

# PHAROS

## High-Power Femtosecond Lasers



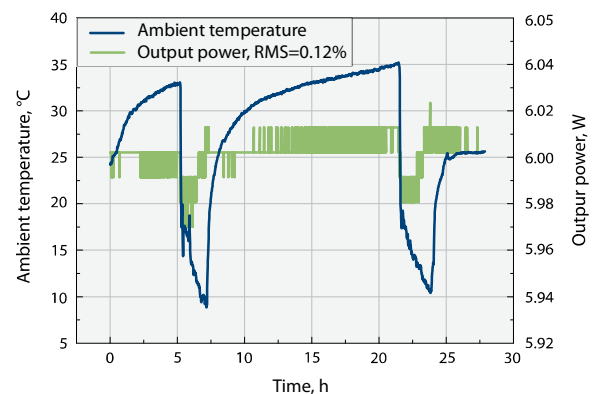
### FEATURES

- <190 fs pulse duration
- Tunable pulse duration 190 fs – 10 ps
- Up to 2 mJ pulse energy
- Up to 15 W average power
- Single pulse – 1 MHz tunable repetition rate
- Includes pulse picker for pulse-on-demand operation
- Rugged, industrial grade mechanical design
- Automatic harmonic generators (2H, 3H, 4H, 5H)

PHAROS is a single-unit integrated femtosecond laser system combining millijoule pulse energies and high average power. PHAROS features a mechanical and optical design optimized for industrial applications such as precise material processing. Market-leading compact size, integrated thermal stabilization system and sealed design allows PHAROS integration into machining workstations. The use of solid state laser diodes for pumping of Yb medium significantly reduces maintenance cost and provides long laser lifetime.

Most of the PHAROS output parameters can be easily set via control pad or PC tuning the laser for a particular application in seconds. Tunability of laser output parameters allows PHAROS system to cover applications normally requiring different classes of lasers. Tunable parameters include: pulse duration (190 fs – 10 ps), repetition rate (1 kHz to 1 MHz), pulse energy (up to 1.5 mJ) and average power (up to 15 W). Its deliverable power is abundant for most of material processing applications at high machining speeds. The built-in pulse picker allows convenient control of the laser output in pulse-on-demand and burst modes. It comes along with an extensive external control interface dedicated for easy laser integration into larger setups and machining workstations. PHAROS compact and robust optomechanical design includes easy to replace modules (oscillator, amplifier and stretcher/compressor) with temperature stabilized and sealed housings ensuring stable laser operation across varying environments. PHAROS is equipped with an extensive software package, which ensures smooth hands-free operation as well as allows fast and easy integration into various processing devices.

PHAROS is built upon the conventional chirped pulse amplification technique, employing the seed oscillator, regenerative amplifier and pulse stretcher/compressor modules. A Kerr lens mode-locked oscillator delivers >700 mW output with sub-80 fs pulse duration. The regenerative amplifier is based on Yb:KGW lasing medium. Both oscillator and amplifier are non-collinearly pumped by one or two (respectively 4 W or 6–15 W PHAROS) Light Conversion proprietary design high brightness, solid state laser diode pump modules. Low loss BBO Pockels cells support operation of the amplifier and pulse picker at repetition rates up to 200 kHz (extendable to 1 MHz). The stretcher/compressor module is based on a single transmission grating exhibiting high efficiency and excellent power handling capability. Operating parameters are adjustable from the remote control module or external PC connected via USB interface.



PHAROS output power with power lock on under unstable environment



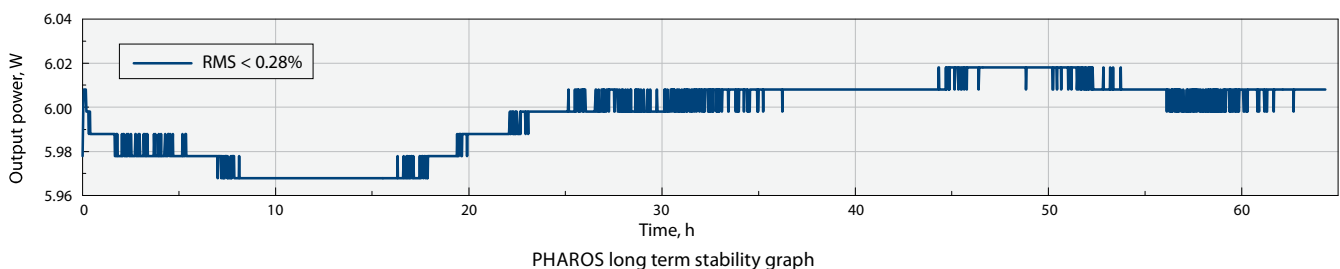
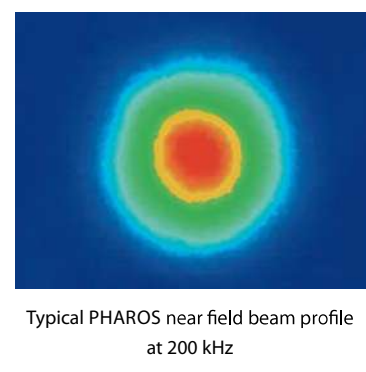
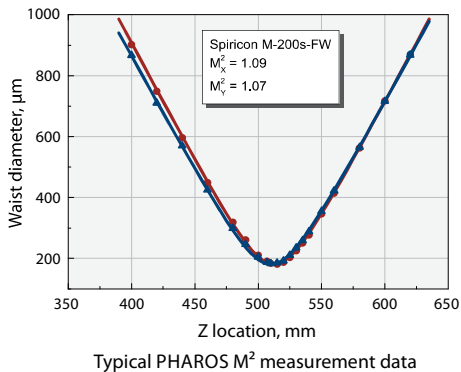
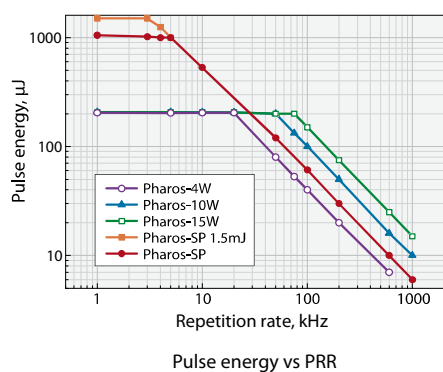
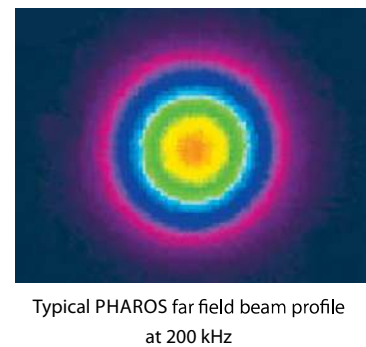
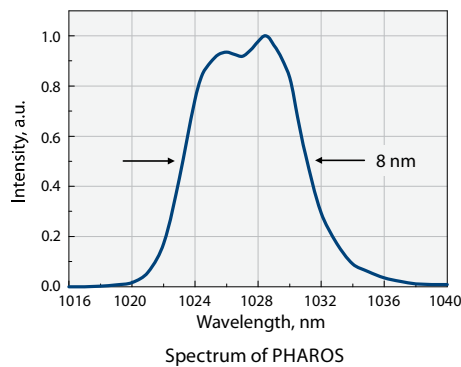
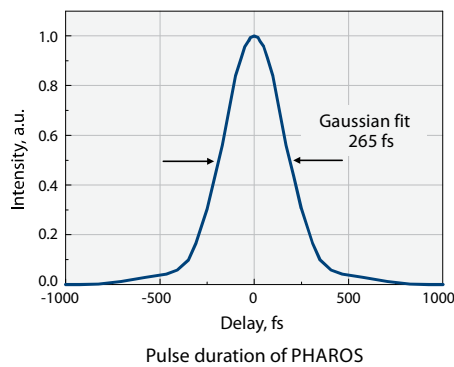
**SPECIFICATIONS**

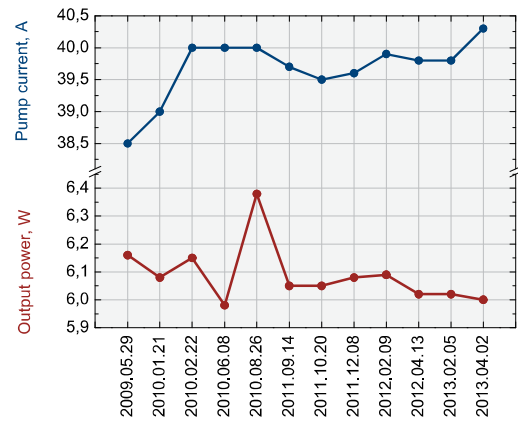
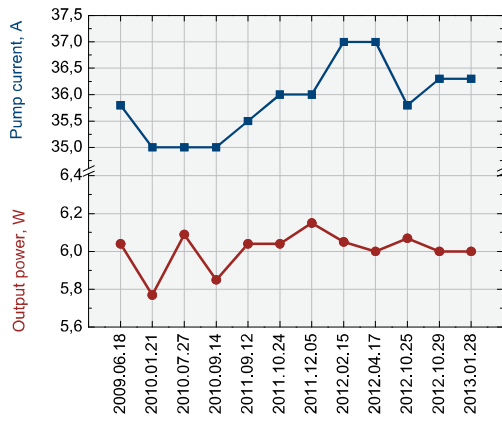
Model	PHAROS-4W	PHAROS-6W	PHAROS-10W	PHAROS-15W	PHAROS SP	PHAROS SP 1.5	PHAROS 2mJ
Max. average power	4 W	6 W	10 W	15 W	6 W		6 W
Pulse duration (assuming Gaussian pulse shape)	290 fs				190 fs		300 fs
Pulse duration range	290 fs – 10 ps				190 fs – 10 ps		300 fs – 10 ps
Max. pulse energy	> 0.2 mJ				> 1.0 mJ	> 1.5 mJ	> 2 mJ
Beam quality	TEM <sub>00i</sub> ; M <sup>2</sup> < 1.2			TEM <sub>00i</sub> ; M <sup>2</sup> < 1.3			
Repetition rate	Single pulse – 200 kHz (extendable to 1 MHz) <sup>1)</sup>						
Centre wavelength	1028 nm ± 5 nm						
Output pulse stability	< 0.5 % rms over 24 hours <sup>2)</sup>						
Pre-pulse contrast	< 1 : 1000 <sup>3)</sup>						
Post-pulse contrast	< 1 : 200						
Polarization	Linear, horizontal						
Beam pointing stability	< 20 μrad/°C						
Burst output	Pulse burst output on trigger signal. Every n <sup>th</sup> pulse continuous or trigger controlled output (pulse temporal spacing in burst corresponds to amplifier repetition rate)						
Oscillator output	Optional, typical output 0.5–1 W, 76 MHz, < 100 fs						

<sup>1)</sup> Some particular repetition rates are software denied due to system design.

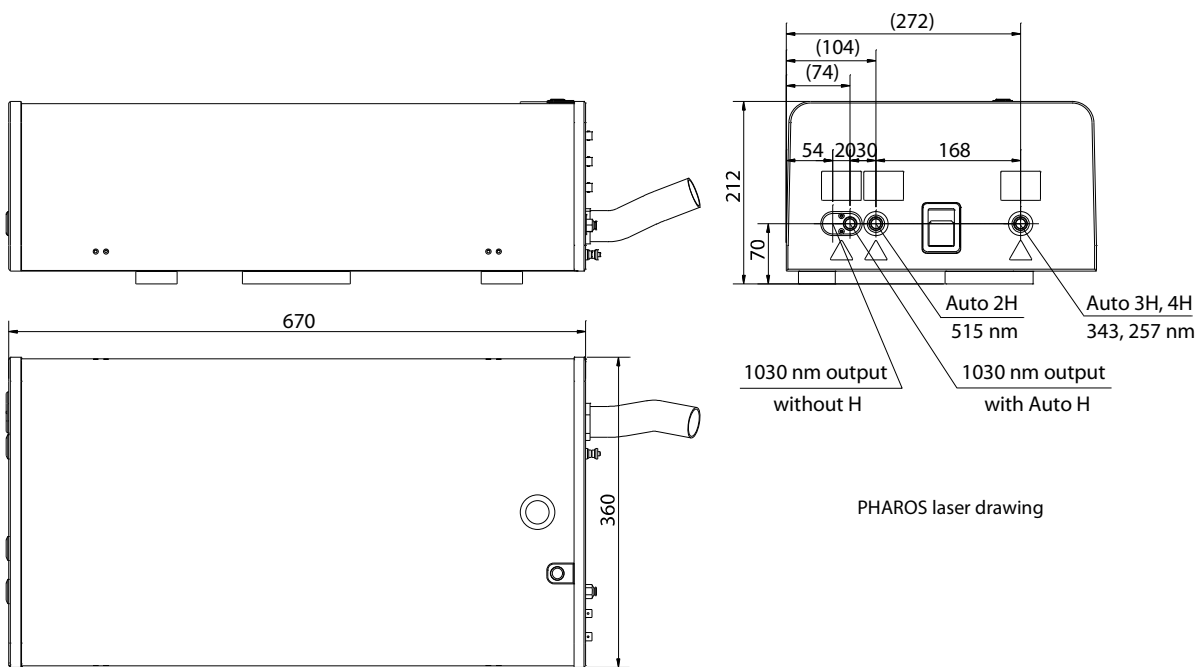
<sup>2)</sup> Under stable environmental conditions.

<sup>3)</sup> With the pulse picker installed.





Output power of industrial PHAROS lasers operating 24/7 and current of pump diodes during the years



**PHYSICAL DIMENSIONS (mm)**

Laser head	640 L x 360 W x 212 H
Power supply rack for PHAROS-4W	640 L x 520 W x 530 H
Power supply rack for other PHAROS models	640 L x 520 W x 660 H

**UTILITY REQUIREMENTS**

Electric	110 VAC, 50-60 Hz, 20 A or 220 VAC, 50-60 Hz, 10 A
Room temperature	15-30 °C (air conditioning recommended)
Relative humidity	20-80 % (non condensing)

# PHAROS

## Automated Harmonic Generators



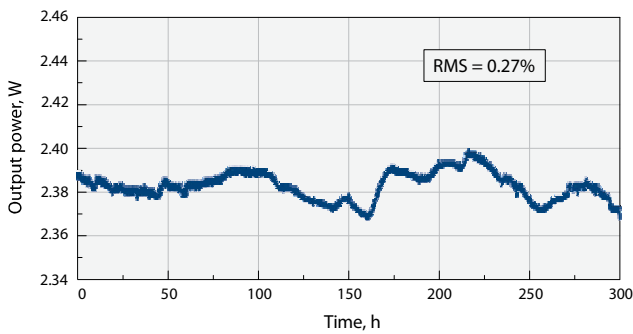
PHAROS laser can be equipped with optional automatic harmonic modules. Selection of fundamental (1030 nm), second (515 nm), third (343 nm), fourth (257 nm) or fifth (206 nm) harmonic output is available by software control. Harmonic generators are designed to be used in industrial applications where a single output wavelength is desired. Modules are mounted directly on the output of the laser and integrated into the system.

The principle of OEM harmonic generators operation is based on collinear generation of higher laser radiation harmonics in angle-phase-matched nonlinear crystals. The optical layout of OEM harmonic generator also includes beam reduction and collimation optics that ensures highest harmonics conversion efficiencies. All the accessible harmonics exiting OEM harmonic generators are separated from the pump radiation by dichroic mirrors.

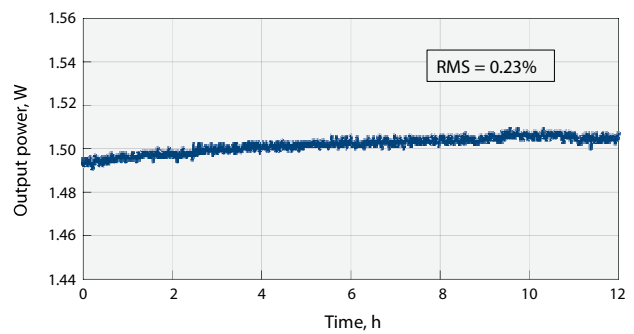
### SPECIFICATIONS

Model	2H	2H-3H	2H-4H	4H-5H
Output wavelength (automated selection)	1030 nm 515 nm	1030 nm 515 nm 343 nm	1030 nm 515 nm 257 nm	1030 nm 257 nm 206 nm
Input pulse energy	20 – 1000 $\mu$ J	50 – 1000 $\mu$ J	20 – 1000 $\mu$ J	200 – 1000 $\mu$ J
Pump pulse duration	190 – 300 fs			
Conversion efficiency	>50 % (2H)	>50 % (2H) >25 % (3H)	>35 % (2H) >10 % (4H) *	>10 % (4H) * >5 % (5H)
Beam quality ( $M^2$ ) <200 $\mu$ J pump	<1.4 (2H)	<1.4 (2H) <1.7 (3H)	<1.4 (2H) n/a (4H)	n/a
Beam quality ( $M^2$ ) >200 $\mu$ J pump	<1.7 (2H), <1.5 typical	<1.7 (2H), <1.5 typical <2 (3H), <1.7 typical	<1.7 (2H), <1.5 typical n/a (4H)	n/a

\*Max 1 W output.



Long term output stability of the third harmonic



Long term output stability of the fourth harmonic



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