

Product Catalog

# Spectroscopy Systems

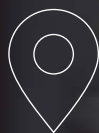
LIGHT CONVERSION is a global leader in ultrafast technology, designing and manufacturing femtosecond lasers, wavelength-tunable sources, optical parametric chirped-pulse amplifiers, spectroscopy systems, and microscopy sources.

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



10 000

Femtosecond laser systems installed worldwide



17 500

Square meters designated for manufacture and R&D



750

Employees, of whom 15% focus on R&D

## About Us

Founded in 1994, LIGHT CONVERSION has evolved into a leading company in ultrafast laser technology with over 10 000 systems installed worldwide and 750 employees, 15% of whom focus on R&D. The company's lasers are used by all of the world's top 50 universities, 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.



AVOID EXPOSURE

DANGER

# Spectroscopy Systems

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HARPIA ultrafast spectroscopy systems perform a variety of sophisticated time-resolved measurements within a compact footprint. With an intuitive user experience and easy day-to-day operation, they meet the demands of modern scientific applications.

Complete single-supplier solutions for sophisticated measurements

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Compact and robust systems, powered by industrial-grade lasers

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High-level automation and software control

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## **HARPIA** | TA

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The system, built around the transient absorption spectrometer, can be expanded with additional modules, including time-correlated single-photon counting, Kerr gate and fluorescence upconversion, and third beam delivery.

## **HARPIA** | LIGHT

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NEW

The transient absorption spectroscopy system, classified as a Class 1 laser product, combines accessibility, versatility, and unparalleled performance in a compact, single-box design.

## Ultrafast Spectroscopy System

Excellent performance at high repetition rates

Measurement range from UV to MIR

Market-leading sensitivity

Modules for time-resolved fluorescence, and multi-pulse experiments

High-level automation in a compact footprint



Layout example

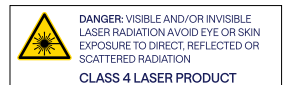
### Specifications

Configuration	UV-VIS	UV-VIS-NIR	MIR
Probe spectral range	350 – 1100 nm <sup>1)</sup>	350 – 1600 nm <sup>1)</sup>	2000 – 13 000 nm <sup>2)</sup>
Pump range	240 – 2200 nm <sup>2)</sup>		450 – 2200 nm <sup>3)</sup>
Delay range (resolution)	8 ns (8.3 fs)		4 ns (4.2 fs)
Temporal resolution	≤ laser pulse duration		
Laser repetition rate	1 – 100 kHz		
Maximum data acquisition rate	3850 Hz		100 kHz
Modes	Reflection and transmission		

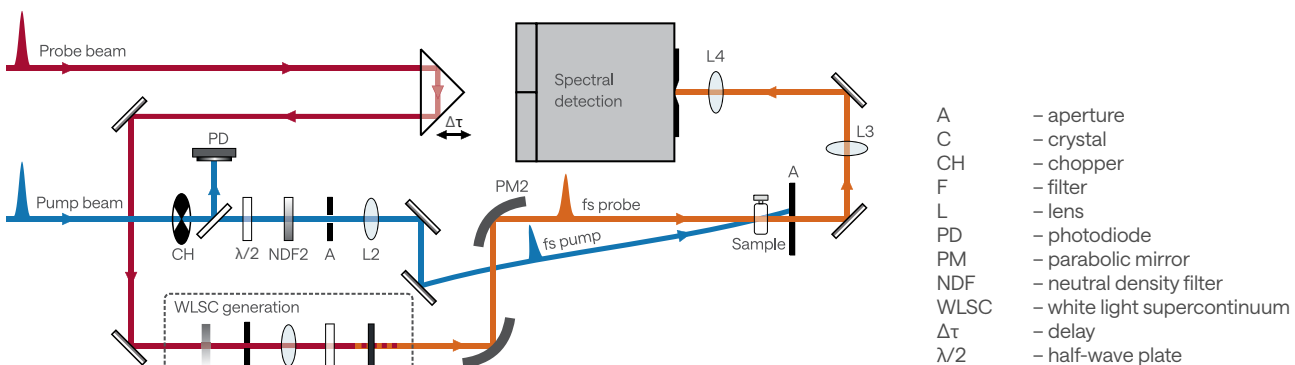
<sup>1)</sup> Pump-probe measurements using Yb-based laser systems may exhibit blind spots at 515 nm and 1030 nm, corresponding to the second harmonic and fundamental wavelength of the laser, where strong pump scattering can interfere with accurate detection.

<sup>2)</sup> The range is determined by the OPA's output spectrum.

<sup>3)</sup> The wavelength range is configurable to 240 – 700 nm. Contact sales@lightcon.com for more details.



### HARPIA-TA optical layout for pump-probe experiments



# HARPIA | TF Time-Resolved Fluorescence Module

## Kerr gate

Ideal for femtosecond fluorescence measurements. Simpler alignment and maintenance. The entire spectrum is measured at once.

## Fluorescence upconversion (FU)

Better temporal resolution for measuring fast fluorescence events.

## Time-correlated single-photon counting (TCSPC)

Fluorescence lifetime measurements are extendible to measure phosphorescence signals.

Time-resolved fluorescence spectroscopy provides valuable insights into molecular processes occurring in the excited states. The HARPIA-TF module combines different measurement modes, enabling the observation of fluorescence dynamics across different time scales. By employing high-repetition-rate CARBIDE or PHAROS lasers, fluorescence dynamics can be measured while exciting the samples with pulse energies as low as several nanojoules.

## Specifications

Module	HARPIA-TF		
	Kerr gate	Fluorescence upconversion	TCSPC
Measurement technique			
Spectral range	380 – 1000 nm	330 – 820 nm <sup>1) 2)</sup>	220 – 820 nm <sup>3)</sup>
Pump range	240 – 2200 nm <sup>4)</sup>		
Temporal resolution	≤ 1 ps	≤ 1.4 x laser pulse duration	< 180 ps or < 50 ps
Delay range (resolution)	8 ns (8.3 fs)		5 μs <sup>5)</sup>
Compatible with	TCSPC		Kerr gate or fluorescence upconversion
Detector	CCD	PMT	
Modes	Transmission		Reflection and transmission

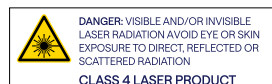
<sup>1)</sup> The fluorescence detection range is extendable up to 1600 nm. Contact sales@lightcon.com for more details.

<sup>2)</sup> Fluorescence detection may exhibit blind spots at 343 nm, 515 nm, and 1030 nm due to harmonic overlap.

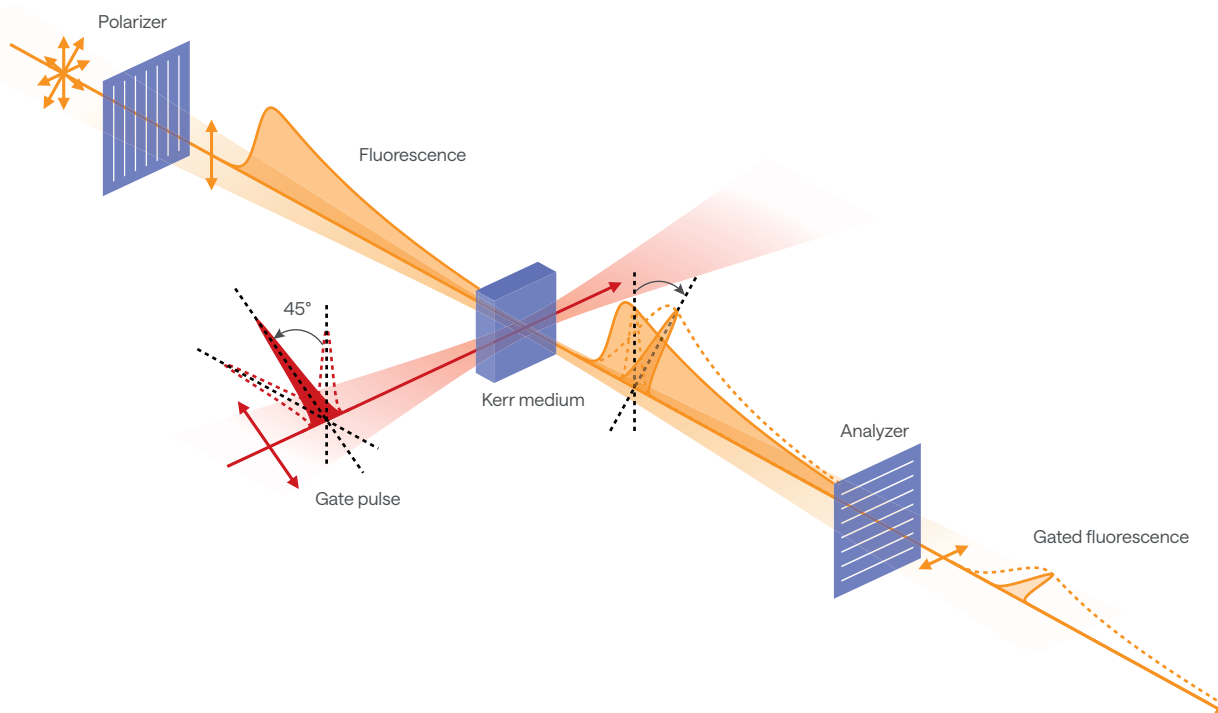
<sup>3)</sup> The spectral range is extendable with an additional NIR detector (measurement range 1000 – 1700 nm). Contact sales@lightcon.com for more details.

<sup>4)</sup> The range is determined by the OPA's output spectrum.

<sup>5)</sup> Using FIFO-based acquisition, the temporal window can be extended up to ~1 s for monitoring longer-timescale processes.



Principle of Kerr gate spectroscopy



# HARPIA | TA-FP Flash Photolysis – Nanosecond TA Module

The flash photolysis experiment is designed to measure the long-lived states of molecular systems. Its principle is analogous to the femtosecond transient absorption (TA) experiment but with a delay in the nanosecond to millisecond range.

In femtosecond transient absorption, the delay between pump and probe pulses is controlled by moving a mechanical delay stage. In contrast, flash photolysis employs a delayed probe pulse generated by an electronically triggered external probe laser – a broadband nanosecond photonic crystal fiber (PCF) laser.

## Specifications

Module	HARPIA-TA-FP		HARPIA-TA-FP-UV	
	UV-VIS	UV-VIS-NIR	UV-VIS	UV-VIS-NIR
HARPIA-TA configuration				
Probe spectral range <sup>1)</sup>	450 – 1100 nm	450 – 1600 nm	350 – 1100 nm	350 – 1600 nm
Pump range	240 – 2200 nm <sup>2)</sup>			
Delay range	up to 485 μs			
Temporal resolution	2 ns		1 ns	
Probe laser repetition rate	1850 Hz			
Maximum data acquisition rate	3850 Hz			
Modes	Reflection and transmission			

<sup>1)</sup> Pump-probe measurements using nanosecond laser systems may exhibit blind spots at 1064 nm, corresponding to the fundamental wavelength of the laser.

<sup>2)</sup> The range is determined by the OPA's output spectrum.

# HARPIA | TB Third Beam Delivery Module

When standard spectroscopy tools are not enough to unravel the intricate ultrafast dynamics of photoactive systems, multi-pulse time-resolved spectroscopic techniques can be utilized to yield additional insight.

The HARPIA-TB module includes a Berek compensator for polarization control, a continuously variable neutral density filter for automated intensity control, and a delay line with a range of up to 4 ns.

## Femtosecond stimulated Raman scattering (FSRS)

Delivering frequency-narrowed picosecond pulses enables FSRS measurements, a relatively recent yet increasingly adopted time-resolved spectroscopy technique for observing changes in the vibrational structure of optically excited molecular systems.

## Multi-pulse time-resolved transient absorption

Enables control over photochemical reactions and access to higher excited states. Precisely timed pulse sequences can initiate a photoreaction and perturb it at defined moments during its evolution. In some cases, an additional pump pulse can re-excite molecules, with the delay between several pump pulses influencing the reaction's outcome.

## Specifications

Module	HARPIA-TB	
	FSRS <sup>1)</sup>	Pump for multi-pulse experiments
Measurement technique		
Probe spectral range	350 – 1100 nm <sup>2)</sup>	Depends on the HARPIA-TA configuration
Raman spectral range	700 - 2000 cm <sup>-1</sup>	n/a
Acceptable wavelength range	450 – 2200 nm <sup>3)</sup>	
Delay range (resolution)	4 ns (4.2 fs)	
Modes	Transmission	

<sup>1)</sup> The results were obtained using a specific system configuration: a PHAROS femtosecond laser, an ORPHEUS-HE OPA, and an SHBC combined with an ORPHEUS-PS OPA. Measurements were performed at a 10 kHz repetition rate with a 540 nm actinic pump and a 450 nm Raman pump. β-carotene was used as the sample. Contact sales@lightcon.com for more details.

<sup>2)</sup> The system may exhibit blind spots at 515 nm and 1030 nm, corresponding to the second harmonic and fundamental wavelength of the laser, where strong pump scattering can interfere with accurate detection.

<sup>3)</sup> The wavelength range is configurable to 240 – 700 nm. Contact sales@lightcon.com for more details.

## Options



### Cryostat Mounting

HARPIA-TA supports cryostats that can be mounted externally or internally.



### Sample Stirrer

Liquid samples are mixed to avoid overexposure and ensure fresh samples.



### Motorized Pump Mirror

Used to automatically optimize pump and probe overlap.



### External Beam Steering

To lock the optical beam paths for OPA wavelengths (350 – 1100 nm).



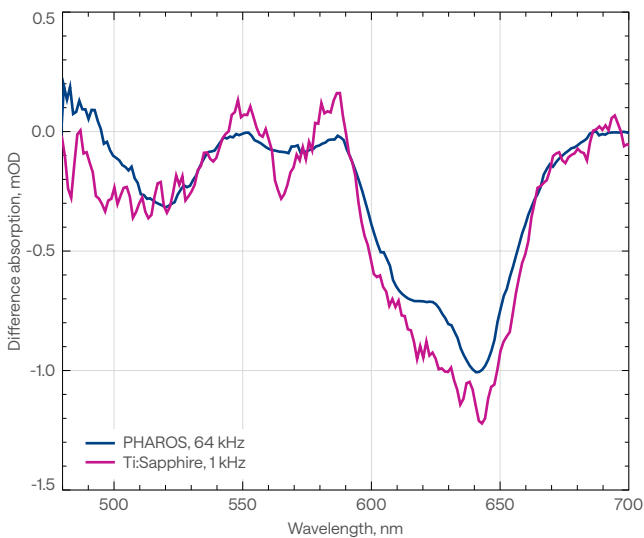
### Beam Profiler

For checking beam shape/size at any position before/after measurement inside HARPIA.

## Performance at high repetition rates

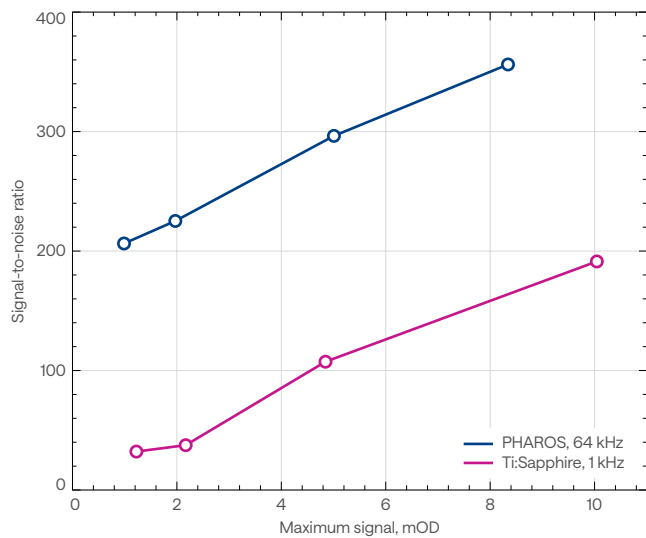
The HARPIA spectroscopy system achieves an excellent signal-to-noise ratio at high repetition rates and low energy excitation conditions. The graphs below compare the

Measured difference absorption spectra of CdSe/ZnS quantum dots using low- and high-repetition rate lasers with 5 s acquisition time



signal-to-noise ratio (SNR) of difference absorption spectra obtained with a Ti:Sapphire laser operating at 1 kHz and a PHAROS laser operating at 64 kHz with the same acquisition time.

Best-effort SNRs, achieved with HARPIA-TA spectrometer driven by a Ti:Sapphire laser at 1 kHz (magenta) and a PHAROS laser at 64 kHz (blue)



## Software

# HARPIA Service App

## Control and data acquisition software

A single software solution for all measurement modes, featuring:

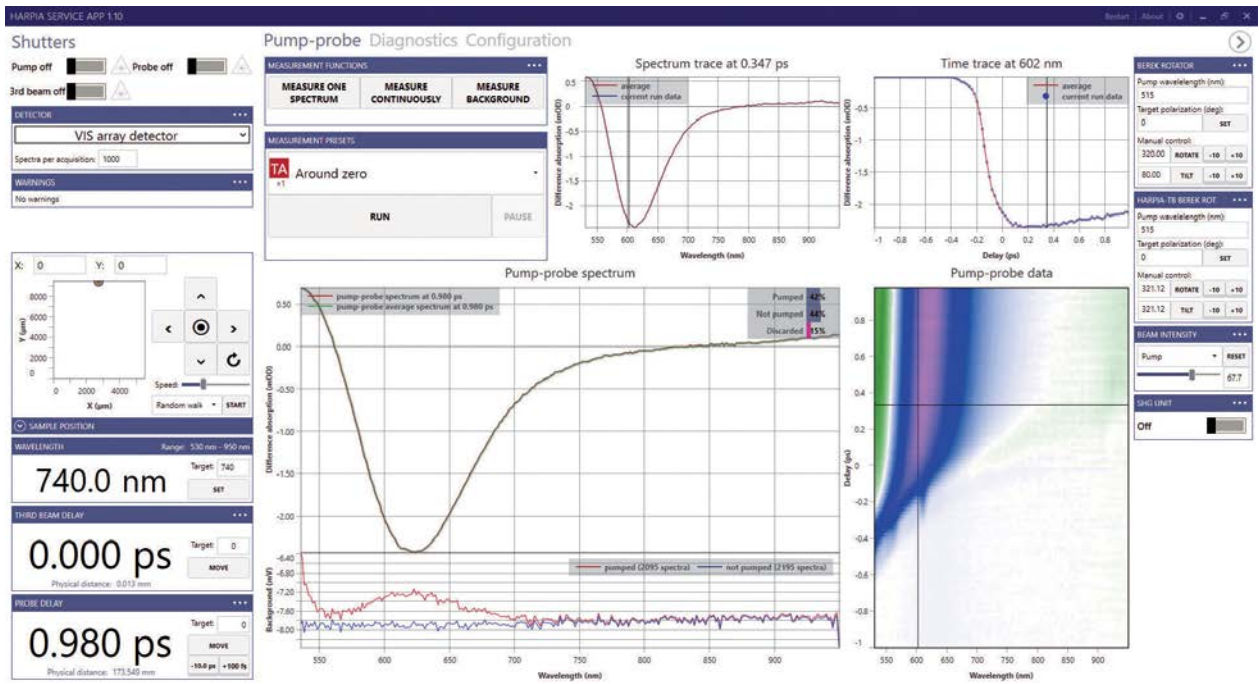
- A user-friendly interface
- Measurement presets
- Measurement noise suppression
- Diagnostics and data export
- Continuous support and updates
- An API for remote experiment control using third-party software (LabVIEW, Python, MATLAB)

## Data analysis software

An ultrafast spectroscopy data analysis software, featuring:

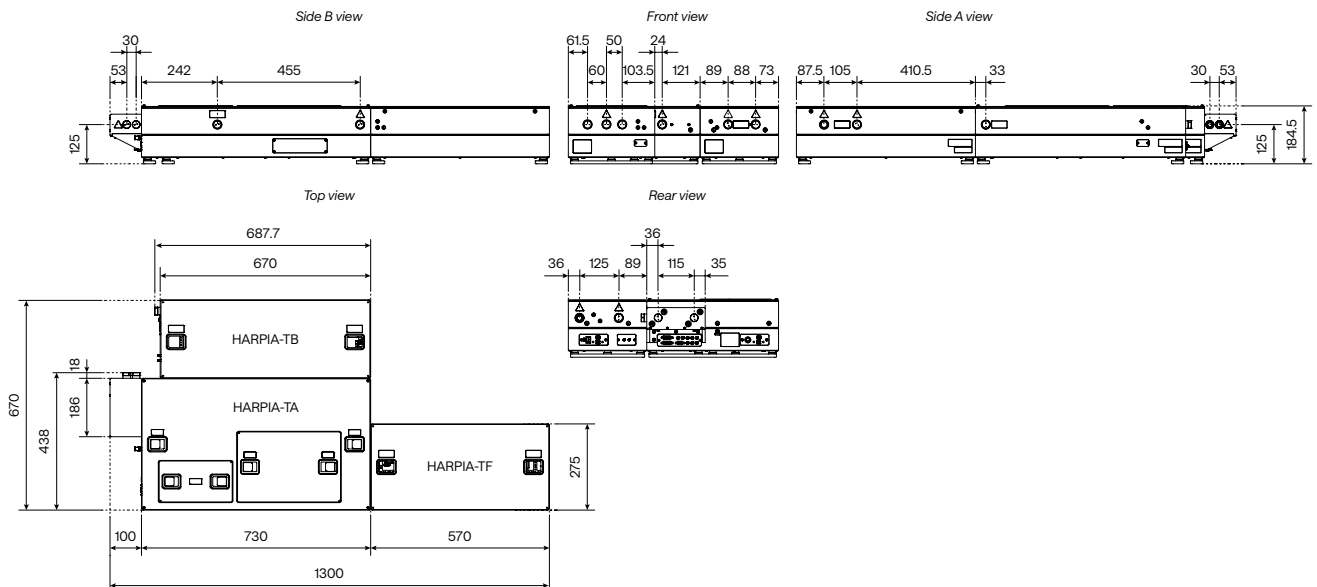
- Advanced data wrangling: slicing, merging, cropping, smoothing, fitting, etc.
- Advanced global and target analysis
- Probe spectral chirp correction, calibration and deconvolution
- Support for 3D data sets (2D electronic spectroscopy, fluorescence lifetime imaging)
- Publication-ready figure preparation and data export

HARPIA Service App main window



## Drawings

HARPIA system with HARPIA-TB and HARPIA-TF modules



## Tabletop Transient Absorption Spectroscopy System

Class 1 laser product

Maintenance-free single-box solution

Plug-and-play installation

Intuitive measurement and data analysis

Femto-to-nanosecond temporal resolution



### Specifications

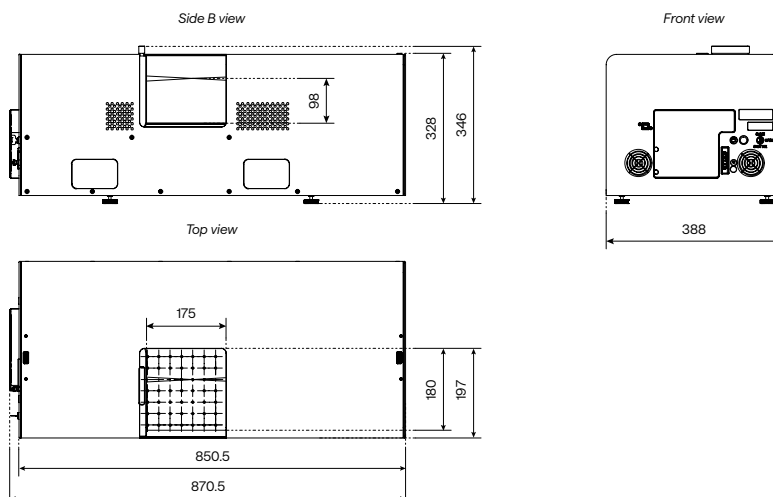
Modes	Transmission and reflection
Probe spectral range	435 – 935 nm
Probe polarization control	Linear (0 – 180°)
Pump wavelengths	515 nm, 343 nm
Delay range (resolution)	7.5 ns (10 fs)
Temporal resolution	≤ 290 fs
Laser repetition rate	60 kHz <sup>1)</sup>

<sup>1)</sup> Pulse selection can be set to any integer division of the 60 kHz fundamental repetition rate.

**CLASS 1  
LASER PRODUCT**

### Drawings

HARPIA-LIGHT





# Femtosecond Lasers

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

High average power and pulse energy at high repetition rates

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Market-proven industrial-grade stability and reliability

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Automated harmonics and wavelength-tunable extensions

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## **CARBIDE**

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

## **PHAROS**

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Scientific flexibility with process-tailored output parameters, offering up to 1 mJ pulse energy at < 100 fs or up to 5 mJ at < 250 fs.

## Industrial Femtosecond Lasers

Maximum output of 120 W (IR)  
or 50 W (UV)

NEW

Single-shot – 10 MHz repetition rate

Pulse-on-demand and  
BiBurst for pulse control

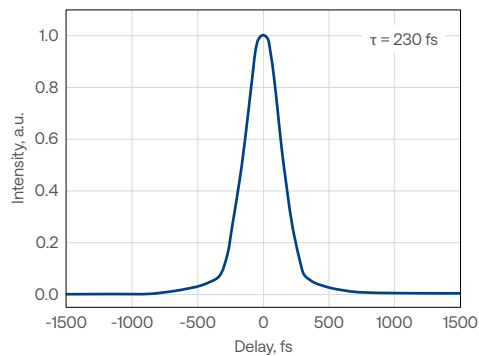
Automated harmonics up to the 5<sup>th</sup>  
and wavelength-tunable extensions

Air-cooled or water-cooled models

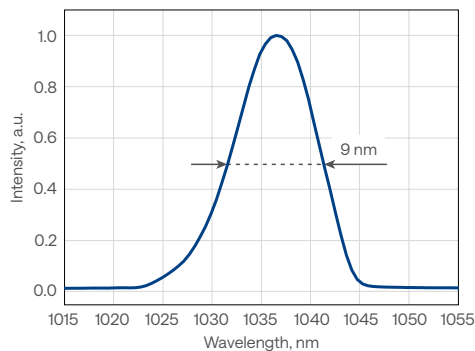


CARBIDE-CB3

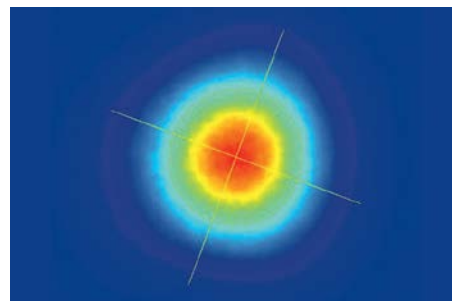
CARBIDE-CB3  
Typical pulse duration



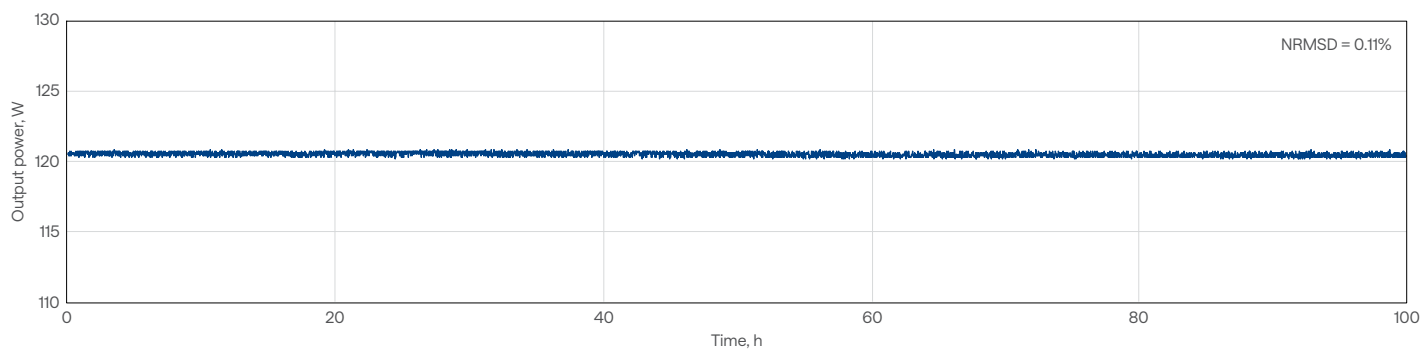
CARBIDE-CB3  
Typical spectrum



CARBIDE-CB3  
Typical beam profile



CARBIDE-CB3-120W  
Long-term power stability





Model	CB3-20W	CB3-40W	CB3-40W-10MHz	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, 12 h <sup>6)</sup>	< 0.5%				
Long-term power stability, 100 h <sup>6)</sup>	< 0.5%				

**MAIN OPTIONS**

Oscillator output <sup>7)</sup>	< 0.5 W, 120 – 250 fs, 1030 ± 10 nm, ≈ 65 MHz				
Harmonic generator <sup>8)</sup>	515 nm, 343 nm, 257 nm, or 206 nm; refer to CARBIDE HG				
Optical parametric amplifier <sup>9)</sup>	UV – MIR; refer to I-OPA or ORPHEUS				
BiBurst option	Tunable GHz and MHz burst with burst-in-burst capability; refer to BiBurst				

**PHYSICAL DIMENSIONS**

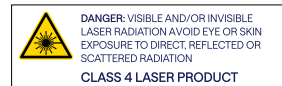
Laser head (L × W × H)	633 × 350 × 174 mm				
Chiller (L × W × H)	585 × 484 × 221 mm		680 × 484 × 307 mm		
24 V DC power supply (L × W × H)	352 × 195 × 75 mm				376 × 449 × 88 mm

**ENVIRONMENTAL & 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	200 – 230 V AC; 50 – 60 Hz		
Rated power	Laser	1000 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 a Gaussian pulse shape.  
<sup>2)</sup> Pulse duration can be reduced to < 250 fs if a 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. An optional integrated waveplate-based variable optical attenuator is available.  
<sup>5)</sup> Waveplate-based variable optical attenuator (VOA); an external analog control input is available. FEC is available for repetition rates up to 2 MHz.

<sup>6)</sup> Under stable environmental conditions. Expressed as normalized root mean squared deviation (NRMSD).  
<sup>7)</sup> Available simultaneously, requires a scientific interface. Contact sales@lightcon.com for more details or customized solutions.  
<sup>8)</sup> Integrated. For an external harmonic generator, refer to HIRO.  
<sup>9)</sup> Integrated. For more details and stand-alone OPAs, refer to wavelength-tunable sources.



## CARBIDE-CB5 specifications

## Air-cooled IR lasers

Model	CB5-6W	CB5-5W	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, 12 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; refer to CARBIDE HG		
Optical parametric amplifier <sup>8)</sup>	UV – MIR; refer to I-OPA or ORPHEUS		
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 &amp; 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	280 W		
Power consumption	250 W		

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

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

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

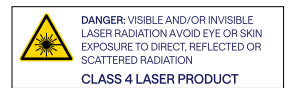
<sup>4)</sup> Waveplate-based variable optical attenuator (VOA); an external analog control input is available.

<sup>5)</sup> Enhanced contrast AOM. Provides fast, full-scale individual pulse energy control; an external analog control input is available.

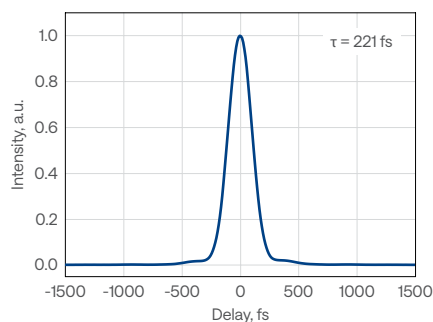
<sup>6)</sup> Under stable environmental conditions. Expressed as normalized root mean squared deviation (NRMSD).

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

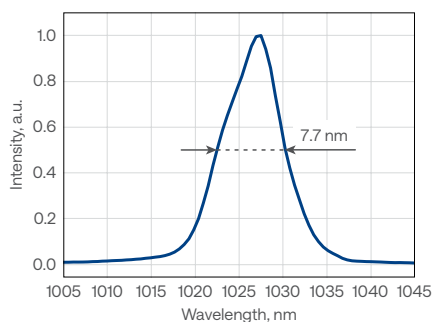
<sup>8)</sup> Integrated. For more details and stand-alone OPAs, refer to wavelength-tunable sources.



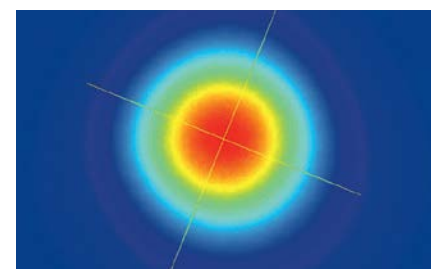
**CARBIDE-CB5**  
Typical pulse duration



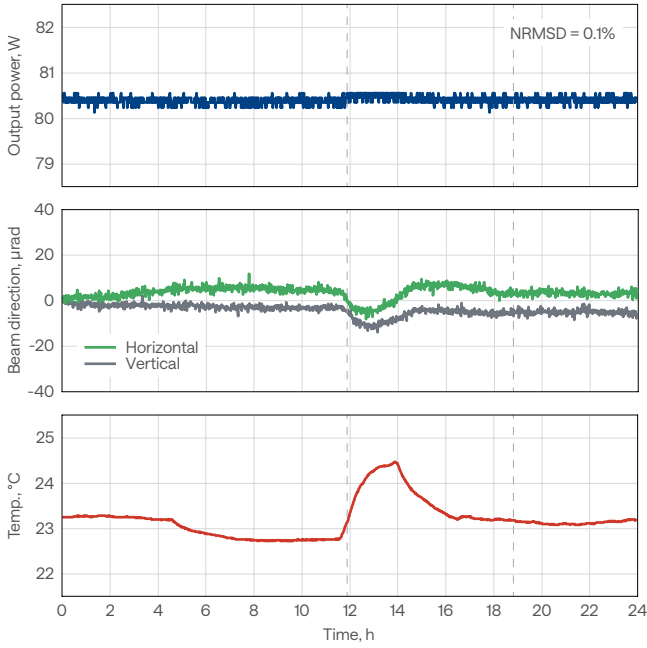
**CARBIDE-CB5**  
Typical spectrum



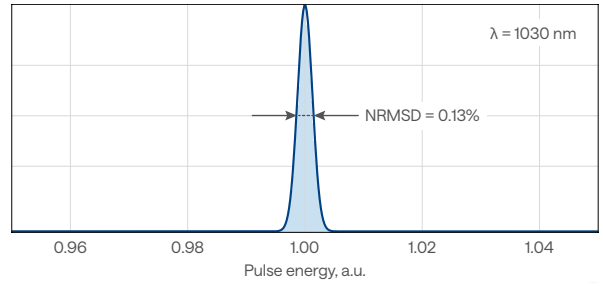
**CARBIDE-CB5**  
Typical beam profile



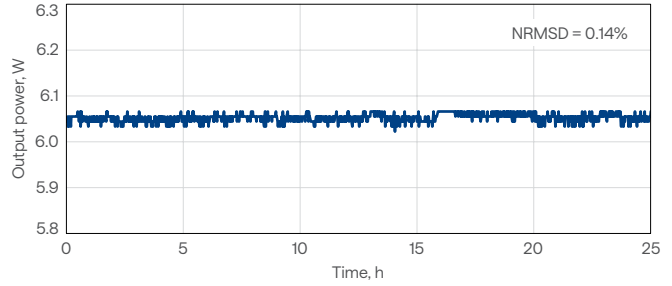
**CARBIDE-CB3** output power and beam direction stability with power lock enabled, across varying environmental conditions



**CARBIDE-CB3** Typical pulse-to-pulse energy stability

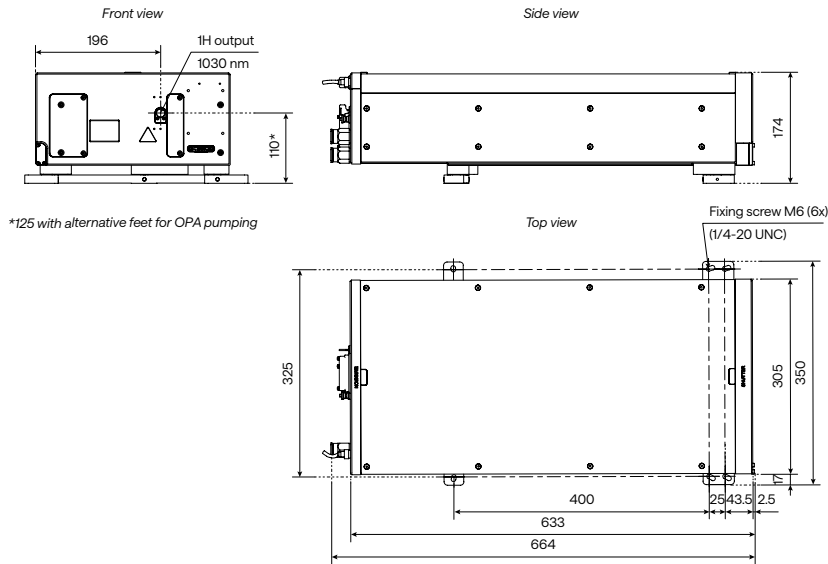


**CARBIDE-CB5-6W** Long-term power stability

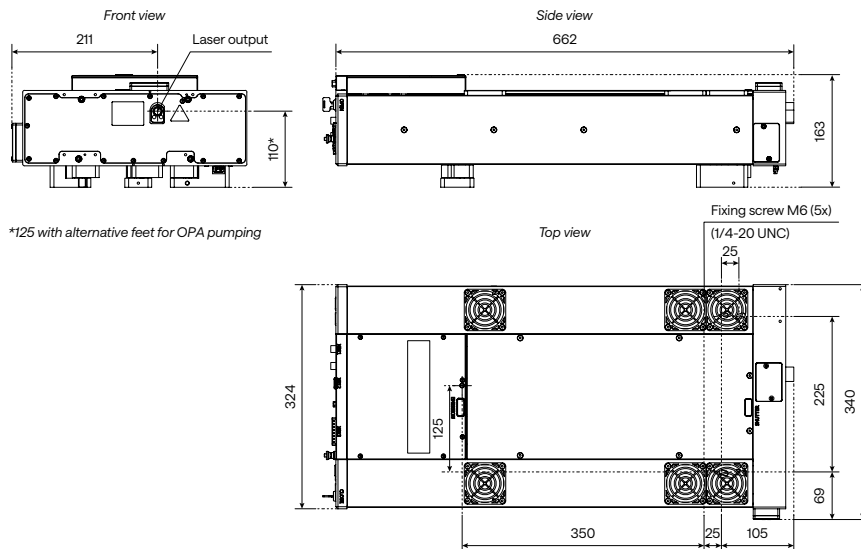


## Drawings

**CARBIDE-CB3**



Air-cooled **CARBIDE-CB5** with an attenuator



The drawings depend on the exact configuration. If crucial for integration, please contact [sales@lightcon.com](mailto:sales@lightcon.com).



## 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

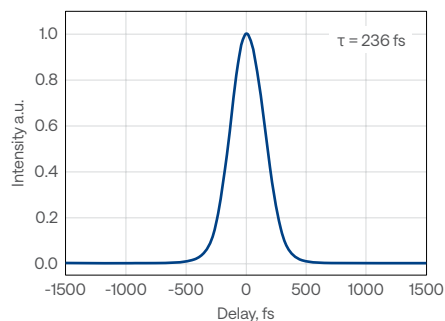
Pulse-on-demand and BiBurst for pulse control

Automated harmonics up to the 5<sup>th</sup> and wavelength-tunable extensions



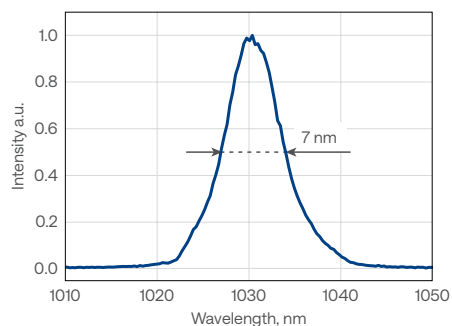
### PHAROS-PH2-5mJ

Typical pulse duration



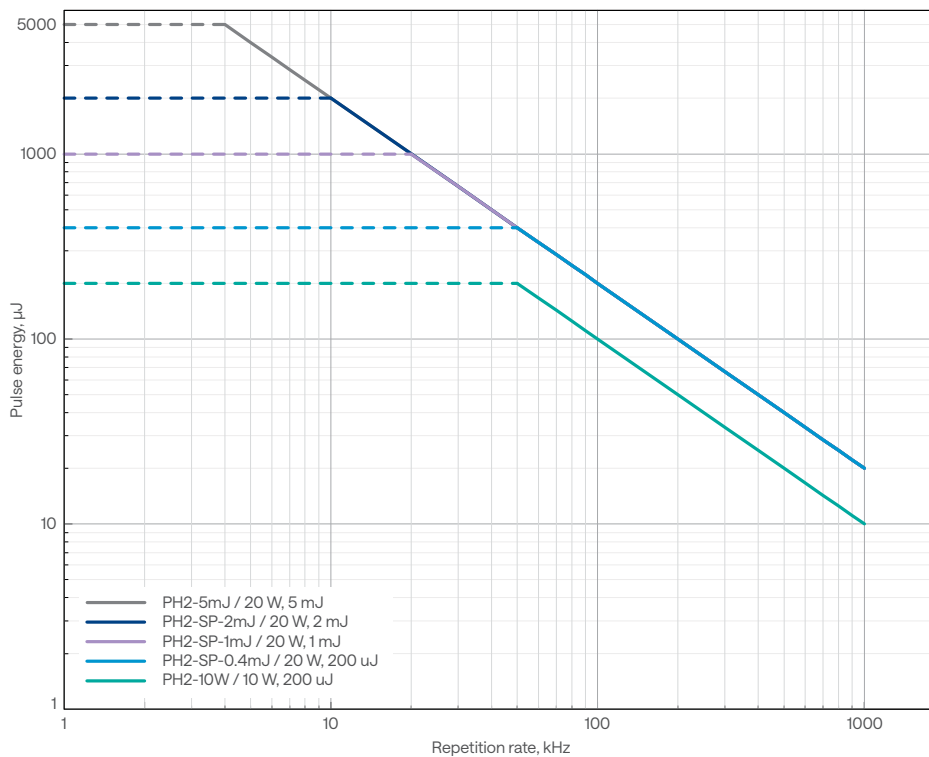
### PHAROS-PH2-5mJ

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 <sup>1)</sup>	1030 ± 10 nm						
Maximum output power	10 W		20 W				
Pulse duration <sup>2)</sup>	< 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 <sup>2</sup>	< 1.2		< 1.3			< 1.2	
Beam diameter <sup>3)</sup>	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, 12 h <sup>4)</sup>	< 0.5%						
Long-term power stability, 100 h <sup>4)</sup>	< 0.5%						

## MAIN OPTIONS

Oscillator output <sup>5)</sup>	1 – 7 W, 50 – 250 fs, ≈ 1035 nm, ≈ 76 MHz						
Harmonic generator <sup>6)</sup>	515 nm, 343 nm, 257 nm, or 206 nm; refer to PHAROS HG or HIRO						
Optical parametric amplifier <sup>7)</sup>	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							

## PHYSICAL DIMENSIONS

Laser head (L × W × H) <sup>8)</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>8)</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 a Gaussian pulse shape.

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

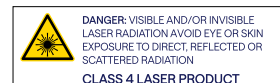
<sup>4)</sup> Under stable environmental conditions. Expressed as normalized root mean squared deviation (NRMSD).

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

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

<sup>7)</sup> Integrated except for PH2-5mJ. For more options and OPAs for -5mJ and -UP models, refer to the ORPHEUS series of OPAs.

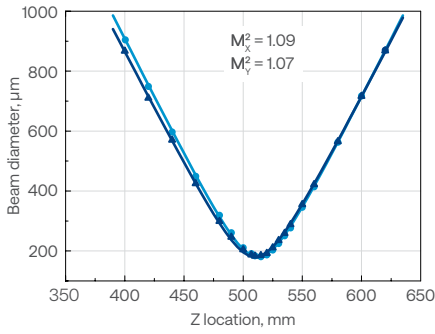
<sup>8)</sup> Dimensions depend on the laser configuration and integrated options.



## Beam properties

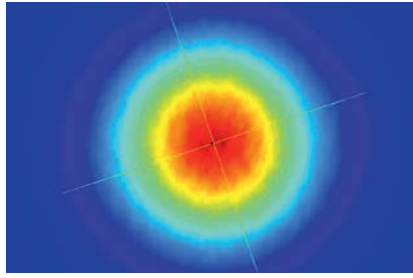
### PHAROS

Typical  $M^2$  measurement data



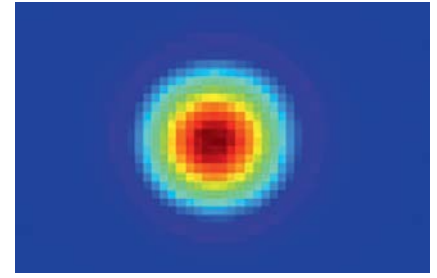
### PHAROS

Typical near-field beam profile



### PHAROS

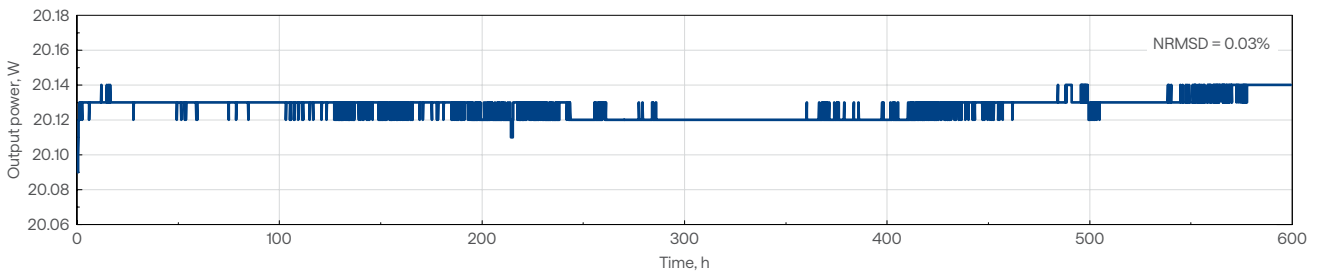
Typical far-field beam profile



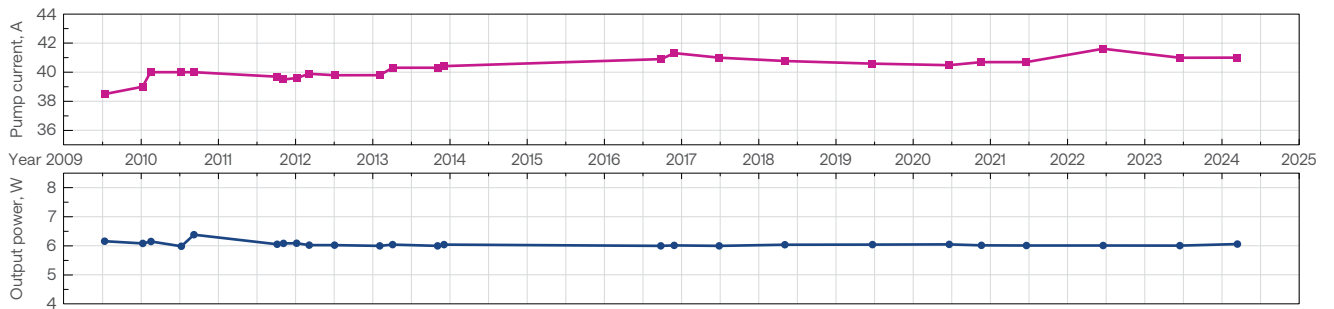
## Stability measurements

### PHAROS

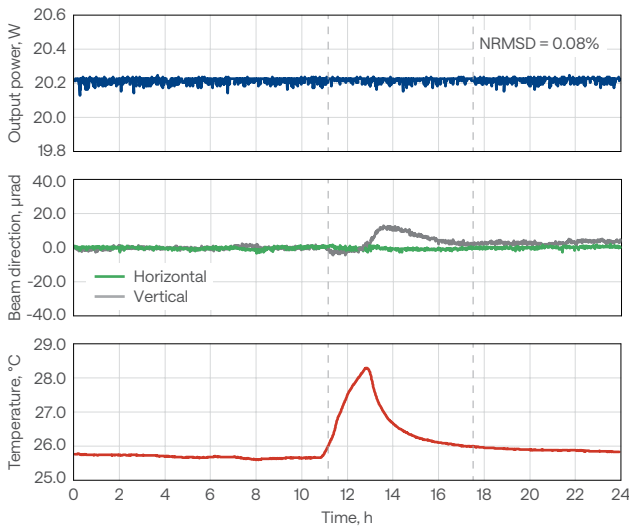
Long-term power stability



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

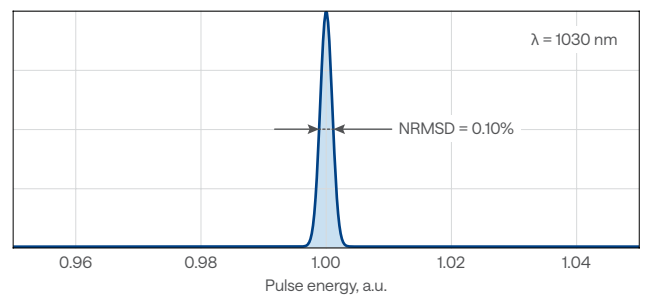


PHAROS output power and beam pointing stability with power lock enabled, across varying environmental conditions



### PHAROS

Typical pulse-to-pulse energy stability



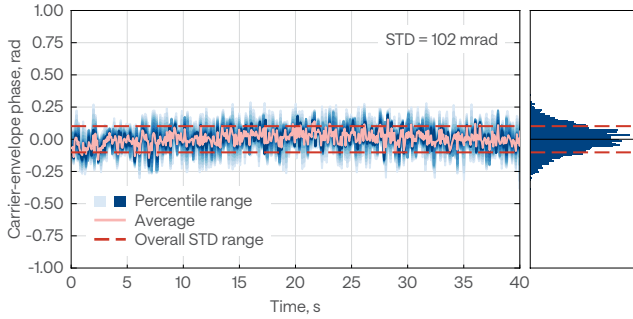
## CEP stabilization

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 1/4<sup>th</sup> 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.

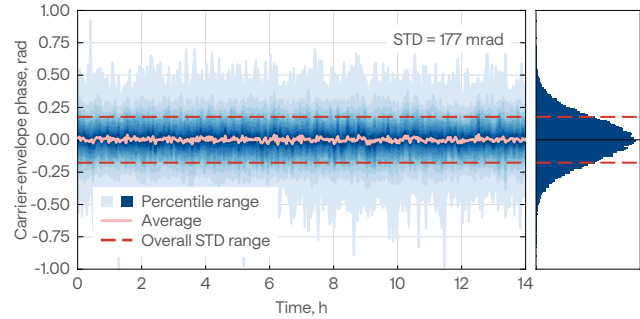
### PHAROS

Short-term CEP stability operating at 200 kHz repetition rate



### PHAROS

Long-term CEP stability operating at 200 kHz repetition rate

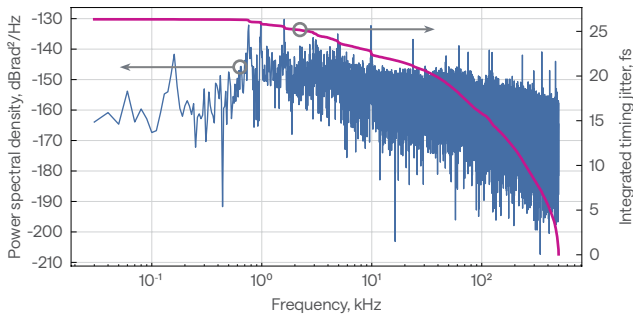


## Repetition rate locking

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.

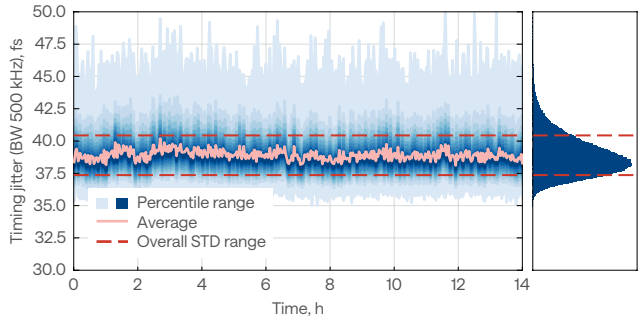
The repetition rate locking system ensures an integrated timing jitter of less than 200 fs for RF reference frequencies above 500 MHz. Additionally, continuous phase shifting is available upon request.

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



Timing jitter stability over 14 h

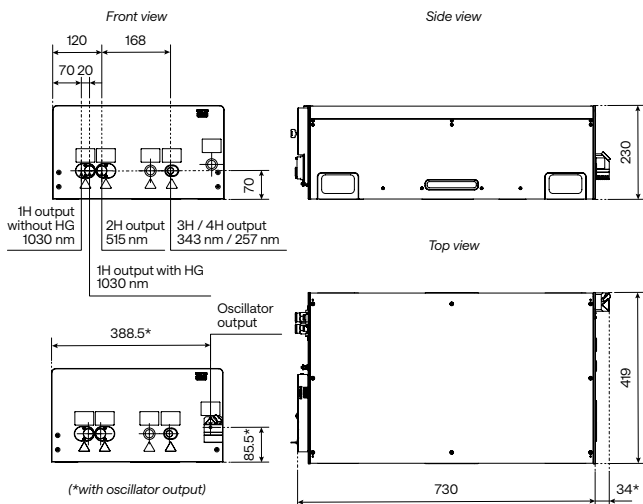
PHAROS oscillator locked to a 2.8 GHz RF source



## Drawings

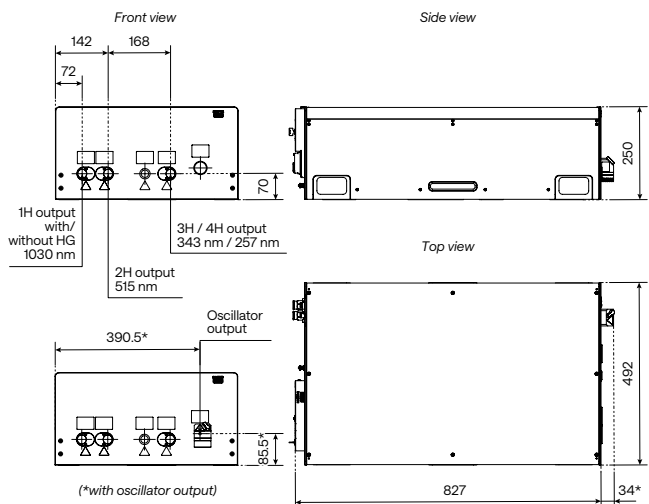
### PHAROS-PH2-730

-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.



## External Harmonic Generator

515 nm, 343 nm, 257 nm,  
and 206 nm outputs

Simple selection of the active harmonic

Simultaneous or switchable outputs

Standalone harmonics module  
for CARBIDE, PHAROS



### HIRO for CARBIDE or PHAROS

Model	HIRO	HIRO-HP	HIRO-HE
Maximum pump power	20 W	80 W	
Pump pulse energy	8 – 400 $\mu$ J	200 – 1000 $\mu$ J	1000 – 4000 $\mu$ J
Available outputs <sup>1) 2)</sup>	Up to 4H <sup>3)</sup>	Up to 5H	
Conversion efficiency <sup>1) 4)</sup>		> 50% (2H) > 25% (3H) > 10% (4H) <sup>5)</sup> > 5% (5H) <sup>6) 7)</sup>	
Polarization <sup>8)</sup>		Linear, horizontal (2H, 5H) Linear, vertical (3H, 4H)	

### PHYSICAL DIMENSIONS

Dimensions (L × W × H)	487 × 176 × 180 mm	552 × 320 × 170 mm
------------------------	--------------------	--------------------

<sup>1)</sup> For harmonic combinations and simultaneous outputs, contact sales@lightcon.com.

<sup>2)</sup> Residual fundamental output available upon request.

<sup>3)</sup> White light continuum output available upon request.

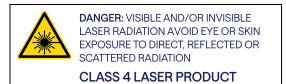
<sup>4)</sup> Percentage of pump power, for repetition rate of up to 1 MHz.

<sup>5)</sup> Maximum output power of 1W.

<sup>6)</sup> Maximum output power of 150 mW. Only for HIRO-HP/HE.

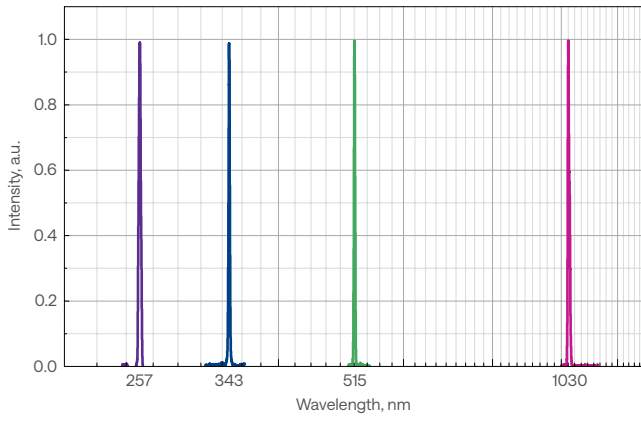
<sup>7)</sup> > 1% when pumped with PHAROS-UP.

<sup>8)</sup> Different polarization is available upon request.

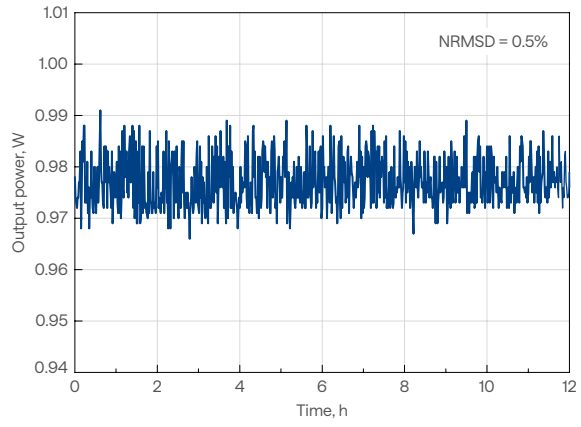


# Performance

HIRO outputs

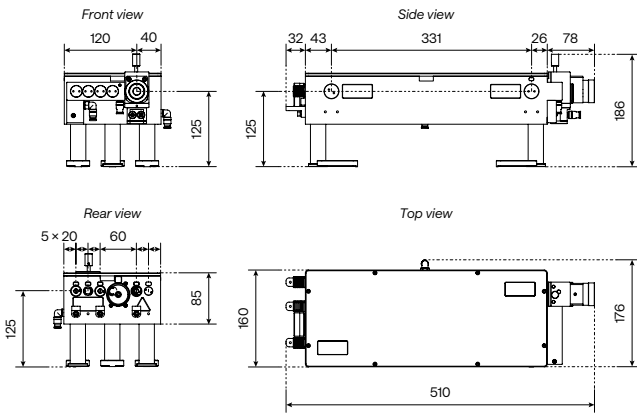


4H output power stability

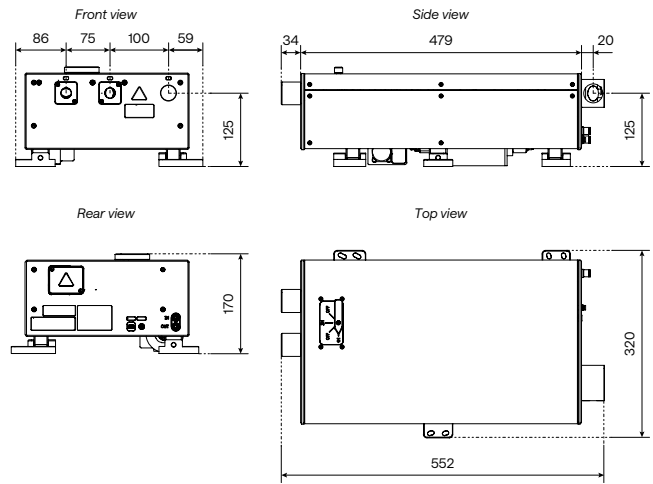


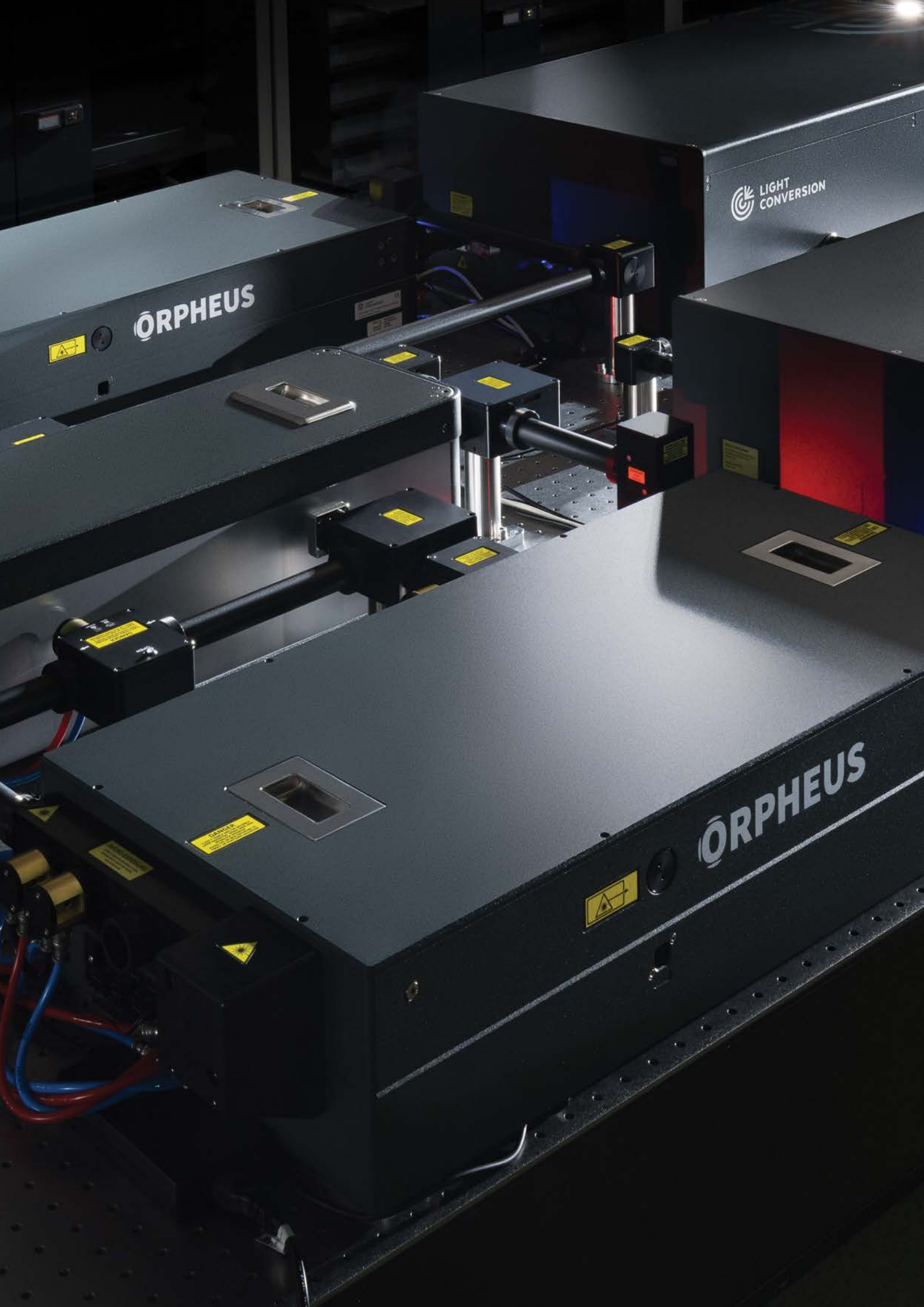
# Drawings

HIRO



HIRO-HP/HE





ORPHEUS

LIGHT  
CONVERSION

ORPHEUS

WARNING  
LASER RADIATION  
CLASS 2  
DO NOT STARE INTO THE BEAM  
DO NOT POINT AT OTHER PEOPLE



# Wavelength-Tunable Sources

---

Coupled with femtosecond lasers, these OPAs provide an invaluable source for ultrafast spectroscopy, nonlinear microscopy, and a variety of other scientific applications.

Continuous wavelength tunability from UV to MIR

---

Pulse durations from tens of femtoseconds to a few picoseconds

---

Leading OPA manufacturer for more than 30 years

---

## I-OPA

---

The only industrial-grade commercial OPA, combining wavelength tunability with compact and robust design.

## ORPHEUS

---

A classic OPA platform that many are familiar with – simple to use yet offers an extensive range of parameters.

## ORPHEUS | NEO

---

Next-generation OPA featuring exceptional stability and multiple detectors for continuous power monitoring and diagnostics.

# I-OPA

## Industrial-Grade Optical Parametric Amplifier

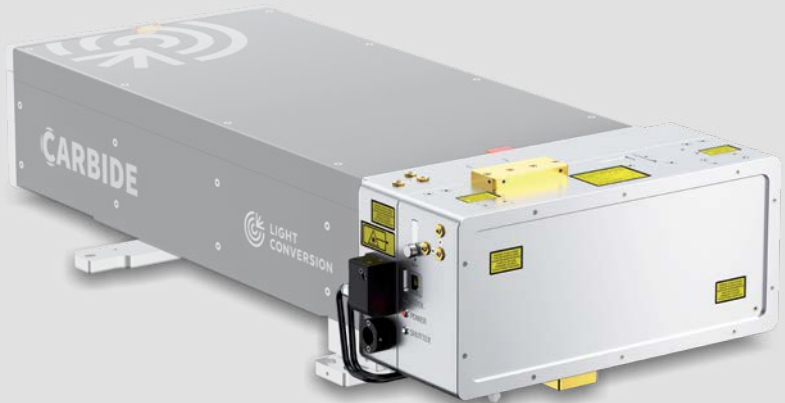
Wavelength tunability in an industrial design

Single-box solution

Tunable or fixed-wavelength models

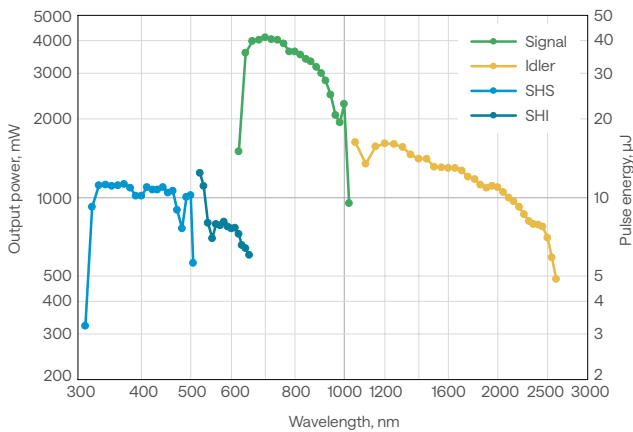
Plug-and-play installation and robust performance

The most compact OPA in the market

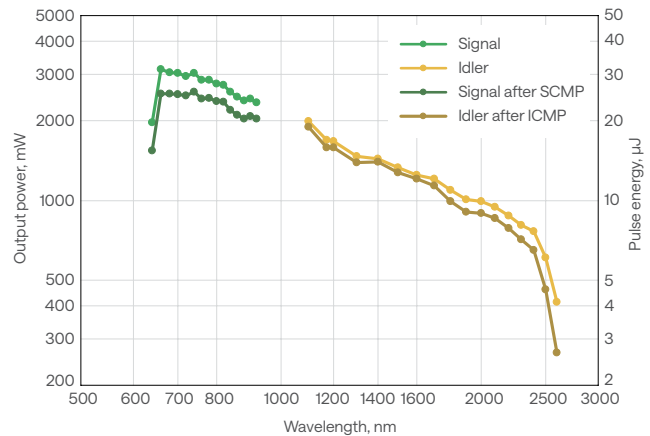


CARBIDE-CB3 with I-OPA-HP

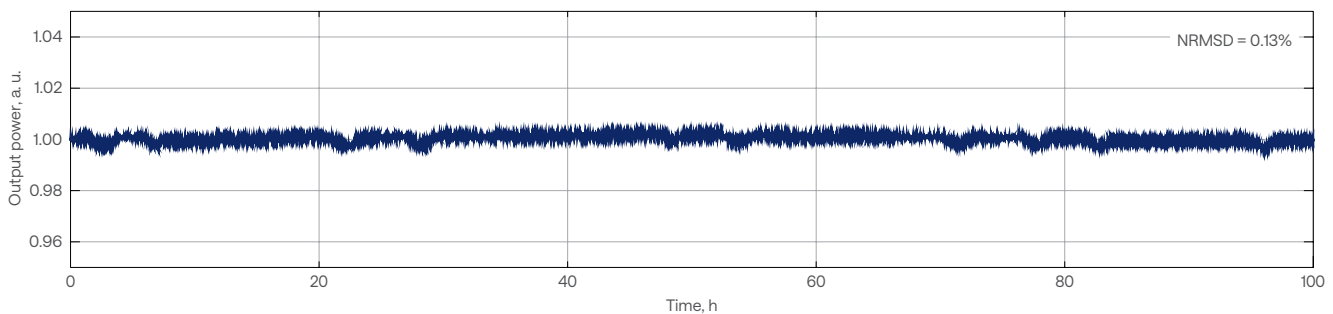
I-OPA-HP typical tuning curves  
Pump: 40 W, 400  $\mu$ J, 100 kHz



I-OPA-F typical tuning curves  
Pump: 40 W, 400  $\mu$ 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 $\mu$ J		
Repetition rate	Up to 2 MHz		
Tuning range <sup>1)</sup>	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 $\mu$ J pump; up to 1 MHz)		> 9% @ 1550 nm (40 – 400 $\mu$ J pump; up to 1 MHz)
	> 3.5% @ 700 nm (20 – 40 $\mu$ J pump; up to 2 MHz)		> 6% @ 1550 nm (20 – 40 $\mu$ J pump; up to 2 MHz)
Spectral bandwidth <sup>2)</sup>	80 – 220 $\text{cm}^{-1}$ @ 700 – 960 nm	200 – 1000 $\text{cm}^{-1}$ @ 650 – 920 nm 150 – 1000 $\text{cm}^{-1}$ @ 1200 – 2000 nm	60 – 150 $\text{cm}^{-1}$ @ 1450 – 2000 nm
Pulse duration <sup>2) 3)</sup>	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 <sup>4)</sup>	< 1% @ 800 nm		< 1% @ 1550 nm
Pulse-to-pulse energy stability, 1 min <sup>4)</sup>	< 1% @ 800 nm		< 1% @ 1550 nm
Wavelength extension options	320 – 505 nm (SHS) <sup>5)</sup> 525 – 640 nm (SHI) <sup>5)</sup>	Contact sales@lightcon.com	4500 – 10 000 nm (DFG)
Pulse compression options <sup>2)</sup>	n/a	SCMP (signal pulse compressor) ICMP (idler pulse compressor)	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 $\mu$ J
Pulse duration	180 – 300 fs

## ENVIRONMENTAL & UTILITY REQUIREMENTS

Refer to lightcon.com

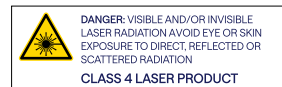
<sup>1)</sup> In the case of a fixed wavelength (FW), a single wavelength can be selected from the signal or idler range. The signal may have an accessible idler pair, and vice versa.

<sup>2)</sup> 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.

<sup>3)</sup> Output pulse duration depends on the selected wavelength and the pump laser pulse duration.

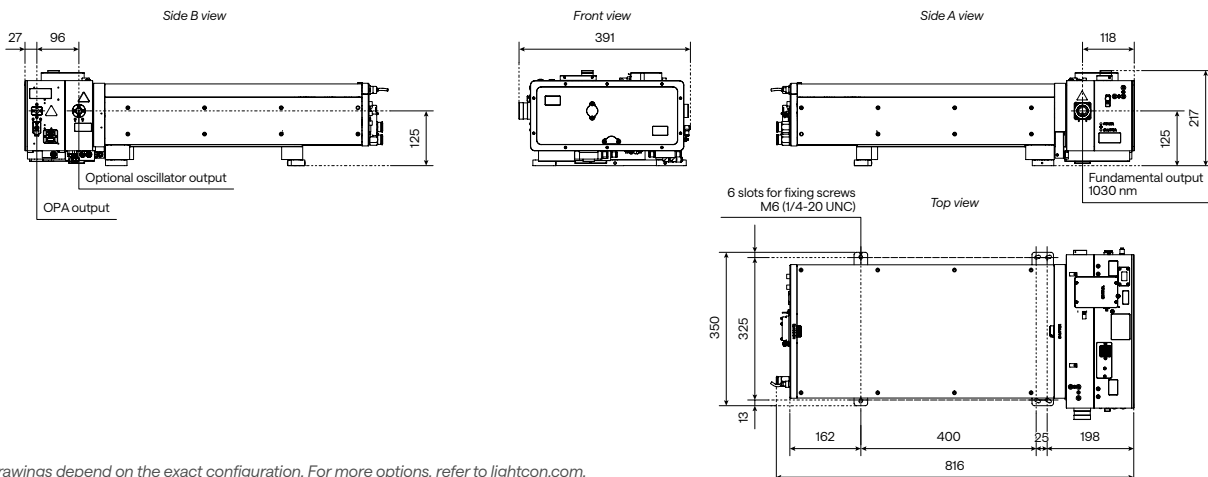
<sup>4)</sup> Expressed as normalized root mean squared deviation (NRMSD).

<sup>5)</sup> 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.



## Optical Parametric Amplifier

Continuous tunability from UV to MIR, 190 – 16 000 nm

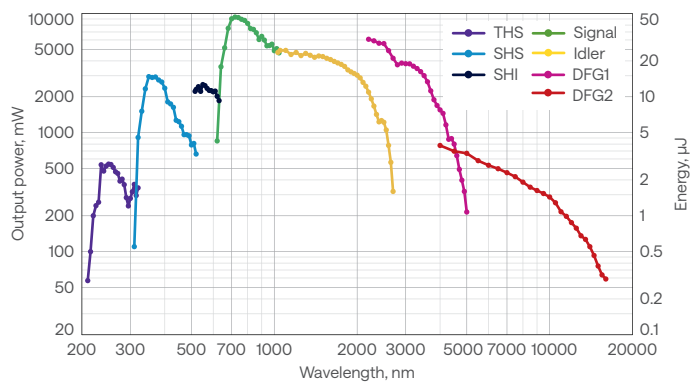
Single-shot – 2 MHz repetition rate

Up to 80 W pump power

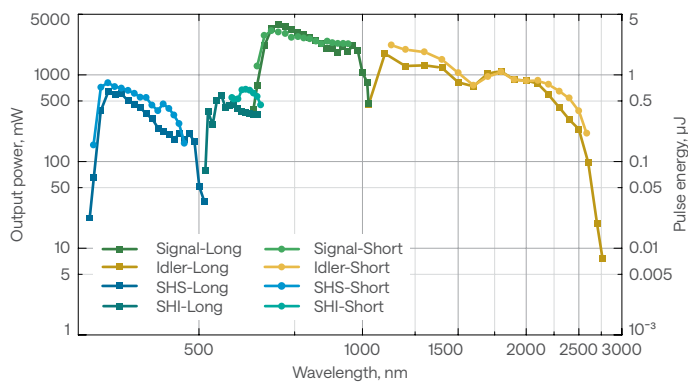
Up to 0.4 mJ pump pulse energy



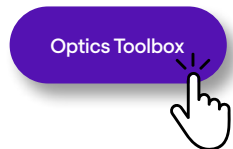
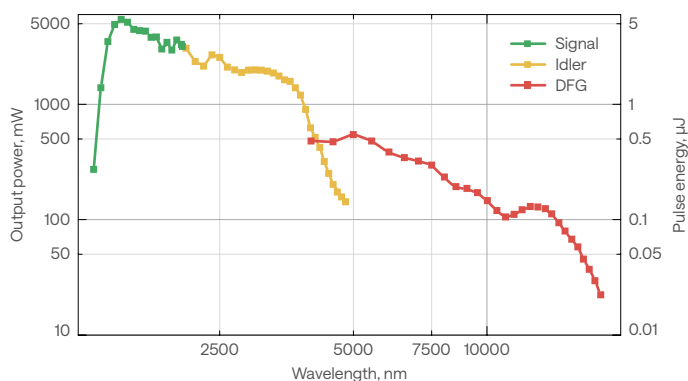
ORPHEUS typical tuning curves  
Pump: 80 W, 400  $\mu$ J, 200 kHz



ORPHEUS-F typical tuning curves  
Pump: 40 W, 40  $\mu$ J, 1000 kHz



ORPHEUS-ONE typical tuning curves  
Pump: 40 W, 40  $\mu$ J, 1000 kHz



# Specifications

Model	ORPHEUS		ORPHEUS-F	ORPHEUS-ONE
Tuning range <sup>1)</sup>	630 – 1030 nm (signal) 1030 – 2600 nm (idler)		650 – 900 nm (signal) 1200 – 2500 nm (idler) <sup>2)</sup>	1400 – 2000 nm (signal) 2100 – 4200 nm (idler)
Pump power	Up to 80 W			
Repetition rate	Up to 2 MHz			
Pump pulse energy <sup>3)</sup>	8 – 20 μJ	20 – 400 μJ	10 – 400 μJ	12 – 400 μJ
Conversion efficiency	> 4.5% @ peak (signal) > 2% @ peak (idler)	> 9% @ peak (signal) > 4% @ peak (idler)	> 7% @ 700 nm <sup>4)</sup>	> 9%, 30 – 40 μJ pump @ 1550 nm > 6%, 12 – 30 μJ pump @ 1550 nm
Pulse duration	120 – 400 fs		< 55 fs @ 800 – 900 nm <sup>5)</sup> < 70 fs @ 650 – 800 nm <sup>5)</sup> < 100 fs @ 1200 – 2000 nm <sup>5)</sup>	100 – 300 fs
Spectral bandwidth	60 – 220 cm <sup>-1</sup>		200 – 750 cm <sup>-1</sup> @ 650 – 900 nm	50 – 150 cm <sup>-1</sup> @ 1450 – 2000 nm
Long-term power stability, 8 h <sup>6)</sup>	< 2% @ 800 nm			< 2% @ 1550 nm
Pulse-to-pulse energy stability, 1 min <sup>6)</sup>	< 2% @ 800 nm			< 2% @ 1550 nm
Compressor transmission	n/a		65% @ 650 – 900 nm 80% @ 1200 – 2000 nm	n/a

## WAVELENGTH EXTENSIONS

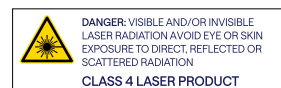
DUV	n/a	190 – 215 nm: > 0.3% @ 200 nm <sup>7)</sup>	n/a	n/a
THS	210 – 315 nm: > 0.4% @ 250 nm <sup>8)</sup>	210 – 315 nm: > 0.8% @ 250 nm <sup>8)</sup>	n/a	n/a
SHS, SHI	315 – 630 nm: > 1.2% @ 350 nm	315 – 630 nm: > 2.4% @ 350 nm	325 – 450 nm: > 1% @ peak 600 – 650 nm: 0.5% @ peak	n/a
DFG	2200 – 4200 nm: > 1.5% @ 3000 nm	2200 – 4200 nm: > 3% @ 3000 nm	n/a	4000 – 16 000 nm: > 0.3% @ 10 000 nm, 30 – 2000 μJ pump > 0.2% @ 10 000 nm, 12 – 30 μJ pump
	4000 – 16 000 nm: > 0.1% @ 10 000 nm	4000 – 16 000 nm: > 0.2% @ 10 000 nm		

## PUPM LASER, ENVIRONMENTAL & UTILITY REQUIREMENTS

Refer to [lightcon.com](http://lightcon.com)

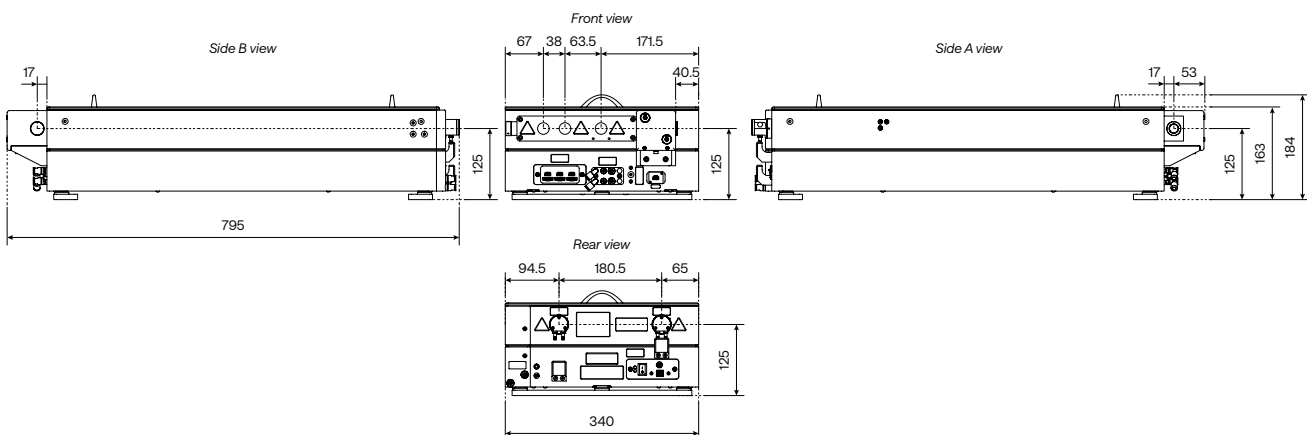
- <sup>1)</sup> Dual output model (-TWINS) available, providing two optically synchronized and simultaneous outputs.
- <sup>2)</sup> Long pulse mode is optional, providing 650 – 1010 nm (signal) and 1050 – 2500 nm (idler) range at < 290 fs.
- <sup>3)</sup> Pump pulse energy up to 5 mJ applicable, refer to ORPHEUS-HE.
- <sup>4)</sup> Specified before pulse compressor. Conversion efficiency at peak is 10% for signal and idler combined.
- <sup>5)</sup> After pulse compression. Typical pulse duration before compression: 120 – 250 fs, after compression: 25 – 70 fs @ 650 – 920 nm, 40 – 100 fs @ 1200 – 2000 nm.

- <sup>6)</sup> Expressed as normalized root mean squared deviation (NRMSD).
- <sup>7)</sup> DUV conversion efficiency is specified for pump power up to 10 W and frequencies up to 200 kHz. In the case of higher pump power, conversion efficiency decreases. The maximum output power is 40 mW at 200 nm.
- <sup>8)</sup> For > 15 μJ pump pulse energy.



## Drawings

### ORPHEUS



## Next-Generation Optical Parametric Amplifier

Wavelength range from UV to MIR, 210 – 16 000 nm

Continuous power monitoring and diagnostics

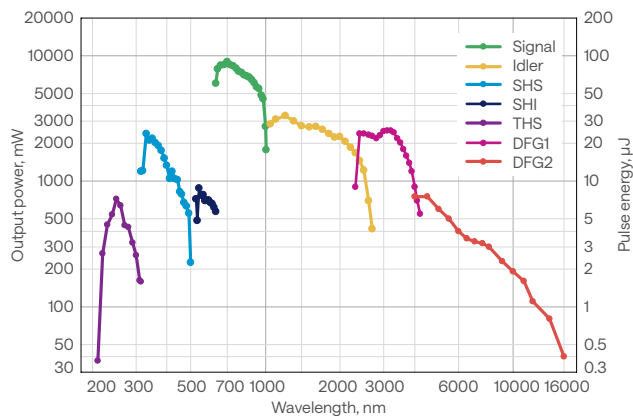
Pumped by PHAROS-UP for 100 fs pulses

Supports up to 80 W, 800  $\mu$ J pump at 2 MHz

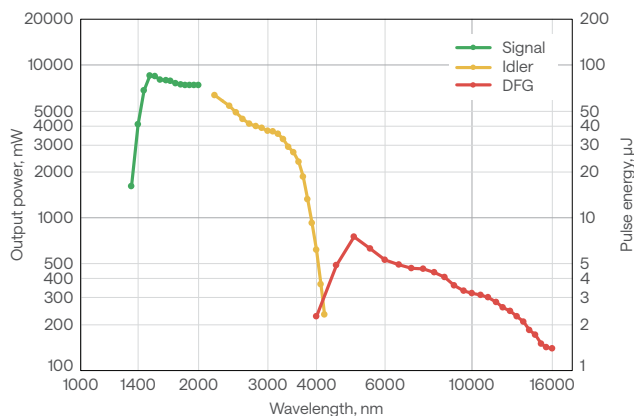
Fully integrated wavelength extensions



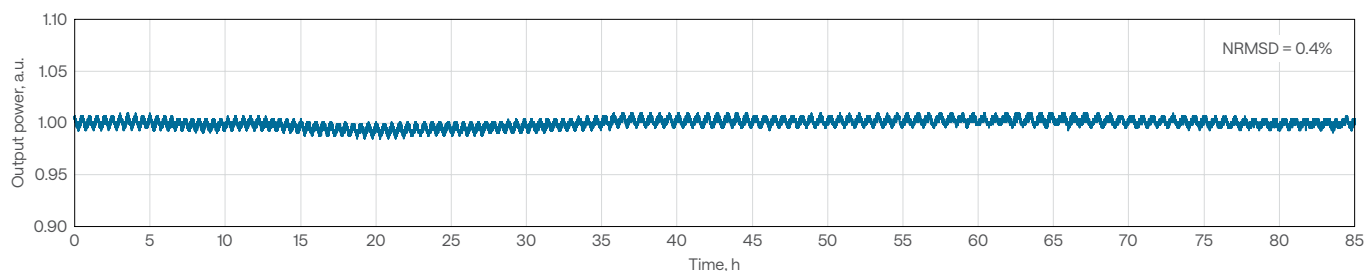
ORPHEUS-NEO typical tuning curves  
Pump: 80 W, 800  $\mu$ J, 100 kHz



ORPHEUS-NEO-ONE typical tuning curves  
Pump: 80 W, 800  $\mu$ J, 100 kHz



ORPHEUS-NEO typical long-term power stability at 800 nm



# ORPHEUS-NEO specifications

Model	ORPHEUS-NEO	ORPHEUS-NEO-ONE	ORPHEUS-NEO-UP	ORPHEUS-NEO-ONE-UP
Configuration	ORPHEUS	ORPHEUS-ONE	ORPHEUS	ORPHEUS-ONE
Pump laser	CARBIDE or PHAROS		PHAROS-UP	
Pump power	Up to 80 W		Up to 20 W	
Pump pulse energy	20 – 800 μJ		20 – 400 μJ	
Repetition rate	Up to 2 MHz		Up to 1 MHz	
Tuning range	640 – 1000 nm (signal) 1050 – 2600 nm (idler)	1400 – 2000 nm (signal) 2100 – 4200 nm (idler)	640 – 1000 nm (signal) 1050 – 2600 nm (idler)	1450 – 2000 nm (signal) 2100 – 4500 nm (idler)
Conversion efficiency	> 7% @ 700 nm (40 – 800 μJ pump; up to 1 MHz)	> 9% @ 1550 nm (40 – 800 μJ pump; up to 1 MHz)	> 7% @ 700 nm	> 9% @ 1550 nm
	> 3.5% @ 700 nm (20 – 40 μJ pump; up to 2 MHz)	> 6% @ 1550 nm (20 – 40 μJ pump; up to 2 MHz)		
Spectral bandwidth	60 – 220 cm <sup>-1</sup> @ 700 – 960 nm	50 – 150 cm <sup>-1</sup> @ 1450 – 2000 nm	120 – 300 cm <sup>-1</sup> @ 700 – 2600 nm	150 – 300 cm <sup>-1</sup> @ 1500 – 1900 nm; 2200 – 3500 nm <sup>1)</sup>
Pulse duration <sup>2)</sup>	120 – 400 fs	100 – 400 fs	< 110 fs @ 700 – 1000 nm < 120 fs @ 1060 – 2000 nm	< 120 fs @ 1500 – 1900 nm
Beam quality, M <sup>2</sup>	< 1.3 @ 800 nm	< 1.3 @ 1550 nm	< 1.3 @ 800 nm	< 1.3 @ 1550 nm
Beam diameter <sup>3)</sup>	2.1 ± 0.9 mm @ 800 nm	2.1 ± 0.9 mm @ 1550 nm	2.1 ± 0.9 mm @ 800 nm	2.1 ± 0.9 mm @ 1550 nm
Beam divergence (full-angle)	< 2 mrad @ 800 nm	< 4 mrad @ 1550 nm	< 2 mrad @ 800 nm	< 4 mrad @ 1550 nm
Long-term power stability, 8 h <sup>4)</sup>	< 1% @ 800 nm	< 1% @ 1550 nm	< 1% @ 800 nm	< 1% @ 1550 nm
Pulse-to-pulse energy stability, 1 min <sup>4)</sup>	< 1% @ 800 nm	< 1% @ 1550 nm	< 1% @ 800 nm	< 1% @ 1550 nm

## WAVELENGTH EXTENSIONS

Conversion efficiency	210 – 320 nm (THS) > 0.4% @ 250 nm	n/a	210 – 320 nm (THS) 0.2% @ 250 nm	n/a
	320 – 500 nm (SHS) and 525 – 640 nm (SHI) > 1.2% @ 350 nm		320 – 500 nm (SHS) and 525 – 640 nm (SHI) 1.2% @ 350 nm	
	n/a	640 – 1000 nm and 1050 – 1350 nm > 1% @ 700 nm	n/a	640 – 1000 nm and 1050 – 1450 nm (VIS-NIR) > 1% @ 700 nm
	2500 – 4200 nm (DFG1) > 3% @ 3000 nm	4000 – 16 000 nm (DFG) <sup>5)</sup> > 0.3% @ 10 000 nm (for > 40 μJ pump)	2500 – 4500 nm (DFG1) 3% @ 3000 nm	4500 – 14 000 nm (DFG) <sup>5)</sup> 0.2% @ 10 000 nm
	4000 – 16 000 nm (DFG2) <sup>5)</sup> > 0.2% @ 10 000 nm		4500 – 14 000 nm (DFG2) <sup>5)</sup> 0.1% @ 10 000 nm	

## PUMP LASER, ENVIRONMENTAL & UTILITY REQUIREMENTS

Refer to [lightcon.com](http://lightcon.com)

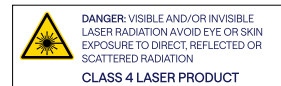
<sup>1)</sup> Spectral bandwidth is equal to 150 – 250 cm<sup>-1</sup> @ 5000 – 12 000 nm.

<sup>2)</sup> Output pulse duration depends on the selected wavelength and the pump laser pulse duration.

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

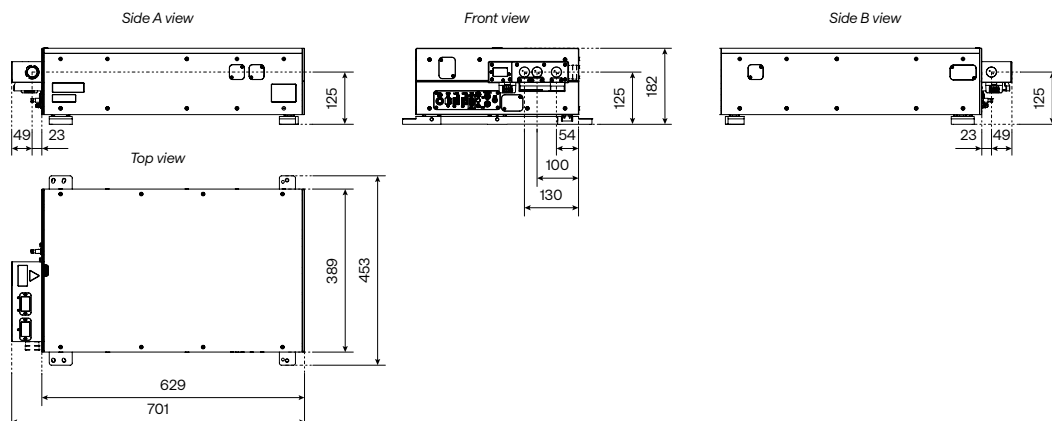
<sup>4)</sup> Expressed as normalized root mean squared deviation (NRMSD).

<sup>5)</sup> Pre-installed output window limits the tuning range to 12 μm. The window is used for dust protection and output power diagnostics, but it can be removed to access the full wavelength range.



## Drawings

### ORPHEUS-NEO / ORPHEUS-NEO-UP





# Ultrafast Spectroscopy Applications

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LIGHT CONVERSION delivers best-in-class lasers and laser systems for today's most demanding applications.

Femtosecond pump-probe

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Time-resolved fluorescence spectroscopy

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Flash photolysis

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# Ultrafast Spectroscopy Applications

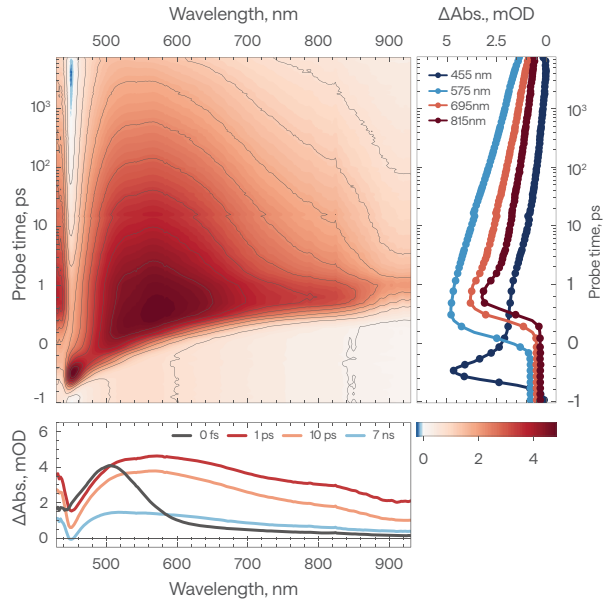
## HARPIA | LIGHT

### Femtosecond pump-probe

Ultrafast dynamics of long-pass filter measurement utilizing the HARPIA-LIGHT transient absorption spectroscopy system.

#### MEASUREMENT CONDITIONS

Pulse repetition rate: 60 kHz  
 Pump wavelength: 343 nm  
 Pump pulse energy: 70 nJ  
 Acquisition time: 1 s per spectrum (per delay point)  
 Total measurement time: 60 min



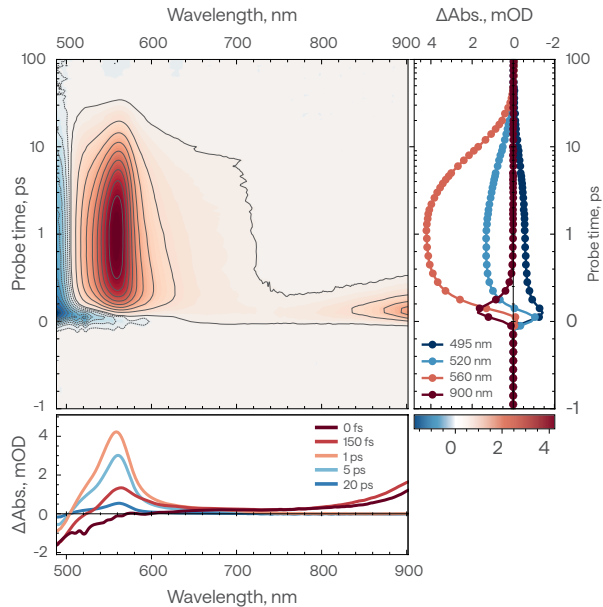
## HARPIA | TA

### Femtosecond pump-probe

Spectral dynamics of  $\beta$ -carotene in solution, acquired using HARPIA-TA.

#### MEASUREMENT CONDITIONS

Pulse repetition rate: 100 kHz  
 Pump wavelength: 490 nm  
 Pump pulse energy: < 10 nJ  
 Acquisition time: 13 s per spectrum (per delay point)



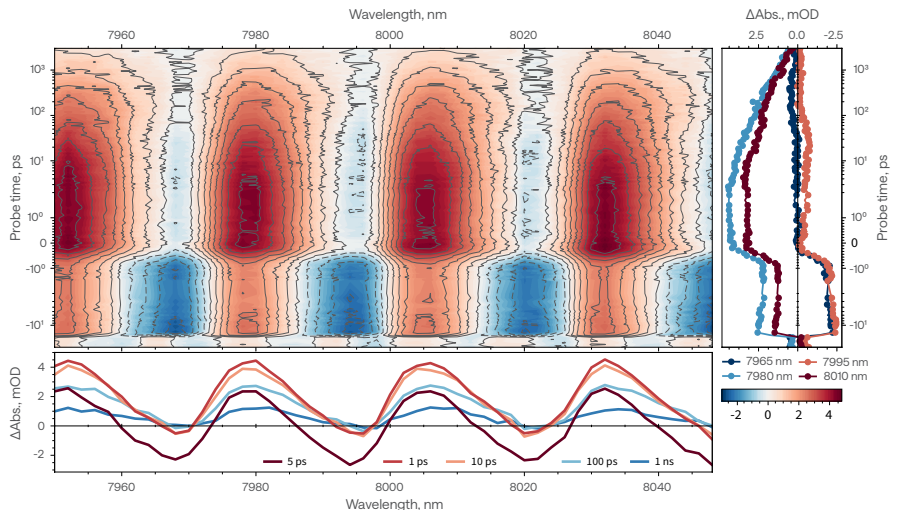
## HARPIA | TA

### IR femtosecond pump-probe

Pump-probe dynamics of a GaAs wafer in the IR, acquired using signal and reference single-channel detectors of HARPIA-TA.

#### MEASUREMENT CONDITIONS

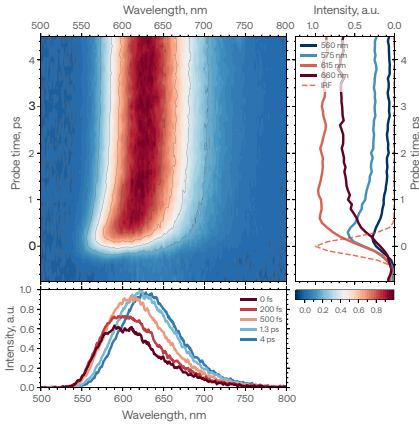
Pulse repetition rate: 75 kHz  
 Pump wavelength: 700 nm  
 Acquisition time: 1 s per point



## Time-resolved fluorescence spectroscopy

### Kerr gate measurements

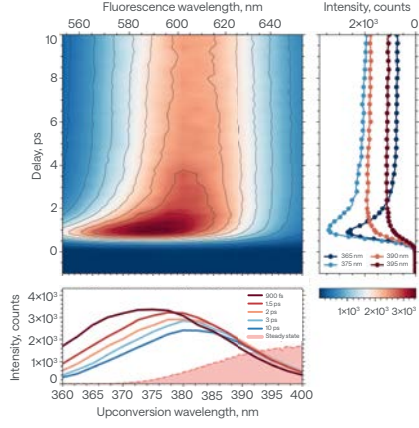
Kerr gate measurements in DCM illustrate the method's ability to probe fluorescence evolution with a sub-picosecond temporal resolution.



### Fluorescence upconversion

Fluorescence dynamics of DCM laser dye in solution, acquired using HARPIA-TF in fluorescence upconversion mode.

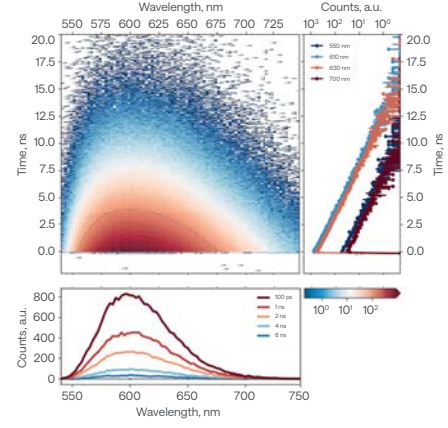
**MEASUREMENT CONDITIONS**  
 Repetition rate: 100 kHz  
 Pump wavelength: 430 nm



### TCSPC

Fluorescence dynamics of DCM laser dye in solution, acquired using HARPIA-TF in TCSPC mode.

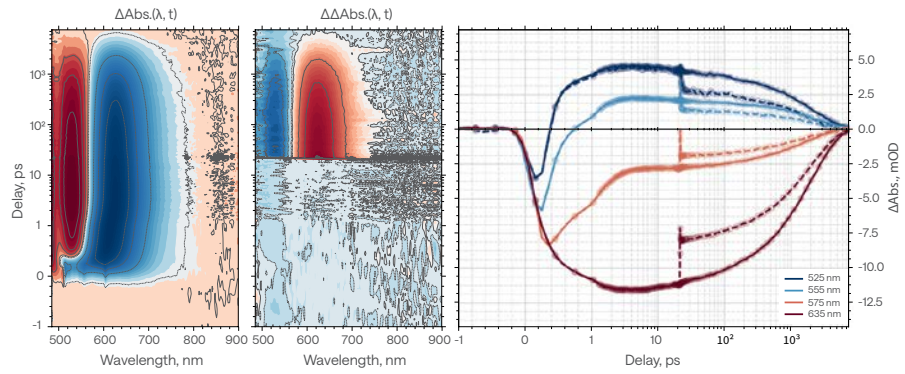
**MEASUREMENT CONDITIONS**  
 Repetition rate: 100 kHz  
 Pump wavelength: 430 nm



## Femtosecond pump-dump-probe

Pump-dump-probe dynamics of DCM laser dye, measured using HARPIA-TB with the dump pulse resonant to the emission band of DCM.

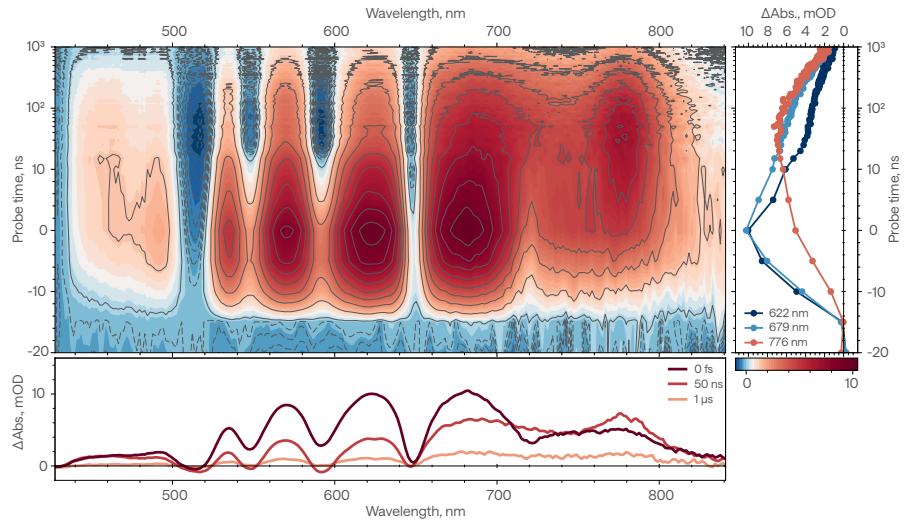
**MEASUREMENT CONDITIONS**  
 Pulse repetition rate: 50 kHz  
 Pump wavelength: 515 nm  
 Dump wavelength: 700 nm  
 Dump delay: 21 ps  
 Pump pulse energy: 90 nJ  
 Dump pulse energy: 190 nJ



## Flash photolysis

Nanosecond spectral dynamics of meso-Tetraphenylporphine in solution, acquired using HARPIA-TA-FP.

**MEASUREMENT CONDITIONS**  
 Pulse repetition rate: 1.8 kHz  
 Pump wavelength: 343 nm  
 Pump pulse energy: 5.4 μJ



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