

# OPCPA Systems



Product Catalog



LIGHT CONVERSION is a global leader in ultrafast technology, designing and manufacturing:

- > Femtosecond Lasers,
- > Wavelength-Tunable Sources,
- > OPCPA Systems,
- > Microscopy Sources,
- > Spectroscopy Systems.

The comprehensive portfolio represents the best-in-class lasers tailored for industry, science, and medicine.

#### About Us

Founded in 1994, LIGHT CONVERSION has evolved into a leading company in ultrafast laser technology with over 9000 systems installed worldwide and 600 employees, 15% of whom focus on R&D. The company's lasers are used in all of the top 50 universities worldwide, highlighting its commitment to state-of-the-art research, while also ensuring the reliability and performance in 24/7 industrial applications. With international offices in the US, China, and Korea, along with a global representative network, the company ensures worldwide sales and service.

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# OPCPA Systems

Optical parametric chirped-pulse amplification (OPCPA) is currently the only laser technology that can simultaneously provide high peak and average power with a few-cycle pulse duration, required for the most demanding scientific applications.

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## **ORPHEUS** | OPCPA

Delivers few-cycle, CEP-stable pulses at one of the four center wavelengths - 800 nm, 1600 nm, 2000 nm, or 3000 nm - in a package as compact as our standard parametric amplifiers.

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## **OPCPA** | HE

High-energy OPCPA systems are scalable to multi-TW peak powers at kHz repetition rates while maintaining few-cycle pulse durations. Thus, they meet the most demanding requirements while providing stability and reliability unprecedented for systems of this scale.

From tabletop systems  
to extreme light  
infrastructures

High peak and average  
power with a few-cycle  
pulse duration

State-of-the-art CEP and  
pulse energy stability

## Compact, Few-Cycle, CEP-Stable OPCPA Systems



Few cycle pulses in a compact footprint

800 nm, 1600 nm, 2000 nm, or 3000 nm output

High repetition rate, up to MHz

High contrast seed source for CPA and OPCPA systems

Exceptional power, pulse energy and CEP stability

SH / TH options

### Specifications

Center wavelength	800 nm	1600 nm	2000 nm	3000 nm
Pump source <sup>1)</sup>	PHAROS / CARBIDE			
Pump power <sup>1)</sup>	20 – 480 W			
Pump pulse energy <sup>1)</sup>	0.2 – 8 mJ			
Repetition rate	1 kHz – 1 MHz			
Conversion efficiency <sup>2)</sup>	> 7%	> 10%	> 9%	> 6%
Pulse duration <sup>2)</sup>	< 10 fs	< 40 fs	< 25 fs	< 45 fs
Transform-limited pulse duration <sup>2)3)</sup>	< 6 fs	< 30 fs	< 15 fs	< 35 fs
CEP stability, 1 h <sup>2)4)</sup>	< 250 mrad			
Long-term power stability, 8 h <sup>2)5)</sup>	< 1.5%			
Pulse-to-pulse energy stability, 1 min <sup>2)5)</sup>	< 1.5%			

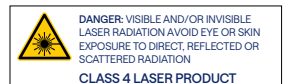
<sup>1)</sup> For using other pump sources, such as thin-disk or innoslab lasers, contact sales@lightcon.com.

<sup>2)</sup> Typical values. For custom inquiries, contact sales@lightcon.com.

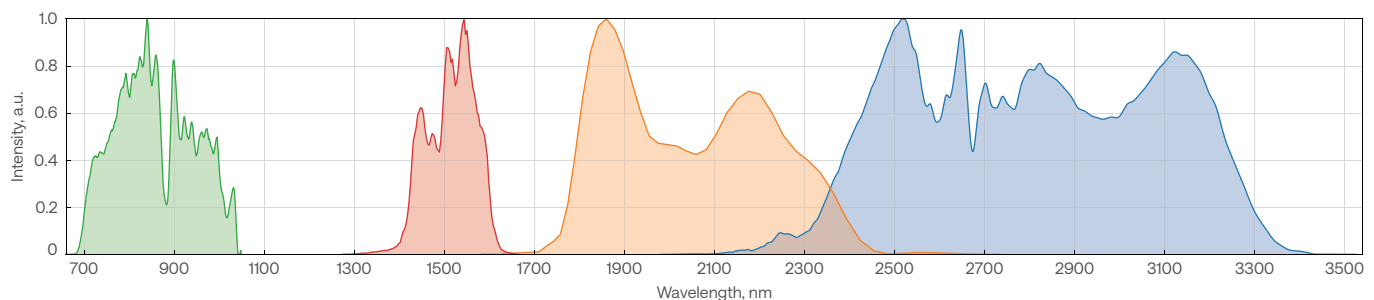
<sup>3)</sup> Uncompressed, for seeding larger amplifiers.

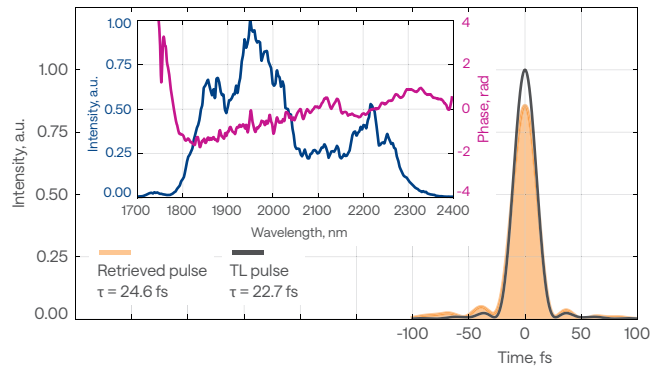
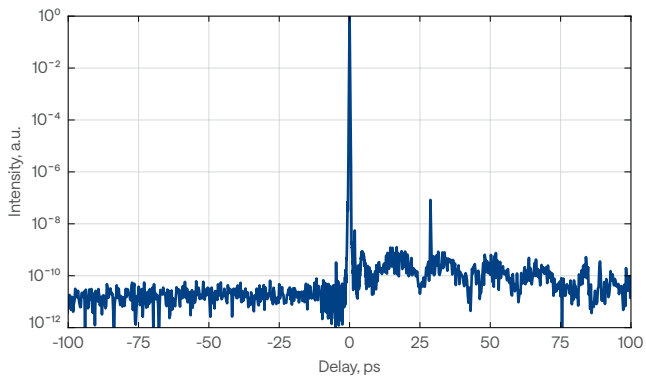
<sup>4)</sup> CEP values calculated from unaveraged, single-shot measurements.

<sup>5)</sup> Expressed as normalized root mean squared deviation (NRMSD).



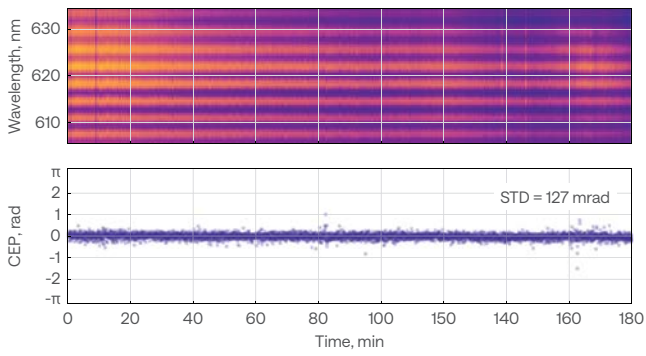
### ORPHEUS-OPCPA example spectra of four models



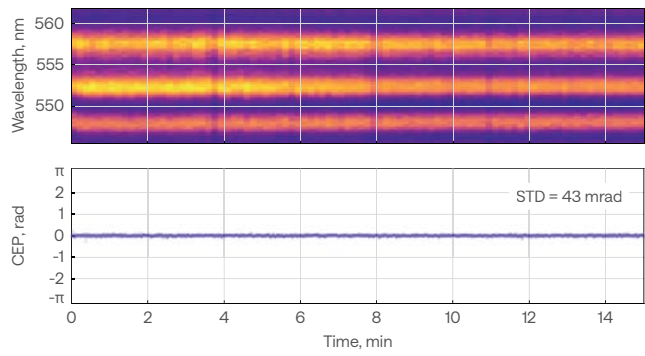


## Stability

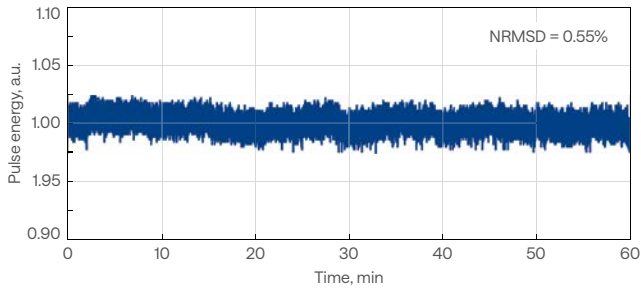
ORPHEUS-OPCPA CEP stability\* (800 nm, 100 kHz)



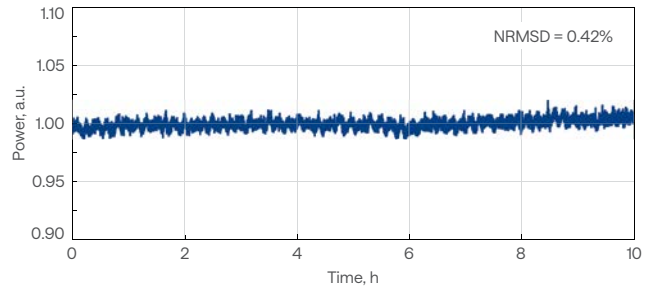
ORPHEUS-OPCPA CEP stability\* (3 μm, 1 kHz)



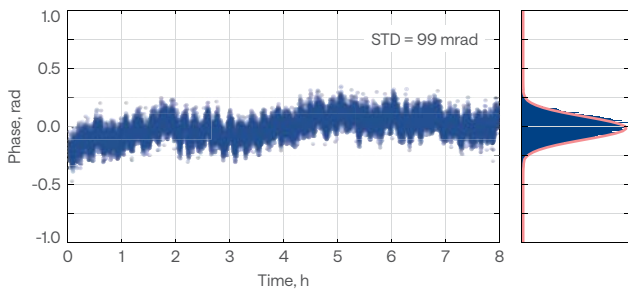
ORPHEUS-OPCPA pulse-to-pulse energy stability at 800 nm



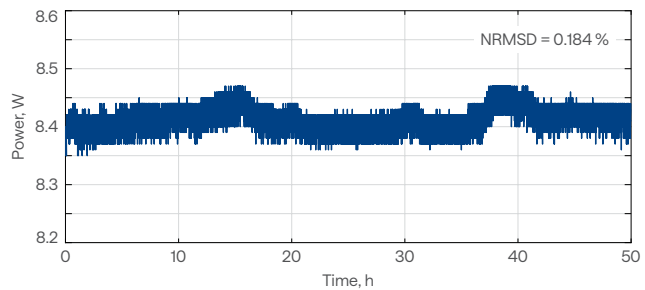
ORPHEUS-OPCPA long-term output stability at 800 nm



ORPHEUS-OPCPA CEP stability\* (2 μm, 100 kHz) without slow-loop CEP stabilization



ORPHEUS-OPCPA long-term output stability at 2 μm



\*All CEP values calculated from unaveraged, single-shot measurements.



## High-Energy OPCPA Systems

Multi-TW peak-power pulses at up to 1 kHz

800 nm, 1600 nm, or 2000 nm output

Few-cycle pulse duration and high pre-pulse contrast

Robust design with a warm-up time of < 1 hour

Exceptional CEP and pulse energy stability

Spectral-temporal pulse shaping options





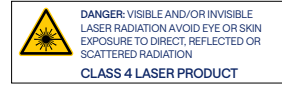
# Specifications

Center wavelength	800 nm	1600 nm	2000 nm
Pump source	Picosecond Nd:YAG lasers, seeded by ORPHEUS-OPCPA		
Repetition rate	10 Hz – 1 kHz		
Maximum output pulse energy <sup>1)</sup>	250 mJ	100 mJ	50 mJ
Pulse duration <sup>1)</sup>	< 9 fs	< 50 fs	< 30 fs
CEP stability, 1 h <sup>1)2)</sup>	< 250 mrad		
Long-term power stability, 8 h <sup>1)3)</sup>	< 1.5%		
Pulse-to-pulse energy stability, 1 min <sup>1)3)</sup>	< 1.5%		

<sup>1)</sup> Typical values. For custom inquiries, contact [sales@lightcon.com](mailto:sales@lightcon.com).

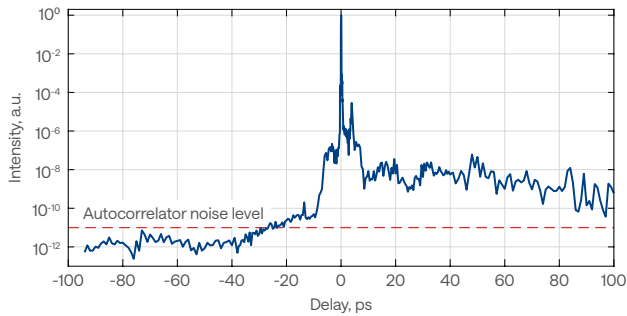
<sup>3)</sup> Expressed as as normalized root mean squared deviation (NRMSD).

<sup>2)</sup> CEP values calculated from unaveraged, single-shot measurements.

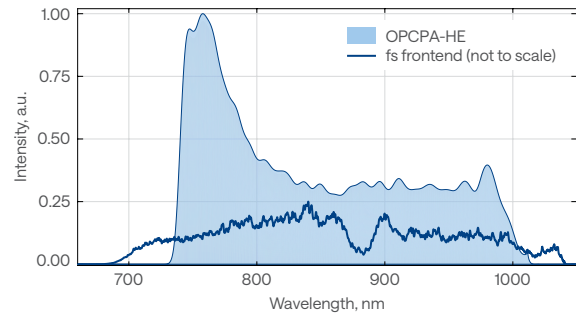


## Performance at 800 nm

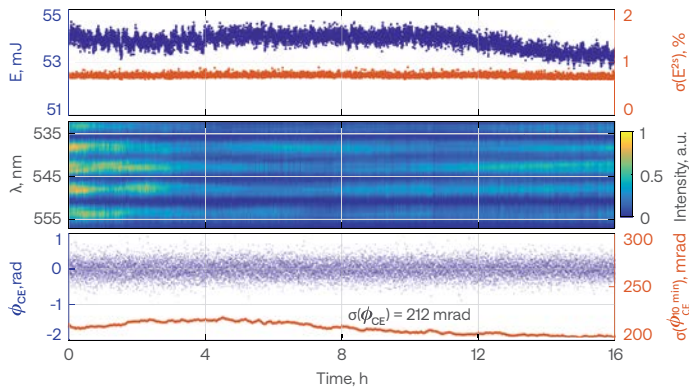
OPCPA-HE system high-dynamic-range third order autocorrelation measurement



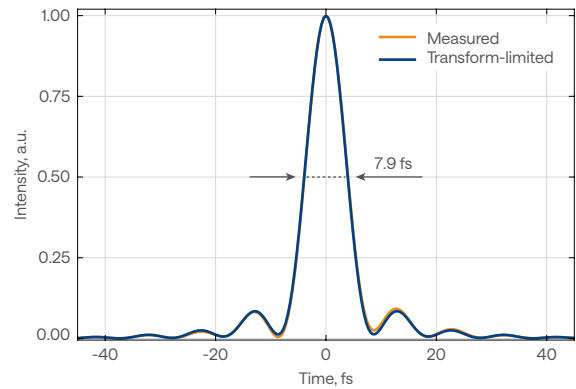
OPCPA-HE output spectrum



OPCPA-HE pulse energy, f-2f interferogram and CEP stability measured over 16 h

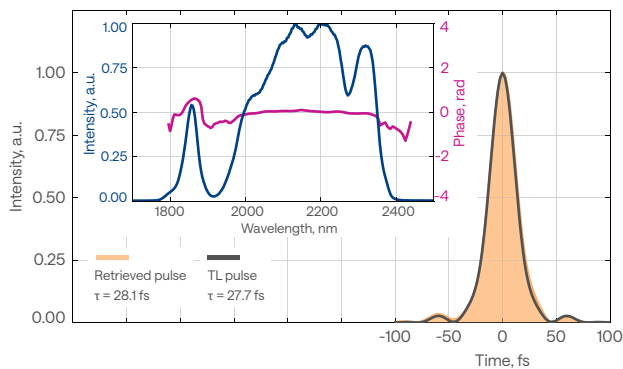


OPCPA-HE output pulses' temporal profile measured with a self-referenced spectral interferometry device

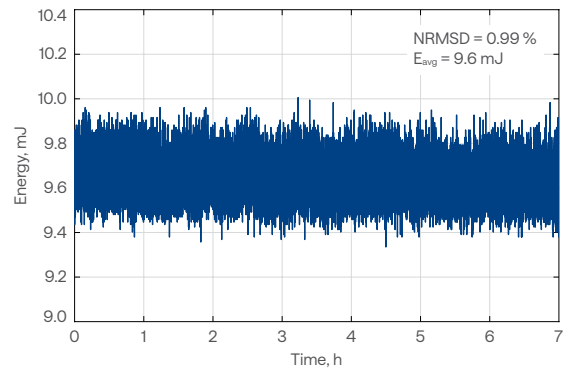


## Performance at 2000 nm

OPCPA-HE output pulses' temporal profile at 2 μm



OPCPA-HE pulse-to-pulse energy stability at 2 μm





# Femtosecond Lasers

LIGHT CONVERSION is world-renowned for its industrial-grade Yb-based femtosecond lasers, covering a wide range of scientific, industrial, and medical applications.

## **CARBIDE**

Compact industrial design in air-cooled and water-cooled models, providing up to 120 W, 1 mJ or 80 W, 2 mJ with excellent output stability.

## **PHAROS**

Scientific flexibility and process-tailored output parameters, providing pulse duration down to 100 fs and pulse energy of up to 4 mJ.

High average power and high pulse energy at a high repetition rate

Market-proven industrial-grade stability and reliability

Tailored to the needs of industry and science

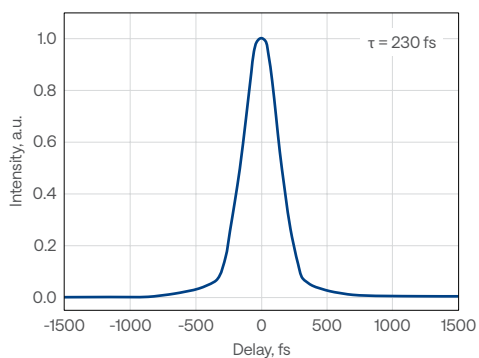
## Unibody-Design Femtosecond Lasers for Industry and Science



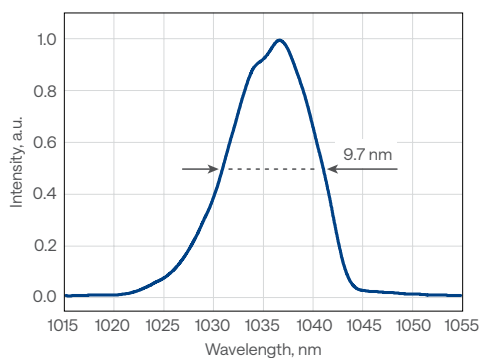
CARBIDE-CB3

- Tunable pulse duration, 190 fs – 20 ps
- Maximum output of 120 W, 1 mJ or 80 W, 2 mJ
- Single-shot – 10 MHz repetition rate NEW
- Pulse-on-demand and BiBurst for pulse control
- Up to 5<sup>th</sup> harmonic or tunable extensions
- Air-cooled and water-cooled models
- Compact industrial-grade design

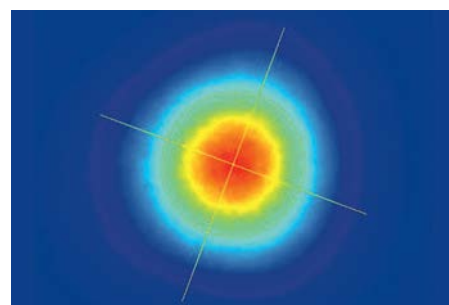
**CARBIDE-CB3**  
Typical pulse duration



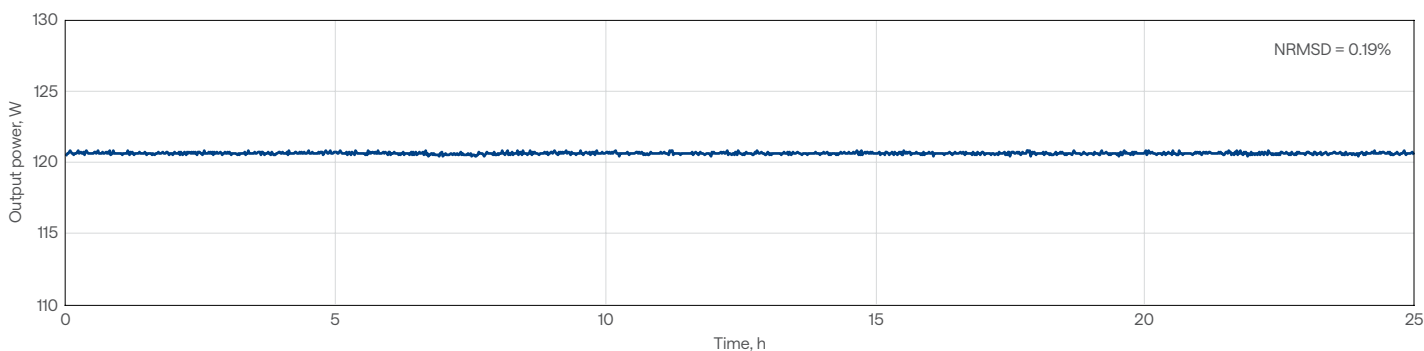
**CARBIDE-CB3**  
Typical spectrum



**CARBIDE-CB3**  
Typical beam profile



**CARBIDE-CB3-120W**  
Long-term power stability



# CARBIDE-CB3 specifications

NEW

Model	CB3-20W	CB3-40W	CB3-80W	CB3-120W
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## OUTPUT CHARACTERISTICS

Cooling method	Water-cooled			
Center wavelength	1030 ± 10 nm			
Maximum output power	20 W	40 W	80 W	120 W
Pulse duration <sup>1)</sup>	< 250 fs		< 350 fs <sup>2)</sup>	< 250 fs
Pulse duration tuning range	250 fs – 10 ps		350 fs – 10 ps	250 fs – 10 ps
Maximum pulse energy	0.4 mJ	0.2 mJ	0.8 mJ	2 mJ
Repetition rate	Single-shot – 1 MHz	Single-shot-1 MHz (2 MHz on request)	Single-shot – 10 MHz	Single-shot – 2 MHz
Pulse selection	Single-shot, pulse-on-demand, any fundamental repetition rate division			
Polarization	Linear, vertical; 1: 1000			
Beam quality, M <sup>2</sup>	< 1.2			
Beam diameter <sup>3)</sup>	3.9 ± 0.4 mm		4.2 ± 0.4 mm	5.1 ± 0.7 mm
Beam pointing stability	< 20 μrad/°C			
Pulse energy control	FEC <sup>4)</sup>	Attenuator <sup>5)</sup>	FEC <sup>4)</sup>	
Pulse picker leakage	< 0.25%	< 0.5%	< 0.25%	
Pulse-to-pulse energy stability, 24 h <sup>6)</sup>	< 0.5%			
Long-term power stability, 100 h <sup>6)</sup>	< 0.5%			

## MAIN OPTIONS

Oscillator output	< 0.5 W, 120 – 250 fs, 1030 ± 10 nm, ≈ 65 MHz <sup>7)</sup>			
Harmonic generator <sup>8)</sup>	515 nm, 343 nm, 257 nm, or 206 nm			
Optical parametric amplifier <sup>9)</sup>	320 – 10000 nm			n/a
BiBurst option	Tunable GHz and MHz burst with burst-in-burst capability			

## PHYSICAL DIMENSIONS

Laser head (L × W × H)	633 × 350 × 174 mm		
Chiller (L × W × H)	585 × 484 × 221 mm	680 × 484 × 307 mm	
24 V DC power supply (L × W × H)	280 × 144 × 49 mm <sup>10)</sup>	320 × 200 × 75 mm	376 × 449 × 88 mm

## ENVIRONMENTAL AND UTILITY REQUIREMENTS

Operating temperature	15 – 30 °C			
Relative humidity	< 80% (non-condensing)			
Electrical requirements	Laser	100 V AC, 7 A – 240 V AC, 3A; 50 – 60 Hz	100 V AC, 12 A – 240 V AC, 5 A 50 – 60 Hz	100 V AC, 15 A – 240 V AC, 7 A 50 – 60 Hz
	Chiller	100 – 230 V AC; 50 – 60 Hz		
Rated power	Laser	600 W	1000 W	2000 W
	Chiller	1400 W	2000 W	
Power consumption	Laser	500 W	900 W	1500 W
	Chiller	1000 W	1300 W	1800 W

<sup>1)</sup> Assuming Gaussian pulse shape.

<sup>2)</sup> Pulse duration can be reduced to < 250 fs if pulse peak intensity of > 50 GW/cm<sup>2</sup> is tolerated by the customer setup.

<sup>3)</sup> FW 1/e<sup>2</sup>, using maximum pulse energy.

<sup>4)</sup> Fast energy control (FEC) provides fast, full-scale individual pulse energy control; an external analog control input is available.

<sup>5)</sup> Waveplate-based variable optical attenuator (VOA); an external analog control input is available.

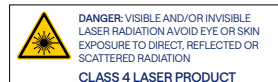
<sup>6)</sup> Under stable environmental conditions. Expressed as normalized root mean squared deviation (NRMSSD)

<sup>7)</sup> Available simultaneously, requires a scientific interface. Contact sales@lightcon.com for more details or customized solutions.

<sup>8)</sup> Integrated. For external harmonic generator, refer to HIRO.

<sup>9)</sup> Integrated. For more options and OPAs, refer to www.lightcon.com.

<sup>10)</sup> Power supply can be different if optional 2 MHz version is selected.



## CARBIDE-CB5 (air-cooled) specifications

Model	CB5		CB5-SP
<b>OUTPUT CHARACTERISTICS</b>			
Cooling method	Air-cooled <sup>1)</sup>		
Center wavelength	1030 ± 10 nm		
Maximum output power	6 W	5 W	
Pulse duration <sup>2)</sup>	< 290 fs		< 190 fs
Pulse duration tuning range	290 fs – 20 ps		190 fs – 20 ps
Maximum pulse energy	100 µJ	83 µJ	100 µJ
Repetition rate	Single-shot – 1 MHz		
Pulse selection	Single-shot, pulse-on-demand, any fundamental repetition rate division		
Polarization	Linear, vertical; 1: 1000		
Beam quality, M <sup>2</sup>	< 1.2		
Beam diameter <sup>3)</sup>	2.1 ± 0.4 mm		
Beam pointing stability	< 20 µrad/°C		
Pulse energy control	Attenuator <sup>4)</sup>	AOM <sup>5)</sup>	Attenuator <sup>4)</sup>
Pulse picker leakage	< 2%	< 0.1%	< 2%
Pulse-to-pulse energy stability, 24 h <sup>6)</sup>	< 0.5%		
Long-term power stability, 100 h <sup>6)</sup>	< 0.5%		

### MAIN OPTIONS

Oscillator output	n/a		
Harmonic generator <sup>7)</sup>	515 nm, 343 nm, 257 nm, or 206 nm		
Optical parametric amplifier <sup>8)</sup>	320 – 10000 nm		
BiBurst option	n/a		

### PHYSICAL DIMENSIONS

Laser head (L × W × H)	633 × 324 × 162 mm		
Chiller	Not required		
24 V DC power supply (L × W × H)	220 × 95 × 46 mm		

### ENVIRONMENTAL AND UTILITY REQUIREMENTS

Operating temperature	17 – 27 °C		
Relative humidity	< 80% (non-condensing)		
Electrical requirements	100 V AC, 3 A – 240 V AC, 1.3 A; 50 – 60 Hz		
Rated power	300 W		
Power consumption	150 W		

<sup>1)</sup> Water-cooled version available on request.

<sup>2)</sup> Assuming Gaussian pulse shape.

<sup>3)</sup>  $FW\ 1/e^2$ , using maximum pulse energy.

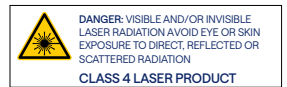
<sup>4)</sup> Waveplate-based variable optical attenuator (VOA); an external analog control input is available.

<sup>5)</sup> Enhanced contrast AOM. Provides fast amplitude control of output pulse train.

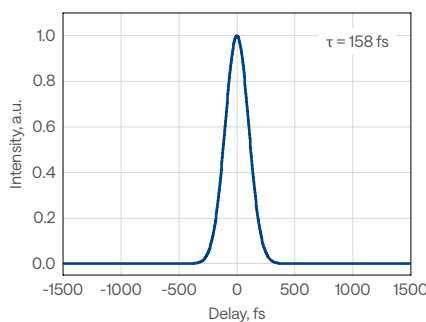
<sup>6)</sup> Under stable environmental conditions. Expressed as normalized root mean squared deviation (NRMSD).

<sup>7)</sup> Integrated. For external harmonic generator, refer to HIRO.

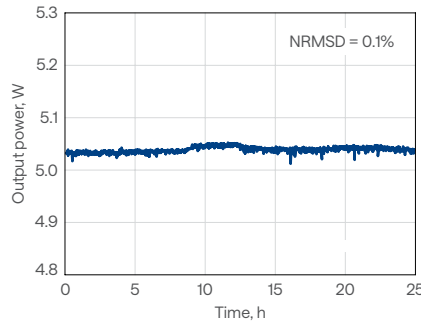
<sup>8)</sup> Integrated. For stand-alone OPAs, refer to [www.lightcon.com](http://www.lightcon.com).



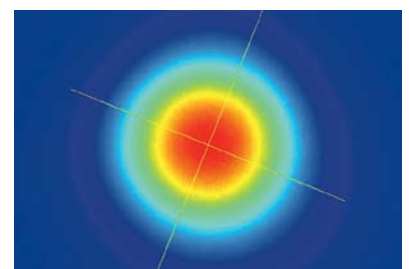
**CARBIDE-CB5-SP**  
Typical pulse duration



**CARBIDE-CB5**  
Long-term power stability

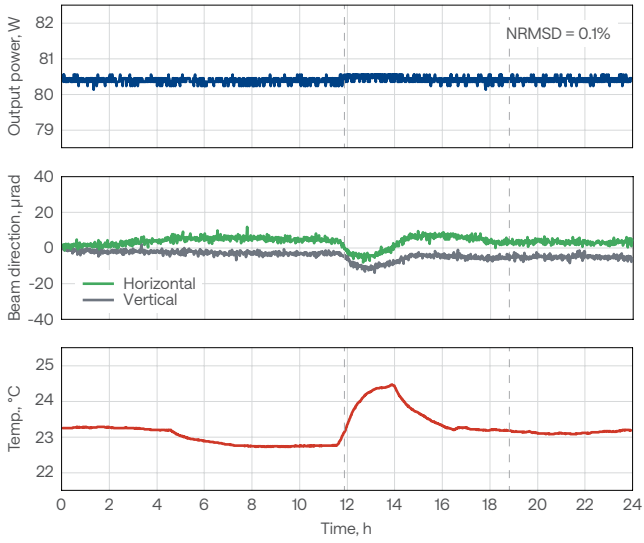


**CARBIDE-CB5**  
Typical beam profile

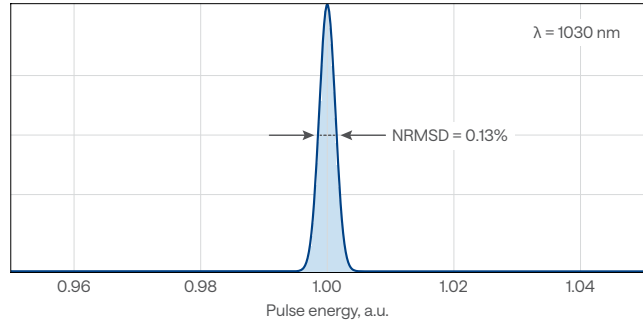


# Stability measurements

CARBIDE-CB3 output power and beam direction stability with power lock enabled, across varying environmental conditions

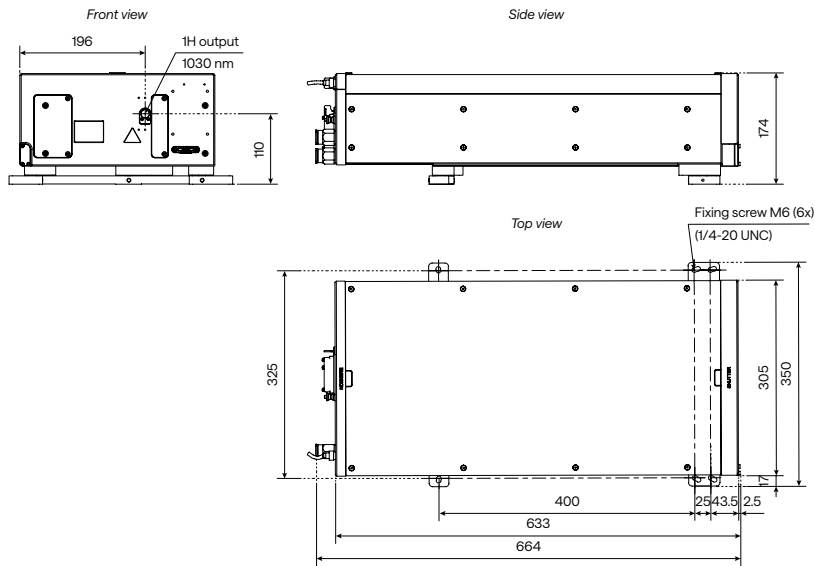


CARBIDE-CB3  
Typical pulse-to-pulse energy stability

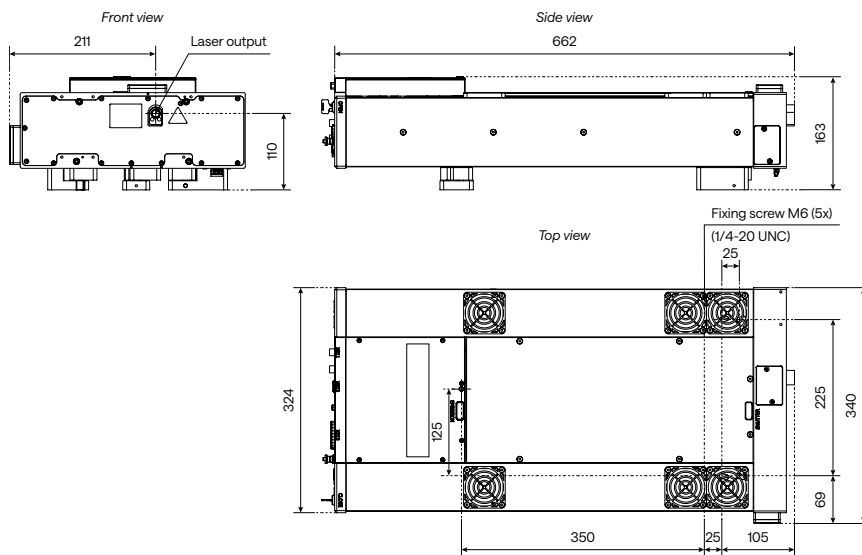


# Drawings

CARBIDE-CB3 drawing



Air-cooled CARBIDE-CB5 with attenuator drawing



# PHAROS

## Modular-Design Femtosecond Lasers for Industry and Science



Tunable pulse duration, 100 fs – 20 ps

Maximum pulse energy of up to 4 mJ

Down to < 100 fs right at the output

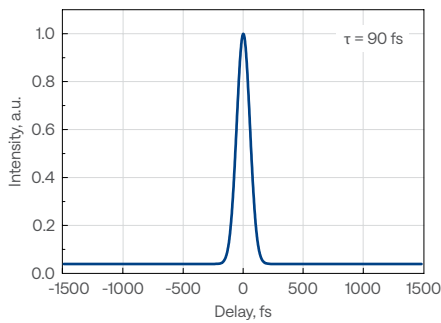
Pulse-on-demand and BiBurst for pulse control

Up to 5<sup>th</sup> harmonic or tunable extensions

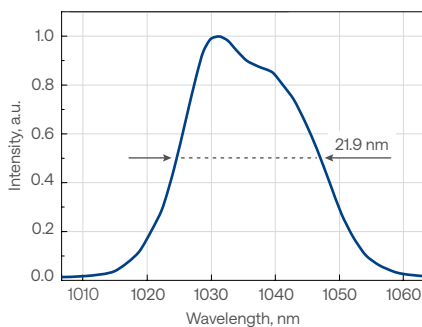
CEP stabilization or repetition rate locking

Thermally-stabilized and sealed design

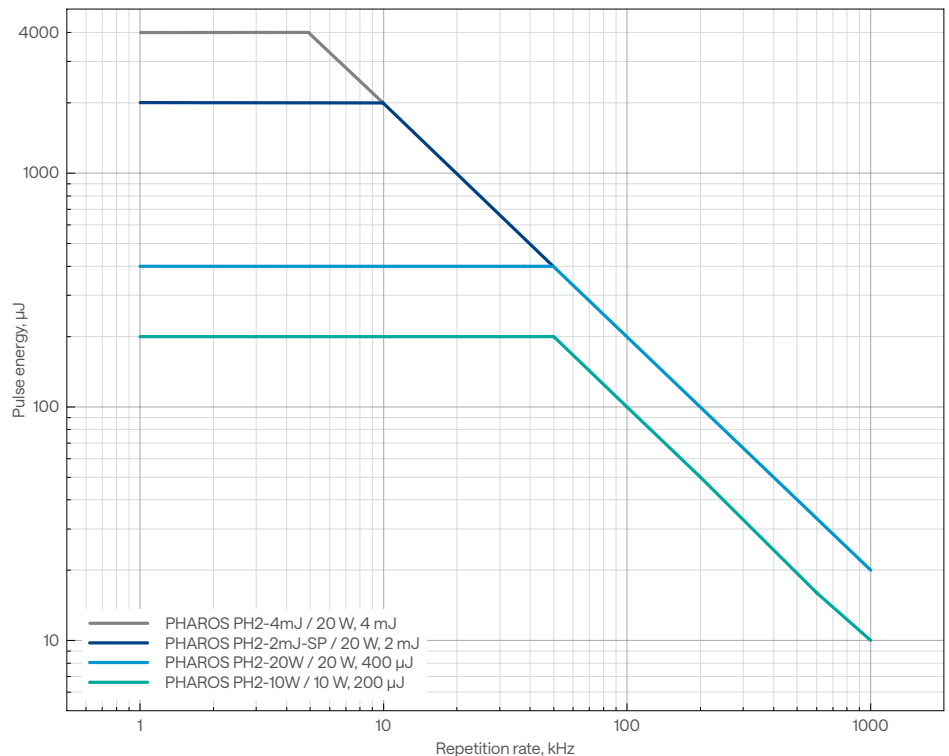
PHAROS-PH2-UP  
Typical pulse duration



PHAROS-PH2-UP  
Typical spectrum



PHAROS  
Pulse energy vs fundamental repetition rate





# Specifications

Model	PH2-10W	PH2-20W-SP			PH2-4mJ	PH2-UP	
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## OUTPUT CHARACTERISTICS

Center wavelength <sup>1)</sup>	1030 ± 10 nm						
Maximum output power	10 W	20 W					
Pulse duration <sup>2)</sup>	< 290 fs	< 190 fs			< 450 fs <sup>3)</sup>	< 100 fs	
Pulse duration tuning range	290 fs – 10 ps (20 ps on request)	190 fs – 10 ps (20 ps on request)			450 fs – 10 ps	100 fs – 10 ps	
Maximum pulse energy	0.2 mJ	0.4 mJ	1 mJ	2 mJ	4 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 <sup>2</sup>	< 1.2	< 1.3				< 1.2	
Beam diameter <sup>4)</sup>	3.3 ± 0.5 mm	4.0 ± 0.5 mm	4.5 ± 0.5 mm	6.8 ± 0.7 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, 24 h <sup>5)</sup>	< 0.5%						
Long-term power stability, 100 h <sup>5)</sup>	< 0.5%						

## MAIN OPTIONS

Oscillator output <sup>6)</sup>	1 – 7 W, 50 – 250 fs, ≈ 1035 nm, ≈ 76 MHz						
Harmonic generator <sup>7)</sup>	515 nm, 343 nm, 257 nm, or 206 nm						
Optical parametric amplifier <sup>8)</sup>	320 – 10000 nm						
BiBurst option	Tunable GHz and MHz burst with burst-in-burst capability						
CEP stabilization	See page 19						
Repetition rate locking							

## PHYSICAL DIMENSIONS

Laser head (L × W × H) <sup>9)</sup>	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) <sup>9)</sup>	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	

<sup>1)</sup> Precise wavelengths for specific models are available upon request.

<sup>2)</sup> Assuming Gaussian pulse shape.

<sup>3)</sup> Pulse duration can be reduced to < 250 fs if pulse peak intensity of > 50 GW/cm<sup>2</sup> is tolerated by the customer setup.

<sup>4)</sup> FW 1/e<sup>2</sup>, measured at laser output, using maximum pulse energy.

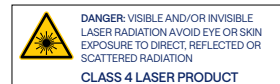
<sup>5)</sup> Under stable environmental conditions. Expressed as normalized root mean squared deviation (NRMDS).

<sup>6)</sup> Available simultaneously. Contact sales@lightcon.com for more details or customized solutions.

<sup>7)</sup> Integrated. For external harmonic generator, refer to HIRO.

<sup>8)</sup> Integrated. For more options and OPAs for -4mJ and -UP models, refer to www.lightcon.com.

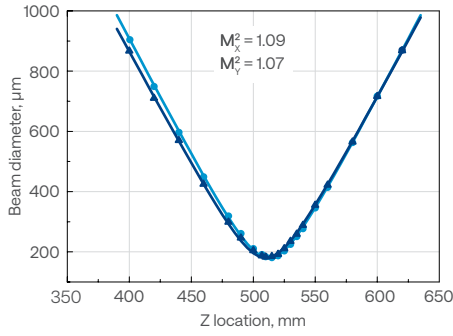
<sup>9)</sup> Dimensions depend on laser configuration and integrated options.



## Beam properties

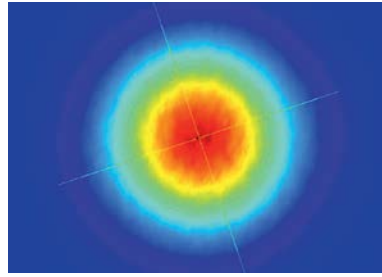
### PHAROS

Typical  $M^2$  measurement data



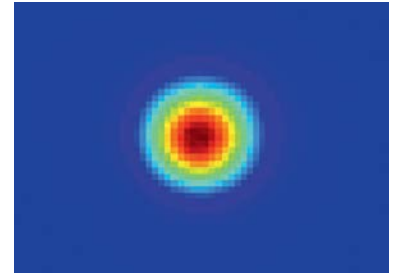
### PHAROS

Typical near-field beam profile



### PHAROS

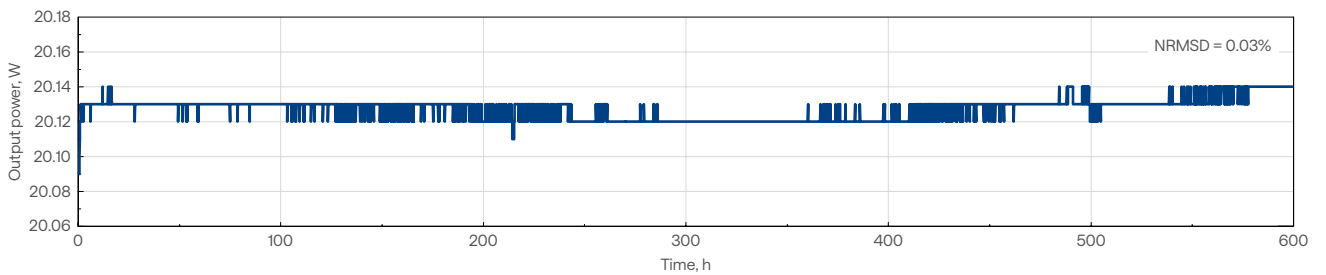
Typical far-field beam profile



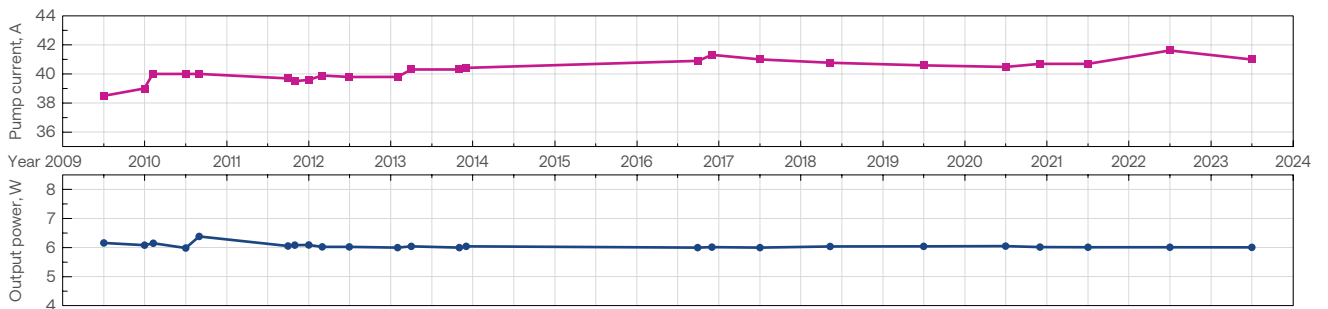
## Stability measurements

### PHAROS

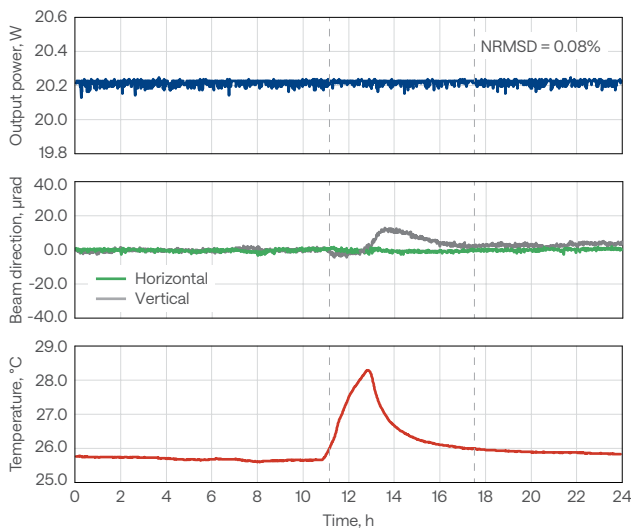
Long-term power stability



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

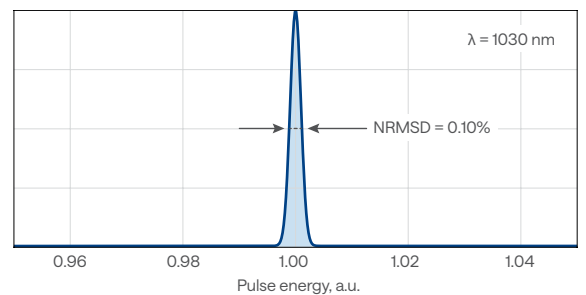


PHAROS output power and the stability of beam direction with power lock enabled, across varying environmental conditions



### PHAROS

Typical pulse-to-pulse energy stability



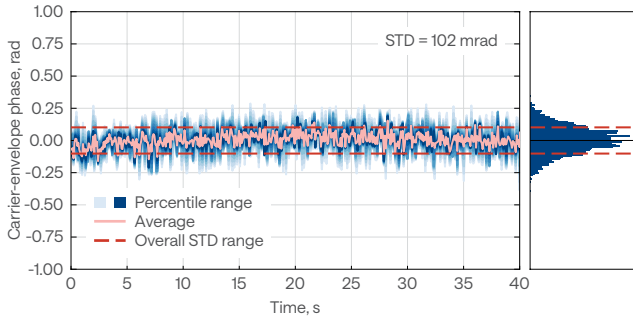
## CEP stabilization

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  $1/4^{\text{th}}$  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.

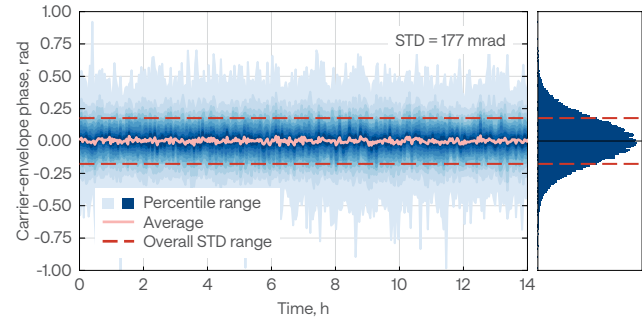
### PHAROS

Short-term CEP stability operating at 200 kHz repetition rate



### PHAROS

Long-term CEP stability operating at 200 kHz repetition rate

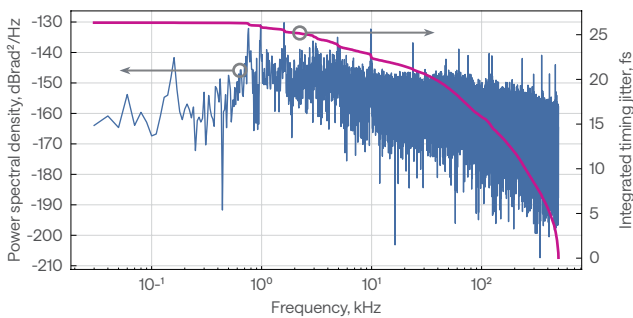


## Repetition rate locking

The oscillator of PHAROS laser can be customized for repetition rate locking applications. Coupled with the necessary feedback electronics, the repetition rate is synchronized to an external RF source using the two piezo stages installed inside the cavity.

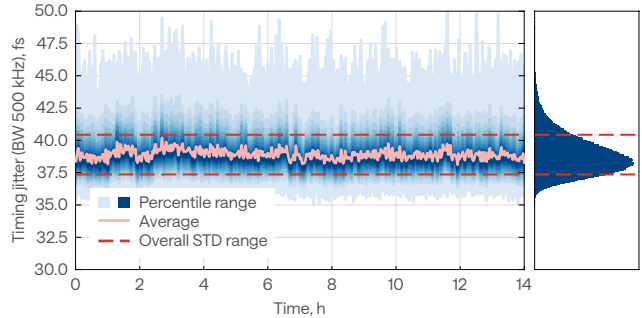
The repetition rate locking system can assure an integrated timing jitter of less than 200 fs for RF reference frequencies larger than 500 MHz. Continuous phase shifting is available on request.

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



Timing jitter stability over 14 h

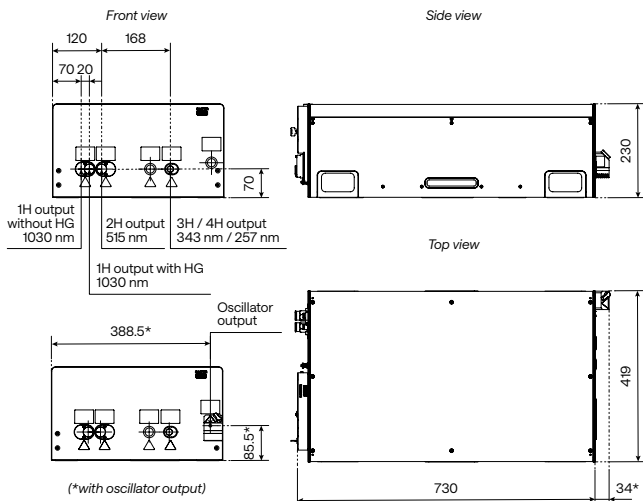
PHAROS oscillator locked to a 2.8 GHz RF source



## Drawings

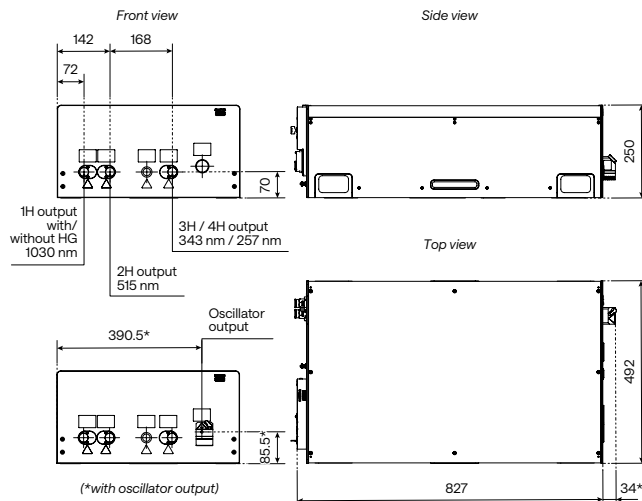
PHAROS-PH2-730 drawing.

PH2 or PH2-SP with FEC, BiBurst, or harmonics



PHAROS-PH2-827 drawing

PH2 with -HE harmonics, PH2-4mJ, or PH2-UP with harmonics



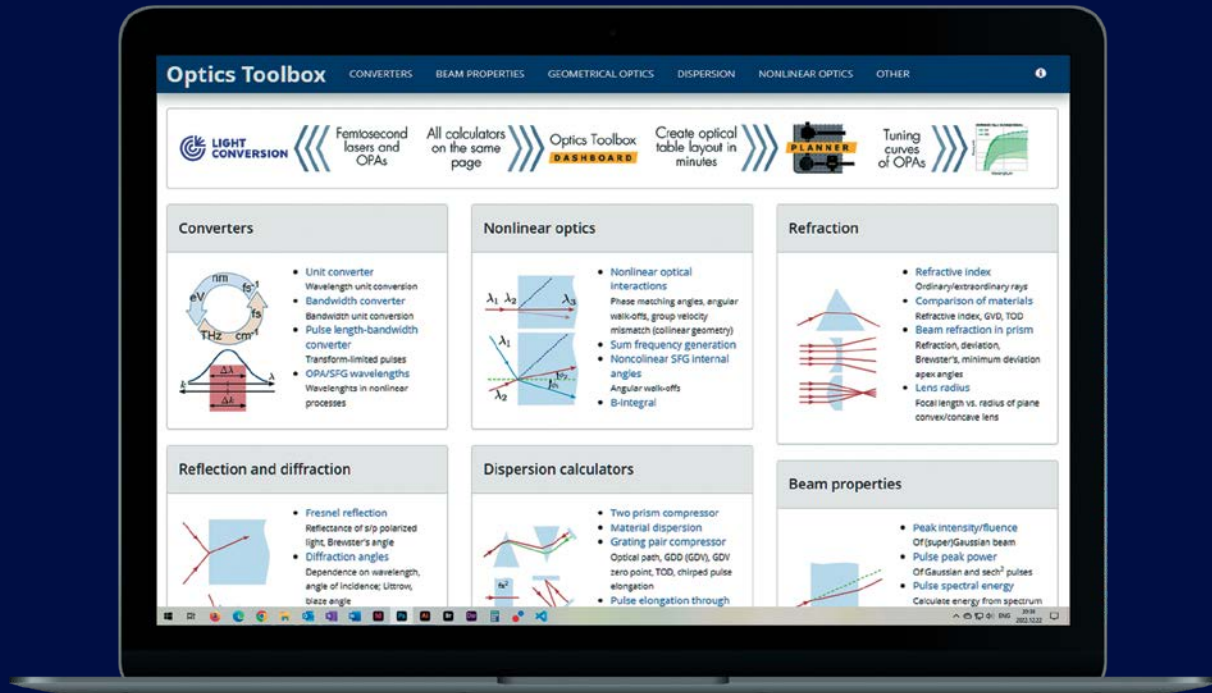
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