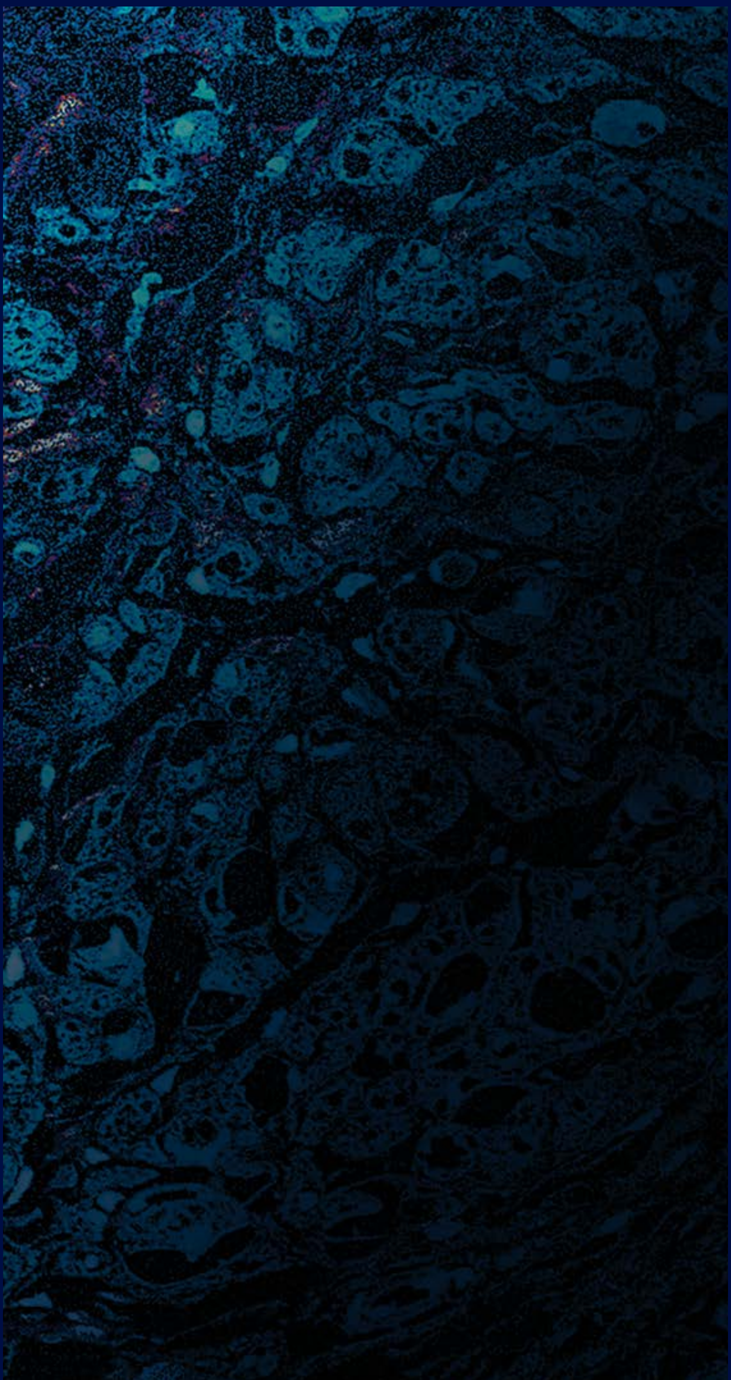
# Microscopy Sources

Product Catalog



lightcon.com

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.

# Contents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# Microscopy Sources

The CRONUS femtosecond lasers cover applications in functional neuroimaging, optogenetics, and deep imaging, using medium-repetition-rate three-photon (3P) excitation and fast high-repetition-rate two-photon (2P) imaging, as well as widefield and holographic excitation.

CRONUS | 2P

Three-channel laser with a high repetition rate for simultaneous 2P excitation of multiple fluorescent probes, calcium indicators, opsins or CARS and SRS.

CRONUS | 3P

Turn-key laser source with µJ-level pulses, covering the biological transparency windows at 1300 and 1700 nm for 3P microscopy and 1030 nm for optogenetic stimulation.

Optimized for advanced multiphoton microscopy

Plug-and-play functionality with automated wavelength and dispersion control

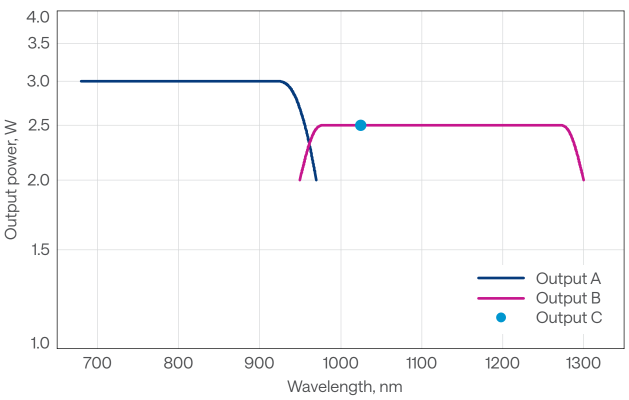
Excellent long-term power and pulse-to-pulse stability

# CRONUS | 2P

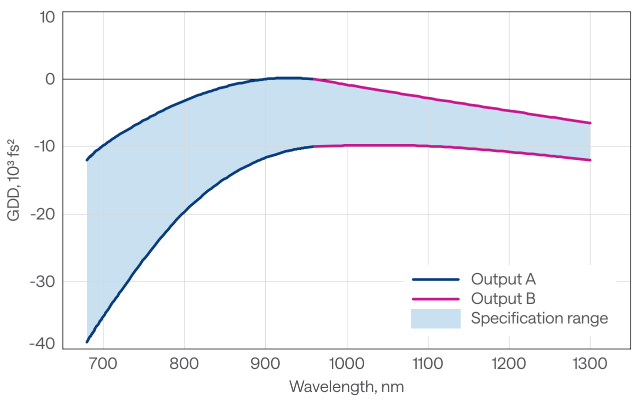
## Three-Channel Wavelength-Tunable Femtosecond Laser


- Watt-level output at high repetition rate for fast imaging
- Two tunable and one fixed output for simultaneous multibeam excitation
- Automated GDD control for shortest pulses at the sample
- Industrial-grade design for high power and beam stability

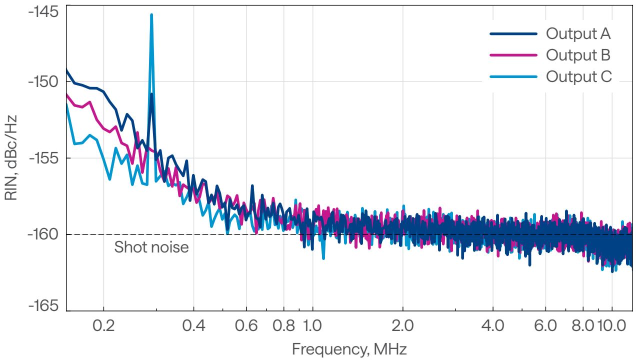
**CRONUS-2P** tuning curve



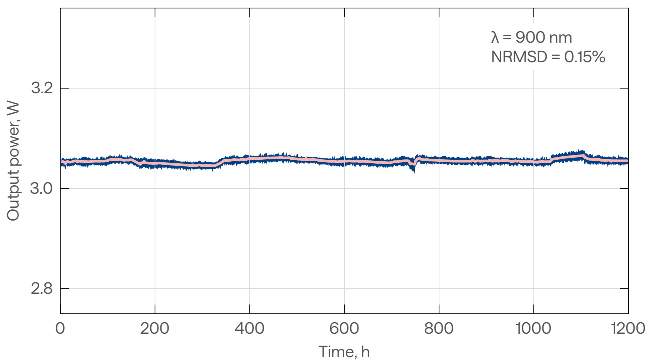

**CRONUS-2P** GDD control range




**CRONUS-2P** relative intensity noise (RIN)




**CRONUS-2P** typical output power stability at 900 nm



# Specifications

| Model | CRONUS-2P | | |
|---|---|---|---|
| | Output A | Output B | Output C |
| Tuning range [1] | 680 – 960 nm | 940 – 1300 nm | 1025 ± 10 nm (fixed) |
| Output power [2,3] | > 3 W @ 920 nm | > 2.5 W @ 1100 nm | > 2.5 W |
| Pulse duration [4,5] | < 160 fs | | |
| Repetition rate | 77 ± 1 MHz | | |
| Beam quality, $M^2$ [3,4] | < 1.2 | | |
| Polarization | Linear, horizontal | | |
| Beam divergence, full angle | < 1 mrad | | < 1.5 mrad |
| Beam diameter [4] (1/e$^2$) | 3.0 ± 0.4 mm | 3.2 ± 0.4 mm | 2.8 ± 0.4 mm |
| Beam ellipticity [4] | > 0.8 | | |
| Beam astigmatism [4] | < 20% | | |
| Beam pointing stability [6] | < 200 µrad | | n/a |
| Long-term power stability, 24 h [4,7] | < 1% | | |
| GDD control range | –10 000 to –35 000 fs$^2$ @ 700 nm<br>–3 000 to –20 000 fs$^2$ @ 800 nm<br>0 to –10 000 fs$^2$ @ 920 nm | 0 to –10 000 fs$^2$ @ 960 nm<br>–3 000 to –10 000 fs$^2$ @ 1100 nm<br>–8 000 to –12 000 fs$^2$ @ 1300 nm | n/a |

## OPTIONAL POWER CONTROL

| | | | |
|---|---|---|---|
| Tuning range [8] | 680 – 960 nm | 940 – 1300 nm | 1025 ± 10 nm (fixed) |
| Output power [9] | > 2 W @ 920 nm | > 2 W @ 1100 nm | > 1.5 W |
| Rise/fall time [10] | < 300 ns | | |
| Contrast ratio | 1000:1 | | |
| GDD control range | 0 to –6 500 fs$^2$ @ 920 nm | 0 to –10 000 fs$^2$ @ 1100 nm | n/a |

## OPTIONAL WAVELENGTH EXTENSIONS (UV – VIS)

| | | | |
|---|---|---|---|
| Second harmonic tuning range | 340 – 480 nm [11] | 480 – 650 nm [11] | n/a |
| Conversion efficiency at peak | > 30% | | |

## ENVIRONMENTAL REQUIREMENTS & DIMENSIONS

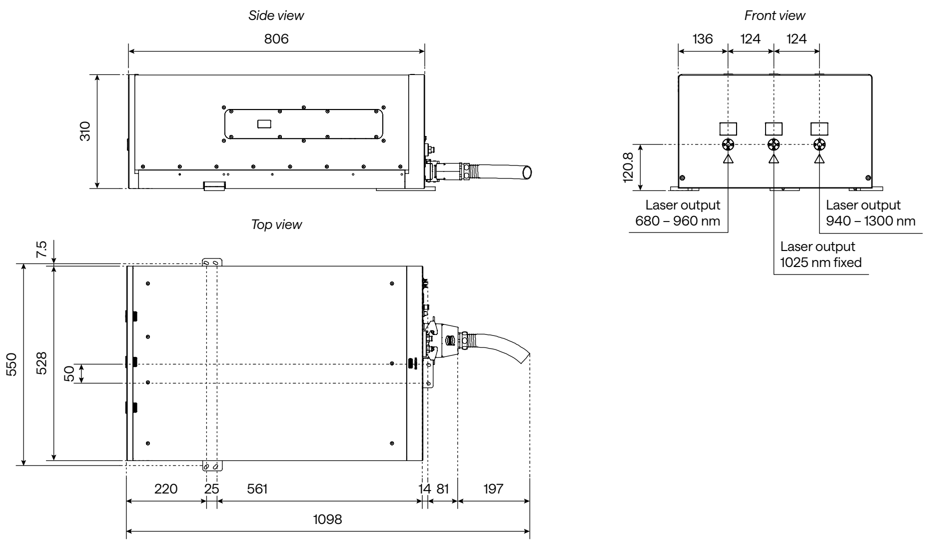
Refer to www.lightcon.com

1) *Configuration with dual-output A or dual-output B is also available.*
2) *Simultaneous mode: > 1 W @ 920 nm, > 1 W @ 1100 nm, and > 2.5 W @ 1025 nm.*
3) *Power control using AOM is applicable, specifications below.*
4) *Speficied at 920 nm, 1100 nm, and 1025 nm, respectively.*
5) *IR pulse duration determined assuming sech2 shape.*
6) *Beam pointing deviation over the entire tuning and GDD control range.*
7) *Expressed as normalized root mean squared deviation (NRMSD); with less than ±1 °C temperature change after 1 h warm up.*
8) *Configuration with dual-output A or dual-output B is also available.*
9) *Simultaneous mode: > 0.7 W @ 920 nm, > 0.7 W @ 1100 nm, and > 1.5 W @ 1025 nm.*
10) *Specified from 5% to 95%.*
11) *Multiple second harmonic configurations available. For more information contact sales@lightcon.com.*

**DANGER:** VISIBLE AND/OR INVISIBLE LASER RADIATION AVOID EYE OR SKIN EXPOSURE TO DIRECT, REFLECTED OR SCATTERED RADIATION
CLASS 4 LASER PRODUCT

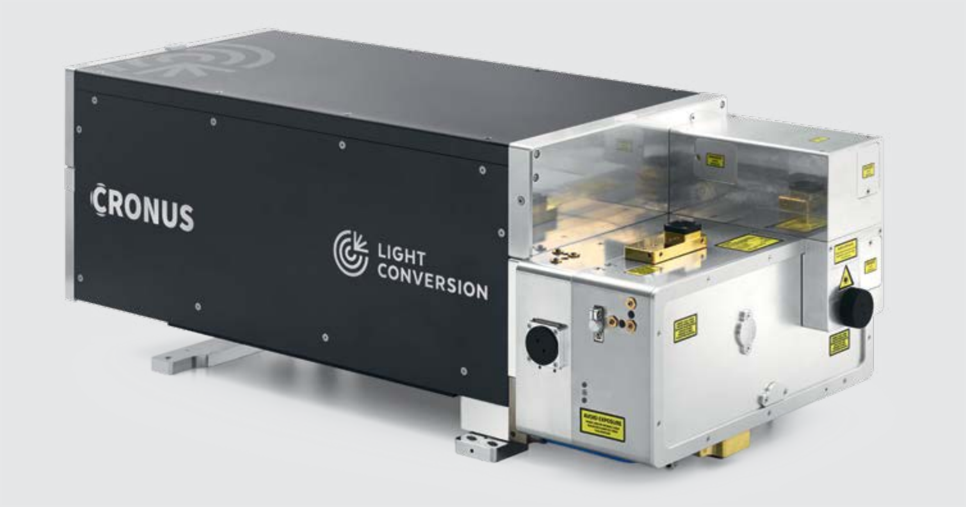
# Drawings

CRONUS-2P drawing



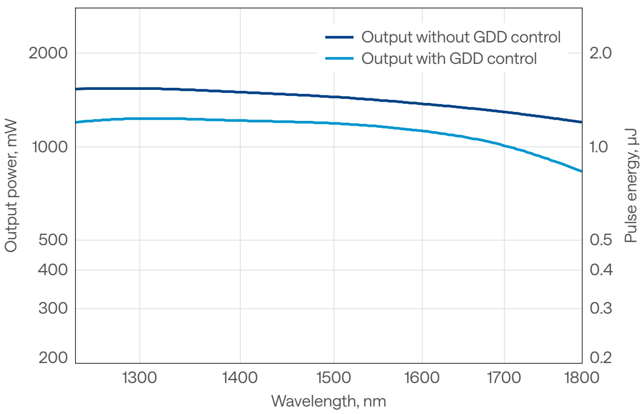
# CRONUS | 3P

## Laser Source for Advanced Nonlinear Microscopy

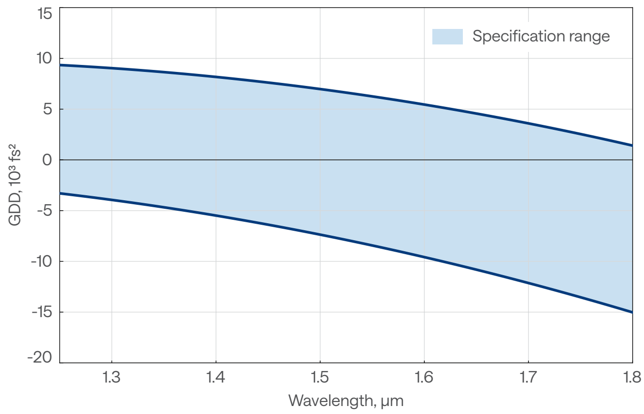



- High pulse energy for deep imaging
- 1250 – 1800 nm tuning range for 3P imaging
- Down to 50 fs pulse duration for high peak power
- Automated wavelength and GDD control for optimal signal
- Market-leading pulse-to-pulse energy stability

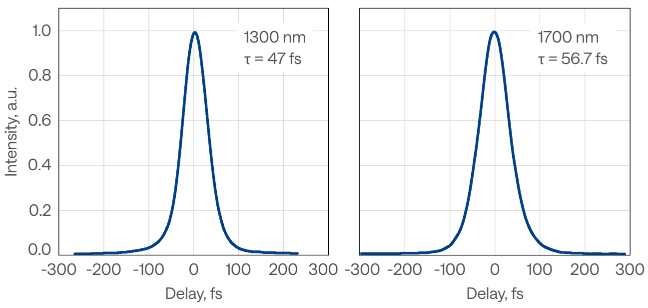
**CRONUS-3P** output power and pulse energy vs wavelength, at 1 MHz



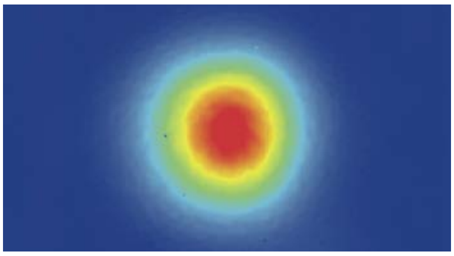

**CRONUS-3P** GDD control range




**CRONUS-3P** typical pulse duration at 1300 nm and 1700 nm




**CRONUS-3P** beam profile at 1300 nm



# Specifications

| Model | CRONUS-3P | | CRONUS-3P with power control | |
|---|---|---|---|---|
| Tuning range | 1250 – 1800 nm | | | |
| Repetition rate [1] | Single-shot – 1 MHz or 2 MHz | | | |
| | 1300 nm | 1700 nm | 1300 nm | 1700 nm |
| Pulse duration | < 50 fs | < 65 fs | < 50 fs | < 65 fs |
| Output power | > 1100 mW @ 1 MHz<br>> 800 mW @ 2 MHz | > 800 mW @ 1 MHz<br>> 500 mW @ 2 MHz | > 1000 mW @ 1 MHz<br>> 700 mW @ 2 MHz | > 700 mW @ 1 MHz<br>> 400 mW @ 2 MHz |
| GDD control range [2] | −4 000 to +9 000 $fs^2$ | −12 000 to +3 500 $fs^2$ | −4 000 to +9 000 $fs^2$ | −12 000 to +3 500 $fs^2$ |
| Beam diameter [3] | 2 – 4 mm | | | |
| Beam quality, $M^2$ | < 1.2 | | | |
| Beam ellipticity | > 0.8 | | | |
| Beam divergence | < 1 mrad | | | |
| Beam pointing stability | < 100 µrad | | | |
| Long-term power stability, 24 h [4] | < 1% | | | |
| Pulse-to-pulse energy stability, 1 min [4] | < 1% | | | |

## MAIN OUTPUT WITHOUT GDD CONTROL

| | | | |
|---|---|---|---|
| Output power [5] | > 1500 mW @ 1 MHz<br>> 1000 mW @ 2 MHz | > 1050 mW @ 1 MHz<br>> 700 mW @ 2 MHz | n/a |

## ADDITIONAL OUTPUTS

| | |
|---|---|
| Auxiliary 1030 nm amplifier output | 1030 ± 10 nm, up to 40 W, up to 2 MHz, < 250 fs |
| Optional 680 – 920 nm amplifier output | 680 – 920 nm, > 1500 mW @ 1 MHz or > 1000 mW @ 2 MHz (@ 920 nm),<br>< 290 fs (compressible to < 50 fs) [6] |
| Optional 1030 nm oscillator output | 1030 ± 10 nm, up to 500 mW, ≈ 65 MHz, ≈ 200 fs |

## ENVIRONMENTAL REQUIREMENTS & DIMENSIONS

Refer to www.lightcon.com

1) *Lower repetition rate with a higher pulse energy option available.*
2) *Continuous dispersion control; −4000 $fs^2$ compensates a microscope with +4000 $fs^2$.*
3) *$1/e^2$, measured at compressor output.*
4) *Expressed as normalized root mean squared deviation (NRMSD).*
5) *Available only for v1. Contact sales@lightcon.com for more details.*
6) *With external compressor without GDD control, < 70% transmission at 920 nm.*

**DANGER:** VISIBLE AND/OR INVISIBLE LASER RADIATION AVOID EYE OR SKIN EXPOSURE TO DIRECT, REFLECTED OR SCATTERED RADIATION
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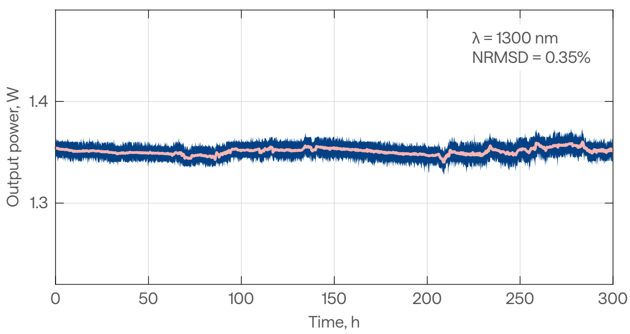
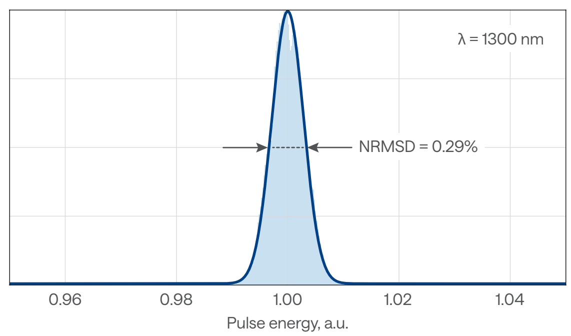
**CRONUS-3P** typical long-term power stability at 1300 nm

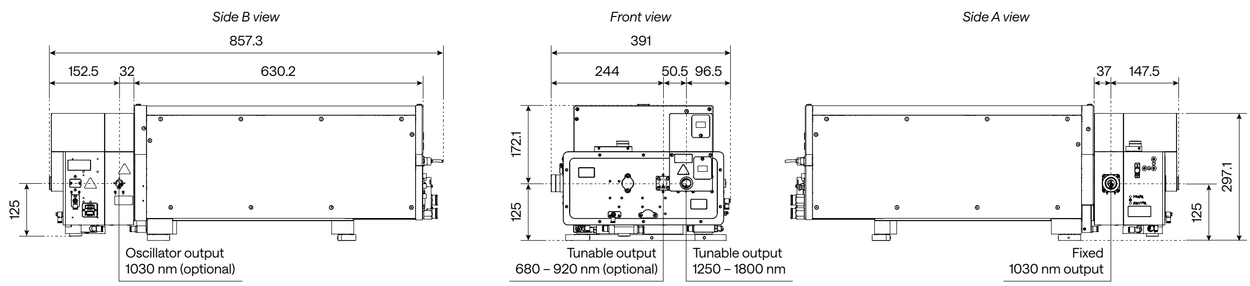


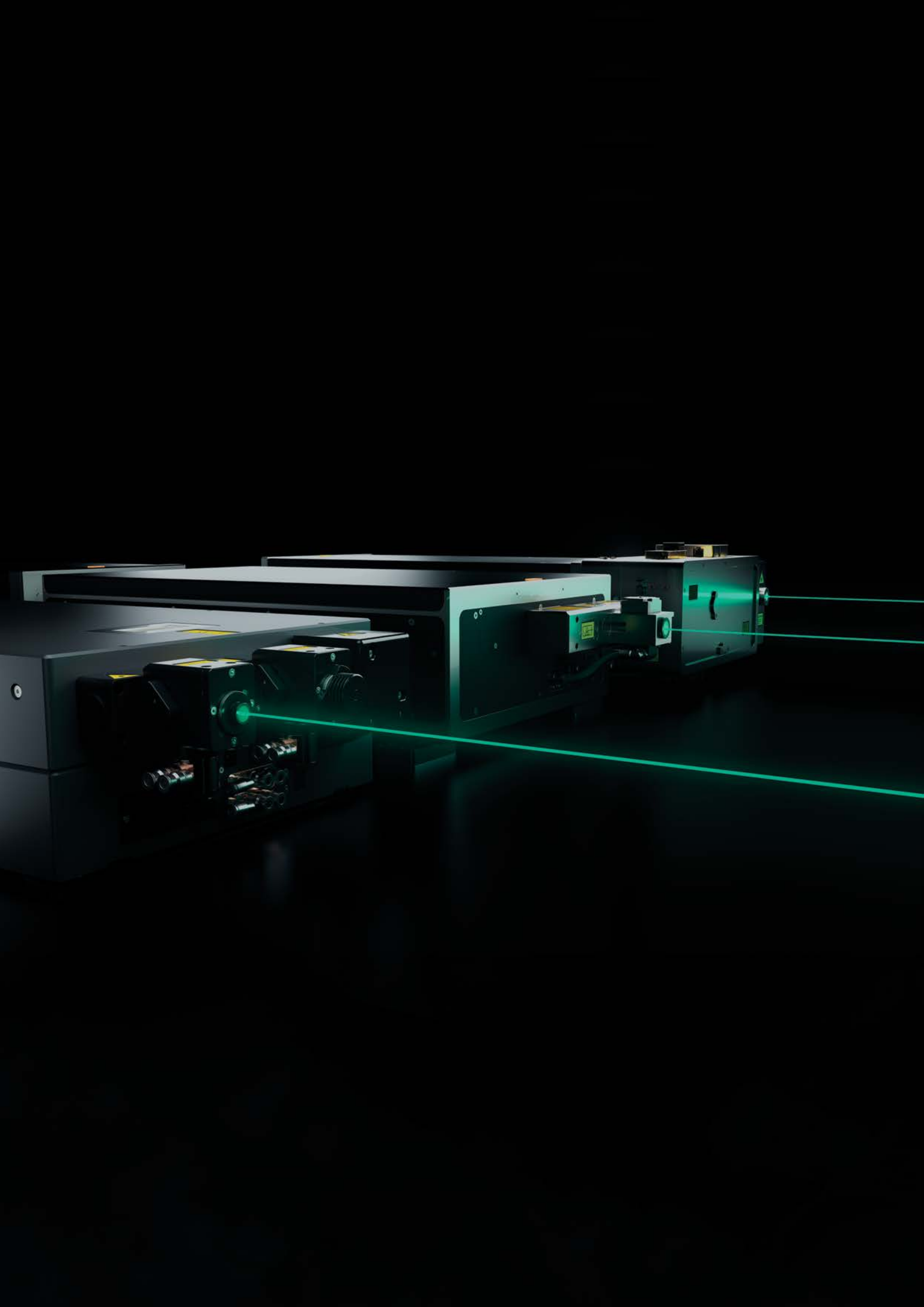

**CRONUS-3P** typical pulse-to-pulse energy distribution at 1300 nm




# Drawings

**CRONUS-3P** drawing





# Wavelength-Tunable Sources

LIGHT CONVERSION's OPAs offer a broad tuning range from deep-UV to mid-IR. Coupled with our femtosecond lasers, these OPAs provide an invaluable source for ultrafast spectroscopy, nonlinear microscopy, and a variety of other scientific applications.

| | |
|---|---|
| **I-OPA** | The only commercial industrial-grade OPA combines wavelength tunability with robust industrial design. |
| **ORPHEUS \| NEO** | The next-generation of OPAs with exceptional stability and multiple detectors for continuous power monitoring and diagnostics. |
| **ORPHEUS** | Classic OPAs that many are used to. Just like TOPAS, they are quite simple yet offer an extensive range of parameters. |
| **TOPAS** | Classic OPAs for Ti:Sapphire lasers. |

Continuous wavelength tunability from UV to MIR

Pulse duration from tens of femtoseconds to a few picoseconds

Leading OPA manufacturer for more than 30 years

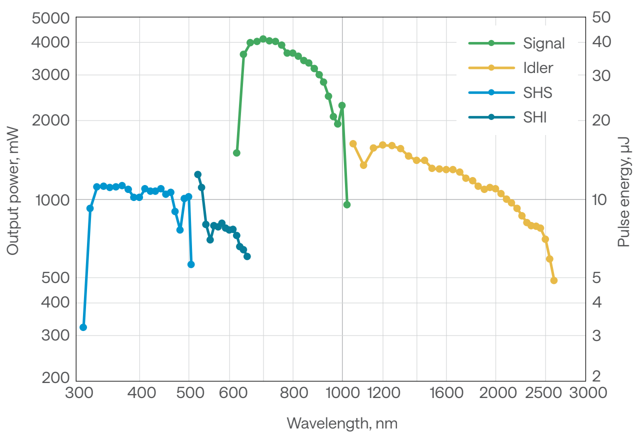
# I-OPA

## Industrial-Grade Optical Parametric Amplifier

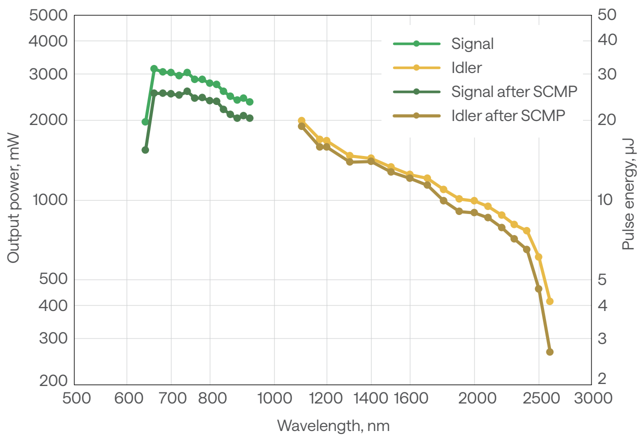
I-OPA-TW on air-cooled CARBIDE-CB5

- 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

**I-OPA-HP** typical tuning curves
Pump: 40 W, 400 µJ, 100 kHz




**I-OPA-F** typical tuning curves
Pump: 40 W, 400 µJ, 100 kHz



## 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 µJ | | |
| Repetition rate | Up to 2 MHz | | |
| Tuning range [1] | 640 – 1010 nm (signal)<br>1050 – 2600 nm (idler) | 650 – 920 nm (signal)<br>1200 – 2500 nm (idler) | 1350 – 2000 nm (signal)<br>2100 – 4500 nm (idler) |
| Conversion efficiency | > 7% @ 700 nm<br>(40 – 400 µJ pump; up to 1 MHz) | | > 9% @ 1550 nm<br>(40 – 400 µJ pump; up to 1 MHz) |
| | > 3.5% @ 700 nm<br>(20 – 40 µJ pump; up to 2 MHz) | | > 6% @ 1550 nm<br>(20 – 40 µJ pump; up to 2 MHz) |
| Spectral bandwidth [2] | 80 – 220 $cm^{-1}$ @ 700 – 960 nm | 200 – 1000 $cm^{-1}$ @ 650 – 920 nm<br>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<br>< 70 fs @ 650 – 800 nm<br>< 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]<br>525 – 640 nm (SHI) [5] | Contact<br>sales@lightcon.com | 4500 – 10000 nm (DFG) |
| Pulse compression options [2] | n/a | SCMP (signal pulse compressor)<br>ICMP (idler pulse compressor)<br>GDD-CMP (compressor with GDD control) | n/a |

### PUMP LASER REQUIREMENTS

| | |
|---|---|
| Pump laser | PHAROS or CARBIDE |
| Center wavelength | 1030 ± 10 nm |
| Maximum pump power | 40 W |
| Maximum repetition rate | Up to 2 MHz |
| Pump pulse energy | 20 – 400 µJ |
| Pulse duration | 180 – 300 fs |

### ENVIRONMENTAL & UTILITY REQUIREMENTS

| | |
|---|---|
| Operating temperature [6] | 19 – 25 °C (air conditioning recommended) |
| Relative humidity [6] | 20 – 70% (non-condensing) |
| Electrical requirements | n/a [7] |

1) *In case of 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 – 900 nm, 40 – 100 fs @ 1200 – 2000 nm.*

3) *Output pulse duration depends on selected wavelength and 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.*

6) *Specifications are guaranteed for a maximum temperature variation of ± 1 °C and humidity variation of ± 10%.*

7) *I-OPA is powered by the same electrical source as the pump laser. Thus, refer to the pump laser electrical requirements.*

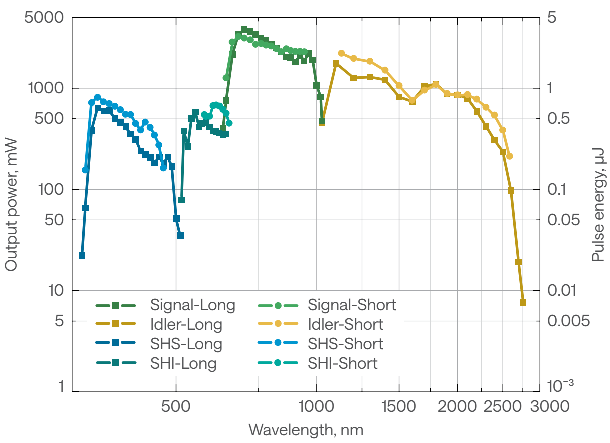
**DANGER:** VISIBLE AND/OR INVISIBLE LASER RADIATION AVOID EYE OR SKIN EXPOSURE TO DIRECT, REFLECTED OR SCATTERED RADIATION
CLASS 4 LASER PRODUCT

# ORPHEUS | F

## Broad-Bandwidth Hybrid Optical Parametric Amplifier

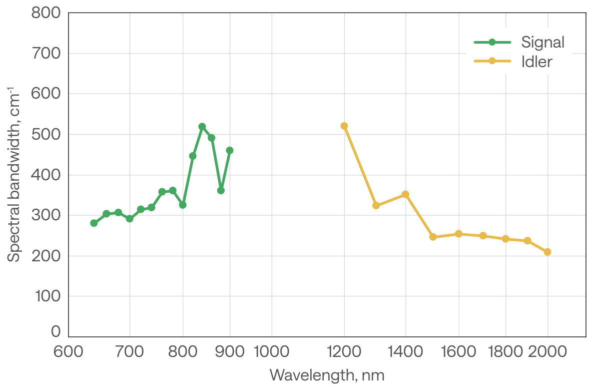

- Combination of best collinear and non-collinear OPA features
- Ultrashort pulses in NIR (650 – 900 nm and 1200 – 2500 nm)
- Single-shot – 2 MHz repetition rate
- < 100 fs pulse duration
- Adjustable spectral bandwidth
- Optional long pulse mode for gap-free tunability

**ORPHEUS-F** typical tuning curves.
Pump: 40 W, 40 μJ, 1000 kHz

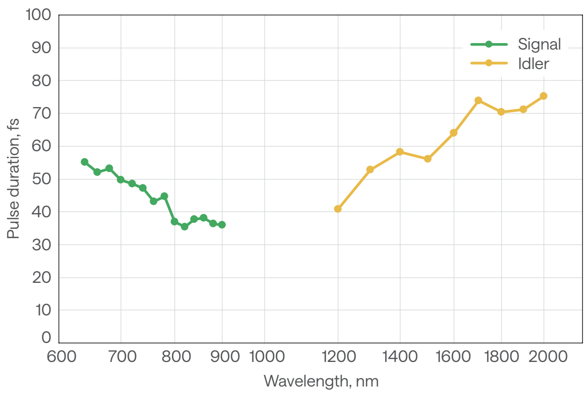



For custom tuning curves visit
*http://toolbox.lightcon.com/tools/tuningcurves*

**ORPHEUS-F** typical spectral bandwidth




**ORPHEUS-F** pulse duration after compression



# Specifications

## MAIN OUTPUT (650 – 900 nm and 1200 – 2500 nm)

| Mode of operation | Short pulse mode [1] | Long pulse mode |
|---|---|---|
| Tuning range | 650 – 900 nm (signal)<br>1200 – 2500 nm (idler) | 650 – 1010 nm (signal)<br>1050 – 2500 nm (idler) |
| Maximum pump power | 80 W | |
| Pump pulse energy | 10 – 500 μJ | |
| Conversion efficiency [2] | > 7% @ 700 nm | |
| Integrated 2H (515 nm) generation efficiency [3] | > 35% | |
| Pulse duration before compression [1] | < 290 fs | |
| Spectral bandwidth | 200 – 750 $cm^{-1}$ @ 650 – 900 nm | 60 – 220 $cm^{-1}$ @ 650 – 900 nm |
| Pulse duration after compressor [1] | < 55 fs @ 800 – 900 nm<br>< 70 fs @ 650 – 800 nm<br>< 100 fs @ 1200 – 2000 nm | n/a |
| Compressor transmission | > 65% @ 650 – 900 nm<br>> 80% @ 1200 – 2000 nm | |
| Long-term power stability, 8 h [4] | < 2% @ 800 nm | |
| Pulse-to-pulse energy stability, 1 min [4] | < 2% @ 800 nm | |

## WAVELENGTH EXTENSION OPTIONS (325 – 15000 nm) [5]

| | | |
|---|---|---|
| 325 – 450 nm (SHS) | > 1% | n/a |
| 325 – 505 nm (SHS) | n/a | > 1% |
| 525 – 650 nm (SHI) | | > 0.5% |
| 600 – 650 nm (SHI) | > 0.5% | n/a |
| 210 – 252 nm (FHS) | n/a | > 0.1% |
| 263 – 325 nm (FHI) | | |
| 2500 – 15000 nm | See ORPHEUS-MIR; | |

## PUMP LASER REQUIREMENTS

| | |
|---|---|
| Pump laser | PHAROS or CARBIDE |
| Center wavelength | 1030 ± 10 nm |
| Maximum pump power | 80 W |
| Repetition rate | Single-shot – 2 MHz |
| Pump pulse energy | 10 – 500 μJ |
| Pulse duration [6] | 180 – 500 fs |

## ENVIRONMENTAL & UTILITY REQUIREMENTS

Refer to www.lightcon.com

[1] *In short pulse mode, broadband pulses are compressed externally. Typical pulse duration before compression: 120 – 250 fs, after compression: 25 – 70 fs @ 650 – 900 nm, 40 – 100 fs @ 1200 – 2000 nm.*

[2] *Specified as a percentage of pump power, before compressor. Conversion efficiency at peak is equal to 10% for signal and idler combined.*

[3] *At designated output port; not simultaneous to OPA output.*

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

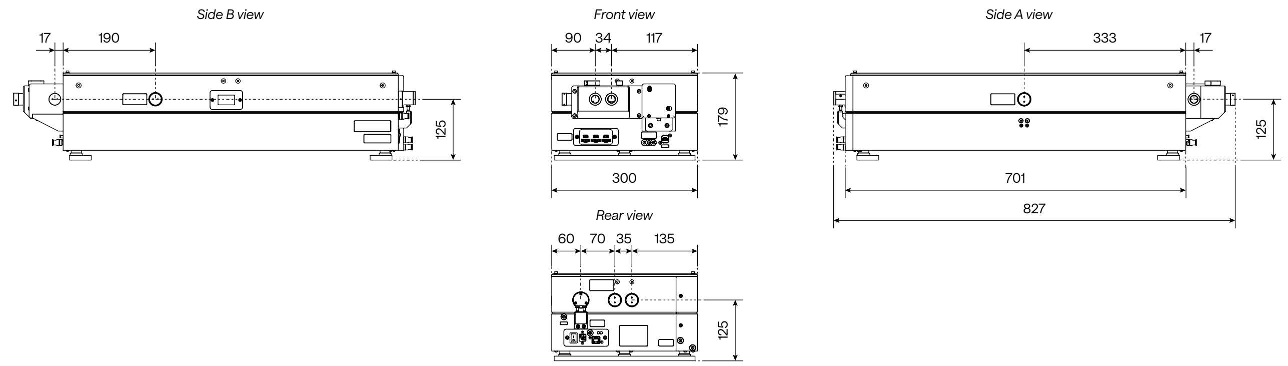
[5] *For > 15 μJ pump pulse energy.*

[6] *FWHM, assuming Gaussian pulse shape.*

DANGER: VISIBLE AND/OR INVISIBLE LASER RADIATION AVOID EYE OR SKIN EXPOSURE TO DIRECT, REFLECTED OR SCATTERED RADIATION
CLASS 4 LASER PRODUCT

# Drawings

ORPHEUS-F drawings



# ORPHEUS | TWINS

## Dual Optical Parametric Amplifier


- Two simultaneous independently tunable outputs
- 210 – 16000 nm tuning range
- Single-shot – 2 MHz repetition rate
- Up to 60 W, 0.5 mJ pump
- Compact and cost-effective
- CEP-stable option

## Specifications

### MAIN OUTPUT

| | |
|---|---|
| Tuning range | Choice between ORPHEUS, ORPHEUS-F, and ORPHEUS-ONE configurations |
| Output pulse energy | Depends on the configuration, see the specifications of the chosen models |
| Spectral bandwidth | Depends on configuration, 100 – 750 $cm^{-1}$ |
| Pulse duration | Depends on configuration, down to < 50 fs |
| Repetition rate | Single-shot – 2 MHz |

### PUMP LASER REQUIREMENTS

| | |
|---|---|
| Pump laser | PHAROS or CARBIDE |
| Center wavelength | 1030 ± 10 nm |
| Maximum pump power | 60 W |
| Repetition rate | Single-shot – 2 MHz |
| Pump pulse energy | 16 – 500 μJ |
| Pulse duration [1] | 180-300 fs |

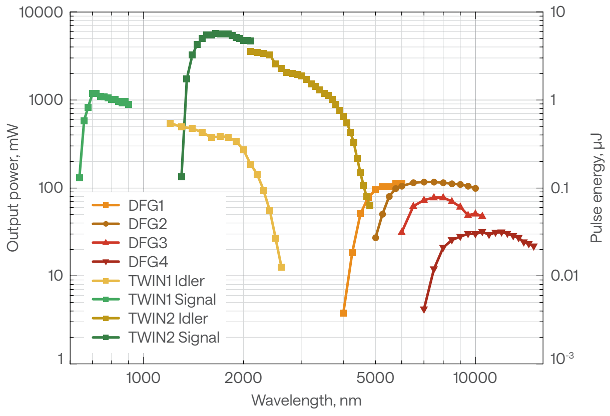
### ENVIRONMENTAL & UTILITY REQUIREMENTS

| | |
|---|---|
| Operating temperature [2] | 19 – 25 °C (air conditioning recommended) |
| Relative humidity [2] | 20 – 70% (non-condensing) |
| Electrical requirements | 100 – 240 V AC, 4.5 A; 50 – 60 Hz |
| Rated power | 280 W |
| Power consumption | Standby: 20 W<br>Max during wavelength tuning: 200 W |

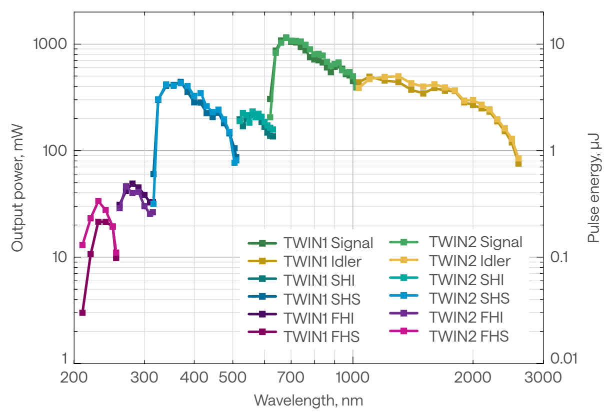
[1] *FWHM, assuming Gaussian pulse shape.*
[2] *Specifications are guaranteed for a maximum temperature variation of ± 1 °C and humidity variation of ± 10%.*

**DANGER:** VISIBLE AND/OR INVISIBLE LASER RADIATION AVOID EYE OR SKIN EXPOSURE TO DIRECT, REFLECTED OR SCATTERED RADIATION
**CLASS 4 LASER PRODUCT**

**ORPHEUS-TWINS** (-ONE/-F configuration)
tuning curves.
Pump: 40 W, 40 µJ, 1000 kHz



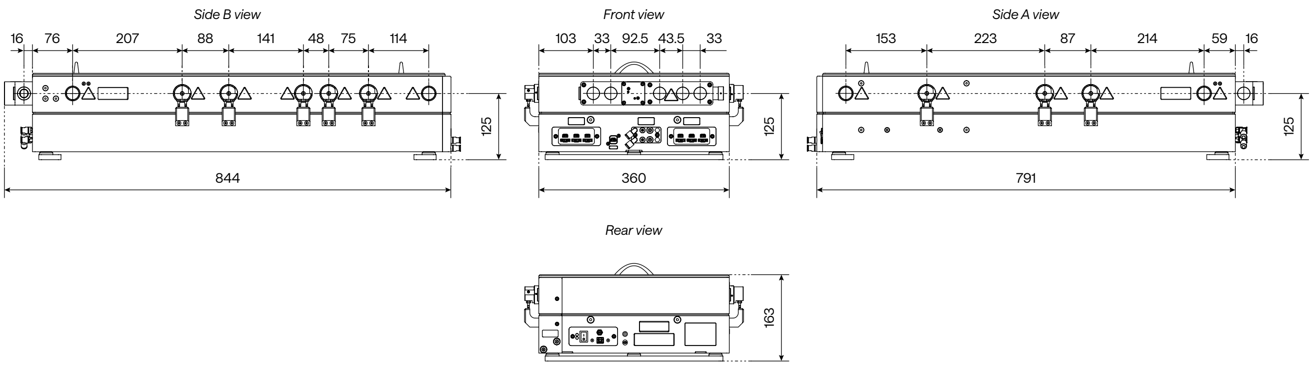

**ORPHEUS-TWINS** (ORPHEUS / ORPHEUS configuration)
tuning curves.
Pump: 20 W, 20 µJ, 100 kHz




For custom tuning curves visit
*http://toolbox.lightcon.com/tools/tuningcurves*

## Drawings

**ORPHEUS-TWINS** drawings




PHAROS
LIGHT CONVERSION
CARBIDE
LIGHT CONVERSION
FLINT

# 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.

| | |
|---|---|
| **FLINT** | Expanding the parameter range with repetition rates ranging from 10 to 100 MHz, with power up to 20 W and pulse duration down to 50 fs. |
| **PHAROS** | Scientific flexibility and process-tailored output parameters, providing pulse duration down to 100 fs and pulse energy of up to 4 mJ. |
| **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. |

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

Market-proven industrial-grade stability and reliability

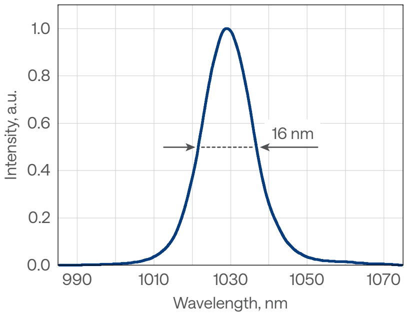
Tailored to the needs of industry and science

# High-Repetition-Rate Lasers

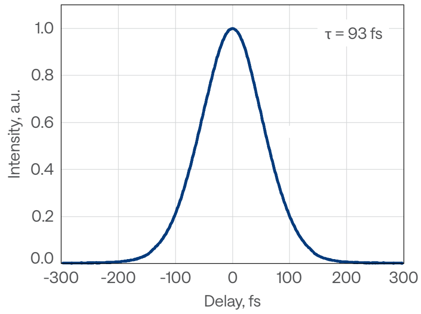

FLINT-FL1

- From 10 to 100 MHz repetition rate
- Down to 50 fs pulse duration
- High-power models, up to 20 W
- High-energy energy models, up to 0.5 µJ
- Industrial-grade design for high output stability
- CEP stabilization or repetition rate locking

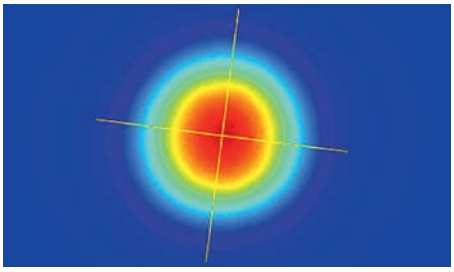
**FLINT-FL1**
Typical spectrum



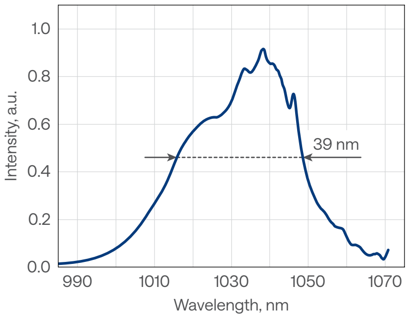

**FLINT-FL1**
Typical pulse duration



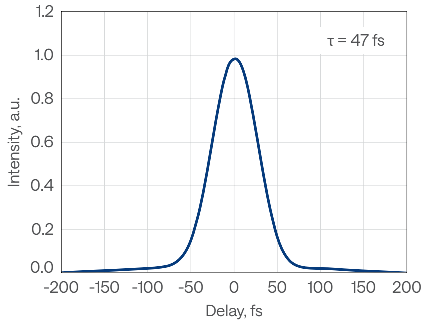

**FLINT-FL1**
Typical beam profile



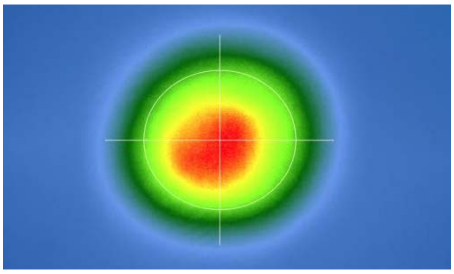
**FLINT-FL2-SP**
Typical spectrum




**FLINT-FL2-SP**
Typical pulse duration




**FLINT-FL2-SP**
Typical beam profile



# Specifications

| Model | FL1 | | | FL2-SP | FL2 | | |
|---|---|---|---|---|---|---|---|
| Key feature | CEP | RRL | Compact | Short pulse | High power and high energy | | |
| Pulse duration | < 100 fs | | < 120 fs | < 50 fs | < 120 fs | < 170 fs [1] | |
| Repetition rate | 60 – 100 MHz [2] | | | 10 MHz | 10 MHz | 40 MHz | 80 MHz |
| Maximum output power | 0.5 W | 1 W | 8 W | 4 W | 5 W | 20 W | |
| Maximum pulse energy | 6 nJ [3] | 12.5 nJ [3] | 100 nJ [3] | 0.4 µJ | 0.5 µJ | | 0.25 µJ |
| Center wavelength | 1035 ± 10 nm | | | 1030 ± 10 nm | 1030 ± 10 nm | | |
| Polarization | Linear, horizontal | | | | | | |
| Beam quality, $M^2$ | < 1.2 | | | < 1.3 | < 1.2 | | |
| Beam pointing stability | < 10 µrad/°C | | | | | | |
| Long-term power stability, 100 h [4] | < 0.5% | | | | | | |
| Integrated 2H generator [5] | n/a | | | | Optional; conversion efficiency > 30% [6] | | |
| External 2H, 3H, or 4H generator [5] | Optional; Refer to HIRO for FLINT | | | | | | |
| Integrated attenuator | n/a | | | Included | | | |

## PHYSICAL DIMENSIONS

| | | |
|---|---|---|
| Laser head (L × W × H) | 448 × 206 × 115 mm | 543 × 322 × 146 mm |
| Power supply and chiller rack (L × W × H) | 642 × 553 × 540 mm | 642 × 553 × 673 mm |
| Chiller | Different options available. Contact sales@lightcon.com | |

## ENVIRONMENTAL AND UTILITY REQUIREMENTS

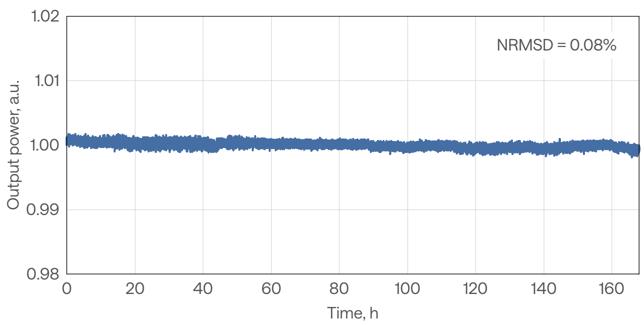
| | | | |
|---|---|---|---|
| Operating temperature | | 15 – 30 °C (air conditioning recommended) | |
| Relative humidity | | < 80% (non-condensing) | |
| Electrical requirements | | 100 V AC, 7 A – 240 V AC, 3 A; 50 – 60 Hz | 100 V AC, 12 A – 240 V AC, 5 A; 50 – 60 Hz |
| Rated power | | 200 W | |
| Power consumption | Laser | 100 W | 150 W |
| | Chiller | 600 W | 1000 W |

1) *For 20 W output power. Lower power models: 8 W and 12 W, are available upon request.*
2) *Standard repetition rate is 80 MHz; custom repetition rate can be factory preset from the given range.*
3) *Depends on the repetition rate. Values are given for 80 MHz.*
4) *With enabled power-lock, under stable environmental conditions. Expressed as normalized root mean squared deviation (NRMSD).*
5) *For external 2H, or even 3H and 4H generation, refer to HIRO for FLINT.*
6) *Conversion efficiency specified at maximum power.*

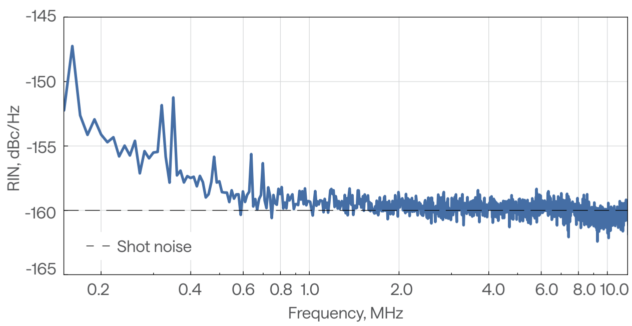
**DANGER:** VISIBLE AND/OR INVISIBLE LASER RADIATION AVOID EYE OR SKIN EXPOSURE TO DIRECT, REFLECTED OR SCATTERED RADIATION
CLASS 4 LASER PRODUCT

# Stability

**FLINT-FL2** (20 W) output power stability under harsh environmental conditions over 7 days




**FLINT** oscillator relative intensity noise (RIN), shot-noise limited at -160 dBc/Hz above 1 MHz

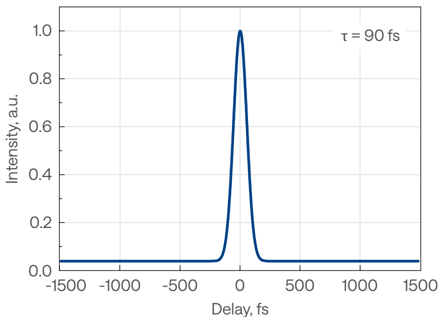


# PHAROS

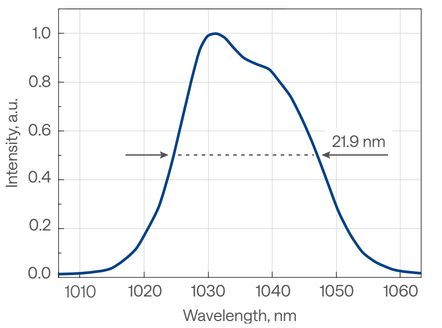
## Modular-Design Femtosecond Lasers for Industry and Science


- 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 5th harmonic or tunable extensions
- CEP stabilization or repetition rate locking
- Thermally-stabilized and sealed design

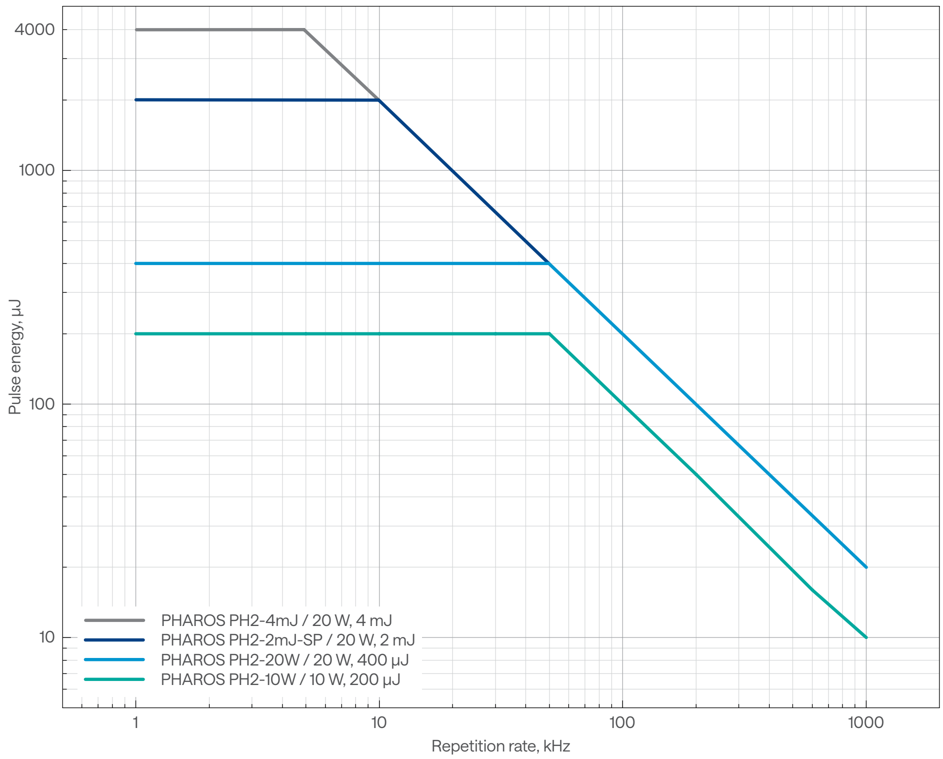
**PHAROS-PH2-UP**
Typical pulse duration




**PHAROS-PH2-UP**
Typical spectrum




**PHAROS**
Pulse energy vs fundamental repetition rate



# Specifications

| Model | PH2-10W | PH2-20W-SP | | | PH2-4mJ | PH2-UP | |
|---|---|---|---|---|---|---|---|
| **OUTPUT CHARACTERISTICS** | | | | | | | |
| Center wavelength [1] | 1030 ± 10 nm | | | | | | |
| Maximum output power | 10 W | 20 W | | | | | |
| Pulse duration [2] | < 290 fs | < 190 fs | | | < 450 fs [3] | < 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, $M^2$ | < 1.2 | < 1.3 | | | | < 1.2 | |
| Beam diameter [4] | 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 [5] | < 0.5% | | | | | | |
| Long-term power stability, 100 h [5] | < 0.5% | | | | | | |
| **MAIN OPTIONS** | | | | | | | |
| Oscillator output [6] | 1 – 7 W, 50 – 250 fs, ≈ 1035 nm, ≈ 76 MHz | | | | | | |
| Harmonic generator [7] | 515 nm, 343 nm, 257 nm, or 206 nm | | | | | | |
| Optical parametric amplifier [8] | 320 – 10000 nm; *see page 12* | | | | | | |
| BiBurst option | Tunable GHz and MHz burst with burst-in-burst capability | | | | | | |
| CEP stabilization | Optional | | | | | | |
| Repetition rate locking | | | | | | | |
| **PHYSICAL DIMENSIONS** | | | | | | | |
| Laser head (L × W × H) [9] | 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) [9] | 280 × 144 × 49 mm | | | | | | |

## ENVIRONMENTAL & UTILITY REQUIREMENTS

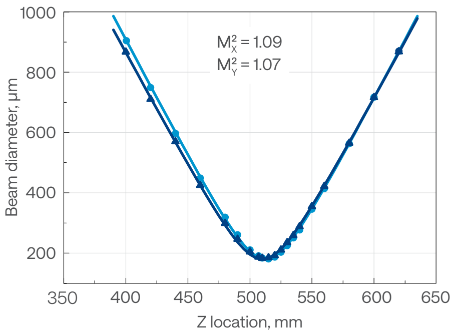
| | | |
|---|---|---|
| Operating temperature | | 15 – 30 °C (air conditioning recommended) |
| Relative humidity | | < 80% (non-condensing) |
| Electrical requirements | Laser | 100 V AC, 12 A – 240 V AC, 5 A, 50 – 60 Hz |
| | Chiller | 100 – 230 V AC, 50 – 60 Hz |
| Rated power | Laser | 1000 W |
|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

1) *Precise wavelengths for specific models are available upon request.*
2) *Assuming Gaussian pulse shape.*
3) *Pulse duration can be reduced to < 250 fs if pulse peak intensity of > 50 $GW/cm^2$ is tolerated by the customer setup.*
4) *FW $1/e^2$, measured at laser output, using maximum pulse energy.*
5) *Under stable environmental conditions. Expressed as normalized root mean squared deviation (NRMSD).*
6) *Available simultaneously. Contact sales@lightcon.com for more details or customized solutions.*
7) *Integrated. For external harmonic generator, refer to HIRO.*
8) *Integrated. For more options and OPAs for -4mJ and -UP models, refer to www.lightcon.com.*
9) *Dimensions depend on laser configuration and integrated options.*

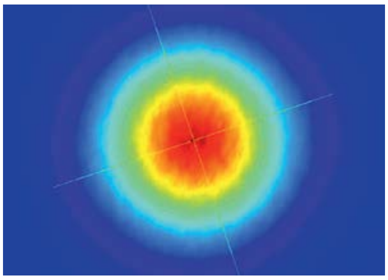
**DANGER:** VISIBLE AND/OR INVISIBLE LASER RADIATION AVOID EYE OR SKIN EXPOSURE TO DIRECT, REFLECTED OR SCATTERED RADIATION
**CLASS 4 LASER PRODUCT**

## Beam properties

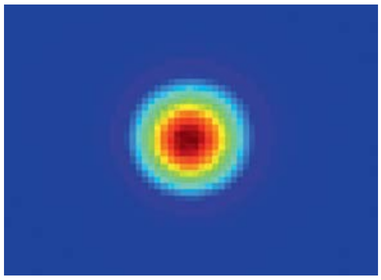
**PHAROS**
Typical M² measurement data




**PHAROS**
Typical near-field beam profile

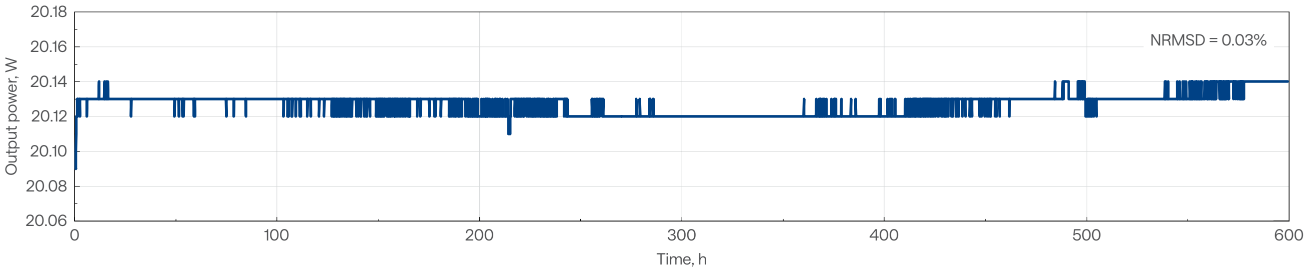


**PHAROS**
Typical far-field beam profile

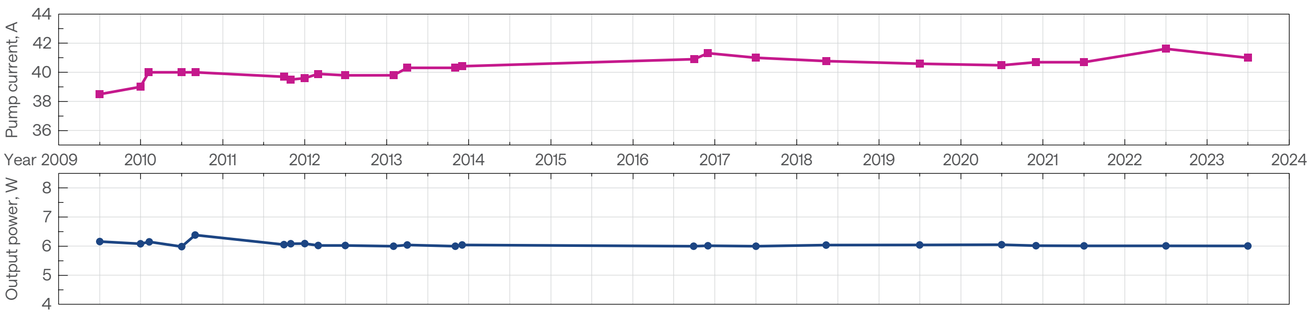


## Stability measurements

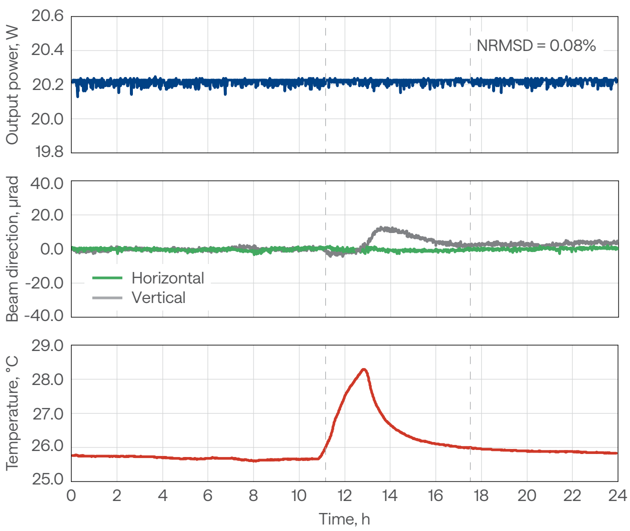
**PHAROS**
Long-term power stability



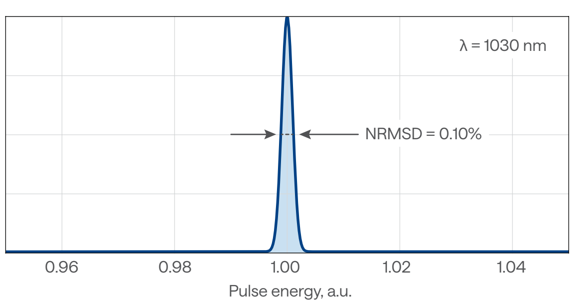

Output power of industrial-grade **PHAROS** lasers operating 24/7 and the current of the pump diodes over the years




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



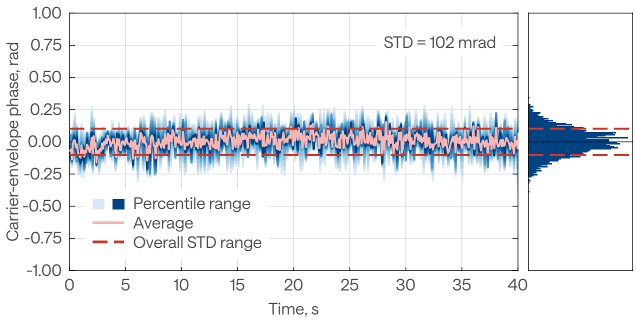

**PHAROS**
Typical pulse-to-pulse energy stability



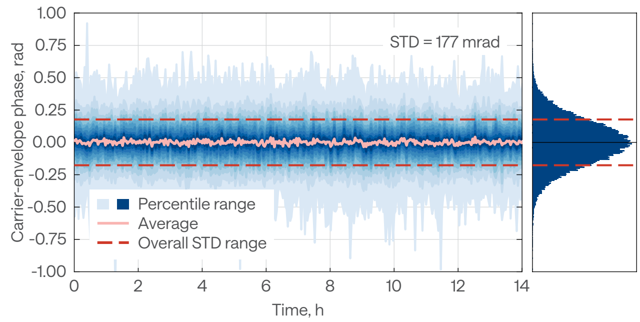
## CEP stabilization

**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 1/4th 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

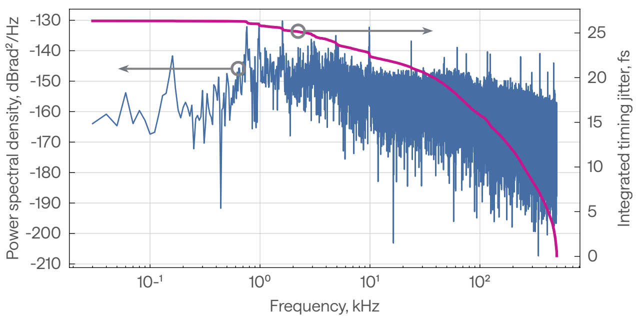



## Repetition rate locking

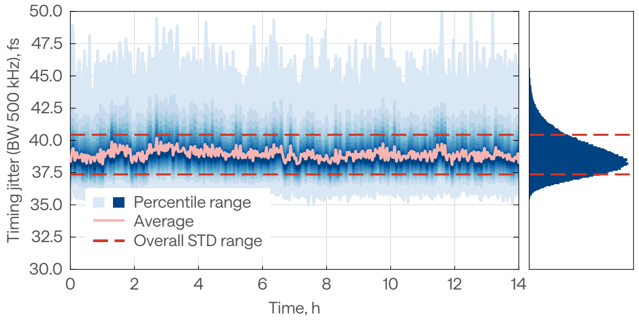
The oscillator of **PHAROS** laser can be customized for repetition rate locking applications. Coupled with the necessary feedback electronics, the repetition rate is synchronized to an external RF source using the two piezo stages installed inside the cavity.

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

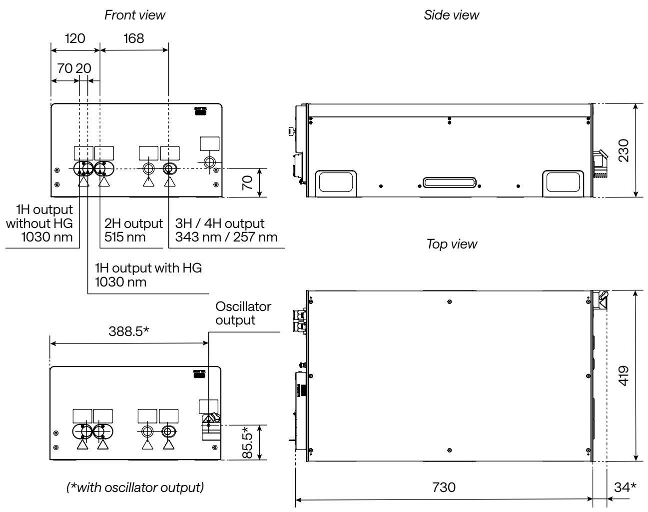



Timing jitter stability over 14 h
**PHAROS** oscillator locked to a 2.8 GHz RF source

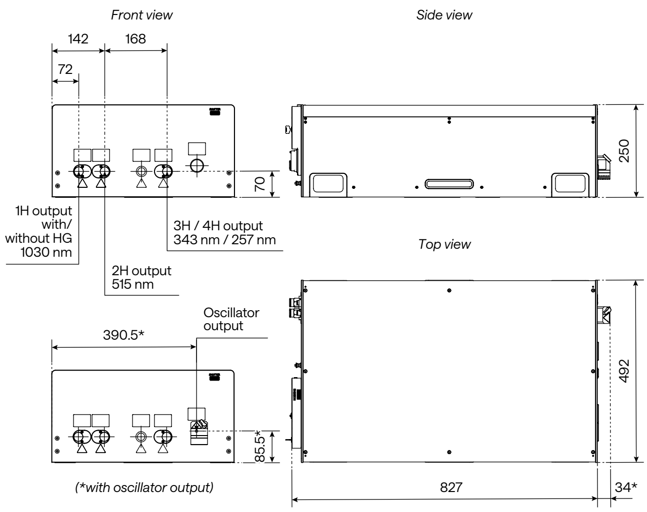



## Drawings

**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



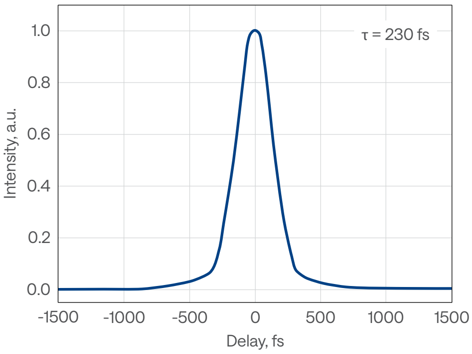
CARBIDE

# Unibody-Design Femtosecond Lasers for Industry and Science

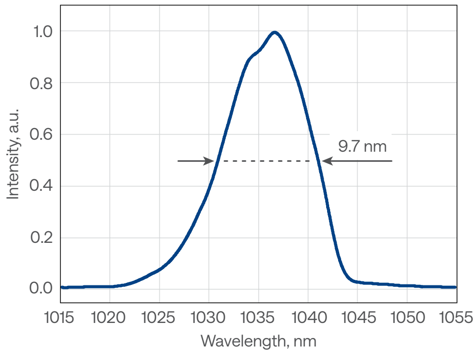

CARBIDE-CB3

- 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 5th harmonic or tunable extensions
- Air-cooled and water-cooled models
- Compact industrial-grade design

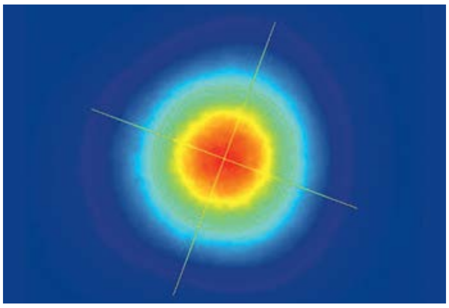
**CARBIDE-CB3**
Typical pulse duration



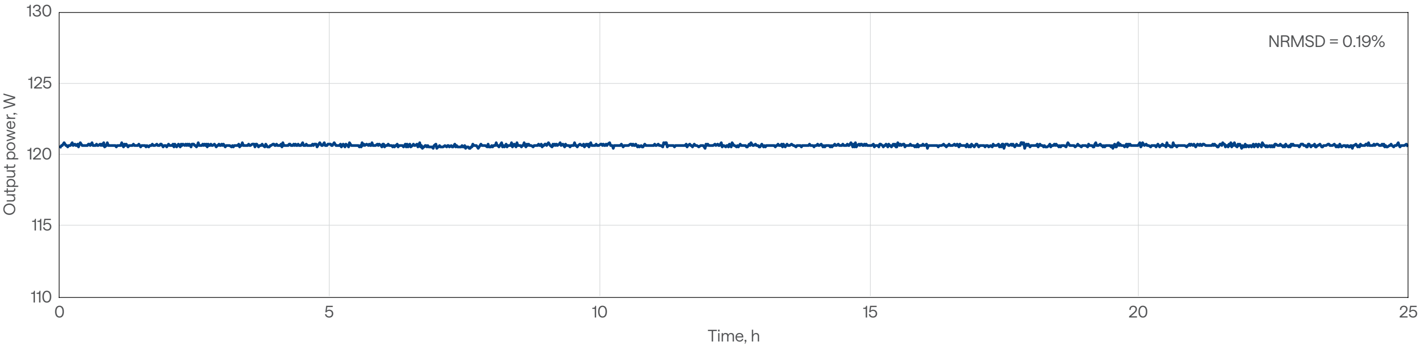

**CARBIDE-CB3**
Typical spectrum




**CARBIDE-CB3**
Typical beam profile



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



# CARBIDE-CB3 specifications

| Model | CB3-20W | CB3-40W (NEW) | | CB3-80W | | CB3-120W |
|---|---|---|---|---|---|---|
| **OUTPUT CHARACTERISTICS** | | | | | | |
| Cooling method | Water-cooled | | | | | |
| Center wavelength | 1030 ± 10 nm | | | | | |
| Maximum output power | 20 W | 40 W | | 80 W | | 120 W |
| Pulse duration [1] | < 250 fs | | | | < 350 fs [2] | < 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 | 1 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, $M^2$ | < 1.2 | | | | | |
| Beam diameter [3] | 3.9 ± 0.4 mm | | | 4.2 ± 0.4 mm | 5.1 ± 0.7 mm | 5 ± 0.5 mm |
| Beam pointing stability | < 20 µrad/°C | | | | | |
| Pulse energy control | FEC [4] | | Attenuator [5] | FEC [4] | | |
| Pulse picker leakage | < 0.25% | | < 0.5% | < 0.25% | | |
| Pulse-to-pulse energy stability, 24 h [6] | < 0.5% | | | | | |
| Long-term power stability, 100 h [6] | < 0.5% | | | | | |
| **MAIN OPTIONS** | | | | | | |
| Oscillator output | < 0.5 W, 120 – 250 fs, 1030 ± 10 nm, ≈ 65 MHz [7] | | | | | |
| Harmonic generator [8] | 515 nm, 343 nm, 257 nm, or 206 nm | | | | | |
| Optical parametric amplifier [9] | 320 – 10000 nm; *see page 12* | | | | | 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 [10] | | 320 × 200 × 75 mm | | | 376 x 449 x 88 mm |

**ENVIRONMENTAL AND UTILITY REQUIREMENTS**

| | | CB3-20W | CB3-40W | | CB3-80W | | CB3-120W |
|---|---|---|---|---|---|---|---|
| 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 | 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 |

1) *Assuming Gaussian pulse shape.*
2) *Pulse duration can be reduced to < 250 fs if pulse peak intensity of > 50 GW/cm² is tolerated by the customer setup.*
3) *FW 1/e², using maximum pulse energy.*
4) *Fast energy control (FEC) provides fast, full-scale individual pulse energy control; an external analog control input is available.*
5) *Waveplate-based variable optical attenuator (VOA); an external analog control input is available.*
6) *Under stable environmental conditions. Expressed as normalized root mean squared deviation (NRMSD)*
7) *Available simultaneously, requires a scientific interface. Contact sales@lightcon.com for more details or customized solutions.*
8) *Integrated. For external harmonic generator, refer to HIRO.*
9) *Integrated. For more options and OPAs, refer to www.lightcon.com.*
10) *Power supply can be different if optional 2 MHz version is selected.*

DANGER: VISIBLE AND/OR INVISIBLE LASER RADIATION AVOID EYE OR SKIN EXPOSURE TO DIRECT, REFLECTED OR SCATTERED RADIATION
CLASS 4 LASER PRODUCT

# CARBIDE-CB5 (air-cooled) specifications

| Model | CB5 | | CB5-SP |
|---|---|---|---|
| **OUTPUT CHARACTERISTICS** | | | |
| Cooling method | Air-cooled [1] | | |
| Center wavelength | 1030 ± 10 nm | | |
| Maximum output power | 6 W | 5 W | |
| Pulse duration [2] | < 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, $M^2$ | < 1.2 | | |
| Beam diameter [3] | 2.1 ± 0.4 mm | | |
| Beam pointing stability | < 20 µrad/°C | | |
| Pulse energy control | Attenuator [4] | AOM [5] | Attenuator [4] |
| Pulse picker leakage | < 2% | < 0.1 % | < 2% |
| Pulse-to-pulse energy stability, 24 h [6] | < 0.5% | | |
| Long-term power stability, 100 h [6] | < 0.5% | | |
| **MAIN OPTIONS** | | | |
| Oscillator output | n/a | | |
| Harmonic generator [7] | 515 nm, 343 nm, 257 nm, or 206 nm; | | |
| Optical parametric amplifier [8] | 320 – 10000 nm; *see page 12* | | |
| 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 | | |

1) *Water-cooled version available on request.*
2) *Assuming Gaussian pulse shape.*
3) *FW 1/e², using maximum pulse energy.*
4) *Waveplate-based variable optical attenuator (VOA); an external analog control input is available.*
5) *Enhanced contrast AOM. Provides fast amplitude control of output pulse train.*
6) *Under stable environmental conditions. Expressed as normalized root mean squared deviation (NRMSD).*
7) *Integrated. For external harmonic generator, refer to HIRO.*
8) *Integrated. For stand-alone OPAs, refer to www.lightcon.com.*

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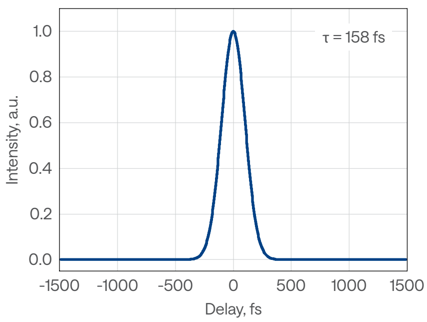
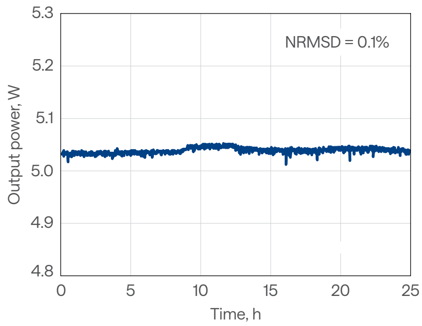
CLASS 4 LASER PRODUCT

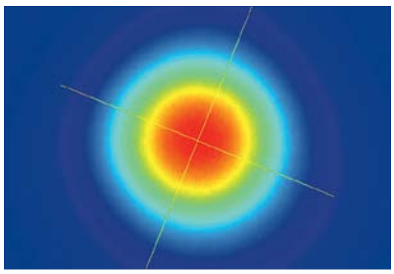
CARBIDE-CB5-SP
Typical pulse duration




CARBIDE-CB5
Long-term power stability

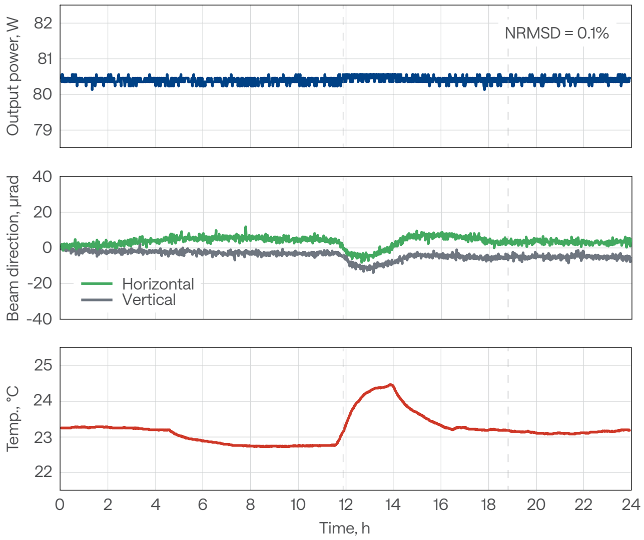



CARBIDE-CB5
Typical beam profile

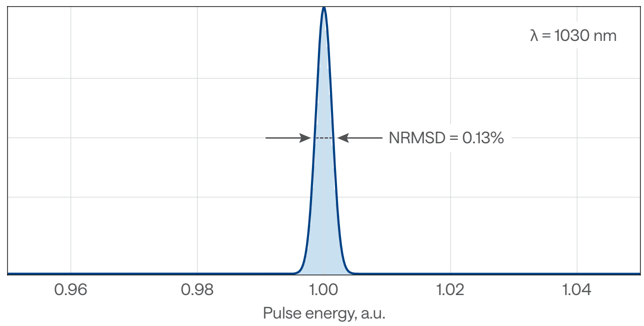


# Stability measurements

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

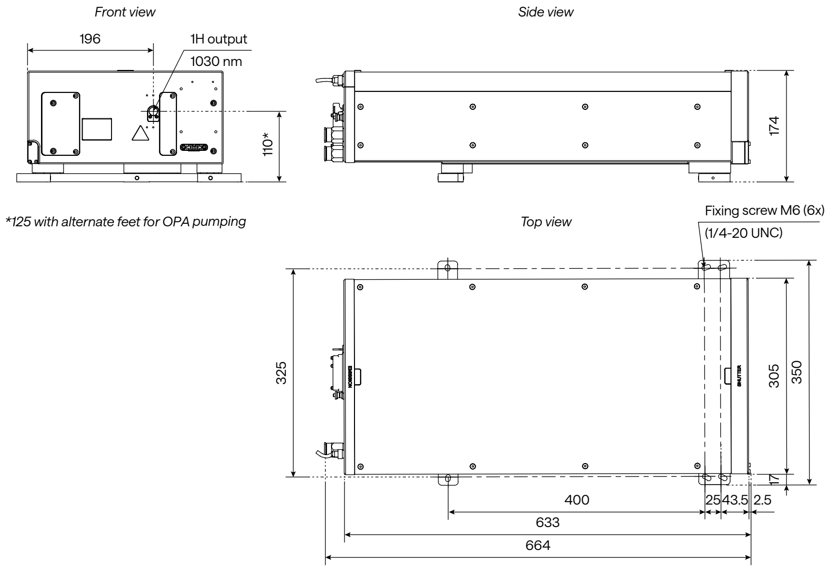



**CARBIDE-CB3**
Typical pulse-to-pulse energy stability

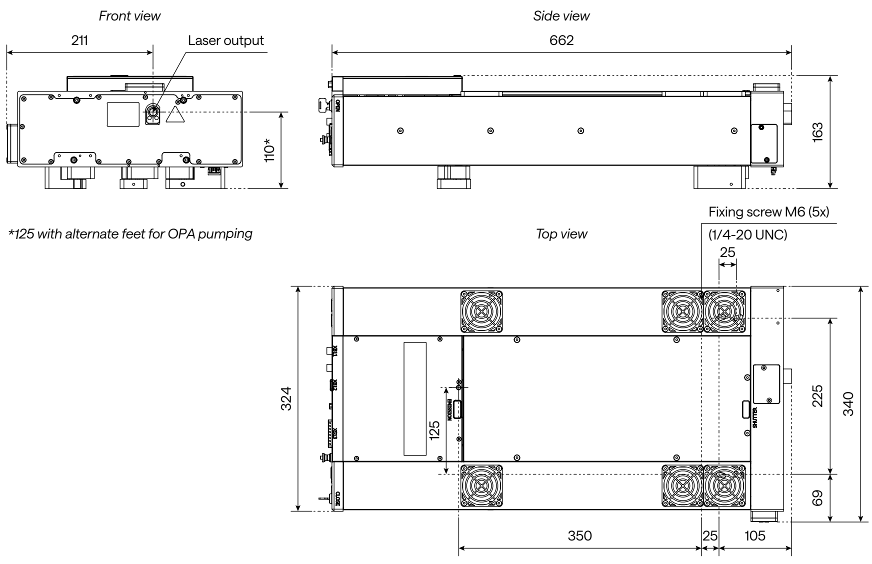


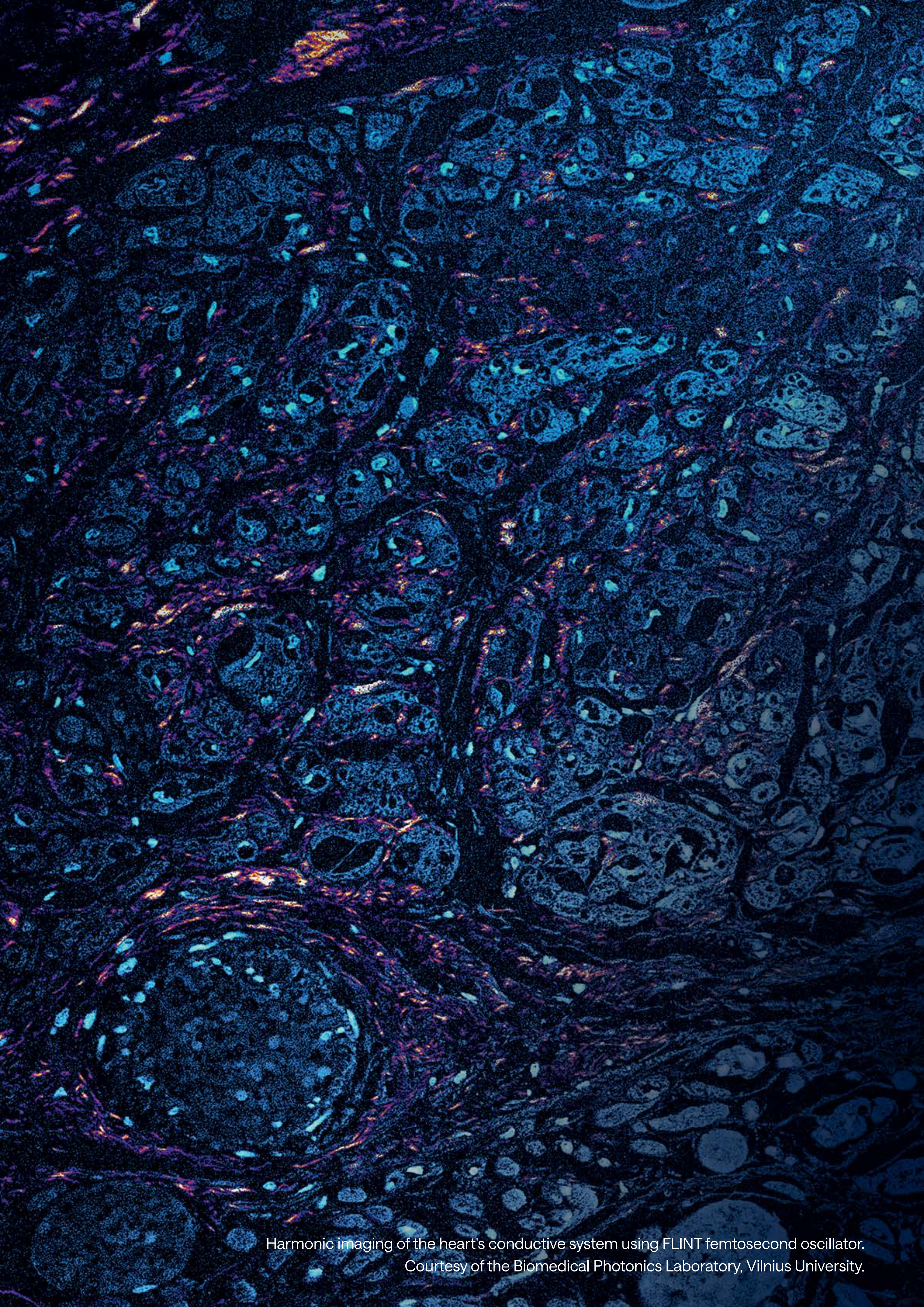

# Drawings

**CARBIDE-CB3** drawing




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





Harmonic imaging of the heart's conductive system using FLINT femtosecond oscillator.
Courtesy of the Biomedical Photonics Laboratory, Vilnius University.

# Nonlinear Microscopy Applications

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

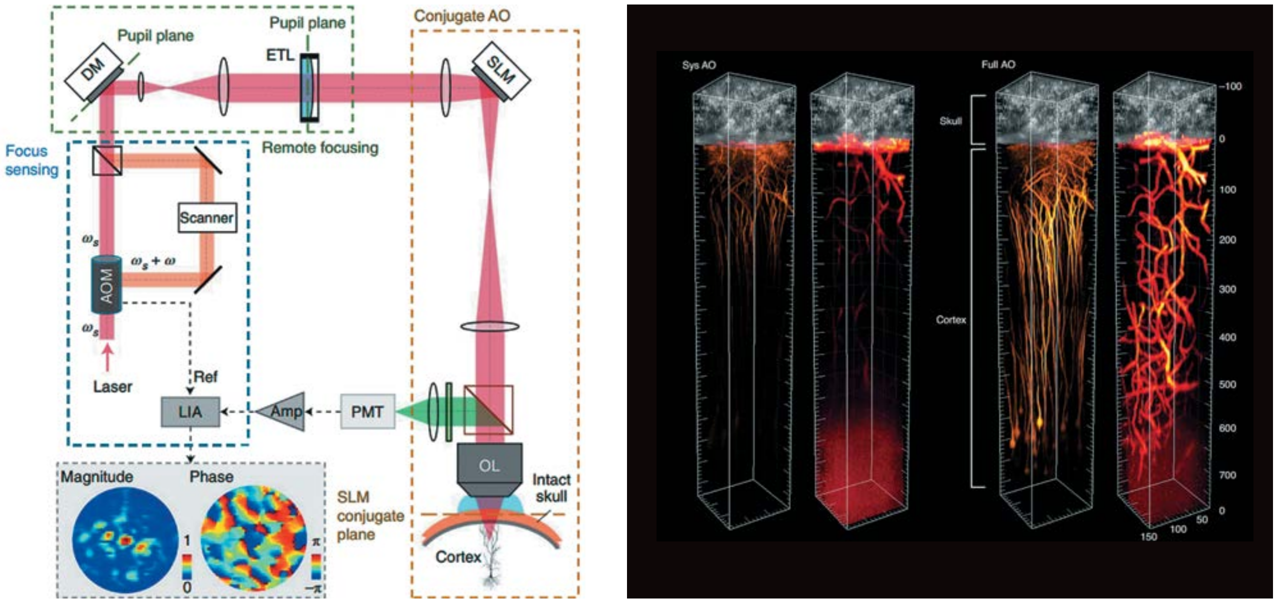
Functional 3P neuroimaging

2P optogenetics

SHG, THG, and 2P imaging

## Functional 3P neuroimaging

Recording real-time single-neuron activity in the deep brain layers of awake animals is essential for understanding behavior, brain connectivity, and function. These applications have been advanced by neuron imaging and stimulation techniques using high-power, high-pulse-energy lasers with medium-repetition rates, tunable in the SWIR range, which aligns with the biological transparency windows at 1300 nm and 1700 nm. For 2P and 3P excited fluorescence, and harmonic-generation (SHG, THG) imaging in deep tissues, dispersion-controlled femtosecond pulses from **I-OPA** and **ORPHEUS** OPAs and microscopy-dedicated **CRONUS** lasers represent state-of-the-art choices.



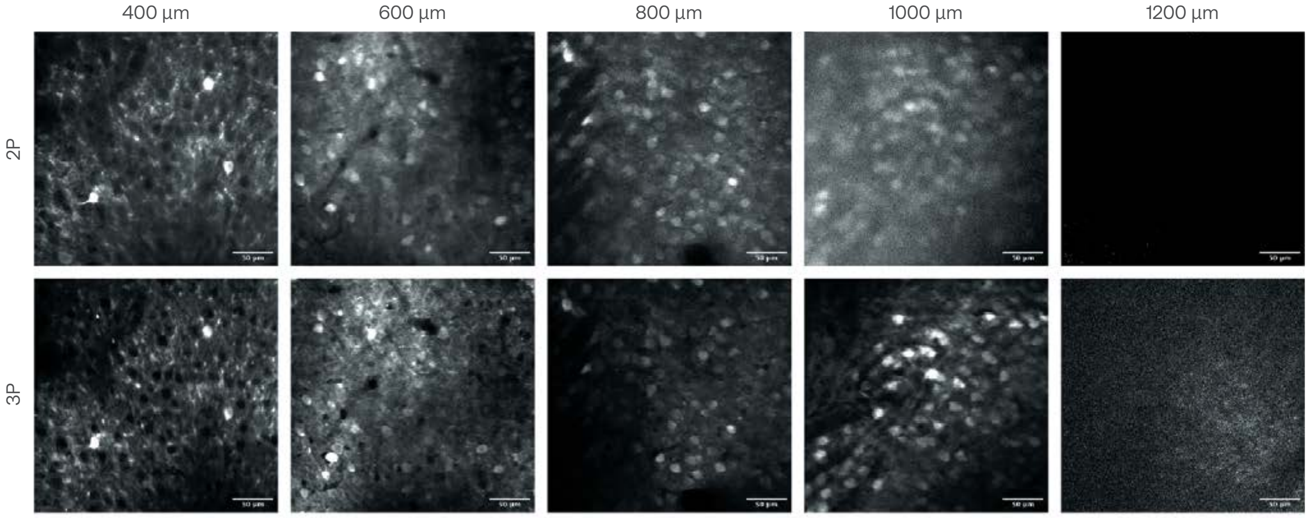

3P microscopy with adaptive optics for focus sensing and shaping to compensate for both aberrations and scattering. **ORPHEUS-F** excitation at 1300 nm enabled imaging up to 1.1 mm below the pia within the intact brain.

Courtesy of Jianan Y. Qu group, the Hong Kong University of Science and Technology. Source: Qin et al., Deep tissue multi-photon imaging using adaptive optics with direct focus sensing and shaping, Nature Biotechnology 40 (2022).

## 2P and 3P calcium imaging at depth in mouse brain

Three-photon microscopy (3PM) has gained popularity as a tool able to extend the capabilities of two-photon microscopy (2PM) by imaging deeper layers in the brain and other tissues such as tumors and bone.

Imaging depth in 2PM is limited by the scattering and absorption of excitation light within the tissue. 3PM overcomes this limit because the higher nonlinearity of the 3P excitation reduces the background.

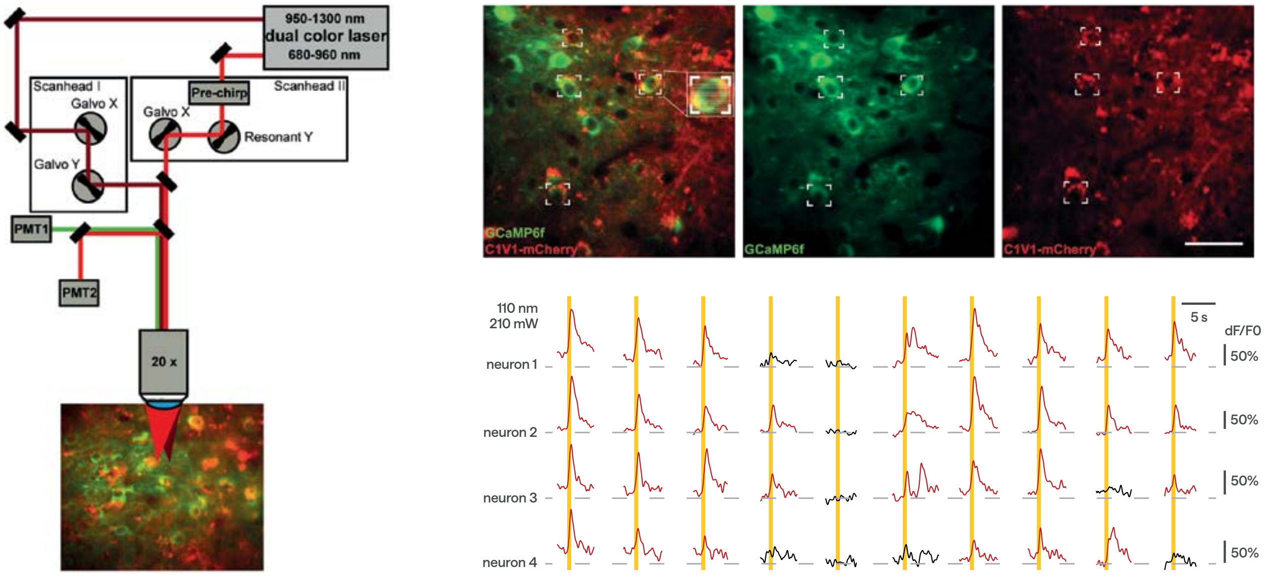



Comparison of in vivo 2P and 3P calcium imaging of mouse visual cortex GCaMP neurons on a Thorlabs Bergamo II microscope using a typical 2P laser and Light Conversion's **CRONUS-3P** (3P) laser at 920 nm and 1300 nm, respectively.

Courtesy of CSHL ISFNS 2024 school organizers, Willis Broden Jr. and Sergey Matveev (Thorlabs).

## 2P optogenetics

Despite the advances in 3-photon excitation sources providing longer wavelengths and higher pulse energies, certain imaging challenges are still better addressed by tunable high-repetition-rate oscillator-based lasers. This is especially true when imaging speed is the primary factor. For these applications, the **CRONUS-2P** laser offers the ultimate solution with its optically synchronized three outputs, two of which are independently tunable. A three-beam source enables a variety of multiphoton excitation pathways, many of which are inaccessible using traditional single- and two-beam solutions. Furthermore, the independent tunability of the two beams enables new coherent Raman scattering modalities.

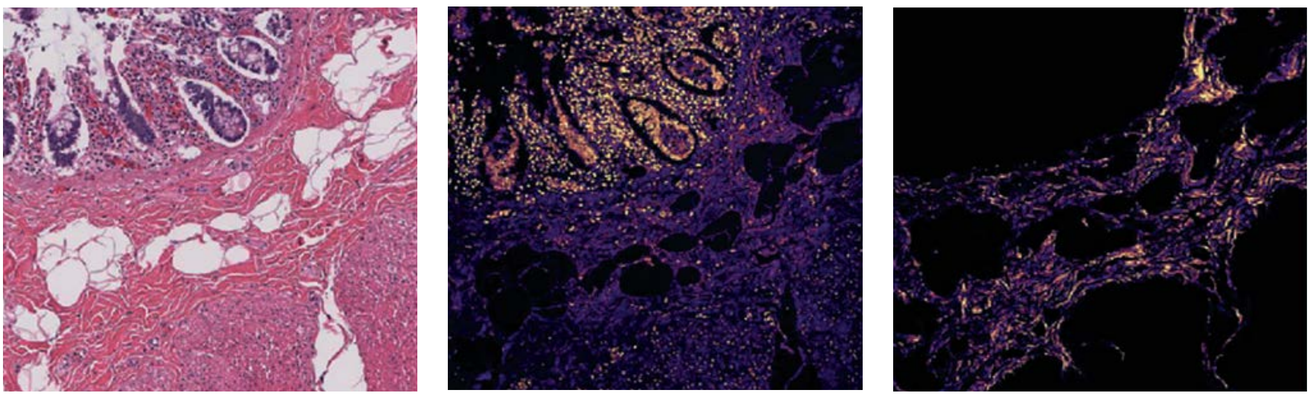



2P optogenetic stimulation of individual neurons using **CRONUS-2P**.

Courtesy of Albrecht Stroh group, University Medical Center Mainz and Leibniz Institute for Resilience Research. Source: T. Fu et al., Exploring two-photon optogenetics beyond 1100 nm for specific and effective all-optical physiology, iScience 24 (2021).

## Raster-scanning 2P/3P microscopy

For applications requiring a fixed-wavelength femtosecond laser, such as multiphoton-driven fluorescence, excited at 1 µm, and harmonic-generation (SHG, THG) microscopy, the **FLINT** oscillator is a high-performance solid-state source in a proven, industrial-grade package and a compact footprint. The **FLINT** oscillator provides stable 24/7 operation with excellent noise performance, characterized by a RIN of < 140 dBc/Hz above 200 kHz and shot-noise-limited performance at -160 dBc/Hz above 1 MHz.



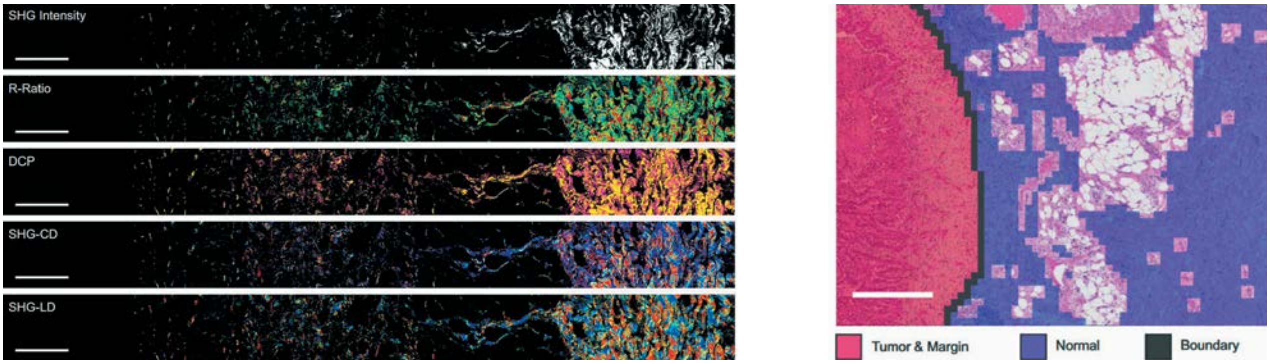
SHG and THG images of H&E-stained colon using the **FLINT** femtosecond oscillator.

Courtesy of Virginijus Barzda group, Vilnius University.

## Widefield polarimetric SHG microscopy

Cancer diagnosis and surgical treatment rely on imaging techniques that demand specificity and high throughput. Polarization-resolved second-harmonic generation (P-SHG) microscopy shows potential for visualizing structural changes in collagen networks and the extracellular matrix associated with tumor development. Moreover, P-SHG imaging is label-free and compatible with live tissue imaging at depth. However, traditional raster scanning methods are too slow for clinical applications, and interpreting the structural sensitivity of P-SHG can be challenging.

Nonlinear widefield microscopy addresses these limitations by utilizing amplified femtosecond lasers to increase imaging throughput and field of view. Additionally, machine learning (ML) techniques enable data-driven analysis, facilitating tasks such as automating tumor margin delineation and scoring. By leveraging **PHAROS** and **CARBIDE** lasers in conjunction with ML-augmented widefield microscopy, we can potentially extend the benefits of nonlinear microscopy to the scale required for biomedical and clinical applications.

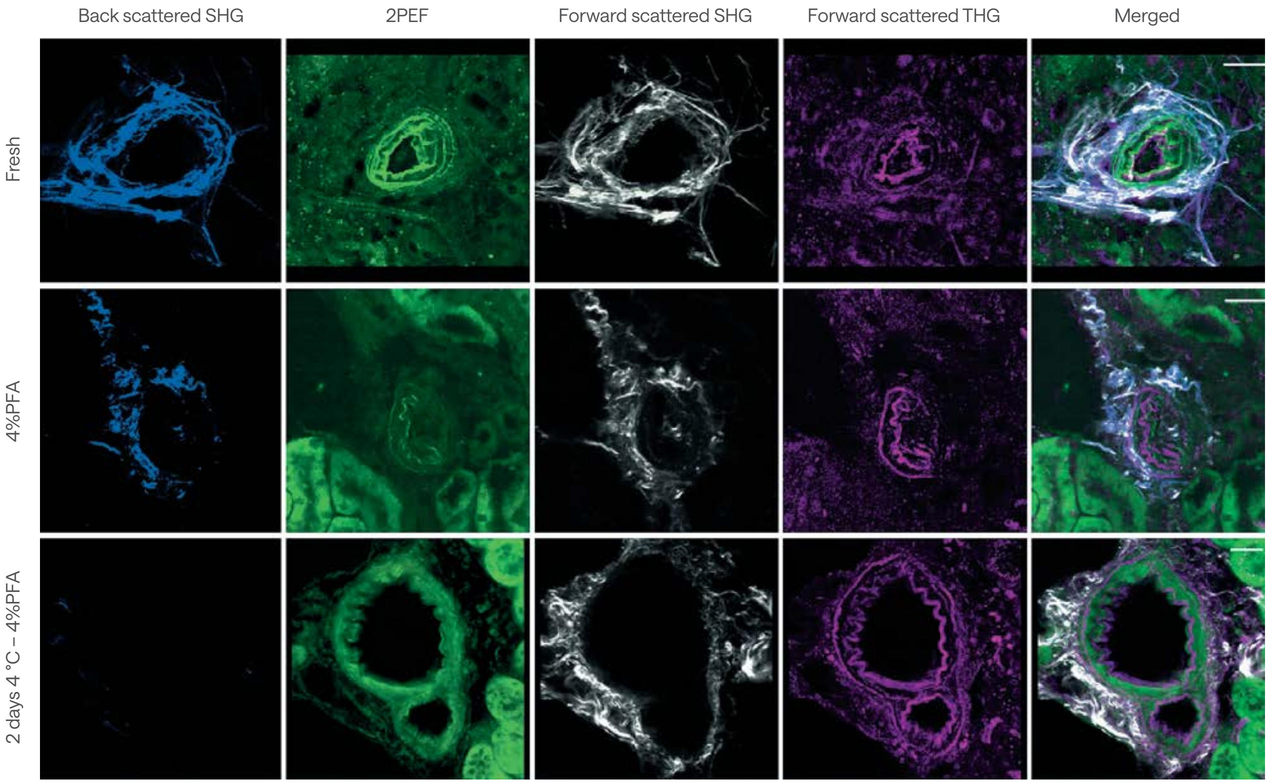



Large-area widefield P-SHG microscopy of human lung tissue tumor margins conducted using the **PHAROS** laser. Image parameters, including SHG intensity, R-ratio, and degree of circular polarization, as well as SHG circular and linear dichroism, are employed in unsupervised ML algorithms to determine the tumor boundary.

Courtesy of Virginijus Barzda group, University of Toronto, and Brian C. Wilson group, Princess Margaret Cancer Centre. Source: Mirsanaye et al., Unsupervised determination of lung tumor margin with widefield polarimetric second-harmonic generation microscopy, Scientific Reports 12 (2022).

## SHG, THG, and 2P imaging

Fixation methods, such as formalin, are commonly used for tissue preservation to maintain their structure as close as possible to the native condition. However, these fixatives chemically interact with tissue molecules, potentially altering their structure. To assess the impact of preservation methods, such as chemical fixatives, on the nonlinear capabilities of protein components within mouse tissues, nonlinear two-photon (2P) microscopy and the **CRONUS-2P** femtosecond laser were utilized. These techniques take advantage of the SHG and THG emission properties of tissue components.



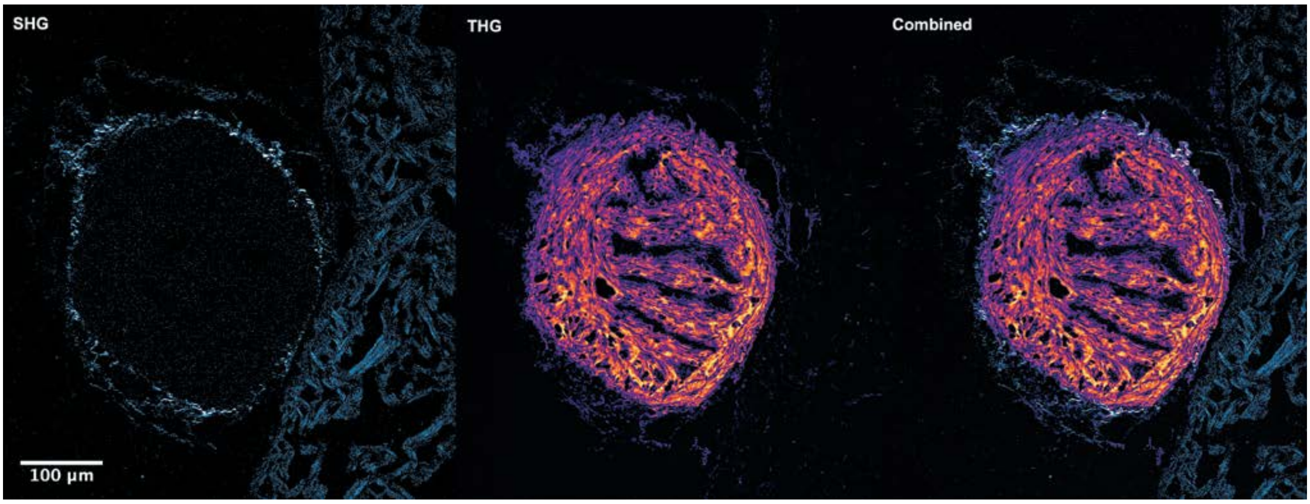

SHG signals from collagen, 2P excitation microscopy and THG signals from elastin in vibratome sections of mouse kidney after different treatments, registered using the **CRONUS-2P** femtosecond laser source.

Courtesy of Frauke Alves and Fernanda Ramos-Gomes, Max-Planck Institute for Multidisciplinary Sciences, Germany.

## Combined SHG and THG imaging

Adult zebrafish heart ventricle section used in a scar formation study imaged with the **FLINT** femtosecond oscillator. The brightfield image is stained with Masson's trichrome (MT), where connective tissue appears blue and muscle appears red/brown.

SHG and THG images reveal collagen and muscle structure at the periphery of the bulbus arteriosus, while MT-stained elastin is visualized in the center in THG.



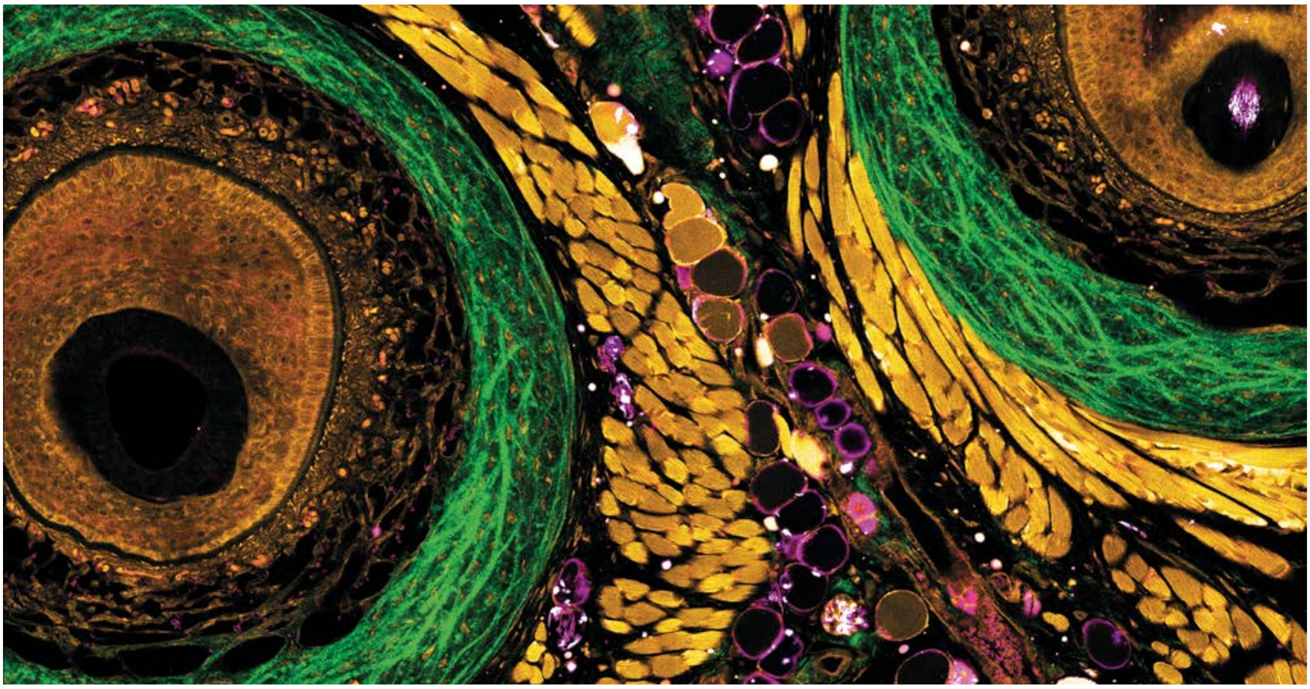

Adult zebrafish heart ventricle section imaged using the **FLINT** femtosecond oscillator.

Samples courtesy of Justas Lazutka at the Vilnius University Life Sciences Center. Nonlinear imaging courtesy of the Virginijus Barzda group at the Vilnius University Faculty of Physics.

## Label-free in vivo imaging

Understanding biological complexity requires minimally disruptive imaging tools capable of providing multiplexed molecular contrasts. To address this need, S. You's laboratory at the Massachusetts Institute of Technology is developing a non-invasive, label-free microscopy approach using CRONUS-3P to visualize biosystems.

As part of a study on neuropathic pain, the image reveals the rich microenvironment of an unprocessed, intact mouse whisker pad: collagen capsule (green), comprising the follicle with muscles (yellow) supporting it, adipocytes (purple), stromal cells, and immune cells.



Mouse whisker pad using label-free microscopy.

Courtesy of Sixian You group, Massachusetts Institute of Technology.

# Global Representative Network

**AUSTRALIA, NEW ZEALAND**
**Lastek Pty Ltd.**
Adelaide, Australia
Phone: +61 8 84 438 668
ricardas@lastek.com.au
www.lastek.com.au

**BELGIUM, NETHERLANDS, LUXEMBOURG**
**Laser 2000 Benelux C.V.**
Vinkeveen, Netherlands
Phone: +31 297 266191
info@laser2000.nl
www.laser2000.nl

**BRAZIL**
**Photonics Ltda**
São Paulo, Brazil
Phone: +55 11 2839 3209
info@photonics.com.br
www.photonics.com.br

**CZECH REPUBLIC, SLOVAKIA**
**Femtonika s.r.o.**
Zbýšov, Czech Republic
Phone: +420 792 417 400
info@femtonika.cz
www.femtonika.cz

**CHINA**
**Light Conversion China**
Shenzhen, China
Phone: +86 189 4874 5558
sales.china@cn.lightcon.com

**Beijing Light-Quantum Technology Co., Ltd.**
Beijing, China
Phone: +86 10 8290 0415
sales@light-quantum.cn
www.light-quantum.cn

**Genuine Optronics Limited**
Shanghai, China
Phone: +86 21 64 325 169
jye@gen-opt.com
www.gen-opt.com

**FRANCE, SWITZERLAND, BELGIUM**
**Jean-François Poisson**
Industrial Market Development Manager
Phone: +33 674 48 0778
jf.poisson@lightcon.com

**FRANCE**
**Frédéric Berthillier**
Scientific Market Development Manager
Phone: +33 745 014 410
frederic.berthillier@lightcon.com

**GERMANY, AUSTRIA, SWITZERLAND**
**Ulrich Höchner**
Industrial Market Development Manager
Phone: +49 157 8202 5058
u.hoechner@lightcon.com

**GERMANY, AUSTRIA**
**Christian Hellwig**
Scientific Market Development Manager
Phone: +49 174 204 9053
christian.hellwig@lightcon.com

**Stefan Piontek**
Scientific Market Development Manager
Mobile +49 176 8345 7119
stefan.piontek@lightcon.com

**INDIA**
**Anatech Laser Instruments Pvt. Ltd.**
Mumbai, India
Phone: +91 22 4121 0001 / 02 / 03
sales@anatechlaser.com
www.anatechlaser.com

**ISRAEL**
**ROSH Electroptics Ltd.**
Natanya, Israel
Phone: +972 (0)9 862 7401
info@roshelop.co.il
www.roshelop.co.il

**ITALY**
**Optoprim S.r.l.**
Vimercate, Italy
Phone: +39 039 834 977
info@optoprim.it
www.optoprim.it

**JAPAN**
**Phototechnica Corp.**
Saitama, Japan
Phone: +81 48 871 0067
voc@phototechnica.co.jp
www.phototechnica.co.jp

**KOREA**
**Light Conversion Korea**
Daejeon, Korea
Phone: +82 42 368 1010
jungsik.seo@lightcon.com

**POLAND**
**Amecam**
Warszawa, Poland
Phone: +48 602 500 680
amecam@amecam.pl
www.amecam.pl

**SINGAPORE**
**Acexon Technologies Pte Ltd.**
Singapore
Phone: +65 6565 7300
sales@acexon.com
www.acexon.com

**SPAIN, PORTUGAL**
**Innova Scientific S.L.**
Las Rozas de Madrid, Spain
Phone: +34 91 710 56 50
rafael.pereira@innovasci.com
www.innovasci.com

**SWITZERLAND**
**GMP SA**
Renens, Switzerland
Phone: +41 21 633 21 21
info@gmp.ch
www.gmp.ch

**TAIWAN**
**Alaser Co. Ltd.**
Taipei, Taiwan
Phone: +886 2 2377 3118
alexfu@alaser.com.tw
www.alaser.com.tw

**TURKEY**
**Innova Teknoloji Ltd.**
İstanbul, Turkey
Phone: +90 216 315 03 36
eryetistir@innova-teknoloji.com
www.innova-teknoloji.com

**UNITED KINGDOM**
**Photonic Solutions Ltd.**
Edinburgh, UK
Phone: +44 (0) 131 664 8122
ben.agate@photonicsolutions.co.uk
www.photonicsolutions.co.uk

**USA, CANADA**
**Light Conversion-USA, Inc.**
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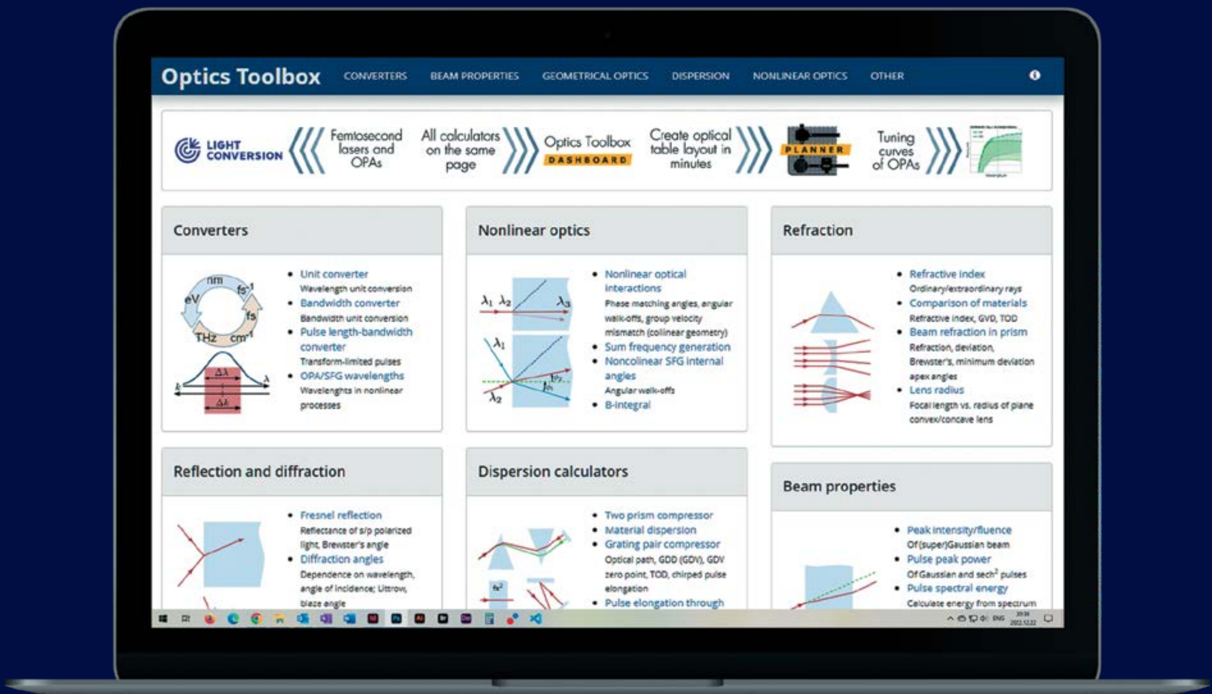


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**LIGHT CONVERSION CHINA**
702-1, F1 Building, TCL Science Park, No.1001
Zhongshanyuan Road, Nanshan Dist., Shenzhen, China
Phone: +86 189 4874 5558
sales.china@cn.lightcon.com

**LIGHT CONVERSION KOREA**
520-ho, 65, Techno 3-ro,
Yuseong-gu, Daejeon, 34016, Korea
Phone: +82 42 368 1010
jungsik.seo@lightcon.com

**LIGHT CONVERSION**
Keramiku 2B, LT-10233 Vilnius, Lithuania

Tel.: +370 5 2491830
Website: www.lightcon.com
Sales: sales@lightcon.com
Service: service@lightcon.com

**LIGHT CONVERSION USA, INC**
619 N Church Ave, Unit #3
Bozeman, MT 59715
Phone: +1 833 685 2872
Fax: +1 833 395 2872
saleslc@lightcon-usa.com

toolbox.lightcon.com