

ParticleMaster

Intelligent Imaging
for Particle & Droplet Sizing



LA VISION

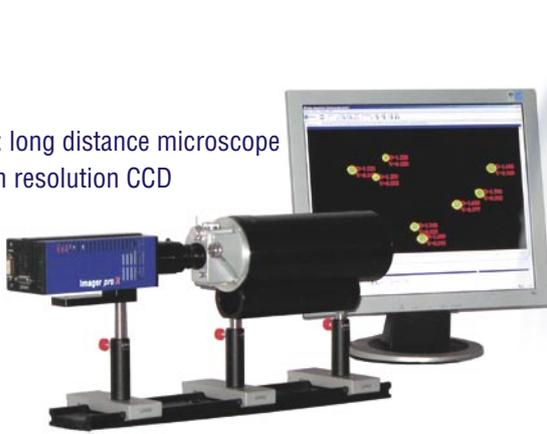
WE COUNT ON PHOTONS



ParticleMaster Shadow

ParticleMaster Shadow is based on backlight illumination and high-magnification imaging. The shadow of particles in the focal plane of the optics is imaged.

detector: long distance microscope with high resolution CCD



particles, droplets

illumination optics



light source: (pulsed) laser or (flash) lamp

information

- ▶ particle size (d)
- ▶ particle position (x, y)
- ▶ particle shape (excentricity)
- ▶ statistics, histograms (D_{10} , D_{32} , D_{v50})
- ▶ velocity (v_x, v_y)
- ▶ density
- ▶ mass flux

applications

- ▶ liquid sprays (water, fuel, paint, emulsions)
- ▶ spray breakup (ligaments, breakup region)
- ▶ powder, solid particles (alloys, ceramics)
- ▶ bubbles (heat exchangers, industrial processes)

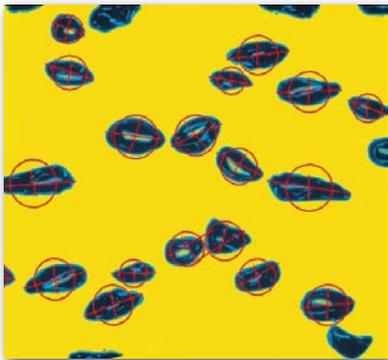
system components

- ▶ ParticleMaster Shadow Sizing software
- ▶ CCD camera*
- ▶ long distance microscope or macro lens
- ▶ laser*, laser diode flasher or flash lights, illumination optics

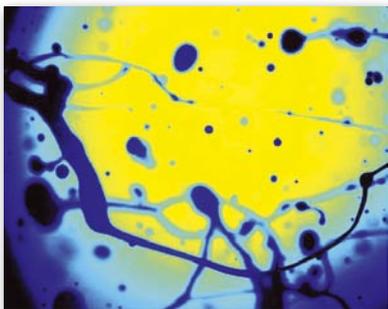
*standard PIV components

upgrades

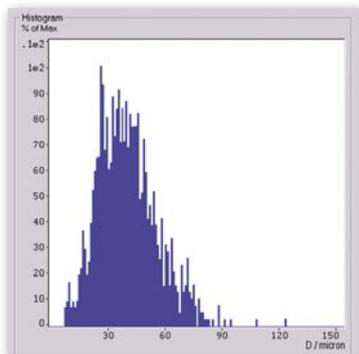
- ▶ PIV or planar LIF systems for multi-phase flows



air bubbles in water



droplets and ligaments in air



particle size histogram



ParticleMaster IMI

ParticleMaster IMI is based on **Interferometric Mie Imaging**. The spatial Mie scattering intensity distribution is recorded. Size information is obtained from defocused imaging.



$$d = \frac{2 \cdot \lambda}{\Delta\phi} \cdot \left[\cos\left(\frac{\phi}{2}\right) + \frac{n \cdot \sin\left(\frac{\phi}{2}\right)}{\sqrt{1 + n^2 - 2 \cdot n \cdot \cos\left(\frac{\phi}{2}\right)}} \right]^{-1}$$

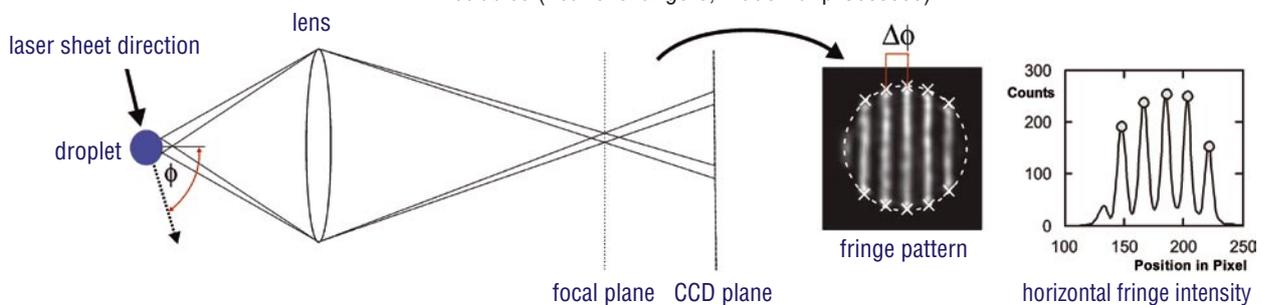
Reference: W. J. Glantschnig, S.-H. Chen, Appl. Opt., 20 (14), 1981.

information

- ▶ particle size (d)
- ▶ particle position (x, y, z)
- ▶ velocity (v_x, v_y, v_z)
- ▶ statistics, histograms (D₁₀, D₃₂, D_{v50})
- ▶ density
- ▶ mass flux

applications

- ▶ transparent sprays (water, fuel, pharma-sprays)
- ▶ droplet clouds (evaporation and condensation)
- ▶ bubbles (heat exchangers, industrial processes)



Reference: A. Graßmann, F. Peters, personal communication, 10th Fachtagung GALA, Rostock, 2002, 11th Fachtagung GALA, Braunschweig, 2003.

special IMI features

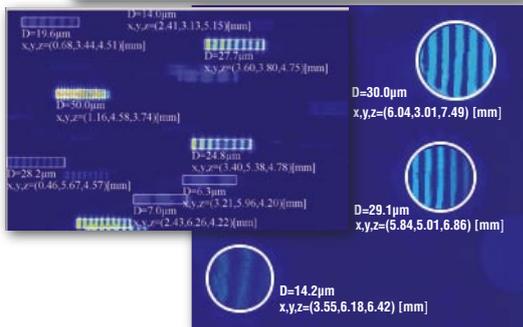
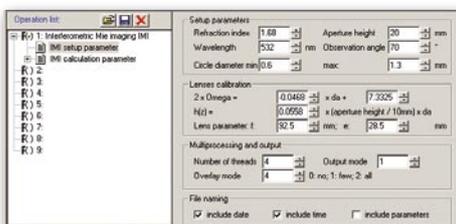
- ▶ auto-detection and fringe pattern analysis (DaVis IMI Sizing)
- ▶ FFT with sub-pixel accuracy & advanced evaluation algorithms
- ▶ centroiding algorithm for high-accuracy positioning and velocity determination
- ▶ high-aperture macro lens

system components

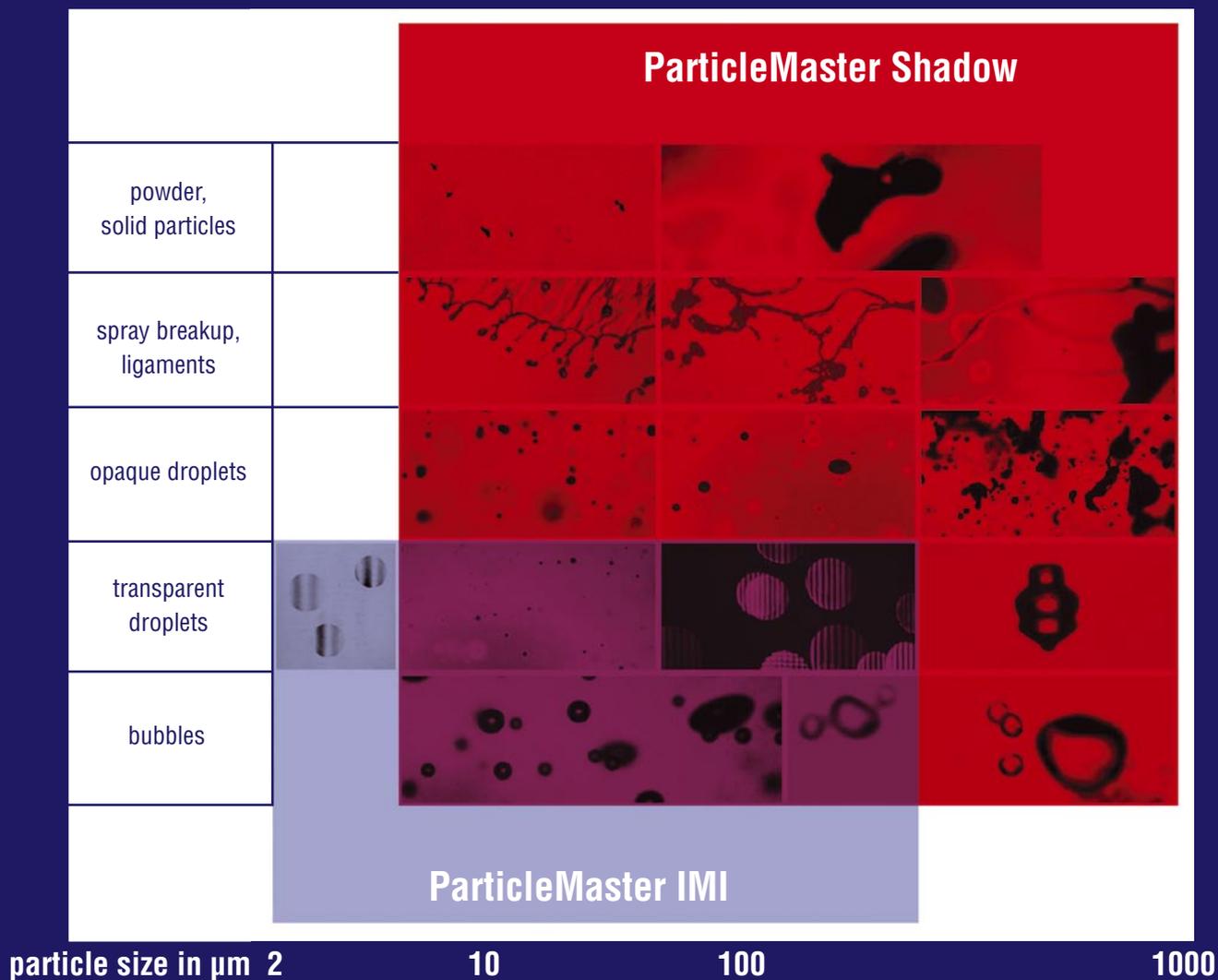
- ▶ ParticleMaster IMI Sizing software
 - ▶ CCD camera*, macro lens
 - ▶ laser*, sheet optics*
- *standard PIV components

upgrades

- ▶ PIV or planar LIF systems for multi-phase flows



ParticleMaster Application Matrix



	Shadow	IMI
particle size in μm	> 5	2 - 200
dynamic range	1:100	1:20
typ. field of view in mm^2	> 1	50 - 500
typ. working distance in mm	50 - 1500	50 - 300
spray density n	10 n_{IMI}	n_{IMI}
opaque particles	yes	no
shape	yes	no
velocity	yes	yes
morphology	yes	no

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