

# Tsunami® Series

## Ti:Sapphire Ultrafast Oscillators



### The Tsunami Advantage

- High-performance optics (HP models) offer the broadest tuning range of 700 to >1080 nm
- High peak power of >450 kW efficiently drives non-linear optical processes
- Regenerative mode locking for long-term stability
- Stable mode locking at the edges of tuning range
- Capable of long pulses up to 100 ps
- Invar tube-based construction for temperature stability and rigidity

The Tsunami® ultrafast Ti:Sapphire oscillator series combines operational simplicity with amazing flexibility, plus unmatched tuning capability and pulse duration range. The Tsunami series' revolutionary regenerative mode-locking mechanism sustains pulses, even during perturbation of the cavity, and enables coverage of long wavelengths and very long picosecond pulses<sup>1</sup>.

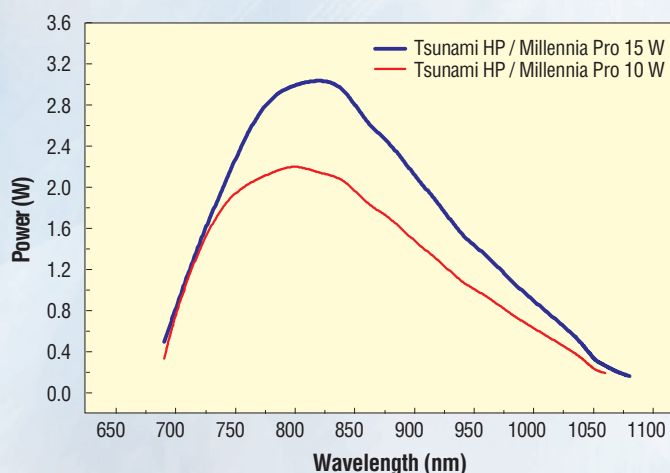
### Short Pulse Width

The short pulse Tsunami systems use the latest generation of high-performance optics to allow >65 nm of bandwidth for <30 fs in pulse width. When pumped by the Millennia® Pro 10, the Tsunami 3941-30-X1S typically achieves >800 mW of average power with >350 kW of peak power, ideal for pumping ultrafast amplifiers, such as the Spectra-Physics Spitfire® Pro.

### Widest Tuning Range

An unprecedented tuning range of 700 to >1080 nm<sup>2</sup> from a single optics set provides tremendous flexibility and extends wavelength coverage further into the IR than any commercial Ti:Sapphire laser.

### Tsunami HP Output Performance



Femtosecond Tsunami HP optics tuning curves with pump powers of 15 W and 10 W from a Millennia Pro 15 W and Millennia Pro 10 W.

The superior design of the Tsunami prism dispersion compensation enables shorter, transform-limited pulses. A unique  $\lambda$ -track prism movement enables excellent beam pointing as the laser is tuned. The use of slits for wavelength selection in femtosecond operation, combined with advanced dispersion compensation allows unusually wide pulse duration adjustment over the femtosecond range from <60 fs to >900 fs.<sup>3</sup> The Tsunami laser can then be easily converted to picosecond mode to cover <2 ps to >80 ps with the appropriate GTI.

The Tsunami laser pulses can be synchronized to other lasers or laboratory equipment with the optional Lok-to-Clock<sup>®</sup> accessory that actively stabilizes cavity length. Lok-to-Clock electronics also provide high-speed input that can be used to slave the laser to a reference pulse train from another laser.

When the Tsunami oscillator is combined with the broad range of Spectra-Physics harmonic generators and optical parametric oscillators, wavelength coverage spans from 210 nm to 5  $\mu$ m. Pulse picking can offer repetition rate flexibility from single shot to 30 MHz, while still providing enough pulse energy for demanding fluorescence lifetime applications.

The extremely broad tuning range, high peak power and average power of the Tsunami HP will enable advancements in applications such as high harmonic generation and deep tissue imaging.

## Spectra-Physics Ultrafast Laser Family

Spectra-Physics offers a complete range of ultrafast solutions ranging from Ti:Sapphire oscillators and accessories to Ti:Sapphire amplifiers and OPAs. The Spectra-Physics Spitfire Pro system is the ideal choice for amplifying the output of the Tsunami or Mai Tai<sup>®</sup> mode-locked Ti:Sapphire lasers. Delivering both high output power and exceptional beam quality, the Spitfire Pro amplifier can also simultaneously pump multiple OPAs such as the OPA-800C and the TOPAS. This enables multicolor pump-probe experiments over a wavelength range from 189 nm to 20  $\mu$ m.

## Spectra-Physics and Newport Deliver Complete Ultrafast Solutions

Spectra-Physics and Newport combine cutting edge ultrafast lasers, detection and diagnostic tools, motion systems, and optical tables, as well as our Helios transient absorption spectrometer to provide researchers with complete ultrafast solutions that reduce set-up time and ensure the highest levels of performance.

1. Standard pulse duration is <2 ps. Pulse durations up to 100 ps are available with the use of appropriate GTI.
2. Tuning range is specified as 700 to 1080 nm with Millennia Pro 15 pump laser. Optional optics sets are available that can extend coverage to 685 nm to 1100 nm.
3. Pulse durations between 120 fs and 900 fs require the use of GTI in combination with slits and prisms.

## Applications

- Time-resolved spectroscopy
- Seed source for high-energy amplifiers
- High harmonic generation
- Deep-penetration multiphoton imaging
- Ultrafast tissue ablation
- Micromachining



The ultra-compact Millennia Pro pumps the Tsunami HP Ti:Sapphire oscillator, resulting in the most compact and stable system in its class.



Tsunami HP high-performance optics offer the broadest tuning range of 700 to >1080 nm



# Specifications<sup>1</sup>

## Tsunami HP

Output Characteristics	Tsunami HP fs 15 W Pump	Tsunami HP ps 15 W Pump	Tsunami HP fs 10 W Pump	Tsunami HP ps 10 W Pump
Tuning Range	700–1080 nm <sup>2</sup>	700–1000 nm	700–1050 nm	700–1000 nm
Average Power <sup>3</sup>	>2.7 W at 800 nm	>2.9 W at 800 nm	>1.4 W at 800 nm	>1.5 W at 800 nm
Pulse Width <sup>3, 4</sup>	<100 fs	<2–100 ps	<100 fs	<2–100 ps
Peak Power <sup>3</sup>	>337 kW at 800 nm	-	>170 kW at 800 nm	-
Pulse Energy	~34 nJ	~36 nJ	~15 nJ	~19 nJ
Tsunami HP Models	3960C-15HP 3941C-15HP	3950-15HP 3960C-15HP <sup>5</sup>	3960-10HP 3960C-10HP 3941-10HP 3941C-10HP	3950-10HP 3960C-10HP <sup>5</sup>

## Tsunami Broadband

Output Characteristics	Tsunami Broadband fs 10 W Pump	Tsunami Broadband ps 10 W Pump	Tsunami Broadband fs 5 W Pump	Tsunami Broadband ps 5 W Pump
Tuning Range	700–1000 nm	700–1000 nm	710–980 nm	710–980 nm
Average Power <sup>3</sup>	>1.4 W at 800 nm	>1.5 W at 800 nm	>0.7 W at 800 nm	>0.7 W at 800 nm
Pulse Width <sup>3, 4</sup>	<100 fs	<2–100 ps	<100 fs	<2–100 ps
Peak Power <sup>3</sup>	>170 kW at 800 nm	-	>85 kW at 800 nm	-
Pulse Energy	~14 nJ	~15 nJ	~8 nJ	~8 nJ
Tsunami Broadband Models	3960-X1BB 3941-X1BB	3950-X1BB 3960-X1BB <sup>5</sup>	3960-M1BB 3941-M1BB	3950-M1BB 3960-M1BB <sup>5</sup>

## Standard Tsunami

Output Characteristics	Tsunami-S fs 10 W Pump	Tsunami-S ps 10 W Pump	Tsunami-S fs 5 W Pump	Tsunami-S ps 5 W Pump	Tsunami-X fs 10 W Pump	Tsunami-X ps 10 W Pump
Tuning Range	720–850 nm	720–850 nm	720–850 nm	720–850 nm	970–1080 nm	970–1080 nm
Average Power <sup>3</sup>	>1.1 W at 800 nm	>1.3 W at 800 nm	>0.7 W at 800 nm	>1.0 W at 800 nm	>0.25 W at 1050 nm	>0.25 W at 1050 nm
Pulse Width <sup>3, 4</sup>	<100 fs	<2–100 ps	<100 fs	<2–100 ps	<100 fs	<2–100 ps
Peak Power <sup>3</sup>	>170 kW at 800 nm	-	>85 kW at 800 nm	-	>170 kW at 800 nm	-
Pulse Energy	~15 nJ	~15 nJ	~8 nJ	~8 nJ	~8 nJ	~8 nJ
Standard Tsunami Models	3960-X1S 3941-X1S	3950-X1S 3960-X1S <sup>5</sup>	3960-M1S 3941-M1S	3950-M1S 3960-M1S <sup>5</sup>	3960-X1X 3941-X1X	3950-X1X 3960-X1X <sup>5</sup>

## Tsunami Short Pulse

Output Characteristics	Sub 30 Tsunami 10 W Pump	Sub 30 Tsunami 5 W Pump	Ultra Short Pulse Tsunami 10 W Pump	Ultra Short Pulse Tsunami 5 W Pump
Tuning Range	780–820 nm	780–820 nm	720–850 nm	720–850 nm
Average Power <sup>3</sup>	750 mW at 800 nm	400 mW at 800 nm	900 mW at 800 nm	500 mW at 800 nm
Pulse Width <sup>3, 4</sup>	<30 fs	<30 fs	<50 fs	<50 fs
Peak Power <sup>3</sup>	>310 kW at 800 nm	>160 kW at 800 nm	>225 kW at 800 nm	>125 kW at 800 nm
Pulse Energy	~9 nJ	~5 nJ	~11 nJ	~6 nJ
Tsunami Short Pulse Models	3941-30-X1S	3941-30-M1S	3960-X1S-USP 3941-X1S-USP	3960-M1S-USP 3941-M1S-USP

## Notes

1. Due to our continuous product improvement program, specifications may change without notice. Specifications only apply when the specific Tsunami model is pumped by a Spectra-Physics Millennia Pro 15 W, 10 W or 5 W solid state laser and the entire Tsunami Environmental Package is installed.
2. Requires Lok-to-Clock. Tuning range without Lok-to-Clock is 700–1050 nm.
3. Specification applies to 800 nm only.
4. A sech<sup>2</sup> pulse shape (0.65 deconvolution factor) is used to determine the pulse width as measured with a Newport PulseScout®.
5. The Tsunami model 3960 requires additional components to run in picosecond mode (sold separately).

## General Tsunami Specifications

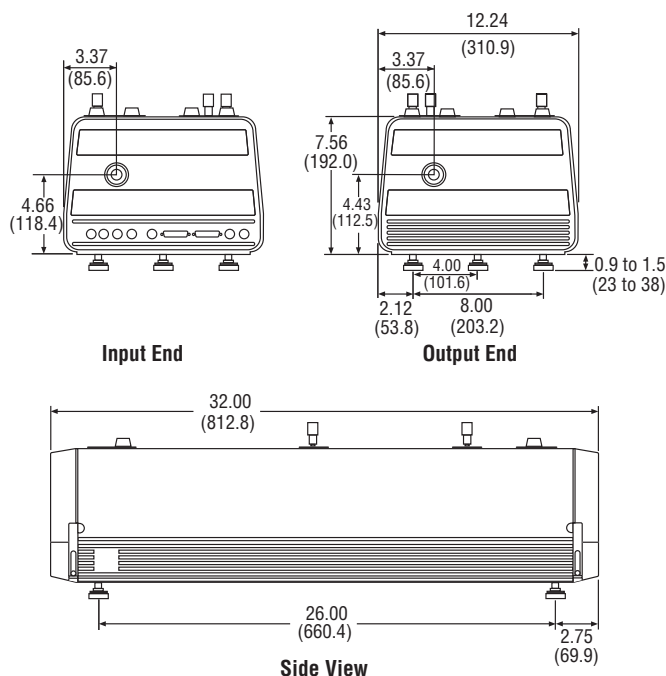
### General Characteristics

Repetition Rate (nominal) <sup>1</sup>	80 MHz
Noise <sup>2</sup>	<0.2
Stability <sup>3</sup>	<5%
Spatial Mode	TEM <sub>00</sub>
Beam Diameter (1/e <sup>2</sup> )	<2 mm
Beam Divergence, full angle	<1 mrad
Polarization	>500:1 vertical

### Notes

1. Laser operation is specified at a nominal repetition rate of 80 MHz.
2. Specification represents rma noise measured in a 10 Hz to 2 MHz bandwidth.
3. Percent power drift in any two-hour period with  $\pm 1^\circ\text{C}$  temperature change after a one-hour warm up.

## Tsunami Dimensions



All dimensions in inches (mm)



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DS-12072 (6/08)