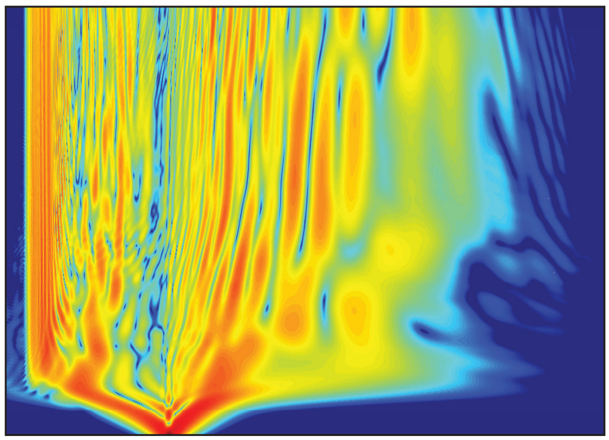
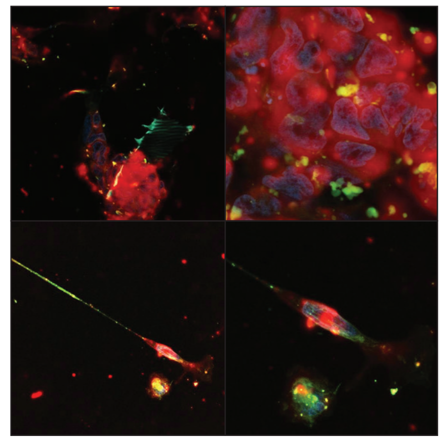
Femtosecond Lasers

TIBERIUS



Numerical Simulation of Supercontinuum Generation Through a Dispersion-Engineered InF_3 Fiber



Two-Photon Image of Oligodendrocyte Culture with Multiple-Dye Excitation Taken Using OCTAVIUS-85M-HP. Images Courtesy of Craig Brideau, Hotchkiss Brain Institue; Calgary, CA

Ultrafast Laser Technologies

Thorlabs offers a comprehensive portfolio of products for customers working in ultrafast science, nonlinear optics, or multiphoton imaging, from femtosecond lasers and supercontinuum sources to autocorrelators and optics to be used with ultrashort pulses.

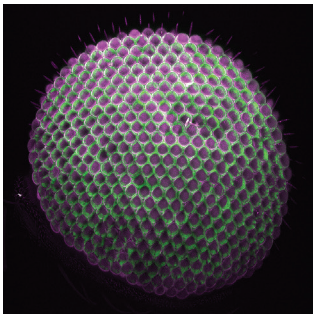
Our femtosecond sources include the Tiberius® Ti:Sapphire Laser with a tunable wavelength range from 720 to 1060 nm, Octavius® fs Laser with <8 fs pulse width, and FSL1950F 2 µm Fiber Laser Source, which produces <80 fs pulses. Expanding into the MIR ultrafast regime, Thorlabs now offers the world's first MIR supercontinuum source with a 1.3 µm to 4.5 µm wavelength range and output power ≥300 mW.

All ultrafast lasers and components are designed in-house by a multidisciplinary team of engineers leveraging Thorlabs' 30+ years of experience in the photonics arena. In addition, a high degree of vertical integration in our design, manufacturing, assembly, and testing processes lowers costs to our customers, delivering superior value.

Product Line Highlights

Multiphoton Imaging

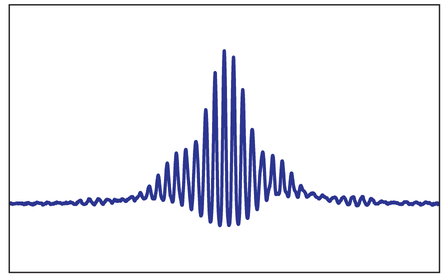
The Tiberius® Ti:Sapphire Laser offers rapid tuning over a broad 720 - 1060 nm wavelength range that makes it ideal for integration into multiphoton imaging systems.



Multiphoton Image of a Fruit Fly Eye

Ultrafast Measurements

The FSAC Autocorrelator provides approximate pulse width measurements in the 650 - 1100 nm wavelength range and is well suited for diagnostics of femtosecond Ti:Sapphire lasers.



Interferometric Autocorrelation of a Ti:Sapphire Pulse

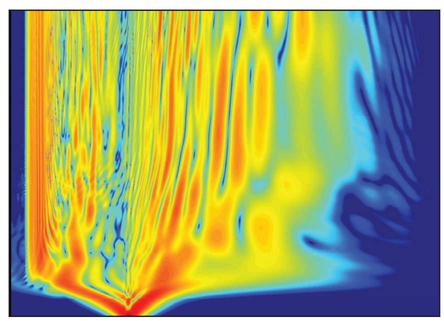
Ultrafast Science

Thorlabs' Octavius® laser features the shortest femtosecond pulses (<8 fs) and high average power.

Spectrum Emitted by OCTAVIUS-85M-HP

MIR Spectroscopy

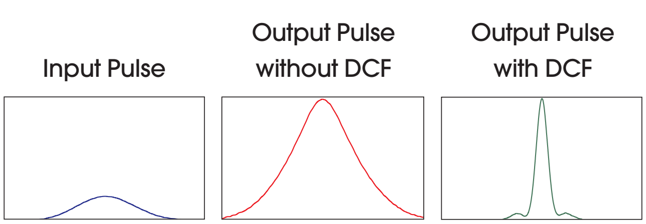
The world's first commercially available femtosecond MIR supercontinuum source, the SC4500 offers high-brightness output from 1.3 µm to 4.5 µm.



Supercontinuum Generation

Ultrafast Pulse Amplification

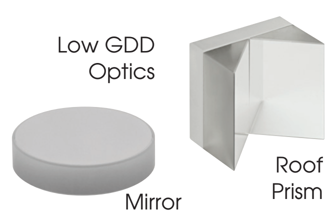
Our Ytterbium-Doped and Erbium-Doped Fiber Amplfiers provide amplification for lasers from 1025 - 1075 nm and 1530 - 1565 nm, respectively. Designed for low dispersion, we have extensively tested these amplifiers with femtosecond lasers.



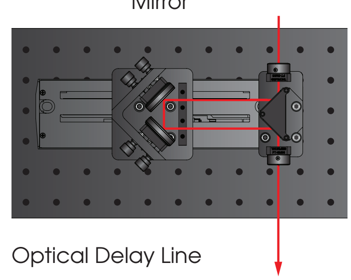
Amplification of Femtosecond Pulse

Ultrafast Tools of the Trade

Low-GDD optics minimize dispersion while chirped optics can help compensate for pulse broadening effects.



Optical delay lines use precisely controlled stages with low-dispersion optics to change the optical path length.



Optical Delay Line

In-House Expertise in Design and Manufacturing

Precision Optomechanics Manufacturing

Machine Shop at Thorlabs' Headquarters in Newton, NJ

Our ultrafast lasers benefit from Thorlabs' 30+ years of experience in manufacturing precision photonics components and assemblies. For example, they extensively incorporate the high-performance, ultrastable Polaris® designs that the company has developed for custom OEM needs and industrial-grade applications. These expert designs minimize thermally induced drift and help ensure stable long-term alignment.

Our high degree of vertical integration lowers costs to our customers and ensures that every aspect of the laser performs as intended, delivering superior value and return on investment.

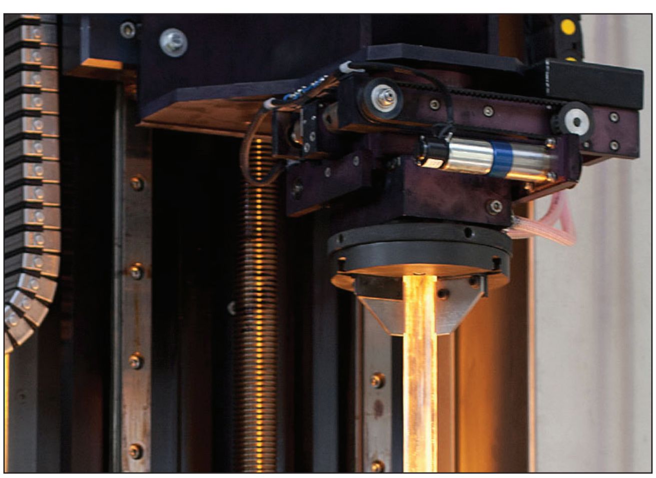
Optics Optimized for Ultrafast Lasers

To maximize optical performance, it is critical to optimize the laser cavity geometry and optics together as a single unit. Our optical coatings are therefore designed by Thorlabs and are precisely tuned for our proprietary designs, enabling the long-term stability and broad tuning range that ultrafast applications require.

To manufacture these high-performance coatings, we selected ion beam sputtering (IBS), which provides the most precise layer control and the most dense coatings among all coating methods. These characteristics result in coatings with high damage thresholds, minimal dependence on environmental factors, and excellent consistency from run to run. Thorlabs operates a number of IBS machines to produce these critical components for our ultrafast lasers.

Ion Beam Sputtering Chamber for Ultrafast Optics in Thorlabs' Headquarters in Newton, NJ

Specialty Fibers for Ultrafast Applications



Preform heated by the oven of our fiber draw tower.

Our in-house fiber draw towers allow for the production of specialty passive and active optical fibers for a variety of applications supporting multiple material systems like ZBLAN and InF_3. In particular, Thorlabs' fluoride fibers are ideal for use out to 5.5 µm. Our engineering team has experience with designing and fabricating fibers for academic, industrial, and government applications.

Tiberius® fs Laser for Life Science Imaging

TIBERIUS

Features

- Wide Tuning Range: 720 nm to 1060 nm
- Fast Tuning Speed: Up to 4000 nm/s
- High Output Power: >2.3 W at 800 nm
- Ultrafast 140 fs Pulses Help Minimize Pulse Broadening
- Long-Term Reliability for Exceptionally Low Cost of Ownership

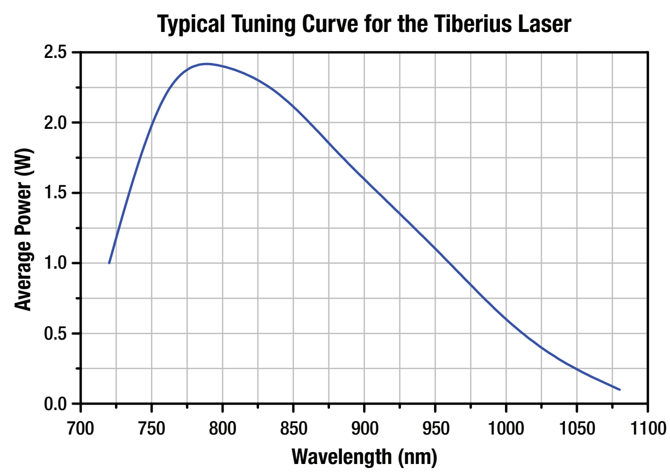
Applications

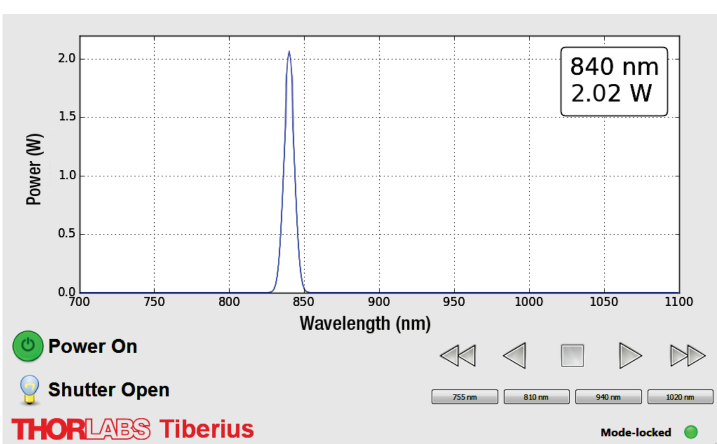
- Two-Photon Microscopy
- Photostimulation and Uncaging
- Label-Free Imaging via Multiphoton Autofluorescence and Second Harmonic Generation
- Fast Sequential Imaging

The Tiberius Femtosecond Tunable Ti:Sapphire Laser was designed in close collaboration with Thorlabs' life science application specialists. Manufactured in-house, it leverages the company's extensive expertise in optical design and precision manufacturing.

This multiphoton imaging laser offers an average power of >2.3 W at 800 nm and a center wavelength that is tunable from 720 nm to 1060 nm. This 340 nm wide tuning range allows the user to target specific compounds for multiphoton fluorescence imaging and photostimulation/uncaging.

The Tiberius laser emits pulses that are 140 fs in duration. The relatively narrow spectral bandwidth of these pulses was selected in order to reduce the pulse broadening caused by Pockels cells and other dispersive elements while still providing high peak intensity for two-photon excitation.





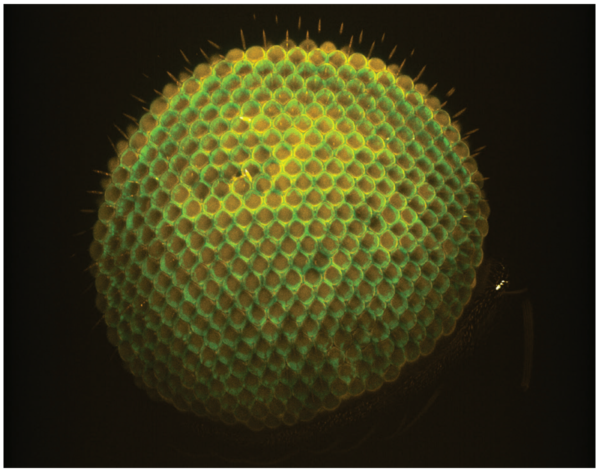
Tiberius Control GUI Provides Real-Time Spectral and Power Data

The Tiberius laser includes an intuitive GUI for control. Shown to the left, the GUI reports the center wavelength and output power of the laser, using the built-in spectrometer to provide real-time diagnostics of the spectral position and shape. User-programmable buttons provide single-click access to commonly used excitation wavelengths.

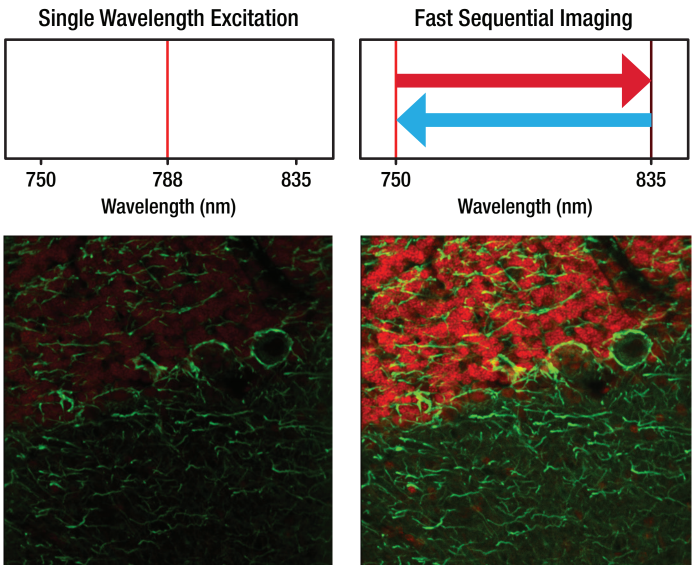
Designed for Two-Photon Imaging

Multiphoton microscopy takes advantage of the NIR transparency windows in living tissue and highly localized excitation to generate multi-channel fluorescence images of 3D volumes. Compared to visible light, which is used in conventional widefield microscopy and confocal microscopy, NIR light offers significantly reduced scatter and absorption by biological compounds, resulting in deeper images below the surface.

The image of a fruit fly eye to the right demonstrates the Tiberius' ability to resolve morphological features. This two-channel image contains GFP-labeled photoreceptors and unlabeled regions that exhibit multiphoton autofluorescence.



Fruit Fly Eye with GFP-Labeled Photoreceptors and Multiphoton Autofluorescence (Excitation Wavelength: 770 nm)



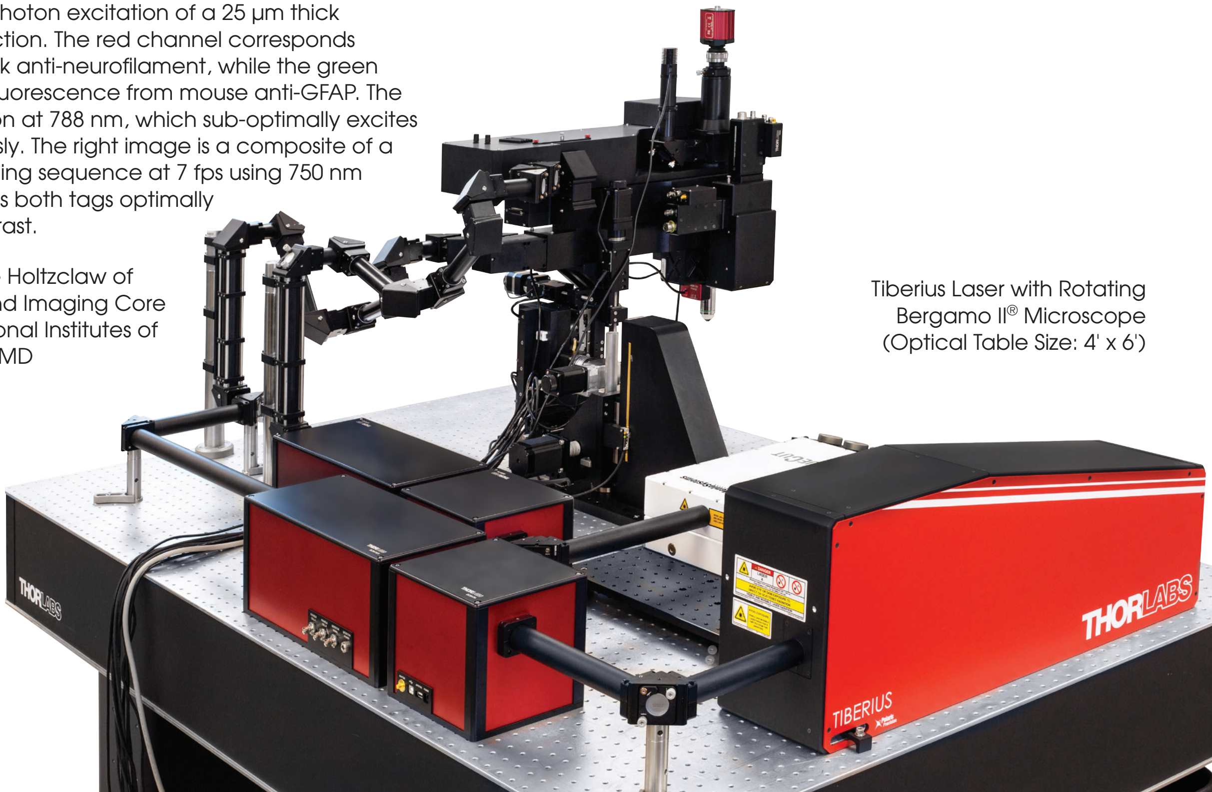
These images show two-photon excitation of a 25 µm thick adult rat brain sagittal section. The red channel corresponds to fluorescence from chick anti-neurofilament, while the green channel corresponds to fluorescence from mouse anti-GFAP. The left image shows excitation at 788 nm, which sub-optimally excites the two tags simultaneously. The right image is a composite of a two-color excitation imaging sequence at 7 fps using 750 nm and 835 nm, which excites both tags optimally and provides higher contrast.

Images Courtesy of Lynne Holtzclaw of the NICHD Microscopy and Imaging Core Facility, a Part of the National Institutes of Health (NIH) in Bethesda, MD

Fast Wavelength Tuning

With an industry-leading tuning speed of up to 4000 nm/s, the Tiberius is ideal for fast multi-color excitation imaging. For example, users can collect a sequence of two-channel fluorescence images by switching rapidly between the two optimum excitation wavelengths. This process, known as fast tuning, maximizes fluorescence at a lower excitation power that reduces the risk of photo bleaching. At full speed, both channels can be collected at an imaging rate of 7 fps with a resolution of 512 x 512 pixels.

Fast tuning integrates seamlessly into our ThorImage®LS software, enabling synchronized control for photoactivation experiments and live high-speed imaging on millisecond timescales using the same laser.

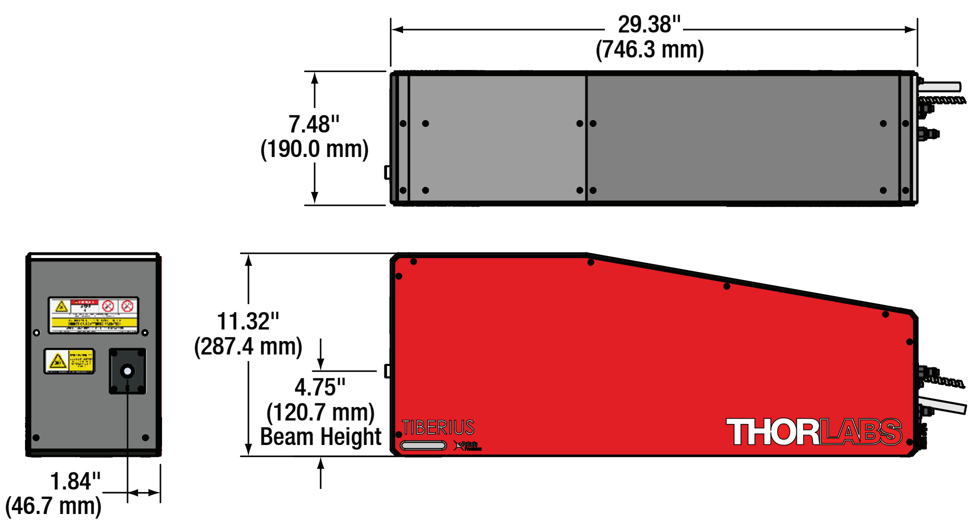


Tiberius Laser with Rotating Bergamo II® Microscope (Optical Table Size: 4' x 6')

Tiberius® fs Laser Specifications

Specifications

Item #	TIBERIUS
Tuning Range	720 - 1060 nm
Pulse Width	140 fs
Average Output Power	>1.0 W at 720 nm, >2.3 W at 800 nm, >1.4 W at 920 nm, >0.5 W at 1000 nm, >0.3 W at 1040 nm
Repetition Rate	77 MHz (Nominal)
Noise	<0.15% (RMS, 10 Hz - 1 MHz Measurement Bandwidth)
Beam Diameter ($1/e^2$)	1.5 mm (Nominal)
M^2	<1.2 at 800 nm
Pointing Stability During Tuning	<50 µrad per 100 nm
Electrical Specifications	
Input Voltage	100 - 240 V
Frequency	50 - 60 Hz
Power Consumption	1.2 kW (Max)
Environmental Requirements	
Room Temperature	17 - 25 °C
Room Temperature Stability	<3 °C over 24 Hours
Physical Dimensions	
Laser Dimensions	29.38" x 7.48" x 11.32" (746.3 mm x 190.0 mm x 287.4 mm)



Compact Footprint

Since tabletop space is often at a premium, the Tiberius laser has been designed with a vertical cavity that minimizes the footprint on the optical table. At 29.38" x 7.48", the Tiberius' footprint is about half that of competing designs, preserving valuable workspace for the rest of your experimental setup.

Femtosecond Pulse Compressor

Features

- 700 - 1050 nm Wavelength Range
- -12,500 to 0 fs² Adjustable Dispersion Compensation Range
- Optimized for >50 fs Input Pulse Width
- Designed for Thorlabs' Tiberius® Femtosecond Laser

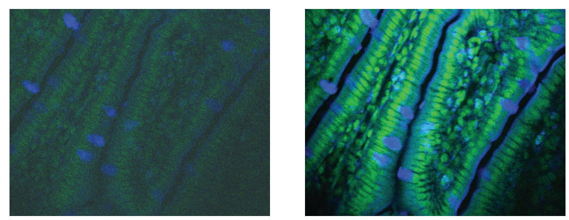
FSPC

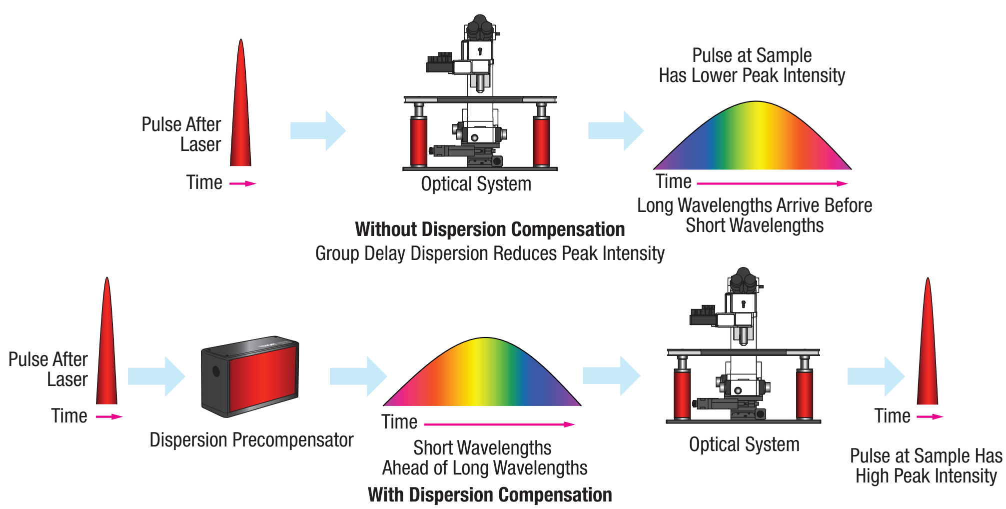
Thorlabs' FSPC Femtosecond Pulse Compressor helps improve image contrast and quality when working with difficult-to-image samples. It accomplishes this by minimizing the pulse duration in the sample plane and compensating for the group delay dispersion (GDD) that occurs in all complex optical systems, such as multiphoton microscopes.

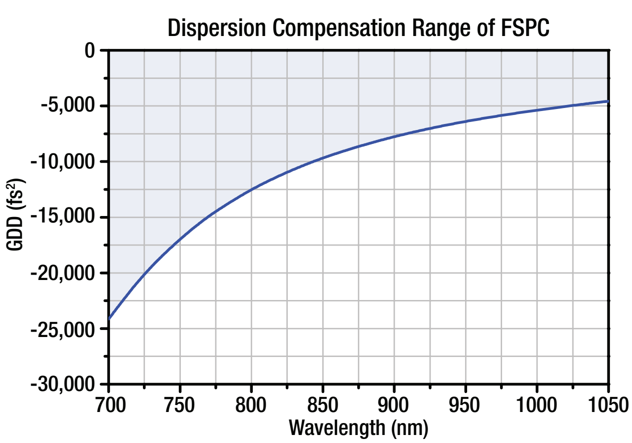
Ultrashort pulses used in multiphoton microscopy are comprised of a spectrum of wavelengths, typically several nanometers wide. As light travels from the laser through the microscope to the sample, each wavelength travels at a different velocity though the optical system, naturally broadening the pulse duration. A broadened optical pulse and therefore reduced peak intensity can decrease image contrast and quality when working with challenging samples (see images to the right). By compensating for GDD in the microscope and hence negating the pulse broadening, the FSPC ensures that the pulse arriving at the sample is as short as possible.

The FSPC features adjustable dispersion compensation up to -12,500 fs² at 800 nm. It can be installed between the femtosecond laser source and the microscope and supports a 4.25" or 4.75" beam height.

Without Dispersion Compensation (Long Pulse at Sample)	With Dispersion Compensation (Short Pulse at Sample)


Shorter Laser Pulses Provide Increased Contrast





Specifications

Item #	FSPC
Wavelength Range	700 - 1050 nm
Dispersion Range at 800 nm	-12,500 fs² to 0 fs²
Transmission at 800 nm	>85%
Input Pulse Width (Recommended)	>50 fs
Input Beam Diameter (1/e²)	2 mm (Max)
Input/Output Polarization	P-Polarized
Polarization Distortion	<1:200
Pointing Stability	<100 µrad

Octavius® fs Ti:Sapphire Lasers

Features

- >600 mW Output Power and <8 fs Pulse Width
- Turnkey, Maintenance-Free Operation
- Low Cost of Ownership

OCTAVIUS-85M-HP

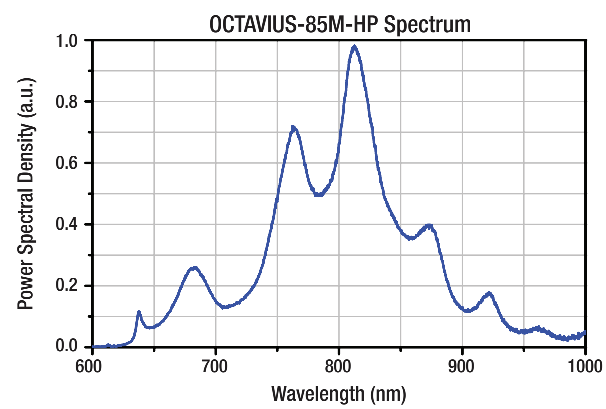
Thorlabs' Octavius 85 MHz Ti:Sapphire laser offers some of the broadest spectra commercially available. The spectrum of this ultrafast laser system is well suited for amplifier seeding, particularly for Optical Parametric Chirped Pulse Amplifiers (OPCPAs), or for use in pump-probe experiments. The OCTAVIUS-85M-HP is a high-power laser capable of >600 mW output while maintaining a <8 fs transform-limited pulse width.

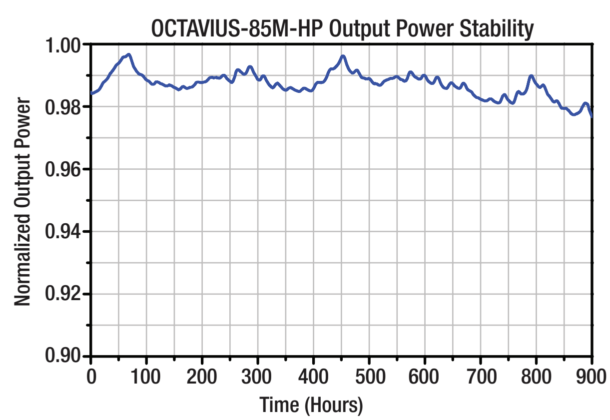
Designed for the physical and life sciences, our Octavius lasers are ideal for many applications, including multiphoton or Coherent Anti-Stokes Raman Scattering (CARS) imaging. With a pulse duration of less than 8 fs, the OCTAVIUS-85M-HP laser provides an exceptionally high peak power of more than 700 kW and a large spectral bandwidth spanning more than 200 nm (at -10 dB). This wide bandwidth covers more than half the typical tuning range of most Ti:Sapphire lasers and allows for the simultaneous excitation of several spectrally separated fluorophores at their optimal absorption wavelengths without tuning.

Thorlabs' femtosecond lasers are engineered to provide peak performance without user intervention, offering minimal downtime and low cost of ownership. In order to provide stable experimental conditions in a variety of lab environments, they incorporate Thorlabs' Polaris® precision designs for ultrastable beam pointing. The laser is factory aligned and sealed for maintenance-free operation.

Applications

- CPA and OPCPA Seeding
- Two-Photon Fluorescence Imaging
- THz Experiments
- Nonlinear Optics
- Ultrafast Spectroscopy





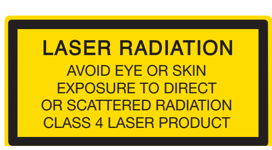
Specifications

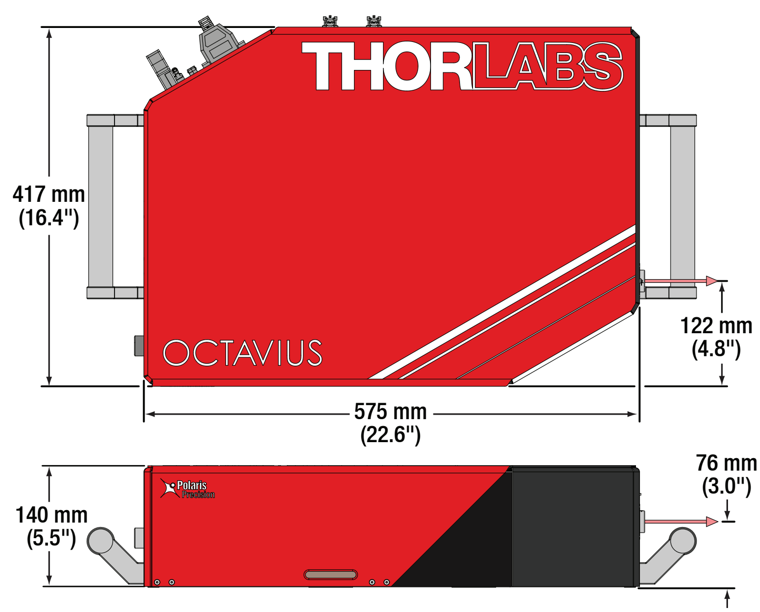
Item #	OCTAVIUS-85M-HP
Transform-Limited Pulse Width[a]	<8 fs
Bandwidth at -10 dB	>200 nm
Average Output Power	>600 mW
Repetition Rate	85 MHz
M^2 at 800 nm	<1.3
Divergence	<2 mrad
Beam Diameter	750 µm (Nominal)
Beam Ellipticity	1.15 (Nominal)
Polarization Ratio	>90:1
Power Stability Over 8 Hours	±0.3%
RMS Noise (10 Hz to 625 kHz)	<0.2%
Physical Specifications	
Laser Housing Dimensions	575 mm x 417 mm x 140 mm (22.6" x 16.4" x 5.5")
Controller Power Consumption	750 W
Controller Dimensions	432 mm x 267 mm x 381 mm (17" x 10.5" x 15")
Chiller Power Consumption	625 W (Max)
Air Circulator Power Consumption	25 W

a. The output pulse is chirped to account for dispersive materials outside the laser. To obtain the transform-limited pulse width, dispersion compensation is needed to counter-chirp and compress the pulse.

Pump Laser

The Octavius laser comes with an integrated pump laser. This pump laser is based on state-of-the-art Optically Pumped Semiconductor Laser (OPSL) technology, which allows for high compactness and a low cost of ownership.



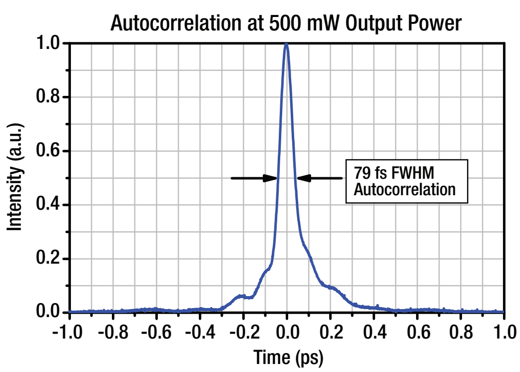


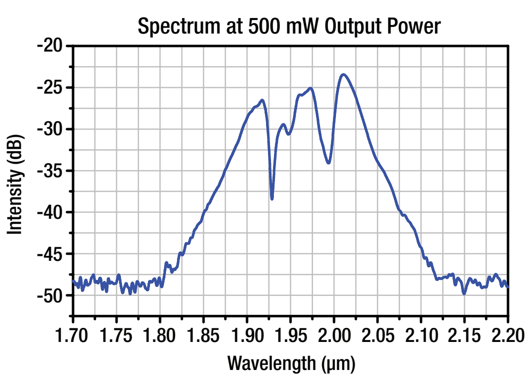
2 µm Femtosecond Fiber Laser

FSL1950F

Thorlabs' FSL1950F is an ultrafast laser with emission centered at 2 µm. By providing <80 fs pulse widths with >500 mW average output power at a repetition rate of 50 MHz, the FSL1950F enables a wide range of applications.

This femtosecond laser is based upon an oscillator-amplifier combination that uses only polarization-maintaining fiber, yielding reliable turnkey operation and exceptional long-term reliability. The pulses are delivered through a pigtailed FC/APC-terminated fiber, providing compatibility with free-space coupling optics, such as a fiber collimator or coupler. A version of the FSL1950F with a collimated free-space output is available by contacting techsales@thorlabs.com.





These autocorrelation and spectrum plots are provided as a reference and not guaranteed.

LASER RADIATION
AVOID EYE OR SKIN EXPOSURE TO DIRECT OR SCATTERED RADIATION
CLASS 4 LASER PRODUCT

Features

- 2 µm Center Wavelength
- Ultrashort Pulses (<80 fs FWHM)
- High Power
  - >500 mW Average Output Power
  - >10 nJ Pulse Energy
- All Polarization-Maintaining Fiber Design
- Reliable Passive Mode-Locking Using a Saturable Absorber
- Turnkey Operation and Exceptional Long-Term Stability
- Pigtailed, FC/APC-Terminated Delivery Fiber
- Free-Space Version Available Upon Request

Applications

- MIR Supercontinuum Generation
- MIR Frequency Combs
- Seeding of Thulium- or Holmium-Doped Amplifiers
- Ultrafast Spectroscopy
- Material Characterization
- Nonlinear Optics

Specifications

Item #	**FSL1950F**
Center Wavelength	1950 nm ± 30 nm
Pulse Width	<80 fs (FWHM)
Output Power	>500 mW (Average)
Repetition Rate	50 MHz (Nominal)
Pulse Energy	>10 nJ
Polarization Extinction Ratio[a]	>15 dB
External Sync Output	SMA Connector
Fiber Specifications	
Connector Type	2.0 mm Narrow Key FC/APC
Mode Field Diameter	~12 µm
Fiber NA	0.13
Length	12" (30 cm) Nominal

a. The output polarization is parallel to the fiber alignment key.

MIR Supercontinuum Laser Source

SC4500

PRISM AWARDS WINNER

Thorlabs is pleased to offer the world's first commercially available femtosecond-laser-pumped MIR Supercontinuum Source. The SC4500 source emits over a wavelength range from approximately 1.3 µm to 4.5 µm (7700 cm^{-1} to 2200 cm^{-1}) and emits more than 300 mW of average output power in a collimated beam. The brightness of this source exceeds traditional Globars and even synchrotron sources by orders of magnitude.

The supercontinuum light is generated by pumping a dispersion-engineered indium fluoride (InF_3) fiber with a high-power femtosecond fiber laser. Unlike supercontinuum sources pumped in the long-pulse regime (picoseconds to nanoseconds), the spectrum of a femtosecond-pumped source is stable from pulse to pulse. As a result, our supercontinuum source provides output with low typical intensity noise of 0.025% (RMS; 10 Hz to 1 MHz).

High brightness and low output noise make the SC4500 the ideal source for sensing and spectroscopy applications in the MIR. Applications range from environmental sensing of greenhouse gases to standoff detection in the field to spectroscopy in the lab using standard FTIR spectrometers.

LASER RADIATION
AVOID EYE OR SKIN EXPOSURE TO DIRECT OR SCATTERED RADIATION
CLASS 4 LASER PRODUCT

An all-fiber design with proprietary fluoride-to-silica fiber splices offers robust, reliable, and maintenance-free performance.

Specifications

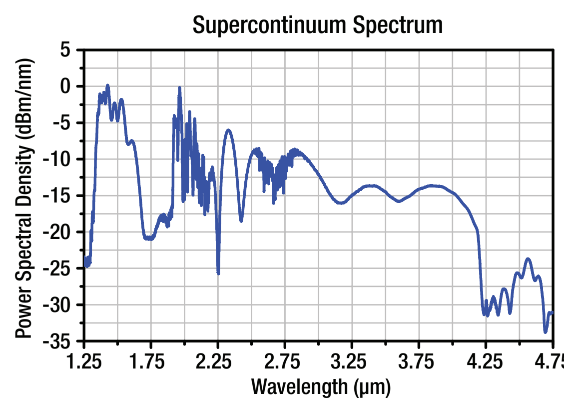
Item #	**SC4500**
Wavelength Range	1.3 - 4.5 µm (7700 - 2200 cm^{-1})
Output Power	300 mW (Minimum)
MIR Output Power	>110 mW (Specified from 2.2 - 4.2 µm)
Output Power Stability	±1% (at Room Temperature ±1°C)
Intensity Noise (10 Hz - 1 MHz)	0.025% (RMS, Typical)
Repetition Rate	50 MHz (Typical)
Beam Output	Collimated; Single Spatial Mode
Dimensions (Laser Head)	17.92" x 15.89" x 5.84" (455.2 mm x 403.5 mm x 148.2 mm)

Features

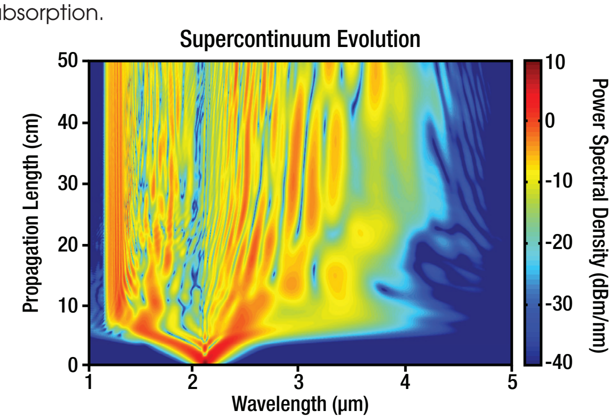
- >110 mW Output Power over 2.2 - 4.2 µm
- 0.025% Typical Intensity Noise Enables Highly Sensitive Measurements
- Record-High Brightness Enables Remote and Standoff Detection
- All-Fiber Design

Applications

- Environmental Sensing
- Standoff Detection of Chemical and Biological Threats
- Infrared Spectromicroscopy
- Ultrafast and Absorption Spectroscopy
- Femtosecond Pulse Generation in the MIR
- MIR Microscopy



Typical power spectral density as a function of wavelength. Please note that this is a sample spectrum and that small variations may occur from unit to unit. The fine structure seen around 2.7 µm is due to water and CO_2 absorption in the beam path of the measurement setup. The sharp dropoff at 4.2 µm is also due to CO_2 absorption.



Simulation of supercontinuum generation in dispersion-engineered InF_3 fiber pumped by a 2.1 µm, 100 fs, 10 nJ source. (see ***Opt. Express*** 2015 Nov 16; **23** (24): 30592-30602.)

Fiber Amplifiers

VISIBLE AND INVISIBLE LASER RADIATION

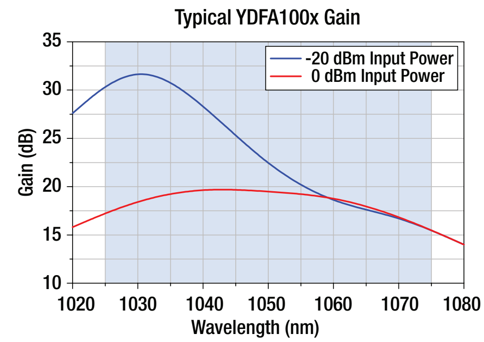
AVOID EXPOSURE TO BEAM
CLASS 3B LASER PRODUCT

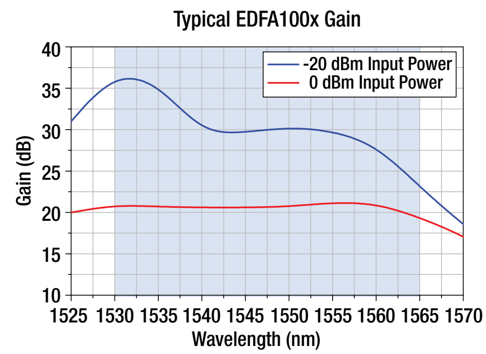
EDFA100S

Features

- Ytterbium-Doped (YDFA) or Erbium-Doped (EDFA) Fiber Amplifiers
- Operating Wavelength Ranges
  - YDFA: 1025 - 1075 nm
  - EDFA: 1530 - 1565 nm (C-Band)
- For CW and Ultrafast Pulse Amplification
- Single Mode or Polarization-Maintaining Versions Available

Thorlabs offers core-pumped ytterbium-doped (YDFA) and erbium-doped (EDFA) fiber amplifiers. Each amplifier is enclosed in a compact, turnkey benchtop package with FC/APC input and output connectors. They also include built-in input and output isolators, and the pump current is adjustable through the instrument's front panel. Remote control of the pump current is supported by sending serial commands via a USB 2.0 connector.





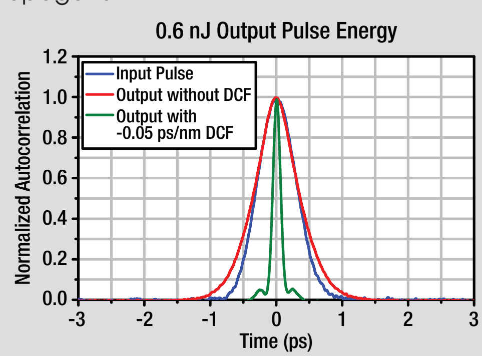
Specifications

Item #	YDFA100S	YDFA100P	EDFA100S	EDFA100P
Amplifier Specifications (at 1000 mA Pump Current)				
Operating Wavelength Range	1025 - 1075 nm		1530 - 1565 nm[a]	
Output Power (at 3 dBm Input Power)	≥19 dBm (1050 nm)		>20 dBm (1550 nm)	
Small Signal Gain (at -20 dBm Input Power)	>22 dB (1050 nm)		>30 dB (1550 nm)	>28 dB (1550 nm)
Noise Figure	<8 dB (1050 nm)		<5 dB (1550 nm) (at 3 dBm Input Power)	
Output Power Stability (at 3 dBm Input Power)	<±2% Over 24 Hours (After 15 Minute Warm-Up for Ambient Temp. ±2 C°)			
Total Absolute Dispersion within Amplifier	<0.2 ps/nm		<0.06 ps/nm	
Laser Class	3B			
Absolute Maximum Input Power	10 dBm			
Absolute Maximum Output Power	23 dBm			
Fiber Specifications				
Output Polarization	Random	Linear[b]	Random	Linear[b]
Polarization Extinction Ratio	N/A	>20 dB	N/A	>25 dB
Polarization-Dependent Gain	<0.3 dB	N/A	<0.2 dB	N/A
Return Loss at Input Port	>50 dB			
Input/Output Isolation	>20 dB		>30 dB	
Input/Output Fiber Type	HI1060	PM980-XP	SMF-28-J9	PM1550-XP
Input/Output Fiber Connectors	FC/APC Compatible, 2.0 mm Narrow Key			

a. The wavelength range over which the output power (at 3 dBm input power) does not fall below 18 dBm.
b. Aligned to Slow Axis

Tested for Ultrafast Applications

Our fiber amplifiers are engineered to impart minimal dispersion to ultrafast pulses. The dispersion and nonlinear parameters of each unit can be provided for modeling amplifier pulse propagation.



Using a pre-chirp DCF to optimize EDFA100P pulse amplification generates compressed pulses at 0.6 nJ with a width of <100 fs (shown above).

Features

- Ultrafast Autocorrelation Measurements for 650 - 1100 nm
- For Pulses from 40 fs to 1 ps or Pulses Down to 15 fs with Precompensation
- Integrated Alignment Target and Iris for Easy Setup
- Selectable Gain up to 70 dB to Accommodate Large Range of Input Powers

FSAC
Front View

The FSAC Interferometric Autocorrelator provides approximate measurements of ultrafast pulse widths. It is based on a modified Michelson interferometer with a nonlinear detector at its output.

This autocorrelator is designed for pulse durations ranging from 15 fs to 1 ps (with precompensation), and the scan range can be adjusted from ±25 fs to ±5 ps. A BNC output connector provides the autocorrelation trace, which can be viewed on any oscilloscope with >1.5 MHz bandwidth. A photodiode amplifier with selectable gain up to 70 dB allows the user to adjust the unit for a large range of input powers.

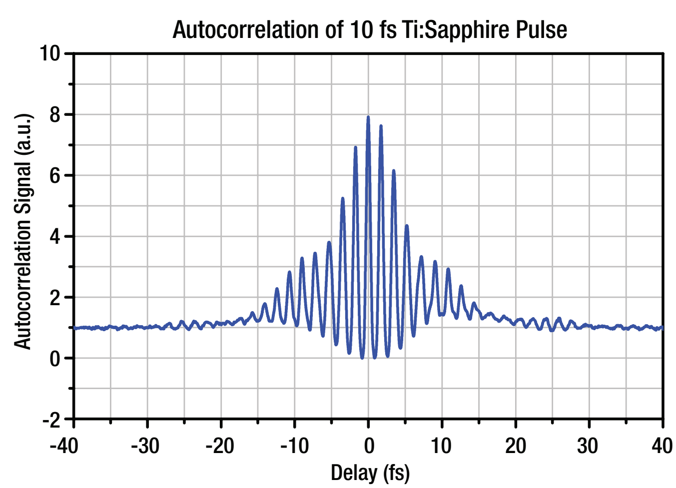
Intuitive, easy-to-reach controls on the outside of the enclosure, shown in the photo to the right, allow the user to optimize the interferogram. A MATLAB® or Python® script is available for converting interferometric autocorrelation data to an intensity correlation trace; this is ideal for cases where bandwidth is insufficient or the pulse is excessively chirped.

FSAC
Back View

Specifications

Item #	FSAC
Input Wavelength Range	650 - 1100 nm
Input Pulse Duration (FWHM)	40 fs - 1 ps (Without Precompensation) 15 fs - 1 ps (With Precompensation)
Full Scan Range	50 fs to 10 ps (±25 fs to ±5 ps)
Input Repetition Rate	>300 kHz
Noise-Equivalent Sensitivity[a]	0.1 W^2 at 800 nm for Ø1 mm Beam ($1/e^2$)
Input Polarization	Horizontal
Input Beam Diameter	<Ø4 mm ($1/e^2$)
Scan Rate	5 Hz
Internal Dispersion (Nominal)	230 fs^2 at 800 nm (GDD) 345 fs^3 at 800 nm (TOD)

a. Peak Power x Average Power of Input Laser

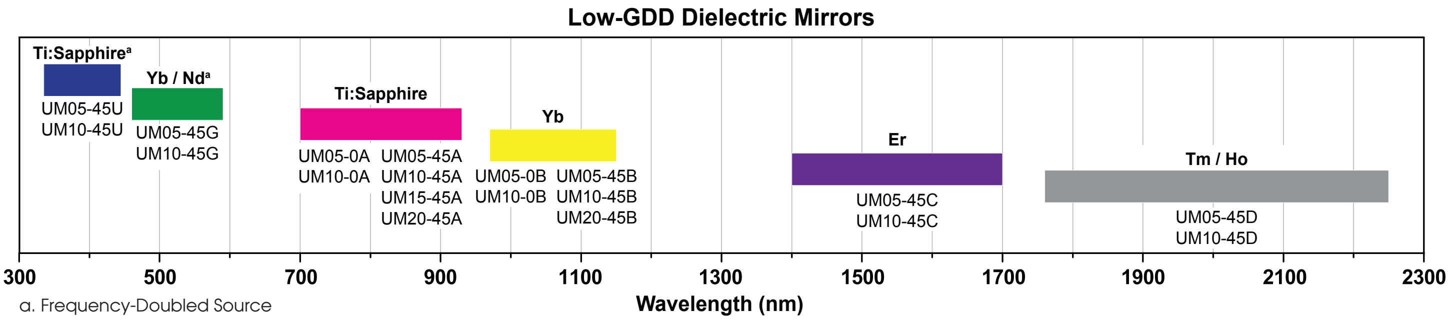


This interferometric autocorrelation was obtained using the OCTAVIUS-85M-HP. Precompensating mirrors were used to chirp the beam prior to the autocorrelator.

Low-Dispersion Optics

Dielectric Mirrors with Low GDD

Our Low Group-Delay-Dispersion (GDD) Mirrors are optimized for low dispersion and high reflectance when used with Ti:Sapphire (Ti:Sa), ytterbium (Yb), neodymium (Nd), erbium (Er), thulium (Tm), or holmium (Ho) lasers.



a. Frequency-Doubled Source

The colored bars represent our selection of low-GDD dielectric mirror coatings available from stock. Each coating is designed to work with a specific laser type, listed above the bar, while the mirrors specified for that wavelength range are indicated by the item #s below the bar. More information is available at www.thorlabs.com.

Mirrors with Ultrafast-Enhanced Silver Coating

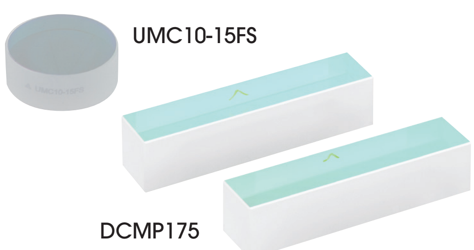
Our Ultrafast-Enhanced Silver Coating for 750 - 1000 nm offers slightly lower reflectance ($R_s > 99.0\%$; $R_p > 98.5\%$) over a much wider wavelength range than dielectric mirrors, making it a great choice when working with low-energy lasers. Each offers $|GDD_s| < 20$ fs^2 and $|GDD_p| < 30$ fs^2 per reflection.

Specifications

Type	Round Mirror			Elliptical Mirror	D-Shaped Mirror		Roof Prism	
Item #	UM05-AG	UM10-AG	UM20-AG	UME1-AG	PFD05-03-AG	PFD10-03-AG	HRS1015-AG	HR1015-AG
Dimensions	Ø1/2"	Ø1"	Ø2"	1"	Ø1/2"	Ø1"	1" x 1"; Unmounted	Ø1"; Mounted

Chirped Mirrors

Our UMC05-15FS and UMC10-15FS mirrors are designed specifically to correct for GDD introduced by fused silica optics in a system. The DCMP175 Chirped Mirror Set compensates for GDD from a complex optical system such as a high-NA microscope objective.



Specifications

Item #	**UMC05-15FS**	**UMC10-15FS**	**DCMP175**
Size	Ø1/2"	Ø1"	53.0 mm x 12.0 mm (Each, Set of 2)
Wavelength Range	650 - 1050 nm		700 - 1000 nm
Reflectance[a]	$R_{abs} > 99.5\%$ at 10° AOI	$R_{abs} > 99.5\%$ at 10° AOI	$R_{avg} > 99\%$ at 8° AOI
GDD per Reflection at 800 nm	-54 fs^2 (-1.5 mm of Fused Silica)	-54 fs^2 (-1.5 mm of Fused Silica)	-175 fs^2

a. Over Wavelength Range

Controlled-GDD Beamsplitters

Controlled-GDD beamsplitters can split p-polarized light in 20:80, 50:50, 80:20, or 90:10 split ratios.

Specifications

Item #	**UFBS2080**	**UFBS5050**	**UFBS8020**	**UFBS9010**	**UFBS50502**
Reflectance/Transmission at 45° AOI	$R_{abs} = 20 \pm 2\%$, $T_{abs} = 80 \pm 2\%$	$R_{abs} = 50 \pm 5\%$, $T_{abs} = 50 \pm 5\%$	$R_{abs} = 80 \pm 5\%$, $T_{abs} = 20 \pm 5\%$	$R_{abs} = 90 \pm 2\%$, $T_{abs} = 10 \pm 2\%$	$R_{abs} = 50 \pm 5\%$, $T_{abs} = 50 \pm 5\%$
Wavelength Range	600 - 1500 nm				1000 - 2000 nm
GDD in Reflection	0.2 mm of Fused Silica	0.7 mm of Fused Silica	2 mm of Fused Silica	-	-
Item # of Infrasil® Window[a]	N/A	UDP05 or UDP10	N/A	N/A	N/A

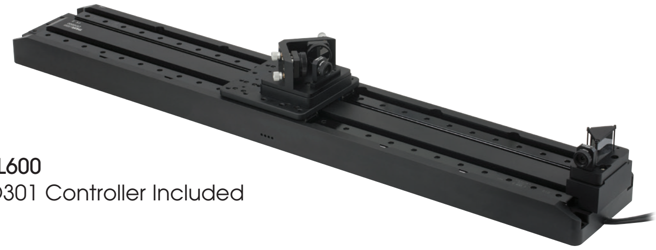
a. Our Infrasil windows will not fully balance the GDD in transmitted and reflected beams for beamsplitters with split ratios other than 50:50. Uncoated fused silica windows may be used as an alternative.

Features

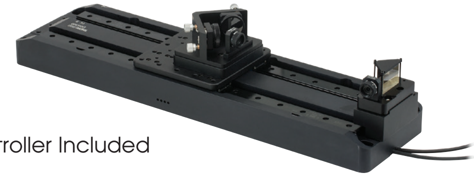
- Precise Variation of Optical Path Length
- Delays up to 4000 ps Available
- Computer-Controlled Stages Provide Repeatable, Sub-Femtosecond Resolution
- Internal and External Triggering Modes
- Includes Low-Dispersion Silver-Coated Optics and Translation Stage Controller

Applications

- Pulsed Pump-Probe Experiments
- Autocorrelation, Cross Correlation, and Optical Sampling
- Pulse Synchronization
- Wavemeters and Other Interferometric Sensors

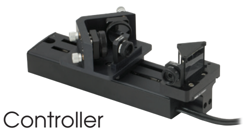


ODL600
BBD301 Controller Included



ODL300
BBD301 Controller Included

ODL220
BBD301 Controller Included



ODL100
KBD101 Controller Included

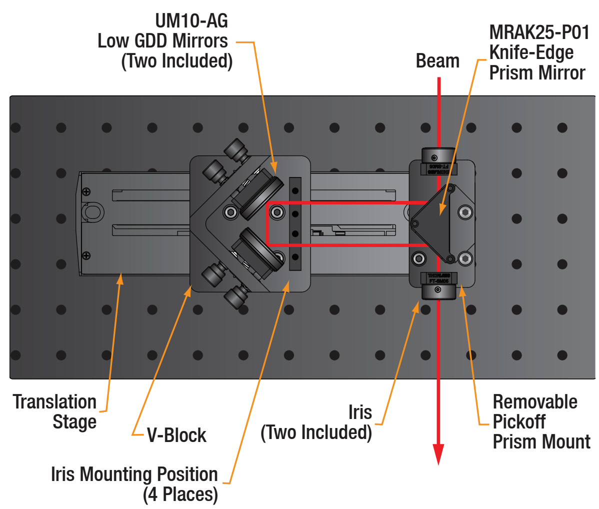
KBD101 Controller

BBD301 Controller

Thorlabs' Free-Space Optical Delay Lines (ODL) enable computer-controlled variation of the optical path length. Each system includes a DC servo stage, controller, and retroreflector optics with mounts. Each system also includes two drop-in irises with four mounting positions for alignment.

These delay lines use direct drive stages that eliminate the need for lead screws and enable backlash-free operation. The absolute position of the stage is determined using a high-resolution, closed-loop optical feedback signal that provides superior bidirectional repeatability. This makes our optical delay systems ideal for high-repetition-rate experiments, where stability during measurements is desired.

The stages also provide long travel ranges and can be driven at higher speeds than stepper motor stages. High-speed measurements can also be used to minimize the effects of slow changes in a system (such as thermal drifts) on experimental data.



The precise positioning and stability of the low-dispersion mirrors on the direct drive stage enables sub-femtosecond delay resolution.

Specifications

Item #	ODL100(/M)	ODL220(/M)	ODL300(/M)	ODL600(/M)
Optical Delay (Max)	670 ps	1470 ps	2000 ps	4000 ps
Minimum Delay Shift[a]	33 fs	0.67 fs	0.67 fs	0.67 fs
Stage Velocity (Max)	500 mm/s	300 mm/s	400 mm/s	400 mm/s
Absolute On-Axis Accuracy	±6.5 µm	±2.0 µm	±7.5 µm	±12.0 µm
Beam Height	2.36" (60.0 mm)	3.22" (81.7 mm)	3.45" (87.7 mm)	3.45" (87.7 mm)

a. Based on the minimum incremental motion of the stage.

Worldwide Support

Thorlabs, Inc.
Newton, New Jersey
Phone: 1-973-300-3000
Email: sales@thorlabs.com

Thorlabs Vytran® Division
Morganville, New Jersey
Phone: 1-973-300-3000
Email: sales@thorlabs.com

Thorlabs Measurement Systems (TMS) - NJ
Blairstown, New Jersey
Phone: 1-908-362-6200
Email: tms-sales@thorlabs.com

Thorlabs Measurement Systems (TMS) - NH
Londonderry, New Hampshire
Phone: 1-973-300-3000
Email: tms-sales@thorlabs.com

Thorlabs Quantum Electronics (TQE)
Jessup, Maryland
Phone: 1-973-300-3000
Email: sales-TQE@thorlabs.com

Thorlabs Imaging Systems
Sterling, Virginia
Phone: 1-703-651-1700
Email: imagingsales@thorlabs.com

Thorlabs Spectral Works (TSW)
West Columbia, South Carolina
Phone: 1-973-300-3000
Email: sales@thorlabs.com

Thorlabs Ultrafast Optoelectronics
Ann Arbor, Michigan
Phone: 1-973-300-3000
Email: sales@thorlabs.com

Thorlabs Laser Division - CO
Lafayette, Colorado
Phone: 1-973-300-3000
Email: sales@thorlabs.com

Thorlabs Crystalline Solutions (TCS)
Santa Barbara, California
Phone: 1-973-300-3000
Email: sales@thorlabs.com

Thorlabs Canada
Phone: 1-973-300-3000
Email: sales@thorlabs.com

Thorlabs Ltda, Brazil
Phone: +55 (16) 3413 7062
Email: brasil@thorlabs.com

Thorlabs Ltd.
Phone: +44 (0)1353 654440
Email: sales.uk@thorlabs.com

Thorlabs SAS France
Phone: +33 (0) 970 444 844
Email: sales.fr@thorlabs.com

Thorlabs GmbH / Thorlabs Lübeck
Phone: +49 (0) 8131 5956-0
Email: europe@thorlabs.com

Thorlabs Elliptec® GmbH
Phone: +44 (0)1353 654440
Email: sales.de@thorlabs.com

Thorlabs Vytran® Europe
Phone: +44 (0) 1392-445777
Email: vytran.uk@thorlabs.com

Thorlabs Sweden AB
Phone: +46 31 733 30 00
Email: scandinavia@thorlabs.com

Thorlabs China Ltd.
Phone: +86 (0)21-60561122
Email: chinasales@thorlabs.com

Thorlabs Japan
Phone: +81-3-6915-7701
Email: sales@thorlabs.jp