

High-Energy Femtosecond Lasers

NEW

Maximum pulse energy of up to 5 mJ

Down to < 100 fs right at the output

Tunable pulse duration, 100 fs – 20 ps

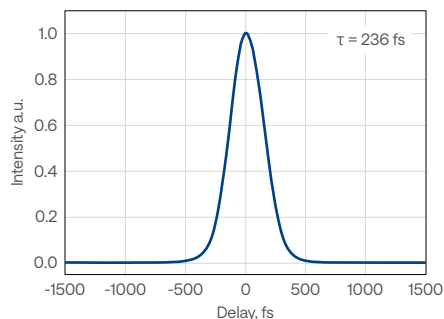
Pulse-on-demand and BiBurst for pulse control

Automated harmonics up to the 5th and wavelength-tunable extensions



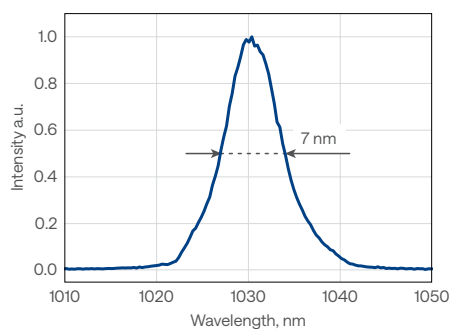
PHAROS-PH2-5mJ

Typical pulse duration



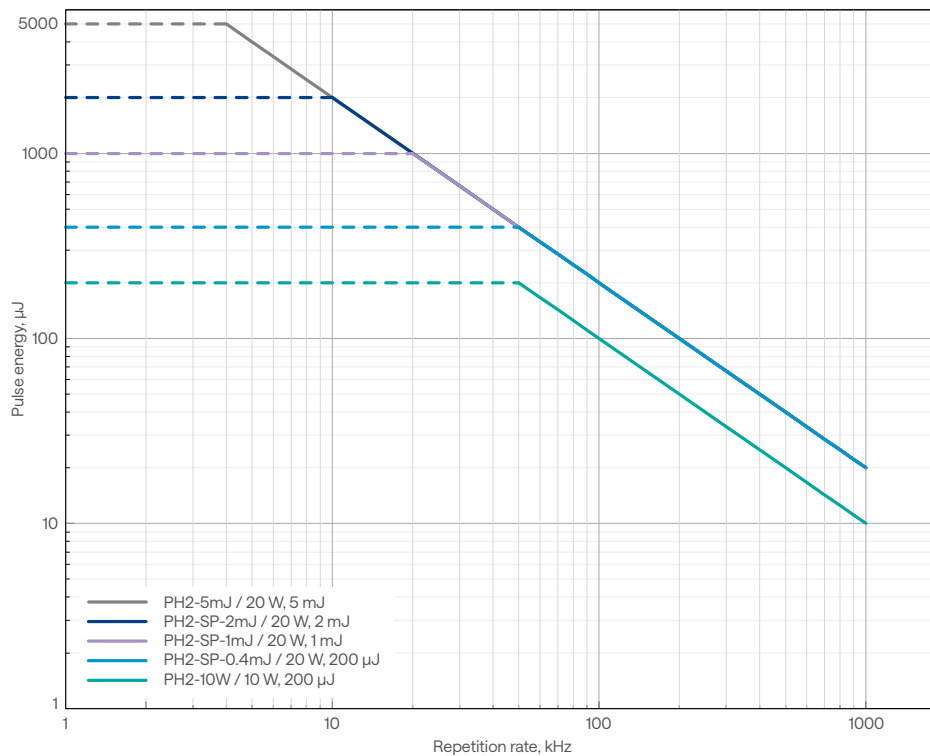
PHAROS-PH2-5mJ

Typical spectrum



PHAROS

Pulse energy vs fundamental repetition rate



Specifications

NEW

Model	PH2-10W	PH2-SP			PH2-5mJ	PH2-UP	
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OUTPUT CHARACTERISTICS

Center wavelength ¹⁾	1030 ± 10 nm						
Maximum output power	10 W	20 W					
Pulse duration ²⁾	< 290 fs	< 190 fs			< 250 fs	< 100 fs	
Pulse duration tuning range	290 fs – 10 ps (20 ps on request)	190 fs – 10 ps (20 ps on request)			n/a	100 fs – 10 ps	
Maximum pulse energy	0.2 mJ	0.4 mJ	1 mJ	2 mJ	5 mJ	0.4 mJ	1 mJ
Repetition rate	Single-shot – 1 MHz						
Pulse selection	Single-shot, pulse-on-demand, any fundamental repetition rate division						
Polarization	Linear, horizontal						
Beam quality, M ²	< 1.2		< 1.3			< 1.2	
Beam diameter ³⁾	3.3 ± 0.5 mm	4.0 ± 0.5 mm	4.5 ± 0.5 mm	6.8 ± 0.7 mm	11 ± 0.5 mm	4.5 ± 0.5 mm	6 ± 0.5 mm
Beam pointing stability	< 20 µrad/°C						
Pre-pulse contrast	< 1 : 1000						
Post-pulse contrast	< 1 : 200						
Pulse-to-pulse energy stability, 8 h ⁴⁾	< 0.5%						
Long-term power stability, 100 h ⁴⁾	< 0.3%						

MAIN OPTIONS

Oscillator output ⁵⁾	1 – 7 W, 50 – 250 fs, ≈ 1035 nm, ≈ 76 MHz						
Harmonic generator ⁶⁾	515 nm, 343 nm, 257 nm, or 206 nm; refer to PHAROS HG or HIRO						
Optical parametric amplifier ⁷⁾	UV – MIR; refer to I-OPA or ORPHEUS						
BiBurst option	Tunable GHz and MHz burst with burst-in-burst capability; refer to BiBurst						
CEP stabilization	Refer to CEP & RRL Option						
Repetition rate locking							

DIMENSIONS

Laser head (L × W × H) ⁸⁾	730 × 419 × 230 mm	827 × 492 × 250 mm	770 × 419 × 230 mm
Chiller (L × W × H)	590 × 484 × 267 mm		
24 V DC power supply (L × W × H) ⁸⁾	280 × 144 × 49 mm		

ENVIRONMENTAL & UTILITY REQUIREMENTS

Operating temperature	15 – 30 °C (air conditioning recommended)		
Relative humidity	< 80% (non-condensing)		
Electrical requirements	Laser	100 V AC, 12 A – 240 V AC; 5 A, 50 – 60 Hz	
	Chiller	100 – 230 V AC; 50 – 60 Hz	
Rated power	Laser	1000 W	
	Chiller	1400 W	
Power consumption	Laser	600 W	
	Chiller	1000 W	

¹⁾ Precise wavelengths for specific models are available upon request.

²⁾ Assuming a Gaussian pulse shape.

³⁾ FW 1/e², measured at laser output, using maximum pulse energy.

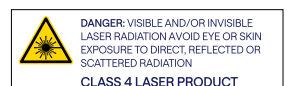
⁴⁾ Under stable environmental conditions. Expressed as normalized root mean squared deviation (NRMSD).

⁵⁾ Available simultaneously. Contact sales@lightcon.com for more details or customized solutions.

⁶⁾ Integrated except for PH2-5mJ. For an external harmonic generator, refer to HIRO.

⁷⁾ Integrated except for PH2-20W-SP-2mJ and PH2-5mJ. For more options and OPAs, refer to the ORPHEUS series of OPAs.

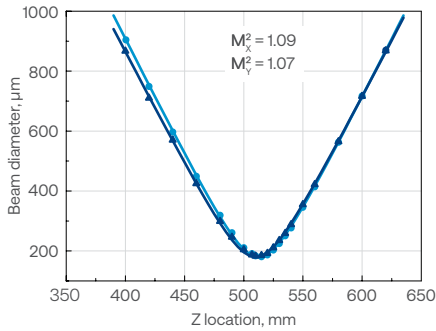
⁸⁾ Dimensions depend on the laser configuration and integrated options.



Beam properties

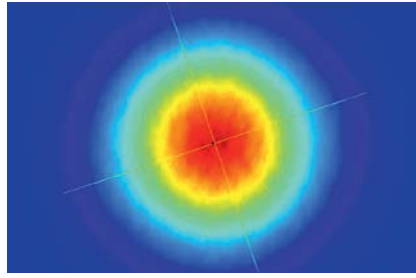
PHAROS

Typical M^2 measurement data



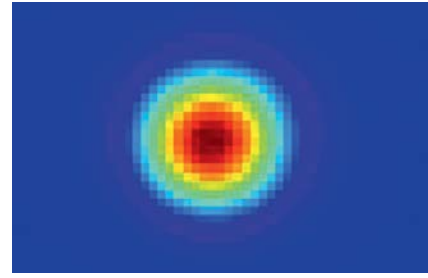
PHAROS

Typical near-field beam profile



PHAROS

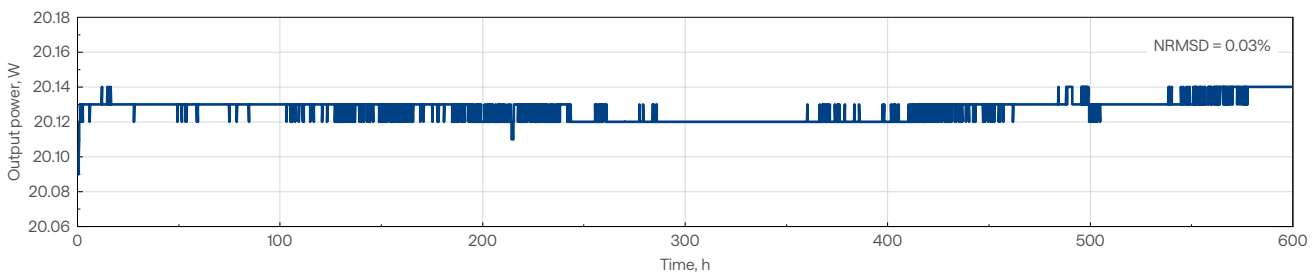
Typical far-field beam profile



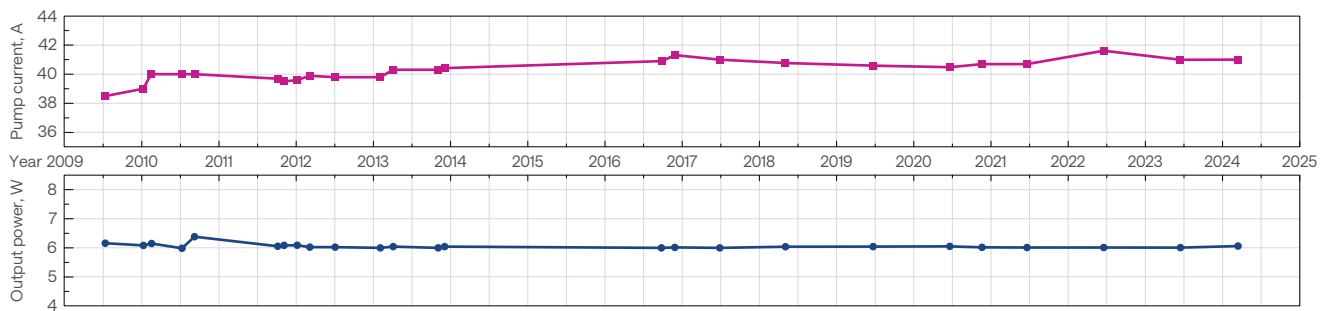
Stability measurements

PHAROS

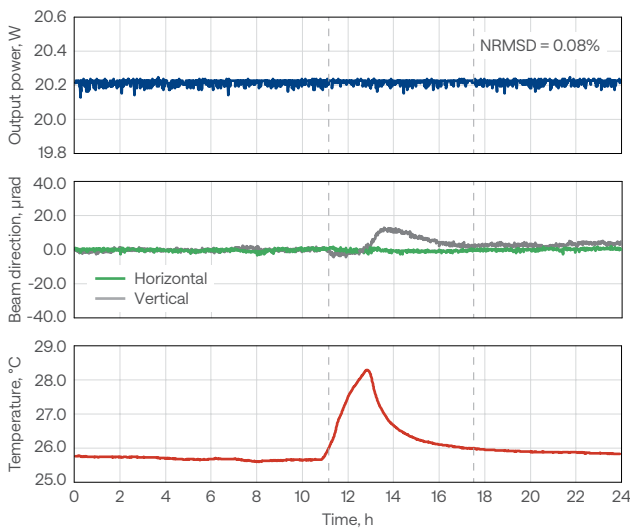
Long-term power stability



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

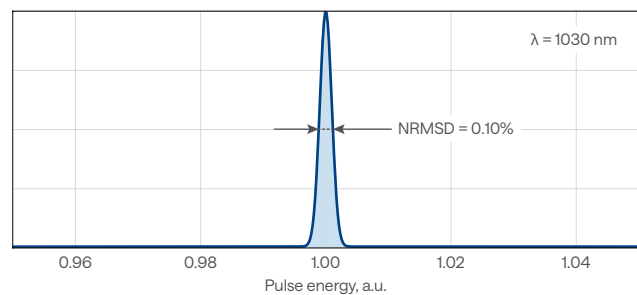


PHAROS output power and beam pointing stability with power lock enabled, across varying environmental conditions



PHAROS

Typical pulse-to-pulse energy stability



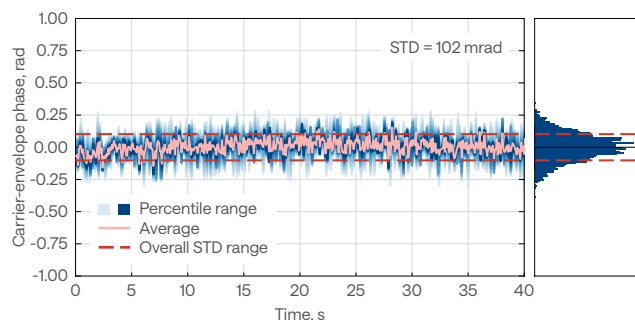
CEP stabilization

PHAROS lasers can be equipped with feedback electronics for carrier-envelope phase (CEP) stabilization of the output pulses. The carrier-envelope offset (CEO) of the **PHAROS** oscillator is actively locked to 1/4th of the repetition rate with a < 100 mrad standard deviation. The CEP stable pulses from the synchronized amplifier

have a < 350 mrad standard deviation. The CEP drift occurring inside the amplifier and the user's setup can be compensated with an out of loop f-2f interferometer, which is a part of the complete **PHAROS** active CEP stabilization package.

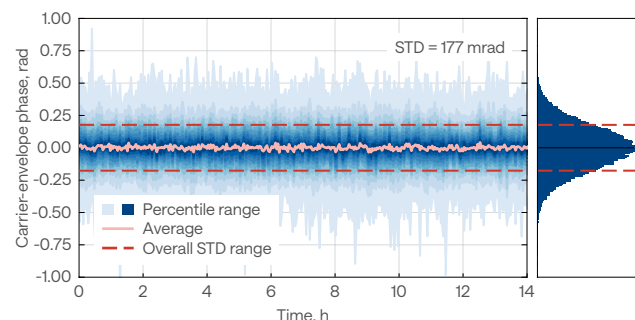
PHAROS

Short-term CEP stability operating at 200 kHz repetition rate



PHAROS

Long-term CEP stability operating at 200 kHz repetition rate

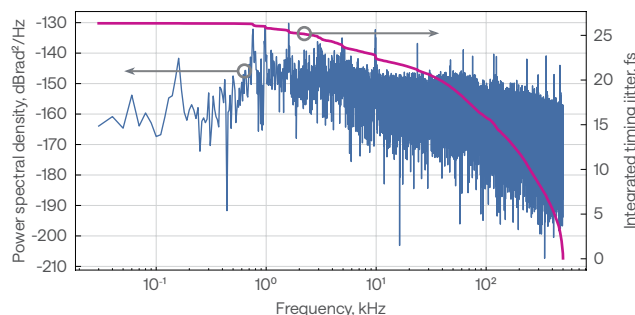


Repetition rate locking

The oscillators in **PHAROS** lasers can be customized for repetition rate locking applications. Coupled with the necessary feedback electronics, the oscillator's repetition rate can be synchronized to an external RF source using the two piezo stages installed within the cavity.

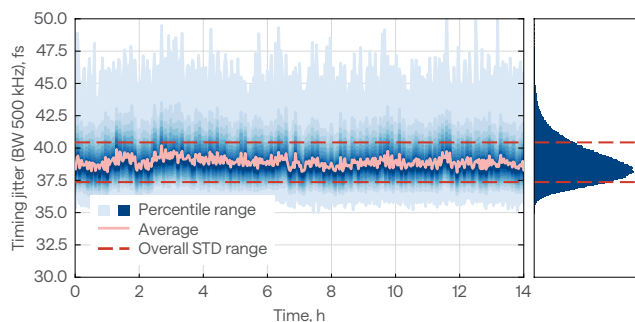
The repetition rate locking system ensures an integrated timing jitter of less than 200 fs for RF reference frequencies above 500 MHz. Additionally, continuous phase shifting is available upon request.

Phase noise data of **PHAROS** oscillator locked to a 2.8 GHz RF source



Timing jitter stability over 14 h

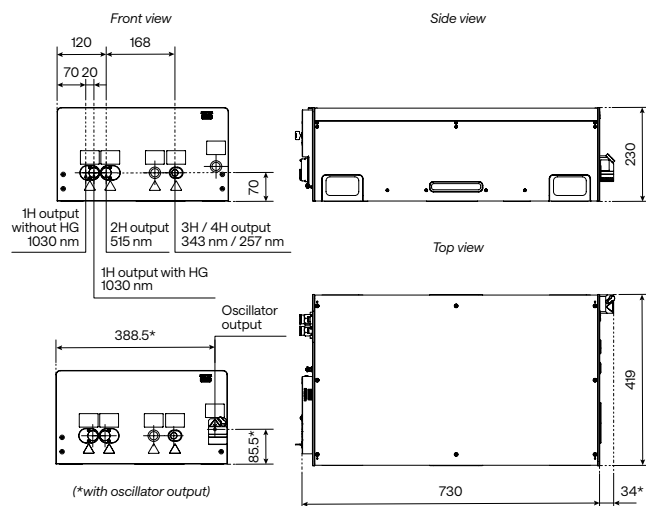
PHAROS oscillator locked to a 2.8 GHz RF source



Drawings

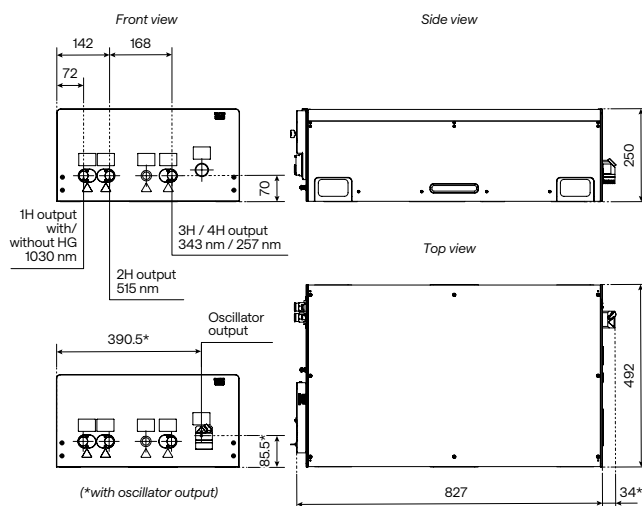
PHAROS-PH2-730

-10W or -20W-SP with a FEC or BiBurst option, or a harmonic generator



PHAROS-PH2-827

-10W with an -HE harmonic generator option, or -5mJ



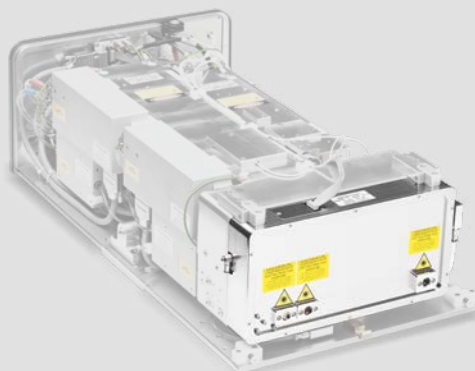
The drawings depend on the exact configuration. If crucial for integration, please contact sales@lightcon.com.

Integrated Harmonic Generators

515 nm, 343 nm, 257 nm,
or 206 nm output

Automated harmonic selection

Industrial-grade design



PHAROS with
a harmonic generator

Specifications

Model		2H (-HE)	2H-3H (-HE)	2H-4H (-HE)	4H-5H
Output wavelength ¹⁾ (automated selection)		1030 nm 515 nm	1030 nm 515 nm 343 nm	1030 nm 515 nm 257 nm	1030 nm 257 nm 206 nm
Pump pulse energy ²⁾		20 – 2000 μ J			
Pump pulse duration		100 – 500 fs			
Conversion efficiency		> 50% (2H)	> 50% (2H) > 25% (3H)	> 50% (2H) > 10% (4H) ³⁾	> 10% (4H) ⁴⁾ > 5% (5H) ⁵⁾
Beam quality, M ²	$\leq 400 \mu$ J pump	< 1.3 (2H)	< 1.3 (2H) < 1.4 (3H)	< 1.3 (2H) n/a (4H)	n/a
	> 400 μ J pump	< 1.4 (2H)	< 1.4 (2H) < 1.5 (3H)	< 1.4 (2H) n/a (4H)	

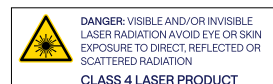
¹⁾ Depends on the pump laser model.

²⁾ For more pump energy options contact sales@lightcon.com

³⁾ Maximum output power: 2 W at 20 – 1000 μ J pump energy, or 1 W at 1000 – 2000 μ J pump energy.

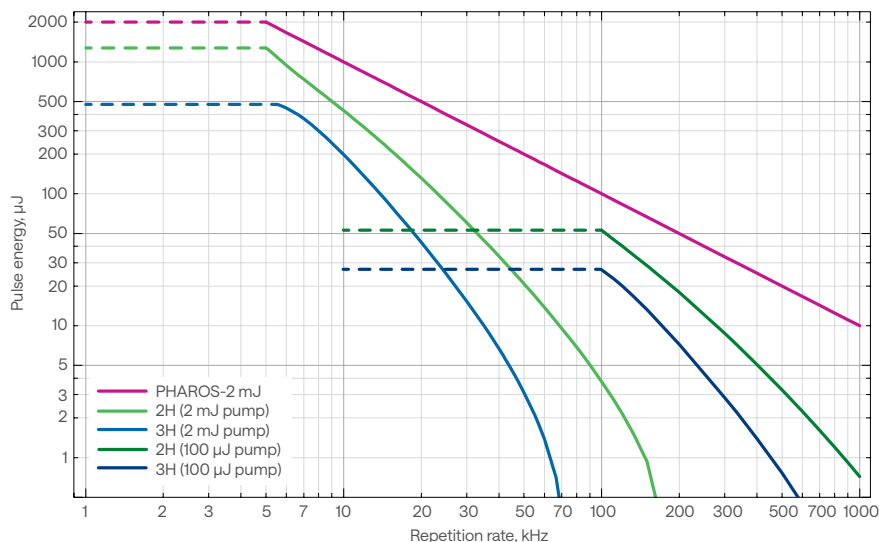
⁴⁾ Maximum output power of 1 W.

⁵⁾ Maximum output power of 150 mW.

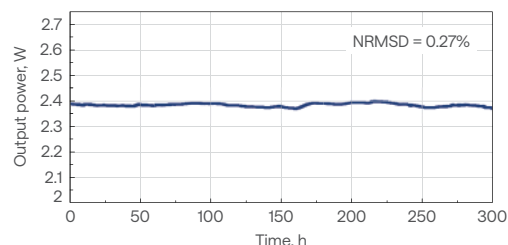


PHAROS with a harmonic generator

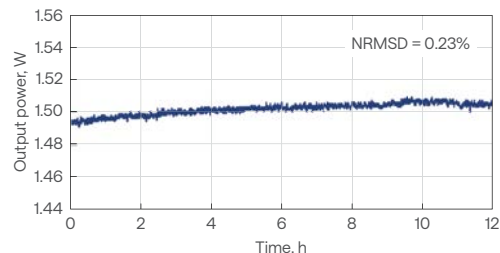
Pulse energy vs repetition rate



3H output power stability



4H output power stability



BiBurst

Tunable GHz and MHz Burst with Burst-in-Burst Capability

Water-cooled **CARBIDE** and **PHAROS** lasers feature the tunable GHz and MHz burst option with burst-in-burst capability, known as BiBurst.

In standard mode, the laser emits a single pulse at a fixed frequency. In burst mode, the output consists of pulse packets instead of single pulses. Each packet consists of a specific number of equally separated pulses. MHz-Burst contains N pulses with a nanosecond period, while GHz-Burst contains P pulses with a picosecond period. When both burst modes are combined, the equally separated pulse packets contain sub-packets of pulses, forming the burst-in-burst or BiBurst.

CARBIDE and **PHAROS** lasers, equipped with tunable GHz and MHz bursts and BiBurst options, bring new capabilities to high-tech

manufacturing industries, such as consumer electronics, integrated photonic chip production, advanced display manufacturing, and quantum technologies.

Applications:

- Brittle material drilling and cutting
- Deep engraving
- Selective ablation
- Volume modification of transparent materials
- Hidden marking
- Surface polishing
- Functional surface structuring

Specifications

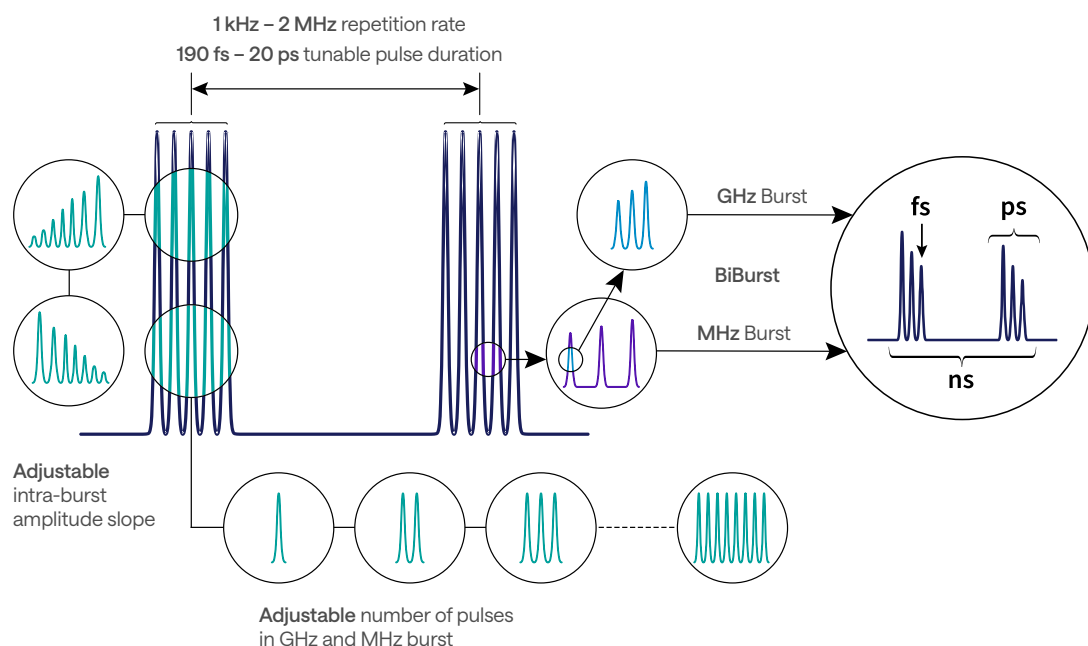
Model		CARBIDE-CB3	PHAROS
GHz Burst	Intra burst pulse period ¹⁾	440 ± 40 ps	200 ± 40 ps
	Number of pulses, P ²⁾	1 – 10 (up to 400) ³⁾	1 – 25
MHz Burst	Intra burst pulse period	≈ 15 ns	
	Number of pulses, N ²⁾	1 – 10	1 – 9 (7 with FEC) ⁴⁾

¹⁾ Custom spacing is available on request. For CARBIDE-CB3-10MHz model standard pulse period is 1500 ps.

²⁾ The maximum number of pulses in a burst depends on the laser repetition rate and energy. CARBIDE-CB3-10MHz model is limited up to 6 pulses.

³⁾ The maximum number of P pulses can be increased to 350 – 400 with optional long GHz burst mode.

⁴⁾ Fast energy control option. Enables formation of any pulse envelope at laser pulse repetition rate.



Industrial-Grade Optical Parametric Amplifiers

Wavelength tunability in an industrial design

Single-box solution

Tunable or fixed-wavelength models

Plug-and-play installation and robust performance

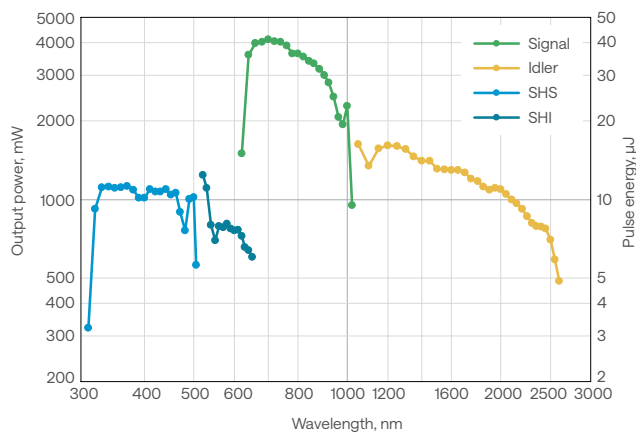
The most compact OPA in the market



CARBIDE-CB3 with I-OPA-HP

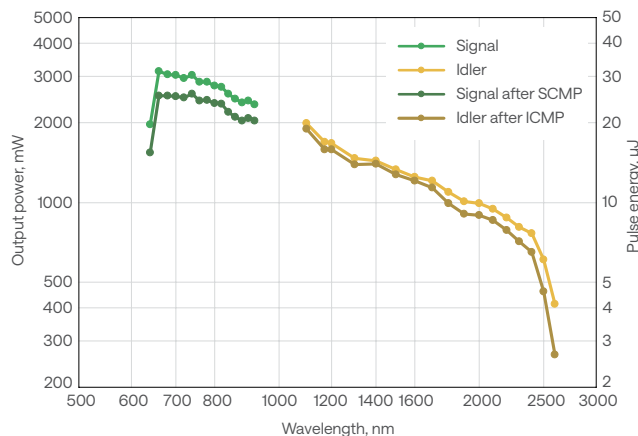
I-OPA-HP typical tuning curves

Pump: 40 W, 400 μ J, 100 kHz



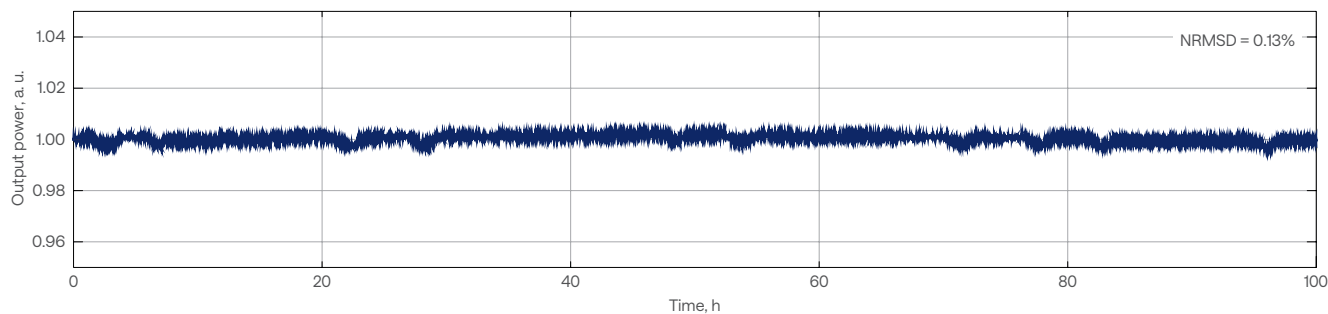
I-OPA-F typical tuning curves

Pump: 40 W, 400 μ J, 100 kHz



I-OPA-HP

Typical power stability at 1300 nm



Specifications

Model	I-OPA-HP	I-OPA-F	I-OPA-ONE
Configuration	ORPHEUS	ORPHEUS-F	ORPHEUS-ONE
Pump power	Up to 40 W		
Pump pulse energy	20 – 400 μ J		
Repetition rate	Up to 2 MHz		
Tuning range ¹⁾	640 – 1010 nm (signal) 1050 – 2600 nm (idler)	650 – 920 nm (signal) 1200 – 2500 nm (idler)	1350 – 2000 nm (signal) 2100 – 4500 nm (idler)
Conversion efficiency	> 7% @ 700 nm (40 – 400 μ J pump; up to 1 MHz)		> 9% @ 1550 nm (40 – 400 μ J pump; up to 1 MHz)
	> 3.5% @ 700 nm (20 – 40 μ J pump; up to 2 MHz)		> 6% @ 1550 nm (20 – 40 μ J pump; up to 2 MHz)
Spectral bandwidth ²⁾	80 – 220 cm^{-1} @ 700 – 960 nm	200 – 1000 cm^{-1} @ 650 – 920 nm 150 – 1000 cm^{-1} @ 1200 – 2000 nm	60 – 150 cm^{-1} @ 1450 – 2000 nm
Pulse duration ^{2) 3)}	120 – 250 fs	< 55 fs @ 800 – 920 nm < 70 fs @ 650 – 800 nm < 100 fs @ 1200 – 2000 nm	100 – 300 fs
Long-term power stability, 8 h ⁴⁾	< 1% @ 800 nm		< 1% @ 1550 nm
Pulse-to-pulse energy stability, 1 min ⁴⁾	< 1% @ 800 nm		< 1% @ 1550 nm
Wavelength extension options	320 – 505 nm (SHS) ⁵⁾ 525 – 640 nm (SHI) ⁵⁾	Contact sales@lightcon.com	4500 – 10 000 nm (DFG)
Pulse compression options ²⁾	n/a	SCMP (signal pulse compressor) ICMP (idler pulse compressor) GDD-CMP (compressor with GDD control)	n/a

PUMP LASER REQUIREMENTS

Pump laser	CARBIDE or PHAROS
Center wavelength	1030 $\pm$ 10 nm
Maximum pump power	40 W
Maximum repetition rate	Up to 2 MHz
Pump pulse energy	20 – 400 μ J
Pulse duration	180 – 300 fs

ENVIRONMENTAL & UTILITY REQUIREMENTS

Refer to lightcon.com

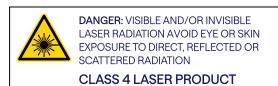
¹⁾ In the case of a fixed wavelength (FW), a single wavelength can be selected from the signal or idler range. The signal may have an accessible idler pair, and vice versa.

²⁾ I-OPA-F broad-bandwidth pulses are compressed externally. Typical pulse duration before compression: 120 – 250 fs, after compression: 25 – 70 fs @ 650 – 920 nm, 40 – 100 fs @ 1200 – 2000 nm.

³⁾ Output pulse duration depends on the selected wavelength and the pump laser pulse duration.

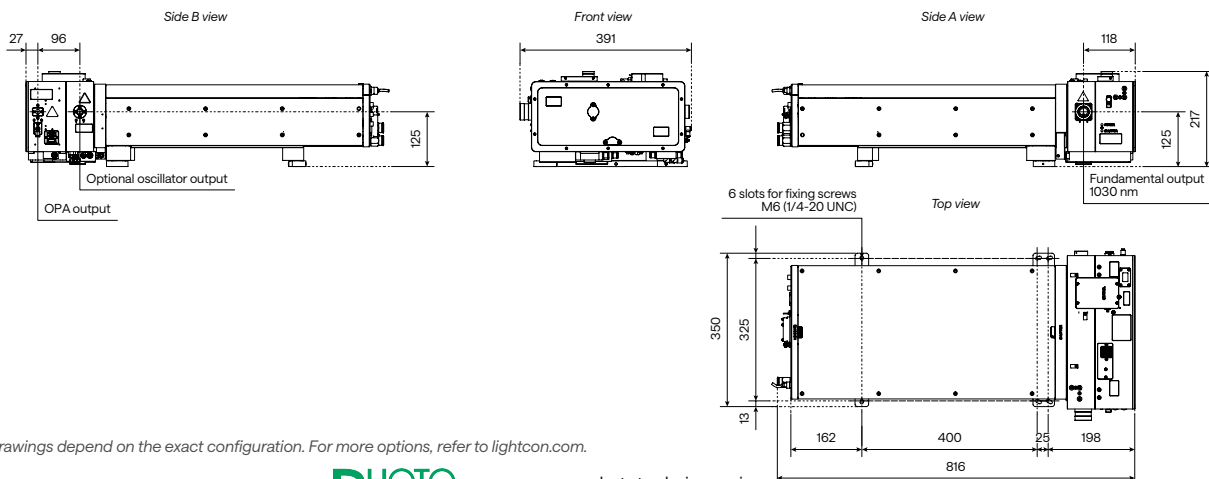
⁴⁾ Expressed as normalized root mean squared deviation (NRMSD).

⁵⁾ Conversion efficiency is 1.2% at peak; specified as a percentage of pump power.



Drawings

CARBIDE-CB3 with I-OPA-HP



The drawings depend on the exact configuration. For more options, refer to lightcon.com.

