EKSPLA

25 Years of Innovation

# Lasers and Laser Systems

Femtosecond

Picosecond

Nanosecond

Tunable Wavelength

High Energy

Laser Spectroscopy

2017

EKSPLA

# Lasers and Laser Systems

2017


Revision 170611

# About Company

## Background

EKSPLA is manufacturer of lasers, laser systems and laser electronics for basic research and industrial applications. Employing 25 years experience and close partnership with scientific community, EKSPLA is focused on design and manufacturing of advanced products.

In house design and manufacturing ensures operative design, manufacturing and customisation of the new products. Products are available from several standard units for R&D applications to series customized solutions for OEM (Original Equipment Manufacturers).

The company is leading in the global market for scientific picosecond lasers and is one of the few in the world that make SFG spectrometers for material surfaces investigation.

EKSPLA exports 90% of its production to more than 60 countries worldwide. EKSPLA work with distributors network in more than 25 countries. Established EKSPLA service team is ready to support customers all over world. You will find EKSPLA lasers in the most famous universities across Europe, America and Asia.

EKSPLA was the first company in Central and Eastern Europe to receive the Prism Awards for Photonics Innovation for the world's most advanced product in the scientific lasers category.

## History

EKSPLA was founded about 25 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.

## Core competencies

- High peak power laser systems
- Short pulse generation and amplification
- Tunable nonlinear devices (OPO, OPA, etc.)
- Nonlinear spectroscopy
- Fast high voltage electronics
- High power electronics

First picosecond laser was introduced more than 20 years ago


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# Contents

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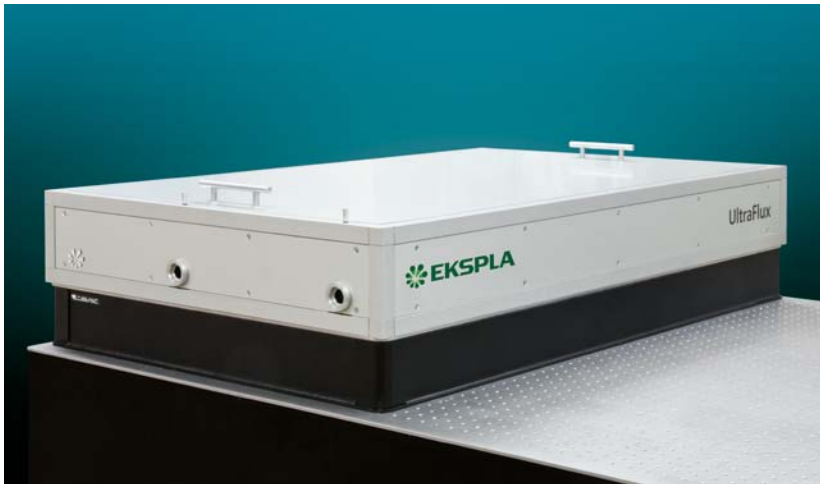
# Femtosecond Laser
# UltraFlux

## Tunable Wavelength Femtosecond Laser System




UltraFlux is the first compact high energy tuneable wavelength femtosecond laser system which incorporates the advantages of ultrafast fiber laser, solid-state and parametric amplification technologies in less than 1 square meter footprint box. Patent pending (application No. EP2924500) OPCPA front end technology uses the same picosecond fiber laser for seeding both picosecond DPSS pump laser and femtosecond parametric amplifier by spectrally broadened output. This approach greatly simplifies the system – excludes femtosecond regenerative amplifier and eliminates the need of pump and seed pulse synchronization. In addition to that, contrast of the output pulses in picosecond to nanosecond time scale is potentially increased.

System generates down to 35 fs pulses, which can be automatically tuned in 700 – 1010 nm wavelength range. Less than 10 fs pulses are obtained in a few-cycle operating regime. Up to 0.3 mJ output pulse energy with better than 1.5% pulse-to-pulse stability at 1 kHz repetition rate is achieved by using a state of the art OPCPA technology.

By incorporating parametric amplifier technology together with a novel ultrafast fiber laser helped to create and bring to the market a new tool for femtosecond pump probe, nonlinear spectroscopy, emerging high harmonic generation experiments and other femtosecond and nonlinear spectroscopy applications. With this laser ultrafast science breakthrough is closer to any photonics lab than ever before.

### FEATURES

- *Based on the novel OPCPA (Optical Parametric Chirped Pulse Amplification) technology – simple and cost-efficient operation*
- *Patented front-end design (patents no. EP2827461 and EP2924500)*
- *Hands free wavelength tuning from 700 to 1010 nm 35 – 60 fs pulse duration (10 fs is available)*
- *1 kHz repetition rate*
- *0.3 mJ pulse energy*
  - *Excellent pulse energy stability: < 1.5 % rms (measuring every pulse during 20 s period)*
  - *Excellent long-term average power stability: ±1 % (peak-to-peak) over > 12 hour period*
- *Small footprint*
- *Compact picosecond pump laser*

### APPLICATIONS

- *Broadband CARS and SFG*
- *Femtosecond pump-probe spectroscopy*
- *Nonlinear spectroscopy*
- *High harmonic generation*
- *Your application is welcome*

### OPTIONS

- *Amplified and compressed supercontinuum output (1 μJ, 10 fs, 680 – 960 nm)*
- *Second harmonics: 350 – 480 nm*
- *Third harmonics: 245 – 320 nm*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## SPECIFICATIONS [1]

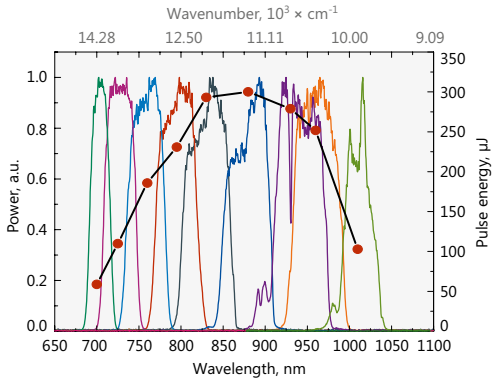
| Model | UltraFlux FT2101 |
|---|---|
| Max. pulse energy [2] | 0.3 mJ |
| Tunability | 700 – 1010 nm |
| Pulse duration [3] | 35 – 60 fs |
| Pulse repetition rate | 1 kHz |
| Beam quality | $M^2$ < 1.5 |
| Pulse energy stability | < 1 % rms (20000 shots) |
| Long-term power stability | ±1 % peak-to-peak (>12 hour period) |
| Footprint | 1.2 × 0.75 m |

[1] Due to continuous improvement, all specifications are subject to change without notice. Parameters marked typical may vary with each unit we manufacture.

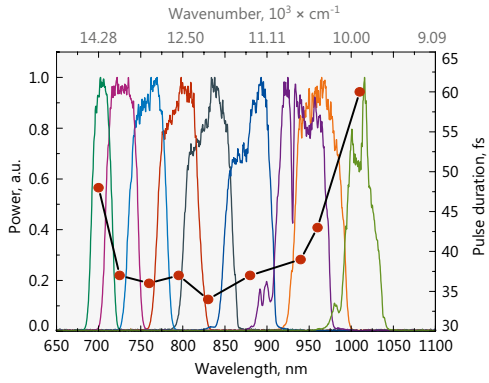
[2] Inquire for higher energy options.

[3] 10 fs is available. Contact Ekspla for pulse energy and other specifications.

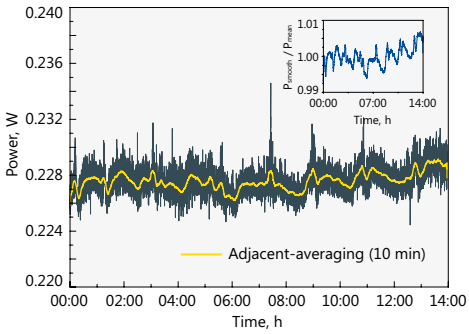

## PERFORMANCE



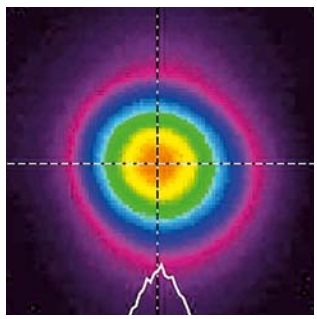

Typical output pulse energy



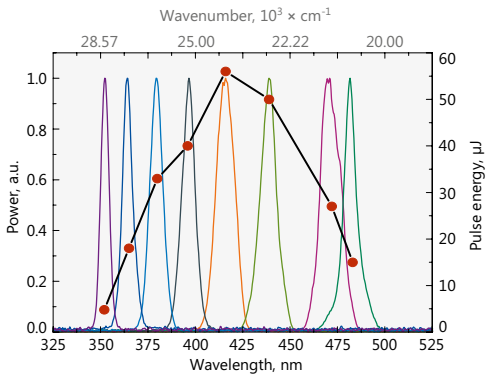

Typical output pulse duration



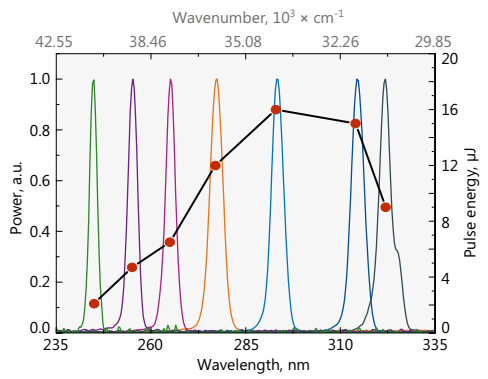

Long-term power stability measurement at 800 nm wavelength



Typical beam profile. Output pulse energy 0.3 mJ




Second harmonic output




Third harmonic output


PL2230 series picosecond laser employs innovative DPSS only technology to ensure high pulse energies at high repetition rates 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 20 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...

The laser can be controlled from remote control pad with backlit display that is easy to read even while wearing laser safety glasses. Alternatively, the laser can be operated also from personal computer through USB (RS-232 is optional) interface using supplied LabVIEW™ drivers.

## 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 | 1 000 Hz | Diode pumped solid state | 25 ± 2 ps | kHz repetition rate | 10 |
| **PL2230** | 140 mJ at 1064 nm | 100 Hz | Diode pumped solid state | 28 ± 3 ps | High pulse energy employing DPSS only technology | 13 |
| **PL2250** | 100 mJ | 50 Hz | Hybrid (DPSS master oscillator and flash-lamp pumped power amplifier) | 30 ± 3 ps | High pulse energy | 17 |
| **PL3140** | 80 mJ at 1053 nm | 10 Hz | Flash-lamp pumped | 10 ± 2 ps | Nd:YLF short pulse picosecond laser | 20 |
| **SL212** | 250 mJ at 1064 nm | 10 Hz | Hybrid (DPSS Q-switched master oscillator and flash-lamp pumped power amplifier) | < 150 ps | Optimized for tattoo removal, material ablation and deposition, remote laser sensing | 23 |
| **SL230** | 250 mJ at 1064 nm | 50 Hz | Diode-pumped Q-switched SLM master oscillator | 100 ± 15 ps | Employs Stimulated Brillouin Scattering (SBS compression) technology | 25 |
| **SL330** | 500 mJ at 1064 nm | 50 Hz | Flash-lamp pumped, self seeding master oscillator | 150 ± 20 ps | Employs Stimulated Brillouin Scattering (SBS compression) technology | 28 |

# PL2210 SERIES

## Diode Pumped Picosecond kHz Pulsed Nd:YAG Lasers


### FEATURES

- *High pulse energy at **kHz rates***
- *Diode pumped **solid state** design*
- ***Air cooled** – external water supply is not required*
- *Turn-key operation*
- *Low maintenance costs*
- *Optional streak camera triggering pulse with <10 ps rms jitter*
- *Remote control pad*
- *PC control via USB with supplied LabVIEW™ drivers*
- *Optional temperature stabilized second, third and fourth **harmonic generators***

### APPLICATIONS

- *Time resolved fluorescence, pump-probe spectroscopy*
- *OPG/OPA/OPO pumping*
- *Remote Laser Sensing*
- *Other spectroscopic and nonlinear optics applications*

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 150 µs lead of triggering pulse is available as a PRETRIG option that is designed to provide precise, very low jitter trigger pulses for a streak camera.

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

### Built-in harmonic generators

Angle-tuned non-linear crystals mounted in temperature stabilized heaters are used for second, third and fourth high spectral purity harmonic generation.

### Available models

| Model | Features |
|---|---|
| PL2210 | Up to 400 µJ, 25 ps pulses at an up to 2 kHz repetition rate |
| PL2210A | Up to 900 µJ, 25 ps pulses at an up to 1 kHz repetition rate |
| PL2210B | Up to 2.5 mJ energy at a 1 kHz repetition rate at 80 ps pulses |
| PL2210B-TR | Model, in addition to a 1 kHz pulse train, has an output of 88 MHz pulse train with 5 W average power that can be used for pumping synchronously pumped OPOs |
| PL2210C | Up to 5 mJ energy at a 1 kHz repetition rate at 80 ps pulses |

### Simple and convenient laser control

The laser can be controlled from a user-friendly remote control pad or USB interface. The remote pad allows easy control of all parameters and features. Alternatively, the laser can be controlled from a computer with supplied software for a Windows™ operating system. LabVIEW™ drivers are supplied as well.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## SPECIFICATIONS [1]

| Model | PL2210 | PL2210A | PL2210B | PL2210B-TR | PL2210C |
|---|---|---|---|---|---|
| Output energy | | | | | |
| at 1064 nm | 0.4 mJ | 0.9 mJ | 2.5 mJ | 2.5 mJ at 1 kHz<br>5 W at 88 MHz | 2.5 / 5 mJ |
| at 532 nm [2] | 0.2 mJ | 0.45 mJ | 1.3 mJ | – | 1.3 / 2.5 mJ |
| at 355 nm [3] | 0.11 mJ | 0.3 mJ | 0.8 mJ | – | 0.8 / 1.3 mJ |
| at 266 nm [4] | 0.05 mJ | 0.15 mJ | 0.5 mJ | – | 0.5 / 0.8 mJ |
| Pulse energy stability (StdDev) [5] | | | | | |
| at 1064 nm | 0.5 % | | | | |
| at 532 nm | 0.8 % | | | | |
| at 355 nm | 1 % | | | | |
| at 266 nm | 2.5 % | | | | |
| Pulse duration (FWHM) [6] | 25±2 ps | 25±2 ps | 80±8 ps | 100±10 ps | 25±2 ps / 80±8 ps |
| Pulse duration stability [7] | ±1 ps | ±1 ps | ±3 ps | ±3 ps | ±1 / ±3 ps |
| Pulse repetition rate [8] | 1 or 2 kHz | 1 kHz | | 1 kHz / 1 MHz | 1 kHz |
| Triggering mode | internal/external | | | | |
| Typical SYNC OUT pulse delay [9] [10] | -500 ... 50 ns | | | | |
| SYNC OUT pulse jitter | <0.1 ns rms | | | | |
| Spatial mode [11] | $TEM_{00}$ | | | | |
| Beam divergence [12] | <1.6 mrad | | | | |
| Beam diameter [13] | ~3 mm | | | | |
| Beam pointing stability [14] | <30 µrad | | | | |
| Pre-pulse contrast | >200:1 | | | | |
| Polarization | linear, >100:1 | | | | |
| **PHYSICAL CHARACTERISTICS** | | | | | |
| Laser head size (W × L × H) [15] | 456 × 1031 × 242 mm | | | 455 × 1235 × 242 mm | |
| Power supply size (W × L × H) | 365 × 392 × 290 mm | | 475 × 460 × 290 mm | | 365 × 285 × 360 mm |
| **OPERATING REQUIREMENTS** | | | | | |
| Water service | not required, air-cooled | | | | |
| Relative humidity | 10–80 % (non condensing) | | | | |
| Ambient temperature | 22±2 °C | | | | |
| Power requirements | 100–240 V AC, single phase 50/60 Hz | | | | |
| Power consumption [16] | <0.5 kW | <1 kW | | <2 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.

2) For PL2210x-SH and PL2210x-SH/FH options. Outputs are not simultaneous. Please inquire for pulse energies for other harmonic generator options.

3) For PL2210x-TH option. Outputs are not simultaneous. Please inquire for pulse energies for other harmonic generator options.

4) For PL2210x-SH/FH option. Outputs are not simultaneous. Please inquire for pulse energies for other harmonic generator options.

5) Averaged from 300 pulses at 1 kHz pulse repetition rate.

6) Optional 80±8 ps duration.

7) Measured over 1 hour period when ambient temperature variation is less than ±2 °C.

8) Should be specified when ordering. Inquire for custom pulse repetition rates.

9) With respect to optical pulse. <10 ps rms jitter is provided with PRETRIG option.

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

11) Gaussian fit >90%.

12) Full angle measured at the $1/e^2$ point at 1064 nm.

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

14) Rms value measured from 300 shots.

15) 455×1235×250 mm (W×L×H) laser head size might be required for some optional configurations.

16) At 1 kHz pulse repetition rate.

## OPTIONS

- **Option PRETRIG** provides low jitter pulse for streak camera triggering with lead/delay in -150...150 µs range and <10 ps rms jitter.
- **Option P80** provides 80±8 ps output pulse duration. Main specifications:

| Model | PL2210 | PL2210A |
|---|---|---|
| Pulse energy [1] | 0.7 mJ | 1.2 mJ |
| Pulse duration (FWHM) | <80 ps | |

[1] At 1064 nm

- **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 harmonics will be reduced by approx. 20% with installation of the –PC option.

## BEAM PROFILE

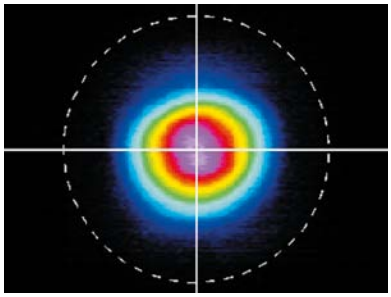

*Fig 1.* Typical near field beam profile of PL2210 series laser

## OUTLINE DRAWINGS

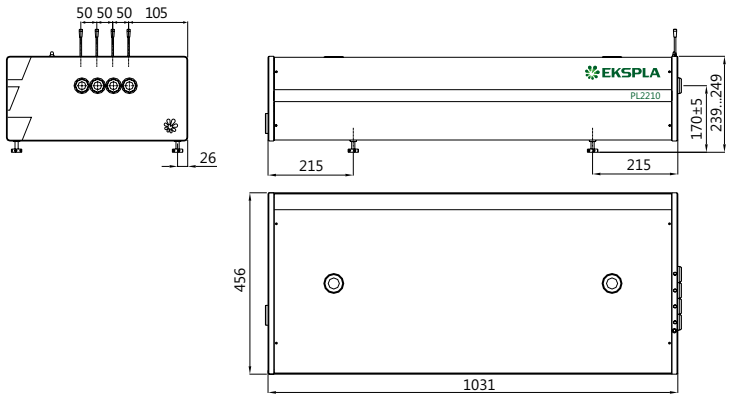


*Fig 2.* Dimensions of PL2210 series laser head (for models PL2210, PL2210A and PL2210B)

## ORDERING INFORMATION

**PL2210A-1K-SH/TH/FH-PRETRIG**

Model

Pulse energy level, A for 0.9 mJ output

Pulse repetition rate in Hz, 1K=1000 Hz

Harmonic generator options:
SH → second harmonic
TH → third harmonic
FH → fourth harmonic

Other pptions:
PRETRIG → pre-trigger option
P80 → 80 ps pulse duration option
PC → pulse picker option
PLL → pulse repetition rate locking option
FS → supercontinuum seeding option
TR → auxiliary quasi-CW train output option



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# PL2230 SERIES

## Diode Pumped High Energy Picosecond Nd:YAG Lasers


Ekspla is proud to introduce the first commercial fully diode pumped high pulse energy mode-locked laser, producing 28 ps pulses with up to 35 mJ (50 mJ preliminary) at 50 Hz pulse repetition rate.

### 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 (88 MHz) with a low single pulse energy of several nJ. Diode pumped amplifiers are used for amplification of the pulse to 35 mJ (50 mJ preliminary) 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. Harmonics 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. If required, up to 1000 µs lead of triggering pulse is available when a PRETRIG option is installed.

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.

### FEATURES

- ***New!*** *Beam profile improvement using advanced beam shaping system*
- *Hermetically sealed DPSS master oscillator*
- *Diode pumped regenerative amplifier*
- *Diode pumped power amplifier producing up to **35 mJ** per pulse (50 mJ preliminary) at 1064 nm*
- *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 trough USB and with supplied LabView™ drivers*
- *Remote control via keypad*

### APPLICATIONS

- *Time resolved spectroscopy*
- *SFG/SHG spectroscopy*
- *Nonlinear spectroscopy*
- *OPG pumping*
- *Remote laser sensing*
- *Satellite ranging*
- *Other spectroscopic and nonlinear optics applications*

## Simple and convenient laser control

For customer convenience the laser can be controlled through a user-friendly remote control pad or USB interface.

The remote pad allows easy control of all parameters and features a back-lit display that is easy to read even with laser safety eye-wear.

Alternatively, the laser can be controlled from a personal computer with supplied software for a Windows™ operating system. LabView™ drivers are supplied as well.

## SPECIFICATIONS [1]

| Model | PL2230-50 | PL2231-100 | PL2231-50 | PL2231A-50 | PL2231B-20 | PL2231C-20 |
|---|---|---|---|---|---|---|
| | | | | Preliminary | | |
| Pulse energy (not less than) [2] | | | | | | |
| at 1064 nm | 3.0 mJ | 15 mJ | 35 mJ | 50 mJ | 100 mJ | 140 mJ |
| at 532 nm [3] | 1.3 mJ | 7 mJ | 16 mJ | 23 mJ | 45 mJ | 60 mJ |
| at 355 nm [4] | 0.9 mJ | 5 mJ | 10 mJ | 14 mJ | 28 mJ | 35 mJ |
| at 266 nm [5] | 0.3 mJ | 1.5 mJ | 4 mJ | 6 mJ | 11 mJ | 15 mJ |
| at 213 nm [6] | 0.2 mJ | 0.7 mJ | 1.8 mJ | 2.5 mJ | 5 mJ | 7 mJ |
| 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] | 28 ps ± 10 % | | | | 80 ps ± 10 % | |
| Pulse duration stability [9] | ± 1 % | | | | | |
| Power drift [10] | ± 2 % | | | | | |
| Pulse repetition rate | 0 – 50 Hz | 100 Hz | 50 Hz | 50 Hz | 20 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 | ≤ 30 µrad StdDev | | | | |
| Typical beam diameter [14] | ~2.5 mm | ~5 mm | ~6 mm | ~7 mm | ~7 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 | 30 min | | | | |

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. Specifications for models PL2231A, B and C 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) 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 with PRETRIG option.


16) With respect to SYNC IN pulse.

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



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## SPECIFICATIONS [1)]

| Model | PL2230-50 | PL2231-100 | PL2231-50 | PL2231A-50 | PL2231B-20 | PL2231C-20 |
|---|---|---|---|---|---|---|
| | | | | Preliminary | | |
| **PHYSICAL CHARACTERISTICS** | | | | | | |
| Laser head size (W × L × H) | 456×1031×249 ± 3 mm | | | | 456×1233×249 ± 3 mm | 456×1432×249 ± 3 mm |
| Electrical cabinet size (W × L × H) | 12 V DC power adapter, 85×170×41 ± 3 mm | 471×391×147 ± 3 mm | | | 520×600×331 ± 3 mm | |
| Umbilical length | 2.5 m | | | | | |
| **OPERATING REQUIREMENTS** | | | | | | |
| Cooling [18)] | Built in 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 | | | < 1.5 kVA | |

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

## OPTIONS

- **Pretriger for streak camera triggering option (–PRETRIG)**
  PL2230 series lasers have build-in low-jitter delay generator for streak camera triggering. Provides low jitter < 10 ps StdDev triggering pulse.

- **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 | PL2231A |
|---|---|---|
| 1064 nm | 25 mJ | 40 mJ |
| 532 nm | 11 mJ | 16 mJ |
| 355 nm | 7 mJ | 10 mJ |
| 266 nm | 3 mJ | 4 mJ |

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

## BEAM PROFILE

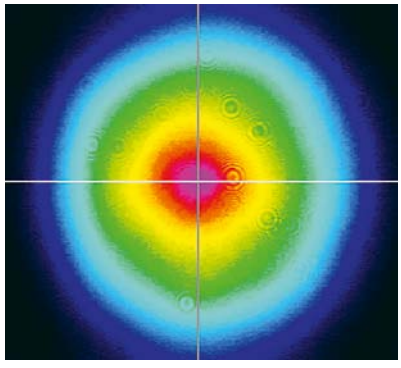

*Fig 1.* Typical near field output beam profile of PL2231 model laser

## OUTLINE DRAWINGS

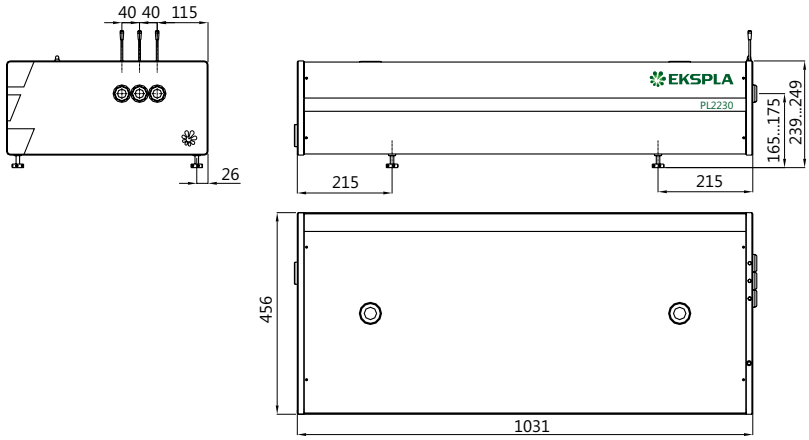


*Fig 2.* Dimensions of PL2230 series laser head

## ORDERING INFORMATION

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

Model

Pulse repetition rate in Hz

Harmonic generator options:
SH → second harmonic
TH → third harmonic
FH → fourth harmonic

Other options:
PRETRIG → pre-trigger option
P20 → 20±2 ps pulse duration option
P80 → 80 ps pulse duration option



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# PL2250 SERIES

## Flash-Lamp Pumped Picosecond Nd:YAG Lasers


### 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 **50 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 via USB and LabVIEW™ drivers*
- *Remote control via keypad*

### APPLICATIONS

- *Time resolved spectroscopy*
- *SFG/SHG spectroscopy*
- *Nonlinear spectroscopy*
- *OPG pumping*
- *Remote laser sensing*
- *Satellite ranging*
- *Other spectroscopic and nonlinear optics experiments*

PL2250 series lasers set a new standard in high pulse energy picosecond lasers. Their innovative and 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. Harmonics 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 option.

Precise pulse energy control, excellent short-term and long-term stability, and up to 50 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 controlled from a user-friendly remote control pad or USB interface.

The remote pad allows easy control of all parameters and features a backlit display that is easy to read even while wearing laser safety eyewear. Alternatively, the laser can be controlled from a personal computer with supplied software for a Windows™ operating system. LabVIEW™ drivers are supplied as well.

## SPECIFICATIONS [1]

| Model | PL2250 | PL2251 | PL2251A | PL2251B | PL2251C |
|---|---|---|---|---|---|
| Pulse energy | | | | | |
| at 1064 nm | 1 mJ | 30 mJ | 50 mJ [2] | 80 mJ [2] | 100 mJ |
| at 532 nm [3] | 0.45 mJ | 15 mJ | 25 mJ | 40 mJ | 50 mJ |
| at 355 nm [4] | 0.3 mJ | 10 mJ | 15 mJ | 24 mJ | 30 mJ |
| at 266 nm [5] | 0.15 mJ | 3 mJ | 7 mJ | 10 mJ | 12 mJ |
| at 213 nm [6] | na | inquire | inquire | inquire | inquire |
| Pulse energy stability (StdDev) [7] | | | | | |
| at 1064 nm | <0.2 % | <0.8 % | | | |
| at 532 nm | <0.4 % | <1.0 % | | | |
| at 355 nm | <0.5 % | <1.1 % | | | |
| at 266 nm | <0.5 % | <1.2 % | | | |
| Pulse duration (FWHM) [8] | 30 ps ± 10 % | | | | |
| Pulse duration stability [9] | ±1.0 % | | | | |
| Repetition rate | 0–50 Hz | 50, 20 or 10 Hz | 50, 20 or 10 Hz | 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 | | | | |
| TRIG1 OUT pulse delay [12] | -500 ... 50 ns | | | | |
| Beam divergence [13] | <1.5 mrad | <0.5 mrad | | | |
| Beam pointing stability [14] | ≤10 µrad | ≤30 µrad | | | |
| Beam diameter [15] | ~2.5 mm | ~8 mm | ~8 mm | ~10 mm | ~12 mm |
| Typical warm-up time | 5 min | 30 min | | | |
| **PHYSICAL CHARACTERISTICS** | | | | | |
| Laser head size (W × L × H) | 456×1031×249 mm ±3 mm | 456×1233×249 mm ±3 mm (for PL2251A, B with harmonics and C models)<br>456×1031×249 mm ±3 mm (for PL2251A, B models without harmonics) | | | |
| Electric cabinet size (W × L × H) | 12 V DC power adapter, 85×170×41 mm ±3 mm | 550×600×550 ±3 mm (19" standard, MR-9) | | | |
| Umbilical length | 2.5 m | | | | |
| **OPERATING REQUIREMENTS** | | | | | |
| Water consumption (max 20 °C) | air cooled | 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] | 110–240 V AC, 50/60 Hz | single phase, 200–240 V AC, 16 A, 50/60 Hz | | | |
| Power [17] | <0.15 kVA | <1.5 kVA | <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.

2) PL2251A-50 has 40 mJ at 1064 nm, 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 with PRETRIG option.

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.



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## OPTIONS

▶ **Pretriger for streak camera trigering option**
PL2250 series lasers have build-in low-jitter delay generator for streak camera triggering. Provides low jitter < 10 ps rms triggering pulse.

▶ **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 | PL2251-10 | PL2251A-10 | PL2251B-10 | PL2251C -10 |
|---|---|---|---|---|
| 1064 nm | 20 mJ | 35 mJ | 60 mJ | 80 mJ |
| 532 nm | 10 mJ | 17 mJ | 30 mJ | 40 mJ |
| 355 nm | 7 mJ | 12 mJ | 18 mJ | 24 mJ |
| 266 nm | 3 mJ | 5 mJ | 8 mJ | 10 mJ |

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

| Model | PL2250 | PL2251 | PL2251A | PL2251B | PL2251C |
|---|---|---|---|---|---|
| Pulse energy at 1064 nm | 1.5 mJ | 60 mJ | 100 mJ | 160 mJ | 200 mJ |

▶ **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

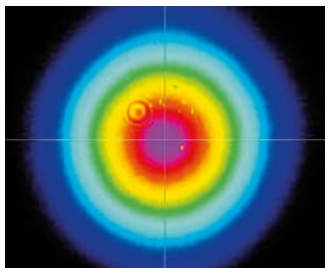

*Fig 1.* Typical near field output beam profile of PL2250 series laser

## OUTLINE DRAWINGS

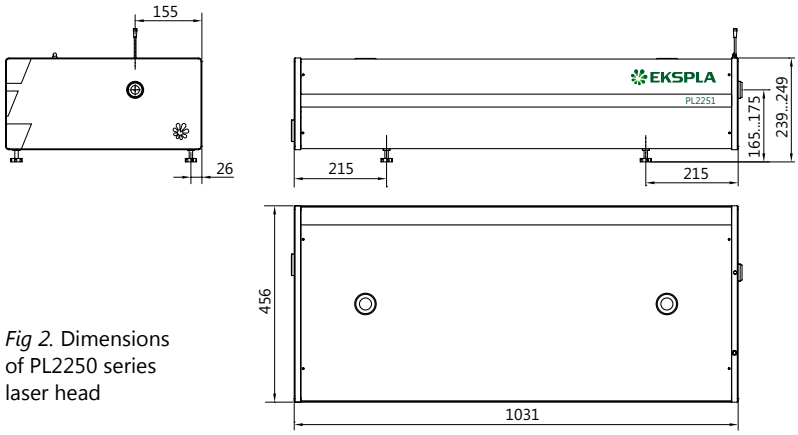


*Fig 2.* Dimensions of PL2250 series laser head

## ORDERING INFORMATION

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

- 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:
  - PRETRIG → pre-trigger option
  - P20 → 20 ps pulse duration option
  - P80 → 80 ps pulse duration option
  - AW → water-air heat exchanger option
  - PLL → pulse repetition rate locking option
  - FS → seeding option

# PL3140 SERIES

## Picosecond Nd:YLF Lasers


### FEATURES

- *Fiber master oscillator*
- *Diode pumped regenerative amplifier*
- *Flashlamp pumped power amplifier producing up to **80 mJ** per pulse at 1053 nm*
- ***10 ps** pulse duration*
- *Excellent pulse duration stability*
- *Up to **10 Hz** repetition rate*
- *PC control via USB (RS232 is optional) and LabView™ drivers*
- *Remote control pad*
- *Optional streak camera triggering pulse with <10 ps rms jitter*
- *Optional thermostabilized second, third or fourth harmonic generators*
- *Optical parametric generators for tunable wavelength output in 210–2600 nm range are available*

### APPLICATIONS

- *Time resolved spectroscopy*
- *Nonlinear spectroscopy*
- *OPG pumping*
- *Other spectroscopic and nonlinear optics experiments*

Nd:YLF mode-locked PL3143 series picosecond lasers produces high energy pulses with as short as 10 ps pulse duration.

### Rugged and reliable design

Diode pumped mode-locked quasi-CW master oscillator produces the train of the pulses that is guided to the regenerative amplifier for further amplification. The single pulse is cavity-dumped from regenerative amplifier and then amplified by linear amplifiers to up to 80 mJ pulse energy. The output pulse energy can be adjusted in approximately 1 % steps from 1 mJ to nominal output, at the same time pulse-to-pulse energy stability remains less than 1.5 % rms at 1053 nm.

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

Build in energy monitors continuously monitors output pulse energy. Data from the energy monitor can be seen on the remote keypad or on PC monitor.

The laser provides triggering pulse for synchronization of customer's equipment with lead up to 500 ns. The lead of triggering pulse can be adjusted in ~0.25 ns steps from control pad or PC.

PRETRIG option is offered for streak camera triggering and can provide pulse with up to 1000 µs lead that can be adjusted from PC with approx. 33 ns step.

### Simple and convenient laser control

For customer convenience the laser can be controlled via user-friendly remote control pad. The remote pad allows easy control of all the parameters and features a backlit display that is easy to read even when wearing laser safety eyewear.

Alternatively, the laser can be controlled from personal computer via USB port using supplied software for Windows™ operating system. LabView™ drivers are supplied as well.


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## SPECIFICATIONS [1]

| Model | PL3143 | PL3143A | PL3143B |
|---|---|---|---|
| Pulse energy | | | |
| at 1053 nm | 30 mJ | 50 mJ | 80 mJ |
| at 526.5 nm [2] | 15 mJ | 25 mJ | 40 mJ |
| at 351 nm [3] | 8 mJ | 12 mJ | 15 mJ |
| at 263 nm [3] | 4 mJ | 6 mJ | 8 mJ |
| Pulse energy stability (StdDev) [4] | | | |
| at 1053 nm | <1.5 % | | |
| at 526.5 nm | <3.0 % | | |
| at 351 nm | <5.5 % | | |
| at 263 nm | <7.0 % | | |
| Pulse duration (FWHM) [5] | 10±2 ps | | |
| Pulse duration stability [6] | ±0.5 ps | | |
| Repetition rate | 10 Hz | 5 or 10 Hz | 5 Hz |
| Polarization | linear, vertical | | |
| Pre-pulse contrast | >200:1 | | |
| Triggering mode | internal / external | | |
| SYNC OUT pulse jitter [7] | <30 ps | | |
| SYNC OUT pulse lead/delay [8] | -500...50 ns | | |
| Beam divergence [9] | <0.7 mrad | <0.6 mrad | <0.6 mrad |
| Beam pointing stability [10] | <20 µrad | | |
| Beam diameter [11] | ~6 mm | ~7 mm | ~8 mm |
| **PHYSICAL CHARACTERISTICS** | | | |
| Laser head size (W × L × H) | 462 × 1245 × 255 mm | | 600 × 1600 × 260 mm |
| Electric cabinet size (W × L × H) | 550 × 600 × 835 mm | | |
| Umbilical length | 2.5 m | | |
| **OPERATING REQUIREMENTS** | | | |
| Water consumption (max 20 °C) | <15 l/min | | |
| Room temperature | 22±2 °C | | |
| Relative humidity | 20–80 % (non-condensing) | | |
| Power requirements [12] | three phase, 208 or 380 V AC, 20 A, 50/60 Hz | | |
| Power consumption | <2.5 kVA | < 3 kVA [13] | <4 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 1053 nm.

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

3) With auxiliary H400 harmonics generator unit. Outputs are not simultaneous. Please inquiry for pulse energies at other wavelengths.

4) Averaged from 300 pulses.

5) Inquiry for optional pulse durations in 20–80 ps range.

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

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

8) SYNC OUT lead or delay can be adjusted with ~0.25 ns steps in specified range. PRETRIG option provide -1000..5000 µs lead/delay time adjustment range.

9) Full angle measured at the $1/e^2$ point at 1053 nm.

10) RMS value measured from 300 shots.

11) Beam diameter is measured at 1053 nm at the $1/e^2$ level.

12) Mains voltage should be specified when ordering.

13) For 10 Hz version.

## OPTIONS

- **PRETRIG** option provides low jitter pulse for streak camera triggering with delay in -1000...5100 μs range and <10 ps rms jitter.

## BEAM PROFILE

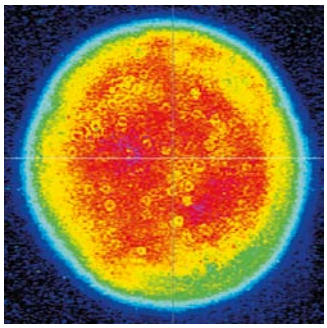

*Fig 1.* Typical beam profile at 1053 nm at 20 cm from PL3143B laser output at 80 mJ pulse energy

## OUTLINE DRAWINGS

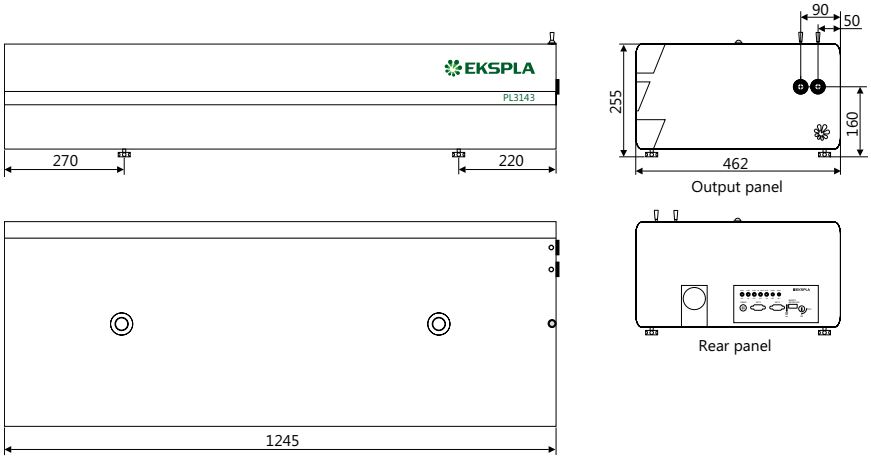


*Fig 2.* Dimensions of PL3143 and PL3143A lasers

## ORDERING INFORMATION

**PL3143A-10-SH/TH/FH-PRETRIG**

Model

Pulse energy level:
A → 50 mJ output
no letter → 30 mJ output

Pulse repetition rate in Hz

Options:
AW → water-air heat exchanger

Harmonic generator options:
SH → second harmonic
TH → third harmonic
FH → fourth harmonic



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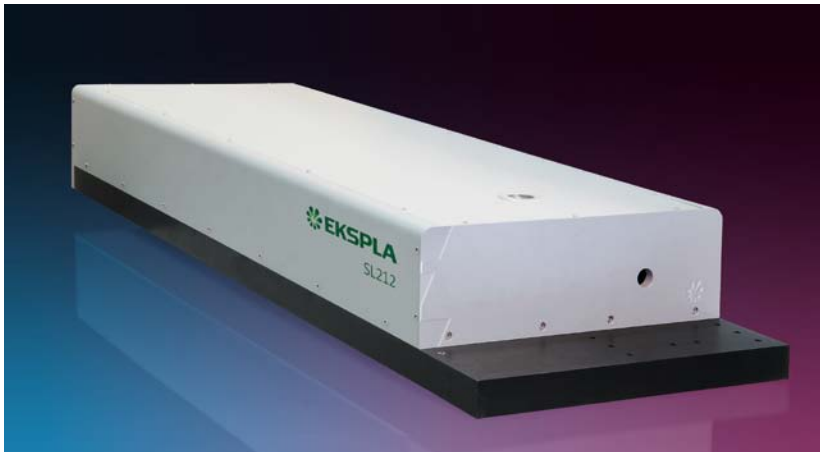
# SL212 SERIES

## SBS Compressed Q-switched Nd:YAG Lasers for OEM




### FEATURES

- *Diode pumped Q-switched oscillator*
- *Advanced SBS compression produces pulses of less than **150 ps** duration*
- *Flashlamp pumped power amplifier for up to **250 mJ** pulse energy at 1064 nm*
- *Excellent pre-pulse contrast ratio*
- *Thermo stabilized harmonic generator options*
- *PC control and LabView™ drivers*
- *Remote control via keypad*

### APPLICATIONS

- *Tattoo removal*
- *Material ablation and deposition*
- *Remote laser sensing*
- *Satellite ranging*

SL212 laser is excellent solution for applications, where high energy picosecond pulses are needed. In contrary to conventional mode-locked lasers the SL212 series lasers use different method of generating short pulses based on backward-stimulated Brillouin scattering (SBS).

Diode pumped passive Q-switched single longitudinal mode (SLM) nanosecond generator is the heart of the system. It provides nanosecond optical pulse that is later compressed during SBS in a special cell.

Pulse compressor consists of optical guiding system and SBS-cell. SBS cell is designed for safe and longlife maintenance free operation.

A linearly polarized light pulse from master oscillator passes through QWP and is focused into SBS-cell by lens. Focusing is arranged in the way to compress the pulse via SBS process. The backscattered Stokes pulse, as its phase is reversed, strictly repeats the path of pump pulse in the opposite direction and with a reversal divergence. The compressed pulse is guided into the amplification stage using polarizer and mirror.

After SBS compression, pulse is directed to multi-pass flashlamp pumped power amplifier system, providing high-energy pulses. SL212 model lasers use multi-pass amplifier system which is based on laser chamber containing Nd:YAG rod pumped by two flash lamps. For smooth obtaining output beam profile pre-amplifier and double-pass amplifier layout is used in SL212 series lasers. Power amplifier includes optical components arranging passes through the active element. Aperture is employed to prevent the returning depolarized radiation from getting back into the amplifier.

Thermocontrolled harmonics' generators, based on angle-tuned non-linear crystals and harmonic separation optics are available as standard options. Fundamental and second harmonics are separated and has a single output port. Harmonics' crystals mounted in temperature-controlled heaters.

Pulse compression during SBS, is a simple and cost effective way for generating high power picosecond pulses. In addition to it, SBS compression allows generation of pulses with exceptional pulse duration range: from 150 ps up to 1000 ps.

A power supply and water/water type cooling units, placed in standard 19" rack, requires a little space under the user's optical table.

## SPECIFICATIONS [1]

| Model | SL212 |
|---|---|
| Max. pulse energy | |
| at 1064 nm | 250 mJ |
| at 532 nm | 150 mJ |
| Pulse energy stability (StDev) [2] | |
| at 1064 nm | < 3 % |
| at 532 nm | < 5 % |
| Pulse duration at 1064 nm (FWHM) [3] | < 150 ps |
| Repetition rate | 10 Hz |
| Polarization ratio at 1064 nm | >1 : 100 |
| Optical pulse jitter [4] | 300 ns |
| Beam profile | close to Hat Top |
| Beam divergence [5] | < 0.5 mrad |
| Beam pointing stability | < 50 µrad |
| Beam height | 107 mm |
| Beam diameter [6] | ~ 10 mm |
| Contrast ratio at 1064 nm | $10^5$ : 1 |
| **PHYSICAL CHARACTERISTICS** | |
| Laser head size (W × L × H) | 370 × 270 × 1000 mm |
| Electric cabinet size (W × L × H) | 550 × 525 × 590 mm |
| Umbilical length | 2.5 m |
| **OPERATING REQUIREMENTS** | |
| Water consumption (max. 20 °C) [7] | < 10 l/min |
| Room temperature | 18–24 °C |
| Relative humidity | 10–80 % (non-condensing) |
| Power requirements | ~ 220 V AC, single phase, 50/60 Hz |
| Power consumption | < 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.

2) Averaged from 500 pulses.

3) Variable pulse duration up to 1500 ps is available, please inquire for detailed specs.

4) RMS value measured from 500 pulses.

5) Full angle measured at $1/e^2$ level at 1064 nm.

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

7) Air-water heat exchanger can be supplied as an option.

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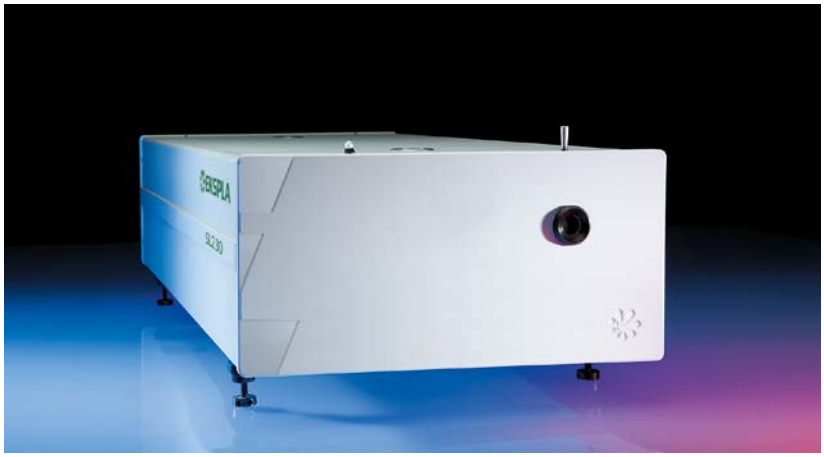
# SL230 SERIES

## SBS Compressed Picosecond DPSS Nd:YAG Lasers



### FEATURES

- *Diode pumped Q-switched SLM master oscillator*
- *Flashlamp pumped power amplifier for up to **250 mJ** pulse energy at 1064 nm*
- *Advanced SBS compression produces pulses down to **100 ps** duration*
- *Up to **50 Hz** pulse repetition rate*
- *Excellent pre-pulse contrast ratio*
- *Thermo stabilized second, third or fourth harmonic generator options*
- *Low jitter external triggering*
- *Pre-trigger option produces sync pulses with <200 ps rms jitter*
- *Laser control from PC via USB port*
- *Simple and reliable design*
- *Low maintenance costs*

### APPLICATIONS

- *Plasma research*
- *Medical*
- *Material ablation and deposition*
- *Holography*
- *Remote laser sensing*
- *Satellite ranging*
- *OPCPA pumping*

SL230 series lasers are excellent solution for applications, where high energy picosecond pulses are needed. Not like conventional mode-locked lasers that typically uses saturable nonlinear absorption or Kerr lensing to produce ultrafast pulses, the SL230 series lasers employ backward-stimulated Brillouin scattering (SBS) in liquid for the same purpose.

### Innovative design

Diode pumped electro-optically Q-switched single longitudinal mode (SLM) nanosecond generator is the heart of the system. It provides nanosecond optical pulse that is later compressed during SBS in a special cell.

Q-switched master oscillator allows precise external triggering with jitter of less than 0.2 ns rms while mode-locked lasers typically have jitters of at least of tens of nanoseconds or even worse. Precise sync pulses from internal delay generator are also available with less than 200 ps rms jitter with respect to optical pulse.

Pulse compression is done in SBS-cell. The geometry of interaction is designed to produce shortest and most stable pulses with 100 ps duration.

After SBS compression, pulse is directed to multi-pass flashlamp pumped power amplifier for amplification to up to 250 mJ pulse energy.

Some versions, like SL230 and SL231 are available with diode pumped power amplifier.

Thermocontrolled harmonics generators, based on angle-tuned KD*P and KDP crystals and harmonic separation optics are available as standard options. Each wavelength has a separate output port.

Build in energy monitors continuously monitors output pulse energy. Data from the energy monitor can be seen on the remote keypad or on PC screen.

Power supply and cooling units are mounted into standard 19" rack.

### Simple and convenient laser control

Laser is controlled by PC via USB port with application for Windows™ operating system.

In addition, major settings of laser can be controlled through user-friendly remote control pad. The remote pad features a backlit display that is easy to read even while wearing laser safety eyewear.

## SPECIFICATIONS [1]

| Model | SL230 | SL231 | SL232 | SL233 | SL234 |
|---|---|---|---|---|---|
| Max. pulse energy: | | | | | |
| at 1064 nm | 5 mJ | 20 mJ | 90 mJ | 150 mJ | 250 mJ |
| at 532 nm [2] | 2 mJ | 8 mJ | 40 mJ | 70 mJ | 125 mJ |
| at 355 nm [3] | 1.5 mJ | 5 mJ | 25 mJ | 40 mJ | 80 mJ |
| at 266 nm [4] | 0.5 mJ | 2 mJ | 10 mJ | 15 mJ | 25 mJ |
| at 213 nm [5] | – | 1 mJ | 4 mJ | 10 mJ | 15 mJ |
| Pulse energy stability (StdDev): [6] | | | | | |
| at 1064 nm | 3 % | 2 % | | 1.5 % | |
| at 532 nm | 5 % | 3.5 % | | 3 % | |
| at 355 nm | 8 % | 5 % | | 4 % | |
| at 266 nm | 10 % | 8 % | | 7 % | |
| at 213 nm | – | 10 % | | 10 % | |
| Pulse duration at 1064 nm (FWHM) [7] | 100±15 ps | | | | |
| Pulse duration stability at 1064 nm (StdDev) [6] | 5 % | | | | |
| Repetition rate | 50 Hz | 10 Hz [8] | | | 10 Hz [9] |
| Linewidth | ≤0.1 $cm^{-1}$ | | | | |
| Polarization ratio at 1064 nm | >1:100 | | | | |
| Optical pulse jitter [10] | 0.2 ns rms | | | | |
| Beam profile | near Gaussian | | Hat Top [11] | | |
| Beam pointing stability at 1064 nm [12] | <50 µrad | | | | |
| Beam divergence [13] | <0.5 mrad | | | | |
| Beam height | 170±5 mm | | | | |
| Contrast ratio at 1064 nm | ≥$10^5$ : 1 | | | | |
| Beam diameter [14] | ~4 mm | ~5 mm | ~8 mm | ~10 mm | ~12 mm |
| **PHYSICAL CHARACTERICTICS** | | | | | |
| Laser head size (W × L × H) [15] | 452 × 810 × 260 mm | | 452 × 1010 × 260 mm | | |
| Electric cabinet size (W × L × H) | 553 × 600 × 665 mm | | | | |
| Umbilical length | 2.5 m | | | | |
| **OPERATING REQUIREMENTS** | | | | | |
| Water consumption (max. 20 °C) | < 10 liters/min | | | | |
| Room temperature | 18–24 °C | | | | |
| Relative humidity | 10–80 % (non-condensing) | | | | |
| Power requirements [16] | 208 or 230 V AC, single phase, 50/60 Hz | | 208 or 380 V AC, three phase, 50/60 Hz | | |
| Power consumption | <2 kVA | <1.5 kVA | <2.5 kVA | <3.5 kVA | <3.5 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.

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

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

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

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

6) Averaged from 300 pulses.

7) Variable pulse duration options are available with 120–500 ps or 500–1000 ps tuning range.

8) Models with pulse repetition rates up to 50 Hz are available.

9) Models with pulse repetition rates up to 20 Hz are available.

10) In external triggering mode with two separate triggering pulses for flashlamps and Q-switch. Low jitter sync pulse available for user equipment triggering.

11) Improved Gaussian fit profile is available by request.

12) RMS value measured from 300 shots.

13) Full angle measured at the $1/e^2$ point at 1064 nm.

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

15) Models with 213 nm output, feature length equal to 1024 mm.

16) Three phase 208 or 380 VAC mains are required for 20 or 50 Hz versions.

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## OPTIONS

### Variable pulse duration options -VPx and -VPCx

SL series lasers offer a unique capability for tuning pulse duration. The tuning is done by changing the geometry of interaction in the SBS compressor. Two tuning ranges – 120–500 ps (option -VP1) and 500–1000 ps (option -VP2) – are available as standard options.

While the -VPx option requires manual tuning of optical layout components for pulse duration change, the -VPCx option provides motorized tuning that allows a change in pulse duration from a personal computer or laser control pad.

*Note. Certain specifications may change when the laser is configured for variable pulse duration. Contact Ekspla for detailed data sheets.*

## OUTLINE DRAWINGS

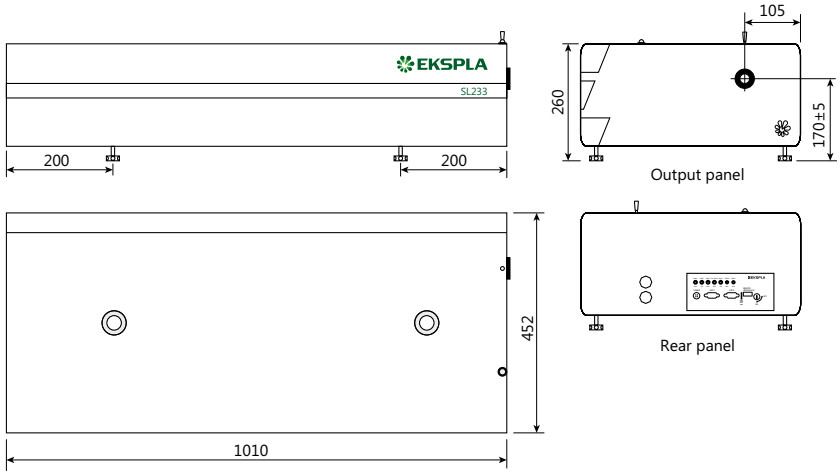


*Fig 1.* SL230 laser head outline drawing

# SL330 SERIES

## SBS Compressed Picosecond Nd:YAG Lasers

SL 300 series lasers are an excellent solution for applications that require high energy picosecond pulses.

Pulse compression during backward-stimulated Brillouin scattering (SBS), used in EKSPLA SL300 series lasers, is a simple and cost-efficient way to generate picosecond pulses, with the unique capability of producing pulses with tunable duration.

An electro-optically Q-switched Single Longitudinal Mode (SLM) nanosecond generator is the heart of the system. Instead of external narrow linewidth diode lasers, the selective properties of Fabry-Perrot etalon, and a laser cavity are used to produce SLM pulses with a smooth temporal envelope. In scientific literature this method of generating SLM pulses is known as a selfseeding technique.

Pulse compression is done in a SBS-cell. Depending on the geometry of interaction, a pulse with duration in the 170–1500 ps range can be produced. Pulse duration can be tuned in discrete steps when a variable pulse duration option (-VPx) is installed.

After SBS compression, the pulse is directed to a multi-pass power amplifier system for amplification to up to 500 mJ energy. Temperature controlled harmonics generators, based on angle-tuned KD*P and KDP crystals and harmonic separation optics, are available as standard options. Each wavelength has a separate output port.

A power supply and cooling units are placed in a standard 19" rack that requires little space under an optical table.

The very low jitter of the optical pulse relative to the Q-switch triggering pulse ensures reliable synchronization of the laser with external equipment.

For customer convenience the laser can be controlled from a user-friendly remote control pad or RS232 interface.

The remote pad allows easy control of all laser parameters and features a backlit display that is easy to read even when wearing laser safety eyewear.

Alternatively, the laser can be controlled from a personal computer with supplied software for a Windows™ operating system. LabView™ drivers are supplied as well.

### FEATURES

- *Innovative and cost-efficient design*
- *Up to **500 mJ** per pulse at 1064 nm*
- ***150 ps** pulse duration*
- *Self seeding SLM master oscillator*
- *More than $10^5$ : 1 pre-pulse contrast ratio*
- *Low jitter external triggering*
- *Versatile synchronization possibilities*
- *Variable pulse duration option*
- *LabVIEW™ drivers for convenient control from PC via RS232 port*
- *Remote control via keypad*
- *Compact laser head and power supply cabinet*

### APPLICATIONS

- *Plasma research*
- *Medical*
- *Material ablation and deposition*
- *Holography*
- *Absorption spectroscopy of laser induced plasmas*
- *Satellite ranging*
- *EUV light source development for photolithography*
- *OPCPA pumping*


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## SPECIFICATIONS [1]

| Model | SL330 | SL332 | SL333 | SL334 |
|---|---|---|---|---|
| Max. pulse energy: | | | | |
| at 1064 nm | 30 mJ | 150 mJ | 250 mJ | 500 mJ |
| at 532 nm [2] | 12 mJ | 70 mJ | 120 mJ | 240 mJ |
| at 355 nm [3] | 7 mJ | 40 mJ | 80 mJ | 140 mJ |
| at 266 nm [4] | 4 mJ | 25 mJ | 40 mJ | 80 mJ |
| at 213 nm [5] | 2 mJ | 10 mJ | 15 mJ | 25 mJ |
| Pulse energy stability (StdDev) [6]: | | | | |
| at 1064 nm | 6 % | 4 % | | |
| at 532 nm | 8 % | 7 % | | |
| at 355 nm | 10 % | 9 % | | |
| at 266 nm | 13 % | 12 % | | |
| at 213 nm | 15 % | 15 % | | |
| Pulse duration at 1064 nm (FWHM) [7] | 150±20 ps | | | 170±20 ps |
| Pulse duration stability at 1064 nm [8] | 10 % (StdDev) | | | |
| Repetition rate [9] | 10 or 50 Hz | 10 Hz | | 5 Hz |
| Linewidth | ≤0.1 $cm^{-1}$ | | | |
| Polarization | linear, >50:1 | | | |
| Optical pulse jitter [10] | 0.5 ns | | | |
| Beam profile [11] | Hat Top, >70% fit to Gaussian | | | |
| Beam pointing stability at 1064 nm [12] | 50 µrad | | | |
| Beam divergence [13] | <0.5 mrad | | | |
| Beam height | 170±5 mm | | | |
| Pre-pulse contrast ratio | $10^5$ : 1 | | | |
| Beam diameter [14] | ~6 mm | ~8 mm | ~10 mm | ~12 mm |
| **PHYSICAL CHARACTERISTICS** | | | | |
| Laser head size (W × L × H) | 255 × 790 × 240 mm | 305 × 990 × 260 mm | | |
| Electric cabinet size (W × L × H) | 550 × 600 × 530 mm | 550 × 600 × 850 mm | | |
| Umbilical length | 2.5 m | | | |
| **OPERATING REQUIREMENTS** | | | | |
| Water consumption (max. 20 °C) | < 10 liters/min | | | |
| Room temperature | 18–27 °C | | | |
| Relative humidity | 10–80 % (non-condensing) | | | |
| Power requirements [15] | 208 or 230 V AC, single phase, 50/60 Hz | | | 208 or 380 V AC, three phase, 50/60 Hz |
| Power consumption [16] | <1.5 kVA | <2.5 kVA | <3.5 kVA | <3.5 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.

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

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

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

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

6) Averaged from 300 pulses.

7) Variable pulse duration options are available with 170–500 ps or 500–1000 ns tuning range.

8) Measured from 300 shots using 40 Gs/s oscilloscope and photodetector with 50 ps rise time.

9) Inquire for up to 50 Hz custom pulse repetition rates.

10) In external triggering mode with two separate triggering pulses for flashlamps and Q-switch. Low jitter sync pulse is available for user equipment triggering.

11) Improved Gaussian fit profile is available on request.

12) RMS value measured from 300 shots.

13) Full angle measured at the $1/e^2$ point at 1064 nm.

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

15) Three phase 208 or 380 V AC mains are required for 20 or 50 Hz versions.

16) For 5 or 10 Hz pulse repetition rate.

## OPTIONS

### ▸ Variable pulse duration options -VPx and -VPCx

SL series lasers offer a unique capability for tuning pulse duration. The tuning is done by changing the geometry of interaction in the SBS compressor. Two tuning ranges – 170–500 ps (option -VP1) and 500–1000 ps (option -VP2) – are available as standard options.

While the -VPx option requires manual tuning of optical layout components for pulse duration change, the -VPCx option provides motorized tuning that allows a change in pulse duration from a personal computer or laser control pad.

*Note. Certain specifications may change when the laser is configured for variable pulse duration. Contact Ekspla for detailed data sheets.*

## OUTLINE DRAWINGS

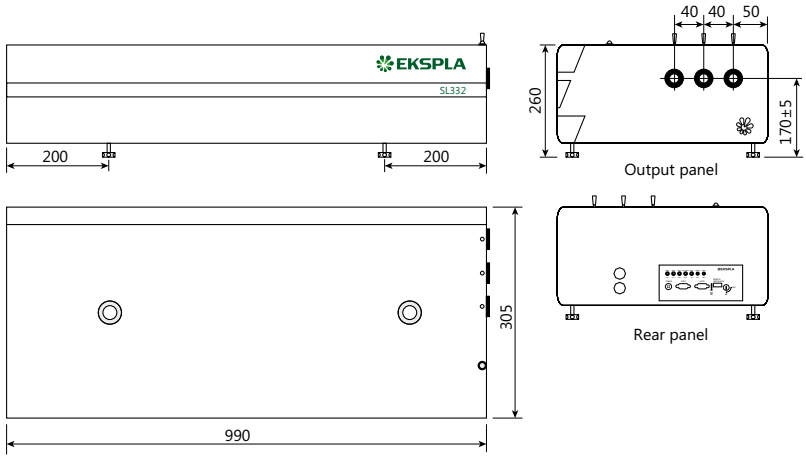


*Fig 1.* Dimensions of SL332, SL333 and SL334 lasers

## APPLICATIONS

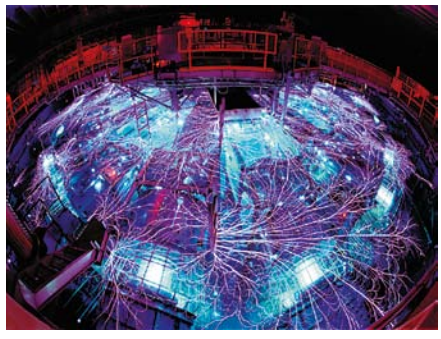

*Fig 2.* SL330 series laser used as a flash in high speed photography to illuminate wires as they explode
*Courtesy of Dr. Randy Montoya, Sandia National Laboratories, USA*



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## ORDERING INFORMATION

**SL332-10-SH-VP1**

Model

Pulse repetition rate in Hz

Harmonic generator options:
SH → second harmonic
TH → third harmonic
FH → fourth harmonic
FiH → fifth harmonic

Other options:
VP1 → 170–500 ps variable pulse duration, manual control
VP2 → 500–1000 ps variable pulse duration, manual control
VPC1 → 170–500 ps variable pulse duration, computer control
VPC2 → 500–1000 ps variable pulse duration, computer control
AW → water-air heat exchanger option. Please inquire Ekspla for more details


Photo: PT series tunable wavelength laser features pump laser and OPG integrated into single/rugged housing for better performance and easy integration in other systems

# 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.

The output wavelength can be set from control pad with backlit display that is easy to read even while wearing laser safety glasses. Alternatively, the laser can be controlled also from personal computer through USB (RS-232 is optional) interface using supplied LabVIEW™ drivers.

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 | 34 |
| **PGx03** | 210–16000 nm | 1000 Hz | <6 $cm^{-1}$ | Operating at kHz repetition rate | 40 |
| **PGx11** | 193–16000 nm | 1000 Hz | <2 $cm^{-1}$ | Narrow linewidth (<0.5 $cm^{-1}$ on some versions) | 44 |
| **PT200** | 690–3400 nm | 1 MHz or 87 MHz | <7 $cm^{-1}$ | DPSS pump laser and OPG integrated into a single housing. Ideal for CARS microscopy / spectroscopy applications | 49 |

# PGx01 SERIES

## High Energy Broadly Tunable OPA

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.

Ekspla offers four models designed for pumping by up to the 4th harmonic of Nd:YAG laser.

### FEATURES

- *Ultra-wide spectral range from **193** to **16000 nm***
- *High peak power (>**50 MW**) ideal for non-linear spectroscopy applications*
- *Narrow linewidth **<6 cm$^{-1}$***
- *Motorized hands-free tuning in 193–2300 nm or 420–10000 nm range*
- *Remote control via keypad*
- *PC control via USB port (RS232 is optional) and LabVIEW™ drivers*

### APPLICATIONS

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

### 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. When combined with an optional second harmonic generator (SHG), Sum Frequency Generator (DUV) or Difference Frequency Generator (DFG) stages, it offers the widest possible tuning range – from 193 to 16000 nm. The wide tuning range makes PG401 units suitable for many spectroscopy application. |
| PG501 | Model has a tuning range from 680 to 2300 nm and highest pulse energy in the near-IR spectral range. Optional DFG stages are available for extension of tuning range to the 2300–16000 nm region. The PG501-DFG1P model is the optimal choice for vibrational-SFG spectroscopy setups. |
| PG701 | Model has a tuning range from 1395 to 4500 nm and is targeted for vibrational-SFG or infrared spectroscopy applications. |


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## 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 system can be controlled through its USB type PC interface (RS232 is optional) with LabView™ drivers or a user-friendly remote control pad. Both options allow easy control of system settings.

## SPECIFICATIONS [1]

| Model | PG401 | PG402 | PG501 | PG701 |
|---|---|---|---|---|
| Tuning range | | | | |
| Signal | 420–680 nm | 410–709 nm | 680–1063 nm | 1395–2100 nm |
| Idler | 740–2300 nm | 710–2300 nm | 1065–2300 nm | 2200–4500 nm |
| Output pulse energy [2] | >1000 µJ at 450 nm | >1000 µJ at 450 nm | >1000 µJ at 800 nm | >600 µJ at 1550 nm<br>>300 µJ at 3700 nm |
| Linewidth | <6 $cm^{-1}$ | <18 $cm^{-1}$ | <6 $cm^{-1}$ | <6 $cm^{-1}$ |
| Max pulse repetition rate | 50 Hz | | | |
| Scanning step | | | | |
| Signal | 0.1 nm | | | |
| Idler | 1 nm | | | |
| Typical beam size [3] | ~4 mm | | | |
| Beam divergence [4] | <2 mrad | | <2 mrad | <4 mrad |
| Beam polarization | | | | |
| Signal | horizontal | | vertical | horizontal |
| Idler | horizontal | | | |
| **PUMP LASER REQUIREMENTS** | | | | |
| Pump energy | 10 mJ at 355 nm | 8 mJ at 355 nm | 10 mJ at 532 nm | 15 mJ at 1064 nm |
| Recommended pump source [5] | PL2251A-TH<br>PL2231-50-TH | PL2251-TH<br>PL2231-50-TH | PL2251-SH<br>PL2231-50-SH | PL2251<br>PL2231-50 |
| Beam divergence | <0.5 mrad | | | |
| Beam profile | homogeneous, without hot spots, Gaussian fit >90 % | | | |
| Pulse duration [6] | 30±3 ps | | | |
| **PHYSICAL CHARACTERISTICS** | | | | |
| Size (W × L × H) | 450 × 582 × 270 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, 800 nm for PG501 units and 1550 nm for PG701 units.

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 the PL2250 series is used, measured beam profile data should be presented when ordering.

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

## Optional tuning range extensions

As mentioned above, the tuning range of PGx01 series units can be extended by adding additional nonlinear conversion stages. Optional Second Harmonic Generation (SHG), Sum Frequency Generation (SFG), or Difference Frequency Generation (DFG) stages allow access to spectral ranges that are not accessible by conventional laser sources.

There are many possible ways to add extension stages to the PGx01 series unit, however, the following configurations are most common:

- **PG401-SH** – second harmonic generator is used to extend the tuning range down to 210 nm resulting in a total tuning range of 210 to 2300 nm.
- **PG401-SH-DUV** – sum frequency generator is used to extend the tuning range down to 193 nm resulting in a total tuning range of 193 to 2300 nm.
- **PG401-DFG1P** provides the broadest hands-free tuning range – from 420 to 10000 nm. It can be further extended up to 16000 nm with -DFG2 option, however, it should be noted, that for the 10000–16000 nm range a different nonlinear crystal is used, and exchange of the crystals needs to be done manually.
- **PG501-DFG1P** unit has a narrower tuning range of 680–10000 nm and is a cost-effective choice for customers who need only the IR tuning range (for example for vibrational-SFG spectroscopy on surfaces). The tuning range also can be extended to 16000 nm in the same way as for the PG401 unit.

Available standard options are summarized in a table on the page below. Custom configurations are available on request.

## OPTIONAL EXTENSIONS OF TUNING RANGE [1)]

| Extension | DUV | SH | DFG1 | DFG1P | DFG2 |
|---|---|---|---|---|---|
| Available on models | PG401-SH | PG401 | PG401 and PG501 | PG401 and PG501 | PG401 and PG501 |
| Tuning range | 193–209.95 nm | 210–419 nm | 2300–10000 nm | 2300–10000 nm | 2300–16000 nm [7)] |
| Output pulse energy [2)] | >30 µJ at 200 nm | >100 µJ | >125 µJ | >250 µJ | >250 µJ at 3700 nm<br>>100 µJ at 10000 nm |
| Linewidth | <9 $cm^{-1}$ | | <6 $cm^{-1}$ | | |
| Scanning step | 0.05 nm | | 1 nm | | |
| Typical beam size [3)] | ~3 mm | | ~6 mm | ~9 mm | ~9 mm |
| Typical beam divergence [4)] | <2 mrad | | <3 mrad | | |
| Polarization | vertical | | horizontal | | |
| **PUMP LASER REQUIREMENTS** | | | | | |
| Pump pulse energy | | | | | |
| at 1064 nm | 2 mJ | – | 5 mJ | 10 mJ | 15 mJ |
| at 532 nm [5)] | – | | 10 mJ | | |
| at 355 nm [6)] | 10 mJ | | 8 mJ | | |
| Recommended pump laser [8)] | PL2251A | PL2251A-TH | PL2251 | PL2251A | PL2251B |
| Recommended harmonics generator module [9)] | H400 / H500 | – | H400 / H500 | | |
| **PHYSICAL CHARACTERISTICS** | | | | | |
| Size (W × L × H) | 456 × 1026 × 273 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 280 nm for -SH option and at 3700 nm for -DFGx options.

2) See tuning curves for typical pulse energies at other wavelengths.

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

4) Full angle measured at the FWHM point.

5) For PG501-DFGx units only.

6) For PG401-DFG units only.

7) 10000–16000 nm range is accessible after manual reconfiguration of DFG stage.

8) If a pump laser other than the PL2251 series is used, measured beam profile data should be presented when ordering.

9) H400 is recommended for PG401-DFGx pumping, H500 for PG501-DFGx pumping. See pictures on the last page for recommended arrangement of pumping laser, harmonics generator module and PGx01 units.



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## TUNING CURVES

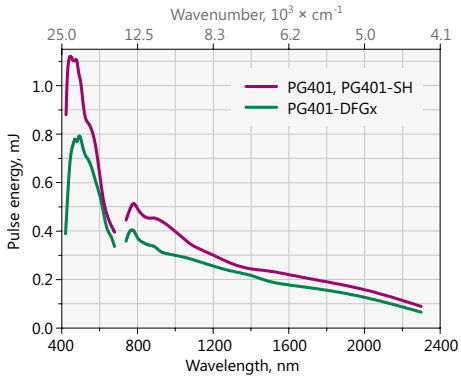


*Fig 1.* Typical PG401 model tuning curve
*Pump energy: 10 mJ at 355 nm*

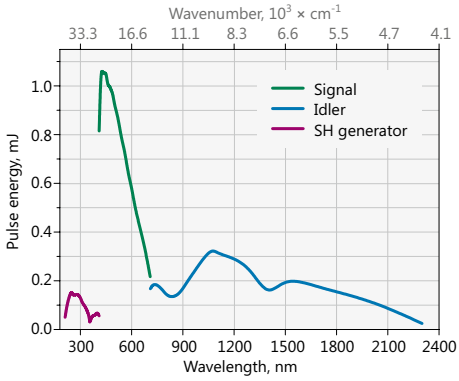


*Fig 2.* Typical PG401A model tuning curve
*Pump energy: 8 mJ at 355 nm*

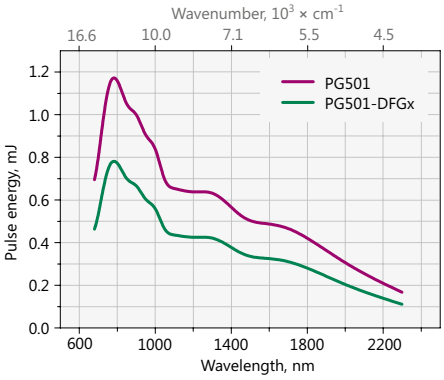


*Fig 3.* Typical PG501 model tuning curve
*Pump energy: 10 mJ at 532 nm*

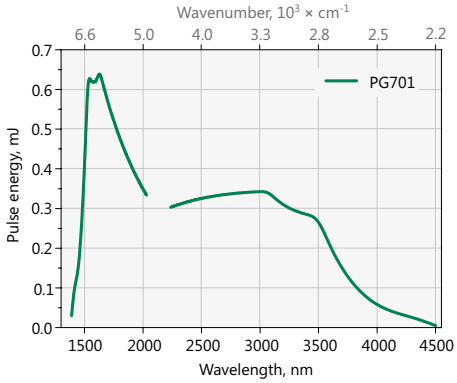


*Fig 4.* Typical PG701 model tuning curve
*Pump energy: 15 mJ at 1064 nm*

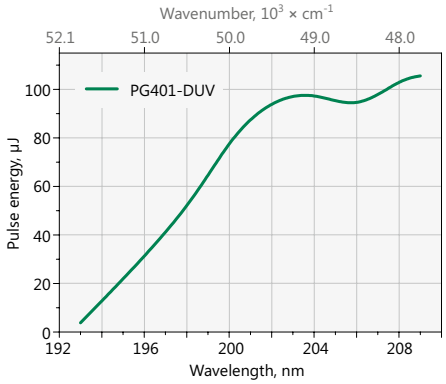


*Fig 5.* Typical PG401-DUV model tuning curve

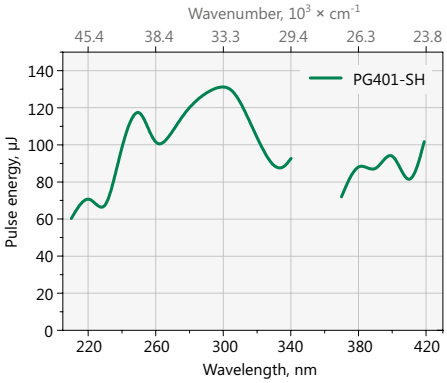


*Fig 6.* Typical PG401-SH model tuning curve. *Pump energy: 10 mJ at 355 nm*

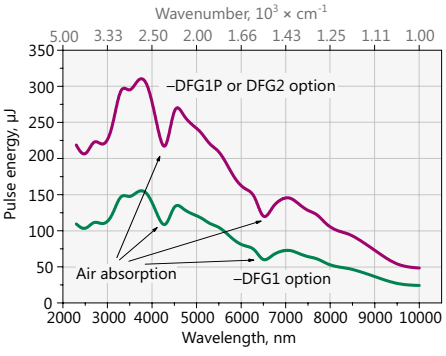


*Fig 7.* Typical DFGx option tuning curve in 2300–10000 nm range
*Pump energy: 10 mJ at 1064 nm*

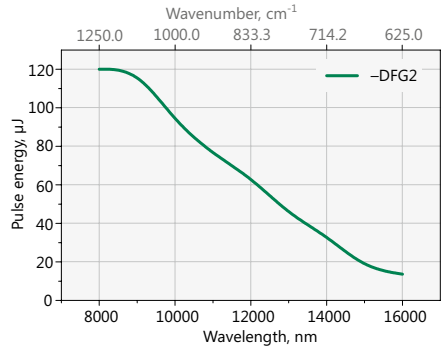


*Fig 8.* Typical DFG2 option tuning curve in 10000–16000 nm range
*Pump energy: 15 mJ at 1064 nm*

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

## RECOMMENDED UNITS ARRANGEMENT ON OPTICAL TABLE

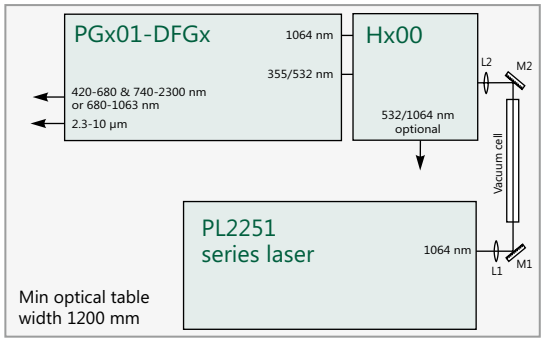


*Fig 8.* Recommended arrangement of pump laser and PGx01-DFGx unit on optical table

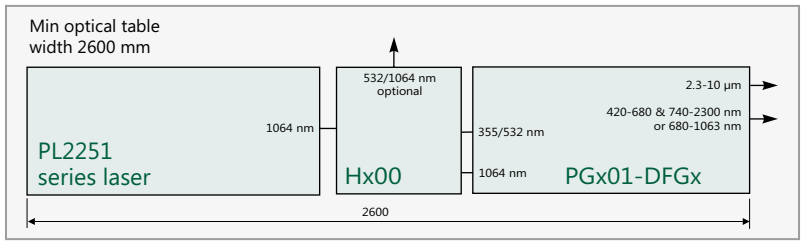


*Fig 9.* Alternative arrangement of pump laser and PGx01-DFGx unit on optical table

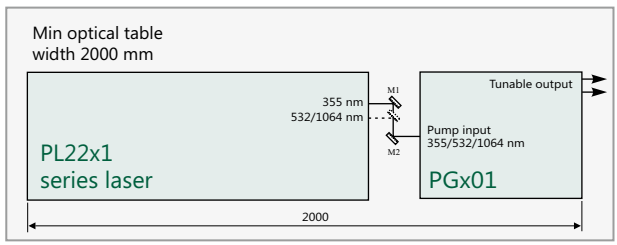


*Fig 10.* Arrangement of pump laser and PGx01 unit on optical table



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## OUTLINE DRAWINGS

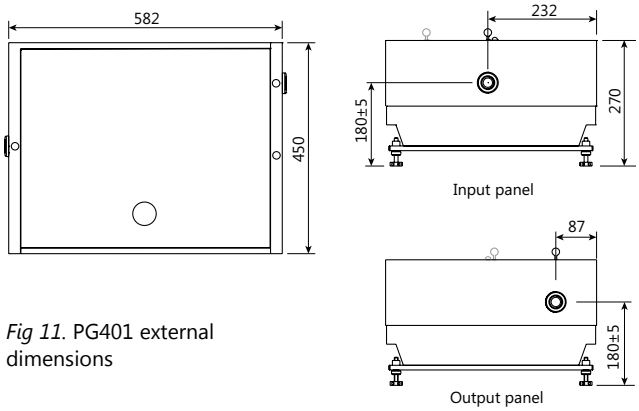


*Fig 11.* PG401 external dimensions

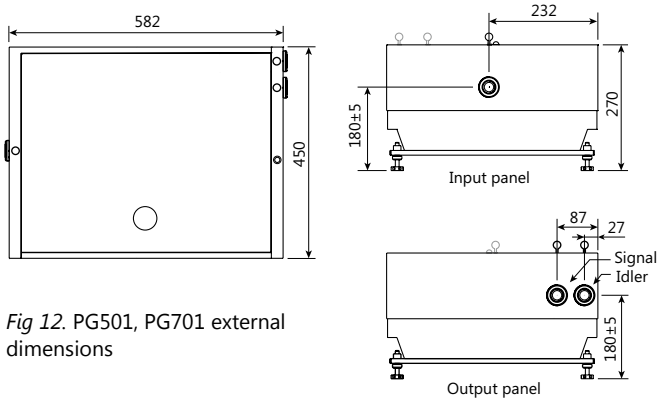


*Fig 12.* PG501, PG701 external dimensions

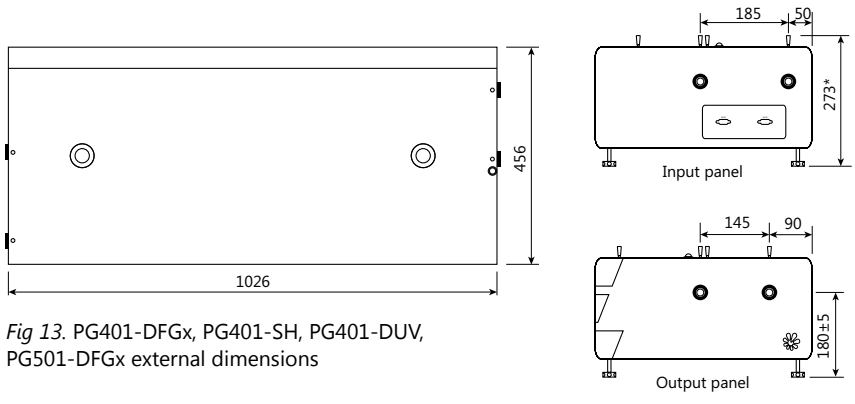


*Fig 13.* PG401-DFGx, PG401-SH, PG401-DUV, PG501-DFGx external dimensions

## ORDERING INFORMATION

**PG401-DFG2**

Model
PG4xx → 355 nm pump
PG5xx → 532 nm pump
PG7xx → 1064 nm pump

Optional tuning range extension
DUV → 193–209.95 nm
SH → 210–419 nm
DFG1 → 2300–10000 nm; >125 μJ at 3700 nm
DFG1P → 2300–10000 nm; >250 μJ at 3700 nm
DFG2 → 2300–16000 nm

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

# PGx03 SERIES

## kHz Repetition Rate Broadly Tunable OPA


PGx03 series Optical Parametric Generators (OPG) are designed to be pumped by 1 kHz mode-locked lasers with 1 W average power. An excellent choice is the PL2210A series mode-locked picosecond laser from EKSPLA.

The optical design is optimized to produce low divergence beams with moderate linewidth (typically 12 $cm^{-1}$) at approximately 20 ps pulse duration.

Due to the unique broad tunability range from 210 to 16000 nm these devices are an excellent choice for many spectroscopic applications.

Upon request the optical layout can be easily modified for pumping by other mode-locked lasers with high pulse energy or longer pulse duration.

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

### Available models

| Model | Features |
|---|---|
| PG403 | Model has a tuning range from 410 to 2300 nm and is optimized for providing the highest pulse energy in the visible part of the spectrum. When combined with an optional Second Harmonic Generator (SHG), it offers the widest possible tuning range – from 210 to 2300 nm. |
| PG503 | Model has a tuning range from 700 to 2300 nm and the highest pulse energy in the near-IR spectral range. PG503 is a cost-effective alternative to the narrow-band mode-locked Ti:S lasers. |
| PG703 | Model is targeted for infrared spectroscopy applications. The tuning range is from 1400 to 4450 nm and with an optional Difference Frequency Generator (DFG) stage it can be extended to 16000 nm. |

### FEATURES

- *Picosecond pulses at **1 kHz** pulse repetition rate*
- *Hands-free wavelength tuning*
- *Tuning range from **210 nm** to **16000 nm***
- *Narrow linewidth **<6 $cm^{-1}$***
- *Low divergence <2 mrad*
- *Remote control via keypad*
- *PC control using USB (RS232 is optional) and LabVIEW™ drivers*

### APPLICATIONS

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


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Microprocessor based control system provides automatic positioning of relevant components for hands free operation. Nonlinear crystals, diffraction grating and filters are rotated by ultra-precise stepper motors in the 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 using a user-friendly remote control pad or through USB interface (RS232 is optional) from a personal computer (PC) using supplied LabVIEW™ drivers.

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

## SPECIFICATIONS [1]

| Model | PG403 | PG403-SH | PG503 | PG703 | PG703-DFG |
|---|---|---|---|---|---|
| **OPG SPECIFICATIONS** | | | | | |
| Output wavelength tuning range | | | | | |
| SH | – | 210–410 nm | – | | |
| Signal | 410–709 nm | | 700–1000 nm | 1550–2020 nm | 1550–2020 nm |
| Idler | 710–2300 m | | 1150–2200 nm | 2250–3350 nm | 2250–3350 nm |
| DFG | – | | | | 3350–16000 nm |
| Output pulse energy [2] | | | | | |
| SH [3] | – | 10 µJ | – | | |
| Signal | 50 µJ | | 70 µJ | 60 µJ | |
| Idler [4] | 15 µJ | | 25 µJ | 20 µJ | |
| DFG [5] | – | | | | 6 µJ |
| Pulse repetition rate | 1000 Hz | | | | |
| Linewidth | <12 $cm^{-1}$ | | <12 $cm^{-1}$ | <6 $cm^{-1}$ | |
| Typical pulse duration [6] | 15 ps | | 20 ps | 20 ps | |
| Scanning step | | | | | |
| SH | – | 0.05 nm | – | | |
| Signal | 0.1 nm | | | | |
| Idler | 1 nm | | | | |
| DFG | – | | | | 1 nm |
| Typical beam size [7] | ~3 mm | | | | |
| Beam divergence [8] | <2 mrad | | | | |
| Beam polarization [9] | | | | | |
| SH | – | vertical | – | | |
| Signal | horizontal | | | | |
| Idler | vertical | | | horizontal | vertical |
| DFG | – | | | | vertical |

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 PG403 units, 800 nm for PG503 units, and 1620 nm for PG703 units.

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

3) Measured at 250 nm.

4) Measured at 1000 nm for PG40x units, 1620 nm for PG503 and 3000 nm for PG703 units.

5) Measured at 5000 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 pump pulse energy.

8) Full angle measured at the FWHM level.

9) Separate output ports for SH, signal, idler and DFG ranges.

## SPECIFICATIONS [1)]

| Model | PG403 | PG403-SH | PG503 | PG703 | PG703-DFG |
|---|---|---|---|---|---|
| **PUMP LASER REQUIREMENTS** | | | | | |
| Min pump energy [10)] | | | | | |
| at 1064 nm | – | | | 0.9 mJ | |
| at 532 nm | – | | 0.45 mJ | – | |
| at 355 nm | 0.3 mJ | | – | | |
| Pulse duration [11)] | 10–30 ps | | | | |
| Beam polarization at pump wavelength | vertical | | horizontal | | |
| Beam size [11)] | 2–3 mm | | | | |
| Beam divergence | <1 mrad | | | | |
| Beam profile | homogeneous, without hot spots, Gaussian fit >90% | | | | |
| Recommended pump source | PL2210A-TH | PL2210A-TH | PL2210A-SH | PL2210A | PL2210A |
| **PHYSICAL CHARACTERISTICS** | | | | | |
| Size (W × L × H) | 456 × 605 × × 273 mm | 456 × 1026 × × 273 mm | 456 × 605 × × 273 mm | 456 × 605 × × 273 mm | 456 × 1026 × × 273 mm |
| **OPERATING REQUIREMENTS** | | | | | |
| Room temperature | 15–30 °C | | | | |
| Power requirements | 100–240 V single phase, 47–63 Hz | | | | |
| Power consumption | <120 W | | | | |

[10)] Max pump energy is limited by available non-linear crystal sizes.

[11)] Should be specified while ordering if non-Ekspla pump laser is used.

## TUNING CURVES

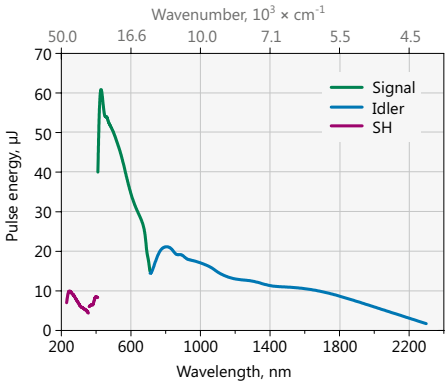


*Fig 1.* Typical PG403-SH model tuning curve.
*Pump energy – 0.3 mJ at 355 nm*

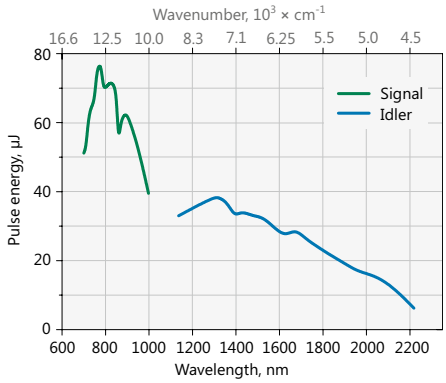


*Fig 2.* Typical PG503 model tuning curve.
*Pump energy – 0.45 mJ at 532 nm*

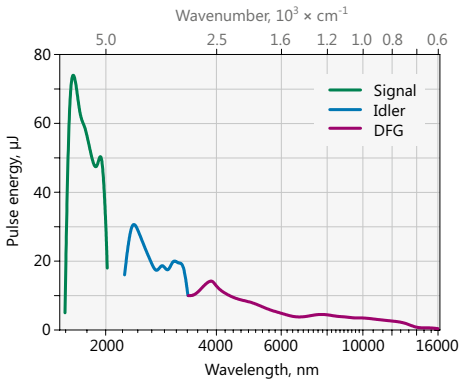


*Fig 3.* Typical PG703-DFG model tuning curve.
*Pump energy – 0.9 mJ at 1064 nm*

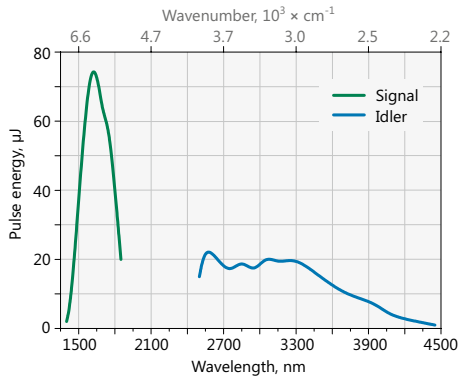


*Fig 4.* Typical PG703 model tuning curve.
*Pump energy – 0.9 mJ at 1064 nm*



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## OUTLINE DRAWINGS

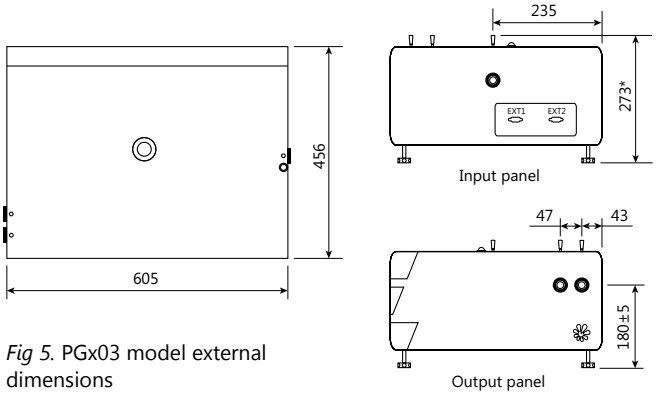



*Fig 5.* PGx03 model external dimensions

## RECOMMENDED UNITS ARRANGEMENT ON OPTICAL TABLE

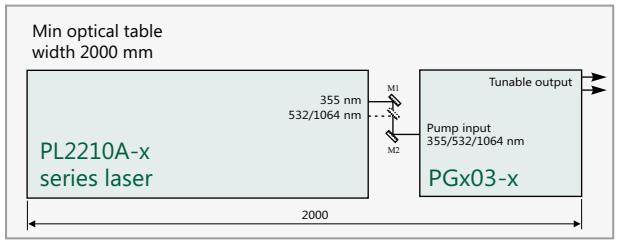



*Fig 6.* Arrangement of pump laser and PGx03 unit on optical table

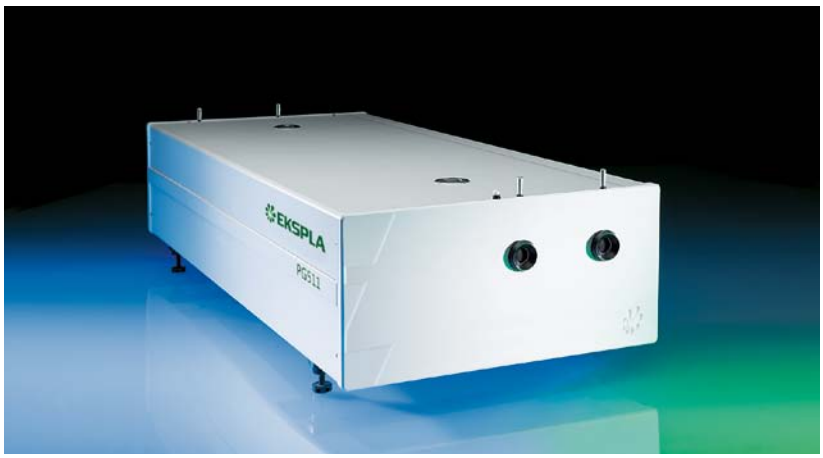
## ORDERING INFORMATION

**PG403-SH**

| Model | Optional tuning range extension |
|---|---|
| PG403 → 355 nm pump | SH → 210–410 nm |
| PG503 → 532 nm pump | DFG (PG703) → 3350–16000 nm |
| PG703 → 1064 nm pump | |

# PGx11 SERIES

## Transform Limited Broadly Tunable Picosecond OPA




### FEATURES

- *High brightness picosecond pulses 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***
- *Remote control via keypad*
- *PC control using USB (RS232 is optional) and LabVIEW™ drivers*

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, CARS, Z-scan*
- *Other laser spectroscopy applications*

### Available models

| Model | Features |
|---|---|
| PG411 | 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. 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 from 725 to 2000 nm and highest pulse energy in near-IR spectral range. With an optional Difference Frequency Generator (DFG) the tuning range can be extended into the 2300–10000 nm range. PG411 and PG511 models are designed to be pumped by PL2250 series lasers with a 10 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 using a user-friendly remote control pad or through USB interface (RS232 is optional) from a personal computer (PC) using supplied LabView™ drivers.

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 |
|---|---|---|---|---|---|---|
| **OPG SPECIFICATIONS** | | | | | | |
| Output wavelength tuning range | | | | | | |
| SH, DUV | – | 210–420 nm | 193–420 nm | – | | |
| Signal | 420–709 nm | | | 725–1000 nm | 1550–2020 nm | |
| Idler | 710–2300 nm | | | 1140–2000 nm | 2250–3350 nm | |
| DFG | – | | | 2300–10000 nm | – | 3350–16000 nm |
| Output pulse energy [2)] | | | | | | |
| SH, DUV | – | 100 µJ [3)] | 50 µJ [3)] | – | | |
| Signal | 700 µJ | | | | 500 µJ | |
| Idler [4)] | 250 µJ | | | | 100 µJ | |
| DFG | – | | | | | 10 µJ [5)] |
| Pulse repetition rate | 10 Hz | | | 10 Hz | 1000 Hz | |
| Linewidth | <2 $cm^{-1}$ [6)] | | | <2 $cm^{-1}$ | <0.5 $cm^{-1}$ | |
| Typical pulse duration [7)] | 15 ps | | | 20 ps | 70 ps | |
| Scanning step | | | | | | |
| SH, DUV | – | 0.01 nm | | – | | |
| Signal | 0.02 nm | | | | | |
| Idler | 0.1 nm | | | | | |
| DFG | – | | | | | 1 nm |
| Pulse contrast [8)] | 500 : 1 | | | | $10^6$ : 1 | |
| Typical beam diameter [9)] | ~4 mm | | | | ~3 mm | |
| Beam divergence [10)] | <2 mrad | | | | | |
| Beam polarization [10)] | | | | | | |
| 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.

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) <2$cm^{-1}$ in signal (420–709 nm ) and <4$cm^{-1}$ in idler (710–2300 nm).

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) Ratio of intensity of single pulse with respect to residual pulse train. In SH or DFG ranges pulse contrast is better than $10^6$ : 1.

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

10) 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 | PL2251A + APL + H411 | | | PL2251A + APL + H511 | PL2210B-TR | |
| Min pump energy or power [11)] | | | | | | |
| at 1064 nm | – | | 2 mJ | (10 mJ) | 5 W (2.5 mJ) | |
| at 532 nm | – | | | 5 mJ ( 8 mJ) | – | |
| at 355 nm | 5 mJ ( 8 mJ) | | | – | | |
| Pulse duration [12)] | 30 ps | | | | 90 ps | |
| Beam polarization at pump wavelength | vertical | | | | horizontal | |
| Beam size [13)] | 7 mm | | | | 2.5 mm | |
| Beam divergence | <1 mrad | | | | | |
| Beam profile | homogeneous, without hot spots | | | | | |
| **PHYSICAL CHARACTERISTICS** | | | | | | |
| Size (W × L × H) | 456 × 1026 × × 273 mm | 456 × 1226 × 273 mm | | | 456 × 1026 × × 273 mm | 456 × 1226 × × 273 mm |
| **OPERATING REQUIREMENTS** | | | | | | |
| Room temperature | 15–30 °C | | | | | |
| Room temperature stability | ±2 °C | | | | | |
| Power requirements | 90–240 V single phase, 47–63 Hz | | | | | |
| Power consumption | <300 W | | | | | |

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

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

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

## OUTLINE DRAWINGS

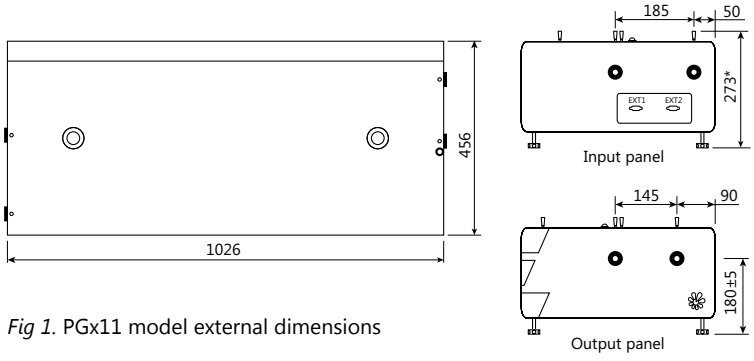


*Fig 1.* PGx11 model external dimensions



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## TUNING CURVES

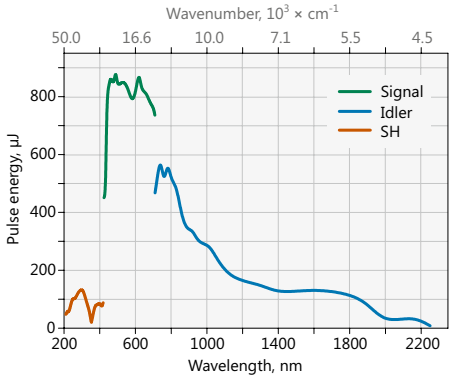


*Fig 2.* Typical PG411-SH model tuning curve

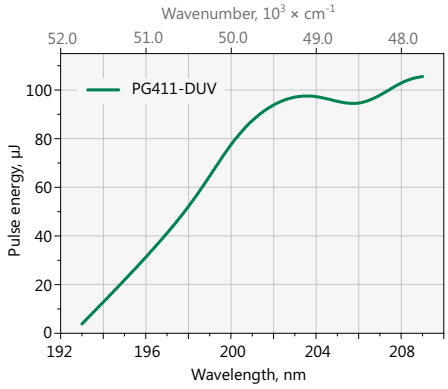


*Fig 3.* Typical PG411-DUV model tuning curve

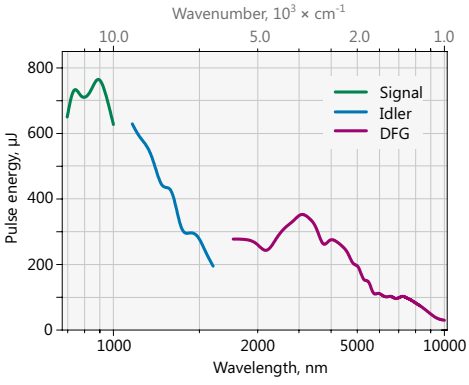


*Fig 4.* Typical PG511-DFG model tuning curve

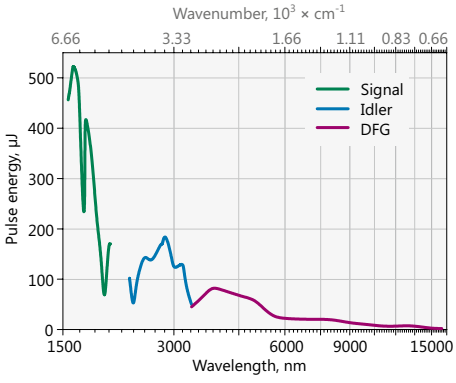


*Fig 5.* Typical PG711-DFG model tuning curve.
*Pump energy: 2.5 mJ at 1064 nm, 1 kHz repetition rate*

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

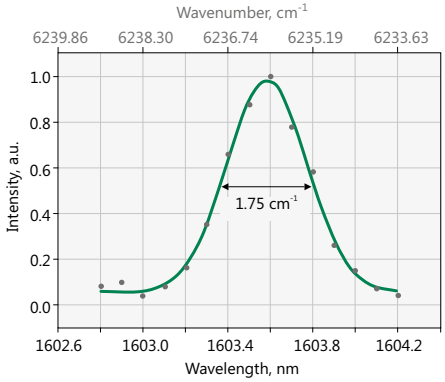


*Fig 6.* PG511-DFG model typical output linewidth

## RECOMMENDED UNITS ARRANGEMENT ON OPTICAL TABLE

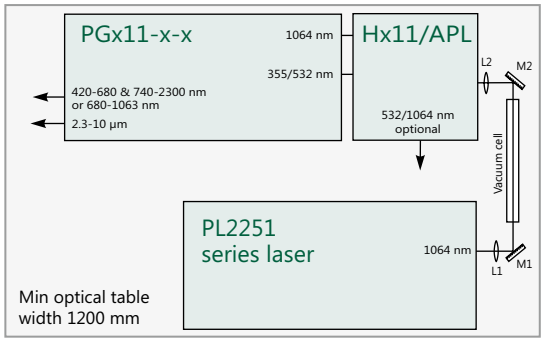


*Fig 7.* Recommended arrangement of pump laser and PGx11-DFGx unit on optical table

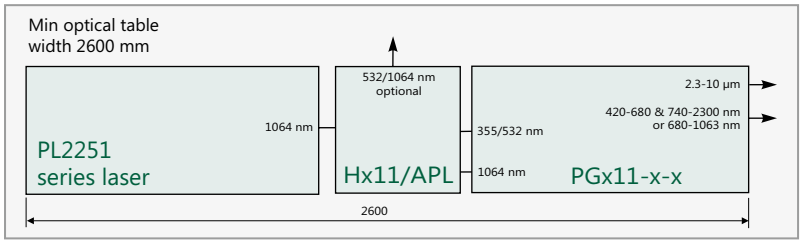


*Fig 8.* Alternative arrangement of pump laser and PGx11-DFGx unit on optical table

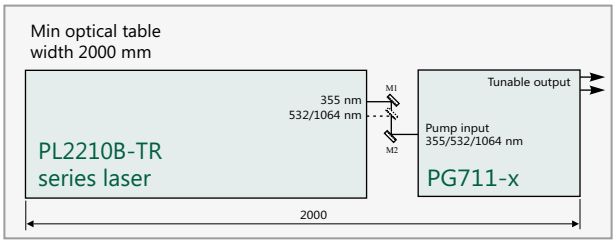


*Fig 9.* Arrangement of pump laser and PGx11 unit on optical table

## ORDERING INFORMATION

**PG511-SH**

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

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



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# PT200 SERIES

## Single Housing NIR-IR Range Tunable Picosecond Laser

### FEATURES

- ***690–3400 nm*** *tuning range*
- *Optional tuning range extension to UV*
- *Nearly Fourier transform-limited linewidth*
- *Nearly diffraction limited divergence*
- *Up to* ***5 kW*** *pulse peak power*
- *Collinear output of two tunable wavelengths for CARS applications (optional)*
- *Output wavelength monitoring (optional)*
- *PC control via USB (RS232 is optional) and LabView™ drivers*

### APPLICATIONS

- *CARS microscopy and spectroscopy*
- *Two-photon fluorescence microscopy*
- *Second harmonic generation microscopy*
- *Laser induced fluorescence microscopy*
- *Infrared spectroscopy*

PT200 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 MHz pulse repetition rate enables the photon-counting detection method in numerous non-linear spectroscopy and microscopy applications.

PT257 and PT259 are targeted for CARS and two photon fluorescence applications. The tuning range of PT257 and PT259 supports Raman shift measurements in the 1000–4000 $cm^{-1}$ range. An optional second harmonic generator extends the PT259 tuning range to UV, enabling time-resolved laser-induced fluorescence measurements.

The PT277 model produces approximately 0.5 W power in mid-IR range from 2.5 to 3.4 µm with nearly Fourier transform limited linewidth. Applications include infrared spectroscopy and vibrational spectroscopy on surfaces.

All models produce nearly diffraction limited divergence beams, with $M^2$ measured as <1.3 over the tuning range.

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.

The lasers may be controlled from a remote keypad or via USB (RS232 is optional) interface from a personal computer using LabView™ drivers.

### PT200 series available models

| Model | Features |
|---|---|
| PT259 | 1 MHz pulse repetition rate, > 25 mW power at 800 nm, 7 ps pulse duration |
| PT257 | 87 MHz pulse repetition rate, > 400 mW power at 800 nm, 3-4 ps pulse duration |
| PT277 | 87 MHz pulse repetition rate, nearly Fourier transform limited (<0.3 $cm^{-1}$) linewidth, 70 ps pulse duration |

## SPECIFICATIONS [1]

| Model | PT259 | PT257 | PT277 |
|---|---|---|---|
| **OPO/OPG** | | | |
| Pulse repetition rate [2] | 1 MHz | 87 MHz | |
| Tuning range | | | |
| Signal | 700–1000 nm [3] | 690–900 nm | 1550–2020 nm |
| Idler | 1150–2200 nm | | 2250–3400 nm |
| SH (optional) | 350–500 nm | — | |
| Output power [4] | | | |
| OPO/OPG [5] | 25 mW | 400 mW | 300 mW |
| SH [6] | 1 mW | — | |
| Linewidth [5] | <8 $cm^{-1}$ | <7 $cm^{-1}$ | <0.3 $cm^{-1}$ |
| Typical pulse duration [5] [7] | 7 ps | | 70 ps |
| Typical time bandwidth product | <0.8 | | |
| Scanning step | | | |
| Signal | 0.1 nm | | |
| Idler | 1 nm | | |
| SH | 0.05 nm | — | |
| Polarization | | | |
| Signal beam | horizontal | | |
| Idler beam | horizontal | | |
| SH | vertical | — | |
| Typical beam diameter [5] [8] | 2 mm | ~4.5 mm | 2 mm |
| Typical beam divergence [5] [9] | <2 mrad | | |
| $M^2$ | <2 [10] | | — |
| **PUMP LASER** [11] | | | |
| Pump wavelength | 532 nm | | 1064 nm |
| Max pump power [12] | 0.45 W | 3 W | 5 W |
| Pulse repetition rate | 1 MHz | 87 MHz | |
| Pulse duration [13] | <10 ps | | 80–100 ps |
| Beam quality | Gaussian >90% fit | | |
| Beam divergence [9] | <2 mrad | | |
| **PHYSICAL CHARACTERISTICS** | | | |
| Unit size (W × L × H) | 455 × 1220 × 260 mm | 330 × 735 × 175 mm | 455 × 1220 × 260 mm |
| Power supply size (W × L × H) | 365 × 395 × 290 mm | 555 × 525 × 530 mm | |
| Umbilical length | 2.5 m | | |
| **OPERATING REQUIREMENTS** | | | |
| Cooling | 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.

2) Inquire for custom pulse repetition rates.

3) Tuning range extension to 620 nm is optional.

4) Output powers are specified at selected wavelengths. See typical tuning curves for power at other wavelengths.

5) Measured at 800 nm for PT25x models, and at 1620 nm for PT277 model at signal range.

6) Measured at 400 nm.

7) Pulse duration can vary depending on wavelength and pump energy.

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

9) Full angle measured at the FWHM level.

10) Specified only for signal output.

11) Separate output port for the pump beam is standard. Output ports for other available harmonics are optional.

12) Data represents typical values. Laser output will be optimised for OPO operation and specification may vary with each unit we manufacture.

13) Measured at 1064 nm.




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## TUNING CURVES

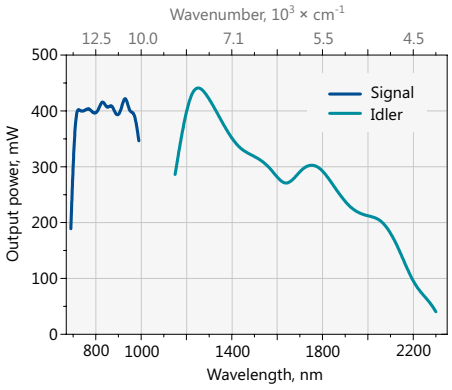



*Fig 1.* Typical output power of PT257 tunable laser.
*The power is shown only at the wavelengths where ambient air absorption is negligible*

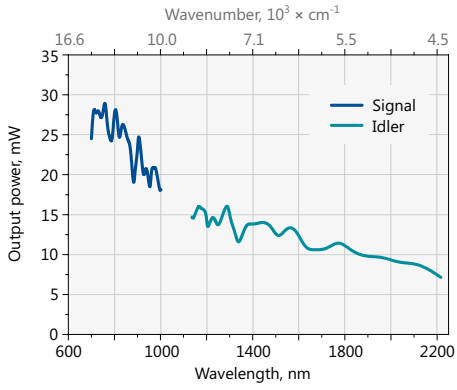



*Fig 2.* Typical output power of PT259 tunable laser

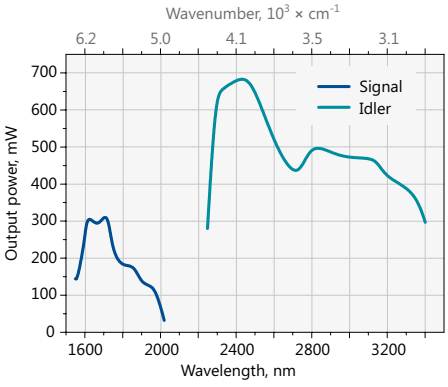



*Fig 3.* Typical output power of PT277 tunable laser.
*The power is shown only at the wavelengths where ambient air absorption is negliglible*

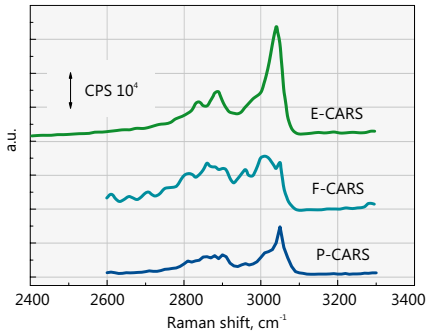



*Fig 4.* E-CARS, F-CARS, P-CARS spectra of a polystyrene bead (1.1 µm in diameter) measured with PT259 laser. The average pump and Stokes powers were 0.26 mW and 0.6 mW, respectively

## OUTLINE DRAWINGS

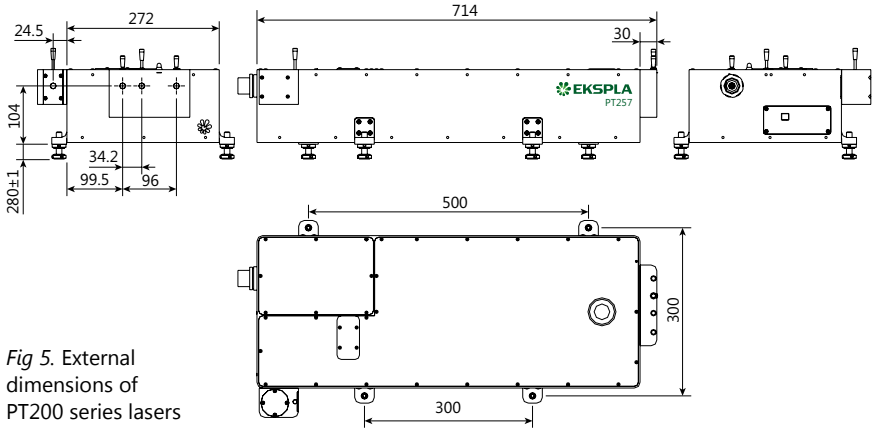
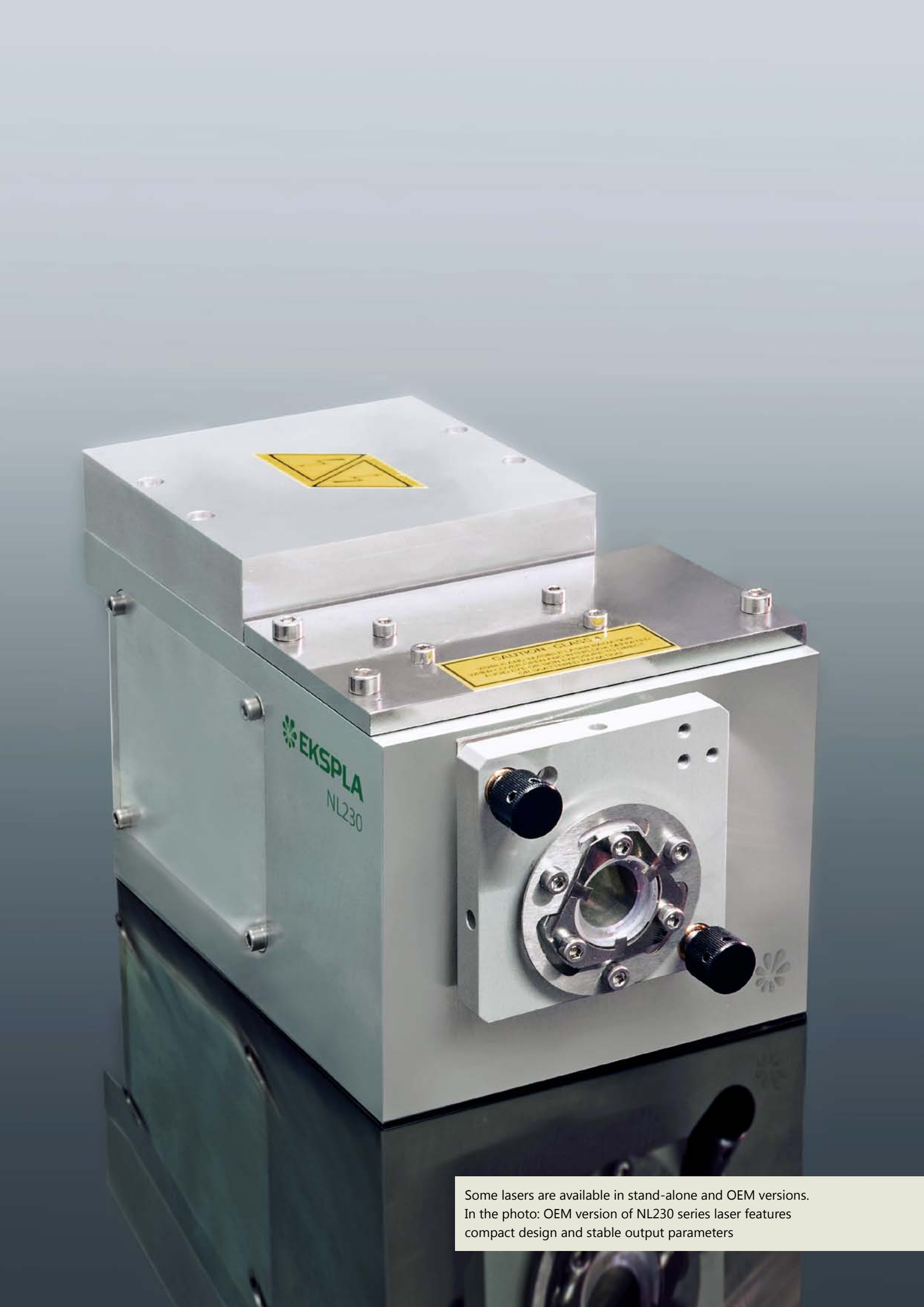



*Fig 5.* External dimensions of PT200 series lasers




Some lasers are available in stand-alone and OEM versions.
In the photo: OEM version of NL230 series laser features compact design and stable output parameters

# Nanosecond Lasers

Short pulse duration, wide range of customization options and high stability are distinctive features of EKSPLA nanosecond lasers. Employing latest achievements in laser technologies, team of dedicated engineers designed wide range of products tailored for specific applications: from compact, simple and robust DPSS NL200 series lasers for OEM manufacturers to high energy customized flash-lamp pumped multijoule systems for research laboratories.

The laser can be controlled from remote control pad with backlit display that is easy to read even while wearing laser safety glasses. Alternatively, the laser can be operated also from personal computer through USB (RS-232 is optional) interface using supplied LabVIEW™ drivers.

Second (532 nm), third (355 nm), fourth (266 nm) and fifth (213 nm) (where available) harmonic options combined with various accessories and customization possibilities make these lasers well suited for many OEM and laboratory applications like OPO, OPCPA, Ti:Sapphire and dye laser pumping, spectroscopy, remote sensing...

## 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 |
|---|---|---|---|---|---|---|
| **NL120** | 10 000 mJ at 1064 nm | 50 Hz | Diode pumped solid state | 2 ± 0.5 ns | High energy single longitudinal mode Q-switched Nd:YAG laser | 54 |
| **NL200** | 4 mJ at 1064 nm | 10 – 2500 Hz | Diode pumped solid state | <7 ns | Compact and robust | 57 |
| **NL220** | 30 mJ at 1064 nm | 1 000 Hz | Diode pumped solid state | 6–8 ns | High pulse energy at kHz repetition rate | 60 |
| **NL230** | 190 mJ at 1064 nm | 100 Hz | Diode pumped solid state | 3–7 ns | Diode pumped only | 63 |
| **NL300** | 800 mJ at 1064 nm | 30 Hz | Flash-lamp pumped | 3–6 ns | Versatile, compact nanosecond laser | 73 |
| **NL303D** | 2 × 720 mJ at 1064 nm | 20 Hz | Flash-lamp pumped | 3–6 ns | Double pulse Q-switched lasers for PIV | 81 |
| **NL740** | 100 mJ at 1064 nm | 100 Hz | Diode pumped solid state | 2–10 ns | Ultra-stable tunable pulse duration nanosecond laser | 83 |

# NL120 SERIES

## SLM Q-switched Nd:YAG Lasers


NL120 series electro-optically Q-switched nanosecond Nd:YAG lasers deliver up to 10 J per pulse with excellent stability. The innovative, diode-pumped, self-seeded master oscillator design results in Single Longitudinal Mode (SLM) output without the use of external expensive narrow linewidth seed diodes and cavity-locking electronics. Unlike more common designs that use an unstable laser cavity, the stable master oscillator cavity produces a $TEM_{00}$ spatial mode output that results in excellent beam properties after the amplification stages.

NL120 series Q-switched nanosecond lasers are an excellent choice for many applications, including OPO, OPCPA or dye laser pumping, holography, LIF spectroscopy, remote sensing, optics testing and other tasks.

For tasks that require a smooth and as close as possible to the Gaussian beam profile, models with improved Gaussian fit are available (see the description of the –G option on the next page).

The low jitter of the optical pulse with respect to the Q-switch triggering pulse allows the reliable synchronization between the laser and external equipment.

The optional second (SH) (for 532 nm), third (TH) (for 355 nm) and fourth (FH) (for 266 nm) harmonics generators provide access to shorter wavelengths.

The laser is controlled by a supplied netbook PC via USB port with application for Windows™ operating system.

In addition, the main settings of the laser can be controlled through an auxiliary user-friendly remote control pad. The remote pad features a backlit display that is easy to read even when wearing laser safety eyewear.

### FEATURES

- *Up to **10 J** pulse energy*
- *Diode-pumped, self-seeded Single Longitudinal Mode (SLM) master oscillator*
- *Stable master oscillator cavity producing $TEM_{00}$ spatial mode output*
- *Excellent pulse energy stability*
- *Up to **50 Hz** pulse repetition rate*
- ***2 ns** pulse duration (7 or 25 ns are optional)*
- *Temperature stabilized harmonics generator options*
- *Remote control via keypad*
- *Laser control from netbook PC via USB port*

### APPLICATIONS

- *Material processing*
- *OPO, OPCPA, Ti:Sapphire, dye laser pumping*
- *Holography*
- *Nonlinear laser spectroscopy*
- *Optics testing*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## SPECIFICATIONS [1]

| Model | NL120 | NL121 | NL122 | NL123 | NL124 | NL125 | NL128 | NL129 |
|---|---|---|---|---|---|---|---|---|
| Pulse energy [2] | | | | | | | | |
| at 1064 nm | 1.9 mJ | 150 mJ | 300 mJ | 600 mJ | 1200 mJ | 1600 mJ | 5000 mJ | 10000 mJ |
| at 532 nm [4] | 0.9 mJ | 60 mJ | 125 mJ | 250 mJ | 500 mJ | 700 mJ | TBA [3] | TBA [3] |
| at 355 nm [5] | 0.6 mJ | 40 mJ | 80 mJ | 160 mJ | 320 mJ | 450 mJ | TBA [3] | TBA [3] |
| at 266 nm [6] | 0.3 mJ | 15 mJ | 40 mJ | 70 mJ | 100 mJ | 140 mJ | TBA [3] | TBA [3] |
| Pulse energy stability (StdDev) [7] | | | | | | | | |
| at 1064 nm | <0.5 % | <1 % | | | | | | |
| at 532 nm [4] | <1 % | <2 % | | | | | | |
| at 355 nm [5] | <1.5 % | <3 % | | | | | | |
| at 266 nm [6] | <2 % | <5 % | | | | | | |
| Pulse duration at 1064 nm (FWHM) [8] | 2 ± 0.5 ns | | | | | | | |
| Pulse repetition rate [9] | 0–50 Hz | 10 or 20 Hz | 10 Hz | | | | | |
| Linewidth | ≤0.02 $cm^{-1}$ (SLM) | | | | | | | |
| Polarization at 1064 nm [10] | linear, >90 % | | | | | | | |
| Optical pulse jitter (StdDev) [11] | <0.2 ns | | | | | | | |
| Beam spatial profile [12] | near $TEM_{00}$, >85 % fit | Hat-Top, >70 % fit | | | | | | |
| Typical beam divergence [13] | <1.5 mrad | <0.5 mrad | | | | | | |
| Beam pointing stability [14] | <25 µrad | | | | | | | |
| Typical beam diameter [15] | ~2 mm | ~5 mm | ~6 mm | ~8 mm | ~10 mm | ~12 mm | ~20 mm | ~27 mm |
| **PHYSICAL CHARACTERISTICS** | | | | | | | | |
| Laser head size (W × L × H) | 305 × 665 × × 260 mm | 455 × 820 × × 270 mm | 455 × 1020 × 270 mm | | 455 × 1220 × 270 mm | | 600 × 1500 × × 300 mm | 600 × 2000 × × 300 mm |
| Power supply size (W × L × H) | n/a | 550 × 600 × 550 mm | | 550 × 600 × × 830 mm | 550 × 600 × 1030 mm | | 550 × 600 × × 1030 mm 2 units | 550 × 600 × × 1650 mm 2 units |
| Umbilical length | 2.5 m | | | | | | | |
| **OPERATING REQUIREMENTS** | | | | | | | | |
| Water consumption (max. 20 °C) | air cooled | <10 l/min | | | <20 l/min | | | |
| Ambient temperature | 18–27 °C | | | | | | | |
| Relative humidity | 10–80 % (non-condensing) | | | | | | | |
| Power requirements [16] | 90–240 V AC, 50/60 Hz | 208 or 240 V AC, single phase 50/60 Hz | | | 208 or 380 V AC, three-phase 50/60 Hz | | | |
| Power consumption [17] | <0.5 kVA | <1.5 kVA | <2.5 kVA | <4 kVA | <4 kVA | <5 kVA | <8 kVA | <10kVA |

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.
2) Outputs are not simultaneous.
3) Contact EKSPLA for more information.
4) For NL12×-SH and NL12×-SH/FH options.
5) For NL12×-TH option.
6) For NL12×-SH/FH option.
7) Averaged from 300 pulses.
8) Optional 7 or 25 ns pulse duration. Inquire for pulse energy specifications.
9) Pulse repetition rates up to 50 Hz are optional. Inquire for pulse energy specifications.
10) For models without harmonics generators.
11) With respect to Q-switch triggering pulse.
12) Measured at 1 m distance from the laser output. Improved fit beam profile is available (see –G option description).
13) Full angle measured at the $1/e^2$ point at 1064 nm.
14) Full angle, 300 shoots, RMS.
15) Beam diameter is measured at 1064 nm at the $1/e^2$ level.
16) Mains should be specified when ordering.
17) For 10 Hz pulse repetition rate.

## OPTIONS

### ▸ -G option — >85 % Gaussian fit beam profile in near field

Pulse energies are presented in the table bellow. Beam profile has lower beam intensity modulation when propagated over long distance. Recommended when application require homogenous, without hot spots, light intensity distribution.

| Model | NL121G | NL122G | NL123G | NL124G |
|---|---|---|---|---|
| Max. pulse energy | | | | |
| at 1064 nm | 60 mJ | 140 mJ | 280 mJ | 550 mJ |
| at 532 nm | 20 mJ | 40 mJ | 80 mJ | 165 mJ |
| at 355 nm | 12 mJ | 30 mJ | 55 mJ | 110 mJ |
| at 266 nm | 3 mJ | 7 mJ | 14 mJ | 30 mJ |
| Typical beam diameter | ~3 mm | ~5 mm | ~7 mm | ~9 mm |
| Beam profile at 1064 nm | Gaussian fit >85 % | | | |

[1] Other specifications of the lasers remain the same.

### ▸ -P7 and -P25 options — 7 or 25 ns pulse duration

For applications requiring longer pulse duration the laser master oscillator cavity can be modified to produce 7 or 25 ns pulses. Note: some of other specifications can be changed. Please contact Ekspla for detailed datasheets.

## OUTLINE DRAWINGS

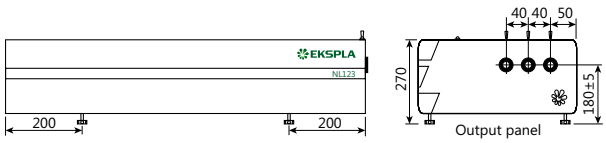


*Fig 1.* Typical external dimensions of NL122 and NL123 lasers

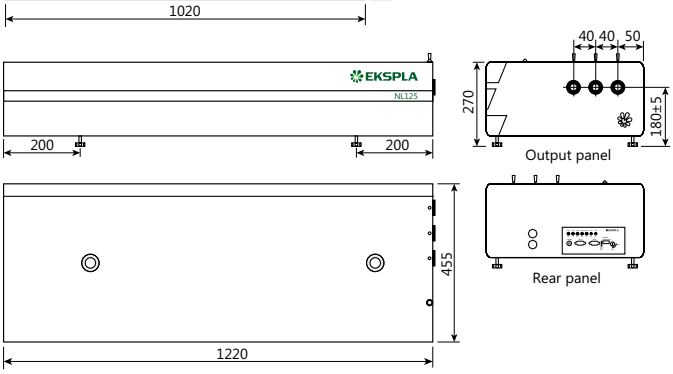


*Fig 2.* Typical external dimensions of NL124 and NL125 lasers

## ORDERING INFORMATION

**NL121G-10-P8-AW-SH/TH**

- Model
- Beam profile: no letter → "hat top"; G → Gaussian
- Pulse repetition rate in Hz
- Pulse duration options: default → 2 ns pulse duration; P8 → 8±2 ns pulse duration
- Options: AW → water-air heat exchanger
- Harmonic generator options: SH → second harmonic; TH → third harmonic



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# NL200 SERIES

## Compact Q-switched DPSS Lasers

NL200 series DPSS Q-switched nanosecond lasers offer high pulse energy at kHz repetition rates. End-pumped design makes this laser compact and easy to integrate. Harmonic generation modules for 532 nm, 355 nm, 266 nm and 213 nm wavelengths can be combined into one module, easily attached to the laser frame.

Featuring short pulse duration, variable repetition rate and external TTL triggering, nanosecond diode pumped NL200 series Q-switched lasers are excellent cost effective sources for specific applications like pulsed laser deposition, ablation through mask or intravolume marking of transparent materials, when higher pulse energy is required. Excellent energy stability and a wide range of wavelength options make this laser a perfect tool for spectroscopy and remote sensing applications.

Mechanically stable and hermetically sealed design ensures reliable operation and long lifetime of laser components.

NL204 laser with attached harmonic module

NL204 laser

### FEATURES

- *Up to **4 mJ** pulse energy at **1064 nm***
- *Up to **2500 Hz** variable repetition rate*
- ***532 nm, 355 nm, 266 nm, 213 nm** wavelengths as standard options*
- ***<7 ns** pulse duration at 1064 nm*
- *Electro-optical Q-switching*
- *Turn-key operation*
- *Sealed cavity*
- *Extremely compact size*
- *Simple and robust*
- *Air cooled*
- *External TTL triggering*
- *Remote control via USB/CAN*
- *Remote control pad*

### APPLICATIONS

- *Spectroscopy*
- *OPO pumping*
- *Remote sensing*
- *Material processing*
- *Marking*
- *Micromachining*
- *Engraving*
- *Laser deposition*
- *Laser cleaning*
- *Ablation*

## SPECIFICATIONS [1]

| Model | NL201 [2] | NL202 [3] | NL204 [4] | NL204-1K |
|---|---|---|---|---|
| Pulse energy | | | | |
| at 1064 nm | 0.9 mJ | 2.0 mJ | 4.0 mJ | 4.0 mJ |
| at 532 nm | 0.3 mJ | 0.9 mJ | 2.0 mJ | 2.0 mJ |
| at 355 nm | 0.2 mJ | 0.6 mJ | 1.3 mJ | 1.3 mJ |
| at 266 nm | 0.08 mJ | 0.2 mJ | 0.6 mJ | 0.6 mJ |
| at 213 nm | 0.04 mJ | 0.1 mJ | 0.2 mJ | 0.2 mJ |
| Pulse to pulse energy stability (StdDev) [5] | | | | |
| at 1064 nm | <0.5 % | <0.5 % | <0.5 % | <0.5 % |
| at 532 nm | 2.5 % | 2.5 % | 2.5 % | 2.5 % |
| at 355 nm | 3.5 % | 3.5 % | 3 % | 3 % |
| at 266 nm | 4 % | 4 % | 3.5 % | 3.5 % |
| at 213 nm | 5 % | 5 % | 5 % | 5 % |
| Typical pulse duration [6] | <7 ns | <9 ns | <8 ns | <8 ns |
| Power drift [7] | ± 2 % | | | |
| Pulse repetition rate [8] | 10–2500 Hz | 10–1000 Hz | 10–500 Hz | 500–1000 Hz |
| Beam spatial profile | $TEM_{00}$ | | | |
| Ellipticity | 0.9–1.1 at 1064 nm | | | |
| $M^2$ | <1.3 | | | |
| Beam divergence [9] | <3 mrad | | | |
| Polarization | linear, 1064 nm, 355 nm, 266 nm – horizontal, 532 nm – vertical, >100:1 | | | |
| Typical beam diameter [10] | 0.6 mm | 0.7 mm | 0.7 mm | 0.7 mm |
| Beam pointing stability [11] | <10 µrad | | | |
| Optical jitter (StdDev) [12] | <0.4 ns rms | | | |
| **PHYSICAL CHARACTERISTICS** | | | | |
| Laser head (W × L × H) [13] | 164 × 320 × 93 mm | | | |
| Power supply unit (W × L × H) | 340 × 365 × 290 mm | | | |
| Umbilical length [14] | 2.5 m | | | |
| **OPERATING REQUIREMENTS** | | | | |
| Cooling | air cooled | | | |
| Ambient temperature | 18–30 °C | | | |
| Realtive humidity | 10–80 % (non-condensing) | | | |
| Power requirements | 85–264 V AC, single phase, 47–63 Hz | | | |
| Power consumption | <600 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 1064 nm.
2) Unless stated otherwise all specifications are measured at 2500 Hz pulse repetition rate.
3) Unless stated otherwise all specifications are measured at 1000 Hz pulse repetition rate.
4) Unless stated otherwise all specifications are measured at 500 Hz pulse repetition rate.
5) Averaged from 1000 pulses at 1064 nm.
6) FWHM at 1064 nm.
7) Over 8 hour period when ambient temperature variation is less than ±2 °C.
8) In internal triggering mode. In external triggering mode, pulses are available from single shot.
9) Full angle measured at the $1/e^2$ level at 1064 nm.
10) Beam diameter is measured at 1064 nm at the $1/e^2$ level.
11) RMS value measured from 300 shots.
12) Respect to Q-switch trigger pulse.
13) Without optional harmonics module.
14) Up to 10 m is available on separate request.




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## PERFORMANCE

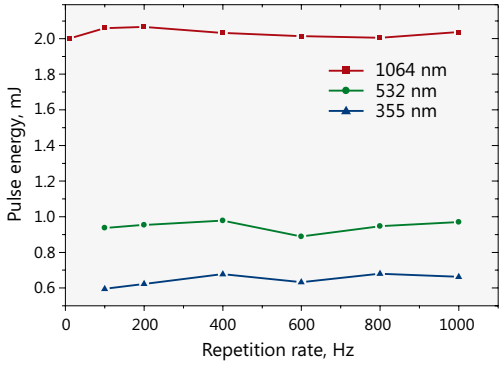


*Fig 1.* Typical performance data of model NL202 laser

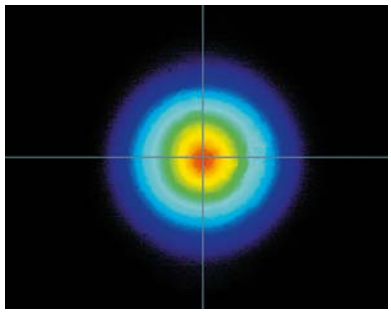

*Fig 2.* Typical beam intensity profile in the far field

## OUTLINE DRAWINGS

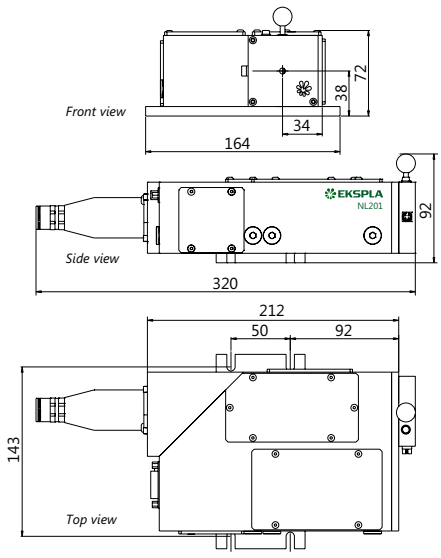


*Fig 3.* NL201 laser head drawing

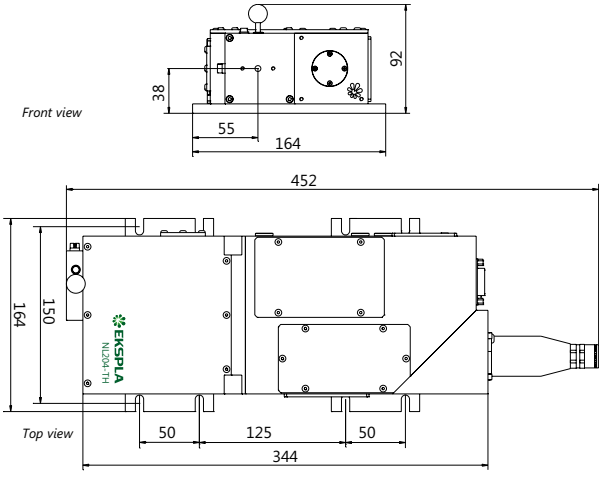


*Fig 4.* NL20× laser head drawing with harmonic module

## ORDERING INFORMATION

**NL201-2.5K-SH-OPO**

- Model
- Pulse repetition rate in kHz
- Harmonic generator options:
  - SH → second harmonic
  - TH → third harmonic
  - FH → fourth harmonic
  - FiH → fifth harmonic
- Other options:
  - OPO → harmonics generator for OPO pumping

# NL220 SERIES

## High Energy kHz Pulsed Q-switched DPSS Nd:YAG Lasers


NL220 series diode pumped Q-switched lasers produce up to 30 mJ at 1000 Hz pulse repetition rate.

The laser is designed to produce high intensity, high brightness pulses and is targeted for applications like OPO, Ti:sapphire or dye laser pumping, nonlinear spectroscopy, material ablation, micromachining, and other tasks.

Employing electro-optical type of Q-switch allows the master oscillator to produce pulses with a short pulse duration of 6 ns, nearly $TEM_{00}$ beam profile and nearly diffraction-limited divergence. The $M^2$ factor of the beam is typically less than 2.5.

Laser cooling uses a closed loop chiller, thus eliminating the need for external cooling water, and reducing running costs.

For PIV applications a double-pulse version of this laser is available.

Angle-tuned LBO and/or BBO crystals mounted in temperature stabilized heaters are used for optional second, third or fourth harmonic generation. The harmonics separation system is designed to ensure a high spectral purity of radiation directed to separate output ports.

For customer convenience the laser can be controlled from a user-friendly remote control pad or USB interface.

The remote pad allows easy control of all parameters and features a backlit display that is easy to read even wearing laser safety eyewear.

Alternatively, the laser can be controlled from a personal computer with supplied software for a Windows™ operating system. LabVIEW™ drivers are supplied as well.

### FEATURES

- ***30 mJ** at **1064 nm***
- ***1 kHz** pulse repetition rate*
- *Close to $TEM_{00}$ beam profile*
- *Simple and robust all-solid-state design*
- *Internal/external triggering*
- *Short warm-up time*
- *Water-to-air cooling (external water service is not required)*
- *Optional temperature stabilized second, third and fourth harmonic generators*
- *PC control via USB (RS232 is optional) with supplied LabVIEW™ drivers*
- *Remote control via keypad*

### APPLICATIONS

- *OPO, Ti:Sapphire and dye laser pumping*
- *PIV*
- *Laser spectroscopy*
- *Material ablation*
- *Micromachining*


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## SPECIFICATIONS [1]

| Model | NL220 | NL220-30-1K |
|---|---|---|
| Pulse energy: | | |
| at 1064 nm | 10 mJ | 30 mJ |
| at 532 nm [2] | 5 mJ | 12 mJ |
| at 355 nm [3] | 3 mJ | 7 mJ |
| at 266 nm [4] | 1 mJ | 2 mJ |
| Pulse to pulse energy stability [5] | | |
| at 1064 nm | <1.0 % rms | <1.5 % rms |
| at 532 nm [2] | <2.0 % rms | <2.5 % rms |
| at 355 nm [3] | <2.5 % rms | <3.5 % rms |
| at 266 nm [4] | <4.0 % rms | <6.0 % rms |
| Pulse duration [6] | 6–8 ns | ~28 ns |
| Pulse repetition rate [7] | 1000 Hz | |
| Beam profile | multimode | |
| Ellipticity | 0.9–1.1 at 1064 nm | |
| $M^2$ | <2.5 [8] | |
| Beam divergence [9] | 2 mrad at 1064 nm | |
| Beam pointing stability | <20 µrad rms | <25 µrad rms |
| Polarization | linear, vertical at 1064 nm, >95 % | |
| Typical beam diameter [10] | 2.5 mm | 3 mm |
| Pulse jitter wrt to SYNC OUT [11] | <0.5 ns rms | |
| Pulse jitter wrt to ext. trigger [12] | <0.5 ns rms | |
| **PHYSICAL CHARACTERISTICS** | | |
| Laser head (W × L × H) | 455 × 826 × 260 mm | 318 × 1035 × 260mm |
| Power supply unit (W × L × H) | 365 × 392 × 289 mm | 552 × 600 × 841 mm |
| Umbilical length | 2.5 m | |
| Chiller [13] | please inquire, depends on location | |
| **OPERATING REQUIREMENTS** | | |
| Cooling | air cooled | air or water cooled |
| Ambient temperature | 18–27 °C | |
| Relative humidity | 20–80 % (non-condensing) | |
| Power requirements | 100–240 V AC, single phase, 50/60 Hz | 220–240 V AC, single phase, 50/60 Hz |
| Power consumption | <1 kVA | <2 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.

2) For NL220-SH option. Outputs are not simultaneous. The laser performance is specified for SH wavelength; specifications for other wavelengths may differ from that indicated above.

3) For NL220-TH option. Outputs are not simultaneous. The laser performance is specified for TH wavelength; specifications for other wavelengths may differ from that indicated above.

4) For NL220-FH option. Outputs are not simultaneous. The laser performance is specified for FH wavelength; specifications for other wavelengths may differ from that indicated above.

5) Averaged from 300 pulses.

6) FWHM at 1064 nm, measured with at 5 Gs/s oscilloscope and photodiode with 1 ns rise time.

7) Optional 100 Hz or 200 Hz pulse repetition rate. Pulse energy specifications are 50 % higher for 100 Hz version and 30 % higher for 200 Hz version.

8) $M^2$ < 1.5 available on request.

9) Full angle measured at the $1/e^2$ level at 1064 nm.

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

11) Optical pulse jitter with respect to SYNC OUT. In internal triggering mode. Typical lead time is 220 ns with respect to optical pulse.

12) Optical pulse jitter with respect to QSW IN. In external triggering mode when triggered with two separate pulses for pump diodes and Q-switch.

13) Available options: water-air or water-water.

## BEAM PROFILE

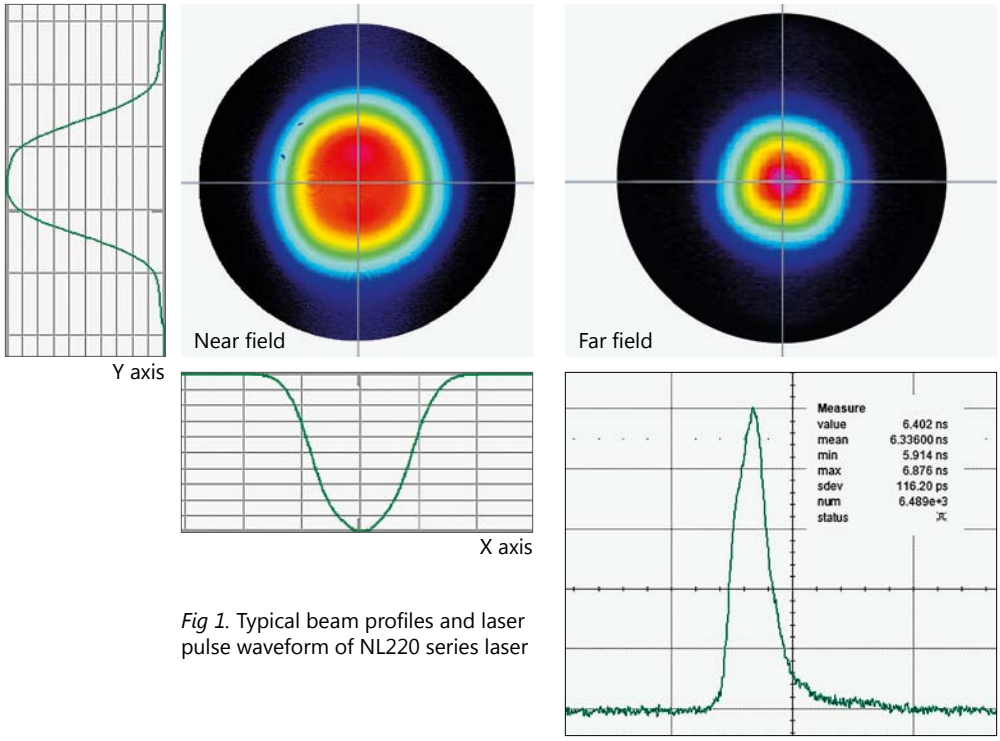


*Fig 1.* Typical beam profiles and laser pulse waveform of NL220 series laser

## OUTLINE DRAWINGS

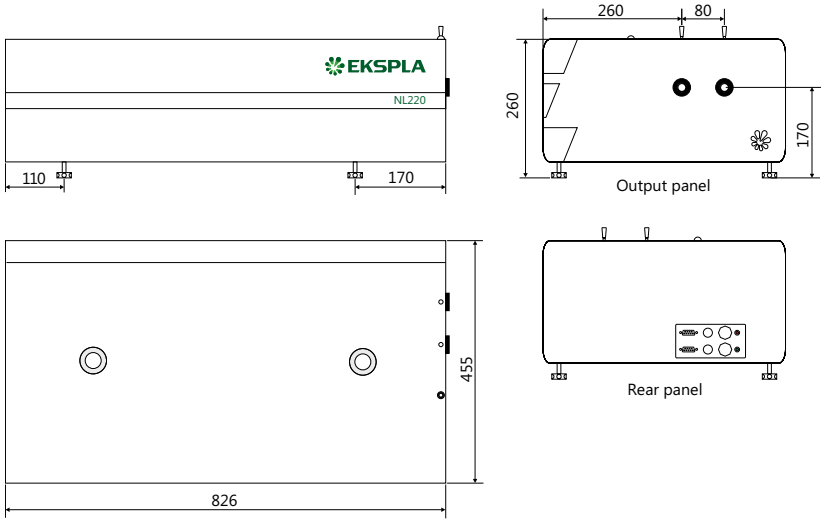


*Fig 2.* NL220 series laser head dimensions

## ORDERING INFORMATION

**NL220D-1K-SH**

Model

Pulse options:
S → single head option
D → double head option

Pulse repetition rate in kHz

Harmonic generator options:
SH → second harmonic
TH → third harmonic
FH → fourth harmonic



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# NL230 SERIES

## High Energy Q-switched DPSS Nd:YAG Lasers


The NL230 series diode-pumped Q-switched lasers produce up to 150 mJ at 100 Hz or up to 190 mJ at 50 Hz pulse repetition rate. Diode pumping allows maintenance-free laser operation for an extended period of time (more than 3 years for an estimated eight working hours per day). The typical pump diode lifetime is more than 1 billion shots.

Lasers are designed to produce high-intensity, high-brightness pulses and are targeted for applications such as material ablation, remote sensing, OPO, Ti:Sapphire or dye laser pumping. Due to an electro-optical Q-switch, the master oscillator generates short duration pulses in the 3–7 ns range. The oscillator cavity optical design features a variable-reflectivity output coupler, giving a low-divergence laser beam.

A closed-loop TEC based chiller is used for laser cooling, eliminating the need for external cooling water and reducing running costs.

Angle-tuned non-linear crystals mounted in temperature stabilized heaters are used for optional second, third or fourth harmonic generation. The harmonics separation system is designed to ensure radiation with a high spectral purity and to direct it to the separate output ports.

For customer convenience the laser can be controlled via a user-friendly remote control pad or a USB interface. The remote pad allows easy control of all parameters and features a backlit display that is easy to read even through laser safety eyewear. Alternatively, the laser can be controlled from a personal computer via supplied Windows™ compatible software. LabVIEW™ drivers are also included with each laser installation package.

OEM version of NL230 series laser features compact design and stable output parameters

### FEATURES

- *Diode-pumped, typical diode lifetime >1 Gshot*
- *Rugged sealed laser cavity*
- *Up to **190 mJ** at **1064 nm** pulse energy*
- *Up to **100 Hz** pulse repetition rate*
- *Short pulse duration in the **3–7 ns** range*
- *Variable reflectivity output coupler for low-divergence beam*
- *Quiet operation: no more flashlamp firing sound*
- *Air cooled*
- *Remote control via keypad and/or PC via USB (RS232 optional) port with supplied LabVIEW™ drivers*
- *Optional temperature-stabilized second, third and fourth harmonic generators*
- *Optional attenuators for fundamental or/and harmonics wavelengths*

### APPLICATIONS

- *OPO, Ti:Sapphire and dye laser pumping*
- *TFT-LCD Repair*
- *Mass Spectroscopy*
- *Remote Sensing*
- *LIDAR (Light Detection And Ranging)*
- *LIF (Light Induced Fluorescence)*
- *PIV (Particle Image Velocimetry)*
- *LIBS (Light Induced Breakdown Spectroscopy)*
- *ESPI (Electronic Speckle Pattern Interferometry)*
- *Medical*
- *Photo acoustic imaging*

## SPECIFICATIONS [1]

| Model | NL230-30 | NL230-100 | NL231-50 | NL231-100 |
|---|---|---|---|---|
| Pulse energy (not less than) [2] | | | | |
| at 1064 nm | 140 mJ | 60 mJ | 190 mJ | 150 mJ |
| at 532 nm [3] | 70 mJ | 30 mJ | 90 mJ | 70 mJ |
| at 355 nm [4] | 40 mJ | 15 mJ | 55 mJ | 40 mJ |
| Pulse energy stability (StdDev) [5] | | | | |
| at 1064 nm | <1 % | | | |
| at 532 nm | <2.5 % | | | |
| at 355 nm | <3.5 % | | | |
| Pulse repetition rate | 30 Hz | 100 Hz | 50 Hz | 100 Hz |
| Power drift [6] | < ±1 % | | | |
| Pulse duration [7] | 3 – 7 ns | | | |
| Linewidth | <1 $cm^{-1}$ at 1064 nm | | | |
| Beam profile [8] | "Top Hat" in near field and close to Gaussian in far field | | | |
| Beam divergence [9] | <0.8 mrad | | | |
| Beam pointing stability [10] | ≤60 µrad rms | | | |
| Polarization | linear, >95 % at 1064 nm | | | |
| Typical beam diameter [11] | 5 mm | | | |
| Optical pulse jitter | | | | |
| Internal triggering regime [12] | <0.5 ns rms | | | |
| External triggering regime [13] | <0.5 ns rms | | | |
| SYNC OUT pulse delay | -100 µs ... 100 ms | | | |
| Typical warm-up time | 5 min | | | |
| **PHYSICAL CHARACTERISTICS** | | | | |
| Laser head size (W × L × H) | 190×305×165 mm ± 3 mm | | | |
| Power supply unit (W × L × H) | | | | |
| Desktop case | 471×391×147 mm ± 3 mm | | | |
| 19" module | 483×355×133 mm ± 3 mm | | | |
| External chiller (where applicable) | inquire | | | |
| Umbilical length | 2.5 m | | | |
| **OPERATING REQUIREMENTS** | | | | |
| Cooling (air cooled) [14] | built in chiller | | external chiller | |
| Ambient temperature | 18–27 °C | | | |
| Relative humidity (non-condensing) | 20–80 % | | | |
| Power requirements | 100–240 V AC, single phase, 50/60 Hz | | | |
| Power consumption | <1.0 kVA | | | |

1) Due to continuous improvement, all specifications are subject to change without notice. The parameters marked typical may vary with each unit we manufacture. Unless stated otherwise all specifications are measured at 1064 nm.

2) Outputs are not simultaneous. Inquire for fourth 266 nm and fifth 213 nm harmonic specifications.

3) With H300SH and H300S or H300SHC harmonics generator module. See harmonics generator selection guide for more detailed information.

4) With H300STH and H300ST harmonics or H300SH and H300THC generator modules. See harmonics generator selection guide for more detailed information.

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

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

7) FWHM.

8) Near field (at the output aperture) TOP HAT fit is >80%.

9) Full angle measured at the $1/e^2$ level.

10) Beam pointing stability is evaluated as movement of the beam centroid in the focal plane of a focusing element.

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

12) With respect to SYNC OUT pulse.

13) With respect to QSW IN pulse.

14) Adequate room air conditioning should be provided.


**Notes:** 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 one side should be ensured. Intensive sources of vibration should be avoided near the laboratory (ex. railway station or similar).



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## CONFIGURATIONS

The following are suggested optimal configurations of H300 series modules for various output wavelengths:

1. For 2nd harmonics output only: the H300SHC module.
2. For 2nd and 3rd harmonics:
   a) H300SH+H300S+H300THC – for SH and TH output.
   b) H300STH+H300ST – a cost-effective solution not requiring the replacement of modules when changing from a 532 nm to 355 nm beam and vice versa. The 532 nm beam specification will, however, be 15% lower relative to the values specified above due to extra components in the beam path.
3. For attenuators for all wavelengths up to the 3th harmonic: H300A1+H300SH+H300A2+H300TH+H300A3 modules.

### Modules Selection Guide

| Module | Description | Output ports | Output pulse energy specifications | Dimensions W×L×H, mm | Extension possible? | Notes |
|---|---|---|---|---|---|---|
| H300SH | Second harmonic generator | Port 1: 1064, 532 nm | N/d | 154×160×128 | Yes | |
| H300S | 532 nm beam separator | Port 1: 532 nm<br>Port 2: residual 1064 nm | See NL230 specifications for 532 nm beam | 154×160×128 | No | Should be used with H300SH |
| H300SHC | Second harmonic generator with 532 nm beam separator | Port 1: 532 nm<br>Port 2: residual 1064 nm | See NL230 specifications for 532 nm beam | 154×210×128 | No | |
| H300TH | Third harmonic generator | Port 1: 1064, 532 & 355 nm | N/a | 154×160×128 | Yes | Should be used with H300SH |
| H300THC | Third harmonic generator with 355 nm beam separator | Port 1: 355 nm<br>Port 2: residual 1064 & 532 nm | See NL230 specifications for 355 nm beam | 154×210×128 | No | Should be used with H300SH |
| H300STH | Second and third harmonics generator | Port 1: 1064, 532 & 355 nm | N/a | 154×210×128 | Yes | |
| H300ST | 355 nm beam separator | Port 1: 355 nm<br>Port 2: residual 532 nm | See NL230 specifications for 355 nm beam | 154×160×128 | No | Recommended to use with H300STH |
| H300A1 | Attenuator for 1064 nm beam | Port 1: 1064 nm beam | Transmission in 5–90% range at 1064 nm | 154×210×128 | No | |
| H300A2 | Attenuator and beam separator for 532 nm beam | Port 1: 532 nm<br>Port 2: residual 532 nm | Transmission in 5–90% range at 532 nm | 154×210×128 | No | Should be used with H300SH |
| H300A3 | Attenuator and beam separator for 355 nm beam | Port 1: 355 nm<br>Port 2: residual 355 nm | Transmission in 5–90% range at 355 nm | 154×210×128 | No | Should be used with H300TH or H300STH |

## PERFORMANCE

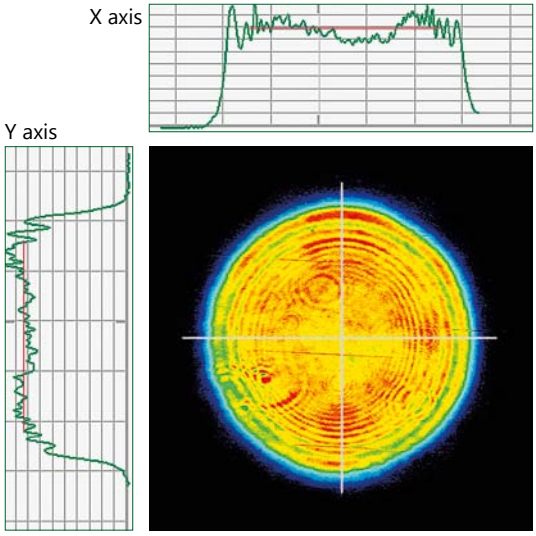



*Fig 1.* NL230 laser typical near field beam profile

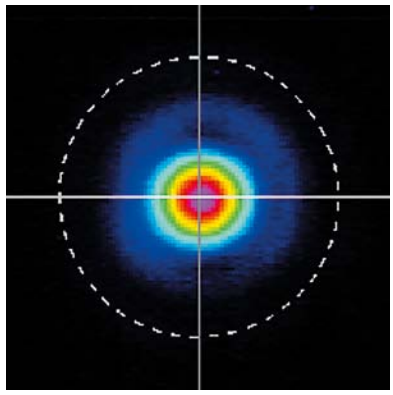
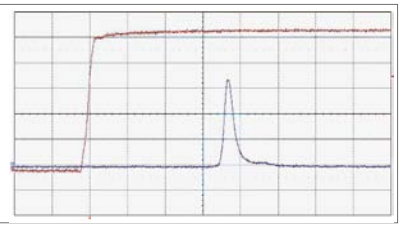


*Fig 2.* NL230 laser typical far field beam profile

| Measure | P1.ddelay | P2.width | P3.area |
|---|---|---|---|
| value | 72.011 ns | 5.507 ns | 2.358455 mVs |
| mean | 72.044 ns | 5.482 ns | 2.355738 mVs |
| min | 71.456 ns | 5.167 ns | 2.277066 mVs |
| max | 72.552 ns | 5.970 ns | 2.409653 mVs |
| sdev | 156.11 ps | 81.27 ps | 16.89196 pVs |
| num | 4.697 × $10^3$ | 4.697 × $10^3$ | 4.697 × $10^3$ |



NL230 laser pulse waveform

## OUTLINE DRAWINGS

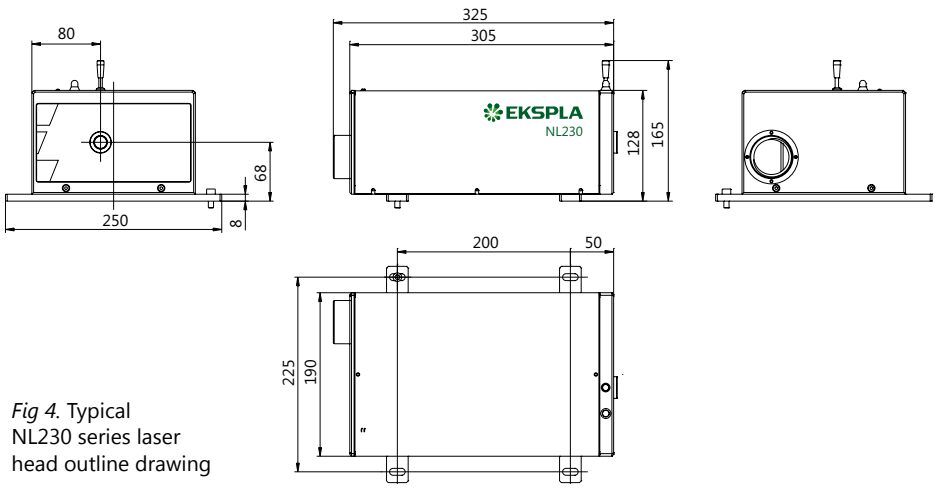



*Fig 4.* Typical NL230 series laser head outline drawing

## ORDERING INFORMATION

**NL230-H300SH-H300THC**

| Model | Optional harmonic generator modules and other accessories |
|---|---|



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# HARMONIC GENERATORS

## For NL230 Series Lasers

Nanosecond Q-switched lasers enable simple and cost effective laser wavelength conversion to shorter wavelengths through harmonics generation. EKSPLA offers a broad selection of wavelength conversion accessories for NL230 series lasers.

The harmonics module uses a modular design that allows reconfiguration of laser output for the appropriate experiment wavelength.

A typical module houses a non-linear crystal together with a set of dichroic mirrors for separating the harmonic beam from the fundamental wavelength. Nonlinear crystals used for the purpose of wavelength conversion are kept at an elevated temperature in a thermo-stabilized oven.

Two or more modules can be joined together for higher harmonics generation: attaching one extra module to a second harmonic generator allows for the generation of 3rd wavelengths.

It should be noted that only modules with a single output port can be joined together: it is possible to attach a H300S module to a H300SH unit for 532 nm beam separation. Modules with two output ports (e.g., H300SHC) cannot be attached to extra units.

### FEATURES

- *Compact harmonic modules*
- *Thermo stabilized crystals for long lifetime*
- *Dichroic mirrors*
- *AR coatings on crystals*
- *Phase matching by mechanical adjustment*
- *High conversion efficiency*
- *Wide selection of different*

## H300SH 2nd harmonic generator

### SPECIFICATIONS

| | |
|---|---|
| Output ports | |
| Port #1 | 1064 & 532 nm |
| Typical conversion efficiency [1)] | 50 – 60% (depending on laser model) |
| Output pulse energy | N/A |
| Dimensions (W×H×L) | 154×128×160 mm |
| Extension possibility | Yes |

1) 1064 nm wavelength beam conversion efficiency.

### FEATURES

- *Contains SH crystal with half-wave plate for input polarization adjustment*
- *532 nm and 1064 nm outputs*
- *SH crystal thermo stabilized for long lifetime*

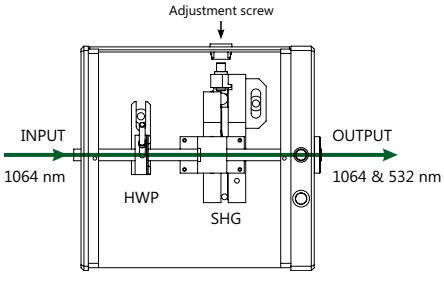


*Fig.1.* Optical layout of the H300SH.

*Note:* The optical layout drawing does not reflect the actual positions or number of optical components – it is simplified for demonstration of layout.

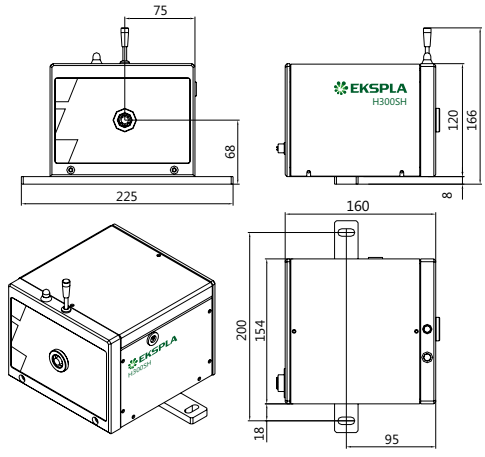


*Fig. 2.* Dimensions and output port position of H300SH module.

# H300S separators module

## SPECIFICATIONS

| | |
|---|---|
| Output ports | |
| Port #1 | 532 nm |
| Port #2 | residual 1064 nm |
| Output pulse energy | See NL230 specifications for 532 nm beam |
| Dimensions (W×H×L) | 154×128×160 mm |
| Extension possibility | No |

## FEATURES

- *532 nm and 1064 nm outputs*

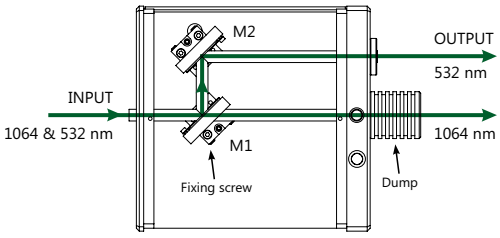


*Fig.1.* Optical layout of the H300S.

*Note:* The optical layout drawing does not reflect the actual positions or number of optical components – it is simplified for demonstration of layout.

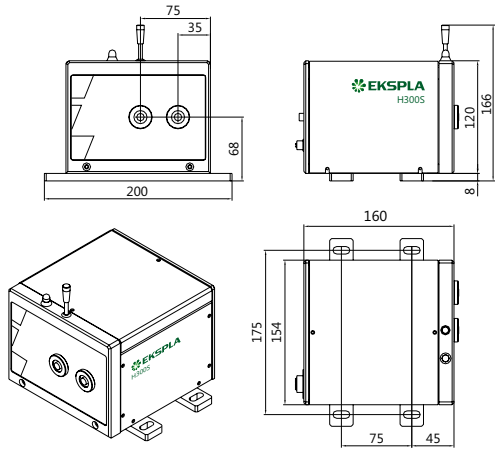


*Fig. 2.* Dimensions and output port position of H300S module.

# H300SHC 2nd harmonic generator with separator

## SPECIFICATIONS

| | |
|---|---|
| Output ports | |
| Port #1 | 532 nm |
| Port #2 | residual 1064 nm |
| Typical conversion efficiency [1] | 50 – 60% (depending on laser model) |
| Output pulse energy | See NL230 specifications for 532 nm beam |
| Dimensions (W×H×L) | 154×128×210 mm |
| Extension possibility | No |

[1] 1064 nm wavelength beam conversion efficiency.

## FEATURES

- *Contains SH crystal with half-wave plate for input polarization adjustment*
- *532 nm and 1064 nm outputs*
- *SH crystal thermo stabilized for long lifetime*

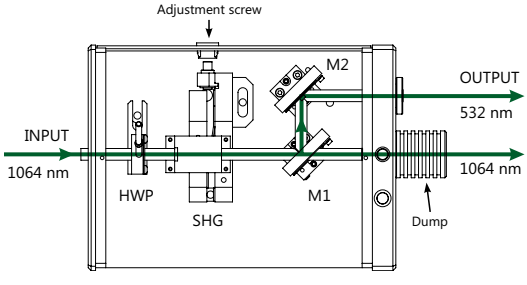


*Fig.1.* Optical layout of the H300SHC.

*Note:* The optical layout drawing does not reflect the actual positions or number of optical components – it is simplified for demonstration of layout.

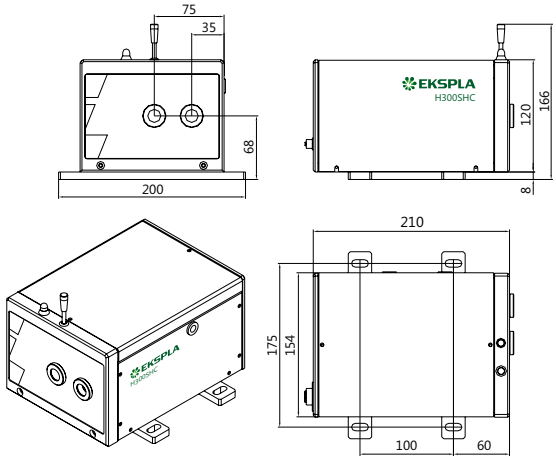


*Fig. 2.* Dimensions and output port position of H300SHC module.



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# H300TH 3rd harmonic generator

## SPECIFICATIONS

| | |
|---|---|
| Output ports | |
| Port #1 | 1064, 532 & 355 nm |
| Typical conversion efficiency [1] | 20 – 30% (depending on laser model) |
| Output pulse energy [2] | N/A |
| Dimensions (W×H×L) | 154×128×160 mm |
| Extension possibility | Yes |

[1] 1064 nm wavelength beam conversion efficiency.
[2] When used with H300SH.

## FEATURES

- *Contains TH crystal with half-wave plate for input polarization adjustment*
- ***355 nm, 532 nm** and **1064 nm** outputs*
- *TH crystal thermo stabilized for long lifetime*

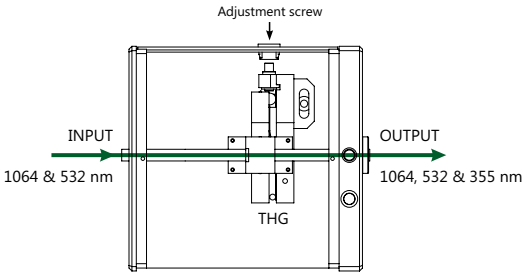


*Fig. 1.* Optical layout of the H300TH.

*Note:* The optical layout drawing does not reflect the actual positions or number of optical components – it is simplified for demonstration of layout.

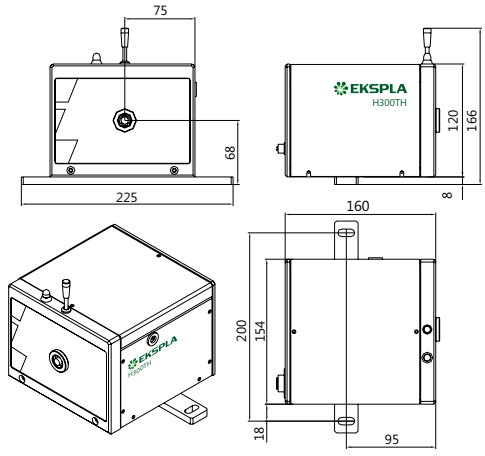


*Fig. 2.* Dimensions and output port position of H300TH module.

# H300ST 2nd and 3rd harmonic separator

## SPECIFICATIONS

| | |
|---|---|
| Output ports | |
| Port #1 | 355 nm |
| Port #2 | residual 532 nm |
| Output pulse energy [1] | See NL230 specifications for 355 nm beam |
| Dimensions (W×H×L) | 154×128×160 mm |
| Extension possibility | No |

[1] When used with H300STH.

## FEATURES

- *355 nm and 532 nm outputs*
- *High damage threshold dielectric mirrors*

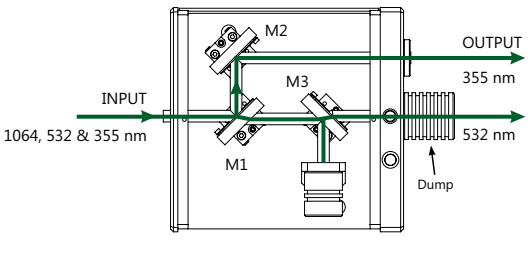


*Fig. 1.* Optical layout of the H300ST.

*Note:* The optical layout drawing does not reflect the actual positions or number of optical components – it is simplified for demonstration of layout.

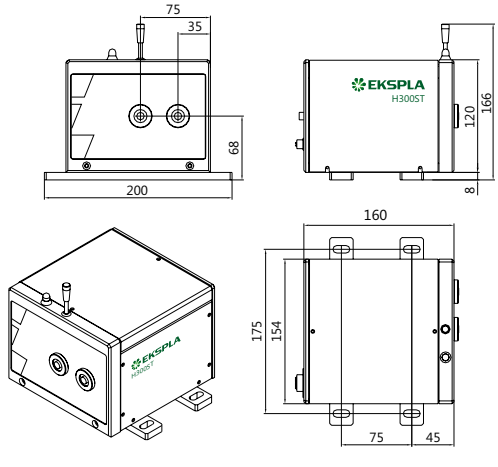


*Fig. 2.* Dimensions and output port position of H300ST module.

## H300THC 3rd harmonic generator with separator

### SPECIFICATIONS

| | |
|---|---|
| Output ports | |
| Port #1 | 355 nm |
| Port #2 | residual 1064 & 532 nm |
| Typical conversion efficiency [1] | 20 – 30 % (depending on laser model) |
| Output pulse energy [2] | See NL230 specifications for 355 nm beam |
| Dimensions (W×H×L) | 154×128×210 mm |
| Extension possibility | No |

[1] From 1064 nm wavelength to respective harmonic wavelength.
[2] When used with H300SH.

### FEATURES

- *Contains TH crystal with half-wave plate for input polarization adjustment*
- *355 nm and 532 nm outputs*
- *TH crystal thermo stabilized for long lifetime*

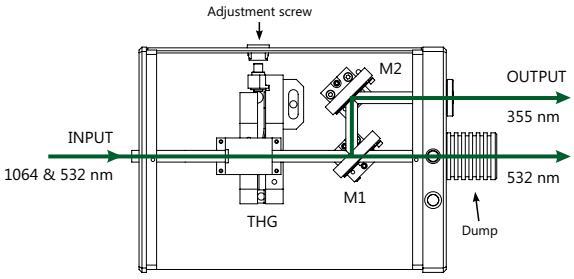


*Fig. 1.* Optical layout of the H300THC.

*Note:* The optical layout drawing does not reflect the actual positions or number of optical components – it is simplified for demonstration of layout.

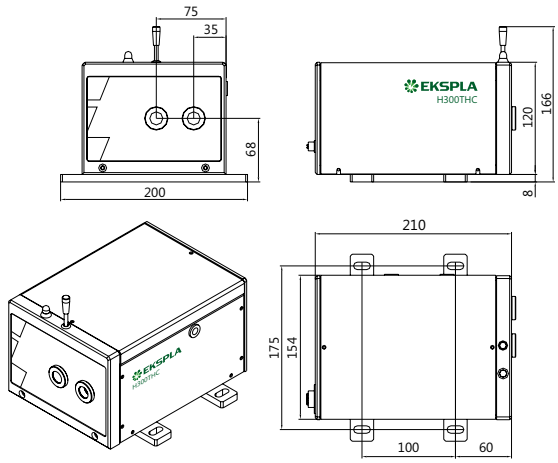


*Fig. 2.* Dimensions and output port position of H300THC module.

## H300STH 2nd and 3rd harmonic generator without separator

### SPECIFICATIONS

| | |
|---|---|
| Output ports | |
| Port #1 | 355 nm and residual 1064 & 532 nm |
| Typical conversion efficiency [1] | 20 – 30 % (depending on laser model) |
| Output pulse energy | N/A |
| Dimensions (W×H×L) | 154×128×210 mm |
| Extension possibility | No |

[1] From 1064 nm wavelength to respective harmonic wavelength.

### FEATURES

- *Contains SH and TH crystals with half-wave plate for input polarization adjustment*
- *355 nm, 532 nm and 1064 nm outputs*
- *SH and TH crystals thermo stabilized for long lifetime*

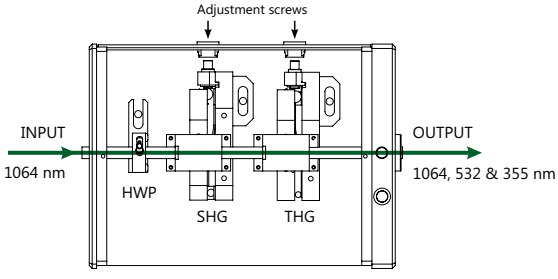


*Fig. 1.* Optical layout of the H300STH.

*Note:* The optical layout drawing does not reflect the actual positions or number of optical components – it is simplified for demonstration of layout.

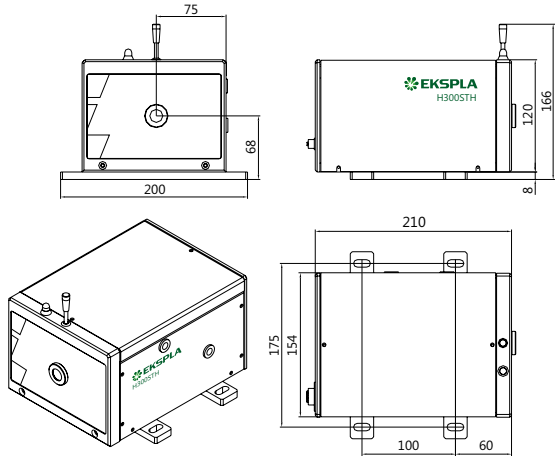


*Fig. 2.* Dimensions and output port position of H300STH module.



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# ATTENUATORS

## For NL230 Series Lasers

NL230 series lasers offer several options for changing output pulse energy. The easiest option is to change the timing of the Q-switch opening relative to the flashlamp pump pulse. This option is a standard feature for all NL230 series lasers. A change in Q-switch timing, however, changes other laser pulse parameters along with the pulse energy.

A decrease in pulse energy results in longer pulse duration, decreased pulse-to-pulse-stability, and possible changes in the spatial beam profile. For applications that require smooth adjustment of output pulse energy while keeping other parameters stable, EKSPLA offers H300Ax series attenuator modules.

### FEATURES

- *Compact design*
- *Motorized*
- *Smooth adjustment of output pulse energy*

## H300A1 attenuator at 1064 nm

### SPECIFICATIONS

| | |
|---|---|
| Output ports | |
| Port #1 | 1064 nm |
| Output pulse energy | transmission in 5 – 90 % range at 1064 nm |
| Dimensions (W×H×L) | 154×128×210 mm |
| Extension possibility | No |

### FEATURES

- *Smooth adjustment of output pulse energy without change of other pulse parameters*
- *Motorized*

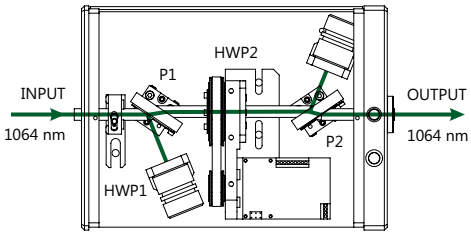


*Fig.1.* Optical layout of the H300A1.

*Note:* The optical layout drawing does not reflect the actual positions or number of optical components – it is simplified for easier understanding. Half wave plate (HWP2) is adjusted automatically.

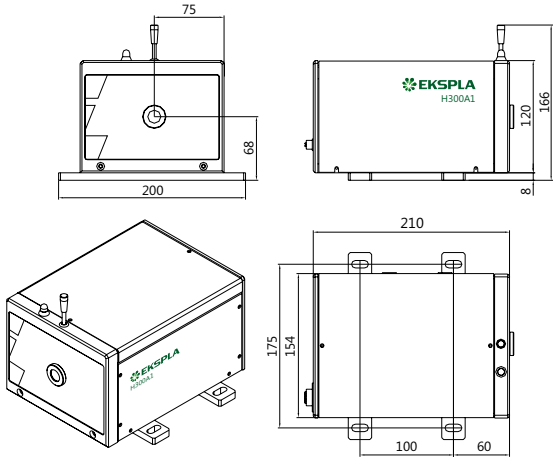


*Fig. 2.* Dimensions and output port position of H300A1 module.

## H300A2 attenuator at 532 nm

### SPECIFICATIONS

| | |
|---|---|
| Output ports | |
| Port #1 | 532 nm |
| Port #2 | residual 532 nm |
| Output pulse energy [1] | transmission in 5 – 90 % range at 532 nm |
| Dimensions (W×H×L) | 154×128×210 mm |
| Extension possibility | No |

[1] When used with H300SH.

### FEATURES

- *Smooth adjustment of output pulse energy without change of other pulse parameters*
- *Motorized*

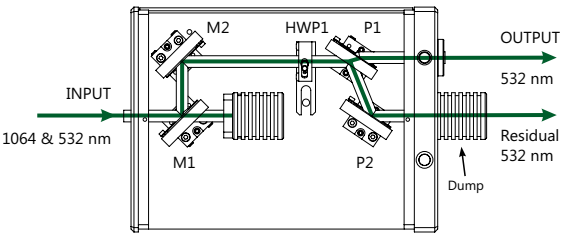


*Fig.1.* Optical layout of the H300A2.

*Note:* The optical layout drawing does not reflect the actual positions or number of optical components – it is simplified for easier understanding. Half wave plate (HWP1) is adjusted automatically.

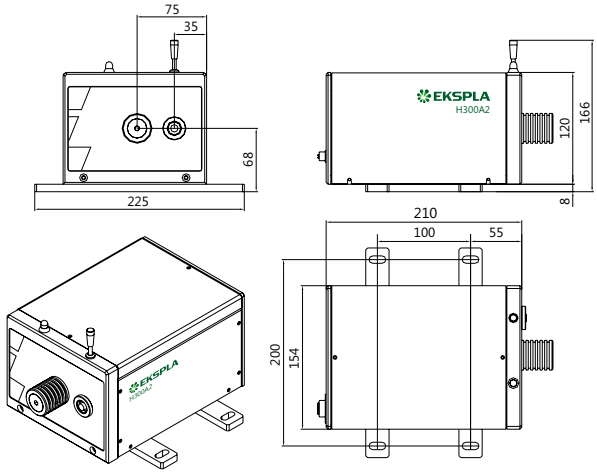


*Fig. 2.* Dimensions and output port position of H300A2 module.

## H300A3 attenuator at 355 nm

### SPECIFICATIONS

| | |
|---|---|
| Output ports | |
| Port #1 | 355 nm |
| Port #2 | residual 355 nm |
| Output pulse energy [1] | transmission in 5 – 90 % range at 355 nm |
| Dimensions (W×H×L) | 154×128×210 mm |
| Extension possibility | No |

[1] When used with H300TH or H300STH.

### FEATURES

- *Smooth adjustment of output pulse energy without change of other pulse parameters*
- *Motorized*

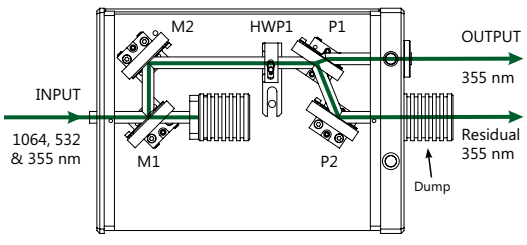


*Fig.1.* Optical layout of the H300A3.

*Note:* The optical layout drawing does not reflect the actual positions or number of optical components – it is simplified for easier understanding. Half wave plate (HWP1) is adjusted automatically.

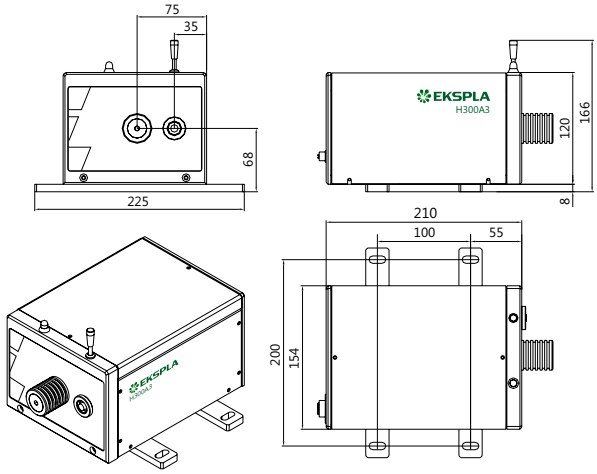


*Fig. 2.* Dimensions and output port position of H300A3 module.



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# NL300 SERIES

## Compact Flash-Lamp Pumped Q-switched Nd:YAG Lasers


NL300 series electro-optically Q-switched nanosecond Nd:YAG lasers produce high energy pulses with 3–6 ns duration. Pulse repetition rate can be selected in range of 10–30 Hz.

NL30×G models are optimized for OPO pumping that requires smooth beam profile without hot spots.

NL30×HT models are designed for maximum energy extraction from the active element. Up to 800 mJ pulse energy can be produced at a 10 Hz pulse repetition rate.

A wide range of harmonic generator modules for generation up to a 5th harmonic is available.

Harmonics generators can be combined with attenuators that allow smooth output energy adjustment without changing other laser parameters, i.e. pulse duration, pulse-to-pulse stability, divergence or beam profile. For a more detailed description of harmonic and attenuator modules please check our harmonic generators selection guide on the page 76.

The extremely compact laser head is approximately 480 mm long and can be fitted into tight spaces. The laser power supply has a 330 × 490 mm footprint. Easy access to the water tank from the back side of the power supply facilitates laser maintenance. Replacement of flashlamp does not require removal of pump chamber from the laser cavity and does not lead to possible misalignment.

The powering unit can be configured with water-to-water or water-to-air heat exchangers. The latter option allows for laser operation without the use of tap water for cooling.

For customer convenience the laser can be controlled via a RS232 or USB port with LabView™ drivers (included) or a user-friendly remote control pad. Both options allow easy control of laser settings.

### FEATURES

- *Rugged sealed laser cavity*
- *Up to **800 mJ** pulse energy*
- *Better than 1 % rms pulse energy stability*
- ***10–30 Hz** pulse repetition rate*
- ***3–6 ns** pulse duration*
- *Thermo stabilized second, third, fourth and fifth harmonics generator modules*
- *Optional attenuators for fundamental and/or harmonics wavelengths*
- *Water-to-water or water-to-air cooling options*
- *Replacement of flashlamps without misalignment of laser cavity*
- *Remote control via keypad and/or RS232/USB port*

### APPLICATIONS

- *Material processing*
- *OPO, Ti:Sapphire, dye laser pumping*
- *Laser spectroscopy*
- *Remote sensing*

## SPECIFICATIONS [1] (part I)

| Model | NL301G [2] | | | NL301HT | | |
|---|---|---|---|---|---|---|
| Pulse repetition rate | 10 Hz | 20 Hz | 30 Hz | 10 Hz | 20 Hz | 30 Hz |
| Pulse energy: | | | | | | |
| at 1064 nm | 240 mJ | 220 mJ | 200 mJ | 400 mJ | 360 mJ | 280 mJ |
| at 532 nm [3] | 100 mJ | 90 mJ | 70 mJ | 180 mJ | 160 mJ | 120 mJ |
| at 355 nm [4] | 70 mJ | 60 mJ | 40 mJ | 120 mJ | 110 mJ | 65 mJ |
| at 266 nm [5] | 25 mJ | 20 mJ | 15 mJ | 40 mJ | 35 mJ | 25 mJ |
| at 213 nm [6] | 5 mJ | 4 mJ | 3 mJ | 8 mJ | 7 mJ | 5 mJ |
| Pulse energy stability (StdDev) [7] | | | | | | |
| at 1064 nm | 1 % | | | | | |
| at 532 nm | 1.5 % | | | | | |
| at 355 nm | 3 % | | | | | |
| at 266 nm | 3.5 % | | | | | |
| at 213 nm | 6 % | | | | | |
| Power drift [8] | ±2 % | | | | | |
| Pulse duration [9] | 3–6 ns | | | | | |
| Polarization | vertical, >90 % | | | | | |
| Optical pulse jitter [10] | <0.5 ns rms | | | | | |
| Linewidth | <1 $cm^{-1}$ | | | | | |
| Beam profile [11] | Hat-Top in near and near Gaussian in far fields | | | | | |
| Typical beam diameter [12] | ~6 mm | | | | | |
| Beam divergence [13] | <0.6 mrad | | | | | |
| Beam pointing stability [14] | 50 µrad rms | | | | | |
| Beam height | 68 mm | | | | | |
| **PHYSICAL CHARACTERISTICS** | | | | | | |
| Laser head size (W × L × H) | 154 × 475 × 128 mm | | | | | |
| Power supply unit (water cooled version) (W × L × H) | 330 × 490 × 585 mm | | | | | |
| Power supply unit (air cooled version) (W × L × H) | 330 × 490 × 585 mm | 550 × 600 × 680 mm | | 330 × 490 × 585 mm | 550 × 600 × 680 mm | |
| Harmonic generator unit sizes (W × L × H) [15] | 154 × 210 × 128 mm for H300SHC or H300STH units<br>154 × 160 × 128 mm for H300S or H300ST units<br>154 × 290 × 128 mm for H300FHC unit | | | | | |
| Umbilical length | 2.5 m | | | | | |
| **OPERATING REQUIREMENTS** | | | | | | |
| Water consumption (max 20 °C) [16] | < 6 l/min | <10 l/min | | <6 l/min | <10 l/min | |
| Ambient temperature | 15–30 °C | | | | | |
| Relative humidity | 20–80 % (non-condensing) | | | | | |
| Power requirements [17] [18] | 208 or 240 V AC, single phase 50/60 Hz | | | | | |
| Power consumption [19] | <1.8 kVA | <3.4 kVA | | <1.8 kVA | <3.4 kVA | |

1) Due to continuous improvement, 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 1064 nm.
2) NL301G and NL303G lasers have beam profile optimized for OPO pumping.
3) With H300SH, H300S or H300SHC harmonics generator modules. See harmonics generator selection guide on the page 76 for more detailed information.
4) With H300STH and H300ST harmonics generator modules. See harmonics generator selection guide on the page 76 for more detailed information.
5) With H300SH and H400FHC harmonics generator modules. See harmonics generator selection guide on the page 76 for more detailed information.
6) With H300FiHC harmonics generator module. See harmonics generator selection guide on the page 76 for more detailed information.
7) Averaged from 300 pulses.
8) Measured over an 8 hour period when ambient temperature variation is less than ± 2 °C.
9) FWHM measured with photodiode featuring 500 ps rise time and 300 MHz bandwidth oscilloscope.
10) Relative to SYNC OUT pulse.
11) Near field Gaussian fit is >70%.
12) Beam diameter is measured at 1064 nm at the $1/e^2$ level.
13) Full angle measured at the $1/e^2$ level.
14) RMS value measured from 300 shots.
15) See harmonics generator selection guide on the page 76 for more detailed information.
16) For water cooled version. Air cooled version does not require tap water for cooling.
17) Power requirements should be specified when ordering.
18) 110 V AC powering is available, please inquiry for details.
19) Required current rating can be calculated by dividing power value by mains voltage value.



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## SPECIFICATIONS [1] (part II)

| Model | NL303G [2] | | NL303HT | |
|---|---|---|---|---|
| Pulse repetition rate | 10 Hz | 20 Hz | 10 Hz | 20 Hz |
| Pulse energy: | | | | |
| at 1064 nm | 500 mJ | 450 mJ | 800 mJ | 700 mJ |
| at 532 nm [3] | 210 mJ | 190 mJ | 360 mJ | 310 mJ |
| at 355 nm [4] | 135 mJ | 120 mJ | 240 mJ | 210 mJ |
| at 266 nm [5] | 50 mJ | 35 mJ | 80 mJ | 60 mJ |
| at 213 nm [6] | 10 mJ | 7 mJ | 13 mJ | 10 mJ |
| Pulse energy stability (StdDev) [7] | | | | |
| at 1064 nm | 1 % | | | |
| at 532 nm | 1.5 % | | | |
| at 355 nm | 3 % | | | |
| at 266 nm | 3.5 % | | | |
| at 213 nm | 6 % | | | |
| Power drift [8] | ±2 % | | | |
| Pulse duration [9] | 3–6 ns | | | |
| Polarization | vertical, >90 % | | | |
| Optical pulse jitter [10] | <0.5 ns rms | | | |
| Linewidth | <1 $cm^{-1}$ | | | |
| Beam profile [11] | Hat-Top in near and near Gaussian in far fields | | | |
| Typical beam diameter [12] | ~8 mm | | | |
| Beam divergence [13] | <0.5 mrad | | | |
| Beam pointing stability [14] | 50 µrad rms | | | |
| Beam height | 68 mm | | | |
| **PHYSICAL CHARACTERISTICS** | | | | |
| Laser head size (W × L × H) | 154 × 475 × 128 mm | | | |
| Power supply unit (water cooled version) (W × L × H) | 330 × 490 × 585 mm | | | |
| Power supply unit (air cooled version) (W × L × H) | 330 × 490 × 585 mm | 550 × 600 × 680 mm | 330 × 490 × 585 mm | 550 × 600 × 680 mm |
| Harmonic generator unit sizes (W × L × H) [15] | 154 × 210 × 128 mm for H300SHC or H300STH units<br>154 × 160 × 128 mm for H300S or H300ST units<br>154 × 290 × 128 mm for H300FHC unit | | | |
| Umbilical length | 2.5 m | | | |
| **OPERATING REQUIREMENTS** | | | | |
| Water consumption (max 20 °C) [16] | <8 l/min | <12 l/min | <8 l/min | <12 l/min |
| Ambient temperature | 15–30 °C | | | |
| Relative humidity | 20–80 % (non-condensing) | | | |
| Power requirements [17] [18] | 208 or 240 V AC, single phase 50/60 Hz | | | |
| Power consumption [19] | <1.8 kVA | <3.4 kVA | <1.8 kVA | <3.4 kVA |

## OPTIONAL HARMONICS GENERATOR AND ATTENUATORS MODULES

The following are suggested optimal configurations of H300 series modules for various output wavelengths:

1. For **2nd harmonics** output only: the H300SHC module.

2. For **2nd and 3rd harmonics**:
   a) H300SH+H300S+H300THC – for SH and TH output as specified in the NL300 series brochure.
   b) H300STH+H300ST – a cost-effective solution not requiring the replacement of modules when changing from a 532 nm to 355 nm beam and vice versa. The 532 nm beam specification will, however, be 15% lower relative to the values in the NL300 series brochure due to extra components in the beam path.

3. For **2nd and 4th harmonics**: H300SH+H300S+H300FHC modules.

4. For **all harmonics including 4th**:
   a) H300STH+H300ST+H300FHC – a cost-effective solution. The 266 nm and 532 nm beam specifications will be 15% lower relative to the values in the NL300 series brochure.
   b) H300SH+H300S+H300THC+H300FHC – a slightly more expensive solution with output values adhering to those in the NL300 series brochure.

5. For **all harmonics including 5th**: modules described in paragraph #4 plus the H300FiHC module.

6. For **attenuators** for all wavelengths up to the 4th harmonic: H300SH+H300A2+H300TH+H300A3+H300A4 modules.

## MODULES SELECTION GUIDE

| Module | Description | Output ports | Output pulse energy specifications | Dimensions W×L×H, mm | Extension possible? | Notes |
|---|---|---|---|---|---|---|
| H300SH | Second harmonic generator | Port 1: 1064, 532 nm | N/A | 154×160×128 | Yes | |
| H300S | 532 nm beam separator | Port 1: 532 nm<br>Port 2: residual 1064 nm | See NL300 specifications for 532 nm beam | 154×160×128 | No | Should be used with H300SH |
| H300SHC | Second harmonic generator with 532 nm beam separator | Port 1: 532 nm<br>Port 2: residual 1064 nm | See NL300 specifications for 532 nm beam | 154×210×128 | No | |
| H300TH | Third harmonic generator | Port 1: 1064, 532 & 355 nm | N/A | 154×160×128 | Yes | Should be used with H300SH |
| H300THC | Third harmonic generator with 355 nm beam separator | Port 1: 355 nm<br>Port 2: residual 1064 & 532 nm | See NL300 specifications for 355 nm beam | 154×210×128 | No | Should be used with H300SH |
| H300STH | Second and third harmonics generator | Port 1: 1064, 532 & 355 nm | N/A | 154×210×128 | Yes | |
| H300ST | 355 nm beam separator | Port 1: 355 nm<br>Port 2: residual 532 nm | See NL300 specifications for 355 nm beam | 154×160×128 | No | Recommended to use with H300STH |
| H300FHC | Fourth harmonic generator with 266 nm beam separator | Port 1: 266 nm<br>Port 2: residual 532 nm | See NL300 specifications for 266 nm beam | 154×290×128 | No | Should be used with H300SH |
| H300FiHC | Fifth harmonics generator with 213 nm beam separator | Port 1: 213 nm<br>Port 2: residual 1064, 532 & 266 nm | See NL300 specifications for 213 nm beam | 154×350×128 | No | |
| H300A1 | Attenuator for 1064 nm beam | Port 1: 1064 nm beam | Transmission in 5-90% range at 1064 nm | 154×210×128 | No | |
| H300A2 | Attenuator and beam separator for 532 nm beam | Port 1: 532 nm<br>Port 2: residual 532 nm | Transmission in 5-90% range at 532 nm | 154×210×128 | No | Should be used with H300SH |
| H300A3 | Attenuator and beam separator for 355 nm beam | Port 1: 355 nm<br>Port 2: residual 355 nm | Transmission in 5-90% range at 355 nm | 154×210×128 | No | Should be used with H300TH or H300STH |
| H300A4 | Fourth harmonic generator, beam sepa-rator and attenuator for 266 nm beam | Port 1: 266 nm<br>Port 2: residual 266 nm | Transmission in 5-90% range at 266 nm | 154×350×128 | No | Should be used with H300SH |



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## OPTIONS

- **Option -AW** – air-cooled power supply option. An adequate air conditioner should be installed in order to keep room temperature stable.
- **Harmonics generator options** – an extensive selection of harmonics generators up to 5th harmonics.
- **Attenuator options** allow a smooth change of laser pulse energy, while other laser pulse parameters, such as pulse duration, jitter, pulse-to-pulse stability, beam divergence and profile remain the same.

## OUTLINE DRAWINGS

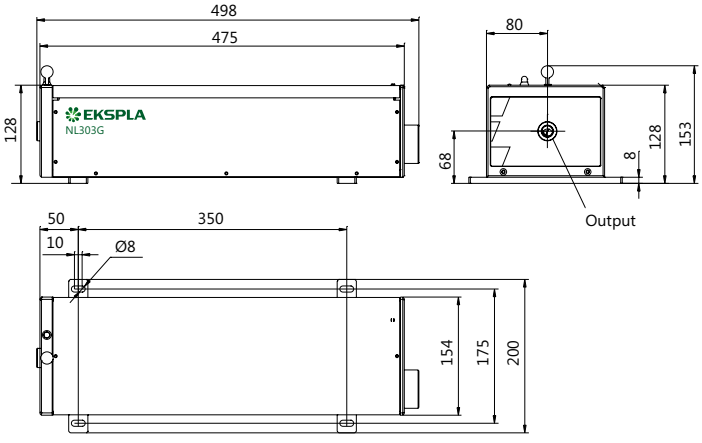



*Fig 1.* Typical NL300 series laser head outline drawing

## ORDERING INFORMATION

**NL303G-10-AW-H300SH-H300THC**

- Model
- Beam profile:
  HT → "hat top"
  G → for OPO pumping
- Pulse repetition rate in Hz
- Optional harmonic generator modules and other accessories
- Options:
  AW → water-air heat exchanger

# HARMONIC GENERATORS

## For NL300 Series Lasers

Nanosecond Q-switched lasers enable simple and cost effective laser wavelength conversion to shorter wavelengths through harmonics generation. EKSPLA offers a broad selection of wavelength conversion accessories for NL300 series lasers. The purpose of this guide is to help configure available harmonic generator and attenuator modules for NL300 series lasers for optimal performance.

The harmonics module uses a modular design that allows reconfiguration of laser output for the appropriate experiment wavelength.

A typical module houses a non-linear crystal together with a set of dichroic mirrors for separating the harmonic beam from the fundamental wavelength. Nonlinear crystals used for the purpose of wavelength conversion are kept at an elevated temperature in a thermo-stabilized oven.

Two or more modules can be joined together for higher harmonics generation: attaching one extra module to a second harmonic generator allows for the generation of 3rd or 4th harmonic wavelengths.

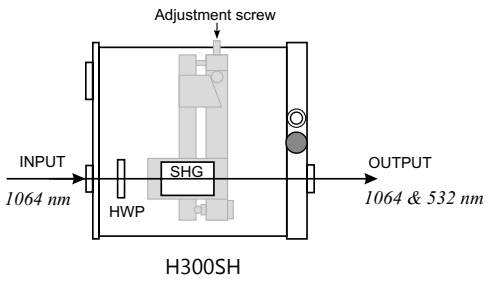
It should be noted that only modules with a single output port can be joined together: it is possible to attach a H300S module to a H300SH unit for 532 nm beam separation, or a H300FHC module for 4th harmonics generation (see detailed description below). Modules with two output ports (e.g., H300SHC) cannot be attached to extra units.

### FEATURES

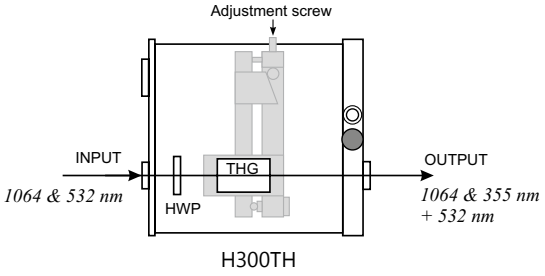
- *Compact harmonic modules*
- *Thermo stabilized crystals for long lifetime*
- *Dichroic mirrors*
- *AR coatings on crystals*
- *Phase matching by mechanical adjustment*
- *High conversion efficiency*
- *Wide selection of different configurations*

### H300SH, H300TH harmonics generators

H300SH or H300TH modules contain a SH or TH crystal with a half-wave plate for input polarization adjustment. The output of the H300SH module has both **532 nm** and **1064 nm** wavelengths; the output of the H300SH+H300TH modules also has a **355 nm** wavelength.



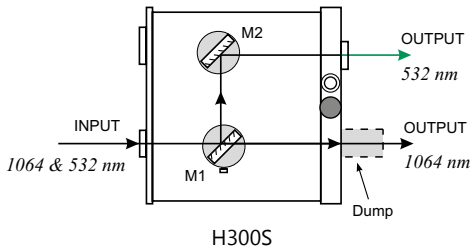

H300SH




H300TH

### H300S harmonics separator

The H300S module has two output ports for the separation of **1064 nm** and **532 nm** wavelengths.




H300S



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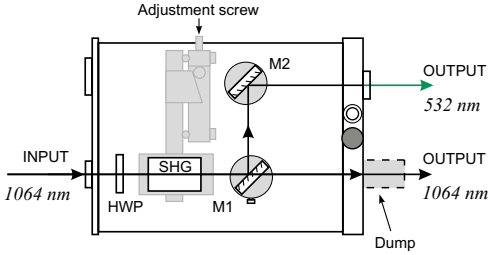
## H300SHC harmonics generator

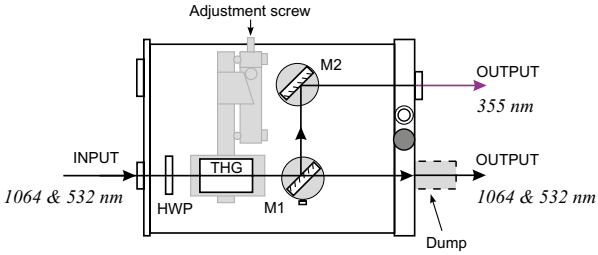
The most cost-effective solution for customers who need a **532 nm** wavelength only, the H300 SHC module combines a SHG crystal and beam separators and has two output ports for **532 nm** and **1064 nm** beams.




H300SHC

## H300THC harmonics generator

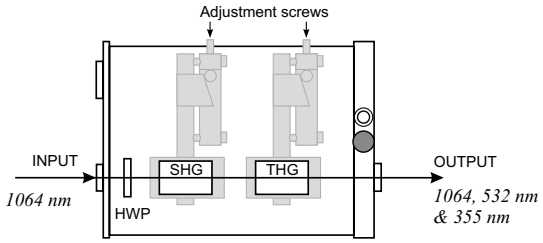
The H300THC module is a third harmonics generator and beam separator with two output ports for a 355 nm beam, and for a residual **532 nm + 1064 nm** beam. This module should be used with the H300SH module.




H300THC

## H300STH harmonics generator

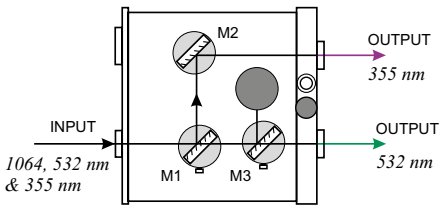
The H300STH module combined with a H300ST separator module is designed for customers who need a **355 nm** wavelength only. The H300STH module has an output port for **355 nm**, **532 nm** and **1064 nm** wavelengths, the H300ST module has two output ports for 355 nm and 532 nm wavelengths. In order to separate 355 nm this module should be used with H300ST.




H300STH

## H300ST harmonics separator

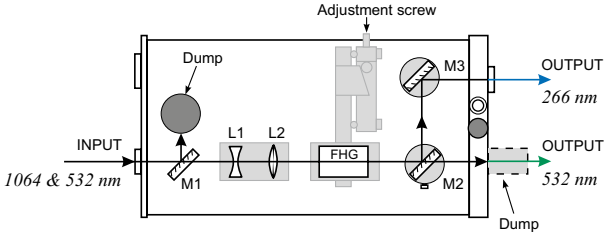
The H300ST module can be used for the separation of **355 nm** and/or **532 nm** beams from residual **1064 nm**, and can be used together with H300STH, H300TH or H300SH modules.




H300ST

## H300FHC harmonics generator

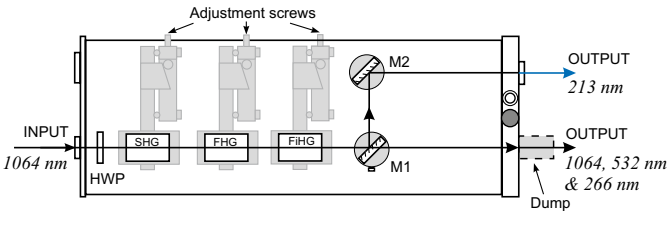
The H300FHC module is a fourth harmonics generator and beam separator for a 266 nm wavelength, with two output ports for a **266 nm** beam, and for a residual **532 nm** beam. This module should be used with the H300SH module.




H300FHC

## H300FiHC harmonics generator

The H300FiHC module is designed to produce a 5th harmonic output. As it requires only a 1064 nm input, the unit contains SH, FH and FiH crystals together with a beam separator for a **213 nm** beam.




H300FiHC

# ATTENUATORS

## For NL300 Series Lasers

NL300 series lasers offer several options for changing output pulse energy. The easiest option is to change the timing of the Q-switch opening relative to the flashlamp pump pulse. This option is a standard feature for all NL300 series lasers. A change in Q-switch timing, however, changes other laser pulse parameters along with the pulse energy.

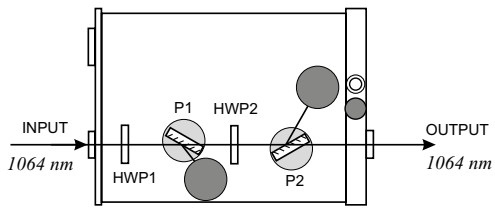
A decrease in pulse energy results in longer pulse duration, decreased pulse-to-pulse-stability, and possible changes in the spatial beam profile. For applications that require smooth adjustment of output pulse energy while keeping other parameters stable, EKSPLA offers H300Ax series attenuator modules.

### FEATURES

- *Compact design*
- *Motorized version is available*
- *Smooth adjustment of output pulse energy*

### H300A1 attenuator

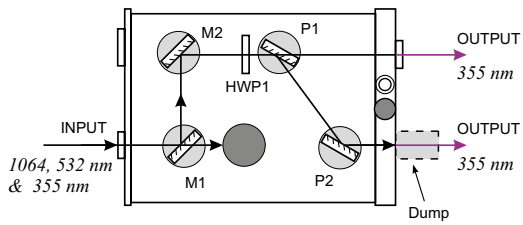
The H300A1 module is designed to attenuate a **1064 nm** beam. Optical layout includes half-wave plates HWP1, HWP2 and polarizers P1, P2 (see picture below). Rotation of the HWP2 half-wave plate changes the polarization of the laser beam and its transmission factor via the P2 polarizer.




H300A1

### H300A3 attenuator

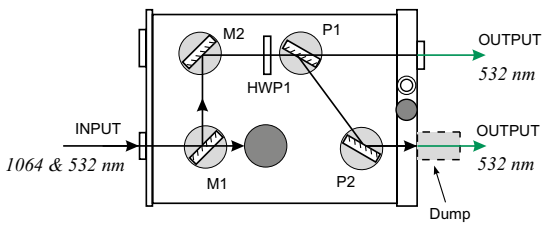
The H300A3 module, designed to attenuate a **355 nm** beam, combines an attenuator with a beam separator and should be used with the H300STH or H300TH modules.




H300A3

### H300A2 attenuator

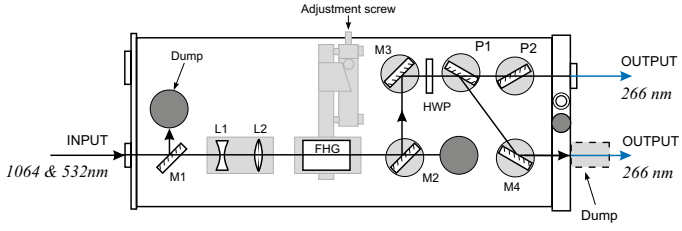
The H300A2 module, designed to attenuate a **532 nm** beam, combines an attenuator with a beam separator and should be used with the H300SH module.




H300A2

### H300A4 attenuator

The H300A4 module is designed to attenuate a **266 nm** beam. It combines a FH crystal, beam separator and attenuator and should be used instead of the H300FHC module for attenuation of a 266 nm beam.




H300A4



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# NL303D SERIES

## Double-Pulse Q-switched Lasers for PIV

### FEATURES

- ***Double-pulsed** output at 1064 nm, 532 nm, 355 nm or 266 nm*
- *Robust design allows easy switching between colors*
- *Control electronics allow operation from external trigger or internal trigger electronics*
- *Frame-delay (delay between pulses) variable from 30 ns to 7.5 ms*
- *Single power supply cabinet*
- *May be controlled by keypad or computer (RS232)*
- *LabView™ drivers are included*
- *Single output for 532 nm, 355 nm and 266 nm*
- *Separate output for 1064 nm*
- *Intelligent triggering:*
  - *Internal/external synchronization*
  - *Triggering for each laser independently*
  - *Single/double electrical pulse triggering*

Stable output specifications, intelligent triggering and easy operation make NL303D series nanosecond lasers an excellent choice for most liquid and many air-based PIV (particle image velocimetry) applications. Extremely low jitter of optical pulse with respect to sync pulse allows reliable synchronization with external equipment.

Optional double UV (355 nm) pulse models allow pumping of double-pulse optical parametric oscillators.

Operating convenience is achieved through versatile triggering capabilities and adjustable delay between pulses.

Simple and proven design allows offering of models for the most common as well as novel research needs. Excellent pulse energy stability and beam quality establish Ekspla lasers as ideal for tasks where high precision and exceptional performance are required.

Compact power supply and cooling units easily fit under tables thus saving valuable laboratory space.

For customer convenience the laser is controlled through either its RS232 type PC interface with LabView™ drivers (included) or a user-friendly remote control keypad. Both options ensure easy control of laser settings.

## SPECIFICATIONS [1]

| Model | NL301D | NL303D |
|---|---|---|
| Pulse energy | | |
| at 1064 nm | 2 × 400 mJ | 2 × 720 mJ |
| at 532 nm | 2 × 180 mJ | 2 × 340 mJ |
| at 355 nm | 2 × 100 mJ | 2 × 190 mJ |
| at 266 nm | 2 × 40 mJ | 2 × 90 mJ |
| Pulse energy stability (StdDev) | | |
| at 1064 nm | <1 % | |
| at 532 nm | <1.5 % | |
| at 355 nm | <3 % | |
| at 266 nm | <3.5 % | |
| Pulse repetition rate | 10 / 20 Hz [2] | |
| Pulse duration [3] | 3–6 ns | |
| Delay between pulses [4] | 30 ns–7.5 ms | |
| Power drift (StdDev) | ±2 % at 1064 nm | |
| Beam divergence [5] | <0.5 mrad | |
| Optical pulse jitter (StdDev) | ≤0.5 ns | |
| Focusability | <2x diffraction limit at 1064 nm | |
| Beam pointing stability | ±50 µrad at 266 nm | |
| Linewidth | <1.4 $cm^{-1}$ at 532 nm | |
| Beam profile | Top Hat in near field, near Gaussian in far field | |
| Beam diameter [6] | 6 mm | 8 mm |
| Polarization | horizontal, >90 % at 1064 nm | |
| **PHYSICAL CHARACTERISTICS** | | |
| Laser head (W × L × H) | 320 × 820 × 220 mm | |
| Power supply/cooling cabinet size (W × L × H) | 555 × 600 × 460 mm (water-water cooling) (MR-9)<br>555 × 600 × 660 mm (air-water cooling) (MR-12) | |
| Umbilical length | 2.5 m | |
| **OPERATING REQUIREMENTS** | | |
| Water consumption (max 20 °C) | <10 l/min | |
| Ambient temperature | 18–27 °C | |
| Relative humidity | 5–80 % (non-condensing) | |
| Power requirements | 208–230 V AC, single phase 60 Hz | |
| Power consumption | <3 kVA × 2 = 5 kVA | |

1) Specifications are subject to changes without advance notice.
2) 20 Hz is available, please inquire for detailed specifications.
3) FWHM at 1064 nm.
4) Variable by 125 ns step. Can be adjusted virtually to any value when externally triggered.
5) Full angle at FWHM level.
6) Measured at $1/e^2$ level.




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# NL740 SERIES

## Tunable Pulse Duration Nd:YAG Lasers


### FEATURES

- *Excellent temporal and spatial output mode stability*
- *Up to **100 mJ** output energy*
- *Up to **100 Hz** repetition rate*
- ***2–10 ns** pulse duration*
- *1064, 532 nm or 355 nm output wavelength*
- *Fibre front end output amplified in diode pumped regenerative amplifier*

The main feature of NL740 series is the output of ultra-stable tunable duration (2 – 10 ns) narrow bandwidth nanosecond pulses based on temporally driven CW diode laser seeder and amplification stages.

Start of the system is the single mode DFB laser with temporal output power modulator. Then light is amplified in diode pumped regenerative amplifier in order to reach energy sufficient to amplify in double pass diode pumped amplifiers. Power amplifier is a chain of double pass amplifiers where pulse is amplified up to required energy. Before amplification spatial beam shaping is employed in order to get flat top shape at the output. The harmonic generators are based on angle tuned nonlinear crystals placed in a heater.

### APPLICATIONS

- *Metrology*
- *Front end for power amplifiers*
- *Ti: Sapphire pumping*
- *Laser peening – material hardening by laser-induced shock wave*
- *Plasma and shock physics*

## SPECIFICATIONS [1]

| Model | NL740 | NL742 |
|---|---|---|
| Pulse energy (rectangular pulse in time domain 5 ns FWHM) | | |
| at 1064 nm | 2 mJ | 100 mJ |
| at 532 nm [2] | NA | 50 mJ |
| at 355 nm [2] | NA | 30 mJ |
| Pulse energy stability (StdDev) [3] | | |
| at 1064 nm | < 0.5 % | |
| at 532 nm | < 1.0 % | |
| at 355 nm | < 1.5 % | |
| Power drift [4] | ± 2 % | |
| Pulse duration [5] | 3 – 10 ns | |
| Repetition rate | 100 Hz | |
| Polarization at 1064 nm | vertical, > 98 % | |
| Optical pulse jitter [6] | < 150 ps | |
| Linewidth | <0.1 $cm^{-1}$ | |
| Beam profile | Gaussian | Hat-Top (at laser output), without diffraction rings |
| Typical beam diameter [7] | ~2 mm | ~5 mm |
| Beam divergence [8] | 1.0 mrad | 0.7 mrad |
| Beam pointing stability (StdDev) | ± 25 µrad | |
| **PHYSICAL CHARACTERISTICS** | | |
| Laser head (W × L × H) | 456 × 1031 × 249 mm | 600 × 1200 × 330 mm |
| Power supply unit (W × L × H) | 85 × 170 × 41 mm | 520 × 500 × 210 mm |
| Umbilical length | 2.5 m ( other length on request ) | |
| **OPERATING REQUIREMENTS** | | |
| Water consumption (max 20° C) | air-cooled | air-cooled /< 4 l/min |
| Ambient temperature | stabilized; from range 18–25 °C | |
| Relative humidity | 20–80 % (non-condensing) | |
| Power requirements [9] | 90–240 V AC, single phase 50/60 Hz | |
| Power consumption | < 200 W | < 1.5 kW |

1) Due to continuous improvement, all specifications are subject to change. Parameters marked typical are illustrative; they are indications of typical performance and will vary with each unit we manufacture. Unless stated otherwise, all specifications are measured at 1064 nm.

2) Harmonics outputs are not simultaneous; only single wavelength beam is present at the output at once. Manual reconfiguration is required to switch wavelength.

3) Standard deviation value averaged from pulses, emitted during 30 sec time interval after 20 minutes of warm-up.

4) Deviation from average value measured over 8 hours of operation when room temperature variation is less than ±2 °C.

5) FWHM. Measured with photodiode with 100 ps rise time and oscilloscope with 600 MHz bandwidth.

6) Standard deviation value, measured with respect to triggering pulse.

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

8) Full angle measured at the $1/e^2$ level at 1064 nm.

9) Mains voltage should be specified when ordering.


## PERFORMANCE

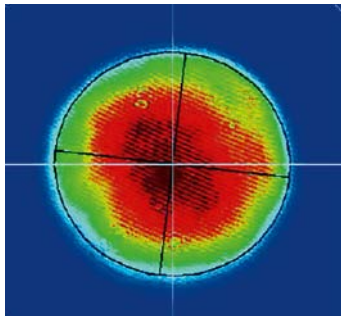

*Fig 1.* Typical NL740 near field beam profile at 532 nm



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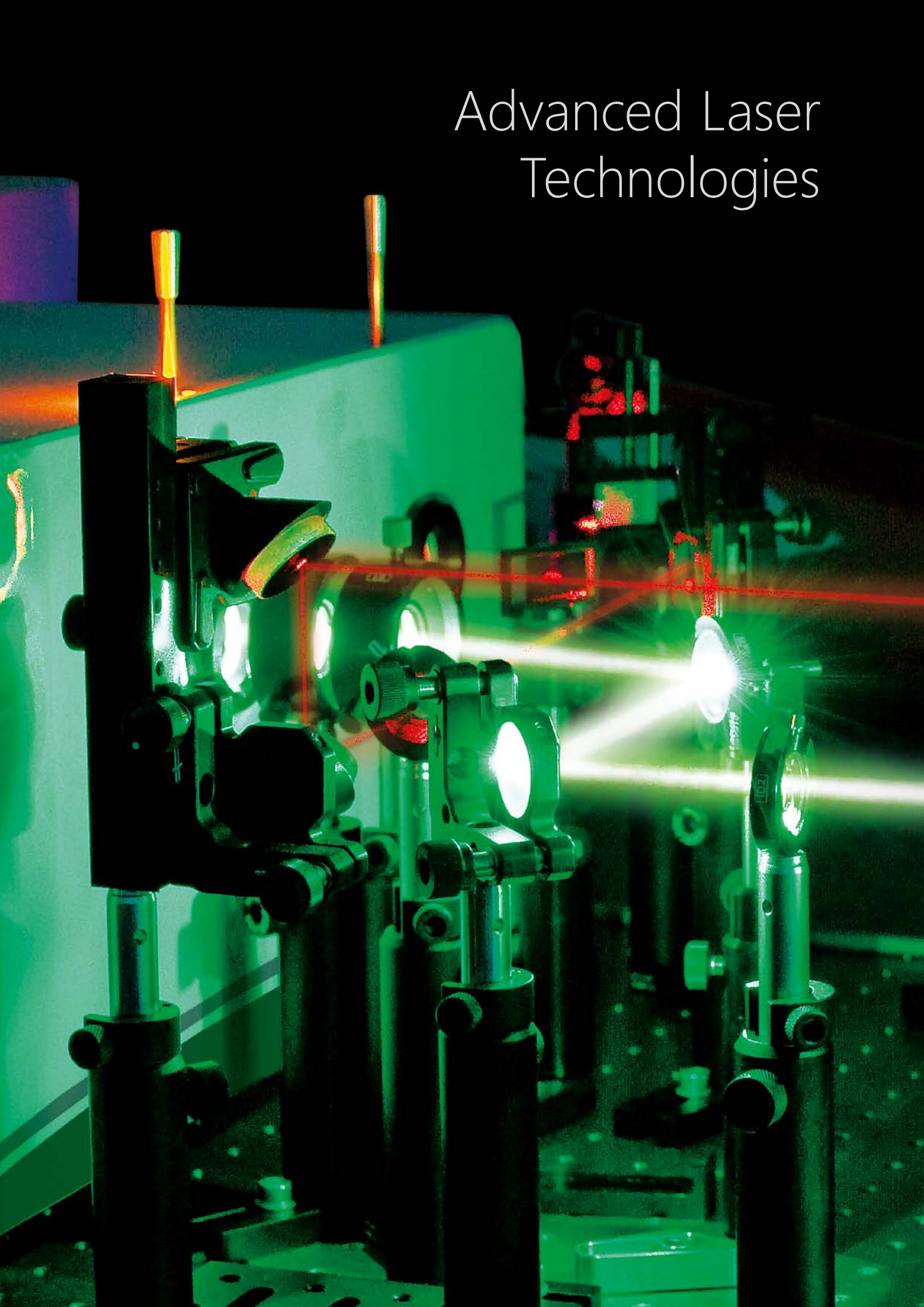
# Advanced Laser Technologies



Integrated pump laser and OPO enable customers to save physical space and reduce maintenance costs.
Photo: manufacturing of NT series laser.

# Nanosecond Tunable Lasers

NT series tunable lasers offer tunable, automated wavelength output from UV to IR out of the one small-footprint box. Integrated into a single compact housing, the diode or flash-lamp pumped Q-switched Nd:YAG laser and OPO offer hands-free, no-gap tuning across the specified range.

The output wavelength can be set from control pad with backlit display that is easy to read even while wearing laser safety glasses. Alternatively, the laser can be controlled also from personal computer through USB (RS-232 is optional) interface using supplied LabVIEW™ drivers.

Most of the pump lasers do not require water for cooling, thus further reducing running and maintenance costs. A built-in OPO pump energy monitor allows monitoring of pump laser performance without the use of external power meters.

Wide range of available options, accessories and modifications enable to tailor laser to better fit for your requirement. High conversion efficiency, stable output, easy maintenance, robust design and compact size make NT series systems an excellent choice for many applications including laser induced fluorescence, flash photolysis, photobiology, metrology, remote sensing and many others.

In the year 2011 the NT series systems has received the Photonics Oscar – Prism Award for Photonics Innovation in Scientific lasers category.

## 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 | Repetition rate, up to | Pump laser | Special feature | Page |
|---|---|---|---|---|---|
| **NT230** | 193–2600 nm | 100 Hz | Diode pumped solid state | High, up to 10 mJ pulse energy from OPO | 88 |
| **NT235** | 335–2600 nm | 100 Hz | Diode pumped solid state | Compact and rugged, tailored for OEM applications | 91 |
| **NT242** | 195–2600 nm | 1000 Hz | Diode pumped solid state | High output power from OPO | 94 |
| **NT200** | 335–12000 nm | 10000 Hz | Diode pumped solid state | Wide range of modifications to tailor for specific applications | 97 |
| **NT342** | 192–2600 nm | 30 Hz | Flash-lamp pump laser | Wide range of modifications to tailor for specific applications | 100 |
| **NT350** | 670–2600 nm | 30 Hz | Flash-lamp pump laser | High output pulse energy | 104 |
| **NT370** | 2500–18000 nm | 20 Hz | Flash-lamp pump laser | Wide IR tuning range | 107 |

# NT230 SERIES

## High Energy Broadly Tunable DPSS Lasers


NT230 series lasers deliver high up to 10 mJ energy pulses at 100 Hz pulse repetition rate, tunable over a broad spectral range. Integrated into a single compact housing, the diode pumped Q-switched Nd:YAG laser and Optical Paramteric Oscillator (OPO) offers hands-free, no-gap tuning from 193 to 2600 nm. With its 100 Hz repetition rate, the NT230 series laser establishes itself as a versatile tool for many laboratory applications, as laser induced fluorescence, flash photolysis, photobiology, metrology, remote sensing, etc.

Due to the innovative diode-pumped design, NT230 series lasers features maintenance-free laser operation for an extended period of time and improved stability (compared with flash-lamp pumped counterparts).

NT230 series systems can be controlled from a user-friendly remote control pad or/and a computer using supplied LabVIEW™ drivers. The control pad allows easy control of all parameters and features on a backlit system display that is easy to read even with laser safety eyewear.

Due to DPSS pump source, the laser requires little maintenance. It is cooled by a built-in chiller, which further reduces running costs.
An OPO pump energy monitor allows monitoring of pump laser performance. A standard feature includes a separate output port for the 355 nm pump beam.

### FEATURES

- *Integrates DPSS pump laser and OPO into a single housing*
- *Hands-free no-gap wavelength tuning from **193** to **2600 nm***
- *High, up to **10 mJ** pulse energy from OPO*
- ***100 Hz** pulse repetition rate*
- *More than **1.5 mJ** output pulse energy in UV*
- *Less than 5 $cm^{-1}$ linewidth*
- ***3–6 ns** pulse duration*
- *Remote control pad*
- *PC control via USB port (RS232 is optional) and LabVIEW™ drivers*
- *Optional separate output port for 355/532/1064 nm beam*

### APPLICATIONS

- *Laser-induced fluorescence*
- *Flash photolysis*
- *Photobiology*
- *Remote sensing*
- *Metrology*
- *Non-linear spectroscopy*
- *Medical*
- *Photo acoustic imaging*

### Accessories and optional items

| Option | Features |
|---|---|
| -SH | Tuning range extension in UV range (210–409 nm) by second harmonics generation |
| -SF | Tuning range extension in 300–409 nm range by sum-frequency generation |
| -SH/SF | Tuning range extension in 210–409 nm range by combining second harmonics and sum-frequency generator outputs for maximum possible pulse energy |
| -SCU | Spectral filtering accessory for improved spectral purity of pulses |
| -H, -2H | 1064 nm or 532 nm output via separate port |
| -FC | Fiber coupled output in 350–700 nm range |
| -DUV | Deep UV option in 193–209.9 nm range |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## SPECIFICATIONS [1]

| Model | NT230-50-SH/SF | NT230-100-SH/SF |
|---|---|---|
| **OPO** | | |
| Wavelength range | | |
| Signal | 405–709 nm | |
| Idler | 710–2600 nm | |
| SH or SF | 210–405 nm [2] | |
| DUV | 193–209.9 nm [3] | |
| Pulse energy [4] | | |
| OPO | 10 mJ | |
| SH and SF | 1.5 mJ at 260 nm and 340 nm | |
| DUV | 0.2 mJ at 200 nm | |
| Pulse repetition rate [5] | 50 Hz [6] | 100 Hz |
| Pulse duration [7] | 3–6 ns | |
| Linewidth [8] | <5 $cm^{-1}$ | |
| Scanning step | | |
| Signal | 0.1 nm | |
| Idler | 1 nm | |
| SH and SF | 0.05 nm | |
| Polarization | | |
| Signal | horizontal | |
| Idler | vertical | |
| SH and SF | vertical | |
| OPO beam divergence [9] | <2 mrad | |
| Typical beam diameter [10] | 4 mm | |
| **PUMP LASER** | | |
| Pump wavelength [11] | 355 / 1064 nm | |
| Max pump pulse energy [12] | 35 / 100 mJ | |
| Pulse duration [7] | 6–8 ns at 1064 nm | |
| **PHYSICAL CHARACTERISTICS** | | |
| Unit size (W × L × H) | 451 × 640 × 162 mm | |
| Power supply size (W × L × H) | 365 × 395 × 290 mm | |
| Umbilical length | 2.5 m | |
| **OPERATING REQUIREMENTS** | | |
| Cooling | build-in chiller | |
| Room temperature | 15–30 °C | |
| Relative humidity | 20–80 % (non-condensing) | |
| Power requirements | 90–240 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 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.

2) Tuning range of 210–405 nm is provided by SH/SFG option.

3) Tuning range of 193–209.9 nm is provided by DUV option.

4) See tuning curves for typical outputs at other wavelengths.

5) Inquire for other pulse repetition rates.

6) Variable repetition rate. Please contact Ekspla for more details.

7) FWHM measured with photodiode featuring 1 ns rise time and 300 MHz bandwidth oscilloscope.

8) Linewidth is <8 $cm^{-1}$ for 210–405 nm range.

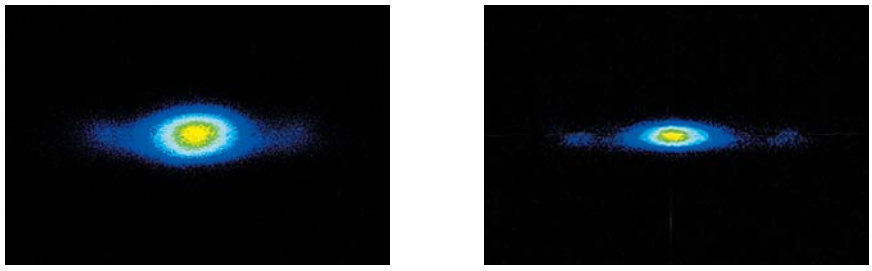
9) Full angle measured at the FWHM level at 450 nm.

10) Beam diameter is measured at 450 nm at the $1/e^2$ level and can vary depending on the pump pulse energy.

11) Separate output port for the 3rd harmonics beam is standard. Output ports for other harmonics are optional.

12) The laser max pulse energy will be optimized for best OPO performance. The actual pump laser output can vary with each unit we manufacture.

## PERFORMANCE



Near field Far field

*Fig 1.* Typical beam profiles of NT230 series lasers at 500 nm

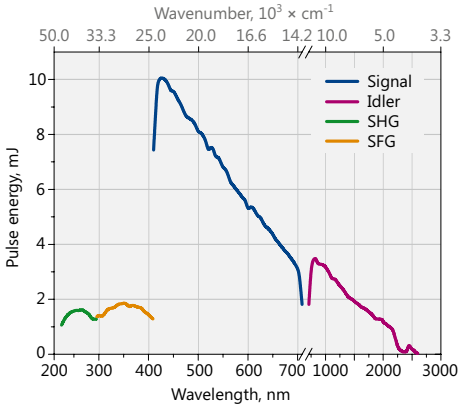



*Fig 2.* Typical output pulse energy of NT230 laser

## OUTLINE DRAWINGS

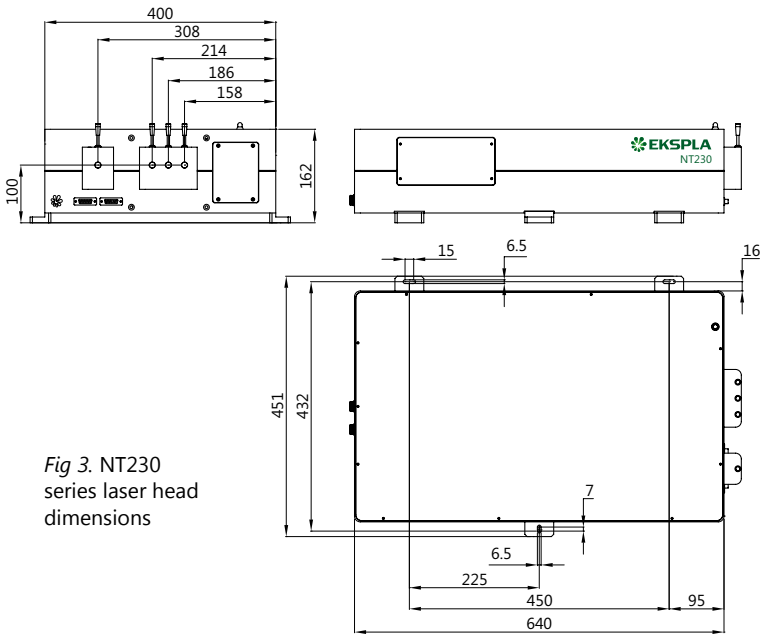



*Fig 3.* NT230 series laser head dimensions

## ORDERING INFORMATION

**NT230-50-SH-H/2H/SCU**

Model

Pulse repetition rate in Hz

Options:
H → extra 1064 nm output
2H → extra 532 nm output
SCU → spectral filtering accessory

Optional tuning range extension:
SH → 210–409 nm
SFG → 300–409 nm
SH/SFG → 225–409 nm



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# NT235 SERIES

**Tunable**
**Wavelength**
**NIR Range**
**DPSS Laser**


NT235 series lasers produce high up to 15 mJ energy pulses at 100 Hz pulse repetition rate, tunable over a broad spectral range. Integrated into a single compact and robust housing, the diode pumped only Q-switched Nd:YAG laser and OPO offers hands-free, tuning from 335 to 2600 nm. With its 100 Hz repetition rate, the NT235 series laser establishes itself as a versatile tool for many laboratory applications, including photo acoustic imaging, laser induced fluorescence, flash photolysis, photobiology, metrology, etc.

Diode-pumped design, gives maintenance-free laser operation for an extended period of time and improved stability (compared with flash-lamp pumped counterparts). It is cooled by a build-in chiller, which further reduces running costs. OPO pump energy monitor allows monitoring of pump laser performance without the use of external power meters.

NT235 series systems controlled from a user-friendly remote control pad or/and a computer. The control pad allows easy control of all parameters and features on a backlit display that is easy to read even with laser safety eyewear.

## FEATURES

- *Integrated DPSS pump laser and OPO into a single housing*
- *Hands-free wavelength tuning from 335 to 2600 nm*
- *High, up to **15 mJ** pulse energy from OPO*
- ***100 Hz** pulse repetition rate*
- *More than **3 mJ** output pulse energy in UV*
- *Less than 10 $cm^{-1}$ linewidth*
- *3–6 ns pulse duration*
- *Remote control pad*
- *PC control via USB port and LabVIEW™ drivers*
- *Compact and robust design*

## APPLICATIONS

- *Laser-induced fluorescence*
- *Flash photolysis*
- *Photobiology*
- *Photo acoustic imaging*
- *Metrology*

## SPECIFICATIONS [1)]

| Model | NT235-SH |
|---|---|
| **OPO** | |
| Wavelength range | |
| Signal | 670–1063 nm |
| Idler | 1064–2600 nm |
| SH | 335–532 nm [2)] |
| Pulse energy [3)] | |
| OPO | 15 mJ |
| SH | 3 mJ at 400 nm |
| Pulse repetition rate [4)] | 100 Hz |
| Pulse duration [5)] | 3–6 ns |
| Linewidth | <10 $cm^{-1}$ |
| Scanning step | |
| Signal | 0.1 nm |
| Idler | 1 nm |
| SH | 0.05 nm |
| Polarization | |
| Signal | horizontal |
| Idler | vertical |
| SH | horizontal |
| OPO beam divergence | <2.5 mrad [6)] |
| Typical beam diameter | 4 mm [7)] |
| **PUMP LASER** | |
| Pump wavelength | 532 nm |
| Max pump pulse energy | 50 mJ [8)] |
| Pulse duration | 5–7 ns at 1064 nm |
| **PHYSICAL CHARACTERISTICS** | |
| Unit size (W × L × H) | 360 × 450 × 150 mm |
| Power supply size (W × L × H) | 510 × 400 × 295 mm |
| Umbilical length | 2.5 m |
| **OPERATING REQUIREMENTS** | |
| Cooling | built-in chiller |
| Room temperature | 18–27 °C |
| Relative humidity | 20–80 % (non-condensing) |
| Power requirements | 90–240 V AC, single phase 50/60 Hz |
| Power consumption | < 1 kVA |

1) Due to continuous improvements all specifications are subject to change. 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 800 nm.

2) Tuning range of 335–532 nm is provided by SH option.

3) See tuning curves for typical outputs at other wavelengths.

4) Inquire for other pulse repetition rates.

5) FWHM measured with photodiode featuring 1 ns rise time and 300 MHz bandwidth oscilloscope.

6) Full angle measured at FWHM level 800 nm.

7) Beam diameter is measured at 800 nm at the FWHM level and can vary depending on the pump pulse energy.

8) The laser max pulse energy will be optimized for best OPO performance. The actual pump laser output can vary with each unit we deliver.




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## ACCESSORIES AND OPTIONAL ITEMS

Optional items and accessories allows the laser to be configured for any application:

- Tuning range extension in UV range (335–531 nm) by second harmonics generation
- Fiber coupled output in 350–2000 nm range (please inquire for precise fiber coupler selection)
- Attenuator option for 670–2600 nm range.

## PERFORMANCE

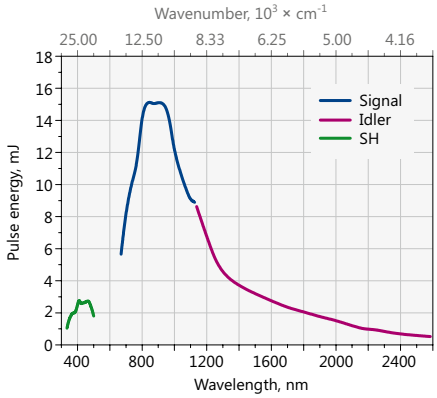


*Fig 1.* Typical output energy from NT235-100 series tunable wavelength system

## OUTLINE DRAWINGS

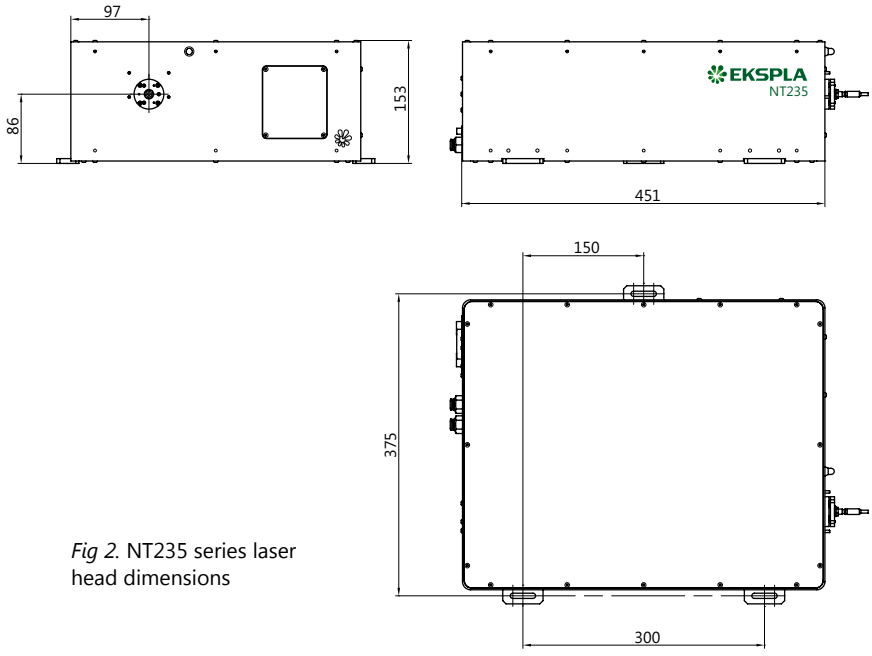


*Fig 2.* NT235 series laser head dimensions

# NT242 SERIES

## Broadly Tunable kHz Pulsed DPSS Lasers


NT242 series lasers produce pulses at an unprecedented 1 kHz pulse repetition rate, tunable over a broad spectral range. Integrated into a single compact housing, the diode pumped Q-switched Nd:YAG laser and OPO offers hands-free, no-gap tuning from 195 to 2600 nm. With its 1000 Hz repetition rate, the NT242 series laser establishes itself as a versatile tool for many laboratory applications, including laser induced fluorescence, flash photolysis, photobiology, metrology, remote sensing, etc.

NT242 series systems can be controlled from a user-friendly remote control pad or/and a computer using supplied LabVIEW™ drivers. The control pad allows easy control of all parameters and features on a backlit display that is easy to read even with laser safety eyewear.

Thanks to a DPSS pump source, the laser requires little maintenance. It is cooled by a stand alone chiller, which further reduces running costs. A built-in OPO pump energy monitor allows monitoring of pump laser performance without the use of external power meters. A standard feature includes a separate output port for the 355 nm pump beam.

### FEATURES

- *Integrates DPSS pump laser and OPO into a single housing*
- *Hands-free no-gap wavelength tuning from **195** to **2600 nm***
- ***1000 Hz** pulse repetition rate*
- *More than **40 μJ** output pulse energy in UV*
- *Less than 5 $cm^{-1}$ linewidth*
- ***3–6 ns** pulse duration*
- *Remote control pad*
- *PC control via USB port (RS232 is optional) and LabVIEW™ drivers*
- *Separate output for the OPO pump beam (355 nm)*

### APPLICATIONS

- *Laser-induced fluorescence*
- *Flash photolysis*
- *Photobiology*
- *Remote sensing*
- *Metrology*
- *Non-linear spectroscopy*
- *Other laser spectroscopy applications*

### Accessories and optional items

| Option | Features |
|---|---|
| -SH | Tuning range extension in UV range (210–355 nm) by second harmonics generation |
| -SF | Tuning range extension in 300–405 nm range by sum-frequency generation |
| -SH/SF | Tuning range extension in 210–405 nm range by combining second harmonics and sum-frequency generator outputs for maximum possible pulse energy |
| -SCU | Spectral filtering accessory for improved spectral purity of pulses |
| -H, -2H | 1064 nm or 532 nm output via separate port |
| -DUV | Deep UV option in 195–209.9 nm range |


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## SPECIFICATIONS [1]

| Model | NT242 | NT242-SH | NT242-SF | NT242-SH/SF-DUV |
|---|---|---|---|---|
| **OPO** | | | | |
| Wavelength range | | | | |
| Signal | 405–709 nm | | | |
| Idler | 710–2600 nm | | | |
| SH and SF | — | 210–405 nm [2] | 300–405 nm [2] | 210–405 nm [2] |
| DUV | — | | | 195–209.9 nm |
| Pulse energy [3] | | | | |
| OPO | 450 µJ | | | |
| SH and SF | — | 40 µJ at 240 nm | 40 µJ at 320 nm | 40 µJ at 320 nm |
| DUV | — | | | 1 µJ at 200 nm |
| Pulse repetition rate [4] | 1000 Hz | | | |
| Pulse duration [5] | 3–6 ns | | | |
| Linewidth [6] | <5 $cm^{-1}$ | | | |
| Scanning step | | | | |
| Signal | 0.1 nm | | | |
| Idler | 1 nm | | | |
| SH and SF | — | 0.05 nm | | — |
| DUV | — | | | 0.05 nm |
| Polarization | | | | |
| Signal | horizontal | | | |
| Idler | vertical | | | |
| SH and SF | — | vertical | | — |
| DUV | — | | | vertical |
| Typical beam diameter [7] | 2.5 mm | | | |
| **PUMP LASER** | | | | |
| Pump wavelength [8] | 355 nm | | 355 / 1064 nm | |
| Max pump pulse energy [9] | 3 mJ | | 3 / 1 mJ | |
| Pulse duration [5] | 6–8 ns at 1064 nm | | | |
| **PHYSICAL CHARACTERISTICS** | | | | |
| Unit size (W × L × H) | 455 × 1030 × 260 mm | | | |
| Power supply size (W × L × H) | 365 × 395 × 290 mm | | | |
| Umbilical length | 2.5 m | | | |
| **OPERATING REQUIREMENTS** | | | | |
| Cooling | stand-alone chiller | | | |
| Room temperature | 15–30 °C | | | |
| Relative humidity | 20–80 % (non-condensing) | | | |
| Power requirements | 90–240 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 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.

2) Tuning range of 210–405 nm is provided by SH/SF option.

3) See tuning curves for typical outputs at other wavelengths.

4) Inquire for other pulse repetition rates.

5) FWHM measured with photodiode featuring 1 ns rise time and 300 MHz bandwidth oscilloscope.

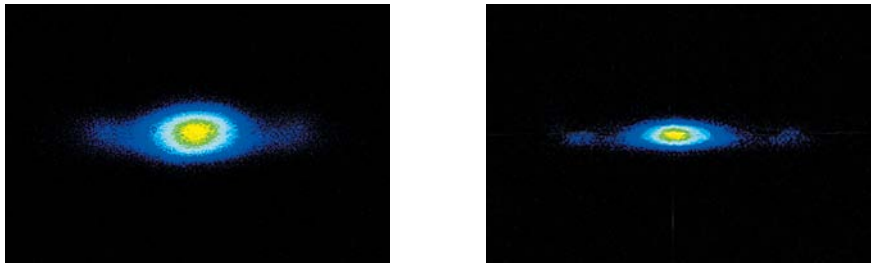
6) Linewidth is <8 $cm^{-1}$ for 210–405 nm range and <10 $cm^{-1}$ for 195–209 nm.

7) Beam diameter is measured at 450 nm at the $1/e^2$ level and can vary depending on the pump pulse energy.

8) Separate output port for the 3rd harmonics beam is standard. Output ports for other harmonics are optional.

9) The laser max pulse energy will be optimized for best OPO performance. The actual pump laser output can vary with each unit we manufacture.

## PERFORMANCE



Near field Far field

*Fig 1.* Typical beam profiles of NT242 series lasers at 500 nm

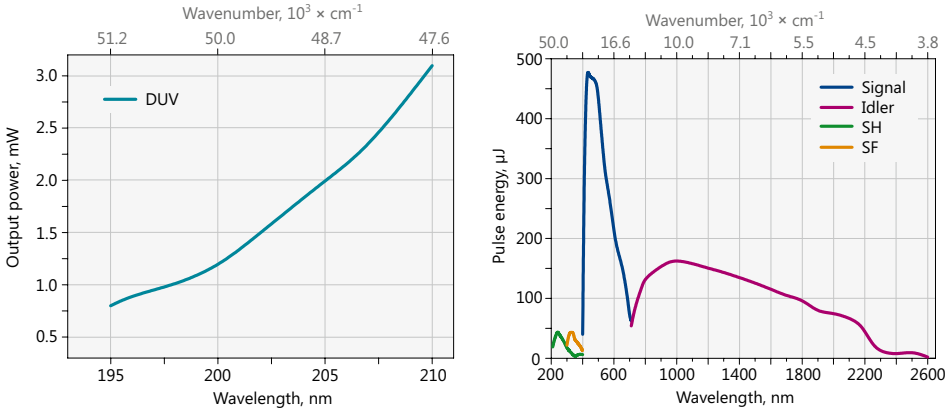



*Fig 2.* Typical output pulse energy of NT242 series tunable laser

## OUTLINE DRAWINGS

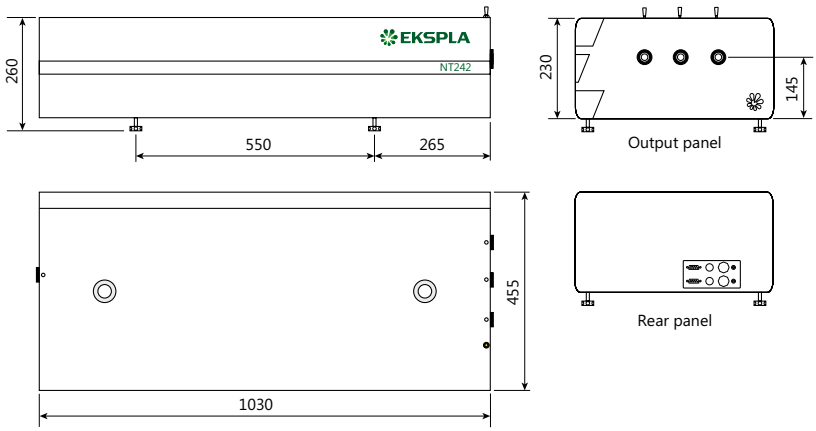



*Fig 3.* NT242 series laser head dimensions

## ORDERING INFORMATION

**NT242-SH-1K-2H/3H/SCU**

Model

Optional tuning range extension:
SH → 210–405 nm
SF → 300–405 nm
SH/SF → 210–405 nm
DUV → 195–209.9 nm

Pulse repetition rate in kHz:
1K=1 kHz

Options:
H → extra 1064 nm output
2H → extra 532 nm output
SCU → spectral filtering accessory



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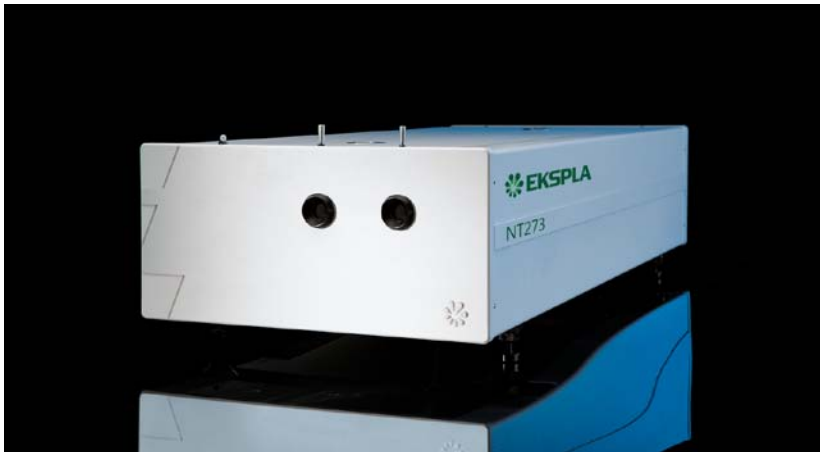
# NT200 SERIES

## Tunable Wavelength NIR-IR Range DPSS Lasers




NT200 series tunable laser systems integrates into a single compact housing a nanosecond Optical Parametric Oscillator (OPO) and Diode-Pumped Solid–State (DPSS) Q-switched pump laser.

Diode pumping enables fast data acquisition at high pulse repetition rates up to 10 kHz (depending on model) while avoiding frequent flashlamp changes that are common when flashlamp pumped lasers are used.

Most of the pump lasers do not require water for cooling, thus further reducing running and maintenance costs.

All lasers feature motorized tuning across the specified tuning range. The output wavelength can be set from control pad with backlit display that is easy to read even while wearing laser safety glasses. Alternatively, the laser can be controlled also from personal computer through USB (RS-232 is optional) interface using supplied LabVIEW™ drivers.

High conversion efficiency, stable output, easy maintenance and compact size make our systems excellent choice for many applications.

### FEATURES

- *Integrates DPSS pump laser and OPO into single housing*
- *Separate output ports for the pump laser and OPO beams*
- *OPO output wavelength range from **335 nm** to **12000 nm***
- *Pulse repetition rates up to **10 kHz***
- *Narrow linewidth*
- *Hands-free tuning*
- ***6-9 ns** pulse duration of pump laser*
- *Remote control pad*
- *PC control via USB (RS-232 is optional) and LabVIEM™ drivers*

### APPLICATIONS

- *Laser-induced fluorescence*
- *Photolysis*
- *IR spectroscopy*
- *Photobiology*
- *Remote sensing*
- *Metrology*
- *Gas spectroscopy*
- *Other laser spectroscopy applications*

### NT200 series available models

| Model | Features |
|---|---|
| NT252 | Highest pulse energy in near IR range, high efficiency second harmonic generator |
| NT253 | Variable pulse repetition rate in 0 – 10 kHz range, 700 – 900 nm and 1300 – 2200 nm tuning range |
| NT273 | Fixed wavelength OPO producing eye-safe output at 1572 nm |
| NT273-XIR | Tunable output in mid to far-IR range from 4100 to 12000 nm |
| NT277 | High pulse repetition rate OPO producing tunable output in 2500 – 4475 nm spectral range |

## SPECIFICATIONS [1]

| Model | NT252 | NT253-10K | NT273 | NT273-XIR | NT277 |
|---|---|---|---|---|---|
| **OPO** | | | | | |
| Wavelength range | | | | | |
| Signal | 670–1063 nm | 700–900 nm | 1572 nm | — | |
| Idler | 1064–2600 nm | 1300–2200 nm | 3293 nm | 4500–12000 nm [2] | 2500–4475 nm |
| SH or SF | 335–531 nm | 350–450 nm | — | | |
| Pulse energy [3] | | | | | |
| OPO | 900 µJ at 800 nm | 20 µJ at 800 nm | 400 µJ at 1572 nm | 20 µJ at 7000 nm | 150 µJ at 3000 nm |
| SH or SF | 180 µJ at 400 nm | 2 µJ at 400 nm | — | | |
| Pulse repetition rate [4] | 1000 Hz | 0–10 kHz | 0–1000 Hz [5] | 1000 Hz | 1000 Hz [5] [6] |
| Linewidth [7] | <8 $cm^{-1}$ | <20 $cm^{-1}$ | <3 $cm^{-1}$ | <6 $cm^{-1}$ | 10–150 $cm^{-1}$ [8] |
| Scanning step | | | | | |
| Signal | 0.1 nm | | — | | |
| Idler | 1 nm | | — | 1 nm | 1 nm |
| SH or SF | 0.05 nm | | — | | |
| Polarization | | | | | |
| Signal | horizontal | vertical | vertical | — | |
| Idler | vertical | | horizontal | horizontal | vertical |
| SH or SF | horizontal | | — | | |
| Typical beam diameter [9] [10] | 2.5 mm | | 2 mm | 4 mm | 4 mm |
| **PUMP LASER** | | | | | |
| Pump wavelength [11] | 532 nm | | 1064 nm | | |
| Max pump pulse energy [12] | 4.5 mJ | 150 µJ | 1.9 mJ | | 4 mJ |
| Pulse duration [13] | <8 ns | <10 ns | <9 ns | | |
| Beam quality | fit to Gaussian >90% | | | | |
| Pulse energy stability (StdDev) | <3 % | | <1 % | | |
| **PHYSICAL CHARACTERISTICS** | | | | | |
| Unit size (W × L × H) | 453 × 1030 × 274 mm | 320 × 800 × 120 mm | 305 × 820 × 270 mm | 305 × 910 × 270 mm | |
| Power supply size (W × L × H) | 365 × 392 × 289 mm | 472 × 461 × 289 mm | 365 × 392 × 289 mm | | |
| Umbilical length | 2.5 m | | | | |
| **OPERATING REQUIREMENTS** | | | | | |
| Cooling | stand-alone chiller | air | | | |
| Room temperature | 15–30 °C | | | | |
| Relative humidity | 20–80 % (non-condensing) | | | | |
| Power requirements | 90–240 V AC, single phase 50/60 Hz | | | | |
| Power consumption | <1 kVA | <0.5 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.

2) Available wavelength range. Custom tuning ranges are available.

3) Inquire about tuning curves for typical outputs at other wavelengths.

4) Inquire for other pulse repetition rates. For some models up to 20 kHz PRR is possible.

5) 500 Hz version is available for higher pulse energy.

6) 100 kHz version is available. Please contact Ekspla for more details.

7) In signal range.

8) <10 $cm^{-1}$ option is available for whole tuning range.

9) Measured at the wavelength indicated in the "Pulse energy" specification row.

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

11) Separate output port for the pump beam is standard. Output ports for other available harmonics are optional.

12) The laser max pulse energy will be optimized for best OPO performance. The actual pump laser output can vary with each unit we manufacture.

13) FWHM measured with photodiode featuring 1 ns rise time and 300 MHz bandwidth oscilloscope.

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## PERFORMANCE

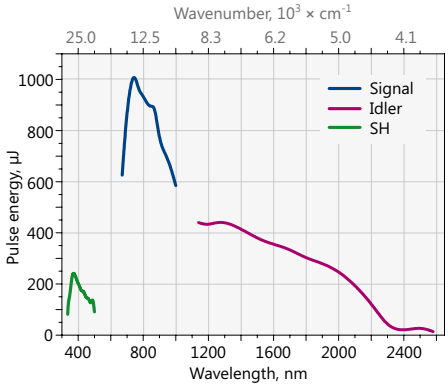



*Fig 1.* Typical output pulse energy of the NT252-SH tunable laser

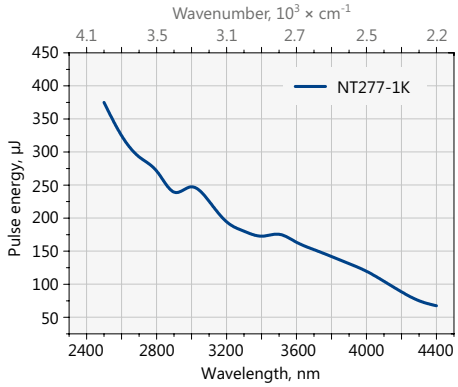



*Fig 2.* Typical output pulse energy of the NT277 tunable laser

## OUTLINE DRAWINGS

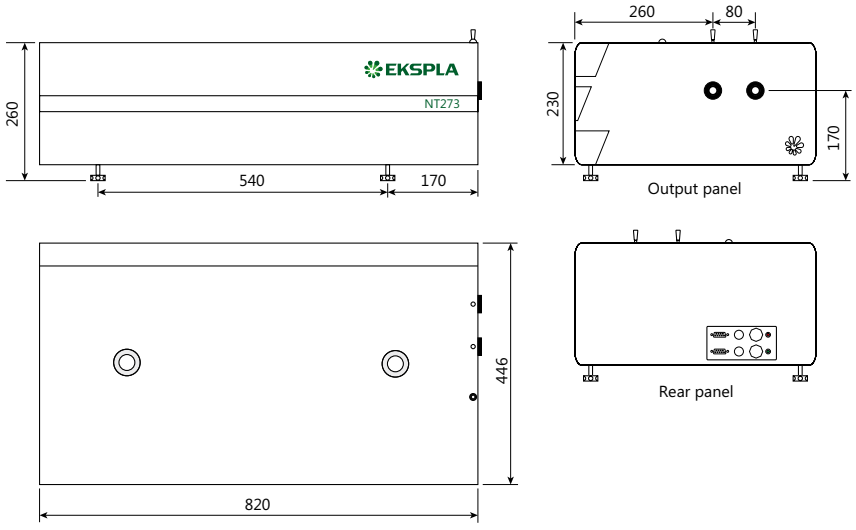



*Fig 3.* NT273 series laser head dimensions

## ORDERING INFORMATION

**NT253A-SH-0.5K-2H**

Model:
NT24x → 355 nm pumped
NT25x → 532 nm pumped
NT27x → 1064 nm pumped

Output pulse energy level

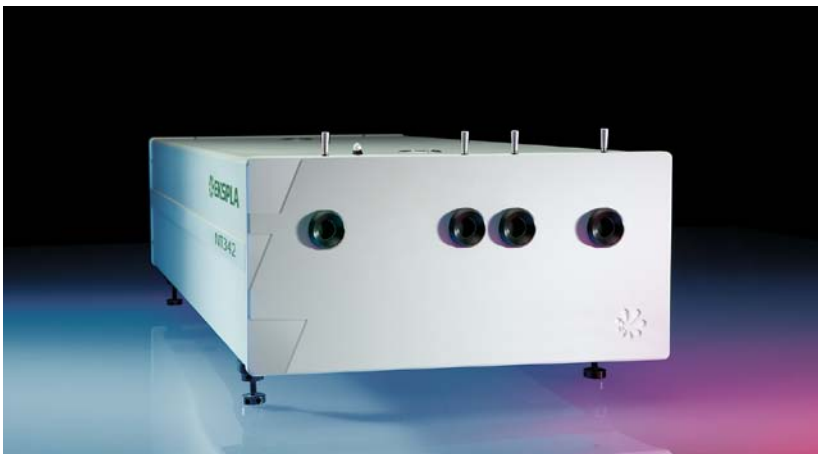
Optional tuning range extension:
SH → 340–500 nm
SF → 300–330 nm

Pulse repetition rate in kHz

Options:
2H → extra 532 nm output
3H → extra 355 nm output
Fxxx → fixed output wavelength (manual tuning)

# NT342 SERIES

## High Energy Broadly Tunable Lasers



The NT342 series tunable wavelength nanosecond laser seamlessly integrates the nanosecond optical parametric oscillator and the Nd:YAG Q-switched nanosecond laser – all in a compact housing.

The main system features are: hands-free wavelength tuning from UV to IR, high conversion efficiency, optional fiber-coupled output and separate output port for pump laser beam.

Narrow bandwidth models have a linewidth of less than 5 $cm^{-1}$, which is ideal for many spectroscopic applications.

The laser is designed for convenient use. It can be controlled from remote keypad or from a PC through an RS232 interface using LabVIEW™ drivers that are supplied with the system. The remote keypad features a backlit display that is easy to read even through laser safety googles. The OPO pump energy monitoring system helps to control pump laser parameters. Replacement of laser flashlamps can be done without misalignment of the laser cavity and/or deterioration of laser performance.

### FEATURES

- *Hands-free no gap wavelength tuning from **192** to **2600 nm***
- *Up to **50 mJ** pulse energy in visible spectral range*
- *Up to **10 mJ** pulse energy in UV spectral range*
- *Less than 5 $cm^{-1}$ linewidth*
- ***3–5 ns** pulse duration*
- *Up to **30 Hz** pulse repetition rate*
- *Remote control pad*
- *PC control via RS232 and LabVIEW™ drivers*
- *Optional separate shared output port for 355/532/1064 nm beam*
- *OPO pump energy monitoring*
- *Replacement of flashlamps without misalignment of the laser cavity*
- *Hermetically sealed oscillator cavity protects non-linear crystals from dust and humidity*

### APPLICATIONS

- *Laser-induced fluorescence*
- *Flash photolysis*
- *Photobiology*
- *Remote sensing*
- *Time-resolved spectroscopy*
- *Non-linear spectroscopy*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## Tuning range extending optional add-ons

| Option | Features |
|---|---|
| -SH | Second harmonic generator for 210–409 nm range |
| -SF | Sum-frequency generator for 300–409 nm range with high pulse energy |
| -SH/SF | Combined option for highest pulse energy in 210–409 nm range |
| -DUV | Deep UV option for 192–209 nm range |

## Accessories and other optional add-ons

| Option | Features |
|---|---|
| -FC | Fiber coupled output in 350–2000 nm range |
| -ATTN | Pulse energy attenuator |
| -H, -2H | Separate shared output port for Nd:YAG pump laser harmonics (532 or 1064 nm wavelengths) |
| -AW | Air cooled power supply |

## SPECIFICATIONS [1)]

| Model | NT342A | NT342B | NT342C |
|---|---|---|---|
| **OPO** | | | |
| Wavelength range [2)] | | | |
| Signal | 410–709 nm [3)] | | |
| Idler | 710–2600 nm | | |
| SH generator (optional) | 210–409 nm | | |
| SH/SF generator (optional) | 210–409 nm | | |
| DUV generator (optional) | 192–209 nm | | |
| Output pulse energy | | | |
| OPO [4)] | 15 mJ | 30 mJ | 50 mJ |
| SH generator (optional) [5)] | 2 mJ | 4 mJ | 6.5 mJ |
| SH/SF generator (optional) [6)] | 3 mJ | 6 mJ | 10 mJ |
| DUV generator (optional) [7)] | 0.3 mJ | 0.6 mJ | 1 mJ |
| Linewidth | <5 $cm^{-1}$ [8)] | | |
| Scanning step [9)] | | | |
| Signal (410–709 nm) | 0.1 nm | | |
| Idler (710–2600 nm) | 1 nm | | |
| SH/SF/DUV beam (192–409 nm) | 0.05 nm | | |
| Pulse duration [10)] | 3–5 ns | | |
| Typical beam diameter [11)] | 4 mm | 5 mm | 7 mm |
| Typical beam divergence [12)] | <2 mrad | | |
| Polarization | | | |
| Signal beam | horizontal | | |
| Idler beam | vertical | | |
| SH/SF/DUV beam | horizontal | | |

## SPECIFICATIONS [1)]

| Model | NT342A | NT342B | NT342C |
|---|---|---|---|
| **PUMP LASER [13)]** | | | |
| Pump wavelength | 355 nm | | |
| Max pump pulse energy | 50 mJ | 100 mJ | 150 mJ |
| Pulse duration | 4–6 ns | | |
| Beam quality | Hat-top in near field, without hot spots | | |
| Beam divergence | <0.6 mrad | | |
| Pulse energy stability (StdDev) | <3.5 % | | |
| Pulse repetition rate | 10 or 20 Hz [14)] | 10 or 20 Hz | 10 Hz |
| **PHYSICAL CHARACTERISTICS** | | | |
| Unit size (W × L × H) [15)] | 452 × 800 × 270 mm | | |
| Power supply size (W × L × H) | 330 × 490 × 585 mm | | |
| Umbilical length | 2.5 m | | |
| **OPERATING REQUIREMENTS** | | | |
| Water consumption (max 20 °C) [16)] | 6 l/min | | |
| Room temperature | 15–30 °C | | |
| Relative humidity | 20–80 % (non-condensing) | | |
| Power requirements | 208 or 240 V AC, single phase 50/60 Hz | | |
| Power consumption [17)] | 1.8 / 3.4 kVA | | |

1) Due to continuous improvement, all specifications are subject to change without notice. Parameters marked typical are indications of typical performance and will vary with each unit we manufacture. Unless stated otherwise, all specifications are measured at 450 nm.

2) Hands-free tuning range is from 192 nm to 2600 nm.

3) Tuning range extension to 400–709 nm is optional.

4) Measured at 450 nm. See tuning curves for typical outputs at other wavelengths.

5) Measured at 260 nm. See tuning curves for typical outputs at other wavelengths.

6) Measured at 340 nm. SF generator is optimized for maximum output in 300–409 nm range. See tuning curves for typical outputs at other wavelengths.

7) Measured at 200 nm.

8) Linewidth is <8 $cm^{-1}$ for 210–409 nm range.

9) Represents wavelength change quantum for manual input from control pad. When wavelength is controlled from PC, the wavelength set precision is ~1 $cm^{-1}$ in OPO range and ~2 $cm^{-1}$ in SH/SFG range.

10) FWHM measured with photodiode featuring 1 ns rise time and 300 MHz bandwidth oscilloscope.

11) Beam diameter is measured at 450 nm at the FWHM level and can vary depending on the pump pulse energy.

12) Full angle measured at the FWHM level at 450 nm.

13) Separate output port for the 355 nm beam is standard. Outputs for 1064 nm and 532 nm beams are optional. Laser output will be optimised for OPO operation and specifications may vary with each unit we manufacture.

14) 30 Hz version is available. Inquire for pulse energy specifications.

15) Length from 821 to 1220 mm depending on configuration.

16) At 10 Hz pulse repetition rate. Air cooled power supply is available.

17) At 10/20 Hz pulse repetition rate.




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## PERFORMANCE

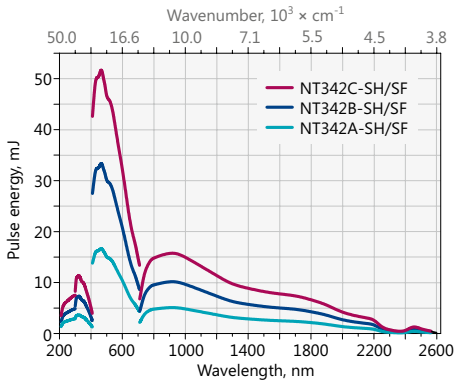


*Fig 1.* Typical output energy of the NT342 series tunable wavelength systems

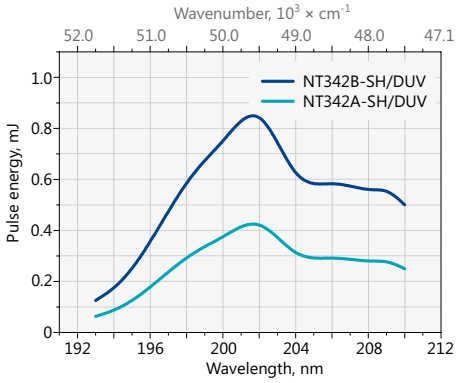


*Fig 2.* Typical output energy of the NT342 series tunable wavelength systems with SH/DUV extension

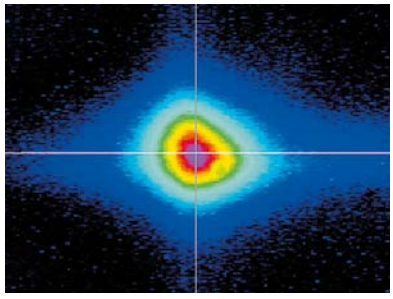

*Fig 3.* Typical far field beam profile of NT342 laser

## OUTLINE DRAWINGS

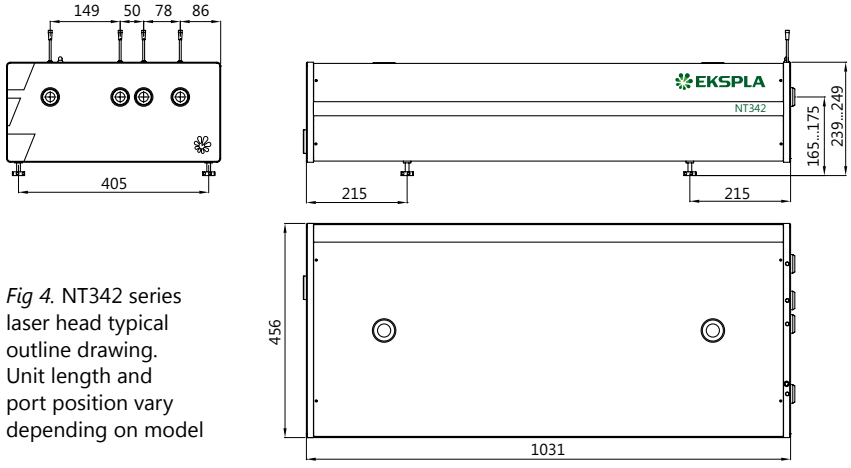


*Fig 4.* NT342 series laser head typical outline drawing. Unit length and port position vary depending on model

## ORDERING INFORMATION

**NT342A-SH-10-AW-H/2H**

- Model
- Output pulse energy:
  A → 15 mJ
  B → 30 mJ
  C → 50 mJ
- Pulse repetition rate, in Hz
- Optional tuning range extension
  SH → 210–409 nm
  DUV → 192–209 nm
- Options:
  AW → water-air heat exchanger
  H → 1054 nm output
  2H → 532 nm output

# NT350 SERIES

## High Energy NIR Range Tunable Lasers

NT352 series tunable laser seamlessly integrates in a compact housing a nanosecond optical parametric oscillator and Nd:YAG Q-switched laser.

Four models with different output pulse energy values are offered. The most powerful model has more than 125 mJ pulse energy at 800 nm.

Narrow linewidth (<10 $cm^{-1}$) is nearly constant trough whole tuning range, which makes laser suitable for many spectroscopy application.

The device is controlled from the remote keypad or from PC through RS232 interface using LabVIEW™ drivers that are supplied with the system. The remote pad features a backlit display that is easy to read even while wearing laser safety glasses.

System is designed for easy and cost-effective maintenance. Replacement of flashlamps can be done without misalignment of the laser cavity and deterioration of laser performance. OPO pump energy monitoring system helps to increase lifetime of the optical components.

Optional items are available allowing to optimize the laser system for Your application, for example:

- Fiber coupled output in 670–1000 nm range;
- Tuning range extension up to 2600 nm;
- Efficient second harmonics generator for 335–500 nm range;
- Pulse energy attenuator;
- Water-air cooled power supply.

Please inquire custom-build versions and options.

### FEATURES

- *Hands-free, automated wavelength tuning from **670** to **2600 nm***
- *Up to **125 mJ** pulse energy in near-IR spectral range*
- *Narrow linewidth across tuning range*
- ***3–5 ns** pulse duration*
- *Up to **30 Hz** pulse repetition rate*
- *Remote control pad*
- *PC control via RS232 and LabVIEW™ drivers*
- *Separate output port for 532 nm beam. Output for 1064 nm is optional*
- *OPO pump energy monitoring*
- *Replacement of the flashlamps can be done without misalignment of the laser cavity*
- *Hermetically sealed oscillator cavity protects non-linear crystals from dust and humidity*

### APPLICATIONS

- *Photoacoustic imaging*
- *Photobiology*
- *Remote sensing*
- *Time-resolved spectroscopy*
- *Non-linear spectroscopy*
- *Other laser spectroscopy applications*


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## SPECIFICATIONS [1]

| Model | NT352 | NT352A | NT352B | NT352C |
|---|---|---|---|---|
| **OPO** | | | | |
| Wavelength range | | | | |
| Signal | 670–1064 nm | | | |
| Idler | 1065–2600 nm | | | |
| SH | 355–500 nm | | | |
| Output pulse energy | | | | |
| OPO [2] | 30 mJ | 60 mJ | 100 mJ | 125 mJ |
| Linewidth | <10 $cm^{-1}$ | | | |
| Scanning step | | | | |
| Signal (670–1064 nm) | 0.1 nm | | | |
| Idler (1064–2300 nm) | 1 nm | | | |
| SH (355–500 nm) | 0.5 nm | | | |
| Pulse duration [3] | 3–5 ns | | | |
| Typical beam diameter [4] | 6 mm | 8 mm | 10 mm | 12 mm |
| Typical beam divergence [5] | <2 mrad | | | |
| Polarization | | | | |
| Signal beam | horizontal | | | |
| Idler beam | vertical | | | |
| **PUMP LASER [6]** | | | | |
| Pump wavelength | 532 nm | | | |
| Max pump pulse energy | 110 mJ | 230 mJ | 400 mJ | 500 mJ |
| Pulse duration | 4 – 6 ns | | | |
| Beam quality | Hat-Top in near field. Close to Gaussian in far field | | | |
| Beam divergence | <0.5 mrad | | | |
| Pulse energy stability (StdDev) | <2.5 % | | | |
| Pulse repetition rate | 10 or 20 Hz [7] | 10 or 20 Hz | 10 Hz [7] | |
| **PHYSICAL CHARACTERISTICS** | | | | |
| Unit size (W × L × H) | 452 × 610 × 270 mm | | 452 × 1020 × 270 mm | |
| Power supply size (W × L × H) | 330 × 490 × 585 mm | | 550 × 600 × 530 mm | |
| Umbilical length | 2.5 m | | | |
| **OPERATING REQUIREMENTS** | | | | |
| Water consumption (max 20 °C) [8] | 6 l/min | | 10 l/min | |
| Room temperature | 15–30 °C | | | |
| Relative humidity | 20–80 % (non-condensing) | | | |
| Power requirements [9] | 208 or 240 V AC, single phase 50/60 Hz | | | |
| Power consumption [10] | 1.8 / 3.4 kVA | | 3.4 kVA | 5 kVA |

1) Due to continuous improvement, 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 800 nm.

2) Measured at 800 nm. See tuning curves for typical outputs at other wavelengths.

3) FWHM measured with photodiode featuring 500 ps rise time and 600 MHz bandwidth oscilloscope.

4) Beam diameter is measured at 800 nm at the FWHM level and can vary depending on the pump pulse energy.

5) Full angle measured at the FWHM level at 800 nm.

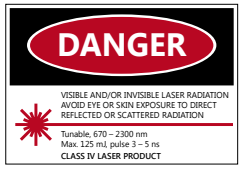
6) Separate output port for the 532 nm beam is standard. Output for 1064 nm beam is optional. Pump laser output will be optimised for OPO operation and specification may vary with each unit we manufacture.

7) Pulse repetition rates up to 30 Hz are possible. Inquire for pulse energy and other specifications.

8) At 10 Hz pulse repetition rate. Air cooled power supply is available as option.

9) Mains voltage should be specified when ordering. 20 and 30 Hz versions of the laser might require three phase mains.

10) At 10/20 Hz pulse repetition rate. Required current rating might be calculated by dividing power consumption value by mains voltage value.



## OPTIONS

▶ **Fiber-coupled output in 355–2000 nm range.**
Please contact EKSPLA for details.

## PERFORMANCE

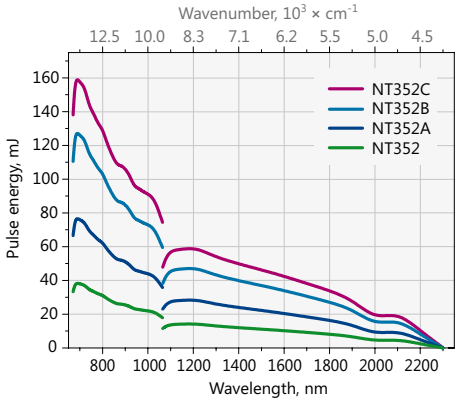



*Fig 1.* Typical output energy of the NT350 series tunable wavelength systems

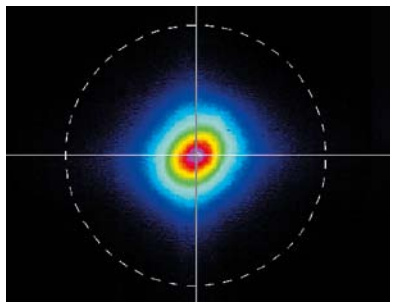


*Fig 2.* Typical far field beam profile of NT352B laser at 800 nm

## ORDERING INFORMATION

**NT352A-10-SH-AW-H**

Model

Output pulse energy:
none → 30 mJ
A → 60 mJ
B → 100 mJ
C → 125 mJ

Pulse repetition rate, in Hz

Optional tuning range extension
SH → 335–500 nm

Options:
AW → water-air heat exchanger
H → 1064 nm output



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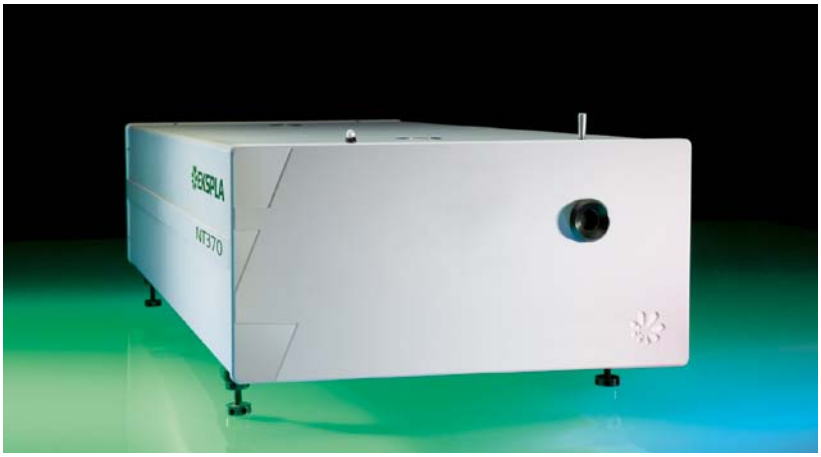
# NT370 SERIES

## High Energy IR Range Tunable Lasers




### FEATURES

- *Hands-free, automated wavelength tuning*
- *Up to **15 mJ** pulse energy in **mid-IR** spectral range*
- *Less than 10 $cm^{-1}$ linewidth for most of the tuning range*
- ***3–5 ns** pulse duration*
- ***10** or **20 Hz** pulse repetition rate*
- *Remote control pad*
- *PC control via RS232 and LabView™ drivers*
- *Separate output port for 1064 nm pump beam*
- *OPO pump energy monitoring*
- *Replacement of the flashlamps is done without misalignment of the laser cavity*

### APPLICATIONS

- *Infrared spectroscopy*
- *Cavity ring-down spectroscopy*
- *Remote sensing*
- *Material processing*
- *Non-linear spectroscopy*
- *Other laser spectroscopy applications*

NT370 series tunable laser seamlessly integrates in a compact housing the nanosecond optical parametric oscillator and Nd:YAG Q-switched laser.

Pumped by fundamental harmonics output the lasers provides tuning in mid- and far-infrared spectral range.

NT373 model delivers eye-safe output at 1570 nm. NT373-XIRx model uses the output from eye-safe OPO to pump IR crystal based cascade OPO for tunable output in 4400–18000 nm range. Customized tuning ranges are available by request. The linewidth of NT373-XIRx model is nearly constant across tuning range and it is less than 6 $cm^{-1}$.

NT377 model produces tunable output in 2500–4400 nm range. Pulse energy is exceeding 10 mJ for wavelengths shorter than 3600 nm, while linewidth is below 10 $cm^{-1}$ for the wavelengths longer than 3000 nm. Because of narrow linewidth of output radiation (typically in 6–10 $cm^{-1}$ range) the laser is suitable for many infrared spectroscopic applications, for example cavity ring-down spectroscopy, gas detection and remote sensing.

The device is controlled from the remote keypad or from PC through RS232 interface using LabVIEW™ drivers that are supplied together with the system. The remote pad features a backlit display that is easy to read even while wearing laser safety glasses.

System is designed for easy and cost-effective maintenance. Replacement of flashlamps can be done without misalignment of the laser cavity and deterioration of laser performance. OPO pump energy monitoring system helps to increase lifetime of the optical components.

### Accessories and optional add-ons

| Option | Features |
|---|---|
| -AW | Water-air cooling option |
| -20 | 20 Hz PRR option |
| -H | Optional 1064 nm output |

## SPECIFICATIONS [1]

| Model | NT377A | NT373 | NT373-XIR |
|---|---|---|---|
| **OPO** | | | |
| Wavelength range | 2500–4400 nm | 1570 nm | 5000–18000 nm [2] |
| Output pulse energy [3] | 12.5 mJ | 50 mJ | 1 mJ |
| Linewidth [4] | <10 $cm^{-1}$ | <3 $cm^{-1}$ | <6 $cm^{-1}$ |
| Scanning step | 1 nm | — | 1 nm |
| Typical pulse duration [5] | 3–5 ns | | |
| Typical beam diameter [6] | 6 mm | 6 mm | 8 mm |
| Polarization | horizontal | vertical | horizontal |
| **PUMP LASER [7]** | | | |
| Pump wavelength | 1064 nm | | |
| Max pump pulse energy | 300 mJ | | |
| Pulse duration | 4–6 ns | | |
| Beam quality | "Hat-Top" in near field | | |
| Beam divergence | <0.5 mrad | | |
| Pulse energy stability (StdDev) | <1 % | | |
| Pulse repetition rate | 10 or 20 Hz | | |
| **PHYSICAL CHARACTERISTICS** | | | |
| Unit size (W × L × H) | 452 × 1020 × 270 mm | 452 × 610 × 270 mm | 452 × 1020 × 270 mm |
| Power supply size (W × L × H) | 330 × 520 × 670 mm | | |
| Umbilical length | 2.5 m | | |
| **OPERATING REQUIREMENTS** | | | |
| Water consumption (max 20 °C) [8] [9] | 10 l/min | | |
| Room temperature | 18–27 °C | | |
| Relative humidity | 20–80 % (non-condensing) | | |
| Power requirements [10] | 208 or 240 V AC, single phase, 50/60 Hz | | |
| Power consumption [11] | 1.5 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 3000 nm for NT377 unit, at 1570 nm for NT373 unit and at 7000 nm for NT373-XIRx units.

2) Please contact Ekspla for more detailed specifications.

3) Output is specified at wavelengths defined in chapter 1. See tuning curves for typical outputs at other wavelengths.

4) Linewidth is specified at wavelengths defined in chapter 1. See graph below for typical linewidth at other wavelengths.

5) Estimate, assuming that pulse duration from OPO is by approx 1 ns shorter than one from pump laser.

6) Beam diameter is measured at the FWHM level at the output aperture and can vary depending on the pump pulse energy.

7) Laser output will be optimised for OPO operation and specification may vary with each unit we manufacture.

8) Air cooled power supply is available as option.

9) For 10 Hz PRR.

10) Should be specified when ordering.

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## PERFORMANCE

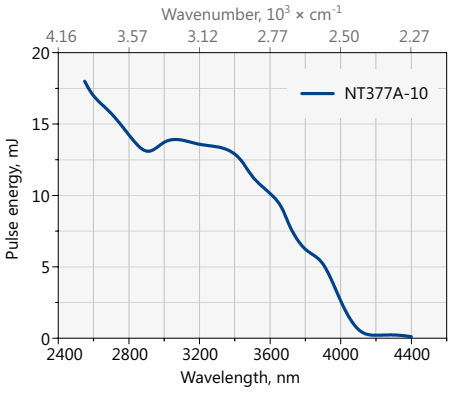


*Fig 1.* Typical output energy of the NT377A tunable wavelength laser

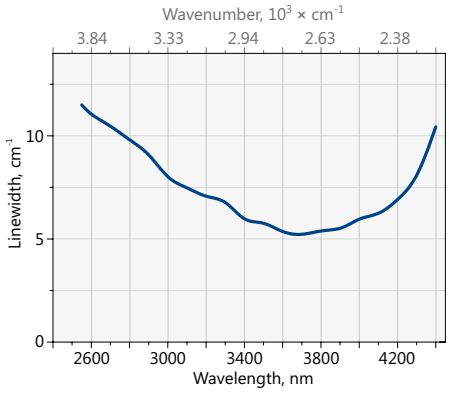


*Fig 2.* Typical linewidth of the NT377A tunable wavelength laser

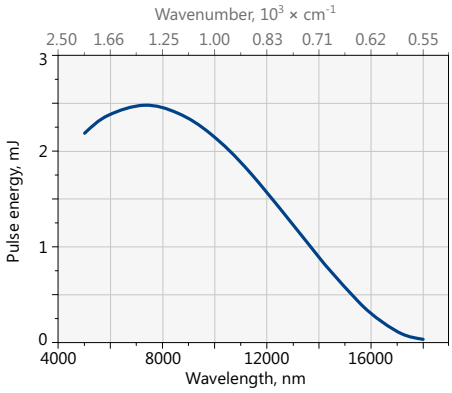


*Fig 3.* Typical output pulse energy of the NT373-XIR tunable wavelength laser


Tuning up the OPCPA laser system NAGLIS at Vilnius University Laser Research Center

# High Energy Laser Systems

Today laser intensities reached levels where relativistic effects dominate in laser-matter interaction. New applications of high pulse energy lasers emerge in various disciplines ranging from fundamental physics to materials research and life sciences. Ekspla presents line of nanosecond and picosecond high pulse energy lasers and amplifiers. Our broad knowledge in high energy laser physics, non-linear materials and more that 20 years of experience in laser design enables us to offer unique solutions for high pulse energy systems.

Our high pulse energy lasers features flash lamp pump for ultra-high pulse energy, diode pump for high average power. Innovative solutions for pulse shaping, precise synchronization between different laser sources enables fit these systems to numerous experiments of modern fundamental science.

## FEATURES

***Nanosecond lasers***

- *Lamp pumped*
  - *up to 10 J at 10 Hz*
  - *up to 160 J, single shot*
- *Diode pumped*
  - *up to 2 J at 100 Hz*
  - *SLM, temporally shaped pulses*

***Picosecond lasers***

- *Lamp pumped*
  - *up to 2 J, 90 ps, 10 Hz*
- *Diode pumped*
  - *up to 150 mJ, 90 ps, 1 kHz*
  - *external seeding*

## 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.

| Series | Pulse duration | Pulse energy at 1064 nm | Repetition rate, up to | Special feature | Page |
|---|---|---|---|---|---|
| **NL940** | 3–10 ns | up to 10 J | 10 Hz | Temporary shaped pulse based on electrooptical modulator driven by programmable arbitrary waveform generator (AWG) | 112 |
| **NL310** | 4–6 ns | up to 10 J | 10 Hz | High pulse energy | 115 |
| **APL2200** | 90 ps | up to 0.15 J | 1000 Hz | High power amplifiers | 118 |
| **APL2100** | 90 ps | up to 2.2 J | 10 Hz | DPSS regenerative amplifier | 121 |
| **Nd:Glass** | 500 ps – 20 ns | up to 150 J | 1 shot in 1 – 20 min | DPSS master oscillator and Nd:Glass power amplifiers | 124 |

# NL940 SERIES

## High Energy Temporary Shaped Nanosecond Nd:YAG Lasers


### FEATURES

- *Up to **10 J** output energy*
- ***10 Hz** repetition rate*
- ***3–10 ns** pulse duration*
- *1064 or 532 nm output wavelength*
- *Spatial flat top beam profile*
- *Fiber front end output amplified in diode pumped regenerative amplifier*

Main laser feature is output of temporary shaped pulses based on electrooptical modulator driven by programmable arbitrary waveform generator (AWG). Pulse shaping resolution is 125 ps, while maximum pulse length is 10 ns. Start of the system is single mode CW laser. Then light is amplified in fiber amplifier, later AWG driven modulator transmits only required temporal shape and duration pulse which is amplified in diode pumped regenerative amplifier in order to reach energy sufficient to amplify in singly pass flash-lamp pumped amplifiers. Power amplifier is a chain of single-pass amplifiers where pulse is amplified up to required energy. During amplification spatial beam shaping is used in order to get flat top shape at the output. The second harmonic generator is based on angle tuned nonlinear crystal placed in a heater.

### APPLICATIONS

- *OPCPA pumping*
- *Front end for power amplifiers*
- *Ti: Sapphire pumping*
- *Laser peening – material hardening by laser-induced shock wave*
- *Plasma and shock physics*


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## SPECIFICATIONS [1]

| Model | NL944 | NL949 |
|---|---|---|
| Pulse energy (rectangular pulse in time domain 5 ns FWHM) | | |
| at 1064 nm | 1.6 J | 10 J |
| at 532 nm [2] | 1.0 J | 6 J |
| Pulse energy stability (Std Dev) [3] | | |
| at 1064 nm | 0.5 % | |
| at 532 nm | 1.0 % | |
| Power drift [4] | ±2 % | |
| Pulse duration [5] | 3–10 ns | |
| Repetition rate | 10 Hz | |
| Polarization @ 1064 nm | vertical, >90 % | |
| Optical pulse jitter [6] | < 30 ps | |
| Linewidth | < 0.1 $cm^{-1}$ | |
| Beam profile | Hat-Top" (at laser output), without diffraction rings | |
| Typical beam diameter [7] | ~11 mm | ~33 mm |
| Beam divergence [8] | < 0.5 mrad | |
| Beam pointing stability | ±50 µrad | |
| **PHYSICAL CHARACTERISTICS** | | |
| Laser head (W × L × H) | 750 × 1350 × 300 mm | 1000 × 2100 × 300 mm |
| Power supply unit (W × L × H) | 550 × 600 × 840 mm – 1 unit<br>550 × 600 × 670 mm – 1 unit | 550 × 600 × 1220 mm - 2 units<br>550 × 600 × 670 mm – 1 unit |
| Umbilical length | 3 m | |
| **OPERATING REQUIREMENTS** | | |
| Water consumption (max 20 °C) | < 8 l/min | < 40 l/min |
| Ambient temperature | stabilized; from range 18–25 °C | |
| Relative humidity | 20–80% (non-condensing) | |
| Power requirements [9] | 208/240 V AC, single phase, 50/60 Hz<br>or 208/380 V AC, three phases, 50/60 Hz | 208/380 V AC, three phases, 50/60 Hz |
| Power consumption | 5.5 kW | 13.2/6.6 kW |

1) Due to continuous improvement, all specifications subject to change without notice. Parameters marked typical may vary with each unit we manufacture.Unless stated otherwise, all specifications are measured at 1064 nm.

2) For NL94X-SH harmonics generator option. Harmonics outputs are not simultaneous; only single wavelength beam is present at the output at once. Manual reconfiguration is required to switch wavelength.

3) Standard deviation value averaged from 1000 shots after 20 minutes of warm-up.

4) Deviation from average value measured over 8 hours of operation when room temperature variation is less than ±2 °C.

5) Measured with photodiode with 100 ps rise time and oscilloscope with 600 MHz bandwidth.

6) Standard deviation value, measured with respect to triggering pulse.

7) Beam diameter is measured at 1064 nm at laser output at the $1/e^2$ level and can vary with each unit we manufacture.

8) Full angle measured at the $1/e^2$ level at 1064 nm.

9) Mains voltage should be specified when ordering.

## BEAM PROFILE

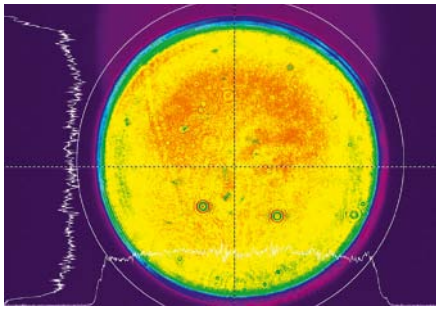

*Fig 1.* Typical NL949 near field beam profile at 532 nm

## PERFORMANCE

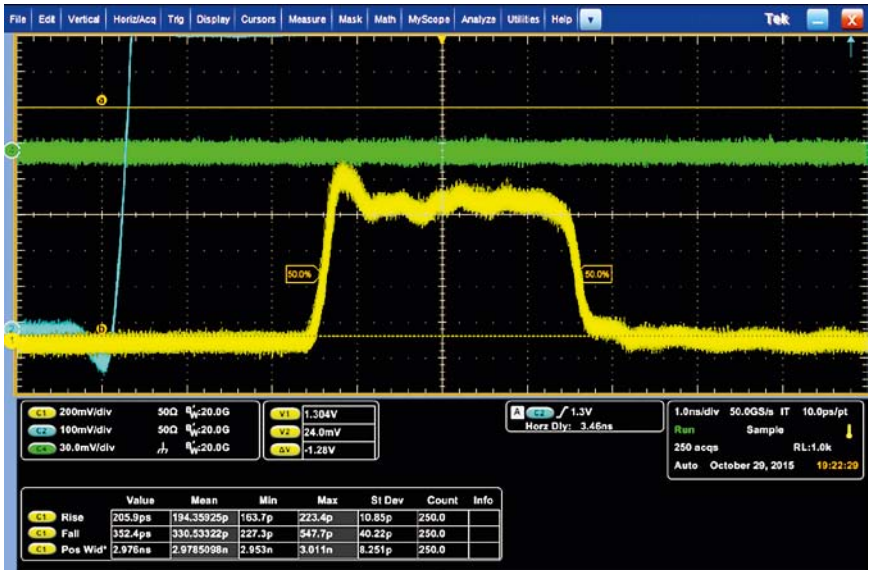


*Fig 2.* Example of temporal pulse shape, stability of pulse shape


*Fig 3.* Jitter measurement results



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# NL310 SERIES

## High Energy Q-switched Nd:YAG Lasers


### FEATURES

- *Up to **10 J** output energy*
- *Better than 0.5% rms pulse energy stability*
- ***4–6 ns** pulse duration*
- ***10** or **20 Hz** repetition rate*
- *Temperature stabilized second, third, fourth and fifth harmonics generators*
- *Remote control via keypad or USB-CAN port*
- *Low jitter internal/external synchronization*
- *Robust and stable laser head*

### APPLICATIONS

- *OPO, Ti: Sapphire, dye laser pumping*
- *Material processing*
- *Plasma generation and diagnostics*
- *Nonlinear spectroscopy*
- *Remote sensing*
- *Your application is welcome!*

High pulse energy NL310 series lasers are targeted for applications like OPO or Ti: Sapphire pumping, material processing and plasma diagnostics. These lasers can produce pulse energies up to 10 J in fundamental wavelength at 10 Hz pulse repetition rate.

For the convenience of customers the NL310 series nanosecond Q-switched laser can be controlled either through a user-friendly remote keypad or USB-CAN port. The remote keypad allows easy control of all parameters and features a backlit display that is easy to read even wearing laser safety eyewear.

Software for Windows™ operating system is provided to control the laser from PC. LabView™ drivers are supplied as well, allowing laser control integration into existing Labview™ programs.

The optional second (SH, 532 nm), third (TH, 355 nm), fourth (FH, 266 nm) and fifth (FiH, 213 nm) harmonic generators can be integrated into laser head or placed outside laser head into auxiliary harmonics generator module. Output wavelength switching is done manually. Motorized wavelength switching is available by request.

Triggering of the laser is possible from built-in internal or external pulse generator. Pulses with TTL levels are required for external triggering. Laser pulses have less than 0.5 ns rms jitter with respect to Q-switch triggering pulse in both cases.

The simple and field proven design ensures easy maintenance and reliable long-term operation of the NL310 series laser.

## SPECIFICATIONS [1]

| Model | NL311 | NL313 | NL315 | NL317 | NL319 |
|---|---|---|---|---|---|
| Pulse energy: | | | | | |
| at 1064 nm | 1300 / 1000 mJ | 1600 mJ | 3500 mJ | 5000 mJ | 10000 mJ |
| at 532 nm [2] | 600 / 440 mJ | 800 mJ | 1700 mJ | 2500 mJ | 5000 mJ |
| at 355 nm [3] | 390 / 290 mJ | 490 mJ | 1000 mJ | 1300 mJ | TBA [4] |
| at 266 nm [5] | 130 / 120 mJ | 180 mJ | 210 mJ | 250 mJ | TBA [4] |
| Pulse energy stability (StdDev): [6] | | | | | |
| at 1064 nm | 0.5 % | | | | |
| at 532 nm | 1.0 % | | | | |
| at 355 nm | 1.8 % | | | | |
| at 266 nm | 3.6 % | | | | |
| Power drift [7] | ±2 % | | | | |
| Pulse duration [8] | 4–6 ns | | 10 ns | | |
| Repetition rate | 10 / 20 Hz [9] | 10 Hz [9] | 10 Hz | | |
| Polarization [10] | vertical, >90 % | | | | |
| Optical pulse jitter [11] | <0.5 ns | | | | |
| Linewidth | <1 $cm^{-1}$ | | | | |
| Beam profile | "Hat-Top" (near field), near Gaussian (far field) | | | | |
| Typical beam diameter [12] | ~10 mm | ~12 mm | ~18 mm | ~21 mm | ~27 mm |
| Beam divergence [13] | <0.5 mrad | | | | |
| Beam pointing stability | ±50 µrad | | | | |
| **PHYSICAL CHARACTERISTICS** | | | | | |
| Laser head (W × L × H) [14] | 310 × 800 × 230 mm | | 460 × 1250 × 260 mm | | 600 × 2000 × 300 mm |
| Power supply unit (W × L × H) [14] | 550 × 600 × 530 mm | | 550 × 600 × × 1235 mm | 550 × 600 × × 1630 mm | 550 × 600 × 1620 mm 2 units |
| Umbilical length | 2.5 m | | | | |
| **OPERATING REQUIREMENTS** | | | | | |
| Water consumption (max 20 °C) [14] | <6 l/min | | 10 l/min | 12 l/min | 15 l/min |
| Ambient temperature | stabilized; from range 18–30°C | | | | |
| Relative humidity | 20–80% (non-condensing) | | | | |
| Power requirements [15] [16] | 208 or 240 V AC, single phase 50/60 Hz | | 208 or 380 V AC, three phases, 50/60 Hz | | |
| Power consumption [14] | 20 A | 25 A | 50/25 A [17] | | 60/30 A |

1) Due to continuous improvement, all specifications 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.

2) For NL31×-SH harmonics generator option. Harmonics outputs are not simultaneous; only single wavelength beam is present at the output at once. Manual reconfiguration is required to switch wavelength.

3) For NL311-SH/TH or NL313-SH/TH harmonics generator option. Harmonics outputs are not simultaneous; only single wavelength beam is present at the output at once. Manual reconfiguration is required to switch wavelength. External harmonics generator module is used in NL315, NL317, NL319 lasers for 355 nm generation (unit dimensions 460×260×460 mm).

4) Contact EKSPLA for more information.

5) For NL311-SH/FH or NL313-SH/FH harmonics generator option. Harmonics outputs are not simultaneous; only single wavelength beam is present at the output at once. Manual reconfiguration is required to switch wavelength. External harmonics generator module is used in NL315, NL317, NL319 lasers for 266 nm generation (unit dimensions 460×260×460 mm).

6) Standard deviation value averaged from 1000 shots after 5 minutes of warm-up.

7) Deviation from average value measured over 8 hours of operation when room temperature variation is less than ±2 °C.

8) Measured with photodiode with 500 ps rise time and oscilloscope with 600 MHz bandwidth.

9) Inquire for models with up to 30 Hz pulse repetition rate.

10) Measured at 10 Hz pulse repetition rate.

11) Standard deviation value, measured with respect to Q-switch triggering pulse.

12) Beam diameter is measured at 1064 nm at laser output at the $1/e^2$ level and can vary with each unit we manufacture.

13) Full angle measured at the $1/e^2$ level at 1064 nm.

14) At 10 Hz pulse repetition rate.

15) Mains voltage should be specified when ordering.

16) For pulse repetition rates higher than 10 Hz three-phase mains are required.

17) First number is for 208 V AC, second – for 380 V AC mains.




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## OPTIONS

- **-G option.** Provides beam profile optimized for OPO pumping or other applications requiring smooth, without hot spots beam profile in the near and medium field. Pulse energies typically are lower by 30% in comparison to standard lasers without -G option.

## BEAM PROFILE

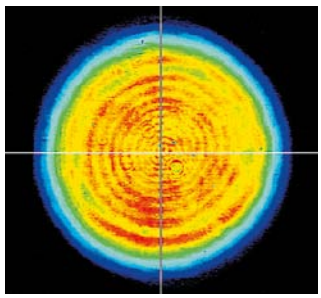

*Fig 1.* Typical beam profile of the NL310 series lasers. Near field

## OUTLINE DRAWINGS

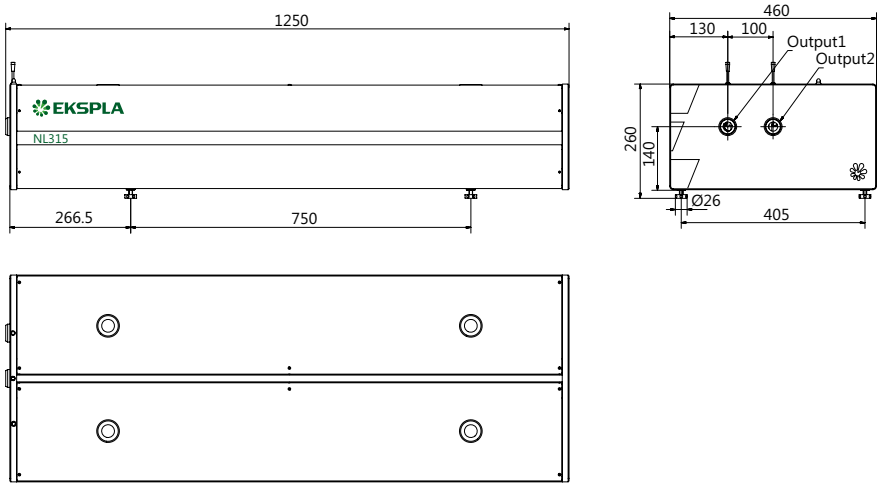


*Fig 2.* NL315 and NL317 lasers head outline drawing

## ORDERING INFORMATION

**NL313-10-SH/TH/FH-AW**

- Model
- Pulse repetition rate in Hz
- Harmonic generator options:
  - SH → second harmonic
  - TH → third harmonic
  - FH → fourth harmonic
  - FiH → fifth harmonic
- Options:
  - AW → water-air heat exchanger

# APL2200 SERIES

## High Energy kHz Repetition Rate Picosecond Amplifiers


### FEATURES

- *High pulse energy at **kHz** rates*
- *Diode pumped **solid state design***
- *Cooled by supplied chiller – tap water is not required*
- ***Low** maintenance **costs***
- *Remote control pad*
- *PC control via USB with supplied LabVIEW™ drivers*
- *Optional temperature stabilized second, third and fourth harmonic generators*

### APPLICATIONS

- *OPG/OPA pumping*
- *OPCPA pumping*
- *Other spectroscopic and nonlinear optics applications...*

APL2200 series amplifiers are designed to produce up to 150 mJ picosecond pulses at kilohertz pulse repetition rate. Short pulse duration, excellent pulse-to-pulse stability, superior beam quality makes APL2200 series diode pumped picosecond amplifiers well suited for applications like OPCPA pumping, non-linear optics and others.

### Regenerative amplifier / Power amplifier design

APL2200 series amplifiers consist of regenerative amplifier and power amplifiers. System could be seeded by built-in picosecond oscillator or other ultrafast laser system. Pulses from regenerative amplifier are spatially shaped and amplified in double-pass amplifiers with thermally induced birefringence compensation. Advanced optical design ensures smooth, without hot spots beam spatial profile at the laser output. Low light depolarization level allows high efficiency generation of up to 4$^{th}$ harmonics with build-in harmonics generators. Repetition rate and timing of the pulses can be locked to the external RF source (with –PLL option) or other ultrafast laser system (with –FS option).

### Build-in harmonic generators

Angle-tuned LBO and/or BBO crystals mounted in temperature stabilized heaters are used for second, third and fourth harmonic generation. Harmonics separation system is designed to ensure high spectral purity of radiation and direct it to the output ports.

### Simple and convenient laser control

For customer convenience the amplifier can be controlled through user-friendly remote control pad or USB interface. Alternatively, the amplifier can be controlled from personal computer with supplied software for Windows™ operating system. LabVIEW™ drivers are supplied as well.

### APL2200 series available models

| Model | Features |
|---|---|
| APL2201 | Delivers 10 mJ, 90 ps pulses at up to 1 kHz repetition rate |
| APL2203 | Delivers 30 mJ, 90 ps pulses at up to 1 kHz repetition rate |
| APL2205 | Delivers 60 mJ, 90 ps pulses at up to 1 kHz repetition rate |
| APL2206 | Delivers 150 mJ, 90 ps pulses at up to 1 kHz repetition rate |


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## SPECIFICATIONS [1]

| Model | APL2201 | APL2203 | APL2205 | APL2206 |
|---|---|---|---|---|
| Output energy | | | | |
| at 1064 nm | 10 mJ | 30 mJ | 60 mJ | 150 mJ |
| at 532 nm [2] | 5 mJ | 15 mJ | 30 mJ | 70 mJ |
| at 355 nm [3] | 3 mJ | 10 mJ | 20 mJ | inquire |
| at 266 nm [4] | 1 mJ | 2.5 mJ | 4 mJ | inquire |
| Pulse energy stability (StdDev) [5] | | | | |
| at 1064 nm | 1 % | | | |
| at 532 nm | 1.5 % | | | |
| at 355 nm | 2 % | | | |
| at 266 nm | 4 % | | | |
| Pulse duration (FWHM) [6] | 90±10 ps | | | |
| Pulse repetition rate [7] | 1 kHz | | | |
| Triggering mode | external | | | |
| Spatial mode [8] | super-Gaussian | | | |
| Beam divergence [9] | <1 mrad | <0.7 mrad | | |
| Typical beam diameter [10] | ~3 mm | ~5 mm | ~6 mm | ~7 mm |
| Beam pointing stability [11] | <100 µrad | | | |
| Pre-pulse contrast | >100 : 1 | | | |
| Polarization | linear, >95 % | | | |
| **INPUT** | | | | |
| Wavelength | 1064 nm | | | |
| Pulse duration range (FWHM) | 20 fs – 90 ps | | | |
| Pulse repetition rate | 50 – 95 MHz | | | |
| Average power | >20 mW | | | |
| **PHYSICAL CHARACTERISTICS** | | | | |
| Laser head size (W×L×H) | 455 × 1035 × 242 mm | 900 × 1500 × 350 mm | 1200 × 2200 × 350 mm | TBA |
| Power supply size (W×L×H) | 550 × 600 × 680 mm | 550 × 600 × 1100 mm | 550 × 600 × 1030 mm | TBA |
| Chiller size (W×L×H) | 400 × 430 × 790 mm | 400 × 430 × 790 mm | 500 × 500 × 850 mm | 600 × 600 × 600 mm |
| **OPERATING REQUIREMENTS** | | | | |
| Water service | not required, air-cooled | | | water-cooled |
| Relative humidity | 20–80 % (non condensing) | | | |
| Operating ambient temperature | 22±2 °C | | | |
| Mains voltage | 208 or 230 V AC, single phase, 50/60 Hz | | | 208 or 230 V AC, three phases, 50/60 Hz |
| Power rating [12] | <1 kVA | <2.5 kVA | <5 kVA | <14 kVA |

1) Due to continuous improvement, all specifications are subject to change. Parameters marked typical are illustrative; they are indications of typical performance and will vary with each unit we manufacture. Unless stated otherwise, all specifications are measured at 1064 nm.

2) For APL210x-SH and APL210x-SH/FH options. Outputs are not simultaneous.

3) For APL210x-TH option. Outputs are not simultaneous.

4) For APL210x-SH/FH option. Outputs are not simultaneous.

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

6) Optional 30 ps duration. Inquire for pulse energies.

7) Should be specified when ordering. Inquire for custom pulse repetition rates.

8) Gaussian fit >80%.

9) Full angle measured at the $1/e^2$ level at 1064 nm.

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

11) Value measured from 300 shots.

12) Required current rating can be calculated by dividing power rating by mains voltage.

## OPTIONS

- **Option P30** provides 30±3 ps output pulse duration. Contact EKSPLA for pulse energy specifications.

## BEAM PROFILE

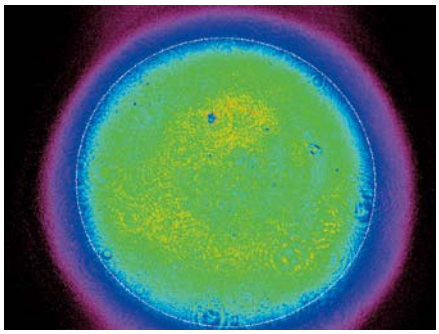

*Fig 1.* Typical beam profile at APL2200 amplifier output

## OPTICAL LAYOUT

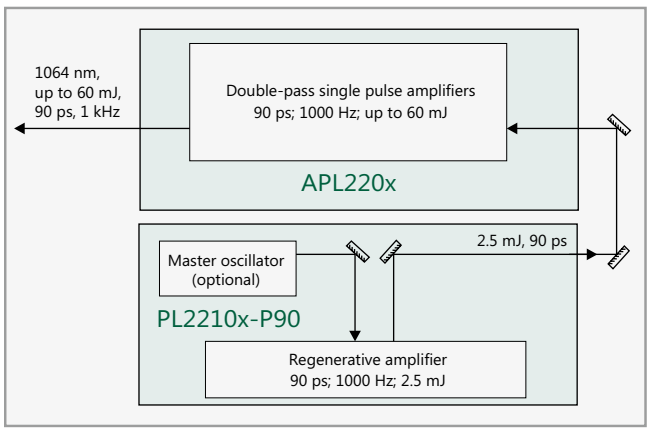


*Fig 2.* Block optical layout of PL2210 series laser and APL2200 series amplifier

## ORDERING INFORMATION

**APL2201-P90-1K-SH/TH/FH**

Model

Pulse duration:
P90 → 90 ps
P30 → 30 ps

Pulse repetition rate in Hz,
1K = 1000 Hz

Harmonic generator options:
SH → second harmonic
TH → third harmonic
FH → fourth harmonic

Recommended seed laser for 90 ps is PL2210B. For 30 ps pulse duration use PL2210A as seed laser.



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# APL2100 SERIES

## High Energy Picosecond Amplifiers


APL210x series amplifiers are designed to produce up to 1000 mJ picosecond pulses. High pulse energy, excellent pulse-to-pulse energy stability, superior beam quality makes APL210x series picosecond amplifiers well suited for applications like OPCPA pumping, non-linear optics and others.

### Regenerative amplifier / Power amplifier design

APL210x series amplifiers are designed to be seeded by external seeding source. Diode pumped regenerative amplifier ensures amplification of seed signal to stable mJ level pulse for amplification in linear amplifiers. Advanced beam shaping ensures smooth, without hot spots beam spatial profile at the laser output. Low light depolarization level allows high efficiency generation of up to 4th harmonics with build-in harmonics generators.

### Build-in harmonic generators

Angle-tuned DKDP crystals harmonics generators mounted in temperature stabilized heaters are used for second, third and fourth harmonic generation. Harmonics separation system is designed to ensure high spectral purity of radiation and direct it to the output ports.

### Simple and convenient laser control

For customer convenience the amplifier can be controlled through user-friendly remote control pad or USB interface. The control pad features a backlit display that is easy to read even while wearing laser safety eyewear. Alternatively, the amplifier can be controlled from personal computer with supplied software for Windows™ operating system. LabVIEW™ drivers are supplied as well.

### FEATURES

- *Diode pumped regenerative amplifier*
- *Seeding of regenerative amplifier with customers super-continuum seeding source*
- *Flashlamp pumped power amplifier*
- *Advanced beam shaping for high pulse energy*
- *Thermally induced birefringence compensated design for high pulse repetition rates*
- *Low jitter synchronisation pulses for streak camera triggering with 10 ps rms jitter (optional)*
- *Water-water heat exchanger for cooling of pump chambers*
- *Remote control pad*
- *Control through CAN or USB interface (RS232 is optional)*
- *Optional temperature stabilized second, third and fourth harmonic generators*

### APPLICATIONS

- *OPCPA pumping*
- *OPG/OPA pumping*
- *Other spectroscopic and nonlinear optics applications...*

### APL2100 series available models

| Model | Features |
|---|---|
| APL2101 | Delivers 200 mJ, 90 ps pulses at up to 10 Hz repetition rate |
| APL2103 | Delivers 300 mJ, 90 ps pulses at up to 10 Hz repetition rate |
| APL2105 | Delivers 550 mJ, 90 ps pulses at up to 10 Hz repetition rate |
| APL2106 | Delivers 1000 mJ, 90 ps pulses at up to 10 Hz repetition rate |
| APL2107 | Delivers 2200 mJ, 90 ps pulses at up to 10 Hz repetition rate |

## SPECIFICATIONS [1]

| Model | APL2101 | APL2103 | APL2105 | APL2106 | APL2107 |
|---|---|---|---|---|---|
| Output energy | | | | | |
| at 1064 nm | 200 mJ | 300 mJ | 550 mJ | 1000 mJ | 2200 mJ |
| at 532 nm [2] | 100 mJ | 150 mJ | 250 mJ | 500 mJ | 1100 mJ |
| at 355 nm [3] | 60 mJ | 90 mJ | 170 mJ | 300 mJ | inquire |
| at 266 nm [4] | 20 mJ | 30 mJ | 60 mJ | 100 mJ | inquire |
| Pulse energy stability (StdDev) [5] | | | | | |
| at 1064 nm | 1.5 % | | | | |
| at 532 nm | 2.5 % | | | | |
| at 355 nm | 5 % | | | | |
| at 266 nm | 7 % | | | | |
| Pulse duration (FWHM) [6] | 90±10 ps | | | | |
| Pulse repetition rate [7] | 10 Hz | | | | |
| Triggering mode | external | | | | |
| Spatial mode [8] | super-Gaussian | | | | |
| Beam divergence [9] | <0.5 mrad | | | | |
| Typical beam diameter [10] | ~11 mm | | | ~17 mm | ~24 mm |
| Beam pointing stability [11] | <±60 µrad | | | | |
| Pre-pulse contrast | >200 : 1 | | | | |
| Polarization | linear, >100 : 1 | | | | |
| **INPUT** | | | | | |
| Wavelength | 1064 nm | | | | |
| Pulse duration range (FWHM) | 20 fs – 90 ps | | | | |
| Pulse repetition rate | 50 – 95 MHz | | | | |
| Average power | >20 mW | | | | |
| **PHYSICAL CHARACTERISTICS** | | | | | |
| Laser head size (W×L×H) | 600 × 1500 × 350 mm | | | 600 × 1800 × 350 mm | TBA |
| Power supply size (W×L×H) | 550 × 600 × 1100 mm | | | 550 × 600 × 1230 mm | TBA |
| **OPERATING REQUIREMENTS** | | | | | |
| Water service | <12 l/min, below 20 °C | | | | <25 l/min, below 20 °C |
| Relative humidity | 20–80 % (non condensing) | | | | |
| Operating ambient temperature | 22±2 °C | | | | |
| Mains voltage | 208 or 230 V AC, single phase, 50/60 Hz | | | | 208 or 230 V AC, three phases, 50/60 Hz |
| Power rating [12] | <2 kVA | <2 kVA | <2.5 kVA | <4.5 kVA | <12 kVA |

1) Due to continuous improvement, all specifications are subject to change. Parameters marked typical are illustrative; they are indications of typical performance and will vary with each unit we manufacture. Unless stated otherwise, all specifications are measured at 1064 nm.
2) For APL210x-SH and APL210x-SH/FH options. Outputs are not simultaneous.
3) For APL210x-TH option. Outputs are not simultaneous.
4) For APL210x-SH/FH option. Outputs are not simultaneous.
5) Averaged from pulses, emitted during 30 sec time interval.
6) Optional 30 ps duration. Inquire for pulse energies.
7) Should be specified when ordering. Inquire for custom pulse repetition rates.
8) Gaussian fit >80%.
9) Full angle measured at the $1/e^2$ level at 1064 nm.
10) Beam diameter is measured at 1064 nm at the $1/e^2$ level.
11) Value measured from 300 shots.
12) Required current rating can be calculated by dividing power rating by mains voltage.




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## OPTIONS

- **Option P30** provides 30±3 ps output pulse duration. Contact EKSPLA for pulse energy specifications.

## ORDERING INFORMATION

**APL2105-P90-10-SH/TH/FH**

- Model
- Pulse duration:
  P90 → 90 ps
  P30 → 30 ps
- Pulse repetition rate in Hz
- Harmonic generator options:
  SH → second harmonic
  TH → third harmonic
  FH → fourth harmonic

# Nd:Glass SYSTEMS

## Nanosecond High Energy Laser Systems

160 J @ 1053 nm MM laser system

Ekspla offers wide range of high energy Nd:Glass laser systems. Typically Nd:Glass laser comprise SLM diode pumped master oscillator, pre-amplifier, pulse shaper and main lamp pumped amplifiers.

### FEATURES

- *Front end options*
  - *Diode pumped SLM or MM master oscillator featuring excellent stability, live time and maintenance-free operation based on Nd:glass or Nd:YLF*
  - *Temporally shaped seeder / regenerative amplifier configuration allowing application of smoothing technics*
  - *Wave front correction system based on DFM*
- *Optional SBS compressor ensuring high contrast pulses and controllable pulse duration*
- *Flashlamp / LD pumped pre-amplifier*
- *Up to Ø60 mm aperture Nd:glass power amplifiers*
- *Laser protection by Faraday isolators preventing damage of laser rods by back-reflected light*
- *Optimized design for maximum pulse energy extraction*
- *Separately controlled PFN circuits for each flash lamp*
- *Diagnostics and monitoring of system status based on microprocessor controller*
- *Software guide for step-by-step performance check at designated control points*
- *Optional second and third harmonics generators*

### SPECIFICATIONS

| Parameter | Value |
|---|---|
| Center wavelength | 1053 – 1060 nm |
| Pulse width | 500 ps – 20 ns |
| Max pulse energy single channel | 150 J |
| Beam spatial profile (near field) | "Top Hat" across 80% of beam cross-section (beam local intensity fluctuation max ±20% from the average intensity) |
| Pulse repetition rates | depending on system configuration from 1 shot in 1 min to 1 shot in 20 min for output energies >10 J |
| Shot to shot stability | below 2.0% rms @ fundamental in single channel configuration |
| Linewidth | <0.02 $cm^{-1}$ @ 2 ns for single longitudinal mode (SLM), <1 $cm^{-1}$ @ 4 ns for multimode (MM) |
| Pre-pulse contrast | better than $1 : 10^5$ |
| Polarization contrast | >100 : 1 |
| Output isolation from back-reflected light | >500 : 1 (Faraday isolator contrast) |
| Optical pulse jitter | typical <0.2 ns RMS, optional <10 ps RMS |
| Flashlamp lifetime | $2 \times 10^5$ shots typical (typically >3000 hours of non-stop operation at PRR 1 shot/minute) |
| Pump diode lifetime | >10 000 hours typical |


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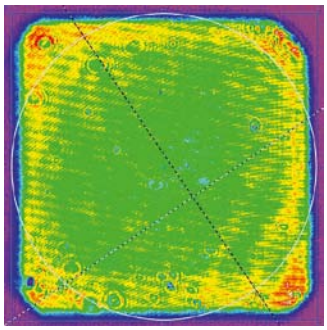
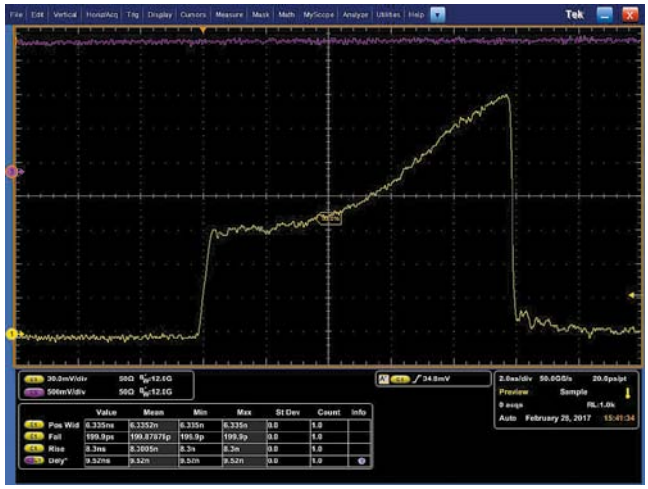
## PERFORMANCE

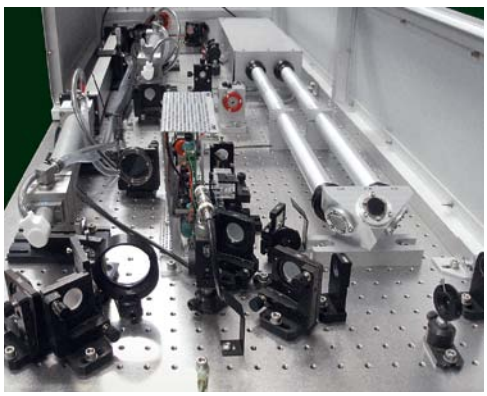


Spatial shaping of 33 J @ 1053 nm output pulses (beam of rectangular shape)

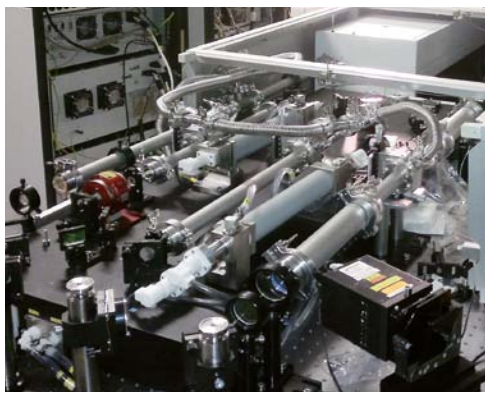


One example of the pulse wave form at the output @ 33 J (fundamental)

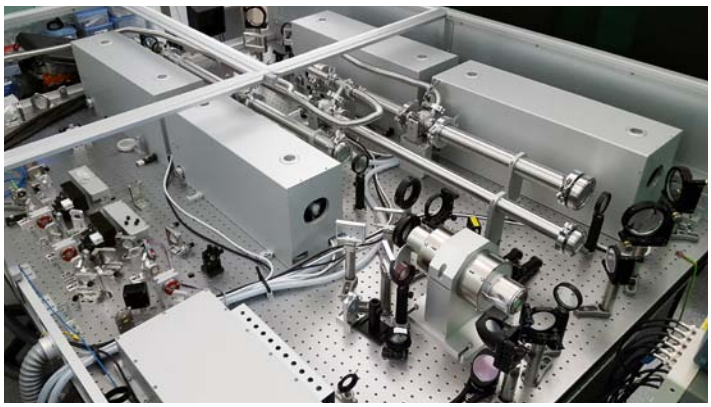
## CUSTOM INSTALATIONS



Amplifier system delivering 1 J at center wavelength 1060 nm, pulse width 800 ps and ~ 4 nm (FWHM) gain bandwidth



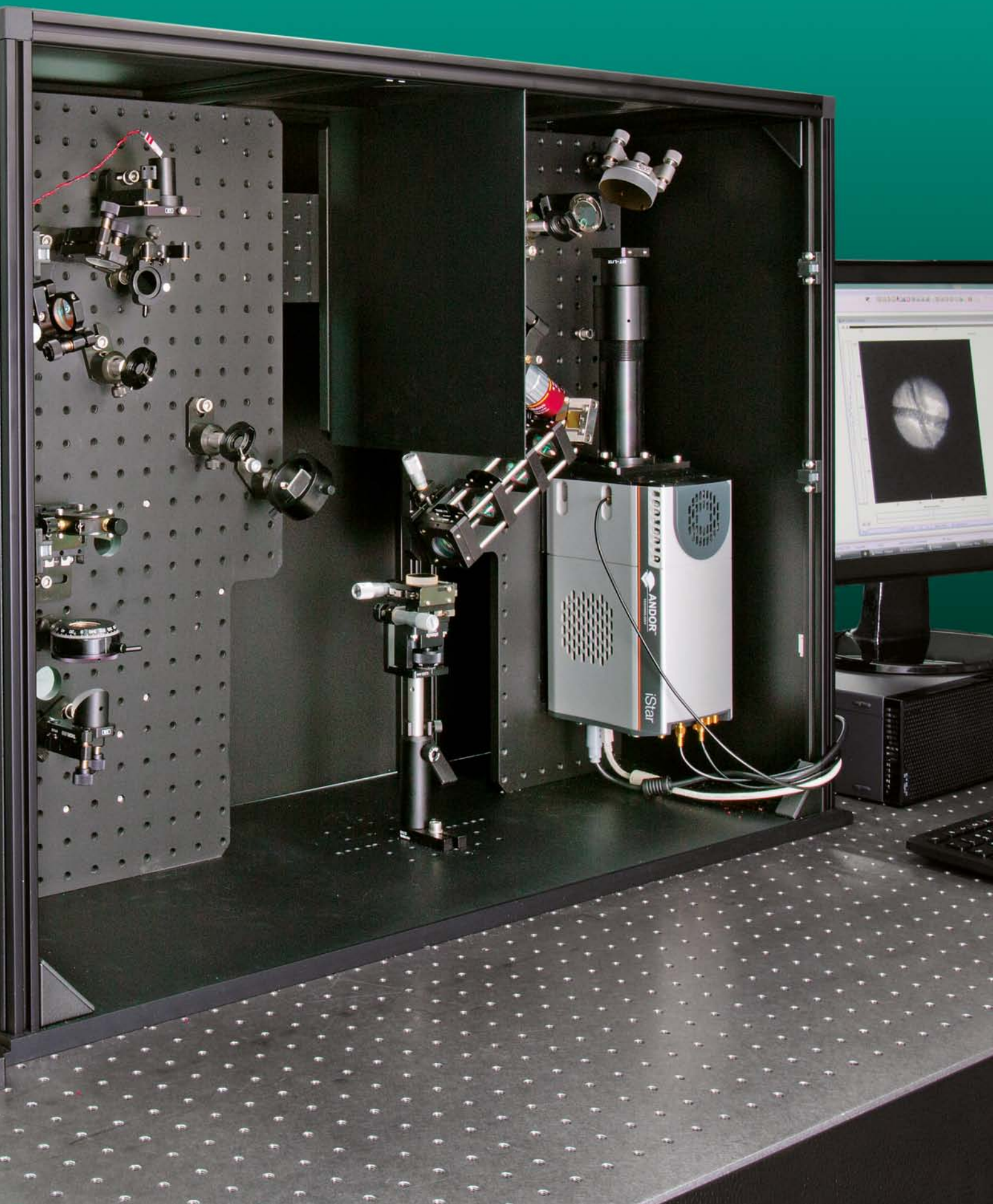
12 J @ 527 nm laser system during development stage



30 J Nd:glass system featuring arbitrary shaped temporal pulse shape

# Laser Spectroscopy Systems


Photo: SFG microscope – provides spectral and spatial surface information with micrometers resolution


ANDOR
iStar

# SFG SPECTROMETER

## Picosecond Vibrational Sum Frequency Generation Spectrometer


### FEATURES

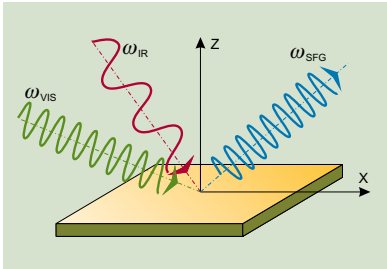
- *Intrinsically surface specific*
- *Selective to adsorbed species*
- *< 6 $cm^{-1}$ (optional < 2 $cm^{-1}$) spectral resolution*
- *Sensitive to submonolayer of molecules*
- *Applicable to all interfaces accessible to light*
- *Nondestructive*
- *Capable of high spectral and spatial resolution*

### APPLICATIONS

- *Investigation of surfaces and interfaces of solids, liquids, polymers, biological membranes and other systems*
- *Studies of surface structure, chemical composition and molecular orientation*
- *Remote sensing in hostile environment*
- *Investigation of surface reactions under real atmosphere, catalysis, surface dynamics*
- *Studies of epitaxial growth, electrochemistry, material and environmental problems*

### Principle of Operation

Sum Frequency Generation Vibrational Spectroscopy (SFG-VS) is a powerful and versatile method to characterize vibrational bonds of molecules at surfaces or interfaces. Sum Frequency signal (SF) is generated in visible spectral range, so it can be efficiently measured using sensitive detectors. In SFG-VS experiment a pulsed tunable infrared IR ($\omega_{IR}$) laser beam is mixed with a visible VIS ($\omega_{VIS}$) beam to produce an output at the sum frequency ($\omega_{SFG} = \omega_{IR} + \omega_{VIS}$). SFG is second order nonlinear process, which is allowed only in media without inversion symmetry. At surfaces or interfaces inversion symmetry is necessarily broken, that makes SFG highly surface specific. As the IR wavelength is scanned, active vibrational modes of molecules at the interface give a resonant contribution to SF signal. The resonant enhancement provides spectral information with resolution < 6 $cm^{-1}$ on surface characteristic vibrational transitions.




### System Components

- Picosecond mode-locked Nd:YAG laser
- Multichannel beam delivery unit
- Picosecond optical parametric generator
- Spectroscopy module
- Monochromator
- PMT based signal detectors
- Data acquisition system
- Dedicated LabView® software package for system control

### SFG Spectrometer Modifications

- **Double resonance SFG spectrometer** – allows investigation of vibrational mode coupling to electron states at a surface
- **Phase sensitive SFG spectrometer** – intensity and phase of the Sum Frequency Generation is measured
- **SFG microscope** – provides spectral and distribution information on the surface with micrometers resolution

### Optional Accessories

- Single or double wavelength VIS beam: 532 nm and/or 1064 nm
- One or two detection channels: main signal and reference
- Second harmonic generation surface spectroscopy option
- High resolution option – down to 2 $cm^{-1}$
- Motorized VIS and IR beams polarisation control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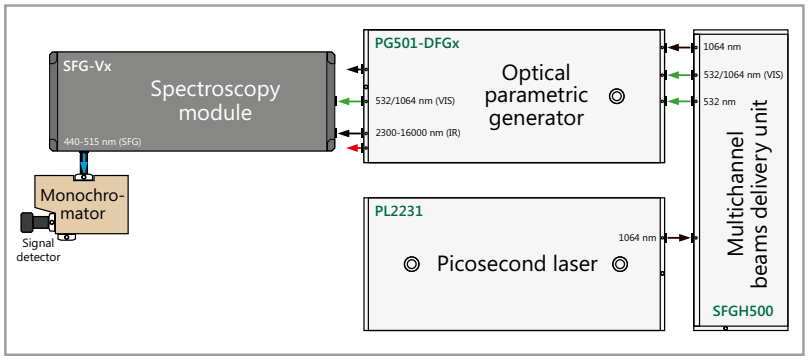
## SPECIFICATIONS [1)]

| Version | Classic | Advanced | Double resonance | Phase Sensitive |
|---|---|---|---|---|
| Spectral range | 1000–4300 $cm^{-1}$ | 625–4300 $cm^{-1}$ | 1000–4300 $cm^{-1}$ | 1000–4300 $cm^{-1}$ |
| Spectral resolution | < 6 $cm^{-1}$ (optional: < 2 $cm^{-1}$) | | < 10 $cm^{-1}$ | < 6 $cm^{-1}$ (optional: < 2 $cm^{-1}$) |
| Spectra acquisition method | Scanning | | | |
| Sample illumination geometry | Top side, reflection (optional: bottom side, top-bottom side, total internal reflection) | | | |
| Incidence beams geometry | Co-propagating, non-colinear (optional: colinear) | | | Non-colinear |
| Incidence angles | Fixed, VIS ~60 deg, IR ~55 deg (optional: tunable) | | | Not tunable |
| VIS beam wavelength | 532 nm (optional: 1064 nm) | | Tunable 420–680 nm (optional: 210–680 nm) | 532 nm |
| Polarization (VIS, IR, SFG) | Linear, selectable "s" or "p", purity >1:100 | | | |
| Beam spot on the sample | Selectable, ~150–600 µm | | | Fixed |
| Sensitivity | Air-water spectra | | | Solid sample |

[1)] Due to continuous improvement, all specifications are subject to change without advance notice. Please ask for separate brochure.

## SPECTROMETER LAYOUT




## EXAMPLES OF SFG SPECTRA

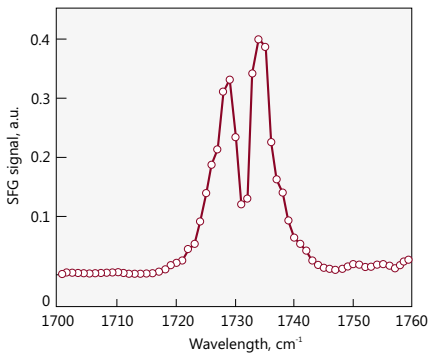



*Fig 1.* SFG spectra of monoolein surface, 1 $cm^{-1}$ scan step, 200 acquisitions per step. *Courtesy of EKSPLA Ltd.*

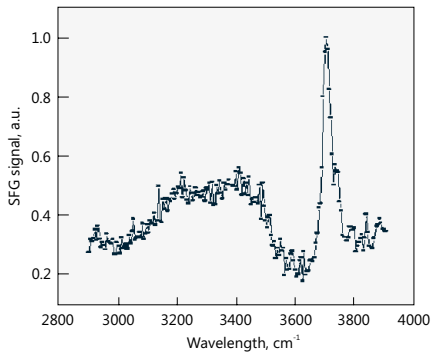
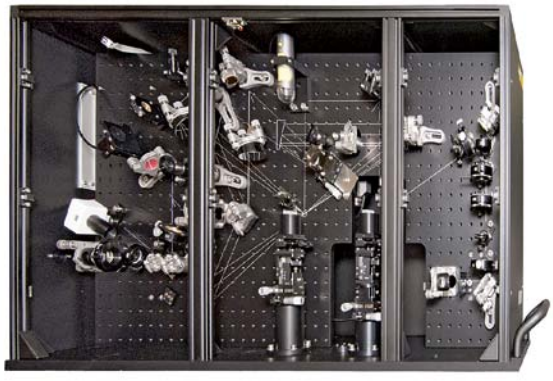



*Fig 2.* Water-air interface spectra, 200 acquisitions per step. *Courtesy of University of Michigan*

## EXAMPLE OF MODIFICATIONS

Ask for separate brochure



SFG spectroscopy module. Classic + Phase sensitive versions in one unit

# CARSCOPE SERIES

## Coherent Anti-Stokes Raman Scattering Microspectrometer

### FEATURES

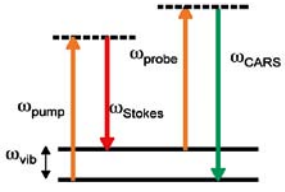
- *Wide range of accessible vibrations: 740-4000 $cm^{-1}$*
- *Minor fluorescence interference*
- *High spectral resolution and sensitivity*
- *Sub-wavelength spatial resolution*
- *F-CARS, E-CARS, P-CARS detection geometries*
- *Easy transformable to fluorescence, TPEF and SHG microscopes*
- *Up to 1300 µm excitation for TPEF*
- *Specially designed cost-effective picosecond tunable laser system*

### APPLICATIONS

- *Species selective spectroscopy and microscopy*
- *Multimodal nonlinear imaging*
- *Deep tissue in vitro imaging*
- *Long term live cell studies*
- *Non-destructive research for the biological and material sciences*

### Principle of Operation

Coherent anti-Stokes Raman scattering (CARS) spectroscopy is sensitive to the vibrational signatures of molecules. CARS is a third-order nonlinear optical process involving three laser beams: a pump beam of frequency $\omega_{pump}$ , a Stokes beam of frequency $\omega_{Stokes}$ and a probe beam at frequency $\omega_{probe}$ . These beams interact with the sample and generate a coherent optical signal at the anti-Stokes frequency $\omega_{CARS} = \omega_{pump} - \omega_{Stokes} + \omega_{probe}$ . The CARS signal ωCARS is resonantly enhanced when the difference between the pump $\omega_{pump}$ and Stokes $\omega_{Stokes}$ frequencies matches a vibrational transition $\omega_{vib}$ of the molecule.
Combining of CARS spectroscopy with the microscopy opens up unique method for chemical imaging. CARS microscopy permits vibrational imaging with high sensitivity, high speed and three-dimensional nearly diffraction limited spatial resolution.




### System Components

- Tunable wavelength picosecond laser PT25x series
- Excitation beams combining, control and monitoring unit
- Inverted microscope platform with forward and backward detection ports
- Three dimensional scanning system (piezo stage or scanning head)
- Signal separation unit (monochromator or set of filters)
- Signal detector and data acquisition unit
- Personal computer and control software

### Options

- Fluorescence microscopy option
- Two photon excitation fluorescence option
- Second harmonic generation option

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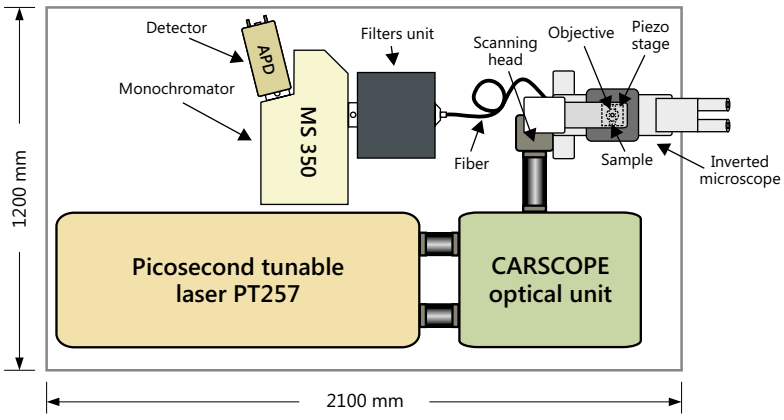
## SPECIFICATIONS [1)]

| Parameter | Value |
|---|---|
| Spectral range | 740–4000 $cm^{-1}$ |
| Pump/probe beams wavelength range | 740–990 nm |
| Stokes wavelength | 1064 nm |
| Spatial resolution | 0.7 µm |
| Pulse repetition rate | 1 MHz or 88 MHz |
| Pulse duration | ~5 ps |
| Linewidth | <8 $cm^{-1}$ |

[1)] Due to continuous improvement, all specifications are subject to change without advance notice. Please ask for separate brochure.

## SYSTEM LAYOUT




## SPECTRA AND IMAGES OF BIOLOGICAL SAMPLES

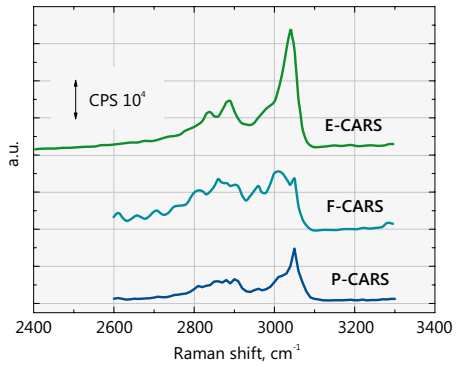



*Fig 1.* E-CARS, F-CARS, P-CARS spectra of a polystyrene bead (1.1 µm in diameter)

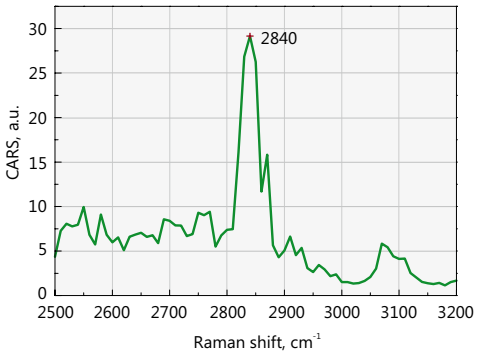



*Fig 2. Nostoc Commune*, spectra of symmetrical -$CH_2$ stretch

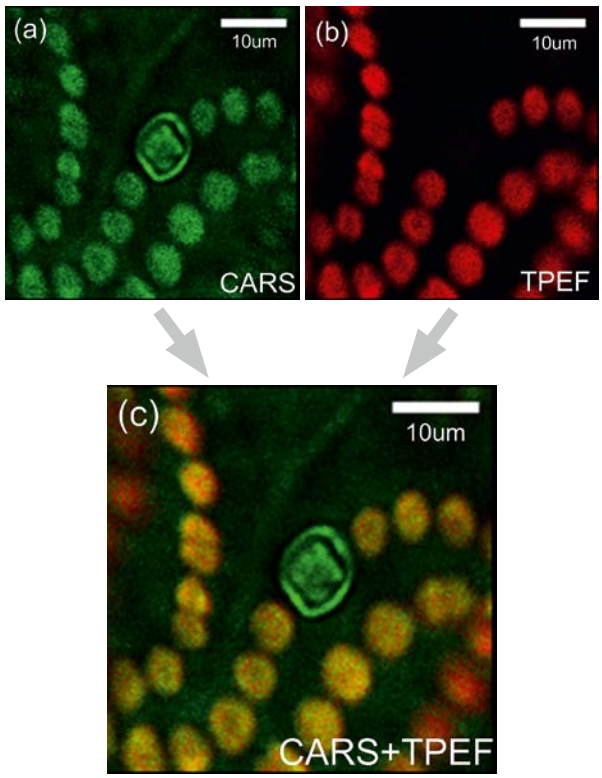



*Fig 3.* Pseudo color images of green algae *Nostoc commune* using different contrast mechanisms: coherent anti-Stokes Raman scattering (a), two-photon excitation fluorescence (b) and overlay of CARS and TPEF images (c)

# T-SPEC SERIES

## Real-Time Terahertz Spectrometer

### FEATURES

- *Wide spectral range up to 5 THz*
- *High dynamic range >90 dB @ 0.4 THz*
- *Real-time data acquisition up to 10 spectra/s*
- *Excellent spectral resolution up to 1 GHz*
- *"No bearing" design of fast delay line – virtually unlimited lifetime*
- *Transmission and reflection modes*
- *High spatial resolution THz imaging*
- *Complete PC control*
- *User-friendly software*

Real-time Terahertz Spectrometer offered by Ekspla is a powerful tool for investigative applications of pulsed terahertz waves. With simple and robust design, it is easy-to-use and adaptable to individual requirements.

The unique design of microstrip photoconductive antenna fabricated on low-temperature grown GaAs substrate ensures broadband spectral coverage and high dynamic range. The system is designed with two delay lines: fast and slow. Fast scan line allows real time data acquisition with 10 spectra/s speed and 116 ps time window. Average of collected spectra can increase dynamic range up to 90 dB at pulse maximum and extend spectral range up to 5 THz. Additional slow delay line allows combination of multiple time windows; thus spectrometer obtains excellent spectral resolution up to 1 GHz. The fast scan line is designed without bearings and uses a magnetically coupled drive which makes it extremely reliable and significantly extends the lifetime.

T-SPEC spectrometer has housing with mounted gas inlets. It can be used as purging box, when experiment requires special environmental conditions, like nitrogen or dried air. The spacious sample area allows easy integration of additional equipment, like cryostat or heater. On a special demand we can provide the integration of such equipment, ensuring good fit, spectrometer box sealing, vibration isolation and operation automation.

Spectrometer is equipped with two standard spectroscopy modules for transmission and reflection configurations. Each module contains motorized sample manipulator. This allows measurements of multiple samples one by one, without physical access to the spectrometer. Reflection module has convenient vertical architecture, where THz beams reaches the sample from bottom and reflects backwards. The measured samples can be replaced quickly just by laying them down on the sample holder. No adjustment is needed either when changing samples or when changing modules.

Our T-SPEC series spectrometer is the perfect choice for broadband THz imaging. It allows scan of up to 25×25 mm sample with spatial resolution of approx. 1 mm. Measurements contain information about the target, revealing both structural and spectroscopic information.

### APPLICATIONS

- *Chemical material characterization*
- *Carrier lifetime and mobility in semiconductors*
- *Dielectric properties and complex refractive index*
- *Metamaterials investigation*
- *Medical and biological nondestructive research*
- *Thickness measurements*

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## SPECIFICATIONS

| Model | T-SPEC 800 | T-SPEC 1000 |
|---|---|---|
| Spectral range | >4.5 THz | >3.5 THz |
| Dynamic range | >90 dB @ 0.4 THz | >70 dB @ 0.4 THz |
| Acquisition rate | 10 scans/s | |
| Spectral resolution: | | |
| fast scan | 8.6 GHz | |
| combined mode (fast + slow) | ~1 GHz | |
| Scan range: | | |
| fast scan | 116 ps | |
| combined mode (fast + slow) | 928 ps | |
| Beam diameter on the sample | ~ 2 mm @ 0.4 THz | |
| Configurations | Transmission / normal reflection | |
| Computer interface | USB 2.0 | |
| Dimensions | 560 × 520 × 202 mm | |

## EXAMPLES OF THz SPECTRA

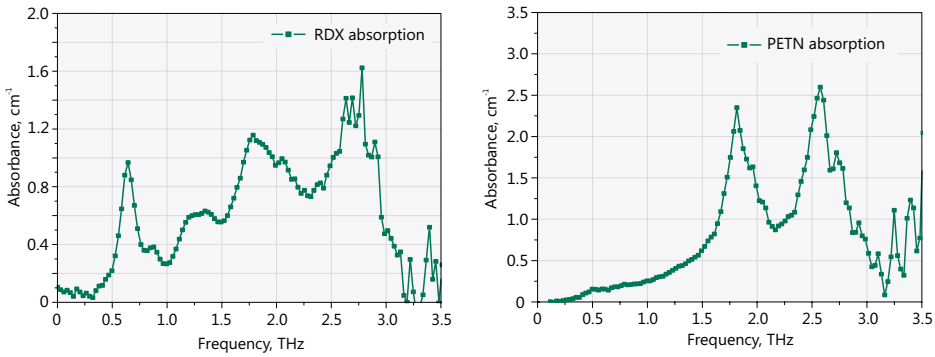



*Fig. 1.* Absorption spectra of explosives in terahertz range measured by Ekspla T-SPEC spectrometer in ambient atmosphere

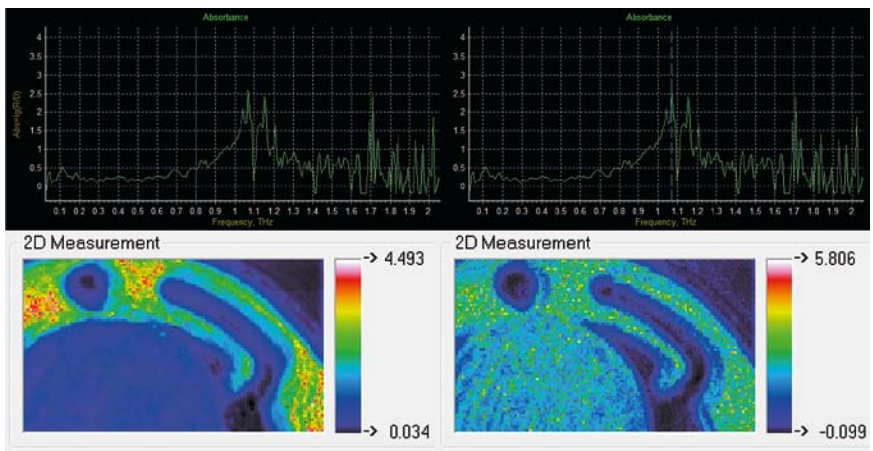



*Fig. 2.* THz image of tablet containing L-Tartaric acid and metallic part taken in transmission geometry. Tablet is almost transparent at 0.8 THz frequency and become visible close to absorption peak at 1.1 THz frequency

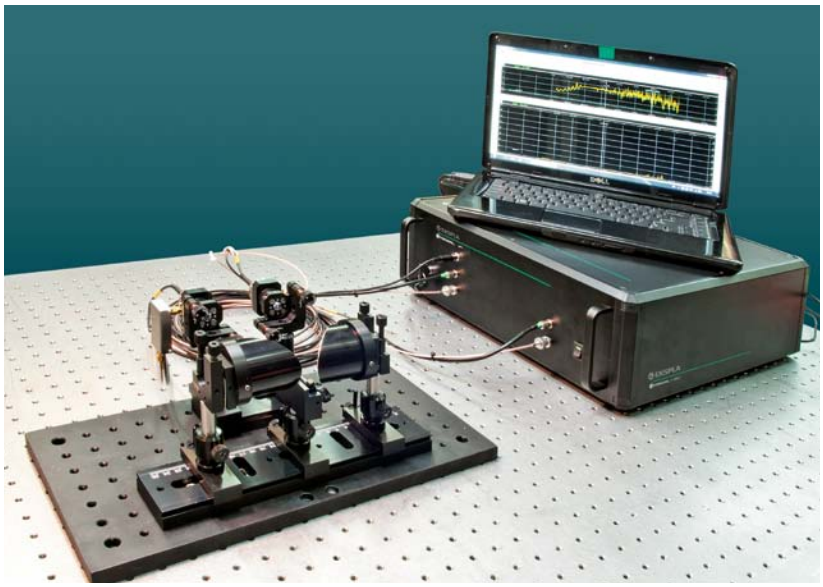
## CUSTOM INSTALATIONS

*Fig. 3.* T-SPEC THz spectrometer installed into LIDAR operating in terahertz range was used to scan remote objects at 7 m distance.

*THz LIDAR installed in Lomonosov Moscow State University, Russia*

# T-FIBER SERIES

## Fiber-Coupled Terahertz Spectrometer



Fiber-coupled Terahertz Spectrometer T-FIBER, offered by Ekspla, features flexible and robust design. It has integrated femtosecond fiber laser with two fiber output ports. Comparing to common Ti:S oscillators, fiber lasers are smaller, cheaper, more reliable and feature parameters that are perfect for terahertz generation.

Femtosecond laser, delay line and signal registration electronics are integrated in a single compact housing with footprint only 40×40 cm. Minimal set of free space optics used in spectrometer allows stable long time operation. Special "no bearing" design of fast delay line makes its lifetime practically unlimited. Delay line allows real time data acquisition with 10 spectra/s speed and 116 ps time window.

Fiber-coupled THz emitter and detector make switching between experiment geometries easier than before. Due to its compact size and reliability during transportation, T-FIBER spectrometer is dedicated for laboratory use as well as for real field applications. We are also happy to customize it according to special OEM customer requirements.

Basic setup of T-FIBER spectrometer includes optical rail, with fiber-coupled THz emitter, detector, two PE lenses and sample holder. This setup provides transmission geometry and it is extremely simple in alignment.

As an option goniometer stage can be supplied. This inexpensive module allows operation in multiple most common geometries, including transmission and tunable angle reflection from approx. 18.5° up to 90°. It also can be used for unique THz scattering experiments, because sample and detector angles can be changed independently. This module gives also better focusability of THz beam.

### FEATURES

- *Pump pulse fiber delivery*
- *Real-time measurements*
- *Unlimited lifetime of delay line*
- *Flexible design*
- *THz imaging capability*
- *Complete PC control*
- *Excellent value for money*

### APPLICATIONS

- *Time-resolved broadband THz spectroscopy*
- *Production processes monitoring*
- *Hazardous substances detection*
- *Paint and coatings layers thickness measurements*
- *Food and agricultural products quality inspection*
- *Medical imaging*

### THZ COMPONENTS AND ACCESSORIES

- *Ask for separate THz brochiure*

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## SPECIFICATIONS

| Model | T-FIBER basic version | T-FIBER with goniometer |
|---|---|---|
| Spectral range | >3 THz | |
| Dynamic range | >60 dB @ 0.4 THz | >65 dB @ 0.4 THz |
| Acquisition rate | 10 scans/s | |
| Spectral resolution | 8.6 GHz | |
| Scan range | 116 ps | |
| Configurations | Transmission | Transmission / tunable angle reflection / scattering |
| Incidence angles range (in reflection mode) | – | 18.5 – 90° |
| Detection angles (in scattering mode) | – | 37 – 286° |
| Computer interface | USB | |
| Main unit dimensions | 400 × 400 × 158 mm | |
| Spectroscopy setup footprint | 670 × 70 mm | 450 × 300 mm |

## SYSTEM LAYOUT

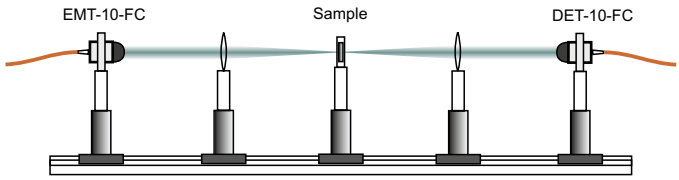



*Fig. 1.* Sample area schematic layout (basic version)

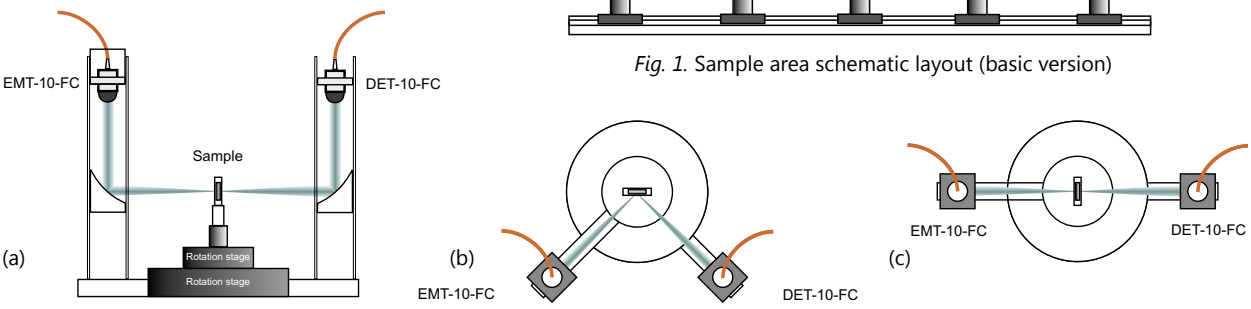
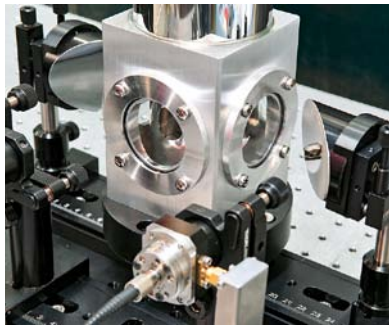
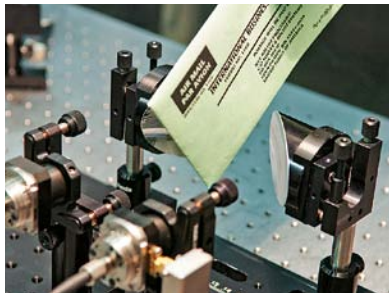


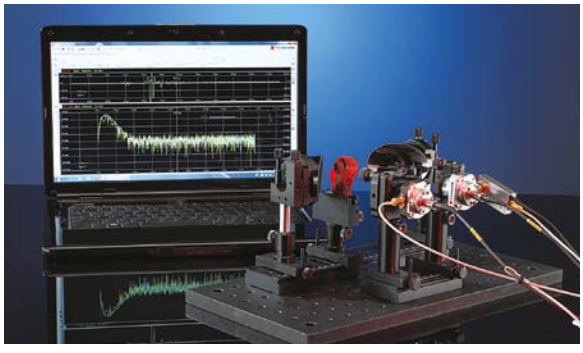

*Fig. 2.* Goniometer schematic layout: side view (a), top view in reflection geometry (b), top view in transmission geometry (c)

## MODIFICATION EXAMPLES

We are happy to tailor our products for your application







# AC SERIES

## Scanning Autocorrelator


### FEATURES

- *Designed for **5–400 ps** pulse duration range*
- ***1064 nm** or **532 nm** wavelength, other wavelengths by request*
- *Single thin nonlinear crystal (for single wavelength models)*
- *Background-free measurements*
- *Simple alignment*
- *LabVIEW™ based software, LabVIEW™ source code by request*

### APPLICATIONS

- *Measurement of pulse duration of mode-locked or SBS-compressed solid-state lasers*

Autocorrelators of AC series are designed for the measurement of pulse duration of ultrafast lasers using the non-collinear second harmonic generation technique. The incoming pulse is split into two identical copies and overlapped spatially in non-linear crystal. The intensity of the generated second harmonic wave depends on the temporal overlap of the two pulses. By scanning the delay of one of the pulses, the shape of the autocorrelation function is measured, and then the pulse duration is calculated, assuming a Gaussian or $sech^2$ incoming pulse shape.

Standard AC series models are targeted to work with mode-locked or SBS-compressed Nd:YAG or Nd:YLF lasers at fundamental or second harmonic wavelength. A double-wavelength model is available as well. The autocorrelator can be built to accept input wavelengths in the 420–2000 nm range on request.

The scanning range can be extended from standard ±300 ps to ±1200 ps for longer pulse duration measurements or for more detailed pulse shape characterisation (for example, the measurement of satellites of the main pulse).

Software supplied together with the autocorrelator allows for automated, hands-free measurement. The user can set the scanning step and range, the number of pulses averaged, and other parameters. The installed input pulse energy monitor allows the user to gate incoming pulses by their energy, making sure that laser instabilities do not influence the result.

The software requires a desktop or a laptop computer with Windows XP/Vista/7 operating system and one USB port. Please note: the computer is not supplied with the unit, and should be provided by the user.

### Measurement range extending add-ons

| Option | Features |
|---|---|
| -P200 | For measurement up to 200 ps FWHM pulse duration. The scan range is ±600 ps |
| -P400 | For measurement up to 400 ps FWHM pulse duration. The scan range is ±1200 ps |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## SPECIFICATIONS [1]

| Model | AC532 | AC1064 | AC532/1064 [2] |
|---|---|---|---|
| Input wavelength [3] | 530–535 nm | 1047–1079 nm | 530–535 nm; 1047–1079 nm |
| Min. measurable pulse duration [4] | 5 ps | | |
| Max. measurable pulse duration [4] [6] | 100 ps | | |
| Scan range [5] | ±300 ps | | |
| Temporal resolution | 33.3 fs/step | | |
| Dynamic range | >1:$10^4$ | | |
| Min. pulse energy required [7] | 50 nJ for 100 ps pulses / 2.5 nJ for 5 ps pulses | | |
| Pulse repetition rate | 1–1000 Hz | | |
| Input light polarization | vertical or horizontal | | |
| Triggering | requires triggering pulse with at least 30 ns lead with respect to optical pulse | | |
| **PHYSICAL CHARACTERISTICS** | | | |
| Size (W × H × L) | 450 × 270 × 450 mm | | |
| **OPERATING REQUIREMENTS [8]** | | | |
| Ambient temperature | 15–25 °C | | |
| Relative humidity (non-condensing) | 10–80 % | | |
| Mains requirements | 90–240 V AC, 2A, single phase, 50/60 Hz | | |

1) 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.

2) For a change of input wavelength, the manual reconfiguration of the optical layout is necessary.

3) Inquire about other available input wavelengths in the 420 nm to 2 µm range.

4) At FWHM level assuming Gaussian pulse shape.

5) The scan range is extended to ±600 ps for the P200 option and to ±1200 ns for the P400 option. Inquire about custom scan ranges.

6) The maximum measurable pulse duration is 200 ps for the P200 option and 400 ps for the P400 option.

7) The typical laser output pulse energy and repetition rate range should be specified when ordering.

8) A desktop or a laptop computer with one USB port is required to run measurement software.

## OPTICAL LAYOUT

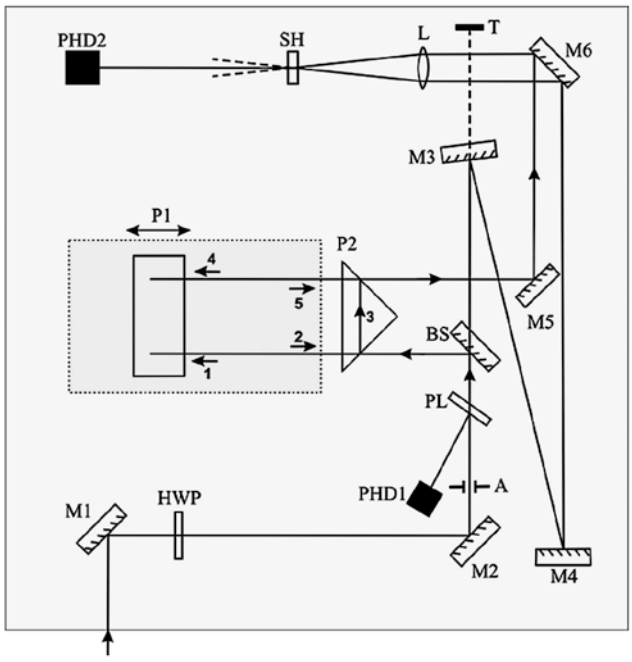


*Fig. 1.* Optical layout of AC1064 autocorrelator

## SOFTWARE

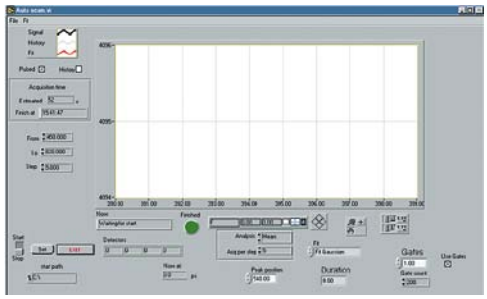

*Fig. 2.* Software window of AC1064/AC532 autocorrelator

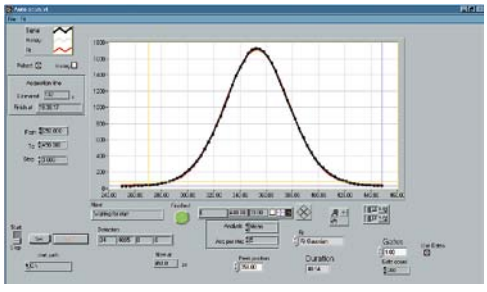

*Fig. 3.* Autocorrelation trace of 40 ps pulse from PL2251 series laser

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Photo: Unique OPCPA based laser system, providing **5 terawatts** of output power at **1 kHz** repetition rate has been produced by Ekspla and Light Conversion led consortium. Sylos 1 named system is generating **10 fs** or shorter pulses and was designed and build for Extreme Light Infrastructure – Attosecond Light Pulse Source facilities (ELI-ALPS) located in Szeged, Hungary

# Notes


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