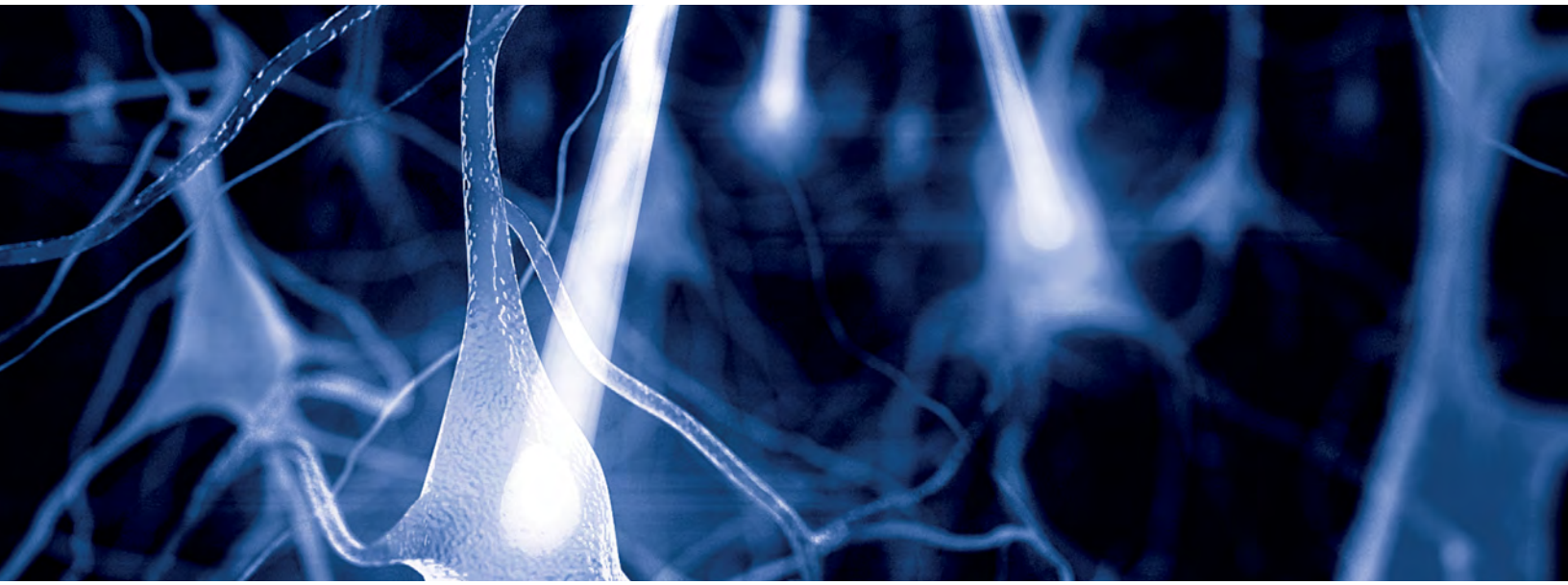
ULTRAFAST LASER SYSTEMS

Product Catalog



COHERENT®

Superior Reliability & Performance


COHERENT

TABLE OF CONTENTS

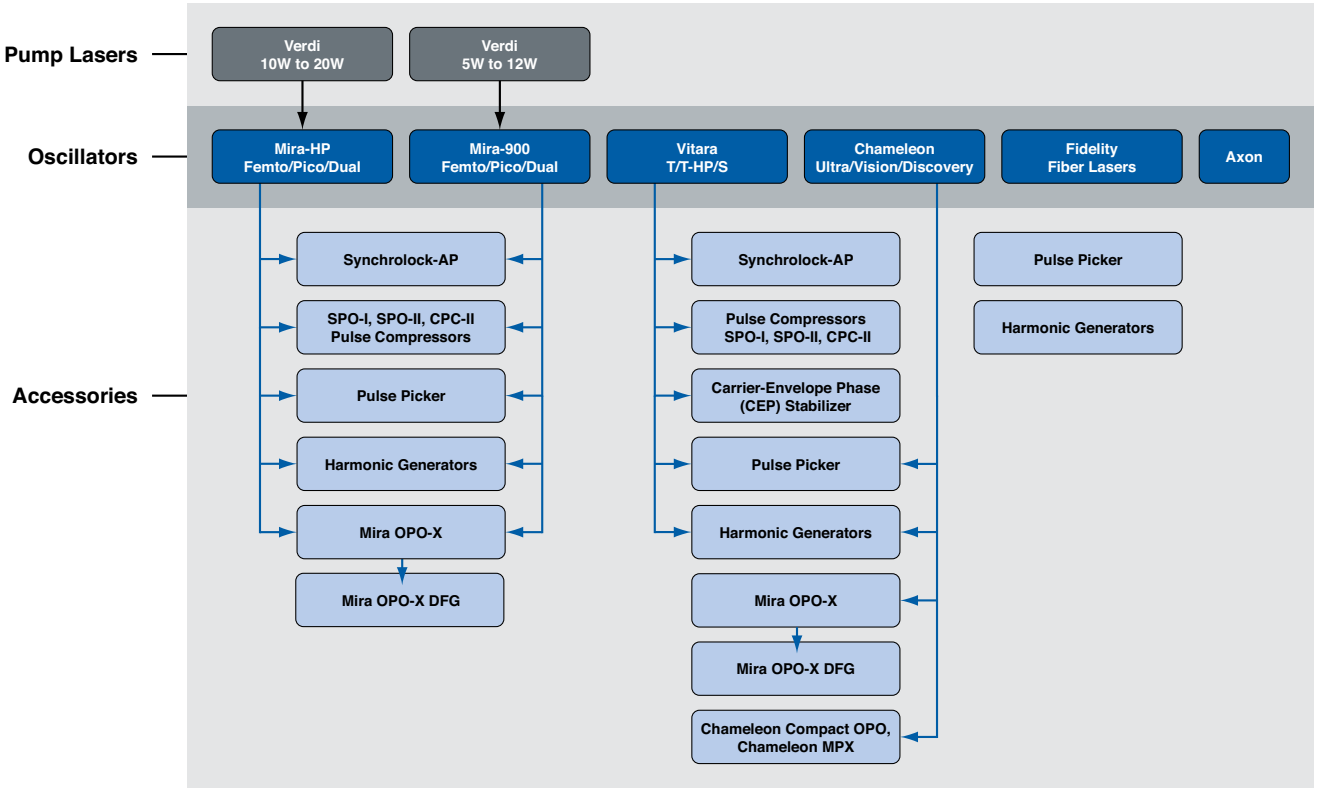
TABLE OF CONTENTS

Oscillators and Accessories

We offer an extensive portfolio of ultrafast oscillator products to choose from. This diagram summarizes the range and also indicates the compatibility of the various available products. For example, the Synchrolock-AP accessory is compatible with the Mira and Vitara, but incompatible with the Chameleon.

Please refer to the specifications on the individual product pages and the accessory compatibility charts on page 83 for more details. If you still have questions regarding specifications of product compatibility, please call or email us.

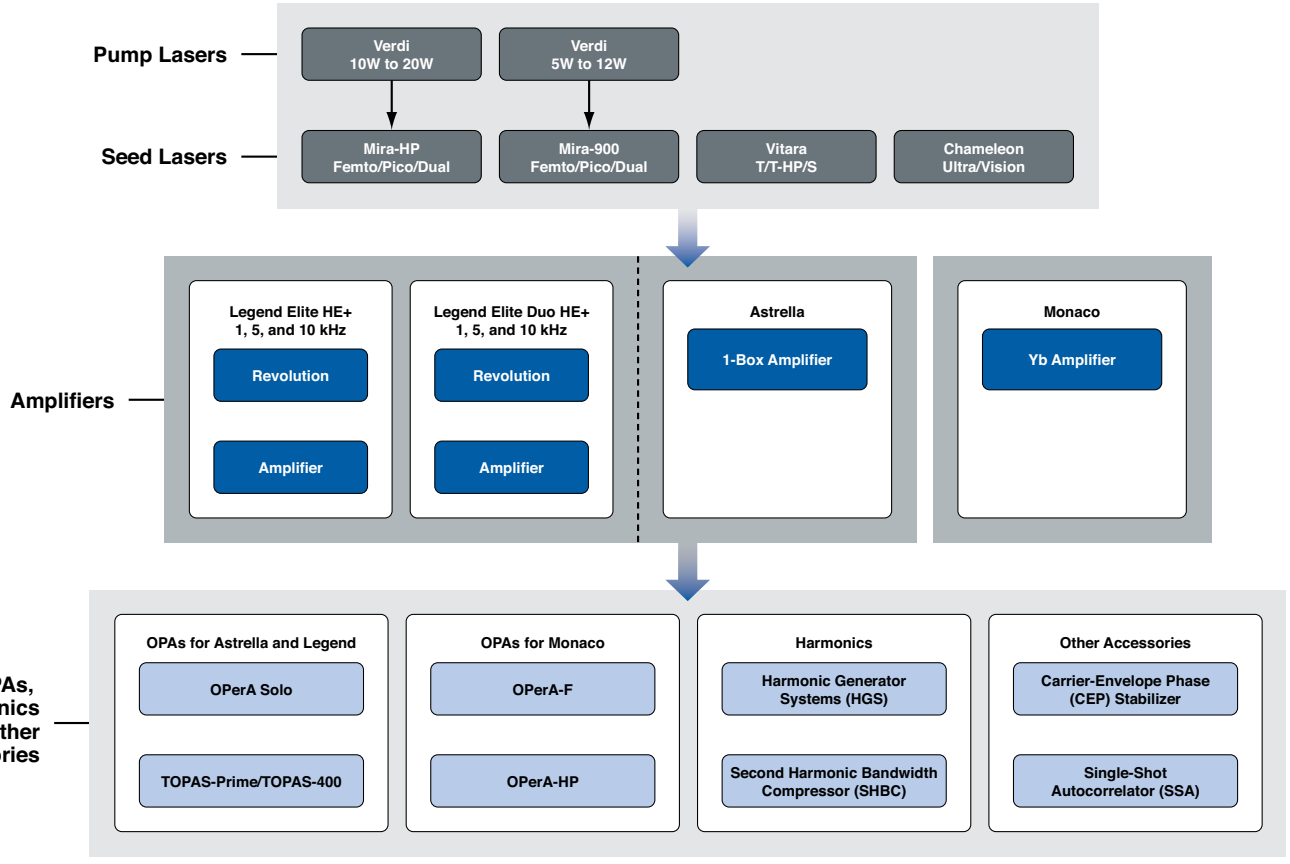
UF Oscillators Families



Amplifiers and Accessories

Our ultrafast amplifier portfolio is the most extensive available. We offer amplified pulse energies in the µJ to mJ range and repetition rates into the MHz regime. The diagram below summarizes the range available and also indicates the compatibility of the various products. Please note that not all oscillator versions are compatible with all versions of our amplifiers. Please refer to the specifications on the individual product pages for more details. If you still have questions regarding specifications or product compatibility, please call or email us.

UF Amplifiers Families



Verdi G-Series

Low-Noise, Green Pump Lasers

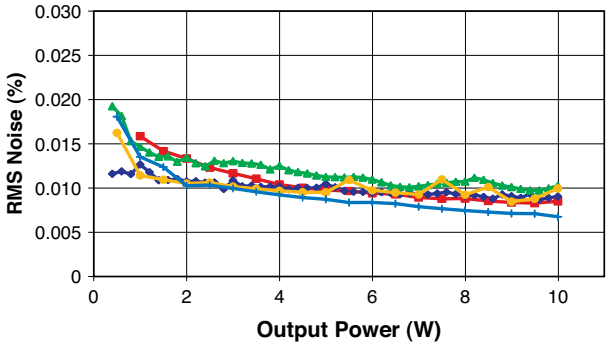
The Verdi G-Series is a revolutionary green pump laser that uses a semiconductor chip as the active medium in place of a conventional laser crystal. This chip has a thickness of only a few microns and is pumped by a diode laser, to generate an infrared beam at a wavelength determined by the chip properties. In all the Verdi G models, the oscillating wavelength is 1064 nm intracavity doubled to produce a 532 nm green output beam.

This Optically-Pumped Semiconductor Laser (OPSL) technology, patented and unique to Coherent, offers numerous benefits. The very short upper state lifetime eliminates the well known "green noise" problem encountered with other multi-frequency solid-state lasers; this results in a noise performance superior to all other green lasers and enabling the most noise-sensitive applications like CEP stabilization.

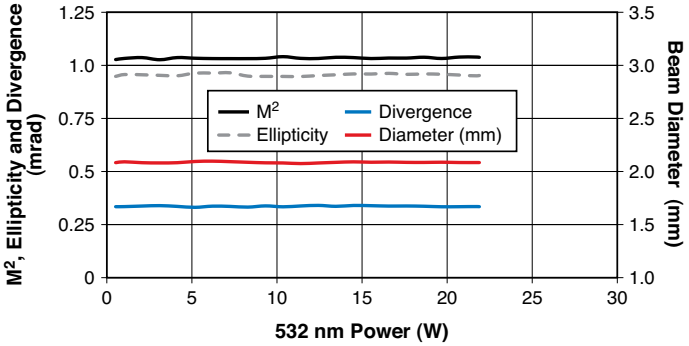
The absence of thermal lensing in the active medium allows adjusting the output power between <100 mW (alignment mode) and the maximum value without changes in beam parameters. The inherently smaller and simpler design is coupled with the well-established advantages of the entire Verdi family – PermAlign technology and vertically integrated pump diode supply – to enable a laser platform that is easily scalable in power and extremely reliable.

OPSL technology has been proven for over 10 years and in over 30,000 worldwide installations of various models operating at many different wavelengths and power levels. Verdi G and other OPSL models are also integrated in the Vitara ultrafast oscillator family.

Verdi G10
RMS Noise (10 Hz to 100 MHz)



Verdi G
Invariant Beam Parameters vs. Power



KEY ADVANTAGES

- 2W to 20W specified power at 532 nm
- Adjustable output power without changes in beam parameters
- Absence of "green noise" enables <0.02% rms noise performance
- 2-Year warranty and low cost of ownership
- PermAlign mounting
- OPSL proven reliability with over 30,000 units installed
- Easy set up and operation
- Vertically integrated diode supply

SPECIFICATIONS[1]	Verdi G2	Verdi G5/G7/G8	Verdi G10	Verdi G12/G15/G18/G20
Wavelength (nm)	532 ±2			
Pulse Format	CW			
Spectral Purity (%)	>99			
Output Power (W)	2	5, 7, 8[2]	10[2]	12, 15, 18, 20[2]
Spatial Mode	TEM_{00}			
Beam Quality	<1.1			
Beam Circularity[3]	1.0 ±0.1			
Beam Waist Diameter (mm) (FW, $1/e^2$)	2.25 ±10%			
Beam Divergence (mrad) (FW, $1/e^2$)	<0.5			
Beam Waist Location[4] (m)	±0.5			
Beam Pointing Stability[5] (µrad/°C)	<2			
Polarization Ratio	Linear, >100:1			
Polarization Direction	Vertical, ±5°			
Noise (%, rms) (10 Hz to 100 MHz)	<0.02			
Power Stability[6] (%) (pk-pk)	±<1			
Warm-Up Time (minutes)	<10			
CDRH Compliant	Yes			
ELECTRICAL SPECIFICATIONS				
Operating Voltage (VAC)	100 to 240			
Frequency (Hz)	50 to 60			
Power Consumption (W)	500 (2W, 5W), 600 (7W, 8W)		700	1000 (12W), 1250 (15W), 1500 (18W, 20W)
ENVIRONMENTAL CONDITIONS				
Ambient Temperature (°C)				
Operating	10 to 40			
Non-Operating	-10 to 60			
Relative Humidity (%)	5 to 95[7]			

1 Optical parameters measured at the output plane of the laser head, unless noted all parameters valid at the nominal output power and for the lifetime of the unit.
2 This product is offered in several output power versions. The output power can be adjusted down to 250 mW (G2-G10) and 750 mW (G12-G20).
3 Circularity defined as vertical diameter divided by horizontal diameter.
4 Negative value corresponds to a location inside head.
5 After 2-hour warm-up.
6 Measured over 8 hrs.
7 Non-condensing.

Revolution

Family of High Energy, kHz, Pulsed Green Lasers

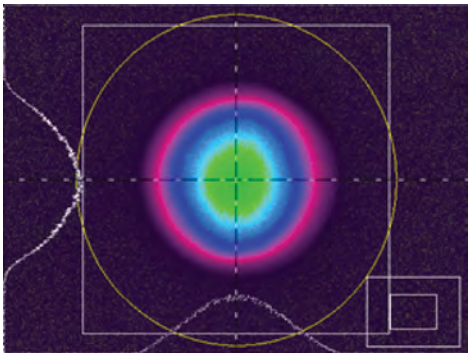
The Revolution laser family from Coherent represents the state-of-the-art in high reliability, high energy, kilohertz pulsed green lasers. All models share the same sealed monolithic construction and compact footprint enabling easy integration and interchangeability. With models delivering up to 45 mJ at 527 nm and average power in excess of 80W, Revolution lasers are the most compact and powerful lasers in their class.

Ideal for pumping ultrafast Ti:S amplifiers, Revolution lasers are the power source at the heart of Coherent's latest one-box Astrella series amplifiers.

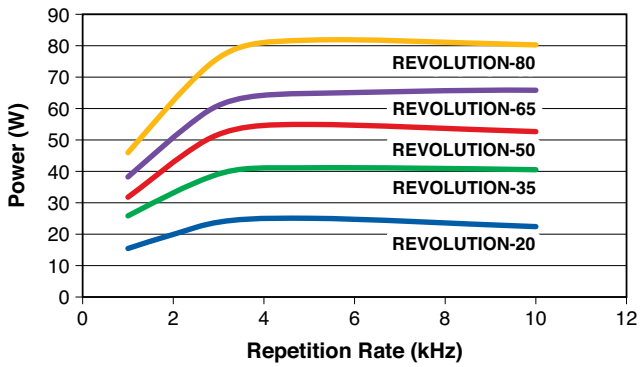
Built to Coherent's exacting industrial manufacturing standards, with every unit HASS screened for quality and reliability, Revolution lasers are equally at home on a 24/7 manufacturing line or in the most demanding of scientific research environments.

Welcome to the laser Revolution.

Example of Revolution's Excellent Beam Quality (Revolution-80 operating at 45 mJ at 1 kHz)



Typical Average Output Power vs. Repetition Rate



KEY ADVANTAGES

- Models up to 45 mJ and average powers >80W at 527 nm
- Nd:YLF gain medium for high energy storage
- Intracavity frequency doubled for best efficiency
- CW diode-pumped for lowest optical noise
- User adjustable repetition rate
- Excellent mode quality with smooth energy distribution
- HASS verified for quality and reliability
- Compact, sealed monolithic design with side or front beam exit port options

OPTIONS AND ACCESSORIES

- High repetition rate (10 kHz to 40 kHz) configuration
- Extended umbilical options
- Extended water hose options
- Side output option
- Water-to-water heat exchanger option
- Double Pulse Operation (DPO) for particle image velocimetry (PIV) applications

PERFORMANCE PARAMETER[1]	Revolution -20	Revolution -35	Revolution -50	Revolution -65	Revolution -80
Wavelength (nm)	527				
Standard Pulse Repetition Rate Range[2] (user adjustable)	Single-shot to 10 kHz				
Average Output Power (W)	15 at 1 kHz 20 at 5 kHz 20 at 10 kHz	22 at 1 kHz 35 at 5 kHz 35 at 10 kHz	30 at 1 kHz 50 at 5 kHz 50 at 10 kHz	38 at 1 kHz 65 at 5 kHz 65 at 10 kHz	45 at 1 kHz 80 at 5 kHz 80 at 10 kHz
Energy per Pulse (mJ)	15 at 1 kHz 4 at 5 kHz 2 at 10 kHz	22 at 1 kHz 7 at 5 kHz 3.5 at 10 kHz	30 at 1 kHz 10 at 5 kHz 5 at 10 kHz	38 at 1 kHz 13 at 5 kHz 6.5 at 10 kHz	45 at 1 kHz 16 at 5 kHz 8 at 10 kHz
Pulse Width (nsec) (FWHM)	<220 at 1 kHz	<180 at 1 kHz	<150 at 1 kHz	<150 at 1 kHz	<150 at 1 kHz
Pulse-to-Pulse Energy Stability[3] (% rms)	<0.5				
BEAM CHARACTERISTICS					
Spatial Mode	Multimode				
Polarization Ratio	Horizontal, >100:1				
Nominal Beam Diameter at Output Window[4] (mm) ($1/e^2$)	4				
Beam Divergence (mrad) (full-angle)	<8				
Beam Circularity (%)	>80				
UTILITY AND ENVIRONMENTAL REQUIREMENTS					
Operating Voltage Laser	200 to 240 VAC, ±10%, single-phase, 50 to 60 Hz				
Operating Voltage Options Chiller	60 Hz, 188 to 253 VAC 50 Hz, 216 to 264 VAC 50 Hz, 180 to 220 VAC 12A Max., single phase				
Warm-up Time (min.) (typ) from standby mode from cold start	 <10 <30				

1 Specifications apply at 1 kHz unless otherwise stated.
2 Operation below 500 Hz requires user supplied external TTL trigger.
3 Measured over 30 minutes, after system warm-up and under stable lab temperature conditions.
4 Average of X & Y.

Axon

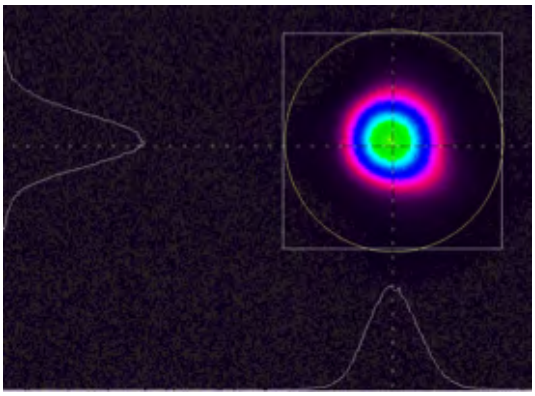
Compact Ultrafast Laser Sources

Axon femtosecond lasers are a family of discrete wavelength, ultrafast sources. Compact design at a breakthrough price point enable a range of life sciences and instrumentation applications.

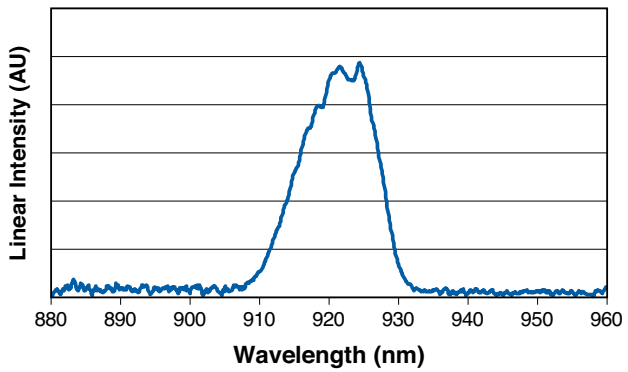
Multiphoton excitation microscopy applications are served by key wavelengths at 920 nm and 1064 nm, with dispersion pre- compensation included to optimize short pulses at the sample plane. Built-in modulation is optional for fast power control and flyback blanking.

Integrators benefit from a common, plug-and-play interface with the same form factor for each wavelength. Systems are completely air-cooled with no maintenance requirements, enabling a low cost of ownership and long lifetimes.

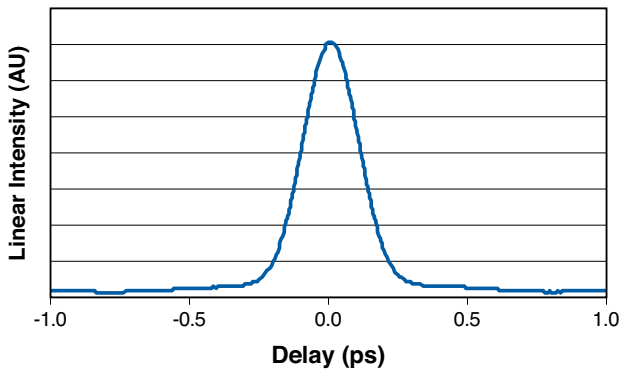
Far Field Beam Profile: Axon



Typical Spectrum: Axon 920



Typical Autocorrelation: Axon 920



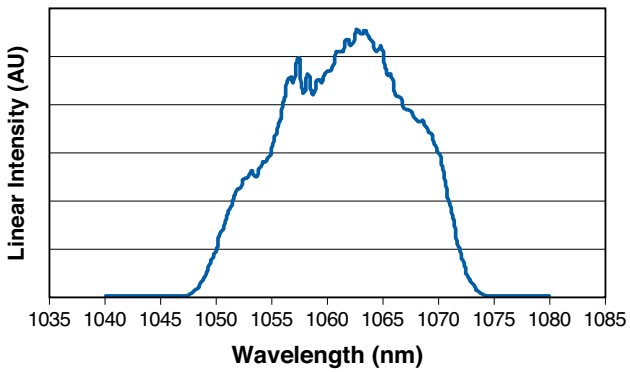
KEY ADVANTAGES

- Compact and cost-effective
- Maintenance-free for low cost of ownership
- Air-cooled for flexible system integration
- Plug-and play-common interface
- Dispersion precompensation for optimal non-linear excitation
- Total Power Control (TPC) – optional built-in power control
- HALT-designed for longest lifetimes and high uptime

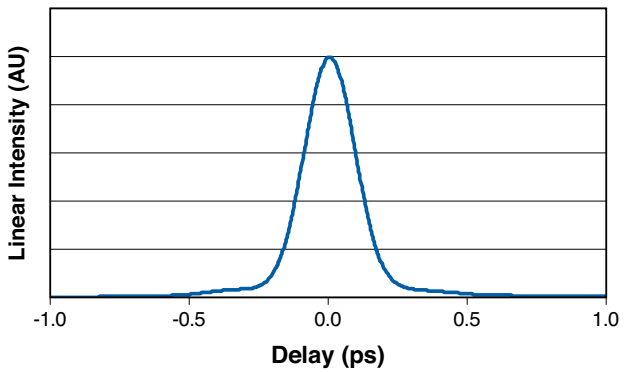
SPECIFICATIONS	Axon 920	Axon 920 TPC	Axon 1064	Axon 1064 TPC
Wavelength[1] (nm)	920		1064	
Average Power (mW)	1000	800	1000	800
Pulse Duration[2] (fs)	<150			
Repetition Rate (MHz)	80 ±1			
Beam Mode	M^2 < 1.3			
Beam Asymmetry[3,4]	0.8-1.2			
Beam Diameter [4] (mm)	1.2 ±0.2			
Astigmatism (%)	<25			
Power Stability[5] (%)	±0.5			
Noise[6] (%)	<0.25			
Polarization	>100:1 Vertical			
Dispersion Precompensation[7] (fs^2)	0 to -30,000	0 to -22,000	0 to -20,000	0 to -13,000
Modulation Rise/Fall Time[8] (ns)	NA	<1000	NA	<1000
Contrast Ratio[9]	NA	>1000:1	NA	>1000:1
Laser Head Dimensions	212 x 318 x 62 mm (8.35 x 12.528 x 2.44 in.)			

1 Center of mass, ±3 nm.
2 Assumes Sech² deconvolution factor.
3 Ratio of waist sizes.
4 Measured at beam waist locations.
5 Over 2 hours, environment stability ±1°C, after warm-up.
6 RMS, 10 Hz to 10 MHz.
7 Adjustable via externally accessible fine adjust. Higher values on request.
8 5% to 95% power level.
9 Measured at one meter from output port.

Typical Spectrum: Axon 1064



Typical Autocorrelation: Axon 1064



Fidelity-2

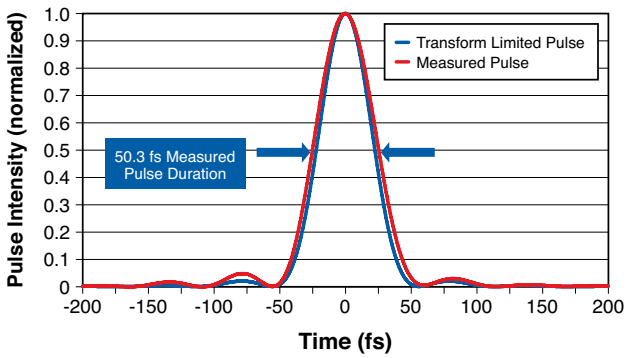
High Power Femtosecond Fiber Laser

Fidelity is a revolutionary ultrafast fiber laser that offers a unique combination of high average power and extremely short pulses in a simple to operate, maintenance-free and compact package.

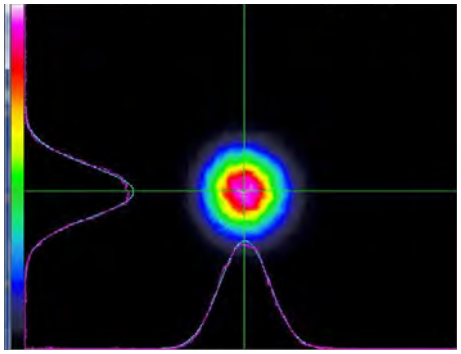
Delivering over 2W of sub-55 fs pulses at 1070 nm, Fidelity opens up a broad range of scientific and commercial opportunities in applications as diverse as optogenetics, terahertz generation and fundamental material research. Of course, for ultrafast pulses to be most effective in these types of applications, they must maintain their pulse width (maximum peak power) on target. By incorporating a user-adjustable pre-chirp pulse compressor into the laser head, Fidelity faithfully delivers the shortest possible pulses to the sample.

With the simplicity and reliability of optical fiber, built to Coherent's exacting industrial manufacturing standards and delivering unmatched ultrafast performance, Fidelity is your powerful and dependable femtosecond light source.

Fidelity-2:
50.3 fs Pulse Duration



Fidelity-2
Typical Far Field Mode Quality



KEY ADVANTAGES

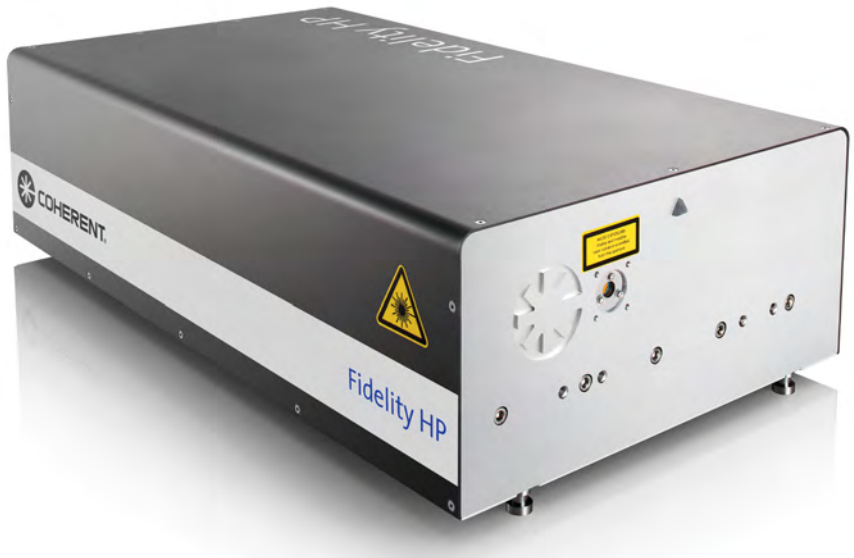
- Shortest specified pulse length from a commercial fiber laser
- High average power >2W
- Built-in automated pre-chirp pulse compressor
- Compact foot print
- Air-cooled
- Maintenance-free
- HASS verified for quality and reliability
- RS-232 interface

SPECIFICATIONS	Fidelity-2
Average Power (W)	>2
Center Wavelength (nominal) (nm)	1070
Pulse Width[1] (fs)	<55
Ratio of Measured to Transform Limited Pulse Duration	<1.2
Peak Power (kW)	>450
RMS Noise[2] (%)	<1
Power Stability[3] (%)	±0.5
Repetition Rate (MHz) (factory set)	70 ±2
M^2 (average of X&Y)	<1.2
Beam Diameter[4] (mm)	1.2 ±0.2
Beam Divergence (mrad)	<1.6
Beam Circularity[5]	0.9 to 1.1
Astigmatism (%)	<10
Polarization	Horizontal
Group Delay Dispersion (GDD) Pre-compensation Range (fs^2)	-30,000 to 0
ELECTRICAL AND COOLING REQUIREMENTS	
Voltage (V)	100 to 240
Current Max. (A)	3
Line Frequency (Hz)	50 to 60
Cooling	Air-cooled
Max. Heat Dissipation from Laser Head (W)	25
Laser Head Dimensions (L x W x H)	317.5 x 317.5 x 146.8 mm (12.5 x 12.5 x 5.78 in.)
Beam Height	120.6 mm (4.75 in.)
Umbilical Length	3m (9.8 ft.)
Laser Head Weight	18.5 kg (40.8 lbs.)
Power Supply Weight	6.5 kg (14.3 lbs.)

1 Based on pulse measurements made using FC Spider (APE GmbH).
2 Measured from 10 Hz to 10 MHz.
3 Measured over 2 hrs. after 30 min. warm-up at constant environmental temperature.
4 Average $1/e^2$ diameter measured at output.
5 Ratio of major to minor $1/e^2$ beam diameter at exit port.

Fidelity HP

High Power Femtosecond Fiber Laser



Fidelity femtosecond laser systems deliver world leading performance in a compact turnkey, low maintenance package. With average output powers up to 18W and short 140 fs pulses, Fidelity accesses high peak power regimes that truly enables a suite of applications in life sciences, applied physics, materials processing and microelectronics.

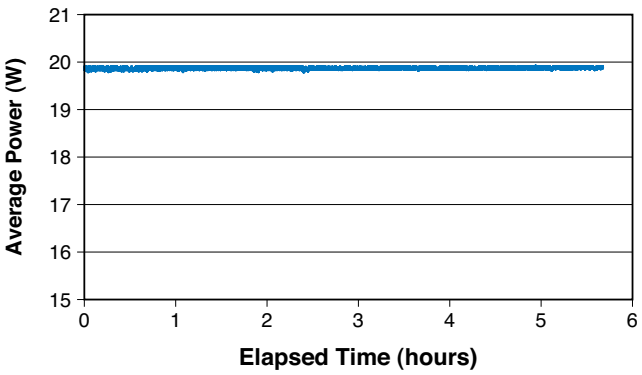
Utilizing Coherent's state of the art fiber laser technology, Fidelity delivers minimal cost of ownership with minimal maintenance requirements. Exquisite beam quality provides optimum focus resolution and efficiency, coupled with extremely stable and low noise output, thanks to a precise light-loop control.

In Multiphoton imaging applications, Fidelity's high average and peak power enables optogenetic photoactivation of large populations of neurons, with precise spatial and temporal resolution. Short pulses are delivered directly to the sample plane by way of user adjustable group dispersion delay compensation (GDD).

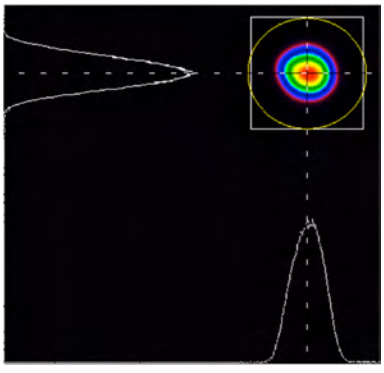
Industrial and commercial applications, such as two photon polymerization, rapid prototyping and scribing, benefit from the finesse and speed of Fidelity's high peak power pulses delivered at 80 MHz.

Fidelity is designed and manufactured with Industrial HASS and HALT methodologies, ensuring optimum product performance and reliability in the widest range of transport and operating environmental conditions.

Fidelity 18 Power Stability



Fidelity HP Beam Quality



KEY ADVANTAGES

- Highest average power
- Short pulses for high peak intensity
- Adjustable GDD precompensation
- Turnkey operation, low maintenance
- Low cost of ownership
- HASS verified for quality and reliability

SPECIFICATIONS[1]	Fidelity 10	Fidelity 18
Average Power (W)	10	18
Wavelength (nm) (nominal)	1040	
Pulse Repetition Rate (MHz)	80	
Pulse Duration[2] (fs)	140	
Noise[3] (%)	<0.25	
Power Stability[4] (%)	±0.5	
M^2	<1.25	
Beam Diameter[5] (mm)	1.2 (±0.2)	
Ellipticity[6]	0.8 to 1.2	
Polarization	100:1 Vertical	
Negative GDD Range (fs^2)	0 to 120,000	
UTILITY REQUIREMENTS		
Power Supply	19" rack mount	
Electrical Requirements (VAC)	100 to 250, 50 to 60 Hz	
Cooling Requirements	Air-cooled closed-loop chiller (included)	
Exyernal Interfaces	RS-232, USB, Sync Out	
ENVIRONMENTAL SPECIFICATIONS		
Operating Temperature (°C)	15 to 35	
Non-Operating Temperature (°C)	0 to 40	
Relative Humidity (%) (non-condensing)	<95	
Altitude (m)	<1000	

1 Specifications subject to change.
2 Based on pulse measurements made using FC Spider (APE GmbH).
3 Measured from 10 Hz to 10 MHz.
4 Measured over 2 hrs. after 30 min. warm-up at constant environmental temperature.
5 Average $1/e^2$ diameter measured at output.
6 Ratio of major to minor $1/e^2$ beam diameter at exit port.

Mira-900

Ultrafast Femtosecond/Picosecond Ti:Sapphire Oscillators

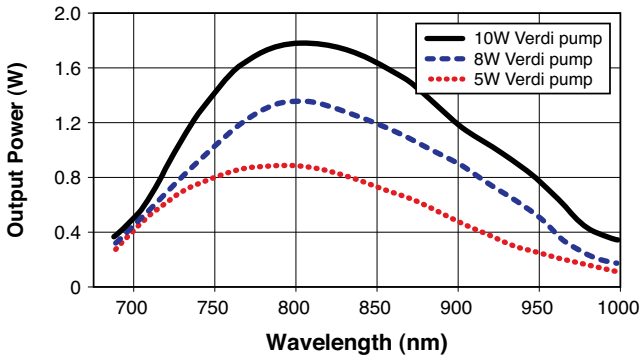
More Mira-900 oscillators are in use today than any other modelocked Ti:Sapphire laser system. The Mira-900 combines simplicity and reliability in an innovative design to produce the most powerful and versatile ultrafast laser system available.

The innovative design of the Mira-900 system makes switching between continuous-wave, picosecond and femtosecond operation simple, while passive Kerr lens modelocking provides greater ease-of-use and reliability.

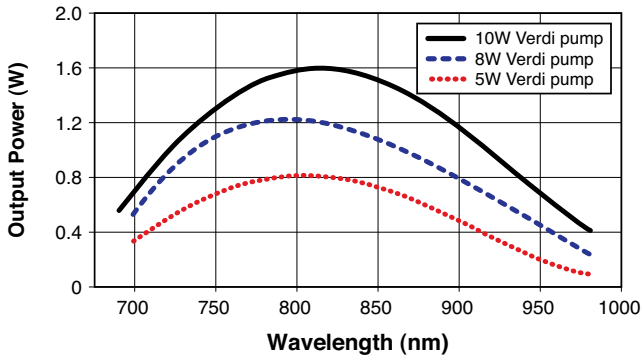
Our built-in Optima control and diagnostics system enables easy adjustment of the output wavelength, pulse width and power. Optima features a fast photodiode, relative power monitor, ß-lock, CW detector, humidity sensor and an automatic starter.

A wide range of accessories is available for the Mira-900. These allow operation at lower repetition-rate (Pulse Picker), shorter wavelengths [Harmonic Generator, Mira OPO-X (VIS)], longer wavelengths [Mira OPO-X (IR)], and the ability to deliver a transform-limited pulse at the sample (SPO-I, SPO-II, CPC-II).

Typical X-Wave Power Curves for Verdi-pumped Mira Optima 900-F



Typical X-Wave Power Curves for Verdi-pumped Mira Optima 900-P



KEY ADVANTAGES

- Simple, stable Kerr lens modelocking for ease-of-use and reliability
- Femtosecond, picosecond and continuous-wave operation
- X-Wave single optics set allows wavelength tuning from 700 nm to 1000 nm
- Verdi 532 nm pump sources between 5W and 12W deliver diode-pumped stability and reliability
- Optima system provides advanced system monitoring and control
- Sealed purgeable enclosure results in higher reliability and full wavelength coverage
- Integrated pump steering optics make pump alignment easy
- Auxiliary CW cavity for general setup and continuous-wave operation

OPTIONS AND ACCESSORIES

- Short pulse option: <70 fs
- Long pulse option: >5 ps
- 2nd, 3rd and 4th harmonic generation
- Mira OPO-X synchronously-pumped OPO
- Pulse Picker
- Synchrolock-AP
- SPO-I, SPO-II and CPC-II pulse compressors

SPECIFICATIONS[1]	Mira Optima 900-F	Mira Optima 900-P	Mira Optima 900-D
Output Power[2,3] (W)			
Verdi-G5		0.75	Dual platform contains all hardware necessary for both femtosecond (-F) and picosecond (-P) operation.
Verdi-G8		1.0	
Verdi-G10		1.4	
Verdi-G12		1.8	
Tuning Range[4] (nm)	700 to 1000		
Pulse Width[2,5]	<115 fs	<2 ps	<115 fs and <2 ps
Repetition-Rate (MHz) (nominal)	76		
Noise[6] (%)	<0.1		
Stability[7] (%)	<3		
Beam Diameter[8] (mm)	0.8		
Beam Divergence[9] (mrad)	1.7		
Spatial Mode[10]	TEM_{00}		
Polarization	Horizontal		
Physical Dimensions	111.1 x 38.1 x 19.7 cm (43.75 x 15 x 7.75 in.)		

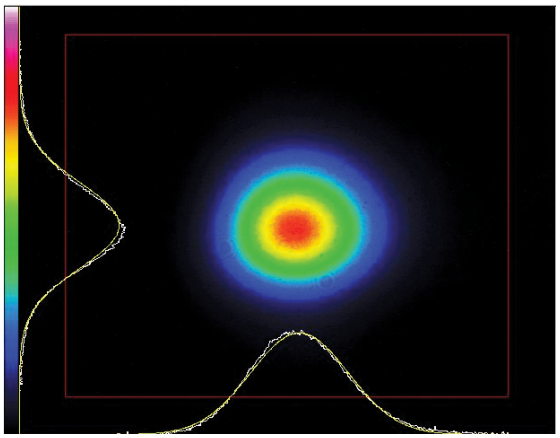
1 Specifications apply only with Coherent pump lasers.
2 At 800 nm.
3 For other pump power call factory.
4 Wider coverage possible with short wave or extended long wave optics sets.
5 Based on $sech^2$ deconvolution of 0.65 times autocorrelation width. Pulse width is <130 fs across specified tuning range in fs mode.
6 Measured rms in a 10 Hz to 20 MHz bandwidth.
7 Power drift in any two-hour period after warm-up when crystal's cooling water is maintained at ±0.1°C.
8 $1/e^2$ diameter (±0.2 mm) at exit port.
9 Full angle divergence (±0.3 mrad) at exit port.
10 Typical measured M^2 value is 1.1.

Mira-HP

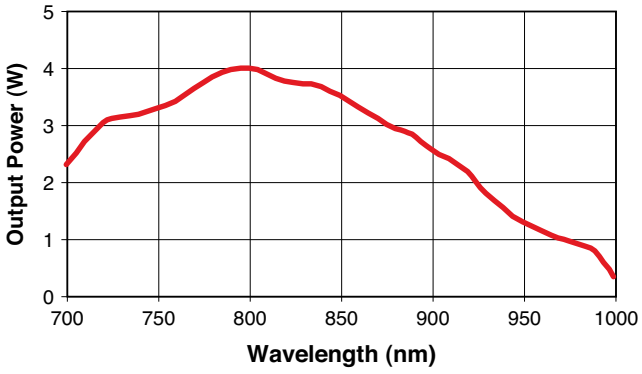
High Power Ultrafast Ti:Sapphire Oscillators

The femtosecond/picosecond Mira-HP is the world's most powerful commercial ultrafast Ti:Sapphire oscillator. Conservatively specified at 3.5W average power in femtosecond mode, the Mira-HP-F typically delivers power in excess of 4W at 800 nm. Designed specifically to be pumped by our Verdi G18 laser, Mira-HP oscillators deliver high power across the entire Ti:Sapphire tuning curve. Like the Mira 900, the Mira-HP features the built-in Optima control and diagnostics system for greater ease-of-use and high reliability.

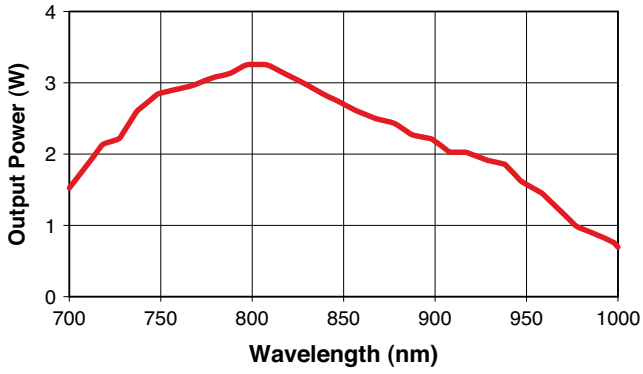
Typical Mira-HP Beam Profile



Typical X-Wave Power Curve for Verdi G18 Pumped Mira-HP-F



Typical X-Wave Power Curve for Verdi G18 Pumped Mira-HP-P



KEY ADVANTAGES

- Simple, stable Kerr lens modelocking for greater ease-of-use and reliability
- X-Wave single optics set supports wavelength tuning from less than 700 nm to more than 1000 nm
- Optima system control and diagnostics package is integral to system
- Purgeable enclosure improves reliability and provides full wavelength coverage
- Integrated pump steering optics for easy pump alignment
- Optional pumping beam directions allow wider choice of optical table layouts
- Auxiliary CW cavity for ease of general setup and continuous-wave operation

OPTIONS AND ACCESSORIES

- Mira OPO-X synchronously-pumped OPO
- 2nd, 3rd and 4th harmonic generation
- Pulse Picker
- Synchrolock-AP
- SPO-I, SPO-II and CPC-II pulse compressors

SPECIFICATIONS[1]	Mira-HP-F	Mira-HP-P	Mira-HP-D
Output Power[2] (W)	>3.5 (>4 typ.)	>3.0 (>3.2 typ.)	Dual platform contains all hardware necessary for both femtosecond (-F) and picosecond (-P) operation.
Tuning Range (nm)	690 to 1050	700 to 1000	700 to 1000
Pulse Width[2,3,4]	<130 fs	<2 ps	<130 fs and <2 ps
Repetition-Rate (MHz) (nominal)	76		
Noise[5] (%)	<0.1		
Stability[6] (%)	<3		
Beam Diameter[7] (mm)	0.8		
Beam Divergence[8] (mrad)	1.5		
Spatial Mode[9]	TEM_{00}		
Polarization	Horizontal		
Physical Dimensions	111.1 x 38.1 x 19.7 cm (43.75 x 15 x 7.75 in.)		

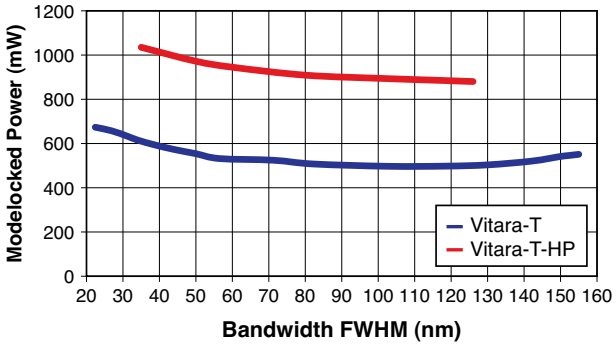
1 Specifications apply only with Coherent Verdi-G18 pump lasers.
2 At 800 nm.
3 Based on $sech^2$ deconvolution of 0.65 times autocorrelation width. Pulse width is <160 fs across specified tuning range in fs mode.
4 In fs mode, the pulses are typically 1.5x the transform limit and so can be further compresses in an external compressor.
5 Measured rms in a 10 Hz to 20 MHz bandwidth.
6 Power drift in any two-hour period after warm-up when crystal's cooling water is maintained at ±0.1°C.
7 $1/e^2$ diameter (±0.2 mm) at exit port.
8 Full angle divergence (±0.3 mrad) at exit port.
9 Typical measured M^2 value is 1.1.

Vitara

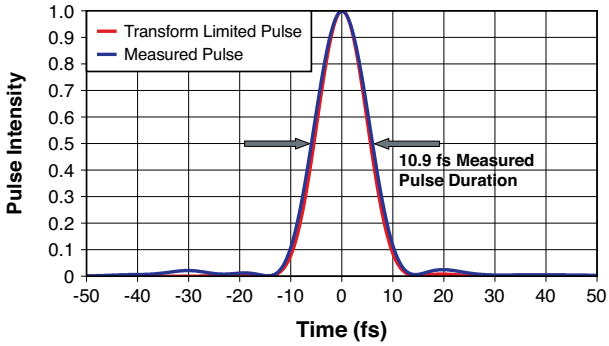
Automated, Hands-Free Ultrashort Pulse Ti:Sapphire Oscillator Family

Vitara is the new industry standard for hands-free, integrated, ultra-broadband, flexible ultrafast lasers. Representing the culmination of 20 years of in-house expertise with Kerr Lens mode-locking and thousands of clean-room manufactured, industrial-grade ultrafast lasers, the Vitara family satisfies the most sophisticated requirements for amplifier seeding, terahertz generation, attosecond studies, quantum control experiments, non-linear imaging and spectroscopy applications. Models within the Vitara family range from a tunable version with user-adjustable bandwidth and sub-12 fs compressed output, a high power version providing 1 Watt-class average power, and a version tailored for seeding ultrafast amplifiers. All models of the Vitara platform provide hands-free operation guaranteed by Coherent's proprietary clean manufacturing practices, our unique Optically Pumped Semiconductor (OPS) pump lasers and a suite of automated controls. In addition to its exquisite flexibility, Vitara satisfies the most sophisticated requirement in Carrier to Envelope Phase (CEP) stabilization and external source synchronization thanks to its broad range of accessories. Designed as a long-lasting and expandable ultrafast laser platform, Vitara provides reliable hands-free operation in the most demanding scientific applications and laboratory environments.

Vitara-T and Vitara-T-HP
Typical Power vs. Bandwidth at 80 MHz



Typical Measured Pulse from Vitara-T
After Compression with CPC-II
Pulse Measured Using FC Spider



KEY ADVANTAGES

- Automated for hands-free, reliable operation
- Computer controlled bandwidth
- Computer tunable center wavelength
- PowerTrack active optimization
- <12 fs to >30 fs pulsewidth capability
- Low noise
- Integrated Verdi G pump laser
- Compact footprint
- HASS verified for quality and reliability

OPTIONS AND ACCESSORIES

- Carrier-Envelope Phase (CEP) Stabilizer
- Pulse synchronization – Synchrolock-AP
- Integrated, calibrated spectrometer
- Compact Pulse Compressor – CPC-II
- Second Harmonic Generator
- Factory configurable for use with internal or external pump laser

SPECIFICATIONS[1,2]	Vitara-T	Vitara-T-HP	Vitara-S
Power (mW)			
at minimum specified bandwidth	>525	>930	-
at 60 nm bandwidth	>450	>850	-
at maximum specified bandwidth	>425	>800	>450
Bandwidth (nm) (FWHM)	30 to 125	40 to 100	70 (fixed)
Tuning Range (nm)			
at minimum specified bandwidth	755 to 860	765 to 810	-
at 60 nm bandwidth	765 to 840	775 to 825	-
at maximum specified bandwidth	790 to 820	795 to 805	-
Uncompressed Pulsewidth[3] (fs)	<20 (typically <15)	<20 (typically <15)	typically <40
Compressed Pulsewidth[3] (fs) with External Compressor (not included)	<12	<15	<20
RMS Noise[4] (%)	<0.05		
Power Stability[5] (%)	±0.5		
Repetition Rate (MHz) (standard)	80[6]	80[6]	80
M^2 (average of X & Y)	<1.3		
Beam Diameter[7] (mm)	2.2		
Beam Divergence (mrad)	<1	<1	<1
Polarization	Horizontal		
ELECTRICAL AND COOLING REQUIREMENTS			
Voltage (VAC)	100 to 240		
Current Max. (A)	5		
Line Frequency (Hz)	50 to 60		
Cooling	Closed-cycle chiller		
Laser Head Dimensions (L x W x H)	609.6 x 427.5 x 162.4 mm (24.0 x 16.8 x 6.4 in.) excluding handles		
Beam Height	120.6 mm (4.75 in.)		

1 Specifications subject to change.
2 Specifications apply at 800 nm and 80 MHz rep. rate unless otherwise stated.
3 At max. bandwidth and measured with FC Spider (APE GmbH).
4 Measured from 10 Hz to 10 MHz.
5 Measured over 2 hrs. after 30 min. warm-up at constant environmental temperature.
6 Can be factory set between 65 to 110 MHz.
7 Average $1/e^2$ diameter measured at output.

Chameleon Discovery NX

Dual-Output, Widely-Tunable Femtosecond Laser

Chameleon Discovery NX is a next-generation automated, ultrafast tunable laser with enhanced performance to address the most demanding requirements in two-photon imaging and spectroscopy.

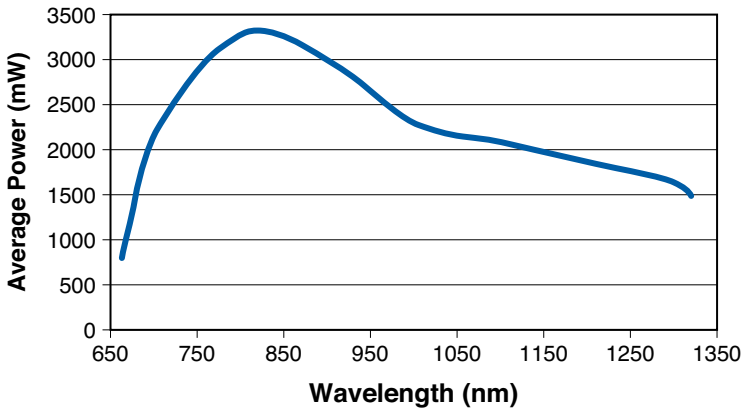
Discovery NX delivers the highest power to enable deep in-vivo excitation of all popular fluorescent probes, whilst the expanded dispersion precompensation range ensures the shortest pulses at the sample plane for a variety of microscopy configurations.

Octave spanning tuning range is especially advantageous for ultrafast spectroscopy applications, and can be coupled with Harmonic generation accessories, assuring gap-free, automated tuning from 330 nm to 1320 nm.

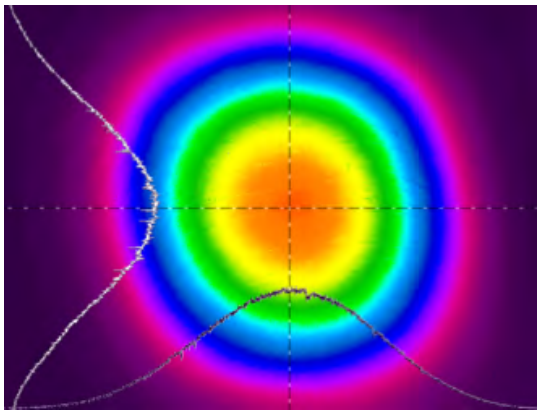
KEY ADVANTAGES

- Automated control for hands-free operation
- Highest average power for deepest imaging
- High dispersion precompensation range for optimized peak power
- Secondary output at 1040 nm for multi-wavelength excitation
- Synchronized output pulse trains
- Industrial design for high uptime and reliability
- Can be upgraded with built-in fast power modulation with Total Power Control (TPC)

Chameleon Discovery NX:
Typical Tuning and Power



Chameleon Discovery NX:
Beam Profile at 900 nm



OPTICAL OUTPUT A	Chameleon Discovery NX
Tuning Range (nm)	660 to 1320
Average Output Power (mW)	
700 nm	2000
800 nm	3000
900 nm	2700
1000 nm	2000
1200 nm	1700
1300 nm	1500
Pulse Duration[1,2] (fs)	100
Repetition Rate (MHz)	80 ±0.5
Beam Mode[1]	M^2 <1.2
Beam Diameter[1] (mm)	1.2 ±0.2
Ellipticity[1]	0.8 to 1.2
Astigmatism[1] (%)	<25
Polarization	Linear, Horizontal
Noise[1,3] (%)	<0.5
Power Stability[4] (%)	±1
Tuning Speed[5] (nm/s)	>50
Pointing Accuracy[6] (µrad)	<350
Dispersion Compensation Range (fs^2)	
680 nm	0 to -50,000
800 nm	0 to -27,000
950 nm	0 to -16,000
1050 nm	0 to -12,000
1300 nm	0 to -10,000
OPTICAL OUTPUT B	
Wavelength (nm)	1040
Average Output Power (mW)	>3500
Pulse Duration[2] (fs)	140
Repetition Rate[7] (MHz)	80 ±0.5
Beam Mode	M^2 <1.2
Beam Diameter (mm)	1.2 ±0.2
Ellipticity	0.8 to 1.2
Astigmatism (%)	<25
Polarization	Linear, Horizontal
Noise[3] (%)	<0.25
Power Stability[4] (%)	±1

1 At 900 nm.
2 Assumes $sech^2$ pulse shape.
3 RMS, 10 Hz to 10 MHz.
4 Power drift in a 2 hour period after 1 hour warm-up and ±1°C ambient temperature change.
5 Averaged over entire tuning range.
6 Maximum deviation over entire GDD dispersion adjustment and wavelength range.
7 Phase locked to Output A.

UTILITY REQUIREMENTS	Chameleon Discovery NX
Operating Voltage (VAC)	90 to 250 (auto ranging)
Maximum Operating Current (A)	
Power Supply	<8 at 90 VAC
Chiller	<14 at 90 VAC
MRU	<2 at 90 VAC
System Power Consumption (W)	2300
Line Frequency (Hz)	47 to 63
Communications/Control Interfaces[1]	RS-232, USB, PC required (Analog in for TPC)
ENVIRONMENTAL REQUIREMENTS	
Operating Temperature Range	15 to 35°C (59 to 95°F)
Storage Temperature Range	0 to 40°C (32 to 104°F)
Humidity	Non-condensing
Altitude (m)	<2000
MECHANICAL SPECIFICATIONS	
Power Supply	19" unit, 3U
Chiller	19" unit, 6U
MRU	19" unit, 2U

1 PC required.

Chameleon Discovery NX with Total Power Control

Widely-Tunable Femtosecond Laser with Built-In Fast Power Control

Chameleon Discovery NX with Total Power Control (TPC) is a next-generation automated, ultrafast tunable laser with enhanced performance to address the most demanding requirements in two-photon imaging and spectroscopy.

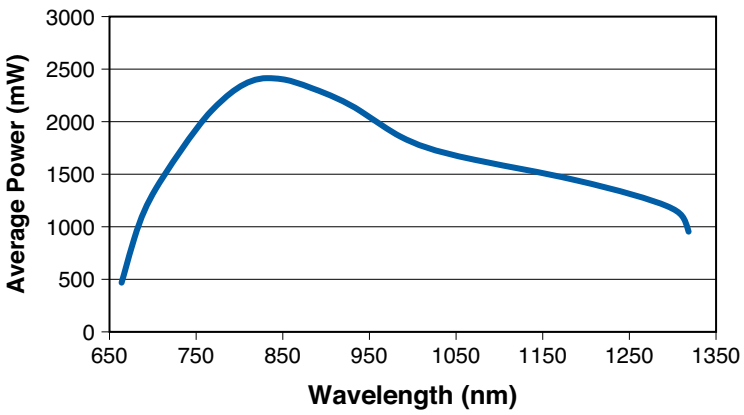
Discovery NX delivers the highest power to enable deep in-vivo excitation of all popular fluorescent probes, whilst the expanded dispersion pre-compensation range ensures the shortest pulses at the sample plane for a variety of microscopy configurations.

Total Power Control uses built-in acousto-optic modulation for fast and high contrast power control, guaranteeing perfect beam parameters directly into the microscope scan head. A secondary 1040 nm output is also available as an option.

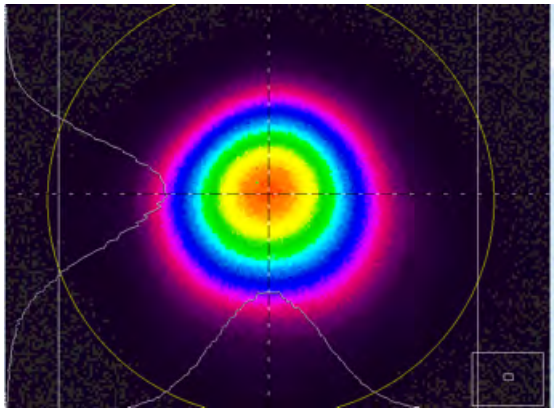
KEY ADVANTAGES

- Automated control for hands-free operation
- Total Power Control (TPC) built-in fast power modulation
- Highest average power for deepest imaging
- High dispersion precompensation range for optimized peak power
- Optional secondary output at 1040 nm for multi-wavelength excitation
- Industrial design for high uptime and reliability

Chameleon Discovery NX TPC:
Typical Tuning and Power



Chameleon Discovery NX TPC:
Beam Profile at 1000 nm



OPTICAL OUTPUT A	Chameleon Discovery NX with Total Power Control
Tuning Range (nm)	660 to 1320
Average Output Power (mW)	
700 nm	1250
800 nm	2200
900 nm	2100
1000 nm	1600
1200 nm	1300
1300 nm	1075
Pulse Duration[1,2] (fs)	100
Repetition Rate (MHz)	80 ±0.5
Beam Mode[1]	M^2 <1.2
Beam Diameter[1] (mm)	1.2 ±0.2
Ellipticity[1]	0.8 to 1.2
Astigmatism[1] (%)	<25
Polarization	Linear, Horizontal
Noise[1,3] (%)	<0.5
Power Stability[4] (%)	±1
Tuning Speed[5] (nm/s)	>50
Pointing Accuracy[6] (µrad)	<350
Rise/Fall Time (ns)	<1000
Contrast Ratio	1000:1
Dispersion Compensation Range (fs^2)	
680 nm	0 to -40,000
800 nm	0 to -17,000
950 nm	0 to -9000
1050 nm	0 to -5000
1300 nm	0 to -4000
OPTICAL OUTPUT B (Optional)	
Wavelength (nm)	1040
Average Output Power (mW)	>2800
Pulse Duration[2] (fs)	140
Repetition Rate[7] (MHz)	80 ±0.5
Beam Mode	M^2 <1.2
Beam Diameter (mm)	1.2 ±0.2
Ellipticity	0.8 to 1.2
Astigmatism (%)	<25
Polarization	Linear, Horizontal
Noise[3] (%)	<0.25
Power Stability[4] (%)	±1
Rise/Fall Time (ns)	<1000
Contrast Ratio	1000:1

1 At 900 nm.
2 Assumes $sech^2$ pulse shape.
3 RMS, 10 Hz to 10 MHz.
4 Power drift in a 2 hour period after 1 hour warm-up and ±1°C ambient temperature change.
5 Averaged over entire tuning range.
6 Maximum deviation over entire GDD dispersion adjustment and wavelength range.
7 Phase locked to Output A.

UTILITY REQUIREMENTS	Chameleon Discovery/Discovery NX with Total Power Control
Operating Voltage (VAC)	90 to 250 (auto ranging)
Maximum Operating Current (A)	
Power Supply	<8 at 90 VAC
Chiller	<14 at 90 VAC
MRU	<2 at 90 VAC
System Power Consumption (W)	2300
Line Frequency (Hz)	47 to 63
Communications/Control Interfaces[1]	RS-232, USB, PC required (Analog in for TPC)
ENVIRONMENTAL REQUIREMENTS	
Operating Temperature Range	15 to 35°C (59 to 95°F)
Storage Temperature Range	0 to 40°C (32 to 104°F)
Humidity	Non-condensing
Altitude (m)	<2000
MECHANICAL SPECIFICATIONS	
Power Supply	19" unit, 3U
Chiller	19" unit, 6U
MRU	19" unit, 2U

1 PC required.

Chameleon Ultra

Integrated, Automated and Widely Tunable Ti:Sapphire Oscillator

More Chameleon Ultra systems are used for Multi-Photon Excitation (MPE) Microscopy and other non-linear imaging techniques than any other laser.

Chameleon Ultra II delivers the highest power, the widest tuning range, the fastest tuning speed and the lowest noise of all commercially available Ti:Sapphire lasers. Its beam quality and pulse duration are specified to perfectly match your microscope or any other femtosecond experiment. Because of these capabilities, it is possible to image more dyes and fluorescent proteins, and to obtain deeper images more quickly than with any other laser.

For example, the Chameleon Ultra II's 680 nm to 1080 nm tuning range allows peak excitation of any marker – from short-wavelength dyes such as Indo or Fura, to new proteins like mCherry – as well as optimum native fluorescence excitation or SHG imaging. Every laser in the Chameleon Ultra family is compatible and has been tested with every inverted or upright MPE microscope on the market.

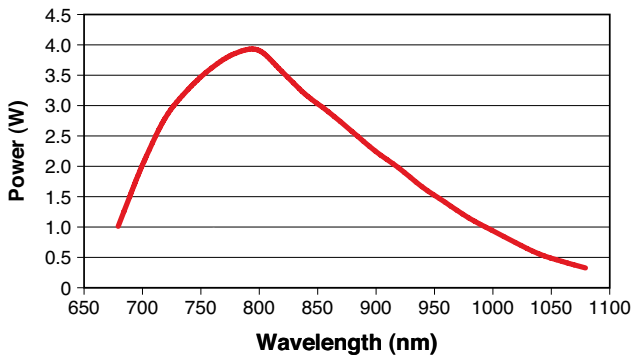
The high power from the Chameleon Ultra II makes it an ideal pump source for the Chameleon Compact OPO wavelength extension, enabling imaging even further into the infrared.

Proprietary PowerTrack and PermAlign technologies ensure stable performance over the laser lifetime without any adjustments.

The features of Chameleon Ultra combine to provide high throughput and quiet, reliable operation for thousands of hours, image after image.

A broad range of accessories, including units for pre-compensation, harmonics generation, and OPO wavelength extension, enable more advanced studies where adjustable pulse duration and UV, visible or longer IR wavelengths are desirable.

Chameleon Ultra II Tuning Curve (typical)



KEY ADVANTAGES

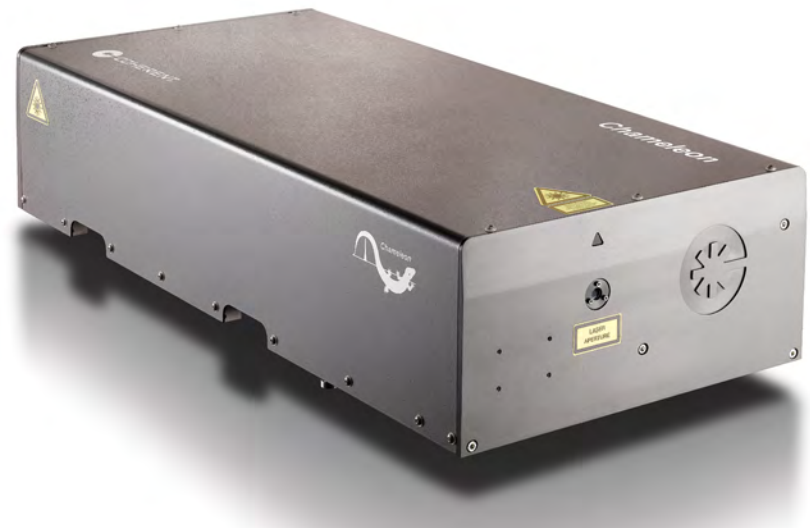
- Highest power for deepest imaging
- Automated tuning and alignment for hands-free operation
- PowerTrack™ active alignment for long-term stability and low maintenance
- Widest tuning range for efficient excitation of the widest gamut of probes
- Simple menu-driven GUI or RS-232 for flexible, intuitive control
- On-board spectrometer for real time spectral feedback
- Extendable wavelength range from 340 nm to 4000 nm with Compact OPO

SYSTEM SPECIFICATIONS	Chameleon Ultra	Chameleon Ultra I	Chameleon Ultra II
Average Power[1] (W)	>2.5	>2.9	>3.5
Tuning Range (nm)	690 to 1020	690 to 1040	680 to 1080
Peak Power[1] (kW)	>200	>250	>300
Power Specifications	>500 mW at 690 nm >1.4 W at 710 nm >2.5 W at 800 nm >1.4 W at 920 nm >450 mW at 1020 nm	>600 mW at 690 nm >1.5 W at 710 nm >2.9 W at 800 nm >1.45 W at 920 nm >450 mW at 1020 nm >300 mW at 1040 nm	>650 mW at 680 nm >1.6 W at 700 nm >3.5 W at 800 nm >1.6 W at 920 nm >550 mW at 1020 nm >200 mW at 1080 nm
Tuning Speed[2] (nm/s)	>35	>40	>40
Pulse Width[1,3] (fs)	140		
Noise[1,4] (%)	<0.15		
Output Power Stability[5] (%)	<±0.5		
Spatial Mode[1]	TEM_{00} (M^2 <1.1)		
Beam Diameter[1,6] (mm)	1.2 ±0.2		
Beam Ellipticity[1,7]	0.9 to 1.1		
Astigmatism[1]	<10%		
Repetition Rate (MHz)	80		
Polarization	Horizontal >500:1		
Pointing (µrad/nm)	<0.5		
Laser Head Physical Dimensions	65.1 x 37.0 x 19.0 cm (25.64 x 14.53 x 7.45 in.)		

1 Specified at peak of tuning range.
2 Average speed measured over entire tuning range.
3 Based on $sech^2$ deconvolution of 0.65 times autocorrelation width.
4 Measured RMS in a 10 Hz to 20 MHz bandwidth.
5 Power drift in any two-hour period with less than ±1°C temperature change after a one-hour warm-up.
6 $1/e^2$ at exit port.
7 Ratio of major to minor $1/e^2$ beam diameter at exit port.

Chameleon Vision and Vision-S

Integrated, Automated and Widely Tunable Ti:Sapphire Oscillators



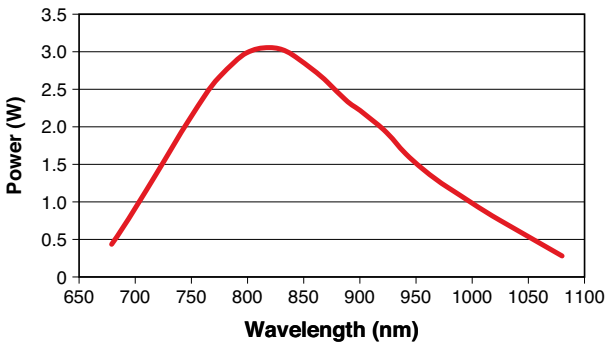
The Chameleon Vision family has been designed to pre-compensate (pre-chirp) for the natural dispersion that occurs when femtosecond pulses pass through optical elements such as lenses.

In some imaging applications, it may be useful to excite the sample with short pulses in order to maximize the efficiency of the non-linear process (two-photon excitation or harmonic generation). To satisfy this need, Chameleon Vision I and Vision II use the same ultrafast cavity design of the Chameleon Ultra family, with the addition of a built-in automated, pre-compensation unit. As a result, the pulse duration at the sample can always be optimized to match its time-bandwidth limited value (about 140 fs at 800 nm).

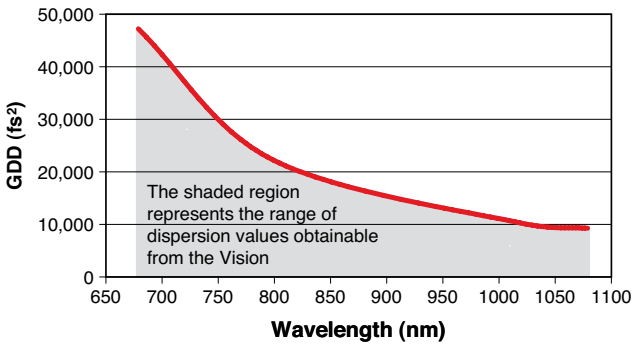
Chameleon Vision-S has been designed for those users who, in addition to pre-compensation, also want to excite the sample with even shorter pulses, but still retain the widest possible tuning range. Short pulses maximize the ratio between peak power and average power, an advantage for those samples where linear (average power-based) damage dominates over non-linear (peak power-based) damage. Chameleon Vision-S fully satisfies this requirement by providing 75 fs pulses at the sample.

Built-in pre-compensation supplies also an easy way to purposely change the pulse duration at the sample, to study of the interplay of peak power, average power and pulse duration on different samples. For example, by mismatching the

Chameleon Vision II Tuning Curve (typical)



Chameleon Vision Maximum Negative Dispersion Capability



KEY ADVANTAGES

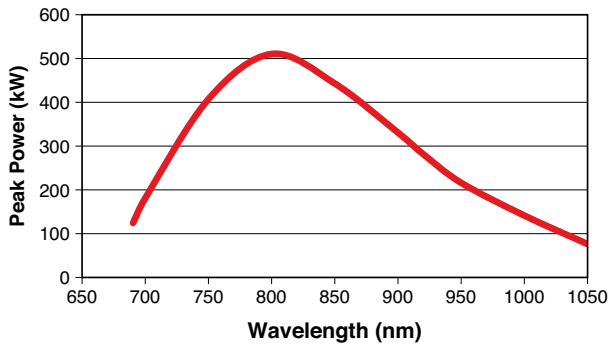
- Sealed construction for hands-free operation
- Choice of 140 fs and 75 fs pulses
- Automated pre-compensation with user-adjustable tables
- Highest average output power among pre-chirped Ti:Sapphire lasers (Vision II)
- Widest Ti:Sapphire tuning range available: 400 nm (Vision II)
- Wide range of dispersion pre-compensation (0 to 47,000 fs^2)
- Simple menu-drive GUI or RS-232 operator interface for laser and pre-chirp management
- On board spectrometer with USB interface for wavelength and bandwidth monitoring
- PowerTrack active alignment and PermAlign manufacturing for long-term stability

pre-compensation, it is possible to vary the pulse duration at the sample between the fully compensated value of 75 fs to chirped pulse durations of several hundreds of femtoseconds.

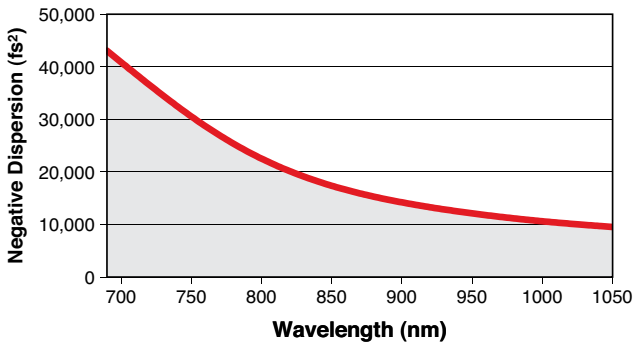
All Chameleon Vision models incorporate our proprietary prism-based design, able to compensate the broadest range of GVD (Group Velocity Dispersion) using the smallest system footprint commercially available. The provided GVD compensation range is wide enough to eliminate the pulse broadening associated with the most sophisticated microscopes, like ones including complex objective lenses, modulators and other optical elements. Chameleon Vision I and II deliver the highest average power, the broadest tuning range, the fastest tuning speed and the lowest noise available on the market among Ti:Sapphire lasers with pre-compensation. Chameleon Vision S delivers the highest peak power at the sample, providing at the same time the broadest tuning range among auto-mated short pulse Ti:Sapphire lasers designed for non-linear imaging. This exceptional performance enables Chameleon Vision to easily manage pulse duration and excitation wavelength, providing brighter images and better sample viability.

The broadly adjustable GVD compensation can be used to optimize image brightness even while pumping the OPO. The flexibility of the Vision family makes it ideal not only for microscopy but also for time-resolved spectroscopy and Terahertz studies.

Chameleon Vision-S
Peak Power (typical)



Chameleon Vision-S Maximum
Negative Dispersion Capability



SYSTEM SPECIFICATIONS	Chameleon Vision I	Chameleon Vision II
Tuning Range (nm)	690 to 1040	680 to 1080
Average Power at Peak (W)	2.5	3.0
Power Specifications	- 640 mW at 690 nm 1.07 W at 710 nm 2.5 W at 800 nm 920 mW at 920 nm 260 mW at 1040 nm -	500 mW at 680 nm - 1.5 W at 710 nm 3.0 W at 800 nm 1.35 W at 920 nm 400 mW at 1040 nm 180 mW at 1080 nm
Dispersion Compensation Range 680 nm 690 nm 800 nm 1020 nm 1080 nm	 - 0 to 43,000 fs^2 0 to 22,000 fs^2 0 to 10,000 fs^2 -	 0 to 47,000 fs^2 - 0 to 22,000 fs^2 0 to 10,000 fs^2 0 to 9000 fs^2
Tuning Speed[2] (nm/s)	>35	>40
Pulse Width[1,3] (fs)	140	
Noise[1,4] (%)	<0.15	
Output Power Stability[1,5]	<±0.5	
Spatial Mode[1]	TEM_{00} (M^2 <1.1)	
Beam Diameter[1,6] (mm)	1.2 ±0.2	
Beam Ellipticity[1,7]	0.9 to 1.1	
Astigmatism[1] (%)	<10	
Repetition Rate (MHz)	80	
Polarization	Horizontal >500:1	
Pointing[8] (µrad/nm)	<80/100	
Operating Voltage (VAC)	90 to 250 (auto ranging)	
Maximum Operating Current (A) Power Supply Chiller MRU x1	 <15 at 90 VAC <7 at 90 VAC <2 at 90 VAC	
System Power Consumption (W)	2300 max., 1300 typical	
Line Frequency (Hz)	47 to 63	
Operating Temperature Range	15 to 35°C (59 to 95°F)	
Non-operating Temperature Range	5 to 40°C (41 to 104°F)	
Weight of Laser Head	52 kg (115 lbs.)	
Weight of Power Supply	41 kg (90 lbs.)	
Umbilical Length	3 m (10 ft.)	
Chiller: Dimensions (L x W x H) Weight	 436 x 270 x 393 mm (17.17 x 10.63 x 15.47 in.) 11 kg (25 lbs.)	
MRU Air Recirculator: Dimensions (L x W x H) Weight	 46 x 43 x 8.5 cm (18 x 17 x 3 in.) 9 kg (20 lbs.)	

1 Specified at peak of tuning range.
2 Average speed measured over entire tuning range.
3 Based on $sech^2$ deconvolution of 0.65 times autocorrelation width.
4 Measured RMS in a 10 Hz to 20 MHz bandwidth.
5 Power drift in any two-hour period with less than ±1°C temperature change after a one-hour warm-up.
6 $1/e^2$ at exit port.
7 Ratio of major to minor $1/e^2$ beam diameter at exit port.
8 Measured over the whole wavelength and GDD dispersion adjustment range.

SYSTEM SPECIFICATIONS	Chameleon Vision-S
Tuning Range (nm)	690 to 1050
Average Power at Peak (W)	>2.5
Peak Power at Peak (kW)	>440
Peak Power Specifications	80 kW at 690 nm 440 kW at 800 nm 240 kW at 920 nm 50 kW at 1050 nm
Dispersion Compensation Range	690 nm 0 to -43,000 fs^2 800 nm 0 to -22,000 fs^2 1050 nm 0 to -9500 fs^2
Tuning Speed[2] (nm/s)	>25
Pulse Width[1,3] (fs)	75
Noise[1,4] (%)	<0.15
Output Power Stability[1,5]	<±0.5
Spatial Mode[1]	TEM_{00} (M^2 <1.1)
Beam Diameter[1,6] (mm)	1.2 ±0.2
Beam Ellipticity[1,7]	0.9 to 1.1
Astigmatism[1] (%)	<10
Repetition Rate (MHz)	80
Polarization	Horizontal >500:1
Pointing[8] (µrad/nm)	<80/100
ENVIRONMENTAL SPECIFICATIONS	
Operating Temperature Range	15 to 28°C (59 to 82.5°F)
Non-operating Temperature Range	5 to 40°C (41 to 104°F)
Storage Temperature Range	5 to 40°C (41 to 104°F)
ELECTRICAL REQUIREMENTS	
Operating Voltage (VAC)	90 to 250 (auto ranging)
Maximum Operating Current (A)	<15 at 90 VAC (power supply) <7 at 90 VAC (chiller) <2 at 90 VAC (MRU)
System Power Consumption (W)	2300 max., 1300 typical
Line Frequency (Hz)	47 to 63
MECHANICAL PARAMETERS	
Weight of Laser Head	52 kg (115 lbs.)
Weight of Power Supply	33 kg (73 lbs.)
Umbilical Length	3 m (10 ft.)
Dimensions (L x W x H) Chiller MRU Air Recirculator	 436 x 270 x 393 mm (17.17 x 10.63 x 15.47 in.) 46 x 43 x 8.5 cm (18 x 17 x 3 in.)
Weight Chiller MRU Air Recirculator	 11 kg (25 lbs.) 9 kg (20 lbs.)

1 At 800 nm
2 Average speed measured over entire tuning range.
3 Based on $sech^2$ deconvolution of 0.65 times autocorrelation width.
4 Measured RMS in a 10 Hz to 20 MHz bandwidth.
5 Power drift in any two-hour period with less than ±1°C temperature change after a one-hour warm-up.
6 $1/e^2$ at exit port.
7 Ratio of major to minor $1/e^2$ beam diameter at exit port.
8 Measured over the whole wavelength and GDD dispersion adjustment range.

Chameleon Compact OPO and OPO-Vis

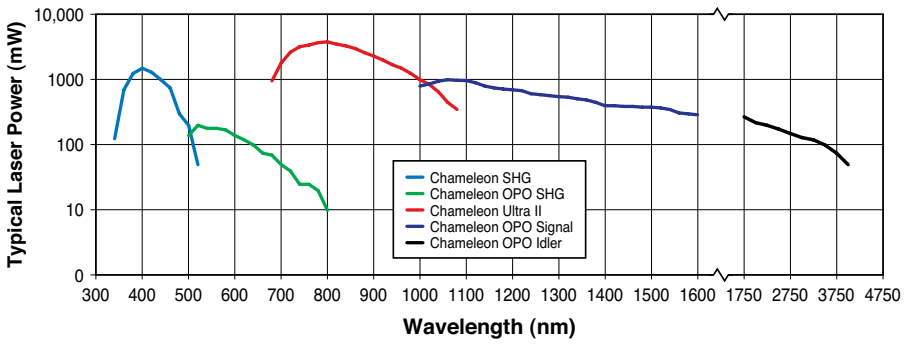
Synchronously-Pumped Optical Parametric Oscillator Accessories

Chameleon Compact OPO is a fully automated Optical Parametric Oscillator tunable between 1000 nm and 1600 nm. Chameleon Compact OPO-Vis, in addition to all the benefits of the Compact OPO, includes also Second Harmonic Generation (SHG) outputs of the Chameleon and the OPO signal wavelengths to provide additional seamless tuning between 340 and 800 nm.

Designed specifically to be pumped by the Chameleon Ultra and Vision families of ultrafast lasers, the Chameleon Compact OPO family offers unique benefits. The non-linear medium is a fan-poled crystal that allows simple and broad tunability of the OPO output over a wide range of pump wavelengths. This feature enables truly independent tuning of Chameleon and Compact OPO output wavelengths over hundreds of nanometers. Thanks to the low OPO threshold and high efficiency, 15% of the Chameleon pump beam can be split off and sent directly to the output port to provide simultaneous user access to both the Chameleon and the OPO output beams. This feature enables two-color non-linear microscopy studies with a flexibility that, until now, required at least two independent lasers. The OPO-Vis extends further this flexibility by adding tunability in the UV, visible and near IR wavelengths.

Both Chameleon and the Compact OPO families are fully computer-controlled and automatically tuned. Their combined output offers an overall tuning range in excess of 900 nm, from 680 nm to 1600 nm, accessible within seconds. This broad and independently accessible tuning

Chameleon Ultra II and Compact OPO-Vis Power vs. Wavelength



KEY ADVANTAGES

- Wavelength extension to IR (OPO) and UV/Visible (OPO-Vis)
- Sealed hands-free performance
- Designed to be pumped by Chameleon Ultra and Vision families
- Automated wavelength tuning with single optic set
- Fan-poled OPO crystal for flexible pump wavelength
- Independent pump laser (Chameleon) and OPO/OPO SHG tuning
- Enables full multimodal imaging (MPE, SHG, THG and CARS)
- RS-232 and USB interface
- Filtered and dry air recirculation unit to tune across water absorption bands
- Vis and Idler outputs available also as after-sale upgrades

range is useful for two-color MPE microscopy, SHG and THG microscopy, and CARS microscopy of lipids. Wavelengths above 1.1 micron optimally excite the new mFruit family of fluorescent proteins at their excitation peaks, in wavelength regions of minimum damage and deepest tissue penetration. The combination of the low pump threshold and the industry-record high power of Chameleon guarantee plenty of power at both the Chameleon and OPO outputs to compensate for losses in complex microscope systems and to enable deep multimodal imaging. The industry's smallest footprint of Chameleon Compact OPO makes it simple to add this laser to existing multiphoton set-ups and upgrade MPE facilities to fully multimodal operations ready for the most advanced spectral imaging and manipulation techniques.

Extension into UV and visible wavelengths enables the Chameleon Compact OPO-Vis to address applications beyond multiphoton microscopy, such as spectroscopy and non-linear optics. The optional idler output enables a unique automated tuning range between 340 nm and 1600 nm and 1750 nm to 4000 nm, enabling also time-resolved vibrational spectroscopy. Multi-user facilities will greatly benefit from this unprecedented flexibility while individual investigators will appreciate how the many possible upgrades can follow their changing research objectives, even with limited initial budgets.

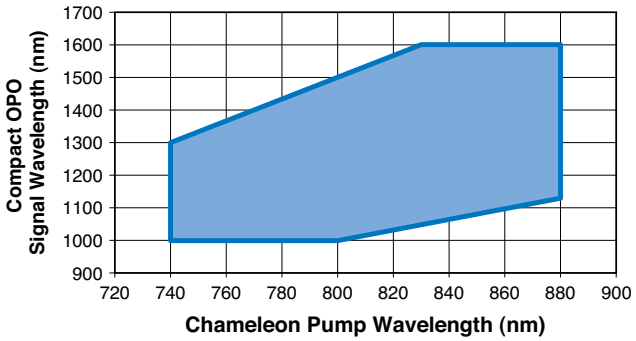
Chameleon Compact OPO-Vis

SPECIFICATIONS	Chameleon Compact OPO Pumped by Chameleon Ultra II	Chameleon Compact OPO Pumped by Chameleon Vision II
Tuning Range[1] (nm)	1000 to 1600	1000 to 1350
Pump Wavelength Range (nm)	740 to 880	760 to 880
Output Power, Signal[2] (mW)	>700	>700[3]
Pump Output Power Available[4] (%) when pumping OPO in bypass mode	 ~15 ~95	
Pulsewidth (fs) (typical)	200	
M^2 (typical)	1.1	
Beam Diameter (mm)	2	
Beam Divergence (mrad) (typical)	0.5	
Polarization	Horizontal	
Repetition-Rate (MHz)	80 (locked to pump laser)	
Dimensions (L x W x H)	520 x 369 x 158 mm (20.5 x 14.5 x 6.2 in.)	
IDLER OPTION		
Additional Tuning Range[1,5] (nm)	1750 to 4000	
Idler Output Power[6] (mW)	>100	
MAXIMUM IR OPTION		
Additional Signal Output Power[7] (%)	15	

1 Tuning range depends on Pump Wavelength.
2 At maximum of pump and OPO signal tuning curve.
3 Vision Dispersion settings optimized for OPO.
4 Typical. Please refer to Chameleon datasheet for respective power specifications. Pump output not available with Max IR option.
5 In addition to OPO signal output range. All other specifications are unaffected.
6 At maximum of pump and OPO idler tuning range .
7 No access to pump beam.

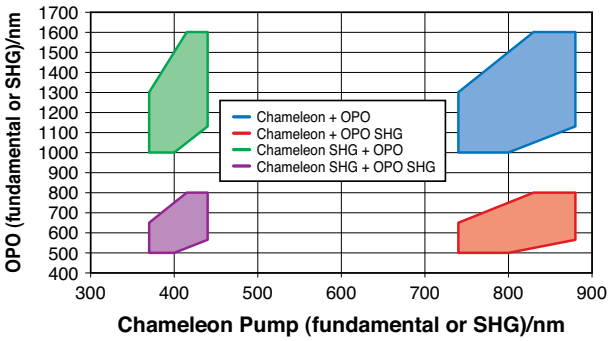
Chameleon Ultra II and Compact OPO Tuning Range

Possible wavelength combinations are in shaded area



Chameleon Ultra II and Compact OPO-Vis Tuning Range

Possible wavelength combinations are in shaded area



SPECIFICATIONS

OPO Bypass Mode	**Chameleon Laser**		**Chameleon SHG**	
Tuning Range (nm)	680 to 1080		340 to 540	
Output Power[2]	~95%[5]		>1000 mW	
Pulse Width (fs) (typical)	140		140	
M^2 (typical)	<1.1		<1.1	
OPO Operation	**Chameleon Laser**	**OPO**	**Chameleon SHG**	**OPO SHG**
Tuning Range (nm)	740 to 880[6]	1000 to 1600[7]	370 to 440[6]	500 to 800[7]
Output Power[3] (mW)	~15%[5]	>700 mW	>50 mW	>110 mW
Pulse Width[2] (fs) (typical)	140	200	140	200
Polarization	Horizontal			
Repetition Rate (MHz)	80			
Dimensions (L x W x H)	768 x 388 x 158 mm (30.2 x 15.3 x 6.2 in.)			

IDLER OPTION

Tuning Range (nm)	1750 to 4000[7]
Idler Output Power[4] (mW)	>100

WAVELENGTH COMBINATION TABLE

Output Port	**Output Scheme**					
	I	II	III	IV	V	VI
Chameleon Fundamental - High Power (680 nm to 1080 nm)	•					
Chameleon Fundamental - Low Power (740 nm to 880 nm)			•	•		
Chameleon Fundamental - Depleted		•			•	•
Chameleon SHG - High Power (340 nm to 540 nm)		•				
Chameleon SHG - Low Power					•	•
OPO Signal (1000 nm to 1600 nm)			•		•	
OPO Signal - Depleted				•		•
OPO Signal SHG (500 nm to 800 nm)				•		•
OPO Idler			•	•	•	•

1 All specifications are shown for pumping with Chameleon model Ultra II. Other pump options available.
2 At peak of tuning curve.
3 At peak of pump laser wavelength and OPO wavelengths.
4 At maximum of pump and OPO idler tuning range.
5 Typical. Please refer to Chameleon datasheet for respective power specifications.
6 Typical, Chameleon Ultra II.
7 Pump wavelength dependent.

Chameleon Discovery NX VUE Harmonics

Visible and Ultraviolet Extension for Chameleon Discovery Lasers

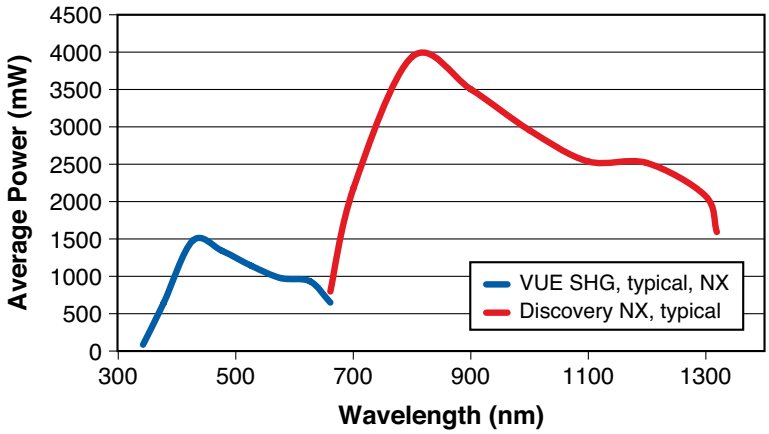
Chameleon Discovery NX VUE is a Harmonics Generator for producing visible and UV wavelengths in an automated hands-free package.

When combined with the octave spanning tuning range of the Chameleon Discovery laser, users can access gap free output from 330 nm to 1320 nm. Ideal for ultrafast spectroscopy applications.

Discovery VUE SHG can communicate with the Discovery GUI software to automatically optimize crystal phase-matching as the wavelength of the fundamental laser varies. The modular instrument design focuses on user-friendliness and compactness, with software-controlled wavelength tuning available.

The unit is also compatible with the Total Power Control (TPC) option for Chameleon Discovery which enables fast and precise power modulation at all wavelengths

Typical Tuning Curve
Discovery NX, with VUE SHG

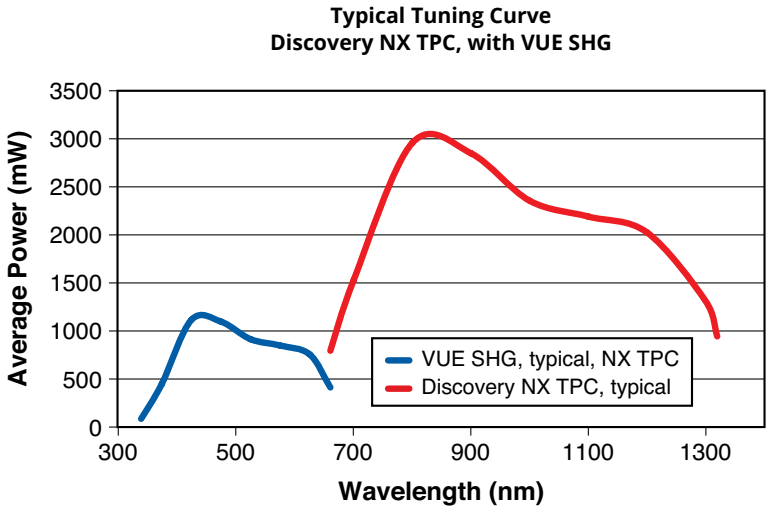


KEY ADVANTAGES

- Widely-tunable visible and UV for spectroscopy
- Gapless, 330 nm to 1320 nm tuning range when paired with standard Chameleon Discovery
- Automated phase-matching for ease of use
- High conversion efficiencies for non-linear optics experiments
- Excellent beam quality for microscopy applications such as FLIM and FRET
- Robust and compact design for long lifetime and low maintenance
- Compatible with all Chameleon Discovery lasers
- User GUI supplied

SPECIFICATIONS	Chameleon Discovery NX
Tuning Range (nm)	330 to 660
Conversion Efficiency[1] (%)	>35
MECHANICAL PARAMETERS	
Dimensions (L x W x H)	385 x 286 x 207 mm (15.2 x 11.3 x 8.1 in.)

1 At the peak of the tuning range.



Mira OPO-X

Fully Automated IR/Visible OPO for femtosecond and picosecond Ti:S Lasers

Mira OPO-X is a synchronously pumped, widely tunable, optical parametric oscillator (OPO) accessory that dramatically extends the wavelength coverage of our fs and ps Ti:Sapphire lasers (such as Mira and Chameleon) from 505 nm to 4000 nm. It is fully automated, i.e. software controlled tuning over the full specified wavelength range. This is made possible by its advanced control electronics, built-in diagnostics, and powerful control software package.

The control software can be accessed remotely via the system's TCP/IP software interface making The MIRA OPO-X easy to integrate into larger experimental set-ups and software controlled environments. Enhanced customer support is enabled through internal error diagnosis and extensive log files, all remotely accessible via TCP/IP interface and LAN, which also enables remote service capabilities.

Mira OPO-X is designed around a unique fan-poled nonlinear crystal technology. Rather than having a single fixed poling period in the OPO gain crystal matched to one pump wavelength, the crystal is poled in a fan geometry across the width of the crystal providing a continuously variable, quasiphase-matching period. This allows fully independent tunability between pump and OPO output wavelengths enabling two-color applications such as simultaneous multi-photon excitation imaging of different fluorophores, uncaging, CARS/SRS and other two-color pump-probe experiments.

The actual Signal wavelength and bandwidth are measured in real-time by an internal high resolution spectrometer and the power is monitored by calibrated photodiodes. The Mira OPO-X is also equipped with real-time pump beam diagnostic that track pump wavelength, power and repetition rate. To tune the output wavelength of the Mira OPO-X, the user simply enters the desired wavelength into the control software. Even a change in pump wavelength is detected and Mira OPO-X automatically adjusts accordingly. The unique optical design and sophisticated control software make the Mira OPO-X fully controllable via PC. Broad tunability of ultrafast light sources has never been easier.

CAVITY CONFIGURATIONS

Linear IR Cavity
The Linear IR configuration is a singly Signal-resonant OPO with a 5-mirror standing wave cavity. It is used for highly efficient IR-generation using a fan-periodically-poled crystal covering the 1.0 ... 1.6 µm wavelength range and up to 4 µm with the non-resonant Idler branch (optional).

Visible Ring with Intracavity SHG
The Ring VIS configuration is a singly Signal-resonant OPO employing an additional intra-cavity SHG module in an 8-mirror Ring cavity. The SHG module is based on tempera-

KEY ADVANTAGES

- Fully automated wavelength tuning
- Unique Fan-Poled crystal technology for independent tunability of pump and OPO wavelengths
- Femtosecond and picosecond options
- High power visible output using efficient intracavity doubling
- Access to idler wavelengths to 4 µm using optional optics sets
- Active cavity length stabilization
- Built-in diagnostics
- Remote service capability

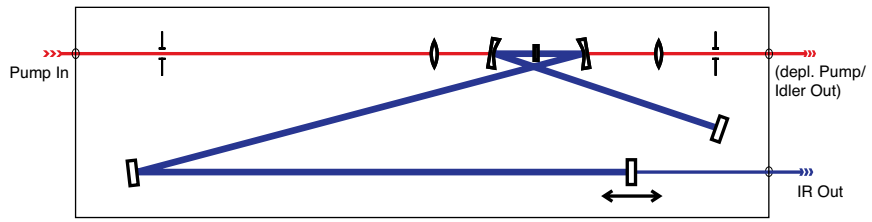
OPTIONS AND ACCESSORIES

- Autocorrelator
- Idler output
- Depleted pump output
- Simultaneous access to Signal IR and VIS outputs from ring configuration
- Difference frequency generation (DFG) for mid-IR generation up to 15 µm

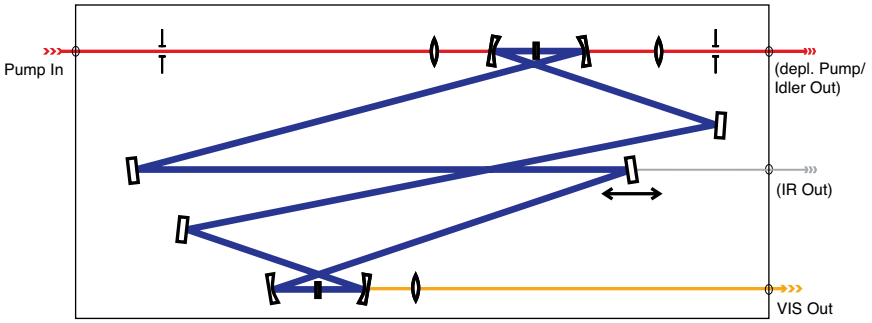
ture tuned non-critically phase matched SHG for highly efficient visible output generation. It covers the 505 nm to 740 nm wavelength range, which fills the gap between the Ti:Sapphire fundamental beam and its frequency doubled Signal (SHG). All Ring VIS systems include the Linear IR operation, which can be reconfigured by the customer.

Both IR Linear and Visible Ring configurations of MIRA OPO-X are available both femto- and picosecond or dual mode (depending on the pump) and switching between mode is achieved by simply exchanging a few optical elements.

Linear IR Cavity



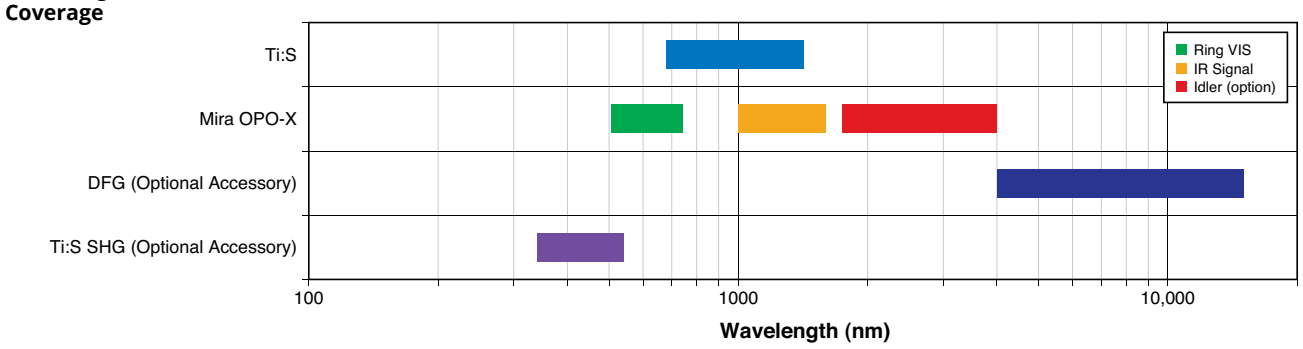
Visible Ring with Intracavity SHG



SPECIFICATIONS[1]	Mira OPO-X (IR)		Mira OPO-X (VIS+IR)	
Model[2]	femtosecond	picosecond	femtosecond	picosecond
Cavity Configuration	IR Linear Cavity		Visible Ring Cavity with Intracavity SHG	
Tuning Range[3] (nm) Signal SHG Signal IR Idler (option)	 NA 1000 to 1600 1750 to 4000		 505 to 740 1000 to 1600 1750 to 4000	
Nominal Pump Wavelength	740 to 880		740 to 880	
Average Output Power[4] (mW) Chameleon Ultra-II 18W Pumped Mira HP 10W Pumped Mira 900 5W Pumped Mira 900	 >650 at 1100 nm >650 at 1100 nm >250 at 1100 nm >75 at 1100 nm	 NA >520 at 1100 nm >250 at 1100 nm >75 at 1100 nm	 >500 at 600 nm >500 at 600 nm >150 at 600 nm >40 at 600 nm	 NA >400 at 600 nm >150 at 600 >40 at 600 nm
Typical Pulse Width[5]	200 fs from 130 fs pump pulse	1.6 ps from 2 ps pump pulse	200 fs from 130 fs pump pulse	1.6 ps from 2 ps pump pulse
Typical Time Bandwidth Product	0.6		0.6	
Polarization IR Signal & Idler Vis SHG Signal	 Linear Horizontal Linear Vertical		 Linear Horizontal Linear Vertical	
M^2	<1.2		<1.2	
Spectrometer Range (nm)	680 to 1640		480 to 1640	
Repetiton Rate	Matched and Synchronized to Pump Laser		Matched and Synchronized to Pump Laser	
Noise[6] (% RMS)	<0.5		<0.5	

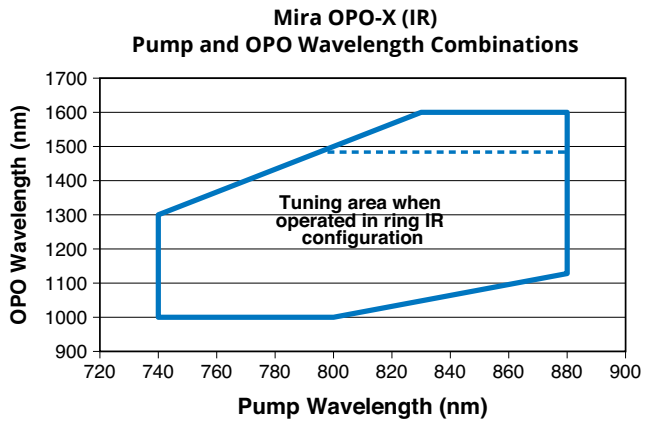
1 Specifications subject to change.
2 Dual models are available that can be configured for fs or ps operation.
3 Depends on actual pump wavelength (see Figure 1).
4 Pumped at 800 nm.
5 Assumes Gaussian pulse shape from OPO (deconvolution factor 0.7).
6 Measured within a 10 Hz to 10 MHz bandwidth.

Wavelength Coverage



TYPICAL PERFORMANCE DATA

Figure 1: Any combination of pump and OPO wavelength within these bounded regions is accessible with the Mira OPO-X system.



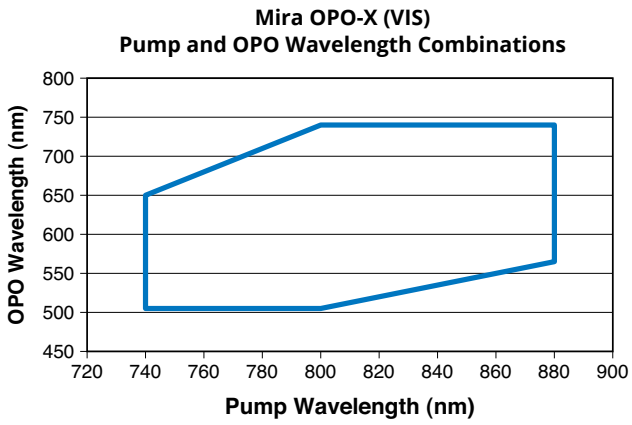
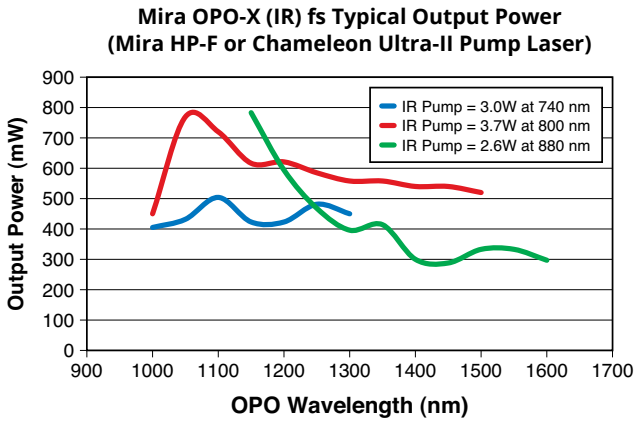


Figure 2: Mira OPO-X (IR) model typical average power.



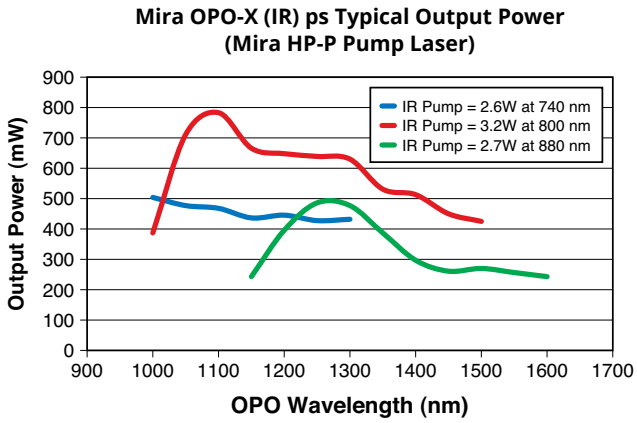
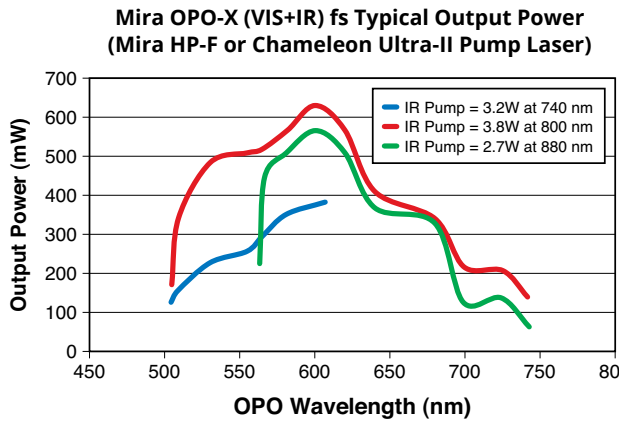
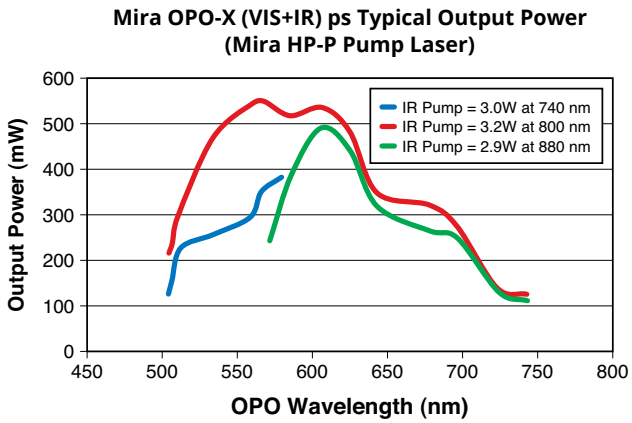


Figure 3: Mira OPO-X (VIS+IR) model typical average power in the visible.





Levante IR fs OPO

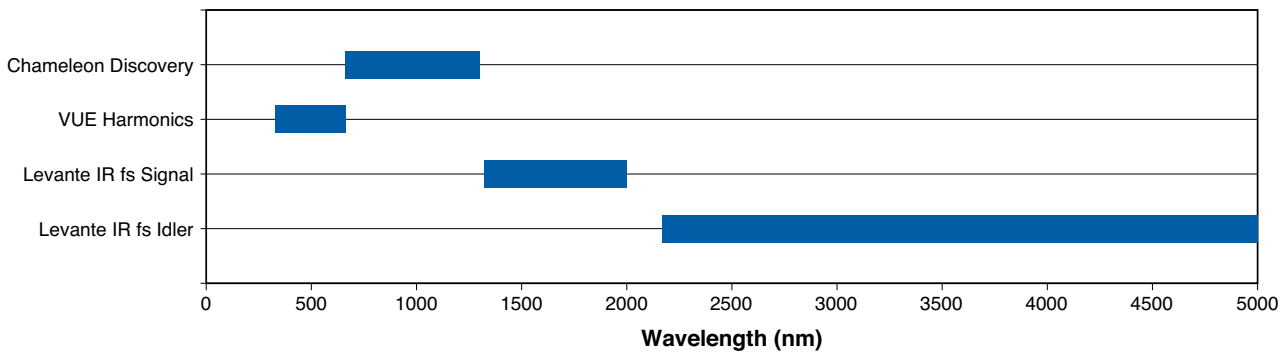
Femtosecond OPO with Automated Wavelength Tuning

Levante IR fs Optical Parametric Oscillator (OPO) is an ideal tool to extend the wavelength coverage of Coherent fs laser sources. A versatile tool for spectroscopy, material science, microscopy and other applications, it can be pumped with either the Fidelity HP or Chameleon Discovery NX laser systems.

The generation of the Signal and Idler pulses is jitter-free with respect to each other as well as to the pump pulse. High power Signal output is tunable between 1320 nm to 2000 nm while Idler output provides 2170 nm to 5000 nm range.

User-oriented design and automated wavelength tuning enable full PC control while easy-to-use data acquisition software and the TCP/IP-based interface allows for real-time data display and straight-forward remote control setup or custom software.

Extensive Spectral Coverage by Chameleon Discovery NX and Wavelength Extension Accessories



KEY ADVANTAGES

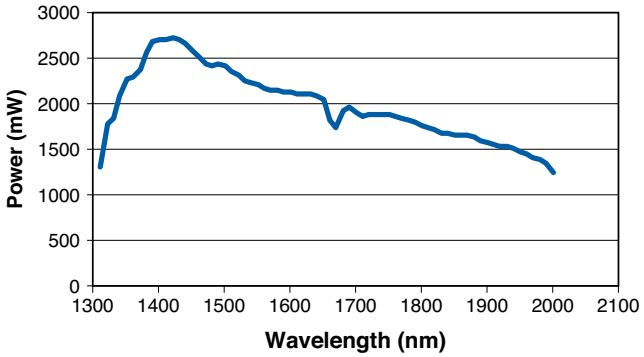
- Automated wavelength tuning
- Synchronous pumping scheme
- Full PC control
- TCP/IP standard Software Interface
- Integrated spectrometer for OPO Signal wavelength range

SPECIFICATIONS	Pumped with Fidelity HP (10 W)	Pumped with Chameleon Discovery NX (fixed wavelength output, 3.5 W)
Pump Wavelength (nm)	1040	
Tuning Range[1] (nm) Signal Idler	 1320 to 2000 2170 to 5000	
Average Output Power (W) Signal, at 1500 nm Idler, at 2500 nm	 >2 >0.7	 >0.9 >0.4
Typical Pulse Width after Compression (fs)	<150	
Pulse Repetition Rate[2] (MHz)	80	
Power Stability[3] (% rms)	<1	
Spatial Mode (Signal and Idler)	TEM_{00}	
Computer Interface	Standardized Software Interface (TCP/IP)	
Weight	88 kg (194 lbs.)	
Dimensions (L x W x H)	1169 x 402 x 204 mm (46.0 x 15.8 x 8.0 in.)	

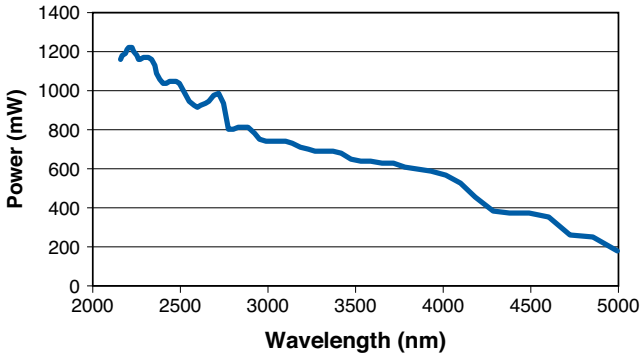
TYPICAL PERFORMANCE DATA

Levante IR Pumped with Fidelity HP (10 W, 80 MHz, 140 fs)

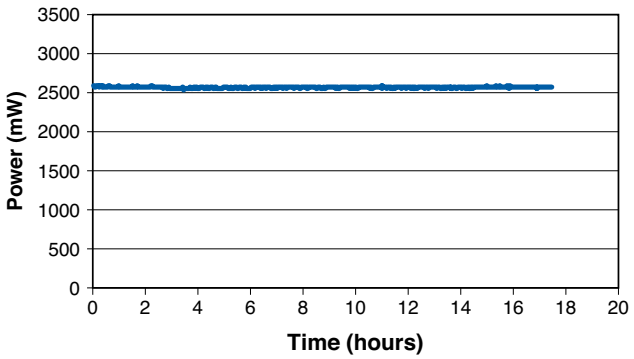
Levante IR
Output Power, Signal



Levante IR
Output Power, Idler



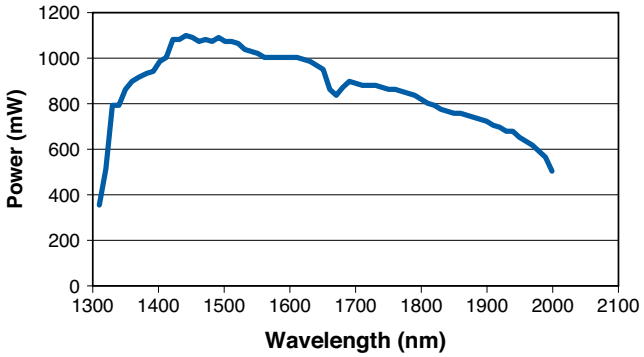
Levante IR
Typical Signal Power Stability (at 1600 nm)



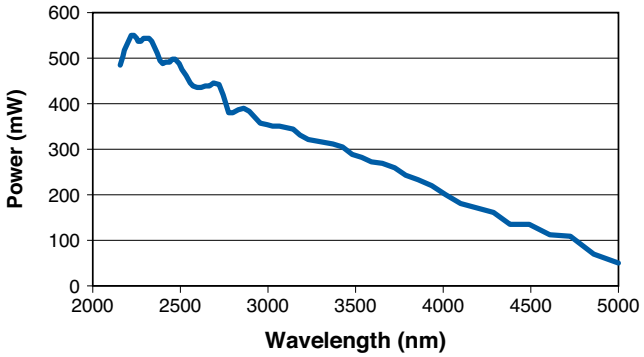
TYPICAL PERFORMANCE DATA

Levante IR Pumped with Chameleon Discovery NX (fixed wavelength output, 1040 nm, 3.5 W)

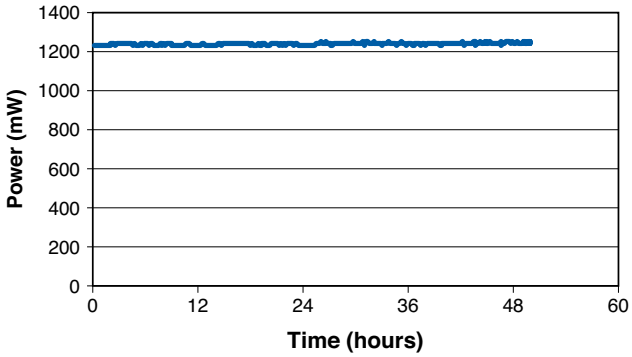
Levante IR
Output Power, Signal



Levante IR
Output Power, Idler



Levante IR
Typical Signal Power Stability (at 1700 nm)



Harmonic Generator

Second, Third and Fourth-Harmonic Accessory for Ti:Sapphire Oscillators

The Harmonic Generator is an extremely flexible and adaptable wavelength extension accessory for Coherent's entire range of ultrafast oscillators (Mira, Chameleon, Vitara, Mira OPO and Chameleon Compact OPO). A wide range of nonlinear crystals and configuration options are available that span second, third and fourth harmonic generation of picosecond or femtosecond pulses at input powers up to 5W.

For third harmonic generation, the unique high efficiency collinear mixing design with walk-off compensation and in-line time delay is simple to align without the complexity of separate optical delay lines and fundamental and SHG spatial separation and recombination.

KEY ADVANTAGES

- Magnetically indexed crystals simplifies SHG/THG/FHG conversion
- Walk-off compensator maintains good beam circularity
- Delay compensator for simple in-line THG generation

SPECIFICATIONS	Harmonic Generator				
	High Power SHG (SHG only)	**Standard SHG**	**THG (incl. Standard SHG)**	**FHG-1 (SHG of SHG) (incl. Standard SHG)**	**FHG-2 (mixing fundamental & THG) (incl. SHG, THG, & FHG-1)**
	Conversion Efficiency for input wavelength of 800 nm unless otherwise stated				
Mira HP-F, 18 W pump	40%	25%	THG: 9%, SHG: 20%	FHG: 4% at 880 nm SHG: 20% at 800 nm	FHG (3+1): 0.15%
Mira HP-P, 18 W pump	15%	10%	THG: 3%, SHG: 10%	FHG: 0.4% at 880 nm SHG: 10% at 800 nm	FHG (3+1): 0.1%
Mira 900-F, 10 W pump	40%	20%	THG: 9%, SHG: 20%	FHG: 4% at 880 nm SHG: 20% at 800 nm	FHG (3+1): 0.115%
Mira 900-P, 10 W pump	15%	10%	THG: 3%, SHG: 10%	Call Factory	Call Factory
Wavelength Range (nm) Input	680 to 1080	680 to 1080	680 to 1080	840 to 920	760 to 840 FHG (3+1)

Pulse Picker

Accessory for Selecting Pulses from Modelocked Ti:Sapphire Oscillators

The Pulse Picker, a standalone accessory for selecting pulses from femtosecond or picosecond Ti:Sapphire oscillator, features a rugged optomechanical head assembly and a versatile controller.

The acousto-optic Bragg cell in the head provides simple single-pass diffraction of the pulse train, while the controller lets the user select any repetition-rate by dividing the Ti:Sapphire oscillator frequency by any integer from 16 to 8192. By applying external control signals, rates down to even single-shot are possible.

Two Bragg cell options are available, SiO_2 for applications demanding the highest contrast ratio for input powers >2W, or the TeO_2 cell which is recommended for input powers <2W and for higher diffraction efficiency.

KEY ADVANTAGES

- For use with femtosecond or picosecond lasers
- Wavelength options covering 500 to 3000 nm
- Single-pass Bragg cell for easy alignment
- High diffraction efficiency and contrast ratio
- Dedicated controller with CPU
- LCD display of operational parameters
- Controller settings provide widely variable repetition-rate: 9.3 kHz to 4.75 MHz

SPECIFICATIONS	Pulse Picker
Pulse Repetition-Rate	9.5 kHz to 4.75 MHz variable by integer division of oscillator frequency.[1] The unit also can be externally triggered at any repetition-rate below 4 MHz or operated single-shot.
Diffraction Efficiency[2] (%)	
TeO_2 Cell	>60
SiO_2 Cell	>50
Contrast Ratio[3] (%)	
TeO_2 Cell	>500:1
SiO_2 Cell	>1000:1
Wavelength Range (nm)	<680 to >1080[4,5] (other ranges available on request)

1 The Pulse Picker accepts the nominal 76 MHz input frequency from the synchronous output photodiode of the Mira 900. A 38 MHz RF clock is divided by 8 thru 4096.
2 Percentage of incident pulse energy in diffracted output pulse.
3 Main pulse to non-adjacent pulses. Main pulse to adjacent pulse is >100: 1 TeO_2 cell or >200:1 SiO_2 cell. Contrast ratios for high power pumped femtosecond systems are 0.5 times the given values for the TeO_2 cell.
4 For SHG operation, the fundamental output must be pulse picked first, then frequency doubled.
5 Requires optics changes.

Pulse Compressors

Pulse Compression Accessories for Coherent Ti:Sapphire Oscillators

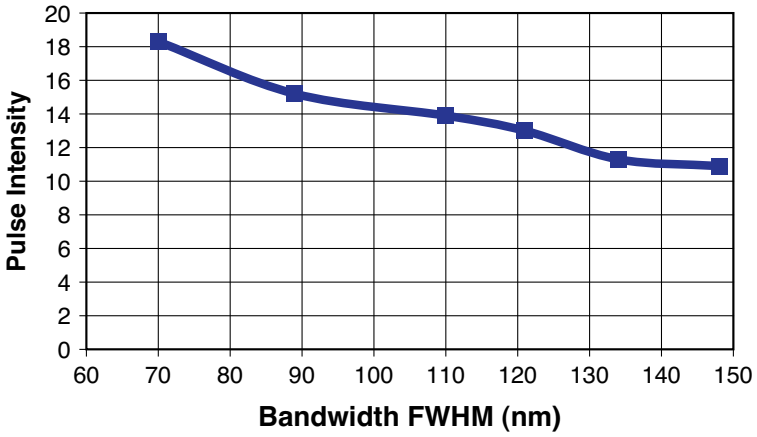
Pulse compressors are versatile accessories that temporally compress the broadband pulses from Mira, Vitara, and Chameleon oscillators enabling operation very close to the transform limit.

By adding Group Velocity Dispersion (GVD), pulse compressors also allow users to pre-compensate for the dispersion introduced when downstream optics are added in order to shorten the pulse width at the sample.

Two types of Coherent pulse compressor accessories are available: the Compact Pulse Compressor (CPC-II), based on chirped-mirror technology, and the prism-based SPO-I and SPO-II Compressors.

SPECIFICATIONS	CPC-II	SPO-I	SPO-II
Oscillator			
Mira	<100 fs	<70 fs	<70 fs
Vitara	<12 fs for >125 nm bandwidth	N/A	<12 fs for >125 nm bandwidth
Chameleon	For MPE applications, please refer to the Chameleon product family that offers a dedicated pre-compensation unit for microscope setups, or contact tech.sales@coherent.com for CPC-II or SPO combinations.		

Typical Compressed Pulse Width from Vitara-T with CPC-II

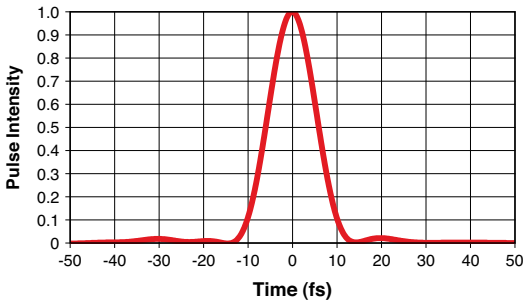


Pulse Compressors

Compact Pulse Compressor (CPC-II) Accessory

Featuring both coarse and fine adjustments, the Compact Pulse Compressor (CPC) provides highly accurate control of the oscillator's final pulse width. Using chirped-mirror technology, the CPC-II provides an ultra-compact footprint for maximum ease-of-use. The input and output beam ports are in line to enable simple experimental setups.

Typical Measured Pulse from Vitara-T After Compression with CPC-II Pulse Measured Using FC Spider



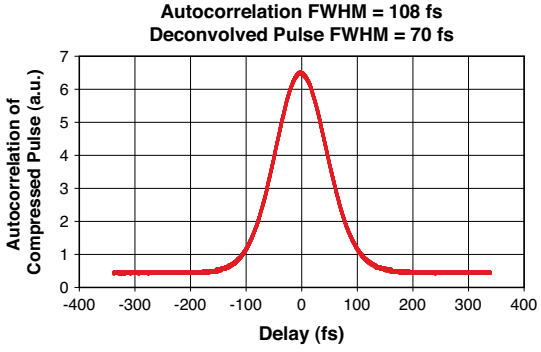
SPO-I and SPO-II Accessory

The SPO-I and SPO-II are prism-based pulse compressor setups specifically designed with a larger footprint than the Compact Pulse Compressor.

The SPO-I compresses the pulses of the Mira-900 and Mira-HP oscillators. It consists of an external prism assembly head, a birefringent filter (BRF), and a mirror-based starter galvanometer – all added to the Mira-900 or Mira-HP laser head.

The SPO-II is a pulse compressor for Mira or Vitara that consists of two, separated prism assembly heads.

Typical Autocorrelation of ~10 nm Bandwidth Pulses from Mira 900-F with SPO-I option



Synchrolock-AP

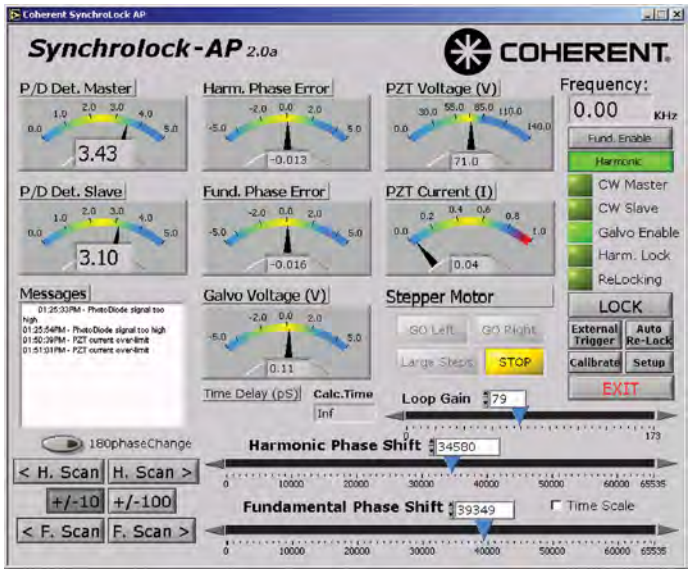
Synchronization Accessory for Mira and Vitara Ti:Sapphire Oscillators

The Synchrolock-AP is used to accurately synchronize two Mira or Vitara-T lasers together, or to synchronize a Mira or Vitara-T laser to an external RF source. Operating in the femtosecond or picosecond (Mira only) regime, the Synchrolock-AP allows smooth wavelength tuning while keeping the lasers synchronized.

Three separate actuators operate at different locations inside the laser head to compensate low, medium and high frequencies. The actuators are controlled by feedback electronics while a high-speed photodiode simultaneously monitors the laser repetition-rate.

The Synchrolock-AP uses the 9th harmonic content of the photodiode signal to provide a higher signal-to-noise ratio, which leads to tighter jitter lock. In this way Synchrolock-AP provides extremely low jitter while ensuring long-term stability.

GUI for Synchrolock-AP



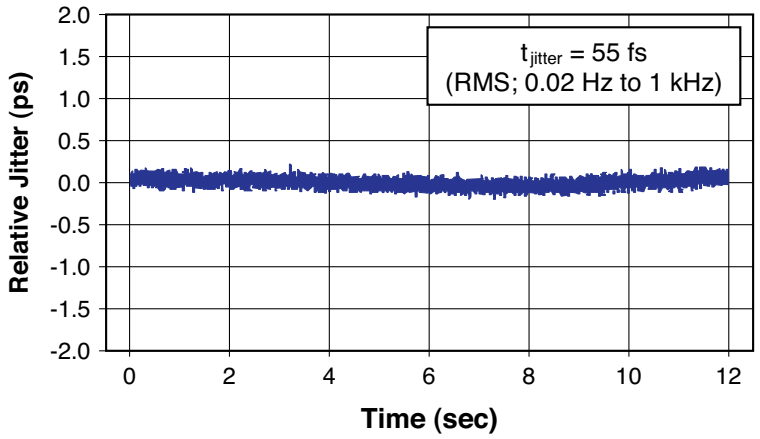
KEY ADVANTAGES

- The Synchrolock-AP accessory locks the pulse repetition-rate of one "Slave" Mira or Vitara-T laser to another "Master" Mira or Vitara-T laser, or to a "Master" external RF source
- Femtosecond (Mira and Vitara-T) and/or picosecond (Mira only) operation
- Three cavity length actuators provide jitter stabilization over a broad bandwidth and large dynamic range
- User adjustable delay between locked pulse trains of up to 13 ns with around 22 fs resolution (for a 76 MHz cavity)
- Simple fiberoptic coupling of slave output beam to the Synchrolock-AP detection system results in minimal losses and ease of use
- Unique feedback locking mechanism locks to the 9th harmonic of the input signal for enhanced signal to noise performance and tighter synchronization between slave and master oscillators
- User-friendly GUI enables automatic locking acquisition, delay control and system monitoring

SPECIFICATIONS[1,2,3,4,5]	Slave Oscillator Jitter (fs)		
	Mira (fs)	Mira (ps)	Vitara-T
Master Oscillator			
Mira (femto)	<250	<250	<250
Mira (pico)	<250	<250	<250
Vitara-T or -S Series	<250	<250	<100
rf Source[6,7] (low harmonic content)	<550	<750	<230
rf Source[7,8] (high harmonic content)	<300	<500	<200

1 Jitter specification is RMS (.02 to 10 kHz) over 1 minute acquisition time assuming Gaussian statistics. Jitter values are in femtoseconds.
2 Jitter values are measured using the time-averaged cross-correlation between slave and master optical outputs with the Synchrolock-AP operating in harmonic lock.
3 Specifications are based on use of isolation optical table, solid-state chillers, and Verdi oscillator pumping.
4 Specifications apply to an oscillator (laser or external) synchronization signal between 70 MHz and 90 MHz.
5 Mira specifications apply to X-Wave tuning range (700 nm to 980 nm). Specifications cover mixed wavelength systems in the X-Wave range.
6 Electronic external sync signal (low harmonic content) into optional slow trigger/oscillator board.
7 Fundamental external electronic sync signal input requirements: 0 to +10 dBm amplitude into 50Ω, <-100 dBc/Hz phase noise at 1 KHz from carrier.
8 Electronic external sync signal (9th harmonic content >-20 dBm) into "COMB IN" input of the controller.

Example showing relative jitter between pulse trains from two synchronized Mira-900 lasers



CEP Stabilizer for Vitara

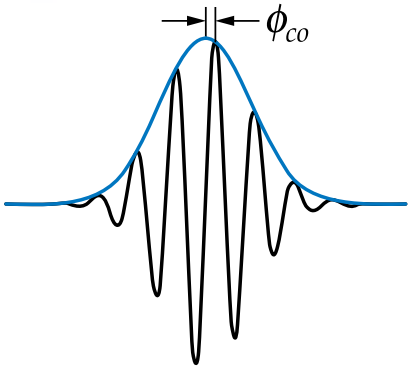
Carrier to Envelope Phase (CEP) Stabilizer Accessory for Vitara

The Vitara CEP Stabilizer is a state-of-the art Carrier-to-Envelope Phase stabilizer accessory designed exclusively for Vitara-T.

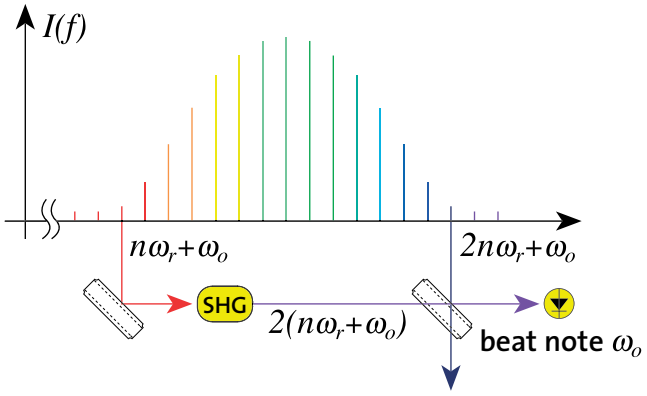
Through the use of active feedback control, Vitara CEP locks the carrier envelope offset frequency (ω_o) to a fraction of the repetition-rate ω_r. This establishes a fixed phase relation between the carrier and the envelope. Maintenance of this phase relationship is of paramount importance in experiments such as Above-Threshold Ionization (ATI) or generation of isolated attosecond pulses.

Vitara CEP consists of CEP actuators incorporated in the Vitara-T, a quasi-collinear f-to-2f interferometer and a wide bandwidth electronics feedback loop. The interferometer uses a photonic crystal fiber to generate an octave-scanning optical spectrum. The red end of this spectrum is frequency-doubled and combined with the green end of this same broad spectrum. A fast photodetector senses the resultant beat frequency and at ω_o, the carrier envelope offset frequency. Our feedback electronics control the fast and slow actuators inside the Vitara-T to stabilize ω_o to a fraction of the repetition-rate which is detected by a fast photodiode in the Vitara-T.

Carrier Offset Phase



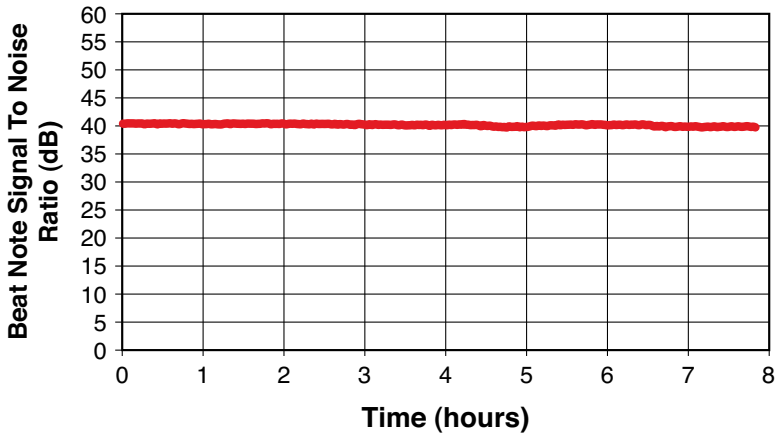
CEP Self-Referencing Stabilization Scheme



KEY ADVANTAGES

- Low phase noise due to excellent common mode noise supersession in the quasi-collinear interferometer design
- Monolithic construction for long term stability
- Requires <200 mW from Vitara-T
- Dual actuators to provide both large bandwidth and dynamic range
- Typical locking times in excess of 10 hours

Vitara-T with CEP Stabilizer
Typical Data Showing Long Term Stability of Detector Beat Note



Legend Elite

High-Performance Ti:Sapphire Amplifier

"Legend Elite series amplifiers are the top-selling, higher-performance kHz repetition rate Ti:Sapphire amplifiers on the market due to their leading combination of performance, stability and reliability.

They feature an integrated HASS verified Revolution pump laser, a thermally stabilized regenerative amplifier and a stretcher/compressor in a single, compact enclosure.

The E-2 Engine, our regenerative amplifier module which is common to every Legend Elite amplifier, now includes our proprietary slab rod design to reliably provide high energy pulses with high efficiency – while delivering a guaranteed beam quality unsurpassed by alternative designs.

In the last few years, Coherent has developed some breakthrough passive and active technologies to become a leader in both very high power (up to 16W) and Carrier to Envelope Phase (CEP) stabilized ultrafast amplifiers for the most demanding advanced applications such as attosecond science.

The new Legend Elite HE+ and Legend Elite Duo HE+ integrate these new technologies, including all CEP-grade hardware, to ensure unmatched level of intrinsic stability with best-in-class energy and pointing performance (respectively specified at <0.5% rms and <10 µrad rms) so every ultrafast application can benefit from these cutting edge developments.

Furthermore both the Legend Elite HE+ and Duo HE+ are de facto CEP-ready, offering to the users the maximum forward flexibility through upgradability.

Legend Elite HE+: Highest power available from a regenerative amplifier.

The Legend Elite HE+ now offers the highest output power (up to >8W) available from a regen-only ultra-fast amplifier using thermo-electrical cooling of the rod. For lower power versions (up to 5W), the efficiency of our proprietary slab rod design allows for a simple and robust water cooled scheme.

Powered by an integrated Revolution pump laser, the legend Elite HE+ is very compact and, when seeded by a hands-free Vitara ultrafast oscillator, the small foot print of such 2-box high-performance amplifier system allows sophisticated experimental setups on a single optical table.

KEY ADVANTAGES

- E-2 Engine, thermally stabilized regenerative amplifier platform for unsurpassed performance, reliability, and environmental stability
- Advanced Ti:Sapphire slab-rod geometry for most efficient cooling
- Proprietary conditioning optics for optimized output beam quality
- CEP-grade components for intrinsic exceptional stability
- BandMax technology in the USX series delivers reliable, sub-25 fs pulse
- Repetition-rate options available up to 10 kHz
- Integrated Revolution pump laser for compactness and stability
- Additional external pump laser for high power configurations
- Ready for seeding with Vitara Family oscillators for maximum flexibility and proven stability
- Multiple upgrade paths assure initial investment meets your future needs

Legend Elite Duo HE+: highest kHz output power available with simple thermo-electrical cooling technology.

For all the energy/power hungry applications, Coherent is now offering the Legend Elite Duo HE+ with up to >13 mJ of output energy per pulse at 1 kHz or up to >16W of output power at 5 kHz. Compared to the Legend Elite HE+, the Duo HE+ integrates an additional single pass booster amplifier (additional external pump laser required for some models) to more than double the output of its regenerative stage while maintaining the same output stability and preserving an excellent mode quality.

Pulse Width Configurations:
All Legend Elite HE+ and Duo HE+ are available in 4 different pulse width configurations: the F models have a pulse widths specified at <110 fs. The ultra-broadband input from the Vitara one-box oscillator, is the key to the performance of the USP (Ultra Short Pulse) versions which feature a proprietary, mixed grating, stretcher/compressor design for optimum pulse width stability. This design very comfortably supports the sub-35 fs specification for USP systems.

For applications such as extreme ultra-violet or attosecond pulse generation, where the shortest pulses are essential, the Vitara T seeded Ultra Short Extreme (USX) versions provide sub-25 fs pulses. Our proprietary BandMax technology is the key to generating and sustaining the broad amplified bandwidth necessary to support reliable, sub-25 fs pulses. Picosecond models provide the short pulses and narrow bandwidth required for both time- resolved and spectrally-resolved experiments. Picosecond versions are typically seeded with a femtosecond oscillator that is spectrally-masked prior to amplification.

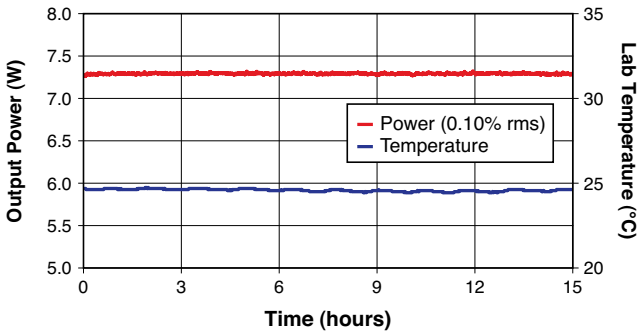
CEP Stabilization:
For applications requiring Carrier Envelope Phase stability, the sub-25 fs Legend Elite USX and sub-35 fs Legend Elite USP models are available with CEP stabilization, combining the benefits of regen design (unmatched mode quality, energy and pointing stability) with a world-class CEP performance (see page 80).

With pulse widths from <25 fs to the picosecond regime, pulse energies up to >13 mJ and output power up to >16W, there is always a Legend Elite model for your ultrafast amplifier application.

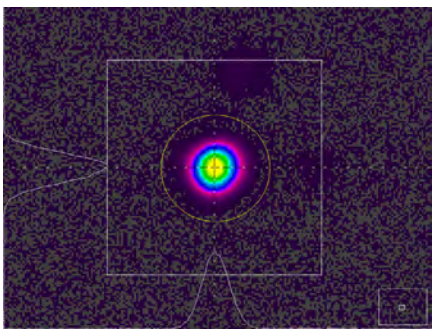
SPECIFICATIONS[1]	Legend Elite HE+			
Center Wavelength[2] (nm)	795 to 805		780 to 820	
Pulse Width Configuration	**USX**	**USP**	**F**	**P**
Pulse Width (fs) (FHWM)	<25[3,4]	<35[5]	<110[5]	500 to 1000[5,6]
Repetition Rate[7] (kHz)	1, 5, or 10			
Contrast Ratio[8]				
Pre-pulse	>1000:1			
Post-pulse	>100:1			
Power Stability[9,10] (%) (rms)	<0.5			
Beam Pointing Stabilty[9,10] (µrad) (rms)	<10			
Spatial Mode	TEM_{00}, M^2 <1.3			
Polarization	linear, horizontal			
Pump Configuration	**-I**	**-II**	**-III**	
Pump Laser[11]	REVOLUTION-20	REVOLUTION-50	REVOLUTION-65	
Energy per Pulse (mJ)	>1.5 at 1 kHz >0.3 at 5 kHz >0.15 at 10 kHz	>5.0 at 1 kHz >1.0 at 5 kHz >0.45 at 10 kHz	>7.0 at 1 kHz >1.6 at 5 kHz >0.7 at 10 kHz	

1 Specifications are given at 800 nm unless otherwise mentioned. Please contact factory for specifications at other wavelengths.
2 Factory set, must be specified when ordered and will be optimized prior to shipment.
3 When seeded by Vitara-T. For other seed lasers, please contact factory. An FFT of the pulse spectrum is used to calculate the transform-limited pulse width and a deconvolution factor which is then used to determine the real pulse width from an autocorrelation signal measured by a Coherent SSA (Single-Shot Autocorrelator).
4 Not available in -I confguration, limited to 4 mJ in -II and 5 mJ in -III configurations.
5 When seeded by Vitara. For other seed lasers, please contact factory. A Gaussian pulse shape deconvolution factor (0.7) is used to determine the pulse width from an autocorrelation signal measured by a Coherent SSA (Single-Shot Autocorrelator).
6 Limited to 6 mJ in -III configuration. For longer pulse width, please contact factory.
7 Repetition rate must be specified when ordered and will be optimized prior to shipment. Options for more than one repetition rate available. Please contact factory for other repetition rates.
8 Contrast ratio is defined as the ratio between the peak intensity of the output pulse to the peak intensity of any other pulse that occurs greater than 1 ns before or after the output pulse.
9 Under stable environmental conditions.
10 Over 24 hours.
11 Sold separately.

Legend Elite HE+
Power Stability



Legend Elite HE+
Typical Far Field Beam Quality

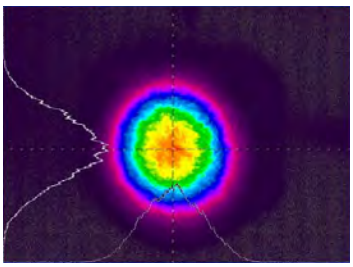


Amplifiers

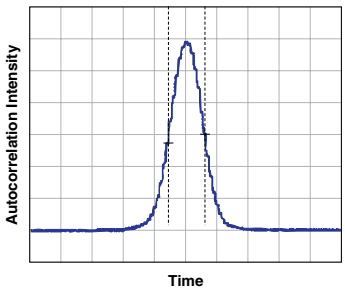
SPECIFICATIONS[1]	Legend Elite Duo HE+			
Center Wavelength[2] (nm)	795 to 805		780 to 820	
Pulse Width Configuration Pulse Width (fs) (FHWM)	**USX** <25[3,4]	**USP** <35[5,6]	**F** <110[5]	**P** 500 to 1000[4,5]
Repetition Rate[7] (kHz)	1, 5, or 10			
Contrast Ratio[8] Pre-pulse Post-pulse	 >1000:1 >100:1			
Power Stability[9,10] (%) (rms)	<0.5			
Beam Pointing Stabilty[9,10] (µrad) (rms)	<10			
Spatial Mode	TEM_{00}, M^2 <1.35[11]			
Polarization	linear, horizontal			
Pump Configuration Pump Laser[12]	**-I** REVOLUTION-80	**-II** REVOLUTION-80 + REVOLUTION-35[13]	**-III** REVOLUTION-80 + REVOLUTION-65[13]	
Energy per Pulse (mJ)	>8.0 at 1 kHz >2.5 at 5 kHz >1.0 at 10 kHz	>10.0 at 1 kHz >3.0 at 5 kHz >1.2 at 10 kHz	>13.0 at 1 kHz >3.2 at 5 kHz >1.4 at 10 kHz	

1 Specifications are given at 800 nm unless otherwise mentioned. Please contact factory for specifications at other wavelengths.
2 Factory set, must be specified when ordered and will be optimized prior to shipment.
3 When seeded by Vitara-T. For other seed lasers, please contact factory. An FFT of the pulse spectrum is used to calculate the transform-limited pulse width and a deconvolution factor which is then used to determine the real pulse width from an autocorrelation signal measured by a Coherent SSA (Single-Shot Autocorrelator).
4 Not available in -III pump configuration.
5 When seeded by Vitara. For other seed lasers, please contact factory. A Gaussian pulse shape deconvolution factor (0.7) is used to determine the pulse width from an autocorrelation signal measured by a Coherent SSA (Single-Shot Autocorrelator).
6 <40 fs in -III pump configuration.
7 Repetition rate must be specified when ordered and will be optimized prior to shipment. Options for more than one repetition rate available. Please contact factory for other repetition rates.
8 Contrast ratio is defined as the ratio between the peak intensity of the output pulse to the peak intensity of any other pulse that occurs greater than 1 ns before or after the output pulse.
9 Under stable environmental conditions.
10 Over 24 hours.
11 M^2 <1.45 at 5 and 10 kHz in -III pump configuration.
12 Sold separately.
13 Mounted external to amplifier enclosure.

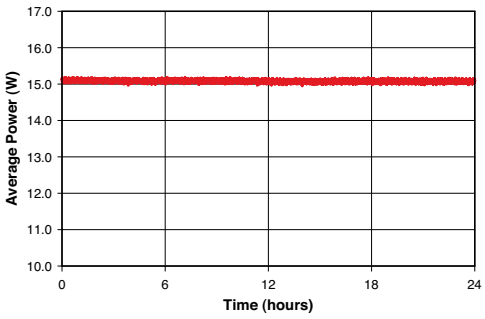
Near-Field Beam Profile (Duo HE+ USP)



Typical Pulse Width ~23 fs (Duo HE+ USX)

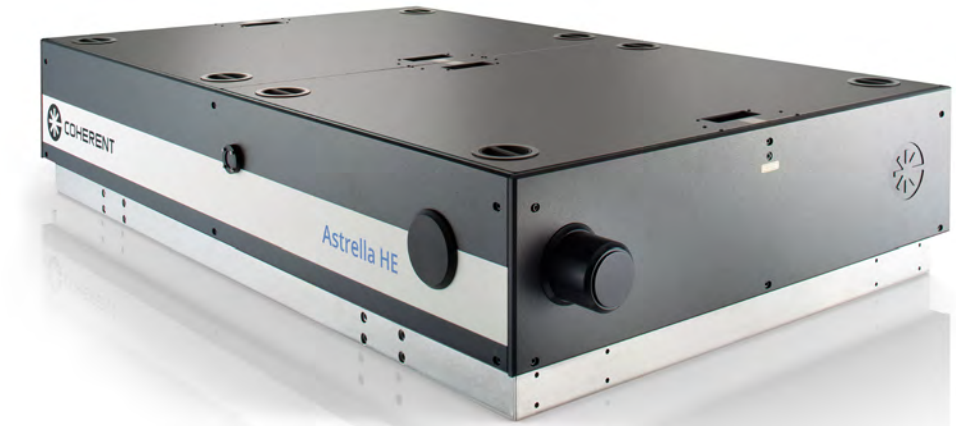


10 kHz Legend Elite Duo HE+ Power Stability (0.22% rms)



Astrella

Industrialized Ti:Sapphire Amplifier



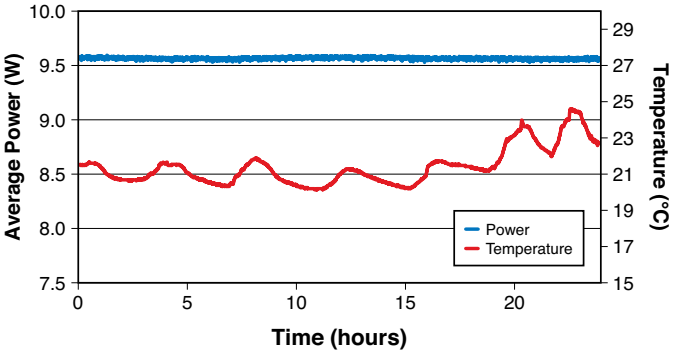
Astrella and the new Astrella HE are next-generation, ultrafast, kHz amplifiers that are the first to combine industry-leading performance and industrialized durability.

Manufactured to Coherent's rigorous standards using advanced stress-testing (HASS), the one-box Astrella system enables a wide range of demanding scientific applications and operating conditions, offering higher productivity and lower data acquisition costs. Delivering high (up to 9 mJ/pulse) energy, short (35 fs or <100 fs) pulse widths, and excellent beam quality (M^2 <1.25), Astrella is ideal for ultrafast spectroscopy, THz studies, femtosecond micromachining, etc.

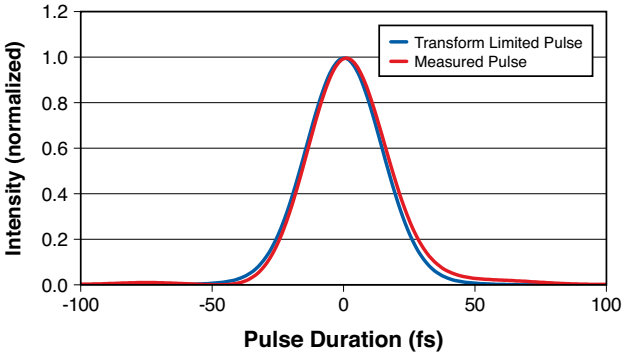
The Astrella one-box amplifier system integrates the industry-leading, hands-free, HASS-verified Vitara fs oscillator. Astrella is powered by the next generation HASS verified Revolution pump laser.

With unmatched performance, reliability and affordability, Astrella stands at the forefront of the industrial revolution in ultrafast science.

Astrella HE
24-Hour Stability



Astrella HE USP
Pulse Width



KEY ADVANTAGES

- One-box, industrialized platform
- HASS* verified for quality and reliability
- >5, >7, >9 mJ, <35 or <100 fs pulses
- High performance STAR regen amplifier (water-only cooling)
- Hands-free Vitara oscillator
- Revolution pump laser for performance overhead
- Sealed stretcher/compressor section with advanced dispersion management for clean, short pulses
- Thermally-stabilized sub-systems for long term stability

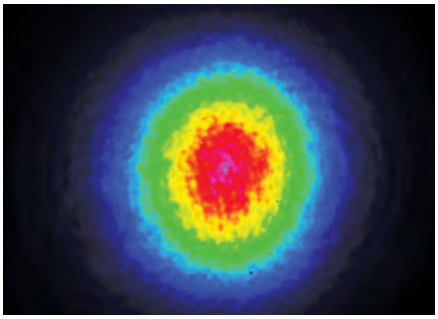
* HASS – Highly Accelerated Stress Screening

SPECIFICATIONS[1]	Astrella USP	Astrella F	Astrella HE USP	Astrella HE F
Center Wavelength[2] (nm) (nominal)	795 to 805	780 to 820	795 to 805	780 to 820
Repetition Rate[3] (kHz)	1 or 5			
Pulse Duration[3,4] (fs) (FWHM)	<35	<100	<35	<100
Contrast Ratio[5]				
Pre-pulse	>1000:1			
Post-pulse	>100:1			
Power Stability[6,7] (rms)	<0.5			
Beam Pointing Stability[6,7] (µrad) (rms)	<10			
Beam Diameter (mm) ($1/e^2$) (nominal)				
1 kHz	11		13	
5 kHz			11	
Spatial Mode	TEM_{00}, M^2 <1.25			
Polarization	linear, horizontal			
Energy per Pulse (mJ)				
1 kHz	>5.0, >7.0		>9.0	
5 kHz	>1.4		>2.0	

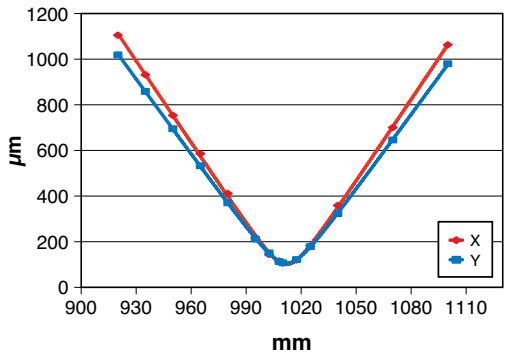
1 Specifications apply at 800 nm.
2 Factory set, must be specified when ordered and will be optimized prior to shipment.
3 Contact factory for other repetition rates and pulse width options.
4 A Gaussian pulse shape de-convolution factor (0.7) is used to determine the pulse width from an autocorrelation signal measured by a Coherent SSA (Single-Shot Autocorrelator).
5 Contrast ratio is defined as the ratio between the peak intensity of the output pulse to the peak intensity of any other pulse that occurs greater than 1 ns before or after the output pulse.
6 Under stable environmental conditions after system warm-up.
7 Over 24 hrs.

Astrella
Superior Mode Quality

Typical Near Field Mode Quality



M^2 (x = 1.11, y = 1.12)



Monaco

High Repetition-Rate, Femtosecond Yb Amplifiers

Monaco is a diode-pumped, fiber-based, Chirped Pulse Amplifier (CPA) MOPA architecture designed for heavy-use, 24/7 applications. The fiber based design offers energy and repetition rate diversity required to cover a wide range of applications requiring high repetition rate, energetic femtosecond pulses.

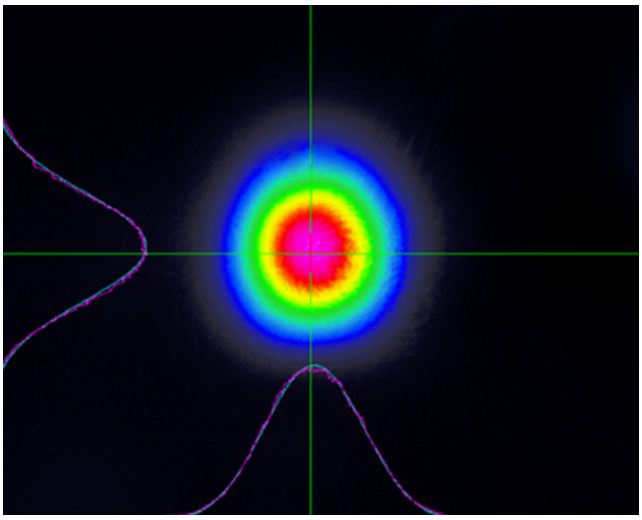
Monaco effortlessly provides 60W of average power at up to 50 MHz. With a pulse duration shorter than 400 fs and an energy per pulse as high as 60 µJ at 1 MHz and 80 µJ at 750 kHz, Monaco-1035-40-1 is ideal for power-hungry scientific applications ranging from material modification and ablation studies to solid-state time-resolved spectroscopy. The 10 µJ, 4 MHz version is ideal for advanced microscopy, where both high speed and energy per pulse are quintessential.

Monaco's exceptional beam quality (M^2 <1.2) result in superior performance in any application where beam profile is critical, like pumping collinear OPAs and NOPAs or for fine material modification studies.

An integrated AOM allow to change the repetition rate on the fly from MHZ to tens of Hz, and also to seamlessly change the energy per pulse.

The Monaco foundation is hewn from a single block of stress relieved aluminum. This monolithic structure ensures an optical alignment that is maintained throughout the life of the laser. The head encases all of the optical elements as well as the Soloboard™ control deck. There are no control umbilicals or remotely located pump diodes, all of which could create potential failure points in a system. Furthermore, Monaco maintains its own clean room environment, thanks to the onboard PureFemto™ cleaning engine.

Monaco Far-Field Beam Profile



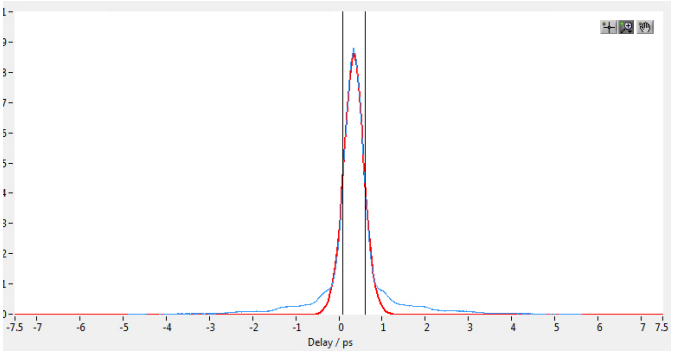
KEY ADVANTAGES

- High energy/pulse: up to 80 µJ
- High repetition rate: versions up to 50 MHz
- Fully adjustable repetition rate and energy per pulse
- Exceptional M^2: <1.2
- <350 fs pulse duration with optional full adjustability to 10 ps
- HALT designed/HASS certified
- Single-box design
- Remote access and diagnostics via Ethernet interface

SPECIFICATIONS[1]	Monaco 1035-40-40	Monaco 1035-80-60
Fundamental Center Wavelength (nm)	1035 ±5	1035 ±5
Output Power (W)	40	60
Energy (µJ)	40 (at 1 MHz)	80 (at 750 kHz.)
Seeder Burst Mode (µJ)	>200	>320
Repetition Rate	Single-shot to 1 MHz, higher rep. rates without AOM pulsepicking: 1 to 50 MHz standard	
Pulsewidth (fs)	<350	
Tuning Range	<350 fs to >10 ps	
Spatial Mode	TEM_{00}, M^2 <1.2	
Beam Divergence (mrad, 2θ)	<1	
Beam Diameter at Output[2] (mm, $1/e^2$)	2.7 ±0.3	
Beam Circularity (%)	>85	
Polarization Ratio	100:1	
Polarization Direction[3]	Vertical ±3°	
Beam Pointing Stability (µrad/°C)	<25	
Pulse Energy Stability (%) (RMS)	<1.5	
Power Stability (%) (RMS, 2σ)	<1.5	
Warm-up Time (minutes) Cold Start Warm Start	 <45 >15	

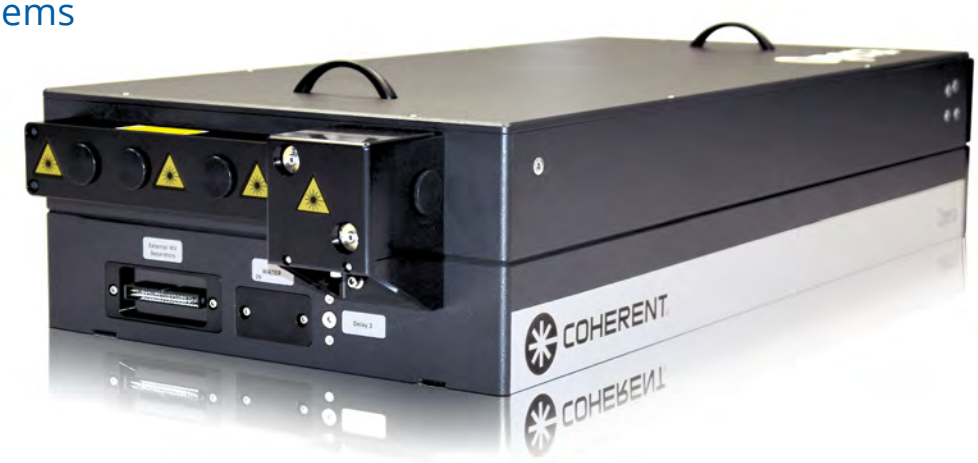
1 All specifications at full energy and repetition rate.
2 Measured at 1m from laser output window.
3 External isolation required depending on application.

Autocorrelation of Monaco



Opera-F

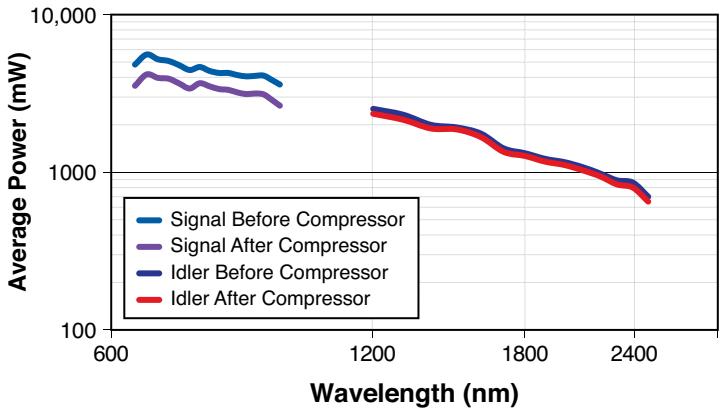
Optical Parametric Amplifier for Yb Systems



The Opera-F is an optical parametric amplifier (OPA) that extends the performance of Coherent's Monaco amplifier. Opera-F delivers a broad tuning range, 650 nm to 900 nm and 1200 nm to 2500 nm. Opera-F is a two stage OPA seeded by a white-light continuum and pumped by the second harmonic of the Monaco. Opera-F uses a non-collinear first stage to generate broad bandwidth and a collinear second stage to generate the large tunable range. The signal output of the Opera-F can be compressed to <75 fs using a prism-based compressor, and the idler pulses to <100 fs, using a bulk compressor.

Pumped by up to 60 W at 4 MHz from a Monaco amplifier, Opera-F can deliver >6W signal + idler. The high power, high repetition rate capabilities of the Opera-F pumped by a Monaco is a superior tool delivering high energies or high repetition rates for demanding experiments.

Opera-F Pumped by up to 60W, 4 MHz from Monaco

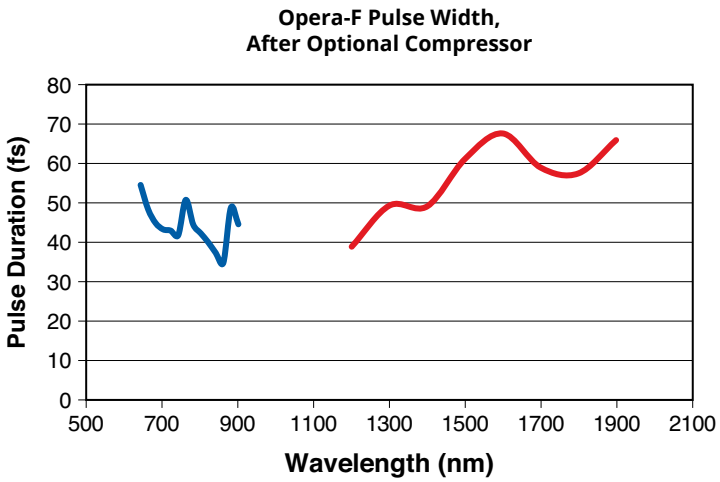


KEY ADVANTAGES

- Up to 60 W pump power
- Conversion efficiency >10% (signal + idler)
- Wavelength range 650 nm to 900 nm (signal), 1200 nm to 2500 nm (idler)
- Pulse widths 50 fs to 100 fs (with optional compressor)
- Dual pulse option to cover gap from 900 nm to 1200 nm at 300 fs pulse duration

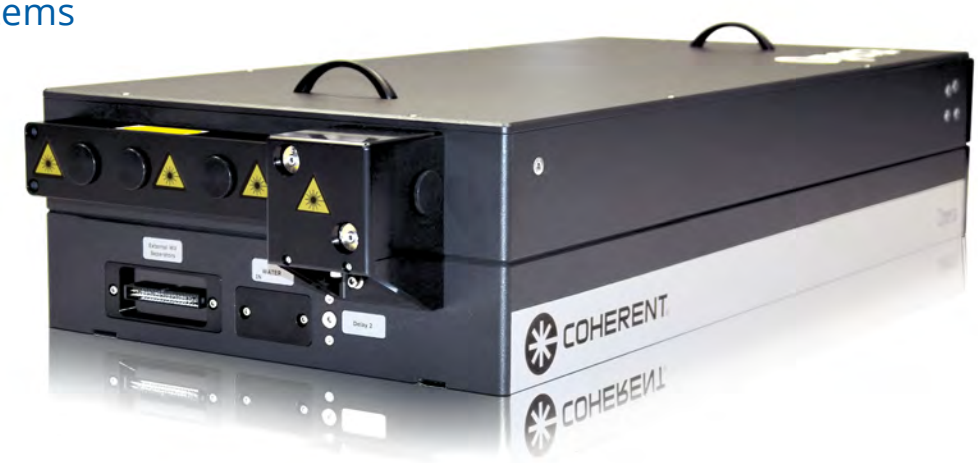
SPECIFICATIONS[1,2]	Opera-F
Wavelength Range[3] (nm)	
Signal	650 to 900
Idler	1200 to 2500
Conversion Effciency[4] (%)	>10
Pulse Bandwidth (cm^{-1})	
650 nm to 900 nm	200 to 600
1200 nm to 2000 nm	150 to 500
Pulse Duration Before Compressor (fs)	<250
After Compression[5] (fs)	
650 nm to 900 nm	50 ±25
1200 nm to 2000 nm	70 ±30
Compresssor Transmission[5] (%)	
700 nm to 900 nm	50 to 70
1200 nm to 2000 nm	70 to 80
Pump Laser	Monaco

1 All specifications are based on pumping with >15 µJ from Monaco.
2 For other pump energies, contact factory.
3 Option available to include coverage from 900 nm to 1200 nm with <300 fs pulse width.
4 Efficiency given at peak of tuning curve, second stage signal + idler, before optional compressor.
5 Optional compressor includes two prism compressor for signal, and bulk compressor for idler.



Opera-HP

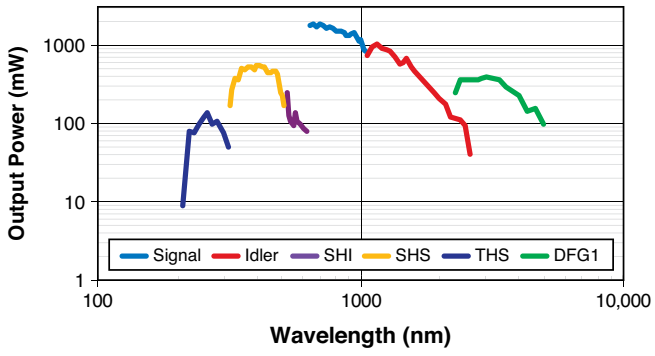
Optical Parametric Amplifier for Yb Systems



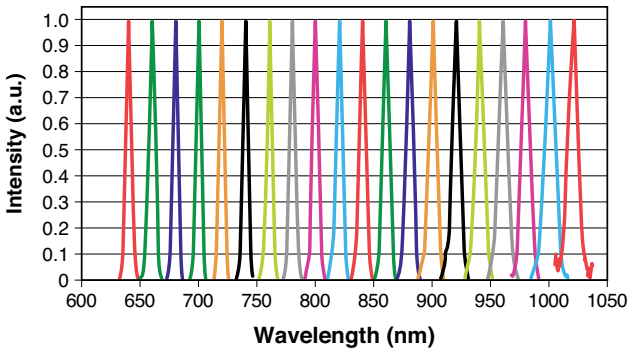
The Opera-HP is an optical parametric amplifier (OPA) used to extend the performance of Coherent's Monaco amplifier. Opera-HP is a white light seeded two stage collinear OPA, delivering <300 fs pulses. Associated wavelength extension packages, offer a broad tuning range covering 210 nm to 16 µm. Outputs from the UV to Near-IR (210 nm to 2600 nm) are delivered via hands-free, computer-controlled, automated tuning and wavelength selection ensuring the same position and direction.

Pumped by up to 60 W at 2 MHz from a Monaco amplifier, Opera-HP can deliver >6W signal + idler at the peak. The high power, high repetition rate capabilities of the Opera-HP pumped by a Monaco is a powerful tool delivering high energies or high repetition rates for demanding experiments.

Opera-HP Tuning Curve Pump
40 µJ at 500 kHz



Opera-HP
Signal Spectra



KEY ADVANTAGES

- Up to 60 W pump power
- Conversion efficiency >10% (signal + idler)
- Wavelength range 630 nm to 1025 nm (signal), 1045 nm to 2600 nm (idler)
- Wavelength extensions covering 210 nm to 16 µm
- Pulse widths 150 fs to 300 fs
- Automated tuning and wavelength selection from UV to Near IR

SPECIFICATIONS[1,2]	Opera-HP
Wavelength Range (nm)	
Signal	635 to 1025
Idler	1045 to 2600
Conversion Effciency[3] (%)	>10
Pulse Bandwidth (cm^{-1})	
700 nm to 960 nm	70 to 120
Pump Laser	Monaco
OPTIONAL WAVELENGTH EXTENSIONS	
SHS/SHI	
Wavelength Range (nm)	
Signal	315 to 510
Idler	525 to 630
Conversion Efficiency[4] (%)	>2.5
THS[5]	
Wavelength Range (nm)	210 to 315
Conversion Efficiency[4,6] (%)	>0.5
DFG1	
Wavelength Range (nm)	2200 to 5000
Conversion Efficiency[4] (%)	>2 at 3000 nm
DFG2	
Wavelength Range (nm)	5000 to 16,000
Conversion Efficiency[4] (%)	>0.15 at 10,000 nm

1 All specifications are based on pumping with >20 µJ from Monaco.
2 For other pump energies, contact factory.
3 Efficiency given at peak of tuning curve, second stage signal + idler, calculated as percentage of input power to Opera-HP.
4 Efficiency given at peak of tuning curve.
5 THS package includes SHS/SHI option.
6 Maximum 400 mW output at peak.

Opera Solo

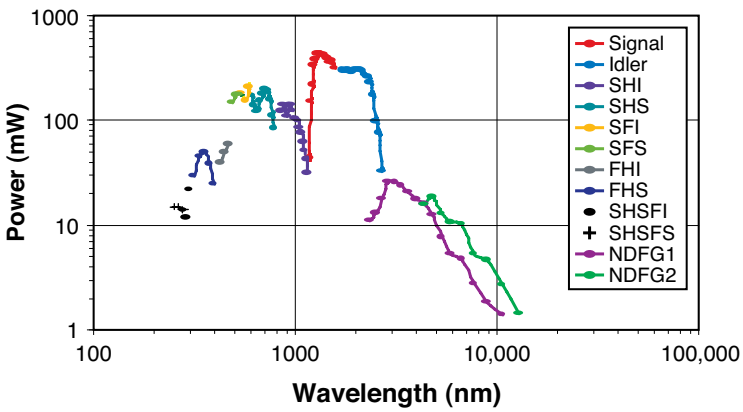
Fully Integrated, Computer-Controlled Femtosecond Optical Parametric Amplifier Accessory

The OPerA Solo is a fully integrated, computer-controlled femtosecond optical parametric amplifier (OPA) that extends the wavelength accessibility of the Astrella and Legend Elite amplifiers from 240 nm to 20 µm.

As the first unit of its kind, the OPerA Solo integrates all pump conditioning optics, wavelength extension options and wavelength separation optics within one enclosure. This makes the OPerA Solo a very compact, easy-to-use and stable device. When pumped by the Astrella or Legend Elite amplifier, the OPerA Solo system provides a unique, compact and reliable approach for high-performance tunable ultra-fast applications.

The OPerA Solo design incorporates well-proven TOPAS technology in the white-light seeded, pre-amplifier followed by a power amplifier. In the sum-frequency-mixing configuration the OPerA Solo uses a fraction of the 800 nm pump beam directly from the Legend Elite output beam for mixing with the OPA signals. This “fresh pump beam” feature enables superior spatial, spectral and temporal beam quality compared to designs that use the “residual” portion of the 800 nm pump beams.

Typical OPerA Solo Tuning Curve
Legend Elite USP-1K-HE Pump (3.3 mJ)



KEY ADVANTAGES

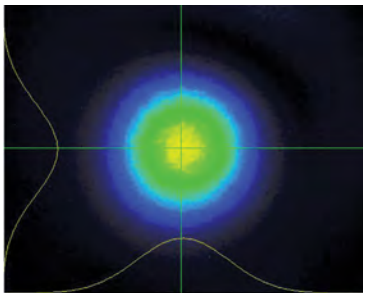
- Fully integrated one-box system
- Convenient computer-controlled tuning
- Options for 240 nm to 20 µm tuning
- Configurations to accommodate pulse widths from all Coherent kHz femtosecond amplifiers (<110 fs, <50 fs, <40 fs, <35 fs, <25 fs)
- Whitelight-seeded pre-amplifier for lowest noise
- "Fresh pump" configuration for optimum spatial, temporal and spectral mixing performance
- Multiple OPAs may be pumped with a single kHz amplifier

SPECIFICATIONS[1,2]		Wavelength Range	Pulse Energy		Polarization
			<50 fs pump	<110 fs pump	
OPerA Solo[3]	Signal	1160 to 1600 nm	>220 µJ (S+I)	>220 µJ (S+I)	V
	Idler	1600 to 2600 nm			H
OPTIONS[4]					
SH Package	SHI	800 to 1160 nm	>30 µJ	>50 µJ	V
	SHS	580 to 800 nm			V
SF Package	SFI	533 to 600 nm	>30 µJ	>50 µJ	V
	SFS	475 to 533 nm	>40 µJ	>70 µJ	V
FH Package	FHI	400 to 480 nm	>5 µJ	>10 µJ	H
	FHS	290 to 400 nm			H
SHSF Package	SHSFI	266 to 295 nm	>3 µJ	>8 µJ	H
	SHSFS	240 to 266 nm			H
NDFG Package	NDFG1[5,6]	2.6 to 11 µm	>2 µJ at 4 µm >0.5 µJ at 9 µm	>8 µJ at 4 µm >1.5 µJ at 10 µm	H
	NDFG1-KTA[6]	2.6 to 4.9 µm	>2 µJ at 4 µm	>8 µJ at 4 µm	H
	NDFG2[6]	4 to 20 µm	>1 µJ at 5 µm >0.1 µJ at 13 µm	>4 µJ at 5 µm >0.3 µJ at 15 µm	H

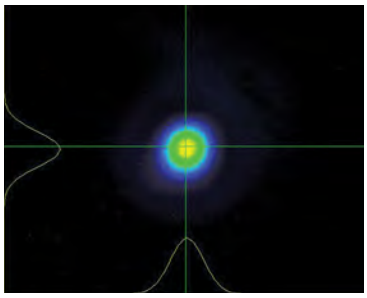
1 1 All specifications are based on pumping with 1 mJ from Astrella or Legend Elite systems at 1 kHz (contact factory for other pump systems). Specifications for harmonic wavelengths pumped by Legend Elite USX and Legend Elite Duo USX models are 25% lower.
2 Energy scales linearly with pump in range 0.2 mJ to 4 mJ for <110 fs pump and 0.2 mJ to 3.5 mJ for <50 fs pump.
3 Signal pulse width is (0.7 to 1.0) x pump for <110 fs pump duration, (1 to 1.5) x pump for <50 sec. pump duration.
4 Energies given at peak of tuning curves. SH/SF/FH/SHSF wavelength extension packages listed include all mixing crystals listed in preceding options (e.g., SHSF option includes crystals, etc., to tune from 240 to 1160 nm).
5 Maximum pump repetition rate – 1 kHz. Limited crystal life time of 1000 to 2000 hr.
6 For <50 fs pump NDFG tuning ranges are as follows: NDFG1- 2.6 µm to 9 µm, NDFG1-KTA - 2.6 µm to 4.5 µm and NDFG2 - 4 µm to 13 µm.

Typical OPerA Solo Beam Profile
500 nm Sum Frequency Generation

Near Field



Far Field



TOPAS-Prime

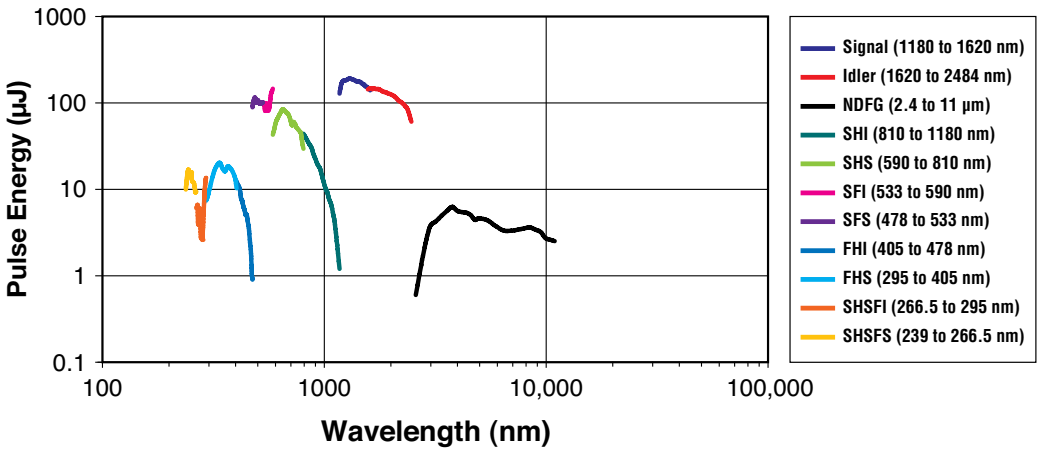
Computer-Controlled, Modular Optical Parametric Amplifier Accessory

TOPAS*-Prime is a computer-controlled optical parametric amplifier (OPA) providing the ability to extend the tuning ranges of the Astrella and Legend Elite ultrafast amplifier families. All of the best features from the TOPAS-800-fs are retained in the TOPAS-Prime including white light seeding for lowest output noise performance. In addition, TOPAS-Prime employs a monolithic housing for improved mechanical stability. TOPAS-Prime uses a modular design and wavelength extension packages to achieve a tuning range of 189 nm to 20 µm.

The standard TOPAS-Prime model accepts pulse energies up to 3.5 mJ, input pulse energies up to 5 mJ can be achieved with the TOPAS-PrimePlus model.

*TOPAS is a registered trademark of Light Conversion.

Typical Tuning Curve
(pumped by 1 mJ, 1 kHz, 800 nm Legend Elite)



KEY ADVANTAGES

- Monolithic housing for mechanical stability
- Computer-controlled tunable output
- Energy conversion >30% to parametric light
- Low output noise due to whitelight seeding
- Optional fresh pump channel for improved sum frequency performance
- Modular option for extended tuning from 189 nm to 20 µm: Standard tuning is from 1140 nm to 2600 nm
- Configurations to accommodate pulse widths from all Coherent kHz femtosecond amplifiers (<110 fs, <50 fs, <40 fs, <35 fs, <25 fs)
- Multiple OPAs can be pumped with one Ti:Sapphire amplifier
- High energy (HE) models available: Up to 20 mJ

SPECIFICATIONS[1,2]		Wavelength Range	Pulse Energy		Polarization
			<50 fs pump	<110 fs pump	
TOPAS-Prime[3]	Signal	1140 to 1600 nm	>250 µJ (S+I)	>250 µJ (S+I)	V
	Idler	1600 to 2600 nm			H
OPTIONS[4]					
VIS Package[5]	SHI	800 to 1150 nm	>15 µJ[6]	>30 µJ[6]	V
	SHS	580 to 800 nm	>30 µJ	>80 µJ	H[7]
BLUE Package[5]	SFI	533 to 600 nm	>30 µJ	>50 µJ	V
	SFS	475 to 533 nm	>40 µJ	>70 µJ	V
UV1 Package	FHI	400 to 480 nm	>2.5 µJ[8]	>6 µJ[8]	H
	FHS	290 to 400 nm	>5 µJ	>15 µJ	V[7]
UV2 Package	SHSFI	266 to 295 nm	>3 µJ	>7 µJ	H
	SHSFS	240 to 266 nm	>3 µJ	>8 µJ	H
DUV Package	DUV[9]	189 to 240 nm	>1 µJ	>3 µJ	V
NDFG Package	NDFG1[10,11]	2.6 to 11 µm	>2 µJ at 4 µm >0.5 µJ at 9 µm	>8 µJ at 4 µm >1.5 µJ at 10 µm	H
	NDFG1-KTA[11]	2.6 to 4.9 µm	>2 µJ at 4 µm	>8 µJ at 4 µm	H
	NDFG2[11]	4 to 20 µm	>1 µJ at 5 µm >0.1 µJ at 13 µm	>4 µJ at 5 µm >0.3 µJ at 15 µm	H

1 All specifications are based on pumping with 1 mJ from Astrella or Legend Elite systems at 1 kHz (contact factory for other pump systems). Specifications for harmonic wavelengths pumped by Legend Elite USX and Legend Elite Duo USX models are 25% lower.
2 Energy scales linearly with pump in range 0.3 mJ to 4 mJ for <110 fs pump and 0.3 mJ to 3.5 mJ for <50 fs pump. TOPAS-PrimePlus model extends pump energy input to 5 mJ for both <50 and <110 fs models.
3 Signal pulse width is (0.7 to 1.0) x pump for <110 fs pump duration, (1 to 1.5) x pump for <50 fs pump duration.
4 Energies given at peak of tuning ranges. VIS/BLUE/UV wavelength extension options listed include all mixing crystals listed in preceding options (e.g., TOPAS-Prime-UV-2 options includes crystals, etc., to tune from 240 to 1150 nm). External mixer or integrated monolithic mixer options available.
5 With optional fresh pump package.
6 With Monolithic mixer option >50 µJ at <110 fs pump and >20 µJ at <50 fs pump.
7 Polarization switches when DUV option is included.
8 With Monolithic mixer option >15 µJ at <110 fs pump and >4 µJ at <50 fs pump.
9 Requires purchase of TOPAS-Prime-M-UV2 option, specifications assume 15 % of pump energy into DUV channel and another 15 % into fresh pump channel. DUV option reduces performance at other wavelengths, contact Coherent for details.
10 Maximum pump repetition rate – 1 kHz. Limited crystal life time of 1000 to 2000 hr.
11 For <50 fs pump NDFG tuning ranges are as follows: NDFG1- 2.6 µm to 9 µm, NDFG1-KTA - 2.6 µm to 4.5 µm and NDFG2 - 4 µm to 13 µm.

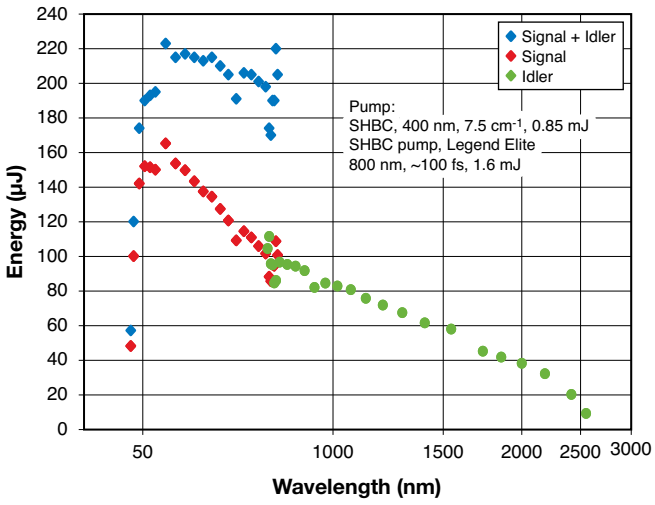
SHBC/TOPAS-400

Computer-Controlled, Line Narrowed, Optical Parametric Amplifier Accessory

The combination of SHBC and TOPAS*-400 provides a unique accessory for generating narrow-band (<20 cm^{-1}), tunable radiation when pumped with the 800 nm output from a femtosecond Astrella or Legend Elite amplifier. When used in conjunction with an additional standard femtosecond OPA, it offers the potential to provide both femtosecond and picosecond tunable beams simultaneously using a single femtosecond amplifier. The SHBC (Second Harmonic Bandwidth Compressor), converts the wide bandwidth beam at 800 nm from the femtosecond ultrafast amplifier (purchased separately) to a narrow bandwidth beam at 400 nm. This 400 nm beam is then used to pump the TOPAS-400-ps-WL picosecond OPA model to generate tunable, narrow bandwidth beam from 480 nm to 2600 nm.

*TOPAS is a registered trademark of Light Conversion.

TOPAS-400-ps-WL Typical Tuning Curve (pumped by output from SHBC)



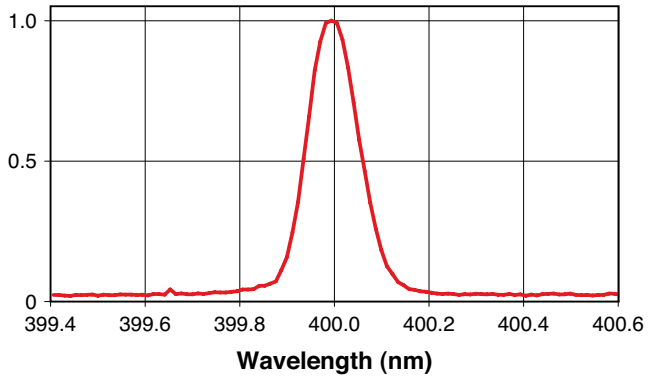
KEY ADVANTAGES

- Converts 800 nm femtosecond pump beam to tunable narrow-band output
- Potential for simultaneous femtosecond and picosecond beams using one femtosecond, Ti:Sapphire amplifier
- Computer-controlled tunable output 480 nm to 2600 nm
- <20 cm^{-1} bandwidth
- Energy conversion >20% conversion to parametric light

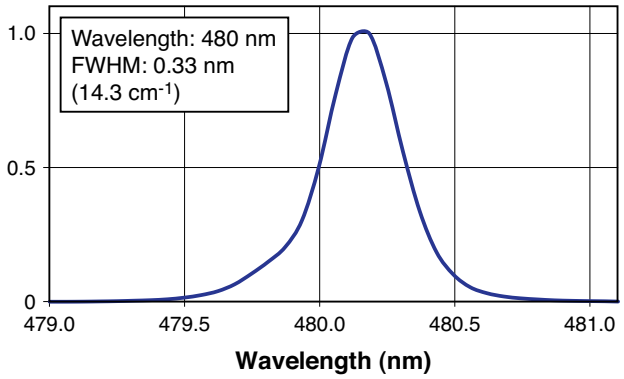
SPECIFICATIONS	SHBC
Pump Laser[1]	Legend Elite, Astrella
Output Wavelength (nm) (nominal)	400
Conversion Efficiency (%)	>25
Spectral Width (cm^{-1})	<10
Energy Stability[2] (% rms)	<3
Polarization	linear, horizontal
SPECIFICATIONS	**TOPAS-400-PS-WL**
Pump Laser	SHBC
Wavelength Range[3] (nm)	480 to 2600
Pulse Energy[4] (signal + Idler at peak, µJ)	>50
Pulse Duration	(0.5 - 1) x pump pulse width
Spectral Width (cm^{-1}) 500 nm to 730 nm 870 nm to 2400 nm	 <20 <20
Spectral Width (cm^{-1}) 500 nm to 700 nm 900 nm to 2000 nm	 <6 <6
Polarization Signal Idler	 linear, vertical linear, horizontal

1 Pump with 0.3 mJ to 2 mJ, 35 fs to 200 fs from Astrella or Legend Elite at 1 kHz (contact factory for other systems).
2 Under stable environmental conditions.
3 Some energy and spectrum modulation possible in the range 730 nm to 870 nm.
4 Assuming 250 µJ, 400 nm pump from SHBC. Scales linearly with pump in range 0.3 mJ to 1 mJ.

SHBC Output Spectrum



TOPAS-400-ps-WL Output Spectrum



Harmonic Generator System (HGS)

Second-, Third-, and Fourth-Harmonic Accessory for Ti:Sapphire Amplifiers

The HGS accessory provides extremely convenient second-, third- or fourth-harmonic output for kHz Astrella and Legend Elite Ti:Sapphire amplifiers. Second- (HGS-D) and third- (HGS-T) harmonic outputs are accessible from a single compact unit. A second enclosure is added for fourth-harmonic (HGS-F) generation.

The HGS employs collinear mixing in high-damage-threshold BBO crystals for high efficiency and ease of use. Crystal rotation and optical delay stages are manually adjustable, and all crystals, focussing optics, dichroic wavelength separation mirrors, etc., are included. The near-diffraction limited beam quality and demonstrated stability of both pulse width and beam pointing from Coherent amplifiers ensure optimum performance at the harmonic wavelengths.

KEY ADVANTAGES

- Widely-tunable ultrafast visible and UV
- High conversion efficiencies
- Excellent beam quality
- Robust and compact design
- Motorized actuators with software control
- User GUI
- Extended wavelengths ranges (FHG) available on request

SPECIFICATIONS	HGS-D	HGS-T	HGS-F
Conversion Efficiency (%, from 800 pump, fsec)	35	15	1
Power Stability (%, rms)	1.5	2.5	3.5

Single-Shot Autocorrelator (SSA)

Pulse Width Measurement Accessory for Ultrafast Amplifier Systems

The SSA accessory is designed for use over a broad range of energies and wavelengths. Available in configurations to measure femtosecond or picosecond pulses, this is an accurate and versatile tool compatible with both commercial amplifier systems – Astrella and Legend Elite – and with home-built amplifier systems.

Two femtosecond models are available (SSA-F and Hi-Res SSA) depending on the pulse lengths to be measured. The picosecond option (SSP) is available with the SSA-F model.

The SSA splits laser pulses into two beams that are then non-colinearly frequency-doubled in a non-linear crystal. In the femtosecond configuration the relative wavefront tilt produces a spatial time delay in the frequency-doubled signal, which results in an autocorrelation of the temporal intensity profile. In picosecond operation one mirror is replaced with a diffraction grating for additional wavefront tilt. In both operations the autocorrelation signal is detected by a CCD array and is available for display on an oscilloscope or as a measurement by a computer DAC card.

KEY ADVANTAGES

- Measures temporal width of amplified pulses
- Broad pulse width range: from 20 fs to 2 ps
- Wavelength coverage in femtosecond operation from 750 nm to 850 nm
- Indexed internal mirror allows beam to be sampled without disrupting experiments

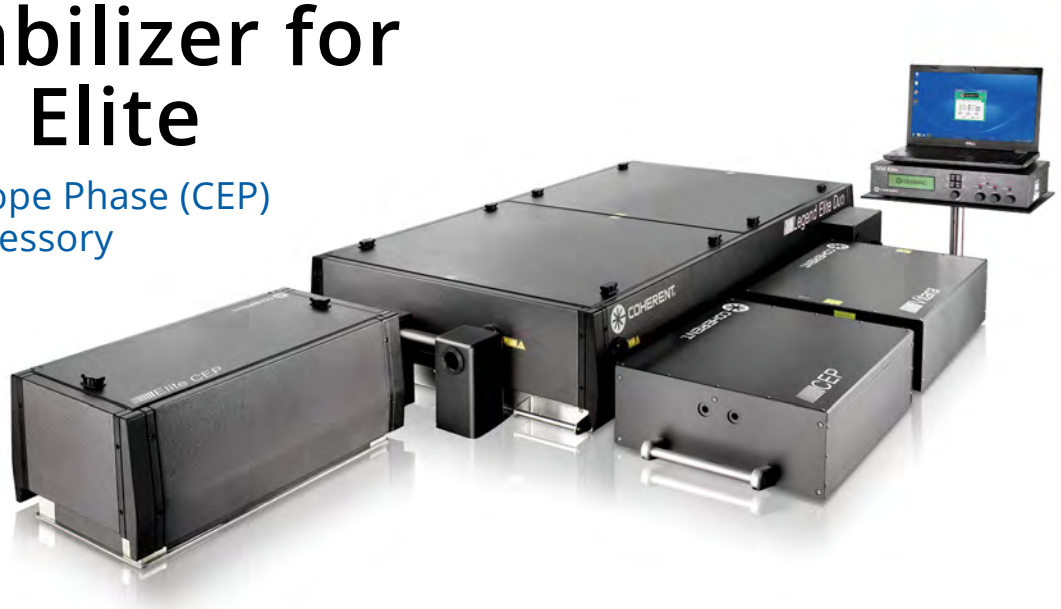
The SSA's indexed internal mirror configuration allows convenient sampling of pulses without disrupting experiments. The compact and rugged SSA also can be left in place after initial installation for accurate in-line measurements.

SPECIFICATIONS	SSA femtosecond		SSA picosecond
	SSA-F	Hi-Res SSA	Hi-Res SSA
Wavelength (nm)	750 to 850		750 to 850
Sampling Rate (Hz)	100		100
Pulse Length (fs)	50 to 500	20 to 50	500 to 2000
Range (ps)	2		34 at 800 nm[1]
Resolution (fs)	5	2	8.5 at 800 nm[1]

1 In picosecond mode, the range and resolution are wavelength-dependent. Contact factory for details.

CEP Stabilizer for Legend Elite

Carrier to Envelope Phase (CEP) Stabilization Accessory for Legend Elite



The Legend Elite CEP Stabilizer is a state-of-the-art Carrier-to-Envelope Phase stabilizer accessory designed exclusively for the Legend Elite amplifiers.

Applications such as High Harmonics Generation and Attosecond Science require CEP stabilized ultrafast pulses, generated by the Vitara oscillator, to be amplified up to the millijoule level of energy by Legend Elite amplifiers while conserving the CEP stability.

The Legend Elite CEP stabilizer includes an active feed-back control to lock the phase velocity of the oscillating light field to the group velocity of the phase envelope. Thus, for ultra-short pulses consisting of only a few optical cycles, the peak of the oscillating electrical field can be maximized under the phase envelope.

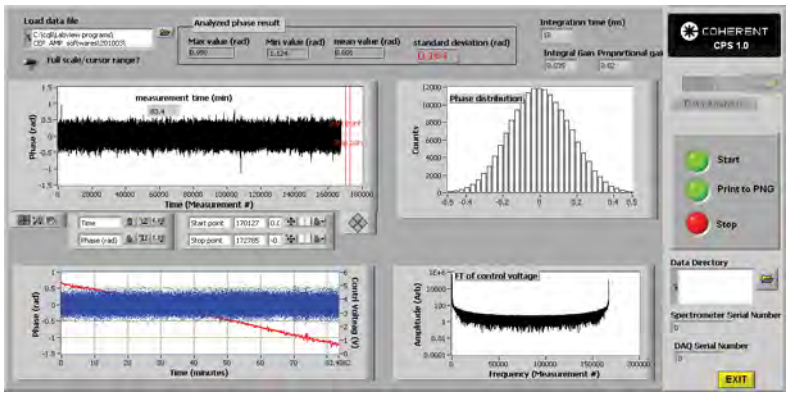
At the heart of the Legend Elite CEP is a separate phase detection module which includes an f-to-2f interferometer. An octave-spanning optical spectrum is generated by focusing a small part of the Legend Elite beam on a sapphire plate. The red end of this spectrum is frequency-doubled and colinearly combined with the blue end of this same broad spectrum. The resulting spectral interference fringes are measured, on every shot, by an analog detector which generates a signal to stabilize and control the Carrier-Envelope Phase by making adjustments in the Legend Elite amplifier.

With the CEP stabilized Verdi pumped Vitara and Revolution pumped Legend Elite, Coherent is the first and only company to offer a complete CEP stabilized ultrafast amplifier system designed and built by a single manufacturer.

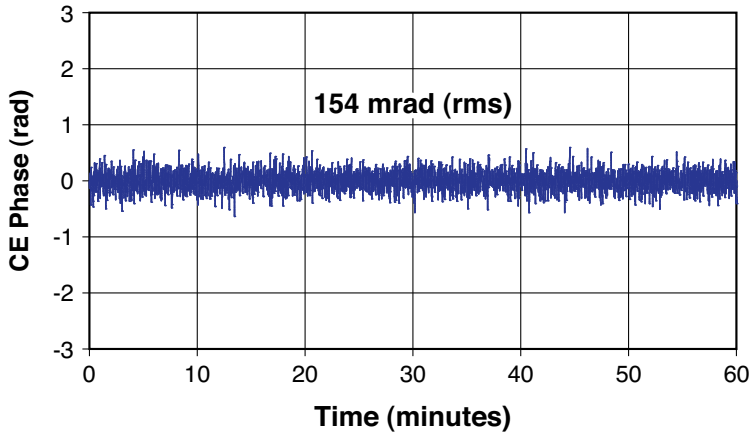
KEY ADVANTAGES

- RMS CEP stability typically sub-200 mrad (10 shots integration)
- f-to-2f collinear interferometer in separate module
- Seeded by our Verdi pumped Vitara CEP
- Regenerative amplifier technology for superior mode quality, beam pointing and output energy stability
- Complete CEP amplifier system from a single manufacturer
- Available for Legend Elite USX and USP models

GUI for Legend Elite CEP



Legend Elite CE Phase Stability



Laser Measurement and Control Accessories

Below and on the following page are recommendations for selecting the power and energy measurement tools for your ultrafast setup. Our power sensors measure the output of all Coherent pump lasers, amplifiers and oscillators, while our pulse energy measurement systems are designed for pump sources or oscillators having repetition-rates less than 10 kHz. And our energy sensors give you immediate feedback when peaking the output of your ultrafast system. All Coherent power and energy measurement products offer superior performance for applications requiring the precise pulse energy specifications.

AMPLIFIER ACCESSORY COMPATIBILITY	Power Meter	Power Sensor	Energy Meter	Energy Sensor
Pump Lasers				
Verdi G2, G5, G7, G8	FieldMaxII-TO	PM10	-	-
Verdi G10, G12, G15, G18	FieldMaxII-TO	PM30	-	-
Revolution-20/35	FieldMaxII-TO	PM30	LabMax-TOP	J-25MT-10KHZ[1]
Revolution-50/65	FieldMaxII-TO	PM150	LabMax-TOP	J-50MT-10KHZ[2]
Revolution-80	FieldMaxII-TO	PM150	-	-
Oscillators				
Fidelity	FieldMaxII-TO	PM10	-	-
Vitara	FieldMaxII-TO	PM10 or PS10[3]	-	-
Mira-900	FieldMaxII-TO	PM10	-	-
Mira-HP	FieldMaxII-TO	PM10	-	-
Chameleon	FieldMaxII-TO	PM10	-	-
Oscillator Accessories				
Mira OPO-X	FieldMaxII-TO	PS10	-	-
Chameleon Compact OPO/OPO-Vis	FieldMaxII-TO	PS10	-	-
Amplifiers				
Legend Elite HE+(F, P, USP, USX)	FieldMaxII-TO	PM10	LabMax-TOP	J-25MT-10KHZ
Legend Elite Duo HE+ (F, P, USP, USX)	FieldMaxII-TO	PM30	LabMax-TOP	J-25MT-10KHZ[1]
Astrella	FieldMaxII-TO	PM10	LabMax-TOP	J-25MT-10KHZ[1]
RegA 9000/9050	FieldMaxII-TO	PS10	-	-
Amplifier Accessories				
OPerA Solo	FieldMaxII-TO	PM10 or PS10[3]	LabMax-TOP (<1 mJ pump) J-10MB-HE (>1 mJ pump)	J-10MT-10KHZ
TOPAS/TOPAS-Prime	FieldMaxII-TO	PM10 or PS10[3]	LabMax-TOP (<1 mJ pump) J-10MB-HE (>1 mJ pump)	J-10MT-10KHZ

LASER ACCESSORY COMPATIBILITY	Mira 900	Mira HP	Vitara-T/ Vitara-T HP	Vitara-S	Chameleon
Harmonic Generator	X	X	X	X	X
Mira OPO-X	X	X			X
Pulse Picker	X	X	X	X	X
Compact Pulse Compressor (CPC)	X	X	X	X	X
Pulse Compressors (SPO1/SPO2)	X	X	X	X	X
Synchrolock-AP	X	X	X		
Vitara CEP			X		

AMPLIFIER ACCESSORY COMPATIBILITY	Astrella	Legend Elite HE
Harmonic Generator	X	X
Opera Solo	X	X[1]
TOPAS	X	X[1]
TOPAS-HE		X
Single-Shot Autocorrelator (SSA)	X	X

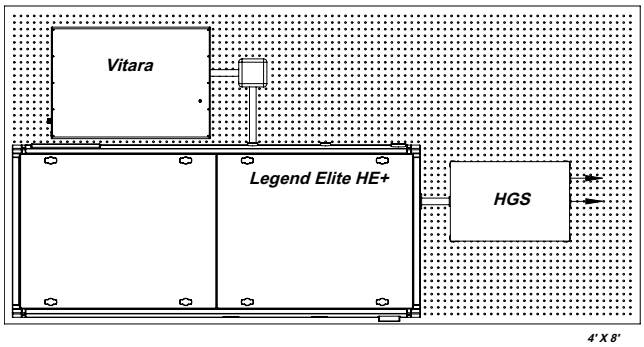
1 Up to 3.5 mJ pump beam.

AMPLIFIER SEED COMPATIBILITY	Vitara-S	Vitara-T	Vitara-T HP	Mira F	Chameleon
Legend Elite USX		X	X		
Legend Elite USP	X	X	X		
Legend Elite F	X	X	X	X	X[1]
Legend Elite P	X	X	X	X	

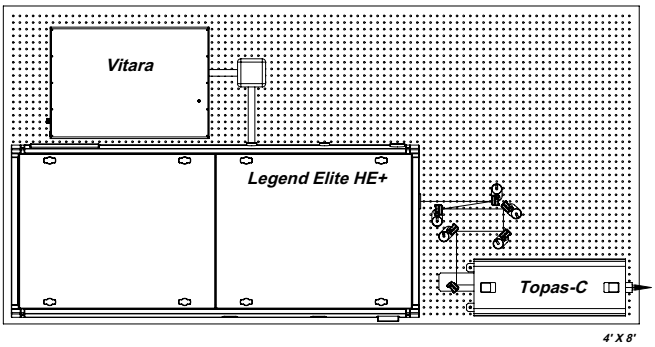
1 At <180 fs.

Sample Ultrafast Table Configurations*

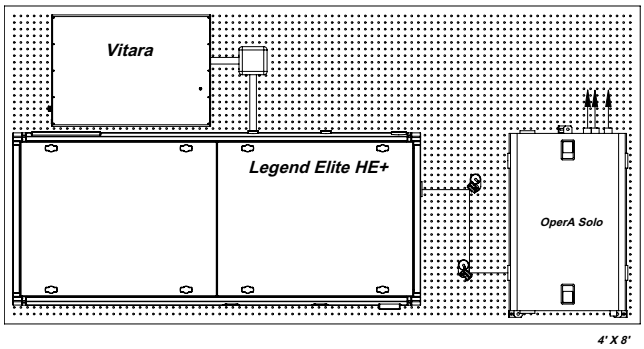
Vitara + Legend Elite + HGS



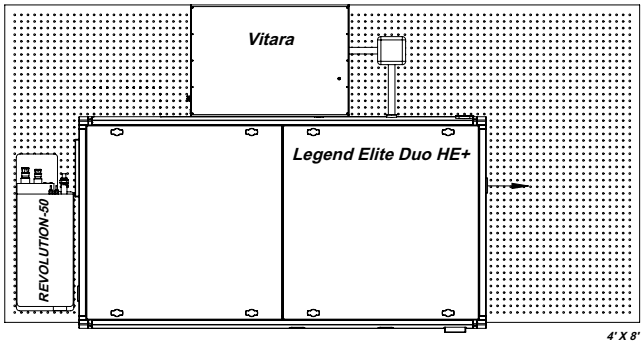
Vitara + Legend Elite + TOPAS



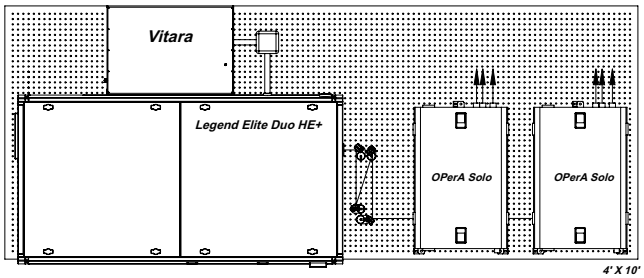
Vitara + Legend Elite + OPerA Solo



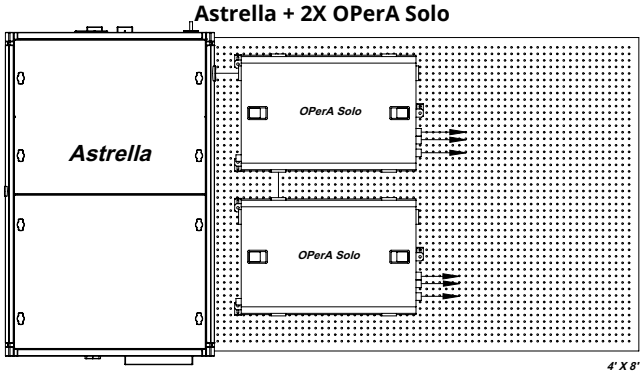
Vitara + Legend Elite DUO + Revolution-50/65 (optional)



Vitara + Legend Elite DUO + 2X OPerA Solo



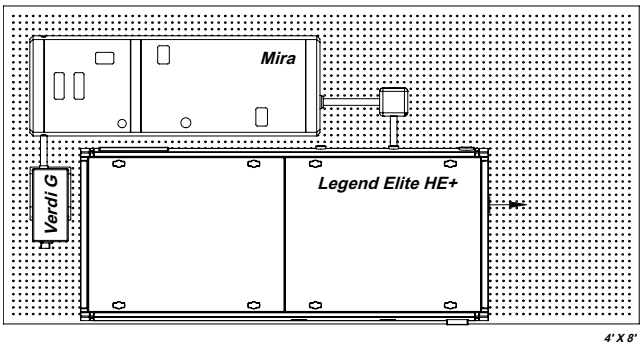
Astrella + 2X OPerA Solo



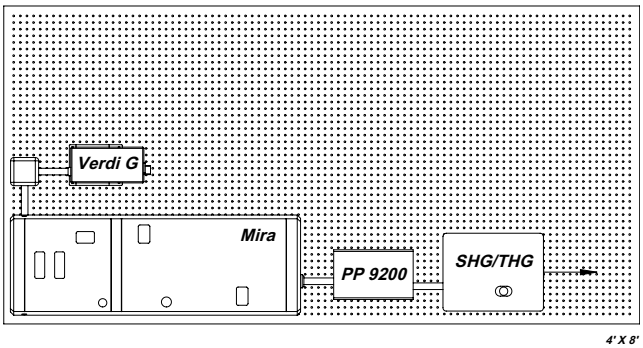
* Contact Coherent for additional table layout configurations.

Sample Ultrafast Table Configurations*

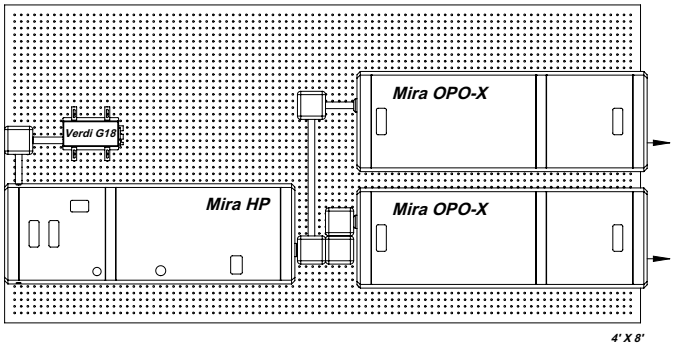
Verdi G + Mira + Legend Elite



Verdi G + Mira + PP 9200 + THG 9300



Verdi G18 + Mira HP + 2X Mira OPO-X



* Contact Coherent for additional table layout configurations.

How to Contact Us

Contact Us by Phone

Coherent, Inc.
(800) 343-4912 or (408) 764-4042

Contact Us by Email

Laser Products: tech.sales@coherent.com

Laser Measurement: lmc.sales@coherent.com

Service: product.support@coherent.com

Doing Business with Coherent

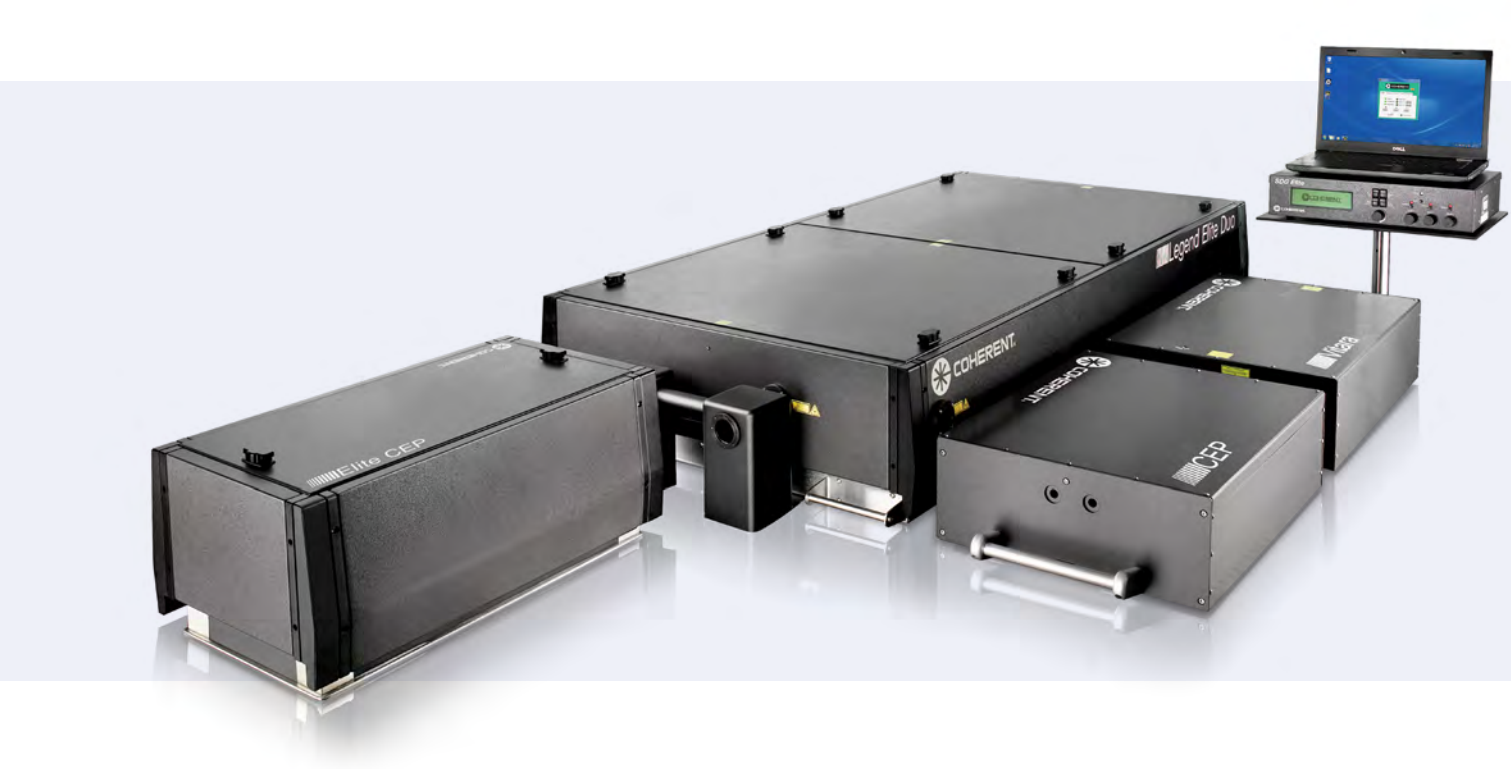
Visit Our Website for Current Terms and Conditions of Sale

Notes

Notes

Notes

Notes



COHERENT

Coherent, Inc.,
5100 Patrick Henry Drive Santa Clara, CA 95054
p. (800) 527-3786 | (408) 764-4983
f. (408) 764-4646

tech.sales@coherent.com **www.coherent.com**