EKSPLA

# FemtoLux Series

## Microjoule Class Femtosecond Fiber Lasers

Passive air cooling

300 fs ... 5 ps tunable pulse duration

$M^2 < 1.2$

FemtoLux 3

**3 W** at 1030 nm

FemtoLux green

**1.5 W** at 515 nm

2019

# FemtoLux SERIES

Microjoule Class
Femtosecond
Fiber Lasers

## 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 µJ 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 µJ with burst shape controlled in real time via analog input. Pulse duration can also be tuned from 300 fs up to 5 ps. Having laser control application running on a wireless tablet, makes FemtoLux series lasers a most technologically advanced and user friendly as never before for any type of user, be it researcher or industrial user.

### FEATURES

- *Output power **3 W at 1030 nm***
- ***300 fs ... 5 ps tunable** pulse duration*
- *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*
- *Micromachining of brittle materials*
- *Photopolymerization*
- *Ophthalmologic surgery*
- *Biological Imaging*
- *Pumping femtosecond OPO/OPA*
- *Multiphoton microscopy*
- *Second harmonic generation imaging*

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# FemtoLux green

NEW


## 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*

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 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.

## APPLICATIONS

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

## SPECIFICATIONS [1]

| Model | FemtoLux 3 | FemtoLux green |
|---|---|---|
| **MAIN SPECIFICATIONS** | | |
| 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 [2] | > 3 W | > 1.5 W |
| Power long term stability (Std. dev.) [3] | ≤ 0.5 % | |
| Maximal pulse energy [2] | 3 µJ | 1.5 µJ |
| Pulse energy stability (Std. dev.) [4] | < 2 % | |
| Laser pulse repetition rate ($PRR_L$) range [5] | 1 – 5 MHz | |
| Pulse repetition rate after pulse picker | PRR = $PRR_L$ / N, N=1, 2, 3, ... , min 10 kHz | |
| External pulse gating | via TTL input | |
| Burst mode [6] | 1 – 10 pulses | |
| Max burst energy | 10 µJ | 5 µJ |
| Burst shape control | via analog input | |
| Power attenuation | 0 – 100 % from software or via analog input | |
| Polarization orientation | linear, vertical | |
| Polarization extinction ratio | >1000:1 | |
| $M^2$ | < 1.2 | |
| Beam divergence (full angle) | <1.0 mrad | |
| Beam pointing stability (pk-to-pk) [7] | < 30 µrad | |
| Beam diameter ($1/e^2$) at 20 cm distance from laser aperture | 2.0 ± 0.3 mm | 1.0 ± 0.2 mm |
| **OPERATING REQUIREMENTS** | | |
| 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 | |
| **PHYSICAL CHARACTERISTICS** | | |
| Cooling | air, passive | |
| 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 | |
| **CLASSIFICATION** | | |
| Classification according EN60825-1 | CLASS 4 laser product | |

[1] Due to continuous improvement, all specifications are subject to change without notice.

[2] See typical power and energy curves for other pulse repetition rates.

[3] At 1 MHz $PRR_L$ during 24 h of operation after warm-up under constant environmental conditions.

[4] At 1 MHz $PRR_L$ under constant environmental conditions.

[5] When pulse picker is set to transmit every pulse.

[6] Time interval between the pulses is about 20 ns.

[7] Beam pointing stability is evaluated as a movement of the beam centroid in the focal plane of a focusing element.


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

## PERFORMANCE

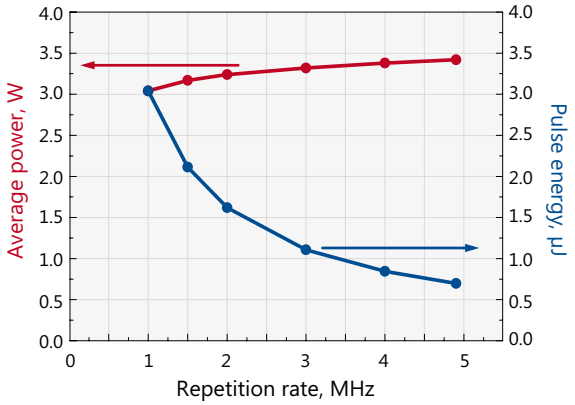


*Fig 1.* Typical dependence of output power and pulse energy of FemtoLux laser **at 1030 nm** when changing internal repetition rate of the laser

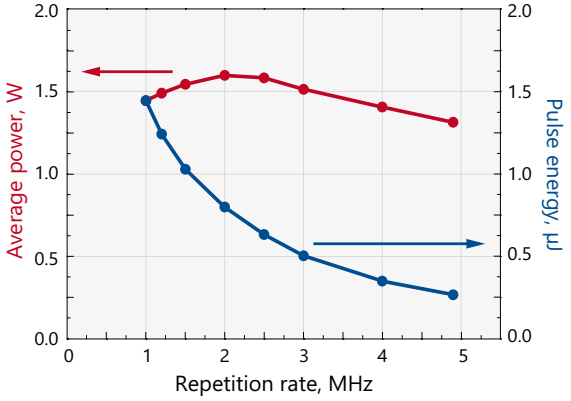


*Fig 2.* Typical dependence of output power and pulse energy of FemtoLux green laser **at 515 nm** on pulse repetition rate

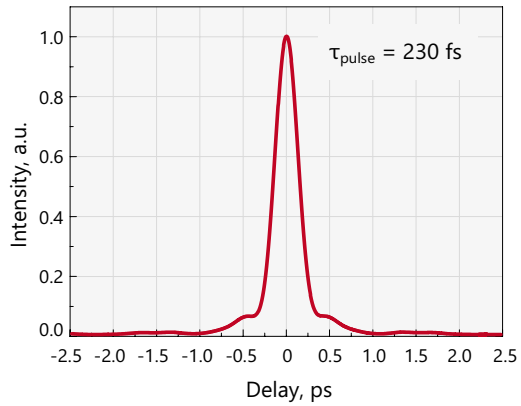


*Fig 3.* Typical FemtoLux laser (**at 1030 nm**) output pulse autocorrelation function at 3 µJ pulse energy. Calculated pulse duration is 230 fs

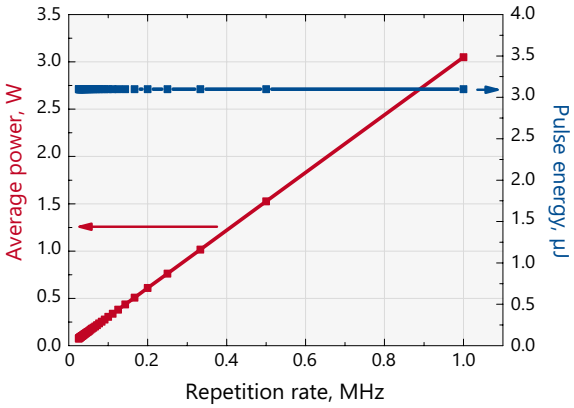


*Fig 4.* Typical dependence of output power and pulse energy of FemtoLux laser **at 1030 nm** when repetition rate is reduced by pulse picker. Internal repetition rate of the laser in this case is 1 MHz

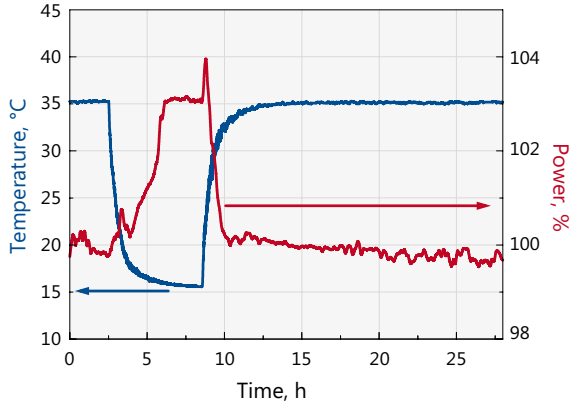


*Fig 5.* Average output power dependance on ambient temperature **at 1030 nm**

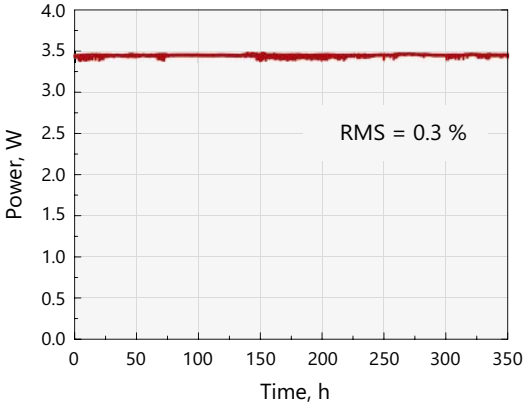


*Fig 6.* Typical long term average output power stability of FemtoLux laser **at 1030 nm** under constant environmental conditions

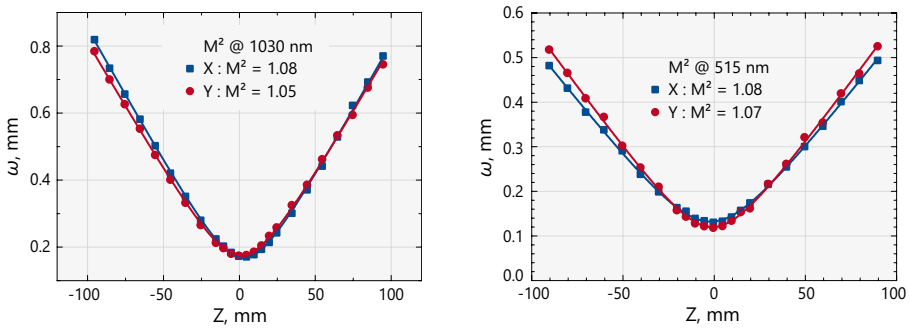


*Fig 7.* Typical $M^2$ measurement of FemtoLux green laser

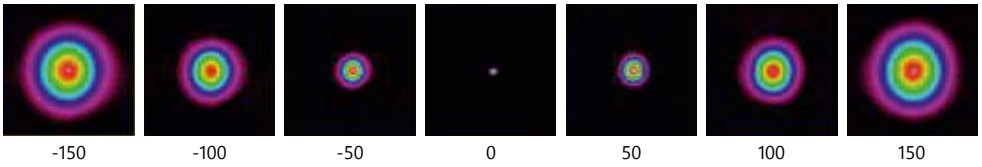


*Fig 8.* Typical beam profiles along propagation axis of FemtoLux series laser

## SOFTWARE

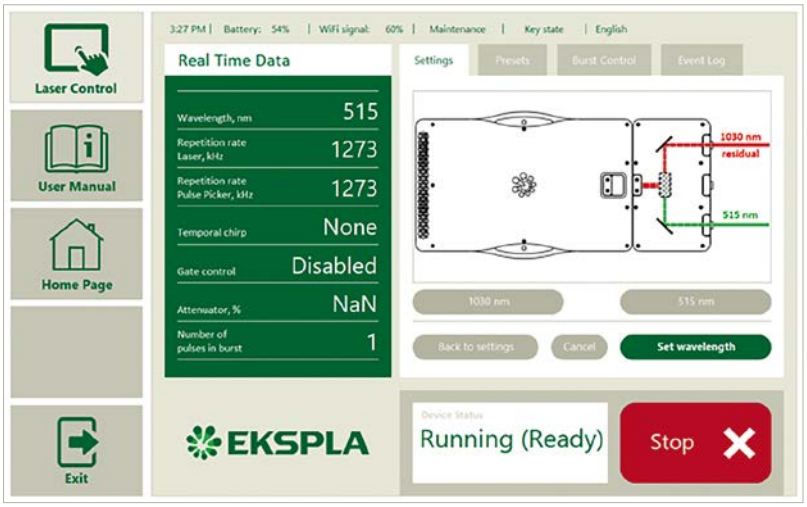


*Fig 9.* Example of FemtoLux control software

## APPLICATIONS EXAMPLES

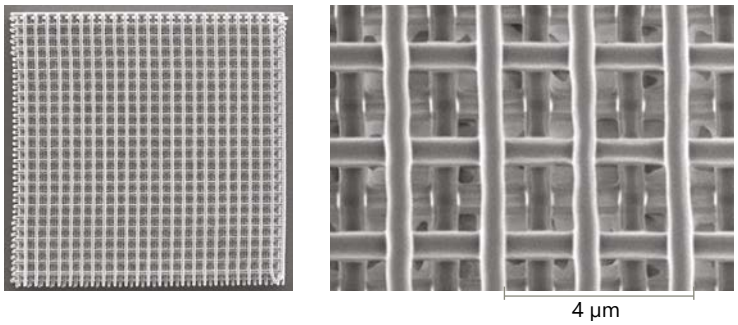


*Fig 10.* Photopolymerization samples made with FemtoLux.
*Courtesy of Workshop of Photonics*

## DRAWINGS

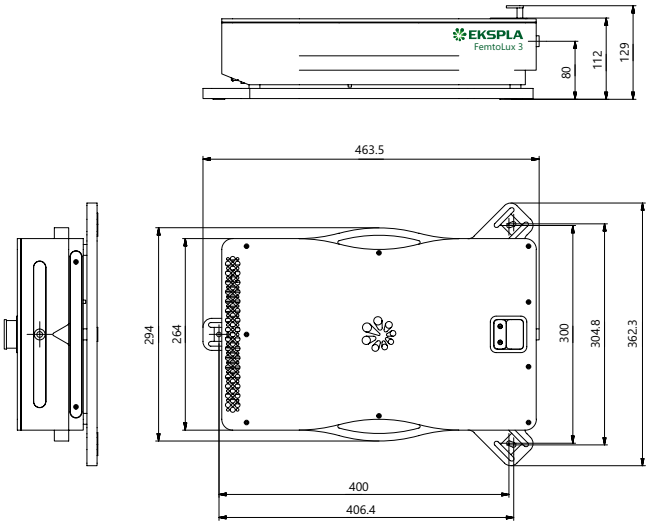


*Fig 11.* Outline drawing of FemtoLux 3 laser head

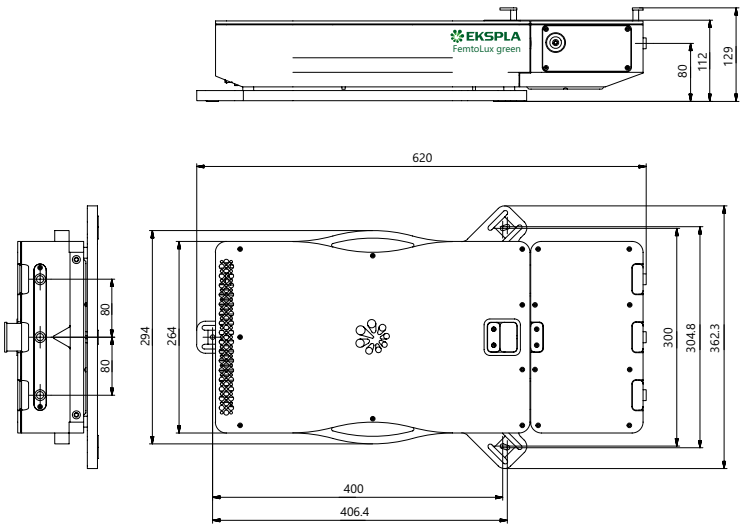


*Fig 12.* Outline drawing of FemtoLux green laser head

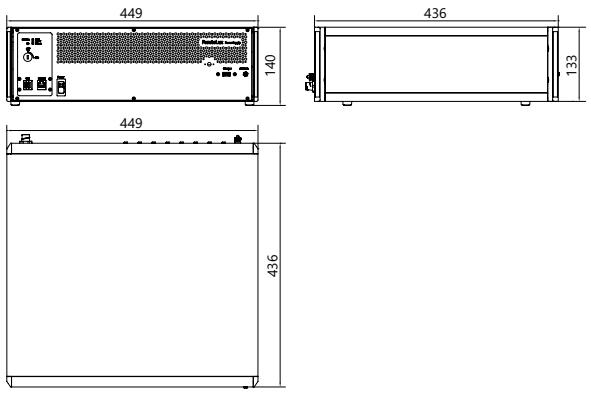


*Fig 13.* Outline drawing of FemtoLux stand-alone control unit

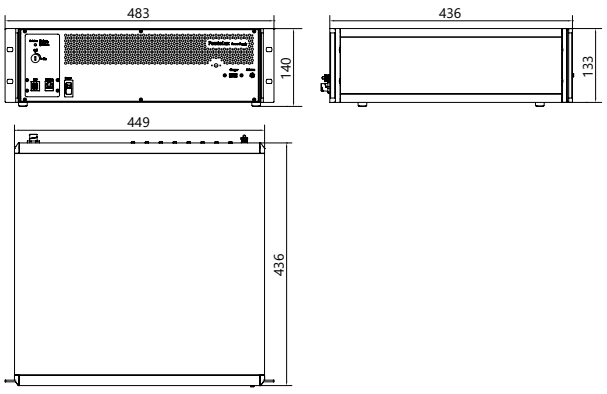


*Fig 14.* Outline drawing of FemtoLux 19" rack mountable control unit

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Tailored for consistency

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