-01
!RADIUS :  1.82299E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.31529E+00
!FAR    :  2.04449E+00
SCEN GEOM NAVI FREE
          LINE SFRE SSHA
     ISO  FILL FIEL ECRO 1 SCAL USER PROG 1.001E5 PAS 0.5E5 7.501E5 TERM
          SUPP LECT tubelp3 tank TERM
     LIMA ON
SLER CAM1 1 NFRA 1
FREQ 1
TRAC OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate lframeb uframe tubelp3 tank TERM ! SYXY
                                   SYXZ
                                   TOLS 1.E-3 NFAI REND
GOTR LOOP 10 OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate lframeb uframe tubelp3 tank TERM ! SYXY
                                   SYXZ
                                   TOLS 1.E-3 NFAI REND
!TRAC OFFS SIZE 1200 1200 FICH BMP
!     OBJE LECT plate lframeb TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
!*---------------------------------------------------------------------
!SCEN GEOM NAVI FREE
!          LINE HEOU SFRE SSHA
!     LIMA ON
!SLER CAM1 1 NFRA 1
!TRAC OFFS SIZE 1200 1200 FICH BMP
!     OBJE LECT plate lframeb TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
ENDPLAY
*=====================================================================
FIN
```

D6_S2_35_FGx.epx

```
D6_S2_35_FGX
ECHO
!CONV WIN
RESU SPLI ALIC 'D6_S2_35_FG.ali' GARD PSCR
COMP COUL VERT LECT plate TERM
          GR50 LECT lframeb uframe TERM
          TURQ LECT tubelp3 tank TERM
SORT VISU NSTO 1
*=====================================================================
PLAY
*---------------------------------------------------------------------
CAME   1 EYE  -4.60000E-03 -7.47801E-10 -1.66049E+00
!        Q    -2.05103E-10 -1.00000E+00 -6.46235E-26  2.77556E-16
         VIEW  5.55112E-16  4.10207E-10  1.00000E+00
         RIGH  1.00000E+00  1.53918E-26 -5.55112E-16
         UP    2.43102E-25 -1.00000E+00  4.10207E-10
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER : -4.60000E-03  0.00000E+00  1.62500E-01
!RSPHERE:  3.64597E-01
!RADIUS :  1.82299E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.31529E+00
!FAR    :  2.04449E+00
SCEN GEOM NAVI FREE
         LINE SFRE SSHA
     LIMA ON
SLER CAM1 1 NFRA 1
FREQ 1
TRAC OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate lframeb uframe tubelp3 tank TERM ! SYXY
                                   SYXZ
                                   TOLS 1.E-3 NFAI REND
GOTR LOOP 10 OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate lframeb uframe tubelp3 tank TERM ! SYXY
                                   SYXZ
                                   TOLS 1.E-3 NFAI REND
!TRAC OFFS SIZE 1200 1200 FICH BMP
!     OBJE LECT plate lframeb TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
!*---------------------------------------------------------------------
!SCEN GEOM NAVI FREE
!          LINE HEOU SFRE SSHA
!     LIMA ON
!SLER CAM1 1 NFRA 1
!TRAC OFFS SIZE 1200 1200 FICH BMP
!     OBJE LECT plate lframeb TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
ENDPLAY
*=====================================================================
FIN
```

D6_S2_35_FGy.epx

```
D6_S2_35_FGY
ECHO
!CONV WIN
RESU SPLI ALIC 'D6_S2_35_FG.ali' GARD PSCR
COMP COUL GR80 LECT plate TERM
          GR50 LECT lframeb uframe TERM
SORT VISU NSTO 1
*=====================================================================
PLAY
CAME   1 EYE  -1.97046E+00  0.00000E+00 -4.08169E-10
!        Q     7.07107E-01  0.00000E+00 -7.07107E-01  0.00000E+00
         VIEW  1.00000E+00  0.00000E+00  2.05103E-10
         RIGH -2.05103E-10  0.00000E+00  1.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  1.96000E-02  0.00000E+00  0.00000E+00
!RSPHERE:  4.42236E-01
!RADIUS :  1.99006E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.54783E+00
!FAR    :  2.87454E+00
*---------------------------------------------------------------------
SCEN GEOM NAVI FREE
         LINE SFRE SSHA
     LIMA ON
SLER CAM1 1 NFRA 1
TRAC OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate lframeb TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
FREQ 1
GOTR LOOP 10 OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate lframeb TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
!*---------------------------------------------------------------------
!     VISU NSTO 1
!*---------------------------------------------------------------------
!SCEN GEOM NAVI FREE
!          LINE HEOU SFRE SSHA
!     LIMA ON
!SLER CAM1 1 NFRA 1
!TRAC OFFS SIZE 1200 1200 FICH BMP
!     OBJE LECT plate lframeb TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
!FREQ 1
!GOTR LOOP 10 OFFS SIZE 1200 1200 FICH BMP
!     OBJE LECT plate lframeb TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
ENDPLAY
*=====================================================================
FIN
```

D6_S2_35_FGyy.epx

```
D6_S2_35_FGYY
ECHO
!CONV WIN
RESU SPLI ALIC 'D6_S2_35_FG.ali' GARD PSCR
COMP COUL GR80 LECT plate TERM
          GR50 LECT lframeb uframe TERM
SORT VISU NSTO 1
*=====================================================================
PLAY
CAME   1 EYE  -1.97046E+00  0.00000E+00 -4.08169E-10
!        Q     7.07107E-01  0.00000E+00 -7.07107E-01  0.00000E+00
```

```
        VIEW  1.00000E+00  0.00000E+00  2.05103E-10
        RIGH -2.05103E-10  0.00000E+00  1.00000E+00
        UP    0.00000E+00  1.00000E+00  0.00000E+00
        FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  1.96000E-02  0.00000E+00  0.00000E+00
!RSPHERE:  4.42236E-01
!RADIUS :  1.99006E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.54783E+00
!FAR    :  2.87454E+00
*-----------------------------------------------------------------------
SCEN GEOM NAVI FREE
        LINE HEOU SFRE SSHA
     LIMA ON
SLER CAM1 1 NFRA 1
TRAC OFFS SIZE 1200 1200 FICH BMP DEFO AMPD 0.0
     OBJE LECT plate TERM SYXY SYXZ TOLS 1.E-3 NFAI ADAP REND
FREQ 1
GOTR LOOP 10 OFFS SIZE 1200 1200 FICH BMP DEFO AMPD 0.0
     OBJE LECT plate TERM SYXY SYXZ TOLS 1.E-3 NFAI ADAP REND
ENDPLAY
*=======================================================================
FIN
```

D6_S2_35_FP.epx

```
D6_S2_35_FP
ECHO
!CONV win
CAST 'S2_FSI.msh' mesh
TRID ALE
EROS 1.0 CROI
DIME ADAP NPOI 200000
          CUVF 200000
          Q4GS 60000
          T3GS 10000
          NVFI 600000
          PMAT 50000
          NPIN 50000
     ENDA
     JONC 475 ! Total n. of nodes in a TUBM juncton
     NALE 1 NBLE 1
     TERM
GEOM CUB8 ecub8
     PR6  epri6
     Q4GS equa4 ! mems pinbcm
     T3GS etri3
     CUVF flui3d tubelp3 tank
     TUVF tubelp1
     PMAT nplate
     CL3D face3d presur abso stub3d ! pre
     TUBM rac3d1d raclp
TERM
COMP EPAI 0.8e-3 LECT plate nplate TERM
     DIAM DROI 0.1692568 LECT tubelp1 TERM
     RACC TUBM LECT rac3d1d  TERM
          NTUB LECT p1a   TERM DTUB 0.1692568
          FACE LECT face3d TERM COEF 1.0
     RACC TUBM LECT raclp  TERM
          NTUB LECT p1d3   TERM DTUB 0.1692568
          FACE LECT stub3d TERM COEF 1.0
! Attention: the TUBM element (raclp) is NOT included
! in the "mesh" object (although it IS indeed passed in from Cast3m).
! For this reason we must add it explicitly in the GROU directive below
! if we want to have it in the extracted element groups.
     GROU 21 'endtube' LECT tube TERM COND XB GT -0.6
            'trigger' LECT tube TERM COND NEAR POIN -0.1501 0 0
            'frefine' LECT flui TERM COND XB GT -0.3
                                     COND XB LT  1.0
            'pp1'    LECT plate TERM
                     COND BOX X0 0.0 Y0 0.0  Z0 0.0
                              DX 0.1 DY 0.15 DZ 0.15
            'pp2'    LECT plate TERM
                     COND BOX X0 0.0 Y0 0.0  Z0 0.0
                              DX 0.1 DY 0.165 DZ 0.165
            'fcoup'  LECT flui  TERM COND XB GT -0.05
                                     COND XB LT 0.150
                                     COND YB LT 0.150
                                     COND ZB LT 0.150
            'scoup'  LECT plate TERM COND YB LT 0.150
                                     COND ZB LT 0.150
            'lfrb2' LECT lframeb TERM
                    COND XB LT -0.865E-2
            'lfrb1' LECT lframeb DIFF lfrb2 TERM
            'uframe2'    LECT uframe DIFF presur TERM
            'S1' LECT tube TERM COND NEAR POIN -0.345 0.0 0.15
            'S2' LECT tube TERM COND NEAR POIN -0.245 0.0 0.15
            'S16' LECT flui3d TERM COND NEAR POIN -15.225 0 0.15
            'S15' LECT flui3d TERM COND NEAR POIN -15.125 0 0.15
            'S12' LECT tube TERM COND NEAR POIN -12.495 0 0.15
            'S11' LECT tube TERM COND NEAR POIN -12.395 0 0.15
            'S6' LECT tube TERM COND NEAR POIN -5.685 0 0.15
            'S5' LECT tube TERM COND NEAR POIN -5.585 0 0.15
            'epar1' LECT tubelp1 TERM COND NEAR NODE LECT p1a TERM
            'epar2' LECT tubelp1 TERM COND NEAR NODE LECT p1d3 TERM
            'tubelpp' LECT tubelp1 DIFF epar1 epar2 TERM
     NGRO 13 'blox'  LECT lframeb TERM COND !X LT -0.0253
                                            X GT 0.0253
            'symy'  LECT plate TERM    COND Y LT 0.0001
            'symz'  LECT plate TERM    COND Z LT 0.0001
            'pt0' LECT tube TERM COND NEAR POIN -16.19999 0.0 0.0
            'cen' LECT plate TERM COND NEAR POIN 0.0 0.0 0.0
            'axis1'   LECT plate TERM COND Y LT 0.0001
            'axis2'   LECT plate TERM COND Z LT 0.0001
            'csymy' LECT uframe lframeb TERM COND Y LT 0.0001
            'csymz' LECT uframe lframeb TERM COND Z LT 0.0001
            'elfb'  LECT lframeb TERM COND ENVE
            'nlfb'  LECT elfb    TERM COND X GT -0.01
                                      COND X LT  0.001
            'nbad1' LECT nlfb TERM
                    COND CONE X1 -0.009 Y1 0.260 Z1 0
                              X2  0.001 Y2 0.260 Z2 0
                              R1  0.009 R2 0.009
            'nbad2' LECT nlfb TERM
                    COND CONE X1 -0.009 Y1 0 Z1 0.260
                              X2  0.001 Y2 0 Z2 0.260
                              R1  0.009 R2 0.009
     COUL TURQ LECT tube tra lp3xl TERM
          VERT LECT plate fir2 TERM
          ROSE LECT fir1 TERM
          ROUG LECT driver TERM
         ROSE LECT S1 S2 S5 S6 S11 S12 S15 S16 TERM
ADAP THRS ECRO 11 TMIN 0.01 TMAX 0.02 MAXL 4 CRIT 1 ! NOUN
          LECT plate TERM
!          LECT pp2 TERM
GRIL LAGR LECT spec TERM
MATE
    !LOI 1
     GAZP RO 20.310 GAMM 1.4 CV 719.286 PINI 17.16E5 PREF 100.8E3
          LECT none TERM
    !LOI 2
     GAZP RO 1.193 GAMM 1.4 CV 719.286 PINI 100.8E3 PREF 100.8E3
          LECT none TERM
    !LOI 3
    GAZP RO 6.720 GAMM 1.4 CV 719.286 PINI 5.677E5 PREF 100.8E3
          LECT none TERM
    !LOI 4
     GAZP RO 1.193 GAMM 1.4 CV 719.286 PINI 100.8E3 PREF 100.8E3
          LECT flui3d TERM ! _cuvf TERM
     GAZP RO 1.193 GAMM 1.4 CV 719.286 PINI 100.8E3 PREF 100.8E3
          LECT epar1 epar2 TERM
     GAZP RO 1.193 GAMM 1.4 CV 719.286 PINI 100.8E3 PREF 100.8E3
          LECT rac3d1d raclp tubelpp TERM
     PARO PSIL 0.02
          LECT tubelpp TERM
     MULT 6 7 LECT tubelpp TERM
! In order to obtain a printout at least of the 3D VFCCs I am obliged
! to use a different material for tubelp3 and other 3D parts, but with
! the same characteristics as the material used for tubelp1
    GAZP RO 1.193 GAMM 1.4 CV 719.286 PINI 100.8E3 PREF 100.8E3
          LECT tubelp3 tank _cuvf TERM
     CLVF ABSO RO 1.187
          LECT abso TERM
     VPJC RO 7850.0 YOUN 2.1E11 NU 0.33 ELAS 3.257E8 MXIT 100
          QR1 2.348E8 CR1 56.2 QR2 4.457E8 CR2 4.7
          PDOT 5.E-4 C 1.E-2 TQ 0.9 CP 452.0
          TM 1800.0 M 1.0 DC 1.0 WC 555.0E6
          RESI 1
          LECT lframeb TERM
     VPJC RO 7850.0 YOUN 2.1E11 NU 0.33 ELAS 3.257E8 MXIT 100
          QR1 2.348E8 CR1 56.2 QR2 4.457E8 CR2 4.7
          PDOT 5.E-4 C 1.E-2 TQ 0.9 CP 452.0
          TM 1800.0 M 1.0 DC 1.0 WC 555.0E6
          RESI 1
          LECT uframe TERM
     VPJC RO 7850.0 YOUN 2.1E11 NU 0.33 ELAS 3.257E8 MXIT 100 ! Docol 600
          QR1 2.348E8 CR1 56.2 QR2 4.457E8 CR2 4.7
          PDOT 5.E-4 C 1.E-2 TQ 0.9 CP 452.0
          TM 1800.0 M 1.0 DC 1.0 WC 555.0E6
          RESI 1
          LECT plate TERM
     MASS 0.0 YOUN 2.1E11 NU 0.33
          LECT nplate TERM
     IMPE PIMP RO 7850.0 PRES 44.0011e6 PREF 1.011E5 !fc To be checked
          LECT presur TERM ! _cl3d TERM
OPTI PINS ASN
LINK COUP SPLT NONE
     BLOQ 123 LECT blox TERM
!    GLIS 2
!               FROT MUST 0.5 MUDY 0.5 GAMM 0
!               PGAP 0.4E-3
!             ! MAIT LECT lframeb TERM
!               MAIT NODE LECT nlfb DIFF nbad1 nbad2 TERM
!               PESC LECT plate TERM
*
!               FROT MUST 0.5 MUDY 0.5 GAMM 0
!               PGAP 0.4E-3
!               MAIT LECT uframe TERM
!               PESC LECT plate TERM
LINK DECO BLOQ 246 LECT symy TERM
          BLOQ 345 LECT symz TERM
          BLOQ 2 LECT csymy TERM
          BLOQ 3 LECT csymz TERM
     PINB PENA SFAC 1.0
          BODY FROT MUST 0.5 MUDY 0.5 GAMM 0 DMIN 0.0004
               LECT lframeb TERM
          BODY FROT MUST 0.5 MUDY 0.5 GAMM 0 DMIN 0.0004
               LECT uframe TERM
          BODY FROT MUST 0.5 MUDY 0.5 GAMM 0 DIAM 0.0004 ADNP
               LECT nplate TERM
          EXCL PAIR 1 2
     FLSW STRU LECT scoup TERM
          FLUI LECT fcoup TERM
```

```
        R 0.0087    ! 0.014
        HGRI 0.00606 ! 0.016
        DGRI
        FACE
        BFLU 2 ! block if at least one node is in influence domain
        FSCP 1 ! couple in all directions
        ADAP LMAX 2 SCAL 6
     TBLO 123    TRIG LECT lframeb uframe TERM
        123456 TRIG LECT plate TERM
INIT MAPP FORM 'ST_MAP3_35.map' MATC OBJE LECT flui3d tubelp1 TERM
ECRI DEPL VITE ECRO FAIL TFRE 0.25E-3
        POIN LECT cen axis1 axis2 TERM
        ELEM LECT S1 TERM
      FICH ALIT FREQ 0 TFRE 0.D0
        TIME PROG 0.D0 PAS 0.5D-3 22.D-3 PAS 0.01D-3 80.D-3
        POIN LECT cen axis1 axis2 TERM
        ELEM LECT S1 S2 S5 S6 S11 S12 S15 S16 TERM
!    FICH PVTK FREQ 0 TFRE 0.D0
!       TIME PROG 0.D0 PAS 0.5D-3 28.D-3 PAS 0.1D-3 40.D-3
!       PAS 1.D-3 50.D-3
!       GROU AUTO
!       VARI DEPL VITE FAIL ACCE VCVI CONT ECRO FLIA
     FICH SPLI ALIC TFRE 0.5E-3
OPTI NOTE CSTA 0.4
     GLIS NORM ELEM
     STEP IO
     LOG 1
     JAUM
     LMST
     PINS GRID DPIN 1.01
     VFCC FCON 6 ! hllc solver
        ORDR 2 ! order in space
        STPS 2 ! order in time
        RECO 1 ! Not accepted by CAL_VFCC_1D
        NTIL
     ADAP RCON WHAN
     ADAP RCON TRIG ECRO 1 TVAL 1.05E5 LECT trigger TERM
     NOCR TRIG LECT plate lframeb uframe TERM
     FLS  CUB8 2 ! For the inverse mapping
CALC TINI 0 TEND 32.0E-3 TFAI 2.0E-8
FIN
```

D6_S2_35_FP_C.epx

```
D6_S2_35_FP_C
ECHO
!CONV win
CAST 'S2_FSI.msh' mesh
TRID ALE
EROS 1.0 CROI
DIME ADAP NPOI 200000
        CUVF 200000
        Q4GS 60000
        T3GS 10000
        NVFI 600000
        PMAT 50000
        NPIN 50000
     ENDA
     JONC 475 ! Total n. of nodes in a TUBM juncton
     NALE 1 NBLE 1
     TERM
GEOM CUB8 ecub8
     PR6  epri6
     Q4GS equa4 ! mems pinbcm
     T3GS etri3
     CUVF flui3d tubelp3 tank
     TUVF tubelp1
     PMAT nplate
     CL3D face3d presur abso stub3d ! pre
     TUBM rac3d1d raclp
TERM
COMP EPAI 0.8e-3 LECT plate nplate TERM
     DIAM DROI 0.1692568 LECT tubelp1 TERM
     RACC TUBM LECT rac3d1d  TERM
        NTUB LECT p1a   TERM DTUB 0.1692568
        FACE LECT face3d TERM COEF 1.0
     RACC TUBM LECT raclp  TERM
        NTUB LECT p1d3   TERM DTUB 0.1692568
        FACE LECT stub3d TERM COEF 1.0
! Attention: the TUBM element (raclp) is NOT included
! in the "mesh" object (although it IS indeed passed in from Cast3m).
! For this reason we must add it explicitly in the GROU directive below
! if we want to have it in the extracted element groups.
     GROU 21 'endtube' LECT tube TERM COND XB GT -0.6
          'trigger' LECT tube TERM COND NEAR POIN -0.1501 0 0
          'frefine' LECT flui TERM COND XB GT -0.3
                                   COND XB LT  1.0
          'pp1'    LECT plate TERM
                   COND BOX X0 0.0 Y0 0.0  Z0 0.0
                            DX 0.1 DY 0.15 DZ 0.15
          'pp2'    LECT plate TERM
                   COND BOX X0 0.0 Y0 0.0  Z0 0.0
                            DX 0.1 DY 0.165 DZ 0.165
          'fcoup'  LECT flui  TERM COND XB GT -0.05
                                   COND XB LT 0.150
                                   COND YB LT 0.150
                                   COND ZB LT 0.150
          'scoup'  LECT plate TERM COND YB LT 0.150
                                   COND ZB LT 0.150
          'lfrb2' LECT lframeb TERM
                   COND XB LT -0.865E-2
          'lfrb1' LECT lframeb DIFF lfrb2 TERM
          'uframe2'    LECT uframe DIFF presur TERM
          'S1' LECT tube TERM COND NEAR POIN -0.345 0.0 0.15
          'S2' LECT tube TERM COND NEAR POIN -0.245 0.0 0.15
          'S16' LECT flui3d TERM COND NEAR POIN -15.225 0 0.15
          'S15' LECT flui3d TERM COND NEAR POIN -15.125 0 0.15
          'S12' LECT tube TERM COND NEAR POIN -12.495 0 0.15
          'S11' LECT tube TERM COND NEAR POIN -12.395 0 0.15
          'S6' LECT tube TERM COND NEAR POIN -5.685 0 0.15
          'S5' LECT tube TERM COND NEAR POIN -5.585 0 0.15
          'epar1' LECT tubelp1 TERM COND NEAR NODE LECT p1a TERM
          'epar2' LECT tubelp1 TERM COND NEAR NODE LECT p1d3 TERM
          'tubelpp' LECT tubelp1 DIFF epar1 epar2 TERM
     NGRO 13 'blox'  LECT lframeb TERM COND !X LT -0.0253
                                             X GT 0.0253
          'symy'  LECT plate TERM    COND Y LT 0.0001
          'symz'  LECT plate TERM    COND Z LT 0.0001
          'pt0' LECT tube TERM COND NEAR POIN -16.19999 0.0 0.0
          'cen' LECT plate TERM COND NEAR POIN 0.0 0.0 0.0
          'axis1'   LECT plate TERM COND Y LT 0.0001
          'axis2'   LECT plate TERM COND Z LT 0.0001
          'csymy' LECT uframe lframeb TERM COND Y LT 0.0001
          'csymz' LECT uframe lframeb TERM COND Z LT 0.0001
          'elfb'  LECT lframeb TERM COND ENVE
          'nlfb'  LECT elfb    TERM COND X GT -0.01
                                    COND X LT  0.001
          'nbad1' LECT nlfb TERM
                  COND CONE X1 -0.009 Y1 0.260 Z1 0
                            X2  0.001 Y2 0.260 Z2 0
                            R1  0.009 R2 0.009
          'nbad2' LECT nlfb TERM
                  COND CONE X1 -0.009 Y1 0 Z1 0.260
                            X2  0.001 Y2 0 Z2 0.260
                            R1  0.009 R2 0.009
     COUL TURQ LECT tube tra lp3xl TERM
          VERT LECT plate fir2 TERM
          ROSE LECT fir1 TERM
          ROUG LECT driver TERM
         ROSE LECT S1 S2 S5 S6 S11 S12 S15 S16 TERM
ADAP THRS ECRO 11 TMIN 0.01 TMAX 0.02 MAXL 4 CRIT 1 ! NOUN
          LECT plate TERM
!          LECT pp2 TERM
GRIL LAGR LECT spec TERM
MATE
    !LOI 1
     GAZP RO 20.310 GAMM 1.4 CV 719.286 PINI 17.16E5 PREF 100.8E3
          LECT none TERM
    !LOI 2
     GAZP RO 1.193 GAMM 1.4 CV 719.286 PINI 100.8E3 PREF 100.8E3
          LECT none TERM
    !LOI 3
    GAZP RO 6.720 GAMM 1.4 CV 719.286 PINI 5.677E5 PREF 100.8E3
          LECT none TERM
    !LOI 4
     GAZP RO 1.193 GAMM 1.4 CV 719.286 PINI 100.8E3 PREF 100.8E3
          LECT flui3d TERM ! _cuvf TERM
     GAZP RO 1.193 GAMM 1.4 CV 719.286 PINI 100.8E3 PREF 100.8E3
          LECT epar1 epar2 TERM
     GAZP RO 1.193 GAMM 1.4 CV 719.286 PINI 100.8E3 PREF 100.8E3
          LECT rac3d1d raclp tubelpp TERM
     PARO PSIL 0.02
          LECT tubelpp TERM
     MULT 6 7 LECT tubelpp TERM
! In order to obtain a printout at least of the 3D VFCCs I am obliged
! to use a different material for tubelp3 and other 3D parts, but with
! the same characteristics as the material used for tubelp1
    GAZP RO 1.193 GAMM 1.4 CV 719.286 PINI 100.8E3 PREF 100.8E3
          LECT tubelp3 tank _cuvf TERM
     CLVF ABSO RO 1.187
          LECT abso TERM
     VPJC RO 7850.0 YOUN 2.1E11 NU 0.33 ELAS 3.257E8 MXIT 100
          QR1 2.348E8 CR1 56.2 QR2 4.457E8 CR2 4.7
          PDOT 5.E-4 C 1.E-2 TQ 0.9 CP 452.0
          TM 1800.0 M 1.0 DC 1.0 WC 555.0E6
          RESI 1
          LECT lframeb TERM
     VPJC RO 7850.0 YOUN 2.1E11 NU 0.33 ELAS 3.257E8 MXIT 100
          QR1 2.348E8 CR1 56.2 QR2 4.457E8 CR2 4.7
          PDOT 5.E-4 C 1.E-2 TQ 0.9 CP 452.0
          TM 1800.0 M 1.0 DC 1.0 WC 555.0E6
          RESI 1
          LECT uframe TERM
     VPJC RO 7850.0 YOUN 2.1E11 NU 0.33 ELAS 3.257E8 MXIT 100 ! Docol 600
          QR1 2.348E8 CR1 56.2 QR2 4.457E8 CR2 4.7
          PDOT 5.E-4 C 1.E-2 TQ 0.9 CP 452.0
          TM 1800.0 M 1.0 DC 1.0 WC 555.0E6
          RESI 1
          LECT plate TERM
     MASS 0.0 YOUN 2.1E11 NU 0.33
          LECT nplate TERM
     IMPE PIMP RO 7850.0 PRES 44.0011e6 PREF 1.011E5 !fc To be checked
          LECT presur TERM ! _cl3d TERM
OPTI PINS ASN
LINK COUP SPLT NONE
     BLOQ 123 LECT blox TERM
!    GLIS 2
!              FROT MUST 0.5 MUDY 0.5 GAMM 0
!              PGAP 0.4E-3
!            ! MAIT LECT lframeb TERM
!              MAIT NODE LECT nlfb DIFF nbad1 nbad2 TERM
!              PESC LECT plate TERM
*
```

```
!               FROT MUST 0.5 MUDY 0.5 GAMM 0
!               PGAP 0.4E-3
!               MAIT LECT uframe TERM
!               PESC LECT plate TERM
LINK DECO BLOQ 246 LECT symy TERM
          BLOQ 345 LECT symz TERM
          BLOQ 2 LECT csymy TERM
          BLOQ 3 LECT csymz TERM
     PINB PENA SFAC 1.0
          BODY FROT MUST 0.5 MUDY 0.5 GAMM 0 DMIN 0.0004
               LECT lframeb TERM
          BODY FROT MUST 0.5 MUDY 0.5 GAMM 0 DMIN 0.0004
               LECT uframe TERM
          BODY FROT MUST 0.5 MUDY 0.5 GAMM 0 DIAM 0.0004 ADNP
               LECT nplate TERM
          EXCL PAIR 1 2
     FLSW STRU LECT scoup TERM
          FLUI LECT fcoup TERM
          R 0.0087    ! 0.014
          HGRI 0.00606 ! 0.016
          DGRI
          FACE
          BFLU 2 ! block if at least one node is in influence domain
          FSCP 1 ! couple in all directions
          ADAP LMAX 2 SCAL 6
     TBLO 123    TRIG LECT lframeb uframe TERM
          123456 TRIG LECT plate TERM
INIT MAPP FORM 'ST_MAP3_35.map' MATC OBJE LECT flui3d tubelp1 TERM
ECRI DEPL VITE ECRO FAIL TFRE 0.25E-3
          POIN LECT cen axis1 axis2 TERM
          ELEM LECT S1 TERM
      FICH ALIT FREQ 0 TFRE 0.D0
          TIME PROG 0.D0 PAS 0.5D-3 22.D-3 PAS 0.01D-3 80.D-3
          POIN LECT cen axis1 axis2 TERM
          ELEM LECT S1 S2 S5 S6 S11 S12 S15 S16 TERM
!    FICH PVTK FREQ 0 TFRE 0.D0
!         TIME PROG 0.D0 PAS 0.5D-3 28.D-3 PAS 0.1D-3 40.D-3
!         PAS 1.D-3 50.D-3
!         GROU AUTO
!         VARI DEPL VITE FAIL ACCE VCVI CONT ECRO FLIA
     FICH SPLI ALIC TFRE 0.5E-3
OPTI NOTE CSTA 0.4
     GLIS NORM ELEM
     STEP IO
     LOG 1
     JAUM
     LMST
     PINS GRID DPIN 1.01
     VFCC FCON 6 ! hllc solver
          ORDR 2 ! order in space
          STPS 2 ! order in time
          RECO 1 ! Not accepted by CAL_VFCC_1D
          NTIL
     ADAP RCON WHAN
     ADAP RCON TRIG ECRO 1 TVAL 1.05E5 LECT trigger TERM
     NOCR TRIG LECT plate lframeb uframe TERM
     FLS  CUB8 2 ! For the inverse mapping
CALC TINI 0 TEND 32.0E-3 TFAI 1.143E-8 ! 2.0E-8
FIN
```

D6_S2_35_FP_Cw.epx

```
D6_S2_35_FP_CW
ECHO
!CONV WIN
RESU SPLI ALIC 'D6_S2_35_FP_C.ali' GARD PSCR
COMP COUL VERT LECT plate TERM
          GR50 LECT lframeb uframe TERM
          TURQ LECT tubelp3 tank TERM
SORT VISU NSTO 1
*=====================================================================
PLAY
*---------------------------------------------------------------------
CAME   1 EYE  -4.60000E-03 -7.47801E-10 -1.66049E+00
!        Q    -2.05103E-10 -1.00000E+00 -6.46235E-26  2.77556E-16
         VIEW  5.55112E-16  4.10207E-10  1.00000E+00
         RIGH  1.00000E+00  1.53918E-26 -5.55112E-16
         UP    2.43102E-25 -1.00000E+00  4.10207E-10
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER : -4.60000E-03  0.00000E+00  1.62500E-01
!RSPHERE:  3.64597E-01
!RADIUS :  1.82299E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.31529E+00
!FAR    :  2.04449E+00
SCEN GEOM NAVI FREE
          LINE SFRE SSHA
     ISO  FILL FIEL ECRO 1 SCAL USER PROG 1.001E5 PAS 0.5E5 7.501E5 TERM
          SUPP LECT tubelp3 tank TERM
     LIMA ON
SLER CAM1 1 NFRA 1
FREQ 1
TRAC OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate lframeb uframe tubelp3 tank TERM ! SYXY
                              SYXZ
                              TOLS 1.E-3 NFAI REND
GOTR LOOP 10 OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate lframeb uframe tubelp3 tank TERM ! SYXY
                              SYXZ
                              TOLS 1.E-3 NFAI REND
!TRAC OFFS SIZE 1200 1200 FICH BMP
!     OBJE LECT plate lframeb TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
!*---------------------------------------------------------------------
!SCEN GEOM NAVI FREE
!         LINE HEOU SFRE SSHA
!     LIMA ON
!SLER CAM1 1 NFRA 1
!TRAC OFFS SIZE 1200 1200 FICH BMP
!     OBJE LECT plate lframeb TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
ENDPLAY
*=====================================================================
FIN
```

D6_S2_35_FP_Cx.epx

```
D6_S2_35_FP_CX
ECHO
!CONV WIN
RESU SPLI ALIC 'D6_S2_35_FP_C.ali' GARD PSCR
COMP COUL VERT LECT plate TERM
          GR50 LECT lframeb uframe TERM
          TURQ LECT tubelp3 tank TERM
SORT VISU NSTO 1
*=====================================================================
PLAY
*---------------------------------------------------------------------
CAME   1 EYE  -4.60000E-03 -7.47801E-10 -1.66049E+00
!        Q    -2.05103E-10 -1.00000E+00 -6.46235E-26  2.77556E-16
         VIEW  5.55112E-16  4.10207E-10  1.00000E+00
         RIGH  1.00000E+00  1.53918E-26 -5.55112E-16
         UP    2.43102E-25 -1.00000E+00  4.10207E-10
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER : -4.60000E-03  0.00000E+00  1.62500E-01
!RSPHERE:  3.64597E-01
!RADIUS :  1.82299E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.31529E+00
!FAR    :  2.04449E+00
SCEN GEOM NAVI FREE
          LINE SFRE SSHA
     LIMA ON
SLER CAM1 1 NFRA 1
FREQ 1
TRAC OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate lframeb uframe tubelp3 tank TERM ! SYXY
                              SYXZ
                              TOLS 1.E-3 NFAI REND
GOTR LOOP 10 OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate lframeb uframe tubelp3 tank TERM ! SYXY
                              SYXZ
                              TOLS 1.E-3 NFAI REND
!TRAC OFFS SIZE 1200 1200 FICH BMP
!     OBJE LECT plate lframeb TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
!*---------------------------------------------------------------------
!SCEN GEOM NAVI FREE
!         LINE HEOU SFRE SSHA
!     LIMA ON
!SLER CAM1 1 NFRA 1
!TRAC OFFS SIZE 1200 1200 FICH BMP
!     OBJE LECT plate lframeb TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
ENDPLAY
*=====================================================================
FIN
```

D6_S2_35_FP_Cy.epx

```
D6_S2_35_FP_CY
ECHO
!CONV WIN
RESU SPLI ALIC 'D6_S2_35_FP_C.ali' GARD PSCR
COMP COUL GR80 LECT plate TERM
          GR50 LECT lframeb uframe TERM
SORT VISU NSTO 1
*=====================================================================
PLAY
CAME   1 EYE  -1.97046E+00  0.00000E+00 -4.08169E-10
!        Q     7.07107E-01  0.00000E+00 -7.07107E-01  0.00000E+00
         VIEW  1.00000E+00  0.00000E+00  2.05103E-10
         RIGH -2.05103E-10  0.00000E+00  1.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  1.96000E-02  0.00000E+00  0.00000E+00
!RSPHERE:  4.42236E-01
!RADIUS :  1.99006E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.54783E+00
!FAR    :  2.87454E+00
*---------------------------------------------------------------------
SCEN GEOM NAVI FREE
          LINE SFRE SSHA
     LIMA ON
SLER CAM1 1 NFRA 1
TRAC OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate lframeb TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
FREQ 1
GOTR LOOP 10 OFFS SIZE 1200 1200 FICH BMP
```

```
    OBJE LECT plate lframeb TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
ENDPLAY
*======================================================================
FIN
```

D6_S2_35_FP_Cyy.epx

```
D6_S2_35_FP_CYY
ECHO
!CONV WIN
RESU SPLI ALIC 'D6_S2_35_FP_C.ali' GARD PSCR
COMP COUL GR80 LECT plate TERM
          GR50 LECT lframeb uframe TERM
SORT VISU NSTO 1
*======================================================================
PLAY
CAME   1 EYE  -1.97046E+00  0.00000E+00 -4.08169E-10
!        Q     7.07107E-01  0.00000E+00 -7.07107E-01  0.00000E+00
         VIEW  1.00000E+00  0.00000E+00  2.05103E-10
         RIGH -2.05103E-10  0.00000E+00  1.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  1.96000E-02  0.00000E+00  0.00000E+00
!RSPHERE:  4.42236E-01
!RADIUS :  1.99006E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.54783E+00
!FAR    :  2.87454E+00
*----------------------------------------------------------------------
SCEN GEOM NAVI FREE
          LINE HEOU SFRE SSHA
     LIMA ON
SLER CAM1 1 NFRA 1
TRAC OFFS SIZE 1200 1200 FICH BMP DEFO AMPD 0.0
     OBJE LECT plate TERM SYXY SYXZ TOLS 1.E-3 NFAI ADAP REND
FREQ 1
GOTR LOOP 10 OFFS SIZE 1200 1200 FICH BMP DEFO AMPD 0.0
     OBJE LECT plate TERM SYXY SYXZ TOLS 1.E-3 NFAI ADAP REND
ENDPLAY
*======================================================================
FIN
```

D6_S2_35_FPN.epx

```
D6_S2_35_FPN
ECHO
!CONV win
CAST 'S2_FSI.msh' mesh
TRID ALE
EROS 1.0 CROI
DIME ADAP NPOI 200000
          CUVF 200000
          Q4GS 60000
          T3GS 10000
          NVFI 600000
          PMAT 50000
          NPIN 50000
     ENDA
     JONC 475 ! Total n. of nodes in a TUBM juncton
     NALE 1 NBLE 1
     TERM
GEOM CUB8 ecub8
     PR6  epri6
     Q4GS equa4 ! mems pinbcm
     T3GS etri3
     CUVF flui3d tubelp3 tank
     TUVF tubelp1
     PMAT nplate
     CL3D face3d presur abso stub3d ! pre
     TUBM rac3d1d raclp
TERM
COMP EPAI 0.8e-3 LECT plate nplate TERM
     DIAM DROI 0.1692568 LECT tubelp1 TERM
     RACC TUBM LECT rac3d1d  TERM
          NTUB LECT p1a   TERM DTUB 0.1692568
          FACE LECT face3d TERM COEF 1.0
     RACC TUBM LECT raclp  TERM
          NTUB LECT p1d3   TERM DTUB 0.1692568
          FACE LECT stub3d TERM COEF 1.0
! Attention: the TUBM element (raclp) is NOT included
! in the "mesh" object (although it IS indeed passed in from Cast3m).
! For this reason we must add it explicitly in the GROU directive below
! if we want to have it in the extracted element groups.
     GROU 21 'endtube' LECT tube TERM COND XB GT -0.6
             'trigger' LECT tube TERM COND NEAR POIN -0.1501 0 0
             'frefine' LECT flui TERM COND XB GT -0.3
                                      COND XB LT  1.0
             'pp1'    LECT plate TERM
                      COND BOX X0 0.0 Y0 0.0  Z0 0.0
                               DX 0.1 DY 0.15 DZ 0.15
             'pp2'    LECT plate TERM
                      COND BOX X0 0.0 Y0 0.0  Z0 0.0
                               DX 0.1 DY 0.165 DZ 0.165
             'fcoup'  LECT flui  TERM COND XB GT -0.05
                                      COND XB LT 0.150
                                      COND YB LT 0.150
                                      COND ZB LT 0.150
             'scoup'  LECT plate TERM COND YB LT 0.150
                                      COND ZB LT 0.150
             'lfrb2' LECT lframeb TERM
                     COND XB LT -0.865E-2
             'lfrb1' LECT lframeb DIFF lfrb2 TERM
             'uframe2'    LECT uframe DIFF presur TERM
             'S1' LECT tube TERM COND NEAR POIN -0.345 0.0 0.15
             'S2' LECT tube TERM COND NEAR POIN -0.245 0.0 0.15
             'S16' LECT flui3d TERM COND NEAR POIN -15.225 0 0.15
             'S15' LECT flui3d TERM COND NEAR POIN -15.125 0 0.15
             'S12' LECT tube TERM COND NEAR POIN -12.495 0 0.15
             'S11' LECT tube TERM COND NEAR POIN -12.395 0 0.15
             'S6' LECT tube TERM COND NEAR POIN -5.685 0 0.15
             'S5' LECT tube TERM COND NEAR POIN -5.585 0 0.15
             'epar1' LECT tubelp1 TERM COND NEAR NODE LECT p1a TERM
             'epar2' LECT tubelp1 TERM COND NEAR NODE LECT p1d3 TERM
             'tubelpp' LECT tubelp1 DIFF epar1 epar2 TERM
     NGRO 13 'blox'  LECT lframeb TERM COND !X LT -0.0253
                                             X GT 0.0253
             'symy'  LECT plate TERM    COND Y LT 0.0001
             'symz'  LECT plate TERM    COND Z LT 0.0001
             'pt0' LECT tube TERM COND NEAR POIN -16.19999 0.0 0.0
             'cen' LECT plate TERM COND NEAR POIN 0.0 0.0 0.0
             'axis1'   LECT plate TERM COND Y LT 0.0001
             'axis2'   LECT plate TERM COND Z LT 0.0001
             'csymy' LECT uframe lframeb TERM COND Y LT 0.0001
             'csymz' LECT uframe lframeb TERM COND Z LT 0.0001
             'elfb'  LECT lframeb TERM COND ENVE
             'nlfb'  LECT elfb    TERM COND X GT -0.01
                                       COND X LT  0.001
             'nbad1' LECT nlfb TERM
                     COND CONE X1 -0.009 Y1 0.260 Z1 0
                               X2  0.001 Y2 0.260 Z2 0
                               R1  0.009 R2 0.009
             'nbad2' LECT nlfb TERM
                     COND CONE X1 -0.009 Y1 0 Z1 0.260
                               X2  0.001 Y2 0 Z2 0.260
                               R1  0.009 R2 0.009
     COUL TURQ LECT tube tra lp3xl TERM
          VERT LECT plate fir2 TERM
          ROSE LECT fir1 TERM
          ROUG LECT driver TERM
         ROSE LECT S1 S2 S5 S6 S11 S12 S15 S16 TERM
ADAP THRS ECRO 11 TMIN 0.01 TMAX 0.02 MAXL 4 CRIT 1 ! NOUN
          LECT plate TERM
!          LECT pp2 TERM
GRIL LAGR LECT spec TERM
MATE
    !LOI 1
     GAZP RO 20.310 GAMM 1.4 CV 719.286 PINI 17.16E5 PREF 100.8E3
          LECT none TERM
    !LOI 2
     GAZP RO 1.193 GAMM 1.4 CV 719.286 PINI 100.8E3 PREF 100.8E3
          LECT none TERM
    !LOI 3
    GAZP RO 6.720 GAMM 1.4 CV 719.286 PINI 5.677E5 PREF 100.8E3
          LECT none TERM
    !LOI 4
     GAZP RO 1.193 GAMM 1.4 CV 719.286 PINI 100.8E3 PREF 100.8E3
          LECT flui3d TERM ! _cuvf TERM
     GAZP RO 1.193 GAMM 1.4 CV 719.286 PINI 100.8E3 PREF 100.8E3
          LECT epar1 epar2 TERM
     GAZP RO 1.193 GAMM 1.4 CV 719.286 PINI 100.8E3 PREF 100.8E3
          LECT rac3d1d raclp tubelpp TERM
     PARO PSIL 0.02
          LECT tubelpp TERM
     MULT 6 7 LECT tubelpp TERM
! In order to obtain a printout at least of the 3D VFCCs I am obliged
! to use a different material for tubelp3 and other 3D parts, but with
! the same characteristics as the material used for tubelp1
    GAZP RO 1.193 GAMM 1.4 CV 719.286 PINI 100.8E3 PREF 100.8E3
          LECT tubelp3 tank _cuvf TERM
     CLVF ABSO RO 1.187
          LECT abso TERM
     VPJC RO 7850.0 YOUN 2.1E11 NU 0.33 ELAS 3.257E8 MXIT 100
          QR1 2.348E8 CR1 56.2 QR2 4.457E8 CR2 4.7
          PDOT 5.E-4 C 1.E-2 TQ 0.9 CP 452.0
          TM 1800.0 M 1.0 DC 1.0 WC 555.0E6
          RESI 1
          LECT lframeb TERM
     VPJC RO 7850.0 YOUN 2.1E11 NU 0.33 ELAS 3.257E8 MXIT 100
          QR1 2.348E8 CR1 56.2 QR2 4.457E8 CR2 4.7
          PDOT 5.E-4 C 1.E-2 TQ 0.9 CP 452.0
          TM 1800.0 M 1.0 DC 1.0 WC 555.0E6
          RESI 1
          LECT uframe TERM
     VPJC RO 7850.0 YOUN 2.1E11 NU 0.33 ELAS 3.257E8 MXIT 100 ! Docol 600
          QR1 2.348E8 CR1 56.2 QR2 4.457E8 CR2 4.7
          PDOT 5.E-4 C 1.E-2 TQ 0.9 CP 452.0
          TM 1800.0 M 1.0 DC 1.0 WC 555.0E6
          RESI 1
          LECT plate TERM
     MASS 0.0 YOUN 2.1E11 NU 0.33
          LECT nplate TERM
     IMPE PIMP RO 7850.0 PRES 44.0011e6 PREF 1.011E5 !fc To be checked
          LECT presur TERM ! _cl3d TERM
OPTI PINS ASN
LINK COUP SPLT NONE
     BLOQ 123 LECT blox TERM
!    GLIS 2
!               FROT MUST 0.5 MUDY 0.5 GAMM 0
!               PGAP 0.4E-3
!             ! MAIT LECT lframeb TERM
!               MAIT NODE LECT nlfb DIFF nbad1 nbad2 TERM
```

```
!               PESC LECT plate TERM
*
!               FROT MUST 0.5 MUDY 0.5 GAMM 0
!               PGAP 0.4E-3
!               MAIT LECT uframe TERM
!               PESC LECT plate TERM
LINK DECO BLOQ 246 LECT symy TERM
          BLOQ 345 LECT symz TERM
          BLOQ 2 LECT csymy TERM
          BLOQ 3 LECT csymz TERM
     PINB PENA SFAC 1.0
          BODY FROT MUST 0.5 MUDY 0.5 GAMM 0 DMIN 0.0004
               LECT lframeb TERM
          BODY FROT MUST 0.5 MUDY 0.5 GAMM 0 DMIN 0.0004
               LECT uframe TERM
          BODY FROT MUST 0.5 MUDY 0.5 GAMM 0 DIAM 0.0004 ADNP
               LECT nplate TERM
          EXCL PAIR 1 2
     FLSW STRU LECT scoup TERM
          FLUI LECT fcoup TERM
          R 0.0087    ! 0.014
          HGRI 0.00606 ! 0.016
          DGRI
          FACE
          BFLU 2 ! block if at least one node is in influence domain
          FSCP 1 ! couple in all directions
          ADAP LMAX 2 SCAL 6
     TBLO 123    TRIG LECT lframeb uframe TERM
          123456 TRIG LECT plate TERM
INIT MAPP FORM 'D7735600map.map' MATC OBJE LECT flui3d tubelp1 TERM
ECRI DEPL VITE ECRO FAIL TFRE 0.25E-3
          POIN LECT cen axis1 axis2 TERM
          ELEM LECT S1 TERM
      FICH ALIT FREQ 0 TFRE 0.D0
          TIME PROG 0.D0 PAS 0.5D-3 22.D-3 PAS 0.01D-3 80.D-3
          POIN LECT cen axis1 axis2 TERM
          ELEM LECT S1 S2 S5 S6 S11 S12 S15 S16 TERM
!    FICH PVTK FREQ 0 TFRE 0.D0
!         TIME PROG 0.D0 PAS 0.5D-3 28.D-3 PAS 0.1D-3 40.D-3
!         PAS 1.D-3 50.D-3
!         GROU AUTO
!         VARI DEPL VITE FAIL ACCE VCVI CONT ECRO FLIA
     FICH SPLI ALIC TFRE 0.5E-3
OPTI NOTE CSTA 0.4
     GLIS NORM ELEM
     STEP IO
     LOG 1
     JAUM
     LMST
     PINS GRID DPIN 1.01
     VFCC FCON 6 ! hllc solver
          ORDR 2 ! order in space
          STPS 2 ! order in time
          RECO 1
          NTIL
     ADAP RCON WHAN
     ADAP RCON TRIG ECRO 1 TVAL 1.05E5 LECT trigger TERM
     NOCR TRIG LECT plate lframeb uframe TERM
     FLS  CUB8 2 ! For the inverse mapping
CALC TINI 0 TEND 32.0E-3 TFAI 1.143E-8 ! 2.0E-8
FIN
```

D6_S2_35_FPNw.epx

```
D6_S2_35_FPNW
ECHO
!CONV WIN
RESU SPLI ALIC 'D6_S2_35_FPN.ali' GARD PSCR
COMP COUL VERT LECT plate TERM
          GR50 LECT lframeb uframe TERM
          TURQ LECT tubelp3 tank TERM
SORT VISU NSTO 1
*=======================================================================
PLAY
*-----------------------------------------------------------------------
CAME   1 EYE  -4.60000E-03 -7.47801E-10 -1.66049E+00
!        Q    -2.05103E-10 -1.00000E+00 -6.46235E-26  2.77556E-16
         VIEW  5.55112E-16  4.10207E-10  1.00000E+00
         RIGH  1.00000E+00  1.53918E-26 -5.55112E-16
         UP    2.43102E-25 -1.00000E+00  4.10207E-10
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER : -4.60000E-03  0.00000E+00  1.62500E-01
!RSPHERE:  3.64597E-01
!RADIUS :  1.82299E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.31529E+00
!FAR    :  2.04449E+00
SCEN GEOM NAVI FREE
          LINE SFRE SSHA
     ISO  FILL FIEL ECRO 1 SCAL USER PROG 1.001E5 PAS 0.5E5 7.501E5 TERM
          SUPP LECT tubelp3 tank TERM
     LIMA ON
SLER CAM1 1 NFRA 1
FREQ 1
TRAC OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate lframeb uframe tubelp3 tank TERM ! SYXY
                                  SYXZ
                                  TOLS 1.E-3 NFAI REND
GOTR LOOP 10 OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate lframeb uframe tubelp3 tank TERM ! SYXY
                                  SYXZ
                                  TOLS 1.E-3 NFAI REND
ENDPLAY
*=======================================================================
FIN
```

D6_S2_35_FPNx.epx

```
D6_S2_35_FPNX
ECHO
!CONV WIN
RESU SPLI ALIC 'D6_S2_35_FPN.ali' GARD PSCR
COMP COUL VERT LECT plate TERM
          GR50 LECT lframeb uframe TERM
          TURQ LECT tubelp3 tank TERM
SORT VISU NSTO 1
*=======================================================================
PLAY
*-----------------------------------------------------------------------
CAME   1 EYE  -4.60000E-03 -7.47801E-10 -1.66049E+00
!        Q    -2.05103E-10 -1.00000E+00 -6.46235E-26  2.77556E-16
         VIEW  5.55112E-16  4.10207E-10  1.00000E+00
         RIGH  1.00000E+00  1.53918E-26 -5.55112E-16
         UP    2.43102E-25 -1.00000E+00  4.10207E-10
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER : -4.60000E-03  0.00000E+00  1.62500E-01
!RSPHERE:  3.64597E-01
!RADIUS :  1.82299E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.31529E+00
!FAR    :  2.04449E+00
SCEN GEOM NAVI FREE
          LINE SFRE SSHA
     LIMA ON
SLER CAM1 1 NFRA 1
FREQ 1
TRAC OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate lframeb uframe tubelp3 tank TERM ! SYXY
                                  SYXZ
                                  TOLS 1.E-3 NFAI REND
GOTR LOOP 10 OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate lframeb uframe tubelp3 tank TERM ! SYXY
                                  SYXZ
                                  TOLS 1.E-3 NFAI REND
ENDPLAY
*=======================================================================
FIN
```

D6_S2_35_FPNy.epx

```
D6_S2_35_FPNY
ECHO
!CONV WIN
RESU SPLI ALIC 'D6_S2_35_FPN.ali' GARD PSCR
COMP COUL GR80 LECT plate TERM
          GR50 LECT lframeb uframe TERM
SORT VISU NSTO 1
*=======================================================================
PLAY
CAME   1 EYE  -1.97046E+00  0.00000E+00 -4.08169E-10
!        Q     7.07107E-01  0.00000E+00 -7.07107E-01  0.00000E+00
         VIEW  1.00000E+00  0.00000E+00  2.05103E-10
         RIGH -2.05103E-10  0.00000E+00  1.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  1.96000E-02  0.00000E+00  0.00000E+00
!RSPHERE:  4.42236E-01
!RADIUS :  1.99006E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.54783E+00
!FAR    :  2.87454E+00
*-----------------------------------------------------------------------
SCEN GEOM NAVI FREE
          LINE SFRE SSHA
     LIMA ON
SLER CAM1 1 NFRA 1
TRAC OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate lframeb TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
FREQ 1
GOTR LOOP 10 OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate lframeb TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
ENDPLAY
*=======================================================================
FIN
```

D6_S2_35_FPNyy.epx

```
D6_S2_35_FPNYY
ECHO
!CONV WIN
RESU SPLI ALIC 'D6_S2_35_FPN.ali' GARD PSCR
COMP COUL GR80 LECT plate TERM
          GR50 LECT lframeb uframe TERM
SORT VISU NSTO 1
*=======================================================================
PLAY
```

```
CAME   1 EYE  -1.97046E+00  0.00000E+00 -4.08169E-10
!        Q     7.07107E-01  0.00000E+00 -7.07107E-01  0.00000E+00
         VIEW  1.00000E+00  0.00000E+00  2.05103E-10
         RIGH -2.05103E-10  0.00000E+00  1.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  1.96000E-02  0.00000E+00  0.00000E+00
!RSPHERE:  4.42236E-01
!RADIUS :  1.99006E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.54783E+00
!FAR    :  2.87454E+00
*-------------------------------------------------------------------------
SCEN GEOM NAVI FREE
          LINE HEOU SFRE SSHA
     LIMA ON
SLER CAM1 1 NFRA 1
TRAC OFFS SIZE 1200 1200 FICH BMP DEFO AMPD 0.0
     OBJE LECT plate TERM SYXY SYXZ TOLS 1.E-3 NFAI ADAP REND
FREQ 1
GOTR LOOP 10 OFFS SIZE 1200 1200 FICH BMP DEFO AMPD 0.0
     OBJE LECT plate TERM SYXY SYXZ TOLS 1.E-3 NFAI ADAP REND
ENDPLAY
*=========================================================================
FIN
```

D6_S2_35_FPNz1.epx

```
D6_S2_35_FPNZ1
ECHO
 CONV WIN
RESU SPLI ALIC 'D6_S2_35_FPN.ali' GARD PSCR
COMP COUL GR80 LECT plate TERM
SORT VISU NSTO 1
*=========================================================================
PLAY
CAME   1 EYE   6.49959E-01  0.00000E+00  1.78574E+00
!        Q    -9.84808E-01  0.00000E+00 -1.73648E-01  0.00000E+00
         VIEW -3.42021E-01  0.00000E+00 -9.39692E-01
         RIGH  9.39692E-01  0.00000E+00 -3.42021E-01
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  9.56724E-18  0.00000E+00  0.00000E+00
!RSPHERE:  4.41942E-01
!RADIUS :  1.90035E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.45841E+00
!FAR    :  2.78423E+00
CAME   2 EYE  -6.49959E-01  0.00000E+00  1.78574E+00
!        Q    -9.84808E-01  0.00000E+00  1.73648E-01  0.00000E+00
         VIEW  3.42021E-01  0.00000E+00 -9.39692E-01
         RIGH  9.39692E-01  0.00000E+00  3.42021E-01
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  9.56724E-18  0.00000E+00  0.00000E+00
!RSPHERE:  4.41942E-01
!RADIUS :  1.90035E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.45841E+00
!FAR    :  2.78423E+00
*-------------------------------------------------------------------------
SCEN GEOM NAVI FREE
          FACE SBAC
          LINE HEOU SFRE SSHA
     LIMA ON
SLER CAM1 1 NFRA 1
TRAC OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate TERM SYXY SYXZ TOLS 1.E-3 NFAI ADAP REND
FREQ 1
GOTR LOOP 10 OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate TERM SYXY SYXZ TOLS 1.E-3 NFAI ADAP REND
ENDPLAY
*=========================================================================
SUIT
Post-treatment (make avi file from bitmaps)
ECHO
RESU SPLI ALIC 'D6_S2_35_FPN.ali' GARD PSCR
*=================================================================
SORT VISU NSTO 1
*=================================================================
PLAY
MAVI FPS 5 KFRE 5 COMP -1 REND
ENDPLAY
*=================================================================
FIN
```

D6_S2_35_FPNz2.epx

```
D6_S2_35_FPNZ2
ECHO
 CONV WIN
RESU SPLI ALIC 'D6_S2_35_FPN.ali' GARD PSCR
COMP COUL GR80 LECT plate TERM
SORT VISU NSTO 1
*=========================================================================
PLAY
CAME   1 EYE   6.49959E-01  0.00000E+00  1.78574E+00
!        Q    -9.84808E-01  0.00000E+00 -1.73648E-01  0.00000E+00
         VIEW -3.42021E-01  0.00000E+00 -9.39692E-01
         RIGH  9.39692E-01  0.00000E+00 -3.42021E-01
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  9.56724E-18  0.00000E+00  0.00000E+00
!RSPHERE:  4.41942E-01
!RADIUS :  1.90035E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.45841E+00
!FAR    :  2.78423E+00
CAME   2 EYE  -6.49959E-01  0.00000E+00  1.78574E+00
!        Q    -9.84808E-01  0.00000E+00  1.73648E-01  0.00000E+00
         VIEW  3.42021E-01  0.00000E+00 -9.39692E-01
         RIGH  9.39692E-01  0.00000E+00  3.42021E-01
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  9.56724E-18  0.00000E+00  0.00000E+00
!RSPHERE:  4.41942E-01
!RADIUS :  1.90035E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.45841E+00
!FAR    :  2.78423E+00
*-------------------------------------------------------------------------
SCEN GEOM NAVI FREE
          FACE SBAC
          LINE HEOU SFRE SSHA
     LIMA ON
SLER CAM1 2 NFRA 1
TRAC OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate TERM SYXY SYXZ TOLS 1.E-3 NFAI ADAP REND
FREQ 1
GOTR LOOP 10 OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate TERM SYXY SYXZ TOLS 1.E-3 NFAI ADAP REND
ENDPLAY
*=========================================================================
SUIT
Post-treatment (make avi file from bitmaps)
ECHO
RESU SPLI ALIC 'D6_S2_35_FPN.ali' GARD PSCR
*=================================================================
SORT VISU NSTO 1
*=================================================================
PLAY
MAVI FPS 5 KFRE 5 COMP -1 REND
ENDPLAY
*=================================================================
FIN
```

D6_S2_35_FPw.epx

```
D6_S2_35_FPW
ECHO
!CONV WIN
RESU SPLI ALIC 'D6_S2_35_FP.ali' GARD PSCR
COMP COUL VERT LECT plate TERM
          GR50 LECT lframeb uframe TERM
          TURQ LECT tubelp3 tank TERM
SORT VISU NSTO 1
*=========================================================================
PLAY
*-------------------------------------------------------------------------
CAME   1 EYE  -4.60000E-03 -7.47801E-10 -1.66049E+00
!        Q    -2.05103E-10 -1.00000E+00 -6.46235E-26  2.77556E-16
         VIEW  5.55112E-16  4.10207E-10  1.00000E+00
         RIGH  1.00000E+00  1.53918E-26 -5.55112E-16
         UP    2.43102E-25 -1.00000E+00  4.10207E-10
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER : -4.60000E-03  0.00000E+00  1.62500E-01
!RSPHERE:  3.64597E-01
!RADIUS :  1.82299E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.31529E+00
!FAR    :  2.04449E+00
SCEN GEOM NAVI FREE
          LINE SFRE SSHA
     ISO  FILL FIEL ECRO 1 SCAL USER PROG 1.001E5 PAS 0.5E5 7.501E5 TERM
          SUPP LECT tubelp3 tank TERM
     LIMA ON
SLER CAM1 1 NFRA 1
FREQ 1
TRAC OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate lframeb uframe tubelp3 tank TERM ! SYXY
                                  SYXZ
                                  TOLS 1.E-3 NFAI REND
GOTR LOOP 10 OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate lframeb uframe tubelp3 tank TERM ! SYXY
                                  SYXZ
                                  TOLS 1.E-3 NFAI REND
!TRAC OFFS SIZE 1200 1200 FICH BMP
!     OBJE LECT plate lframeb TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
!*-----------------------------------------------------------------------
!SCEN GEOM NAVI FREE
!         LINE HEOU SFRE SSHA
!     LIMA ON
!SLER CAM1 1 NFRA 1
```

```
!TRAC OFFS SIZE 1200 1200 FICH BMP
!     OBJE LECT plate lframeb TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
ENDPLAY
*=======================================================================
FIN
```

D6_S2_35_FPx.epx

```
D6_S2_35_FPX
ECHO
!CONV WIN
RESU SPLI ALIC 'D6_S2_35_FP.ali' GARD PSCR
COMP COUL VERT LECT plate TERM
          GR50 LECT lframeb uframe TERM
          TURQ LECT tubelp3 tank TERM
SORT VISU NSTO 1
*=======================================================================
PLAY
*-----------------------------------------------------------------------
CAME   1 EYE  -4.60000E-03 -7.47801E-10 -1.66049E+00
!        Q    -2.05103E-10 -1.00000E+00 -6.46235E-26  2.77556E-16
         VIEW  5.55112E-16  4.10207E-10  1.00000E+00
         RIGH  1.00000E+00  1.53918E-26 -5.55112E-16
         UP    2.43102E-25 -1.00000E+00  4.10207E-10
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER : -4.60000E-03  0.00000E+00  1.62500E-01
!RSPHERE:  3.64597E-01
!RADIUS :  1.82299E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.31529E+00
!FAR    :  2.04449E+00
SCEN GEOM NAVI FREE
          LINE SFRE SSHA
     LIMA ON
SLER CAM1 1 NFRA 1
FREQ 1
TRAC OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate lframeb uframe tubelp3 tank TERM ! SYXY
                              SYXZ
                              TOLS 1.E-3 NFAI REND
GOTR LOOP 10 OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate lframeb uframe tubelp3 tank TERM ! SYXY
                              SYXZ
                              TOLS 1.E-3 NFAI REND
!TRAC OFFS SIZE 1200 1200 FICH BMP
!     OBJE LECT plate lframeb TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
!*-----------------------------------------------------------------------
!SCEN GEOM NAVI FREE
!          LINE HEOU SFRE SSHA
!     LIMA ON
!SLER CAM1 1 NFRA 1
!TRAC OFFS SIZE 1200 1200 FICH BMP
!     OBJE LECT plate lframeb TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
ENDPLAY
*=======================================================================
FIN
```

D6_S2_35_FPy.epx

```
D6_S2_35_FPY
ECHO
!CONV WIN
RESU SPLI ALIC 'D6_S2_35_FP.ali' GARD PSCR
COMP COUL GR80 LECT plate TERM
          GR50 LECT lframeb uframe TERM
SORT VISU NSTO 1
*=======================================================================
PLAY
CAME   1 EYE  -1.97046E+00  0.00000E+00 -4.08169E-10
!        Q     7.07107E-01  0.00000E+00 -7.07107E-01  0.00000E+00
         VIEW  1.00000E+00  0.00000E+00  2.05103E-10
         RIGH -2.05103E-10  0.00000E+00  1.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  1.96000E-02  0.00000E+00  0.00000E+00
!RSPHERE:  4.42236E-01
!RADIUS :  1.99006E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.54783E+00
!FAR    :  2.87454E+00
*-----------------------------------------------------------------------
SCEN GEOM NAVI FREE
          LINE SFRE SSHA
     LIMA ON
SLER CAM1 1 NFRA 1
TRAC OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate lframeb TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
FREQ 1
GOTR LOOP 10 OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate lframeb TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
ENDPLAY
*=======================================================================
FIN
```

D6_S2_35_FPyy.epx

```
D6_S2_35_FPYY
ECHO
!CONV WIN
RESU SPLI ALIC 'D6_S2_35_FP.ali' GARD PSCR
COMP COUL GR80 LECT plate TERM
          GR50 LECT lframeb uframe TERM
SORT VISU NSTO 1
*=======================================================================
PLAY
CAME   1 EYE  -1.97046E+00  0.00000E+00 -4.08169E-10
!        Q     7.07107E-01  0.00000E+00 -7.07107E-01  0.00000E+00
         VIEW  1.00000E+00  0.00000E+00  2.05103E-10
         RIGH -2.05103E-10  0.00000E+00  1.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  1.96000E-02  0.00000E+00  0.00000E+00
!RSPHERE:  4.42236E-01
!RADIUS :  1.99006E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.54783E+00
!FAR    :  2.87454E+00
*-----------------------------------------------------------------------
SCEN GEOM NAVI FREE
          LINE HEOU SFRE SSHA
     LIMA ON
SLER CAM1 1 NFRA 1
TRAC OFFS SIZE 1200 1200 FICH BMP DEFO AMPD 0.0
     OBJE LECT plate TERM SYXY SYXZ TOLS 1.E-3 NFAI ADAP REND
FREQ 1
GOTR LOOP 10 OFFS SIZE 1200 1200 FICH BMP DEFO AMPD 0.0
     OBJE LECT plate TERM SYXY SYXZ TOLS 1.E-3 NFAI ADAP REND
ENDPLAY
*=======================================================================
FIN
```

D6_S2_35_z1.epx

```
D6_S2_35_Z1
ECHO
 CONV WIN
RESU SPLI ALIC 'D6_S2_35.ali' GARD PSCR
COMP COUL GR80 LECT plate TERM
SORT VISU NSTO 1
*=======================================================================
PLAY
CAME   1 EYE   6.49959E-01  0.00000E+00  1.78574E+00
!        Q    -9.84808E-01  0.00000E+00 -1.73648E-01  0.00000E+00
         VIEW -3.42021E-01  0.00000E+00 -9.39692E-01
         RIGH  9.39692E-01  0.00000E+00 -3.42021E-01
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  9.56724E-18  0.00000E+00  0.00000E+00
!RSPHERE:  4.41942E-01
!RADIUS :  1.90035E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.45841E+00
!FAR    :  2.78423E+00
CAME   2 EYE  -6.49959E-01  0.00000E+00  1.78574E+00
!        Q    -9.84808E-01  0.00000E+00  1.73648E-01  0.00000E+00
         VIEW  3.42021E-01  0.00000E+00 -9.39692E-01
         RIGH  9.39692E-01  0.00000E+00  3.42021E-01
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  9.56724E-18  0.00000E+00  0.00000E+00
!RSPHERE:  4.41942E-01
!RADIUS :  1.90035E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.45841E+00
!FAR    :  2.78423E+00
*-----------------------------------------------------------------------
SCEN GEOM NAVI FREE
          FACE SBAC
          LINE HEOU SFRE SSHA
     LIMA ON
SLER CAM1 1 NFRA 1
TRAC OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate TERM SYXY SYXZ TOLS 1.E-3 NFAI ADAP REND
FREQ 1
GOTR LOOP 25 OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate TERM SYXY SYXZ TOLS 1.E-3 NFAI ADAP REND
ENDPLAY
*=======================================================================
SUIT
Post-treatment (make avi file from bitmaps)
ECHO
RESU SPLI ALIC 'D6_S2_35.ali' GARD PSCR
*=================================================================
SORT VISU NSTO 1
*=================================================================
PLAY
MAVI FPS 5 KFRE 5 COMP -1 REND
ENDPLAY
*=================================================================
FIN
```

D6_S2_35_z2.epx

```
D6_S2_35_Z2
ECHO
 CONV WIN
RESU SPLI ALIC 'D6_S2_35.ali' GARD PSCR
COMP COUL GR80 LECT plate TERM
SORT VISU NSTO 1
*=======================================================================
PLAY
CAME   1 EYE   6.49959E-01  0.00000E+00  1.78574E+00
!        Q    -9.84808E-01  0.00000E+00 -1.73648E-01  0.00000E+00
         VIEW -3.42021E-01  0.00000E+00 -9.39692E-01
         RIGH  9.39692E-01  0.00000E+00 -3.42021E-01
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  9.56724E-18  0.00000E+00  0.00000E+00
!RSPHERE:  4.41942E-01
!RADIUS :  1.90035E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.45841E+00
!FAR    :  2.78423E+00
CAME   2 EYE  -6.49959E-01  0.00000E+00  1.78574E+00
!        Q    -9.84808E-01  0.00000E+00  1.73648E-01  0.00000E+00
         VIEW  3.42021E-01  0.00000E+00 -9.39692E-01
         RIGH  9.39692E-01  0.00000E+00  3.42021E-01
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER :  9.56724E-18  0.00000E+00  0.00000E+00
!RSPHERE:  4.41942E-01
!RADIUS :  1.90035E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.45841E+00
!FAR    :  2.78423E+00
*-----------------------------------------------------------------------
SCEN GEOM NAVI FREE
          FACE SBAC
          LINE HEOU SFRE SSHA
     LIMA ON
SLER CAM1 2 NFRA 1
TRAC OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate TERM SYXY SYXZ TOLS 1.E-3 NFAI ADAP REND
FREQ 1
GOTR LOOP 25 OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate TERM SYXY SYXZ TOLS 1.E-3 NFAI ADAP REND
ENDPLAY
*=======================================================================
SUIT
Post-treatment (make avi file from bitmaps)
ECHO
RESU SPLI ALIC 'D6_S2_35.ali' GARD PSCR
*=================================================================
SORT VISU NSTO 1
*=================================================================
PLAY
MAVI FPS 5 KFRE 5 COMP -1 REND
ENDPLAY
*=================================================================
FIN
```

D6_S2_35f.epx

```
D6_S2_35F
ECHO
!CONV WIN
RESU SPLI ALIC 'D6_S2_35.ali' GARD PSCR
COMP COUL GR80 LECT plate TERM
SORT VISU NSTO 1
PLAY
CAME   1 EYE  -1.85740E+00  2.10571E-03  2.10571E-03
!        Q     7.07107E-01  0.00000E+00 -7.07107E-01  0.00000E+00
         VIEW  1.00000E+00  0.00000E+00  2.05103E-10
         RIGH -2.05103E-10  0.00000E+00  1.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER : -2.25515E-03  2.10571E-03  2.10571E-03
!RSPHERE:  4.63787E-01
!RADIUS :  1.85515E+00
!ASPECT :  1.00000E+00
!NEAR   :  1.39136E+00
!FAR    :  2.78272E+00
SCEN GEOM NAVI FREE
          LINE HEOU SFRE
SLER CAM1 1 NFRA 1
FREQ 1
TRAC DEFO AMPD 0.0 OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate TERM
     SYXY SYXZ ! TOLS 1.E-2
     NFAI ADAP REND
GOTR LOOP 25 DEFO AMPD 0.0 OFFS SIZE 1200 1200 FICH BMP
     OBJE LECT plate TERM
     SYXY SYXZ ! TOLS 1.E-2
     NFAI ADAP REND
ENDPLAY
*=======================================================================
SUIT
Post-treatment (make avi file from bitmaps)
ECHO
RESU SPLI ALIC 'D6_S2_35.ali' GARD PSCR
*=================================================================
SORT VISU NSTO 1
*=================================================================
PLAY
MAVI FPS 5 KFRE 5 COMP -1 REND
ENDPLAY
*=================================================================
FIN
```

D7705600map.dgibi

```
opti echo 0;
*opti donn 'px4cir3d.proc';
*$$$$ PX4CIR3D
*
* Pour generer le maillage 3D (plan) d'un quart de cercle
* avec seulement des quadrilateres a 4 noeuds.
* Le quart de cercle est defini par les deux extremes
* d'un arc (de 90 degrees), par le centre du cercle
* et par un autre point qui definit l'axe de rotation
* (axe perpendiculaire au plan du cercle, passant pour son centre).
*
* Input:
* =====
* P1 = premiere extremite de l'arc
* P2 = deuxieme extremite de l'arc
* PC = centre de l'arc
* PZ = autre point de l'axe
* N  = nombre de mailles a generer sur chaque cote (doit etre pair)
* TOL= tolerance pour l'elimination des noeuds doubles
*
* Output:
* ======
* SUR = objet MAILLAGE d'elements de type QUA4
* IER = 0: pas d'erreur, .NE.0: erreur dans la generation de SUR
*
'DEBPROC' PX4CIR3D P1*'POINT' P2*'POINT' PC*'POINT' PZ*'POINT'
                   N*'ENTIER' TOL*'FLOTTANT';
*------------------------------------------------------------------
*
ier=0;
n2 = n / 2;
p0 = 0 0 0;
pm1 = p1 plus p0;
depl pm1 tour 45 pc pz;
pm2 = 0.5*(pc plus p2);
pm3 = 0.5*(pc plus p1);
pm = 0.5*(pc plus pm1);
c1a = cerc n2 p1 pc pm1;
c1b = cerc n2 pm1 pc p2;
c2a = droi n2 p2 pm2;
c2b = droi n2 pm2 pc;
c3a = droi n2 pc pm3;
c3b = droi n2 pm3 p1;
c4a = droi n2 pm pm1;
c4b = droi n2 pm pm2;
c4c = droi n2 pm pm3;
sur1 = dall plan c4c c3b c1a (inve c4a);
sur2 = dall plan c4a c1b c2a (inve c4b);
sur3 = dall plan c2b c3a (inve c4c) c4b;
sur = sur1 et sur2 et sur3;
*
elim tol sur;
*
'FINPROC' sur ier;
************************************************************************
************************************************************************
'DEBPROC' pxextr3d m*'MAILLAGE' x1*'FLOTTANT' x2*'FLOTTANT'
                   y1*'FLOTTANT' y2*'FLOTTANT'
                   z1*'FLOTTANT' z2*'FLOTTANT';
*
*-------------------------------------------------
* Extracts from the 3D mesh m the elements whose nodes are
* located in the box [x1-x2,y1-y2,z1-z2].
*
* Input :
* -----
*     m                       : 3D mesh
*     x1, x2, y1, y2, z1, z2 : extremes of the box
* Output :
* ------
*     box : mesh contained in the box
*-------------------------------------------------
*
x = coor 1 m;
sx = x POIN COMP x1 x2;
y = coor 2 sx;
sy = y POIN COMP y1 y2;
z = coor 3 sy;
sz = z POIN COMP z1 z2;
box = m ELEM APPU STRI sz NOVE;
*
finproc box;
************************************************************************
*
*opti donn 'px4car3d.proc';
*$$$$ PX4CAR3D
*
* This procedure is similar to PX4CIR3D but instead of a fourth
* of a circle it generates a (fourth of a) square, homeomorphic
```

```
* to the fourth of a circle that would be generated by PX4CIR3D
* by using the same input parameters (except for PZ which is
* unused in this case).
* In this way the two surfaces (the circle and the square)
* can be connected volumetrically by the VOLU operator:
*    vol = cir VOLU n squ;
*
* Input:
* =====
* P1 = premiere extremite de l'arc (cote du quadrangle, ici)
* P2 = deuxieme extremite de l'arc (cote du quadrangle, ici)
* PC = centre de l'arc (quadrangle, ici)
* N  = nombre de mailles a generer sur chaque cote (doit etre pair)
* TOL= tolerance pour l'elimination des noeuds doubles
*
* Output:
* ======
* SUR = objet MAILLAGE d'elements de type QUA4
* IER = 0: pas d'erreur, .NE.0: erreur dans la generation de SUR
*
'DEBPROC' PX4CAR3D P1*'POINT' P2*'POINT' PC*'POINT'
                   N*'ENTIER' TOL*'FLOTTANT';
*-----------------------------------------------------------------
*
ier=0;
n2 = n / 2;
p0 = 0 0 0;
pm1 = p1 plus (p2 moin pc);
pm2 = 0.5*(pc plus p2);
pm3 = 0.5*(pc plus p1);
pm = 0.5*(pc plus pm1);
c1a = droi n2 p1 pm1;
c1b = droi n2 pm1 p2;
c2a = droi n2 p2 pm2;
c2b = droi n2 pm2 pc;
c3a = droi n2 pc pm3;
c3b = droi n2 pm3 p1;
c4a = droi n2 pm pm1;
c4b = droi n2 pm pm2;
c4c = droi n2 pm pm3;
sur1 = dall plan c4c c3b c1a (inve c4a);
sur2 = dall plan c4a c1b c2a (inve c4b);
sur3 = dall plan c2b c3a (inve c4c) c4b;
sur = sur1 et sur2 et sur3;
*
elim tol sur;
*
'FINPROC' sur ier;
************************************************************************
opti echo 1;
*
opti dime 3 elem cub8;
opti sauv form 'D7705600map.msh';
opti trac psc ftra 'D7705600map_mesh.ps';
*
tol = 1.E-5;
dia = 0.331E0;
rad = 0.5D0*dia;
cot = 0.300E0;
co2 = 0.5D0*cot;
ldr = 0.77E0;
lf1 = 0.07E0;
lf2 = 0.07E0;
ltublp = 16.195;
ltra = 0.60E0;
lp3xd = 3.5E0;
lp3x= lp3xd - ltra;
*lext= ltublp - ltra;
lext = ltublp - lp3xd;
X0 = 0.0 - (ltublp + lf1 + lf2 + ldr);
p0 = X0 0 0;
py = X0 rad 0;
pz = X0 0 rad;
p0b = X0 0 0;
pyb = X0 co2 0;
pzb = X0 0 co2;
px = ldr 0 0;
nr = 16;
h = 0.01E0;
ndr = enti ((ldr+tol) / h);
nf1 = enti ((lf1+tol) / h);
nf2 = enti ((lf2+tol) / h);
ntra = enti ((ltra+tol) / h);
n3x = enti ((lp3x+tol) / h);
fond ier = PX4CIR3D py pz p0 px nr tol;
bout ier = PX4CAR3D pyb pzb p0b nr tol;
bout = bout plus ((ldr + lf1 + lf2 + ltra) 0 0);
driver = fond volu tran ndr (ldr 0 0);
fir1 = (fond plus (ldr 0 0)) volu tran nf1 (lf1 0 0);
fir1 = coul vert (fir1);
fir2 = (fond plus ((ldr + lf1) 0 0)) volu tran nf2 (lf2 0 0);
fir2 = coul bleu (fir2);
tra = (fond plus ((ldr + lf1 + lf2) 0 0)) volu ntra bout;
trac cach qual (tra et fir1 et fir2 et driver);
*
************************************************************************
* Spurious contact surface/tube/trans for membranes
************************************************************************
*
ddr = 0.0025;
rsh = ddr;
pst1 = p0 PLUS (0 0 0);
pst2 = py PLUS (0 rsh 0);
pst3 = pz PLUS (0 0 rsh);
pst4 = px PLUS (0 0 0);
*
fondd ier = PX4CIR3D pst2 pst3 pst1 pst4 (nr) tol;
*
pst5 = p0b PLUS (0 0 0);
pst6 = pyb PLUS (0 rsh 0);
pst7 = pzb PLUS (0 0 rsh);
*
boutd ier = PX4CAR3D pst6 pst7 pst5 (nr) tol;
boutd = boutd plus ((ldr + lf1 + lf2 + ltra) 0 0);
*
tradd = (fondd plus ((ldr + lf1 + lf2) 0 0)) volu (ntra) boutd;
ndum = nf1;
fird1 = (fondd plus ((ldr-0.01) 0 0)) volu tran (ndum+1)
((lf1+0.01) 0 0);
fird2 = (fondd plus ((ldr + lf1) 0 0)) volu tran (nf2) (lf2 0 0);
*
trad = tradd et fird1 et fird2;
elim tol trad;
*
tras = enve trad;
trac cach qual trad;
*trac cach qual tras;
trac cach qual (fondd et boutd);
trac cach qual (fondd et boutd et tras);
*
************************************************************************
* Extract non-outward-directed walls from tras
************************************************************************
*
nout1 = (pxextr3d tras -16.347 -16.343 -0.001 0.175 -0.001 0.175)
        COUL VERT;
nout2 = (pxextr3d tras -15.597 -15.593 -0.001 0.175 -0.001 0.175)
        COUL VERT;
nout3 = (pxextr3d tras -16.347 -15.593 -0.001 0.175 -0.001 0.001)
        COUL VERT;
nout4 = (pxextr3d tras -16.347 -15.593 -0.001 0.001 -0.001 0.175)
        COUL VERT;
nout = nout1 et nout2 et nout3 et nout4;
pinbcm = (tras DIFF nout) COUL ROUG;
npincm = chan poi1 pinbcm;
trac cach qual (nout1 et nout2 et nout3);
trac cach qual nout;
trac cach qual pinbcm;
trac cach qual (fondd et boutd et pinbcm);
trac cach qual (tra et pinbcm);
trac cach qual (tra et npincm);
*
************************************************************************
*
boutx = bout plus ((lp3x) 0 0);
lp3xl = bout volu n3x boutx;
*
flui3d = driver et fir1 et fir2 et tra et lp3xl;
elim tol flui3d;
trac cach qual flui3d;
trac cach qual (flui3d et pinbcm);
list (nbel flui3d);
list (nbel (flui3d elem cub8));
mem1 = fond plus (ldr 0 0);
mem2 = mem1 plus (lf1 0 0);
*mem3 = mem2 plus (lf2 0 0);
*mems = mem1 et mem2 et mem3;
mems = mem1 et mem2;
pre1 = mem1 coul jaun;
pre2 = mem2 coul jaun;
*pre3 = mem3 coul jaun;
*pre = pre1 et pre2 et pre3;
pre = pre1 et pre2;
*
*face3d = bout PLUS (0 0 0);
face3d = boutx PLUS (0 0 0);
pface3d = chan poi1 face3d;
elim tol (pface3d et flui3d);
p1a = (0 - lext) 0 0;
trac cach qual (p1a et face3d et pinbcm);
rac3d1d = manu supe (p1a et face3d);
list (nbno rac3d1d);
list (nbno face3d);
mesh1 = mems et flui3d et pre et face3d et rac3d1d;
*
p1d1 = (0 - lext) 0 0;
*p1d3 = 0 0 0;
lenlp3d = 0.6;
p1d3 = (0 - lenlp3d) 0 0;
tubelp1 = p1d1 d p1d3 dini h dfin h;
*
trac cach qual (p1a et face3d et pinbcm et tubelp1);
*
tube = tubelp1;
*
trac cach qual (tubelp1 ET p1d1 ET p1d3);
trac cach qual (tubelp1 ET p1d1 ET p1d3 et pinbcm);
*
elim tol (p1a et tubelp1);
*
oubl ltubhp;
oubl ltube;
oubl tol;
oubl p0;
oubl d1;
```

```
oubl d2;
oubl p1d1;
*
* we add a fake triangle to host a fake pinball which is never eroded
* (to avoid a bug in the code)
pfake1 = -16.300  0 0;
pfake2 = -16.297  0 0;
pfake3 = -16.2985 0.003 0;
fake = manu tri3 pfake1 pfake2 pfake3;
*
mesh = tube et mesh1 et fake et pinbcm et npincm;
trac cach qual mesh;
tass mesh noop;
sauv form mesh;
list;
*
fin;
```

D7705600map.epx

```
D7705600map
ECHO
!CONV win
CAST mesh
TRID ALE
EROS 1.0
DIME ADAP NPOI 300000
          CUVF 300000
          NVFI 800000
          Q4GS 10000
          CL3D 10000
          NPIN 10000
     ENDA
     JONC 218 ! Total n. of nodes in a TUBM juncton
     NALE 1 NBLE 1
     TERM
GEOM
     Q4GS  mems pinbcm
     PMAT npincm
     CUVF flui3d
     T3GS fake
     TUVF tubelp1
     CL3D pre face3d
     TUBM rac3d1d
TERM
COMP DIAM DROI 0.1692568 LECT tubelp1 TERM
     RACC TUBM LECT rac3d1d  TERM
          NTUB LECT p1a   TERM DTUB 0.1692568
          FACE LECT face3d TERM COEF 1.0
! Attention: the TUBM element (raclp) is NOT included
! in the "mesh" object (although it IS indeed passed in from Cast3m).
! For this reason we must add it explicitly in the GROU directive below
! if we want to have it in the extracted element groups.
     GROU 17 'nrac3d1d' LECT mesh1 rac3d1d TERM
                   COND XB GT -12.6952 COND XB LT -12.6948
            'fcoup1' LECT flui3d TERM
                   COND XB GT -16.405
                   COND XB LT -15.105
            'S1' LECT tube TERM COND NEAR POIN -0.345 0.15 0.15
            'S2' LECT tube TERM COND NEAR POIN -0.245 0.15 0.15
            'S3' LECT tube TERM COND NEAR POIN 0.0 0.0 0.0
            'S16' LECT flui3d TERM COND NEAR POIN -15.225 0 0.15
            'S15' LECT flui3d TERM COND NEAR POIN -15.125 0 0.15
            'S12' LECT tube TERM COND NEAR POIN -12.495 0 0.15
            'S11' LECT tube TERM COND NEAR POIN -12.395 0 0.15
            'S6' LECT tube TERM COND NEAR POIN -5.685 0 0.15
            'S5' LECT tube TERM COND NEAR POIN -5.585 0 0.15
            'epar1' LECT tubelp1 TERM COND NEAR NODE LECT p1a TERM
            'epar2' LECT tubelp1 TERM COND NEAR NODE LECT p1d3 TERM
            'tubelpp' LECT tubelp1 DIFF epar1 epar2 TERM
!            'tubelpp' LECT tubelp1 DIFF epar1 TERM ! epar2 TERM
            'memc1' LECT mem1 TERM COND NEAR POIN -16.435 0 0
            'memc1d' LECT mem1 TERM COND CYLI X1 -16.505 Y1 0 Z1 0
                                         X2 -16.305 Y2 0 Z2 0 R .15
            'memc1b' LECT mem1 DIFF memc1d TERM
     NGRO 7 'nmemi' LECT mems TERM
                   COND CYLI X1 -20 Y1 0 Z1 0 X2 20 Y2 0 Z2 0 R 0.1650
            'nmemo' LECT mems DIFF nmemi TERM
            'nsymy' LECT mems TERM COND Y LT 0.001
            'nsymz' LECT mems TERM COND Z LT 0.001
            'm1c'   LECT mem1 TERM COND NEAR POIN -16.335 0 0
            'm2c'   LECT mem2 TERM COND NEAR POIN -16.265 0 0
!            'm3c'   LECT mem3 TERM COND NEAR POIN -16.195 0 0
            'pt0' LECT tube TERM COND NEAR POIN -16.19999 0.0 0.0
     EPAI 0.25E-3 LECT mems DIFF memc1 memc1b TERM
          0.22E-3 LECT memc1 TERM
          0.29E-3 LECT memc1b TERM
          3.00E-3 LECT fake TERM
          1.00E-3 LECT pinbcm TERM
          5.00E-3 LECT npincm TERM ! Only for visualization
     COUL TURQ LECT tube tra lp3xl TERM
          VERT LECT fir2 TERM
          ROSE LECT fir1 TERM
          ROUG LECT driver TERM
          GR50 LECT mems TERM
          ROUG LECT fake TERM
          JAUN LECT pre TERM
          GR50 LECT pinbcm TERM
          ROSE LECT S3 S1 S2 S5 S6 S11 S12 S15 S16 TERM
!       DIAM DROI 0.1692568 LECT tubelp1 TERM
ADAP THRS ECRO 3 TMIN 0.01 TMAX 0.4 MAXL 3
          LECT mems TERM
GRIL LAGR LECT mems fake TERM
FONC 1 TABL 5 0.0       0.0
              5.0E-3    1.0
              6.999E-3  1.0
              7.0E-3    0.0
              100.0E-3  0.0
MATE
    !LOI 1
     VM23 RO 1380 YOUN 2757.9E6 NU 0.495 ELAS 160.E6 ! "Melinex/Mylar/
                                                     !  PET" EPAI<0.5
                                                     !  = Material 7
          FAIL PEPR LIMI 1.2
          TRAC 3 160.E6 0.058015156
                 180.E6 1.5
                 207.E6 3.5
          LECT mems _q4gs TERM
    !LOI 2
     GAZP RO 7.5326 GAMM 1.4 CV 719.286 PINI 6.376E5 PREF 100.5E3
          LECT none TERM
    !LOI 3
     GAZP RO 1.187 GAMM 1.4 CV 719.286 PINI 100.5E3 PREF 100.5E3
          LECT none TERM
    !LOI 4
     GAZP RO 1.187 GAMM 1.4 CV 719.286 PINI 100.5E3 PREF 100.5E3
          LECT none TERM
    !LOI 5
     GAZP RO 1.187 GAMM 1.4 CV 719.286 PINI 100.5E3 PREF 100.5E3
          LECT flui3d _cuvf TERM
    !LOI 6
  !   IMPE PIMP PRES 13.723E5 PREF 1.011E5 FONC 1
  !   IMPE PIMP PRES 12.98E5 PREF 0 FONC 1
     IMPE PIMP PRES 2.25E5 PREF 0 FONC 1
          LECT pre _cl3d TERM
     GAZP RO 1.187 GAMM 1.4 CV 719.286 PINI 100.5E3 PREF 100.5E3
          LECT epar1 epar2 TERM
     GAZP RO 1.187 GAMM 1.4 CV 719.286 PINI 100.5E3 PREF 100.5E3
          LECT rac3d1d tubelpp TERM
     PARO PSIL 0.02
          LECT tubelpp TERM
     MULT 8 9 LECT tubelpp TERM
     GAZP RO 1.187 GAMM 1.4 CV 719.286 PINI 100.5E3 PREF 100.5E3
          LECT _cuvf TERM
     FANT 0.0
          LECT fake TERM
     VM23 RO 7850 YOUNG 2.1E11 NU 0.3 ELAS 1000E6 ! Elastic steel
          TRAC 2 1000E6 0.0047619048
                 1100E6 5.1
          LECT pinbcm TERM
     MASS 0.0 YOUN 2.1E11 NU 0.33
          LECT npincm TERM
! In order to obtain a printout at least of the 3D VFCCs I am obliged
! to use a different material for tubelp3 and other 3D parts, but with
! the same characteristics as the material used for tubelp1
!OPTI PINS ASN
LINK COUP SPLT NONE
     BLOQ 123 LECT nmemo TERM
     BLOQ 123 LECT pinbcm TERM
     CONT SPLA NX 0 NY 1 NZ 0 LECT nsymy TERM
     CONT SPLA NX 0 NY 0 NZ 1 LECT nsymz TERM
LINK DECO
     PINB PENA SFAC 1.0
          BODY                              DMIN 0.003  ! #6
               LECT mem1 TERM
          BODY                              DMIN 0.003  ! #7
               LECT mem2 TERM
!          BODY                              DMIN 0.003  ! #8
!               LECT mem3 TERM
          BODY                              MLEV 0      ! #8
               LECT fake TERM
          BODY                              DIAM 5.E-3
               LECT npincm TERM
          EXCL PAIR 1 3
          EXCL PAIR 2 3
!          EXCL PAIR 3 4
          EXCL PAIR 3 4
     FLSW STRU LECT mems TERM
          FLUI LECT fcoup1 TERM
          R 0.025 ! 0.014
          HGRI 0.016
          DGRI
          FACE
          BFLU 2 ! block if at least one node is in influence domain
          FSCP 1 ! couple in all directions
          ADAP LMAX 3 SCAL 2
INIT SKIP UPTO 7.E-3 VFCC
     ADAP IMAT TIME 7.E-3
               2 MATE 2 OBJE LECT flui3d TERM
                        INSI SURF LECT mem1 TERM
                MATE 3 OBJE LECT flui3d TERM
                       OUTS SURF LECT mem1 TERM
                       INSI SURF LECT mem2 TERM
!                 MATE 4 OBJE LECT flui3d TERM
!                         OUTS SURF LECT mem2 TERM
!                         INSI SURF LECT mem3 TERM
ECRI DEPL VITE ECRO FAIL TFRE 0.25E-3
          NOPO !POIN LECT cen TERM
          ELEM LECT S1 TERM
     FICH ALIC TEMP TFRE 10.e-6
    ! FICH ALIT FREQ 0 TFRE 0.D0
         ! TIME PROG 0.D0 PAS 0.5D-3 28.D-3 PAS 0.01D-3 110.D-3
          !POIN LECT cen TERM
```

```
        ELEM LECT S1 S2 S3 S5 S6 S11 S12 S15 S16 TERM
!   FICH PVTK FREQ 0 TFRE 0.D0
!       TIME PROG 0.D0 PAS 0.5D-3 28.D-3 PAS 0.1D-3 50.D-3
!       PAS 2.D-3 110.D-3
!       GROU AUTO
!       VARI DEPL VITE FAIL ACCE VCVI CONT ECRO FLIA DTST
    FICH FORM MAPP OBJE LECT flui3d tubelp1 TERM
                   TIME PROG 38.0E-3 TERM
!                   TIME PROG 31.0E-3 TERM
    FICH SPLI ALIC FREQ 0 TFRE 1.D-3 ! 0.D0
    !      TIME PROG 0.D0 PAS 0.5D-3 28.D-3 PAS 0.1D-3 50.D-3
    !      PAS 2.D-3 80.D-3
OPTI NOTE CSTA 0.25
     STEP IO
     LOG 1
     JAUM
     LMST
     FANT 10.0E-3 LECT mems TERM !_q4gs TERM ! Corresponds to FANT 6E-3
                                            ! in other analyses
     VFCC FCON 6 ! hllc solver
          ORDR 2 ! order in space
          STPS 2 ! order in time
          RECO 1 ! Not accepted by CAL_VFCC_1D
          NTIL
     ADAP RCON !TRIG ECRO 1 TVAL 1.02E5 LECT trigger TERM
     PINS GRID DPIN 1.01
     FLS  CUB8 2 ! For the inverse mapping
     QUAS STAT 2000 0.1 UPTO 5.0E-3
CALC TINI 0 TEND 44.0E-3
FIN
```

D7705600mapw.epx

```
D7705600MAPW
ECHO
 CONV WIN
RESU SPLI ALIC 'D7705600map.ali' GARD PSCR
COMP COUL ROUG LECT mem1 TERM
          VERT LECT mem2 TERM
!         TURQ LECT mem3 TERM
          GR50 LECT pinbcm TERM
          TURQ LECT flui3d TERM
*=====================================================================
SORT VISU NSTO 1
*=====================================================================
PLAY
CAME   1 EYE  -1.64954E+01 -9.15031E-01  2.02341E-03
!        Q     6.95266E-01  6.95266E-01 -1.28860E-01 -1.28860E-01
         VIEW  3.58368E-01  9.33580E-01  1.91478E-10
         RIGH  9.33580E-01 -3.58368E-01 -7.35028E-11
         UP    3.05311E-16 -2.05101E-10  1.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: FREE CAMERA
!CENTER : -1.62650E+01  8.28568E-02  2.02341E-03
!RSPHERE:  2.04827E-01
!RADIUS :  1.02414E+00
!ASPECT :  1.33333E+00
!NEAR   :  8.09342E-01
!FAR    :  1.21900E+00
SCEN GEOM NAVI FREE
          FACE SBAC
          LINE SFRE
     ISO  FILL FIEL ECRO 1 SCAL USER PROG 1.E5 PAS 0.5E5 7.5E5 TERM
          SUPP LECT flui3d TERM
     LIMA ON
SLER CAM1 1 NFRA 1
FREQ 1
TRAC OFFS SIZE 800 600 FICH BMP
          OBJE LECT mems pinbcm flui3d TERM SYXY TOLS 1.E-3 NFAI REND
GOTR LOOP 10 OFFS SIZE 800 600 FICH BMP
          OBJE LECT mems pinbcm flui3d TERM SYXY TOLS 1.E-3 NFAI REND
ENDPLAY
*=====================================================================
FIN
```

D7705600mapx.epx

```
D7705600mapx
ECHO
!CONV WIN
RESU SPLI ALIC 'D7705600map.ali' GARD PSCR
COMP NGRO 1 'xaxo' LECT flui3d tubelp1 TERM
                   COND LINE X1 -17.105 Y1 0 Z1 0
                             X2 -0.6    Y2 0 Z2 0 TOL 1.E-3
SORT GRAP
AXTE 1.0 'Time [s]'
SCOU 1 'p_38' T 38.E-3 SAXE 1.0 'Abscissa' INIT LECT xaxo TERM
                       ECRO COMP 1
                       SUPP LECT flui3d tubelp1 TERM
SCOU 2 'r_38' T 38.E-3 SAXE 1.0 'Abscissa' INIT LECT xaxo TERM
                       ECRO COMP 2
                       SUPP LECT flui3d tubelp1 TERM
SCOU 3 'v_38' T 38.E-3 SAXE 1.0 'Abscissa' INIT LECT xaxo TERM
                       VCVI COMP 1
                       SUPP LECT flui3d tubelp1 TERM
RCOU 11 'p_38' FICH 'D7705600mapx_old.pun' RENA 'p_38_2021'
RCOU 12 'r_38' FICH 'D7705600mapx_old.pun' RENA 'r_38_2021'
RCOU 13 'v_38' FICH 'D7705600mapx_old.pun' RENA 'v_38_2021'
TRAC 1 11 AXES 1.0 'PRESS. [Pa]'
COLO NOIR ROUG
TRAC 2 12 AXES 1.0 'DENS. [kg/m3]'
COLO NOIR ROUG
TRAC 3 13 AXES 1.0 'VELO. [m/s]'
COLO NOIR ROUG
LIST 1 AXES 1.0 'PRESS. [Pa]'
LIST 2 AXES 1.0 'DENS. [kg/m3]'
LIST 3 AXES 1.0 'VELO. [m/s]'
FIN
```

D7705600mapy.epx

```
D7705600MAPY
ECHO
 CONV WIN
RESU SPLI ALIC 'D7705600map.ali' GARD PSCR
COMP COUL ROUG LECT mem1 TERM
          VERT LECT mem2 TERM
!         TURQ LECT mem3 TERM
          GR50 LECT pinbcm TERM
*=====================================================================
SORT VISU NSTO 10
*=====================================================================
PLAY
CAME   1 EYE  -1.72612E+01  2.81122E-03  2.81116E-03
!        Q     7.07107E-01  0.00000E+00 -7.07107E-01  0.00000E+00
         VIEW  1.00000E+00  0.00000E+00  2.05103E-10
         RIGH -2.05103E-10  0.00000E+00  1.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER : -1.62964E+01  2.81122E-03  2.81116E-03
!RSPHERE:  2.41195E-01
!RADIUS :  9.64780E-01
!ASPECT :  1.00000E+00
!NEAR   :  7.23585E-01
!FAR    :  1.44717E+00
SCEN GEOM NAVI FREE
          FACE SBAC
     LIMA ON
SLER CAM1 1 NFRA 1
FREQ 1
TRAC DEFO AMPD 0.0
     OFFS SIZE 600 600 FICH BMP
          OBJE LECT mem1 pinbcm TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
TRAC DEFO AMPD 0.0
     OFFS SIZE 600 600 FICH BMP
          OBJE LECT mem2 pinbcm TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
!TRAC DEFO AMPD 0.0
!     OFFS SIZE 600 600 FICH BMP
!          OBJE LECT mem3 pinbcm TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
ENDPLAY
*=====================================================================
FIN
```

D7710600mapa.dgibi

```
opti echo 0;
*opti donn 'px4cir3d.proc';
*$$$$ PX4CIR3D
*
* Pour generer le maillage 3D (plan) d'un quart de cercle
* avec seulement des quadrilateres a 4 noeuds.
* Le quart de cercle est defini par les deux extremes
* d'un arc (de 90 degrees), par le centre du cercle
* et par un autre point qui definit l'axe de rotation
* (axe perpendiculaire au plan du cercle, passant pour son centre).
*
* Input:
* =====
* P1 = premiere extremite de l'arc
* P2 = deuxieme extremite de l'arc
* PC = centre de l'arc
* PZ = autre point de l'axe
* N  = nombre de mailles a generer sur chaque cote (doit etre pair)
* TOL= tolerance pour l'elimination des noeuds doubles
*
* Output:
* ======
* SUR = objet MAILLAGE d'elements de type QUA4
* IER = 0: pas d'erreur, .NE.0: erreur dans la generation de SUR
*
'DEBPROC' PX4CIR3D P1*'POINT' P2*'POINT' PC*'POINT' PZ*'POINT'
                 N*'ENTIER' TOL*'FLOTTANT';
*-----------------------------------------------------------------
*
ier=0;
n2 = n / 2;
p0 = 0 0 0;
pm1 = p1 plus p0;
depl pm1 tour 45 pc pz;
pm2 = 0.5*(pc plus p2);
pm3 = 0.5*(pc plus p1);
pm = 0.5*(pc plus pm1);
c1a = cerc n2 p1 pc pm1;
c1b = cerc n2 pm1 pc p2;
c2a = droi n2 p2 pm2;
c2b = droi n2 pm2 pc;
c3a = droi n2 pc pm3;
c3b = droi n2 pm3 p1;
```

```
c4a = droi n2 pm pm1;
c4b = droi n2 pm pm2;
c4c = droi n2 pm pm3;
sur1 = dall plan c4c c3b c1a (inve c4a);
sur2 = dall plan c4a c1b c2a (inve c4b);
sur3 = dall plan c2b c3a (inve c4c) c4b;
sur = sur1 et sur2 et sur3;
*
elim tol sur;
*
'FINPROC' sur ier;
************************************************************************
************************************************************************
'DEBPROC' pxextr3d m*'MAILLAGE' x1*'FLOTTANT' x2*'FLOTTANT'
                   y1*'FLOTTANT' y2*'FLOTTANT'
                   z1*'FLOTTANT' z2*'FLOTTANT';
*
*--------------------------------------------------
* Extracts from the 3D mesh m the elements whose nodes are
* located in the box [x1-x2,y1-y2,z1-z2].
*
* Input :
* -----
*     m                       : 3D mesh
*     x1, x2, y1, y2, z1, z2 : extremes of the box
* Output :
* ------
*     box : mesh contained in the box
*--------------------------------------------------
*
x = coor 1 m;
sx = x POIN COMP x1 x2;
y = coor 2 sx;
sy = y POIN COMP y1 y2;
z = coor 3 sy;
sz = z POIN COMP z1 z2;
box = m ELEM APPU STRI sz NOVE;
*
finproc box;
************************************************************************
*
*opti donn 'px4car3d.proc';
*$$$$ PX4CAR3D
*
* This procedure is similar to PX4CIR3D but instead of a fourth
* of a circle it generates a (fourth of a) square, homeomorphic
* to the fourth of a circle that would be generated by PX4CIR3D
* by using the same input parameters (except for PZ which is
* unused in this case).
* In this way the two surfaces (the circle and the square)
* can be connected volumetrically by the VOLU operator:
*    vol = cir VOLU n squ;
*
* Input:
* =====
* P1 = premiere extremite de l'arc (cote du quadrangle, ici)
* P2 = deuxieme extremite de l'arc (cote du quadrangle, ici)
* PC = centre de l'arc (quadrangle, ici)
* N  = nombre de mailles a generer sur chaque cote (doit etre pair)
* TOL= tolerance pour l'elimination des noeuds doubles
*
* Output:
* ======
* SUR = objet MAILLAGE d'elements de type QUA4
* IER = 0: pas d'erreur, .NE.0: erreur dans la generation de SUR
*
'DEBPROC' PX4CAR3D P1*'POINT' P2*'POINT' PC*'POINT'
                   N*'ENTIER' TOL*'FLOTTANT';
*------------------------------------------------------------------
*
ier=0;
n2 = n / 2;
p0 = 0 0 0;
pm1 = p1 plus (p2 moin pc);
pm2 = 0.5*(pc plus p2);
pm3 = 0.5*(pc plus p1);
pm = 0.5*(pc plus pm1);
c1a = droi n2 p1 pm1;
c1b = droi n2 pm1 p2;
c2a = droi n2 p2 pm2;
c2b = droi n2 pm2 pc;
c3a = droi n2 pc pm3;
c3b = droi n2 pm3 p1;
c4a = droi n2 pm pm1;
c4b = droi n2 pm pm2;
c4c = droi n2 pm pm3;
sur1 = dall plan c4c c3b c1a (inve c4a);
sur2 = dall plan c4a c1b c2a (inve c4b);
sur3 = dall plan c2b c3a (inve c4c) c4b;
sur = sur1 et sur2 et sur3;
*
elim tol sur;
*
'FINPROC' sur ier;
************************************************************************
opti echo 1;
*
opti dime 3 elem cub8;
opti sauv form 'D7710600mapa.msh';
opti trac psc ftra 'D7710600mapa_mesh.ps';
*
tol = 1.E-5;
dia = 0.331E0;
rad = 0.5D0*dia;
cot = 0.300E0;
co2 = 0.5D0*cot;
ldr = 0.77E0;
lf1 = 0.07E0;
lf2 = 0.07E0;
ltublp = 16.195;
ltra = 0.60E0;
lp3xd = 3.5E0;
lp3x= lp3xd - ltra;
*lext= ltublp - ltra;
lext = ltublp - lp3xd;
X0 = 0.0 - (ltublp + lf1 + lf2 + ldr);
p0 = X0 0 0;
py = X0 rad 0;
pz = X0 0 rad;
p0b = X0 0 0;
pyb = X0 co2 0;
pzb = X0 0 co2;
px = ldr 0 0;
nr = 16;
h = 0.01E0;
ndr = enti ((ldr+tol) / h);
nf1 = enti ((lf1+tol) / h);
nf2 = enti ((lf2+tol) / h);
ntra = enti ((ltra+tol) / h);
n3x = enti ((lp3x+tol) / h);
fond ier = PX4CIR3D py pz p0 px nr tol;
bout ier = PX4CAR3D pyb pzb p0b nr tol;
bout = bout plus ((ldr + lf1 + lf2 + ltra) 0 0);
driver = fond volu tran ndr (ldr 0 0);
fir1 = (fond plus (ldr 0 0)) volu tran nf1 (lf1 0 0);
fir1 = coul vert (fir1);
fir2 = (fond plus ((ldr + lf1) 0 0)) volu tran nf2 (lf2 0 0);
fir2 = coul bleu (fir2);
tra = (fond plus ((ldr + lf1 + lf2) 0 0)) volu ntra bout;
trac cach qual (tra et fir1 et fir2 et driver);
*
************************************************************************
* Spurious contact surface/tube/trans for membranes
************************************************************************
*
ddr = 0.0025;
rsh = ddr;
pst1 = p0 PLUS (0 0 0);
pst2 = py PLUS (0 rsh 0);
pst3 = pz PLUS (0 0 rsh);
pst4 = px PLUS (0 0 0);
*
fondd ier = PX4CIR3D pst2 pst3 pst1 pst4 (nr) tol;
*
pst5 = p0b PLUS (0 0 0);
pst6 = pyb PLUS (0 rsh 0);
pst7 = pzb PLUS (0 0 rsh);
*
boutd ier = PX4CAR3D pst6 pst7 pst5 (nr) tol;
boutd = boutd plus ((ldr + lf1 + lf2 + ltra) 0 0);
*
tradd = (fondd plus ((ldr + lf1 + lf2) 0 0)) volu (ntra) boutd;
ndum = nf1;
fird1 = (fondd plus ((ldr-0.01) 0 0)) volu tran (ndum+1)
((lf1+0.01) 0 0);
fird2 = (fondd plus ((ldr + lf1) 0 0)) volu tran (nf2) (lf2 0 0);
*
trad = tradd et fird1 et fird2;
elim tol trad;
*
tras = enve trad;
trac cach qual trad;
*trac cach qual tras;
trac cach qual (fondd et boutd);
trac cach qual (fondd et boutd et tras);
*
************************************************************************
* Extract non-outward-directed walls from tras
************************************************************************
*
nout1 = (pxextr3d tras -16.347 -16.343 -0.001 0.175 -0.001 0.175)
        COUL VERT;
nout2 = (pxextr3d tras -15.597 -15.593 -0.001 0.175 -0.001 0.175)
        COUL VERT;
nout3 = (pxextr3d tras -16.347 -15.593 -0.001 0.175 -0.001 0.001)
        COUL VERT;
nout4 = (pxextr3d tras -16.347 -15.593 -0.001 0.001 -0.001 0.175)
        COUL VERT;
nout = nout1 et nout2 et nout3 et nout4;
pinbcm = (tras DIFF nout) COUL ROUG;
npincm = chan poi1 pinbcm;
trac cach qual (nout1 et nout2 et nout3);
trac cach qual nout;
trac cach qual pinbcm;
trac cach qual (fondd et boutd et pinbcm);
trac cach qual (tra et pinbcm);
trac cach qual (tra et npincm);
*
************************************************************************
*
boutx = bout plus ((lp3x) 0 0);
lp3xl = bout volu n3x boutx;
*
flui3d = driver et fir1 et fir2 et tra et lp3xl;
elim tol flui3d;
```

```
trac cach qual flui3d;
trac cach qual (flui3d et pinbcm);
list (nbel flui3d);
list (nbel (flui3d elem cub8));
mem1 = fond plus (ldr 0 0);
mem2 = mem1 plus (lf1 0 0);
*mem3 = mem2 plus (lf2 0 0);
*mems = mem1 et mem2 et mem3;
mems = mem1 et mem2;
pre1 = mem1 coul jaun;
pre2 = mem2 coul jaun;
*pre3 = mem3 coul jaun;
*pre = pre1 et pre2 et pre3;
pre = pre1 et pre2;
*
*face3d = bout PLUS (0 0 0);
face3d = boutx PLUS (0 0 0);
pface3d = chan poi1 face3d;
elim tol (pface3d et flui3d);
p1a = (0 - lext) 0 0;
trac cach qual (p1a et face3d et pinbcm);
rac3d1d = manu supe (p1a et face3d);
list (nbno rac3d1d);
list (nbno face3d);
mesh1 = mems et flui3d et pre et face3d et rac3d1d;
*
p1d1 = (0 - lext) 0 0;
*p1d3 = 0 0 0;
lenlp3d = 0.6;
p1d3 = (0 - lenlp3d) 0 0;
tubelp1 = p1d1 d p1d3 dini h dfin h;
*
trac cach qual (p1a et face3d et pinbcm et tubelp1);
*
tube = tubelp1;
*
trac cach qual (tubelp1 ET p1d1 ET p1d3);
trac cach qual (tubelp1 ET p1d1 ET p1d3 et pinbcm);
*
elim tol (p1a et tubelp1);
*
oubl ltubhp;
oubl ltube;
oubl tol;
oubl p0;
oubl d1;
oubl d2;
oubl p1d1;
*
* we add a fake triangle to host a fake pinball which is never eroded
* (to avoid a bug in the code)
pfake1 = -16.300  0 0;
pfake2 = -16.297  0 0;
pfake3 = -16.2985 0.003 0;
fake = manu tri3 pfake1 pfake2 pfake3;
*
mesh = tube et mesh1 et fake et pinbcm et npincm;
trac cach qual mesh;
tass mesh noop;
sauv form mesh;
list;
*
fin;
```

D7710600mapa.epx

```
D7710600mapa
ECHO
!CONV win
CAST mesh
TRID ALE
EROS 1.0
DIME ADAP NPOI 300000
          CUVF 300000
          NVFI 800000
          Q4GS 10000
          CL3D 10000
          NPIN 10000
     ENDA
     JONC 218 ! Total n. of nodes in a TUBM juncton
     NALE 1 NBLE 1
     TERM
GEOM
     Q4GS  mems pinbcm
     PMAT npincm
     CUVF flui3d
     T3GS fake
     TUVF tubelp1
     CL3D pre face3d
     TUBM rac3d1d
TERM
COMP DIAM DROI 0.1692568 LECT tubelp1 TERM
     RACC TUBM LECT rac3d1d  TERM
          NTUB LECT p1a   TERM DTUB 0.1692568
          FACE LECT face3d TERM COEF 1.0
! Attention: the TUBM element (raclp) is NOT included
! in the "mesh" object (although it IS indeed passed in from Cast3m).
! For this reason we must add it explicitly in the GROU directive below
! if we want to have it in the extracted element groups.
     GROU 17 'nrac3d1d' LECT mesh1 rac3d1d TERM
                  COND XB GT -12.6952 COND XB LT -12.6948
             'fcoup1' LECT flui3d TERM
                  COND XB GT -16.405
                  COND XB LT -15.105
             'S1' LECT tube TERM COND NEAR POIN -0.345 0.15 0.15
             'S2' LECT tube TERM COND NEAR POIN -0.245 0.15 0.15
             'S3' LECT tube TERM COND NEAR POIN 0.0 0.0 0.0
             'S16' LECT flui3d TERM COND NEAR POIN -15.225 0 0.15
             'S15' LECT flui3d TERM COND NEAR POIN -15.125 0 0.15
             'S12' LECT tube TERM COND NEAR POIN -12.495 0 0.15
             'S11' LECT tube TERM COND NEAR POIN -12.395 0 0.15
             'S6' LECT tube TERM COND NEAR POIN -5.685 0 0.15
             'S5' LECT tube TERM COND NEAR POIN -5.585 0 0.15
             'epar1' LECT tubelp1 TERM COND NEAR NODE LECT p1a TERM
             'epar2' LECT tubelp1 TERM COND NEAR NODE LECT p1d3 TERM
             'tubelpp' LECT tubelp1 DIFF epar1 epar2 TERM
!             'tubelpp' LECT tubelp1 DIFF epar1 TERM ! epar2 TERM
             'memc1' LECT mem1 TERM COND NEAR POIN -16.435 0 0
             'memc1d' LECT mem1 TERM COND CYLI X1 -16.505 Y1 0 Z1 0
                                              X2 -16.305 Y2 0 Z2 0 R .15
             'memc1b' LECT mem1 DIFF memc1d TERM
     NGRO 7 'nmemi' LECT mems TERM
                  COND CYLI X1 -20 Y1 0 Z1 0 X2 20 Y2 0 Z2 0 R 0.1650
             'nmemo' LECT mems DIFF nmemi TERM
             'nsymy' LECT mems TERM COND Y LT 0.001
             'nsymz' LECT mems TERM COND Z LT 0.001
             'm1c'   LECT mem1 TERM COND NEAR POIN -16.335 0 0
             'm2c'   LECT mem2 TERM COND NEAR POIN -16.265 0 0
!             'm3c'   LECT mem3 TERM COND NEAR POIN -16.195 0 0
             'pt0' LECT tube TERM COND NEAR POIN -16.19999 0.0 0.0
     EPAI 0.50E-3 LECT mems TERM
          3.00E-3 LECT fake TERM
          1.00E-3 LECT pinbcm TERM
          5.00E-3 LECT npincm TERM ! Only for visualization
     COUL TURQ LECT tube tra lp3xl TERM
          VERT LECT fir2 TERM
          ROSE LECT fir1 TERM
          ROUG LECT driver TERM
          GR50 LECT mems TERM
          ROUG LECT fake TERM
          JAUN LECT pre TERM
          GR50 LECT pinbcm TERM
          ROSE LECT S3 S1 S2 S5 S6 S11 S12 S15 S16 TERM
!       DIAM DROI 0.1692568 LECT tubelp1 TERM
ADAP THRS ECRO 3 TMIN 0.01 TMAX 0.4 MAXL 3
          LECT mems TERM
GRIL LAGR LECT mems fake TERM
FONC 1 TABL 5 0.0       0.0
              5.0E-3    1.0
              6.999E-3  1.0
              7.0E-3    0.0
              100.0E-3  0.0
MATE
    !LOI 1
     VM23 RO 1380 YOUN 2757.9E6 NU 0.495 ELAS 100.E6 ! "Melinex/Mylar/
                                                     !  PET" EPAI=0.5
                                                     !  = Material 2
          FAIL PEPR LIMI 1.0
          TRAC 3 100.E6 0.03626
                 180.E6 1.5
                 230.E6 3.5
          LECT mems _q4gs TERM
    !LOI 2
     GAZP RO 13.445 GAMM 1.4 CV 719.286 PINI 11.36E5 PREF 9.968E4
          LECT none TERM
    !LOI 3
     GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
          LECT none TERM
    !LOI 4
     GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
          LECT none TERM
    !LOI 5
     GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
          LECT flui3d _cuvf TERM
    !LOI 6
  !   IMPE PIMP PRES 13.723E5 PREF 1.011E5 FONC 1
  !   IMPE PIMP PRES 12.98E5 PREF 0 FONC 1
     IMPE PIMP PRES 4.20E5 PREF 0 FONC 1
          LECT pre _cl3d TERM
     GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
          LECT epar1 epar2 TERM
     GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
          LECT rac3d1d tubelpp TERM
     PARO PSIL 0.02
          LECT tubelpp TERM
     MULT 8 9 LECT tubelpp TERM
     GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
          LECT _cuvf TERM
     FANT 0.0
          LECT fake TERM
     VM23 RO 7850 YOUNG 2.1E11 NU 0.3 ELAS 1000E6 ! Elastic steel
          TRAC 2 1000E6 0.0047619048
                 1100E6 5.1
          LECT pinbcm TERM
     MASS 0.0 YOUN 2.1E11 NU 0.33
          LECT npincm TERM
! In order to obtain a printout at least of the 3D VFCCs I am obliged
! to use a different material for tubelp3 and other 3D parts, but with
! the same characteristics as the material used for tubelp1
!OPTI PINS ASN
LINK COUP SPLT NONE
     BLOQ 123 LECT nmemo TERM
     BLOQ 123 LECT pinbcm TERM
```

```
     CONT SPLA NX 0 NY 1 NZ 0 LECT nsymy TERM
     CONT SPLA NX 0 NY 0 NZ 1 LECT nsymz TERM
LINK DECO
     PINB PENA SFAC 1.0
          BODY                               DMIN 0.003  ! #6
               LECT mem1 TERM
          BODY                               DMIN 0.003  ! #7
               LECT mem2 TERM
!          BODY                               DMIN 0.003  ! #8
!               LECT mem3 TERM
          BODY                               MLEV 0      ! #8
               LECT fake TERM
          BODY                               DIAM 5.E-3
               LECT npincm TERM
          EXCL PAIR 1 3
          EXCL PAIR 2 3
!          EXCL PAIR 3 4
          EXCL PAIR 3 4
     FLSW STRU LECT mems TERM
          FLUI LECT fcoup1 TERM
          R 0.025 ! 0.014
          HGRI 0.016
          DGRI
          FACE
          BFLU 2 ! block if at least one node is in influence domain
          FSCP 1 ! couple in all directions
          ADAP LMAX 3 SCAL 2
INIT SKIP UPTO 7.E-3 VFCC
     ADAP IMAT TIME 7.E-3
               2 MATE 2 OBJE LECT flui3d TERM
                        INSI SURF LECT mem1 TERM
                MATE 3 OBJE LECT flui3d TERM
                       OUTS SURF LECT mem1 TERM
                       INSI SURF LECT mem2 TERM
!                 MATE 4 OBJE LECT flui3d TERM
!                        OUTS SURF LECT mem2 TERM
!                        INSI SURF LECT mem3 TERM
ECRI DEPL VITE ECRO FAIL TFRE 0.25E-3
          NOPO !POIN LECT cen TERM
          ELEM LECT S1 TERM
     FICH ALIC TEMP TFRE 10.e-6
    ! FICH ALIT FREQ 0 TFRE 0.D0
         ! TIME PROG 0.D0 PAS 0.5D-3 28.D-3 PAS 0.01D-3 110.D-3
          !POIN LECT cen TERM
          ELEM LECT S1 S2 S3 S5 S6 S11 S12 S15 S16 TERM
!   FICH PVTK FREQ 0 TFRE 0.D0
!        TIME PROG 0.D0 PAS 0.5D-3 28.D-3 PAS 0.1D-3 50.D-3
!        PAS 2.D-3 110.D-3
!        GROU AUTO
!        VARI DEPL VITE FAIL ACCE VCVI CONT ECRO FLIA DTST
    FICH FORM MAPP OBJE LECT flui3d tubelp1 TERM
!                   TIME PROG 38.0E-3 TERM
!                   TIME PROG 31.0E-3 TERM
                    TIME PROG 31.0E-3 TERM !fc is this OK?
    FICH SPLI ALIC FREQ 0 TFRE 1.D-3 ! 0.D0
    !      TIME PROG 0.D0 PAS 0.5D-3 28.D-3 PAS 0.1D-3 50.D-3
    !      PAS 2.D-3 80.D-3
OPTI NOTE CSTA 0.25
     STEP IO
     LOG 1
     JAUM
     LMST
     FANT 8.0E-3 LECT mems TERM !_q4gs TERM !fc is this OK?
     VFCC FCON 6 ! hllc solver
          ORDR 2 ! order in space
          STPS 2 ! order in time
          RECO 1 ! Not accepted by CAL_VFCC_1D
          NTIL
     ADAP RCON !TRIG ECRO 1 TVAL 1.02E5 LECT trigger TERM
     PINS GRID DPIN 1.01
     FLS  CUB8 2 ! For the inverse mapping
     QUAS STAT 1670 0.1 UPTO 7.0E-3 !fc is this OK ???
CALC TINI 0 TEND 40.0E-3
FIN
```

D7710600mapaw.epx

```
D7710600MAPAW
ECHO
 CONV WIN
RESU SPLI ALIC 'D7710600mapa.ali' GARD PSCR
COMP COUL ROUG LECT mem1 TERM
          VERT LECT mem2 TERM
!         TURQ LECT mem3 TERM
          GR50 LECT pinbcm TERM
          TURQ LECT flui3d TERM
*=====================================================================
SORT VISU NSTO 1
*=====================================================================
PLAY
CAME   1 EYE  -1.64954E+01 -9.15031E-01  2.02341E-03
!        Q     6.95266E-01  6.95266E-01 -1.28860E-01 -1.28860E-01
         VIEW  3.58368E-01  9.33580E-01  1.91478E-10
         RIGH  9.33580E-01 -3.58368E-01 -7.35028E-11
         UP    3.05311E-16 -2.05101E-10  1.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: FREE CAMERA
!CENTER : -1.62650E+01  8.28568E-02  2.02341E-03
!RSPHERE:  2.04827E-01
!RADIUS :  1.02414E+00
!ASPECT :  1.33333E+00
!NEAR   :  8.09342E-01
!FAR    :  1.21900E+00
SCEN GEOM NAVI FREE
          FACE SBAC
          LINE SFRE
     ISO  FILL FIEL ECRO 1 SCAL USER PROG 1.E5 PAS 0.5E5 7.5E5 TERM
          SUPP LECT flui3d TERM
     LIMA ON
SLER CAM1 1 NFRA 1
FREQ 1
TRAC OFFS SIZE 800 600 FICH BMP
          OBJE LECT mems pinbcm flui3d TERM SYXY TOLS 1.E-3 NFAI REND
GOTR LOOP 10 OFFS SIZE 800 600 FICH BMP
          OBJE LECT mems pinbcm flui3d TERM SYXY TOLS 1.E-3 NFAI REND
ENDPLAY
*=====================================================================
FIN
```

D7710600mapax.epx

```
D7710600mapax
ECHO
!CONV WIN
RESU SPLI ALIC 'D7710600mapa.ali' GARD PSCR
COMP NGRO 1 'xaxo' LECT flui3d tubelp1 TERM
                   COND LINE X1 -17.105 Y1 0 Z1 0
                             X2 -0.6    Y2 0 Z2 0 TOL 1.E-3
SORT GRAP
AXTE 1.0 'Time [s]'
SCOU 1 'p_31' T 31.E-3 SAXE 1.0 'Abscissa' INIT LECT xaxo TERM
                       ECRO COMP 1
                       SUPP LECT flui3d tubelp1 TERM
SCOU 2 'r_31' T 31.E-3 SAXE 1.0 'Abscissa' INIT LECT xaxo TERM
                       ECRO COMP 2
                       SUPP LECT flui3d tubelp1 TERM
SCOU 3 'v_31' T 31.E-3 SAXE 1.0 'Abscissa' INIT LECT xaxo TERM
                       VCVI COMP 1
                       SUPP LECT flui3d tubelp1 TERM
TRAC 1 AXES 1.0 'PRESS. [Pa]'
TRAC 2 AXES 1.0 'DENS. [kg/m3]'
TRAC 3 AXES 1.0 'VELO. [m/s]'
LIST 1 AXES 1.0 'PRESS. [Pa]'
LIST 2 AXES 1.0 'DENS. [kg/m3]'
LIST 3 AXES 1.0 'VELO. [m/s]'
FIN
```

D7710600mapay.epx

```
D7710600MAPAY
ECHO
 CONV WIN
RESU SPLI ALIC 'D7710600mapa.ali' GARD PSCR
COMP COUL ROUG LECT mem1 TERM
          VERT LECT mem2 TERM
!         TURQ LECT mem3 TERM
          GR50 LECT pinbcm TERM
*=====================================================================
SORT VISU NSTO 9
*=====================================================================
PLAY
CAME   1 EYE  -1.72612E+01  2.81122E-03  2.81116E-03
!        Q     7.07107E-01  0.00000E+00 -7.07107E-01  0.00000E+00
         VIEW  1.00000E+00  0.00000E+00  2.05103E-10
         RIGH -2.05103E-10  0.00000E+00  1.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER : -1.62964E+01  2.81122E-03  2.81116E-03
!RSPHERE:  2.41195E-01
!RADIUS :  9.64780E-01
!ASPECT :  1.00000E+00
!NEAR   :  7.23585E-01
!FAR    :  1.44717E+00
SCEN GEOM NAVI FREE
          FACE SBAC
     LIMA ON
SLER CAM1 1 NFRA 1
FREQ 1
TRAC DEFO AMPD 0.0
     OFFS SIZE 600 600 FICH BMP
          OBJE LECT mem1 pinbcm TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
TRAC DEFO AMPD 0.0
     OFFS SIZE 600 600 FICH BMP
          OBJE LECT mem2 pinbcm TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
!TRAC DEFO AMPD 0.0
!     OFFS SIZE 600 600 FICH BMP
!          OBJE LECT mem3 pinbcm TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
ENDPLAY
*=====================================================================
FIN
```

D7710600mapb.epx

```
D7710600mapb
ECHO
!CONV win
CAST mesh
TRID ALE
```

```
EROS 1.0
DIME ADAP NPOI 300000
          CUVF 300000
          NVFI 800000
          Q4GS 10000
          CL3D 10000
          NPIN 10000
     ENDA
     JONC 218 ! Total n. of nodes in a TUBM juncton
     NALE 1 NBLE 1
     TERM
GEOM
     Q4GS  mems pinbcm
     PMAT npincm
     CUVF flui3d
     T3GS fake
     TUVF tubelp1
     CL3D pre face3d
     TUBM rac3d1d
TERM
COMP DIAM DROI 0.1692568 LECT tubelp1 TERM
     RACC TUBM LECT rac3d1d  TERM
          NTUB LECT p1a   TERM DTUB 0.1692568
          FACE LECT face3d TERM COEF 1.0
! Attention: the TUBM element (raclp) is NOT included
! in the "mesh" object (although it IS indeed passed in from Cast3m).
! For this reason we must add it explicitly in the GROU directive below
! if we want to have it in the extracted element groups.
     GROU 21 'nrac3d1d' LECT mesh1 rac3d1d TERM
                     COND XB GT -12.6952 COND XB LT -12.6948
            'fcoup1' LECT flui3d TERM
                     COND XB GT -16.405
                     COND XB LT -15.105
            'S1' LECT tube TERM COND NEAR POIN -0.345 0.15 0.15
            'S2' LECT tube TERM COND NEAR POIN -0.245 0.15 0.15
            'S3' LECT tube TERM COND NEAR POIN 0.0 0.0 0.0
            'S16' LECT flui3d TERM COND NEAR POIN -15.225 0 0.15
            'S15' LECT flui3d TERM COND NEAR POIN -15.125 0 0.15
            'S12' LECT tube TERM COND NEAR POIN -12.495 0 0.15
            'S11' LECT tube TERM COND NEAR POIN -12.395 0 0.15
            'S6' LECT tube TERM COND NEAR POIN -5.685 0 0.15
            'S5' LECT tube TERM COND NEAR POIN -5.585 0 0.15
            'epar1' LECT tubelp1 TERM COND NEAR NODE LECT p1a TERM
            'epar2' LECT tubelp1 TERM COND NEAR NODE LECT p1d3 TERM
            'tubelpp' LECT tubelp1 DIFF epar1 epar2 TERM
!            'tubelpp' LECT tubelp1 DIFF epar1 TERM ! epar2 TERM
            'memc1' LECT mem1 TERM COND NEAR POIN -16.435 0 0
            'memc1d' LECT mem1 TERM COND CYLI X1 -16.505 Y1 0 Z1 0
                                           X2 -16.305 Y2 0 Z2 0 R .15
            'memc1b' LECT mem1 DIFF memc1d TERM
            'e4' LECT flui3d TERM COND NEAR POIN -16.340 0.1655 0
            'e3' LECT flui3d TERM COND NEAR POIN -16.270 0.1655 0
            'e2' LECT flui3d TERM COND NEAR POIN -16.200 0.1655 0
            'e1' LECT flui3d TERM COND NEAR POIN -16.190 0.1655 0
     NGRO 7 'nmemi' LECT mems TERM
                    COND CYLI X1 -20 Y1 0 Z1 0 X2 20 Y2 0 Z2 0 R 0.1650
            'nmemo' LECT mems DIFF nmemi TERM
            'nsymy' LECT mems TERM COND Y LT 0.001
            'nsymz' LECT mems TERM COND Z LT 0.001
            'm1c'   LECT mem1 TERM COND NEAR POIN -16.335 0 0
            'm2c'   LECT mem2 TERM COND NEAR POIN -16.265 0 0
!            'm3c'   LECT mem3 TERM COND NEAR POIN -16.195 0 0
            'pt0' LECT tube TERM COND NEAR POIN -16.19999 0.0 0.0
     EPAI 0.50E-3 LECT mems TERM
          3.00E-3 LECT fake TERM
          1.00E-3 LECT pinbcm TERM
          5.00E-3 LECT npincm TERM ! Only for visualization
     COUL TURQ LECT tube tra lp3xl TERM
          VERT LECT fir2 TERM
          ROSE LECT fir1 TERM
          ROUG LECT driver TERM
          GR50 LECT mems TERM
          ROUG LECT fake TERM
          JAUN LECT pre TERM
          GR50 LECT pinbcm TERM
          ROSE LECT S3 S1 S2 S5 S6 S11 S12 S15 S16 TERM
!       DIAM DROI 0.1692568 LECT tubelp1 TERM
ADAP THRS ECRO 3 TMIN 0.01 TMAX 0.4 MAXL 3
          LECT mems TERM
GRIL LAGR LECT mems fake TERM
FONC 1 TABL 5 0.0       0.0
              1.0E-3    1.0
              2.999E-3  1.0
              3.0E-3    0.0
              100.0E-3  0.0
MATE
    !LOI 1
     VM23 RO 1380 YOUN 2757.9E6 NU 0.495 ELAS 100.E6 ! "Melinex/Mylar/
                                                     !  PET" EPAI=0.5
                                                     !  = Material 2
          FAIL PEPR LIMI 1.0
          TRAC 3 100.E6 0.03626
                 180.E6 1.5
                 230.E6 3.5
          LECT mems _q4gs TERM
    !LOI 2
     GAZP RO 13.445 GAMM 1.4 CV 719.286 PINI 11.36E5 PREF 9.968E4
          LECT none TERM
    !LOI 3
     GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
          LECT none TERM
    !LOI 4
     GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
          LECT none TERM
    !LOI 5
     GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
          LECT flui3d _cuvf TERM
    !LOI 6
 !   IMPE PIMP PRES 13.723E5 PREF 1.011E5 FONC 1
 !   IMPE PIMP PRES 12.98E5 PREF 0 FONC 1
     IMPE PIMP PRES 4.20E5 PREF 0 FONC 1
          LECT pre _cl3d TERM
     GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
          LECT epar1 epar2 TERM
     GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
          LECT rac3d1d tubelpp TERM
     PARO PSIL 0.02
          LECT tubelpp TERM
     MULT 8 9 LECT tubelpp TERM
     GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
          LECT _cuvf TERM
     FANT 0.0
          LECT fake TERM
     VM23 RO 7850 YOUNG 2.1E11 NU 0.3 ELAS 1000E6 ! Elastic steel
          TRAC 2 1000E6 0.0047619048
                 1100E6 5.1
          LECT pinbcm TERM
     MASS 0.0 YOUN 2.1E11 NU 0.33
          LECT npincm TERM
! In order to obtain a printout at least of the 3D VFCCs I am obliged
! to use a different material for tubelp3 and other 3D parts, but with
! the same characteristics as the material used for tubelp1
!OPTI PINS ASN
LINK COUP SPLT NONE
     BLOQ 123 LECT nmemo TERM
     BLOQ 123 LECT pinbcm TERM
     CONT SPLA NX 0 NY 1 NZ 0 LECT nsymy TERM
     CONT SPLA NX 0 NY 0 NZ 1 LECT nsymz TERM
LINK DECO
     PINB PENA SFAC 1.0
          BODY                                   DMIN 0.003  ! #6
               LECT mem1 TERM
          BODY                                   DMIN 0.003  ! #7
               LECT mem2 TERM
!          BODY                                   DMIN 0.003  ! #8
!               LECT mem3 TERM
          BODY                                   MLEV 0      ! #8
               LECT fake TERM
          BODY                                   DIAM 5.E-3
               LECT npincm TERM
          EXCL PAIR 1 3
          EXCL PAIR 2 3
!          EXCL PAIR 3 4
          EXCL PAIR 3 4
     FLSW STRU LECT mems TERM
          FLUI LECT fcoup1 TERM
          R 0.025 ! 0.014
          HGRI 0.016
          DGRI
          FACE
          BFLU 2 ! block if at least one node is in influence domain
          FSCP 1 ! couple in all directions
          ADAP LMAX 3 SCAL 2
INIT SKIP UPTO 3.E-3 VFCC
     ADAP IMAT TIME 3.E-3
             2 MATE 2 OBJE LECT flui3d TERM
                       INSI SURF LECT mem1 TERM
               MATE 3 OBJE LECT flui3d TERM
                      OUTS SURF LECT mem1 TERM
                      INSI SURF LECT mem2 TERM
!                MATE 4 OBJE LECT flui3d TERM
!                        OUTS SURF LECT mem2 TERM
!                        INSI SURF LECT mem3 TERM
ECRI DEPL VITE ECRO FAIL TFRE 0.25E-3
          NOPO !POIN LECT cen TERM
          ELEM LECT S1 TERM
     FICH ALIC TEMP TFRE 10.e-6
    ! FICH ALIT FREQ 0 TFRE 0.D0
        ! TIME PROG 0.D0 PAS 0.5D-3 28.D-3 PAS 0.01D-3 110.D-3
          !POIN LECT cen TERM
          POIN LECT m1c m2c TERM
          ELEM LECT S1 S2 S3 S5 S6 S11 S12 S15 S16 e1 e2 e3 e4 TERM
!    FICH PVTK FREQ 0 TFRE 0.D0
!         TIME PROG 0.D0 PAS 0.5D-3 28.D-3 PAS 0.1D-3 50.D-3
!         PAS 2.D-3 110.D-3
!         GROU AUTO
!         VARI DEPL VITE FAIL ACCE VCVI CONT ECRO FLIA DTST
     FICH FORM MAPP OBJE LECT flui3d tubelp1 TERM
!                   TIME PROG 38.0E-3 TERM
!                   TIME PROG 31.0E-3 TERM
                    TIME PROG 33.0E-3 TERM !fc is this OK?
     FICH SPLI ALIC FREQ 0 TFRE 1.D-3 ! 0.D0
    !       TIME PROG 0.D0 PAS 0.5D-3 28.D-3 PAS 0.1D-3 50.D-3
    !       PAS 2.D-3 80.D-3
OPTI NOTE CSTA 0.25
     STEP IO
     LOG 1
     JAUM
     LMST
     FANT 8.0E-3 LECT mems TERM !_q4gs TERM !fc is this OK?
     VFCC FCON 6 ! hllc solver
          ORDR 2 ! order in space
          STPS 2 ! order in time
          RECO 1 ! Not accepted by CAL_VFCC_1D
          NTIL
```

```
     ADAP RCON !TRIG ECRO 1 TVAL 1.02E5 LECT trigger TERM
     PINS GRID DPIN 1.01
     FLS  CUB8 2 ! For the inverse mapping
     QUAS STAT 1670 0.1 UPTO 3.0E-3 !fc is this OK ???
CALC TINI 0 TEND 40.0E-3
FIN
```

D7710600mapbw.epx

```
D7710600MAPBW
ECHO
 CONV WIN
RESU SPLI ALIC 'D7710600mapb.ali' GARD PSCR
COMP COUL ROUG LECT mem1 TERM
          VERT LECT mem2 TERM
!         TURQ LECT mem3 TERM
          GR50 LECT pinbcm TERM
          TURQ LECT flui3d TERM
*=======================================================================
SORT VISU NSTO 1
*=======================================================================
PLAY
CAME   1 EYE  -1.64954E+01 -9.15031E-01  2.02341E-03
!         Q     6.95266E-01  6.95266E-01 -1.28860E-01 -1.28860E-01
          VIEW  3.58368E-01  9.33580E-01  1.91478E-10
          RIGH  9.33580E-01 -3.58368E-01 -7.35028E-11
          UP    3.05311E-16 -2.05101E-10  1.00000E+00
          FOV   2.48819E+01
!NAVIGATION MODE: FREE CAMERA
!CENTER : -1.62650E+01  8.28568E-02  2.02341E-03
!RSPHERE:  2.04827E-01
!RADIUS :  1.02414E+00
!ASPECT :  1.33333E+00
!NEAR   :  8.09342E-01
!FAR    :  1.21900E+00
SCEN GEOM NAVI FREE
          FACE SBAC
          LINE SFRE
     ISO  FILL FIEL ECRO 1 SCAL USER PROG 1.E5 PAS 0.5E5 7.5E5 TERM
          SUPP LECT flui3d TERM
     LIMA ON
SLER CAM1 1 NFRA 1
FREQ 1
TRAC OFFS SIZE 800 600 FICH BMP
          OBJE LECT mems pinbcm flui3d TERM SYXY TOLS 1.E-3 NFAI REND
GOTR LOOP 10 OFFS SIZE 800 600 FICH BMP
          OBJE LECT mems pinbcm flui3d TERM SYXY TOLS 1.E-3 NFAI REND
ENDPLAY
*=======================================================================
FIN
```

D7710600mapbx.epx

```
D7710600mapbx
ECHO
!CONV WIN
RESU SPLI ALIC 'D7710600mapb.ali' GARD PSCR
COMP NGRO 1 'xaxo' LECT flui3d tubelp1 TERM
                   COND LINE X1 -17.105 Y1 0 Z1 0
                             X2 -0.6    Y2 0 Z2 0 TOL 1.E-3
SORT GRAP
AXTE 1.0 'Time [s]'
SCOU 1 'p_33' T 33.E-3 SAXE 1.0 'Abscissa' INIT LECT xaxo TERM
                       ECRO COMP 1
                       SUPP LECT flui3d tubelp1 TERM
SCOU 2 'r_33' T 33.E-3 SAXE 1.0 'Abscissa' INIT LECT xaxo TERM
                       ECRO COMP 2
                       SUPP LECT flui3d tubelp1 TERM
SCOU 3 'v_33' T 33.E-3 SAXE 1.0 'Abscissa' INIT LECT xaxo TERM
                       VCVI COMP 1
                       SUPP LECT flui3d tubelp1 TERM
RCOU 11 'p_31' FICH 'D7710600mapax.pun' RENA 'p_a_31'
RCOU 12 'r_31' FICH 'D7710600mapax.pun' RENA 'r_a_31'
RCOU 13 'v_31' FICH 'D7710600mapax.pun' RENA 'v_a_31'
TRAC 1 11 AXES 1.0 'PRESS. [Pa]'
COLO NOIR ROUG
TRAC 2 12 AXES 1.0 'DENS. [kg/m3]'
COLO NOIR ROUG
TRAC 3 13 AXES 1.0 'VELO. [m/s]'
COLO NOIR ROUG
LIST 1 AXES 1.0 'PRESS. [Pa]'
LIST 2 AXES 1.0 'DENS. [kg/m3]'
LIST 3 AXES 1.0 'VELO. [m/s]'
SCOU 21 'p_31' T 31.E-3 SAXE 1.0 'Abscissa' INIT LECT xaxo TERM
                       ECRO COMP 1
                       SUPP LECT flui3d tubelp1 TERM
SCOU 22 'r_31' T 31.E-3 SAXE 1.0 'Abscissa' INIT LECT xaxo TERM
                       ECRO COMP 2
                       SUPP LECT flui3d tubelp1 TERM
SCOU 23 'v_31' T 31.E-3 SAXE 1.0 'Abscissa' INIT LECT xaxo TERM
                       VCVI COMP 1
                       SUPP LECT flui3d tubelp1 TERM
TRAC 21 11 AXES 1.0 'PRESS. [Pa]'
COLO NOIR ROUG
TRAC 22 12 AXES 1.0 'DENS. [kg/m3]'
COLO NOIR ROUG
TRAC 23 13 AXES 1.0 'VELO. [m/s]'
COLO NOIR ROUG
FIN
```

D7710600mapby.epx

```
D7710600MAPBY
ECHO
 CONV WIN
RESU SPLI ALIC 'D7710600mapb.ali' GARD PSCR
COMP COUL ROUG LECT mem1 TERM
          VERT LECT mem2 TERM
!         TURQ LECT mem3 TERM
          GR50 LECT pinbcm TERM
*=======================================================================
SORT VISU NSTO 9
*=======================================================================
PLAY
CAME   1 EYE  -1.72612E+01  2.81122E-03  2.81116E-03
!         Q     7.07107E-01  0.00000E+00 -7.07107E-01  0.00000E+00
          VIEW  1.00000E+00  0.00000E+00  2.05103E-10
          RIGH -2.05103E-10  0.00000E+00  1.00000E+00
          UP    0.00000E+00  1.00000E+00  0.00000E+00
          FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER : -1.62964E+01  2.81122E-03  2.81116E-03
!RSPHERE:  2.41195E-01
!RADIUS :  9.64780E-01
!ASPECT :  1.00000E+00
!NEAR   :  7.23585E-01
!FAR    :  1.44717E+00
SCEN GEOM NAVI FREE
          FACE SBAC
     LIMA ON
SLER CAM1 1 NFRA 1
FREQ 1
TRAC DEFO AMPD 0.0
     OFFS SIZE 600 600 FICH BMP
          OBJE LECT mem1 pinbcm TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
TRAC DEFO AMPD 0.0
     OFFS SIZE 600 600 FICH BMP
          OBJE LECT mem2 pinbcm TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
!TRAC DEFO AMPD 0.0
!     OFFS SIZE 600 600 FICH BMP
!          OBJE LECT mem3 pinbcm TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
ENDPLAY
*=======================================================================
FIN
```

D7710600mapc.epx

```
D7710600MAPC
ECHO
!CONV win
CAST mesh
TRID ALE
EROS 1.0
DIME ADAP NPOI 300000
          CUVF 300000
          NVFI 800000
          Q4GS 10000
          CL3D 10000
          NPIN 10000
     ENDA
     JONC 218 ! Total n. of nodes in a TUBM juncton
     NALE 1 NBLE 1
     TERM
GEOM
     Q4GS  mems pinbcm
     PMAT npincm
     CUVF flui3d
     T3GS fake
     TUVF tubelp1
     CL3D pre face3d
     TUBM rac3d1d
TERM
COMP DIAM DROI 0.1692568 LECT tubelp1 TERM
     RACC TUBM LECT rac3d1d  TERM
          NTUB LECT p1a   TERM DTUB 0.1692568
          FACE LECT face3d TERM COEF 1.0
! Attention: the TUBM element (raclp) is NOT included
! in the "mesh" object (although it IS indeed passed in from Cast3m).
! For this reason we must add it explicitly in the GROU directive below
! if we want to have it in the extracted element groups.
     GROU 21 'nrac3d1d' LECT mesh1 rac3d1d TERM
                 COND XB GT -12.6952 COND XB LT -12.6948
           'fcoup1' LECT flui3d TERM
                 COND XB GT -16.405
                 COND XB LT -15.105
           'S1' LECT tube TERM COND NEAR POIN -0.345 0.15 0.15
           'S2' LECT tube TERM COND NEAR POIN -0.245 0.15 0.15
           'S3' LECT tube TERM COND NEAR POIN 0.0 0.0 0.0
           'S16' LECT flui3d TERM COND NEAR POIN -15.225 0 0.15
           'S15' LECT flui3d TERM COND NEAR POIN -15.125 0 0.15
           'S12' LECT tube TERM COND NEAR POIN -12.495 0 0.15
           'S11' LECT tube TERM COND NEAR POIN -12.395 0 0.15
           'S6' LECT tube TERM COND NEAR POIN -5.685 0 0.15
           'S5' LECT tube TERM COND NEAR POIN -5.585 0 0.15
           'epar1' LECT tubelp1 TERM COND NEAR NODE LECT p1a TERM
           'epar2' LECT tubelp1 TERM COND NEAR NODE LECT p1d3 TERM
           'tubelpp' LECT tubelp1 DIFF epar1 epar2 TERM
!           'tubelpp' LECT tubelp1 DIFF epar1 TERM ! epar2 TERM
           'memc1' LECT mem1 TERM COND NEAR POIN -16.435 0 0
```

```
           'memc1d' LECT mem1 TERM COND CYLI X1 -16.505 Y1 0 Z1 0
                                             X2 -16.305 Y2 0 Z2 0 R .15
           'memc1b' LECT mem1 DIFF memc1d TERM
           'e4' LECT flui3d TERM COND NEAR POIN -16.340 0.1655 0
           'e3' LECT flui3d TERM COND NEAR POIN -16.270 0.1655 0
           'e2' LECT flui3d TERM COND NEAR POIN -16.200 0.1655 0
           'e1' LECT flui3d TERM COND NEAR POIN -16.190 0.1655 0
     NGRO 7 'nmemi' LECT mems TERM
                   COND CYLI X1 -20 Y1 0 Z1 0 X2 20 Y2 0 Z2 0 R 0.1650
           'nmemo' LECT mems DIFF nmemi TERM
           'nsymy' LECT mems TERM COND Y LT 0.001
           'nsymz' LECT mems TERM COND Z LT 0.001
           'm1c'   LECT mem1 TERM COND NEAR POIN -16.335 0 0
           'm2c'   LECT mem2 TERM COND NEAR POIN -16.265 0 0
!           'm3c'   LECT mem3 TERM COND NEAR POIN -16.195 0 0
           'pt0' LECT tube TERM COND NEAR POIN -16.19999 0.0 0.0
     EPAI 0.50E-3 LECT mems TERM
          3.00E-3 LECT fake TERM
          1.00E-3 LECT pinbcm TERM
          5.00E-3 LECT npincm TERM ! Only for visualization
     COUL TURQ LECT tube tra lp3xl TERM
          VERT LECT fir2 TERM
          ROSE LECT fir1 TERM
          ROUG LECT driver TERM
          GR50 LECT mems TERM
          ROUG LECT fake TERM
          JAUN LECT pre TERM
          GR50 LECT pinbcm TERM
          ROSE LECT S3 S1 S2 S5 S6 S11 S12 S15 S16 TERM
!       DIAM DROI 0.1692568 LECT tubelp1 TERM
ADAP THRS ECRO 3 TMIN 0.01 TMAX 0.4 MAXL 3
          LECT mems TERM
GRIL LAGR LECT mems fake TERM
FONC 1 TABL 5 0.0       0.0
              1.0E-3    1.0
              2.999E-3  1.0
              3.0E-3    0.0
              100.0E-3  0.0
MATE
    !LOI 1
     VM23 RO 1380 YOUN 2757.9E6 NU 0.495 ELAS 100.E6 ! "Melinex/Mylar/
                                                     !  PET" EPAI=0.5
                                                     !  = Material 2
          FAIL PEPR LIMI 1.0
          TRAC 3 100.E6 0.03626
                 180.E6 1.5
                 230.E6 3.5
          LECT mems _q4gs TERM
    !LOI 2
     GAZP RO 13.445 GAMM 1.4 CV 719.286 PINI 11.36E5 PREF 9.968E4
          LECT none TERM
    !LOI 3
     GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
          LECT none TERM
    !LOI 4
     GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
          LECT none TERM
    !LOI 5
     GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
          LECT flui3d _cuvf TERM
    !LOI 6
  !   IMPE PIMP PRES 13.723E5 PREF 1.011E5 FONC 1
  !   IMPE PIMP PRES 12.98E5 PREF 0 FONC 1
     IMPE PIMP PRES 4.20E5 PREF 0 FONC 1
          LECT pre _cl3d TERM
     GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
          LECT epar1 epar2 TERM
     GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
          LECT rac3d1d tubelpp TERM
     PARO PSIL 0.02
          LECT tubelpp TERM
     MULT 8 9 LECT tubelpp TERM
     GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
          LECT _cuvf TERM
     FANT 0.0
          LECT fake TERM
     VM23 RO 7850 YOUNG 2.1E11 NU 0.3 ELAS 1000E6 ! Elastic steel
          TRAC 2 1000E6 0.0047619048
                  1100E6 5.1
          LECT pinbcm TERM
     MASS 0.0 YOUN 2.1E11 NU 0.33
          LECT npincm TERM
! In order to obtain a printout at least of the 3D VFCCs I am obliged
! to use a different material for tubelp3 and other 3D parts, but with
! the same characteristics as the material used for tubelp1
!OPTI PINS ASN
LINK COUP SPLT NONE
     BLOQ 123 LECT nmemo TERM
     BLOQ 123 LECT pinbcm TERM
     CONT SPLA NX 0 NY 1 NZ 0 LECT nsymy TERM
     CONT SPLA NX 0 NY 0 NZ 1 LECT nsymz TERM
LINK DECO
     PINB PENA SFAC 1.0
          BODY                               DMIN 0.003  ! #6
               LECT mem1 TERM
          BODY                               DMIN 0.003  ! #7
               LECT mem2 TERM
!          BODY                               DMIN 0.003  ! #8
!               LECT mem3 TERM
          BODY                               MLEV 0      ! #8
               LECT fake TERM
          BODY                               DIAM 5.E-3
               LECT npincm TERM
          EXCL PAIR 1 3
          EXCL PAIR 2 3
!          EXCL PAIR 3 4
          EXCL PAIR 3 4
     FLSW STRU LECT mems TERM
          FLUI LECT fcoup1 TERM
          R 0.025 ! 0.014
          HGRI 0.016
          DGRI
          FACE
          BFLU 2 ! block if at least one node is in influence domain
          FSCP 1 ! couple in all directions
          ADAP LMAX 3 SCAL 2
INIT SKIP UPTO 3.E-3 VFCC
     ADAP IMAT TIME 3.E-3
          2 MATE 2 OBJE LECT flui3d TERM
                        INSI SURF LECT mem1 TERM
            MATE 3 OBJE LECT flui3d TERM
                        OUTS SURF LECT mem1 TERM
                        INSI SURF LECT mem2 TERM
!              MATE 4 OBJE LECT flui3d TERM
!                        OUTS SURF LECT mem2 TERM
!                        INSI SURF LECT mem3 TERM
ECRI DEPL VITE ECRO FAIL TFRE 0.25E-3
          NOPO !POIN LECT cen TERM
          ELEM LECT S1 TERM
     FICH ALIC TEMP TFRE 10.e-6
    ! FICH ALIT FREQ 0 TFRE 0.D0
         ! TIME PROG 0.D0 PAS 0.5D-3 28.D-3 PAS 0.01D-3 110.D-3
          !POIN LECT cen TERM
          POIN LECT m1c m2c TERM
          ELEM LECT S1 S2 S3 S5 S6 S11 S12 S15 S16 e1 e2 e3 e4 TERM
!   FICH PVTK FREQ 0 TFRE 0.D0
!        TIME PROG 0.D0 PAS 0.5D-3 28.D-3 PAS 0.1D-3 50.D-3
!        PAS 2.D-3 110.D-3
!        GROU AUTO
!        VARI DEPL VITE FAIL ACCE VCVI CONT ECRO FLIA DTST
   FICH FORM MAPP OBJE LECT flui3d tubelp1 TERM
!                  TIME PROG 38.0E-3 TERM
!                  TIME PROG 31.0E-3 TERM
                   TIME PROG 31.0E-3 PAS 0.5E-3 33.0E-3 TERM
   FICH SPLI ALIC FREQ 0 TFRE 1.D-3 ! 0.D0
    !      TIME PROG 0.D0 PAS 0.5D-3 28.D-3 PAS 0.1D-3 50.D-3
    !      PAS 2.D-3 80.D-3
OPTI NOTE CSTA 0.25
     STEP IO
     LOG 1
     JAUM
     LMST
     FANT 8.0E-3 LECT mems TERM !_q4gs TERM !fc is this OK?
     VFCC FCON 6 ! hllc solver
          ORDR 2 ! order in space
          STPS 2 ! order in time
          RECO 1 ! Not accepted by CAL_VFCC_1D
          NTIL
     ADAP RCON !TRIG ECRO 1 TVAL 1.02E5 LECT trigger TERM
     PINS GRID DPIN 1.01
     FLS  CUB8 2 ! For the inverse mapping
     QUAS STAT 1670 0.1 UPTO 3.0E-3 !fc is this OK ???
CALC TINI 0 TEND 40.0E-3
FIN
```

D7710600mapcw.epx

```
D7710600MAPCW
ECHO
 CONV WIN
RESU SPLI ALIC 'D7710600mapb.ali' GARD PSCR
COMP COUL ROUG LECT mem1 TERM
          VERT LECT mem2 TERM
!         TURQ LECT mem3 TERM
          GR50 LECT pinbcm TERM
          TURQ LECT flui3d TERM
*=====================================================================
SORT VISU NSTO 1
*=====================================================================
PLAY
CAME   1 EYE  -1.64954E+01 -9.15031E-01  2.02341E-03
!        Q     6.95266E-01  6.95266E-01 -1.28860E-01 -1.28860E-01
         VIEW  3.58368E-01  9.33580E-01  1.91478E-10
         RIGH  9.33580E-01 -3.58368E-01 -7.35028E-11
         UP    3.05311E-16 -2.05101E-10  1.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: FREE CAMERA
!CENTER : -1.62650E+01  8.28568E-02  2.02341E-03
!RSPHERE:  2.04827E-01
!RADIUS :  1.02414E+00
!ASPECT :  1.33333E+00
!NEAR   :  8.09342E-01
!FAR    :  1.21900E+00
SCEN GEOM NAVI FREE
          FACE SBAC
          LINE SFRE
     ISO  FILL FIEL ECRO 1 SCAL USER PROG 1.E5 PAS 0.5E5 7.5E5 TERM
          SUPP LECT flui3d TERM
     LIMA ON
SLER CAM1 1 NFRA 1
FREQ 1
TRAC OFFS SIZE 800 600 FICH BMP
          OBJE LECT mems pinbcm flui3d TERM SYXY TOLS 1.E-3 NFAI REND
```

```
GOTR LOOP 10 OFFS SIZE 800 600 FICH BMP
        OBJE LECT mems pinbcm flui3d TERM SYXY TOLS 1.E-3 NFAI REND
ENDPLAY
*=======================================================================
FIN
```

D7710600mapcx.epx

```
D7710600MAPCX
ECHO
!CONV WIN
RESU SPLI ALIC 'D7710600MAPC.ali' GARD PSCR
COMP NGRO 1 'xaxo' LECT flui3d tubelp1 TERM
               COND LINE X1 -17.105 Y1 0 Z1 0
                       X2 -0.6    Y2 0 Z2 0 TOL 1.E-3
SORT GRAP
AXTE 1.0 'Time [s]'
SCOU 11 'p_31' T 31.E-3 SAXE 1.0 'Abscissa' INIT LECT xaxo TERM
                      ECRO COMP 1
                      SUPP LECT flui3d tubelp1 TERM
SCOU 12 'r_31' T 31.E-3 SAXE 1.0 'Abscissa' INIT LECT xaxo TERM
                      ECRO COMP 2
                      SUPP LECT flui3d tubelp1 TERM
SCOU 13 'v_31' T 31.E-3 SAXE 1.0 'Abscissa' INIT LECT xaxo TERM
                      VCVI COMP 1
                      SUPP LECT flui3d tubelp1 TERM
SCOU 21 'p_32' T 32.E-3 SAXE 1.0 'Abscissa' INIT LECT xaxo TERM
                      ECRO COMP 1
                      SUPP LECT flui3d tubelp1 TERM
SCOU 22 'r_32' T 32.E-3 SAXE 1.0 'Abscissa' INIT LECT xaxo TERM
                      ECRO COMP 2
                      SUPP LECT flui3d tubelp1 TERM
SCOU 23 'v_32' T 32.E-3 SAXE 1.0 'Abscissa' INIT LECT xaxo TERM
                      VCVI COMP 1
                      SUPP LECT flui3d tubelp1 TERM
SCOU 31 'p_33' T 33.E-3 SAXE 1.0 'Abscissa' INIT LECT xaxo TERM
                      ECRO COMP 1
                      SUPP LECT flui3d tubelp1 TERM
SCOU 32 'r_33' T 33.E-3 SAXE 1.0 'Abscissa' INIT LECT xaxo TERM
                      ECRO COMP 2
                      SUPP LECT flui3d tubelp1 TERM
SCOU 33 'v_33' T 33.E-3 SAXE 1.0 'Abscissa' INIT LECT xaxo TERM
                      VCVI COMP 1
                      SUPP LECT flui3d tubelp1 TERM
TRAC 11 21 31 AXES 1.0 'PRESS. [Pa]'
COLO NOIR ROUG VERT
TRAC 12 22 32 AXES 1.0 'DENS. [kg/m3]'
COLO NOIR ROUG VERT
TRAC 13 23 33 AXES 1.0 'VELO. [m/s]'
COLO NOIR ROUG VERT
LIST 11 21 31 AXES 1.0 'PRESS. [Pa]'
LIST 12 22 32 AXES 1.0 'DENS. [kg/m3]'
LIST 13 23 33 AXES 1.0 'VELO. [m/s]'
FIN
```

D7710600mapcy.epx

```
D7710600MAPCY
ECHO
 CONV WIN
RESU SPLI ALIC 'D7710600MAPC.ali' GARD PSCR
COMP COUL ROUG LECT mem1 TERM
        VERT LECT mem2 TERM
!       TURQ LECT mem3 TERM
        GR50 LECT pinbcm TERM
*=======================================================================
SORT VISU NSTO 9
*=======================================================================
PLAY
CAME   1 EYE  -1.72612E+01  2.81122E-03  2.81116E-03
!        Q     7.07107E-01  0.00000E+00 -7.07107E-01  0.00000E+00
         VIEW  1.00000E+00  0.00000E+00  2.05103E-10
         RIGH -2.05103E-10  0.00000E+00  1.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER : -1.62964E+01  2.81122E-03  2.81116E-03
!RSPHERE:  2.41195E-01
!RADIUS :  9.64780E-01
!ASPECT :  1.00000E+00
!NEAR   :  7.23585E-01
!FAR    :  1.44717E+00
SCEN GEOM NAVI FREE
        FACE SBAC
     LIMA ON
SLER CAM1 1 NFRA 1
FREQ 1
TRAC DEFO AMPD 0.0
     OFFS SIZE 600 600 FICH BMP
        OBJE LECT mem1 pinbcm TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
TRAC DEFO AMPD 0.0
     OFFS SIZE 600 600 FICH BMP
        OBJE LECT mem2 pinbcm TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
!TRAC DEFO AMPD 0.0
!     OFFS SIZE 600 600 FICH BMP
!         OBJE LECT mem3 pinbcm TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
ENDPLAY
*=======================================================================
FIN
```

D7710600mapd.epx

```
D7710600mapd
ECHO
!CONV win
CAST mesh
TRID ALE
EROS 1.0
DIME ADAP NPOI 300000
          CUVF 300000
          NVFI 800000
          Q4GS 10000
          CL3D 10000
          NPIN 10000
     ENDA
     JONC 218 ! Total n. of nodes in a TUBM juncton
     NALE 1 NBLE 1
     TERM
GEOM
     Q4GS  mems pinbcm
     PMAT npincm
     CUVF flui3d
     T3GS fake
     TUVF tubelp1
     CL3D pre face3d
     TUBM rac3d1d
TERM
COMP DIAM DROI 0.1692568 LECT tubelp1 TERM
     RACC TUBM LECT rac3d1d  TERM
          NTUB LECT p1a   TERM DTUB 0.1692568
          FACE LECT face3d TERM COEF 1.0
! Attention: the TUBM element (raclp) is NOT included
! in the "mesh" object (although it IS indeed passed in from Cast3m).
! For this reason we must add it explicitly in the GROU directive below
! if we want to have it in the extracted element groups.
     GROU 22 'nrac3d1d' LECT mesh1 rac3d1d TERM
                  COND XB GT -12.6952 COND XB LT -12.6948
            'fcoup1' LECT flui3d TERM
                  COND XB GT -16.405
                  COND XB LT -15.105
            'S1' LECT tube TERM COND NEAR POIN -0.345 0.15 0.15
            'S2' LECT tube TERM COND NEAR POIN -0.245 0.15 0.15
            'S3' LECT tube TERM COND NEAR POIN 0.0 0.0 0.0
            'S16' LECT flui3d TERM COND NEAR POIN -15.225 0 0.15
            'S15' LECT flui3d TERM COND NEAR POIN -15.125 0 0.15
            'S12' LECT tube TERM COND NEAR POIN -12.495 0 0.15
            'S11' LECT tube TERM COND NEAR POIN -12.395 0 0.15
            'S6' LECT tube TERM COND NEAR POIN -5.685 0 0.15
            'S5' LECT tube TERM COND NEAR POIN -5.585 0 0.15
            'epar1' LECT tubelp1 TERM COND NEAR NODE LECT p1a TERM
            'epar2' LECT tubelp1 TERM COND NEAR NODE LECT p1d3 TERM
            'tubelpp' LECT tubelp1 DIFF epar1 epar2 TERM
!            'tubelpp' LECT tubelp1 DIFF epar1 TERM ! epar2 TERM
            'memc1' LECT mem1 TERM COND NEAR POIN -16.435 0 0
            'memc1d' LECT mem1 TERM COND CYLI X1 -16.505 Y1 0 Z1 0
                                       X2 -16.305 Y2 0 Z2 0 R .15
            'memc1b' LECT mem1 DIFF memc1d TERM
            'e4' LECT flui3d TERM COND NEAR POIN -16.340 0.1655 0
            'e3' LECT flui3d TERM COND NEAR POIN -16.270 0.1655 0
            'e2' LECT flui3d TERM COND NEAR POIN -16.200 0.1655 0
            'e1' LECT flui3d TERM COND NEAR POIN -16.190 0.1655 0
            'trigger' LECT tube TERM COND NEAR POIN -0.70 0 0
     NGRO 7 'nmemi' LECT mems TERM
                COND CYLI X1 -20 Y1 0 Z1 0 X2 20 Y2 0 Z2 0 R 0.1650
            'nmemo' LECT mems DIFF nmemi TERM
            'nsymy' LECT mems TERM COND Y LT 0.001
            'nsymz' LECT mems TERM COND Z LT 0.001
            'm1c'   LECT mem1 TERM COND NEAR POIN -16.335 0 0
            'm2c'   LECT mem2 TERM COND NEAR POIN -16.265 0 0
!            'm3c'   LECT mem3 TERM COND NEAR POIN -16.195 0 0
            'pt0' LECT tube TERM COND NEAR POIN -16.19999 0.0 0.0
     EPAI 0.50E-3 LECT mems TERM
          3.00E-3 LECT fake TERM
          1.00E-3 LECT pinbcm TERM
          5.00E-3 LECT npincm TERM ! Only for visualization
     COUL TURQ LECT tube tra lp3xl TERM
          VERT LECT fir2 TERM
          ROSE LECT fir1 TERM
          ROUG LECT driver TERM
          GR50 LECT mems TERM
          ROUG LECT fake TERM
          JAUN LECT pre TERM
          GR50 LECT pinbcm TERM
          ROSE LECT S3 S1 S2 S5 S6 S11 S12 S15 S16 TERM
!       DIAM DROI 0.1692568 LECT tubelp1 TERM
ADAP THRS ECRO 3 TMIN 0.01 TMAX 0.4 MAXL 3
          LECT mems TERM
GRIL LAGR LECT mems fake TERM
FONC 1 TABL 5 0.0       0.0
              1.0E-3    1.0
              2.999E-3  1.0
              3.0E-3    0.0
              100.0E-3  0.0
MATE
    !LOI 1
     VM23 RO 1380 YOUN 2757.9E6 NU 0.495 ELAS 100.E6 ! "Melinex/Mylar/
                                                     !  PET" EPAI=0.5
                                                     !  = Material 2
          FAIL PEPR LIMI 1.0
          TRAC 3 100.E6 0.03626
                 180.E6 1.5
```

```
            230.E6 3.5
        LECT mems _q4gs TERM
    !LOI 2
     GAZP RO 13.445 GAMM 1.4 CV 719.286 PINI 11.36E5 PREF 9.968E4
        LECT none TERM
    !LOI 3
     GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
        LECT none TERM
    !LOI 4
     GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
        LECT none TERM
    !LOI 5
     GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
        LECT flui3d _cuvf TERM
    !LOI 6
  !   IMPE PIMP PRES 13.723E5 PREF 1.011E5 FONC 1
  !   IMPE PIMP PRES 12.98E5 PREF 0 FONC 1
     IMPE PIMP PRES 4.20E5 PREF 0 FONC 1
        LECT pre _cl3d TERM
     GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
        LECT epar1 epar2 TERM
     GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
        LECT rac3d1d tubelpp TERM
     PARO PSIL 0.02
        LECT tubelpp TERM
     MULT 8 9 LECT tubelpp TERM
     GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
        LECT _cuvf TERM
     FANT 0.0
        LECT fake TERM
     VM23 RO 7850 YOUNG 2.1E11 NU 0.3 ELAS 1000E6 ! Elastic steel
        TRAC 2 1000E6 0.0047619048
            1100E6 5.1
        LECT pinbcm TERM
     MASS 0.0 YOUN 2.1E11 NU 0.33
        LECT npincm TERM
! In order to obtain a printout at least of the 3D VFCCs I am obliged
! to use a different material for tubelp3 and other 3D parts, but with
! the same characteristics as the material used for tubelp1
!OPTI PINS ASN
LINK COUP SPLT NONE
     BLOQ 123 LECT nmemo TERM
     BLOQ 123 LECT pinbcm TERM
     CONT SPLA NX 0 NY 1 NZ 0 LECT nsymy TERM
     CONT SPLA NX 0 NY 0 NZ 1 LECT nsymz TERM
LINK DECO
     PINB PENA SFAC 1.0
        BODY                              DMIN 0.003  ! #6
            LECT mem1 TERM
        BODY                              DMIN 0.003  ! #7
            LECT mem2 TERM
!        BODY                              DMIN 0.003  ! #8
!            LECT mem3 TERM
        BODY                              MLEV 0      ! #8
            LECT fake TERM
        BODY                              DIAM 5.E-3
            LECT npincm TERM
        EXCL PAIR 1 3
        EXCL PAIR 2 3
!        EXCL PAIR 3 4
        EXCL PAIR 3 4
     FLSW STRU LECT mems TERM
        FLUI LECT fcoup1 TERM
        R 0.025 ! 0.014
        HGRI 0.016
        DGRI
        FACE
        BFLU 2 ! block if at least one node is in influence domain
        FSCP 1 ! couple in all directions
        ADAP LMAX 3 SCAL 2
INIT SKIP UPTO 3.E-3 VFCC
     ADAP IMAT TIME 3.E-3
            2 MATE 2 OBJE LECT flui3d TERM
                    INSI SURF LECT mem1 TERM
             MATE 3 OBJE LECT flui3d TERM
                   OUTS SURF LECT mem1 TERM
                   INSI SURF LECT mem2 TERM
!              MATE 4 OBJE LECT flui3d TERM
!                    OUTS SURF LECT mem2 TERM
!                    INSI SURF LECT mem3 TERM
ECRI DEPL VITE ECRO FAIL TFRE 0.25E-3
        NOPO !POIN LECT cen TERM
        ELEM LECT S1 TERM
     FICH ALIC TEMP TFRE 10.e-6
    ! FICH ALIT FREQ 0 TFRE 0.D0
        ! TIME PROG 0.D0 PAS 0.5D-3 28.D-3 PAS 0.01D-3 110.D-3
        !POIN LECT cen TERM
        POIN LECT m1c m2c TERM
        ELEM LECT S1 S2 S3 S5 S6 S11 S12 S15 S16 e1 e2 e3 e4 TERM
    FICH SPLI ALIC FREQ 0 TFRE 1.D-3 ! 0.D0
    !     TIME PROG 0.D0 PAS 0.5D-3 28.D-3 PAS 0.1D-3 50.D-3
    !     PAS 2.D-3 80.D-3
!   FICH PVTK FREQ 0 TFRE 0.D0
!       TIME PROG 0.D0 PAS 0.5D-3 28.D-3 PAS 0.1D-3 50.D-3
!       PAS 2.D-3 110.D-3
!       GROU AUTO
!       VARI DEPL VITE FAIL ACCE VCVI CONT ECRO FLIA DTST
    FICH FORM MAPP OBJE LECT flui3d tubelp1 TERM
!                 TIME PROG 38.0E-3 TERM
!                 TIME PROG 31.0E-3 TERM
!                 TIME PROG 31.0E-3 PAS 0.5E-3 33.0E-3 TERM
                  TRIG ECRO 1 TSTO TVAL 1.02E5 LECT trigger TERM
OPTI NOTE CSTA 0.25
     STEP IO
     LOG 1
     JAUM
     LMST
     FANT 8.0E-3 LECT mems TERM !_q4gs TERM !fc is this OK?
     VFCC FCON 6 ! hllc solver
          ORDR 2 ! order in space
          STPS 2 ! order in time
          RECO 1 ! Not accepted by CAL_VFCC_1D
          NTIL
     ADAP RCON !TRIG ECRO 1 TVAL 1.02E5 LECT trigger TERM
     PINS GRID DPIN 1.01
     FLS  CUB8 2 ! For the inverse mapping
     QUAS STAT 1670 0.1 UPTO 3.0E-3 !fc is this OK ???
CALC TINI 0 TEND 40.0E-3
FIN
```

D7710600mapdw.epx

```
D7710600MAPDW
ECHO
 CONV WIN
RESU SPLI ALIC 'D7710600mapd.ali' GARD PSCR
COMP COUL ROUG LECT mem1 TERM
          VERT LECT mem2 TERM
!         TURQ LECT mem3 TERM
          GR50 LECT pinbcm TERM
          TURQ LECT flui3d TERM
*=====================================================================
SORT VISU NSTO 1
*=====================================================================
PLAY
CAME   1 EYE  -1.64954E+01 -9.15031E-01  2.02341E-03
!        Q     6.95266E-01  6.95266E-01 -1.28860E-01 -1.28860E-01
         VIEW  3.58368E-01  9.33580E-01  1.91478E-10
         RIGH  9.33580E-01 -3.58368E-01 -7.35028E-11
         UP    3.05311E-16 -2.05101E-10  1.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: FREE CAMERA
!CENTER : -1.62650E+01  8.28568E-02  2.02341E-03
!RSPHERE:  2.04827E-01
!RADIUS :  1.02414E+00
!ASPECT :  1.33333E+00
!NEAR   :  8.09342E-01
!FAR    :  1.21900E+00
SCEN GEOM NAVI FREE
          FACE SBAC
          LINE SFRE
     ISO  FILL FIEL ECRO 1 SCAL USER PROG 1.E5 PAS 0.5E5 7.5E5 TERM
          SUPP LECT flui3d TERM
     LIMA ON
SLER CAM1 1 NFRA 1
FREQ 1
TRAC OFFS SIZE 800 600 FICH BMP
          OBJE LECT mems pinbcm flui3d TERM SYXY TOLS 1.E-3 NFAI REND
GOTR LOOP 10 OFFS SIZE 800 600 FICH BMP
          OBJE LECT mems pinbcm flui3d TERM SYXY TOLS 1.E-3 NFAI REND
ENDPLAY
*=====================================================================
FIN
```

D7710600mapdx.epx

```
D7710600MAPDX
ECHO
!CONV WIN
RESU SPLI ALIC 'D7710600MAPD.ali' GARD PSCR
COMP NGRO 1 'xaxo' LECT flui3d tubelp1 TERM
                COND LINE X1 -17.105 Y1 0 Z1 0
                          X2 -0.6    Y2 0 Z2 0 TOL 1.E-3
SORT GRAP
AXTE 1.0 'Time [s]'
SCOU 1 'p_trig' NSTO 34 SAXE 1.0 'Abscissa' INIT LECT xaxo TERM
                     ECRO COMP 1
                     SUPP LECT flui3d tubelp1 TERM
SCOU 2 'r_trig' NSTO 34 SAXE 1.0 'Abscissa' INIT LECT xaxo TERM
                     ECRO COMP 2
                     SUPP LECT flui3d tubelp1 TERM
SCOU 3 'v_trig' NSTO 34 SAXE 1.0 'Abscissa' INIT LECT xaxo TERM
                     VCVI COMP 1
                     SUPP LECT flui3d tubelp1 TERM
TRAC 1 AXES 1.0 'PRESS. [Pa]'
TRAC 2 AXES 1.0 'DENS. [kg/m3]'
TRAC 3 AXES 1.0 'VELO. [m/s]'
LIST 1 AXES 1.0 'PRESS. [Pa]'
LIST 2 AXES 1.0 'DENS. [kg/m3]'
LIST 3 AXES 1.0 'VELO. [m/s]'
FIN
```

D7710600mapdy.epx

```
D7710600MAPDY
ECHO
 CONV WIN
RESU SPLI ALIC 'D7710600mapd.ali' GARD PSCR
COMP COUL ROUG LECT mem1 TERM
          VERT LECT mem2 TERM
!         TURQ LECT mem3 TERM
          GR50 LECT pinbcm TERM
```

```
*======================================================================
SORT VISU NSTO 9
*======================================================================
PLAY
CAME   1 EYE  -1.72612E+01  2.81122E-03  2.81116E-03
!        Q     7.07107E-01  0.00000E+00 -7.07107E-01  0.00000E+00
         VIEW  1.00000E+00  0.00000E+00  2.05103E-10
         RIGH -2.05103E-10  0.00000E+00  1.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER : -1.62964E+01  2.81122E-03  2.81116E-03
!RSPHERE:  2.41195E-01
!RADIUS :  9.64780E-01
!ASPECT :  1.00000E+00
!NEAR   :  7.23585E-01
!FAR    :  1.44717E+00
SCEN GEOM NAVI FREE
         FACE SBAC
     LIMA ON
SLER CAM1 1 NFRA 1
FREQ 1
TRAC DEFO AMPD 0.0
     OFFS SIZE 600 600 FICH BMP
         OBJE LECT mem1 pinbcm TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
TRAC DEFO AMPD 0.0
     OFFS SIZE 600 600 FICH BMP
         OBJE LECT mem2 pinbcm TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
!TRAC DEFO AMPD 0.0
!     OFFS SIZE 600 600 FICH BMP
!          OBJE LECT mem3 pinbcm TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
ENDPLAY
*======================================================================
FIN
```

D7710600mape.epx

```
D7710600MAPE
ECHO
!CONV win
CAST mesh
TRID ALE
EROS 1.0
DIME ADAP NPOI 300000
          CUVF 300000
          NVFI 800000
          Q4GS 10000
          CL3D 10000
          NPIN 10000
     ENDA
     JONC 218 ! Total n. of nodes in a TUBM juncton
     NALE 1 NBLE 1
     TERM
GEOM
     Q4GS  mems pinbcm
     PMAT npincm
     CUVF flui3d
     T3GS fake
     TUVF tubelp1
     CL3D pre face3d
     TUBM rac3d1d
TERM
COMP DIAM DROI 0.1692568 LECT tubelp1 TERM
     RACC TUBM LECT rac3d1d  TERM
          NTUB LECT p1a   TERM DTUB 0.1692568
          FACE LECT face3d TERM COEF 1.0
! Attention: the TUBM element (raclp) is NOT included
! in the "mesh" object (although it IS indeed passed in from Cast3m).
! For this reason we must add it explicitly in the GROU directive below
! if we want to have it in the extracted element groups.
     GROU 22 'nrac3d1d' LECT mesh1 rac3d1d TERM
                    COND XB GT -12.6952 COND XB LT -12.6948
            'fcoup1' LECT flui3d TERM
                    COND XB GT -16.405
                    COND XB LT -15.105
            'S1' LECT tube TERM COND NEAR POIN -0.345 0.15 0.15
            'S2' LECT tube TERM COND NEAR POIN -0.245 0.15 0.15
            'S3' LECT tube TERM COND NEAR POIN 0.0 0.0 0.0
            'S16' LECT flui3d TERM COND NEAR POIN -15.225 0 0.15
            'S15' LECT flui3d TERM COND NEAR POIN -15.125 0 0.15
            'S12' LECT tube TERM COND NEAR POIN -12.495 0 0.15
            'S11' LECT tube TERM COND NEAR POIN -12.395 0 0.15
            'S6' LECT tube TERM COND NEAR POIN -5.685 0 0.15
            'S5' LECT tube TERM COND NEAR POIN -5.585 0 0.15
            'epar1' LECT tubelp1 TERM COND NEAR NODE LECT p1a TERM
            'epar2' LECT tubelp1 TERM COND NEAR NODE LECT p1d3 TERM
            'tubelpp' LECT tubelp1 DIFF epar1 epar2 TERM
!            'tubelpp' LECT tubelp1 DIFF epar1 TERM ! epar2 TERM
            'memc1' LECT mem1 TERM COND NEAR POIN -16.435 0 0
            'memc1d' LECT mem1 TERM COND CYLI X1 -16.505 Y1 0 Z1 0
                                        X2 -16.305 Y2 0 Z2 0 R .15
            'memc1b' LECT mem1 DIFF memc1d TERM
            'e4' LECT flui3d TERM COND NEAR POIN -16.340 0.1655 0
            'e3' LECT flui3d TERM COND NEAR POIN -16.270 0.1655 0
            'e2' LECT flui3d TERM COND NEAR POIN -16.200 0.1655 0
            'e1' LECT flui3d TERM COND NEAR POIN -16.190 0.1655 0
            'trigger' LECT tube TERM COND NEAR POIN -0.70 0 0
     NGRO 7 'nmemi' LECT mems TERM
                   COND CYLI X1 -20 Y1 0 Z1 0 X2 20 Y2 0 Z2 0 R 0.1650
            'nmemo' LECT mems DIFF nmemi TERM
            'nsymy' LECT mems TERM COND Y LT 0.001
            'nsymz' LECT mems TERM COND Z LT 0.001
            'm1c'   LECT mem1 TERM COND NEAR POIN -16.335 0 0
            'm2c'   LECT mem2 TERM COND NEAR POIN -16.265 0 0
!            'm3c'   LECT mem3 TERM COND NEAR POIN -16.195 0 0
            'pt0' LECT tube TERM COND NEAR POIN -16.19999 0.0 0.0
     EPAI 0.50E-3 LECT mems TERM
          3.00E-3 LECT fake TERM
          1.00E-3 LECT pinbcm TERM
          5.00E-3 LECT npincm TERM ! Only for visualization
     COUL TURQ LECT tube tra lp3xl TERM
          VERT LECT fir2 TERM
          ROSE LECT fir1 TERM
          ROUG LECT driver TERM
          GR50 LECT mems TERM
          ROUG LECT fake TERM
          JAUN LECT pre TERM
          GR50 LECT pinbcm TERM
          ROSE LECT S3 S1 S2 S5 S6 S11 S12 S15 S16 TERM
!       DIAM DROI 0.1692568 LECT tubelp1 TERM
ADAP THRS ECRO 3 TMIN 0.01 TMAX 0.4 MAXL 3
          LECT mems TERM
GRIL LAGR LECT mems fake TERM
FONC 1 TABL 5 0.0       0.0
              1.0E-3    1.0
              2.999E-3  1.0
              3.0E-3    0.0
              100.0E-3  0.0
MATE
    !LOI 1
     VM23 RO 1380 YOUN 2757.9E6 NU 0.495 ELAS 100.E6 ! "Melinex/Mylar/
                                                     !  PET" EPAI=0.5
                                                     !  = Material 2
          FAIL PEPR LIMI 1.0
          TRAC 3 100.E6 0.03626
                 180.E6 1.5
                 230.E6 3.5
          LECT mems _q4gs TERM
    !LOI 2
     GAZP RO 13.445 GAMM 1.4 CV 719.286 PINI 11.36E5 PREF 9.968E4
          LECT none TERM
    !LOI 3
     GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
          LECT none TERM
    !LOI 4
     GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
          LECT none TERM
    !LOI 5
     GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
          LECT flui3d _cuvf TERM
    !LOI 6
  !   IMPE PIMP PRES 13.723E5 PREF 1.011E5 FONC 1
  !   IMPE PIMP PRES 12.98E5 PREF 0 FONC 1
     IMPE PIMP PRES 4.20E5 PREF 0 FONC 1
          LECT pre _cl3d TERM
     GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
          LECT epar1 epar2 TERM
     GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
          LECT rac3d1d tubelpp TERM
     PARO PSIL 0.02
          LECT tubelpp TERM
     MULT 8 9 LECT tubelpp TERM
     GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
          LECT _cuvf TERM
     FANT 0.0
          LECT fake TERM
     VM23 RO 7850 YOUNG 2.1E11 NU 0.3 ELAS 1000E6 ! Elastic steel
          TRAC 2 1000E6 0.0047619048
                 1100E6 5.1
          LECT pinbcm TERM
     MASS 0.0 YOUN 2.1E11 NU 0.33
          LECT npincm TERM
! In order to obtain a printout at least of the 3D VFCCs I am obliged
! to use a different material for tubelp3 and other 3D parts, but with
! the same characteristics as the material used for tubelp1
!OPTI PINS ASN
LINK COUP SPLT NONE
     BLOQ 123 LECT nmemo TERM
     BLOQ 123 LECT pinbcm TERM
     CONT SPLA NX 0 NY 1 NZ 0 LECT nsymy TERM
     CONT SPLA NX 0 NY 0 NZ 1 LECT nsymz TERM
LINK DECO
     PINB PENA SFAC 1.0
          BODY                               DMIN 0.003  ! #6
               LECT mem1 TERM
          BODY                               DMIN 0.003  ! #7
               LECT mem2 TERM
!          BODY                               DMIN 0.003  ! #8
!               LECT mem3 TERM
          BODY                               MLEV 0      ! #8
               LECT fake TERM
          BODY                               DIAM 5.E-3
               LECT npincm TERM
          EXCL PAIR 1 3
          EXCL PAIR 2 3
!          EXCL PAIR 3 4
          EXCL PAIR 3 4
     FLSW STRU LECT mems TERM
          FLUI LECT fcoup1 TERM
          R 0.025 ! 0.014
          HGRI 0.016
          DGRI
          FACE
          BFLU 2 ! block if at least one node is in influence domain
```

```
         FSCP 1 ! couple in all directions
         ADAP LMAX 3 SCAL 2
INIT SKIP UPTO 3.E-3 VFCC
     ADAP IMAT TIME 3.E-3
              2 MATE 2 OBJE LECT flui3d TERM
                     INSI SURF LECT mem1 TERM
               MATE 3 OBJE LECT flui3d TERM
                    OUTS SURF LECT mem1 TERM
                    INSI SURF LECT mem2 TERM
!                MATE 4 OBJE LECT flui3d TERM
!                     OUTS SURF LECT mem2 TERM
!                     INSI SURF LECT mem3 TERM
ECRI DEPL VITE ECRO FAIL TFRE 0.25E-3
         NOPO !POIN LECT cen TERM
         ELEM LECT S1 TERM
     FICH ALIC TEMP TFRE 10.e-6
    ! FICH ALIT FREQ 0 TFRE 0.D0
        ! TIME PROG 0.D0 PAS 0.5D-3 28.D-3 PAS 0.01D-3 110.D-3
         !POIN LECT cen TERM
         POIN LECT m1c m2c TERM
         ELEM LECT S1 S2 S3 S5 S6 S11 S12 S15 S16 e1 e2 e3 e4 TERM
    FICH SPLI ALIC FREQ 0 TFRE 1.D-3 ! 0.D0
    !      TIME PROG 0.D0 PAS 0.5D-3 28.D-3 PAS 0.1D-3 50.D-3
    !      PAS 2.D-3 80.D-3
!   FICH PVTK FREQ 0 TFRE 0.D0
!       TIME PROG 0.D0 PAS 0.5D-3 28.D-3 PAS 0.1D-3 50.D-3
!       PAS 2.D-3 110.D-3
!       GROU AUTO
!       VARI DEPL VITE FAIL ACCE VCVI CONT ECRO FLIA DTST
    FICH FORM MAPP OBJE LECT flui3d tubelp1 TERM
!                   TIME PROG 38.0E-3 TERM
!                   TIME PROG 31.0E-3 TERM
!                   TIME PROG 31.0E-3 PAS 0.5E-3 33.0E-3 TERM
                    TRIG ECRO 1 TSTO TVAL 1.02E5 LECT trigger TERM
OPTI NOTE CSTA 0.25
     STEP IO
     LOG 1
     JAUM
     LMST
   ! FANT 8.0E-3 LECT mems TERM !_q4gs TERM !fc is this OK?
     VFCC FCON 6 ! hllc solver
          ORDR 2 ! order in space
          STPS 2 ! order in time
          RECO 1 ! Not accepted by CAL_VFCC_1D
          NTIL
     ADAP RCON !TRIG ECRO 1 TVAL 1.02E5 LECT trigger TERM
     PINS GRID DPIN 1.01
     FLS  CUB8 2 ! For the inverse mapping
     QUAS STAT 1670 0.1 UPTO 3.0E-3 !fc is this OK ???
CALC TINI 0 TEND 40.0E-3
FIN
```

D7710600mapew.epx

```
D7710600MAPEW
ECHO
 CONV WIN
RESU SPLI ALIC 'D7710600MAPE.ali' GARD PSCR
COMP COUL ROUG LECT mem1 TERM
          VERT LECT mem2 TERM
!         TURQ LECT mem3 TERM
          GR50 LECT pinbcm TERM
          TURQ LECT flui3d TERM
*=====================================================================
SORT VISU NSTO 1
*=====================================================================
PLAY
CAME   1 EYE  -1.64954E+01 -9.15031E-01  2.02341E-03
!        Q     6.95266E-01  6.95266E-01 -1.28860E-01 -1.28860E-01
         VIEW  3.58368E-01  9.33580E-01  1.91478E-10
         RIGH  9.33580E-01 -3.58368E-01 -7.35028E-11
         UP    3.05311E-16 -2.05101E-10  1.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: FREE CAMERA
!CENTER : -1.62650E+01  8.28568E-02  2.02341E-03
!RSPHERE:  2.04827E-01
!RADIUS :  1.02414E+00
!ASPECT :  1.33333E+00
!NEAR   :  8.09342E-01
!FAR    :  1.21900E+00
SCEN GEOM NAVI FREE
          FACE SBAC
          LINE SFRE
     ISO  FILL FIEL ECRO 1 SCAL USER PROG 1.E5 PAS 0.5E5 7.5E5 TERM
          SUPP LECT flui3d TERM
     LIMA ON
SLER CAM1 1 NFRA 1
FREQ 1
TRAC OFFS SIZE 800 600 FICH BMP
          OBJE LECT mems pinbcm flui3d TERM SYXY TOLS 1.E-3 NFAI REND
GOTR LOOP 33 OFFS SIZE 800 600 FICH BMP
          OBJE LECT mems pinbcm flui3d TERM SYXY TOLS 1.E-3 NFAI REND
ENDPLAY
*=====================================================================
FIN
```

D7710600mapex.epx

```
D7710600MAPEX
ECHO
!CONV WIN
RESU SPLI ALIC 'D7710600MAPE.ali' GARD PSCR
COMP NGRO 1 'xaxo' LECT flui3d tubelp1 TERM
                   COND LINE X1 -17.105 Y1 0 Z1 0
                             X2 -0.6    Y2 0 Z2 0 TOL 1.E-3
SORT GRAP
AXTE 1.0 'Time [s]'
SCOU 1 'p_trig' NSTO 34 SAXE 1.0 'Abscissa' INIT LECT xaxo TERM
                       ECRO COMP 1
                       SUPP LECT flui3d tubelp1 TERM
SCOU 2 'r_trig' NSTO 34 SAXE 1.0 'Abscissa' INIT LECT xaxo TERM
                       ECRO COMP 2
                       SUPP LECT flui3d tubelp1 TERM
SCOU 3 'v_trig' NSTO 34 SAXE 1.0 'Abscissa' INIT LECT xaxo TERM
                       VCVI COMP 1
                       SUPP LECT flui3d tubelp1 TERM
!
RCOU 11 'p_trig' FICH 'D7710600MAPDX.pun' RENA 'p_d_trig'
RCOU 12 'r_trig' FICH 'D7710600MAPDX.pun' RENA 'r_d_trig'
RCOU 13 'v_trig' FICH 'D7710600MAPDX.pun' RENA 'v_d_trig'
TRAC 1 11 AXES 1.0 'PRESS. [Pa]'
COLO NOIR ROUG
TRAC 2 12 AXES 1.0 'DENS. [kg/m3]'
COLO NOIR ROUG
TRAC 3 13 AXES 1.0 'VELO. [m/s]'
COLO NOIR ROUG
!
TRAC 1 AXES 1.0 'PRESS. [Pa]'
TRAC 2 AXES 1.0 'DENS. [kg/m3]'
TRAC 3 AXES 1.0 'VELO. [m/s]'
LIST 1 AXES 1.0 'PRESS. [Pa]'
LIST 2 AXES 1.0 'DENS. [kg/m3]'
LIST 3 AXES 1.0 'VELO. [m/s]'
!
FIN
```

D7710600mapey.epx

```
D7710600MAPEY
ECHO
 CONV WIN
RESU SPLI ALIC 'D7710600MAPE.ali' GARD PSCR
COMP COUL ROUG LECT mem1 TERM
          VERT LECT mem2 TERM
!         TURQ LECT mem3 TERM
          GR50 LECT pinbcm TERM
*=====================================================================
SORT VISU NSTO 9
*=====================================================================
PLAY
CAME   1 EYE  -1.72612E+01  2.81122E-03  2.81116E-03
!        Q     7.07107E-01  0.00000E+00 -7.07107E-01  0.00000E+00
         VIEW  1.00000E+00  0.00000E+00  2.05103E-10
         RIGH -2.05103E-10  0.00000E+00  1.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER : -1.62964E+01  2.81122E-03  2.81116E-03
!RSPHERE:  2.41195E-01
!RADIUS :  9.64780E-01
!ASPECT :  1.00000E+00
!NEAR   :  7.23585E-01
!FAR    :  1.44717E+00
SCEN GEOM NAVI FREE
          FACE SBAC
     LIMA ON
SLER CAM1 1 NFRA 1
TRAC DEFO AMPD 0.0
     OFFS SIZE 600 600 FICH BMP
          OBJE LECT mem1 pinbcm TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
TRAC DEFO AMPD 0.0
     OFFS SIZE 600 600 FICH BMP
          OBJE LECT mem2 pinbcm TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
FREQ 25
GO
TRAC DEFO AMPD 0.0
     OFFS SIZE 600 600 FICH BMP
          OBJE LECT mem1 pinbcm TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
TRAC DEFO AMPD 0.0
     OFFS SIZE 600 600 FICH BMP
          OBJE LECT mem2 pinbcm TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
ENDPLAY
*=====================================================================
FIN
```

D7710600mapey2.epx

```
D7710600MAPEY2
ECHO
 CONV WIN
RESU SPLI ALIC 'D7710600MAPE.ali' GARD PSCR
COMP COUL ROUG LECT mem1 TERM
          VERT LECT mem2 TERM
!         TURQ LECT mem3 TERM
          GR50 LECT pinbcm TERM
*=====================================================================
SORT VISU NSTO 9
*=====================================================================
PLAY
```

```
CAME   1 EYE  -1.72612E+01  2.81122E-03  2.81116E-03
!        Q     7.07107E-01  0.00000E+00 -7.07107E-01  0.00000E+00
         VIEW  1.00000E+00  0.00000E+00  2.05103E-10
         RIGH -2.05103E-10  0.00000E+00  1.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER : -1.62964E+01  2.81122E-03  2.81116E-03
!RSPHERE:  2.41195E-01
!RADIUS :  9.64780E-01
!ASPECT :  1.00000E+00
!NEAR   :  7.23585E-01
!FAR    :  1.44717E+00
SCEN GEOM NAVI FREE
         FACE SBAC
     LIMA ON
SLER CAM1 1 NFRA 1
TRAC DEFO AMPD 0.0
     OFFS SIZE 600 600 FICH BMP
         OBJE LECT mem1 pinbcm TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
TRAC DEFO AMPD 0.0
     OFFS SIZE 600 600 FICH BMP
         OBJE LECT mem2 pinbcm TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
ENDPLAY
*=======================================================================
FIN
```

D7710600mapey3.epx

```
D7710600MAPEY3
ECHO
 CONV WIN
RESU SPLI ALIC 'D7710600MAPE.ali' GARD PSCR
COMP COUL ROUG LECT mem1 TERM
          VERT LECT mem2 TERM
!         TURQ LECT mem3 TERM
          GR50 LECT pinbcm TERM
*=======================================================================
SORT VISU NSTO 15
*=======================================================================
PLAY
CAME   1 EYE  -1.72612E+01  2.81122E-03  2.81116E-03
!        Q     7.07107E-01  0.00000E+00 -7.07107E-01  0.00000E+00
         VIEW  1.00000E+00  0.00000E+00  2.05103E-10
         RIGH -2.05103E-10  0.00000E+00  1.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER : -1.62964E+01  2.81122E-03  2.81116E-03
!RSPHERE:  2.41195E-01
!RADIUS :  9.64780E-01
!ASPECT :  1.00000E+00
!NEAR   :  7.23585E-01
!FAR    :  1.44717E+00
SCEN GEOM NAVI FREE
          FACE SBAC
     LIMA ON
SLER CAM1 1 NFRA 1
TRAC DEFO AMPD 0.0
     OFFS SIZE 600 600 FICH BMP
          OBJE LECT mem1 pinbcm TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
TRAC DEFO AMPD 0.0
     OFFS SIZE 600 600 FICH BMP
          OBJE LECT mem2 pinbcm TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
ENDPLAY
*=======================================================================
FIN
```

D7710600mapf.epx

```
D7710600MAPF
ECHO
!CONV win
CAST mesh
TRID ALE
EROS 1.0
DIME ADAP NPOI 300000
          CUVF 300000
          NVFI 800000
          Q4GS 10000
          CL3D 10000
          NPIN 10000
     ENDA
     JONC 218 ! Total n. of nodes in a TUBM juncton
     NALE 1 NBLE 1
     TERM
GEOM
     Q4GS  mems pinbcm
     PMAT npincm
     CUVF flui3d
     T3GS fake
     TUVF tubelp1
     CL3D pre face3d
     TUBM rac3d1d
TERM
COMP DIAM DROI 0.1692568 LECT tubelp1 TERM
     RACC TUBM LECT rac3d1d  TERM
          NTUB LECT p1a   TERM DTUB 0.1692568
          FACE LECT face3d TERM COEF 1.0
! Attention: the TUBM element (raclp) is NOT included
! in the "mesh" object (although it IS indeed passed in from Cast3m).
! For this reason we must add it explicitly in the GROU directive below
! if we want to have it in the extracted element groups.
     GROU 22 'nrac3d1d' LECT mesh1 rac3d1d TERM
                  COND XB GT -12.6952 COND XB LT -12.6948
            'fcoup1' LECT flui3d TERM
                  COND XB GT -16.405
                  COND XB LT -15.105
            'S1' LECT tube TERM COND NEAR POIN -0.345 0.15 0.15
            'S2' LECT tube TERM COND NEAR POIN -0.245 0.15 0.15
            'S3' LECT tube TERM COND NEAR POIN 0.0 0.0 0.0
            'S16' LECT flui3d TERM COND NEAR POIN -15.225 0 0.15
            'S15' LECT flui3d TERM COND NEAR POIN -15.125 0 0.15
            'S12' LECT tube TERM COND NEAR POIN -12.495 0 0.15
            'S11' LECT tube TERM COND NEAR POIN -12.395 0 0.15
            'S6' LECT tube TERM COND NEAR POIN -5.685 0 0.15
            'S5' LECT tube TERM COND NEAR POIN -5.585 0 0.15
            'epar1' LECT tubelp1 TERM COND NEAR NODE LECT p1a TERM
            'epar2' LECT tubelp1 TERM COND NEAR NODE LECT p1d3 TERM
            'tubelpp' LECT tubelp1 DIFF epar1 epar2 TERM
!            'tubelpp' LECT tubelp1 DIFF epar1 TERM ! epar2 TERM
            'memc1' LECT mem1 TERM COND NEAR POIN -16.435 0 0
            'memc1d' LECT mem1 TERM COND CYLI X1 -16.505 Y1 0 Z1 0
                                           X2 -16.305 Y2 0 Z2 0 R .15
            'memc1b' LECT mem1 DIFF memc1d TERM
            'e4' LECT flui3d TERM COND NEAR POIN -16.340 0.1655 0
            'e3' LECT flui3d TERM COND NEAR POIN -16.270 0.1655 0
            'e2' LECT flui3d TERM COND NEAR POIN -16.200 0.1655 0
            'e1' LECT flui3d TERM COND NEAR POIN -16.190 0.1655 0
            'trigger' LECT tube TERM COND NEAR POIN -0.70 0 0
     NGRO 7 'nmemi' LECT mems TERM
                  COND CYLI X1 -20 Y1 0 Z1 0 X2 20 Y2 0 Z2 0 R 0.1650
            'nmemo' LECT mems DIFF nmemi TERM
            'nsymy' LECT mems TERM COND Y LT 0.001
            'nsymz' LECT mems TERM COND Z LT 0.001
            'm1c'   LECT mem1 TERM COND NEAR POIN -16.335 0 0
            'm2c'   LECT mem2 TERM COND NEAR POIN -16.265 0 0
!            'm3c'   LECT mem3 TERM COND NEAR POIN -16.195 0 0
            'pt0' LECT tube TERM COND NEAR POIN -16.19999 0.0 0.0
     EPAI 0.50E-3 LECT mems TERM
          3.00E-3 LECT fake TERM
          1.00E-3 LECT pinbcm TERM
          5.00E-3 LECT npincm TERM ! Only for visualization
     DERO DISP 1.230 LECT mem1 TERM
          DISP 1.160 LECT mem2 TERM
     COUL TURQ LECT tube tra lp3xl TERM
          VERT LECT fir2 TERM
          ROSE LECT fir1 TERM
          ROUG LECT driver TERM
          GR50 LECT mems TERM
          ROUG LECT fake TERM
          JAUN LECT pre TERM
          GR50 LECT pinbcm TERM
          ROSE LECT S3 S1 S2 S5 S6 S11 S12 S15 S16 TERM
!       DIAM DROI 0.1692568 LECT tubelp1 TERM
ADAP THRS ECRO 3 TMIN 0.01 TMAX 0.4 MAXL 3
          LECT mems TERM
GRIL LAGR LECT mems fake TERM
FONC 1 TABL 5 0.0       0.0
              1.0E-3    1.0
              2.999E-3  1.0
              3.0E-3    0.0
              100.0E-3  0.0
MATE
    !LOI 1
     VM23 RO 1380 YOUN 2757.9E6 NU 0.495 ELAS 100.E6 ! "Melinex/Mylar/
                                                     !  PET" EPAI=0.5
                                                     !  = Material 2
          FAIL PEPR LIMI 1.0
          TRAC 3 100.E6 0.03626
                 180.E6 1.5
                 230.E6 3.5
          LECT mems _q4gs TERM
    !LOI 2
     GAZP RO 13.445 GAMM 1.4 CV 719.286 PINI 11.36E5 PREF 9.968E4
          LECT none TERM
    !LOI 3
     GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
          LECT none TERM
    !LOI 4
     GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
          LECT none TERM
    !LOI 5
     GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
          LECT flui3d _cuvf TERM
    !LOI 6
   !   IMPE PIMP PRES 13.723E5 PREF 1.011E5 FONC 1
   !   IMPE PIMP PRES 12.98E5 PREF 0 FONC 1
     IMPE PIMP PRES 4.20E5 PREF 0 FONC 1
          LECT pre _cl3d TERM
     GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
          LECT epar1 epar2 TERM
     GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
          LECT rac3d1d tubelpp TERM
     PARO PSIL 0.02
          LECT tubelpp TERM
     MULT 8 9 LECT tubelpp TERM
     GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
          LECT _cuvf TERM
     FANT 0.0
          LECT fake TERM
```

```
     VM23 RO 7850 YOUNG 2.1E11 NU 0.3 ELAS 1000E6 ! Elastic steel
          TRAC 2 1000E6 0.0047619048
                 1100E6 5.1
          LECT pinbcm TERM
     MASS 0.0 YOUN 2.1E11 NU 0.33
          LECT npincm TERM
! In order to obtain a printout at least of the 3D VFCCs I am obliged
! to use a different material for tubelp3 and other 3D parts, but with
! the same characteristics as the material used for tubelp1
!OPTI PINS ASN
LINK COUP SPLT NONE
     BLOQ 123 LECT nmemo TERM
     BLOQ 123 LECT pinbcm TERM
     CONT SPLA NX 0 NY 1 NZ 0 LECT nsymy TERM
     CONT SPLA NX 0 NY 0 NZ 1 LECT nsymz TERM
LINK DECO
     PINB PENA SFAC 1.0
          BODY                               DMIN 0.003  ! #6
               LECT mem1 TERM
          BODY                               DMIN 0.003  ! #7
               LECT mem2 TERM
!          BODY                               DMIN 0.003  ! #8
!               LECT mem3 TERM
          BODY                               MLEV 0      ! #8
               LECT fake TERM
          BODY                               DIAM 5.E-3
               LECT npincm TERM
          EXCL PAIR 1 3
          EXCL PAIR 2 3
!          EXCL PAIR 3 4
          EXCL PAIR 3 4
     FLSW STRU LECT mems TERM
          FLUI LECT fcoup1 TERM
          R 0.025 ! 0.014
          HGRI 0.016
          DGRI
          FACE
          BFLU 2 ! block if at least one node is in influence domain
          FSCP 1 ! couple in all directions
          ADAP LMAX 3 SCAL 2
INIT SKIP UPTO 3.E-3 VFCC
     ADAP IMAT TIME 3.E-3
               2 MATE 2 OBJE LECT flui3d TERM
                        INSI SURF LECT mem1 TERM
                MATE 3 OBJE LECT flui3d TERM
                       OUTS SURF LECT mem1 TERM
                       INSI SURF LECT mem2 TERM
!                 MATE 4 OBJE LECT flui3d TERM
!                         OUTS SURF LECT mem2 TERM
!                         INSI SURF LECT mem3 TERM
ECRI DEPL VITE ECRO FAIL TFRE 0.25E-3
          NOPO !POIN LECT cen TERM
          ELEM LECT S1 TERM
     FICH ALIC TEMP TFRE 10.e-6
    ! FICH ALIT FREQ 0 TFRE 0.D0
         ! TIME PROG 0.D0 PAS 0.5D-3 28.D-3 PAS 0.01D-3 110.D-3
          !POIN LECT cen TERM
          POIN LECT m1c m2c TERM
          ELEM LECT S1 S2 S3 S5 S6 S11 S12 S15 S16 e1 e2 e3 e4 TERM
    FICH SPLI ALIC FREQ 0 TFRE 1.D-3 ! 0.D0
    !      TIME PROG 0.D0 PAS 0.5D-3 28.D-3 PAS 0.1D-3 50.D-3
    !      PAS 2.D-3 80.D-3
!   FICH PVTK FREQ 0 TFRE 0.D0
!        TIME PROG 0.D0 PAS 0.5D-3 28.D-3 PAS 0.1D-3 50.D-3
!        PAS 2.D-3 110.D-3
!        GROU AUTO
!        VARI DEPL VITE FAIL ACCE VCVI CONT ECRO FLIA DTST
    FICH FORM MAPP OBJE LECT flui3d tubelp1 TERM
!                   TIME PROG 38.0E-3 TERM
!                   TIME PROG 31.0E-3 TERM
!                   TIME PROG 31.0E-3 PAS 0.5E-3 33.0E-3 TERM
                    TRIG ECRO 1 TSTO TVAL 1.02E5 LECT trigger TERM
OPTI NOTE CSTA 0.25
     STEP IO
     LOG 1
     JAUM
     LMST
   ! FANT 8.0E-3 LECT mems TERM !_q4gs TERM !fc is this OK?
     VFCC FCON 6 ! hllc solver
          ORDR 2 ! order in space
          STPS 2 ! order in time
          RECO 1 ! Not accepted by CAL_VFCC_1D
          NTIL
     ADAP RCON !TRIG ECRO 1 TVAL 1.02E5 LECT trigger TERM
     PINS GRID DPIN 1.01
     FLS  CUB8 2 ! For the inverse mapping
     QUAS STAT 1670 0.1 UPTO 3.0E-3 !fc is this OK ???
CALC TINI 0 TEND 40.0E-3
FIN
```

D7710600mapfw.epx

```
D7710600MAPFW
ECHO
 CONV WIN
RESU SPLI ALIC 'D7710600MAPF.ali' GARD PSCR
COMP COUL ROUG LECT mem1 TERM
          VERT LECT mem2 TERM
!         TURQ LECT mem3 TERM
          GR50 LECT pinbcm TERM
          TURQ LECT flui3d TERM
*=====================================================================
SORT VISU NSTO 1
*=====================================================================
PLAY
CAME   1 EYE  -1.64954E+01 -9.15031E-01  2.02341E-03
!        Q     6.95266E-01  6.95266E-01 -1.28860E-01 -1.28860E-01
         VIEW  3.58368E-01  9.33580E-01  1.91478E-10
         RIGH  9.33580E-01 -3.58368E-01 -7.35028E-11
         UP    3.05311E-16 -2.05101E-10  1.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: FREE CAMERA
!CENTER : -1.62650E+01  8.28568E-02  2.02341E-03
!RSPHERE:  2.04827E-01
!RADIUS :  1.02414E+00
!ASPECT :  1.33333E+00
!NEAR   :  8.09342E-01
!FAR    :  1.21900E+00
SCEN GEOM NAVI FREE
         FACE SBAC
         LINE SFRE
     ISO  FILL FIEL ECRO 1 SCAL USER PROG 1.E5 PAS 0.5E5 7.5E5 TERM
         SUPP LECT flui3d TERM
     LIMA ON
SLER CAM1 1 NFRA 1
FREQ 1
TRAC OFFS SIZE 800 600 FICH BMP
         OBJE LECT mems pinbcm flui3d TERM SYXY TOLS 1.E-3 NFAI REND
GOTR LOOP 19 OFFS SIZE 800 600 FICH BMP
         OBJE LECT mems pinbcm flui3d TERM SYXY TOLS 1.E-3 NFAI REND
ENDPLAY
*=====================================================================
FIN
```

D7710600mapfx.epx

```
D7710600MAPFX
ECHO
!CONV WIN
RESU SPLI ALIC 'D7710600MAPF.ali' GARD PSCR
COMP NGRO 1 'xaxo' LECT flui3d tubelp1 TERM
                  COND LINE X1 -17.105 Y1 0 Z1 0
                            X2 -0.6    Y2 0 Z2 0 TOL 1.E-3
SORT GRAP
AXTE 1.0 'Time [s]'
SCOU 1 'p_33' T 33.E-3 SAXE 1.0 'Abscissa' INIT LECT xaxo TERM
                     ECRO COMP 1
                     SUPP LECT flui3d tubelp1 TERM
SCOU 2 'r_33' T 33.E-3 SAXE 1.0 'Abscissa' INIT LECT xaxo TERM
                     ECRO COMP 2
                     SUPP LECT flui3d tubelp1 TERM
SCOU 3 'v_33' T 33.E-3 SAXE 1.0 'Abscissa' INIT LECT xaxo TERM
                     VCVI COMP 1
                     SUPP LECT flui3d tubelp1 TERM
RCOU 11 'p_31' FICH 'D7710600mapax.pun' RENA 'p_a_31'
RCOU 12 'r_31' FICH 'D7710600mapax.pun' RENA 'r_a_31'
RCOU 13 'v_31' FICH 'D7710600mapax.pun' RENA 'v_a_31'
TRAC 1 11 AXES 1.0 'PRESS. [Pa]'
COLO NOIR ROUG
TRAC 2 12 AXES 1.0 'DENS. [kg/m3]'
COLO NOIR ROUG
TRAC 3 13 AXES 1.0 'VELO. [m/s]'
COLO NOIR ROUG
LIST 1 AXES 1.0 'PRESS. [Pa]'
LIST 2 AXES 1.0 'DENS. [kg/m3]'
LIST 3 AXES 1.0 'VELO. [m/s]'
SCOU 21 'p_31' T 31.E-3 SAXE 1.0 'Abscissa' INIT LECT xaxo TERM
                     ECRO COMP 1
                     SUPP LECT flui3d tubelp1 TERM
SCOU 22 'r_31' T 31.E-3 SAXE 1.0 'Abscissa' INIT LECT xaxo TERM
                     ECRO COMP 2
                     SUPP LECT flui3d tubelp1 TERM
SCOU 23 'v_31' T 31.E-3 SAXE 1.0 'Abscissa' INIT LECT xaxo TERM
                     VCVI COMP 1
                     SUPP LECT flui3d tubelp1 TERM
TRAC 21 11 AXES 1.0 'PRESS. [Pa]'
COLO NOIR ROUG
TRAC 22 12 AXES 1.0 'DENS. [kg/m3]'
COLO NOIR ROUG
TRAC 23 13 AXES 1.0 'VELO. [m/s]'
COLO NOIR ROUG
FIN
```

D7710600mapfy.epx

```
D7710600MAPFY
ECHO
 CONV WIN
RESU SPLI ALIC 'D7710600MAPF.ali' GARD PSCR
COMP COUL ROUG LECT mem1 TERM
          VERT LECT mem2 TERM
!         TURQ LECT mem3 TERM
          GR50 LECT pinbcm TERM
*=====================================================================
SORT VISU NSTO 9
*=====================================================================
PLAY
CAME   1 EYE  -1.72612E+01  2.81122E-03  2.81116E-03
!        Q     7.07107E-01  0.00000E+00 -7.07107E-01  0.00000E+00
         VIEW  1.00000E+00  0.00000E+00  2.05103E-10
         RIGH -2.05103E-10  0.00000E+00  1.00000E+00
```

```
        UP    0.00000E+00  1.00000E+00  0.00000E+00
        FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER : -1.62964E+01  2.81122E-03  2.81116E-03
!RSPHERE:  2.41195E-01
!RADIUS :  9.64780E-01
!ASPECT :  1.00000E+00
!NEAR   :  7.23585E-01
!FAR    :  1.44717E+00
SCEN GEOM NAVI FREE
         FACE SBAC
     LIMA ON
SLER CAM1 1 NFRA 1
TRAC DEFO AMPD 0.0
     OFFS SIZE 600 600 FICH BMP
          OBJE LECT mem1 pinbcm TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
TRAC DEFO AMPD 0.0
     OFFS SIZE 600 600 FICH BMP
          OBJE LECT mem2 pinbcm TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
FREQ 11
GO
TRAC DEFO AMPD 0.0
     OFFS SIZE 600 600 FICH BMP
          OBJE LECT mem1 pinbcm TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
TRAC DEFO AMPD 0.0
     OFFS SIZE 600 600 FICH BMP
          OBJE LECT mem2 pinbcm TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
ENDPLAY
*=====================================================================
FIN
```

D7710600mapg.epx

```
D7710600MAPG
ECHO
!CONV win
CAST mesh
TRID ALE
EROS 1.0
DIME ADAP NPOI 300000
          CUVF 300000
          NVFI 800000
          Q4GS 10000
          CL3D 10000
          NPIN 10000
     ENDA
     JONC 218 ! Total n. of nodes in a TUBM juncton
     NALE 1 NBLE 1
     TERM
GEOM
     Q4GS  mems pinbcm
     PMAT npincm
     CUVF flui3d
     T3GS fake
     TUVF tubelp1
     CL3D pre face3d
     TUBM rac3d1d
TERM
COMP DIAM DROI 0.1692568 LECT tubelp1 TERM
     RACC TUBM LECT rac3d1d  TERM
          NTUB LECT p1a   TERM DTUB 0.1692568
          FACE LECT face3d TERM COEF 1.0
! Attention: the TUBM element (raclp) is NOT included
! in the "mesh" object (although it IS indeed passed in from Cast3m).
! For this reason we must add it explicitly in the GROU directive below
! if we want to have it in the extracted element groups.
     GROU 21 'nrac3d1d' LECT mesh1 rac3d1d TERM
                   COND XB GT -12.6952 COND XB LT -12.6948
            'fcoup1' LECT flui3d TERM
                   COND XB GT -16.405
                   COND XB LT -15.105
            'S1' LECT tube TERM COND NEAR POIN -0.345 0.15 0.15
            'S2' LECT tube TERM COND NEAR POIN -0.245 0.15 0.15
            'S3' LECT tube TERM COND NEAR POIN 0.0 0.0 0.0
            'S16' LECT flui3d TERM COND NEAR POIN -15.225 0 0.15
            'S15' LECT flui3d TERM COND NEAR POIN -15.125 0 0.15
            'S12' LECT tube TERM COND NEAR POIN -12.495 0 0.15
            'S11' LECT tube TERM COND NEAR POIN -12.395 0 0.15
            'S6' LECT tube TERM COND NEAR POIN -5.685 0 0.15
            'S5' LECT tube TERM COND NEAR POIN -5.585 0 0.15
            'epar1' LECT tubelp1 TERM COND NEAR NODE LECT p1a TERM
            'epar2' LECT tubelp1 TERM COND NEAR NODE LECT p1d3 TERM
            'tubelpp' LECT tubelp1 DIFF epar1 epar2 TERM
!            'tubelpp' LECT tubelp1 DIFF epar1 TERM ! epar2 TERM
            'memc1' LECT mem1 TERM COND NEAR POIN -16.435 0 0
            'memc1d' LECT mem1 TERM COND CYLI X1 -16.505 Y1 0 Z1 0
                                         X2 -16.305 Y2 0 Z2 0 R .15
            'memc1b' LECT mem1 DIFF memc1d TERM
            'e4' LECT flui3d TERM COND NEAR POIN -16.340 0.1655 0
            'e3' LECT flui3d TERM COND NEAR POIN -16.270 0.1655 0
            'e2' LECT flui3d TERM COND NEAR POIN -16.200 0.1655 0
            'e1' LECT flui3d TERM COND NEAR POIN -16.190 0.1655 0
     NGRO 7 'nmemi' LECT mems TERM
                   COND CYLI X1 -20 Y1 0 Z1 0 X2 20 Y2 0 Z2 0 R 0.1650
            'nmemo' LECT mems DIFF nmemi TERM
            'nsymy' LECT mems TERM COND Y LT 0.001
            'nsymz' LECT mems TERM COND Z LT 0.001
            'm1c'   LECT mem1 TERM COND NEAR POIN -16.335 0 0
            'm2c'   LECT mem2 TERM COND NEAR POIN -16.265 0 0
!            'm3c'   LECT mem3 TERM COND NEAR POIN -16.195 0 0
            'pt0' LECT tube TERM COND NEAR POIN -16.19999 0.0 0.0
     EPAI 0.50E-3 LECT mems TERM
          3.00E-3 LECT fake TERM
          1.00E-3 LECT pinbcm TERM
          5.00E-3 LECT npincm TERM ! Only for visualization
     DERO DISP 0.20 LECT mem1 TERM
     COUL TURQ LECT tube tra lp3xl TERM
          VERT LECT fir2 TERM
          ROSE LECT fir1 TERM
          ROUG LECT driver TERM
          GR50 LECT mems TERM
          ROUG LECT fake TERM
          JAUN LECT pre TERM
          GR50 LECT pinbcm TERM
          ROSE LECT S3 S1 S2 S5 S6 S11 S12 S15 S16 TERM
!      DIAM DROI 0.1692568 LECT tubelp1 TERM
ADAP THRS ECRO 3 TMIN 0.01 TMAX 0.4 MAXL 3
          LECT mems TERM
GRIL LAGR LECT mems fake TERM
FONC 1 TABL 5 0.0       0.0
              1.0E-3    1.0
              2.999E-3  1.0
              3.0E-3    0.0
              100.0E-3  0.0
MATE
    !LOI 1
     VM23 RO 1380 YOUN 2757.9E6 NU 0.495 ELAS 100.E6 ! "Melinex/Mylar/
                                                     !  PET" EPAI=0.5
                                                     !  = Material 2
          FAIL PEPR LIMI 1.0
          TRAC 3 100.E6 0.03626
                 180.E6 1.5
                 230.E6 3.5
          LECT mems _q4gs TERM
    !LOI 2
     GAZP RO 13.445 GAMM 1.4 CV 719.286 PINI 11.36E5 PREF 9.968E4
          LECT none TERM
    !LOI 3
     GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
          LECT none TERM
    !LOI 4
     GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
          LECT none TERM
    !LOI 5
     GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
          LECT flui3d _cuvf TERM
    !LOI 6
  !   IMPE PIMP PRES 13.723E5 PREF 1.011E5 FONC 1
  !   IMPE PIMP PRES 12.98E5 PREF 0 FONC 1
     IMPE PIMP PRES 4.20E5 PREF 0 FONC 1
          LECT pre _cl3d TERM
     GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
          LECT epar1 epar2 TERM
     GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
          LECT rac3d1d tubelpp TERM
     PARO PSIL 0.02
          LECT tubelpp TERM
     MULT 8 9 LECT tubelpp TERM
     GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
          LECT _cuvf TERM
     FANT 0.0
          LECT fake TERM
     VM23 RO 7850 YOUNG 2.1E11 NU 0.3 ELAS 1000E6 ! Elastic steel
          TRAC 2 1000E6 0.0047619048
                 1100E6 5.1
          LECT pinbcm TERM
     MASS 0.0 YOUN 2.1E11 NU 0.33
          LECT npincm TERM
! In order to obtain a printout at least of the 3D VFCCs I am obliged
! to use a different material for tubelp3 and other 3D parts, but with
! the same characteristics as the material used for tubelp1
!OPTI PINS ASN
LINK COUP SPLT NONE
     BLOQ 123 LECT nmemo TERM
     BLOQ 123 LECT pinbcm TERM
     CONT SPLA NX 0 NY 1 NZ 0 LECT nsymy TERM
     CONT SPLA NX 0 NY 0 NZ 1 LECT nsymz TERM
LINK DECO
     PINB PENA SFAC 1.0
          BODY                               DMIN 0.003  ! #6
               LECT mem1 TERM
          BODY                               DMIN 0.003  ! #7
               LECT mem2 TERM
!          BODY                               DMIN 0.003  ! #8
!               LECT mem3 TERM
          BODY                               MLEV 0      ! #8
               LECT fake TERM
          BODY                               DIAM 5.E-3
               LECT npincm TERM
          EXCL PAIR 1 3
          EXCL PAIR 2 3
!          EXCL PAIR 3 4
          EXCL PAIR 3 4
     FLSW STRU LECT mems TERM
          FLUI LECT fcoup1 TERM
          R 0.025 ! 0.014
          HGRI 0.016
          DGRI
          FACE
          BFLU 2 ! block if at least one node is in influence domain
          FSCP 1 ! couple in all directions
          ADAP LMAX 3 SCAL 2
INIT SKIP UPTO 3.E-3 VFCC
```

```
     ADAP IMAT TIME 3.E-3
               2 MATE 2 OBJE LECT flui3d TERM
                        INSI SURF LECT mem1 TERM
                MATE 3 OBJE LECT flui3d TERM
                       OUTS SURF LECT mem1 TERM
                       INSI SURF LECT mem2 TERM
!                 MATE 4 OBJE LECT flui3d TERM
!                        OUTS SURF LECT mem2 TERM
!                        INSI SURF LECT mem3 TERM
ECRI DEPL VITE ECRO FAIL TFRE 0.25E-3
          NOPO !POIN LECT cen TERM
          ELEM LECT S1 TERM
     FICH ALIC TEMP TFRE 10.e-6
    ! FICH ALIT FREQ 0 TFRE 0.D0
         ! TIME PROG 0.D0 PAS 0.5D-3 28.D-3 PAS 0.01D-3 110.D-3
          !POIN LECT cen TERM
          POIN LECT m1c m2c TERM
          ELEM LECT S1 S2 S3 S5 S6 S11 S12 S15 S16 e1 e2 e3 e4 TERM
!   FICH PVTK FREQ 0 TFRE 0.D0
!        TIME PROG 0.D0 PAS 0.5D-3 28.D-3 PAS 0.1D-3 50.D-3
!        PAS 2.D-3 110.D-3
!        GROU AUTO
!        VARI DEPL VITE FAIL ACCE VCVI CONT ECRO FLIA DTST
    FICH FORM MAPP OBJE LECT flui3d tubelp1 TERM
!                   TIME PROG 38.0E-3 TERM
!                   TIME PROG 31.0E-3 TERM
                    TIME PROG 33.0E-3 TERM !fc is this OK?
    FICH SPLI ALIC FREQ 0 TFRE 1.D-3 ! 0.D0
    !      TIME PROG 0.D0 PAS 0.5D-3 28.D-3 PAS 0.1D-3 50.D-3
    !      PAS 2.D-3 80.D-3
OPTI NOTE CSTA 0.25
     STEP IO
     LOG 1
     JAUM
     LMST
     FANT 8.0E-3 LECT mems TERM !_q4gs TERM !fc is this OK?
     VFCC FCON 6 ! hllc solver
          ORDR 2 ! order in space
          STPS 2 ! order in time
          RECO 1 ! Not accepted by CAL_VFCC_1D
          NTIL
     ADAP RCON !TRIG ECRO 1 TVAL 1.02E5 LECT trigger TERM
     PINS GRID DPIN 1.01
     FLS  CUB8 2 ! For the inverse mapping
     QUAS STAT 1670 0.1 UPTO 3.0E-3 !fc is this OK ???
CALC TINI 0 TEND 4.0E-3
FIN
```

D7710600mapgm.epx

```
D7710600MAPGM
ECHO
!CONV WIN
RESU SPLI ALIC 'D7710600mapb.ali' GARD PSCR
SORT ARRE NSTO 34 ! TEMP 33.0E-3
ECRI FICH FORM MAPP OBJE LECT flui3d tubelp1 TERM
                    TIME PROG 32.99E-3 TERM ! 33.0E-3 TERM
FIN
```

D7710600mapgw.epx

```
D7710600MAPGW
ECHO
 CONV WIN
RESU SPLI ALIC 'D7710600mapb.ali' GARD PSCR
COMP COUL ROUG LECT mem1 TERM
          VERT LECT mem2 TERM
!         TURQ LECT mem3 TERM
          GR50 LECT pinbcm TERM
          TURQ LECT flui3d TERM
*=======================================================================
SORT VISU NSTO 1
*=======================================================================
PLAY
CAME   1 EYE  -1.64954E+01 -9.15031E-01  2.02341E-03
!        Q     6.95266E-01  6.95266E-01 -1.28860E-01 -1.28860E-01
         VIEW  3.58368E-01  9.33580E-01  1.91478E-10
         RIGH  9.33580E-01 -3.58368E-01 -7.35028E-11
         UP    3.05311E-16 -2.05101E-10  1.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: FREE CAMERA
!CENTER : -1.62650E+01  8.28568E-02  2.02341E-03
!RSPHERE:  2.04827E-01
!RADIUS :  1.02414E+00
!ASPECT :  1.33333E+00
!NEAR   :  8.09342E-01
!FAR    :  1.21900E+00
SCEN GEOM NAVI FREE
          FACE SBAC
          LINE SFRE
     ISO  FILL FIEL ECRO 1 SCAL USER PROG 1.E5 PAS 0.5E5 7.5E5 TERM
          SUPP LECT flui3d TERM
     LIMA ON
SLER CAM1 1 NFRA 1
FREQ 1
TRAC OFFS SIZE 800 600 FICH BMP
         OBJE LECT mems pinbcm flui3d TERM SYXY TOLS 1.E-3 NFAI REND
GOTR LOOP 10 OFFS SIZE 800 600 FICH BMP
         OBJE LECT mems pinbcm flui3d TERM SYXY TOLS 1.E-3 NFAI REND
ENDPLAY
*=======================================================================
FIN
```

D7710600mapgx.epx

```
D7710600mapbx
ECHO
!CONV WIN
RESU SPLI ALIC 'D7710600mapb.ali' GARD PSCR
COMP NGRO 1 'xaxo' LECT flui3d tubelp1 TERM
                   COND LINE X1 -17.105 Y1 0 Z1 0
                             X2 -0.6    Y2 0 Z2 0 TOL 1.E-3
SORT GRAP
AXTE 1.0 'Time [s]'
SCOU 1 'p_33' T 33.E-3 SAXE 1.0 'Abscissa' INIT LECT xaxo TERM
                       ECRO COMP 1
                       SUPP LECT flui3d tubelp1 TERM
SCOU 2 'r_33' T 33.E-3 SAXE 1.0 'Abscissa' INIT LECT xaxo TERM
                       ECRO COMP 2
                       SUPP LECT flui3d tubelp1 TERM
SCOU 3 'v_33' T 33.E-3 SAXE 1.0 'Abscissa' INIT LECT xaxo TERM
                       VCVI COMP 1
                       SUPP LECT flui3d tubelp1 TERM
RCOU 11 'p_31' FICH 'D7710600mapax.pun' RENA 'p_a_31'
RCOU 12 'r_31' FICH 'D7710600mapax.pun' RENA 'r_a_31'
RCOU 13 'v_31' FICH 'D7710600mapax.pun' RENA 'v_a_31'
TRAC 1 11 AXES 1.0 'PRESS. [Pa]'
COLO NOIR ROUG
TRAC 2 12 AXES 1.0 'DENS. [kg/m3]'
COLO NOIR ROUG
TRAC 3 13 AXES 1.0 'VELO. [m/s]'
COLO NOIR ROUG
LIST 1 AXES 1.0 'PRESS. [Pa]'
LIST 2 AXES 1.0 'DENS. [kg/m3]'
LIST 3 AXES 1.0 'VELO. [m/s]'
SCOU 21 'p_31' T 31.E-3 SAXE 1.0 'Abscissa' INIT LECT xaxo TERM
                       ECRO COMP 1
                       SUPP LECT flui3d tubelp1 TERM
SCOU 22 'r_31' T 31.E-3 SAXE 1.0 'Abscissa' INIT LECT xaxo TERM
                       ECRO COMP 2
                       SUPP LECT flui3d tubelp1 TERM
SCOU 23 'v_31' T 31.E-3 SAXE 1.0 'Abscissa' INIT LECT xaxo TERM
                       VCVI COMP 1
                       SUPP LECT flui3d tubelp1 TERM
TRAC 21 11 AXES 1.0 'PRESS. [Pa]'
COLO NOIR ROUG
TRAC 22 12 AXES 1.0 'DENS. [kg/m3]'
COLO NOIR ROUG
TRAC 23 13 AXES 1.0 'VELO. [m/s]'
COLO NOIR ROUG
FIN
```

D7710600mapgy.epx

```
D7710600MAPGY
ECHO
 CONV WIN
RESU SPLI ALIC 'D7710600MAPG.ali' GARD PSCR
COMP COUL ROUG LECT mem1 TERM
          VERT LECT mem2 TERM
!         TURQ LECT mem3 TERM
          GR50 LECT pinbcm TERM
*=======================================================================
SORT VISU NSTO 5
*=======================================================================
PLAY
CAME   1 EYE  -1.72612E+01  2.81122E-03  2.81116E-03
!        Q     7.07107E-01  0.00000E+00 -7.07107E-01  0.00000E+00
         VIEW  1.00000E+00  0.00000E+00  2.05103E-10
         RIGH -2.05103E-10  0.00000E+00  1.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER : -1.62964E+01  2.81122E-03  2.81116E-03
!RSPHERE:  2.41195E-01
!RADIUS :  9.64780E-01
!ASPECT :  1.00000E+00
!NEAR   :  7.23585E-01
!FAR    :  1.44717E+00
SCEN GEOM NAVI FREE
          FACE SBAC
     LIMA ON
SLER CAM1 1 NFRA 1
FREQ 1
TRAC DEFO AMPD 0.0
     OFFS SIZE 600 600 FICH BMP
          OBJE LECT mem1 pinbcm TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
TRAC DEFO AMPD 0.0
     OFFS SIZE 600 600 FICH BMP
          OBJE LECT mem2 pinbcm TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
ENDPLAY
*=======================================================================
FIN
```

D7710600maph.epx

```
D7710600MAPH
ECHO
!CONV win
CAST mesh
TRID ALE
EROS 1.0
DIME ADAP NPOI 300000
          CUVF 300000
          NVFI 800000
          Q4GS 10000
          CL3D 10000
          NPIN 10000
     ENDA
     JONC 218 ! Total n. of nodes in a TUBM juncton
     NALE 1 NBLE 1
     TERM
GEOM
     Q4GS mems ! pinbcm
     PMAT npincm
     CUVF flui3d
     T3GS fake
     TUVF tubelp1
     CL3D pre face3d
     TUBM rac3d1d
TERM
COMP DIAM DROI 0.1692568 LECT tubelp1 TERM
     RACC TUBM LECT rac3d1d  TERM
          NTUB LECT p1a   TERM DTUB 0.1692568
          FACE LECT face3d TERM COEF 1.0
! Attention: the TUBM element (raclp) is NOT included
! in the "mesh" object (although it IS indeed passed in from Cast3m).
! For this reason we must add it explicitly in the GROU directive below
! if we want to have it in the extracted element groups.
     GROU 24 'nrac3d1d' LECT mesh1 rac3d1d TERM
                    COND XB GT -12.6952 COND XB LT -12.6948
            'fcoup1' LECT flui3d TERM
                    COND XB GT -16.405
                    COND XB LT -15.105
            'S1' LECT tube TERM COND NEAR POIN -0.345 0.15 0.15
            'S2' LECT tube TERM COND NEAR POIN -0.245 0.15 0.15
            'S3' LECT tube TERM COND NEAR POIN 0.0 0.0 0.0
            'S16' LECT flui3d TERM COND NEAR POIN -15.225 0 0.15
            'S15' LECT flui3d TERM COND NEAR POIN -15.125 0 0.15
            'S12' LECT tube TERM COND NEAR POIN -12.495 0 0.15
            'S11' LECT tube TERM COND NEAR POIN -12.395 0 0.15
            'S6' LECT tube TERM COND NEAR POIN -5.685 0 0.15
            'S5' LECT tube TERM COND NEAR POIN -5.585 0 0.15
            'epar1' LECT tubelp1 TERM COND NEAR NODE LECT p1a TERM
            'epar2' LECT tubelp1 TERM COND NEAR NODE LECT p1d3 TERM
            'tubelpp' LECT tubelp1 DIFF epar1 epar2 TERM
!            'tubelpp' LECT tubelp1 DIFF epar1 TERM ! epar2 TERM
            'memc1' LECT mem1 TERM COND NEAR POIN -16.435 0 0
            'memc1d' LECT mem1 TERM COND CYLI X1 -16.505 Y1 0 Z1 0
                                          X2 -16.305 Y2 0 Z2 0 R .15
            'memc1b' LECT mem1 DIFF memc1d TERM
            'e4' LECT flui3d TERM COND NEAR POIN -16.340 0.1655 0
            'e3' LECT flui3d TERM COND NEAR POIN -16.270 0.1655 0
            'e2' LECT flui3d TERM COND NEAR POIN -16.200 0.1655 0
            'e1' LECT flui3d TERM COND NEAR POIN -16.190 0.1655 0
            'trigger' LECT tube TERM COND NEAR POIN -0.70 0 0
            'npmem1' LECT npincm TERM COND XB GT -16.340
                                 COND XB LT -16.330
            'npmem2' LECT npincm TERM COND XB GT -16.270
                                 COND XB LT -16.260
     NGRO 7 'nmemi' LECT mems TERM
                   COND CYLI X1 -20 Y1 0 Z1 0 X2 20 Y2 0 Z2 0 R 0.1650
            'nmemo' LECT mems DIFF nmemi TERM
            'nsymy' LECT mems TERM COND Y LT 0.001
            'nsymz' LECT mems TERM COND Z LT 0.001
            'm1c'   LECT mem1 TERM COND NEAR POIN -16.335 0 0
            'm2c'   LECT mem2 TERM COND NEAR POIN -16.265 0 0
!            'm3c'   LECT mem3 TERM COND NEAR POIN -16.195 0 0
            'pt0' LECT tube TERM COND NEAR POIN -16.19999 0.0 0.0
     EPAI 0.50E-3 LECT mems TERM
          3.00E-3 LECT fake TERM
        ! 1.00E-3 LECT pinbcm TERM
          5.00E-3 LECT npincm TERM ! Only for visualization
     DERO DISP 1.230 LECT mem1 TERM
          DISP 1.160 LECT mem2 TERM
     COUL TURQ LECT tube tra lp3xl TERM
          VERT LECT fir2 TERM
          ROSE LECT fir1 TERM
          ROUG LECT driver TERM
          GR50 LECT mems TERM
          ROUG LECT fake TERM
          JAUN LECT pre TERM
          GR50 LECT npincm TERM ! pinbcm TERM
          ROSE LECT S3 S1 S2 S5 S6 S11 S12 S15 S16 TERM
!       DIAM DROI 0.1692568 LECT tubelp1 TERM
ADAP THRS ECRO 3 TMIN 0.01 TMAX 0.4 MAXL 3
          LECT mems TERM
GRIL LAGR LECT mems fake TERM
FONC 1 TABL 5 0.0       0.0
              1.0E-3    1.0
              2.999E-3  1.0
              3.0E-3    0.0
              100.0E-3  0.0
MATE
    !LOI 1
     VM23 RO 1380 YOUN 2757.9E6 NU 0.495 ELAS 100.E6 ! "Melinex/Mylar/
                                                   !  PET" EPAI=0.5
                                                   !  = Material 2
          FAIL PEPR LIMI 1.0
          TRAC 3 100.E6 0.03626
                 180.E6 1.5
                 230.E6 3.5
          LECT mems _q4gs TERM
    !LOI 2
     GAZP RO 13.445 GAMM 1.4 CV 719.286 PINI 11.36E5 PREF 9.968E4
          LECT none TERM
    !LOI 3
     GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
          LECT none TERM
    !LOI 4
     GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
          LECT none TERM
    !LOI 5
     GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
          LECT flui3d _cuvf TERM
    !LOI 6
  !   IMPE PIMP PRES 13.723E5 PREF 1.011E5 FONC 1
  !   IMPE PIMP PRES 12.98E5 PREF 0 FONC 1
     IMPE PIMP PRES 4.20E5 PREF 0 FONC 1
          LECT pre _cl3d TERM
     GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
          LECT epar1 epar2 TERM
     GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
          LECT rac3d1d tubelpp TERM
     PARO PSIL 0.02
          LECT tubelpp TERM
     MULT 8 9 LECT tubelpp TERM
     GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
          LECT _cuvf TERM
     FANT 0.0
          LECT fake TERM
   ! VM23 RO 7850 YOUNG 2.1E11 NU 0.3 ELAS 1000E6 ! Elastic steel
   !      TRAC 2 1000E6 0.0047619048
   !             1100E6 5.1
   !      LECT pinbcm TERM
     MASS 0.0 YOUN 2.1E11 NU 0.33
          LECT npincm TERM
! In order to obtain a printout at least of the 3D VFCCs I am obliged
! to use a different material for tubelp3 and other 3D parts, but with
! the same characteristics as the material used for tubelp1
!OPTI PINS ASN
LINK COUP SPLT NONE
     BLOQ 123 LECT nmemo TERM
   ! BLOQ 123456 LECT pinbcm TERM
     BLOQ 123 LECT npincm TERM
     CONT SPLA NX 0 NY 1 NZ 0 LECT nsymy TERM
     CONT SPLA NX 0 NY 0 NZ 1 LECT nsymz TERM
LINK DECO
     PINB PENA SFAC 1.0
          BODY                              DMIN 0.003  ! #6
               LECT mem1 TERM
          BODY                              DMIN 0.003  ! #7
               LECT mem2 TERM
!          BODY                              DMIN 0.003  ! #8
!               LECT mem3 TERM
          BODY                              MLEV 0      ! #8
               LECT fake TERM
          BODY                              DIAM 5.E-3
               LECT npincm DIFF npmem1 npmem2 TERM
          EXCL PAIR 1 3
          EXCL PAIR 2 3
!          EXCL PAIR 3 4
          EXCL PAIR 3 4
     FLSW STRU LECT mems TERM
          FLUI LECT fcoup1 TERM
          R 0.025 ! 0.014
          HGRI 0.016
          DGRI
          FACE
          BFLU 2 ! block if at least one node is in influence domain
          FSCP 1 ! couple in all directions
          ADAP LMAX 3 SCAL 2
INIT SKIP UPTO 3.E-3 VFCC
     ADAP IMAT TIME 3.E-3
               2 MATE 2 OBJE LECT flui3d TERM
                       INSI SURF LECT mem1 TERM
                MATE 3 OBJE LECT flui3d TERM
                      OUTS SURF LECT mem1 TERM
                      INSI SURF LECT mem2 TERM
!               MATE 4 OBJE LECT flui3d TERM
!                      OUTS SURF LECT mem2 TERM
!                      INSI SURF LECT mem3 TERM
ECRI DEPL VITE ECRO FAIL TFRE 0.25E-3
          NOPO !POIN LECT cen TERM
          ELEM LECT S1 TERM
     FICH ALIC TEMP TFRE 10.e-6
    ! FICH ALIT FREQ 0 TFRE 0.D0
        ! TIME PROG 0.D0 PAS 0.5D-3 28.D-3 PAS 0.01D-3 110.D-3
          !POIN LECT cen TERM
          POIN LECT m1c m2c TERM
          ELEM LECT S1 S2 S3 S5 S6 S11 S12 S15 S16 e1 e2 e3 e4 TERM
    FICH SPLI ALIC FREQ 0 TFRE 1.D-3 ! 0.D0
    !      TIME PROG 0.D0 PAS 0.5D-3 28.D-3 PAS 0.1D-3 50.D-3
    !      PAS 2.D-3 80.D-3
!   FICH PVTK FREQ 0 TFRE 0.D0
!       TIME PROG 0.D0 PAS 0.5D-3 28.D-3 PAS 0.1D-3 50.D-3
!       PAS 2.D-3 110.D-3
!       GROU AUTO
!       VARI DEPL VITE FAIL ACCE VCVI CONT ECRO FLIA DTST
    FICH FORM MAPP OBJE LECT flui3d tubelp1 TERM
```

```
!                   TIME PROG 38.0E-3 TERM
!                   TIME PROG 31.0E-3 TERM
!                   TIME PROG 31.0E-3 PAS 0.5E-3 33.0E-3 TERM
                    TRIG ECRO 1 TSTO TVAL 1.02E5 LECT trigger TERM
OPTI NOTE CSTA 0.70 CSVF 0.471 ! So that C_s is 0.33 for the VFCC
     STEP IO
     LOG 1
     JAUM
     LMST
   ! FANT 8.0E-3 LECT mems TERM !_q4gs TERM !fc is this OK?
   ! NOCR LECT pinbcm TERM
     NOCR LECT npincm TERM
     VFCC FCON 6 ! hllc solver
          ORDR 2 ! order in space
          STPS 2 ! order in time
          RECO 1 ! Not accepted by CAL_VFCC_1D
          CENE   ! Correct gradients (second order) so EINT stays positive
     ADAP RCON !TRIG ECRO 1 TVAL 1.02E5 LECT trigger TERM
     PINS GRID DPIN 1.01
     FLS  CUB8 2 ! For the inverse mapping
     QUAS STAT 1670 0.1 UPTO 3.0E-3 !fc is this OK ???
CALC TINI 0 TEND 40.0E-3 PAS1 1.E-8 TFAI 6.0E-7
FIN
```

D7710600maphw.epx

```
D7710600MAPHW
ECHO
 CONV WIN
RESU SPLI ALIC 'D7710600MAPH.ali' GARD PSCR
COMP COUL ROUG LECT mem1 TERM
          VERT LECT mem2 TERM
!         TURQ LECT mem3 TERM
          GR50 LECT pinbcm TERM
          TURQ LECT flui3d TERM
*=======================================================================
SORT VISU NSTO 1
*=======================================================================
PLAY
CAME   1 EYE  -1.64954E+01 -9.15031E-01  2.02341E-03
!        Q     6.95266E-01  6.95266E-01 -1.28860E-01 -1.28860E-01
         VIEW  3.58368E-01  9.33580E-01  1.91478E-10
         RIGH  9.33580E-01 -3.58368E-01 -7.35028E-11
         UP    3.05311E-16 -2.05101E-10  1.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: FREE CAMERA
!CENTER : -1.62650E+01  8.28568E-02  2.02341E-03
!RSPHERE:  2.04827E-01
!RADIUS :  1.02414E+00
!ASPECT :  1.33333E+00
!NEAR   :  8.09342E-01
!FAR    :  1.21900E+00
SCEN GEOM NAVI FREE
          FACE SBAC
          LINE SFRE
     ISO  FILL FIEL ECRO 1 SCAL USER PROG 1.E5 PAS 0.5E5 7.5E5 TERM
          SUPP LECT flui3d TERM
     LIMA ON
SLER CAM1 1 NFRA 1
FREQ 1
TRAC OFFS SIZE 800 600 FICH BMP
          OBJE LECT mems pinbcm flui3d TERM SYXY TOLS 1.E-3 NFAI REND
GOTR LOOP 10 OFFS SIZE 800 600 FICH BMP
          OBJE LECT mems pinbcm flui3d TERM SYXY TOLS 1.E-3 NFAI REND
ENDPLAY
*=======================================================================
FIN
```

D7710600maphx.epx

```
D7710600MAPHX
ECHO
!CONV WIN
RESU SPLI ALIC 'D7710600MAPH.ali' GARD PSCR
COMP NGRO 1 'xaxo' LECT flui3d tubelp1 TERM
                   COND LINE X1 -17.105 Y1 0 Z1 0
                             X2 -0.6    Y2 0 Z2 0 TOL 1.E-3
SORT GRAP
AXTE 1.0 'Time [s]'
SCOU 1 'p_33' T 33.E-3 SAXE 1.0 'Abscissa' INIT LECT xaxo TERM
                       ECRO COMP 1
                       SUPP LECT flui3d tubelp1 TERM
SCOU 2 'r_33' T 33.E-3 SAXE 1.0 'Abscissa' INIT LECT xaxo TERM
                       ECRO COMP 2
                       SUPP LECT flui3d tubelp1 TERM
SCOU 3 'v_33' T 33.E-3 SAXE 1.0 'Abscissa' INIT LECT xaxo TERM
                       VCVI COMP 1
                       SUPP LECT flui3d tubelp1 TERM
RCOU 11 'p_31' FICH 'D7710600mapax.pun' RENA 'p_a_31'
RCOU 12 'r_31' FICH 'D7710600mapax.pun' RENA 'r_a_31'
RCOU 13 'v_31' FICH 'D7710600mapax.pun' RENA 'v_a_31'
TRAC 1 11 AXES 1.0 'PRESS. [Pa]'
COLO NOIR ROUG
TRAC 2 12 AXES 1.0 'DENS. [kg/m3]'
COLO NOIR ROUG
TRAC 3 13 AXES 1.0 'VELO. [m/s]'
COLO NOIR ROUG
LIST 1 AXES 1.0 'PRESS. [Pa]'
LIST 2 AXES 1.0 'DENS. [kg/m3]'
LIST 3 AXES 1.0 'VELO. [m/s]'
SCOU 21 'p_31' T 31.E-3 SAXE 1.0 'Abscissa' INIT LECT xaxo TERM
                        ECRO COMP 1
                        SUPP LECT flui3d tubelp1 TERM
SCOU 22 'r_31' T 31.E-3 SAXE 1.0 'Abscissa' INIT LECT xaxo TERM
                        ECRO COMP 2
                        SUPP LECT flui3d tubelp1 TERM
SCOU 23 'v_31' T 31.E-3 SAXE 1.0 'Abscissa' INIT LECT xaxo TERM
                        VCVI COMP 1
                        SUPP LECT flui3d tubelp1 TERM
TRAC 21 11 AXES 1.0 'PRESS. [Pa]'
COLO NOIR ROUG
TRAC 22 12 AXES 1.0 'DENS. [kg/m3]'
COLO NOIR ROUG
TRAC 23 13 AXES 1.0 'VELO. [m/s]'
COLO NOIR ROUG
FIN
```

D7710600maphy.epx

```
D7710600MAPHY
ECHO
 CONV WIN
RESU SPLI ALIC 'D7710600MAPH.ali' GARD PSCR
COMP COUL ROUG LECT mem1 TERM
          VERT LECT mem2 TERM
!         TURQ LECT mem3 TERM
          GR50 LECT pinbcm TERM
*=======================================================================
SORT VISU NSTO 9
*=======================================================================
PLAY
CAME   1 EYE  -1.72612E+01  2.81122E-03  2.81116E-03
!        Q     7.07107E-01  0.00000E+00 -7.07107E-01  0.00000E+00
         VIEW  1.00000E+00  0.00000E+00  2.05103E-10
         RIGH -2.05103E-10  0.00000E+00  1.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER : -1.62964E+01  2.81122E-03  2.81116E-03
!RSPHERE:  2.41195E-01
!RADIUS :  9.64780E-01
!ASPECT :  1.00000E+00
!NEAR   :  7.23585E-01
!FAR    :  1.44717E+00
SCEN GEOM NAVI FREE
          FACE SBAC
     LIMA ON
SLER CAM1 1 NFRA 1
FREQ 1
TRAC DEFO AMPD 0.0
     OFFS SIZE 600 600 FICH BMP
          OBJE LECT mem1 pinbcm TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
TRAC DEFO AMPD 0.0
     OFFS SIZE 600 600 FICH BMP
          OBJE LECT mem2 pinbcm TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
!TRAC DEFO AMPD 0.0
!    OFFS SIZE 600 600 FICH BMP
!         OBJE LECT mem3 pinbcm TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
ENDPLAY
*=======================================================================
FIN
```

D7710600mapi.epx

```
D7710600MAPI
ECHO
!CONV win
CAST mesh
TRID ALE
EROS 1.0
DIME ADAP NPOI 300000
          CUVF 300000
          NVFI 800000
          Q4GS 10000
          CL3D 10000
          NPIN 10000
     ENDA
     JONC 218 ! Total n. of nodes in a TUBM juncton
     NALE 1 NBLE 1
     TERM
GEOM
     Q4GS mems ! pinbcm
     PMAT npincm
     CUVF flui3d
     T3GS fake
     TUVF tubelp1
     CL3D pre face3d
     TUBM rac3d1d
TERM
COMP DIAM DROI 0.1692568 LECT tubelp1 TERM
     RACC TUBM LECT rac3d1d  TERM
          NTUB LECT p1a   TERM DTUB 0.1692568
          FACE LECT face3d TERM COEF 1.0
! Attention: the TUBM element (raclp) is NOT included
! in the "mesh" object (although it IS indeed passed in from Cast3m).
! For this reason we must add it explicitly in the GROU directive below
! if we want to have it in the extracted element groups.
     GROU 24 'nrac3d1d' LECT mesh1 rac3d1d TERM
                     COND XB GT -12.6952 COND XB LT -12.6948
```

```
          'fcoup1' LECT flui3d TERM
                   COND XB GT -16.405
                   COND XB LT -15.105
          'S1' LECT tube TERM COND NEAR POIN -0.345 0.15 0.15
          'S2' LECT tube TERM COND NEAR POIN -0.245 0.15 0.15
          'S3' LECT tube TERM COND NEAR POIN 0.0 0.0 0.0
          'S16' LECT flui3d TERM COND NEAR POIN -15.225 0 0.15
          'S15' LECT flui3d TERM COND NEAR POIN -15.125 0 0.15
          'S12' LECT tube TERM COND NEAR POIN -12.495 0 0.15
          'S11' LECT tube TERM COND NEAR POIN -12.395 0 0.15
          'S6' LECT tube TERM COND NEAR POIN -5.685 0 0.15
          'S5' LECT tube TERM COND NEAR POIN -5.585 0 0.15
          'epar1' LECT tubelp1 TERM COND NEAR NODE LECT p1a TERM
          'epar2' LECT tubelp1 TERM COND NEAR NODE LECT p1d3 TERM
          'tubelpp' LECT tubelp1 DIFF epar1 epar2 TERM
!          'tubelpp' LECT tubelp1 DIFF epar1 TERM ! epar2 TERM
          'memc1' LECT mem1 TERM COND NEAR POIN -16.435 0 0
          'memc1d' LECT mem1 TERM COND CYLI X1 -16.505 Y1 0 Z1 0
                                   X2 -16.305 Y2 0 Z2 0 R .15
          'memc1b' LECT mem1 DIFF memc1d TERM
          'e4' LECT flui3d TERM COND NEAR POIN -16.340 0.1655 0
          'e3' LECT flui3d TERM COND NEAR POIN -16.270 0.1655 0
          'e2' LECT flui3d TERM COND NEAR POIN -16.200 0.1655 0
          'e1' LECT flui3d TERM COND NEAR POIN -16.190 0.1655 0
          'trigger' LECT tube TERM COND NEAR POIN -0.70 0 0
          'npmem1' LECT npincm TERM COND XB GT -16.340
                                   COND XB LT -16.330
          'npmem2' LECT npincm TERM COND XB GT -16.270
                                   COND XB LT -16.260
    NGRO 7 'nmemi' LECT mems TERM
                  COND CYLI X1 -20 Y1 0 Z1 0 X2 20 Y2 0 Z2 0 R 0.1650
          'nmemo' LECT mems DIFF nmemi TERM
          'nsymy' LECT mems TERM COND Y LT 0.001
          'nsymz' LECT mems TERM COND Z LT 0.001
          'm1c'   LECT mem1 TERM COND NEAR POIN -16.335 0 0
          'm2c'   LECT mem2 TERM COND NEAR POIN -16.265 0 0
!          'm3c'   LECT mem3 TERM COND NEAR POIN -16.195 0 0
          'pt0' LECT tube TERM COND NEAR POIN -16.19999 0.0 0.0
    EPAI 0.50E-3 LECT mems TERM
         3.00E-3 LECT fake TERM
       ! 1.00E-3 LECT pinbcm TERM
         5.00E-3 LECT npincm TERM ! Only for visualization
    DERO DISP 1.230 LECT mem1 TERM
         DISP 1.160 LECT mem2 TERM
    COUL TURQ LECT tube tra lp3xl TERM
         VERT LECT fir2 TERM
         ROSE LECT fir1 TERM
         ROUG LECT driver TERM
         GR50 LECT mems TERM
         ROUG LECT fake TERM
         JAUN LECT pre TERM
         GR50 LECT npincm TERM ! pinbcm TERM
         ROSE LECT S3 S1 S2 S5 S6 S11 S12 S15 S16 TERM
!      DIAM DROI 0.1692568 LECT tubelp1 TERM
ADAP THRS ECRO 3 TMIN 0.01 TMAX 0.4 MAXL 3
         LECT mems TERM
GRIL LAGR LECT mems fake TERM
FONC 1 TABL 5 0.0       0.0
              1.0E-3    1.0
              2.999E-3  1.0
              3.0E-3    0.0
              100.0E-3  0.0
MATE
    !LOI 1
    VM23 RO 1380 YOUN 2757.9E6 NU 0.495 ELAS 100.E6 ! "Melinex/Mylar/
                                                    !  PET" EPAI=0.5
                                                    !  = Material 2
         FAIL PEPR LIMI 1.0
         TRAC 3 100.E6 0.03626
                180.E6 1.5
                230.E6 3.5
         LECT mems _q4gs TERM
    !LOI 2
    GAZP RO 13.445 GAMM 1.4 CV 719.286 PINI 11.36E5 PREF 9.968E4
         LECT none TERM
    !LOI 3
    GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
         LECT none TERM
    !LOI 4
    GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
         LECT none TERM
    !LOI 5
    GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
         LECT flui3d _cuvf TERM
    !LOI 6
  !   IMPE PIMP PRES 13.723E5 PREF 1.011E5 FONC 1
  !   IMPE PIMP PRES 12.98E5 PREF 0 FONC 1
    IMPE PIMP PRES 4.20E5 PREF 0 FONC 1
         LECT pre _cl3d TERM
    GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
         LECT epar1 epar2 TERM
    GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
         LECT rac3d1d tubelpp TERM
    PARO PSIL 0.02
         LECT tubelpp TERM
    MULT 8 9 LECT tubelpp TERM
    GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
         LECT _cuvf TERM
    FANT 0.0
         LECT fake TERM
   ! VM23 RO 7850 YOUNG 2.1E11 NU 0.3 ELAS 1000E6 ! Elastic steel
   !     TRAC 2 1000E6 0.0047619048
   !              1100E6 5.1
   !       LECT pinbcm TERM
     MASS 0.0 YOUN 2.1E11 NU 0.33
          LECT npincm TERM
! In order to obtain a printout at least of the 3D VFCCs I am obliged
! to use a different material for tubelp3 and other 3D parts, but with
! the same characteristics as the material used for tubelp1
!OPTI PINS ASN
LINK COUP SPLT NONE
     BLOQ 123 LECT nmemo TERM
   ! BLOQ 123456 LECT pinbcm TERM
     BLOQ 123 LECT npincm TERM
     CONT SPLA NX 0 NY 1 NZ 0 LECT nsymy TERM
     CONT SPLA NX 0 NY 0 NZ 1 LECT nsymz TERM
LINK DECO
     PINB PENA SFAC 1.0
          BODY                              DMIN 0.003  ! #6
               LECT mem1 TERM
          BODY                              DMIN 0.003  ! #7
               LECT mem2 TERM
!          BODY                              DMIN 0.003  ! #8
!               LECT mem3 TERM
          BODY                              MLEV 0      ! #8
               LECT fake TERM
          BODY                              DIAM 5.E-3
               LECT npincm DIFF npmem1 npmem2 TERM
          EXCL PAIR 1 3
          EXCL PAIR 2 3
!          EXCL PAIR 3 4
          EXCL PAIR 3 4
     FLSW STRU LECT mems TERM
          FLUI LECT fcoup1 TERM
          R 0.025 ! 0.014
          HGRI 0.016
          DGRI
          FACE
          BFLU 2 ! block if at least one node is in influence domain
          FSCP 1 ! couple in all directions
          ADAP LMAX 3 SCAL 2
INIT SKIP UPTO 3.E-3 VFCC
     ADAP IMAT TIME 3.E-3
               2 MATE 2 OBJE LECT flui3d TERM
                        INSI SURF LECT mem1 TERM
                MATE 3 OBJE LECT flui3d TERM
                       OUTS SURF LECT mem1 TERM
                       INSI SURF LECT mem2 TERM
!                 MATE 4 OBJE LECT flui3d TERM
!                        OUTS SURF LECT mem2 TERM
!                        INSI SURF LECT mem3 TERM
ECRI DEPL VITE ECRO FAIL TFRE 0.25E-3
          NOPO !POIN LECT cen TERM
          ELEM LECT S1 TERM
     FICH ALIC TEMP TFRE 10.e-6
    ! FICH ALIT FREQ 0 TFRE 0.D0
         ! TIME PROG 0.D0 PAS 0.5D-3 28.D-3 PAS 0.01D-3 110.D-3
          !POIN LECT cen TERM
          POIN LECT m1c m2c TERM
          ELEM LECT S1 S2 S3 S5 S6 S11 S12 S15 S16 e1 e2 e3 e4 TERM
    FICH SPLI ALIC FREQ 0 TFRE 1.D-3 ! 0.D0
    !      TIME PROG 0.D0 PAS 0.5D-3 28.D-3 PAS 0.1D-3 50.D-3
    !      PAS 2.D-3 80.D-3
!   FICH PVTK FREQ 0 TFRE 0.D0
!        TIME PROG 0.D0 PAS 0.5D-3 28.D-3 PAS 0.1D-3 50.D-3
!        PAS 2.D-3 110.D-3
!        GROU AUTO
!        VARI DEPL VITE FAIL ACCE VCVI CONT ECRO FLIA DTST
    FICH FORM MAPP OBJE LECT flui3d tubelp1 TERM
!                   TIME PROG 38.0E-3 TERM
!                   TIME PROG 31.0E-3 TERM
!                   TIME PROG 31.0E-3 PAS 0.5E-3 33.0E-3 TERM
                    TRIG ECRO 1 TSTO TVAL 1.02E5 LECT trigger TERM
OPTI NOTE CSTA 0.25
     STEP IO
     LOG 1
     JAUM
     LMST
   ! FANT 8.0E-3 LECT mems TERM !_q4gs TERM !fc is this OK?
   ! NOCR LECT pinbcm TERM
     NOCR LECT npincm TERM
     VFCC FCON 6 ! hllc solver
          ORDR 2 ! order in space
          STPS 2 ! order in time
          RECO 1 ! Not accepted by CAL_VFCC_1D
          CENE   ! Correct gradients (second order) so EINT stays positive
     ADAP RCON !TRIG ECRO 1 TVAL 1.02E5 LECT trigger TERM
     PINS GRID DPIN 1.01
     FLS  CUB8 2 ! For the inverse mapping
     QUAS STAT 1670 0.1 UPTO 3.0E-3 !fc is this OK ???
CALC TINI 0 TEND 40.0E-3 PAS1 1.E-8 TFAI 2.15E-7
FIN
```

D7710600mapiw.epx

```
D7710600MAPIW
ECHO
 CONV WIN
RESU SPLI ALIC 'D7710600MAPI.ali' GARD PSCR
COMP COUL ROUG LECT mem1 TERM
          VERT LECT mem2 TERM
!         TURQ LECT mem3 TERM
          GR50 LECT pinbcm TERM
```

```
        TURQ LECT flui3d TERM
*=======================================================================
SORT VISU NSTO 1
*=======================================================================
PLAY
CAME   1 EYE  -1.64954E+01 -9.15031E-01  2.02341E-03
!        Q     6.95266E-01  6.95266E-01 -1.28860E-01 -1.28860E-01
         VIEW  3.58368E-01  9.33580E-01  1.91478E-10
         RIGH  9.33580E-01 -3.58368E-01 -7.35028E-11
         UP    3.05311E-16 -2.05101E-10  1.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: FREE CAMERA
!CENTER : -1.62650E+01  8.28568E-02  2.02341E-03
!RSPHERE:  2.04827E-01
!RADIUS :  1.02414E+00
!ASPECT :  1.33333E+00
!NEAR   :  8.09342E-01
!FAR    :  1.21900E+00
SCEN GEOM NAVI FREE
          FACE SBAC
          LINE SFRE
     ISO  FILL FIEL ECRO 1 SCAL USER PROG 1.E5 PAS 0.5E5 7.5E5 TERM
          SUPP LECT flui3d TERM
     LIMA ON
SLER CAM1 1 NFRA 1
FREQ 1
TRAC OFFS SIZE 800 600 FICH BMP
          OBJE LECT mems pinbcm flui3d TERM SYXY TOLS 1.E-3 NFAI REND
GOTR LOOP 10 OFFS SIZE 800 600 FICH BMP
          OBJE LECT mems pinbcm flui3d TERM SYXY TOLS 1.E-3 NFAI REND
ENDPLAY
*=======================================================================
FIN
```

D7710600mapix.epx

```
D7710600MAPIX
ECHO
!CONV WIN
RESU SPLI ALIC 'D7710600MAPI.ali' GARD PSCR
COMP NGRO 1 'xaxo' LECT flui3d tubelp1 TERM
                   COND LINE X1 -17.105 Y1 0 Z1 0
                             X2 -0.6    Y2 0 Z2 0 TOL 1.E-3
SORT GRAP
AXTE 1.0 'Time [s]'
SCOU 1 'p_33' T 33.E-3 SAXE 1.0 'Abscissa' INIT LECT xaxo TERM
                       ECRO COMP 1
                       SUPP LECT flui3d tubelp1 TERM
SCOU 2 'r_33' T 33.E-3 SAXE 1.0 'Abscissa' INIT LECT xaxo TERM
                       ECRO COMP 2
                       SUPP LECT flui3d tubelp1 TERM
SCOU 3 'v_33' T 33.E-3 SAXE 1.0 'Abscissa' INIT LECT xaxo TERM
                       VCVI COMP 1
                       SUPP LECT flui3d tubelp1 TERM
RCOU 11 'p_31' FICH 'D7710600mapax.pun' RENA 'p_a_31'
RCOU 12 'r_31' FICH 'D7710600mapax.pun' RENA 'r_a_31'
RCOU 13 'v_31' FICH 'D7710600mapax.pun' RENA 'v_a_31'
TRAC 1 11 AXES 1.0 'PRESS. [Pa]'
COLO NOIR ROUG
TRAC 2 12 AXES 1.0 'DENS. [kg/m3]'
COLO NOIR ROUG
TRAC 3 13 AXES 1.0 'VELO. [m/s]'
COLO NOIR ROUG
LIST 1 AXES 1.0 'PRESS. [Pa]'
LIST 2 AXES 1.0 'DENS. [kg/m3]'
LIST 3 AXES 1.0 'VELO. [m/s]'
SCOU 21 'p_31' T 31.E-3 SAXE 1.0 'Abscissa' INIT LECT xaxo TERM
                       ECRO COMP 1
                       SUPP LECT flui3d tubelp1 TERM
SCOU 22 'r_31' T 31.E-3 SAXE 1.0 'Abscissa' INIT LECT xaxo TERM
                       ECRO COMP 2
                       SUPP LECT flui3d tubelp1 TERM
SCOU 23 'v_31' T 31.E-3 SAXE 1.0 'Abscissa' INIT LECT xaxo TERM
                       VCVI COMP 1
                       SUPP LECT flui3d tubelp1 TERM
TRAC 21 11 AXES 1.0 'PRESS. [Pa]'
COLO NOIR ROUG
TRAC 22 12 AXES 1.0 'DENS. [kg/m3]'
COLO NOIR ROUG
TRAC 23 13 AXES 1.0 'VELO. [m/s]'
COLO NOIR ROUG
FIN
```

D7710600mapiy.epx

```
D7710600MAPIY
ECHO
 CONV WIN
RESU SPLI ALIC 'D7710600MAPI.ali' GARD PSCR
COMP COUL ROUG LECT mem1 TERM
          VERT LECT mem2 TERM
!         TURQ LECT mem3 TERM
          GR50 LECT pinbcm TERM
*=======================================================================
SORT VISU NSTO 9
*=======================================================================
PLAY
CAME   1 EYE  -1.72612E+01  2.81122E-03  2.81116E-03
!        Q     7.07107E-01  0.00000E+00 -7.07107E-01  0.00000E+00
         VIEW  1.00000E+00  0.00000E+00  2.05103E-10
         RIGH -2.05103E-10  0.00000E+00  1.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER : -1.62964E+01  2.81122E-03  2.81116E-03
!RSPHERE:  2.41195E-01
!RADIUS :  9.64780E-01
!ASPECT :  1.00000E+00
!NEAR   :  7.23585E-01
!FAR    :  1.44717E+00
SCEN GEOM NAVI FREE
          FACE SBAC
     LIMA ON
SLER CAM1 1 NFRA 1
FREQ 1
TRAC DEFO AMPD 0.0
     OFFS SIZE 600 600 FICH BMP
          OBJE LECT mem1 pinbcm TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
TRAC DEFO AMPD 0.0
     OFFS SIZE 600 600 FICH BMP
          OBJE LECT mem2 pinbcm TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
!TRAC DEFO AMPD 0.0
!     OFFS SIZE 600 600 FICH BMP
!          OBJE LECT mem3 pinbcm TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
ENDPLAY
*=======================================================================
FIN
```

D7710600mapj.epx

```
D7710600MAPJ
ECHO
!CONV win
CAST mesh
TRID ALE
EROS 1.0
DIME ADAP NPOI 300000
          CUVF 300000
          NVFI 800000
          Q4GS 10000
          CL3D 10000
          NPIN 10000
     ENDA
     JONC 218 ! Total n. of nodes in a TUBM juncton
     NALE 1 NBLE 1
     TERM
GEOM
     Q4GS  mems pinbcm
     PMAT npincm
     CUVF flui3d
     T3GS fake
     TUVF tubelp1
     CL3D pre face3d
     TUBM rac3d1d
TERM
COMP DIAM DROI 0.1692568 LECT tubelp1 TERM
     RACC TUBM LECT rac3d1d  TERM
          NTUB LECT p1a   TERM DTUB 0.1692568
          FACE LECT face3d TERM COEF 1.0
! Attention: the TUBM element (raclp) is NOT included
! in the "mesh" object (although it IS indeed passed in from Cast3m).
! For this reason we must add it explicitly in the GROU directive below
! if we want to have it in the extracted element groups.
     GROU 22 'nrac3d1d' LECT mesh1 rac3d1d TERM
                    COND XB GT -12.6952 COND XB LT -12.6948
           'fcoup1' LECT flui3d TERM
                    COND XB GT -16.405
                    COND XB LT -15.105
           'S1' LECT tube TERM COND NEAR POIN -0.345 0.15 0.15
           'S2' LECT tube TERM COND NEAR POIN -0.245 0.15 0.15
           'S3' LECT tube TERM COND NEAR POIN 0.0 0.0 0.0
           'S16' LECT flui3d TERM COND NEAR POIN -15.225 0 0.15
           'S15' LECT flui3d TERM COND NEAR POIN -15.125 0 0.15
           'S12' LECT tube TERM COND NEAR POIN -12.495 0 0.15
           'S11' LECT tube TERM COND NEAR POIN -12.395 0 0.15
           'S6' LECT tube TERM COND NEAR POIN -5.685 0 0.15
           'S5' LECT tube TERM COND NEAR POIN -5.585 0 0.15
           'epar1' LECT tubelp1 TERM COND NEAR NODE LECT p1a TERM
           'epar2' LECT tubelp1 TERM COND NEAR NODE LECT p1d3 TERM
           'tubelpp' LECT tubelp1 DIFF epar1 epar2 TERM
!           'tubelpp' LECT tubelp1 DIFF epar1 TERM ! epar2 TERM
           'memc1' LECT mem1 TERM COND NEAR POIN -16.435 0 0
           'memc1d' LECT mem1 TERM COND CYLI X1 -16.505 Y1 0 Z1 0
                                             X2 -16.305 Y2 0 Z2 0 R .15
           'memc1b' LECT mem1 DIFF memc1d TERM
           'e4' LECT flui3d TERM COND NEAR POIN -16.340 0.1655 0
           'e3' LECT flui3d TERM COND NEAR POIN -16.270 0.1655 0
           'e2' LECT flui3d TERM COND NEAR POIN -16.200 0.1655 0
           'e1' LECT flui3d TERM COND NEAR POIN -16.190 0.1655 0
           'trigger' LECT tube TERM COND NEAR POIN -0.70 0 0
     NGRO 7 'nmemi' LECT mems TERM
                   COND CYLI X1 -20 Y1 0 Z1 0 X2 20 Y2 0 Z2 0 R 0.1650
           'nmemo' LECT mems DIFF nmemi TERM
           'nsymy' LECT mems TERM COND Y LT 0.001
           'nsymz' LECT mems TERM COND Z LT 0.001
           'm1c'   LECT mem1 TERM COND NEAR POIN -16.335 0 0
           'm2c'   LECT mem2 TERM COND NEAR POIN -16.265 0 0
!           'm3c'   LECT mem3 TERM COND NEAR POIN -16.195 0 0
           'pt0' LECT tube TERM COND NEAR POIN -16.19999 0.0 0.0
     EPAI 0.50E-3 LECT mems TERM
          3.00E-3 LECT fake TERM
```

```
        1.00E-3 LECT pinbcm TERM
        5.00E-3 LECT npincm TERM ! Only for visualization
    DERO DISP 1.230 LECT mem1 TERM
        DISP 1.160 LECT mem2 TERM
    COUL TURQ LECT tube tra lp3xl TERM
        VERT LECT fir2 TERM
        ROSE LECT fir1 TERM
        ROUG LECT driver TERM
        GR50 LECT mems TERM
        ROUG LECT fake TERM
        JAUN LECT pre TERM
        GR50 LECT pinbcm TERM
        ROSE LECT S3 S1 S2 S5 S6 S11 S12 S15 S16 TERM
!      DIAM DROI 0.1692568 LECT tubelp1 TERM
ADAP THRS ECRO 3 TMIN 0.01 TMAX 0.4 MAXL 3
        LECT mems TERM
GRIL LAGR LECT mems fake TERM
FONC 1 TABL 5 0.0       0.0
            1.0E-3    1.0
            2.999E-3  1.0
            3.0E-3    0.0
            100.0E-3  0.0
MATE
    !LOI 1
    VM23 RO 1380 YOUN 2757.9E6 NU 0.495 ELAS 100.E6 ! "Melinex/Mylar/
                                                     !  PET" EPAI=0.5
                                                     !  = Material 2
        FAIL PEPR LIMI 1.0
        TRAC 3 100.E6 0.03626
               180.E6 1.5
               230.E6 3.5
        LECT mems _q4gs TERM
    !LOI 2
     GAZP RO 13.445 GAMM 1.4 CV 719.286 PINI 11.36E5 PREF 9.968E4
        LECT none TERM
    !LOI 3
     GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
        LECT none TERM
    !LOI 4
     GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
        LECT none TERM
    !LOI 5
     GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
        LECT flui3d _cuvf TERM
    !LOI 6
  !   IMPE PIMP PRES 13.723E5 PREF 1.011E5 FONC 1
  !   IMPE PIMP PRES 12.98E5 PREF 0 FONC 1
    IMPE PIMP PRES 4.20E5 PREF 0 FONC 1
        LECT pre _cl3d TERM
    GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
        LECT epar1 epar2 TERM
    GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
        LECT rac3d1d tubelpp TERM
    PARO PSIL 0.02
        LECT tubelpp TERM
    MULT 8 9 LECT tubelpp TERM
    GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
        LECT _cuvf TERM
    FANT 0.0
        LECT fake TERM
    VM23 RO 7850 YOUNG 2.1E11 NU 0.3 ELAS 1000E6 ! Elastic steel
        TRAC 2 1000E6 0.0047619048
               1100E6 5.1
        LECT pinbcm TERM
    MASS 0.0 YOUN 2.1E11 NU 0.33
        LECT npincm TERM
! In order to obtain a printout at least of the 3D VFCCs I am obliged
! to use a different material for tubelp3 and other 3D parts, but with
! the same characteristics as the material used for tubelp1
!OPTI PINS ASN
LINK COUP SPLT NONE
    BLOQ 123 LECT nmemo TERM
    BLOQ 123 LECT pinbcm TERM
    CONT SPLA NX 0 NY 1 NZ 0 LECT nsymy TERM
    CONT SPLA NX 0 NY 0 NZ 1 LECT nsymz TERM
LINK DECO
    PINB PENA SFAC 1.0
        BODY                             DMIN 0.003  ! #6
            LECT mem1 TERM
        BODY                             DMIN 0.003  ! #7
            LECT mem2 TERM
!        BODY                             DMIN 0.003  ! #8
!            LECT mem3 TERM
        BODY                             MLEV 0      ! #8
            LECT fake TERM
        BODY                             DIAM 5.E-3
            LECT npincm TERM
        EXCL PAIR 1 3
        EXCL PAIR 2 3
!        EXCL PAIR 3 4
        EXCL PAIR 3 4
    FLSW STRU LECT mems TERM
        FLUI LECT fcoup1 TERM
        R 0.025 ! 0.014
        HGRI 0.016
        DGRI
        FACE
        BFLU 2 ! block if at least one node is in influence domain
        FSCP 1 ! couple in all directions
        ADAP LMAX 3 SCAL 2
INIT SKIP UPTO 3.E-3 VFCC
    ADAP IMAT TIME 3.E-3
                  2 MATE 2 OBJE LECT flui3d TERM
                           INSI SURF LECT mem1 TERM
                   MATE 3 OBJE LECT flui3d TERM
                          OUTS SURF LECT mem1 TERM
                          INSI SURF LECT mem2 TERM
!                    MATE 4 OBJE LECT flui3d TERM
!                           OUTS SURF LECT mem2 TERM
!                           INSI SURF LECT mem3 TERM
ECRI DEPL VITE ECRO FAIL TFRE 0.25E-3
          NOPO !POIN LECT cen TERM
          ELEM LECT S1 TERM
     FICH ALIC TEMP TFRE 10.e-6
    ! FICH ALIT FREQ 0 TFRE 0.D0
         ! TIME PROG 0.D0 PAS 0.5D-3 28.D-3 PAS 0.01D-3 110.D-3
          !POIN LECT cen TERM
          POIN LECT m1c m2c TERM
          ELEM LECT S1 S2 S3 S5 S6 S11 S12 S15 S16 e1 e2 e3 e4 TERM
    FICH SPLI ALIC FREQ 0 TFRE 1.D-3 ! 0.D0
    !      TIME PROG 0.D0 PAS 0.5D-3 28.D-3 PAS 0.1D-3 50.D-3
    !      PAS 2.D-3 80.D-3
!   FICH PVTK FREQ 0 TFRE 0.D0
!        TIME PROG 0.D0 PAS 0.5D-3 28.D-3 PAS 0.1D-3 50.D-3
!        PAS 2.D-3 110.D-3
!        GROU AUTO
!        VARI DEPL VITE FAIL ACCE VCVI CONT ECRO FLIA DTST
    FICH FORM MAPP OBJE LECT flui3d tubelp1 TERM
!                   TIME PROG 38.0E-3 TERM
!                   TIME PROG 31.0E-3 TERM
!                   TIME PROG 31.0E-3 PAS 0.5E-3 33.0E-3 TERM
                    TRIG ECRO 1 TSTO TVAL 1.02E5 LECT trigger TERM
OPTI NOTE CSTA 0.25
     STEP IO
     LOG 1
     JAUM
     LMST
   ! FANT 8.0E-3 LECT mems TERM !_q4gs TERM !fc is this OK?
     VFCC FCON 6 ! hllc solver
          ORDR 2 ! order in space
          STPS 2 ! order in time
          RECO 1 ! Not accepted by CAL_VFCC_1D
          LMAS 3 ! Dubois reconstructioin limiter (default)
          LQDM 3
          LENE 3
          KMAS 0.75 ! Dubois parameter (default is 0.5)
          KQDM 0.75
          KENE 0.75
          NTIL
          CENE
     ADAP RCON !TRIG ECRO 1 TVAL 1.02E5 LECT trigger TERM
     PINS GRID DPIN 1.01
     FLS  CUB8 2 ! For the inverse mapping
     QUAS STAT 1670 0.1 UPTO 3.0E-3 !fc is this OK ???
CALC TINI 0 TEND 40.0E-3
FIN
```

D7710600mapjv.epx

```
D7710600MAPJV
ECHO
 CONV WIN
RESU SPLI ALIC 'D7710600MAPJ.ali' GARD PSCR
COMP COUL ROUG LECT mem1 TERM
          VERT LECT mem2 TERM
!         TURQ LECT mem3 TERM
          GR50 LECT pinbcm TERM
          TURQ LECT flui3d TERM
*=====================================================================
SORT VISU NSTO 1
*=====================================================================
PLAY
CAME   1 EYE  -1.64954E+01 -9.15031E-01  2.02341E-03
!        Q     6.95266E-01  6.95266E-01 -1.28860E-01 -1.28860E-01
         VIEW  3.58368E-01  9.33580E-01  1.91478E-10
         RIGH  9.33580E-01 -3.58368E-01 -7.35028E-11
         UP    3.05311E-16 -2.05101E-10  1.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: FREE CAMERA
!CENTER : -1.62650E+01  8.28568E-02  2.02341E-03
!RSPHERE:  2.04827E-01
!RADIUS :  1.02414E+00
!ASPECT :  1.33333E+00
!NEAR   :  8.09342E-01
!FAR    :  1.21900E+00
SCEN GEOM NAVI FREE
          FACE SBAC
          LINE SFRE
     LIMA ON
SLER CAM1 1 NFRA 1
FREQ 1
TRAC OFFS SIZE 800 600 FICH BMP
          OBJE LECT mems pinbcm flui3d TERM SYXY TOLS 1.E-3 NFAI REND
GOTR LOOP 33 OFFS SIZE 800 600 FICH BMP
          OBJE LECT mems pinbcm flui3d TERM SYXY TOLS 1.E-3 NFAI REND
ENDPLAY
*=====================================================================
SUIT
Post-treatment (make avi file from bitmaps)
ECHO
RESU SPLI ALIC 'D7710600MAPJ.ali' GARD PSCR
*================================================================
SORT VISU NSTO 1
```

```
*================================================================
PLAY
MAVI FPS 5 KFRE 5 COMP -1 REND
ENDPLAY
*================================================================
FIN
```

D7710600mapjw.epx

```
D7710600MAPJW
ECHO
 CONV WIN
RESU SPLI ALIC 'D7710600MAPJ.ali' GARD PSCR
COMP COUL ROUG LECT mem1 TERM
          VERT LECT mem2 TERM
!         TURQ LECT mem3 TERM
          GR50 LECT pinbcm TERM
          TURQ LECT flui3d TERM
*======================================================================
SORT VISU NSTO 1
*======================================================================
PLAY
CAME   1 EYE  -1.64954E+01 -9.15031E-01  2.02341E-03
!        Q     6.95266E-01  6.95266E-01 -1.28860E-01 -1.28860E-01
         VIEW  3.58368E-01  9.33580E-01  1.91478E-10
         RIGH  9.33580E-01 -3.58368E-01 -7.35028E-11
         UP    3.05311E-16 -2.05101E-10  1.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: FREE CAMERA
!CENTER : -1.62650E+01  8.28568E-02  2.02341E-03
!RSPHERE:  2.04827E-01
!RADIUS :  1.02414E+00
!ASPECT :  1.33333E+00
!NEAR   :  8.09342E-01
!FAR    :  1.21900E+00
SCEN GEOM NAVI FREE
          FACE SBAC
          LINE SFRE
     ISO  FILL FIEL ECRO 1 SCAL USER PROG 1.E5 PAS 0.5E5 7.5E5 TERM
          SUPP LECT flui3d TERM
     LIMA ON
SLER CAM1 1 NFRA 1
FREQ 1
TRAC OFFS SIZE 800 600 FICH BMP
          OBJE LECT mems pinbcm flui3d TERM SYXY TOLS 1.E-3 NFAI REND
GOTR LOOP 33 OFFS SIZE 800 600 FICH BMP
          OBJE LECT mems pinbcm flui3d TERM SYXY TOLS 1.E-3 NFAI REND
ENDPLAY
*======================================================================
SUIT
Post-treatment (make avi file from bitmaps)
ECHO
RESU SPLI ALIC 'D7710600MAPJ.ali' GARD PSCR
*================================================================
SORT VISU NSTO 1
*================================================================
PLAY
MAVI FPS 5 KFRE 5 COMP -1 REND
ENDPLAY
*================================================================
FIN
```

D7710600mapjx.epx

```
D7710600MAPJX
ECHO
!CONV WIN
RESU SPLI ALIC 'D7710600MAPJ.ali' GARD PSCR
COMP NGRO 1 'xaxo' LECT flui3d tubelp1 TERM
                 COND LINE X1 -17.105 Y1 0 Z1 0
                          X2 -0.6    Y2 0 Z2 0 TOL 1.E-3
SORT GRAP
AXTE 1.0 'Time [s]'
SCOU 1 'p_trig' NSTO 34 SAXE 1.0 'Abscissa' INIT LECT xaxo TERM
                     ECRO COMP 1
                     SUPP LECT flui3d tubelp1 TERM
SCOU 2 'r_trig' NSTO 34 SAXE 1.0 'Abscissa' INIT LECT xaxo TERM
                     ECRO COMP 2
                     SUPP LECT flui3d tubelp1 TERM
SCOU 3 'v_trig' NSTO 34 SAXE 1.0 'Abscissa' INIT LECT xaxo TERM
                     VCVI COMP 1
                     SUPP LECT flui3d tubelp1 TERM
RCOU 11 'p_trig' FICH 'D7710600MAPDX.pun' RENA 'p_d_trig'
RCOU 12 'r_trig' FICH 'D7710600MAPDX.pun' RENA 'r_d_trig'
RCOU 13 'v_trig' FICH 'D7710600MAPDX.pun' RENA 'v_d_trig'
RCOU 21 'p_trig' FICH 'D7710600MAPEX.pun' RENA 'p_e_trig'
RCOU 22 'r_trig' FICH 'D7710600MAPEX.pun' RENA 'r_e_trig'
RCOU 23 'v_trig' FICH 'D7710600MAPEX.pun' RENA 'v_e_trig'
TRAC 1 11 21 AXES 1.0 'PRESS. [Pa]'
COLO VERT ROUG NOIR
TRAC 2 12 22 AXES 1.0 'DENS. [kg/m3]'
COLO VERT ROUG NOIR
TRAC 3 13 23 AXES 1.0 'VELO. [m/s]'
COLO VERT ROUG NOIR
!
TRAC 1 AXES 1.0 'PRESS. [Pa]'
TRAC 2 AXES 1.0 'DENS. [kg/m3]'
TRAC 3 AXES 1.0 'VELO. [m/s]'
LIST 1 AXES 1.0 'PRESS. [Pa]'
LIST 2 AXES 1.0 'DENS. [kg/m3]'
LIST 3 AXES 1.0 'VELO. [m/s]'
FIN
```

D7710600mapjy.epx

```
D7710600MAPJY
ECHO
 CONV WIN
RESU SPLI ALIC 'D7710600MAPJ.ali' GARD PSCR
COMP COUL ROUG LECT mem1 TERM
          VERT LECT mem2 TERM
!         TURQ LECT mem3 TERM
          GR50 LECT pinbcm TERM
*======================================================================
SORT VISU NSTO 9
*======================================================================
PLAY
CAME   1 EYE  -1.72612E+01  2.81122E-03  2.81116E-03
!        Q     7.07107E-01  0.00000E+00 -7.07107E-01  0.00000E+00
         VIEW  1.00000E+00  0.00000E+00  2.05103E-10
         RIGH -2.05103E-10  0.00000E+00  1.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER : -1.62964E+01  2.81122E-03  2.81116E-03
!RSPHERE:  2.41195E-01
!RADIUS :  9.64780E-01
!ASPECT :  1.00000E+00
!NEAR   :  7.23585E-01
!FAR    :  1.44717E+00
SCEN GEOM NAVI FREE
          FACE SBAC
     LIMA ON
SLER CAM1 1 NFRA 1
TRAC DEFO AMPD 0.0
     OFFS SIZE 600 600 FICH BMP
          OBJE LECT mem1 pinbcm TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
TRAC DEFO AMPD 0.0
     OFFS SIZE 600 600 FICH BMP
          OBJE LECT mem2 pinbcm TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
FREQ 25
GO
TRAC DEFO AMPD 0.0
     OFFS SIZE 600 600 FICH BMP
          OBJE LECT mem1 pinbcm TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
TRAC DEFO AMPD 0.0
     OFFS SIZE 600 600 FICH BMP
          OBJE LECT mem2 pinbcm TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
ENDPLAY
*======================================================================
FIN
```

D7710600mapjzz.epx

```
D7710600MAPJZZ
ECHO
 CONV WIN
RESU SPLI ALIC 'D7710600MAPJ.ali' GARD PSCR
COMP COUL ROUG LECT mem1 TERM
          VERT LECT mem2 TERM
!         TURQ LECT mem3 TERM
          GR50 LECT pinbcm TERM
*======================================================================
SORT VISU NSTO 1
*======================================================================
PLAY
CAME   1 EYE  -1.64954E+01 -9.15031E-01  2.02341E-03
!        Q     6.95266E-01  6.95266E-01 -1.28860E-01 -1.28860E-01
         VIEW  3.58368E-01  9.33580E-01  1.91478E-10
         RIGH  9.33580E-01 -3.58368E-01 -7.35028E-11
         UP    3.05311E-16 -2.05101E-10  1.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: FREE CAMERA
!CENTER : -1.62650E+01  8.28568E-02  2.02341E-03
!RSPHERE:  2.04827E-01
!RADIUS :  1.02414E+00
!ASPECT :  1.33333E+00
!NEAR   :  8.09342E-01
!FAR    :  1.21900E+00
SCEN GEOM NAVI FREE
          FACE SBAC
     LIMA ON
SLER CAM1 1 NFRA 1
FREQ 1
TRAC OFFS SIZE 800 600 FICH BMP
          OBJE LECT mems pinbcm TERM SYXY TOLS 1.E-3 NFAI REND
GOTR LOOP 33 OFFS SIZE 800 600 FICH BMP
          OBJE LECT mems pinbcm TERM SYXY TOLS 1.E-3 NFAI REND
ENDPLAY
*======================================================================
SUIT
Post-treatment (make avi file from bitmaps)
ECHO
RESU SPLI ALIC 'D7710600MAPJ.ali' GARD PSCR
*================================================================
SORT VISU NSTO 1
*================================================================
```

```
PLAY
MAVI FPS 5 KFRE 5 COMP -1 REND
ENDPLAY
*================================================================
FIN
```

D7710600mapk.epx

```
D7710600MAPK
ECHO
!CONV win
CAST mesh
TRID ALE
EROS 1.0
DIME ADAP NPOI 300000
          CUVF 300000
          NVFI 800000
          Q4GS 10000
          CL3D 10000
          NPIN 10000
     ENDA
     JONC 218 ! Total n. of nodes in a TUBM juncton
     NALE 1 NBLE 1
     TERM
GEOM
     Q4GS  mems pinbcm
     PMAT npincm
     CUVF flui3d
     T3GS fake
     TUVF tubelp1
     CL3D pre face3d
     TUBM rac3d1d
TERM
COMP DIAM DROI 0.1692568 LECT tubelp1 TERM
     RACC TUBM LECT rac3d1d  TERM
          NTUB LECT p1a   TERM DTUB 0.1692568
          FACE LECT face3d TERM COEF 1.0
! Attention: the TUBM element (raclp) is NOT included
! in the "mesh" object (although it IS indeed passed in from Cast3m).
! For this reason we must add it explicitly in the GROU directive below
! if we want to have it in the extracted element groups.
     GROU 22 'nrac3d1d' LECT mesh1 rac3d1d TERM
                     COND XB GT -12.6952 COND XB LT -12.6948
             'fcoup1' LECT flui3d TERM
                     COND XB GT -16.405
                     COND XB LT -15.105
             'S1' LECT tube TERM COND NEAR POIN -0.345 0.15 0.15
             'S2' LECT tube TERM COND NEAR POIN -0.245 0.15 0.15
             'S3' LECT tube TERM COND NEAR POIN 0.0 0.0 0.0
             'S16' LECT flui3d TERM COND NEAR POIN -15.225 0 0.15
             'S15' LECT flui3d TERM COND NEAR POIN -15.125 0 0.15
             'S12' LECT tube TERM COND NEAR POIN -12.495 0 0.15
             'S11' LECT tube TERM COND NEAR POIN -12.395 0 0.15
             'S6' LECT tube TERM COND NEAR POIN -5.685 0 0.15
             'S5' LECT tube TERM COND NEAR POIN -5.585 0 0.15
             'epar1' LECT tubelp1 TERM COND NEAR NODE LECT p1a TERM
             'epar2' LECT tubelp1 TERM COND NEAR NODE LECT p1d3 TERM
             'tubelpp' LECT tubelp1 DIFF epar1 epar2 TERM
!             'tubelpp' LECT tubelp1 DIFF epar1 TERM ! epar2 TERM
             'memc1' LECT mem1 TERM COND NEAR POIN -16.435 0 0
             'memc1d' LECT mem1 TERM COND CYLI X1 -16.505 Y1 0 Z1 0
                                           X2 -16.305 Y2 0 Z2 0 R .15
             'memc1b' LECT mem1 DIFF memc1d TERM
             'e4' LECT flui3d TERM COND NEAR POIN -16.340 0.1655 0
             'e3' LECT flui3d TERM COND NEAR POIN -16.270 0.1655 0
             'e2' LECT flui3d TERM COND NEAR POIN -16.200 0.1655 0
             'e1' LECT flui3d TERM COND NEAR POIN -16.190 0.1655 0
             'trigger' LECT tube TERM COND NEAR POIN -0.70 0 0
     NGRO 7 'nmemi' LECT mems TERM
                    COND CYLI X1 -20 Y1 0 Z1 0 X2 20 Y2 0 Z2 0 R 0.1650
             'nmemo' LECT mems DIFF nmemi TERM
             'nsymy' LECT mems TERM COND Y LT 0.001
             'nsymz' LECT mems TERM COND Z LT 0.001
             'm1c'   LECT mem1 TERM COND NEAR POIN -16.335 0 0
             'm2c'   LECT mem2 TERM COND NEAR POIN -16.265 0 0
!             'm3c'   LECT mem3 TERM COND NEAR POIN -16.195 0 0
             'pt0' LECT tube TERM COND NEAR POIN -16.19999 0.0 0.0
     EPAI 0.50E-3 LECT mems TERM
          3.00E-3 LECT fake TERM
          1.00E-3 LECT pinbcm TERM
          5.00E-3 LECT npincm TERM ! Only for visualization
     COUL TURQ LECT tube tra lp3xl TERM
          VERT LECT fir2 TERM
          ROSE LECT fir1 TERM
          ROUG LECT driver TERM
          GR50 LECT mems TERM
          ROUG LECT fake TERM
          JAUN LECT pre TERM
          GR50 LECT pinbcm TERM
          ROSE LECT S3 S1 S2 S5 S6 S11 S12 S15 S16 TERM
!       DIAM DROI 0.1692568 LECT tubelp1 TERM
ADAP THRS ECRO 3 TMIN 0.01 TMAX 0.4 MAXL 3
          LECT mems TERM
GRIL LAGR LECT mems fake TERM
FONC 1 TABL 5 0.0       0.0
              1.0E-3    1.0
              2.999E-3  1.0
              3.0E-3    0.0
              100.0E-3  0.0
MATE
    !LOI 1
     VM23 RO 1380 YOUN 2757.9E6 NU 0.495 ELAS 100.E6 ! "Melinex/Mylar/
                                                      !  PET" EPAI=0.5
                                                      !  = Material 2
          FAIL PEPR LIMI 1.0
          TRAC 3 100.E6 0.03626
                 180.E6 1.5
                 230.E6 3.5
          LECT mems _q4gs TERM
    !LOI 2
     GAZP RO 13.445 GAMM 1.4 CV 719.286 PINI 11.36E5 PREF 9.968E4
          LECT none TERM
    !LOI 3
     GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
          LECT none TERM
    !LOI 4
     GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
          LECT none TERM
    !LOI 5
     GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
          LECT flui3d _cuvf TERM
    !LOI 6
  !   IMPE PIMP PRES 13.723E5 PREF 1.011E5 FONC 1
  !   IMPE PIMP PRES 12.98E5 PREF 0 FONC 1
     IMPE PIMP PRES 4.20E5 PREF 0 FONC 1
          LECT pre _cl3d TERM
     GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
          LECT epar1 epar2 TERM
     GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
          LECT rac3d1d tubelpp TERM
     PARO PSIL 0.02
          LECT tubelpp TERM
     MULT 8 9 LECT tubelpp TERM
     GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
          LECT _cuvf TERM
     FANT 0.0
          LECT fake TERM
     VM23 RO 7850 YOUNG 2.1E11 NU 0.3 ELAS 1000E6 ! Elastic steel
          TRAC 2 1000E6 0.0047619048
                 1100E6 5.1
          LECT pinbcm TERM
     MASS 0.0 YOUN 2.1E11 NU 0.33
          LECT npincm TERM
! In order to obtain a printout at least of the 3D VFCCs I am obliged
! to use a different material for tubelp3 and other 3D parts, but with
! the same characteristics as the material used for tubelp1
!OPTI PINS ASN
LINK COUP SPLT NONE
     BLOQ 123 LECT nmemo TERM
     BLOQ 123 LECT pinbcm TERM
     CONT SPLA NX 0 NY 1 NZ 0 LECT nsymy TERM
     CONT SPLA NX 0 NY 0 NZ 1 LECT nsymz TERM
LINK DECO
     PINB PENA SFAC 1.0
          BODY                                DMIN 0.003  ! #6
               LECT mem1 TERM
          BODY                                DMIN 0.003  ! #7
               LECT mem2 TERM
!          BODY                                DMIN 0.003  ! #8
!               LECT mem3 TERM
          BODY                                MLEV 0      ! #8
               LECT fake TERM
          BODY                                DIAM 5.E-3
               LECT npincm TERM
          EXCL PAIR 1 3
          EXCL PAIR 2 3
!          EXCL PAIR 3 4
          EXCL PAIR 3 4
     FLSW STRU LECT mems TERM
          FLUI LECT fcoup1 TERM
          R 0.025 ! 0.014
          HGRI 0.016
          DGRI
          FACE
          BFLU 2 ! block if at least one node is in influence domain
          FSCP 0 ! couple only in normal direction
          ADAP LMAX 3 SCAL 2
INIT SKIP UPTO 3.E-3 VFCC
     ADAP IMAT TIME 3.E-3
               2 MATE 2 OBJE LECT flui3d TERM
                        INSI SURF LECT mem1 TERM
                MATE 3 OBJE LECT flui3d TERM
                       OUTS SURF LECT mem1 TERM
                        INSI SURF LECT mem2 TERM
!                 MATE 4 OBJE LECT flui3d TERM
!                        OUTS SURF LECT mem2 TERM
!                        INSI SURF LECT mem3 TERM
ECRI DEPL VITE ECRO FAIL TFRE 0.25E-3
          NOPO !POIN LECT cen TERM
          ELEM LECT S1 TERM
     FICH ALIC TEMP TFRE 10.e-6
    ! FICH ALIT FREQ 0 TFRE 0.D0
         ! TIME PROG 0.D0 PAS 0.5D-3 28.D-3 PAS 0.01D-3 110.D-3
          !POIN LECT cen TERM
          POIN LECT m1c m2c TERM
          ELEM LECT S1 S2 S3 S5 S6 S11 S12 S15 S16 e1 e2 e3 e4 TERM
    FICH SPLI ALIC FREQ 0 TFRE 1.D-3 ! 0.D0
    !      TIME PROG 0.D0 PAS 0.5D-3 28.D-3 PAS 0.1D-3 50.D-3
    !      PAS 2.D-3 80.D-3
!   FICH PVTK FREQ 0 TFRE 0.D0
!        TIME PROG 0.D0 PAS 0.5D-3 28.D-3 PAS 0.1D-3 50.D-3
!        PAS 2.D-3 110.D-3
!        GROU AUTO
```

```
!       VARI DEPL VITE FAIL ACCE VCVI CONT ECRO FLIA DTST
    FICH FORM MAPP OBJE LECT flui3d tubelp1 TERM
!                    TIME PROG 38.0E-3 TERM
!                    TIME PROG 31.0E-3 TERM
!                    TIME PROG 31.0E-3 PAS 0.5E-3 33.0E-3 TERM
                     TRIG ECRO 1 TSTO TVAL 1.02E5 LECT trigger TERM
OPTI NOTE CSTA 0.25
     STEP IO
     LOG 1
     JAUM
     LMST
   ! FANT 8.0E-3 LECT mems TERM !_q4gs TERM !fc is this OK?
     VFCC FCON 6 ! hllc solver
          ORDR 2 ! order in space
          STPS 2 ! order in time
          RECO 1 ! Not accepted by CAL_VFCC_1D
          NTIL
     ADAP RCON !TRIG ECRO 1 TVAL 1.02E5 LECT trigger TERM
     PINS GRID DPIN 1.01
     FLS  CUB8 2 ! For the inverse mapping
     QUAS STAT 1670 0.1 UPTO 3.0E-3 !fc is this OK ???
CALC TINI 0 TEND 40.0E-3
FIN
```

D7710600mapkw.epx

```
D7710600MAPKW
ECHO
 CONV WIN
RESU SPLI ALIC 'D7710600MAPK.ali' GARD PSCR
COMP COUL ROUG LECT mem1 TERM
          VERT LECT mem2 TERM
!         TURQ LECT mem3 TERM
          GR50 LECT pinbcm TERM
          TURQ LECT flui3d TERM
*=======================================================================
SORT VISU NSTO 1
*=======================================================================
PLAY
CAME   1 EYE  -1.64954E+01 -9.15031E-01  2.02341E-03
!        Q     6.95266E-01  6.95266E-01 -1.28860E-01 -1.28860E-01
         VIEW  3.58368E-01  9.33580E-01  1.91478E-10
         RIGH  9.33580E-01 -3.58368E-01 -7.35028E-11
         UP    3.05311E-16 -2.05101E-10  1.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: FREE CAMERA
!CENTER : -1.62650E+01  8.28568E-02  2.02341E-03
!RSPHERE:  2.04827E-01
!RADIUS :  1.02414E+00
!ASPECT :  1.33333E+00
!NEAR   :  8.09342E-01
!FAR    :  1.21900E+00
SCEN GEOM NAVI FREE
          FACE SBAC
          LINE SFRE
     ISO  FILL FIEL ECRO 1 SCAL USER PROG 1.E5 PAS 0.5E5 7.5E5 TERM
          SUPP LECT flui3d TERM
     LIMA ON
SLER CAM1 1 NFRA 1
FREQ 1
TRAC OFFS SIZE 800 600 FICH BMP
          OBJE LECT mems pinbcm flui3d TERM SYXY TOLS 1.E-3 NFAI REND
GOTR LOOP 33 OFFS SIZE 800 600 FICH BMP
          OBJE LECT mems pinbcm flui3d TERM SYXY TOLS 1.E-3 NFAI REND
ENDPLAY
*=======================================================================
SUIT
Post-treatment (make avi file from bitmaps)
ECHO
RESU SPLI ALIC 'D7710600MAPK.ali' GARD PSCR
*=================================================================
SORT VISU NSTO 1
*=================================================================
PLAY
MAVI FPS 10 KFRE 10 COMP -1 REND
ENDPLAY
*=================================================================
FIN
```

D7710600mapkx.epx

```
D7710600MAPKX
ECHO
!CONV WIN
RESU SPLI ALIC 'D7710600MAPK.ali' GARD PSCR
COMP NGRO 1 'xaxo' LECT flui3d tubelp1 TERM
                   COND LINE X1 -17.105 Y1 0 Z1 0
                             X2 -0.6    Y2 0 Z2 0 TOL 1.E-3
SORT GRAP
AXTE 1.0 'Time [s]'
SCOU 1 'p_trig' NSTO 34 SAXE 1.0 'Abscissa' INIT LECT xaxo TERM
                       ECRO COMP 1
                       SUPP LECT flui3d tubelp1 TERM
SCOU 2 'r_trig' NSTO 34 SAXE 1.0 'Abscissa' INIT LECT xaxo TERM
                       ECRO COMP 2
                       SUPP LECT flui3d tubelp1 TERM
SCOU 3 'v_trig' NSTO 34 SAXE 1.0 'Abscissa' INIT LECT xaxo TERM
                       VCVI COMP 1
                       SUPP LECT flui3d tubelp1 TERM
!
RCOU 11 'p_trig' FICH 'D7710600MAPDX.pun' RENA 'p_d_trig'
RCOU 12 'r_trig' FICH 'D7710600MAPDX.pun' RENA 'r_d_trig'
RCOU 13 'v_trig' FICH 'D7710600MAPDX.pun' RENA 'v_d_trig'
TRAC 1 11 AXES 1.0 'PRESS. [Pa]'
COLO NOIR ROUG
TRAC 2 12 AXES 1.0 'DENS. [kg/m3]'
COLO NOIR ROUG
TRAC 3 13 AXES 1.0 'VELO. [m/s]'
COLO NOIR ROUG
!
TRAC 1 AXES 1.0 'PRESS. [Pa]'
TRAC 2 AXES 1.0 'DENS. [kg/m3]'
TRAC 3 AXES 1.0 'VELO. [m/s]'
LIST 1 AXES 1.0 'PRESS. [Pa]'
LIST 2 AXES 1.0 'DENS. [kg/m3]'
LIST 3 AXES 1.0 'VELO. [m/s]'
!
FIN
```

D7710600mapky.epx

```
D7710600MAPKY
ECHO
 CONV WIN
RESU SPLI ALIC 'D7710600MAPK.ali' GARD PSCR
COMP COUL ROUG LECT mem1 TERM
          VERT LECT mem2 TERM
!         TURQ LECT mem3 TERM
          GR50 LECT pinbcm TERM
*=======================================================================
SORT VISU NSTO 9
*=======================================================================
PLAY
CAME   1 EYE  -1.72612E+01  2.81122E-03  2.81116E-03
!        Q     7.07107E-01  0.00000E+00 -7.07107E-01  0.00000E+00
         VIEW  1.00000E+00  0.00000E+00  2.05103E-10
         RIGH -2.05103E-10  0.00000E+00  1.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER : -1.62964E+01  2.81122E-03  2.81116E-03
!RSPHERE:  2.41195E-01
!RADIUS :  9.64780E-01
!ASPECT :  1.00000E+00
!NEAR   :  7.23585E-01
!FAR    :  1.44717E+00
SCEN GEOM NAVI FREE
          FACE SBAC
     LIMA ON
SLER CAM1 1 NFRA 1
TRAC DEFO AMPD 0.0
     OFFS SIZE 600 600 FICH BMP
          OBJE LECT mem1 pinbcm TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
TRAC DEFO AMPD 0.0
     OFFS SIZE 600 600 FICH BMP
          OBJE LECT mem2 pinbcm TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
FREQ 25
GO
TRAC DEFO AMPD 0.0
     OFFS SIZE 600 600 FICH BMP
          OBJE LECT mem1 pinbcm TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
TRAC DEFO AMPD 0.0
     OFFS SIZE 600 600 FICH BMP
          OBJE LECT mem2 pinbcm TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
ENDPLAY
*=======================================================================
FIN
```

D7710600mapl.epx

```
D7710600MAPL
ECHO
!CONV win
CAST mesh
TRID ALE
EROS 1.0
!DIME ADAP NPOI 300000
!          CUVF 300000
!          NVFI 800000
DIME ADAP NPOI 600000
          CUVF 600000
          NVFI 1600000
          Q4GS 10000
          CL3D 10000
          NPIN 10000
     ENDA
     JONC 218 ! Total n. of nodes in a TUBM juncton
     NALE 1 NBLE 1
     TERM
GEOM
     Q4GS  mems pinbcm
     PMAT npincm
     CUVF flui3d
     T3GS fake
     TUVF tubelp1
     CL3D pre face3d
     TUBM rac3d1d
TERM
COMP DIAM DROI 0.1692568 LECT tubelp1 TERM
```

```
    RACC TUBM LECT rac3d1d  TERM
         NTUB LECT p1a   TERM DTUB 0.1692568
         FACE LECT face3d TERM COEF 1.0
! Attention: the TUBM element (raclp) is NOT included
! in the "mesh" object (although it IS indeed passed in from Cast3m).
! For this reason we must add it explicitly in the GROU directive below
! if we want to have it in the extracted element groups.
    GROU 22 'nrac3d1d' LECT mesh1 rac3d1d TERM
                    COND XB GT -12.6952 COND XB LT -12.6948
            'fcoup1' LECT flui3d TERM
                    COND XB GT -16.405
                    COND XB LT -15.105
            'S1' LECT tube TERM COND NEAR POIN -0.345 0.15 0.15
            'S2' LECT tube TERM COND NEAR POIN -0.245 0.15 0.15
            'S3' LECT tube TERM COND NEAR POIN 0.0 0.0 0.0
            'S16' LECT flui3d TERM COND NEAR POIN -15.225 0 0.15
            'S15' LECT flui3d TERM COND NEAR POIN -15.125 0 0.15
            'S12' LECT tube TERM COND NEAR POIN -12.495 0 0.15
            'S11' LECT tube TERM COND NEAR POIN -12.395 0 0.15
            'S6' LECT tube TERM COND NEAR POIN -5.685 0 0.15
            'S5' LECT tube TERM COND NEAR POIN -5.585 0 0.15
            'epar1' LECT tubelp1 TERM COND NEAR NODE LECT p1a TERM
            'epar2' LECT tubelp1 TERM COND NEAR NODE LECT p1d3 TERM
            'tubelpp' LECT tubelp1 DIFF epar1 epar2 TERM
!           'tubelpp' LECT tubelp1 DIFF epar1 TERM ! epar2 TERM
            'memc1' LECT mem1 TERM COND NEAR POIN -16.435 0 0
            'memc1d' LECT mem1 TERM COND CYLI X1 -16.505 Y1 0 Z1 0
                                          X2 -16.305 Y2 0 Z2 0 R .15
            'memc1b' LECT mem1 DIFF memc1d TERM
            'e4' LECT flui3d TERM COND NEAR POIN -16.340 0.1655 0
            'e3' LECT flui3d TERM COND NEAR POIN -16.270 0.1655 0
            'e2' LECT flui3d TERM COND NEAR POIN -16.200 0.1655 0
            'e1' LECT flui3d TERM COND NEAR POIN -16.190 0.1655 0
            'trigger' LECT tube TERM COND NEAR POIN -0.70 0 0
    NGRO 7 'nmemi' LECT mems TERM
                    COND CYLI X1 -20 Y1 0 Z1 0 X2 20 Y2 0 Z2 0 R 0.1650
            'nmemo' LECT mems DIFF nmemi TERM
            'nsymy' LECT mems TERM COND Y LT 0.001
            'nsymz' LECT mems TERM COND Z LT 0.001
            'm1c'   LECT mem1 TERM COND NEAR POIN -16.335 0 0
            'm2c'   LECT mem2 TERM COND NEAR POIN -16.265 0 0
!           'm3c'   LECT mem3 TERM COND NEAR POIN -16.195 0 0
            'pt0' LECT tube TERM COND NEAR POIN -16.19999 0.0 0.0
    EPAI 0.50E-3 LECT mems TERM
         3.00E-3 LECT fake TERM
         1.00E-3 LECT pinbcm TERM
         5.00E-3 LECT npincm TERM ! Only for visualization
    COUL TURQ LECT tube tra lp3xl TERM
         VERT LECT fir2 TERM
         ROSE LECT fir1 TERM
         ROUG LECT driver TERM
         GR50 LECT mems TERM
         ROUG LECT fake TERM
         JAUN LECT pre TERM
         GR50 LECT pinbcm TERM
         ROSE LECT S3 S1 S2 S5 S6 S11 S12 S15 S16 TERM
!      DIAM DROI 0.1692568 LECT tubelp1 TERM
ADAP THRS ECRO 3 TMIN 0.01 TMAX 0.4 MAXL 2
         LECT mems TERM
GRIL LAGR LECT mems fake TERM
FONC 1 TABL 5 0.0       0.0
              1.0E-3    1.0
              2.999E-3  1.0
              3.0E-3    0.0
              100.0E-3  0.0
MATE
    !LOI 1
    VM23 RO 1380 YOUN 2757.9E6 NU 0.495 ELAS 100.E6 ! "Melinex/Mylar/
                                                    !  PET" EPAI=0.5
                                                    !  = Material 2
         FAIL PEPR LIMI 1.0
         TRAC 3 100.E6 0.03626
               180.E6 1.5
               230.E6 3.5
         LECT mems _q4gs TERM
    !LOI 2
    GAZP RO 13.445 GAMM 1.4 CV 719.286 PINI 11.36E5 PREF 9.968E4
         LECT none TERM
    !LOI 3
    GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
         LECT none TERM
    !LOI 4
    GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
         LECT none TERM
    !LOI 5
    GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
         LECT flui3d _cuvf TERM
    !LOI 6
  !  IMPE PIMP PRES 13.723E5 PREF 1.011E5 FONC 1
  !  IMPE PIMP PRES 12.98E5 PREF 0 FONC 1
    IMPE PIMP PRES 4.20E5 PREF 0 FONC 1
         LECT pre _cl3d TERM
    GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
         LECT epar1 epar2 TERM
    GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
         LECT rac3d1d tubelpp TERM
    PARO PSIL 0.02
         LECT tubelpp TERM
    MULT 8 9 LECT tubelpp TERM
    GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
         LECT _cuvf TERM
    FANT 0.0
         LECT fake TERM
    VM23 RO 7850 YOUNG 2.1E11 NU 0.3 ELAS 1000E6 ! Elastic steel
         TRAC 2 1000E6 0.0047619048
                1100E6 5.1
         LECT pinbcm TERM
    MASS 0.0 YOUN 2.1E11 NU 0.33
         LECT npincm TERM
! In order to obtain a printout at least of the 3D VFCCs I am obliged
! to use a different material for tubelp3 and other 3D parts, but with
! the same characteristics as the material used for tubelp1
!OPTI PINS ASN
LINK COUP SPLT NONE
    BLOQ 123 LECT nmemo TERM
    BLOQ 123 LECT pinbcm TERM
    CONT SPLA NX 0 NY 1 NZ 0 LECT nsymy TERM
    CONT SPLA NX 0 NY 0 NZ 1 LECT nsymz TERM
LINK DECO
    PINB PENA SFAC 1.0
         BODY                             DMIN 0.003  ! #6
              LECT mem1 TERM
         BODY                             DMIN 0.003  ! #7
              LECT mem2 TERM
!         BODY                             DMIN 0.003  ! #8
!              LECT mem3 TERM
         BODY                             MLEV 0      ! #8
              LECT fake TERM
         BODY                             DIAM 5.E-3
              LECT npincm TERM
         EXCL PAIR 1 3
         EXCL PAIR 2 3
!         EXCL PAIR 3 4
         EXCL PAIR 3 4
    FLSW STRU LECT mems TERM
         FLUI LECT fcoup1 TERM
         GAMM 1.1
         DELE 1.1
         DGRI
         FACE
         BFLU 2 ! block if at least one node is in influence domain
         FSCP 1 ! couple in all directions
         ADAP LMAX 3 SCAL 1.5
INIT SKIP UPTO 3.E-3 VFCC
    ADAP IMAT TIME 3.E-3
              2 MATE 2 OBJE LECT flui3d TERM
                       INSI SURF LECT mem1 TERM
               MATE 3 OBJE LECT flui3d TERM
                      OUTS SURF LECT mem1 TERM
                      INSI SURF LECT mem2 TERM
!              MATE 4 OBJE LECT flui3d TERM
!                      OUTS SURF LECT mem2 TERM
!                      INSI SURF LECT mem3 TERM
ECRI DEPL VITE ECRO FAIL TFRE 0.25E-3
         NOPO !POIN LECT cen TERM
         ELEM LECT S1 TERM
    FICH ALIC TEMP TFRE 10.e-6
   ! FICH ALIT FREQ 0 TFRE 0.D0
        ! TIME PROG 0.D0 PAS 0.5D-3 28.D-3 PAS 0.01D-3 110.D-3
         !POIN LECT cen TERM
         POIN LECT m1c m2c TERM
         ELEM LECT S1 S2 S3 S5 S6 S11 S12 S15 S16 e1 e2 e3 e4 TERM
   FICH SPLI ALIC FREQ 0 TFRE 1.D-3 ! 0.D0
   !      TIME PROG 0.D0 PAS 0.5D-3 28.D-3 PAS 0.1D-3 50.D-3
   !      PAS 2.D-3 80.D-3
!   FICH PVTK FREQ 0 TFRE 0.D0
!       TIME PROG 0.D0 PAS 0.5D-3 28.D-3 PAS 0.1D-3 50.D-3
!       PAS 2.D-3 110.D-3
!       GROU AUTO
!       VARI DEPL VITE FAIL ACCE VCVI CONT ECRO FLIA DTST
   FICH FORM MAPP OBJE LECT flui3d tubelp1 TERM
!                TIME PROG 38.0E-3 TERM
!                TIME PROG 31.0E-3 TERM
!                TIME PROG 31.0E-3 PAS 0.5E-3 33.0E-3 TERM
                 TRIG ECRO 1 TSTO TVAL 1.02E5 LECT trigger TERM
OPTI NOTE CSTA 0.25
    STEP IO
    LOG 1
    JAUM
    LMST
  ! FANT 8.0E-3 LECT mems TERM !_q4gs TERM !fc is this OK?
    VFCC FCON 6 ! hllc solver
         ORDR 2 ! order in space
         STPS 2 ! order in time
         RECO 1 ! Not accepted by CAL_VFCC_1D
         NTIL
    ADAP RCON !TRIG ECRO 1 TVAL 1.02E5 LECT trigger TERM
    PINS GRID DPIN 1.01
    FLS  CUB8 2 ! For the inverse mapping
    QUAS STAT 1670 0.1 UPTO 3.0E-3 !fc is this OK ???
CALC TINI 0 TEND 40.0E-3
FIN
```

D7710600maplw.epx

```
D7710600MAPLW
ECHO
 CONV WIN
RESU SPLI ALIC 'D7710600MAPL.ali' GARD PSCR
COMP COUL ROUG LECT mem1 TERM
         VERT LECT mem2 TERM
!         TURQ LECT mem3 TERM
         GR50 LECT pinbcm TERM
```

```
         TURQ LECT flui3d TERM
*======================================================================
SORT VISU NSTO 1
*======================================================================
PLAY
CAME   1 EYE  -1.64954E+01 -9.15031E-01  2.02341E-03
!        Q     6.95266E-01  6.95266E-01 -1.28860E-01 -1.28860E-01
        VIEW  3.58368E-01  9.33580E-01  1.91478E-10
        RIGH  9.33580E-01 -3.58368E-01 -7.35028E-11
        UP    3.05311E-16 -2.05101E-10  1.00000E+00
        FOV   2.48819E+01
!NAVIGATION MODE: FREE CAMERA
!CENTER : -1.62650E+01  8.28568E-02  2.02341E-03
!RSPHERE:  2.04827E-01
!RADIUS :  1.02414E+00
!ASPECT :  1.33333E+00
!NEAR   :  8.09342E-01
!FAR    :  1.21900E+00
SCEN GEOM NAVI FREE
         FACE SBAC
         LINE SFRE
     ISO  FILL FIEL ECRO 1 SCAL USER PROG 1.E5 PAS 0.5E5 7.5E5 TERM
         SUPP LECT flui3d TERM
     LIMA ON
SLER CAM1 1 NFRA 1
FREQ 1
TRAC OFFS SIZE 800 600 FICH BMP
         OBJE LECT mems pinbcm flui3d TERM SYXY TOLS 1.E-3 NFAI REND
GOTR LOOP 33 OFFS SIZE 800 600 FICH BMP
         OBJE LECT mems pinbcm flui3d TERM SYXY TOLS 1.E-3 NFAI REND
ENDPLAY
*======================================================================
SUIT
Post-treatment (make avi file from bitmaps)
ECHO
RESU SPLI ALIC 'D7710600MAPL.ali' GARD PSCR
*=================================================================
SORT VISU NSTO 1
*=================================================================
PLAY
MAVI FPS 10 KFRE 10 COMP -1 REND
ENDPLAY
*=================================================================
FIN
```

D7710600maplx.epx

```
D7710600MAPLX
ECHO
!CONV WIN
RESU SPLI ALIC 'D7710600MAPL.ali' GARD PSCR
COMP NGRO 1 'xaxo' LECT flui3d tubelp1 TERM
                  COND LINE X1 -17.105 Y1 0 Z1 0
                            X2 -0.6    Y2 0 Z2 0 TOL 1.E-3
SORT GRAP
AXTE 1.0 'Time [s]'
SCOU 1 'p_trig' NSTO 34 SAXE 1.0 'Abscissa' INIT LECT xaxo TERM
                    ECRO COMP 1
                    SUPP LECT flui3d tubelp1 TERM
SCOU 2 'r_trig' NSTO 34 SAXE 1.0 'Abscissa' INIT LECT xaxo TERM
                    ECRO COMP 2
                    SUPP LECT flui3d tubelp1 TERM
SCOU 3 'v_trig' NSTO 34 SAXE 1.0 'Abscissa' INIT LECT xaxo TERM
                    VCVI COMP 1
                    SUPP LECT flui3d tubelp1 TERM
!
RCOU 11 'p_trig' FICH 'D7710600MAPDX.pun' RENA 'p_d_trig'
RCOU 12 'r_trig' FICH 'D7710600MAPDX.pun' RENA 'r_d_trig'
RCOU 13 'v_trig' FICH 'D7710600MAPDX.pun' RENA 'v_d_trig'
TRAC 1 11 AXES 1.0 'PRESS. [Pa]'
COLO NOIR ROUG
TRAC 2 12 AXES 1.0 'DENS. [kg/m3]'
COLO NOIR ROUG
TRAC 3 13 AXES 1.0 'VELO. [m/s]'
COLO NOIR ROUG
!
TRAC 1 AXES 1.0 'PRESS. [Pa]'
TRAC 2 AXES 1.0 'DENS. [kg/m3]'
TRAC 3 AXES 1.0 'VELO. [m/s]'
LIST 1 AXES 1.0 'PRESS. [Pa]'
LIST 2 AXES 1.0 'DENS. [kg/m3]'
LIST 3 AXES 1.0 'VELO. [m/s]'
!
FIN
```

D7710600maply.epx

```
D7710600MAPLY
ECHO
 CONV WIN
RESU SPLI ALIC 'D7710600MAPL.ali' GARD PSCR
COMP COUL ROUG LECT mem1 TERM
         VERT LECT mem2 TERM
!        TURQ LECT mem3 TERM
         GR50 LECT pinbcm TERM
*======================================================================
SORT VISU NSTO 9
*======================================================================
PLAY
CAME   1 EYE  -1.72612E+01  2.81122E-03  2.81116E-03
!        Q     7.07107E-01  0.00000E+00 -7.07107E-01  0.00000E+00
         VIEW  1.00000E+00  0.00000E+00  2.05103E-10
         RIGH -2.05103E-10  0.00000E+00  1.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER : -1.62964E+01  2.81122E-03  2.81116E-03
!RSPHERE:  2.41195E-01
!RADIUS :  9.64780E-01
!ASPECT :  1.00000E+00
!NEAR   :  7.23585E-01
!FAR    :  1.44717E+00
SCEN GEOM NAVI FREE
         FACE SBAC
     LIMA ON
SLER CAM1 1 NFRA 1
TRAC DEFO AMPD 0.0
     OFFS SIZE 600 600 FICH BMP
         OBJE LECT mem1 pinbcm TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
TRAC DEFO AMPD 0.0
     OFFS SIZE 600 600 FICH BMP
         OBJE LECT mem2 pinbcm TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
FREQ 25
GO
TRAC DEFO AMPD 0.0
     OFFS SIZE 600 600 FICH BMP
         OBJE LECT mem1 pinbcm TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
TRAC DEFO AMPD 0.0
     OFFS SIZE 600 600 FICH BMP
         OBJE LECT mem2 pinbcm TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
ENDPLAY
*======================================================================
FIN
```

D7710600maply2.epx

```
D7710600MAPLY2
ECHO
 CONV WIN
RESU SPLI ALIC 'D7710600MAPL.ali' GARD PSCR
COMP COUL ROUG LECT mem1 TERM
         VERT LECT mem2 TERM
!        TURQ LECT mem3 TERM
         GR50 LECT pinbcm TERM
*======================================================================
SORT VISU NSTO 9
*======================================================================
PLAY
CAME   1 EYE  -1.72612E+01  2.81122E-03  2.81116E-03
!        Q     7.07107E-01  0.00000E+00 -7.07107E-01  0.00000E+00
         VIEW  1.00000E+00  0.00000E+00  2.05103E-10
         RIGH -2.05103E-10  0.00000E+00  1.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER : -1.62964E+01  2.81122E-03  2.81116E-03
!RSPHERE:  2.41195E-01
!RADIUS :  9.64780E-01
!ASPECT :  1.00000E+00
!NEAR   :  7.23585E-01
!FAR    :  1.44717E+00
SCEN GEOM NAVI FREE
         FACE SBAC
     LIMA ON
SLER CAM1 1 NFRA 1
TRAC DEFO AMPD 0.0
     OFFS SIZE 600 600 FICH BMP
         OBJE LECT mem1 pinbcm TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
TRAC DEFO AMPD 0.0
     OFFS SIZE 600 600 FICH BMP
         OBJE LECT mem2 pinbcm TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
!FREQ 25
!GO
!TRAC DEFO AMPD 0.0
!     OFFS SIZE 600 600 FICH BMP
!         OBJE LECT mem1 pinbcm TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
!TRAC DEFO AMPD 0.0
!     OFFS SIZE 600 600 FICH BMP
!         OBJE LECT mem2 pinbcm TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
ENDPLAY
*======================================================================
FIN
```

D7710600mapmy3.epx

```
D7710600MAPMY3
ECHO
 CONV WIN
RESU SPLI ALIC 'D7710600MAPM.ali' GARD PSCR
COMP COUL ROUG LECT mem1 TERM
         VERT LECT mem2 TERM
!        TURQ LECT mem3 TERM
         GR50 LECT pinbcm TERM
*======================================================================
SORT VISU NSTO 15
*======================================================================
PLAY
CAME   1 EYE  -1.72612E+01  2.81122E-03  2.81116E-03
!        Q     7.07107E-01  0.00000E+00 -7.07107E-01  0.00000E+00
```

```
        VIEW  1.00000E+00  0.00000E+00  2.05103E-10
        RIGH -2.05103E-10  0.00000E+00  1.00000E+00
        UP    0.00000E+00  1.00000E+00  0.00000E+00
        FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER : -1.62964E+01  2.81122E-03  2.81116E-03
!RSPHERE:  2.41195E-01
!RADIUS :  9.64780E-01
!ASPECT :  1.00000E+00
!NEAR   :  7.23585E-01
!FAR    :  1.44717E+00
SCEN GEOM NAVI FREE
         FACE SBAC
     LIMA ON
SLER CAM1 1 NFRA 1
TRAC DEFO AMPD 0.0
     OFFS SIZE 600 600 FICH BMP
          OBJE LECT mem1 pinbcm TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
TRAC DEFO AMPD 0.0
     OFFS SIZE 600 600 FICH BMP
          OBJE LECT mem2 pinbcm TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
ENDPLAY
*=====================================================================
FIN
```

D7710600mapn.epx

```
D7710600MAPN
ECHO
!CONV win
CAST mesh
TRID ALE
EROS 1.0
!DIME ADAP NPOI 300000
!          CUVF 300000
!          NVFI 800000
DIME ADAP NPOI 600000
          CUVF 600000
          NVFI 1600000
          Q4GS 10000
          CL3D 10000
          NPIN 10000
     ENDA
     JONC 218 ! Total n. of nodes in a TUBM juncton
     NALE 1 NBLE 1
     TERM
GEOM
     Q4GS  mems pinbcm
     PMAT npincm
     CUVF flui3d
     T3GS fake
     TUVF tubelp1
     CL3D pre face3d
     TUBM rac3d1d
TERM
COMP DIAM DROI 0.1692568 LECT tubelp1 TERM
     RACC TUBM LECT rac3d1d  TERM
          NTUB LECT p1a   TERM DTUB 0.1692568
          FACE LECT face3d TERM COEF 1.0
! Attention: the TUBM element (raclp) is NOT included
! in the "mesh" object (although it IS indeed passed in from Cast3m).
! For this reason we must add it explicitly in the GROU directive below
! if we want to have it in the extracted element groups.
     GROU 22 'nrac3d1d' LECT mesh1 rac3d1d TERM
                   COND XB GT -12.6952 COND XB LT -12.6948
            'fcoup1' LECT flui3d TERM
                   COND XB GT -16.405
                   COND XB LT -15.105
            'S1' LECT tube TERM COND NEAR POIN -0.345 0.15 0.15
            'S2' LECT tube TERM COND NEAR POIN -0.245 0.15 0.15
            'S3' LECT tube TERM COND NEAR POIN 0.0 0.0 0.0
            'S16' LECT flui3d TERM COND NEAR POIN -15.225 0 0.15
            'S15' LECT flui3d TERM COND NEAR POIN -15.125 0 0.15
            'S12' LECT tube TERM COND NEAR POIN -12.495 0 0.15
            'S11' LECT tube TERM COND NEAR POIN -12.395 0 0.15
            'S6' LECT tube TERM COND NEAR POIN -5.685 0 0.15
            'S5' LECT tube TERM COND NEAR POIN -5.585 0 0.15
            'epar1' LECT tubelp1 TERM COND NEAR NODE LECT p1a TERM
            'epar2' LECT tubelp1 TERM COND NEAR NODE LECT p1d3 TERM
            'tubelpp' LECT tubelp1 DIFF epar1 epar2 TERM
!            'tubelpp' LECT tubelp1 DIFF epar1 TERM ! epar2 TERM
            'memc1' LECT mem1 TERM COND NEAR POIN -16.435 0 0
            'memc1d' LECT mem1 TERM COND CYLI X1 -16.505 Y1 0 Z1 0
                                       X2 -16.305 Y2 0 Z2 0 R .15
            'memc1b' LECT mem1 DIFF memc1d TERM
            'e4' LECT flui3d TERM COND NEAR POIN -16.340 0.1655 0
            'e3' LECT flui3d TERM COND NEAR POIN -16.270 0.1655 0
            'e2' LECT flui3d TERM COND NEAR POIN -16.200 0.1655 0
            'e1' LECT flui3d TERM COND NEAR POIN -16.190 0.1655 0
            'trigger' LECT tube TERM COND NEAR POIN -0.70 0 0
     NGRO 7 'nmemi' LECT mems TERM
                  COND CYLI X1 -20 Y1 0 Z1 0 X2 20 Y2 0 Z2 0 R 0.1650
            'nmemo' LECT mems DIFF nmemi TERM
            'nsymy' LECT mems TERM COND Y LT 0.001
            'nsymz' LECT mems TERM COND Z LT 0.001
            'm1c'   LECT mem1 TERM COND NEAR POIN -16.335 0 0
            'm2c'   LECT mem2 TERM COND NEAR POIN -16.265 0 0
!            'm3c'   LECT mem3 TERM COND NEAR POIN -16.195 0 0
            'pt0' LECT tube TERM COND NEAR POIN -16.19999 0.0 0.0
     EPAI 0.50E-3 LECT mems TERM
          3.00E-3 LECT fake TERM
          1.00E-3 LECT pinbcm TERM
          5.00E-3 LECT npincm TERM ! Only for visualization
     COUL TURQ LECT tube tra lp3xl TERM
          VERT LECT fir2 TERM
          ROSE LECT fir1 TERM
          ROUG LECT driver TERM
          GR50 LECT mems TERM
          ROUG LECT fake TERM
          JAUN LECT pre TERM
          GR50 LECT pinbcm TERM
          ROSE LECT S3 S1 S2 S5 S6 S11 S12 S15 S16 TERM
!       DIAM DROI 0.1692568 LECT tubelp1 TERM
ADAP THRS ECRO 3 TMIN 0.01 TMAX 0.4 MAXL 2
          LECT mems TERM
GRIL LAGR LECT mems fake TERM
FONC 1 TABL 5 0.0       0.0
              1.0E-3    1.0
              2.999E-3  1.0
              3.0E-3    0.0
              100.0E-3  0.0
MATE
    !LOI 1
     VM23 RO 1380 YOUN 2757.9E6 NU 0.495 ELAS 100.E6 ! "Melinex/Mylar/
                                                      !  PET" EPAI=0.5
                                                      !  = Material 2
          FAIL PEPR LIMI 1.0
          TRAC 3 100.E6 0.03626
                 180.E6 1.5
                 230.E6 3.5
          LECT mems _q4gs TERM
    !LOI 2
     GAZP RO 13.445 GAMM 1.4 CV 719.286 PINI 11.36E5 PREF 9.968E4
          LECT none TERM
    !LOI 3
     GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
          LECT none TERM
    !LOI 4
     GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
          LECT none TERM
    !LOI 5
     GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
          LECT flui3d _cuvf TERM
    !LOI 6
  !   IMPE PIMP PRES 13.723E5 PREF 1.011E5 FONC 1
  !   IMPE PIMP PRES 12.98E5 PREF 0 FONC 1
     IMPE PIMP PRES 4.20E5 PREF 0 FONC 1
          LECT pre _cl3d TERM
     GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
          LECT epar1 epar2 TERM
     GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
          LECT rac3d1d tubelpp TERM
     PARO PSIL 0.02
          LECT tubelpp TERM
     MULT 8 9 LECT tubelpp TERM
     GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
          LECT _cuvf TERM
     FANT 0.0
          LECT fake TERM
     VM23 RO 7850 YOUNG 2.1E11 NU 0.3 ELAS 1000E6 ! Elastic steel
          TRAC 2 1000E6 0.0047619048
                 1100E6 5.1
          LECT pinbcm TERM
     MASS 0.0 YOUN 2.1E11 NU 0.33
          LECT npincm TERM
! In order to obtain a printout at least of the 3D VFCCs I am obliged
! to use a different material for tubelp3 and other 3D parts, but with
! the same characteristics as the material used for tubelp1
!OPTI PINS ASN
LINK COUP SPLT NONE
     BLOQ 123 LECT nmemo TERM
     BLOQ 123 LECT pinbcm TERM
     CONT SPLA NX 0 NY 1 NZ 0 LECT nsymy TERM
     CONT SPLA NX 0 NY 0 NZ 1 LECT nsymz TERM
LINK DECO
     PINB PENA SFAC 1.0
          BODY                               DMIN 0.003  ! #6
               LECT mem1 TERM
          BODY                               DMIN 0.003  ! #7
               LECT mem2 TERM
!          BODY                               DMIN 0.003  ! #8
!               LECT mem3 TERM
          BODY                               MLEV 0      ! #8
               LECT fake TERM
          BODY                               DIAM 5.E-3
               LECT npincm TERM
          EXCL PAIR 1 3
          EXCL PAIR 2 3
!          EXCL PAIR 3 4
          EXCL PAIR 3 4
     FLSW STRU LECT mems TERM
          FLUI LECT fcoup1 TERM
          GAMM 1.1
          DELE 1.1
          DGRI
          FACE
          BFLU 2 ! block if at least one node is in influence domain
          FSCP 1 ! couple in all directions
          ADAP LMAX 3 SCAL 1.5
INIT SKIP UPTO 3.E-3 VFCC
     ADAP IMAT TIME 3.E-3
              2 MATE 2 OBJE LECT flui3d TERM
                       INSI SURF LECT mem1 TERM
                MATE 3 OBJE LECT flui3d TERM
```

```
                      OUTS SURF LECT mem1 TERM
                      INSI SURF LECT mem2 TERM
!                MATE 4 OBJE LECT flui3d TERM
!                       OUTS SURF LECT mem2 TERM
!                       INSI SURF LECT mem3 TERM
ECRI DEPL VITE ECRO FAIL TFRE 0.25E-3
          NOPO !POIN LECT cen TERM
          ELEM LECT S1 TERM
     FICH ALIC TEMP TFRE 10.e-6
    ! FICH ALIT FREQ 0 TFRE 0.D0
         ! TIME PROG 0.D0 PAS 0.5D-3 28.D-3 PAS 0.01D-3 110.D-3
          !POIN LECT cen TERM
          POIN LECT m1c m2c TERM
          ELEM LECT S1 S2 S3 S5 S6 S11 S12 S15 S16 e1 e2 e3 e4 TERM
    FICH SPLI ALIC FREQ 0 TFRE 1.D-3 ! 0.D0
    !      TIME PROG 0.D0 PAS 0.5D-3 28.D-3 PAS 0.1D-3 50.D-3
    !      PAS 2.D-3 80.D-3
!   FICH PVTK FREQ 0 TFRE 0.D0
!        TIME PROG 0.D0 PAS 0.5D-3 28.D-3 PAS 0.1D-3 50.D-3
!        PAS 2.D-3 110.D-3
!        GROU AUTO
!        VARI DEPL VITE FAIL ACCE VCVI CONT ECRO FLIA DTST
    FICH FORM MAPP OBJE LECT flui3d tubelp1 TERM
!                   TIME PROG 38.0E-3 TERM
!                   TIME PROG 31.0E-3 TERM
!                   TIME PROG 31.0E-3 PAS 0.5E-3 33.0E-3 TERM
                    TRIG ECRO 1 TSTO TVAL 1.02E5 LECT trigger TERM
OPTI NOTE CSTA 0.25
     STEP IO
     LOG 1
     JAUM
     LMST
   ! FANT 8.0E-3 LECT mems TERM !_q4gs TERM !fc is this OK?
     VFCC FCON 6 ! hllc solver
          ORDR 2 ! order in space
          STPS 2 ! order in time
          RECO 1 ! Not accepted by CAL_VFCC_1D
          NTIL
     ADAP RCON !TRIG ECRO 1 TVAL 1.02E5 LECT trigger TERM
     PINS GRID DPIN 1.01
     FLS  CUB8 2 ! For the inverse mapping
     QUAS STAT 1670 0.1 UPTO 3.0E-3 !fc is this OK ???
CALC TINI 0 TEND 40.0E-3
FIN
```

D7710600mapnw.epx

```
D7710600MAPNW
ECHO
 CONV WIN
RESU SPLI ALIC 'D7710600MAPN.ali' GARD PSCR
COMP COUL ROUG LECT mem1 TERM
          VERT LECT mem2 TERM
!         TURQ LECT mem3 TERM
          GR50 LECT pinbcm TERM
          TURQ LECT flui3d TERM
*=======================================================================
SORT VISU NSTO 1
*=======================================================================
PLAY
CAME   1 EYE  -1.64954E+01 -9.15031E-01  2.02341E-03
!        Q     6.95266E-01  6.95266E-01 -1.28860E-01 -1.28860E-01
         VIEW  3.58368E-01  9.33580E-01  1.91478E-10
         RIGH  9.33580E-01 -3.58368E-01 -7.35028E-11
         UP    3.05311E-16 -2.05101E-10  1.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: FREE CAMERA
!CENTER : -1.62650E+01  8.28568E-02  2.02341E-03
!RSPHERE:  2.04827E-01
!RADIUS :  1.02414E+00
!ASPECT :  1.33333E+00
!NEAR   :  8.09342E-01
!FAR    :  1.21900E+00
SCEN GEOM NAVI FREE
          FACE SBAC
          LINE SFRE
     ISO  FILL FIEL ECRO 1 SCAL USER PROG 1.E5 PAS 0.5E5 7.5E5 TERM
          SUPP LECT flui3d TERM
     LIMA ON
SLER CAM1 1 NFRA 1
FREQ 1
TRAC OFFS SIZE 800 600 FICH BMP
          OBJE LECT mems pinbcm flui3d TERM SYXY TOLS 1.E-3 NFAI REND
GOTR LOOP 33 OFFS SIZE 800 600 FICH BMP
          OBJE LECT mems pinbcm flui3d TERM SYXY TOLS 1.E-3 NFAI REND
ENDPLAY
*=======================================================================
SUIT
Post-treatment (make avi file from bitmaps)
ECHO
RESU SPLI ALIC 'D7710600MAPN.ali' GARD PSCR
*=================================================================
SORT VISU NSTO 1
*=================================================================
PLAY
MAVI FPS 5 KFRE 5 COMP -1 REND
ENDPLAY
*=================================================================
FIN
```

D7710600mapnx.epx

```
D7710600MAPNX
ECHO
!CONV WIN
RESU SPLI ALIC 'D7710600MAPN.ali' GARD PSCR
COMP NGRO 1 'xaxo' LECT flui3d tubelp1 TERM
                   COND LINE X1 -17.105 Y1 0 Z1 0
                             X2 -0.6    Y2 0 Z2 0 TOL 1.E-3
SORT GRAP
AXTE 1.0 'Time [s]'
SCOU 1 'p_trig' NSTO 34 SAXE 1.0 'Abscissa' INIT LECT xaxo TERM
                      ECRO COMP 1
                      SUPP LECT flui3d tubelp1 TERM
SCOU 2 'r_trig' NSTO 34 SAXE 1.0 'Abscissa' INIT LECT xaxo TERM
                      ECRO COMP 2
                      SUPP LECT flui3d tubelp1 TERM
SCOU 3 'v_trig' NSTO 34 SAXE 1.0 'Abscissa' INIT LECT xaxo TERM
                      VCVI COMP 1
                      SUPP LECT flui3d tubelp1 TERM
RCOU 11 'p_trig' FICH 'D7710600MAPDX.pun' RENA 'p_d_trig'
RCOU 12 'r_trig' FICH 'D7710600MAPDX.pun' RENA 'r_d_trig'
RCOU 13 'v_trig' FICH 'D7710600MAPDX.pun' RENA 'v_d_trig'
RCOU 21 'p_trig' FICH 'D7710600MAPEX.pun' RENA 'p_e_trig'
RCOU 22 'r_trig' FICH 'D7710600MAPEX.pun' RENA 'r_e_trig'
RCOU 23 'v_trig' FICH 'D7710600MAPEX.pun' RENA 'v_e_trig'
RCOU 31 'p_trig' FICH 'D7710600MAPJX.pun' RENA 'p_j_trig'
RCOU 32 'r_trig' FICH 'D7710600MAPJX.pun' RENA 'r_j_trig'
RCOU 33 'v_trig' FICH 'D7710600MAPJX.pun' RENA 'v_j_trig'
TRAC 1 11 21 31 AXES 1.0 'PRESS. [Pa]'
COLO TURQ VERT ROUG NOIR
TRAC 2 12 22 32 AXES 1.0 'DENS. [kg/m3]'
COLO TURQ VERT ROUG NOIR
TRAC 3 13 23 33 AXES 1.0 'VELO. [m/s]'
COLO TURQ VERT ROUG NOIR
!
TRAC 1 AXES 1.0 'PRESS. [Pa]'
TRAC 2 AXES 1.0 'DENS. [kg/m3]'
TRAC 3 AXES 1.0 'VELO. [m/s]'
LIST 1 AXES 1.0 'PRESS. [Pa]'
LIST 2 AXES 1.0 'DENS. [kg/m3]'
LIST 3 AXES 1.0 'VELO. [m/s]'
FIN
```

D7710600mapny.epx

```
D7710600MAPNY
ECHO
 CONV WIN
RESU SPLI ALIC 'D7710600MAPN.ali' GARD PSCR
COMP COUL ROUG LECT mem1 TERM
          VERT LECT mem2 TERM
!         TURQ LECT mem3 TERM
          GR50 LECT pinbcm TERM
*=====================================================================
SORT VISU NSTO 9
*=====================================================================
PLAY
CAME   1 EYE  -1.72612E+01  2.81122E-03  2.81116E-03
!        Q     7.07107E-01  0.00000E+00 -7.07107E-01  0.00000E+00
         VIEW  1.00000E+00  0.00000E+00  2.05103E-10
         RIGH -2.05103E-10  0.00000E+00  1.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER : -1.62964E+01  2.81122E-03  2.81116E-03
!RSPHERE:  2.41195E-01
!RADIUS :  9.64780E-01
!ASPECT :  1.00000E+00
!NEAR   :  7.23585E-01
!FAR    :  1.44717E+00
SCEN GEOM NAVI FREE
          FACE SBAC
     LIMA ON
SLER CAM1 1 NFRA 1
TRAC DEFO AMPD 0.0
     OFFS SIZE 600 600 FICH BMP
          OBJE LECT mem1 pinbcm TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
TRAC DEFO AMPD 0.0
     OFFS SIZE 600 600 FICH BMP
          OBJE LECT mem2 pinbcm TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
FREQ 25
GO
TRAC DEFO AMPD 0.0
     OFFS SIZE 600 600 FICH BMP
          OBJE LECT mem1 pinbcm TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
TRAC DEFO AMPD 0.0
     OFFS SIZE 600 600 FICH BMP
          OBJE LECT mem2 pinbcm TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
ENDPLAY
*=====================================================================
FIN
```

D7710600mapnzz.epx

```
D7710600MAPNZZ
ECHO
 CONV WIN
RESU SPLI ALIC 'D7710600MAPN.ali' GARD PSCR
```

```
COMP COUL ROUG LECT mem1 TERM
          VERT LECT mem2 TERM
!         TURQ LECT mem3 TERM
          GR50 LECT pinbcm TERM
*=======================================================================
SORT VISU NSTO 1
*=======================================================================
PLAY
CAME   1 EYE  -1.64954E+01 -9.15031E-01  2.02341E-03
!        Q     6.95266E-01  6.95266E-01 -1.28860E-01 -1.28860E-01
         VIEW  3.58368E-01  9.33580E-01  1.91478E-10
         RIGH  9.33580E-01 -3.58368E-01 -7.35028E-11
         UP    3.05311E-16 -2.05101E-10  1.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: FREE CAMERA
!CENTER : -1.62650E+01  8.28568E-02  2.02341E-03
!RSPHERE:  2.04827E-01
!RADIUS :  1.02414E+00
!ASPECT :  1.33333E+00
!NEAR   :  8.09342E-01
!FAR    :  1.21900E+00
SCEN GEOM NAVI FREE
          FACE SBAC
     LIMA ON
SLER CAM1 1 NFRA 1
FREQ 1
TRAC OFFS SIZE 800 600 FICH BMP
          OBJE LECT mems pinbcm TERM SYXY TOLS 1.E-3 NFAI REND
GOTR LOOP 33 OFFS SIZE 800 600 FICH BMP
          OBJE LECT mems pinbcm TERM SYXY TOLS 1.E-3 NFAI REND
ENDPLAY
*=======================================================================
SUIT
Post-treatment (make avi file from bitmaps)
ECHO
RESU SPLI ALIC 'D7710600MAPN.ali' GARD PSCR
*=================================================================
SORT VISU NSTO 1
*=================================================================
PLAY
MAVI FPS 10 KFRE 10 COMP -1 REND
ENDPLAY
*=================================================================
FIN
```

D7710600mapo.epx

```
D7710600MAPO
ECHO
!CONV win
CAST mesh
TRID ALE
EROS 1.0
DIME ADAP NPOI 4000000
          CUVF 4000000
          NVFI 10000000
          Q4GS 10000
          CL3D 10000
          NPIN 10000
     ENDA
     JONC 218 ! Total n. of nodes in a TUBM juncton
     NALE 1 NBLE 1
     TERM
GEOM
     Q4GS  mems pinbcm
     PMAT npincm
     CUVF flui3d
     T3GS fake
     TUVF tubelp1
     CL3D pre face3d
     TUBM rac3d1d
TERM
COMP DIAM DROI 0.1692568 LECT tubelp1 TERM
     RACC TUBM LECT rac3d1d  TERM
          NTUB LECT p1a   TERM DTUB 0.1692568
          FACE LECT face3d TERM COEF 1.0
! Attention: the TUBM element (raclp) is NOT included
! in the "mesh" object (although it IS indeed passed in from Cast3m).
! For this reason we must add it explicitly in the GROU directive below
! if we want to have it in the extracted element groups.
     GROU 22 'nrac3d1d' LECT mesh1 rac3d1d TERM
                     COND XB GT -12.6952 COND XB LT -12.6948
             'fcoup1' LECT flui3d TERM
                     COND XB GT -16.405
                     COND XB LT -15.105
             'S1' LECT tube TERM COND NEAR POIN -0.345 0.15 0.15
             'S2' LECT tube TERM COND NEAR POIN -0.245 0.15 0.15
             'S3' LECT tube TERM COND NEAR POIN 0.0 0.0 0.0
             'S16' LECT flui3d TERM COND NEAR POIN -15.225 0 0.15
             'S15' LECT flui3d TERM COND NEAR POIN -15.125 0 0.15
             'S12' LECT tube TERM COND NEAR POIN -12.495 0 0.15
             'S11' LECT tube TERM COND NEAR POIN -12.395 0 0.15
             'S6' LECT tube TERM COND NEAR POIN -5.685 0 0.15
             'S5' LECT tube TERM COND NEAR POIN -5.585 0 0.15
             'epar1' LECT tubelp1 TERM COND NEAR NODE LECT p1a TERM
             'epar2' LECT tubelp1 TERM COND NEAR NODE LECT p1d3 TERM
             'tubelpp' LECT tubelp1 DIFF epar1 epar2 TERM
!             'tubelpp' LECT tubelp1 DIFF epar1 TERM ! epar2 TERM
             'memc1' LECT mem1 TERM COND NEAR POIN -16.435 0 0
             'memc1d' LECT mem1 TERM COND CYLI X1 -16.505 Y1 0 Z1 0
                                          X2 -16.305 Y2 0 Z2 0 R .15
             'memc1b' LECT mem1 DIFF memc1d TERM
             'e4' LECT flui3d TERM COND NEAR POIN -16.340 0.1655 0
             'e3' LECT flui3d TERM COND NEAR POIN -16.270 0.1655 0
             'e2' LECT flui3d TERM COND NEAR POIN -16.200 0.1655 0
             'e1' LECT flui3d TERM COND NEAR POIN -16.190 0.1655 0
             'trigger' LECT tube TERM COND NEAR POIN -0.70 0 0
     NGRO 7 'nmemi' LECT mems TERM
                    COND CYLI X1 -20 Y1 0 Z1 0 X2 20 Y2 0 Z2 0 R 0.1650
             'nmemo' LECT mems DIFF nmemi TERM
             'nsymy' LECT mems TERM COND Y LT 0.001
             'nsymz' LECT mems TERM COND Z LT 0.001
             'm1c'   LECT mem1 TERM COND NEAR POIN -16.335 0 0
             'm2c'   LECT mem2 TERM COND NEAR POIN -16.265 0 0
!             'm3c'   LECT mem3 TERM COND NEAR POIN -16.195 0 0
             'pt0' LECT tube TERM COND NEAR POIN -16.19999 0.0 0.0
     EPAI 0.50E-3 LECT mems TERM
          3.00E-3 LECT fake TERM
          1.00E-3 LECT pinbcm TERM
          5.00E-3 LECT npincm TERM ! Only for visualization
     DERO DISP 1.230 LECT mem1 TERM
          DISP 1.160 LECT mem2 TERM
     COUL TURQ LECT tube tra lp3xl TERM
          VERT LECT fir2 TERM
          ROSE LECT fir1 TERM
          ROUG LECT driver TERM
          GR50 LECT mems TERM
          ROUG LECT fake TERM
          JAUN LECT pre TERM
          GR50 LECT pinbcm TERM
          ROSE LECT S3 S1 S2 S5 S6 S11 S12 S15 S16 TERM
!       DIAM DROI 0.1692568 LECT tubelp1 TERM
ADAP THRS ECRO 3 TMIN 0.01 TMAX 0.4 MAXL 3
          LECT mems TERM
GRIL LAGR LECT mems fake TERM
FONC 1 TABL 5 0.0       0.0
              1.0E-3    1.0
              2.999E-3  1.0
              3.0E-3    0.0
              100.0E-3  0.0
MATE
    !LOI 1
     VM23 RO 1380 YOUN 2757.9E6 NU 0.495 ELAS 100.E6 ! "Melinex/Mylar/
                                                     !  PET" EPAI=0.5
                                                     !  = Material 2
          FAIL PEPR LIMI 1.0
          TRAC 3 100.E6 0.03626
                 180.E6 1.5
                 230.E6 3.5
          LECT mems _q4gs TERM
    !LOI 2
     GAZP RO 13.445 GAMM 1.4 CV 719.286 PINI 11.36E5 PREF 9.968E4
          LECT none TERM
    !LOI 3
     GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
          LECT none TERM
    !LOI 4
     GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
          LECT none TERM
    !LOI 5
     GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
          LECT flui3d _cuvf TERM
    !LOI 6
  !   IMPE PIMP PRES 13.723E5 PREF 1.011E5 FONC 1
  !   IMPE PIMP PRES 12.98E5 PREF 0 FONC 1
     IMPE PIMP PRES 4.20E5 PREF 0 FONC 1
          LECT pre _cl3d TERM
     GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
          LECT epar1 epar2 TERM
     GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
          LECT rac3d1d tubelpp TERM
     PARO PSIL 0.02
          LECT tubelpp TERM
     MULT 8 9 LECT tubelpp TERM
     GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
          LECT _cuvf TERM
     FANT 0.0
          LECT fake TERM
     VM23 RO 7850 YOUNG 2.1E11 NU 0.3 ELAS 1000E6 ! Elastic steel
          TRAC 2 1000E6 0.0047619048
                 1100E6 5.1
          LECT pinbcm TERM
     MASS 0.0 YOUN 2.1E11 NU 0.33
          LECT npincm TERM
! In order to obtain a printout at least of the 3D VFCCs I am obliged
! to use a different material for tubelp3 and other 3D parts, but with
! the same characteristics as the material used for tubelp1
!OPTI PINS ASN
LINK COUP SPLT NONE
     BLOQ 123 LECT nmemo TERM
     BLOQ 123 LECT pinbcm TERM
     CONT SPLA NX 0 NY 1 NZ 0 LECT nsymy TERM
     CONT SPLA NX 0 NY 0 NZ 1 LECT nsymz TERM
LINK DECO
     PINB PENA SFAC 1.0
          BODY                              DMIN 0.003  ! #6
               LECT mem1 TERM
          BODY                              DMIN 0.003  ! #7
               LECT mem2 TERM
!          BODY                              DMIN 0.003  ! #8
!               LECT mem3 TERM
          BODY                              MLEV 0      ! #8
               LECT fake TERM
```

```
        BODY                              DIAM 5.E-3
             LECT npincm TERM
        EXCL PAIR 1 3
        EXCL PAIR 2 3
!        EXCL PAIR 3 4
        EXCL PAIR 3 4
     FLSW STRU LECT mems TERM
        FLUI LECT fcoup1 TERM
        GAMM 1.1
        DELE 1.1
        DGRI
        FACE
        BFLU 2 ! block if at least one node is in influence domain
        FSCP 1 ! couple in all directions
        ADAP LMAX 4 SCAL 1.2
INIT SKIP UPTO 3.E-3 VFCC
     ADAP IMAT TIME 3.E-3
             2 MATE 2 OBJE LECT flui3d TERM
                      INSI SURF LECT mem1 TERM
              MATE 3 OBJE LECT flui3d TERM
                     OUTS SURF LECT mem1 TERM
                     INSI SURF LECT mem2 TERM
!               MATE 4 OBJE LECT flui3d TERM
!                      OUTS SURF LECT mem2 TERM
!                      INSI SURF LECT mem3 TERM
ECRI DEPL VITE ECRO FAIL TFRE 0.25E-3
        NOPO !POIN LECT cen TERM
        ELEM LECT S1 TERM
     FICH ALIC TEMP TFRE 10.e-6
    ! FICH ALIT FREQ 0 TFRE 0.D0
        ! TIME PROG 0.D0 PAS 0.5D-3 28.D-3 PAS 0.01D-3 110.D-3
        !POIN LECT cen TERM
        POIN LECT m1c m2c TERM
        ELEM LECT S1 S2 S3 S5 S6 S11 S12 S15 S16 e1 e2 e3 e4 TERM
    FICH SPLI ALIC FREQ 0 TFRE 1.D-3 ! 0.D0
    !      TIME PROG 0.D0 PAS 0.5D-3 28.D-3 PAS 0.1D-3 50.D-3
    !      PAS 2.D-3 80.D-3
!   FICH PVTK FREQ 0 TFRE 0.D0
!       TIME PROG 0.D0 PAS 0.5D-3 28.D-3 PAS 0.1D-3 50.D-3
!       PAS 2.D-3 110.D-3
!       GROU AUTO
!       VARI DEPL VITE FAIL ACCE VCVI CONT ECRO FLIA DTST
    FICH FORM MAPP OBJE LECT flui3d tubelp1 TERM
!                  TIME PROG 38.0E-3 TERM
!                  TIME PROG 31.0E-3 TERM
!                  TIME PROG 31.0E-3 PAS 0.5E-3 33.0E-3 TERM
                   TRIG ECRO 1 TSTO TVAL 1.02E5 LECT trigger TERM
OPTI NOTE CSTA 0.25
     STEP IO
     LOG 1
     JAUM
     LMST
   ! FANT 8.0E-3 LECT mems TERM !_q4gs TERM !fc is this OK?
     VFCC FCON 6 ! hllc solver
        ORDR 2 ! order in space
        STPS 2 ! order in time
        RECO 1 ! Not accepted by CAL_VFCC_1D
        NTIL
     ADAP RCON !TRIG ECRO 1 TVAL 1.02E5 LECT trigger TERM
     PINS GRID DPIN 1.01
     FLS  CUB8 2 ! For the inverse mapping
     QUAS STAT 1670 0.1 UPTO 3.0E-3 !fc is this OK ???
CALC TINI 0 TEND 40.0E-3
FIN
```

D7710600mapov.epx

```
D7710600MAPOV
ECHO
 CONV WIN
RESU SPLI ALIC 'D7710600MAPO.ali' GARD PSCR
COMP COUL ROUG LECT mem1 TERM
          VERT LECT mem2 TERM
!         TURQ LECT mem3 TERM
          GR50 LECT pinbcm TERM
          TURQ LECT flui3d TERM
*=======================================================================
SORT VISU NSTO 1
*=======================================================================
PLAY
CAME   1 EYE  -1.64954E+01 -9.15031E-01  2.02341E-03
!        Q     6.95266E-01  6.95266E-01 -1.28860E-01 -1.28860E-01
         VIEW  3.58368E-01  9.33580E-01  1.91478E-10
         RIGH  9.33580E-01 -3.58368E-01 -7.35028E-11
         UP    3.05311E-16 -2.05101E-10  1.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: FREE CAMERA
!CENTER : -1.62650E+01  8.28568E-02  2.02341E-03
!RSPHERE:  2.04827E-01
!RADIUS :  1.02414E+00
!ASPECT :  1.33333E+00
!NEAR   :  8.09342E-01
!FAR    :  1.21900E+00
SCEN GEOM NAVI FREE
          FACE SBAC
          LINE SFRE
     LIMA ON
SLER CAM1 1 NFRA 1
FREQ 1
TRAC OFFS SIZE 800 600 FICH BMP
          OBJE LECT mems pinbcm flui3d TERM SYXY TOLS 1.E-3 NFAI REND
GOTR LOOP 33 OFFS SIZE 800 600 FICH BMP
          OBJE LECT mems pinbcm flui3d TERM SYXY TOLS 1.E-3 NFAI REND
ENDPLAY
*=======================================================================
SUIT
Post-treatment (make avi file from bitmaps)
ECHO
RESU SPLI ALIC 'D7710600MAPO.ali' GARD PSCR
*=================================================================
SORT VISU NSTO 1
*=================================================================
PLAY
MAVI FPS 10 KFRE 10 COMP -1 REND
ENDPLAY
*=================================================================
FIN
```

D7710600mapow.epx

```
D7710600MAPOW
ECHO
 CONV WIN
RESU SPLI ALIC 'D7710600MAPO.ali' GARD PSCR
COMP COUL ROUG LECT mem1 TERM
          VERT LECT mem2 TERM
!         TURQ LECT mem3 TERM
          GR50 LECT pinbcm TERM
          TURQ LECT flui3d TERM
*=======================================================================
SORT VISU NSTO 1
*=======================================================================
PLAY
CAME   1 EYE  -1.64954E+01 -9.15031E-01  2.02341E-03
!        Q     6.95266E-01  6.95266E-01 -1.28860E-01 -1.28860E-01
         VIEW  3.58368E-01  9.33580E-01  1.91478E-10
         RIGH  9.33580E-01 -3.58368E-01 -7.35028E-11
         UP    3.05311E-16 -2.05101E-10  1.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: FREE CAMERA
!CENTER : -1.62650E+01  8.28568E-02  2.02341E-03
!RSPHERE:  2.04827E-01
!RADIUS :  1.02414E+00
!ASPECT :  1.33333E+00
!NEAR   :  8.09342E-01
!FAR    :  1.21900E+00
SCEN GEOM NAVI FREE
          FACE SBAC
          LINE SFRE
     ISO  FILL FIEL ECRO 1 SCAL USER PROG 1.E5 PAS 0.5E5 7.5E5 TERM
          SUPP LECT flui3d TERM
     LIMA ON
SLER CAM1 1 NFRA 1
FREQ 1
TRAC OFFS SIZE 800 600 FICH BMP
          OBJE LECT mems pinbcm flui3d TERM SYXY TOLS 1.E-3 NFAI REND
GOTR LOOP 33 OFFS SIZE 800 600 FICH BMP
          OBJE LECT mems pinbcm flui3d TERM SYXY TOLS 1.E-3 NFAI REND
ENDPLAY
*=======================================================================
SUIT
Post-treatment (make avi file from bitmaps)
ECHO
RESU SPLI ALIC 'D7710600MAPO.ali' GARD PSCR
*=================================================================
SORT VISU NSTO 1
*=================================================================
PLAY
MAVI FPS 5 KFRE 5 COMP -1 REND
ENDPLAY
*=================================================================
FIN
```

D7710600mapox.epx

```
D7710600MAPOX
ECHO
!CONV WIN
RESU SPLI ALIC 'D7710600MAPO.ali' GARD PSCR
COMP NGRO 1 'xaxo' LECT flui3d tubelp1 TERM
                COND LINE X1 -17.105 Y1 0 Z1 0
                          X2 -0.6    Y2 0 Z2 0 TOL 1.E-3
SORT GRAP
AXTE 1.0 'Time [s]'
SCOU 1 'p_trig' NSTO 34 SAXE 1.0 'Abscissa' INIT LECT xaxo TERM
                    ECRO COMP 1
                    SUPP LECT flui3d tubelp1 TERM
SCOU 2 'r_trig' NSTO 34 SAXE 1.0 'Abscissa' INIT LECT xaxo TERM
                    ECRO COMP 2
                    SUPP LECT flui3d tubelp1 TERM
SCOU 3 'v_trig' NSTO 34 SAXE 1.0 'Abscissa' INIT LECT xaxo TERM
                    VCVI COMP 1
                    SUPP LECT flui3d tubelp1 TERM
RCOU 11 'p_trig' FICH 'D7710600MAPDX.pun' RENA 'p_d_trig'
RCOU 12 'r_trig' FICH 'D7710600MAPDX.pun' RENA 'r_d_trig'
RCOU 13 'v_trig' FICH 'D7710600MAPDX.pun' RENA 'v_d_trig'
RCOU 21 'p_trig' FICH 'D7710600MAPEX.pun' RENA 'p_e_trig'
RCOU 22 'r_trig' FICH 'D7710600MAPEX.pun' RENA 'r_e_trig'
RCOU 23 'v_trig' FICH 'D7710600MAPEX.pun' RENA 'v_e_trig'
RCOU 31 'p_trig' FICH 'D7710600MAPJX.pun' RENA 'p_j_trig'
RCOU 32 'r_trig' FICH 'D7710600MAPJX.pun' RENA 'r_j_trig'
```

```
RCOU 33 'v_trig' FICH 'D7710600MAPJX.pun' RENA 'v_j_trig'
TRAC 1 11 21 31 AXES 1.0 'PRESS. [Pa]'
COLO TURQ VERT ROUG NOIR
TRAC 2 12 22 32 AXES 1.0 'DENS. [kg/m3]'
COLO TURQ VERT ROUG NOIR
TRAC 3 13 23 33 AXES 1.0 'VELO. [m/s]'
COLO TURQ VERT ROUG NOIR
!
TRAC 1 AXES 1.0 'PRESS. [Pa]'
TRAC 2 AXES 1.0 'DENS. [kg/m3]'
TRAC 3 AXES 1.0 'VELO. [m/s]'
LIST 1 AXES 1.0 'PRESS. [Pa]'
LIST 2 AXES 1.0 'DENS. [kg/m3]'
LIST 3 AXES 1.0 'VELO. [m/s]'
FIN
```

D7710600mapoy.epx

```
D7710600MAPOY
ECHO
 CONV WIN
RESU SPLI ALIC 'D7710600MAPO.ali' GARD PSCR
COMP COUL ROUG LECT mem1 TERM
          VERT LECT mem2 TERM
!         TURQ LECT mem3 TERM
          GR50 LECT pinbcm TERM
*=======================================================================
SORT VISU NSTO 9
*=======================================================================
PLAY
CAME   1 EYE  -1.72612E+01  2.81122E-03  2.81116E-03
!        Q     7.07107E-01  0.00000E+00 -7.07107E-01  0.00000E+00
         VIEW  1.00000E+00  0.00000E+00  2.05103E-10
         RIGH -2.05103E-10  0.00000E+00  1.00000E+00
         UP    0.00000E+00  1.00000E+00  0.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: ROTATING CAMERA
!CENTER : -1.62964E+01  2.81122E-03  2.81116E-03
!RSPHERE:  2.41195E-01
!RADIUS :  9.64780E-01
!ASPECT :  1.00000E+00
!NEAR   :  7.23585E-01
!FAR    :  1.44717E+00
SCEN GEOM NAVI FREE
          FACE SBAC
     LIMA ON
SLER CAM1 1 NFRA 1
TRAC DEFO AMPD 0.0
     OFFS SIZE 600 600 FICH BMP
          OBJE LECT mem1 pinbcm TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
TRAC DEFO AMPD 0.0
     OFFS SIZE 600 600 FICH BMP
          OBJE LECT mem2 pinbcm TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
FREQ 25
GO
TRAC DEFO AMPD 0.0
     OFFS SIZE 600 600 FICH BMP
          OBJE LECT mem1 pinbcm TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
TRAC DEFO AMPD 0.0
     OFFS SIZE 600 600 FICH BMP
          OBJE LECT mem2 pinbcm TERM SYXY SYXZ TOLS 1.E-3 NFAI REND
ENDPLAY
*=======================================================================
FIN
```

D7710600mapozz.epx

```
D7710600MAPOZZ
ECHO
 CONV WIN
RESU SPLI ALIC 'D7710600MAPO.ali' GARD PSCR
COMP COUL ROUG LECT mem1 TERM
          VERT LECT mem2 TERM
!         TURQ LECT mem3 TERM
          GR50 LECT pinbcm TERM
*=======================================================================
SORT VISU NSTO 1
*=======================================================================
PLAY
CAME   1 EYE  -1.64954E+01 -9.15031E-01  2.02341E-03
!        Q     6.95266E-01  6.95266E-01 -1.28860E-01 -1.28860E-01
         VIEW  3.58368E-01  9.33580E-01  1.91478E-10
         RIGH  9.33580E-01 -3.58368E-01 -7.35028E-11
         UP    3.05311E-16 -2.05101E-10  1.00000E+00
         FOV   2.48819E+01
!NAVIGATION MODE: FREE CAMERA
!CENTER : -1.62650E+01  8.28568E-02  2.02341E-03
!RSPHERE:  2.04827E-01
!RADIUS :  1.02414E+00
!ASPECT :  1.33333E+00
!NEAR   :  8.09342E-01
!FAR    :  1.21900E+00
SCEN GEOM NAVI FREE
          FACE SBAC
     LIMA ON
SLER CAM1 1 NFRA 1
FREQ 1
TRAC OFFS SIZE 800 600 FICH BMP
          OBJE LECT mems pinbcm TERM SYXY TOLS 1.E-3 NFAI REND
GOTR LOOP 33 OFFS SIZE 800 600 FICH BMP
          OBJE LECT mems pinbcm TERM SYXY TOLS 1.E-3 NFAI REND
ENDPLAY
*=======================================================================
SUIT
Post-treatment (make avi file from bitmaps)
ECHO
RESU SPLI ALIC 'D7710600MAPO.ali' GARD PSCR
*=================================================================
SORT VISU NSTO 1
*=================================================================
PLAY
MAVI FPS 10 KFRE 10 COMP -1 REND
ENDPLAY
*=================================================================
FIN
```

dero00.epx

```
DERO00
ECHO
!CONV WIN
EROS 1.0
LAGR DPLA
GEOM LIBR POIN 12 Q41L 5 TERM
  0 0  1 0  2 0  3 0  4 0  5 0
  0 1  1 1  2 1  3 1  4 1  5 1
  1 2 8 7
  2 3 9 8
  3 4 10 9
  4 5 11 10
  5 6 12 11
COMP EPAI 1. LECT tous TERM
     DERO DISP 0.1 LECT 4 5 TERM
          DISP 0.2 LECT 2 3 TERM
MATE VM23 RO 8000. YOUN 2.D8 NU 0.3 ELAS 2.D8
          TRAC 1 2.D8 1.0
          LECT tous TERM
INIT VITE 1 10 LECT tous TERM
ECRI FREQ 100
OPTI PAS AUTO NOTE LOG 1
CALC TINI 0. TEND 0.03D0
FIN
```

dero01.epx

```
DERO01
ECHO
!CONV WIN
EROS 1.0
LAGR DPLA
DIME ADAP NPOI 10 Q41l 8 ENDA TERM
GEOM LIBR POIN 12 Q41L 5 TERM
  0 0  1 0  2 0  3 0  4 0  5 0
  0 1  1 1  2 1  3 1  4 1  5 1
  1 2 8 7
  2 3 9 8
  3 4 10 9
  4 5 11 10
  5 6 12 11
COMP EPAI 1. LECT 1 PAS 1 5 TERM
     DERO DISP 0.1 LECT 4 5 TERM
          DISP 0.2 LECT 2 3 TERM
MATE VM23 RO 8000. YOUN 2.D8 NU 0.3 ELAS 2.D8
          TRAC 1 2.D8 1.0
          LECT 1 PAS 1 5 TERM
LINK COUP
INIT VITE 1 10.0 LECT 1 PAS 1 12 TERM
     ADAP SPLI LEVE 2 LECT 3 5 TERM
ECRI FREQ 100
OPTI PAS AUTO NOTE LOG 1
CALC TINI 0. TEND 0.03D0
FIN
```

dero02.epx

```
DERO02
ECHO
!CONV WIN
EROS 1.0
LAGR TRID
DIME ADAP NPOI 10 Q4GS 8 ENDA TERM
GEOM LIBR POIN 12 Q4GS 5 TERM
  0 0 0  1 0 0  2 0 0  3 0 0  4 0 0  5 0 0
  0 1 0  1 1 0  2 1 0  3 1 0  4 1 0  5 1 0
  1 2 8 7
  2 3 9 8
  3 4 10 9
  4 5 11 10
  5 6 12 11
COMP EPAI 1. LECT 1 PAS 1 5 TERM
     DERO DISP 0.1 LECT 4 5 TERM
          DISP 0.2 LECT 2 3 TERM
MATE LINE RO 8000. YOUN 2.D8 NU 0.3 ! ELAS 2.D8
        ! TRAC 1 2.D8 1.0
          LECT 1 PAS 1 5 TERM
```

```
LINK COUP
INIT VITE 1 10.0 LECT 1 PAS 1 12 TERM
     ADAP SPLI LEVE 2 LECT 3 5 TERM
ECRI FAIL FREQ 100
OPTI PAS AUTO NOTE LOG 1
CALC TINI 0. TEND 0.03D0
FIN
```

dero03.epx

```
DERO03
ECHO
!CONV WIN
EROS 1.0
LAGR TRID
DIME ADAP NPOI 10 Q4GS 8 CL3D 8 ENDA TERM
GEOM LIBR POIN 12 Q4GS 5 CL3D 5 TERM
  0 0 0  1 0 0  2 0 0  3 0 0  4 0 0  5 0 0
  0 1 0  1 1 0  2 1 0  3 1 0  4 1 0  5 1 0
  1 2 8 7
  2 3 9 8
  3 4 10 9
  4 5 11 10
  5 6 12 11
  1 2 8 7
  2 3 9 8
  3 4 10 9
  4 5 11 10
  5 6 12 11
COMP EPAI 1. LECT 1 PAS 1 5 TERM
     DERO DISP 0.1 LECT 4 5 TERM
          DISP 0.2 LECT 2 3 TERM
MATE LINE RO 8000. YOUN 2.D8 NU 0.3 ! ELAS 2.D8
        ! TRAC 1 2.D8 1.0
          LECT 1 PAS 1 5 TERM
     IMPE PIMP PRES 0.0 LECT 6 PAS 1 10 TERM
LINK COUP
INIT VITE 1 10.0 LECT 1 PAS 1 12 TERM
     ADAP SPLI LEVE 2 LECT 3 5 TERM
ECRI FAIL FREQ 100
OPTI PAS AUTO NOTE LOG 1
CALC TINI 0. TEND 0.03D0
FIN
```

log2plot_mape.epx

```
LOG2PLOT_MAPE
ECHO
*CONV WIN
LAGR CPLA
GEOM LIBR POIN 4 CAR1 1 TERM
   0 0  1 0  1 1  0 1
   1 2 3 4
MATE LINE RO 8000. YOUN 1.D11 NU 0.3
          LECT 1 TERM
ECRI FICH ALIC FREQ 1
CALC TINI 0.0 TEND 1.0 NMAX 0
*=================================================================
SUIT
Post-treatment
ECHO
RESU ALIC GARD PSCR
SORT GRAP
AXTE 1.0 'Time [s]'
RCOU  1 'cpu'     FICH 'D7710600MAPE.log.pun'
RCOU  2 'dtcrit'  FICH 'D7710600MAPE.log.pun'
RCOU  3 'dee'     FICH 'D7710600MAPE.log.pun'
RCOU  4 'dmmn'    FICH 'D7710600MAPE.log.pun'
RCOU  5 'dmme'    FICH 'D7710600MAPE.log.pun'
RCOU  6 'dtmx'    FICH 'D7710600MAPE.log.pun'
RCOU  7 'vitmax'  FICH 'D7710600MAPE.log.pun'
RCOU  8 'memory'  FICH 'D7710600MAPE.log.pun'
RCOU  9 'mempeak' FICH 'D7710600MAPE.log.pun'
RCOU 10 'cpupstep' FICH 'D7710600MAPE.log.pun'
TRAC  1 AXES 1.0 'CPU [S]' YZER XGRD YGRD
TRAC  2 AXES 1.0 'DTCRIT [S]' YZER XGRD YGRD
TRAC  3 AXES 1.0 'DEE [-]' YZER XGRD YGRD
TRAC  4 AXES 1.0 'DMMN [-]' YZER XGRD YGRD
TRAC  5 AXES 1.0 'DMME [-]' YZER XGRD YGRD
TRAC  6 AXES 1.0 'DTMX [S]' YZER XGRD YGRD
TRAC  7 AXES 1.0 'VITMAX [M/S]' YZER XGRD YGRD
TRAC  8 AXES 1.0 'MEMORY [BYTE]' YZER XGRD YGRD
TRAC  9 AXES 1.0 'MEMPEAK [BYTE]' YZER XGRD YGRD
TRAC 10 AXES 1.0 'CPUPSTEP [S]' YZER XGRD YGRD
TRAC 8 9 AXES 1.0 'MEM [BYTE]' YZER XGRD YGRD
COLO NOIR ROUG
TRAC  2 AXES 1.0 'DTCRIT [S]' YLOG YZER XGRD YGRD
LIST  1 AXES 1.0 'CPU [S]' YZER XGRD YGRD
LIST  2 AXES 1.0 'DTCRIT [S]' YZER XGRD YGRD
LIST  3 AXES 1.0 'DEE [-]' YZER XGRD YGRD
LIST  4 AXES 1.0 'DMMN [-]' YZER XGRD YGRD
LIST  5 AXES 1.0 'DMME [-]' YZER XGRD YGRD
LIST  6 AXES 1.0 'DTMX [S]' YZER XGRD YGRD
LIST  7 AXES 1.0 'VITMAX [M/S]' YZER XGRD YGRD
LIST  8 AXES 1.0 'MEMORY [BYTE]' YZER XGRD YGRD
LIST  9 AXES 1.0 'MEMPEAK [BYTE]' YZER XGRD YGRD
LIST 10 AXES 1.0 'CPUPSTEP [S]' YZER XGRD YGRD
*
COUR 17 'vmax' ADDC 7 1.0
TRAC 17 AXES 1.0 'VMAX [M/S]' YLOG YZER XGRD YGRD
LIST 17 AXES 1.0 'VMAX [M/S]' YZER XGRD YGRD
*=================================================================
FIN
```

log2plot_mapf.epx

```
LOG2PLOT_MAPF
ECHO
*CONV WIN
LAGR CPLA
GEOM LIBR POIN 4 CAR1 1 TERM
   0 0  1 0  1 1  0 1
   1 2 3 4
MATE LINE RO 8000. YOUN 1.D11 NU 0.3
          LECT 1 TERM
ECRI FICH ALIC FREQ 1
CALC TINI 0.0 TEND 1.0 NMAX 0
*=================================================================
SUIT
Post-treatment
ECHO
RESU ALIC GARD PSCR
SORT GRAP
AXTE 1.0 'Time [s]'
RCOU  1 'cpu'     FICH 'D7710600MAPF.log.pun'
RCOU  2 'dtcrit'  FICH 'D7710600MAPF.log.pun'
RCOU  3 'dee'     FICH 'D7710600MAPF.log.pun'
RCOU  4 'dmmn'    FICH 'D7710600MAPF.log.pun'
RCOU  5 'dmme'    FICH 'D7710600MAPF.log.pun'
RCOU  6 'dtmx'    FICH 'D7710600MAPF.log.pun'
RCOU  7 'vitmax'  FICH 'D7710600MAPF.log.pun'
RCOU  8 'memory'  FICH 'D7710600MAPF.log.pun'
RCOU  9 'mempeak' FICH 'D7710600MAPF.log.pun'
TRAC  1 AXES 1.0 'CPU [S]' YZER XGRD YGRD
!       XMIN 0.0 XMAX 14.4E-4 DX 2.E-4
TRAC  2 AXES 1.0 'DTCRIT [S]' YZER XGRD YGRD
!       XMIN 0.0 XMAX 14.4E-4 DX 2.E-4
TRAC  3 AXES 1.0 'DEE [-]' YZER XGRD YGRD
!       XMIN 0.0 XMAX 14.4E-4 DX 2.E-4
TRAC  4 AXES 1.0 'DMMN [-]' YZER XGRD YGRD
!       XMIN 0.0 XMAX 14.4E-4 DX 2.E-4
TRAC  5 AXES 1.0 'DMME [-]' YZER XGRD YGRD
!       XMIN 0.0 XMAX 14.4E-4 DX 2.E-4
TRAC  6 AXES 1.0 'DTMX [S]' YZER XGRD YGRD
!       XMIN 0.0 XMAX 14.4E-4 DX 2.E-4
TRAC  7 AXES 1.0 'VITMAX [M/S]' YZER XGRD YGRD
!       XMIN 0.0 XMAX 14.4E-4 DX 2.E-4
TRAC  8 AXES 1.0 'MEMORY [BYTE]' YZER XGRD YGRD
!       XMIN 0.0 XMAX 14.4E-4 DX 2.E-4
TRAC  9 AXES 1.0 'MEMPEAK [BYTE]' YZER XGRD YGRD
!       XMIN 0.0 XMAX 14.4E-4 DX 2.E-4
TRAC 8 9 AXES 1.0 'MEM [BYTE]' YZER XGRD YGRD
COLO NOIR ROUG
TRAC  2 AXES 1.0 'DTCRIT [S]' YLOG YZER XGRD YGRD
!       XMIN 0.0 XMAX 14.4E-4 DX 2.E-4
LIST  1 AXES 1.0 'CPU [S]' YZER XGRD YGRD
LIST  2 AXES 1.0 'DTCRIT [S]' YZER XGRD YGRD
LIST  3 AXES 1.0 'DEE [-]' YZER XGRD YGRD
LIST  4 AXES 1.0 'DMMN [-]' YZER XGRD YGRD
LIST  5 AXES 1.0 'DMME [-]' YZER XGRD YGRD
LIST  6 AXES 1.0 'DTMX [S]' YZER XGRD YGRD
LIST  7 AXES 1.0 'VITMAX [M/S]' YZER XGRD YGRD
LIST  8 AXES 1.0 'MEMORY [BYTE]' YZER XGRD YGRD
LIST  9 AXES 1.0 'MEMPEAK [BYTE]' YZER XGRD YGRD
*
COUR 17 'vmax' ADDC 7 1.0
TRAC 17 AXES 1.0 'VMAX [M/S]' YLOG YZER XGRD YGRD
LIST 17 AXES 1.0 'VMAX [M/S]' YZER XGRD YGRD
*
RCOU 101 'cpu'     FICH 'log2plot_mape.pun' RENA 'cpu_e'
RCOU 102 'dtcrit'  FICH 'log2plot_mape.pun' RENA 'dtcrit_e'
RCOU 107 'vitmax'  FICH 'log2plot_mape.pun' RENA 'vitmax_e'
COUR 117 'vmax_e' ADDC 107 1.0
TRAC 1 101 AXES 1.0 'CPU [S]' YZER XGRD YGRD
COLO NOIR ROUG
TRAC 2 102 AXES 1.0 'DTCRIT [S]' YZER XGRD YGRD
COLO NOIR ROUG
TRAC 2 102 AXES 1.0 'DTCRIT [S]' YLOG YZER XGRD YGRD
COLO NOIR ROUG
TRAC 17 117 AXES 1.0 'VMAX [M/S]' YLOG YZER XGRD YGRD
COLO NOIR ROUG
*=================================================================
FIN
```

log2plot_mapj.epx

```
LOG2PLOT_MAPJ
ECHO
*CONV WIN
LAGR CPLA
GEOM LIBR POIN 4 CAR1 1 TERM
   0 0  1 0  1 1  0 1
   1 2 3 4
MATE LINE RO 8000. YOUN 1.D11 NU 0.3
          LECT 1 TERM
ECRI FICH ALIC FREQ 1
CALC TINI 0.0 TEND 1.0 NMAX 0
*=================================================================
SUIT
```

```
Post-treatment
ECHO
RESU ALIC GARD PSCR
SORT GRAP
AXTE 1.0 'Time [s]'
RCOU  1 'cpu'     FICH 'D7710600MAPJ.log.pun'
RCOU  2 'dtcrit'  FICH 'D7710600MAPJ.log.pun'
RCOU  3 'dee'     FICH 'D7710600MAPJ.log.pun'
RCOU  4 'dmmn'    FICH 'D7710600MAPJ.log.pun'
RCOU  5 'dmme'    FICH 'D7710600MAPJ.log.pun'
RCOU  6 'dtmx'    FICH 'D7710600MAPJ.log.pun'
RCOU  7 'vitmax'  FICH 'D7710600MAPJ.log.pun'
RCOU  8 'memory'  FICH 'D7710600MAPJ.log.pun'
RCOU  9 'mempeak' FICH 'D7710600MAPJ.log.pun'
TRAC  1 AXES 1.0 'CPU [S]' YZER XGRD YGRD
TRAC  2 AXES 1.0 'DTCRIT [S]' YZER XGRD YGRD
TRAC  3 AXES 1.0 'DEE [-]' YZER XGRD YGRD
TRAC  4 AXES 1.0 'DMMN [-]' YZER XGRD YGRD
TRAC  5 AXES 1.0 'DMME [-]' YZER XGRD YGRD
TRAC  6 AXES 1.0 'DTMX [S]' YZER XGRD YGRD
TRAC  7 AXES 1.0 'VITMAX [M/S]' YZER XGRD YGRD
TRAC  8 AXES 1.0 'MEMORY [BYTE]' YZER XGRD YGRD
TRAC  9 AXES 1.0 'MEMPEAK [BYTE]' YZER XGRD YGRD
TRAC 8 9 AXES 1.0 'MEM [BYTE]' YZER XGRD YGRD
COLO NOIR ROUG
TRAC  2 AXES 1.0 'DTCRIT [S]' YLOG YZER XGRD YGRD
LIST  1 AXES 1.0 'CPU [S]' YZER XGRD YGRD
LIST  2 AXES 1.0 'DTCRIT [S]' YZER XGRD YGRD
LIST  3 AXES 1.0 'DEE [-]' YZER XGRD YGRD
LIST  4 AXES 1.0 'DMMN [-]' YZER XGRD YGRD
LIST  5 AXES 1.0 'DMME [-]' YZER XGRD YGRD
LIST  6 AXES 1.0 'DTMX [S]' YZER XGRD YGRD
LIST  7 AXES 1.0 'VITMAX [M/S]' YZER XGRD YGRD
LIST  8 AXES 1.0 'MEMORY [BYTE]' YZER XGRD YGRD
LIST  9 AXES 1.0 'MEMPEAK [BYTE]' YZER XGRD YGRD
*
COUR 17 'vmax' ADDC 7 1.0
TRAC 17 AXES 1.0 'VMAX [M/S]' YLOG YZER XGRD YGRD
LIST 17 AXES 1.0 'VMAX [M/S]' YZER XGRD YGRD
*=================================================================
FIN
```

log2plot_mapk.epx

```
LOG2PLOT_MAPK
ECHO
*CONV WIN
LAGR CPLA
GEOM LIBR POIN 4 CAR1 1 TERM
   0 0  1 0  1 1  0 1
   1 2 3 4
MATE LINE RO 8000. YOUN 1.D11 NU 0.3
          LECT 1 TERM
ECRI FICH ALIC FREQ 1
CALC TINI 0.0 TEND 1.0 NMAX 0
*=================================================================
SUIT
Post-treatment
ECHO
RESU ALIC GARD PSCR
SORT GRAP
AXTE 1.0 'Time [s]'
RCOU  1 'cpu'     FICH 'D7710600MAPK.log.pun'
RCOU  2 'dtcrit'  FICH 'D7710600MAPK.log.pun'
RCOU  3 'dee'     FICH 'D7710600MAPK.log.pun'
RCOU  4 'dmmn'    FICH 'D7710600MAPK.log.pun'
RCOU  5 'dmme'    FICH 'D7710600MAPK.log.pun'
RCOU  6 'dtmx'    FICH 'D7710600MAPK.log.pun'
RCOU  7 'vitmax'  FICH 'D7710600MAPK.log.pun'
RCOU  8 'memory'  FICH 'D7710600MAPK.log.pun'
RCOU  9 'mempeak' FICH 'D7710600MAPK.log.pun'
TRAC  1 AXES 1.0 'CPU [S]' YZER XGRD YGRD
!       XMIN 0.0 XMAX 14.4E-4 DX 2.E-4
TRAC  2 AXES 1.0 'DTCRIT [S]' YZER XGRD YGRD
!       XMIN 0.0 XMAX 14.4E-4 DX 2.E-4
TRAC  3 AXES 1.0 'DEE [-]' YZER XGRD YGRD
!       XMIN 0.0 XMAX 14.4E-4 DX 2.E-4
TRAC  4 AXES 1.0 'DMMN [-]' YZER XGRD YGRD
!       XMIN 0.0 XMAX 14.4E-4 DX 2.E-4
TRAC  5 AXES 1.0 'DMME [-]' YZER XGRD YGRD
!       XMIN 0.0 XMAX 14.4E-4 DX 2.E-4
TRAC  6 AXES 1.0 'DTMX [S]' YZER XGRD YGRD
!       XMIN 0.0 XMAX 14.4E-4 DX 2.E-4
TRAC  7 AXES 1.0 'VITMAX [M/S]' YZER XGRD YGRD
!       XMIN 0.0 XMAX 14.4E-4 DX 2.E-4
TRAC  8 AXES 1.0 'MEMORY [BYTE]' YZER XGRD YGRD
!       XMIN 0.0 XMAX 14.4E-4 DX 2.E-4
TRAC  9 AXES 1.0 'MEMPEAK [BYTE]' YZER XGRD YGRD
!       XMIN 0.0 XMAX 14.4E-4 DX 2.E-4
TRAC 8 9 AXES 1.0 'MEM [BYTE]' YZER XGRD YGRD
COLO NOIR ROUG
TRAC  2 AXES 1.0 'DTCRIT [S]' YLOG YZER XGRD YGRD
!       XMIN 0.0 XMAX 14.4E-4 DX 2.E-4
LIST  1 AXES 1.0 'CPU [S]' YZER XGRD YGRD
LIST  2 AXES 1.0 'DTCRIT [S]' YZER XGRD YGRD
LIST  3 AXES 1.0 'DEE [-]' YZER XGRD YGRD
LIST  4 AXES 1.0 'DMMN [-]' YZER XGRD YGRD
LIST  5 AXES 1.0 'DMME [-]' YZER XGRD YGRD
LIST  6 AXES 1.0 'DTMX [S]' YZER XGRD YGRD
LIST  7 AXES 1.0 'VITMAX [M/S]' YZER XGRD YGRD
LIST  8 AXES 1.0 'MEMORY [BYTE]' YZER XGRD YGRD
LIST  9 AXES 1.0 'MEMPEAK [BYTE]' YZER XGRD YGRD
*
COUR 17 'vmax' ADDC 7 1.0
TRAC 17 AXES 1.0 'VMAX [M/S]' YLOG YZER XGRD YGRD
LIST 17 AXES 1.0 'VMAX [M/S]' YZER XGRD YGRD
*=================================================================
FIN
```

log2plot_mapl.epx

```
LOG2PLOT_MAPL
ECHO
*CONV WIN
LAGR CPLA
GEOM LIBR POIN 4 CAR1 1 TERM
   0 0  1 0  1 1  0 1
   1 2 3 4
MATE LINE RO 8000. YOUN 1.D11 NU 0.3
          LECT 1 TERM
ECRI FICH ALIC FREQ 1
CALC TINI 0.0 TEND 1.0 NMAX 0
*=================================================================
SUIT
Post-treatment
ECHO
RESU ALIC GARD PSCR
SORT GRAP
AXTE 1.0 'Time [s]'
RCOU  1 'cpu'     FICH 'D7710600MAPL.log.pun'
RCOU  2 'dtcrit'  FICH 'D7710600MAPL.log.pun'
RCOU  3 'dee'     FICH 'D7710600MAPL.log.pun'
RCOU  4 'dmmn'    FICH 'D7710600MAPL.log.pun'
RCOU  5 'dmme'    FICH 'D7710600MAPL.log.pun'
RCOU  6 'dtmx'    FICH 'D7710600MAPL.log.pun'
RCOU  7 'vitmax'  FICH 'D7710600MAPL.log.pun'
RCOU  8 'memory'  FICH 'D7710600MAPL.log.pun'
RCOU  9 'mempeak' FICH 'D7710600MAPL.log.pun'
TRAC  1 AXES 1.0 'CPU [S]' YZER XGRL YGRD
!       XMIN 0.0 XMAX 14.4E-4 DX 2.E-4
TRAC  2 AXES 1.0 'DTCRIT [S]' YZER XGRD YGRD
!       XMIN 0.0 XMAX 14.4E-4 DX 2.E-4
TRAC  3 AXES 1.0 'DEE [-]' YZER XGRD YGRD
!       XMIN 0.0 XMAX 14.4E-4 DX 2.E-4
TRAC  4 AXES 1.0 'DMMN [-]' YZER XGRD YGRD
!       XMIN 0.0 XMAX 14.4E-4 DX 2.E-4
TRAC  5 AXES 1.0 'DMME [-]' YZER XGRD YGRD
!       XMIN 0.0 XMAX 14.4E-4 DX 2.E-4
TRAC  6 AXES 1.0 'DTMX [S]' YZER XGRD YGRD
!       XMIN 0.0 XMAX 14.4E-4 DX 2.E-4
TRAC  7 AXES 1.0 'VITMAX [M/S]' YZER XGRD YGRD
!       XMIN 0.0 XMAX 14.4E-4 DX 2.E-4
TRAC  8 AXES 1.0 'MEMORY [BYTE]' YZER XGRD YGRD
!       XMIN 0.0 XMAX 14.4E-4 DX 2.E-4
TRAC  9 AXES 1.0 'MEMPEAK [BYTE]' YZER XGRD YGRD
!       XMIN 0.0 XMAX 14.4E-4 DX 2.E-4
TRAC 8 9 AXES 1.0 'MEM [BYTE]' YZER XGRD YGRD
COLO NOIR ROUG
TRAC  2 AXES 1.0 'DTCRIT [S]' YLOG YZER XGRD YGRD
!       XMIN 0.0 XMAX 14.4E-4 DX 2.E-4
LIST  1 AXES 1.0 'CPU [S]' YZER XGRD YGRD
LIST  2 AXES 1.0 'DTCRIT [S]' YZER XGRD YGRD
LIST  3 AXES 1.0 'DEE [-]' YZER XGRD YGRD
LIST  4 AXES 1.0 'DMMN [-]' YZER XGRD YGRD
LIST  5 AXES 1.0 'DMME [-]' YZER XGRD YGRD
LIST  6 AXES 1.0 'DTMX [S]' YZER XGRD YGRD
LIST  7 AXES 1.0 'VITMAX [M/S]' YZER XGRD YGRD
LIST  8 AXES 1.0 'MEMORY [BYTE]' YZER XGRD YGRD
LIST  9 AXES 1.0 'MEMPEAK [BYTE]' YZER XGRD YGRD
*
COUR 17 'vmax' ADDC 7 1.0
TRAC 17 AXES 1.0 'VMAX [M/S]' YLOG YZER XGRD YGRD
LIST 17 AXES 1.0 'VMAX [M/S]' YZER XGRD YGRD
*=================================================================
FIN
```

log2plot_mapn.epx

```
LOG2PLOT_MAPN
ECHO
*CONV WIN
LAGR CPLA
GEOM LIBR POIN 4 CAR1 1 TERM
   0 0  1 0  1 1  0 1
   1 2 3 4
MATE LINE RO 8000. YOUN 1.D11 NU 0.3
          LECT 1 TERM
ECRI FICH ALIC FREQ 1
CALC TINI 0.0 TEND 1.0 NMAX 0
*=================================================================
SUIT
Post-treatment
ECHO
RESU ALIC GARD PSCR
SORT GRAP
AXTE 1.0 'Time [s]'
RCOU  1 'cpu'      FICH 'D7710600MAPN.log.pun'
RCOU  2 'dtcrit'   FICH 'D7710600MAPN.log.pun'
RCOU  3 'dee'      FICH 'D7710600MAPN.log.pun'
RCOU  4 'dmmn'     FICH 'D7710600MAPN.log.pun'
RCOU  5 'dmme'     FICH 'D7710600MAPN.log.pun'
RCOU  6 'dtmx'     FICH 'D7710600MAPN.log.pun'
```

```
RCOU  7 'vitmax'   FICH 'D7710600MAPN.log.pun'
RCOU  8 'memory'   FICH 'D7710600MAPN.log.pun'
RCOU  9 'mempeak'  FICH 'D7710600MAPN.log.pun'
RCOU 10 'cpupstep' FICH 'D7710600MAPN.log.pun'
TRAC  1 AXES 1.0 'CPU [S]' YZER XGRD YGRD
TRAC  2 AXES 1.0 'DTCRIT [S]' YZER XGRD YGRD
TRAC  3 AXES 1.0 'DEE [-]' YZER XGRD YGRD
TRAC  4 AXES 1.0 'DMMN [-]' YZER XGRD YGRD
TRAC  5 AXES 1.0 'DMME [-]' YZER XGRD YGRD
TRAC  6 AXES 1.0 'DTMX [S]' YZER XGRD YGRD
TRAC  7 AXES 1.0 'VITMAX [M/S]' YZER XGRD YGRD
TRAC  8 AXES 1.0 'MEMORY [BYTE]' YZER XGRD YGRD
TRAC  9 AXES 1.0 'MEMPEAK [BYTE]' YZER XGRD YGRD
TRAC 10 AXES 1.0 'CPUPSTEP [S]' YZER XGRD YGRD
TRAC 8 9 AXES 1.0 'MEM [BYTE]' YZER XGRD YGRD
COLO NOIR ROUG
TRAC  2 AXES 1.0 'DTCRIT [S]' YLOG YZER XGRD YGRD
LIST  1 AXES 1.0 'CPU [S]' YZER XGRD YGRD
LIST  2 AXES 1.0 'DTCRIT [S]' YZER XGRD YGRD
LIST  3 AXES 1.0 'DEE [-]' YZER XGRD YGRD
LIST  4 AXES 1.0 'DMMN [-]' YZER XGRD YGRD
LIST  5 AXES 1.0 'DMME [-]' YZER XGRD YGRD
LIST  6 AXES 1.0 'DTMX [S]' YZER XGRD YGRD
LIST  7 AXES 1.0 'VITMAX [M/S]' YZER XGRD YGRD
LIST  8 AXES 1.0 'MEMORY [BYTE]' YZER XGRD YGRD
LIST  9 AXES 1.0 'MEMPEAK [BYTE]' YZER XGRD YGRD
LIST 10 AXES 1.0 'CPUPSTEP [S]' YZER XGRD YGRD
*
COUR 17 'vmax' ADDC 7 1.0
TRAC 17 AXES 1.0 'VMAX [M/S]' YLOG YZER XGRD YGRD
LIST 17 AXES 1.0 'VMAX [M/S]' YZER XGRD YGRD
*=================================================================
FIN
```

log2plot_mapo.epx

```
LOG2PLOT_MAPO
ECHO
*CONV WIN
LAGR CPLA
GEOM LIBR POIN 4 CAR1 1 TERM
   0 0  1 0  1 1  0 1
   1 2 3 4
MATE LINE RO 8000. YOUN 1.D11 NU 0.3
         LECT 1 TERM
ECRI FICH ALIC FREQ 1
CALC TINI 0.0 TEND 1.0 NMAX 0
*=================================================================
SUIT
Post-treatment
ECHO
RESU ALIC GARD PSCR
SORT GRAP
AXTE 1.0 'Time [s]'
RCOU  1 'cpu'      FICH 'D7710600MAPO.log.pun'
RCOU  2 'dtcrit'   FICH 'D7710600MAPO.log.pun'
RCOU  3 'dee'      FICH 'D7710600MAPO.log.pun'
RCOU  4 'dmmn'     FICH 'D7710600MAPO.log.pun'
RCOU  5 'dmme'     FICH 'D7710600MAPO.log.pun'
RCOU  6 'dtmx'     FICH 'D7710600MAPO.log.pun'
RCOU  7 'vitmax'   FICH 'D7710600MAPO.log.pun'
RCOU  8 'memory'   FICH 'D7710600MAPO.log.pun'
RCOU  9 'mempeak'  FICH 'D7710600MAPO.log.pun'
RCOU 10 'cpupstep' FICH 'D7710600MAPO.log.pun'
TRAC  1 AXES 1.0 'CPU [S]' YZER XGRD YGRD
TRAC  2 AXES 1.0 'DTCRIT [S]' YZER XGRD YGRD
TRAC  3 AXES 1.0 'DEE [-]' YZER XGRD YGRD
TRAC  4 AXES 1.0 'DMMN [-]' YZER XGRD YGRD
TRAC  5 AXES 1.0 'DMME [-]' YZER XGRD YGRD
TRAC  6 AXES 1.0 'DTMX [S]' YZER XGRD YGRD
TRAC  7 AXES 1.0 'VITMAX [M/S]' YZER XGRD YGRD
TRAC  8 AXES 1.0 'MEMORY [BYTE]' YZER XGRD YGRD
TRAC  9 AXES 1.0 'MEMPEAK [BYTE]' YZER XGRD YGRD
TRAC 10 AXES 1.0 'CPUPSTEP [S]' YZER XGRD YGRD
TRAC 8 9 AXES 1.0 'MEM [BYTE]' YZER XGRD YGRD
COLO NOIR ROUG
TRAC  2 AXES 1.0 'DTCRIT [S]' YLOG YZER XGRD YGRD
LIST  1 AXES 1.0 'CPU [S]' YZER XGRD YGRD
LIST  2 AXES 1.0 'DTCRIT [S]' YZER XGRD YGRD
LIST  3 AXES 1.0 'DEE [-]' YZER XGRD YGRD
LIST  4 AXES 1.0 'DMMN [-]' YZER XGRD YGRD
LIST  5 AXES 1.0 'DMME [-]' YZER XGRD YGRD
LIST  6 AXES 1.0 'DTMX [S]' YZER XGRD YGRD
LIST  7 AXES 1.0 'VITMAX [M/S]' YZER XGRD YGRD
LIST  8 AXES 1.0 'MEMORY [BYTE]' YZER XGRD YGRD
LIST  9 AXES 1.0 'MEMPEAK [BYTE]' YZER XGRD YGRD
LIST 10 AXES 1.0 'CPUPSTEP [S]' YZER XGRD YGRD
*
COUR 17 'vmax' ADDC 7 1.0
TRAC 17 AXES 1.0 'VMAX [M/S]' YLOG YZER XGRD YGRD
LIST 17 AXES 1.0 'VMAX [M/S]' YZER XGRD YGRD
*=================================================================
FIN
```

mamu01.epx

```
MAMU01
ECHO
!CONV WIN
DPLA EULE
GEOM LIBR POIN 202 Q4VF 100 TERM
 0 0  1 0  2 0  3 0  4 0  5 0  6 0  7 0  8 0  9 0  10 0
    11 0 12 0 13 0 14 0 15 0 16 0 17 0 18 0 19 0  20 0
    21 0 22 0 23 0 24 0 25 0 26 0 27 0 28 0 29 0  30 0
    31 0 32 0 33 0 34 0 35 0 36 0 37 0 38 0 39 0  40 0
    41 0 42 0 43 0 44 0 45 0 46 0 47 0 48 0 49 0  50 0
    51 0 52 0 53 0 54 0 55 0 56 0 57 0 58 0 59 0  60 0
    61 0 62 0 63 0 64 0 65 0 66 0 67 0 68 0 69 0  70 0
    71 0 72 0 73 0 74 0 75 0 76 0 77 0 78 0 79 0  80 0
    81 0 82 0 83 0 84 0 85 0 86 0 87 0 88 0 89 0  90 0
    91 0 92 0 93 0 94 0 95 0 96 0 97 0 98 0 99 0 100 0
 0 1  1 1  2 1  3 1  4 1  5 1  6 1  7 1  8 1  9 1  10 1
    11 1 12 1 13 1 14 1 15 1 16 1 17 1 18 1 19 1  20 1
    21 1 22 1 23 1 24 1 25 1 26 1 27 1 28 1 29 1  30 1
    31 1 32 1 33 1 34 1 35 1 36 1 37 1 38 1 39 1  40 1
    41 1 42 1 43 1 44 1 45 1 46 1 47 1 48 1 49 1  50 1
    51 1 52 1 53 1 54 1 55 1 56 1 57 1 58 1 59 1  60 1
    61 1 62 1 63 1 64 1 65 1 66 1 67 1 68 1 69 1  70 1
    71 1 72 1 73 1 74 1 75 1 76 1 77 1 78 1 79 1  80 1
    81 1 82 1 83 1 84 1 85 1 86 1 87 1 88 1 89 1  90 1
    91 1 92 1 93 1 94 1 95 1 96 1 97 1 98 1 99 1 100 1
  1   2 103 102
  2   3 104 103
  3   4 105 104
  4   5 106 105
  5   6 107 106
  6   7 108 107
  7   8 109 108
  8   9 110 109
  9  10 111 110
 10  11 112 111

 11  12 113 112
 12  13 114 113
 13  14 115 114
 14  15 116 115
 15  16 117 116
 16  17 118 117
 17  18 119 118
 18  19 120 119
 19  20 121 120
 20  21 122 121

 21  22 123 122
 22  23 124 123
 23  24 125 124
 24  25 126 125
 25  26 127 126
 26  27 128 127
 27  28 129 128
 28  29 130 129
 29  30 131 130
 30  31 132 131

 31  32 133 132
 32  33 134 133
 33  34 135 134
 34  35 136 135
 35  36 137 136
 36  37 138 137
 37  38 139 138
 38  39 140 139
 39  40 141 140
 40  41 142 141

 41  42 143 142
 42  43 144 143
 43  44 145 144
 44  45 146 145
 45  46 147 146
 46  47 148 147
 47  48 149 148
 48  49 150 149
 49  50 151 150
 50  51 152 151

 51  52 153 152
 52  53 154 153
 53  54 155 154
 54  55 156 155
 55  56 157 156
 56  57 158 157
 57  58 159 158
 58  59 160 159
 59  60 161 160
 60  61 162 161

 61  62 163 162
 62  63 164 163
 63  64 165 164
 64  65 166 165
 65  66 167 166
 66  67 168 167
 67  68 169 168
 68  69 170 169
 69  70 171 170
 70  71 172 171

 71  72 173 172
 72  73 174 173
 73  74 175 174
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  74  75 176 175
  75  76 177 176
  76  77 178 177
  77  78 179 178
  78  79 180 179
  79  80 181 180
  80  81 182 181

  81  82 183 182
  82  83 184 183
  83  84 185 184
  84  85 186 185
  85  86 187 186
  86  87 188 187
  87  88 189 188
  88  89 190 189
  89  90 191 190
  90  91 192 191

  91  92 193 192
  92  93 194 193
  93  94 195 194
  94  95 196 195
  95  96 197 196
  96  97 198 197
  97  98 199 198
  98  99 200 199
  99 100 201 200
 100 101 202 201
COMP GROU 2 ’hp’ LECT  1 PAS 1  50 TERM
            ’lp’ LECT 51 PAS 1 100 TERM
     COUL ROUG LECT hp TERM
          TURQ LECT lp TERM
MATE GAZP RO 13. PINI 1.E6 GAMM 1.402 PREF 1.E5
               CV 713.3
               LECT hp TERM
     GAZP RO 1.3 PINI 1.E5 GAMM 1.402 PREF 1.E5
               CV 713.3
               LECT lp TERM
ECRI VFCC TFRE 10.E-3
     FICH ALIC TFRE 10.E-3
     FICH FORM MAPP OBJE LECT tous TERM TIME PROG 50.E-3 60.E-3 TERM
OPTI NOTE STEP IO LOG 1
     VFCC FCON 6
CALC TINI 0. TFIN 80.E-3
SUIT
Post treatment
RESU ALIC GARD PSCR
SORT GRAP AXTE 1.0 ’T [s]’
SCOU 1 ’p00’ ECRO COMP 1 T  0.E-3 SAXE 1.0 ’ABSC’ LECT 1 PAS 1 101 TERM
SCOU 2 ’p10’ ECRO COMP 1 T 10.E-3 SAXE 1.0 ’ABSC’ LECT 1 PAS 1 101 TERM
SCOU 3 ’p20’ ECRO COMP 1 T 20.E-3 SAXE 1.0 ’ABSC’ LECT 1 PAS 1 101 TERM
SCOU 4 ’p30’ ECRO COMP 1 T 30.E-3 SAXE 1.0 ’ABSC’ LECT 1 PAS 1 101 TERM
SCOU 5 ’p40’ ECRO COMP 1 T 40.E-3 SAXE 1.0 ’ABSC’ LECT 1 PAS 1 101 TERM
SCOU 6 ’p50’ ECRO COMP 1 T 50.E-3 SAXE 1.0 ’ABSC’ LECT 1 PAS 1 101 TERM
SCOU 7 ’p60’ ECRO COMP 1 T 60.E-3 SAXE 1.0 ’ABSC’ LECT 1 PAS 1 101 TERM
SCOU 8 ’p70’ ECRO COMP 1 T 70.E-3 SAXE 1.0 ’ABSC’ LECT 1 PAS 1 101 TERM
SCOU 9 ’p80’ ECRO COMP 1 T 80.E-3 SAXE 1.0 ’ABSC’ LECT 1 PAS 1 101 TERM
TRAC 1 2 3 4 5 6 7 8 9 AXES 1.0 ’PRES [PA]’
LIST 1 2 3 4 5 6 7 8 9 AXES 1.0 ’PRES [PA]’
SCOU 11 ’r00’ ECRO COMP 2 T  0.E-3 SAXE 1.0 ’ABSC’ LECT 1 PAS 1 101 TERM
SCOU 12 ’r10’ ECRO COMP 2 T 10.E-3 SAXE 1.0 ’ABSC’ LECT 1 PAS 1 101 TERM
SCOU 13 ’r20’ ECRO COMP 2 T 20.E-3 SAXE 1.0 ’ABSC’ LECT 1 PAS 1 101 TERM
SCOU 14 ’r30’ ECRO COMP 2 T 30.E-3 SAXE 1.0 ’ABSC’ LECT 1 PAS 1 101 TERM
SCOU 15 ’r40’ ECRO COMP 2 T 40.E-3 SAXE 1.0 ’ABSC’ LECT 1 PAS 1 101 TERM
SCOU 16 ’r50’ ECRO COMP 2 T 50.E-3 SAXE 1.0 ’ABSC’ LECT 1 PAS 1 101 TERM
SCOU 17 ’r60’ ECRO COMP 2 T 60.E-3 SAXE 1.0 ’ABSC’ LECT 1 PAS 1 101 TERM
SCOU 18 ’r70’ ECRO COMP 2 T 70.E-3 SAXE 1.0 ’ABSC’ LECT 1 PAS 1 101 TERM
SCOU 19 ’r80’ ECRO COMP 2 T 80.E-3 SAXE 1.0 ’ABSC’ LECT 1 PAS 1 101 TERM
TRAC 11 12 13 14 15 16 17 18 19 AXES 1.0 ’DENS [KG/M3]’
LIST 11 12 13 14 15 16 17 18 19 AXES 1.0 ’DENS [KG/M3]’
FIN
```

matr01.epx

```
MATR01
ECHO
!CONV WIN
DPLA EULE
GEOM LIBR POIN 202 Q4VF 100 TERM
 0 0  1 0  2 0  3 0  4 0  5 0  6 0  7 0  8 0  9 0  10 0
    11 0 12 0 13 0 14 0 15 0 16 0 17 0 18 0 19 0  20 0
    21 0 22 0 23 0 24 0 25 0 26 0 27 0 28 0 29 0  30 0
    31 0 32 0 33 0 34 0 35 0 36 0 37 0 38 0 39 0  40 0
    41 0 42 0 43 0 44 0 45 0 46 0 47 0 48 0 49 0  50 0
    51 0 52 0 53 0 54 0 55 0 56 0 57 0 58 0 59 0  60 0
    61 0 62 0 63 0 64 0 65 0 66 0 67 0 68 0 69 0  70 0
    71 0 72 0 73 0 74 0 75 0 76 0 77 0 78 0 79 0  80 0
    81 0 82 0 83 0 84 0 85 0 86 0 87 0 88 0 89 0  90 0
    91 0 92 0 93 0 94 0 95 0 96 0 97 0 98 0 99 0 100 0
 0 1  1 1  2 1  3 1  4 1  5 1  6 1  7 1  8 1  9 1  10 1
    11 1 12 1 13 1 14 1 15 1 16 1 17 1 18 1 19 1  20 1
    21 1 22 1 23 1 24 1 25 1 26 1 27 1 28 1 29 1  30 1
    31 1 32 1 33 1 34 1 35 1 36 1 37 1 38 1 39 1  40 1
    41 1 42 1 43 1 44 1 45 1 46 1 47 1 48 1 49 1  50 1
    51 1 52 1 53 1 54 1 55 1 56 1 57 1 58 1 59 1  60 1
    61 1 62 1 63 1 64 1 65 1 66 1 67 1 68 1 69 1  70 1
    71 1 72 1 73 1 74 1 75 1 76 1 77 1 78 1 79 1  80 1
    81 1 82 1 83 1 84 1 85 1 86 1 87 1 88 1 89 1  90 1
    91 1 92 1 93 1 94 1 95 1 96 1 97 1 98 1 99 1 100 1
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  1   2 103 102
  2   3 104 103
  3   4 105 104
  4   5 106 105
  5   6 107 106
  6   7 108 107
  7   8 109 108
  8   9 110 109
  9  10 111 110
 10  11 112 111

 11  12 113 112
 12  13 114 113
 13  14 115 114
 14  15 116 115
 15  16 117 116
 16  17 118 117
 17  18 119 118
 18  19 120 119
 19  20 121 120
 20  21 122 121

 21  22 123 122
 22  23 124 123
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 29  30 131 130
 30  31 132 131

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 34  35 136 135
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 51  52 153 152
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 59  60 161 160
 60  61 162 161

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 62  63 164 163
 63  64 165 164
 64  65 166 165
 65  66 167 166
 66  67 168 167
 67  68 169 168
 68  69 170 169
 69  70 171 170
 70  71 172 171

 71  72 173 172
 72  73 174 173
 73  74 175 174
 74  75 176 175
 75  76 177 176
 76  77 178 177
 77  78 179 178
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 79  80 181 180
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 81  82 183 182
 82  83 184 183
 83  84 185 184
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 85  86 187 186
 86  87 188 187
 87  88 189 188
 88  89 190 189
 89  90 191 190
 90  91 192 191

 91  92 193 192
 92  93 194 193
 93  94 195 194
 94  95 196 195
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  95  96 197 196
  96  97 198 197
  97  98 199 198
  98  99 200 199
  99 100 201 200
 100 101 202 201
COMP GROU 3 'hp' LECT  1 PAS 1  50 TERM
            'lp' LECT 51 PAS 1 100 TERM
            'trigger' LECT 81 TERM
     COUL ROUG LECT hp TERM
          TURQ LECT lp TERM
MATE GAZP RO 13. PINI 1.E6 GAMM 1.402 PREF 1.E5
               CV 713.3
               LECT hp TERM
     GAZP RO 1.3 PINI 1.E5 GAMM 1.402 PREF 1.E5
               CV 713.3
               LECT lp TERM
ECRI VFCC TFRE 10.E-3
     FICH ALIC TFRE 10.E-3
     FICH FORM MAPP OBJE LECT tous TERM
                    TRIG ECRO 1 TVAL 1.1E5 LECT trigger TERM
                  ! TIME PROG 50.E-3 TERM
OPTI NOTE STEP IO LOG 1
     VFCC FCON 6
CALC TINI 0. TFIN 80.E-3
SUIT
Post treatment
RESU ALIC GARD PSCR
SORT GRAP AXTE 1.0 'T [s]'
SCOU 1 'p00' ECRO COMP 1 T  0.E-3 SAXE 1.0 'ABSC' LECT 1 PAS 1 101 TERM
SCOU 2 'p10' ECRO COMP 1 T 10.E-3 SAXE 1.0 'ABSC' LECT 1 PAS 1 101 TERM
SCOU 3 'p20' ECRO COMP 1 T 20.E-3 SAXE 1.0 'ABSC' LECT 1 PAS 1 101 TERM
SCOU 4 'p30' ECRO COMP 1 T 30.E-3 SAXE 1.0 'ABSC' LECT 1 PAS 1 101 TERM
SCOU 5 'p40' ECRO COMP 1 T 40.E-3 SAXE 1.0 'ABSC' LECT 1 PAS 1 101 TERM
SCOU 6 'p50' ECRO COMP 1 T 50.E-3 SAXE 1.0 'ABSC' LECT 1 PAS 1 101 TERM
SCOU 7 'p60' ECRO COMP 1 T 60.E-3 SAXE 1.0 'ABSC' LECT 1 PAS 1 101 TERM
SCOU 8 'p70' ECRO COMP 1 T 70.E-3 SAXE 1.0 'ABSC' LECT 1 PAS 1 101 TERM
SCOU 9 'p80' ECRO COMP 1 T 80.E-3 SAXE 1.0 'ABSC' LECT 1 PAS 1 101 TERM
TRAC 1 2 3 4 5 6 7 8 9 AXES 1.0 'PRES [PA]'
LIST 1 2 3 4 5 6 7 8 9 AXES 1.0 'PRES [PA]'
SCOU 11 'r00' ECRO COMP 2 T  0.E-3 SAXE 1.0 'ABSC' LECT 1 PAS 1 101 TERM
SCOU 12 'r10' ECRO COMP 2 T 10.E-3 SAXE 1.0 'ABSC' LECT 1 PAS 1 101 TERM
SCOU 13 'r20' ECRO COMP 2 T 20.E-3 SAXE 1.0 'ABSC' LECT 1 PAS 1 101 TERM
SCOU 14 'r30' ECRO COMP 2 T 30.E-3 SAXE 1.0 'ABSC' LECT 1 PAS 1 101 TERM
SCOU 15 'r40' ECRO COMP 2 T 40.E-3 SAXE 1.0 'ABSC' LECT 1 PAS 1 101 TERM
SCOU 16 'r50' ECRO COMP 2 T 50.E-3 SAXE 1.0 'ABSC' LECT 1 PAS 1 101 TERM
SCOU 17 'r60' ECRO COMP 2 T 60.E-3 SAXE 1.0 'ABSC' LECT 1 PAS 1 101 TERM
SCOU 18 'r70' ECRO COMP 2 T 70.E-3 SAXE 1.0 'ABSC' LECT 1 PAS 1 101 TERM
SCOU 19 'r80' ECRO COMP 2 T 80.E-3 SAXE 1.0 'ABSC' LECT 1 PAS 1 101 TERM
TRAC 11 12 13 14 15 16 17 18 19 AXES 1.0 'DENS [KG/M3]'
LIST 11 12 13 14 15 16 17 18 19 AXES 1.0 'DENS [KG/M3]'
FIN
```

matr02.epx

```
MATR02
ECHO
!CONV WIN
DPLA EULE
GEOM LIBR POIN 202 Q4VF 100 TERM
 0 0  1 0  2 0  3 0  4 0  5 0  6 0  7 0  8 0  9 0  10 0
    11 0 12 0 13 0 14 0 15 0 16 0 17 0 18 0 19 0  20 0
    21 0 22 0 23 0 24 0 25 0 26 0 27 0 28 0 29 0  30 0
    31 0 32 0 33 0 34 0 35 0 36 0 37 0 38 0 39 0  40 0
    41 0 42 0 43 0 44 0 45 0 46 0 47 0 48 0 49 0  50 0
    51 0 52 0 53 0 54 0 55 0 56 0 57 0 58 0 59 0  60 0
    61 0 62 0 63 0 64 0 65 0 66 0 67 0 68 0 69 0  70 0
    71 0 72 0 73 0 74 0 75 0 76 0 77 0 78 0 79 0  80 0
    81 0 82 0 83 0 84 0 85 0 86 0 87 0 88 0 89 0  90 0
    91 0 92 0 93 0 94 0 95 0 96 0 97 0 98 0 99 0 100 0
 0 1  1 1  2 1  3 1  4 1  5 1  6 1  7 1  8 1  9 1  10 1
    11 1 12 1 13 1 14 1 15 1 16 1 17 1 18 1 19 1  20 1
    21 1 22 1 23 1 24 1 25 1 26 1 27 1 28 1 29 1  30 1
    31 1 32 1 33 1 34 1 35 1 36 1 37 1 38 1 39 1  40 1
    41 1 42 1 43 1 44 1 45 1 46 1 47 1 48 1 49 1  50 1
    51 1 52 1 53 1 54 1 55 1 56 1 57 1 58 1 59 1  60 1
    61 1 62 1 63 1 64 1 65 1 66 1 67 1 68 1 69 1  70 1
    71 1 72 1 73 1 74 1 75 1 76 1 77 1 78 1 79 1  80 1
    81 1 82 1 83 1 84 1 85 1 86 1 87 1 88 1 89 1  90 1
    91 1 92 1 93 1 94 1 95 1 96 1 97 1 98 1 99 1 100 1
   1   2 103 102
   2   3 104 103
   3   4 105 104
   4   5 106 105
   5   6 107 106
   6   7 108 107
   7   8 109 108
   8   9 110 109
   9  10 111 110
  10  11 112 111

  11  12 113 112
  12  13 114 113
  13  14 115 114
  14  15 116 115
  15  16 117 116
  16  17 118 117
  17  18 119 118
  18  19 120 119
  19  20 121 120
  20  21 122 121

  21  22 123 122
  22  23 124 123
  23  24 125 124
  24  25 126 125
  25  26 127 126
  26  27 128 127
  27  28 129 128
  28  29 130 129
  29  30 131 130
  30  31 132 131

  31  32 133 132
  32  33 134 133
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  34  35 136 135
  35  36 137 136
  36  37 138 137
  37  38 139 138
  38  39 140 139
  39  40 141 140
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  41  42 143 142
  42  43 144 143
  43  44 145 144
  44  45 146 145
  45  46 147 146
  46  47 148 147
  47  48 149 148
  48  49 150 149
  49  50 151 150
  50  51 152 151

  51  52 153 152
  52  53 154 153
  53  54 155 154
  54  55 156 155
  55  56 157 156
  56  57 158 157
  57  58 159 158
  58  59 160 159
  59  60 161 160
  60  61 162 161

  61  62 163 162
  62  63 164 163
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  64  65 166 165
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  66  67 168 167
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  68  69 170 169
  69  70 171 170
  70  71 172 171

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  90  91 192 191

  91  92 193 192
  92  93 194 193
  93  94 195 194
  94  95 196 195
  95  96 197 196
  96  97 198 197
  97  98 199 198
  98  99 200 199
  99 100 201 200
 100 101 202 201
COMP GROU 3 'hp' LECT  1 PAS 1  50 TERM
            'lp' LECT 51 PAS 1 100 TERM
            'trigger' LECT 81 TERM
     COUL ROUG LECT hp TERM
          TURQ LECT lp TERM
MATE GAZP RO 13. PINI 1.E6 GAMM 1.402 PREF 1.E5
               CV 713.3
               LECT hp TERM
     GAZP RO 1.3 PINI 1.E5 GAMM 1.402 PREF 1.E5
               CV 713.3
               LECT lp TERM
ECRI VFCC TFRE 10.E-3
     FICH ALIC TFRE 10.E-3
     FICH FORM MAPP OBJE LECT tous TERM
```

```
                   TRIG ECRO 1 TSTO TVAL 1.1E5 LECT trigger TERM
OPTI NOTE STEP IO LOG 1
     VFCC FCON 6
CALC TINI 0. TFIN 80.E-3
SUIT
Post treatment
RESU ALIC GARD PSCR
SORT GRAP AXTE 1.0 'T [s]'
SCOU 1 'p00' ECRO COMP 1 T  0.E-3 SAXE 1.0 'ABSC' LECT 1 PAS 1 101 TERM
SCOU 2 'p10' ECRO COMP 1 T 10.E-3 SAXE 1.0 'ABSC' LECT 1 PAS 1 101 TERM
SCOU 3 'p20' ECRO COMP 1 T 20.E-3 SAXE 1.0 'ABSC' LECT 1 PAS 1 101 TERM
SCOU 4 'p30' ECRO COMP 1 T 30.E-3 SAXE 1.0 'ABSC' LECT 1 PAS 1 101 TERM
SCOU 5 'p40' ECRO COMP 1 T 40.E-3 SAXE 1.0 'ABSC' LECT 1 PAS 1 101 TERM
SCOU 6 'p50' ECRO COMP 1 T 50.E-3 SAXE 1.0 'ABSC' LECT 1 PAS 1 101 TERM
SCOU 7 'ptr' ECRO COMP 1   NSTO 7 SAXE 1.0 'ABSC' LECT 1 PAS 1 101 TERM
TRAC 1 2 3 4 5 6 7 AXES 1.0 'PRES [PA]'
COLO NOIR NOIR NOIR NOIR NOIR NOIR ROUG
LIST 1 2 3 4 5 6 7 AXES 1.0 'PRES [PA]'
SCOU 11 'r00' ECRO COMP 2 T  0.E-3 SAXE 1.0 'ABSC' LECT 1 PAS 1 101 TERM
SCOU 12 'r10' ECRO COMP 2 T 10.E-3 SAXE 1.0 'ABSC' LECT 1 PAS 1 101 TERM
SCOU 13 'r20' ECRO COMP 2 T 20.E-3 SAXE 1.0 'ABSC' LECT 1 PAS 1 101 TERM
SCOU 14 'r30' ECRO COMP 2 T 30.E-3 SAXE 1.0 'ABSC' LECT 1 PAS 1 101 TERM
SCOU 15 'r40' ECRO COMP 2 T 40.E-3 SAXE 1.0 'ABSC' LECT 1 PAS 1 101 TERM
SCOU 16 'r50' ECRO COMP 2 T 50.E-3 SAXE 1.0 'ABSC' LECT 1 PAS 1 101 TERM
SCOU 17 'rtr' ECRO COMP 2   NSTO 7 SAXE 1.0 'ABSC' LECT 1 PAS 1 101 TERM
TRAC 11 12 13 14 15 16 17 AXES 1.0 'DENS [KG/M3]'
COLO NOIR NOIR NOIR NOIR NOIR NOIR ROUG
LIST 11 12 13 14 15 16 17 AXES 1.0 'DENS [KG/M3]'
FIN
```

matr03.epx

```
MATR03
ECHO
!CONV WIN
DPLA EULE
GEOM LIBR POIN 202 Q4VF 100 TERM
 0 0  1 0  2 0  3 0  4 0  5 0  6 0  7 0  8 0  9 0  10 0
     11 0 12 0 13 0 14 0 15 0 16 0 17 0 18 0 19 0  20 0
     21 0 22 0 23 0 24 0 25 0 26 0 27 0 28 0 29 0  30 0
     31 0 32 0 33 0 34 0 35 0 36 0 37 0 38 0 39 0  40 0
     41 0 42 0 43 0 44 0 45 0 46 0 47 0 48 0 49 0  50 0
     51 0 52 0 53 0 54 0 55 0 56 0 57 0 58 0 59 0  60 0
     61 0 62 0 63 0 64 0 65 0 66 0 67 0 68 0 69 0  70 0
     71 0 72 0 73 0 74 0 75 0 76 0 77 0 78 0 79 0  80 0
     81 0 82 0 83 0 84 0 85 0 86 0 87 0 88 0 89 0  90 0
     91 0 92 0 93 0 94 0 95 0 96 0 97 0 98 0 99 0 100 0
 0 1  1 1  2 1  3 1  4 1  5 1  6 1  7 1  8 1  9 1  10 1
     11 1 12 1 13 1 14 1 15 1 16 1 17 1 18 1 19 1  20 1
     21 1 22 1 23 1 24 1 25 1 26 1 27 1 28 1 29 1  30 1
     31 1 32 1 33 1 34 1 35 1 36 1 37 1 38 1 39 1  40 1
     41 1 42 1 43 1 44 1 45 1 46 1 47 1 48 1 49 1  50 1
     51 1 52 1 53 1 54 1 55 1 56 1 57 1 58 1 59 1  60 1
     61 1 62 1 63 1 64 1 65 1 66 1 67 1 68 1 69 1  70 1
     71 1 72 1 73 1 74 1 75 1 76 1 77 1 78 1 79 1  80 1
     81 1 82 1 83 1 84 1 85 1 86 1 87 1 88 1 89 1  90 1
     91 1 92 1 93 1 94 1 95 1 96 1 97 1 98 1 99 1 100 1
   1   2 103 102
   2   3 104 103
   3   4 105 104
   4   5 106 105
   5   6 107 106
   6   7 108 107
   7   8 109 108
   8   9 110 109
   9  10 111 110
  10  11 112 111

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  12  13 114 113
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  92  93 194 193
  93  94 195 194
  94  95 196 195
  95  96 197 196
  96  97 198 197
  97  98 199 198
  98  99 200 199
  99 100 201 200
 100 101 202 201
COMP GROU 3 'hp' LECT  1 PAS 1  50 TERM
           'lp' LECT 51 PAS 1 100 TERM
           'trigger' LECT 81 TERM
     COUL ROUG LECT hp TERM
          TURQ LECT lp TERM
MATE GAZP RO 13. PINI 1.E6 GAMM 1.402 PREF 1.E5
            CV 713.3
            LECT hp TERM
     GAZP RO 1.3 PINI 1.E5 GAMM 1.402 PREF 1.E5
            CV 713.3
            LECT lp TERM
ECRI VFCC TFRE 10.E-3
     FICH FORM MAPP OBJE LECT tous TERM
                   TRIG ECRO 1 TSTO TVAL 1.1E5 LECT trigger TERM
OPTI NOTE STEP IO LOG 1
     VFCC FCON 6
CALC TINI 0. TFIN 80.E-3
FIN
```

matr04.epx

```
MATR04
ECHO
!CONV WIN
DPLA EULE
GEOM LIBR POIN 202 Q4VF 100 TERM
 0 0  1 0  2 0  3 0  4 0  5 0  6 0  7 0  8 0  9 0  10 0
     11 0 12 0 13 0 14 0 15 0 16 0 17 0 18 0 19 0  20 0
     21 0 22 0 23 0 24 0 25 0 26 0 27 0 28 0 29 0  30 0
     31 0 32 0 33 0 34 0 35 0 36 0 37 0 38 0 39 0  40 0
     41 0 42 0 43 0 44 0 45 0 46 0 47 0 48 0 49 0  50 0
     51 0 52 0 53 0 54 0 55 0 56 0 57 0 58 0 59 0  60 0
     61 0 62 0 63 0 64 0 65 0 66 0 67 0 68 0 69 0  70 0
     71 0 72 0 73 0 74 0 75 0 76 0 77 0 78 0 79 0  80 0
     81 0 82 0 83 0 84 0 85 0 86 0 87 0 88 0 89 0  90 0
     91 0 92 0 93 0 94 0 95 0 96 0 97 0 98 0 99 0 100 0
 0 1  1 1  2 1  3 1  4 1  5 1  6 1  7 1  8 1  9 1  10 1
```

```
    11 1 12 1 13 1 14 1 15 1 16 1 17 1 18 1 19 1  20 1
    21 1 22 1 23 1 24 1 25 1 26 1 27 1 28 1 29 1  30 1
    31 1 32 1 33 1 34 1 35 1 36 1 37 1 38 1 39 1  40 1
    41 1 42 1 43 1 44 1 45 1 46 1 47 1 48 1 49 1  50 1
    51 1 52 1 53 1 54 1 55 1 56 1 57 1 58 1 59 1  60 1
    61 1 62 1 63 1 64 1 65 1 66 1 67 1 68 1 69 1  70 1
    71 1 72 1 73 1 74 1 75 1 76 1 77 1 78 1 79 1  80 1
    81 1 82 1 83 1 84 1 85 1 86 1 87 1 88 1 89 1  90 1
    91 1 92 1 93 1 94 1 95 1 96 1 97 1 98 1 99 1 100 1
 1   2 103 102
 2   3 104 103
 3   4 105 104
 4   5 106 105
 5   6 107 106
 6   7 108 107
 7   8 109 108
 8   9 110 109
 9  10 111 110
10  11 112 111

11  12 113 112
12  13 114 113
13  14 115 114
14  15 116 115
15  16 117 116
16  17 118 117
17  18 119 118
18  19 120 119
19  20 121 120
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23  24 125 124
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35  36 137 136
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39  40 141 140
40  41 142 141

41  42 143 142
42  43 144 143
43  44 145 144
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74  75 176 175
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79  80 181 180
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82  83 184 183
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85  86 187 186
  86  87 188 187
  87  88 189 188
  88  89 190 189
  89  90 191 190
  90  91 192 191

  91  92 193 192
  92  93 194 193
  93  94 195 194
  94  95 196 195
  95  96 197 196
  96  97 198 197
  97  98 199 198
  98  99 200 199
  99 100 201 200
 100 101 202 201
COMP GROU 3 'hp' LECT  1 PAS 1  50 TERM
            'lp' LECT 51 PAS 1 100 TERM
            'trigger' LECT 81 TERM
     COUL ROUG LECT hp TERM
          TURQ LECT lp TERM
MATE GAZP RO 13. PINI 1.E6 GAMM 1.402 PREF 1.E5
              CV 713.3
              LECT hp TERM
     GAZP RO 1.3 PINI 1.E5 GAMM 1.402 PREF 1.E5
              CV 713.3
              LECT lp TERM
ECRI VFCC TFRE 10.E-3
     FICH FORM MAPP OBJE LECT tous TERM
                   TRIG ECRO 1 TSTO TVAL 1.1E5 LECT trigger TERM
     FICH ALIC TFRE 10.E-3
OPTI NOTE STEP IO LOG 1
     VFCC FCON 6
CALC TINI 0. TFIN 80.E-3
SUIT
Post treatment
RESU ALIC GARD PSCR
SORT GRAP AXTE 1.0 'T [s]'
SCOU 1 'p00' ECRO COMP 1 T  0.E-3 SAXE 1.0 'ABSC' LECT 1 PAS 1 101 TERM
SCOU 2 'p10' ECRO COMP 1 T 10.E-3 SAXE 1.0 'ABSC' LECT 1 PAS 1 101 TERM
SCOU 3 'p20' ECRO COMP 1 T 20.E-3 SAXE 1.0 'ABSC' LECT 1 PAS 1 101 TERM
SCOU 4 'p30' ECRO COMP 1 T 30.E-3 SAXE 1.0 'ABSC' LECT 1 PAS 1 101 TERM
SCOU 5 'p40' ECRO COMP 1 T 40.E-3 SAXE 1.0 'ABSC' LECT 1 PAS 1 101 TERM
SCOU 6 'p50' ECRO COMP 1 T 50.E-3 SAXE 1.0 'ABSC' LECT 1 PAS 1 101 TERM
SCOU 7 'ptr' ECRO COMP 1   NSTO 7 SAXE 1.0 'ABSC' LECT 1 PAS 1 101 TERM
TRAC 1 2 3 4 5 6 7 AXES 1.0 'PRES [PA]'
COLO NOIR NOIR NOIR NOIR NOIR NOIR ROUG
LIST 1 2 3 4 5 6 7 AXES 1.0 'PRES [PA]'
SCOU 11 'r00' ECRO COMP 2 T  0.E-3 SAXE 1.0 'ABSC' LECT 1 PAS 1 101 TERM
SCOU 12 'r10' ECRO COMP 2 T 10.E-3 SAXE 1.0 'ABSC' LECT 1 PAS 1 101 TERM
SCOU 13 'r20' ECRO COMP 2 T 20.E-3 SAXE 1.0 'ABSC' LECT 1 PAS 1 101 TERM
SCOU 14 'r30' ECRO COMP 2 T 30.E-3 SAXE 1.0 'ABSC' LECT 1 PAS 1 101 TERM
SCOU 15 'r40' ECRO COMP 2 T 40.E-3 SAXE 1.0 'ABSC' LECT 1 PAS 1 101 TERM
SCOU 16 'r50' ECRO COMP 2 T 50.E-3 SAXE 1.0 'ABSC' LECT 1 PAS 1 101 TERM
SCOU 17 'rtr' ECRO COMP 2   NSTO 7 SAXE 1.0 'ABSC' LECT 1 PAS 1 101 TERM
TRAC 11 12 13 14 15 16 17 AXES 1.0 'DENS [KG/M3]'
COLO NOIR NOIR NOIR NOIR NOIR NOIR ROUG
LIST 11 12 13 14 15 16 17 AXES 1.0 'DENS [KG/M3]'
FIN
```

S2.dgibi

```
*$$$$ PX4CIR3D
*
* Pour generer le maillage 3D (plan) d'un quart de cercle
* avec seulement des quadrilateres a 4 noeuds.
* Le quart de cercle est defini par les deux extremes
* d'un arc (de 90 degrees), par le centre du cercle
* et par un autre point qui definit l'axe de rotation
* (axe perpendiculaire au plan du cercle, passant pour son centre).
*
* Input:
* =====
* P1 = premiere extremite de l'arc
* P2 = deuxieme extremite de l'arc
* PC = centre de l'arc
* PZ = autre point de l'axe
* N  = nombre de mailles a generer sur chaque cote (doit etre pair)
* TOL= tolerance pour l'elimination des noeuds doubles
*
* Output:
* ======
* SUR = objet MAILLAGE d'elements de type QUA4
* IER = 0: pas d'erreur, .NE.0: erreur dans la generation de SUR
*
'DEBPROC' PX4CIR3D P1*'POINT' P2*'POINT' PC*'POINT' PZ*'POINT'
                   N*'ENTIER' TOL*'FLOTTANT';
*-----------------------------------------------------------------
*
ier=0;
n2 = n / 2;
p0 = 0 0 0;
pm1 = p1 plus p0;
depl pm1 tour 45 pc pz;
pm2 = 0.5*(pc plus p2);
pm3 = 0.5*(pc plus p1);
pm = 0.5*(pc plus pm1);
c1a = cerc n2 p1 pc pm1;
c1b = cerc n2 pm1 pc p2;
c2a = droi n2 p2 pm2;
c2b = droi n2 pm2 pc;
```

```
c3a = droi n2 pc pm3;
c3b = droi n2 pm3 p1;
c4a = droi n2 pm pm1;
c4b = droi n2 pm pm2;
c4c = droi n2 pm pm3;
sur1 = dall plan c4c c3b c1a (inve c4a);
sur2 = dall plan c4a c1b c2a (inve c4b);
sur3 = dall plan c2b c3a (inve c4c) c4b;
sur = sur1 et sur2 et sur3;
*
elim tol sur;
*
'FINPROC' sur ier;
************************************************************************
opti echo 1;
opti dime 3 elem cub8;
opti sauv form 'S2.msh';
opti trac psc ftra 'S2_mesh.ps';
*
* upper frame
*
ref = 2;
*
tol = 1.E-5;
p0 = 0 0 0;
pz = 0 0 1;
p1 = 0.150 0 0;
dhole = 0.025;
rhole = dhole / 2.0;
dhext = 0.045;
rhext = dhext / 2.0;
p2 = (0.260 - rhext) 0 0;
p3 = (0.260 + rhext) 0 0;
p4 = 0.325 0 0;
p5 = p4 tour 45.0 p0 pz;
p6 = p3 tour 45.0 p0 pz;
p7 = p2 tour 45.0 p0 pz;
p8 = 0.150 0.150 0;
*
c1 = p1 d (9*ref) p2;
pc1 = 0.260 0 0;
pz1 = pc1 plus pz;
p2b = p3 tour 90.0 pc1 pz1;
c2 = p2 c (2*ref) pc1 p2b c (2*ref) pc1 p3;
c3 = p3 d (4*ref) p4;
c4 = p4 c (13*ref) p0 p5;
c5 = p5 d (3*ref) p6;
pc2 = pc1 tour 45.0 p0 pz;
pz2 = pc2 plus pz;
p6b = p7 tour 90.0 pc2 pz2;
c6 = p6 c (2*ref) pc2 p6b c (2*ref) pc2 p7;
c7 = p7 d (3*ref) p8;
* attention, following line should not use ref!
c8 = p8 d 25 p1;
*
cc0 = c1 et c2 et c3 et c4 et c5 et c6 et c7 et c8;
elim tol cc0;
*
c9a = c2 tour 15.0 p0 pz;
c9b = c6 tour (0 - 30.0) p0 pz;
c9 = elim tol (c9a et c9b);
c10 = c9 tour 15.0 p0 pz;
cc = cc0 et c9 et c10;
*
bas1 = surf cc plan;
bas1 = orie bas1 dire pz;
*
c11 = ((0.260 + rhole) 0 0) d (1*ref) p3;
pre1 = c11 rota (4*ref) 180.0 pc1 pz1;
pre2a = pre1 tour 15.0 p0 pz;
pc3 = pc1 tour 15.0 p0 pz;
pre2b = pre2a tour 180.0 pc3 (pc3 plus pz);
pre2 = pre2a et pre2b;
pre3 = pre2 tour 15.0 p0 pz;
pre4 = pre2b tour 30.0 p0 pz;
baspr = pre1 et pre2 et pre3 et pre4;
baspr = orie baspr dire pz;
elim tol (bas1 et baspr);
*
bas2 = bas1 syme plan p8 p5 (p8 plus pz);
baspr2 = baspr syme plan p8 p5 (p8 plus pz);
bas = bas1 et baspr et bas2 et baspr2;
elim tol bas;
bas = orie bas dire pz;
trac bas;
*
gap = 0.0008;
gap2 = gap / 2.0;
ubas = bas plus (0 0 gap2);
thu = 0.025;
uframe = ubas volu tran (3) (0 0 thu);
trac cach uframe;
*
* plate
*
dpla = 0.3;
rpla = 0.5 * dpla;
*
* aux = 0.03*cos(45)
*
aux = 0.0212132;
auxa = 0.06 - aux;
auxb = 0.06 + aux;
*
p0s = 0 0 0;
p1s = rpla 0 0;
p2s = rpla rpla 0;
p3s = 0 rpla 0;
*
p4s = auxa 0 0;
p5s = auxb 0 0;
p6s = 0 auxa 0;
p7s = auxa auxa 0;
p8s = auxb auxa 0;
p9s = 0.15 0.03 0;
p10s = 0 auxb 0;
p11s = auxa auxb 0;
p12s = auxb auxb 0;
p13s = 0.15 0.09 0;
p14s = 0.03 0.15 0;
p15s = 0.09 0.15 0;
*
nrp1 = 5;
nrp2 = 10;
nrp3 = 10;
*
c1s = p0s d nrp1 p4s;
c2s = p4s d nrp1 p7s;
c3s = p7s d nrp1 p6s;
c4s = p6s d nrp1 p0s;
pla1 = dall c1s c2s c3s c4s plan;
c1s = p4s d nrp2 p5s;
c2s = p5s d nrp1 p8s;
c3s = p8s d nrp2 p7s;
c4s = p7s d nrp1 p4s;
pla2 = dall c1s c2s c3s c4s plan;
c1s = p5s d nrp3 p1s;
c2s = p1s d nrp1 p9s;
c3s = p9s d nrp3 p8s;
c4s = p8s d nrp1 p5s;
pla3 = dall c1s c2s c3s c4s plan;
c1s = p6s d nrp1 p7s;
c2s = p7s d nrp2 p11s;
c3s = p11s d nrp1 p10s;
c4s = p10s d nrp2 p6s;
pla4 = dall c1s c2s c3s c4s plan;
c1s = p8s d nrp3 p9s;
c2s = p9s d nrp2 p13s;
c3s = p13s d nrp3 p12s;
c4s = p12s d nrp2 p8s;
pla5 = dall c1s c2s c3s c4s plan;
c1s = p10s d nrp1 p11s;
c2s = p11s d nrp3 p14s;
c3s = p14s d nrp1 p3s;
c4s = p3s d nrp3 p10s;
pla6 = dall c1s c2s c3s c4s plan;
c1s = p11s d nrp2 p12s;
c2s = p12s d nrp3 p15s;
c3s = p15s d nrp2 p14s;
c4s = p14s d nrp3 p11s;
pla7 = dall c1s c2s c3s c4s plan;
c1s = p12s d nrp3 p13s;
c2s = p13s d nrp3 p2s;
c3s = p2s d nrp3 p15s;
c4s = p15s d nrp3 p12s;
pla8 = dall c1s c2s c3s c4s plan;
place = pla1 et pla2 et pla3 et pla4 et pla5 et pla6 et
        pla7 et pla8;
elim tol place;
p16s = auxa auxa 0;
p17s = auxb auxa 0;
p18s = 0.06 0.06 0;
p19s = 0.06 0.06 1;
c1s = p16s d nrp2 p17s;
c2s = p17s d nrp2 p18s;
c3s = p18s d nrp2 p16s;
qu1 = surf (c1s et c2s et c3s) plan;
qu2 = qu1 tour 90 p18s p19s;
qu3 = qu2 tour 90 p18s p19s;
qu4 = qu3 tour 90 p18s p19s;
elim tol (place et qu1);
elim tol (place et qu2);
elim tol (place et qu3);
elim tol (place et qu4);
placen = place et qu1 et qu2 et qu3 et qu4;
*
p4p = 0.3125 0 0;
c3p = p3 d (3*ref) p4p;
p5p = 0.3125 0.3125 0;
c4p = p4p d (16*ref) p5p;
c5p = p5p d (9*ref) p6;
cc0p = c1 et c2 et c3p et c4p et c5p et c6 et c7 et c8;
*
ccp = cc0p et c9 et c10;
elim tol ccp;
*
bas1p = surf ccp plan;
bas1p = orie bas1p dire pz;
bas2p = bas1p syme plan p8 p5 (p8 plus pz);
elim tol (bas1p et baspr et bas2p et baspr2 et place);
plate = bas1p et baspr et bas2p et baspr2 et placen;
plate = orie plate dire pz;
trac plate;
trac cach (uframe et plate);
*
```

```
* lower frame with bolts
*
dbolt = 0.0245;
rbolt = dbolt / 2.0;
*
lpb = (0.260 + rbolt) 0 0;
c11 = lpb d (1*ref) p3;
lpre1 = c11 rota (4*ref) 180.0 pc1 pz1;
lpre2a = lpre1 tour 15.0 p0 pz;
lpre2b = lpre2a tour 180.0 pc3 (pc3 plus pz);
lpre2 = lpre2a et lpre2b;
lpre3 = lpre2 tour 15.0 p0 pz;
lpre4 = lpre2b tour 30.0 p0 pz;
lbaspr = lpre1 et lpre2 et lpre3 et lpre4;
lbaspr = orie lbaspr dire pz;
elim tol (bas1 et lbaspr);
*
lbaspr2 = lbaspr syme plan p8 p5 (p8 plus pz);
lbas = bas1 et lbaspr et bas2 et lbaspr2;
elim tol lbas;
lbas = orie lbas dire pz;
trac lbas;
*
thl = 0.025;
lobas = lbas plus (0 0 (0 - gap2 - thl));
lframe = lobas volu tran (3) (0 0 thl);
trac cach lframe;
trac cach (uframe et lframe);
trac cach (uframe et plate et lframe);
*
lpb2 = lpb tour 90.0 pc1 pz1;
sur11 ier = PX4CIR3D lpb lpb2 pc1 pz1 (2*ref) 1.E-3;
sur12 = sur11 tour 90.0 pc1 pz1;
sur1 = sur11 et sur12;
elim tol sur1;
sur1 = orie sur1 dire pz;
*
sur2a = sur1 tour 30.0 p0 pz;
sur1s = sur1 syme plan pc1 lpb pz1;
sur1s = orie sur1s dire pz;
sur2b = sur1s tour 30.0 p0 pz;
sur2 = sur2a et sur2b;
elim tol sur2;
sur2 = orie sur2 dire pz;
sur3 = sur2 tour 30.0 p0 pz;
sur4 = sur1s tour 90.0 p0 pz;
sur1 = sur1 plus (0 0 (0 - gap2 - thl));
sur2 = sur2 plus (0 0 (0 - gap2 - thl));
sur3 = sur3 plus (0 0 (0 - gap2 - thl));
sur4 = sur4 plus (0 0 (0 - gap2 - thl));
*
hbolt = 0.06;
hboltu = hbolt - thl;
*
bolt1a = sur1 volu tran (3) (0 0 thl);
bolt1b = (sur1 plus (0 0 thl)) volu tran (4) (0 0 hboltu);
bolt1 = bolt1a et bolt1b;
elim tol (bolt1 et lframe);
bolt2a = sur2 volu tran (3) (0 0 thl);
bolt2b = (sur2 plus (0 0 thl)) volu tran (4) (0 0 hboltu);
bolt2 = bolt2a et bolt2b;
elim tol (bolt2 et lframe);
bolt3a = sur3 volu tran (3) (0 0 thl);
bolt3b = (sur3 plus (0 0 thl)) volu tran (4) (0 0 hboltu);
bolt3 = bolt3a et bolt3b;
elim tol (bolt3 et lframe);
bolt4a = sur4 volu tran (3) (0 0 thl);
bolt4b = (sur4 plus (0 0 thl)) volu tran (4) (0 0 hboltu);
bolt4 = bolt4a et bolt4b;
elim tol (bolt4 et lframe);
bolts = bolt1 et bolt2 et bolt3 et bolt4;
lframeb = lframe et bolts;
elim tol lframeb;
trac cach lframeb;
trac cach (lframeb et plate);
trac cach (lframeb et plate et uframe);
*
* pressurized clamping surfaces
*
presa = pre1 plus (0 0 (gap2 + thu));
presa = presa orie dire pz;
presb = pre3 plus (0 0 (gap2 + thu));
presb = presb orie dire pz;
presc = presb tour 30.0 p0 pz;
presd = (presa tour 90.0 p0 pz) syme plan p0 (0 1 0) pz;
presd = presd orie dire pz;
presur = presa et presb et presc et presd;
elim tol (presur et uframe);
trac cach (presur et uframe);
*
preplat = placen coul roug;
trac cach (plate et preplat);
*
oubl tol;
oubl p0;
oubl pz;
oubl p1;
oubl dhole;
oubl rhole;
oubl dext;
oubl rext;
oubl p2;
oubl p3;
oubl p4;
oubl p5;
oubl p6;
oubl p7;
oubl p8;
oubl c1;
oubl pc1;
oubl pz1;
oubl p2b;
oubl c2;
oubl c3;
oubl c4;
oubl c5;
oubl pc2;
oubl pz2;
oubl p6b;
oubl c6;
oubl c7;
oubl c8;
oubl cc0;
oubl c9a;
oubl c9b;
oubl c9;
oubl c10;
oubl cc;
oubl bas1;
oubl c11;
oubl pre1;
oubl pre2a;
oubl pc3;
oubl pre2b;
oubl pre2;
oubl pre3;
oubl pre4;
oubl baspr;
oubl bas2;
oubl baspr2;
oubl bas;
oubl gap;
oubl gap2;
oubl ubas;
oubl thu;
oubl cl2;
*
*oubl c12;
oubl dpla;
oubl rpla;
oubl p0s;
oubl p1s;
oubl p2s;
oubl p3s;
oubl p4s;
oubl p5s;
oubl p6s;
oubl p7s;
oubl p8s;
oubl p9s;
oubl p10s;
oubl p11s;
oubl p12s;
oubl p13s;
oubl p14s;
oubl p15s;
oubl p16s;
oubl p17s;
oubl p18s;
oubl p19s;
oubl nrp1;
oubl nrp2;
oubl nrp3;
*oubl qu1;
*oubl qu2;
*oubl qu3;
*oubl qu4;
oubl c1s;
oubl c2s;
oubl c3s;
oubl c4s;
oubl pla1;
oubl pla2;
oubl pla3;
oubl pla4;
oubl pla5;
oubl pla6;
oubl pla7;
oubl pla8;
oubl place;
oubl placen;
*
oubl p4p;
oubl c3p;
oubl p5p;
oubl c4p;
oubl c5p;
oubl cc0p;
oubl ccp;
oubl bas1p;
oubl bas2p;
oubl dbolt;
oubl rbolt;
oubl lpb;
oubl lpre1;
```

```
oubl lpre2a;
oubl lpre2b;
oubl lpre2;
oubl lpre3;
oubl lpre4;
oubl lbaspr;
oubl lbaspr2;
oubl lbas;
oubl thl;
oubl lobas;
oubl lframe;
oubl lpb2;
oubl sur11;
oubl ier;
oubl sur12;
oubl sur1;
oubl sur2a;
oubl sur1s;
oubl sur2b;
oubl sur2;
oubl sur3;
oubl sur4;
oubl hbolt;
oubl hboltu;
oubl bolt1a;
oubl bolt1b;
oubl bolt1;
oubl bolt2a;
oubl bolt2b;
oubl bolt2;
oubl bolt3a;
oubl bolt3b;
oubl bolt3;
oubl bolt4a;
oubl bolt4b;
oubl bolt4;
oubl bolts;
oubl presa;
oubl presb;
oubl presc;
oubl presd;
oubl ref;
list;
*
nplate = chan poi1 plate;
*
ecub8 = (lframeb et uframe) elem cub8;
epri6 = (lframeb et uframe) elem pri6;
equa4 = plate elem qua4;
etri3 = plate elem tri3;
ppqua4 = preplat elem qua4;
pptri3 = preplat elem tri3;
*
spec = lframeb et plate et uframe et presur et ppqua4 et pptri3
       et nplate et ecub8 et epri6 et equa4 et etri3;
*
* We use the "DEPL spec TOUR ..." directive to rotate
* the entire mesh (spec)
* (together with its components: points/lines/parts)
* to become oriented like the fluid model, ready to be used
* (also) in a FSI calculation.
* One should NOT use the form "spec = spec TOUR ..." because only
* the main object (and NOT its components) would be rotated.
*
depl spec tour 90 (0 0 0) (0 -1 0);
*
tass spec noop;
sauv form spec;
trac cach spec;
list;
*
fin;
```

S2_FSI.dgibi

```
opti echo 0;
*opti donn 'px4cir3d.proc';
*$$$$ PX4CIR3D
*
* Pour generer le maillage 3D (plan) d'un quart de cercle
* avec seulement des quadrilateres a 4 noeuds.
* Le quart de cercle est defini par les deux extremes
* d'un arc (de 90 degrees), par le centre du cercle
* et par un autre point qui definit l'axe de rotation
* (axe perpendiculaire au plan du cercle, passant pour son centre).
*
* Input:
* =====
* P1 = premiere extremite de l'arc
* P2 = deuxieme extremite de l'arc
* PC = centre de l'arc
* PZ = autre point de l'axe
* N  = nombre de mailles a generer sur chaque cote (doit etre pair)
* TOL= tolerance pour l'elimination des noeuds doubles
*
* Output:
* ======
* SUR = objet MAILLAGE d'elements de type QUA4
* IER = 0: pas d'erreur, .NE.0: erreur dans la generation de SUR
*
'DEBPROC' PX4CIR3D P1*'POINT' P2*'POINT' PC*'POINT' PZ*'POINT'
                   N*'ENTIER' TOL*'FLOTTANT';
*------------------------------------------------------------------
*
ier=0;
n2 = n / 2;
p0 = 0 0 0;
pm1 = p1 plus p0;
depl pm1 tour 45 pc pz;
pm2 = 0.5*(pc plus p2);
pm3 = 0.5*(pc plus p1);
pm = 0.5*(pc plus pm1);
c1a = cerc n2 p1 pc pm1;
c1b = cerc n2 pm1 pc p2;
c2a = droi n2 p2 pm2;
c2b = droi n2 pm2 pc;
c3a = droi n2 pc pm3;
c3b = droi n2 pm3 p1;
c4a = droi n2 pm pm1;
c4b = droi n2 pm pm2;
c4c = droi n2 pm pm3;
sur1 = dall plan c4c c3b c1a (inve c4a);
sur2 = dall plan c4a c1b c2a (inve c4b);
sur3 = dall plan c2b c3a (inve c4c) c4b;
sur = sur1 et sur2 et sur3;
*
elim tol sur;
*
'FINPROC' sur ier;
************************************************************************
************************************************************************
'DEBPROC' pxextr3d m*'MAILLAGE' x1*'FLOTTANT' x2*'FLOTTANT'
                   y1*'FLOTTANT' y2*'FLOTTANT'
                   z1*'FLOTTANT' z2*'FLOTTANT';
*
*-------------------------------------------------
* Extracts from the 3D mesh m the elements whose nodes are
* located in the box [x1-x2,y1-y2,z1-z2].
*
* Input :
* -----
*     m                      : 3D mesh
*     x1, x2, y1, y2, z1, z2 : extremes of the box
* Output :
* ------
*     box : mesh contained in the box
*-------------------------------------------------
*
x = coor 1 m;
sx = x POIN COMP x1 x2;
y = coor 2 sx;
sy = y POIN COMP y1 y2;
z = coor 3 sy;
sz = z POIN COMP z1 z2;
box = m ELEM APPU STRI sz NOVE;
*
finproc box;
************************************************************************
*
*opti donn 'px4car3d.proc';
*$$$$ PX4CAR3D
*
* This procedure is similar to PX4CIR3D but instead of a fourth
* of a circle it generates a (fourth of a) square, homeomorphic
* to the fourth of a circle that would be generated by PX4CIR3D
* by using the same input parameters (except for PZ which is
* unused in this case).
* In this way the two surfaces (the circle and the square)
* can be connected volumetrically by the VOLU operator:
*    vol = cir VOLU n squ;
*
* Input:
* =====
* P1 = premiere extremite de l'arc (cote du quadrangle, ici)
* P2 = deuxieme extremite de l'arc (cote du quadrangle, ici)
* PC = centre de l'arc (quadrangle, ici)
* N  = nombre de mailles a generer sur chaque cote (doit etre pair)
* TOL= tolerance pour l'elimination des noeuds doubles
*
* Output:
* ======
* SUR = objet MAILLAGE d'elements de type QUA4
* IER = 0: pas d'erreur, .NE.0: erreur dans la generation de SUR
*
'DEBPROC' PX4CAR3D P1*'POINT' P2*'POINT' PC*'POINT'
                   N*'ENTIER' TOL*'FLOTTANT';
*------------------------------------------------------------------
*
ier=0;
n2 = n / 2;
p0 = 0 0 0;
pm1 = p1 plus (p2 moin pc);
pm2 = 0.5*(pc plus p2);
pm3 = 0.5*(pc plus p1);
pm = 0.5*(pc plus pm1);
c1a = droi n2 p1 pm1;
c1b = droi n2 pm1 p2;
c2a = droi n2 p2 pm2;
c2b = droi n2 pm2 pc;
c3a = droi n2 pc pm3;
c3b = droi n2 pm3 p1;
c4a = droi n2 pm pm1;
c4b = droi n2 pm pm2;
```

```
c4c = droi n2 pm pm3;
sur1 = dall plan c4c c3b c1a (inve c4a);
sur2 = dall plan c4a c1b c2a (inve c4b);
sur3 = dall plan c2b c3a (inve c4c) c4b;
sur = sur1 et sur2 et sur3;
*
elim tol sur;
*
'FINPROC' sur ier;
************************************************************************
opti echo 1;
*
opti dime 3 elem cub8;
opti sauv form 'S2_FSI.msh';
opti trac psc ftra 'S2_FSI_mesh.ps';
*
tol = 1.E-5;
dia = 0.331E0;
rad = 0.5D0*dia;
cot = 0.300E0;
co2 = 0.5D0*cot;
ldr = 0.77E0;
lf1 = 0.07E0;
lf2 = 0.07E0;
ltublp = 16.195;
ltra = 0.60E0;
lp3xd = 3.5E0;
lp3x= lp3xd - ltra;
*lext= ltublp - ltra;
lext = ltublp - lp3xd;
X0 = 0.0 - (ltublp + lf1 + lf2 + ldr);
p0 = X0 0 0;
py = X0 rad 0;
pz = X0 0 rad;
p0b = X0 0 0;
pyb = X0 co2 0;
pzb = X0 0 co2;
px = ldr 0 0;
nr = 16;
h = 0.01E0;
ndr = enti ((ldr+tol) / h);
nf1 = enti ((lf1+tol) / h);
nf2 = enti ((lf2+tol) / h);
ntra = enti ((ltra+tol) / h);
n3x = enti ((lp3x+tol) / h);
fond ier = PX4CIR3D py pz p0 px nr tol;
bout ier = PX4CAR3D pyb pzb p0b nr tol;
bout = bout plus ((ldr + lf1 + lf2 + ltra) 0 0);
driver = fond volu tran ndr (ldr 0 0);
fir1 = (fond plus (ldr 0 0)) volu tran nf1 (lf1 0 0);
fir1 = coul vert (fir1);
fir2 = (fond plus ((ldr + lf1) 0 0)) volu tran nf2 (lf2 0 0);
fir2 = coul bleu (fir2);
tra = (fond plus ((ldr + lf1 + lf2) 0 0)) volu ntra bout;
trac cach qual (tra et fir1 et fir2 et driver);
*
************************************************************************
* Spurious contact surface/tube/trans for membranes
************************************************************************
*
ddr = 0.0025;
rsh = ddr;
pst1 = p0 PLUS (0 0 0);
pst2 = py PLUS (0 rsh 0);
pst3 = pz PLUS (0 0 rsh);
pst4 = px PLUS (0 0 0);
*
fondd ier = PX4CIR3D pst2 pst3 pst1 pst4 (nr) tol;
*
pst5 = p0b PLUS (0 0 0);
pst6 = pyb PLUS (0 rsh 0);
pst7 = pzb PLUS (0 0 rsh);
*
boutd ier = PX4CAR3D pst6 pst7 pst5 (nr) tol;
boutd = boutd plus ((ldr + lf1 + lf2 + ltra) 0 0);
*
tradd = (fondd plus ((ldr + lf1 + lf2) 0 0)) volu (ntra) boutd;
ndum = nf1;
fird1 = (fondd plus ((ldr-0.01) 0 0)) volu tran (ndum+1)
((lf1+0.01) 0 0);
fird2 = (fondd plus ((ldr + lf1) 0 0)) volu tran (nf2) (lf2 0 0);
*
trad = tradd et fird1 et fird2;
elim tol trad;
*
tras = enve trad;
trac cach qual trad;
*trac cach qual tras;
trac cach qual (fondd et boutd);
trac cach qual (fondd et boutd et tras);
*
************************************************************************
* Extract non-outward-directed walls from tras
************************************************************************
*
nout1 = (pxextr3d tras -16.347 -16.343 -0.001 0.175 -0.001 0.175)
        COUL VERT;
nout2 = (pxextr3d tras -15.597 -15.593 -0.001 0.175 -0.001 0.175)
        COUL VERT;
nout3 = (pxextr3d tras -16.347 -15.593 -0.001 0.175 -0.001 0.001)
        COUL VERT;
nout4 = (pxextr3d tras -16.347 -15.593 -0.001 0.001 -0.001 0.175)
        COUL VERT;
nout = nout1 et nout2 et nout3 et nout4;
pinbcm = (tras DIFF nout) COUL ROUG;
npincm = chan poi1 pinbcm;
trac cach qual (nout1 et nout2 et nout3);
trac cach qual nout;
trac cach qual pinbcm;
trac cach qual (fondd et boutd et pinbcm);
trac cach qual (tra et pinbcm);
trac cach qual (tra et npincm);
*
************************************************************************
*
boutx = bout plus ((lp3x) 0 0);
lp3xl = bout volu n3x boutx;
*
flui3d = driver et fir1 et fir2 et tra et lp3xl;
elim tol flui3d;
trac cach qual flui3d;
trac cach qual (flui3d et pinbcm);
list (nbel flui3d);
list (nbel (flui3d elem cub8));
mem1 = fond plus (ldr 0 0);
mem2 = mem1 plus (lf1 0 0);
mem3 = mem2 plus (lf2 0 0);
mems = mem1 et mem2 et mem3;
pre1 = mem1 coul jaun;
pre2 = mem2 coul jaun;
pre3 = mem3 coul jaun;
pre = pre1 et pre2 et pre3;
*
*face3d = bout PLUS (0 0 0);
face3d = boutx PLUS (0 0 0);
pface3d = chan poi1 face3d;
elim tol (pface3d et flui3d);
p1a = (0 - lext) 0 0;
trac cach qual (p1a et face3d et pinbcm);
rac3d1d = manu supe (p1a et face3d);
list (nbno rac3d1d);
list (nbno face3d);
mesh1 = mems et flui3d et pre et face3d et rac3d1d;
*
************************************************************************
*
dtub = 0.3;
rtub = 0.5 * dtub;
dext = 0.625;
rext = 0.5 * dext;
dtank = 1.6;
rtank = 0.5 * dtank;
ltan0 = -0.7;
ltan1 = 0.9;
ltanopen = 1.4;
ltan2 = 1.5;
*
*ltubhp = 0.27;
*ltublp = 16.195;
*ltube = ltubhp + ltublp;
*
nrtub = 15;
tol = 0.01 * dtub / nrtub;
*
p0 = 0 0 0;
p1 = 0 rtub 0;
p2 = 0 rtub rtub;
p3 = 0 0 rtub;
*
c1 = p0 d nrtub p1;
c2 = p1 d nrtub p2;
c3 = p2 d nrtub p3;
c4 = p3 d nrtub p0;
sflu1 = dall c1 c2 c3 c4 plan;
*
paxis = 1 0 0;
p4 = 0 rext 0;
p5 = p4 tour 45 p0 paxis;
p6 = 0 0 rext;
*
c5 = p1 d nrtub p4;
c6 = p4 c nrtub p0 p5;
c7 = p5 d nrtub p2;
c8 = p2 d nrtub p1;
sflu2 = dall c5 c6 c7 c8 plan;
*
c9  = p2 d nrtub p5;
c10 = p5 c nrtub p0 p6;
c11 = p6 d nrtub p3;
c12 = p3 d nrtub p2;
sflu3 = dall c9 c10 c11 c12 plan;
*
p7 = 0 rtank 0;
p8 = p7 tour 45 p0 paxis;
p9 = 0 0 rtank;
*
din = (rext - rtub) / nrtub;
dfi = din * dtank / dext;
dfi = dfi * 4;
c13 = p4 d p7 dini din dfin dfi;
sflu4 = c13 rota nrtub 45 p0 paxis;
*
sflu5 = sflu4 tour 45 p0 paxis;
*
sflu0 = sflu4 et sflu5;
```

```
sflu = sflu1 et sflu2 et sflu3 et sflu0;
elim tol sflu;
*
d1 = 0.01;
d2 = d1 * 8;
d3  = d2;
vtan0 = (sflu0 plus (ltan0 0 0)) volu dini d2 dfin d1
        tran ((0-ltan0) 0 0);
vtan1a = sflu volu dini d1 dfin d1 tran (dtub 0 0);
vtan1b = (sflu plus (dtub 0 0)) volu dini d1 dfin d2
         tran ((ltan1 - dtub) 0 0);
vtan1 = vtan1a et vtan1b;
vtanopen = (sflu plus (ltan1 0 0)) volu dini d2 dfin d3
        tran (ltanopen 0 0);
vtan2 = (sflu plus ((ltan1+ltanopen) 0 0)) volu dini d3 dfin d3
        tran (ltan2 0 0);
tank = vtan0 et vtan1 et vtanopen et vtan2;
elim tol tank;
*
pa1 = ltan1 rtank 0;
pa2 = (ltan1 + ltanopen) rtank 0;
cab = d pa1 pa2 dini d2 dfin d3;
abso = cab rota (2*nrtub) 90 p0 paxis;
elim tol (abso et tank);
*
************************************************************************
*
*
*p1d1 = (0 - ltube) 0 0;
*p1d2 = p1d1 plus (ltubhp 0 0);
*tubehp = p1d1 d p1d2 dini d1 dfin d1;
*lenlp3d = 0.6;
*p1d3 = (0 - lenlp3d) 0 0;
*tubelp1 = p1d2 d p1d3 dini d1 dfin d1;
*stub3d = sflu1 plus p1d3;
*tubelp3 = stub3d volu dini d1 dfin d1 tran (lenlp3d 0 0);
*tubelp = tubelp1 et tubelp3;
*
*raclp = manu supe (p1d3 et stub3d);
*
*tube = tubehp et tubelp;
*
*
p1d1 = (0 - lext) 0 0;
*p1d3 = 0 0 0;
lenlp3d = 0.6;
p1d3 = (0 - lenlp3d) 0 0;
tubelp1 = p1d1 d p1d3 dini h dfin h;
stub3d = sflu1 plus p1d3;
tubelp3 = stub3d volu dini d1 dfin d1 tran (lenlp3d 0 0);
trac cach qual (tubelp3 ET tubelp1 ET fir1);
tubelp = tubelp1 et tubelp3;
*
raclp = manu supe (p1d3 et stub3d);
*
trac cach qual (p1a et face3d et pinbcm et tubelp);
*
*tube = tubelp1;
tube = tubelp;
*
trac cach qual (tubelp1 ET p1d1 ET p1d3);
trac cach qual (tubelp1 ET p1d1 ET p1d3 et pinbcm);
*
flui = tube et tank;
elim tol flui;
trac cach tank;
trac cach flui;
*
list (nbel flui);
list (nbno flui);
list (nbel tube);
list (nbel tank);
*
elim tol (p1a et tubelp1);
*
oubl dtub;
oubl rtub;
oubl dext;
oubl rext;
oubl dtank;
oubl rtank;
oubl ltan0;
oubl ltan1;
oubl ltanopen;
oubl ltan2;
oubl ltubhp;
oubl ltube;
oubl nrpla;
oubl nrtub;
oubl tol;
oubl p0;
oubl p1;
oubl p2;
oubl p3;
oubl c1;
oubl c2;
oubl c3;
oubl c4;
oubl sflu1;
oubl p4;
oubl p5;
oubl p6;
oubl c5;
oubl c6;
oubl c7;
oubl c8;
oubl sflu2;
oubl c9;
oubl c10;
oubl c11;
oubl c12;
oubl sflu3;
oubl p7;
oubl p8;
oubl p9;
oubl din;
oubl dfi;
oubl c13;
oubl sflu4;
oubl sflu5;
oubl sflu0;
oubl sflu;
oubl d1;
oubl d2;
oubl d3;
oubl vtan0;
oubl vtan1a;
oubl vtan1b;
oubl vtan1;
oubl vtanopen;
oubl vtan2;
oubl pa1;
oubl pa2;
oubl cab;
oubl p1d1;
oubl p1d2;
oubl lenlp3d;
oubl paxis;
*
devi = flui et abso et raclp;
*
* we add a fake triangle to host a fake pinball which is never eroded
* (to avoid a bug in the code)
pfake1 = -16.300  0 0;
pfake2 = -16.297  0 0;
pfake3 = -16.2985 0.003 0;
fake = manu tri3 pfake1 pfake2 pfake3;
*
*opti rest form 'FP_LC.msh';
*opti rest form 'FP_LAG_35.msh';
opti rest form 'S2.msh';
*
rest form;
*list;
mesh = devi et spec et mesh1 et fake et pinbcm et npincm;
tass mesh noop;
sauv form mesh;
list;
trac cach mesh;
*mesh = tube et mesh1 et fake et pinbcm et npincm;
*trac cach qual mesh;
*tass mesh noop;
*sauv form mesh;
*list;
*
fin;
```

ST_EUL_10.dgibi

```
opti echo 0;
*opti donn 'px4cir3d.proc';
*$$$$ PX4CIR3D
*
* Pour generer le maillage 3D (plan) d'un quart de cercle
* avec seulement des quadrilateres a 4 noeuds.
* Le quart de cercle est defini par les deux extremes
* d'un arc (de 90 degrees), par le centre du cercle
* et par un autre point qui definit l'axe de rotation
* (axe perpendiculaire au plan du cercle, passant pour son centre).
*
* Input:
* =====
* P1 = premiere extremite de l'arc
* P2 = deuxieme extremite de l'arc
* PC = centre de l'arc
* PZ = autre point de l'axe
* N  = nombre de mailles a generer sur chaque cote (doit etre pair)
* TOL= tolerance pour l'elimination des noeuds doubles
*
* Output:
* ======
* SUR = objet MAILLAGE d'elements de type QUA4
* IER = 0: pas d'erreur, .NE.0: erreur dans la generation de SUR
*
'DEBPROC' PX4CIR3D P1*'POINT' P2*'POINT' PC*'POINT' PZ*'POINT'
                   N*'ENTIER' TOL*'FLOTTANT';
*-----------------------------------------------------------------
*
ier=0;
n2 = n / 2;
p0 = 0 0 0;
pm1 = p1 plus p0;
depl pm1 tour 45 pc pz;
pm2 = 0.5*(pc plus p2);
pm3 = 0.5*(pc plus p1);
```

```
pm = 0.5*(pc plus pm1);
c1a = cerc n2 p1 pc pm1;
c1b = cerc n2 pm1 pc p2;
c2a = droi n2 p2 pm2;
c2b = droi n2 pm2 pc;
c3a = droi n2 pc pm3;
c3b = droi n2 pm3 p1;
c4a = droi n2 pm pm1;
c4b = droi n2 pm pm2;
c4c = droi n2 pm pm3;
sur1 = dall plan c4c c3b c1a (inve c4a);
sur2 = dall plan c4a c1b c2a (inve c4b);
sur3 = dall plan c2b c3a (inve c4c) c4b;
sur = sur1 et sur2 et sur3;
*
elim tol sur;
*
'FINPROC' sur ier;
************************************************************************
************************************************************************
'DEBPROC' pxextr3d m*'MAILLAGE' x1*'FLOTTANT' x2*'FLOTTANT'
                   y1*'FLOTTANT' y2*'FLOTTANT'
                   z1*'FLOTTANT' z2*'FLOTTANT';
*
*--------------------------------------------------
* Extracts from the 3D mesh m the elements whose nodes are
* located in the box [x1-x2,y1-y2,z1-z2].
*
* Input :
* -----
*     m                        : 3D mesh
*     x1, x2, y1, y2, z1, z2 : extremes of the box
* Output :
* ------
*     box : mesh contained in the box
*--------------------------------------------------
*
x = coor 1 m;
sx = x POIN COMP x1 x2;
y = coor 2 sx;
sy = y POIN COMP y1 y2;
z = coor 3 sy;
sz = z POIN COMP z1 z2;
box = m ELEM APPU STRI sz NOVE;
*
finproc box;
************************************************************************
*
*opti donn 'px4car3d.proc';
*$$$$ PX4CAR3D
*
* This procedure is similar to PX4CIR3D but instead of a fourth
* of a circle it generates a (fourth of a) square, homeomorphic
* to the fourth of a circle that would be generated by PX4CIR3D
* by using the same input parameters (except for PZ which is
* unused in this case).
* In this way the two surfaces (the circle and the square)
* can be connected volumetrically by the VOLU operator:
*    vol = cir VOLU n squ;
*
* Input:
* =====
* P1 = premiere extremite de l'arc (cote du quadrangle, ici)
* P2 = deuxieme extremite de l'arc (cote du quadrangle, ici)
* PC = centre de l'arc (quadrangle, ici)
* N  = nombre de mailles a generer sur chaque cote (doit etre pair)
* TOL= tolerance pour l'elimination des noeuds doubles
*
* Output:
* ======
* SUR = objet MAILLAGE d'elements de type QUA4
* IER = 0: pas d'erreur, .NE.0: erreur dans la generation de SUR
*
'DEBPROC' PX4CAR3D P1*'POINT' P2*'POINT' PC*'POINT'
                   N*'ENTIER' TOL*'FLOTTANT';
*-------------------------------------------------------------------
*
ier=0;
n2 = n / 2;
p0 = 0 0 0;
pm1 = p1 plus (p2 moin pc);
pm2 = 0.5*(pc plus p2);
pm3 = 0.5*(pc plus p1);
pm = 0.5*(pc plus pm1);
c1a = droi n2 p1 pm1;
c1b = droi n2 pm1 p2;
c2a = droi n2 p2 pm2;
c2b = droi n2 pm2 pc;
c3a = droi n2 pc pm3;
c3b = droi n2 pm3 p1;
c4a = droi n2 pm pm1;
c4b = droi n2 pm pm2;
c4c = droi n2 pm pm3;
sur1 = dall plan c4c c3b c1a (inve c4a);
sur2 = dall plan c4a c1b c2a (inve c4b);
sur3 = dall plan c2b c3a (inve c4c) c4b;
sur = sur1 et sur2 et sur3;
*
elim tol sur;
*
'FINPROC' sur ier;
************************************************************************
```

```
opti echo 1;
*
opti dime 3 elem cub8;
opti sauv form 'ST_EUL_10.msh';
opti trac psc ftra 'ST_EUL_mesh.ps';
*
tol = 1.E-5;
dia = 0.331E0;
rad = 0.5D0*dia;
cot = 0.300E0;
co2 = 0.5D0*cot;
ldr = 0.77E0;
lf1 = 0.07E0;
lf2 = 0.07E0;
ltublp = 16.195;
ltra = 0.60E0;
lp3xd = 3.5E0;
lp3x= lp3xd - ltra;
*lext= ltublp - ltra;
lext = ltublp - lp3xd;
X0 = 0.0 - (ltublp + lf1 + lf2 + ldr);
p0 = X0 0 0;
py = X0 rad 0;
pz = X0 0 rad;
p0b = X0 0 0;
pyb = X0 co2 0;
pzb = X0 0 co2;
px = ldr 0 0;
nr = 16;
h = 0.01E0;
ndr = enti ((ldr+tol) / h);
nf1 = enti ((lf1+tol) / h);
nf2 = enti ((lf2+tol) / h);
ntra = enti ((ltra+tol) / h);
n3x = enti ((lp3x+tol) / h);
fond ier = PX4CIR3D py pz p0 px nr tol;
bout ier = PX4CAR3D pyb pzb p0b nr tol;
bout = bout plus ((ldr + lf1 + lf2 + ltra) 0 0);
driver = fond volu tran ndr (ldr 0 0);
fir1 = (fond plus (ldr 0 0)) volu tran nf1 (lf1 0 0);
fir1 = coul vert (fir1);
fir2 = (fond plus ((ldr + lf1) 0 0)) volu tran nf2 (lf2 0 0);
fir2 = coul bleu (fir2);
tra = (fond plus ((ldr + lf1 + lf2) 0 0)) volu ntra bout;
trac cach qual (tra et fir1 et fir2 et driver);
*
************************************************************************
* Spurious contact surface/tube/trans for membranes
************************************************************************
*
ddr = 0.0025;
rsh = ddr;
pst1 = p0 PLUS (0 0 0);
pst2 = py PLUS (0 rsh 0);
pst3 = pz PLUS (0 0 rsh);
pst4 = px PLUS (0 0 0);
*
fondd ier = PX4CIR3D pst2 pst3 pst1 pst4 (nr) tol;
*
pst5 = p0b PLUS (0 0 0);
pst6 = pyb PLUS (0 rsh 0);
pst7 = pzb PLUS (0 0 rsh);
*
boutd ier = PX4CAR3D pst6 pst7 pst5 (nr) tol;
boutd = boutd plus ((ldr + lf1 + lf2 + ltra) 0 0);
*
tradd = (fondd plus ((ldr + lf1 + lf2) 0 0)) volu (ntra) boutd;
ndum = nf1;
fird1 = (fondd plus ((ldr-0.01) 0 0)) volu tran (ndum+1)
((lf1+0.01) 0 0);
fird2 = (fondd plus ((ldr + lf1) 0 0)) volu tran (nf2) (lf2 0 0);
*
trad = tradd et fird1 et fird2;
elim tol trad;
*
tras = enve trad;
trac cach qual trad;
*trac cach qual tras;
trac cach qual (fondd et boutd);
trac cach qual (fondd et boutd et tras);
*
************************************************************************
* Extract non-outward-directed walls from tras
************************************************************************
*
nout1 = (pxextr3d tras -16.347 -16.343 -0.001 0.175 -0.001 0.175)
        COUL VERT;
nout2 = (pxextr3d tras -15.597 -15.593 -0.001 0.175 -0.001 0.175)
        COUL VERT;
nout3 = (pxextr3d tras -16.347 -15.593 -0.001 0.175 -0.001 0.001)
        COUL VERT;
nout4 = (pxextr3d tras -16.347 -15.593 -0.001 0.001 -0.001 0.175)
        COUL VERT;
nout = nout1 et nout2 et nout3 et nout4;
pinbcm = (tras DIFF nout) COUL ROUG;
npincm = chan poi1 pinbcm;
trac cach qual (nout1 et nout2 et nout3);
trac cach qual nout;
trac cach qual pinbcm;
trac cach qual (fondd et boutd et pinbcm);
trac cach qual (tra et pinbcm);
trac cach qual (tra et npincm);
*
```

```
************************************************************************
*
boutx = bout plus ((lp3x) 0 0);
lp3xl = bout volu n3x boutx;
*
flui3d = driver et fir1 et fir2 et tra et lp3xl;
elim tol flui3d;
trac cach qual flui3d;
trac cach qual (flui3d et pinbcm);
list (nbel flui3d);
list (nbel (flui3d elem cub8));
mem1 = fond plus (ldr 0 0);
mem2 = mem1 plus (lf1 0 0);
mem3 = mem2 plus (lf2 0 0);
mems = mem1 et mem2 et mem3;
pre1 = mem1 coul jaun;
pre2 = mem2 coul jaun;
pre3 = mem3 coul jaun;
pre = pre1 et pre2 et pre3;
*
*face3d = bout PLUS (0 0 0);
face3d = boutx PLUS (0 0 0);
pface3d = chan poi1 face3d;
elim tol (pface3d et flui3d);
p1a = (0 - lext) 0 0;
trac cach qual (p1a et face3d et pinbcm);
rac3d1d = manu supe (p1a et face3d);
list (nbno rac3d1d);
list (nbno face3d);
mesh1 = mems et flui3d et pre et face3d et rac3d1d;
*
************************************************************************
*
dtub = 0.3;
rtub = 0.5 * dtub;
dext = 0.625;
rext = 0.5 * dext;
dtank = 1.6;
rtank = 0.5 * dtank;
ltan0 = -0.7;
ltan1 = 0.9;
ltanopen = 1.4;
ltan2 = 1.6;
*
*ltubhp = 0.27;
*ltublp = 16.195;
*ltube = ltubhp + ltublp;
*
*nrtub = 15;
nrtub = 2 * 15;
tol = 0.01 * dtub / nrtub;
*
p0 = 0 0 0;
p1 = 0 rtub 0;
p2 = 0 rtub rtub;
p3 = 0 0 rtub;
*
c1 = p0 d nrtub p1;
c2 = p1 d nrtub p2;
c3 = p2 d nrtub p3;
c4 = p3 d nrtub p0;
sflu1 = dall c1 c2 c3 c4 plan;
*
trac cach qual sflu1;
*
paxis = 1 0 0;
p4 = 0 rext 0;
p5 = p4 tour 45 p0 paxis;
p6 = 0 0 rext;
*
c5 = p1 d nrtub p4;
c6 = p4 c nrtub p0 p5;
c7 = p5 d nrtub p2;
c8 = p2 d nrtub p1;
*sflu2 = dall c5 c6 c7 c8 plan;
*
*trac cach qual sflu2;
*trac cach qual (sflu1 et sflu2);
*
c9  = p2 d nrtub p5;
c10 = p5 c nrtub p0 p6;
c11 = p6 d nrtub p3;
c12 = p3 d nrtub p2;
*sflu3 = dall c9 c10 c11 c12 plan;
*
*trac cach qual sflu3;
*trac cach qual (sflu1 et sflu2 et sflu3);
*
p7 = 0 rtank 0;
p8 = p7 tour 45 p0 paxis;
p9 = 0 0 rtank;
*
din = (rext - rtub) / nrtub;
dfi = din * dtank / dext;
*dfi = dfi * 4;
dfi = dfi * 4 * 2;
c13 = p4 d p7 dini din dfin dfi;
*sflu4 = c13 rota nrtub 45 p0 paxis;
*
*trac cach qual sflu4;
*trac cach qual (sflu1 et sflu2 et sflu3 et sflu4);
*
*sflu5 = sflu4 tour 45 p0 paxis;
*
*sflu0 = sflu4 et sflu5;
*sflu = sflu1 et sflu2 et sflu3 et sflu0;
sflu = sflu1;
*
*trac cach qual sflu5;
*trac cach qual (sflu);
*elim tol sflu;
*
*d1 = 0.01;
d1 = 0.005;
d2 = d1 * 8;
d3  = d2;
dp1 = 0.03;
*vtan0 = (sflu0 plus (ltan0 0 0)) volu dini d2 dfin d1
*        tran ((0-ltan0) 0 0);
*vtan01 = sflu0 volu dini d1 dfin d1 tran ((2*dp1) 0 0);
*vtan03 = (sflu1 plus (dp1 0 0)) volu dini d1 dfin d1 tran (dp1 0 0);
*vtan1a = (sflu plus ((2*dp1) 0 0)) volu dini d1 dfin d1
*         tran ((dtub-(2*dp1)) 0 0);
*vtan1b = (sflu plus (dtub 0 0)) volu dini d1 dfin d2
*         tran ((ltan1 - dtub) 0 0);
*vtan1 = vtan1a et vtan1b;
**vtanopen = (sflu plus (ltan1 0 0)) volu dini d2 dfin d3
**        tran (ltanopen 0 0);
**vtan2 = (sflu plus ((ltan1+ltanopen) 0 0)) volu dini d3 dfin d3
**        tran (ltan2 0 0);
*vtan2 = (sflu plus (ltan1 0 0)) volu dini d3 dfin d3
*        tran (ltan2 0 0);
*
*p0 = 0 0 0;
*p1 = 0 rtub 0;
*p2 = 0 rtub rtub;
*p3 = 0 0 rtub;
*
*p4s = 0 0.06 0;
*p6s = 0 0 0.06;
*p7s = 0 0.06 0.06;
*
*nrp2 = 6;
*nrp2 = 2 * 6;
*
*c1s = p0 d nrp2 p4s;
*c2s = p4s d nrp2 p7s;
*c3s = p7s d nrp2 p6s;
*c4s = p6s d nrp2 p0;
*
*pla1 = dall c1s c2s c3s c4s plan;
*
*vtan02 = pla1 volu dini d1 dfin d1 tran (dp1 0 0);
*
*tank = vtan0 et vtan1 et vtanopen et vtan2 et vtan01 et vtan02;
*tank = vtan0 et vtan1 et vtan2 et vtan01 et vtan02 et vtan03;
*
*trac cach qual tank;
*
*trac cach qual sflu5;
*trac cach qual (sflu);
*trac cach qual (sflu et vtan0);
*trac cach qual (sflu et vtan0 et vtan01);
*trac cach qual (sflu et vtan0 et vtan01 et vtan02);
*trac cach qual (sflu et vtan0 et vtan01 et vtan02 et vtan03);
*trac cach qual (sflu et vtan0 et vtan01 et vtan02 et vtan03
*               et vtan1a);
*trac cach qual (sflu et vtan0 et vtan1a et vtan1);
*trac cach qual (sflu et vtan0 et vtan1a et vtan1 et vtan2);
*trac cach qual (sflu et vtan0 et vtan1a et vtan1 et vtanopen et vtan2);
*elim tol tank;
*trac cach qual (sflu et vtan0 et vtan1a et vtan1 et vtanopen et vtan2);
*trac cach qual (sflu et vtan0 et vtan1a et vtan1 et vtan2);
*elim tol tank;
*trac cach qual (sflu et vtan0 et vtan1a et vtan1 et vtan2);
*trac cach qual tank;
*
*pa1 = ltan1 rtank 0;
*pa2 = (ltan1 + ltanopen) rtank 0;
*pa2 = (ltan1 + ltanopen) rtank 0;
*cab = d pa1 pa2 dini d2 dfin d3;
*abso = cab rota (2*nrtub) 90 p0 paxis;
*elim tol (abso et tank);
*
************************************************************************
*
*
*p1d1 = (0 - ltube) 0 0;
*p1d2 = p1d1 plus (ltubhp 0 0);
*tubehp = p1d1 d p1d2 dini d1 dfin d1;
*lenlp3d = 0.6;
*p1d3 = (0 - lenlp3d) 0 0;
*tubelp1 = p1d2 d p1d3 dini d1 dfin d1;
*stub3d = sflu1 plus p1d3;
*tubelp3 = stub3d volu dini d1 dfin d1 tran (lenlp3d 0 0);
*tubelp = tubelp1 et tubelp3;
*
*raclp = manu supe (p1d3 et stub3d);
*
*tube = tubehp et tubelp;
*
*
p1d1 = (0 - lext) 0 0;
*p1d3 = 0 0 0;
lenlp3d = 0.6;
```

```
p1d3 = (0 - lenlp3d) 0 0;
tubelp1 = p1d1 d p1d3 dini h dfin h;
stub3d = sflu1 plus p1d3;
tubelp3 = stub3d volu dini d1 dfin d1 tran (lenlp3d 0 0);
*
trac cach qual stub3d;
trac cach qual (sflu et stub3d);
trac cach qual (sflu et stub3d et tubelp3);
*
trac cach qual (tubelp3 ET tubelp1 ET fir1);
tubelp = tubelp1 et tubelp3;
*
trac cach qual (sflu et stub3d et tubelp3 et tubelp1);
*
raclp = manu supe (p1d3 et stub3d);
*
list (nbno raclp);
list (nbno stub3d);
*
trac cach qual (p1a et face3d et pinbcm et tubelp);
*
*tube = tubelp1;
tube = tubelp;
*
trac cach qual (tubelp1 ET p1d1 ET p1d3);
trac cach qual (tubelp1 ET p1d1 ET p1d3 et pinbcm);
*
*flui = tube et tank;
flui = tube;
elim tol flui;
*trac cach tank;
trac cach flui;
*
list (nbel flui);
list (nbno flui);
list (nbel tube);
*list (nbel tank);
*
elim tol (p1a et tubelp1);
*
oubl dtub;
oubl rtub;
oubl dext;
oubl rext;
oubl dtank;
oubl rtank;
oubl ltan0;
oubl ltan1;
oubl ltanopen;
oubl ltan2;
oubl ltubhp;
oubl ltube;
oubl nrpla;
oubl nrtub;
oubl tol;
oubl p0;
oubl p1;
oubl p2;
oubl p3;
oubl c1;
oubl c2;
oubl c3;
oubl c4;
oubl sflu1;
oubl p4;
oubl p5;
oubl p6;
oubl c5;
oubl c6;
oubl c7;
oubl c8;
*oubl sflu2;
oubl c9;
oubl c10;
oubl c11;
oubl c12;
*oubl sflu3;
oubl p7;
oubl p8;
oubl p9;
oubl din;
oubl dfi;
oubl c13;
*oubl sflu4;
*oubl sflu5;
*oubl sflu0;
oubl sflu;
oubl d1;
oubl d2;
oubl d3;
*oubl vtan0;
*oubl vtan1a;
*oubl vtan1b;
*oubl vtan1;
*oubl vtanopen;
*oubl vtan2;
*oubl pa1;
*oubl pa2;
oubl cab;
oubl p1d1;
oubl p1d2;
oubl lenlp3d;
oubl paxis;
*
*devi = flui et abso et raclp;
devi = flui et raclp;
*
* we add a fake triangle to host a fake pinball which is never eroded
* (to avoid a bug in the code)
*pfake1 = -16.300  0 0;
*pfake2 = -16.297  0 0;
*pfake3 = -16.2985 0.003 0;
*fake = manu tri3 pfake1 pfake2 pfake3;
*
*opti rest form 'P1.msh';
*rest form;
*list;
*mesh = devi et spec et mesh1 et fake et pinbcm et npincm;
mesh = devi et mesh1 et pinbcm et npincm;
tass mesh noop;
sauv form mesh;
list;
trac cach mesh;
*mesh = tube et mesh1 et fake et pinbcm et npincm;
*trac cach qual mesh;
*tass mesh noop;
*sauv form mesh;
*list;
*
fin;
```

ST_EUL_10.epx

```
ST_EUL_10
ECHO
!CONV win
CAST mesh
TRID EULE
!EROS 1.0
DIME
     JONC 1180 ! Total n. of nodes in a TUBM juncton
     NALE 1 NBLE 1
     TERM
GEOM ! T3GS fake
     CUVF flui3d tubelp3 ! tank
     TUVF tubelp1
     CL3D face3d stub3d ! pre
     TUBM rac3d1d raclp
TERM
COMP ! EPAI 3.00E-3 LECT fake TERM
     DIAM DROI 0.1692568 LECT tubelp1 TERM
     RACC TUBM LECT rac3d1d  TERM
          NTUB LECT p1a   TERM DTUB 0.1692568
          FACE LECT face3d TERM COEF 1.0
     RACC TUBM LECT raclp  TERM
          NTUB LECT p1d3   TERM DTUB 0.1692568
          FACE LECT stub3d TERM COEF 1.0
! Attention: the TUBM element (raclp) is NOT included
! in the "mesh" object (although it IS indeed passed in from Cast3m).
! For this reason we must add it explicitly in the GROU directive below
! if we want to have it in the extracted element groups.
     GROU 17 'endtube' LECT tube TERM COND XB GT -0.6
            'trigger' LECT tube TERM COND NEAR POIN -0.1501 0 0
            'frefine' LECT flui TERM COND XB GT -0.3
                                     COND XB LT  1.0
            'S1' LECT tube TERM COND NEAR POIN 0 0 0.12
            'S2' LECT tube TERM COND NEAR POIN 0 0 0.06
            'S3' LECT tube TERM COND NEAR POIN 0 0 0
            'S4' LECT tube TERM COND NEAR POIN 0 0.06 0.12
            'S5' LECT tube TERM COND NEAR POIN 0 0.06 0.06
            'S6' LECT tube TERM COND NEAR POIN 0 0.06 0
            'S7' LECT tube TERM COND NEAR POIN 0 0.12 0.12
            'S8' LECT tube TERM COND NEAR POIN 0 0.12 0.06
            'S9' LECT tube TERM COND NEAR POIN 0 0.12 0
            'S01' LECT tube TERM COND NEAR POIN -0.245 0 0.15
            'S02' LECT tube TERM COND NEAR POIN -0.345 0 0.15
            'epar1' LECT tubelp1 TERM COND NEAR NODE LECT p1a TERM
            'epar2' LECT tubelp1 TERM COND NEAR NODE LECT p1d3 TERM
            'tubelpp' LECT tubelp1 DIFF epar1 epar2 TERM
     NGRO 1 'pt0' LECT tube TERM COND NEAR POIN -16.19999 0.0 0.0
     COUL TURQ LECT tube tra lp3xl TERM
          VERT LECT fir2 TERM
          ROSE LECT fir1 TERM
          ROUG LECT driver TERM
         ROSE LECT S1 S2 S3 S4 S5 S6 S7 S8 S9 S01 S02 TERM
MATE
    !LOI 2
     GAZP RO 13.445 GAMM 1.4 CV 719.286 PINI 11.36E5 PREF 9.968E4
          LECT none TERM
    !LOI 3
     GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
          LECT none TERM
    !LOI 4
     GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
          LECT none TERM
    !LOI 5
     GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
          LECT flui3d TERM ! _cuvf TERM
     GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
          LECT epar1 epar2 TERM
     GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
          LECT rac3d1d raclp tubelpp TERM
     PARO PSIL 0.02
          LECT tubelpp TERM
     MULT 6 7 LECT tubelpp TERM
```

```
! In order to obtain a printout at least of the 3D VFCCs I am obliged
! to use a different material for tubelp3 and other 3D parts, but with
! the same characteristics as the material used for tubelp1
     GAZP RO 1.179 GAMM 1.4 CV 719.286 PINI 9.968E4 PREF 9.968E4
          LECT tubelp3 _cuvf TERM ! tank _cuvf TERM
INIT MAPP FORM 'D7710600mape_01.map' MATC OBJE LECT flui3d tubelp1 TERM
ECRI DEPL VITE ECRO FAIL TFRE 0.25E-3
          POIN LECT pt0 TERM
          ELEM LECT S1 TERM
     FICH ALIC TEMP TFRE 1.e-5
!      FICH ALIT './D7710600eule.alt' FREQ 0 TFRE 0.D0
!      FICH ALIT FREQ 0 TFRE 0.D0
!         TIME PROG 0.D0 PAS 0.5D-3 22.D-3 PAS 0.01D-3 60.D-3
!         PAS 1.D-3 120.D-3
          POIN LECT pt0 TERM
          ELEM LECT S1 S2 S3 S4 S5 S6 S7 S8 S9 S01 S02 TERM
!    FICH PVTK './D7710600eule.pvd' FREQ 0 TFRE 0.D0
!    Fichier PVTK  TFREQ  10.0e-3
!        GROU AUTO
!        VARI DEPL VITE FAIL ACCE VCVI CONT ECRO FLIA
     FICH SPLI ALIC TFRE 0.5E-3
OPTI NOTE CSTA 0.25
     LOG 1
     VFCC FCON 6 ! hllc solver
          ORDR 2 ! order in space
          STPS 2 ! order in time
          RECO 1
          NTIL
CALC TINI 0 TEND 44.0E-3
FIN
```

ST_EUL_10p.epx

```
ST_EUL_10p
ECHO
RESU SPLI ALIC TEMP 'ST_EUL_10.alt' GARD PSCR
SORT GRAP
AXTE 1.0 'Time [s]'
COUR 1 'S1' ECRO COMP 1 LECT S1 TERM ! Sensors 1 to 0
COUR 2 'S2' ECRO COMP 1 LECT S2 TERM
COUR 3 'S3' ECRO COMP 1 LECT S3 TERM
COUR 4 'S4' ECRO COMP 1 LECT S4 TERM
COUR 5 'S5' ECRO COMP 1 LECT S5 TERM
COUR 6 'S6' ECRO COMP 1 LECT S6 TERM
COUR 7 'S7' ECRO COMP 1 LECT S7 TERM
COUR 8 'S8' ECRO COMP 1 LECT S8 TERM
COUR 9 'S9' ECRO COMP 1 LECT S9 TERM
TRAC 1 2 3 4 5 6 7 8 9 AXES 1.0 'Sensors'
     XMIN 32.E-3 XMAX 44.E-3 NX 12 YZER
     COLO turq rose roug bleu noir vert turq rose roug
     THIC 0.8 0.8 0.8 0.8 0.8 0.8 0.8 0.8 0.8
COUR 10 'Pave' MEAN 9 1 2 3 4 5 6 7 8 9 ! Take the average
TRAC 10 AXES 1.0 'Average'
     XMIN 32.E-3 XMAX 44.E-3 NX 12 YZER
COUR 11 'Sub' SUBC 10 0.9968e5           ! Subtract ambient pressure
COUR 12 'Pressure' MOVE 11 -33.0e-3      ! Shift in time
TRAC 12 AXES 1.0 'Pres [Pa]' YZER        ! This is the final result
     COLO BLEU
     THIC 0.8
LIST 12 AXES 1.0 'Pres [Pa]' YZER
QUAL COUR 12 REFE  0.00000E+00 TOLE 1.E-2
FIN
```

List of input files

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