

# FemtoLux SERIES

## FemtoLux 3



FemtoLux 3 is a modern femtosecond fiber laser aimed for both R&D use and industrial integration. Laser delivers up to 3 W of average power and up to 3  $\mu\text{J}$  femtosecond pulse energy. FemtoLux 3 is a flexible platform which allows to optimize output parameters for the desired process. The repetition rate as well as the output power can be easily changed with integrated pulse picker.

With burst mode enabled FemtoLux 3 can generate bursts of pulses with energy above 10  $\mu\text{J}$  with burst shape controlled in real time via analog input. Pulse duration can also be automatically tuned from 300 fs up to 5 ps. User friendly software provides multiple useful utilities like automatic pulse duration calibration, regular maintenance, real time parameters monitoring.

### Microjoule Class Femtosecond Fiber Lasers

#### FEATURES

- ▶ Output power **3 W at 1030 nm**
- ▶ **300 fs ... 5 ps tunable pulse duration**
- ▶ Up to **3  $\mu\text{J}/\text{pulse}$  and 10  $\mu\text{J}/\text{burst}$**  (at 1030 nm)
- ▶ Excellent beam quality  $M^2 < 1.2$
- ▶ Individual pulse control
- ▶ Burst shape control
- ▶ Passive cooling (convective) of laser head
- ▶ 24/7 operation

#### APPLICATIONS

- ▶ Marking and structuring
- ▶ Volume modification of transparent materials
- ▶ Micromachining of brittle materials
- ▶ Photopolymerization
- ▶ Ophthalmologic surgery
- ▶ Biological Imaging
- ▶ Pumping femtosecond OPO/OPA

# FemtoLux green

NEW



In some important applications like multiphoton polymerization, writing of fiber Bragg gratings, volume modification of transparent materials, nonlinear microscopy, silicon and sapphire scribing, marking of some kind of materials, different wavelength than fundamental output is needed. Important point is that requirements for sufficient pulse energy as well as beam quality remains. Having in mind such needs, FemtoLux green, femtosecond fiber laser, was developed. Unlike other commercially used fiber lasers, FemtoLux provides perfectly linearly polarized light with polarization extinction ratio >1000:1. This allows generation of second harmonic with great efficiency better

than 50% and excellent spatial beam and temporal pulse parameters. Fiber based front-end allows multiple pulse train control functions like: wide range of operating pulse repetition rates, individual pulse gating up to 10 MHz, burst mode with active burst envelope shaping, real time pulse amplitude control. Pulse duration can also be automatically tuned from 300 fs up to 5 ps. Providing more than 1.5 W average power, it's reasonably high wall plug efficiency as well as smart heat management makes laser head passively cooled with only ~60 W of heat dissipations, when operating at full power.

## Microjoule Class Femtosecond Green Fiber Lasers

### FEATURES

- ▶ Output power **1.5 W at 515 nm** or **3 W at 1030 nm**
- ▶ **300 fs ... 5 ps tunable pulse duration**
- ▶ Up to **1.5 μJ/pulse** and **5 μJ/burst** (at 515 nm)
- ▶ Up to **3 μJ/pulse** and **10 μJ/burst** (at 1030 nm)
- ▶ Excellent beam quality  $M^2 < 1.2$
- ▶ Individual pulse control
- ▶ Burst shape control
- ▶ Passive cooling (convective) of laser head
- ▶ 24/7 operation

### APPLICATIONS

- ▶ Marking and structuring
- ▶ Volume modification of transparent materials
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- ▶ Photopolymerization
- ▶ Ophthalmologic surgery
- ▶ Biological Imaging
- ▶ Pumping femtosecond OPO/OPA

SPECIFICATIONS <sup>1)</sup>

Model	FemtoLux 3	FemtoLux green
<b>MAIN SPECIFICATIONS</b>		
Wavelength	1030 ± 2 nm	515 ± 1 nm
Minimal pulse duration (FWHM)	< 300 fs	
Pulse duration tuning range	300 fs – 5 ps	
Maximal average output power <sup>2)</sup>	> 3 W	> 1.5 W
Power fluctuations (pk-to-pk) <sup>3)</sup>	< ±2 %	
Maximal pulse energy <sup>2)</sup>	3 µJ	1.5 µJ
Pulse energy stability (Std. dev.) <sup>4)</sup>	< 2 %	
Laser pulse repetition rate (PRR <sub>L</sub> ) range <sup>5)</sup>	1 – 5 MHz	
Pulse repetition rate after pulse picker	PRR = PRR <sub>L</sub> / N, N=1, 2, 3, ... , min 10 kHz	
External pulse gating	via TTL input	
Burst mode <sup>6)</sup>	1 – 10 pulses	
Max burst energy	10 µJ	5 µJ
Burst control	via analog input	
Power attenuation	0 – 100 % from software or via analog input	
Polarization orientation	linear, vertical	
Polarization extinction ratio	>1000:1	
M <sup>2</sup>	< 1.2	
Beam divergence (full angle)	<1.0 mrad	
Beam pointing stability (pk-to-pk) <sup>7)</sup>	< 50 µrad	
Beam diameter (1/e <sup>2</sup> ) at 20 cm distance from laser aperture	2.0 ± 0.3 mm	1.0 ± 0.2 mm
<b>OPERATING REQUIREMENTS</b>		
Mains requirements	100 ... 240 V AC, 5A, single phase 47... 63 Hz	
Maximal power consumption	< 500 W	
Operating ambient temperature	15 – 30 °C	
Relative humidity	10 – 80 % (non-condensing)	
Air contamination level	ISO 9 (room air) or better	
<b>PHYSICAL CHARACTERISTICS</b>		
Cooling	air	
Laser head size (L×W×H)	464 × 363 × 129 mm	620 × 363 × 129 mm
Power supply unit size (L×W×H)	449 × 436 × 140 mm (stand-alone) or 483 × 436 × 140 mm (19" rack mountable)	
Umbilical length	5 m	
<b>CLASSIFICATION</b>		
Classification according EN60825-1	CLASS 4 laser product	

<sup>1)</sup> Due to continuous improvement, all specifications are subject to change without notice.

<sup>2)</sup> See typical power and energy curves for other pulse repetition rates.

<sup>3)</sup> In bandwidth below 1 Hz during 24 h operation under constant environmental conditions.

<sup>4)</sup> In 1 MHz – 0.1 Hz bandwidth.

<sup>5)</sup> When pulse picker is set to transmit every pulse.

<sup>6)</sup> Time interval between the pulses is about 20 ns.

<sup>7)</sup> Defined as short term < 2 min beam angular stability.



**Note:** It is recommended to use clean air generator with FemtoLux green in order to assure it's performance stability.

PERFORMANCE

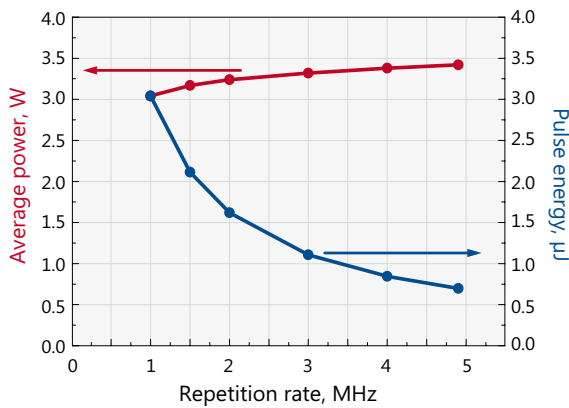


Fig 1. Typical dependence of output power and pulse energy of FemtoLux laser at 1030 nm when changing internal repetition rate of the laser

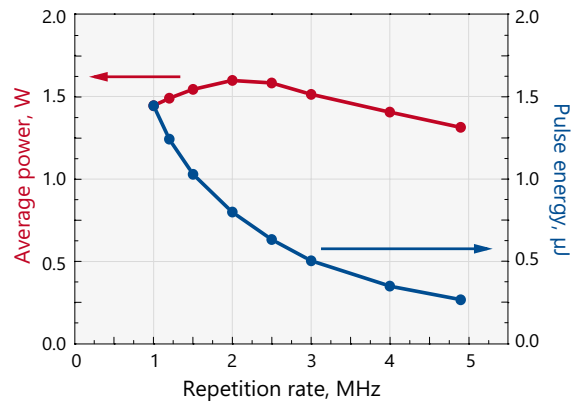


Fig 2. Typical dependence of output power and pulse energy of FemtoLux green laser at 515 nm on pulse repetition rate

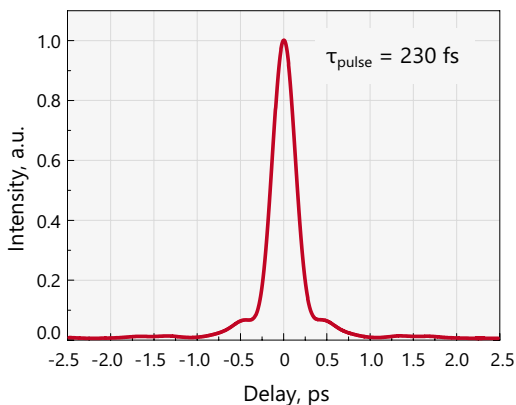


Fig 3. Typical FemtoLux laser (at 1030 nm) output pulse autocorrelation function at 3 µJ pulse energy. Calculated pulse duration is 230 fs

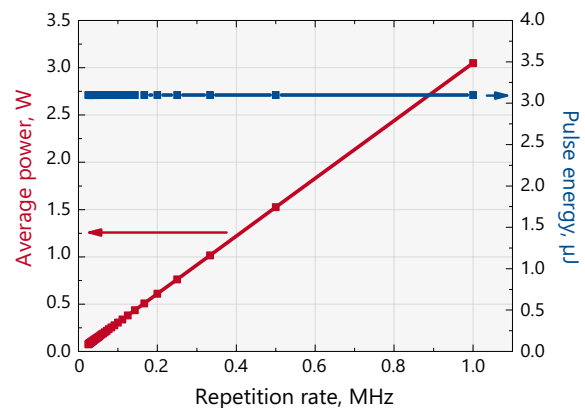


Fig 4. Typical dependence of output power and pulse energy of FemtoLux laser at 1030 nm when repetition rate is reduced by pulse picker. Internal repetition rate of the laser in this case is 1 MHz

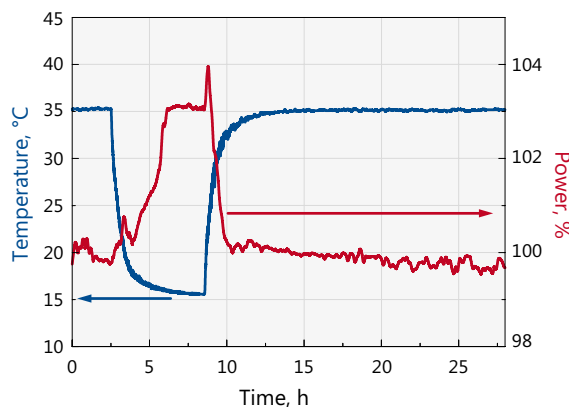


Fig 5. Typical long term average output power stability of FemtoLux laser at 1030 nm under constant environmental conditions

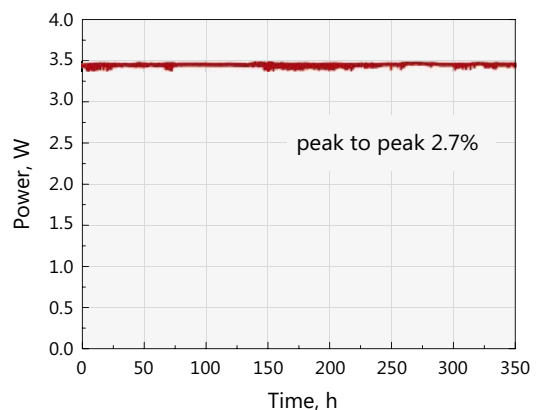


Fig 6. Typical long term average output power stability of FemtoLux laser at 1030 nm under constant environmental conditions

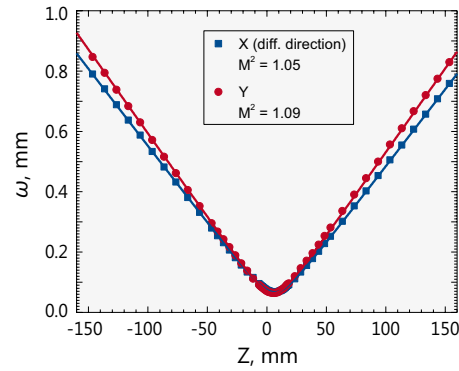
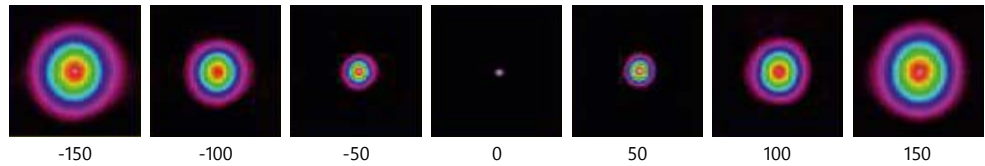


Fig 7. Beam profiles along propagation axis of FemtoLux 3 laser



SOFTWARE

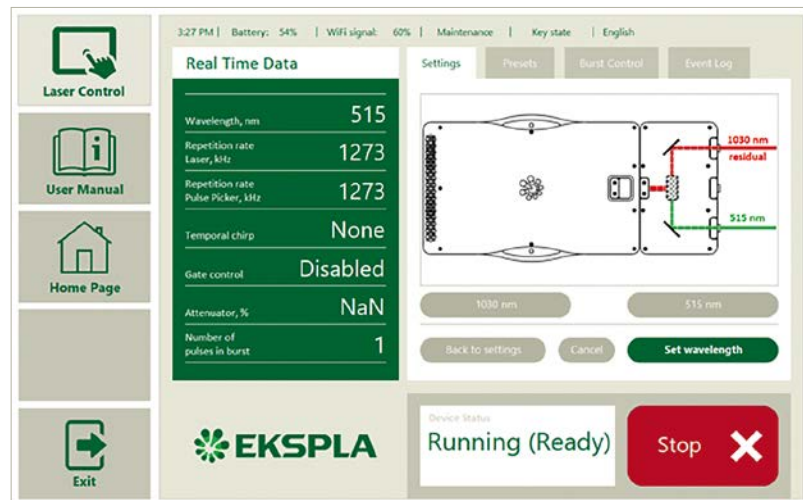


Fig 8. Example of FemtoLux control software

APPLICATIONS EXAMPLES

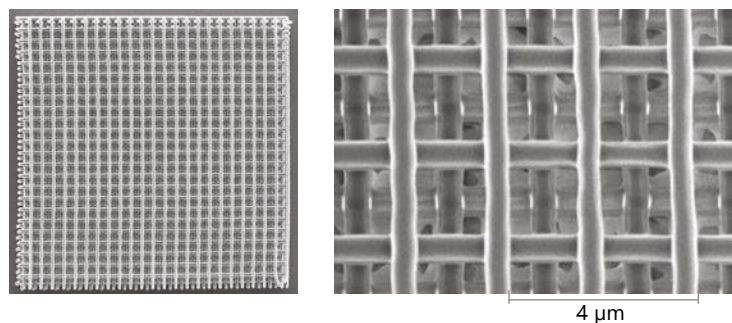


Fig 9. Photopolymerization samples made with FemtoLux.  
Courtesy of Workshop of Photonics

DRAWINGS

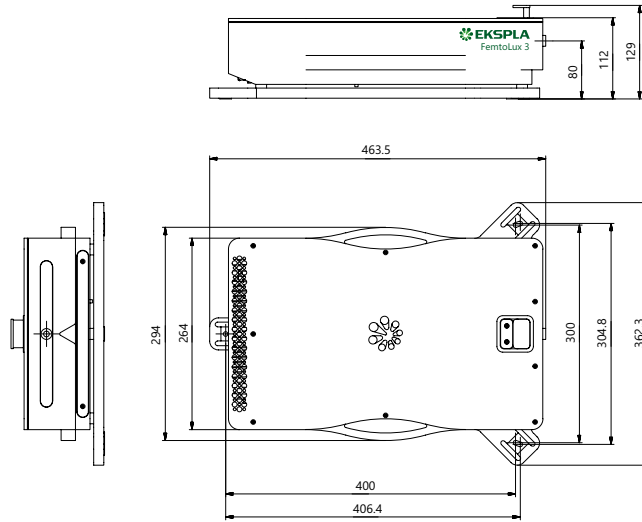


Fig 10. Outline drawing of FemtoLux 3 laser head

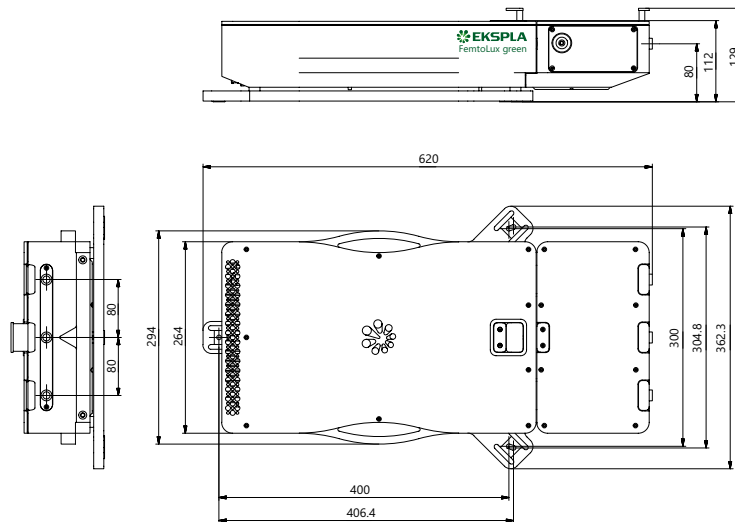


Fig 11. Outline drawing of FemtoLux green laser head

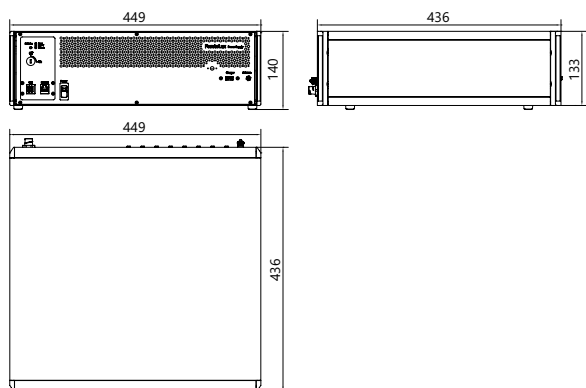


Fig 12. Outline drawing of FemtoLux stand-alone control unit

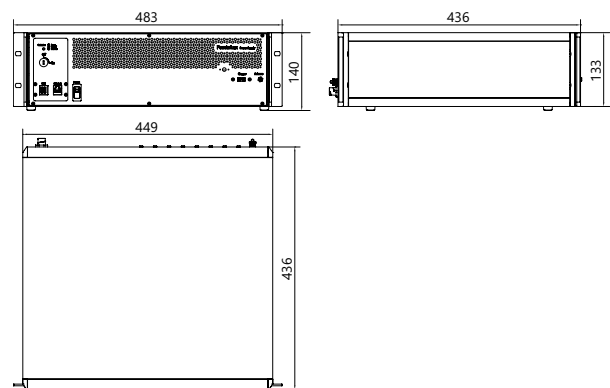


Fig 13. Outline drawing of FemtoLux 19" rack mountable control unit