

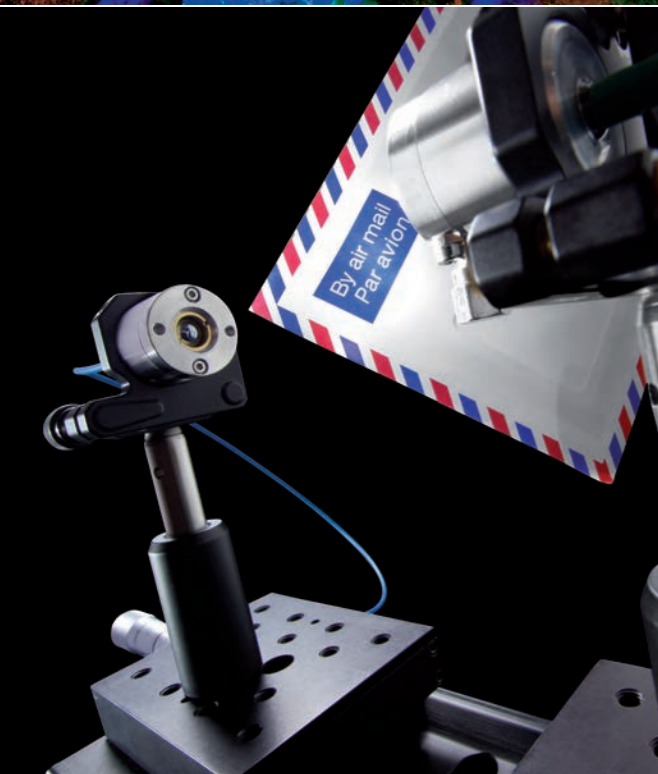
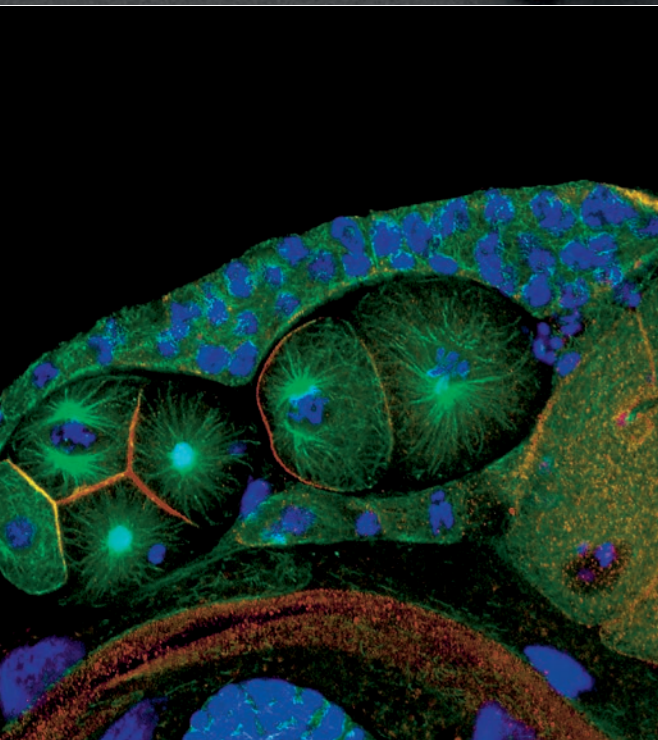
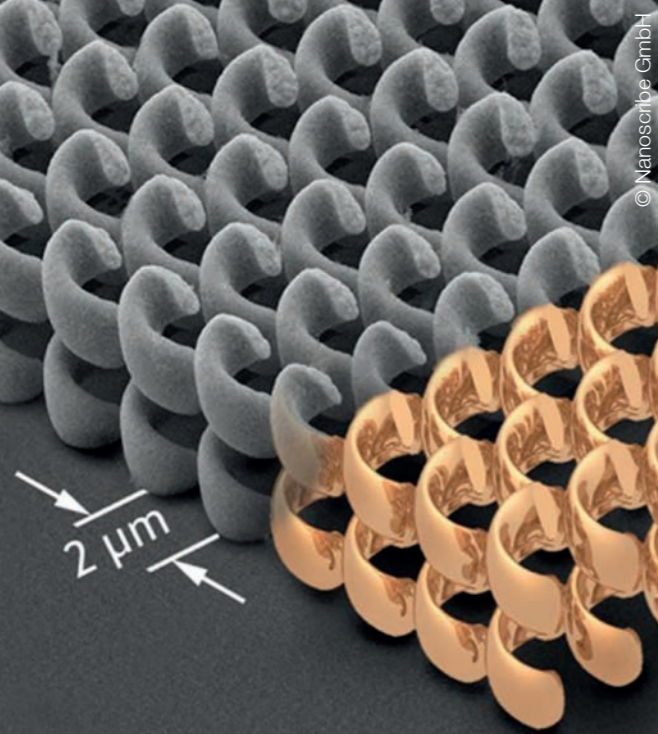
FemtoFiber Lasers

Femtosecond, Picosecond - All Wavelengths.



MPE Microscopy
Two-Photon Polymerization
Time-Domain Terahertz
Pump-Probe Spectroscopy
Material Processing
Label Free Imaging
Chemical Mapping





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FEMTOFIBER LASERS

The Next Generation of Ultrafast Technology

Ultrafast technology has seen an unpredictable success ever since it was introduced. Today physicists are still pushing the limits, e.g. the pulse duration of lasers down to a single optical cycle and the peak power up to tera- or even petawatt. On the other hand, many promising applications have emerged outside the laser laboratories. Mainly the high peak power and ultra-short pulse duration make ultrafast lasers very attractive. Both give rise to nonlinear effects and open new paths in engineering and scientific research.

Additionally TOPTICA's smart laser series delivering sub-ps and fs pulses are widely used as seed lasers for material processing units.

Independent of the application, the key for successful integration of ultrafast lasers is the reduction of complexity. Many years ago, only laser experts could handle such sensitive devices. Today, one expects an ultrafast laser to work by pushing a single

button. TOPTICA's answer to these expectations resulted in several sophisticated products: The FemtoFiber pro and FemtoFiber smart series, as well as the new FemtoFiber dichro and FemtoFiber ultra. First of all, these fiber laser systems are based on polarization-maintaining fibers. Reliable mode-locking is achieved with a saturable absorber mirror (SAM). Only high quality components with extraordinary long lifetimes are integrated. These comply with telcordia specifications and are suitable for 24/7 operation. The heart of each laser – namely the master oscillator and the amplifier – is completely fiber-based which makes alignment redundant and the systems extremely robust.

These and other advantages helped TOPTICA's ultrafast fiber lasers to become the source of choice for many applications: Life sciences, time-domain terahertz spectroscopy, attosecond science and material processing among others.

Applications

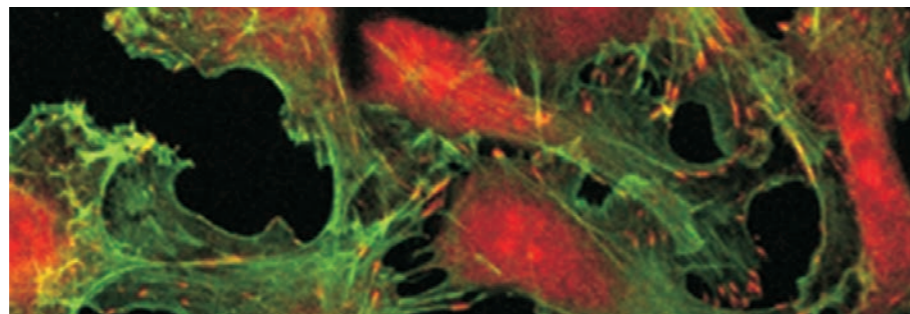
- Microscopy
- Two-photon polymerization
- Time-domain terahertz
- Pump-probe spectroscopy
- Material processing
- Label free imaging
- Chemical mapping



FEMTOFIBER APPLICATIONS

Over the last years, TOPTICA has developed more and more application fields for its ultrafast fiber lasers. A wide range of different models is available, with each model designed to meet the special needs of an application.

The following list gives an overview of the most popular applications and matching lasers of the FemtoFiber pro, FemtoFiber dichro, FemtoFiber ultra and FemtoFiber smart series. Several systems might meet the general requirements of one application; however, the proper choice often depends on the precise specifications of an application and on properties such as cost-benefit, flexibility and mobility.



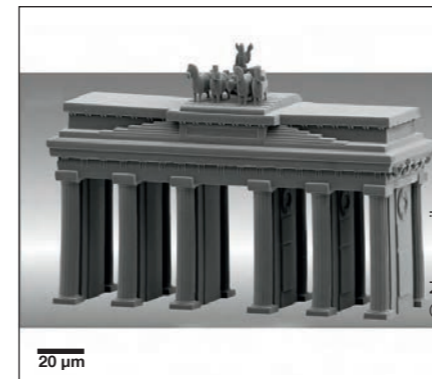
Microscopy

Laser requirements

- Tunability
- Ultrashort pulses
- Multi-color
- Intrinsically synchronized excitation beams (attosecond level)

Recommended products

- FemtoFiber pro TVIS (p 33)
- FemtoFiber pro TNIR (p 32)
- FemtoFiber pro NIR (p 28)
- FemtoFiber smart 780 (p 16)
- FemtoFiber ultra 780, 920 and 1050 (p 19 ff.)



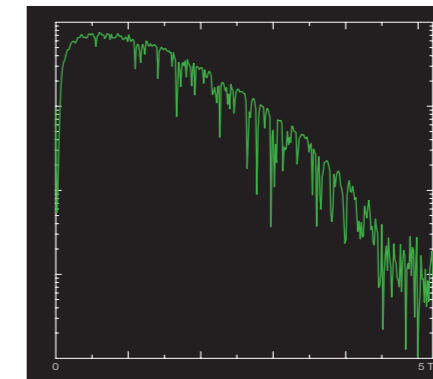
Two-Photon Polymerization

Laser requirements

- High laser peak power
- Short pulses

Recommended products

- FemtoFiber pro NIR (p 28)
- FemtoFiber smart 780 (p 16)
- FemtoFiber ultra 780 (p 19)
- FemtoFiber ultra 1050 (p 21)



Time-Domain Terahertz

Laser requirements

- < 100 fs pulse duration
- 1560 nm or 780 nm

Recommended products

- FemtoFiber pro IR or IRS II (p 26/27)
- FemtoFiber pro NIR (p 28)
- FemtoFerb 1560 (FD6.5) (p 14)
- FemtoFiber smart 780 (p 16)



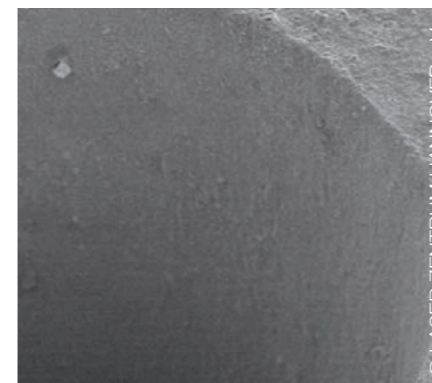
Pump-Probe Spectroscopy

Laser requirements:

- Phase coherent dual-beam system
- Independently configured outputs

Recommended products:

- FemtoFiber pro with multi-beam option (p 35)
- FemtoFiber dichro midIR (p 23)
- FemtoFiber customized (p 36)



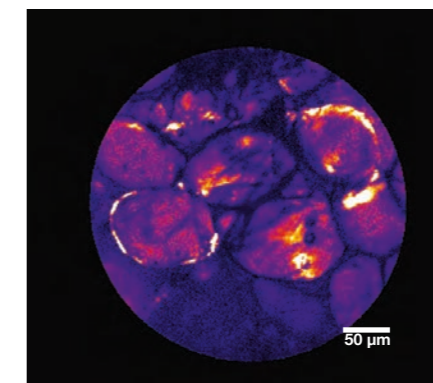
Material Processing

Laser requirements

- Picosecond or sub-picosecond pulses
- 1030 nm or 1064 nm

Recommended products (seeders)

- PicoFYb 1030 (p 10)
- PicoFYb 1064 (p 10)
- FemtoFYb 1030 - 400/800 (p 12)



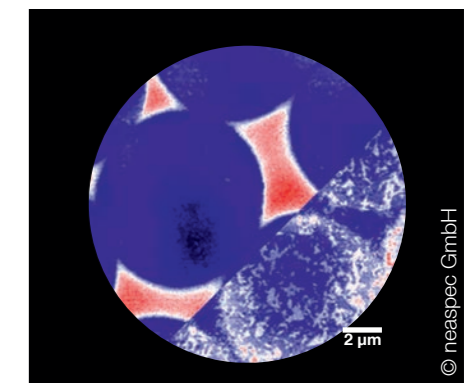
Label Free Imaging

Laser requirements

- Picosecond or femtosecond pulses
- Frequency and time-correlated laser pulses

Recommended products

- FemtoFiber pro IR or IRS II (p 26/27) + FemtoFiber pro SCIR (p 30)
- FemtoFiber pro UCP (p 31)
- FemtoFiber ultra 780, 920 and 1050 (p 19 ff.)
- FemtoFiber customized (p 36)



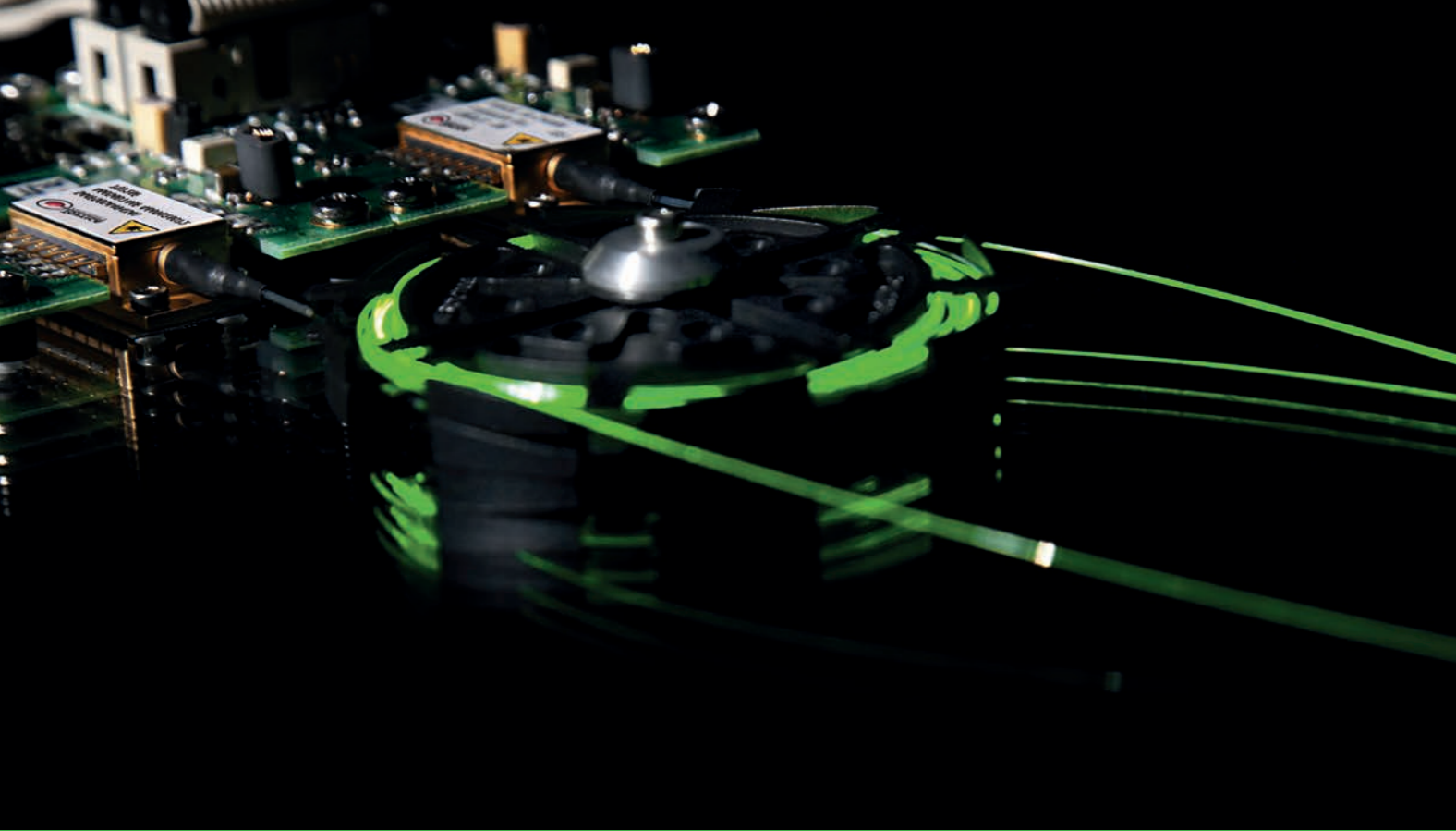
Chemical Mapping

Laser requirements

- Tunable mid-infrared laser pulses
- Very broad emission spectra

Recommended products

- FemtoFiber pro IR or IRS II (p 26/27)
- FemtoFiber pro SCIR (p 30)
- FemtoFiber pro UCP (p 31)
- FemtoFiber dichro midIR (p 23)
- FemtoFiber customized (p 36)

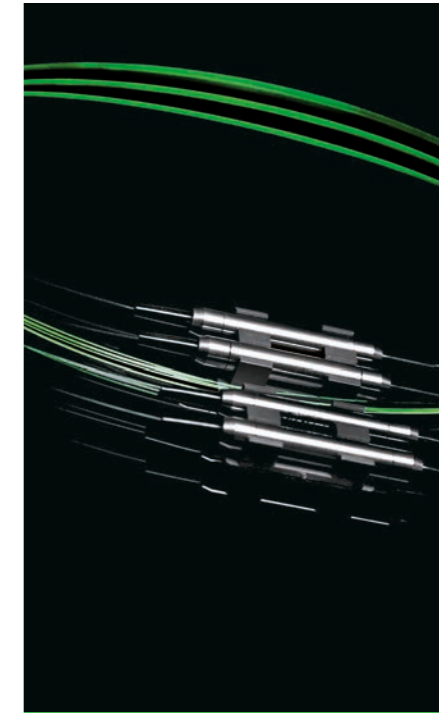


FEMTOFIBER™ TECHNOLOGY



Robust 24/7 Operation

- PM fiber assembly
- All-fiber, alignment-free
- Telcordia proven components



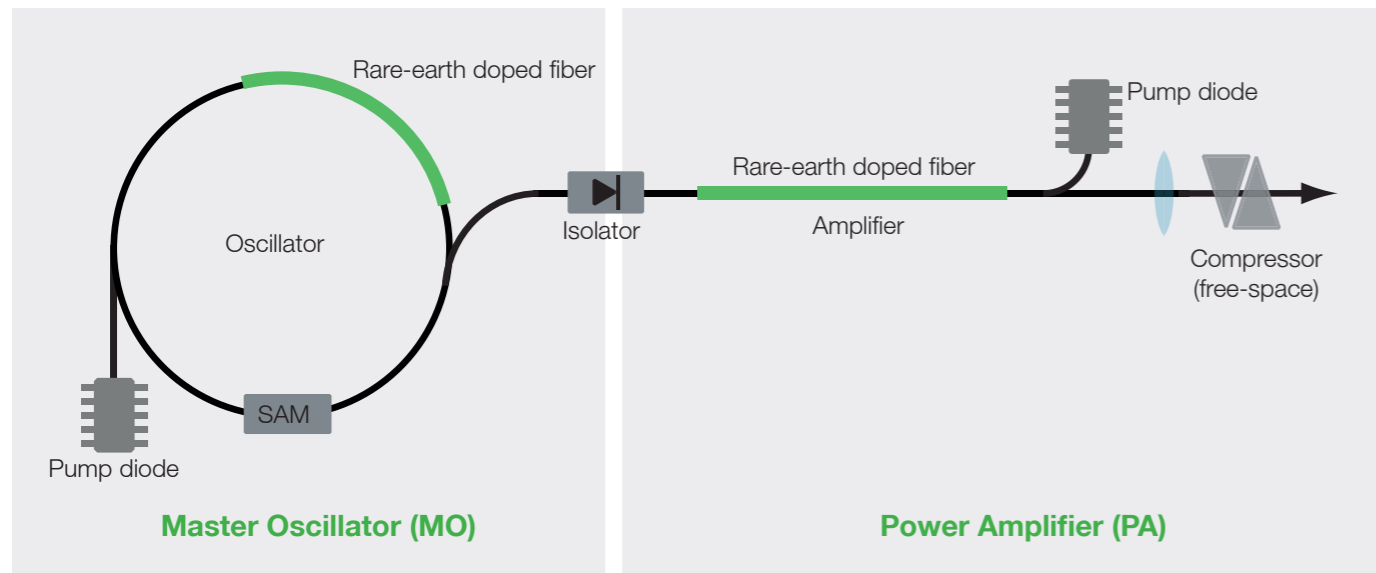
Turnkey Solution

- Reliable SAM technology
- Passive mode-locking



Cost-effective and Compact

- Low cost of ownership
- Compact footprint
- No cooling required

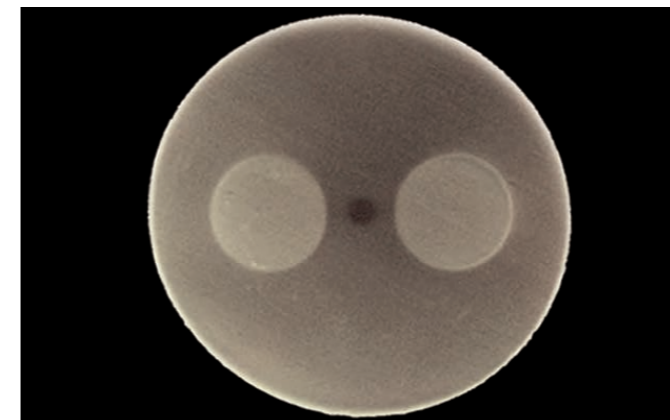


Master Oscillator - Power Amplifier (MOPA) system - Mode of operation

The engine of TOPTICA's fiber lasers is a SAM mode-locked ring oscillator. This configuration – protected by an optical isolator – is known as most robust against back reflections of any kind. Running in the solitonic regime, the oscillator operates in a well defined state.

Special TOPTICA design ensures full suppression of parasitic pedestals (Kelly-bands). The soliton pulses are carefully amplified to very high peak powers in a subsequent fiber amplifier. This MOPA platform is an all-fiber setup based completely on polarization-maintaining fibers. By using

Erbium and Ytterbium doped fibers, TOPTICA provides these advantages of fiber lasers for two fundamental wavelength regions around 1560 nm (Er) and 1030 - 1064 nm (Yb).



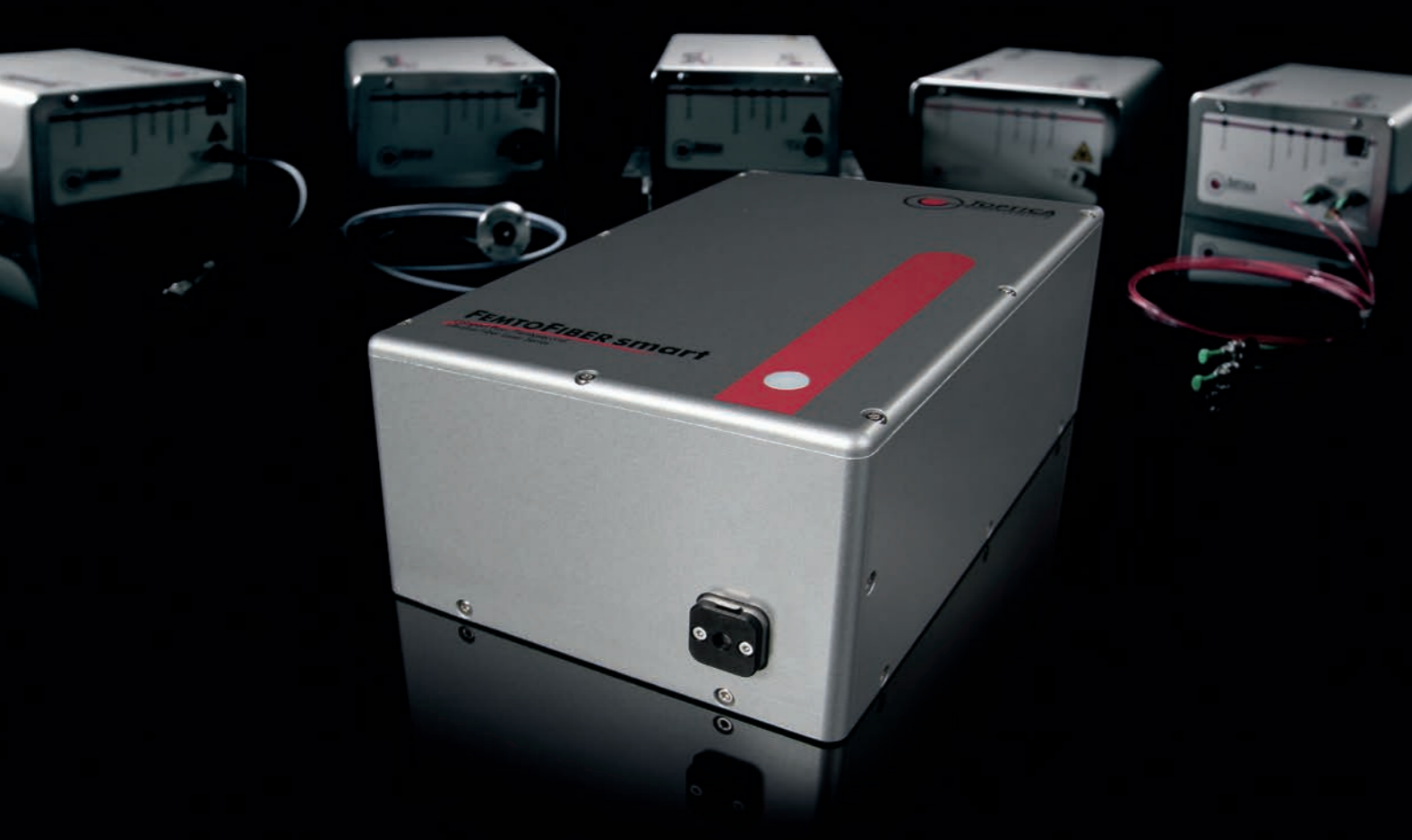
PM Fiber Technology

Polarization-maintaining (PM) fibers preserve the linear state of polarization under all circumstances: Temperature, mechanical stress, humidity or other environmental influences can't disturb the stable laser operation.



SAM Mode-Locking Technology

The saturable absorber mirror (SAM) ensures self-starting and reliable mode-locking. This passive device efficiently suppresses Q-switching operation. Only intense solitonic laser pulses are stabilized and reflected by the SAM.



FEMTOFIBER SMART Compact and Efficient Fiber Lasers

Ultrafast, extremely stable, turnkey operation

The FemtoFiber smart laser systems are turnkey fiber-based picosecond and femtosecond mode-locked fiber lasers. The PicoFYb and FemtoFYb are oscillators ideally suited for seeding industrial laser systems. The FemtoERb 1560 is the most compact and cost-effective source for terahertz generation. The FemtoFiber smart 780 is the ideal choice for integration into microscopes, but also for two-photon generation or seeding of titanium-sapphire lasers.

The FemtoFiber smart laser pulses exhibit excellent amplitude and frequency jitter parameters. The PicoFYb is typically amplified to multi-Watt levels in the MOPA (Master Oscillator Power Amplifier) laser systems of our customers.

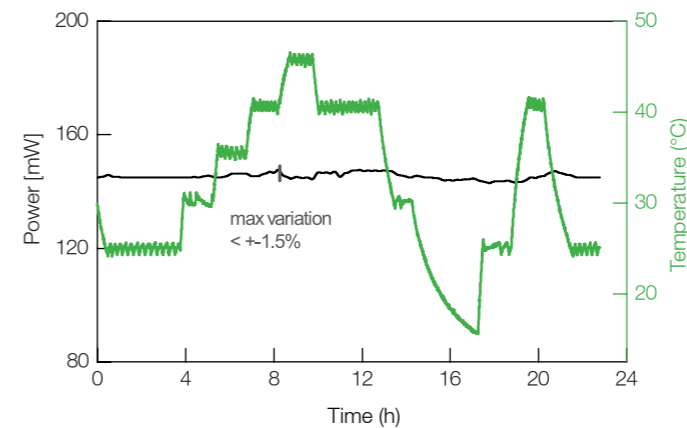
The FemtoERb has an output power of more than 100 mW and with the outstanding performing fiber delivery it fits perfectly to applications such as terahertz generation or metrology.

Based on state-of-the-art FemtoFiber technology, the FemtoFiber smart lasers set the benchmark for the new generation of ultrafast lasers satisfying the most advanced industrial requirements. Applications benefit from the extremely stable, compact and cost effective laser design, a key to a modular customer integration.

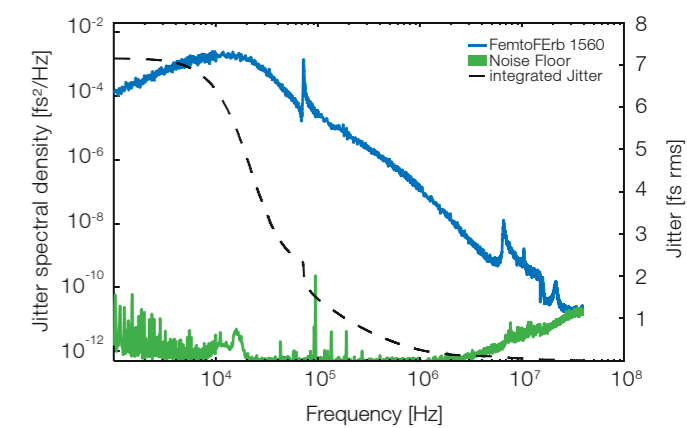
The specifications are derived from our current OEM developments. Further customization (wavelength, pulse duration, footprint, interfacing, etc.) is possible under usual OEM conditions.

Key Features

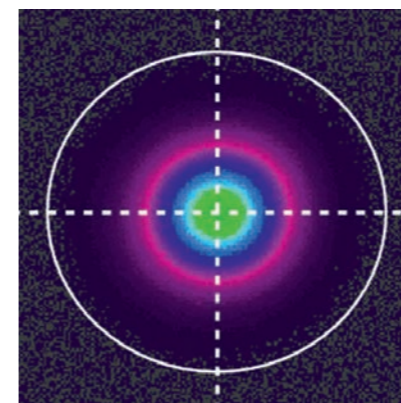
- SAM mode-locked all PM fiber setup
- User friendly turnkey operation
- Robust and reliable, compact design
- Optics and electronics in just one box
- 12V DC power supply with lowest power consumption



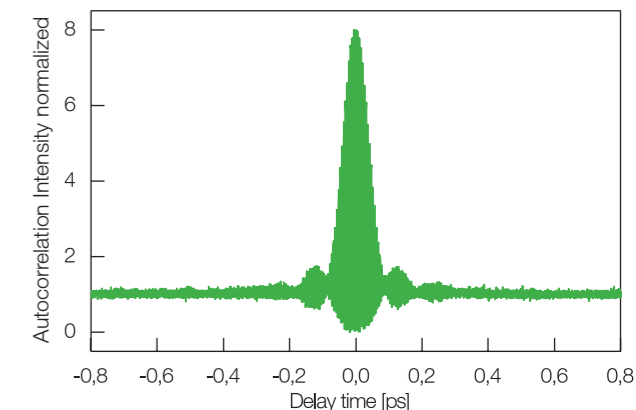
Power stability of the FemtoERb 1560 system under thermal cycling test.



FemtoERb 1560: Lowest noise at any frequency - integrated (1 kHz - 50 MHz) RMS jitter < 7.5 fs.



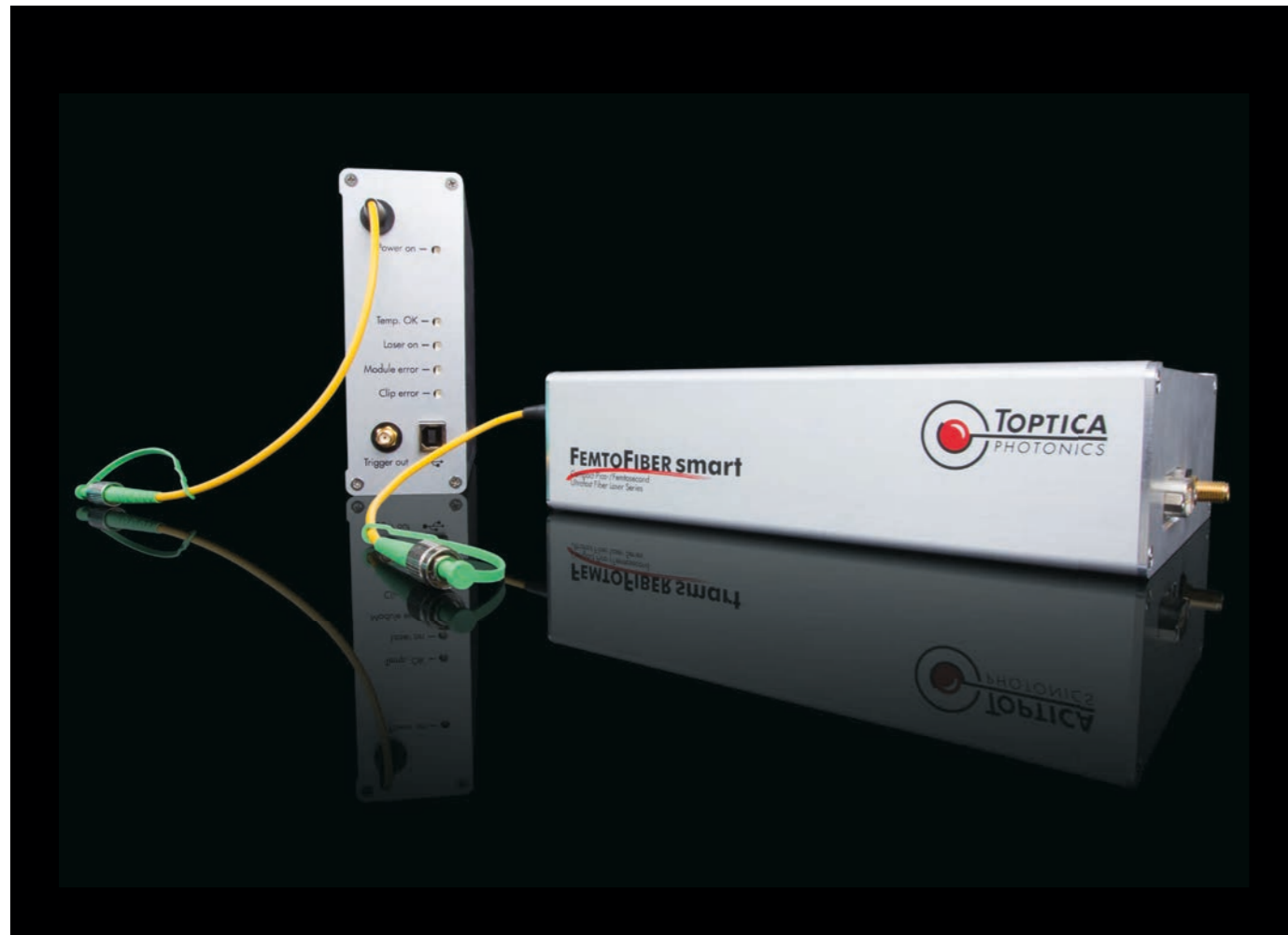
FemtoFiber smart 780: Typical focused spot profile.



Shortest pulses available even after 25m fiber delivery (FemtoERb 1560 FD25 customized system, dual output ports with 50:50 power split ratio).

Overview

FemtoFiber smart	Center wavelength	Pulse duration	Average output power	Repetition rate	Page
PicoFYb 1030	1030.5 ± 0.5 nm	< 10 ps	> 10 mW	30 ± 0.5 MHz	11
PicoFYb 1064	1064.3 ± 0.5 nm	< 10 ps	> 10 mW	20 ± 0.5 MHz	10
FemtoFYb 1030-400	1030.5 ± 1.5 nm	< 2 ps (chirped) compressible to < 400 fs	> 0.5 mW	30 ± 0.5 MHz	12
FemtoFYb 1030-800	1030.5 ± 1.5 nm	< 800 fs	> 0.5 mW	20 ± 0.5 MHz	12
FemtoERb 1560	1560 ± 10 nm	< 80 fs (typ. 50 fs)	> 120 mW (typ. 140 mW)	100 MHz	14
FemtoERb 1560 FD6.5	1560 ± 10 nm	< 60 fs (typ. 50 fs)	> 80 mW (typ. 90 mW)	100 MHz	15
FemtoFiber smart 780	785 ± 5 nm	< 100 fs (typ. 80 fs)	> 120 mW (typ. 140 mW)	80 MHz	16



Key Features

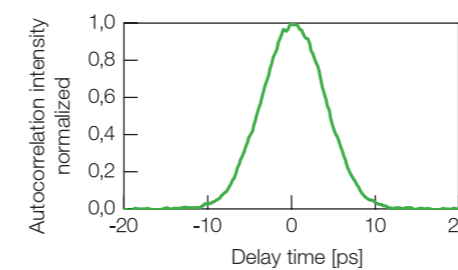
- SAM mode-locking all PM fiber setup
- User-friendly turnkey operation, alignment-free system
- Robust and reliable, compact design
- Optics and electronics in just one box
- 12 VDC power supply with lowest consumption
- Fiber-coupled output

Options

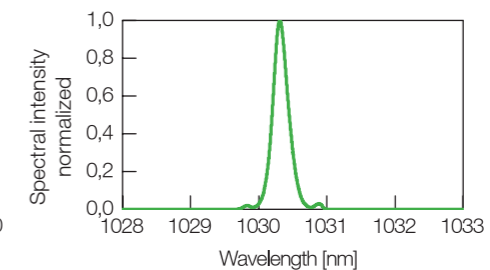
- Other center wavelengths on request
- Up to 60 mW output power
- Other repetition rates on request
- Specific pulse durations on request
- Switchbox for stand-alone operation (incl. 12 V power supply)

Specifications	PicoFYb 1030	PicoFYb 1064
Center wavelength (referenced to air)	1030.5 ± 0.5 nm	1064.3 ± 0.5 nm
Pulse duration	< 10 ps	
Average output power	> 10 mW	
Repetition rate	30 ± 0.5 MHz	20 ± 0.5 MHz
Linear polarization	PER > 20 dB (typ.)	
Spectral width	< 0.5 nm	
Time-bandwidth-product (TBP)	< 0.5 (typ)	
RF side mode supression	> 50 dBc	
Peak-to-peak noise	< 3 %	
Output coupling	SM/PM 980 fiber pigtail with narrow key FC/APC connector, length > 20 cm	
Beam shape	TEM ₀₀ , M ² < 1.2	
Trigger Signal (SMA connector)	> 150 mV @ 50 Ohm (300 MHz BW), positive	
Dimensions laser head	50 x 135 x 194 mm ³	
Weight laser head	< 2 kg	
Power supply	12 VDC	
Power consumption	< 10 Watt	
Interfaces	TTL control lines, Switchbox (optional) or remote control (USB)	
Environment temperature	15 - 40 °C (operating), 0 - 40 °C (storage and transport)	
Environment humidity	Non-condensing	

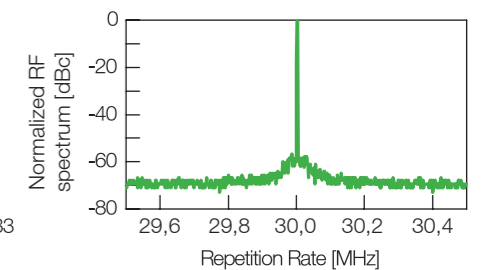
PicoFYb 1030



Typical autocorrelation intensity, 6 ps (sech²).

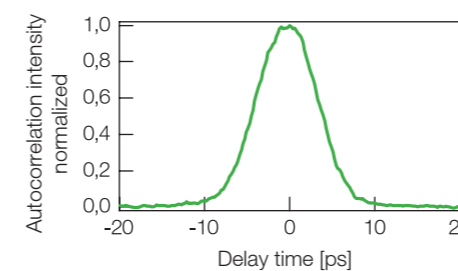


Typical output spectrum.

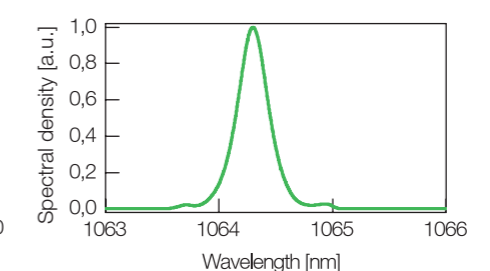


Typical RF spectrum.

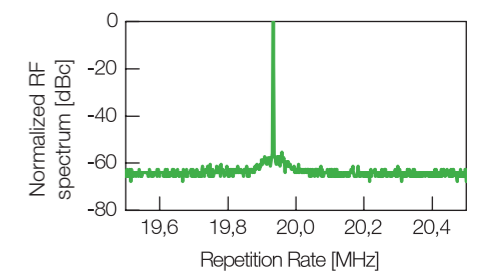
PicoFYb 1064



Typical autocorrelation intensity, 6 ps (sech²).



Typical output spectrum.



Typical RF spectrum.



Key Features

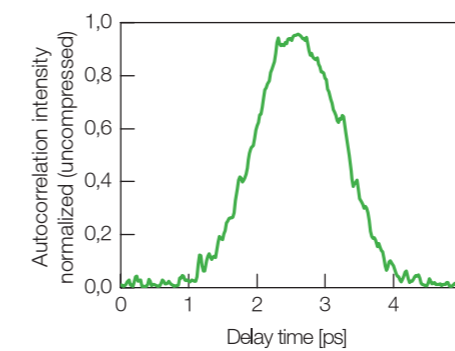
- SAM mode-locking all PM fiber setup
- User-friendly turnkey operation, alignment-free system
- Robust and reliable, compact design
- Optics and electronics in just one box
- 12 VDC power supply with lowest consumption
- Fiber coupled output

Options

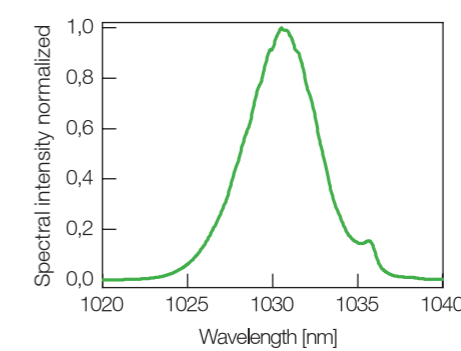
- Other center wavelength on request
- Other repetition rate on request
- Specific pulse duration on request
- Switchbox for stand-alone operation (incl. 12 V power supply)

Specifications	FemtoFYb 1030-400	FemtoFYb 1030-800
Center wavelength (referenced to air)	1030.5 ± 1.5 nm	
Pulse duration	< 2 ps (chirped output) compressible to < 400 fs	< 800 fs (fourier-limited output)
Average output power	> 0.5 mW	
Repetition rate	30 ± 0.5 MHz	20 ± 0.5 MHz
Linear polarization	PER > 20 dB (typ.)	
Spectral width	> 4 nm	< 3 nm
RF side mode supression	> 50 dBc	
Output coupling	SM/PM 980 fiber pigtail with narrow key FC/APC connector, length > 20 cm	
Beam shape	TEM ₀₀ , M ² < 1.2	
Trigger Signal (SMA connector)	> 150 mV @ 50 Ohm (300 MHz BW), positive	
Dimensions laser head	50 x 135 x 194 mm ³	
Weight laser head	< 2 kg	
Power supply	12 VDC	
Power consumption	< 10 Watt	
Interfaces	TTL control lines, Switchbox (optional) or remote control (USB)	
Environment temperature	15 - 40 °C (operating), 0 - 40 °C (storage and transport)	
Environment humidity	Non-condensing	

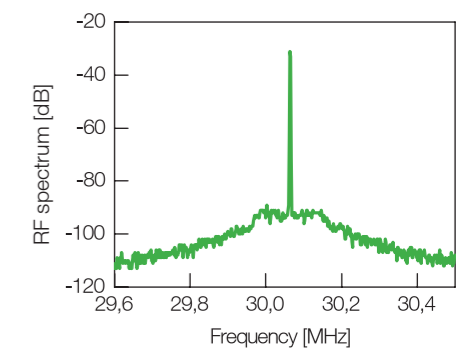
FemtoFYb 1030-400



Typical autocorrelation intensity (uncompressed).

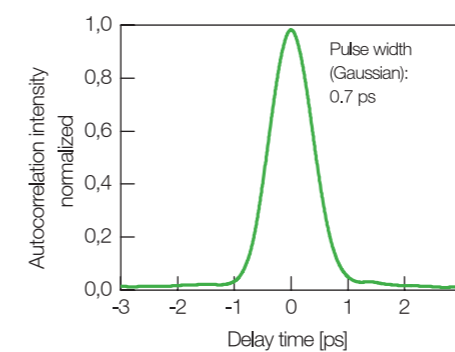


Typical emission spectrum.

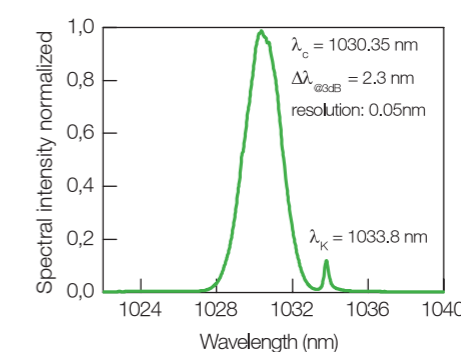


Typical RF spectrum.

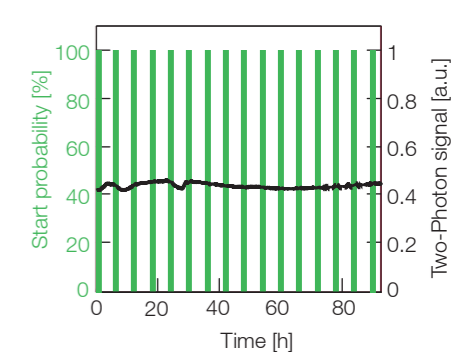
FemtoFYb 1030-800



Typical autocorrelation intensity.



Typical output spectrum.



Start probability (histogram bars over 100 starts each) and power/pulse stability (two-photon detected signal).



Key Features

- 50 fs – 140 mW – 100 MHz (typical)
- SAM mode-locking technology
- Alignment-free all-fiber setup, use of PM fibers only
- Compact design: optics and electronics just in one box
- Ideal laser source for time-domain THz applications

Options

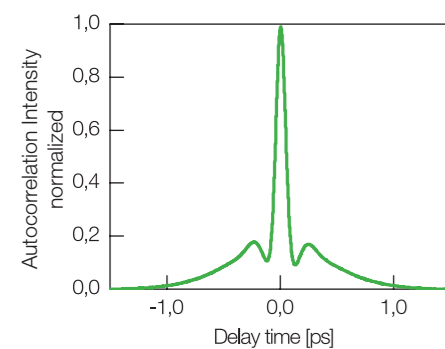
- Switchbox for stand-alone operation (incl. 12 V power supply)
- QuTE-Technology for soft start (recommended for THz applications: option "THz")
- Fiber collimator for collimated beam (option "FiberOut FF smart")
- Different repetition rates on request
- Power stabilization (option "P-STAB") additional detector and close loop electronics for active power stabilization

QuTE-Technology

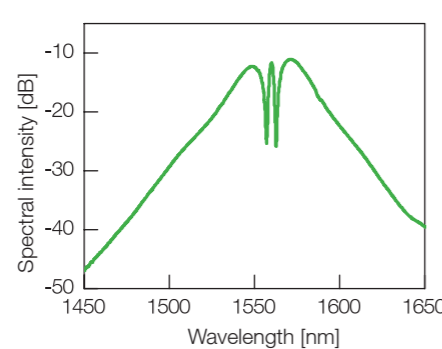
- Q(u)-Switch Termination protection mechanism
- Enables soft start of pulses after switch-on
- Protects fiber coupled devices from potentially increased peak powers at start-up



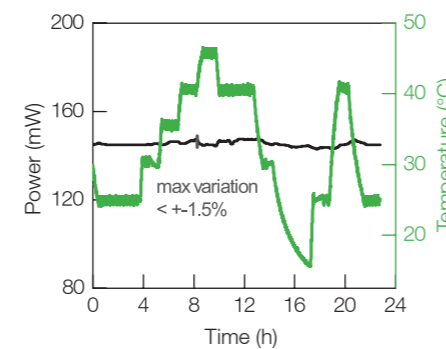
Specifications FemtoFErb 1560	
Center wavelength	1560 nm ± 10 nm
Pulse duration	< 80 fs (typ. 50 fs)
Average output power	> 120 mW (typ. 140 mW)
Repetition rate	100 MHz (standard, other on request)
Linear polarization	PER > 20 dB (typ.)
Beam shape	TEM ₀₀ , M ² < 1.2
Output coupling	SM/PM 1550 fiber-pigtail with FC/APC connector, length > 20 cm
Trigger Signal (SMA connector)	> 100 mV @ 50 Ohm (300 MHz BW), negative
Dimensions laser head	69 x 122 x 202 mm ³
Weight laser head	< 2.2 kg
Power supply	12 VDC
Power consumption	< 20 Watt
Interfaces	TTL control lines, Switchbox (optional) or remote control (USB)
Environment temperature	15 - 40 °C (operating), 0 - 40 °C (storage and transport)
Environment humidity	Non-condensing



Typical autocorrelation intensity.



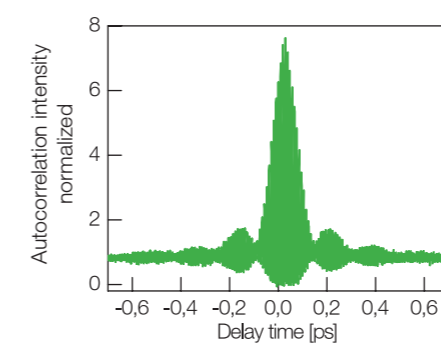
Typical output spectrum.



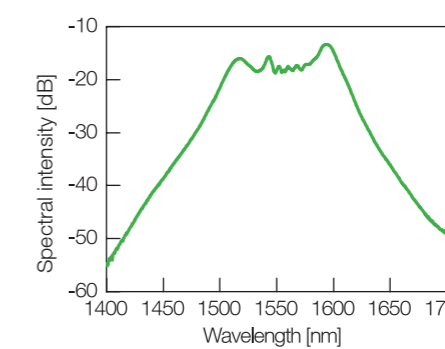
Typical power stability.



Specifications FemtoFErb 1560 FD6.5	
Center wavelength	1560 nm ± 10 nm
Pulse duration	< 60 fs (typ. 50 fs)
Average output power	> 80 mW (typ. 90 mW)
Repetition rate	100 MHz (standard, other on request)
Linear polarization	PER > 15 dB (typ.)
Beam shape	TEM ₀₀ , M ² < 1.2
Output coupling	SM/PM 1550 FC/APC patch cable with plastic tubing, 6.5 m standard length, detachable; other fiber lengths on request
Trigger Signal (SMA connector)	> 100 mV @ 50 Ohm (300 MHz BW), negative
Dimensions laser head	69 x 122 x 202 mm ³
Weight laser head	< 2.2 kg
Power supply	12 VDC
Power consumption	< 20 Watt
Interfaces	TTL control lines, Switchbox (optional) or remote control (USB)
Environment temperature	15 - 40 °C (operating), 0 - 40 °C (storage and transport)
Environment humidity	Non-condensing



Typical autocorrelation intensity.



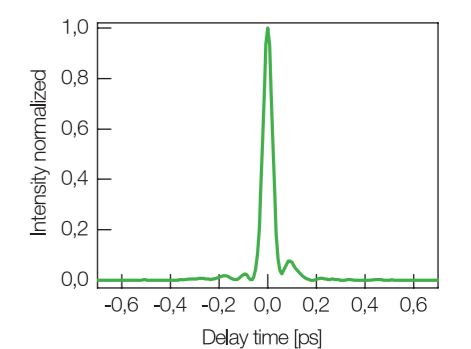
Typical emission spectrum.

Key Features

- 6.5 m fiber length (standard)
- Single-mode, polarization-maintaining fibers
- Dispersion compensation integrated in laser head
- Short pulses (typ. 50 fs) at fiber output
- FC/APC connectors at laser head and at external fibers (external fiber can be disconnected)

Options

- Switchbox for stand-alone operation (incl. 12 V power supply)
- QuTE-Technology for soft start (recommended for THz applications: option "THz")
- Fiber collimator for collimated beam output (option "FiberOut FF smart")
- Fiber patch cable with mechanical protection (metal jacket)
- Different output fiber lengths (up to 25 meters) on request (For example pulse data see page 9)
- Different repetition rate on request
- Power Stabilization (option "P-STAB") additional detector and close loop electronics for active power stabilization



Retrieved pulse shape, more than 70 % of power in main peak typically.



Key Features

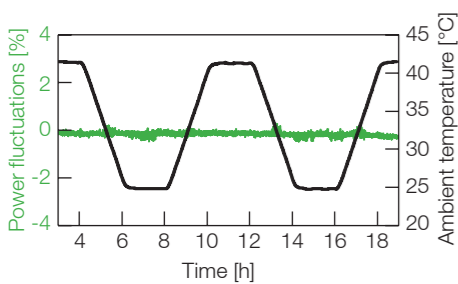
- Up to 140 mW avg. power with typ. 80 fs pulses
- Alignment-free all-fiber setup, use of PM fibers only
- SAM mode-locking technology
- Free-beam output with excellent TEM₀₀ mode
- Compact design: optics and electronics just in one box

Options

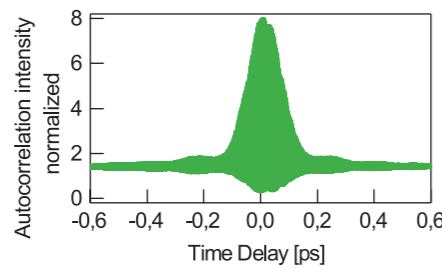
- Switchbox for stand-alone operation (incl. 12 V power supply)
- External SHG unit separated from laser head with fiber-delivery to SHG
- Different repetition rate on request



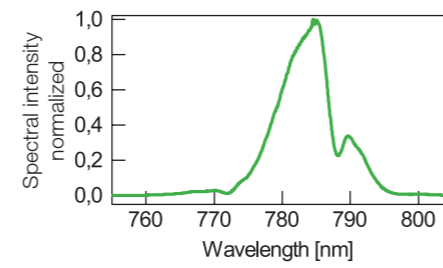
Specifications FemtoFiber smart 780	
Center wavelength	785 nm ± 5 nm
Pulse duration	< 100 fs (typ. 80 fs)
Average output power	> 120 mW (typ. 140 mW)
Repetition rate	80 MHz
Output coupling	Free space
Beam properties	Ø 1.3 mm (1/e ²) typ. TEM ₀₀ , M ² < 1.2
Beam divergence	< 1 mrad
Linear polarization	> 95 %, vertical
Dimensions laser head	85 x 140 x 210 mm ³
Weight laser head	< 2.5 kg
Power supply	12 V DC
Power consumption	< 20 Watt
Interfaces	TTL control lines, Switchbox (optional) or remote control (USB, Ethernet)
Environment temperature	15 - 35 °C (operating), 0 - 40 °C (storage and transport)
Environment humidity	Non-condensing



Typical power stability.



Typical autocorrelation intensity.



Typical output spectrum.

Optional Switchbox for manual laser operation

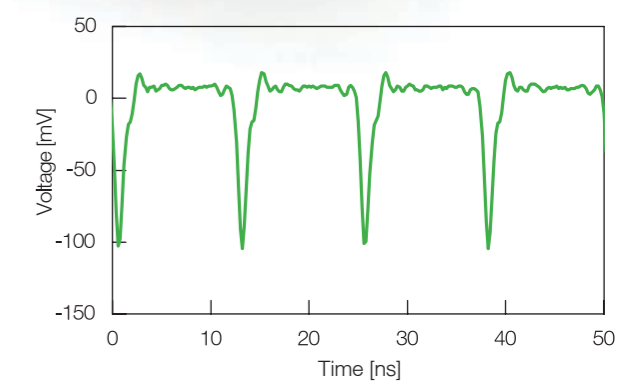
- The Switchbox adds full CDRH / DIN EN 60825-1 compliance features to the OEM-design laser systems (mandatory for end-user customers)
- Key-switch and interlock functions
- Supports all current FemtoFiber smart versions
- included: 12 V / 5 Amp switching power supply and all cables needed for plug & play experience



FemtoFerb laser head (as example)



Graphical user interface available.



Typical photodiode signal (e.g. FemtoFerb @ 80 MHz) e.g. for triggering external devices.



Class 4 Laser Product EN 60825-1:2014.
Invisible laser radiation. Avoid direct exposure to beam.

FemtoFiber ultra FemtoFiber ultra 780



FEMTOFIBER ULTRA High-Power Ultrafast Fiber Laser System

High-power ultrafast Erbium fiber laser system

The FemtoFiber ultra is part of TOPTICA's third generation of fiber lasers. It provides pulses at common wavelengths with a duration below 150 fs and a repetition rate of 80 MHz. The platform reaches average power values beyond 5 W due to its completely revised system architecture, utilizing double-clad pumping into large mode area fibers.

The pulses are generated using a SAM-mode-locked ring fiber oscillator (patented design), followed by a high-power fiber amplifier. For reaching highest reliability levels, only polarization-maintaining, Erbium-doped fibers are used.

The oscillator and (pre-)amplifier generate pulses at a fundamental wavelength of 1560 nm. Depending on the model, different high-power amplifiers are boosting

the output power. All of this is integrated in a unit with a footprint of 25 x 38 cm². The laser system is easily controlled via Ethernet or USB. A simple graphics user interface (GUI) enables user-friendly access to all laser parameters.

The FemtoFiber ultra series shares the advantages of TOPTICA's previous ultrafast fiber laser generations. It is a compact laser system and works reliable just after a push-button start. No water-cooling is required since a simple air-cooling is sufficient for a stable operation of the system. It is a cost-effective and compact laser system that provides femtosecond pulses with high average power in the near-infrared with an excellent beam quality. It is a great solution for applications in nonlinear microscopy like effective two-photon excitation of fluorescent proteins and SHG based contrast mechanisms.

Key Features

- SAM mode-locked ring fiber oscillator
- Patented design (US 8,457,164)
- High-power fiber amplifier
- Polarization maintaining fibers only
- Compact air-cooled systems

Key Features

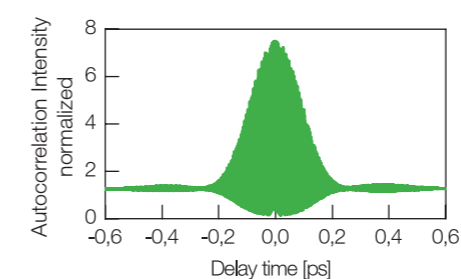
- Ultrafast fiber laser @ 780 nm
- > 500 mW average power
- < 100 fs or < 150 fs pulse duration
- SAM mode-locking, PM fiber based MOPA system
- Robust, reliable, compact, cost-effective, push-button
- Air cooled system
- < 150 W power consumption

Options

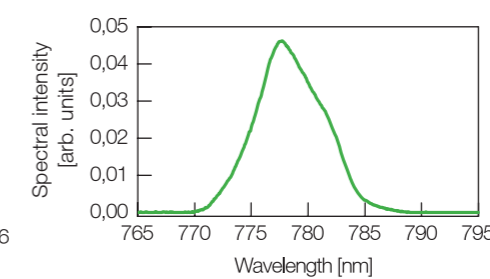
- Additional 1560 nm output (residual non-converted 1560 nm light) on request
- Higher average output power, up to 1 W
- Different repetition rate
- AMP system for multi-arm configurations
- Additional seed ports for being a master system in a multi-arm configuration

Specifications FemtoFiber ultra 780

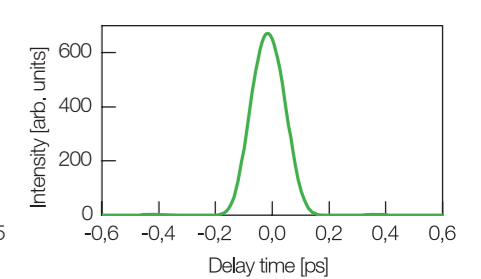
Center wavelength	780 nm
Pulse duration	< 100 fs or < 150 fs
Average output power	> 500 mW
Repetition rate	80 MHz
Beam shape	TEM ₀₀ , M ² < 1.2
Beam divergence	< 1 mrad
Beam size (1/e ²)	Ø1.1 mm (typ.)
Linear polarization	> 95 %, horizontal
Output coupling	Free space
Dimensions laser head	111 x 250 x 380 mm ³
Weight laser head	< 15 kg
Dimensions supply unit	154 x 342 x 382 mm ³ (incl. stand) (height 3U/HE, width/horizontal pitch 63 HP/TE)
Weight supply unit	< 10 kg
Power supply	100 - 240V AC, 50/60 Hz
Power consumption	< 150 W
PC interface	Ethernet, USB
Environment temperature	19 - 25 °C (operating), 0 - 40 °C (storage and transport)
Environment humidity	Non-condensing



Autocorrelation pulse duration < 150 fs (gaussian fit).



Typical emission spectrum.



Retrieved pulse shape with typ. 99 % of power in main peak.



Class 4 Laser Product EN 60825-1:2014.
Invisible laser radiation. Avoid direct exposure to beam.



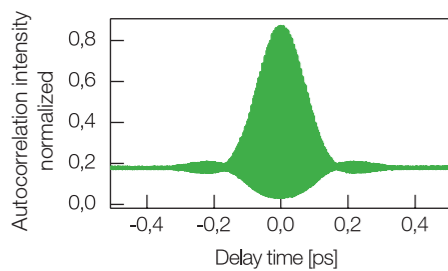
Class 4 Laser Product EN 60825-1:2014.
Invisible laser radiation. Avoid direct exposure to beam.

Key Features

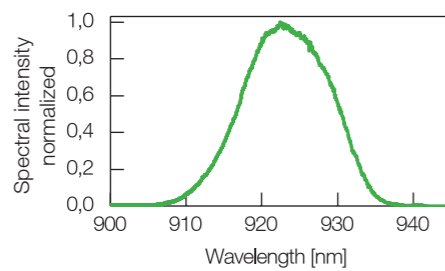
- SAM mode-locked ring fiber oscillator
- Patented and patent pending design (US 8,457,164)
- Unique approach with < 100 fs pulses at > 1.5 W
- Polarization maintaining fibers only
- „Cold“ and compact laser head design
- Optimized system design for OEM integration
- Air-cooled system
- Excellent price-performance point
- 24 VDC power supply
- < 150 W power consumption



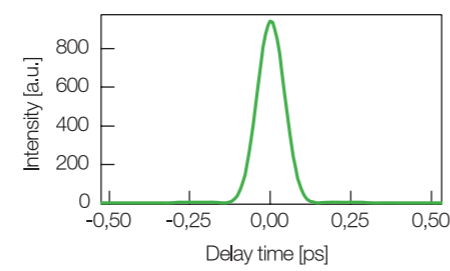
Specifications FemtoFiber ultra 920	
Center wavelength	920 nm
Pulse duration	< 100 fs
Laser output power	> 1.5 W
Repetition rate	80 MHz
Beam shape	TEM ₀₀ , M ² < 1.2
Beam divergence	< 1 mrad
Beam size (1/e ²)	Ø 1.0 mm (typ.)
Linear polarization	> 95 %, vertical
Output coupling	Free space
Dimensions laser head	77 x 155 x 230 mm ³
Weight laser head	< 4 kg
Dimensions supply unit	134 x 483 x 600 mm ³
Weight supply unit	< 20 kg
Power supply	24 V DC (AC power supply optionally included)
Power consumption	< 150 W
PC interface	Ethernet, USB
Environment temperature	19 - 25 °C (operating) 0 - 40 °C (storage and transport)
Environment humidity	non-condensing



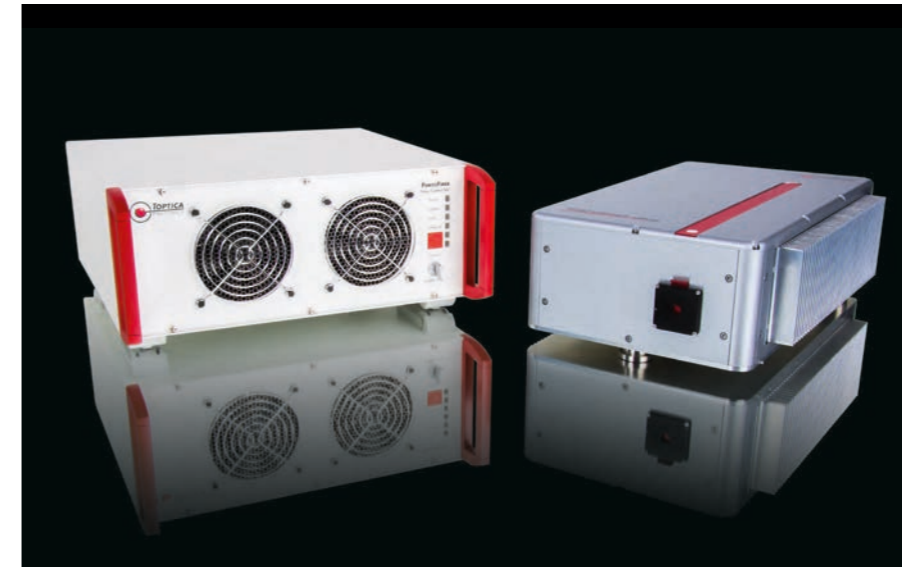
Autocorrelation pulse duration < 150 fs (gaussian fit).



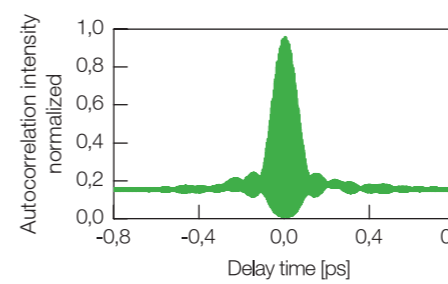
Typical emission spectrum.



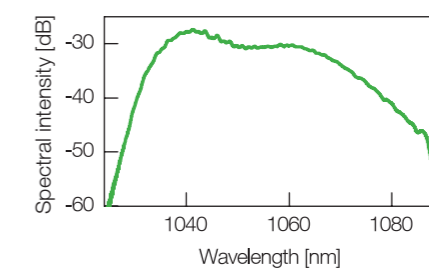
Retrieved pulse shape with typ. 99 % of power in main peak.



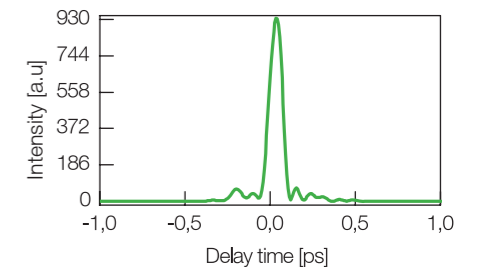
Specifications FemtoFiber ultra 1050	
Center wavelength	1050 nm
Pulse duration	< 120 fs (typ. 90 - 100 fs)
Average output power	> 5 W or > 10 W
Repetition rate	80 MHz
Beam shape	TEM ₀₀ , M ² < 1.2
Beam divergence	< 1 mrad
Beam size (1/e ²)	Ø 1.2..1.3 mm (typ.)
Linear polarization	> 95 %, vertical
Output coupling	Free space
Dispersion Compensation Range	-20000 .. 0 fs ²
Dimensions laser head	111 x 250 x 380 mm ³
Weight laser head	< 15 kg
Dimensions supply unit	154 x 342 x 382 mm ³ (incl. stand) (height 3U/HE, width/horizontal pitch 63 HP/TE)
Weight supply unit	< 10 kg
Power supply	100 - 240 V AC, 50/60 Hz
Power consumption	< 150 W
PC interface	Ethernet, USB
Environment temperature	19 - 25 °C (operating), 0 - 40 °C (storage and transport)
Environment humidity	Non-condensing



Typical autocorrelation trace.



Typical emission spectrum.



Retrieved pulse shape.

Key Features

- Ultrafast fiber laser @ 1050 nm
- > 5 W or > 10 W average power, < typ. 90-100 fs pulse duration
- SAM mode-locking, PM fiber based MOPA system
- Robust, reliable, compact, cost-effective, push-button
- Air cooled system
- < 150 W power consumption
- Motorized dispersion compensation (range -20000 to 0 fs²) for group delay dispersion (GDD) adjustment

Options

- Higher average output power, up to 10 W
- Different center wavelength and repetition rate
- AMP system for multi-arm configurations
- Additional seed ports for being a master system in a multi-arm configuration



FEMTOFIBER DICHRO

Broadband Mid-IR Laser Source

The new FemtoFiber dichro series simultaneously generates two perfectly synchronized laser beams at different wavelengths. This new concept provides compact and easy-to-use laser systems which requires no more than the push of a button for laser operation.

TOPTICA's first laser system based on this novel platform is the FemtoFiber dichro midIR, which uses this new approach to generate a broadband mid-infrared spectrum. The Er-doped fiber laser based system provides broadband laser pulses that are tunable in the range of 5 - 15 μm . The mid-infrared pulses are generated in a difference frequency process (DFG) between a 1.5 μm funda-

mental source, and a 1.7 - 2 μm supercontinuum source.

The unit includes a SAM – mode-locked ring oscillator which provides seed pulses centered at 1.5 μm for two Er-doped amplifiers at a 80 MHz repetition rate. One of the two amplifier outputs is used to generate the 1.7 - 2 μm supercontinuum in a special highly-nonlinear fiber (HNLF).

For a perfect temporal overlap between both amplifier outputs, the pulses of the other amplifier are guided through an internal delay stage. In a next step, the broadband mid-infrared spectrum is generated via DFG. For this, the two pulses at 1.5 μm and 1.7 - 2 μm are

spatially and temporally overlapped in a nonlinear crystal. This way a tunable broadband mid-infrared output in the range of 5 - 15 μm with a typical average power level of 1 mW is generated.

The FemtoFiber dichro midIR is an ideal tool for the analysis of materials with nanoscale resolution accuracy, e.g. in near-field spectroscopy systems. In such devices, a near-field probe is used in conjunction with a mid-infrared broadband illumination to analyze material properties at the nano scale (scanning nearfield optical microscope).



Class 4 Laser Product EN 60825-1:2014.
Invisible laser radiation. Avoid direct exposure to beam.

FemtoFiber dichro

FemtoFiber dichro midIR



Key Features

- Broadband mid-IR laser source (> 400 cm^{-1})
- Spectral coverage 5 – 15 μm (20 - 60 THz / 670 - 2000 cm^{-1})
- Average output power typ. 1 mW range (integrated spectrum)
- SAM mode-locked all PM fiber setup
- User friendly turnkey operation
- Fully automated DFG optimization
- Fully computer controlled via Ethernet or USB interface

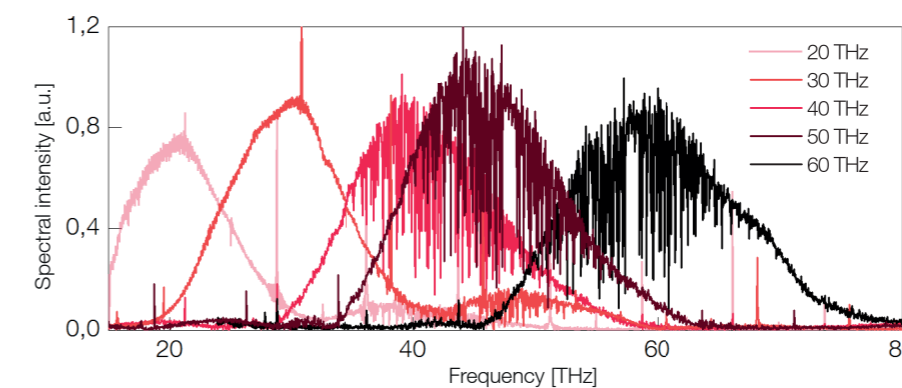
Specifications FemtoFiber dichro midIR

Spectral tuning range	5 - 15 μm (20 - 60 THz / 670 - 2000cm^{-1})
Average output power	typ. 1 mW (integrated spectrum)*
Emission bandwidth	> 400 cm^{-1}
Repetition rate	80 MHz
Output power stability	< 1 % / h
Beam diameter	typ. 10 - 15 mm (1/e ²)
Polarization	1:100, vertical
Pointing stability	< 1 mrad (22 \pm 1°C)
Output coupling	Free space
Dimensions laser head	161 x 375 x 502 mm ³
Weight laser head	< 30 kg
Line input	100 - 240 V AC, 50/60 Hz (or 24 V DC), < 160 W
PC interface	Ethernet, USB

*for strongest emission setting (typ. @ 50 THz)

Options

- FemtoFiber multiarm-capable system (see AMP option p. 35), other laser systems (e.g. FemtoFiber pro, ultra, ...) can be added for pump-probe experiments.
- Additional delay unit for external pump laser.



Typical emission spectra superimposed with water absorption lines.



FEMTOFIBER PRO

Versatile, Powerful, High Performance

The FemtoFiber pro is the successor of our previous FemtoFiber Scientific platform (FFS) and establishes a Gold standard for ultrafast fiber lasers. The FemtoFiber pro includes a mode-locking mechanism based on saturable absorber mirrors (SAM) and uses only polarization maintaining (PM) fibers.

Both features increase the robustness and reliability of the fiber laser, which has been proven for more than 10 years of experience with the FemtoFiber pro platform. The system is available with a fundamental output at 1560 nm (FemtoFiber pro IR) and also with second harmonic output at 780 nm (FemtoFiber pro NIR).

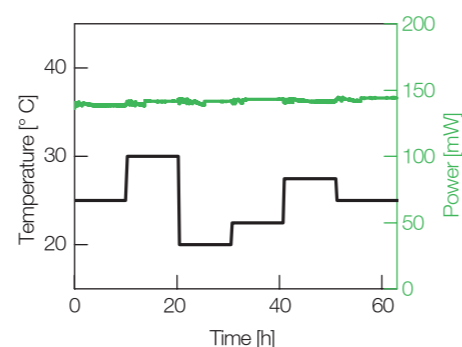
Another system version generates a super-continuum which spans more than an octave in the frequency domain (FemtoFiber pro SCIR), while the FemtoFiber pro SCYb adds a 1030 nm emitting laser system with Yb-based amplification with shorter than

100 fs pulses. The FemtoFiber pro IRS-II allows a very short pulse duration for the 1560 nm wavelength range. All of the aforementioned systems are using same housing with a footprint of only A4.

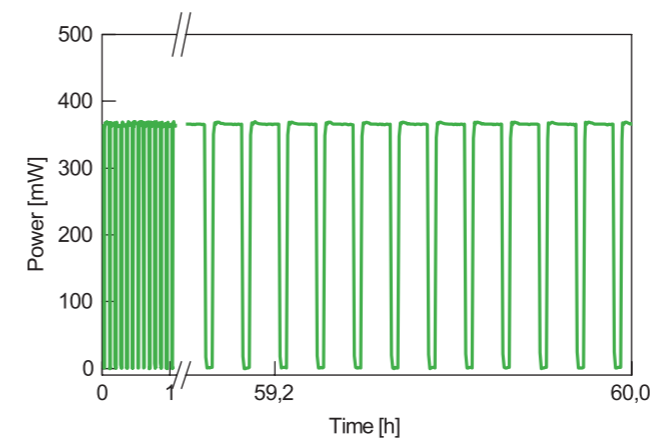
With the supercontinuum generation as one of the basic ingredients for this platform, even further models with ultra compressed pulses with a few-cycle long pulse duration (FemtoFiber pro UCP), and tunable laser systems in the visible and near-infrared range (FemtoFiber pro TVIS, TNIR), are possible. Last but not least, the multi-beam capability of this platform allows to combine various laser versions to a multi-color system with synchronized outputs

Key Features

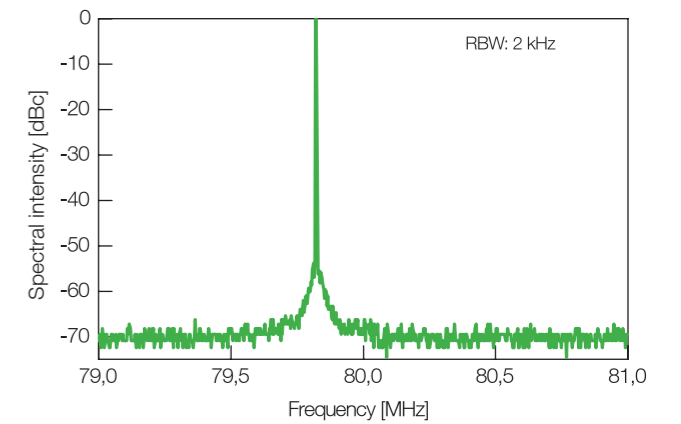
- SAM mode-locked all PM fiber setup
- User-friendly turnkey operation
- Robust and reliable, compact design
- Unique wavelength coverage
- Multi-color synchronized outputs



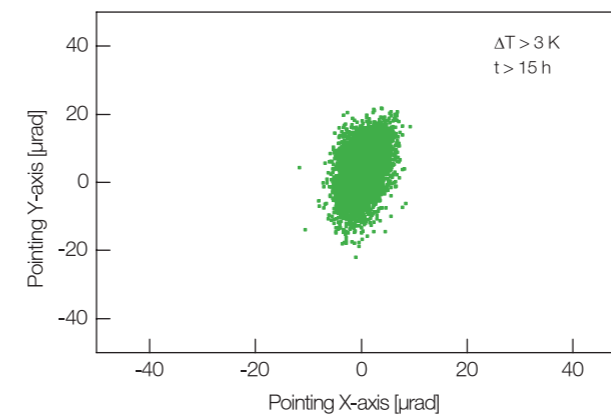
Excellent thermal power stability (e.g. NIR system).



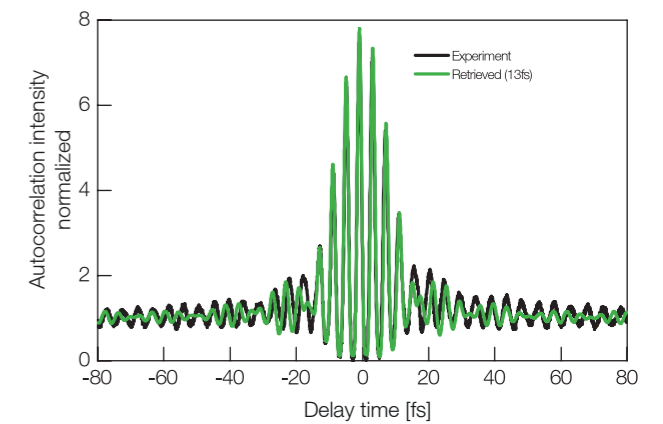
On-off cycling of IR system shows 100 % starting probability.



Excellent flat noise spectrum of oscillator.



Outstanding pointing stability of the FemtoFiber pro output beam (NIR).



Shortest pulses available with the UCP system.

Overview

FemtoFiber pro	Wavelength	Pulse duration	Average output power	Repetition rate	Page
FemtoFiber pro IR	1560 nm (center)	< 100 fs	> 350 mW	40* or 80 MHz	26
FemtoFiber pro IRS-II	1570 nm (center)	< 40 fs	> 200 mW	40* or 80 MHz****	27
FemtoFiber pro NIR	780 nm / 1560 nm*** (center)	< 100 fs / < 100 fs	> 140 mW / > 350 mW	40* or 80 MHz	28
FemtoFiber pro SCYb	1030 nm (center)	< 100 fs	> 500 mW	40* or 80 MHz****	29
FemtoFiber pro SCIR	980 .. 2200 nm (bandwidth)	---	> 150 mW (typ. 200 mW)	40* or 80 MHz	30
FemtoFiber pro UCP	980 .. 1400 nm (bandwidth)	< 25 fs**	30 mW**	40* or 80 MHz	31
FemtoFiber pro TNIR	830 - 1100 nm (tuning range)	< 250 fs**	1 - 5 mW**	40* or 80 MHz	32
FemtoFiber pro TVIS	488 - 640 nm (tuning range) or 488 - 700 nm (with dual crystal option)	< 1 ps (< 150 fs with short-pulse option)**	1 - 10 mW**	40* or 80 MHz	33

*Standard repetition rate is 80 MHz - for 40 MHz versions please add option M40 when ordering. Specifications may change slightly.

Please ask TOPTICA for details. Other customized repetition rates are available upon request.

**Depends on selected center wavelength. See individual product pages for details.

***Mechanical switchable outputs

****No VAR/LRC options available for this model



Class 3B Laser Product EN 60825-1:2014.
Invisible laser radiation. Avoid direct exposure to beam.
Caution - Class 4 invisible laser radiation when open.
Avoid exposure to the beam



Class 3B Laser Product EN 60825-1:2014.
Invisible laser radiation. Avoid direct exposure to beam.
Caution - Class 4 invisible laser radiation when open.
Avoid exposure to the beam

Key Features

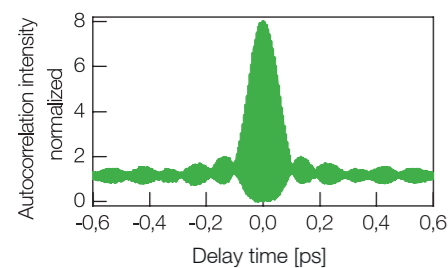
- Ultrafast fiber laser @ 1560 nm
- Short pulse (<100 fs) with highest power (>350 mW)
- SAM mode locking, PM fiber based MOPA system
- Robust and reliable design, push button operation
- Compact footprint < Letter/A4 format

Options

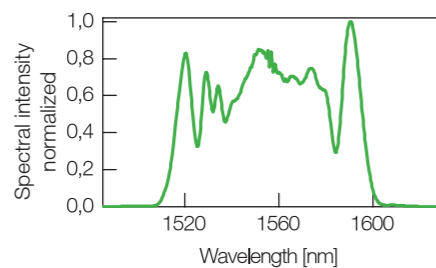
- M40: Repetition rate 40 MHz instead of standard 80 MHz
- Customized repetition rate, e.g. 68 MHz, 77 MHz, ...
- AMP: System without oscillator for multi-beam systems, to be seeded by external source
- VAR: Variable repetition rate
- LRC: Laser repetition rate control
- Additional seed ports for future multi-beam setups



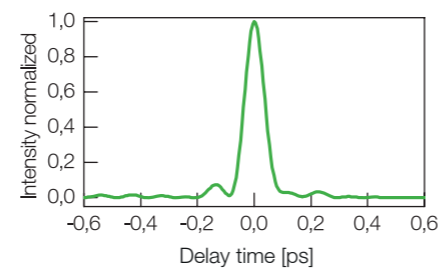
Specifications FemtoFiber pro IR	
Center wavelength	1560 nm
Pulse duration	< 100 fs
Average output power	> 350 mW
Repetition rate	80 MHz standard
Beam shape	TEM ₀₀ , M ² < 1.2
Beam size (1/e ²)	Ø 3.5 mm (typ.)
Beam divergence	< 2 mrad
Linear polarization	> 95%, horizontal
Output coupling	Free space
Dimensions laser head	151 x 280 x 229 mm ³
Weight laser head	< 10 kg
Dimensions control unit	140 x 235 x 315 mm ³ (H x W x D)
Weight control unit	< 4.5 kg
Power supply	100 to 240 VAC, 50/60 Hz, IEC 60320-C14 socket
Power consumption	< 40 W
PC Interface	Ethernet, USB, RS-232
Environment temperature	20 - 30 °C (operating), 0 - 40 °C (storage and transport)
Environment humidity	Non-condensing



Autocorrelation pulse duration < 100 fs at 1560 nm.



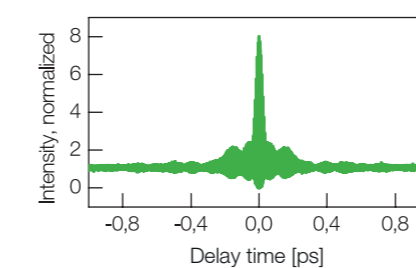
80 nm wide linear spectrum, centered at 1560 nm.



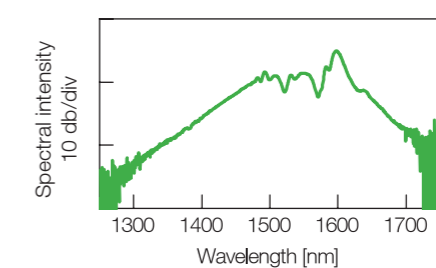
Retrieved pulse shape with typ. 80 % of power in main peak.



Specifications FemtoFiber pro IRS-II	
Center wavelength	1570 nm
Pulse duration	< 40 fs (typ. 30 fs)
Average output power	> 200 mW
Repetition rate	80 MHz standard
Beam shape	TEM ₀₀ , M ² < 1.2
Beam size (1/e ²)	Ø1.8 mm (typ.)
Beam divergence	< 1 mrad
Linear polarization	>95%, horizontal
Output coupling	Free space
Dimensions laser head	151 x 280 x 229 mm ³
Weight laser head	< 10 kg
Dimensions control unit	140 x 235 x 315 mm ³ (H x W x D)
Weight control unit	< 4.5 kg
Power supply	100 to 240 VAC, 50/60 Hz, IEC 60320-C14 socket
Power consumption	< 40 W
PC interface	Ethernet, USB, RS-232
Environment temperature	20 - 30 °C (operating), 0 - 40 °C (storage and transport)
Environment humidity	Non-condensing



Typical autocorrelation width < 40 fs (FWHM).



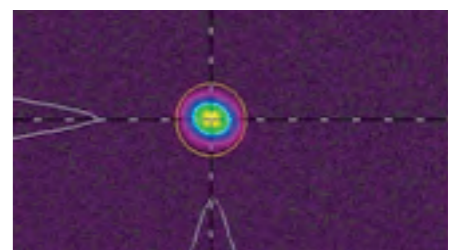
Typical emission spectrum.

Key Features

- Ultrafast fiber laser @ 1570 nm center wavelength
- Shortest pulse (of typ. 30 fs) at high power (> 200 mW)
- SAM mode locking, PM fiber based MOPA system
- Robust and reliable design, push button operation
- Compact footprint < Letter/A4 format

Options

- M40: Repetition rate 40 MHz instead of standard 80 MHz
- Customized repetition rate, e.g. 68 MHz, 77 MHz, ...
- AMP: System without oscillator for multi-beam systems, to be seeded by external source
- Vertical polarization direction
- Additional seed ports for future multi-beam setups



Typical focused spot profile.



Class 3B Laser Product EN 60825-1:2014.
Invisible laser radiation. Avoid direct exposure to beam.
Caution - Class 4 invisible laser radiation when open.
Avoid exposure to the beam



Class 4 Laser Product EN 60825-1:2014.
Invisible laser radiation. Avoid direct exposure to beam.
Caution - Class 4 invisible laser radiation when open.
Avoid exposure to the beam

Key Features

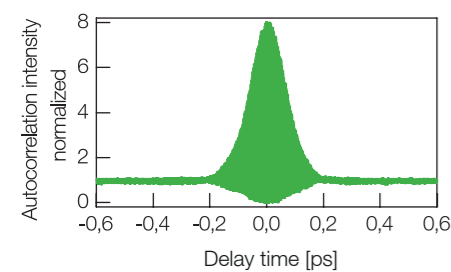
- Ultrafast fiber laser @ 1560 and 780 nm
- Fundamental or SHG output: manually switchable
- SAM mode locking, PM fiber based MOPA system
- Robust and reliable design, push button operation
- Compact footprint < Letter/A4 format

Options

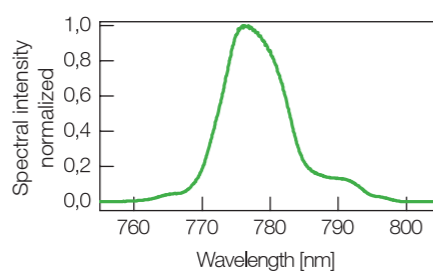
- M40: Repetition rate 40 MHz instead of standard 80 MHz
- Customized repetition rate, e.g. 68 MHz, 77 MHz, ...
- AMP: System without oscillator for multi-beam systems, to be seeded by external source
- VAR: Variable repetition rate
- LRC: Laser repetition rate control
- 1PS: Extended pulse length towards picosecond range : typ. 1 - 3 ps @ 780 nm rectangular pulse shape other specifications may change (please consult TOPTICA)
- Additional seed ports for future multi-beam setups
- Fixed or variable split ratio between 1560 and 780 nm instead of mechanical switch



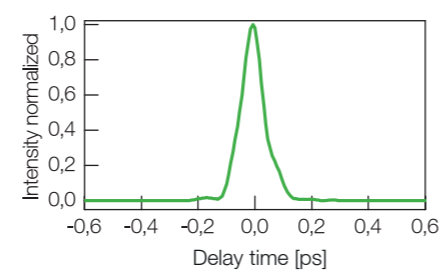
Specifications FemtoFiber pro NIR	
Center wavelength	780 nm / 1560 nm
Average output power	> 140 mW (780 nm) / > 350 mW (1560 nm)
Pulse duration	< 100 fs
Repetition rate	80 MHz standard
Beam shape	TEM ₀₀ , M ² < 1.2
Beam size (1/e ²)	Ø 1.2 mm (typ.) / Ø 3.5 mm (typ.)
Beam divergence	< 1 mrad (780 nm) / < 2 mrad (1560 nm)
Linear polarization	> 95%, horizontal
Output coupling	Free space
Dimensions laser head	151 x 280 x 229 mm ³
Weight laser head	< 10 kg
Dimensions control unit	140 x 235 x 315 mm ³
Weight control unit	< 4.5 kg
Power supply	100 to 240 VAC, 50/60 Hz, IEC 60320-C14 socket
Power consumption	< 40 W
PC Interface	Ethernet, USB, RS-232
Environment temperature	20 - 30 °C (operating), 0 - 40 °C (storage and transport)
Environment humidity	Non-condensing



Autocorrelation pulse duration < 100 fs at 780 nm.



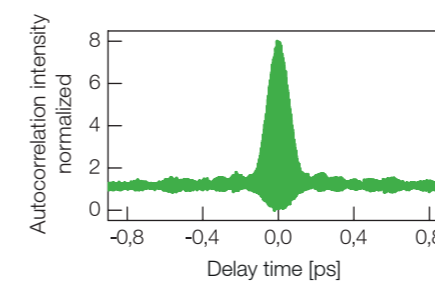
Linear emission spectrum, centered around 780 nm.



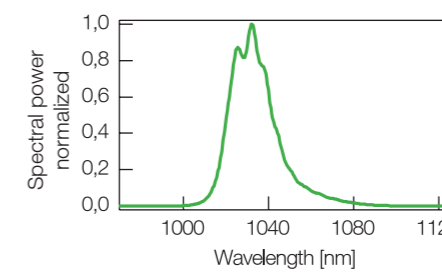
Retrieved pulse shape with typ. 90 % of power in main peak.



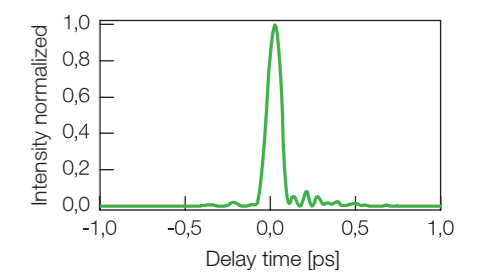
Specifications FemtoFiber pro SCYb	
Center wavelength	1030 nm
Average output power	> 500 mW (typ. 600 mW)
Pulse duration	typ. 100 fs
Repetition rate	80 MHz standard
Beam shape	TEM ₀₀ , M ² < 1.2
Beam size (1/e ²)	Ø 2 mm (typ.)
Beam divergence	< 2 mrad
Linear polarization	> 95 %, horizontal
Output coupling	Free space
Dimensions laser head	120 x 280 x 229 mm ³
Weight laser head	< 10 kg
Dimensions control unit	140 x 235 x 315 mm ³
Weight control unit	< 4.5 kg
Power supply	100 to 240 VAC, 50/60 Hz, IEC 60320-C14 socket
Power consumption	< 40 W
PC Interface	Ethernet, USB, RS-232
Environment temperature	20 - 30 °C (operating), 0 - 40 °C (storage and transport)
Environment humidity	Non-condensing



Interferometric autocorrelation trace.



Typical emission spectrum.



Retrieved pulse shape.

Key Features

- Er/Yb-based fiber laser source 1030 nm
- Shortest pulses < 100 fs, more than 500 mW
- SAM mode locking, PM fiber based MOPA system
- Robust and reliable design, push button operation
- Compact footprint, < Letter/A4 format

Options

- M40: Repetition rate 40 MHz instead of standard 80 MHz
- Customized repetition rate, e.g. 68 MHz, 77 MHz, ...
- AMP: System without oscillator for multi-beam systems, to be seeded by external source
- Additional seed ports for future multi-beam setups
- Standard system includes grating compressor. Optionally the system can also be delivered without grating compressor, having chirped output, e.g. for seeding CPA systems



Class 3B Laser Product EN 60825-1:2014.
Invisible laser radiation. Avoid direct exposure to beam.
Caution - Class 4 invisible laser radiation when open.
Avoid exposure to the beam



Class 3B Laser Product EN 60825-1:2014.
Invisible laser radiation. Avoid direct exposure to beam.
Caution - Class 4 invisible laser radiation when open.
Avoid exposure to the beam

Key Features

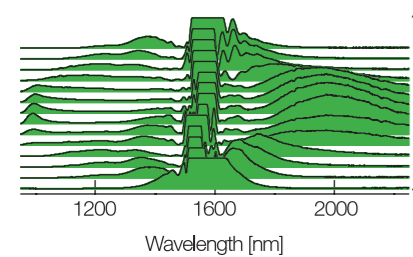
- Broadband infrared fiber laser source: 980 - 2200 nm
- Octave spanning continuum generated by HNLF
- SAM mode locking, PM fiber based MOPA system
- Robust and reliable design, push button operation
- Compact footprint, < Letter/A4 format

Options

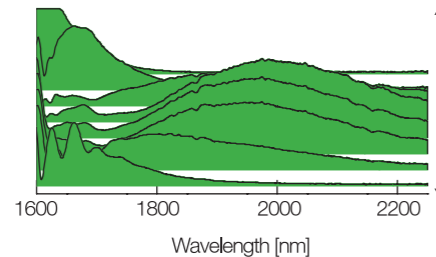
- M40: Repetition rate 40 MHz instead of standard 80 MHz
- Customized repetition rate, e.g. 68 MHz, 77 MHz, ...
- AMP: System without oscillator for multi-beam systems, to be seeded by external source
- VAR: Variable repetition rate
- LRC: Laser repetition rate control
- Additional seed ports for future multi-beam setups



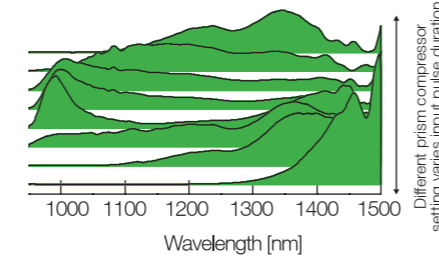
Specifications FemtoFiber pro SCIR	
Wavelength range of continuum	980 - 2200 nm
Average output power	> 150 mW (typ. 200 mW)
Pulse duration	not defined
Repetition rate	80 MHz standard
Beam shape	TEM ₀₀ , M ² < 1.2
Beam size (1/e ²)	Ø 2.4 mm (typ.)
Beam divergence	< 1 mrad
Linear polarization	> 95%, horizontal
Output coupling	Free space
Dimensions laser head	151 x 280 x 229 mm ³
Weight laser head	< 10 kg
Dimensions control unit	140 x 235 x 315 mm ³
Weight control unit	< 4.5 kg
Power supply	100 to 240 VAC, 50/60 Hz, IEC 60320-C14 socket
Power consumption	< 40 W
PC interface	Ethernet, USB, RS-232
Environment temperature	20 - 30 °C (operating), 0 - 40 °C (storage and transport)
Environment humidity	Non-condensing



Supercontinuum spectrum (full range)



Long wavelength part (magnified)



Short wavelength part (magnified)

Different prism compressor setting varies input pulse duration



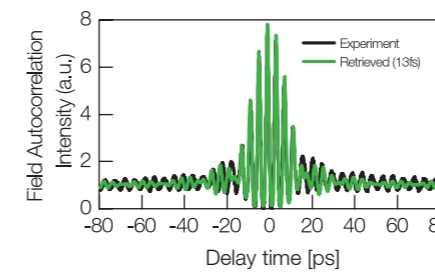
Specifications FemtoFiber pro UCP	
Wavelength range of continuum	980 - 1400 nm
Average output power	30 mW (typ. values / shortest pulse settings)
Pulse duration	< 25 fs (typ. values / shortest pulse settings)
Repetition rate	80 MHz standard
Beam shape	TEM ₀₀ , M ² < 1.2
Beam size (1/e ²)	Ø 4 mm (typ.)
Beam divergence	< 1 mrad
Linear polarization	> 95%, horizontal
Output coupling	Free space
Dimensions laser head	151 x 280 x 458 mm ³
Weight laser head	< 15 kg
Dimensions control unit	140 x 235 x 315 mm ³
Weight control unit	< 4.5 kg
Power supply	100 to 240 VAC, 50/60 Hz, IEC 60320-C14 socket
Power consumption	< 40 W
PC interface	Ethernet, USB, RS-232
Environment temperature	20 - 30 °C (operating), 0 - 40 °C (storage and transport)
Environment humidity	Non-condensing

Key Features

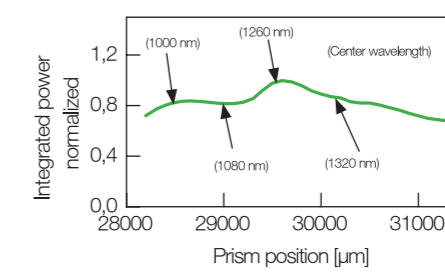
- Broadband fiber laser @ 980-1400 nm
- Shortest pulses < 25 fs for a fiber laser source
- SAM mode locking, PM fiber based MOPA system
- Pulse duration / power optimization with two compressors
- Robust and reliable design, push-button operation

Options

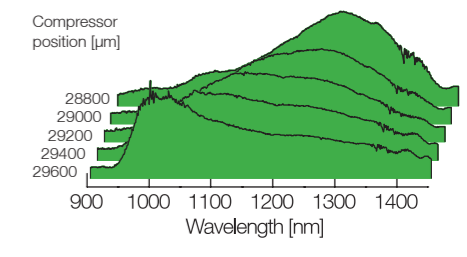
- M40: Repetition rate 40 MHz instead of standard 80 MHz
- Customized repetition rate, e.g. 68 MHz, 77 MHz, ...
- AMP: System without oscillator for multi-beam systems, to be seeded by external source
- VAR: Variable repetition rate
- LRC: Laser repetition rate control
- TNIR: Addition for FemtoFiber pro UCP or TVIS (two-in-one system; see page 34)
- Additional seed ports for future multi-beam setups



Typical autocorrelation intensity (e.g. at 1235 nm).



Typical output power at different prism compressor settings.



Typical spectral tunability of the UCP system.



Class 3B Laser Product EN 60825-1:2014.
Invisible laser radiation. Avoid direct exposure to beam.
Caution - Class 4 invisible laser radiation when open.
Avoid exposure to the beam



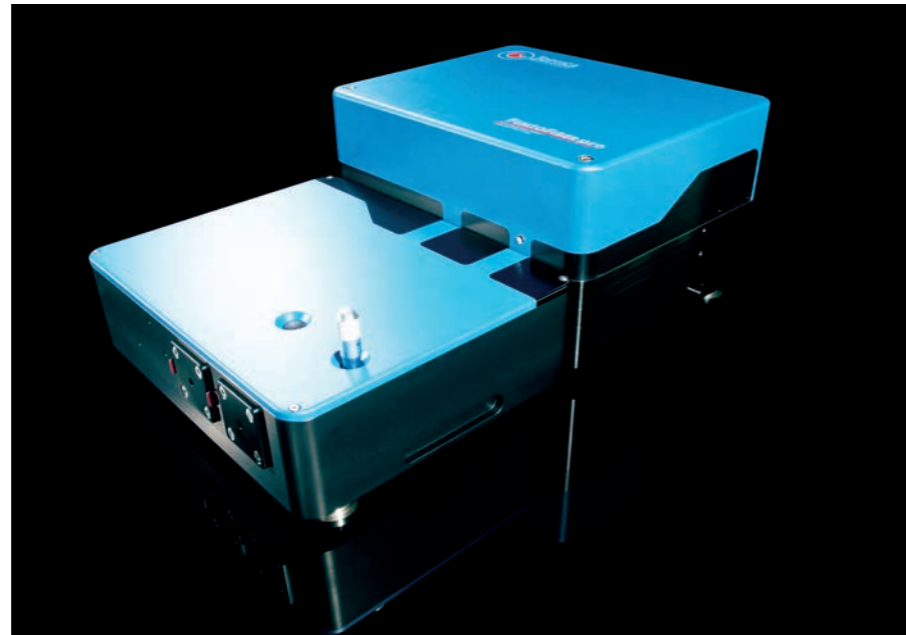
Class 3B Laser Product EN 60825-1:2014.
Visible and Invisible laser radiation. Avoid direct exposure to beam.
Caution - Class 4 visible and invisible laser radiation when open.
Avoid exposure to the beam

Key Features

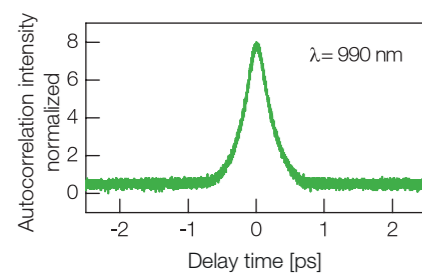
- Tunable near infrared fiber laser @ 830 - 1100 nm
- High spectral purity due to selective SHG process
- SAM mode locking, PM fiber based MOPA system
- Robust and reliable design, push button operation
- Free beam output

Options

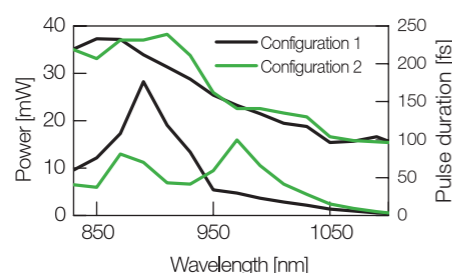
- M40: Repetition rate 40 MHz instead of standard 80 MHz
- Customized repetition rate, e.g. 68 MHz, 77 MHz, ...
- AMP: System without oscillator for multi-beam systems, to be seeded by external source
- VAR: Variable repetition rate
- LRC: Laser repetition rate control
- 1PS: Extended pulse length towards picosecond range by using two exchangeable crystals: typ. 0.5-1 ps @ 850 - 940 / 940 - 1100 nm rectangular pulse shape other specifications may change (please consult TOPTICA for further details)
- 2 different configurations for increased power in certain wavelength range, see graphics below.



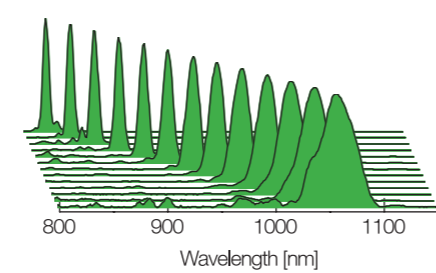
Specifications FemtoFiber pro TNIR	
Wavelength tuning range	830 - 1100 nm
Average output power	1 - 5 mW (wavelength dependent, see graphics below)
Pulse duration	< 250 fs (wavelength dependent, see graphics below)
Repetition rate	80 MHz standard
Beam shape	TEM ₀₀ , M ² < 1.2
Beam size (1/e ²)	customized
Beam divergence	< 1 mrad
Linear polarization	> 95%, horizontal
Output coupling	Free space
Dimensions laser head	151 x 280 x 458 mm ³
Weight laser head	< 15 kg
Dimensions control unit	140 x 235 x 315 mm ³
Weight control unit	< 4.5 kg
Power supply	100 to 240 VAC, 50/60 Hz, IEC 60320-C14 socket
Power consumption	< 40 W
PC interface	Ethernet, USB, RS-232
Environment temperature	20 - 30 °C (operating), 0 - 40 °C (storage and transport)
Environment humidity	Non-condensing



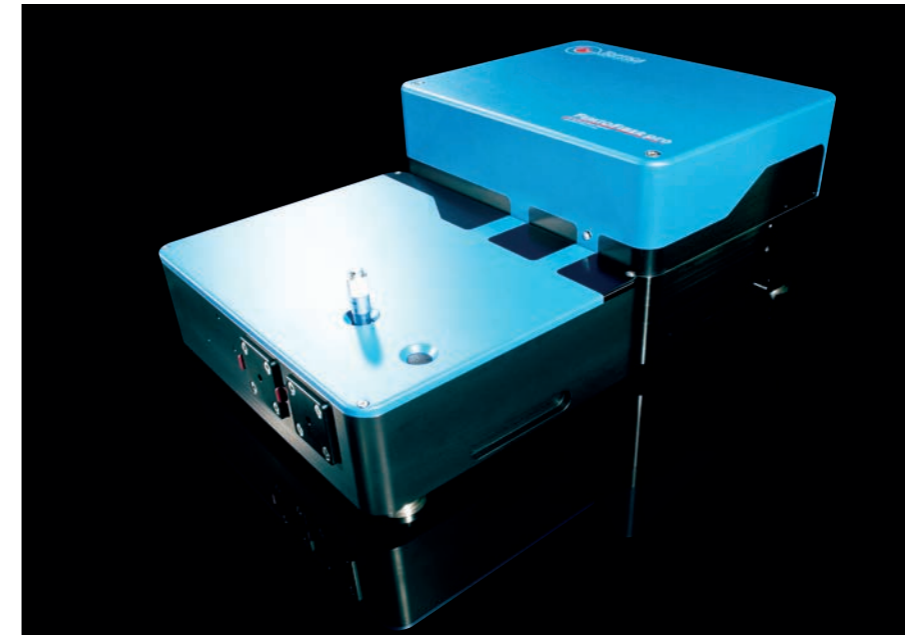
Typical autocorrelation intensity (e.g. at 990 nm).



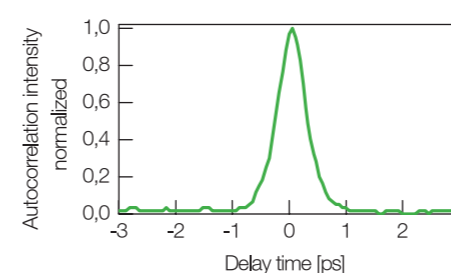
Typical spectral output power levels and pulse durations (Standard crystal, two system configurations possible).



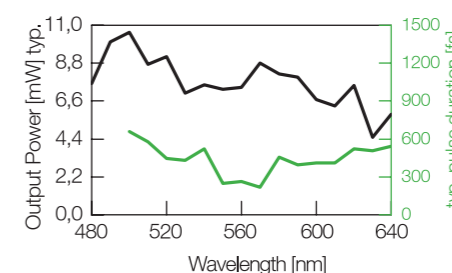
Spectral tunability between 830 and 1100 nm.



Specifications FemtoFiber pro TVIS	
Wavelength tuning range	488 - 640 nm (488 - 700 nm with dual-crystal option)
Average output power	1 - 10 mW (wavelength dependent, see graphics below)
Pulse duration	< 1 ps (< 150 fs with short-pulse option)
Repetition rate	80 MHz standard
Beam shape	TEM ₀₀ , M ² < 1.2
Beam size (1/e ²)	customized
Beam divergence	< 1 mrad
Linear polarization	> 95%, horizontal
Output coupling	Free space
Dimensions laser head	151 x 280 x 458 mm ³
Weight laser head	< 15 kg
Dimensions control unit	140 x 235 x 315 mm ³
Weight control unit	< 4.5 kg
Power supply	100 to 240 VAC, 50/60 Hz, IEC 60320-C14 socket
Power consumption	< 40 W
PC interface	Ethernet, USB, RS-232
Environment temperature	20 - 30 °C (operating), 0 - 40 °C (storage and transport)
Environment humidity	Non-condensing



Typical autocorrelation intensity (e.g. at 640 nm).



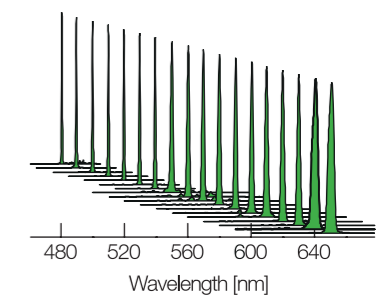
Typical spectral output power levels and pulse durations.

Key Features

- Tunable visible fiber laser @ 488 - 640 nm
- High spectral purity due to selective SHG process
- SAM mode locking, PM fiber based MOPA system
- Robust and reliable design, push-button operation
- Free beam output

Options

- M40: Repetition rate 40 MHz instead of standard 80 MHz
- Customized repetition rate, e.g. 68 MHz, 77 MHz, ...
- AMP: System without oscillator for multi-beam systems, to be seeded by external source
- VAR: Variable repetition rate
- LRC: Laser repetition rate control
- TNIR: Addition for FemtoFiber pro UCP or TVIS (two-in-one system; see page 34)
- Dual-crystal option: Extended tuning range from 488 - 700 nm by using two exchangeable crystals
- Short-pulse option: Pulse duration below 150 fs over the whole tuning range
- See also FF customized FluoLife (special product based on FemtoFiber pro TVIS) - page 39



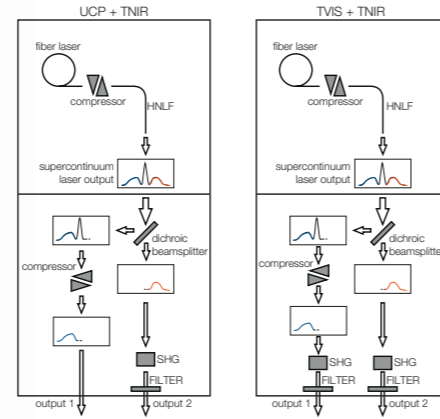
Spectral tunability between 480 and 650 nm.

FemtoFiber pro

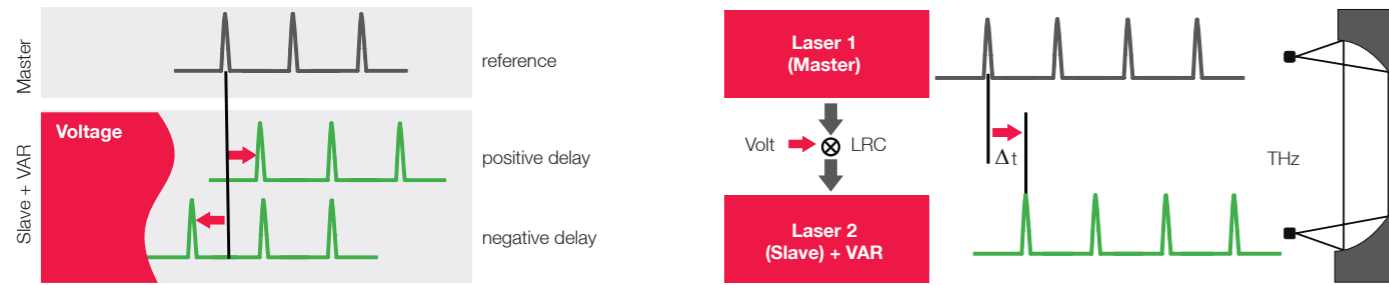
Options for Flexibility



LRC electronics rack (Option LRC)



Schematic setup (Option TNIR "two-in-one")



Principle of operation (Option VAR & Option LRC). Adjustable (or modulated) phase shift between pulse trains.

Option VAR

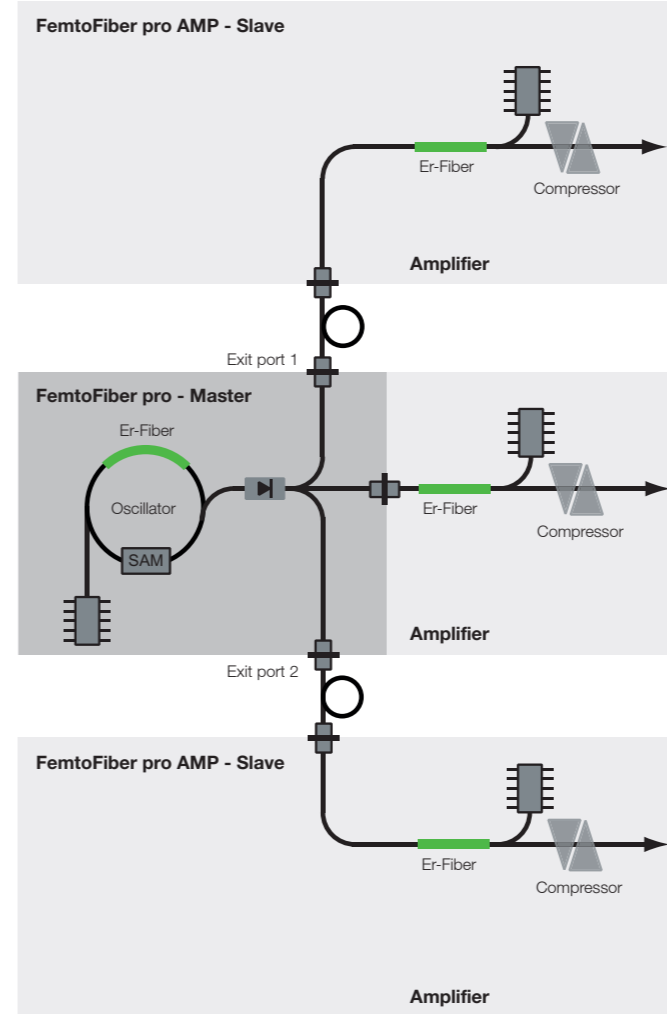
- VAR** – **V**ariable laser **R**epetition rate
- Adaptation to the oscillator unit, enabling modulation of the repetition rate
 - Adjustable resonator length by piezo transducer and translation stage
 - Repetition rate tuning range $> \pm 100$ kHz from nominal repetition rate
 - Only for 80 MHz systems (not to combine with M40 option)

Option LRC

- LRC** – **L**aser **R**epetition rate **C**ontrol
- Phase-locked loop electronics for synchronization of the laser pulse train to external reference signal
 - RMS jitter < 200 fs
 - Electronics rack with power supply
 - USB interface and control software
 - ECOPS capability

Option TNIR

- TNIR** – "two-in-one" system for UCP or TVIS models
- System with one pulse source – two different outputs
 - Cost-effective one-box solution
 - Available for UCP or TVIS only



Schematic setup of a 3-arm system (Option AMP)

Option M40

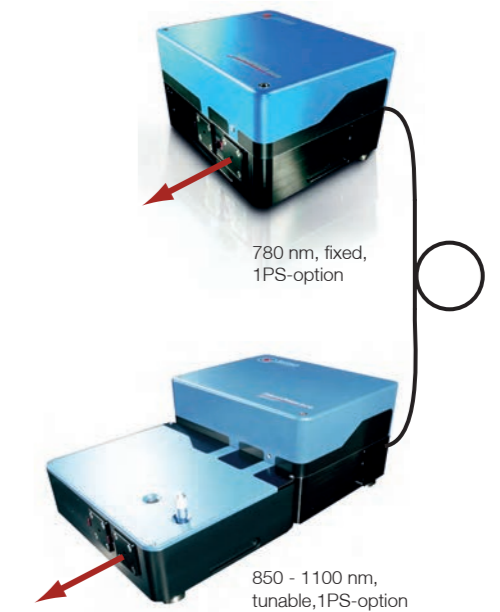
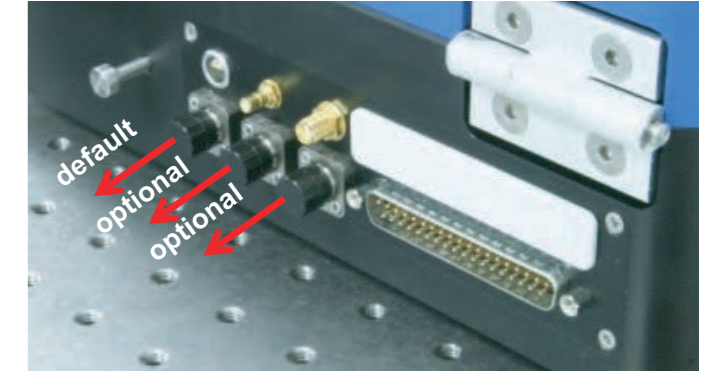
- M40** – 40 MHz repetition rate
- Oscillator design with 40 MHz repetition rate
 - Some specifications may change (ask TOPTICA for details)
 - Option M40 cannot be combined with option VAR
 - Other repetition rates than 40, 80 MHz on special request.

Option AMP

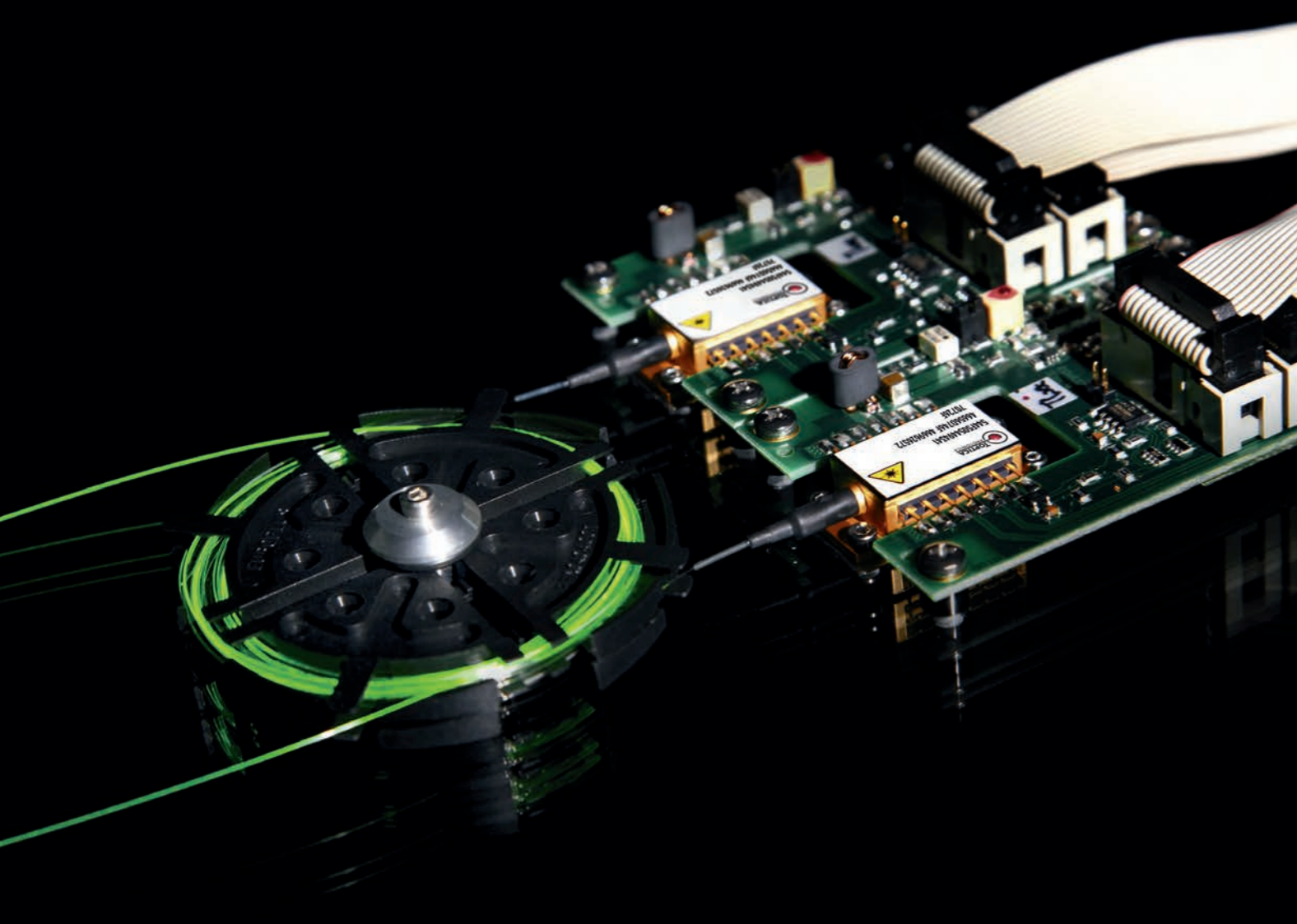
- AMP** – Multi-beam configuration
- System only equipped with amplifier, but no oscillator („AMP“)
 - FC/APC fiber input for external seeding by the master system (includes oscillator)
 - Additional seed ports can be added to each master system, allowing multi-beam systems of up to 4 units

Option 1PS

- „1PS“** – extended pulse length
- Available for NIR or TNIR models
 - Pulse length typ. 1 ps (NIR/780 nm) or 0.5 - 1 ps (TNIR/850 - 1100 nm)
 - Rectangular temporal pulse shape
 - Further specifications may change
 - Alternative crystal implemented, replaces standard crystal (standard crystal not included anymore when this option is added)



Schematic setup of a CARS laser system



FEMTOFIBER CUSTOMIZED Tailored Laser Systems for Specific Applications

TOPTICA's femtosecond fiber laser systems support a multitude of exciting applications ranging from time-resolved microscopy and spectroscopy to sophisticated pump-probe measurements like ASOPS (Asynchronous Optical Sampling), CARS (Coherent Anti-Stokes Raman Spectroscopy), or SRS (Stimulated Raman Spectroscopy).

To meet the broad range of requirements, the FemtoFiber product line is designed with maximum flexibility and compatibility, which enables the design of complex systems and highly customized solutions.

The key behind TOPTICA's fiber laser technology is the possibility to link different laser amplifiers to a common master oscillator. The optical parameters of each amplifier can be entirely customized regarding wave-

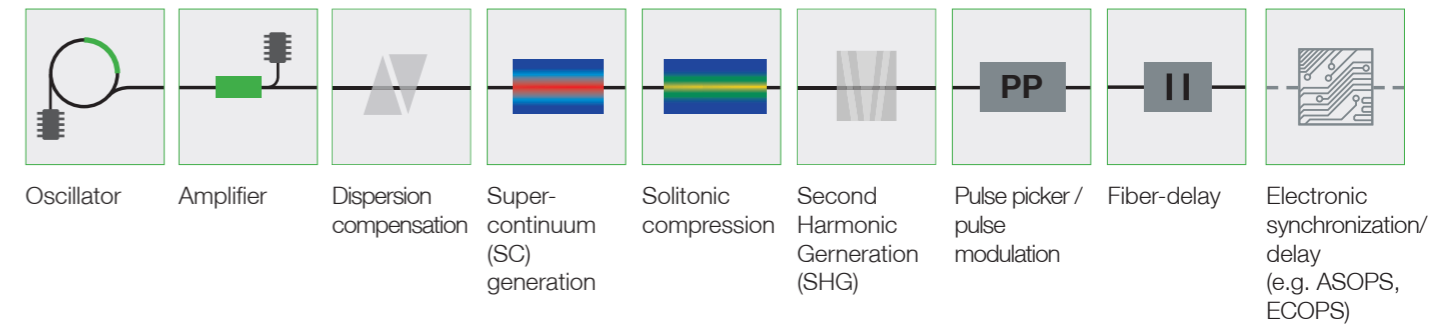
length, spectral width, pulse duration, output power, and repetition rate. With that tailored, phase-locked femtosecond laser pulse trains can be generated that are synchronized to one another with attosecond precision. TOPTICA has now expanded its capabilities by introducing a dedicated department for highly customized solutions that provide tailored fiber laser systems for novel applications in ultrafast optics.

A representative selection of unique laser solutions for a variety of applications are shown within this section. The applications range from terahertz generation in cryostats for low temperature experiments, to modified lasers for high-end fluorescence lifetime imaging, to sophisticated multi-arm solutions for time-resolved pump-probe spectroscopy.



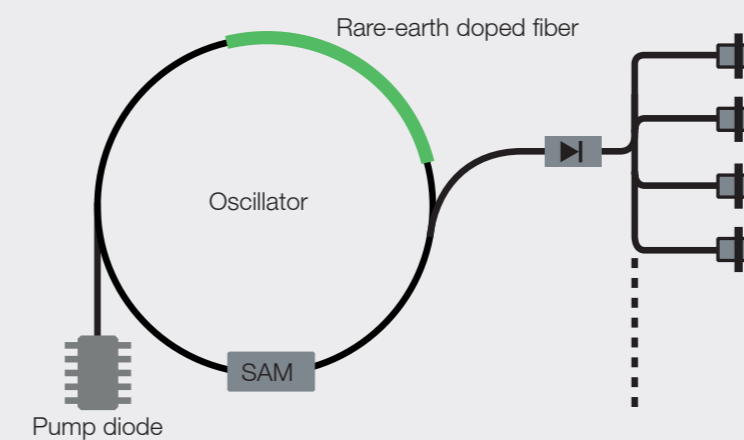
FemtoFiber Customized offers solutions that go beyond the standard product portfolio. Extended wavelength coverage, multi-arm systems, or repetition rate stabilization & control are just a few examples of possible laser modifications.

Modular Design



The modular concept of the FemtoFiber technology provides the basis for a large variety of laser configurations that cover the electromagnetic spectrum from the visible (390 nm) to the terahertz spectral range (0.1 THz). In combination with the ability to seed several amplifiers with a common master oscillator, highly customized solutions and multi-arm configurations can easily be engineered that are tailored to any specific application. Standard product configurations and tailored systems based on the FemtoFiber pro technology can be seen within this section.

The FemtoFiber Customized Master Oscillator



The core of each customized fiber laser is a multifunctional master oscillator based on SAM passive mode-lock technology. The patented oscillator design offers multiple seed ports for subsequent power amplification and routinely features repetition rate modification and active repetition rate control. This makes the oscillator the ideal choice for e.g. sophisticated measurement modes like ASOPS / ECOPS or frequency comb technology.

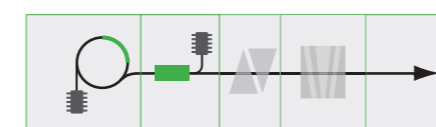
Benefits of one oscillator for several amplifiers

- Alignment free combination of different FemtoFiber lasers
- Intrinsic optical synchronization in time and phase
- Wide wavelength coverage (390 nm - 3000 μ m)
- Each seed-port can be equipped with an in-fiber delay line (500 ps)
- Repetition rate control and picker electronic modules available

- Cost effective and compact
- Robust and reliable design
- Push-button solution

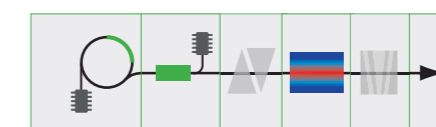
Selected laser configurations

FemtoFiber pro NIR



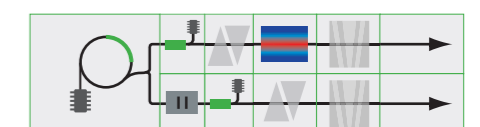
Er:fiber laser with additional second harmonic generation to 780 nm.
780 nm
> 140 mW
< 100 fs

FemtoFiber pro TNIR



Laser system with ultrashort pulses, continuously tunable from 830 - 1100 nm.
830 - 1100 nm
> 1 - 5 mW
< 250 fs

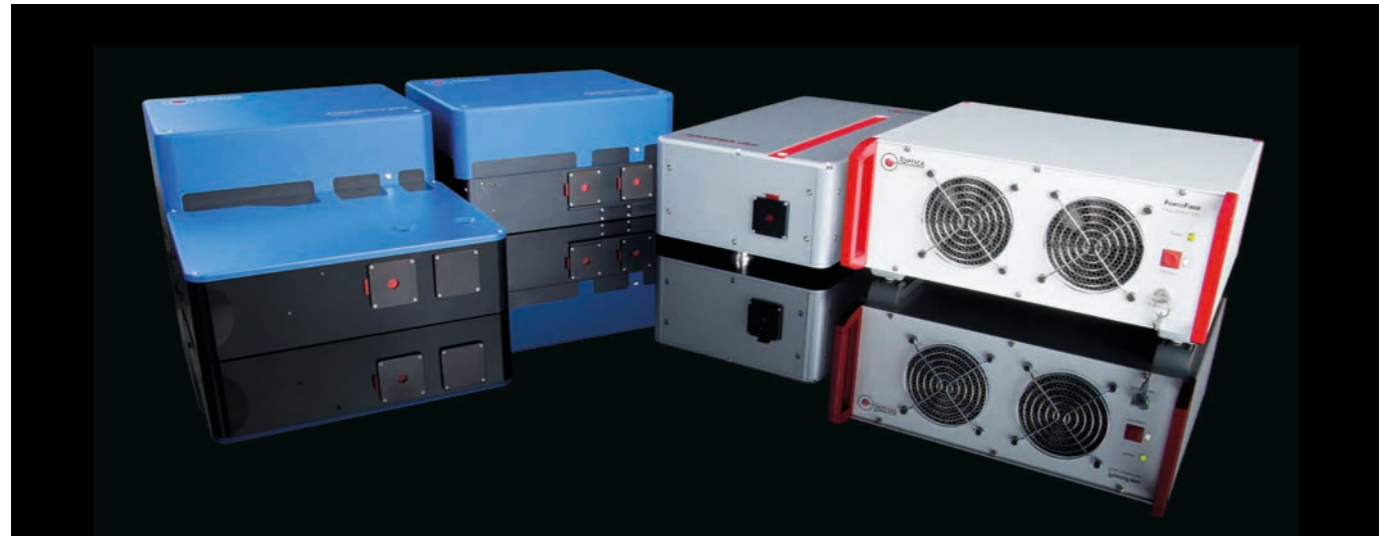
FemtoFiber pro CARS



Multi-arm solution consisting of a FemtoFiber pro NIR and an optically synchronized FemtoFiber pro TNIR.



Class 4 Laser Product EN 60825-1:2014.
Visible and Invisible laser radiation. Avoid direct exposure to beam.
Caution - Class 4 visible and invisible laser radiation when open.
Avoid exposure to the beam



Key Features

- Ultracompact laser system for label-free nonlinear microscopy (CARS / SRS)
- Fixed frequency pump laser at 780 nm or 1050 nm
- Tunable or broadband Stokes lasers covering 488 - 1400 nm
- Adjustable timing between pump and Stokes laser
- SAM mode locking, PM fiber based MOPA system
- Robust and reliable design, push-button operation
- Free beam output

FemtoFiber CARS

Coherent Anti-stokes Raman Spectroscopy (CARS) and Stimulated Raman Scattering (SRS) are powerful and label-free techniques for chemical identification of molecules by their characteristic vibrational and rotational modes. TOPTICA provides a variety of pump and Stokes laser configurations for CARS and SRS covering the entire fingerprint region from 450 – 12500 cm⁻¹. The pump and Stokes laser are optically synchronized and their relative timing can be adjusted using a built-in optical delay.

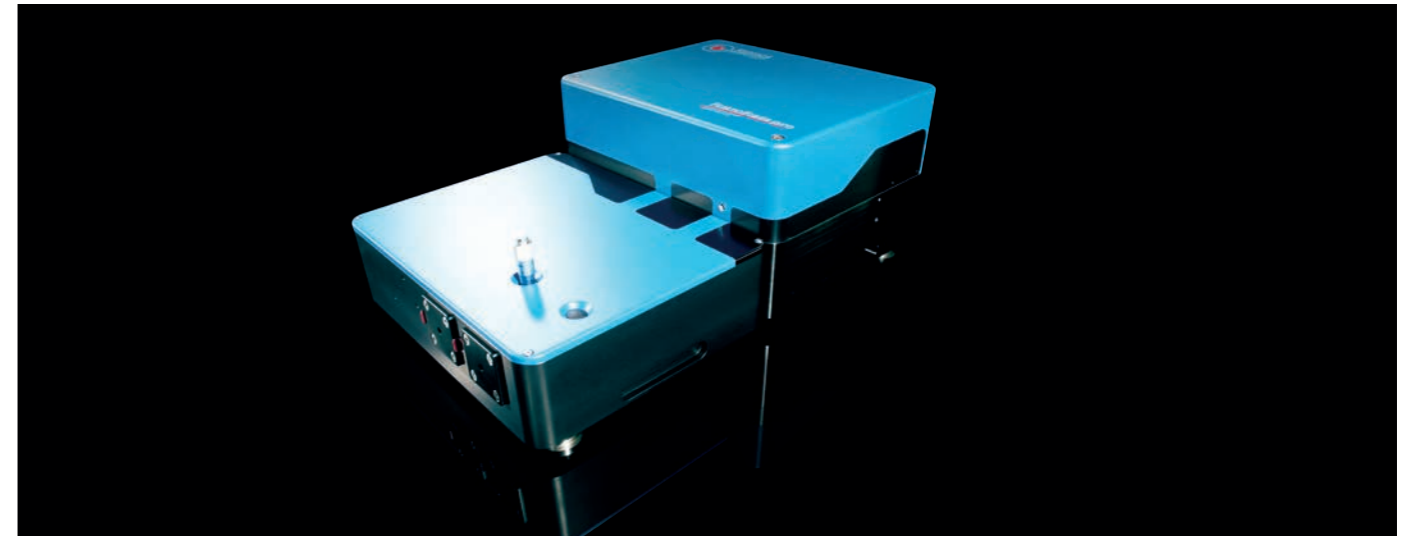
System Schematics: FF pro NIR (1 ps) + FF pro UCP AMP



Specifications FemtoFiber CARS				
Configuration		Laser 1	Laser 2	Spectral region
Laser 1	Laser 2	Wavelength / pulse duration	Wavelength / pulse duration	cm ⁻¹ / coverage
FF pro NIR (1PS)	FF pro TVIS AMP	780 nm / 1 ps	488 - 640 nm / < 1 ps	2805 - 7671
FF pro NIR (1PS)	FF pro TNIR AMP (1PS)	780 nm / 1 ps	830 - 1100 nm / 1 ps	772 - 3730
FF pro NIR (1PS)	FF pro UCP AMP	780 nm / 1 ps	980 - 1400 nm (broadband) / 25 fs	2616 - 5678
FF ultra 780	FF pro TVIS AMP	780 nm / 150 fs	488 - 640 nm / < 1 ps	2805 - 7671
FF ultra 780	FF pro TNIR AMP (1PS)	780 nm / 150 fs	830 - 1100 nm / 1 ps	772 - 3730
FF ultra 780	FF pro UCP AMP	780 nm / 150 fs	980 - 1400 nm (broadband) / 25 fs	2616 - 5678
FF ultra 1050	FF pro TNIR AMP (1PS)	1050 nm / 100 fs	830 - 1100 nm / 1 ps	433 - 2525
FF ultra 1050	FF pro UCP AMP	1050 nm / 100 fs	980 - 1400 nm (broadband) / 25 fs	681 - 2381
FF ultra 1050	FF ultra 780	1050 nm / 100 fs	780 nm / 150 fs	9523 - 12820



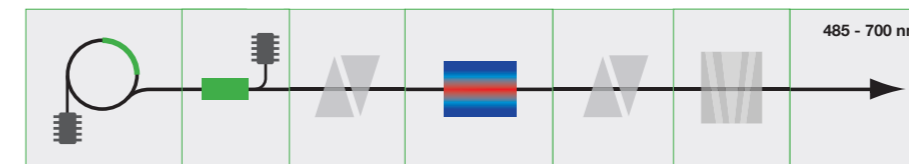
Class 3B Laser Product EN 60825-1:2014.
Visible and Invisible laser radiation. Avoid direct exposure to beam.
Caution - Class 4 visible and invisible laser radiation when open.
Avoid exposure to the beam



FemtoFiber FluoLife

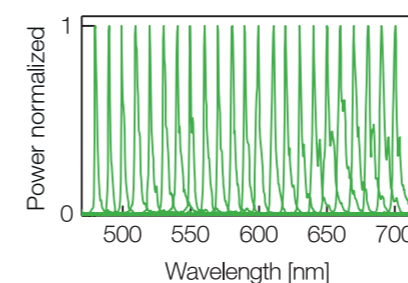
Optimized for fluorescence lifetime imaging, the FemtoFiber FluoLife provides tunable laser pulses with pulse durations below 150 fs at wavelengths between 485 nm and 700 nm.

System Schematics

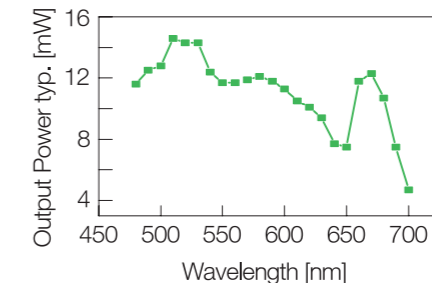


Specifications FemtoFiber FluoLife	
Wavelength tuning range	485 - 700 nm (with dual crystal option)
Laser Output Power	> 4 mW (typ. ~10 mW)
Pulse Duration	< 150 fs (typ. < 120 fs)
Repetition Rate	80 MHz
Output coupling	Free space

For further specifications please check FemtoFiber pro TVIS on page 33.



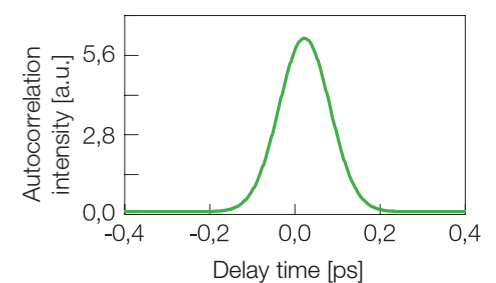
Typical spectral shape.



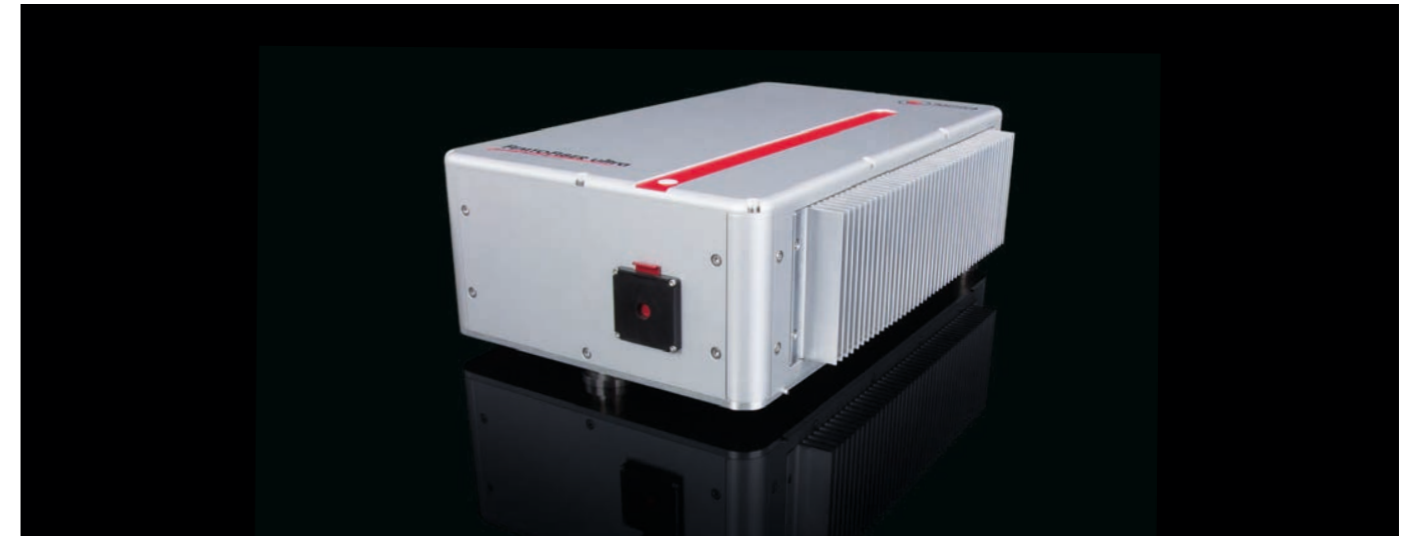
Typical spectral output power.

Key Features

- Tunable pulsed fiber laser for fluorescence lifetime microscopy
- 485 - 700 nm with dual crystal option
- Guaranteed pulse duration < 150 fs (typ. < 120 fs)
- Transform limited pulses
- High spectral purity due to selective SHG process
- SAM mode locking, PM fiber based MOPA system
- Stable and reliable design, push-button operation
- Free beam output



Autocorrelation intensity (typical, e.g. at 640 nm).



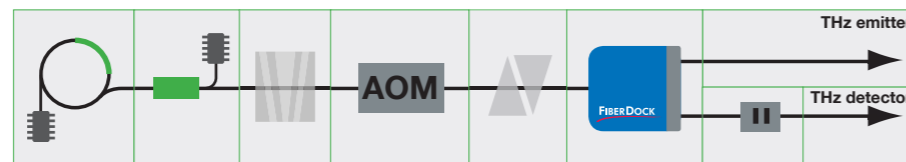
Key Features

- Fiber-coupled laser system for terahertz spectroscopy in cryostats
- Two synchronized outputs: 780 nm, 8 mW, < 300 fs each
- Pump-probe delay up to 500 ps
- Compensation of temperature-induced dispersion changes in cryostat
- Fast AOM for intensity modulation/ beam blanking
- SAM mode locking, PM fiber based MOPA system
- Stable and reliable design, push-button operation
- Fiber-coupled output

FemtoFiber Terahertz Freeze

Terahertz spectroscopy provides fundamental new insights into the characteristics and dynamics of low-energy elementary excitations, such as phonons, plasmons, or excitons. Performing such measurements at ultralow temperatures is however challenging due to power loss and beam distortion of the terahertz pulses at the cryostat window. The FemtoFiber Terahertz Freeze offers the first all-fiber solution for intra-cryostat terahertz generation and detection at 780 nm. The system is completely automated, featuring pulse modulation and blanking using an AOM, full dispersion control, and a fiber-based delay line for photoconductive or electro-optic sampling.

System Schematics

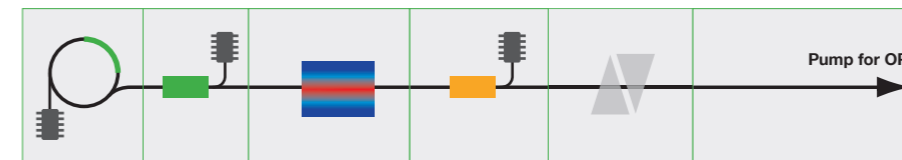


Specifications FemtoFiber Terahertz Freeze	
Wavelength	780 nm each
Laser output power	8 mW each
Pulse duration	< 300 fs each
Repetition rate	30 MHz
Output coupling	2x FC/APC fiber-coupled

FemtoFiber OPO

Optical Parametric Amplifiers (OPA) and Oscillators (OPO) are ideal tools to extend the wavelength range of TOPTICAs FemtoFiber ultra 1050 laser towards the infrared wavelength region. In combination with subsequent frequency conversion, OPA and OPO can cover a large portion of the electromagnetic spectrum, making them a flexible choice for optical spectroscopy and microscopy.

System Schematics



Specifications FemtoFiber OPO	
Wavelength	1050 nm
Laser output power	> 5 W
Pulse duration	< 120 fs
Repetition rate	80 MHz
Output coupling	Free space

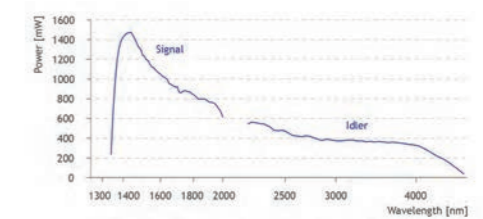
Specifications FemtoFiber OPO + APE Levante IR	
Wavelength tuning range	1350 - 2000 nm (Signal) 2190 - 4600 nm (Idler)
Laser output power	> 1.1 W at 1500 nm (Signal) > 0.4 W at 2500 nm (Idler)
Pulse duration	typ. 200 fs
Repetition rate	80 MHz
Output coupling	Free space

Key Features

- Ultrafast fiber laser tailored for pumping OPAs / OPOs @ 1050 nm
- > 5 W average power,
- < 120 fs pulse duration
- SAM mode locking, PM fiber based MOPA system
- Robust, compact, cost-effective, push-button
- Exchangeable pump modules



APE Levante IR.



Typical OPO Output Spectrum.

FemtoFiber customized FemtoFiber Terahertz Pump-Probe



Class 4 Laser Product EN 60825-1:2014.
Visible and Invisible laser radiation. Avoid direct exposure to beam.
Caution - Class 4 visible and invisible laser radiation when open.
Avoid exposure to the beam



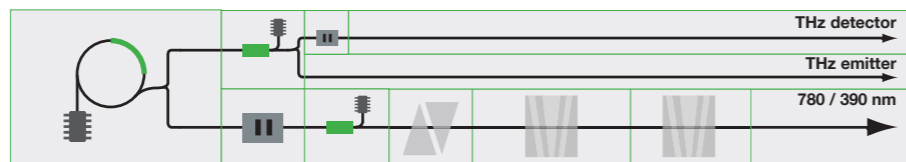
Key Features

- Laser system for time-resolved terahertz time-domain spectroscopy
- Synchronized TeraFlash + FemtoFiber ultra 780 / 390 nm
- Pulse duration of < 200 fs and power > 100 mW
- Pump-probe delay up to 500 ps
- SAM mode locking, PM fiber based MOPA system
- Stable and reliable design, push-button operation
- Free space output, 780 nm / 390 nm (switchable)

FemtoFiber Terahertz Pump-Probe

A detailed understanding of ultrafast carrier dynamics in photoexcited materials is of great interest for both fundamental research as well as material and device engineering. The FemtoFiber Terahertz Pump-Probe system is built to provide a straightforward tool to address these questions. Based on fiber-coupled photo-conductive antennas the terahertz spectrometer offers a bandwidth of 0.1 - 5 THz with a peak dynamic range of > 90 dB. In addition, the system features an optically synchronized pump laser operating either at 780 nm or 390 nm, which is used for ultrafast sample excitation.

System Schematics



Specifications FemtoFiber Terahertz Pump-Probe		
	Master	Slave
Laser	Teraflash	FemtoFiber ultra 780/390
Spectral coverage / Wavelength	0.1 - 5 THz	780 nm / 390 nm (switchable)
Laser output power	> 30 μW	> 500 mW / > 100 mW
Pulse duration	not defined	< 150 fs / < 200 fs
Repetition rate	80 MHz	
Output coupling	Free space	



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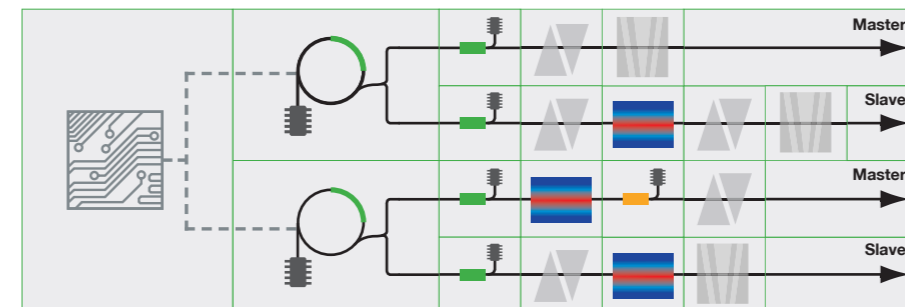
FemtoFiber customized FemtoFiber Quantum Microscopy



FemtoFiber Quantum Microscopy

The FemtoFiber Quantum Microscopy is designed for time-resolved Faraday rotation of coherent spin dynamics in semiconductor nanostructures. The modular design of the fiber laser technology in combination with sophisticated electronics for Asynchronous Optical Sampling (ASOPS) provide highest flexibility in terms of laser parameters, pump-probe configurations, and data acquisition times. The system is based on a FemtoFiber ultra 1050 and a FemtoFiber ultra 780, both electronically stabilized to one another via an ASOPS system. In addition, each FemtoFiber ultra can be used as a seed for either a FemtoFiber pro TVIS or a FemtoFiber pro TNIR amplifier.

System Schematics



Specifications FemtoFiber Quantum Microscopy				
	Master 1	Master 2	Slave 1	Slave 2
Laser	FemtoFiber ultra 780	FemtoFiber ultra 1050	FemtoFiber pro TVIS	FemtoFiber pro TNIR
Wavelength	780 nm	1050 nm	488 - 640 nm	830 - 1100 nm
Laser output power	> 500 mW	> 5 W	1 - 10 mW	1 - 5 mW
Pulse duration	< 150 fs	< 120 fs	< 1 ps	< 250 fs
Repetition rate	80 MHz			
Output coupling	Free space			

Key Features

- Laser system combination for time-resolved pump-probe experiments
- System configuration: FemtoFiber pro TVIS & TNIR, FemtoFiber ultra 780 & 1050
- SAM mode locking, PM fiber based MOPA system
- Stable and reliable design, push-button operation
- Free space output

Specifications

FemtoFiber smart



Class 3B Laser Product EN 60825-1:2014.
Invisible laser radiation. Avoid direct exposure to beam.

Specifications FemtoFiber smart							
	FemtoFiber smart 780	FemtoFerb 1560	FemtoFerb 1560 FD6.5	PicoFYb 1030	PicoFYb 1064	FemtoFYb 1030-400	FemtoFYb 1030-800
Center Wavelength	785 nm ± 5 nm	1560 nm ± 10 nm		1030.5 ± 0.5 nm	1064.3 ± 0.5 nm	1030.5 ± 1.5 nm	
Pulse Duration	< 100 fs (typ. 80 fs)	< 80 fs (typ. 50 fs)	< 60 fs (typ. 50 fs)	< 10 ps		< 2 ps (chirped output) compressible to < 400 fs	< 800 fs (fourier-limited output)
Laser Output Power	> 120 mW (typ. 140 mW)		> 80 mW (typ. 90 mW)	> 10 mW		> 0.5 mW	
Repetition Rate	80 MHz	100 MHz		30 ± 0.5 MHz	20 ± 0.5 MHz	30 ± 0.5 MHz	20 ± 0.5 MHz
Linear polarization	> 95 %, vertical	PER > 20 dB (typ.)	PER > 15 dB (typ.)	PER > 20 dB (typ.)			
Beam shape	TEM ₀₀ , M ² < 1.2						
Beam size (1/e ²)	Ø 1.3 mm (typ.)						
Spectral width				< 0.5 nm	> 4 nm (typ. 4.5 nm)	< 3 nm	
Output coupling	Free space	SM/PM 1550 fiber-pigtail with FC/APC connector, length > 20 cm	SM/PM 1550 FC/APC patch cable with plastic tubing, 6.5 m standard length, detachable; other fiber lengths on request	SM/PM 980 fiber pigtail with narrow key FC/APC connector, length > 20 cm			
Trigger Signal (SMA connector)	> 100 mV @ 50 Ohm (300 MHz BW), negative			> 150 mV @ 50 Ohm (300 MHz BW), positive			
Dimensions laser head	85 x 140 x 210 mm ³	69 x 122 x 202 mm ³		50 x 135 x 194 mm ³			
Weight laser head	< 2.5 kg	< 2.2 kg		< 2 kg			
Power supply	12 VDC						
Power consumption	< 20 W			< 10 W			
Interfaces	TTL control lines, Switchbox (optional) or remote control (USB, Ethernet)	TTL control lines, Switchbox (optional) or remote control (USB)					
Environment temperature	15 - 35 °C (operating), 0 - 40 °C (storage and transport)	15 - 40 °C (operating), 0 - 40 °C (storage and transport)					
Environment humidity	Non-condensing						

For dimension drawings please check our website www.toptica.com



Class 4 Laser Product EN 60825-1:2014.
Invisible laser radiation. Avoid direct exposure to beam.

Specifications

FemtoFiber ultra / dichro midIR

Specifications FemtoFiber ultra				
	FemtoFiber ultra 780	FemtoFiber ultra 920	FemtoFiber ultra 1050	FemtoFiber ultra 1560
Center Wavelength	780 nm	920 nm	1050 nm	1560 nm
Pulse Duration	< 100 fs or < 150 fs	< 100 fs	< 120 fs (typ. 90 - 100 fs)	< 200 fs
Laser Output Power	> 500 mW	> 1.5 W	> 5 W or > 10 W	> 2 W
Repetition Rate	80 MHz standard			
Beam shape	TEM ₀₀ , M ² < 1.2			
Beam divergence	< 1 mrad			
Beam size (1/e ²)	Ø1.1 mm (typ.)	Ø 1.0 mm (typ.)	Ø1.2..1.3 mm (typ.)	Ø 2 mm (typ.)
Linear polarization	> 95 %, horizontal	> 95 %, vertical		> 95 %, horizontal
Output coupling	Free space			
Dimensions laser head	111 x 250 x 380 mm ³	77 x 155 x 230 mm ³	111 x 250 x 380 mm ³	
Weight laser head	< 15 kg	< 3 kg	< 15 kg	
Dimensions supply unit	154 x 342 x 382 mm ³ (incl. stand) (height 3U/HE, width/horizontal pitch 63 HP/TE)	134 x 483 x 600 mm ³	154 x 342 x 382 mm ³ (incl. stand) (height 3U/HE, width/horizontal pitch 63 HP/TE)	
Weight supply unit	< 10 kg	< 18 kg	< 10 kg	
Power supply	100 - 240V AC, 50/60 Hz	24 V DC (AC power supply optionally included)	100 - 240 V AC, 50/60 Hz	100 - 240V AC, 50/60 Hz
Power consumption	< 150 W			
PC interface	Ethernet, USB			
Environment temperature	19 - 25°C (operating), 15 - 35°C (extended operating temperature when heat-sinked, not all specs are guaranteed if laser head case temp exceeds 40°C), 0-40°C (storage and transport)			
Environment humidity	Non-condensing			

For dimension drawings please check our website www.toptica.com

Specifications FemtoFiber dichro midIR	
Spectral tuning range	5 - 15 µm (20 - 60 THz / 670 - 2000 cm⁻¹)
Average Output Power	typ. 1 mW (integrated spectrum)*
Emission Bandwidth	> 400 cm ⁻¹
Repetition Rate	80 MHz
Output power stability	< 1 % / h
Beam diameter	typ. 10 - 15 mm (1/e ²)
Polarization	1:100, vertical
Pointing stability	< 1 mrad (22 ± 1°C)
Output coupling	Free space
Dimensions laser head	161 x 375 x 502 mm ³
Weight laser head	< 30 kg
Line input	100 - 240 V AC, 50/60 Hz (or 24 V DC), < 160 W
PC interface	Ethernet, USB

For dimension drawings please check our website www.toptica.com

Specifications

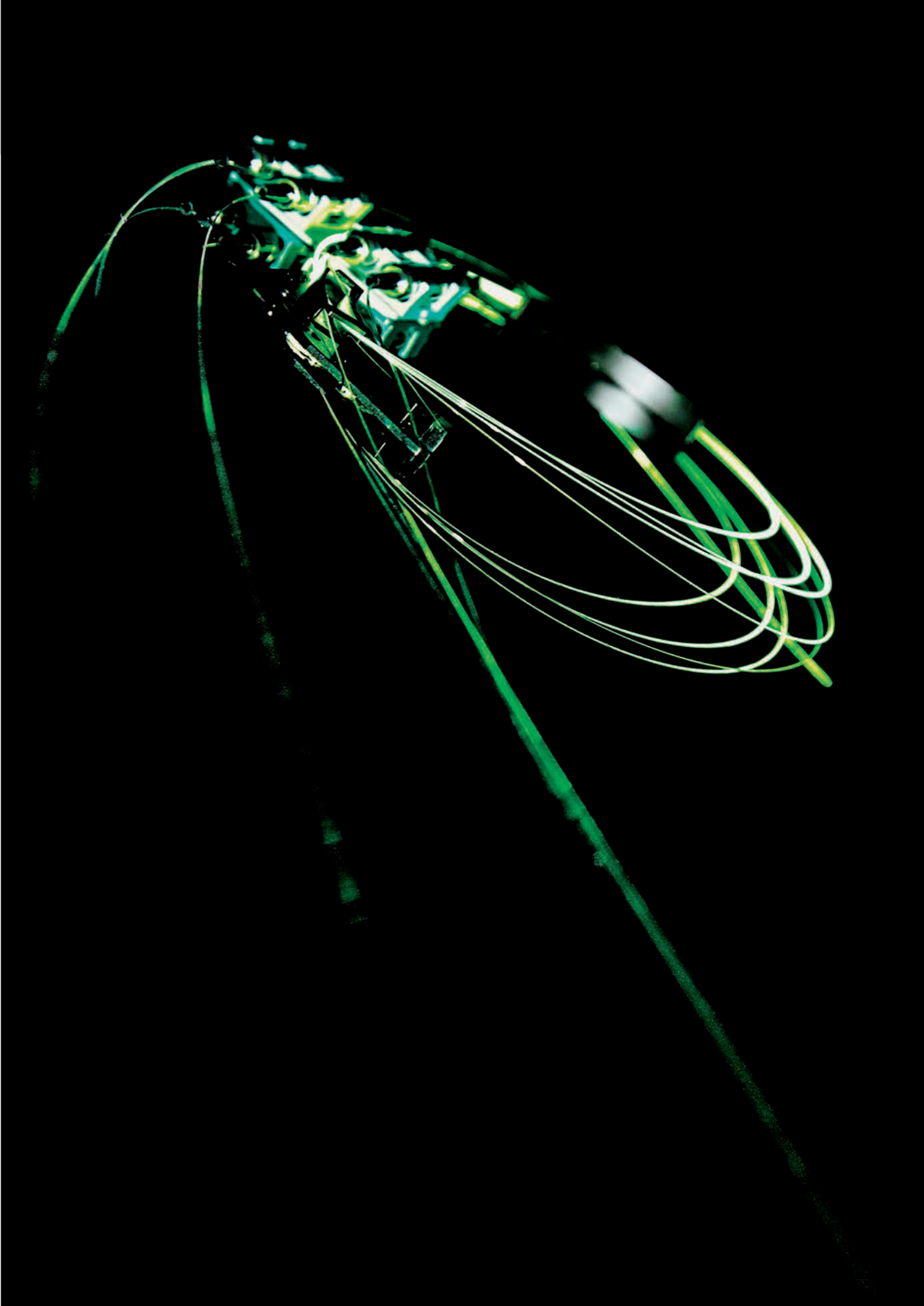
FemtoFiber pro



Class 3B or 4 Laser Product EN 60825-1:2014.
Visible or Invisible laser radiation. Avoid direct exposure to beam.
Caution - Class 3B or 4 visible or invisible laser radiation when open.
Avoid exposure to the beam

Specifications FemtoFiber pro								
	FemtoFiber pro IR	FemtoFiber pro IRS-II	FemtoFiber pro NIR*	FemtoFiber pro SCYb	FemtoFiber pro SCIR	FemtoFiber pro UCP	FemtoFiber pro TNIR	FemtoFiber pro TVIS
Wavelength	1560 nm	1570 nm	780 nm / 1560 nm	1030 nm	980 -2200 nm	980 -1400 nm	830 - 1100 nm	488 - 640 nm (488 - 700 nm with dual-crystal option)
Pulse Duration	< 100 fs	< 40 fs (typ. 30 fs)	< 100 fs	< 100 fs	**	< 25 fs	< 250 fs	< 1 ps (< 150 fs with short-pulse option)
Laser Output Power	> 350 mW	> 200 mW	> 140 mW / > 350 mW	> 500 mW (typ. 600 mW)	> 150 mW (typ. 200 mW)	> 30 mW	1 - 5 mW (wavelength dependent)	1 - 10 mW (wavelength dependent)
Repetition Rate	80 MHz standard							
Beam shape	TEM ₀₀ , M ² < 1.2							
Beam divergence	< 2 mrad	< 1 mrad	< 1 mrad / < 2 mrad	< 2 mrad	< 1 mrad	< 1 mrad	< 1 mrad	< 1 mrad
Beam size (1/e ²)	Ø 3.5 mm (typ.)	Ø 1.8 mm (typ.)	Ø 1.2 mm (typ.) / Ø 3.5 mm (typ.)	Ø 2 mm (typ.)	Ø 2.4 mm (typ.)	Ø 4 mm (typ.)	customized	customized
Linear polarization	> 95 %, horizontal							
Output coupling	Free space							
Dimensions laser head	151 x 280 x 229 mm ³	120 x 280 x 229 mm ³	151 x 280 x 229 mm ³	120 x 280 x 229 mm ³	151 x 280 x 229 mm ³	151 x 280 x 458 mm ³		
Weight laser head	< 10 kg					< 15 kg		
Dimensions supply unit	140 x 235 x 315 mm ³ (H x W x D)							
Weight supply unit	< 4.5 kg							
Power supply	100 to 240 VAC, 50/60 Hz, IEC 60320-C14 socket							
Power consumption	< 40 W							
PC interface	Ethernet, USB, RS-232							
Environment temperature	20 - 30 °C (operating), 0 - 40 °C (storage and transport)							
Environment humidity	Non-condensing							
Available options***	VAR, LRC M40****, AMP	M40****, AMP	VAR, LRC M40****, AMP, 1 PS****	M40****, AMP	VAR, LRC M40****, AMP	VAR, LRC M40****, AMP, TNIR	VAR, LRC M40****, AMP, 1 PS****	VAR, LRC M40****, AMP, TNIR
<p>* NIR model also includes IR-model (selective 1560/780 nm output via mechanical switch).</p> <p>** Pulse duration not defined for supercontinuum source.</p> <p>*** Options: VAR and M40 options cannot be combined, LRC requires VAR.</p> <p>**** Some specifications may change when adding this option. Please ask TOPTICA for details.</p>								

For dimension drawings please check our website www.toptica.com



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