GMP
GENERAL
MICROTECHNOLOGY
& PHOTONICS

EKSPLA

# Lasers and Laser Systems

Picosecond

ADVANCED LASER TECHNOLOGIES

2022

# About Company

## Background

EKSPLA focuses on the design and manufacturing of advanced lasers & systems and employs 30 years' experience as well as a close partnership with the scientific community. 76 out of the 100 top universities use EKSPLA lasers. The company is leading in the global market for scientific picosecond lasers.

Clients like CERN, NASA, ELI, Max Planck Institutes, Cambridge University and Massachusetts Institute of Technology have chosen Ekspla as their partner.

For scientist who needs unique instrument for research, we provide parameter tailored laser systems that enable customer to perform complex experiments. In-house design and manufacturing ensures operative design, manufacturing and customization of new products.

Highly stable and reliable EKSPLA lasers combined with our own subsidiaries in the US, UK and China as well as more than 20 approved representative offices with properly trained laser engineers worldwide, ensure short response time and fast laser service as well as maintenance.

## History

EKSPLA was founded about 30 years ago by a small team of engineers united around the idea of making the most advanced lasers in the world. EKSPLA was independent company with little money, but lots of creativity, and a deep technical understanding of lasers and how useful they could be for research and industry. From the start, the whole team had a deep mutual respect and believed in and supported each other. The first laser was sold at its first launch event, at an international exhibition in Germany. Soon after, the innovation was noticed by partners in Japan, and supply of the systems to leading universities there has been started. The concept of continuous improvement was admired and embraced, so it has become one of the key principles that apply to everything is done.

# Contents


KSPLA
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# FemtoLux 30

## Femtosecond Industrial Lasers


### FEATURES

- ***30 W*** *typical max output power*
- ***> 90 µJ*** *max pulse energy*
- ***> 250 µJ*** *in a burst mode*
- ***< 350 fs – 1 ps***
- ***Single shot to 4 MHz*** *(AOM controlled)*
- *<0.5% RMS power long term stability over 100 hours*
- *$M^2$ < 1.2*
- *Beam circularity > 0.85*
- *Zero maintenance*
- *Dry cooling (no water used)*
- *PSU and cooling unit integrated into single 4U rack housing*
- *Easy and quick installation*
- *Compatible with galvo and Polygon scanners as well as PSO controllers*
- *2 years of total warranty*

### APPLICATIONS

- *LCD, LED, OLED drilling, cutting and repair*
- *Microelectronics manufacturing*
- *Glass, sapphire and ceramics micro processing*
- *Glass intra volume structuring*
- *Micro processing of different polymers and metals*

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### INNOVATIVE "DRY" COOLING SYSTEM

The FemtoLux 30 laser employs an innovative cooling system and sets new reliability standards among industrial femtosecond lasers. No additional bulky and heavy water chiller is needed.

The chiller requires periodic maintenance – cooling system draining and rinsing and water and particle filter replacement. Moreover, water leakage can cause damage to the laser head and other equipment. Instead of using water for transferring heat from a laser head, the FemtoLux 30 laser uses an innovative Direct Refrigerant Cooling method.

The refrigerant agent circulates from a PSU-integrated compressor and condenser, to a cooling plate via armored flexible lines.

The entire cooling circuit is permanently hermetically sealed and requires no maintenance.

### SIMPLE & RELIABLE COOLING PLATE ATTACHMENT

The cooling plate is detachable from the laser head for more convenient laser installation.

The laser cooling equipment is integrated with the laser power supply unit into a single 4U rack-mounted housing with a total weight of 15 kg.

### PERFECT AND VERSATILE TOOL FOR MICROMACHINING

The FemtoLux 30 femtosecond laser has a tunable pulse duration from <350 fs to 1 ps and can operate in a broad AOM controlled range of pulse repetition rates from a single shot to 4 MHz.

The maximum pulse energy is more than 90 µJ operating with single pulses and can reach 250 µJ in burst mode, ensuring higher ablation rates and processing throughput for different materials.

The FemtoLux 30 beam parameters will meet the requirements of the most demanding materials and micro-machining applications.

Innovative laser control electronics ensure simple control of the FemtoLux 30 laser by external controllers that could run on different platforms, be it Windows, Linux or others using REST API commands.

This makes easy integration and reduces the time and human resources required to integrate this laser into any laser micromachining equipment.

## SPECIFICATIONS [1]

| Model | FemtoLux 30 |
|---|---|
| **MAIN SPECIFICATIONS** | |
| Wavelength | 1030 nm |
| Pulse Repetition Rate (PRR) [2] | 200 kHz – 4 MHz |
| Pulse repetition frequency (PRF) after frequency divider | PRF = PRR / N, N=1, 2, 3, ... , 65000; single shot |
| Maximal average output power | > 27 W (typical 30 W) |
| Maximal pulse energy | > 90 µJ |
| Maximal total energy in a burst mode [3] | > 250 µJ |
| Power long term stability (Std. dev.) [4] | < 0.5 % |
| Pulse energy stability (Std. dev.) [5] | < 1 % |
| Pulse duration (FWHM) | Tunable, < 350 fs [6] – 1 ps |
| Beam quality | $M^2$ < 1.2 (typical < 1.1) |
| Beam circularity, far field | > 0.85 |
| Beam divergence (full angle) | < 1 mrad |
| Beam pointing thermal stability | < 20 µrad/°C |
| Triggering mode | internal / external |
| Pulse output control | frequency divider, pulse picker, burst mode, packet triggering, power attenuation |
| Control interfaces | USB / RS232 / LAN |
| Length of the umbilical cord | 3 m, detachable |
| Laser head cooling type | dry (direct refrigerant cooling through detachable cooling plate) |
| **PHYSICAL CHARACTERISTICS** | |
| Laser head (W × L × H) | 429 × 569 × 130 mm |
| Power supply unit (W × L × H) | 449 × 376 × 177 mm |
| **OPERATING REQUIREMENTS** | |
| Mains requirements | 100 – 240 V AC, single phase, 50/60 Hz |
| Operating ambient temperature | 18 – 27 °C |
| Relative humidity | 10–80 % (non-condensing) |
| Air contamination level | ISO 9 (room air) or better |

1) Due to continuous improvement, all specifications are subject to change without notice. Parameters marked typical are not specifications. They are indications of typical performance and will vary with each unit we manufacture. All parameters are specified for a shortest pulse duration.

2) When frequency divider is set to transmit every pulse. Fully controllable by integrated AOM.

3) When number of pulses within a burst is set to 10 and PRR is set to a minimum value. Separation between pulses within a burst - ~20 ns.

4) Over 100 h after warm-up under constant environmental conditions.

5) Under constant environmental conditions.

6) At PRR > 500 kHz. At PRR < 500 kHz shortest pulse duration is < 400 fs.


### SEAMLESS USER EXPERIENCE

- *Easy integration.*
  *Remote control using REST API commands via USB, RS232 and LAN*
- *Reduced integration time.*
  *Demo electronics is available for laser control programming in advance*
- *Easy and quick installation.*
  *No water, fully disconnected laser head. Can be installed by the end-user.*
- *Easy troubleshooting.*
  *Integrated detectors and constant system status logging.*
- *No periodic maintenance required*



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## PERFORMANCE

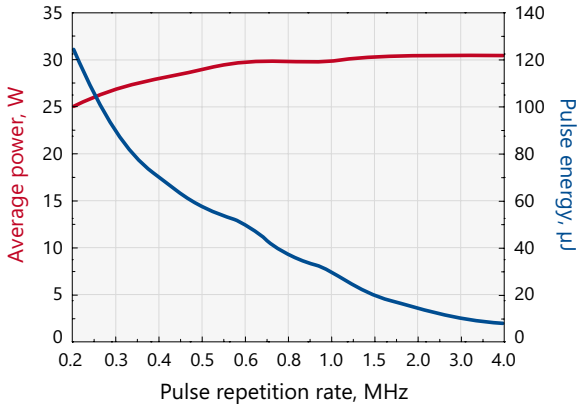



*Fig 1.* Typical dependence of output power and pulse energy of FemtoLux 30 laser on pulse repetition rate

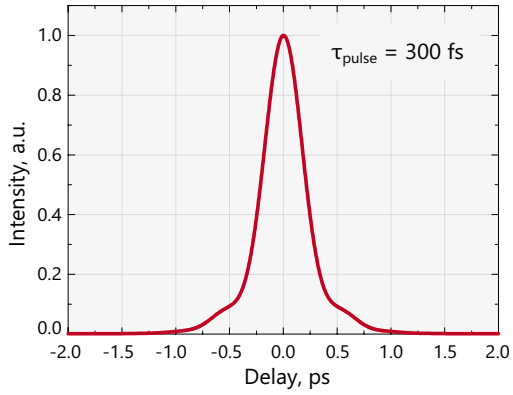



*Fig 2.* Typical FemtoLux 30 laser (at 1030 nm) output pulse autocorrelation function

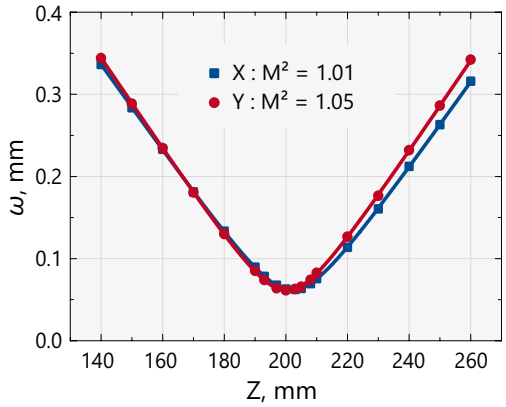



*Fig 3.* Typical $M^2$ measurement of FemtoLux 30 laser at 1030 nm

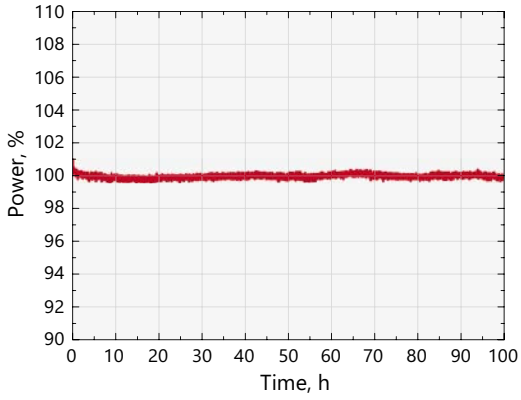



*Fig 4.* Typical long term average power stability of FemtoLux 30 laser at 1030 nm under constant environmental conditions

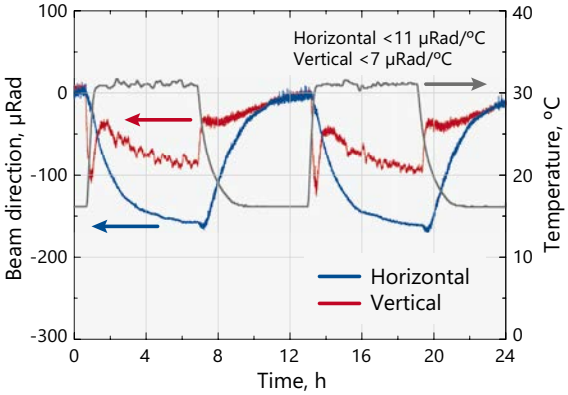



*Fig 5.* Typical beam direction stability of FemtoLux 30 under harsh environmental conditions

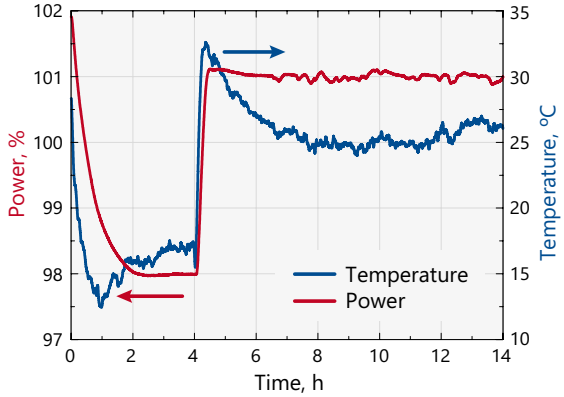
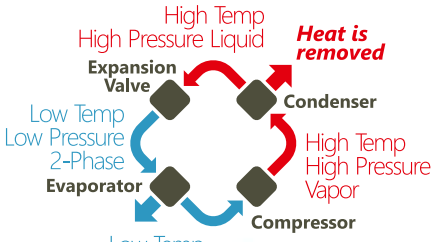



*Fig 6.* Average output power dependance of FemtoLux 30 laser on ambient temperature at 1030 nm

## DIRECT REFRIGERANT COOLING SYSTEM

### FEATURES

- *Military-grade reliability*
- *Permanently hermetically sealed system >90,000 hour MTBF*
- *No maintenance*
- *High cooling efficiency*
- *>45% lower power consumption compared to water cooling equipment*
- *Compact and light*




Compressor picture courtesy of Aspen Systems Inc.



Simple and reliable cooling plate attachment

## DRAWINGS

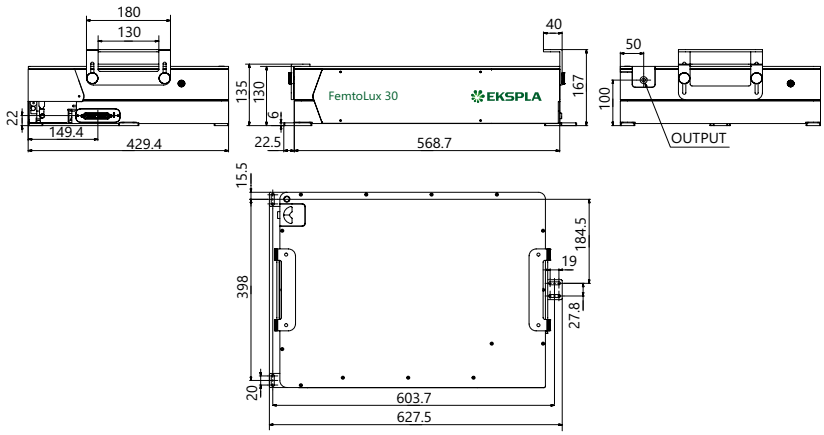



*Fig 7.* FemtoLux 30 laser head outline drawing

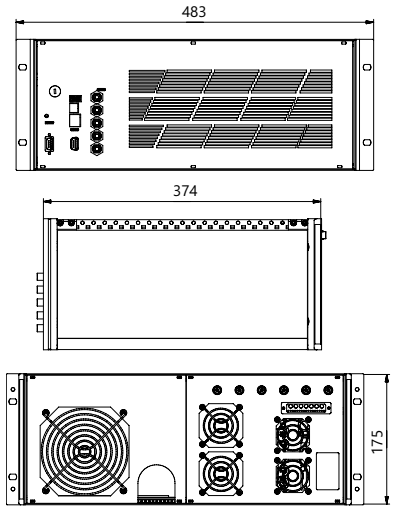



*Fig 8.* Power supply outline drawing



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# FemtoLux 3

## Microjoule Class Femtosecond Industrial Lasers


FemtoLux 3 is a modern femtosecond fiber laser aimed for both R&D use and industrial integration. Tunable pulse duration in a range of 300 fs – 5 ps, adjustable pulse repetition rate up to 10 MHz and adjustable pulse energy up to 3 µJ allows optimization of laser parameters for the desired application. These include marking and volume structuring of transparent materials, photopolymerization, biological imaging, nonlinear microscopy and many others. To expand the scope of applications even further this laser can be equipped with a second harmonics module.

With burst mode enabled, FemtoLux 3 can generate bursts of pulses with energy above 10 µJ with instant burst shape control which can significantly improve the efficiency of some processes.

Having a rigid, compact, passive air-cooled laser head and the possibility to control the laser from a wireless tablet, FemtoLux 3 can be integrated with different equipment, be it laser equipment for material micro-processing, microscopy or any other research equipment.

Ask for separate brochure

### FEATURES

- ***300 fs ... 5 ps** tunable pulse duration*
- *Output power **3 W at 1030 nm** or **1.2 W at 515 nm***
- *Up to **3 µJ/pulse** and **10 µJ/burst** (at 1030 nm)*
- *Up to **1.2 µJ/pulse** and **5 µJ/burst** (at 515 nm)*
- *Excellent beam quality **$M^2$ < 1.2***
- *Versatile laser control and syncronisation capabilities*
- *Up to **10 MHz** pulse repetition rate*
- *Smart triggering for synchronous operation with polygon scanner and PSO*
- *Instant amplitude control*
- *Passive air cooling of the laser head*
- *24/7 operation*

### APPLICATIONS

- *Inner volume marking of transparent materials*
- *Marking and structuring*
- *Micromachining of brittle materials*
- *Photopolymerization*
- *Ophthalmologic surgery*
- *Biological Imaging*
- *Pumping of femtosecond OPO/OPA*
- *Microscopy*

## SPECIFICATIONS [1]

| Model | FemtoLux 3 |
|---|---|
| **MAIN SPECIFICATIONS** | |
| Central wavelength | |
| Fundamental | 1030 ± 2 nm |
| With second harmonic option | 515 ± 1 nm |
| Minimal pulse duration (FWHM) at 1030 nm | < 300 fs (typical ~230 fs) |
| Pulse duration tuning range | 300 fs – 5 ps |
| Maximal average output power [2] | |
| at 1030 nm | > 3 W |
| at 515 nm | > 1.2 W |
| Power long term stability (Std. dev.) [3] | ≤ 0.5 % |
| Maximal pulse energy [2] | |
| at 1030 nm | > 3 µJ |
| at 515 nm | > 1.2 µJ |
| Pulse energy stability (Std. dev.) [4] | < 2 % |
| Laser pulse repetition rate ($PRR_L$) range [5] | 1 – 10 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 | |
| at 1030 nm | > 10 µJ |
| at 515 nm | > 5 µJ |
| Burst shape control | via analog input |
| Power attenuation | 0 – 100 % from remote control application 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 circularity (far field) | > 0.85 |
| Beam pointing stability (pk-to-pk) [7] | < 30 µrad |
| Beam diameter ($1/e^2$) at 20 cm distance from laser aperture | |
| at 1030 nm | 2.0 ± 0.3 mm |
| at 515 nm | 1.0 ± 0.2 mm |
| **OPERATING REQUIREMENTS** | |
| Mains requirements | 100–240 V AC, 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 of the laser head | air, passive |
| Laser head size (L×W×H) | |
| at 1030 ± 2 nm | 464 × 363 × 129 mm |
| at 515 ± 1 nm | 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. Parameters marked typical are not specifications. They are indications of typical performance and will vary with each unit we manufacture.

[2] See typical power and energy curves for other pulse repetition rates at Fig 1., Fig 2. and Fig 4.

[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] Pulse separation inside the burst 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.




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## PERFORMANCE

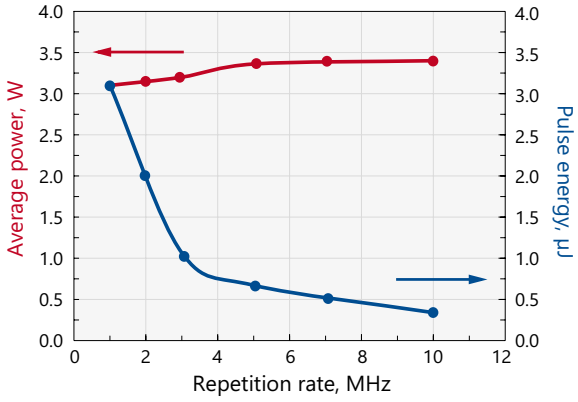


*Fig 1.* Typical dependence of output power and pulse energy of FemtoLux 3 laser **at 1030 nm** when changing internal repetition rate of the laser

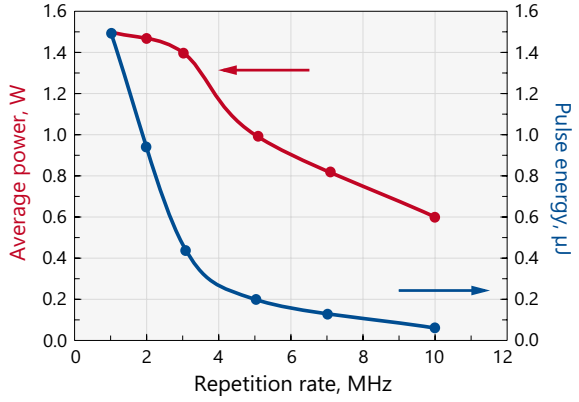


*Fig 2.* Typical dependence of output power and pulse energy of FemtoLux 3 laser **at 515 nm** on pulse repetition rate

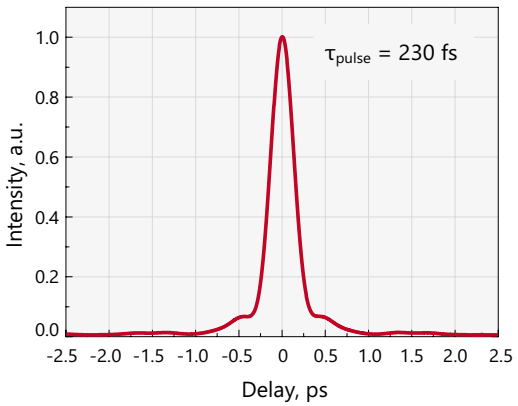


*Fig 3.* Typical FemtoLux 3 laser (**at 1030 nm**) output pulse autocorrelation function at 3 µJ pulse energy. Calculated pulse duration is 230 fs

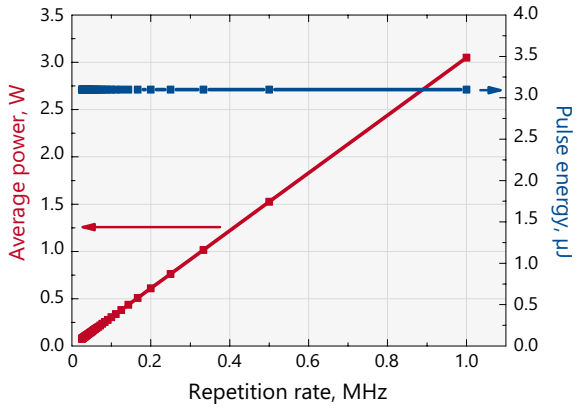


*Fig 4.* Typical dependence of output power and pulse energy of FemtoLux 3 laser **at 1030 nm** when repetition rate is reduced by pulse picker. Internal repetition rate of the laser in this case is 1 MHz

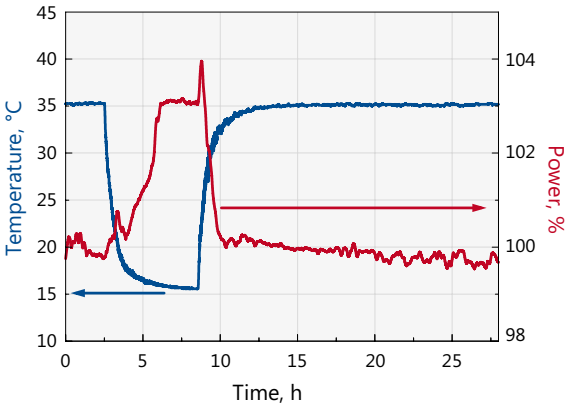


*Fig 5.* Average output power dependance on ambient temperature **at 1030 nm**

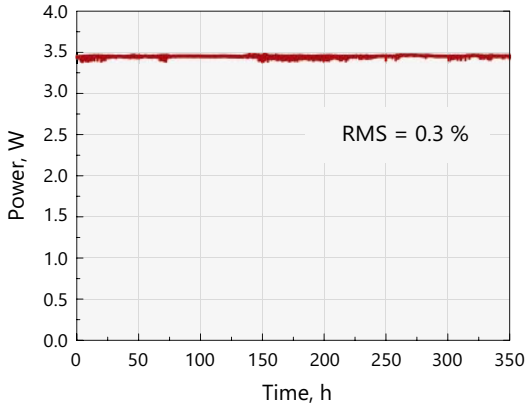


*Fig 6.* Typical long term average output power stability of FemtoLux 3 laser **at 1030 nm** under constant environmental conditions

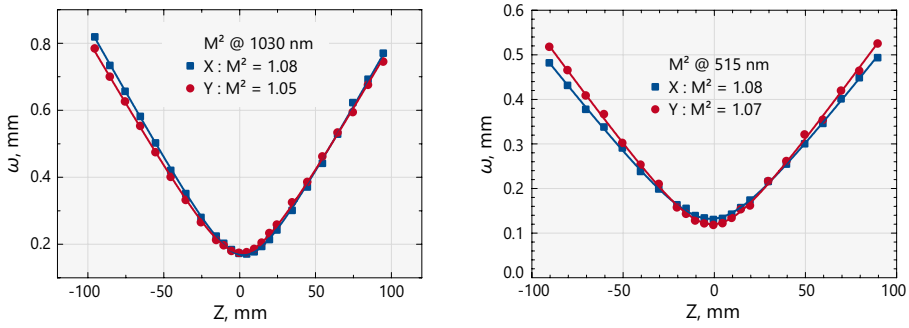


*Fig 7.* Typical $M^2$ measurement of FemtoLux 3 laser

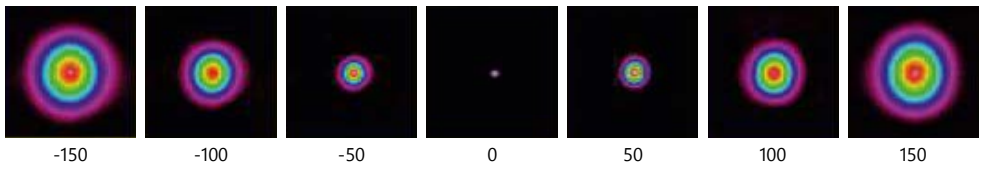


*Fig 8.* Typical beam profiles along propagation axis of FemtoLux 3 series laser

## REMOTE CONTROL APPLICATION

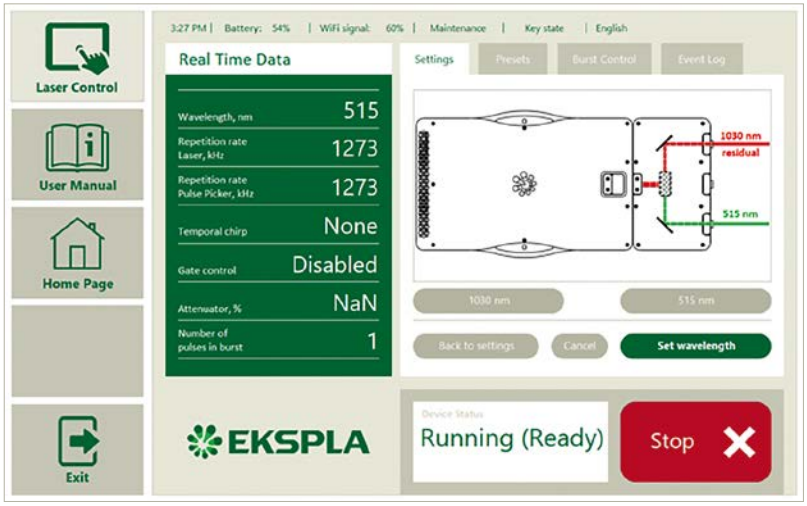


*Fig 9.* Example of FemtoLux 3 remote control application



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## DRAWINGS

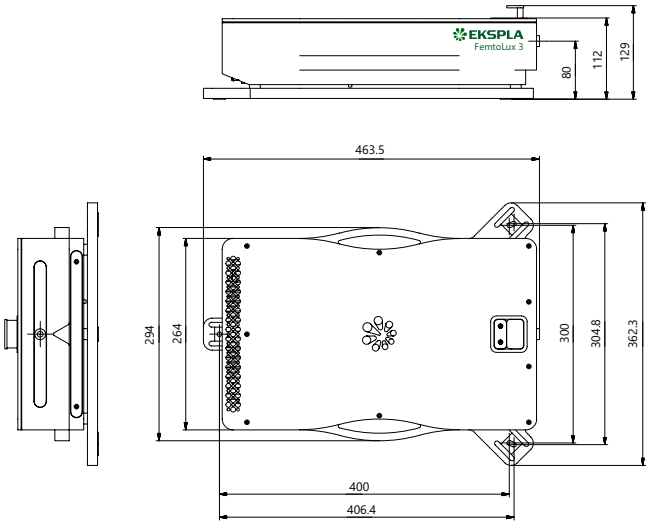


*Fig 11.* Outline drawings of FemtoLux 3 laser head

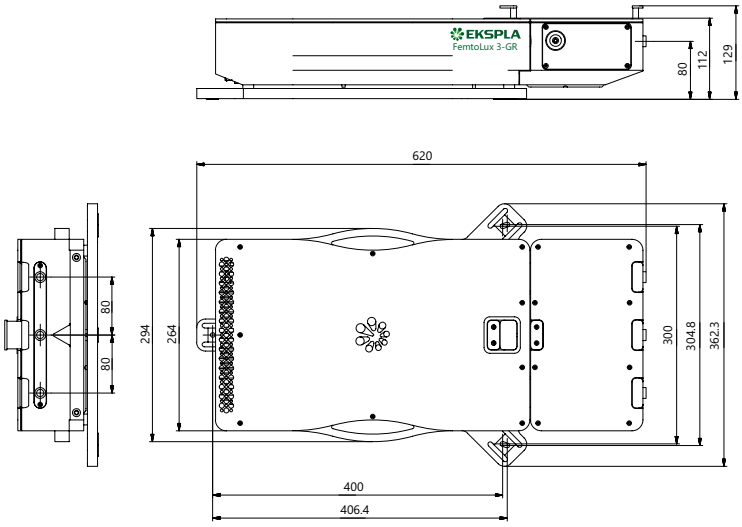


*Fig 12.* Outline drawings of FemtoLux 3 laser head with second harmonic option

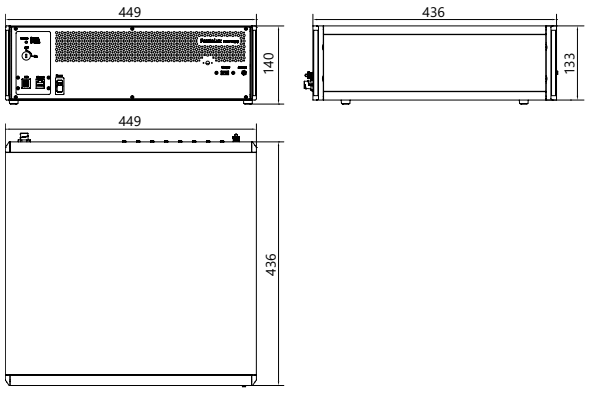


*Fig 13.* Outline drawings of FemtoLux 3 stand-alone control unit

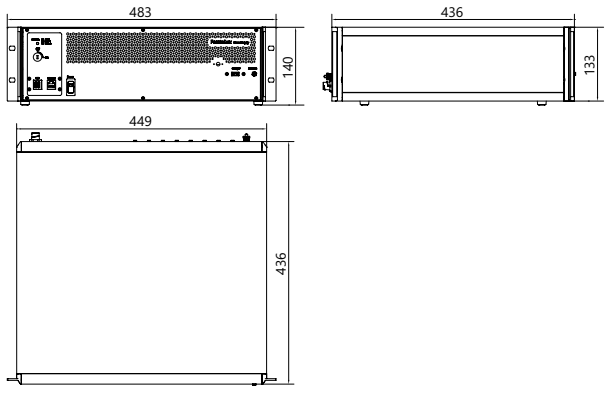


*Fig 14.* Outline drawings of FemtoLux 3 19" rack mountable control unit


PL2230 series picosecond laser employs innovative DPSS only technology to ensure high pulse energies with longer periods between maintenance

# Picosecond Lasers

The first EKSPLA picosecond laser has been sold on its first launch event in exhibition in Germany more than 28 years ago. Due to their excellent stability and high output parameters EKSPLA scientific picosecond lasers established their name as "Gold Standard" among scientific picosecond lasers.

Innovative design of new generation of picosecond mode-locked lasers feature diode-pumping-only technology, thus reducing maintenance costs and improving output parameters.

Second, third, fourth and fifth (on some versions) harmonic options combined with various accessories, advanced electronics (for streak camera synchronization, phase-locked loop, synchronization of fs laser) and customization possibilities make these lasers well suited for many scientific applications, including optical parametric generator pumping, time-resolved spectroscopy, nonlinear spectroscopy, remote sensing, metrology...

For customer convenience the laser can be operated from master device or personal computer through USB (VCP, ASCII commands), RS232 (ASCII commands), LAN (REST API) or RS232 (ASCII commands), LAN (REST API) depending on the system configuration or from remote control pad with backlit display that is easy to read even while wearing laser safety glasses.

## SHORT SELECTION GUIDE

For Your convenience, table contains all available options and highest parameter values. Not all output specifications are available at the same time simultaneously. Please refer to the catalog page for exact specifications and available options.

| Model | Max pulse energy at fundamental wavelength | Repetition rate, up to | Pumping | Pulse duration | Special feature | Page |
|---|---|---|---|---|---|---|
| **PL2210** | 5 mJ at 1064 nm | 1000 Hz | Diode pumped solid state | 29 ± 4 ps | kHz repetition rate | 16 |
| **PL2230** | 40 mJ at 1064 nm | 100 Hz | Diode pumped solid state | 29 ± 4 ps | High pulse energy employing DPSS only technology | 19 |
| **PL2250** | 100 mJ | 20 Hz | Hybrid (DPSS master oscillator and flash-lamp pumped power amplifier) | 29 ± 4 ps | High pulse energy | 23 |

# PL2210 SERIES

## Diode Pumped Picosecond kHz Pulsed Nd:YAG Lasers


PL2210 series diode-pumped, air-cooled, mode-locked Nd:YAG lasers provide picosecond pulses at a kilohertz pulse repetition rate.

Short pulse duration, excellent pulse-to-pulse stability, superior beam quality makes PL2210 series diode pumped picosecond lasers well suited for many applications, including material processing, time-resolved spectroscopy, optical parametric generator pumping, and other tasks.

### Flexible design

PL2210 series lasers offer a number of optional items that extend the capabilities of the laser.
A pulse picker option allows control of the pulse repetition rate of the laser and operation in single-shot mode.

The repetition rate and timing of pulses can be locked to an external RF source (with –PLL option) or other ultrafast laser system (with –FS option). The laser provides a triggering pulse for synchronization of the customer's equipment. A low jitter SYNC OUT pulse has a lead up to 500 ns that can be adjusted in ~0.25 ns steps from a PC. Up to 400 µs lead of triggering pulse is available as a PRETRIG feature that is designed to provide precise, very low jitter trigger pulses for a streak camera.

### Built-in harmonic generators

Motorised switching of wavelength for PL2210A. Non-linear crystals mounted in temperature stabilized heaters are used for second, third and fourth high spectral purity harmonic generation.

### Available models [1)]

| Model | Features |
|---|---|
| PL2210A-1k | Up to 900 µJ, 28 ps pulses at an up to 1 kHz repetition rate |
| PL2211A | Up to 5 mJ energy at a 1 kHz repetition rate at 28 ps pulses |

1) Custom-built models with higher pulse energy are available on request.

### FEATURES

- *High pulse energy at **kHz rates***
- *Diode pumped **solid state** design*
- ***Air cooled** – external water supply is not required (for PL2210A-1k only)*
- *Turn-key operation*
- *Low maintenance costs*
- *Optional streak camera triggering pulse with <10 ps rms jitter*
- *Remote control pad*
- *PC control*
- *Optional temperature stabilized second, third and fourth **harmonic generators***

### APPLICATIONS

- *Time resolved fluorescence (including streak camera measurements), pump-probe spectroscopy*
- *OPG/OPA/OPO pumping*
- *Remote Laser Sensing*
- *Other spectroscopic and nonlinear optics applications*

### Simple and convenient laser control

For customer convenience the laser can be operated from master device or personal computer through USB (VCP, ASCII commands), RS232 (ASCII commands), LAN (REST API) or RS232 (ASCII commands), LAN (REST API) depending on the system configuration or from remote control pad with backlit display that is easy to read even while wearing laser safety glasses.

## SPECIFICATIONS [1]

| Model | PL2210A | PL2211A |
|---|---|---|
| Output energy | | |
| at 1064 nm | 0.9 mJ | 5 mJ |
| at 532 nm [2] | 0.45 mJ | 2.5 mJ |
| at 355 nm [3] | 0.35 mJ | 1.6 mJ |
| at 266 nm [4] | 0.16 mJ | 1 mJ |
| Pulse energy stability (StdDev) [5] | | |
| at 1064 nm | 0.5 % | |
| at 532 nm | 0.8 % | |
| at 355 nm | 1 % | |
| at 266 nm | 2 % | |
| Pulse duration (FWHM) [6] | 29 ± 4 ps | |
| Pulse repetition rate | 1 kHz | |
| Triggering mode | internal/external | |
| Typical TRIG1 OUT pulse delay [8] | -500 ... 50 ns | |
| TRIG1 OUT pulse jitter | < 0.1 ns rms | |
| Spatial mode [9] | Close to Gaussian | |
| Beam divergence [10] | <1 mrad | |
| Beam diameter [11] | 1.7 ± 0.3 mm | ~3 mm |
| Beam pointing stability [12] | < 30 µrad | |
| Pre-pulse contrast | > 200 : 1 | |
| Polarization | linear, >100 : 1 | |
| **PHYSICAL CHARACTERISTICS** | | |
| Laser head size (W × L × H) [13] | 456 × 1031 × 249 mm | |
| Power supply size (W × L × H) | 365 × 392 × 290 mm | 550 × 600 × 550 ±3 mm (19" standard, MR-9) |
| **OPERATING REQUIREMENTS** | | |
| Water service | not required, air cooled | |
| Relative humidity | 20–80 % (non condensing) | |
| Ambient temperature | 22 ± 2 °C | |
| Power requirements | 100–240 V AC, single phase 50/60 Hz | |
| Power consumption [14] | <1 kW | <1.5 kW |

1) Due to continuous improvement, all specifications are subject to change without notice. Parameters marked typical are not specifications. They are indications of typical performance and will vary with each unit we manufacture. Unless stated otherwise, all specifications are measured at 1064 nm and for basic system without options.

2) For PL2210 series laser with –SH, -SH/TH, -SH/FH or -SH/TH/FH option. Outputs are not simultaneous.

3) For PL2210 series laser with –TH, -SH/TH or -SH/TH/FH option. Outputs are not simultaneous.

4) For PL2210 series laser with -SH/FH or -SH/TH/FH option. Outputs are not simultaneous.

5) Averaged from pulses, emitted during 30 sec time interval.

6) Optional 80 or 22 ps ± 10% duration. Pulse energy specifications may differ from indicated here.

7) With respect to optical pulse. <10 ps rms jitter is provided optionally with PRETRIG feature.

8) TRIG1 OUT lead or delay can be adjusted with 0.25 ns steps in specified range.

9) Near field Gaussian fit is >90%.

10) Average of X- and Y-plane full angle divergence values measured at the $1/e^2$ level at 1064 nm.

11) Beam diameter is measured at 1064 nm at the $1/e^2$ point.

12) Beam pointing stability is evaluated from fluctuations of beam centroid position in the far field.

13) 456×1233×249 mm (W×L×H) laser head size might be required for some optional configurations.

14) At 1 kHz pulse repetition rate.

## OPTIONS

- **PRETRIG** provides low jitter pulse for streak camera triggering with lead/delay in -400...600 µs range and <10 ps rms jitter.
- **Option P80** provides 80 ps ± 10 % output pulse duration. Inquire for pulse energy specifications.
- **Option P20** provides 22 ps ± 10 % output pulse duration. Inquire for pulse energy specifications.
- **Option PC** allows reduction of the pulse repetition rate of the PL2210 series laser by integer numbers. Single shot mode is also possible. In addition, the –PC option reduces the low-intensity quasi-CW background that is present at laser output at 1064 nm wavelength. Please note that the output of fundamental wavelength and harmonic will be reduced by approx. 20% with installation of the –PC option.

## BEAM PROFILE

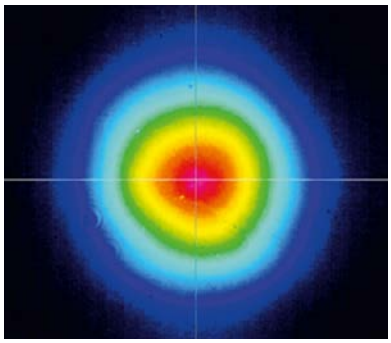

*Fig 1.* Typical PL2210 series laser near field beam profile at 1064 nm except PL2211A

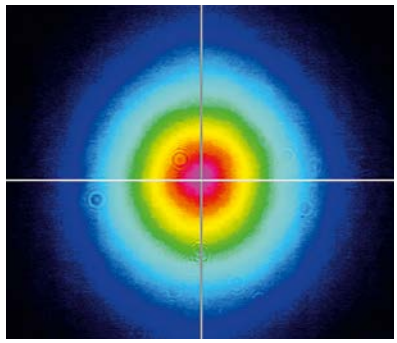

*Fig 2.* Typical PL2211A laser near field beam profile at 1064 nm

## OUTLINE DRAWINGS

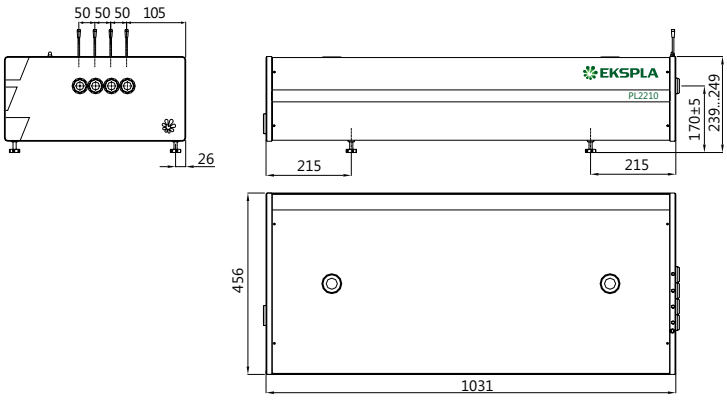


*Fig 3.* Dimensions of PL2210 series laser head

## ORDERING INFORMATION

**Note:** Laser must be connected to the mains electricity all the time. If there will be no mains electricity for longer that 1 hour then laser (system) needs warm up for a few hours before switching on.

**PL2210A-SH/TH/FH-P20**

- Model
- Pulse energy level, A for 0.9 mJ output
- Harmonic generator options:
  - SH → second harmonic
  - TH → third harmonic
  - FH → fourth harmonic
- Other pptions:
  - P80 → 80 ps pulse duration option
  - P20 → 20 ps pulse duration option
  - PC → pulse picker option
  - PLL → pulse repetition rate locking option



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# PL2230 SERIES

## Diode Pumped High Energy Picosecond Nd:YAG Lasers


### Innovative design

The heart of the system is a diode pumped solid state (DPSS) master oscillator placed in a sealed monolithic block, producing high repetition rate pulse trains (87 MHz) with a low single pulse energy of several nJ. Diode pumped amplifiers are used for amplification of the pulse to 30 mJ or up to 40 mJ output. The high-gain regenerative amplifier has an amplification factor in the proximity of $10^6$. After the regenerative amplifier, the pulse is directed to a multipass power amplifier that is optimized for efficient stored energy extraction from the Nd:YAG rod, while maintaining a near Gaussian beam profile and low wavefront distortion. The output pulse energy can be adjusted in approximately 1% steps, while pulse-to-pulse energy stability remains at less than 0.5% rms at 1064 nm.

Angle-tuned KD*P and KDP crystals mounted in thermostabilised ovens are used for second, third, and fourth harmonic generation. Harmonic separators ensure the high spectral purity of each harmonic guided to different output ports.

Built-in energy monitors continuously monitor output pulse energy. Data from the energy monitor can be seen on the remote keypad or on a PC monitor. The laser provides triggering pulses for the synchronisation of your equipment. The lead of the triggering pulse can be up to 500 ns and is user adjustable in ~0.25 ns steps from a personal computer. Up to 1000 µs lead of triggering pulse is available as a pretrigger feature. Precise pulse energy control, excellent short-term and long-term stability, and a 50 Hz repetition rate makes PL2230 series lasers an excellent choice for many demanding scientific applications.

### Simple and convenient laser control

For customer convenience the laser can be operated from master device or personal computer through USB (VCP, ASCII commands), RS232 (ASCII commands), LAN (REST API) or RS232 (ASCII commands), LAN (REST API) depending on the system configuration or from remote control pad with backlit display that is easy to read even while wearing laser safety glasses.

### FEATURES

- *Diode pumped power amplifier producing up to **40 mJ** per pulse at 1064 nm*
- *Beam profile improvement using advanced beam shaping system*
- *Hermetically sealed DPSS master oscillator*
- *Diode pumped regenerative amplifier*
- *Air-cooled*
- ***<30 ps** pulse duration*
- *Excellent pulse duration stability*
- *Up to **100 Hz** repetition rate*
- *Streak camera triggering pulse with <10 ps jitter*
- *Excellent beam pointing stability*
- *Thermo stabilized second, third or fourth harmonic generator options*
- *PC control*
- *Remote control via keypad*

### APPLICATIONS

- *Time resolved fluorescence (including streak camera measurements)*
- *SFG/SHG spectroscopy*
- *Nonlinear spectroscopy*
- *Laser-induced breakdown spectroscopy*
- *OPG pumping*
- *Remote laser sensing*
- *Satellite ranging*
- *Other spectroscopic and nonlinear optics applications*

## SPECIFICATIONS [1]

| Model | PL2230-100 | PL2231-100 | PL2231-50 | PL2231A-50 |
|---|---|---|---|---|
| Pulse energy [2] | | | | |
| at 1064 nm | 3 mJ | 12 mJ | 30 mJ | 40 mJ |
| at 532 nm [3] | 1.3 mJ | 5 mJ | 13 mJ | 18 mJ |
| at 355 nm [4] | 0.9 mJ | 3.5 mJ | 9 mJ | 13 mJ |
| at 266 nm [5] | 0.3 mJ | 1.2 mJ | 3 mJ | 5 mJ |
| at 213 nm [6] | inquire | | | |
| Pulse energy stability (StdDev) [7] | | | | |
| at 1064 nm | < 0.2 % | < 0.5 % | | |
| at 532 nm | < 0.4 % | < 0.8 % | | |
| at 355 nm | < 0.5 % | < 1.1 % | | |
| at 266 nm | < 0.5 % | < 1.2 % | | |
| at 213 nm | < 1.5 % | < 1.5 % | | |
| Pulse duration (FWHM) [8] | 29 ± 4 ps | | | |
| Pulse duration stability [9] | ± 1 % | | | |
| Power drift [10] | ± 2 % | | | |
| Pulse repetition rate | 0 – 100 Hz | 100 Hz | 50 Hz | 50 Hz |
| Polarization | vertical, >99 % at 1064 nm | | | |
| Pre-pulse contrast | > 200 : 1 (peak-to-peak with respect to residual pulses) | | | |
| Beam profile [11] | close to Gaussian in near and far fields | | | |
| Beam divergence [12] | < 1.5 mrad | < 0.7 mrad | | |
| Beam propagation ratio $M^2$ | < 1.3 | < 2.5 | | |
| Beam pointing stability [13] | ≤ 10 µrad StdDev | ≤ 20 µrad StdDev | | |
| Typical beam diameter [14] | ~ 2 mm | ~ 6 mm | | ~ 7 mm |
| Optical pulse jitter | | | | |
| Internal triggering regime [15] | <50 ps (StdDev) with respect to TRIG1 OUT pulse | | | |
| External triggering regime [16] | ~3 ns (StdDev) with respect to SYNC IN pulse | | | |
| TRIG1 OUT pulse delay [17] | -500 ... 50 ns | | | |
| Typical warm-up time | 5 min | 15 min | | |
| **PHYSICAL CHARACTERISTICS** | | | | |
| Laser head size (W × L × H) | 456×1031×249 ± 3 mm | | | |
| Electrical cabinet size (W × L × H) | 12 V DC power adapter, 85×170×41 ± 3 mm | 471×391×147 ± 3 mm | | |
| Umbilical length | 2.5 m | | | |
| **OPERATING REQUIREMENTS** | | | | |
| Cooling [18] | stand-alone chiller | | | |
| Room temperature | 22±2 °C | | | |
| Relative humidity | 20 – 80 % (non-condensing) | | | |
| Power requirements | 110–240 V AC, 50/60 Hz | Single phase, 110–240 V AC, 5 A, 50/60 Hz | | |
| Power consumption | < 0.15 kVA | < 1.0 kVA | | |

1) Due to continuous improvement, all specifications are subject to change without notice. Parameters marked typical are not specifications. They are indications of typical performance and will vary with each unit we manufacture. Unless stated otherwise, all specifications are measured at 1064 nm and for basic system without options.

2) Outputs are not simultaneous.

3) For PL2230 series laser with –SH, -SH/TH, -SH/FH or -SH/TH/FH option or –SH/TH/FH/FiH module.

4) For PL2230 series laser with –TH, -SH/TH or -SH/TH/FH option or –SH/TH/FH/FiH module.

5) For PL2230 series laser with -SH/FH or -SH/TH/FH option or –SH/TH/FH/FiH module.

6) For PL2230 series laser with –SH/TH/FH/FiH module.

7) Averaged from pulses, emitted during 30 sec time interval.

8) FWHM. Inquire for optional pulse durations in 20 – 90 ps range. Pulse energy specifications may differ from indicated here.

9) Measured over 1 hour period when ambient temperature variation is less than ±1 °C.

10) Measured over 8 hours period after 20 min warm-up when ambient temperature variation is less than ± 2 °C.

11) Near field Gaussian fit is >80%.

12) Average of X- and Y-plane full angle divergence values measured at the $1/e^2$ level at 1064 nm.

13) Beam pointing stability is evaluated from fluctuations of beam centroid position in the far field.

14) Beam diameter is measured at 1064 nm at the $1/e^2$ level.

15) With respect to TRIG1 OUT pulse. <10 ps jitter is provided optionally with PRETRIG feature.


16) With respect to SYNC IN pulse.

17) TRIG1 OUT lead or delay can be adjusted with 0.25 ns steps in specified range.

18) Air cooled. Adequate room air conditioning should be provided.

If laser is optimised for pumping parametrical generator, maximum output energy may be different than specified for stand alone application.



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## Custom products, tailored for specific applications [1]

| Model | PL2231C-20 (inquire) |
|---|---|
| Pulse energy [2] | |
| at 1064 nm | 140 mJ |
| at 532 nm [3] | 60 mJ |
| at 355 nm [4] | 35 mJ |
| at 266 nm [5] | 15 mJ |
| Pulse duration (FWHM) [6] | 80 ps ± 10 % |
| Pulse repetition rate | 20 Hz |

[1] Due to continuous improvement, all specifications are subject to change without notice. Parameters marked typical are not specifications. They are indications of typical performance and will vary with each unit we manufacture. Unless stated otherwise, all specifications are measured at 1064 nm and for basic system without options. Specifications for model PL2231C are preliminary and should be confirmed against quotation and purchase order.

[2] Outputs are not simultaneous.

[3] For PL2230 series laser with –SH, -SH/TH, -SH/FH or -SH/TH/FH option or –SH/TH/FH/FiH module.

[4] For PL2230 series laser with –TH, -SH/TH or -SH/TH/FH option or –SH/TH/FH/FiH module.

[5] For PL2230 series laser with -SH/FH or -SH/TH/FH option or –SH/TH/FH/FiH module.

[6] FWHM. Inquire for optional pulse durations in 20 – 90 ps range. Pulse energy specifications may differ from indicated here.

## OPTIONS

- **Option P20** provides 20 ps ±10% output pulse duration. Pulse energies are ~ 30 % lower in comparison to the 28 ps pulse duration version. See table below for pulse energy specifications:

| Model | PL2231-50 | PL2231A-50 |
|---|---|---|
| 1064 nm | 23 mJ | 28 mJ |
| 532 nm | 9 mJ | 13 mJ |
| 355 nm | 6 mJ | 9 mJ |
| 266 nm | 2 mJ | 4 mJ |

- **Option P80** provides 80 ps ± 10% output pulse duration. Pulse energy specifications are same as those of 28 ps lasers.

- **Option PLL** allows locking the master oscillator pulse train repetition rate to an external RF generator, enabling precise external triggering with low jitter. Inquire for more information.

## BEAM PROFILE

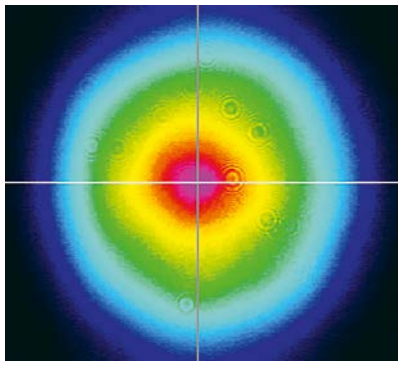

*Fig 1.* Typical near field output beam profile of PL2230 model laser

## OUTLINE DRAWINGS

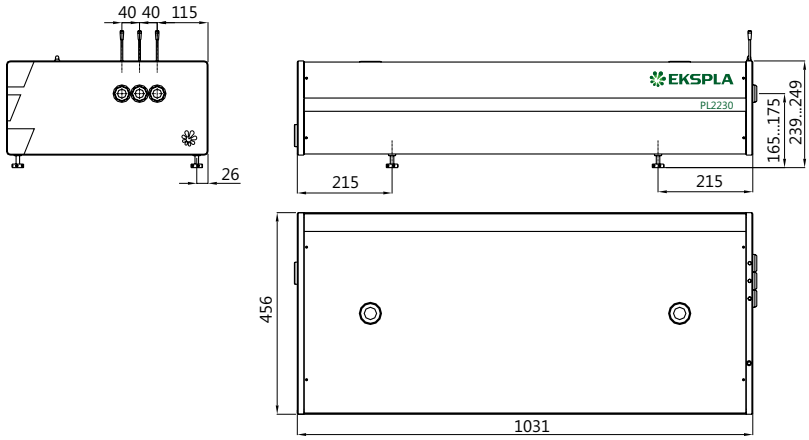


*Fig 2.* Dimensions of PL2230 series laser head

## ORDERING INFORMATION

**Note:** Laser must be connected to the mains electricity all the time. If there will be no mains electricity for longer that 1 hour then laser (system) needs warm up for a few hours before switching on.

**PL2231-50-SH/TH/FH-P20**

- Model
- Pulse repetition rate in Hz
- Harmonic generator options:
  - SH → second harmonic
  - TH → third harmonic
  - FH → fourth harmonic
- Other options:
  - P20 → 20±2 ps pulse duration option
  - P80 → 80 ps pulse duration option
  - PLL → pulse repetition rate locking option



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# PL2250 SERIES

## Flash-Lamp Pumped Picosecond Nd:YAG Lasers


PL2250 series lasers cost-effective design improves laser reliability and reduces running and maintenance costs.

### Innovative design

The heart of the system is a diode pumped solid state (DPSS) master oscillator placed in a hermetically sealed monolithic block. The flashlamp pumped regenerative amplifier is replaced by an innovative diode pumped regenerative amplifier. Diode pumping results in negligible thermal lensing, which allows operation of the regenerative amplifier at variable repetition rates, as well as improved long-term stability and maintenance-free operation.

The optimized multiple-pass power amplifier is flashlamp pumped and is optimized for efficient amplification of pulse while maintaining a near Gaussian beam profile and low wavefront distortion. The output pulse energy can be adjusted in approximately 1% steps, at the same time as pulse-to-pulse energy stability remains less than 0.8% rms at 1064 nm.

Angle-tuned KD*P and KDP crystals mounted in thermostabilised ovens are used for second, third and fourth harmonic generation. Harmonic separators ensure the high spectral purity of each harmonic directed to different output ports.

Built-in energy monitors continuously monitor output pulse energy. Data from the energy monitor can be seen on the remote keypad or PC monitor. The laser provides several triggering pulses for synchronization of the customer's equipment. The lead or delay of the triggering pulse can be adjusted in 0.25 ns steps from the control pad or PC. Up to 1000 µs lead of triggering pulse is available as a pretrigger feature.

Precise pulse energy control, excellent short-term and long-term stability, and up to 20 Hz repetition rate makes PL2250 series lasers an excellent choice for many demanding scientific applications.

### Simple and convenient laser control

For customer convenience the laser can be operated from master device or personal computer through USB (VCP, ASCII commands), RS232 (ASCII commands), LAN (REST API) or RS232 (ASCII commands), LAN (REST API) depending on the system configuration or from remote control pad with backlit display that is easy to read even while wearing laser safety glasses.

### FEATURES

- *Hermetically sealed DPSS master oscillator*
- *Diode pumped regenerative amplifier*
- *Flashlamp pumped power amplifier producing up to **100 mJ** per pulse at 1064 nm*
- ***30 ps** pulse duration (20 ps optional)*
- *Excellent pulse duration stability*
- *Up to **20 Hz** repetition rate*
- *Streak camera triggering pulse with <10 ps jitter*
- *Excellent beam pointing stability*
- *Thermo-stabilized second, third, fourth and fifth harmonic generator options*
- *PC control*
- *Remote control via keypad*

### APPLICATIONS

- *Time resolved fluorescence (including streak camera measurements)*
- *SFG/SHG spectroscopy*
- *Nonlinear spectroscopy*
- *Laser-induced breakdown spectroscopy*
- *OPG pumping*
- *Remote laser sensing*
- *Satellite ranging*
- *Other spectroscopic and nonlinear optics experiments*

## SPECIFICATIONS [1]

| Model | PL2251A | PL2251B | PL2251C |
|---|---|---|---|
| Pulse energy | | | |
| at 1064 nm | 50 mJ [2] | 80 mJ [2] | 100 mJ |
| at 532 nm [3] | 25 mJ | 40 mJ | 50 mJ |
| at 355 nm [4] | 15 mJ | 24 mJ | 30 mJ |
| at 266 nm [5] | 7 mJ | 10 mJ | 12 mJ |
| at 213 nm [6] | inquire | | |
| Pulse energy stability, (StdDev.) [7] | | | |
| at 1064 nm | < 0.8 % | | |
| at 532 nm | <1.0 % | | |
| at 355 nm | < 1.1 % | | |
| at 266 nm | < 1.2 % | | |
| Pulse duration (FWHM) [8] | 29 ± 4 ps | | |
| Pulse duration stability [9] | ± 1.0 ps | | |
| Repetition rate | 20 or 10 Hz | | 10 Hz |
| Polarization | linear, vertical, >99 % | | |
| Pre-pulse contrast | >200:1 (peak-to-peak with respect to residual pulses) | | |
| Optical pulse jitter | internal / external | | |
| Internal triggering regime [10] | <50 ps (StdDev) with respect to TRIG1 OUT pulse | | |
| External triggering regime [11] | ~3 ns (StdDev) with respect to SYNC IN pulse | | |
| SYNC OUT pulse jitter [10] | -500 ... 50 ns | | |
| SYNC OUT pulse delay [12] | -500 ... 50 ns | | |
| Beam divergence [13] | < 0.5 mrad | | |
| Beam pointing stability [14] | ≤ 20 μrad | | |
| Beam diameter [15] | ~ 8 mm | ~10 mm | ~12 mm |
| Typical warm-up time | 30 min | | |
| **PHYSICAL CHARACTERISTICS** | | | |
| Laser head size (W × L × H) | 456×1233×249 mm ±3 mm (for PL2251A, B with harmonic and C models)<br>456×1031×249 mm ±3 mm (for PL2251A, B models without harmonic) | | |
| Electric cabinet size (W × L × H) | 550×600×550 ±3 mm (19" standard, MR-9) | | |
| Umbilical length | 2.5 m | | |
| **OPERATING REQUIREMENTS** | | | |
| Water consumption (max 20 °C ) | water cooled, water consumption (max. 20 °C), <8 l/min, 2 bar | | |
| Room temperature | 22 ± 2 °C | | |
| Relative humidity | 20–80 % (non-condensing) | | |
| Power requirements [16] | single phase, 200–240 V AC, 16 A, 50/60 Hz | | |
| Power [17] | < 1.5 kVA | < 2.5 kVA | < 2.5 kVA |

1) Due to continuous improvement, all specifications are subject to change without notice. Parameters marked typical are not specifications. They are indications of typical performance and will vary with each unit we manufacture. Unless stated otherwise, all specifications are measured at 1064 nm and for basic system without options.

2) PL2251B-20 has 70 mJ at 1064 nm output energy. Inquire for these energies at other wavelengths.

3) For -SH option. Outputs are not simultaneous. Please inquire for pulse energies at other wavelengths.

4) For -TH option. Outputs are not simultaneous. Please inquire for pulse energies at other wavelengths.

5) For -FH option. Outputs are not simultaneous. Please inquire for pulse energies at other wavelengths.

6) For PL2250 series laser with custom -FiH option.

7) Averaged from pulses, emitted during 30 sec time interval.

8) FWHM. Inquire for optional pulse durations in 20 – 90 ps range. Pulse energy specifications may differ from indicated here.

9) Measured over 1 hour period when ambient temperature variation is less than ±1 °C.

10) With respect to TRIG1 OUT pulse. <10 ps jitter is provided optionally with PRETRIG feature.

11) With respect to SYNC IN pulse.

12) TRIG1 OUT lead or delay can be adjusted with 0.25 ns steps in specified range.

13) Average of X- and Y-plane full angle divergence values measured at the $1/e^2$ level at 1064 nm.

14) Beam pointing stability is evaluated from fluctuations of beam centroid position in the far field.

15) Beam diameter is measured at 1064 nm at the $1/e^2$ point.


16) Three phase 208 or 380 VAC mains are required for 50 Hz versions.

17) For 10 Hz version.

If laser is optimised for pumping parametrical generator, maximum output energy may be different than specified for stand alone application.



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## OPTIONS

▶ **Option P20** provides 20 ps ± 10% output pulse duration. Pulse energies are 30% lower in comparison to the 30 ps pulse duration version. Linewidth <2 $cm^{-1}$ at 1064 nm. See table below for pulse energy specifications:

| Model | PL2251A-10 | PL2251B-10 | PL2251C -10 |
|---|---|---|---|
| 1064 nm | 35 mJ | 60 mJ | 80 mJ |
| 532 nm | 17 mJ | 30 mJ | 40 mJ |
| 355 nm | 12 mJ | 18 mJ | 24 mJ |
| 266 nm | 5 mJ | 8 mJ | 10 mJ |

▶ **Option P80** provides 80 ps ±10% output pulse duration. Pulse energy specifications as below:

| Model | PL2251A | PL2251B | PL2251C |
|---|---|---|---|
| Pulse energy at 1064 nm | 70 mJ | 100 mJ | 160 mJ |

## BEAM PROFILE

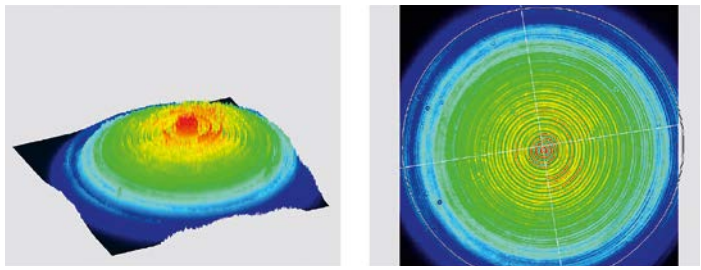

*Fig 1.* Typical near field output beam profile of PL2250 series laser

## OUTLINE DRAWINGS

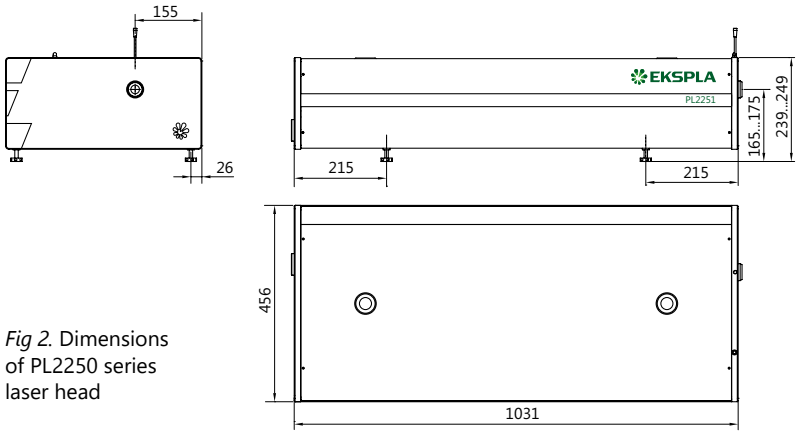


*Fig 2.* Dimensions of PL2250 series laser head

## ORDERING INFORMATION

**Note:** Laser must be connected to the mains electricity all the time. If there will be no mains electricity for longer that 1 hour then laser (system) needs warm up for a few hours before switching on.

**PL2251A-50-SH/TH/FH-P20**

- Model
- Pulse energy level, A for 50 mJ output
- Pulse repetition rate in Hz
- Harmonic generator options:
  - SH → second harmonic
  - TH → third harmonic
  - FH → fourth harmonic
- Other options:
  - P20 → 20 ps pulse duration option
  - P80 → 80 ps pulse duration option
  - AW → water-air heat exchanger option
  - FS → seeding option


Photo: Single Housing MIR Tunable Picosecond Laser PT277-XIR integrate a picosecond optical parametric oscillator and DPSS pump laser into a single compact housing.

# Picosecond Tunable Systems

For researchers demanding wide tuning range, high conversion efficiency and narrow line-width, EKSPLA PG series optical parametric generators is an excellent choice. All models feature hands-free wavelength tuning, valuable optical components protection system as well as wide range of accessories and extension units.

Long-term experience and close cooperation with scientific institutions made it possible to create range of models, offering probably the widest tuning range: from 193 nm to 16000 nm. Versions, offering near transform limited line-width as well as operating at kHz repetition rates are available.

For customer convenience the wavelength can be set from personal computer through USB (VCP, ASCII commands), RS232 (ASCII commands), LAN (REST API) or RS232 (ASCII commands), LAN (REST API) depending on the system configuration or from remote control pad with backlit display that is easy to read even while wearing laser safety glasses.

EKSPLA PL series picosecond mode-locked lasers are recommended for pumping of PG series Optical Parametric Generators. Combining together, researchers get complete tunable wavelength system, capable to assist researchers in wide range of spectroscopy applications: time-resolved pump-probe, nonlinear, infrared spectroscopy, laser-induced fluorescence.

## SHORT SELECTION GUIDE

For Your convenience, table contains all available options and highest parameter values. Not all output specifications are available at the same time simultaneously. Please refer to the catalog page for exact specifications and available options.

| Model | Output wavelength range | Max pulse repetition rate | Linewidth | Special feature | Page |
|---|---|---|---|---|---|
| **PGx01** | 193 – 16000 nm | 50 Hz | < 6 $cm^{-1}$ | High peak power (>50 MW), ideal for non-linear spectroscopy | 28 |
| **PGx11** | 193 – 16000 nm | 50 Hz or 1000 Hz | < 2 $cm^{-1}$ | Narrow linewidth (<0.8 $cm^{-1}$ on some versions) | 32 |
| **PT277-XIR** | 1400 – 16000 nm | 87 MHz | < 5 $cm^{-1}$ | Picosecond MHz rate MIR range laser system | 37 |
| **PT277** | 1400 – 2050, 2200–4450 nm | 87 MHz | < 2.5 $cm^{-1}$ | Optional intensity modulation up to 2 MHz | 39 |
| **PT403** | 210 – 2300 nm | 1000 Hz | < 9 $cm^{-1}$ | Pump laser and OPG integrated in 2-in-1 combo housing | 41 |

# PGx01 SERIES

## High Energy Broadly Tunable OPA


### FEATURES

- *Ultra-wide spectral range from **193** to **16 000 nm***
- *High peak power (**>50 MW**) ideal for non-linear spectroscopy applications*
- *Narrow linewidth **<6 cm$^{-1}$** (for UV < 9 cm$^{-1}$)*
- *Motorized hands-free tuning in 193–2300 nm or 2300–16 000 nm range*
- *PC control*
- *Remote control via keypad*

### APPLICATIONS

- *Nonlinear spectroscopy: vibrational-SFG, surface-SH, Z-scan*
- *Pump-probe experiments*
- *Laser-induced fluorescence (LIF)*
- *Other laser spectroscopy applications*

Travelling Wave Optical Parametric Generators (TWOPG) are an excellent choice for researchers who need an ultra-fast tunable coherent light source from UV to mid IR.

### Design

The units can be divided into several functional modules:

- optical parametric generator (OPG);
- diffraction grating based linewidth narrowing system (LNS);
- optical parametric amplifier (OPA);
- electronic control unit.

The purpose of the OPG module is to generate parametric superfluorescence (PS). Spectral properties of the PS are determined by the properties of a nonlinear crystal and usually vary with the generated wavelength. In order to produce narrowband radiation, the output from OPG is narrowed by LNS down to 6 cm$^{-1}$ and then used to seed OPA.

Output wavelength tuning is achieved by changing the angle of the nonlinear crystal(s) and grating. To ensure exceptional wavelength reproducibility, computerized control unit driven precise stepper motors rotate the nonlinear crystals and diffraction grating. Nonlinear crystal temperature stabilization ensures long-term stability of the output radiation wavelength.

In order to protect nonlinear crystals from damage, the pump pulse energy is monitored by built-in photodetectors, and the control unit produces an alert signal when pump pulse energy exceeds the preset value.

For customer convenience the laser can be operated from master device or personal computer through USB (VCP, ASCII commands), RS232 (ASCII commands), LAN (REST API) or RS232 (ASCII commands), LAN (REST API) depending on the system configuration or from remote control pad with backlit display that is easy to read even while wearing laser safety glasses.

### Available models

| Model | Features |
|---|---|
| PG401 | Model has a tuning range from 420 to 2300 nm and is optimized for providing highest pulse energy in the visible part of the spectrum. The wide tuning range makes PG401 units suitable for many spectroscopy application. |
| PG501-DFG | Model has a tuning range from 2300 to 16000 nm. The PG501-DFG1 model is the optimal choice for vibrational-SFG spectroscopy setups. |


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## SPECIFICATIONS [1]

| Model | PG401 | PG401-SH | PG401-DUV | PG501-DFG1 | PG501-DFG2 |
|---|---|---|---|---|---|
| Tuning range | | | | | |
| DUV | – | | 193–209.95 nm | – | |
| SH | – | 210–340, 370–419 nm | | – | |
| Signal | 420 – 680 nm | – | | | |
| Idler | 740 – 2300 nm | – | | | |
| DFG | | | | 2300–10000 nm | 2300–16000 nm |
| Output pulse energy [2] | > 1000 µJ at 450 nm | > 100 µJ at 300 nm | > 50 µJ at 200 nm | > 250 µJ at 3700 nm, > 40 µJ at 10000 nm | > 250 µJ at 3700 nm, > 80 µJ at 10000 nm |
| Linewidth | < 6 $cm^{-1}$ | < 9 $cm^{-1}$ | | < 6 $cm^{-1}$ | |
| Max pulse repetition rate | 50 Hz | | | | |
| Scanning step | | | | | |
| Signal | 0.1 nm | – | | | |
| Idler | 1 nm | – | | | |
| Typical beam size [3] | ~4 mm | ~3 mm | | ~9 mm | |
| Beam divergence [4] | < 2 mrad | | | – | |
| Beam polarization | – | vertical | | horizontal | |
| Signal | horizontal | – | | | |
| Idler | horizontal | – | | | |
| Typical pulse duration | ~20 ps | ~15 ps | | ~20 ps | |
| **PUMP LASER REQUIREMENTS** | | | | | |
| Pump energy | | | | | |
| at 355 nm | 10 mJ | | | – | |
| at 532 nm | – | | | 10 mJ | |
| at 1064 nm | – | | 2 mJ | 6 mJ | 15 mJ |
| Recommended pump source [5] | PL2231-50-TH, PL2251A-TH | | | PL2231-50-TH, PL2251A-TH | PL2231A-50-SH, PL2251B-SH |
| Beam divergence | < 0.5 mrad | | | | |
| Beam profile | homogeneous, without hot spots, Gaussian fit >90 % | | | | |
| Pulse duration [6] | 29 ± 4 ps | | | | |
| **PHYSICAL CHARACTERISTICS** | | | | | |
| Size (W x L x H) | 456 × 633 × 244 mm | 456 × 1031 × 249 ± 3 mm | | | |
| **OPERATING REQUIREMENTS** | | | | | |
| Room temperature | 15 – 30 °C | | | | |
| Power requirements | 100 – 240 V AC single phase, 47 – 63 Hz | | | | |
| Power consumption | < 100 W | | | | |

1) Due to continuous improvement, all specifications are subject to change without notice. Parameters marked typical are not specifications. They are indications of typical performance and will vary with each unit we manufacture. Unless stated otherwise, all specifications are measured at 450 nm for PG401 units, 3000 nm for PG501 units and 300 nm for PG401SH units and for basic system without options.

2) See tuning curves for typical pulse energies at other wavelengths. Higher energies are available, please contact Ekspla for more details.

3) Beam diameter is measured at the $1/e^2$ level.

4) Full angle measured at the FWHM point.

5) If a pump laser other than PL2250 or PL2230 is used, measured beam profile data should be presented when ordering.

6) Should be specified if non-EKSPLA pump laser is used.

## CUSTOMIZED FOR SPECIFIC REQUIREMENTS

Please note that these products are custom solutions tailored for specific applications or specific requirements.

Interested? Tell us more about your needs and we will be happy to provide you with tailored solution.

### PG401-DFG1 provides:

- The broadest hands-free tuning range – from 420 to 10000 nm
- It can be further extended up to 16000 nm with -DFG2 option. It should be noted, that for the 8000 – 16000 nm range a different nonlinear crystal is used, and exchange of the crystals needs to be done manually

### PG402 features:

- Gap-free tuning range 410 – 709, 710 – 2300 nm
- Linewidth < 18 $cm^{-1}$

## TUNING CURVES

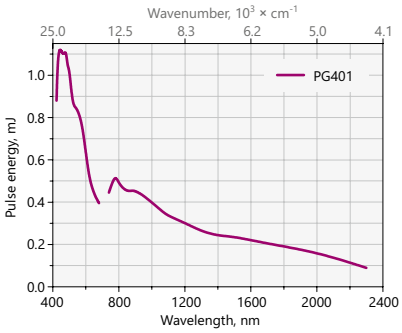


*Fig 1.* Typical PG401 model tuning curve
*Pump energy: 10 mJ at 355 nm*

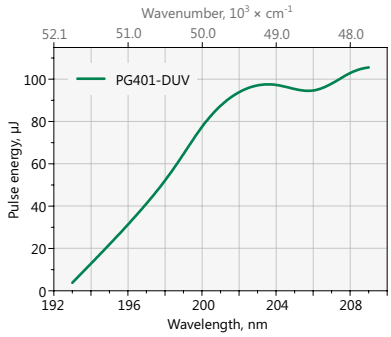


*Fig 2.* Typical PG401-DUV model tuning curve

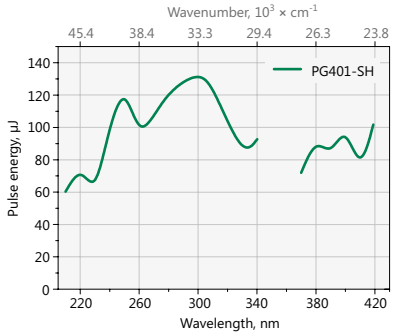


*Fig 3.* Typical PG401-SH model tuning curve. *Pump energy: 10 mJ at 355 nm*

*Note: The energy tuning curves are affected by air absorption due narrow linewidth. These pictures present pulse energies where air absorption is negligible.*

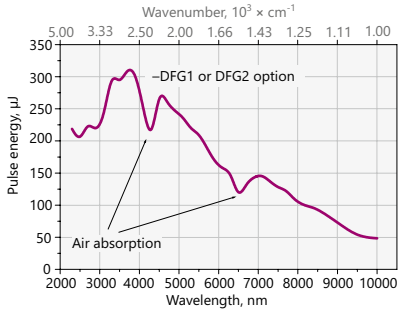


*Fig 4.* Typical PG501-DFG1 tuning curve in 2300–10000 nm range
*Pump energy: 7 mJ at 1064 nm*

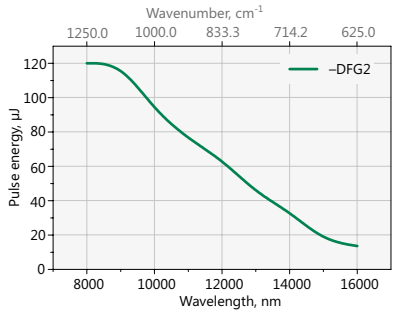


*Fig 5.* Typical PG501-DFG2 tuning curve in 8000–16000 nm range
*Pump energy: 15 mJ at 1064 nm*

## RECOMMENDED UNITS ARRANGEMENT ON OPTICAL TABLE

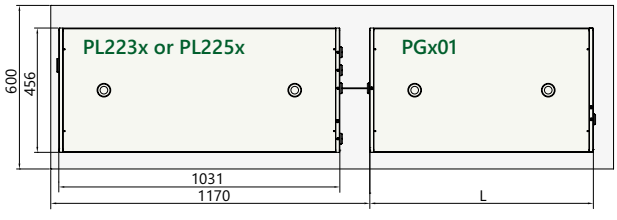


*Fig 6.* Arrangement of pump laser and PGx01 unit on optical table

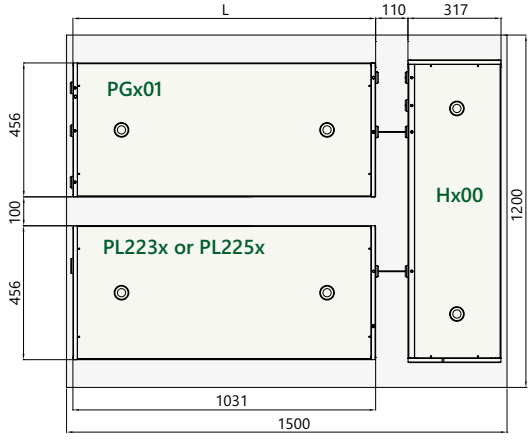


*Fig 7.* Recommended arrangement of pump laser and PGx01-DFGx unit on optical table



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## OUTLINE DRAWINGS

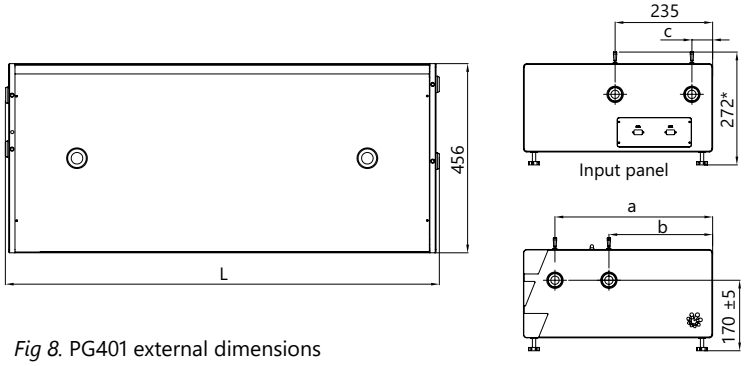



*Fig 8.* PG401 external dimensions

## OUTPUTS PORTS

| Model | L, mm | a, mm | b, mm | c, mm | Port 1 | Port 2 |
|---|---|---|---|---|---|---|
| PG401 | 633 | 380 | × | × | 420–680 nm, 740–2300 nm | – |
| PG401-SH | 838 | 380 | × | × | 210–340 nm, 370–419.9 nm, 420–680 nm, 740–2300 nm | – |
| PG401-SH/DUV | 1026 | 380 | 250 | 50 | 210–340 nm, 370–419 nm, 420–680 nm, 740–2300 nm | 192–209.95 nm |

For SFG optional 532 nm output port 2.

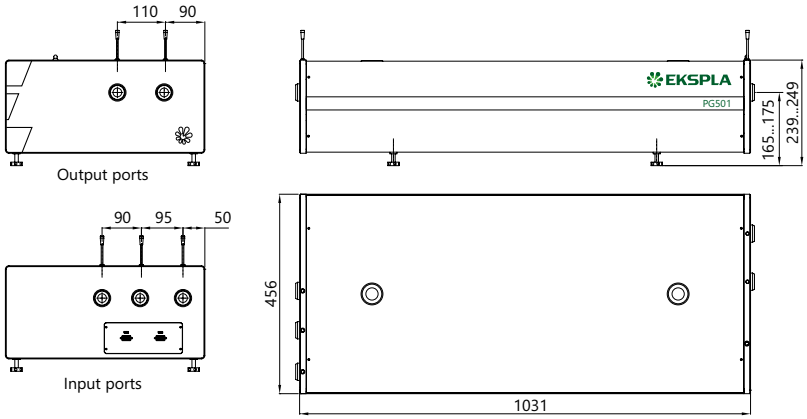



*Fig 9.* PG501 external dimensions

## ORDERING INFORMATION

**PG401-DUV**

Model
PG4xx → 355 nm pump

01 → travelling wave, narrowed linewidth
02 → travelling wave, not narrowed
11 → synchronous pumping, narrowed

Optional tuning range extension
DUV → 193–209.95 nm
SH → 210-340 nm & 370-420 nm

*Custom products, tailored for specific applications. Inquire for other specifications.*

DFG1 → 2300–10000 nm; >250 μJ at 3700 nm
DFG2 → 2300–16000 nm

**PG501-DFG1**

Model
PG5xx → 532 nm pump

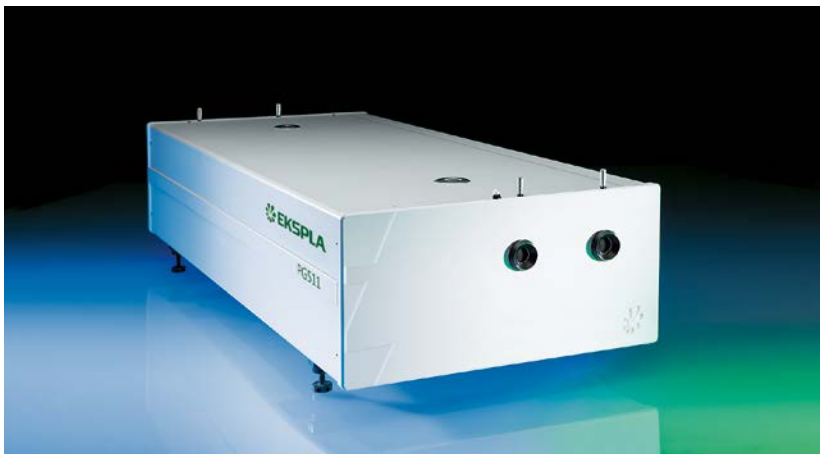
01 → travelling wave, narrowed linewidth

Tuning range
DFG1 → 2300–10000 nm; >250 μJ at 3700 nm
DFG2 → 2300–16000 nm

**Note:** Laser must be connected to the mains electricity all the time. If there will be no mains electricity for longer that 1 hour then laser (system) needs warm up for a few hours before switching on.

# PGx11 SERIES

## Transform Limited Broadly Tunable Picosecond OPA




### FEATURES

- *2 $cm^{-1}$ or **1 $cm^{-1}$** linewidth*
- *High brightness picosecond pulses at 50 Hz or at up to **1 kHz** pulse repetition rate*
- *Nearly Fourier-transform limited linewidth*
- *Low divergence <2 mrad*
- *Hands-free wavelength tuning*
- *Tuning range from **193 nm** to **16000 nm***
- *PC control*
- *Remote control via keypad*

PGx11 series optical parametric devices employ advanced design concepts in order to produce broadly tunable picosecond pulses with nearly Fourier-transform limited linewidth and low divergence. High brightness output beam makes the PGx11 series units an excellent choice for advanced spectroscopy applications.

Optical layout of PGx11 units consists of Synchronously pumped Optical Parametric Oscillator (SOPO) and Optical Parametric Amplifier (OPA). SOPO is pumped by a train of pulses at approx. 87 MHz pulse repetition rate. The output from SOPO consists of a train of pulses with excellent spatial and spectral characteristics, determined by the SOPO cavity parameters.

OPA is pumped by a single pulse temporally overlapped with SOPO output. After amplification at SOPO resonating wavelength, the PGx11 output represents a high intensity single pulse on top of a low-intensity train, while in all other spectral ranges (idler for PG411 and PG711, signal for PG511, also DFG stages) only a single high intensity pulse is present.

Three models designed for pumping by up to the 3rd harmonic of Nd:YAG laser are available.

### APPLICATIONS

- *Time resolved pump-probe spectroscopy*
- *Laser-induced fluorescence*
- *Infrared spectroscopy*
- *Nonlinear spectroscopy: vibrational-SFG, surface-SH, Z-scan, pump probe*
- *Other laser spectroscopy applications*

### Available models

| Model | Features |
|---|---|
| PG411 | Model has a tuning range from 410 to 2300 nm and is optimized for providing highest pulse energy in the visible part of the spectrum. When combined with an optional Second Harmonic Generator (SHG) and Sum Frequency Generator (-DUV), it offers the widest possible tuning range – from 193 to 2300 nm. |
| PG511 | Model has a tuning range 2300–10000 nm. PG411 and PG511 models are designed to be pumped by PL2230 series lasers with a 50 Hz pulse repetition rate. |
| PG711 | Model has 1 kHz pulse repetition rate and uses DPSS mode-locked laser of the PL2210 series for pumping. When pumped with pulses of 90 ps duration, linewidths of less than 1 $cm^{-1}$ were measured in the spectral range up to 16 μm, which makes this device an excellent choice for time-resolved or nonlinear infrared spectroscopy. |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Microprocessor based control system provides automatic positioning of relevant components, allowing hands free operation. Nonlinear crystals, diffraction grating and filters are rotated by ultra-precise stepper motors in microstepping mode, with excellent reproducibility.

Precise nonlinear crystal temperature stabilization ensures long-term stability of generated wavelength and output power.

For customer convenience the system can be controlled through USB (VCP, ASCII commands), RS232 (ASCII commands), LAN (REST API) or RS232 (ASCII commands), LAN (REST API) depending on the system configuration or a remote control pad. Both options allow easy control of system settings.

Available standard models are summarized in a table below. Please inquire for custom-built versions.

## SPECIFICATIONS [1]

| Model | PG411 | PG411-SH | PG411-SH-DUV | PG511-DFG | PG711 | PG711-DFG |
|---|---|---|---|---|---|---|
| Output wavelength tuning range | | | | | | |
| SH, DUV | – | 210–410 nm | 193–410 nm | – | | |
| Signal | 410–709 nm | | | – | 1550–2020 nm | |
| Idler | 710–2300 nm | | | – | 2250–3350 nm | |
| DFG | – | | | 2300–10000 nm | – | 3350–16000 nm |
| DFG2 (up to 16000 nm) | – | | | inquire | – | |
| Output pulse energy [2] | | | | | | |
| SH, DUV | – | 100 µJ [3] | 50 µJ [3] | – | | |
| Signal | 700 µJ | | | – | 500 µJ | |
| Idler [4] | 250 µJ | | | – | 100 µJ | |
| DFG | – | | | > 200 µJ at 3700 nm, > 40 µJ at 10000 nm | – | 20 µJ [5] |
| Max pulse repetition rate | 50 Hz | | | 50 Hz | 1000 Hz | |
| Linewidth | < 3 $cm^{-1}$ [6] | | | < 2 $cm^{-1}$ | < 1 $cm^{-1}$ | |
| Linewidth Idler | < 5 $cm^{-1}$ [6] | | | – | | |
| Typical pulse duration [7] | ~20 ps | | | ~20 ps | ~70 ps | |
| Scanning step | | | | | | |
| SH, DUV | – | 0.01 nm | | – | | |
| Signal | 0.1 nm | | | | | |
| Idler | 1 nm | | | | | |
| DFG | – | | | | | 1 nm |
| Typical beam diameter [8] | ~ 4 mm | | | ~ 9 mm | ~ 3 mm | |
| Beam divergence [9] | < 2 mrad | | | | | |
| Beam polarization [9] | | | | | | |
| SH, DUV | – | vertical | | – | | |
| Signal | horizontal | | | vertical | horizontal | |
| Idler | vertical | | | horizontal | vertical | |
| DFG | – | | | horizontal | – | horizontal |

1) Due to continuous improvement, all specifications are subject to change without notice. Parameters marked typical are not specifications. They are indications of typical performance and will vary with each unit we manufacture. Unless stated otherwise, all specifications are measured at 450 nm for PG411 units, 800 nm for PG511 units, and 1620 nm for PG711 units and for basic system without options.

2) Pulse energies are specified at selected wavelengths. See typical tuning curves for pulse energies at other wavelengths.

3) Measured at 280 nm for SH and 200 nm for DUV.

4) Measured at 1000 nm for PG411 units, 1620 nm for PG511, and 3000 nm for PG711 units.

5) Measured at 10000 nm.

6) Linewidth for signal (409 – 710 nm) < 3 $cm^{-1}$, linewidth for idler and SH-DUV (710 – 2300 nm and 193 – 409 nm) < 5 $cm^{-1}$.

7) Estimated FWHM assuming pump pulse duration 30 ps at 1064 nm for PG411 and PG511 units, and 90 ps at 1064 nm for PG711 units.

8) Beam diameter is measured at $1/e^2$ level and can vary depending on the pump pulse energy.

9) Full angle measured at FWHM level.

## SPECIFICATIONS [1)]

| Model | PG411 | PG411-SH | PG411-SH-DUV | PG511-DFG | PG711 | PG711-DFG |
|---|---|---|---|---|---|---|
| **PUMP LASER REQUIREMENTS** | | | | | | |
| Recommended pump source | PL2231 + APL2100-TRAIN-H411 | | | PL2231 + H500-APL2100-TRAIN | PL2211A TR | |
| Min. pump energy or power [10)] | | | | | | |
| at 1064 nm | – | | 2 mJ | (10 mJ) | 5 mJ at 1 kHz | |
| at 532 nm | – | | | 5 mJ (8 mJ) | | |
| at 355 nm | 5 mJ (10 mJ) | | | – | | |
| Pulse duration [11)] | 30 ps | | | | 90 ps | |
| Bream polarization at pump wavelength | vertical | | | horizontal | | |
| Beam size [12)] | 7 mm | | | | 2.5 mm | |
| Beam divergence | < 0.5 mrad | | | | | |
| Beam profile | homogeneous, without hot spots | | | | | |
| **PHYSICAL CHARACTERISTICS** | | | | | | |
| Size (W × L × H) | 456 × 1026 × 244 mm | 456 × 1226 × 244 mm | | PL2231: 456 × 1026 × 244 mm H500-APL2100-TRAIN: 456 × 1026 × 244 mm | | 456 × 1026 × 244 mm |
| **OPERATING REQUIREMENTS** | | | | | | |
| Room temperature | 15–30 °C | | | | | |
| Room temperature stability | ± 2 °C | | | | | |
| Power requirements | 100–240 V single phase, 47–63 Hz | | | | | |
| Power consumption | < 300 W | | | | | |

[10)] The first number represents pulse train energy or power, while the value in brackets represents single pulse energy.

[11)] At FWHM level. Inquire for other available pulse duration options.

[12)] Beam diameter measured at $1/e^2$ level.

## RECOMMENDED UNITS ARRANGEMENT ON OPTICAL TABLE

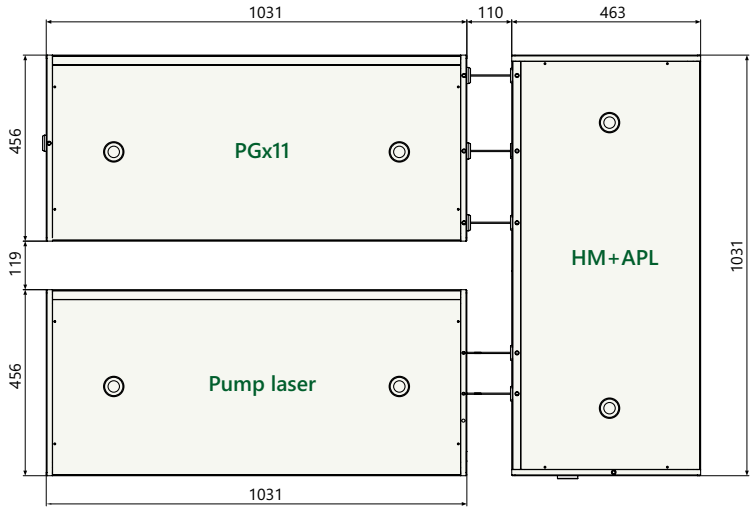


*Fig 1.* Arrangement of pump laser and PGx11 unit on optical table



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## TUNING CURVES

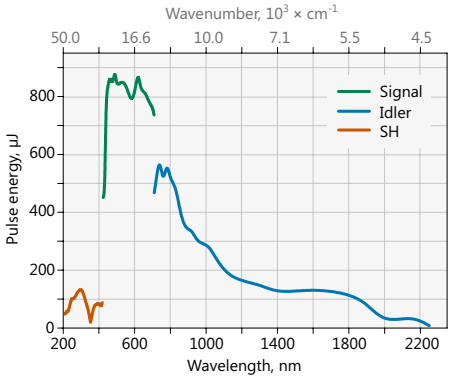


*Fig 2.* Typical PG411-SH model tuning curve

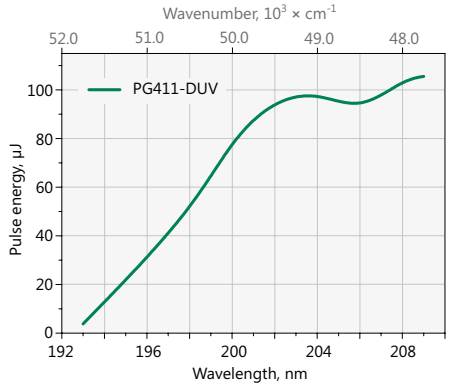


*Fig 3.* Typical PG411-DUV model tuning curve

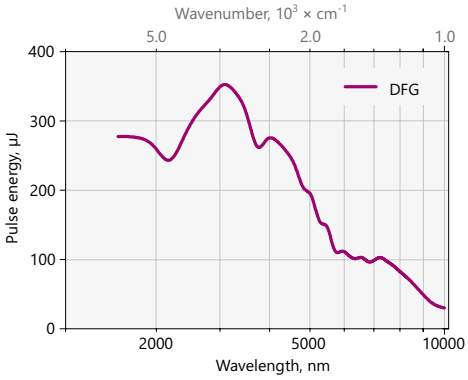


*Fig 4* Typical PG511-DFG model tuning curve

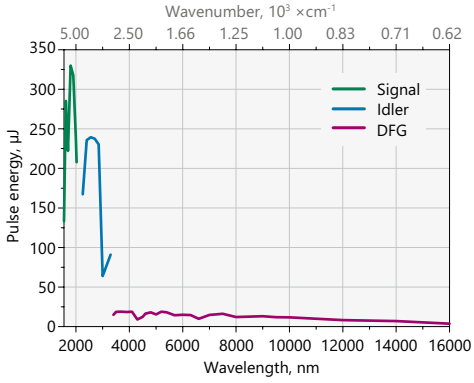


*Fig 5.* Typical PG711-DFG model tuning curve.
*Pump energy: 2.5 mJ at 1064 nm, 1 kHz repetition rate*

*Note: The energy tuning curves are affected by air absorption due narrow linewidth. These pictures present pulse energies where air absorption is negligible.*

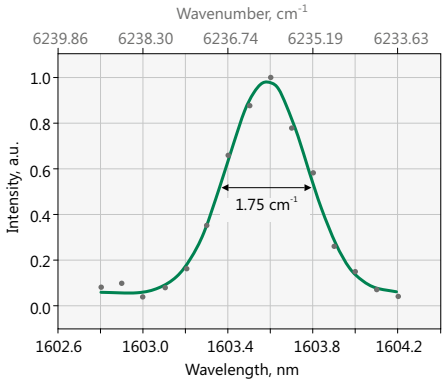


*Fig 6.* PG511-DFG model typical output linewidth

## OUTLINE DRAWINGS

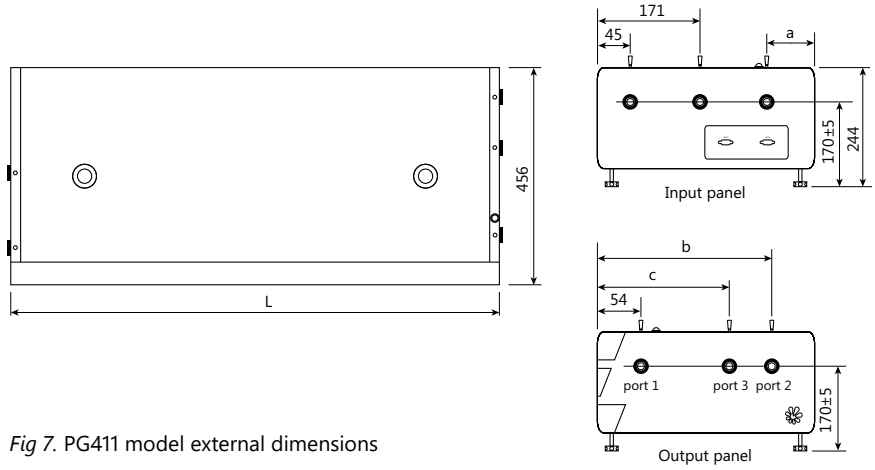


*Fig 7.* PG411 model external dimensions

## OUTPUTS PORTS

| Model | L, mm | a, mm | b, mm | c, mm | Port 1 | Port 2 | Port 3 |
|---|---|---|---|---|---|---|---|
| PG411 | 1026 | × | 411 | × | 420–709 nm, 710–2300 nm | 420–709 nm, 710–2300 nm | – |
| PG411-SH | 1226 | × | 411 | × | 420–709 nm, 710–2300 nm | 210–419 nm, 420–709 nm, 710–2300 nm | – |
| PG411-SH/DUV | 1226 | 235 | 411 | 331 | 420–709 nm, 710–2300 nm | 210–419 nm, 420–709 nm, 710–2300 nm | 192–209.95 nm |

## ORDERING INFORMATION

**Note:** Laser must be connected to the mains electricity all the time. If there will be no mains electricity for longer that 1 hour then laser (system) needs warm up for a few hours before switching on.

**PGx11-SH**

Model
PG411 → ps 355 nm pump
PG511 → ps 532 nm pump
PG711 → ps 1064 nm pump

Optional tuning range extension
SH (PG411) → 210–420 nm
SH/DUV (PG411) → 193–420 nm
DFG (PG511) → 2300–10000 nm
DFG (PG711) → 3350–16000 nm



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# PT277-XIR SERIES

## Single Housing MIR (mid infrared range) Tunable Picosecond Laser


### FEATURES

- ***1400 – 16000 nm (7000 – 625 cm$^{-1}$)*** *tuning range*
- *Linewidth* ***<5 cm$^{-1}$*** *in the full tuning range*
- *Nearly diffraction limited divergence*
- *Remote control via keypad and/or any controller running on any OS using REST API commands*
- *PC control via USB (virtual com port), RS232, LAN*

### APPLICATIONS

- *Infrared spectroscopy*

PT277 series laser systems integrate a picosecond optical parametric oscillator and DPSS pump laser into a single compact housing. Mounting the components into one frame provides a cost-effective and robust solution. It makes laser installation shorter and improves long-term stability, reduces maintenance costs. The tuning range for the model PT277-XIR 1400 – 2000, 2280 – 4450, 4800 – 16000 nm (7000 – 5000, 4385 – 2245, 2080 – 625 cm$^{-1}$) with linewidth <5 cm$^{-1}$ in the full tuning range.

The fast wavelength tuning is based on the microprocessor-control and wavelength tuning is fully automatic. The wavelength tuning elements are mounted on precise closed loop micro stepping motors. The temperatures of the non linear crystals is controlled by a precise thermocontrollers. For customer convenience the system can be controlled via keypad and/or any controller running on any OS using REST API commands. Variety of interfaces USB, RS232, LAN, WLAN (optionally) ensures easy control and integration with other equipment.

### TUNING CURVES

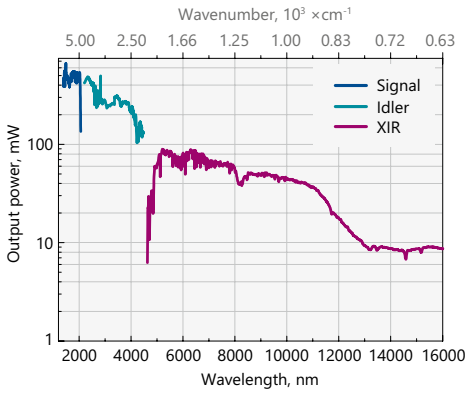


*Fig 1.* Typical output PT277-XIR tuning curve.
*The actual tuning curve might differ from presented here.*

## SPECIFICATIONS

| Model | PT277 - XIR |
|---|---|
| **SYNCHRONOUSLY PUMPED OPO SPECIFICATIONS** [1] | |
| Tuning range | |
| Signal | 1400 – 2000 nm (7000 – 5000 $cm^{-1}$) |
| Idler | 2280 – 4450 nm (4385 – 2245 $cm^{-1}$) |
| XIR | 4800 – 16000 nm (2080 – 625 $cm^{-1}$) |
| Linewidth | < 5 $cm^{-1}$ |
| Output power [2] | |
| OPO @ 4000 nm (2500 $cm^{-1}$) | > 150 mW |
| OPO @ 12500 nm (800 $cm^{-1}$) | > 10 mW |
| Pulse repetition rate | 87 MHz |
| Pulse duration (pump laser) | ~8 ps |
| Scanning step | |
| Signal | 0.1 nm |
| Idler, XIR | 1 nm |
| Polarization | vertical |
| Typical beam diameter [3] [4] | ~3 mm |
| Typical beam divergence [5] | < 2 mrad (for signal) |
| Beam pointing stability | < 50 µrad rms @ 1596 nm |
| AOM modulation | 70 kHz – 2 MHz |
| Fast spectral scan, scan speed (for spectral range) | |
| Idler | < 2 s |
| XIR | < 1 s |
| **PHYSICAL CHARACTERISTICS** | |
| Unit size (W×L×H) | 320 × 766 × 241 mm |
| Power supply size (W×L×H) | 483 × 140 × 390 mm |
| Umbilical length | 2.5 m |
| **OPERATING REQUIREMENTS** | |
| Cooling | water-air (by provided chiller) |
| Room temperature | 22 ± 2 °C |
| Room temperature stability | ± 1 °C |
| Relative humidity | 20 – 80 % (noncondensing) |
| Power requirements | 100 – 240 VAC (-10% / +5%), single phase, 50/60 Hz |
| Power consumption | < 1 kVA |
| Cleanness of the room | not worse than ISO Class 9 |

[1] All specifications are subject to change without notice. The parameters marked typical are not specifications. They are indications of typical performance and will vary with each unit we manufacture. Unless stated otherwise all specifications are measured at 1596 nm.

[2] Output powers are specified at selected wavelengths. See typical tuning curves for power at other wavelengths.

[3] Measured at 3000 nm.

[4] Beam diameter at the $1/e^2$ level and can vary depending on the pump pulse energy.

[5] Full angle measured at the FWHM level.

**Note:** Laser must be connected to the mains electricity all the time. If there will be no mains electricity for longer that 1 hour then laser (system) needs warm up for a few hours before switching on. The laser and auxiliary units must be settled in such a place void of dust and aerosols. It is advisable to operate the laser in air conditioned room, provided that the laser is placed at a distance from air conditioning outlets. The laser should be positioned on a solid worktable. Access from both sides should be ensured. Intensive sources of vibration should be avoided, like railways station etc nearby laboratory.


## OUTLINE DRAWINGS

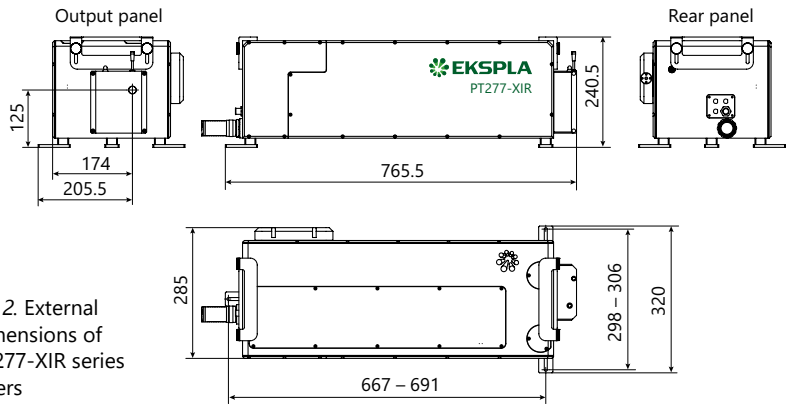


*Fig 2.* External dimensions of PT277-XIR series lasers



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# PT277 SERIES

## Single Housing NIR-IR Range Tunable Picosecond Laser

### FEATURES

- ***1400–4450 nm*** *tuning range*
- *Nearly Fourier transform-limited linewidth*
- *Nearly diffraction limited divergence*
- *Output wavelength monitoring (optional)*
- *PC control*

### APPLICATIONS

- *Infrared microscopy*
- *Infrared spectroscopy*
- *Near field spectroscopy*

PT277 series laser systems integrate a picosecond optical parametric oscillator and DPSS pump laser into a single compact housing. Mounting the components into one frame provides a cost-effective and robust solution with improved long-term stability and reduced maintenance costs.

The tuning range is for the model PT277 1400 – 2050 and 2200 to 4450 nm with nearly Fourier transform limited linewidth.

The microprocessor-controlled wavelength tuning is fully automatic. The wavelength controlling elements are mounted on precise micro-stepping motors. The temperature of the non-linear crystal is controlled by a precise thermocontroller with a bidirectional Peltier element, resulting in the fast tuning of crystal temperature. For customer convenience the system can be controlled through USB (VCP, ASCII commands), RS232 (ASCII commands), LAN (REST API) or RS232 (ASCII commands), LAN (REST API) depending on the system configuration or a remote control pad. Both options allow easy control of system settings.

### TUNING CURVES

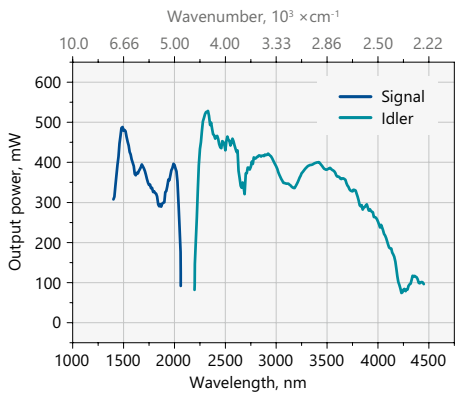


*Fig 1.* Typical output power of PT277 tunable laser.
*The power is shown only at the wavelengths where ambient air absorption is negligible*

## SPECIFICATIONS [1]

| Model | PT277 |
|---|---|
| Pulse repetition rate [2] | 87 MHz |
| Tuning range | |
| Signal | 1400 – 2050 nm |
| Idler | 2200 – 4450 nm |
| Output power [3] | |
| OPO [4] | > 500 mW |
| Linewidth [4] | < 2.5 $cm^{-1}$ |
| Typical pulse duration [4] [5] | 70 ps |
| Scanning step | |
| Signal | 0.1 nm |
| Idler | 0.1 nm |
| Polarization | |
| Signal beam | horizontal |
| Idler beam | horizontal |
| Typical beam diameter [4] [6] | ~2 mm |
| Typical beam diameter, Idler [4] [6] | ~5 mm |
| Typical beam divergence [4] [7] | < 2 mrad |
| **PHYSICAL CHARACTERISTICS** | |
| Unit size (W × L × H) | 370 × 800 × 260 mm |
| Power supply size (W × L × H) | 520 × 500 × 290 mm |
| Umbilical length | 2 m |
| **OPERATING REQUIREMENTS** | |
| Cooling | water-air |
| Room temperature | 22 ± 2 °C |
| Relative humidity | 20 – 80 % (noncondensing) |
| Power requirements | 100 – 240 V AC, single phase 50/60 Hz |
| Power consumption | < 1 kVA |

[1] Due to continuous improvement, all specifications are subject to change without notice. Parameters marked 'typical' are indications of typical performance (not specifications) and will vary with each unit we manufacture. Unless stated otherwise, all specifications are measured at 1064 nm and for basic system without options.

[2] Inquire for custom pulse repetition rates.

[3] Output powers are specified at selected wavelengths. See typical tuning curves for power at other wavelengths.

[4] Measured at 1600 nm for PT277 model at signal range.

[5] Pulse duration can vary depending on wavelength and pump energy.

[6] Beam diameter at the $1/e^2$ level and can vary depending on the pump pulse energy.

[7] Full angle measured at the FWHM level.


## OUTLINE DRAWINGS

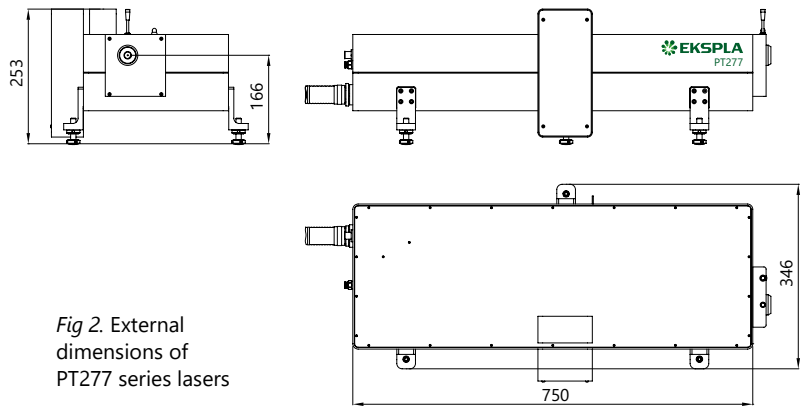


*Fig 2.* External dimensions of PT277 series lasers

**Note:** Laser must be connected to the mains electricity all the time. If there will be no mains electricity for longer that 1 hour then laser (system) needs warm up for a few hours before switching on.



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# PT403 SERIES

## Tunable Wavelength Picosecond Laser


PT403 series laser systems integrate a picosecond 1 kHz repetition rate DPSS pump laser and optical parametric generator into a single housing. New picosecond tunable wavelength laser system provide from 210 to 2300 nm from the one box.

Unlike other solutions in the market, offering laser and OPO in different units, new approach features pump laser and OPO integrated into one unit. That delivers almost twice smaller footprint, shorter installation, better stability and other substantial benefits for user.

All-in one-box solution features all components placed into one compact housing. It means better overall stability because all potential causes for misalignment between separate units of pump laser and optical parametric generator are eliminated.

To ensure reliability industry and market tested solutions were employed during the build-up of PT403.

Pump laser is based on industry "gold standard" diode pumped Ekspla PL2210 series picosecond mode-locked laser. Improved output parameters and reduced maintenance costs are achieved by employing diode-pumped-only technology.

Optical parametric generator is based on PGx03 picosecond optical parametric amplifier systems. Fully automatized and microprocessor based control system ensures hands free precise wavelength tuning.

PT403 was built without sacrificing any parameters or reliability. The optical design is optimized to produce low divergence beams with moderate linewidth (typically < 9 $cm^{-1}$) at approximately 20 ps pulse duration. Featuring 1 kHz repetition rate PT403 tuneable laser is versatile cost-efficient tool for scientists researching various kind of disciplines like time resolved fluorescence, pump-probe spectroscopy, laser-induced fluorescence, Infrared spectroscopy and other aplications.

### Simple and convenient laser control

For customer convenience the laser can be operated from master device or personal computer through USB (VCP, ASCII commands), RS232 (ASCII commands), LAN (REST API) or RS232 (ASCII commands), LAN (REST API) depending on the system configuration or from remote control pad with backlit display that is easy to read even while wearing laser safety glasses.

### FEATURES

- *Tuning range: 210 – 2300 nm*
- *Motorized hands-free tuning*
- *High pulse energy at 1 kHz rates*
- *Diode pumped solid state design*
- *Narrow linewidth < 9 $cm^{-1}$*
- *Remote control via keypad*
- *PC control*
- *Optional streak camera triggering pulse with < 10 ps rms jitter*
- *Turn-key operation*
- *Air cooled – external water supply is not required*
- *Low maintenance costs*

### APPLICATIONS

- *Time resolved fluorescence (including streak camera measurements), pump-probe spectroscopy*
- *Laser-induced fluorescence*
- *Infrared spectroscopy*
- *Nonlinear spectroscopy: surface-SH, Z-scan*
- *Other spectroscopic and nonlinear optics applications*

### BENEFITS

- *Better long term stability (compared with layout where laser and OPO are in different units)*
- *Higher safety – all beams are in the box*
- *Shorter installation time*
- *Almost twice smaller footprint*

## SPECIFICATIONS [1]

| Model | PT403 | PT403-SH |
|---|---|---|
| **OPA SPECIFICATIONS** | | |
| Output wavelength tuning range | | |
| SH | – | 210 – 409 nm |
| Signal | 410 – 709 nm | |
| Idler | 710 – 2300 nm | |
| Output pulse energy [2] | | |
| SH [3] | – | 15 µJ |
| Signal [4] | 80 µJ | |
| Idler [5] | 25 µJ | |
| Pulse repetition rate | 1000 Hz | |
| Linewidth | < 9 $cm^{-1}$ | < 12 $cm^{-1}$ |
| Typical pulse duration [6] | ~ 20 ps | |
| Scanning step | | |
| SH | – | 0.05 nm |
| Signal | 0.1 nm | |
| Idler | 1 nm | |
| Typical beam size [7] | ~ 2 mm | |
| Beam divergence [8] | < 2 mrad | |
| Beam pointing stability | ≤ 100 µrad rms | |
| Beam polarization | | |
| SH | – | horizontal |
| Signal | horizontal | |
| Idler | vertical | |
| Optical pulse jitter | | |
| Internal triggering regime [9] | < 50 ps (StDev) in respect to TRIG1 OUT pulse | |
| External triggering regime | ~ 3 ns (StDev) in respect to SYNC IN pulse | |
| TRIG1 OUT pulse delay [10] | -400 ... 150 ns | |
| **OPERATING REQUIREMENTS** | | |
| Room temperature | 22 ± 2 °C | |
| Relative humidity | 20 – 80% (non-condensing) | |
| Power requirements | 100 – 240 V single phase, 47 – 63 Hz | |
| Power consumption | < 0.6 kW | |
| Water service | air cooled | |
| Cleanness of the room | not worse than ISO Class 9 | |

[1] Due to continuous improvement, all specifications are subject to change without notice. Parameters marked typical are not specifications. They are indications of typical performance and will vary with each unit we manufacture. Unless stated otherwise, all specifications are measured at 450 nm for PT403 units for basic system without options.

[2] Pulse energies are specified at selected wavelengths. See typical tuning curves for pulse energies at other wavelengths.

[3] Measured at 260 nm.

[4] Measured at 450 nm.

[5] Measured at 1000 nm.

[6] Estimated assuming 30 ps at 1064 nm pump pulse. Pulse duration varies depending on wavelength and pump energy.

[7] Beam diameter at the $1/e^2$ level. Can vary depending on the wavelength.

[8] Beam divergence measured at FWHM.

[9] < 10 ps jitter is provided with PRETRIG option.


### Communication module interfaces

| Interface | Description |
|---|---|
| USB | virtual serial port, ASCII commands |
| RS232 | ASCII commands |
| LAN | REST API |
| WLAN | REST API |

## DESIGN

The units can be divided into several functional parts:

1. 1 kHz repetition rate DPSS pump laser,
2. Optical parametric generator (OPG),
3. Electronic control unit.


*Fig 1.* PT403 unit

PT403 series laser systems integrate a picosecond 1 kHz repetition rate DPSS pump laser and optical parametric generator into a single housing. As pump laser is used PL2210 series diode-pumped, air-cooled, mode-locked Nd:YAG laser. Picosecond tunable wavelength laser system provide from 210 to 2300 nm from the single optical unit.

## OPTIONS

### ▶ Option SF

Energy increasing in 300 – 409 nm range by sum-frequency generation. > 20 µJ @ 340 nm. Pulse energies are ~ 10 % lower in comparison to the system without SF option. See table below for pulse energy specifications:

| Model [1] | PT403 | PT403-SH |
|---|---|---|
| SH [2] | – | > 13 µJ |
| Signal [3] | > 70 µJ | |
| Idler [4] | > 22 µJ | |

[1] Due to continuous improvement, all specifications are subject to change without notice. Parameters marked typical are not specifications. They are indications of typical performance and will vary with each unit we manufacture.

[2] Measured at 260 nm.
[3] Measured at 450 nm.
[4] Measured at 1000 nm.

### ▶ Options -H, -2H, -3H

1064 nm or 532 nm, or 355 nm outputs [1] [2]

– H output energy 0.7 mJ;

– 2H output energy 0.3 mJ;

– 3H output energy 0.3 mJ.

[1] Outputs are not simultaneous.
[2] Inquire for outputs simultaneously with PG.

## CUSTOMIZED FOR SPECIFIC REQUIREMENTS

Please note that these products are custom solutions tailored for specific applications or specific requirements.

**Interested?** Tell us more about your needs and we will be happy to provide you with tailored solution.

## PT503 FEATURES

- The higher pulse energy in the near-IR spectral range
- Tuning range from 700 to 2200 nm

## TUNING CURVES

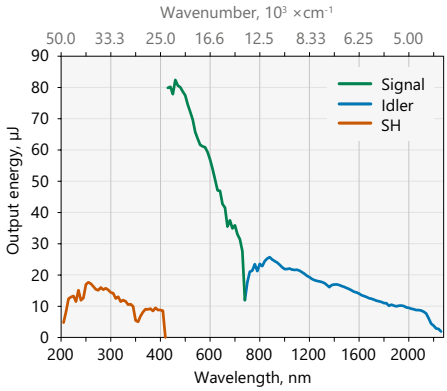


*Fig 2.* Typical PT403 tuning curves in signal (420 – 709 nm) and idler (710 – 2300 nm) ranges.

*Note: The energy tuning curves are affected by air absorption due narrow linewidth. These pictures present pulse energies where air absorption is negligible.*

## OUTLINE DRAWINGS

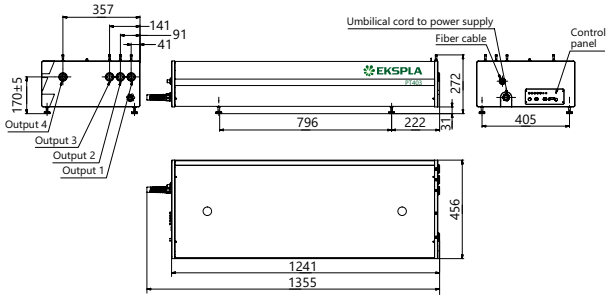


*Fig 3.* PT403 series laser head typical outline drawing

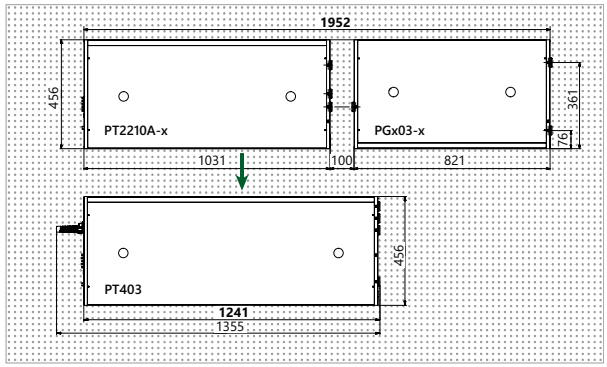


*Fig 4.* Compared with layout where laser and OPO are in different units, PT403 features almost twice smaller footprint



| Model | L, mm | Port 1 | Port 2 | Port 3 | Port 4 |
|---|---|---|---|---|---|
| PT403 | 1241 | 1064 / 532 nm | – | 355 nm | 410 – 2300 nm |
| PT403-SH/SF | 1441 | 1064 / 532 nm | 210 – 2300 nm | 355 nm | 410 – 2300 nm |

**Note:** Laser must be connected to the mains electricity all the time. If there will be no mains electricity for longer that 1 hour then laser (system) needs warm up for a few hours before switching on.


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| | | | | | |
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