

I-OPA

Industrial-Grade Optical Parametric Amplifier



FEATURES

- Tunable or fixed wavelength options
- Industrial-grade design
- Plug-and-play installation and user-friendly operation
- Single-shot – 2 MHz repetition rate
- Up to 40 W pump power
- < 100 fs pulse duration option
- Integrated tunable beam splitter for pump laser beam



I-OPA-TW attached to air-cooled CARBIDE-CB5

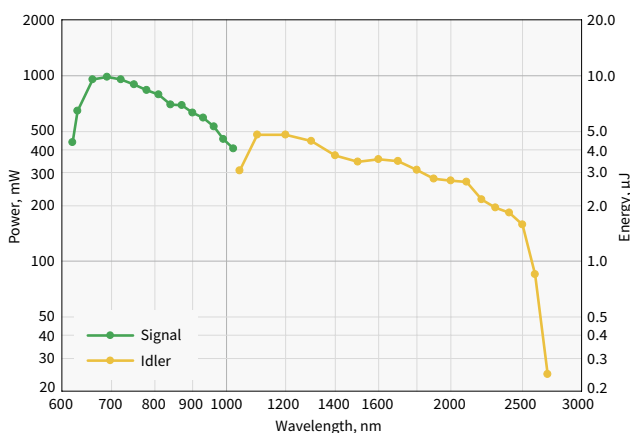
The industrial-grade optical parametric amplifier I-OPA series marks a new era of simplicity in the world of tunable wavelength femtosecond light sources. Based on over 10 years of experience producing the ORPHEUS series of optical parametric amplifiers, this solution brings together the tunability of wavelength with the robust industrial-grade design. The I-OPA is a rugged module attachable to our PHAROS and CARBIDE lasers, providing long-term stability comparable to that of the industrial-grade harmonic generators.

The tunable-wavelength I-OPA (I-OPA-TW) provides a wide tuning range and is primarily intended for spectroscopy and microscopy applications. In particular, the -HP model is targeted to be coupled with our HARPIA spectroscopy

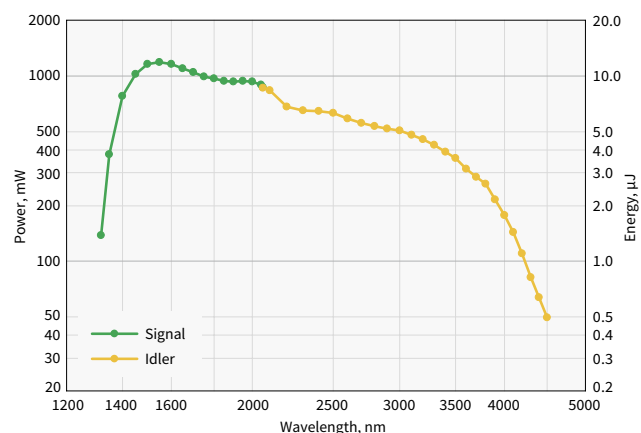
system as a pump beam source for ultrafast pump-probe spectroscopy. The -F model is primarily designed as a light source for multiphoton microscopy, the -ONE model – for IR spectroscopy and other applications where high energy mid-IR pulses are desired. All of the models can also be used for micromachining and other industrial applications.

The fixed-wavelength I-OPA (I-OPA-FW) is primarily intended for applications that desire a single-wavelength output. The industrial-grade design provides mechanical stability and eliminates the effects of air-turbulence, minimizing energy fluctuations and ensuring stable long-term performance.

The I-OPA-TW is best suited for R&D systems, while the I-OPA-FW is a cost-effective solution for large-scale production.



Typical I-OPA-TW-HP tuning curves.
Pump: 10 W, 100 µJ, 100 kHz



Typical I-OPA-TW-ONE tuning curves.
Pump: 10 W, 100 µJ, 100 kHz

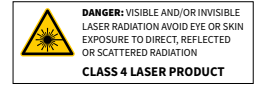
SPECIFICATIONS OF TUNABLE I-OPA

Model	I-OPA-TW-HP	I-OPA-TW-F	I-OPA-TW-ONE
Based on ORPHEUS model	ORPHEUS	ORPHEUS-F	ORPHEUS-ONE
Pump power	Up to 40 W		
Pump pulse energy	10 – 400 μ J		20 – 400 μ J
Repetition rate	Up to 2 MHz		
Tuning range, Signal	640 – 1010 nm	650 – 900 nm	1350 – 2060 nm
Tuning range, Idler	1050 – 2600 nm	1200 – 2500 nm	2060 – 4500 nm
Conversion efficiency at peak	> 7% @ 700 nm (40 – 400 μ J pump; up to 1 MHz)		> 9% @ 1550 nm (40 – 400 μ J pump; up to 1 MHz)
	> 3.5% @ 700 nm (10 – 40 μ J pump; up to 2 MHz)		> 6% @ 1550 nm (20 – 40 μ J pump; up to 2 MHz)
Long-term power stability (8 h)	< 1.5% @ 800 nm		< 1.5% @ 1550 nm
Pulse energy stability (1 min)	< 1.5% @ 800 nm		< 1.5% @ 1550 nm
Additional options	n/a	SCMP (Signal pulse compressor) ICMP (Idler pulse compressor) PCMP (pre-chirp dispersion compensator)	n/a
Spectral bandwidth ¹⁾	80 – 220 cm^{-1} @ 700 – 960 nm	200 – 750 cm^{-1} @ 650 – 900 nm 150 – 500 cm^{-1} @ 1200 – 2000 nm	60 – 150 cm^{-1} @ 1450 – 2000 nm
Pulse duration ²⁾	120 – 250 fs	< 60 fs @ 800 – 900 nm < 70 fs @ 650 – 800 nm < 100 fs @ 1200 – 2000 nm	100 – 300 fs
Optional wavelength extensions	SHS: 320 – 505 nm SHI: 525 – 640 nm Conversion efficiency 1.2% at peak	Contact sales@lightcon.com	DFG: 4500 – 10000 nm ³⁾
Applications	Micromachining Microscopy Spectroscopy	Nonlinear microscopy Ultrafast spectroscopy	Mid-IR spectroscopy AFM microscopy

¹⁾ I-OPA-TW-F outputs broad bandwidth pulses which are compressed externally.

²⁾ Output pulse duration depends on wavelength and pump laser pulse duration. I-OPA-TW-F requires pulse compressors to achieve short pulse duration.

³⁾ Up to 16 μ m tuning range is accessible with external difference frequency generator (DFG).



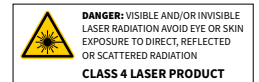
SPECIFICATIONS OF FIXED WAVELENGTH I-OPA

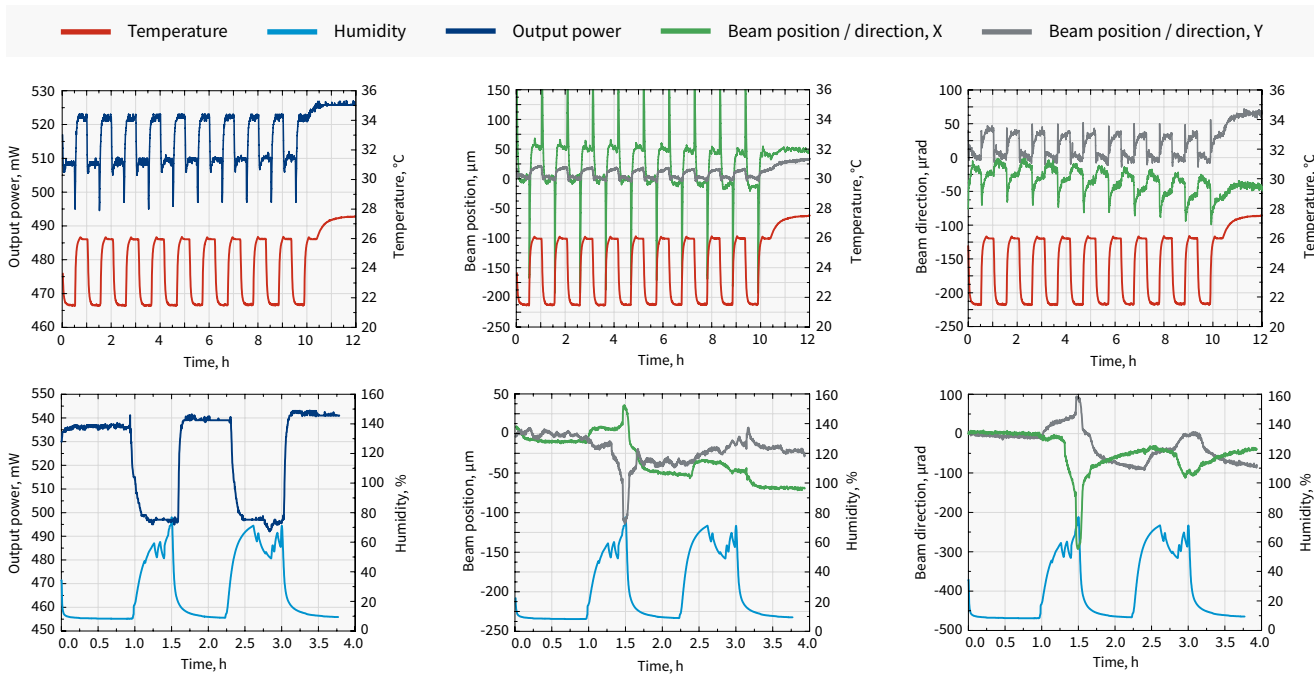
Model	I-OPA-FW-HP	I-OPA-FW-F	I-OPA-FW-ONE
Pump power	Up to 40 W		
Pump pulse energy	10 – 500 μ J		20 – 1000 μ J
Repetition rate	Up to 2 MHz		
Wavelength selection range, Signal ¹⁾	640 – 1010 nm	650 – 900 nm	1350 – 2060 nm
Wavelength selection range, Idler ¹⁾	1050 – 2600 nm	1200 – 2500 nm	2060 – 4500 nm
Conversion efficiency at peak	> 7% @ 700 nm (40 – 500 μ J pump; up to 1 MHz)		> 9% @ 1550 nm (40 – 1000 μ J pump; up to 1 MHz)
	> 3.5% @ 700 nm (10 – 40 μ J pump; up to 2 MHz)		> 6% @ 1550 nm (10 – 40 μ J pump; up to 2 MHz)
Long-term power stability (8 h)	< 1.5% @ 800 nm		< 1.5% @ 1550 nm
Pulse energy stability (1 min)	< 1.5% @ 800 nm		< 1.5% @ 1550 nm
Spectral bandwidth ²⁾	80 – 220 cm^{-1} @ 700 – 960 nm	200 – 750 cm^{-1} @ 650 – 900 nm 150 – 500 cm^{-1} @ 1200 – 2000 nm	60 – 150 cm^{-1} @ 1450 – 2000 nm
Pulse duration ³⁾	120 – 250 fs	< 60 fs @ 800 – 900 nm < 70 fs @ 650 – 800 nm < 100 fs @ 1200 – 2000 nm	150 – 300 fs
Applications	Micromachining Microscopy Spectroscopy	Nonlinear microscopy Ultrafast spectroscopy	Micromachining Mid-IR generation

¹⁾ A single wavelength can be selected from the Signal/Idler range. Signal will have accessible Idler pair, and vice versa.

²⁾ I-OPA-FW-F outputs broad bandwidth pulses which are compressed externally.

³⁾ Output pulse duration depends on wavelength and pump laser pulse duration. I-OPA-FW-F requires external pulse compressors to achieve short pulse duration.





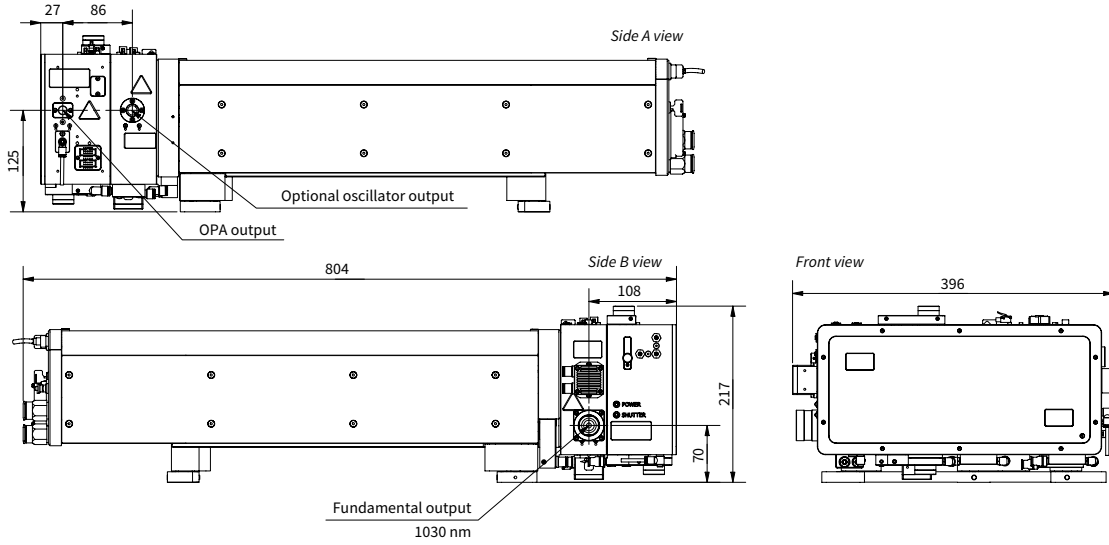
I-OPA-FW output power, beam position, and beam direction under harsh environmental conditions

COMPARISON WITH OTHER FEMTOSECOND AND PICOSECOND LASERS

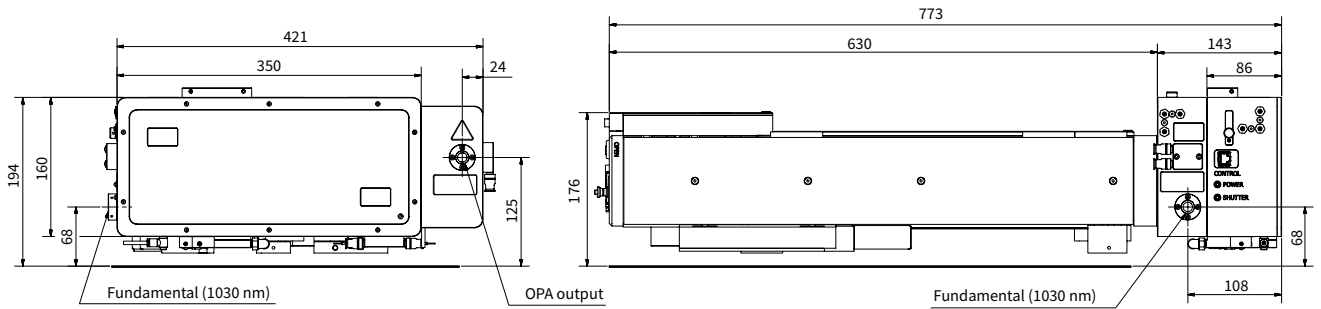
Laser technology	Our solution	HG or HIRO	I-OPA-FW-F	I-OPA-FW-ONE
Pulse energy at 100 kHz, using PHAROS-10W laser				
Excimer (193 nm, 213 nm)	5H of PHAROS (205 nm)	5 μJ	n/a	n/a
3H of Ti:Sapphire (266 nm)	4H of PHAROS (257 nm)	10 μJ		
3H of Nd:YAG (355 nm)	3H of PHAROS (343 nm)	25 μJ		
2H of Nd:YAG (532 nm)	2H of PHAROS (515 nm)	50 μJ	35 μJ	
Ti:Sapphire (800 nm)	OPA output (750 – 850 nm)	n/a	10 μJ	
Nd:YAG (1064 nm)	PHAROS output (1030 nm)		100 μJ	
Cr:Forsterite (1240 nm)	OPA output (1200 – 1300 nm)	n/a	5 μJ	n/a
Erbium (1560 nm)	OPA output (1500 – 1600 nm)		3 μJ	15 μJ
Thulium / Holmium (1.95 – 2.15 μm)	OPA output (1900 – 2200 nm)		2 μJ	10 μJ
Other sources (2.5 – 4.0 μm)	OPA output			1 – 5 μJ

Note that the pulse energy scales linearly in a broad range of pump parameters. For example, a PHAROS-PH2-20W laser at 50 kHz (400 μJ energy) will increase the output power twice, and the pulse energy 4 times compared to the reference table above. The pulse duration at the output is < 300 fs in all cases. The OPA output is not limited to these particular ranges of operation, it is continuously tunable as shown in tuning curves.

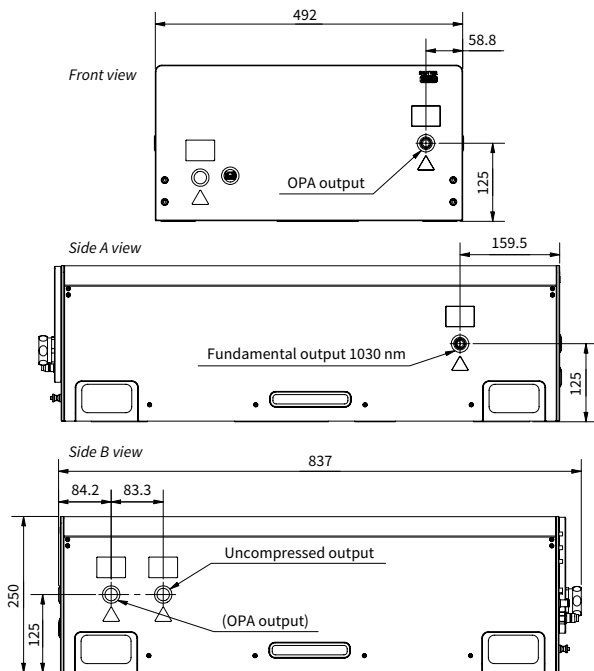
DRAWINGS



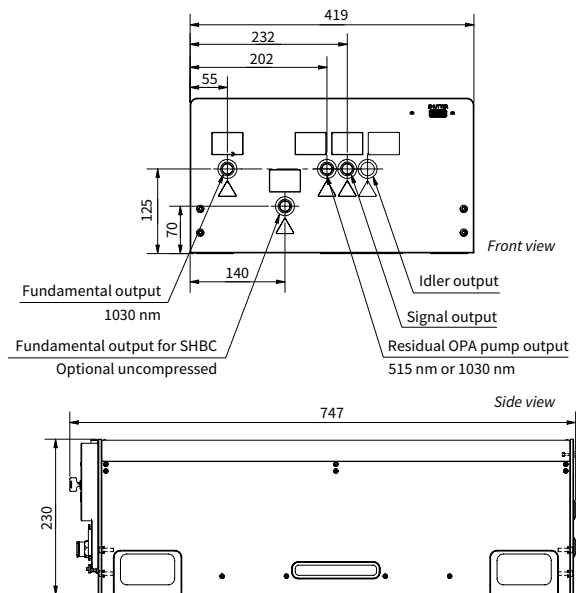
Drawing and output ports of CARBIDE-CB3 with tunable I-OPA-TW-HP



Drawing and output ports of CARBIDE-CB5 with tunable I-OPA-TW-HP



Drawing and output ports of PHAROS-PH2 with tunable I-OPA-TW-HP



Drawing and output ports of PHAROS-PH2 with fixed-wavelength I-OPA-FW-HP