Aurura OPO

Turn-key 19” 2U benchtop box system

The Aurora OPO

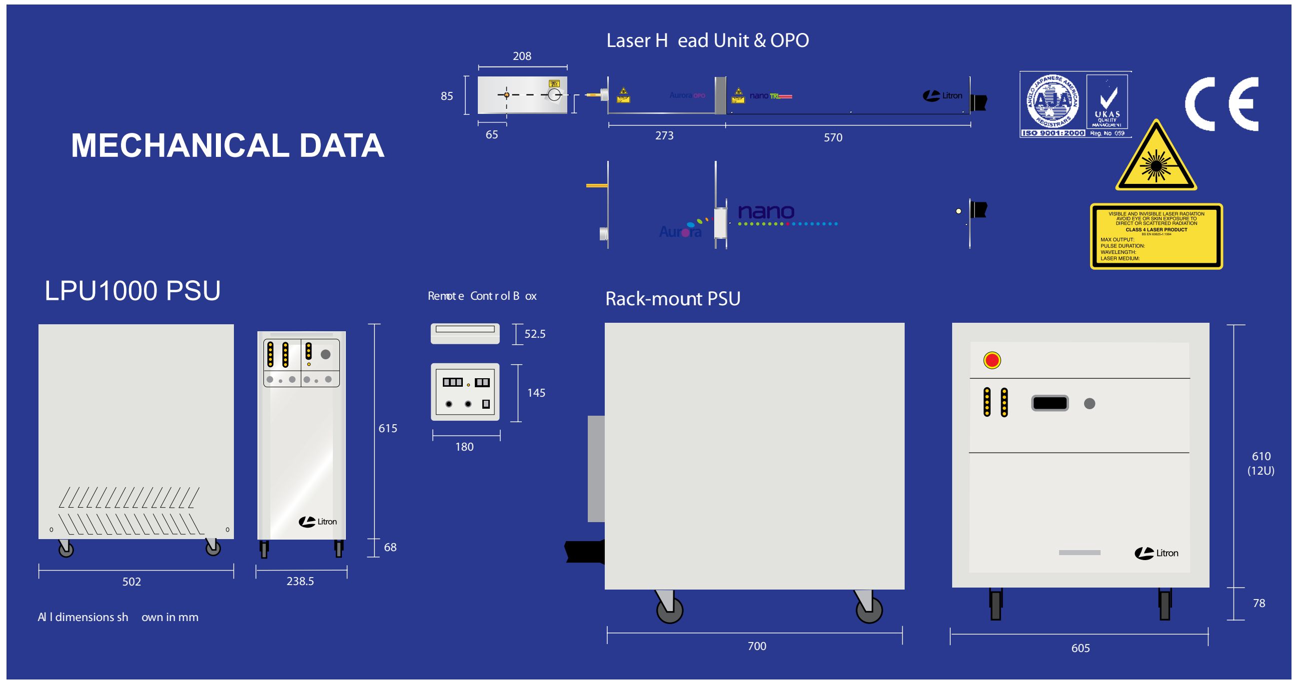
Based around BBO, the Aurora is a broadband device pumped at 355nm. It is continuously tunable from 410nm to 680nm and the corresponding idler output to 2400nm is also available. Designed to be fully integrated with either the Nano series or the larger LPY series of systems the OPO is a modular attachment designed specifically for use with Litron’s lasers. Precise stepper motor control of the crystal and accurate optical encoding of its position ensure accurate and repeatable wavelength tuning and output.

Conversion efficiencies of up to 30% are achieved allowing outputs of >50mJ in the visible from a compact laser and OPO combination making it ideal for either laboratory based or portable applications requiring a tunable source.

SPECIFICATIONS

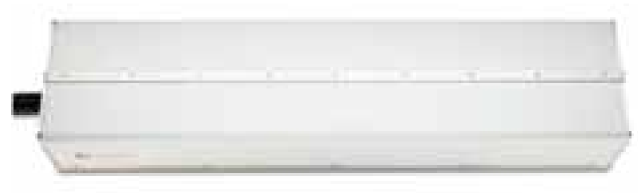
Model	Aurora 20	Aurora 35	Aurora 50
Pump energy (mJ @355nm)	75	110	180
Max. signal output (mJ)	20	35	50
Linewidth (cm^{-1})	5 - 250	5 - 250	5 - 250
Repetition rate (Hz) (1)	0 - 200	0 - 200	0 - 200
Signal tuning range (nm)	410 - 680	410 - 680	410 - 680
Laser type	Nano LG Nano TRL	Nano TRL	LPY700

(1) Maximum repetition rate depends upon pump laser specification.



LPY7000

The LPY7000 Series Ultra-High Energy Pulsed Q-switched Nd:YAG Lasers



FEATURES

- Rugged Industrial Build
- Up to 3.5J @ 1064nm
- Telescopic or Gaussian Resonators
- Full Energy in <5 Minutes at All Wavelengths
- Optional Seeder Package
- All Harmonics to 5th Available
- Full RS232 Software Control

The LP7000 lasers offer extremely high Q-switched outputs at repetition rates of up to 50Hz. Based around our proven self-supporting invar frame, their robust build quality suits them to both industrial and scientific applications.

The lasers are provided in an oscillator, preamplifier, main amplifier arrangement. The oscillator may be configured as a stable telescopic resonator offering a low order multimode output with a smooth spatial and temporal profile, or as an unstable Gaussian-coupled resonator offering a single transverse mode utput with slightly higher peak powers.

Lamp change is performed in a matter of minutes with no need for any realignment at all. An IP54 sealed case ensures that the laser is protected against the ingress of dirt and moisture when used in industrial environments.

For very narrow linewidths an optional injection seeder is available.

LPY7000 Series Uncovered

1 **Rear Mirror**

2 **Intracavity Telescope**

The intracavity telescope has a twofold use. Firstly it compensates for the thermal lensing of the laser rod.
Secondly it reduces the intra-cavity beam diameter, thus effectively increasing the diffraction length in the resonator. The result is very low divergence output beams whose beam profiles are spatially extremely homogeneous.

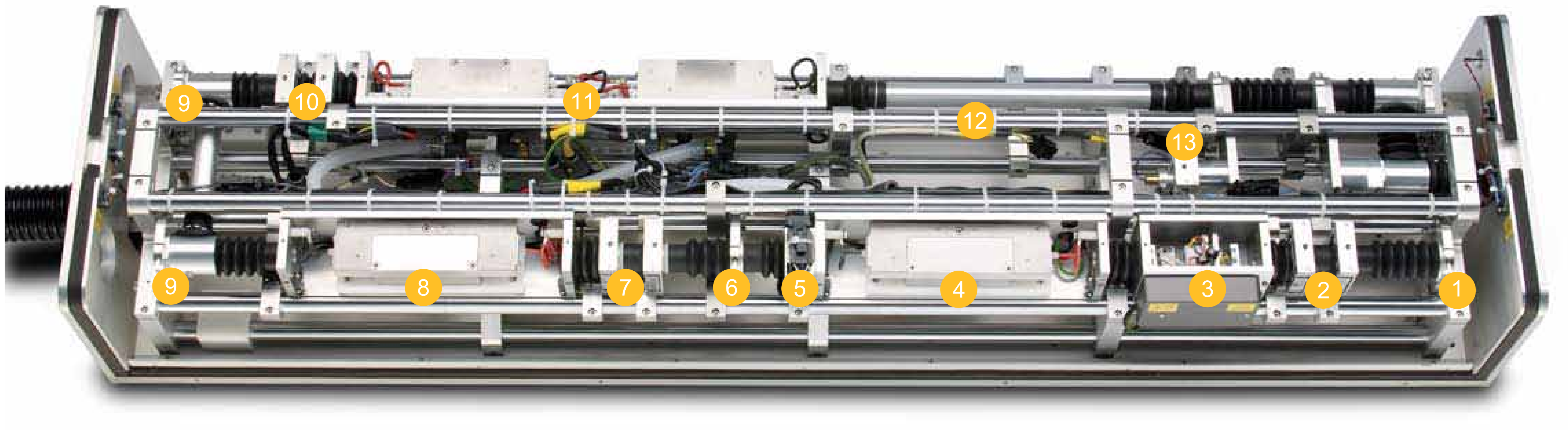
3 **Electro-optic Q-Switch**

A KD*P Pockels cell is used within the Q-switch assembly.

4 **Oscillator Pump Chamber**

All pump chambers are machined from solid 316 stainless steel. The chambers are split such that the lamp housing can be removed easily during lamp changes, leaving the rod untouched. The chambers are fitted with close coupled ceramic reflectors for efficient and uniform pumping. A proprietary filter plate protects the laser rod from UV emission from the lamp and also in the event of a lamp failure.

The design of the chambers is such that a large turbulent water flow leads to very uniform cooling of the rod, essential for good pointing and overall stability.



5 **Intra-cavity Shutter**

An electronically verified, electronically actuated, intra-cavity safety shutter is standard on all of Litron's lasers.

6 **Output Coupler**

7 **Expanding Telescope**

An expanding telescope is used to expand and collimate the oscillator output prior to amplification.

8 **Preamplifier Pump Chamber**

9 **Steering Mirrors**

10 **Expanding Telescope**

11 **Main Amplifier Pump Chambers**

The main amplifier is configured in a birefringence-compensated twin-rod topology. This minimises the depolarisation of the laser beam and leads to more uniform and more cient harmonic generation.

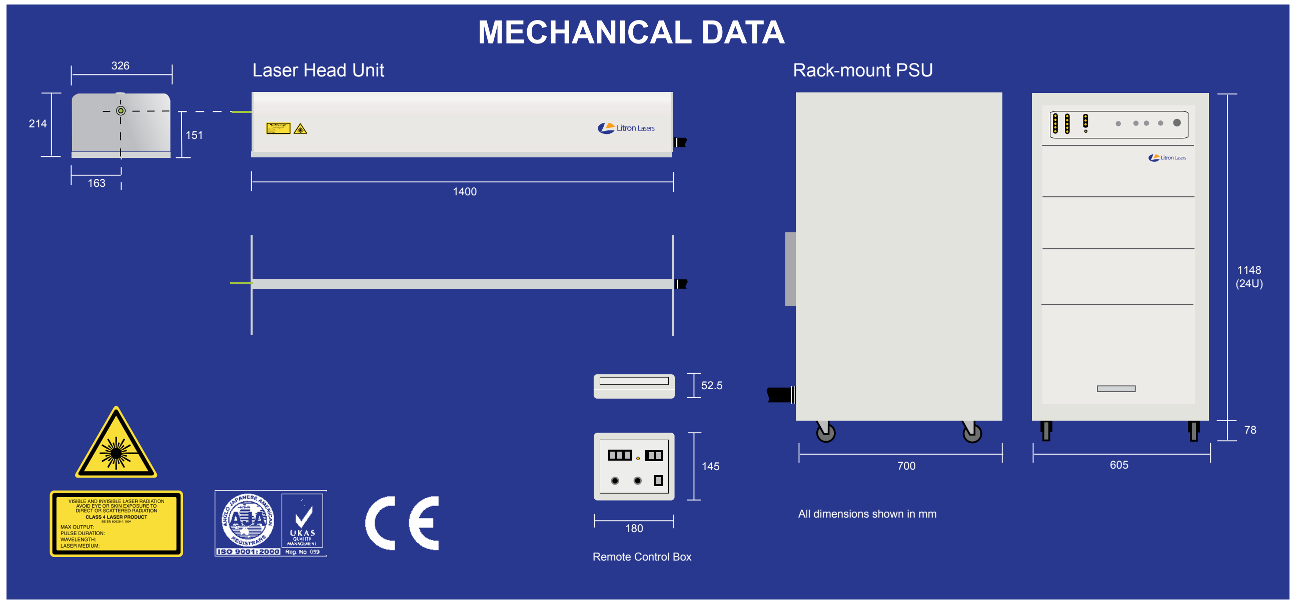
12 **Invar Rail**

The lasers are built on a rugged self supporting invar rail. This feature sets them apart from all competitors as it is both more robust and more stable them conventional base-plate constructions. The modular nature of the rail allows for easy customisation of the lasers.

13 **Optional Aiming Diode**

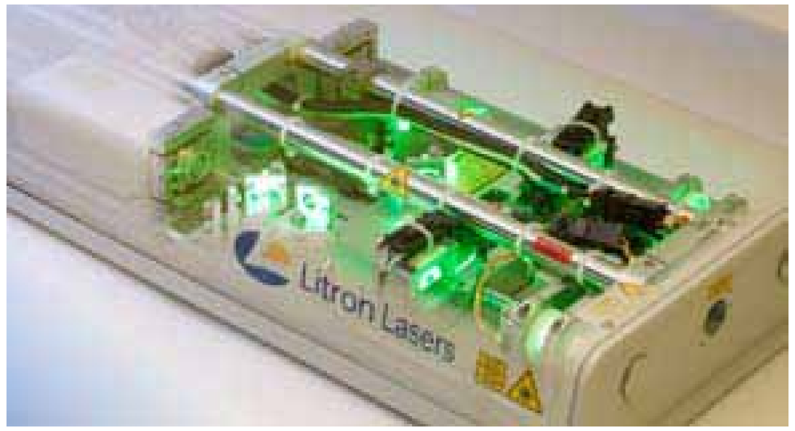
Model	LPY7864-10	LPY7864-20	LPY7864-30	LPY7864-50	LPY7875-10	LPY7875-20
Repetition Rate (Hz)	10	20	30	50	10	20
Output Energy (nm)						
1064nm	2750	2250	2000	1400	3500	2750
532nm	1400	1100	1000	700	1750	1350
355nm	600	480	450	250	700	600
266nm	250	140	95	80	275	170
Parameter						
Divergence (mrad) (1)	0.5	0.5	0.5	0.5	0.5	0.5
Pointing Stability(urad) (2)	50	50	50	50	50	50
Pulse length (ns)	10-12	10-12	10-12	10-12	10-12	10-12
Jitter (ps) (3)	500	500	500	500	500	500
Stability (+/-%)	2	2	2	2	2	2
Beam diameter (mm) (4)	12.5	12.5	12.5	12.5	15	15
Services						
Voltage (VAC)	220-250	220-250	220-250	220-250	220-250	220-250
Frequency (Hz)	50-60	50-60	50-60	50-60	50-60	50-60
Water (l/min) @ 3-5bar	5	5	5	5	5	5

NOTE
(1) Full angle for 90% of the energy.
(2) Full angle.
(3) With respect to the external Q-switch trigger input.
(4) Quoted as the main amplifier rod diameter.



Telescopic Lasers for PIV

Broader, Thinner and More Uniform Light Sheets



Litron offers telescopic versions of its popular Nano L and LPY PIV laser systems for dual pulse applications requiring a significantly lower M2 value than traditional lasers but with the excellent spatial uniformity of a conventional resonator.

This gives the possibility to make broad, thin, uniform light sheets for large area or high resolution PIV studies.

Litron can achieve a beam divergence as low as 0.8mrad at 532nm by placing a telescope inside the resonator. This is around four times lower than with a conventional laser and around twice that of a Gaussian coupled laser. However, the Gaussian coupled laser suffers from poor mid-field spatial uniformity, leading to non-uniform illumination of the experimental area.

Beam divergence does not tell the whole story. A 'figure of merit' for comparing a laser beam's focusability is M-squared. A theoretically perfect laser beam has an M2 value of one and real lasers have values of greater than one; the actual value of a real laser beam denotes how many times narrower or thicker a light sheet will be compared with a sheet from a perfect beam.

For Gaussian unstable lasers, M2 is typically less than the value predicted by measuring the divergence and beam diameter at the output; the two values are usually closely related for stable lasers.

For PIV applications, a four times lower M2 value means that a light sheet can be four times thinner for a given propagation distance or else four times longer for a given thickness.

Comparison of Laser Types

	M^2 Value	Light Sheet Extent	Light Sheet Uniformity
Conventional Stable	~12-15	Fair	Excellent
Gaussian Unstable	~1.6-1.8	Excellent	Poor
Telescopic Stable	**~3.5**	**Very Good**	**Excellent**

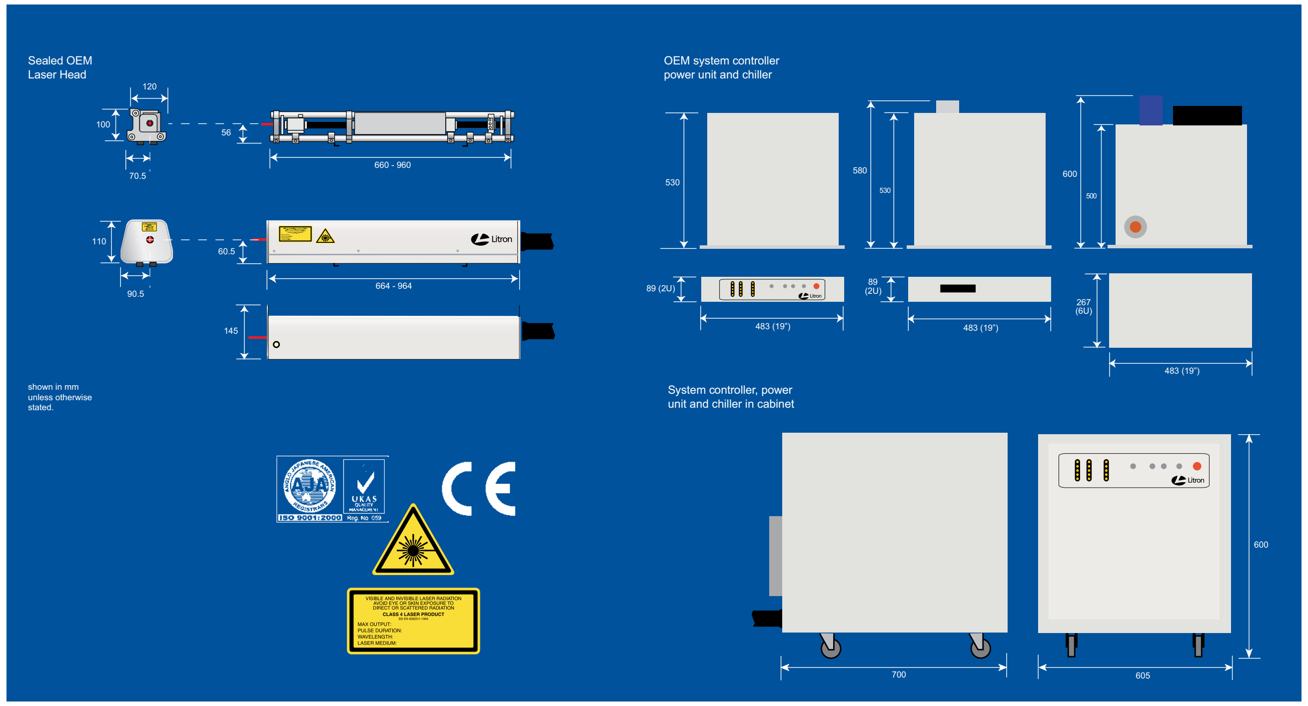
LCY Lasers

LCY Series Indu strial CW & Q-switched CW Nd:YAG Lasers

LCY Range Specification									
Nd:YAG CW Laser Oscillator	Single Linear Arc Lamp Pumped								
Wavelength (nm)	1064	1064	1064	1064	1064	1064	1064	1064	1064
Model	LCY20T	LCY35	LCY35T	LCY45	LCY45T	LCY70	LCY70T	LCY90	LCY90T
CW Specification									
Mode	TEM_{00}	MM	TEM_{00}	MM	TEM_{00}	MM	TEM_{00}	MM	TEM_{00}
Maximum CW output power (W)	20	35	6	45	6	70	18	90	20
Rated Lamp Input for Max CW Output (kW)	4	2	2	2.2	2	3.6	3.6	5	5
Beam Divergence [Full Angle 1/e^2] (mrad)	2.5	3	1.5	3	1.5	5	1.5	6.5	2.5
Beam Quality at Rated Input (M^2)	<1.3	7	<1.3	7	<1.3	8	<1.3	8	<1.3
Stability at Rated Input (% RMS)	1.5	1.5	1.5	1.5	1.5	1.5	1.5	2	2
Linear Polarisation	Std.	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Model	LCYT20Q	LCY35Q	LCY35TQ	LCY45Q	LCY45TQ	LCY70Q	LCY70TQ	LCY90Q	LCY90TQ
Q-Switched Specification									
Mode	TEM_{00}	MM	TEM_{00}	MM	TEM_{00}	MM	TEM_{00}	MM	TEM_{00}
CW output power for Q-switching (W)	20	35	6	45	6	70	18	90	20
Rated Lamp Input for Max Q-switched Output (kW)	4	2	2	2.2	2	3.6	3.6	5	5
Beam Divergence [Full Angle 1/e^2] (mrad)	2.5	3	1.5	3	1.5	5	1.5	6.5	2.5
Beam Quality at Rated Input (M2)	<1.3	7	<1.3	7	<1.3	8	<1.3	8	<1.3
Pulse to Pulse Stability at 5kHz, pk-pk% (% RMS)	3(1)	4(1.5)	4(1.5)	4(1.5)	4(1.5)	4(1.5)	4(1.5)	6(2)	6(2)
Q-switch Frequency Range (kHz)	1-100	1-100	1-100	1-100	1-100	1-100	1-100	1-100	1-100
Linear Polarisation	Std.	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Q-Switched Performance @ 1kHz									
Mode	TEM_{00}	MM	TEM_{00}	MM	TEM_{00}	MM	TEM_{00}	MM	TEM_{00}
Pulse Peak Power (kW)	45	80	14.5	100	14.5	150	45	200	45
Pulse Energy (mJ)	4.5	9	1.6	11	1.6	18	5	20	4.5
Pulse FWHM (ns)	100	110	110	110	110	120	110	100	100
Average Power (W)	4.5	9	1.6	11	1.6	18	5	20	4.5

Services									
Max. Ambient Temperature (°C) (Running)	35	35	35	35	35	35	35	35	35
Electrical Consumption at Specified Power (kW)	4.2	2.3	2.3	2.5	2.4	4.2	4.2	5.5	5.5
Electrical Input 3 Phase Type I (VAC)	380-440	220/240	220/240	220/240	220/240	380-440	380-440	380-440	380-440
Eletrical Input Frequency (Hz)	50/60	50/60	50/60	50/60	50/60	50/60	50/60	50/60 5	0/60
Cooling									
Minimum Pressure (bar)	2	Chiller cooled Max Ambient: 35°C	Chiller cooled Max Ambient: 35°C	2	2	2	2	2	2
Maximum (bar)	5			5	5	5	5	5	5
Water Consumption (lpm) @ 20°C	7.5			7.5	7.5	.5	7.5	9.5	9.5
Maximum Water Temperature °C	20			20	20	20	20	20	20
Lamp Life (Only for Litron Supplied Lamps)									
Guaranteed (hrs)	600	1500	1500	1500	1500	800	800	400	400
Nominal [Continuous Running at Rated Input] (hrs)	>800	2500	2500	>2200	>2200	>1000	>1000	>600	>600
PSU Type									

LCY Range Dimensions



Total Laser Capability

- LIBS
- Spectroscopy
- LIDAR
- Remote Sensing
- PIV
- Photochemistry
- LIF
- Nonlinear Optics
- Ti:SPumping
- Particle Sizing
- Flow Monitoring
- OPO Pumping
- Dye Laser Pumping
- Ablation
- Deflashing
- Laser Marking
- Mask Repair
- Engraving
- Stent / Stencil Cutting
- Hole Drilling
- Micromachining
- Materials Processing
- Silicon Dicing

COMPACT PULSED Nd:YAG LASER SYSTEMS

Nano Series

Ultra compact design.
Monolithic laser resonator.
Conventional stable, graded reflectivity unstable and telescopic stable resonators available.
Energy up to 900mJ.
Repetition rates up to 200Hz.
Rugged mechanical and optical design.
Turn-key operation RS232 interface.
Full range of harmonic generation assemblies.
Large range of accessories. Universal input voltage 90-260VAC.

Nano S - Small,

rugged, reliable and efficient.
Conventional stable resonator with electronically verified intra-cavity safety shutter. Available as TEM_{00} by the inclusion of an intra cavity aperture.
Repetition rate: up to 100Hz.
Energy: up to 130mJ at 10Hz.

Nano L - Rigid,

stable construction through elegant design lends itself to use in demanding industrial applications.
Repetition rate: up to 100Hz.
Energy: up to 320mJ at 10Hz.

Nano T -

As the Nano L but with telescopic stable resonator for very low beam divergence and excellent uniformity.
Repetition rate: up to 50Hz.
Energy: up to 320mJ at 10Hz.

Nano TRL –

Twin rod oscillator
with birefringence compensation for excellent beam quality. Extra rugged industrial design.
Repetition rate: up to 200Hz.
Energy: up to 900mJ at 10Hz.

Nano O -

Smallest head in the range, designed specifically for incorporation into customers' equipment.
Fully air cooled option available where water is not desired such as portable LIBS applications.
Repetition rate: up to 100Hz.
Energy: up to 130mJ at 10Hz.

HIGH POWER PULSED Nd:YAG LASER SYSTEMS

LPY 600/700 series

Invar stabilised resonator.
Modular construction for economical custom design.
Gaussian coupled or telescopic resonator. RS232 interface.
Full TTL control. Energies up to 2J. Repetition rate up to 200Hz.Birefringence compensation as standard on LPY700 series.

LPY600 Series -

Economical, robust and efficient range of single rod oscillators and oscillator/amplifiers. An excellent scientific system at an economical price.

LPY700 Series -

Twin rod oscillator laser for higher energies and full birefringence compensation for superior beam quality.

PIV LASER SERIES

Twin head design.
Ultra compact Nano PIV series.
Energy up to 1J.
Repetition rate up to 200Hz.
Twin wavelength option (532nm and 355nm or 266nm).
Dual LIBS/PIV configuration. Custom configurations available.

Nano S PIV - The smallest in the series. Two Nano S lasers mounted onto an aluminium gauge plate to provide robustness. Beam combination optics and any harmonic generation units are mounted onto this plate for increased stability. Both lasers share the same integral power supply and cooling unit.

Nano L PIV - Exceptional industrial robustness.
The Nano L laser can be run at 100Hz enabling results to be taken at 200Hz. Exceptional specification is achieved from a very compact laser head.

Nano T PIV – Like Nano L but with telescopic resonators for low divergence, enabling light sheets up to four times thinner or longer than most other systems.

LPY PIV - Invar stabilized PIV lasers for high average power PIV and other double pulse applications. Twin rod birefringence compensation provided for stability and beam homogeneity.
Up to 800mJ at 15Hz and 50mJ at 200Hz

LDY300-PIV - High energy.
0-10kHz Continuously variable dual cavity system. 10-20mJ @ 527nm per head per pulse. Field replaceable diodes.

PULSED Nd:YLF DIODE PUMPED SYSTEMS

LDY300 series - State-of-theart, high repetition rate lasers. Rugged, industrial design 10, 20 or 30mJ at 527nm, 1kHz. Field replaceable diodes. Control via LCD interface and supplied software suite. Power supply and integrated chiller in a compact rackmounted unit.

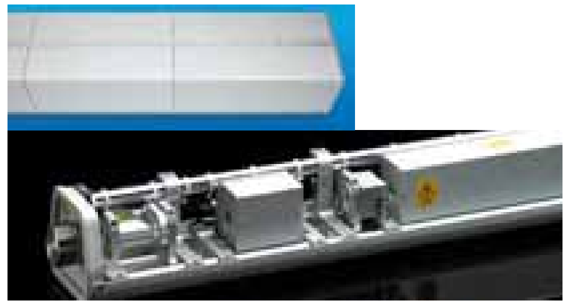
DPSS · LPSS Laser

PULSED WELDER AND LASER CUTTING SERIES

LPY800 Series
Frequencies of 1-10kHz and pulse energies of up to 50mJ.
Completely variable pulse length ideal for welding applications.

GLASS LASERS Can be made to special order.

LAMP PUMPED CW Nd:YAG LASERS



Rugged industrial design
High performance Invar stabilised rail for maximum stability.
Diffuse ceramic reflectors. Easy lamp change without need for re-alignment. Full RS232 and TTL controls.

LCY20 TEM_{00} - Compact laser head where space is a premium.
Power: up to 20W TEM_{00}.

LCY35/45 Series - Available as multimode, TEM00 or as multimode and TEM_{00}. All variations available with or without Q-switch.
Power: up to 35W/45W MM and 6W TEM_{00}.

LCY70/90/100 Series - The most advanced range of lamp pumped, continuous wave laser sources available today. Pure CW output, Q-switched. CW output and optional TEM_{00} versions.
Power: up to 90W MM and 18W TEM_{00}.

LDY SERIES CW DIODE PUMPED LASERS

Sealed, rugged industrial design. Q-switched up to 100kHz or true CW. Up to 60W multimode or 16W TEM_{00}.
Compact single phase power supply and self contained cooling system.

CUSTOM SYSTEMS

In addition to its standard range, Litron produces a great variety of custom systems, both based on standard modules and, where necessary, offers a complete design to fit your needs.
Contact Litron to discuss your custom laser needs.

APPLICATION SELECTOR GUIDE

We have included this guide to help you quickly find the most appropriate **Litron product to match your application.**

If your application or exact requirement is not shown here please contact Litron, we will make every effort to find a solution to fit your needs.

LASER APPLICATION \ LASER MODEL	Nano 0	Nano S (G)	Nano L (G)	Nano T	Nano TRL	Nano TRL (G)	Nano S PIV	Nano L PIV	Nano T PIV	Nano TRL PIV	LPY 600 (G)	LPY700	LPY700 (G)	LPY 800	LPY PIV	LPY Welder	LDY Series	LDY 300 PIV	LCY Series
LIBS	●	●	●	●	●	●					●	●	●						
SPECTROSCOPY	●	●	●	●	●	●					●	●	●						
LI DAR	●	●	●	●	●	●					●	●	●						
REMOTE SENSING	●	●	●	●	●	●					●	●	●						
PIV							●	●	●	●					●			●	
PHOTOCHEMISTRY			●	●	●	●						●							
LIF	●	●	●	●	●	●	●	●	●	●	●	●	●		●		●	●	
NONLINEAR OPTICS		●	●			●						●	●		●			●	
Ti:S PUMPING				●	●	●					●	●	●				●	●	
PARTICLE SIZING		●	●	●	●	●						●							
FLOW MONITORING							●	●	●	●					●			●	
OPO PUMPING			●	●	●	●						●					●		
DYE LASER PUMPING				●	●						●	●	●						
ABLATION		●	●	●	●	●						●	●						
DEFLASHING						●						●							
MARKING																	●		●
MASK REPAIR	●	●																	
ENGRAVING																	●		●
HOLE DRILLING													●	●			●		●
MICROMACHINING														●		●			●
MATERIALS PROCESSING		●	●	●	●								●	●		●	●		●
SILICON DICING																			●
WELDING																●			●
STENT/STENCIL CUTTING														●		●			

LASER APPLICATION	1064/1053nm	532nm	527nm	355nm	351nm	266nm	213nm
LIBS	●	●		●		●	
SPECTROSCOPY	●	●	●	●	●	●	●
LI DAR	●	●		●		●	
REMOTE SENSING	●	●		●		●	
PIV		●		●		●	
PHOTOCHEMISTRY	●	●	●	●	●	●	●
LIF				●		●	
NONLINEAR OPTICS	●	●	●	●	●	●	
Ti:S PUMPING		●	●				
PARTICLE SIZING		●		●		●	
FLOW MONITORING		●					
OPO PUMPING	●	●	●	●	●	●	
DYE LASER PUMPING		●		●		●	
ABLATION	●	●	●	●	●	●	
DEFLASHING	●	●		●			
MARKING	●	●	●	●	●	●	
MASK REPAIR	●	●	●	●	●	●	
ENGRAVING	●	●	●	●	●	●	
HOLE DRILLING	●	●	●	●	●	●	
MICROMACHINING	●	●	●	●	●	●	
MATERIALS PROCESSING	●	●	●	●	●	●	
SILICON DICING	●						
WELDING	●						
STENT/STENCIL CUTTING	●						

Nano Series Ultra Compact Pulsed Nd:YAG Lasers

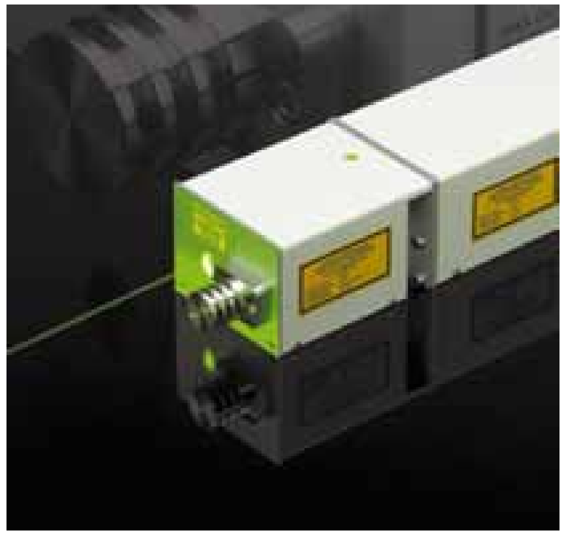
The Nano series of pulsed Q-switched Nd:YAG lasers have been designed to satisfy the demands of customers today. With industry leading performance in every respect, and unsurpassed design and build quality, the Nano series sets the new benchmark for laser systems today.

World class performance results only from world class design. During the design process every aspect of the Nano range of laser systems has been attended to in great detail, leading to a range of laser systems that are rugged, reliable, and which perform optimally with little need for maintenance. Heed has been paid to comments from customers and service engineers, and design features resulting in useable and serviceable systems have been incorporated wherever possible. For example, simple flashlamp change without the need for either complete removal of the pumping chamber or optical realignment, easily removable and cleanable optics, an electronic intra-cavity safety shutter and a latched interlock suite are but a few of the features which set Litron's Nano series apart from the competition.

As with any piece of equipment it is the performance of the device, both in terms of reliability and in terms of specification, which define its suitability for an application. Nowadays, applications for laser systems are extremely varied, and as such a 'one system suits all' approach is rarely acceptable. On this basis the Nano range comprises four laser head models and three power supplies allowing Q-switched outputs from 10mJ per pulse to 500mJ per pulse at repetition rates of up to 100Hz. This allows us to provide our customers with a solution tailored to their specific need, saving both time and expense.

The Nano Series Superior Performance Through Attentive Design

- Spectroscopy
- Remote Sensing
- Photochemistry
- Non-Linear Optics
- OPO Pumping
- Ablation
- PIV
- ESPI
- LIDAR
- LIBS
- LIF



Engineering Excellence

MECHANICAL

Implicit in good design is good engineering. When considering the important mechanical aspects of a laser system, mechanical and thermal stability and insensitivity to misalignment coupled with ease of maintenance come first. The Nano series laser heads are machined from solid aluminium, and the optical resonator is an integral part of the aluminium body. This results in a mechanically rigid and rugged design, whose thermal stability is as good as a self supporting invar structure.

The pumping chamber is machined from 316 surgical grade stainless steel, and houses a pair of close coupled ceramic reflectors. The pumping chamber is thermally decoupled from the resonator resulting in good thermal stability even at high flashlamp power loadings. The ceramic reflectors allow very uniform pumping of the laser rod, and as a direct consequence exceptional output beam quality. Other aspects of beam quality, such as pointing stability, are affected by the efficiency with which the laser rod is cooled.

By ensuring the laser rod is cooled before the flashlamp, and by ensuring a large turbulent flow over the laser rod, the pulse to pulse stability and the pointing stability of the Nano series are amongst the best available. Also the serial flow ensures very uniform cooling of the laser rod and flashlamp, leading to a longer flashlamp life. This is because there are no voids in the cooling as are commonly seen in parallel flow arrangements, where flashlamps may even distort due to extreme localised heating.

De-ionised water is corrosive: the cooling system therefore comprises entirely of hard plastic or stainless steel parts which are totally inert to de-ionised water. As a result there is no risk of contamination from the cooling system compromising laser performance, and further there is no need to worry about draining or running the laser system should it stand idle for protracted periods of time. An easily changeable de-ioniser cartridge is standard on all power supplies. The cooling system in all of the power supplies is a closed loop with a water to air heat exchanger. This means that the entire laser system is totally self contained with no need for an external coolant supply.

OPTICAL

Optically the KD*P Pockels cell is mounted in a fully sealed housing, eliminating any possibility of crystal damage due to moisture or dirt. All optics are coated with hard dielectric coatings that have extremely high damage thresholds. The diffuse cavity reflectors are arranged to give the highest pump uniformity of the laser rod, and therefore the best beam quality.

In any optical system, the need may arise to clean the optics. To this end, all optics are fully demountable for cleaning. Alignment of the laser system is by two adjustable mirror mounts that can be firmly locked in place. Whilst cleaning of the optics and system alignment should not normally be necessary, the design of the system allows the customer to undertake such procedures quickly and easily, without the need for any expensive service visits or protracted periods of down time.

The Nano Range – A solution for every problem

There are three 'end user' laser heads in the Nano series, the Nano S, the Nano L and the Nano T. All three laser heads are fundamentally the same in terms of construction: they are all machined from a solid block of aluminium, have electronic intra-cavity safety shutters, fully sealed Pockels cells, stainless steel close coupled pumping chambers and easily adjustable and cleanable mirrors and optics.

The design of the Nano range facilitates the connection of any power supply to any head. This benefits the customer both in terms of size and cost of the laser system, as the system provided will be optimally tailored to the requirements of the customer.

THE NANO S

130mJ

The Nano S is one of the smallest 'end user' laser system of its type in the world. Its footprint is just 272mm x 82mm x 62mm. It offers the user energies of up to 130mJ per pulse and repetition rates of up to 50Hz. It is supplied with a conventional stable resonator, and can be configured to give TEM00 if required, by the inclusion of an intra-cavity aperture.

THE NANO L

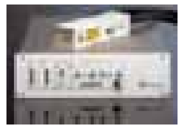
350mJ

The Nano L has a footprint of only 360mm x 96mm x 74mm. Output energies of up to 350mJ and repetition rates of up to 100Hz are available. It can be supplied with either a stable resonator or with Gaussian optics. If required an intra-cavity aperture can be fitted to give a TEM00 output.

THE NANO T

500mJ

The Nano T has a footprint of 500mm x 96mm x 74mm. Output energies of up to 500mJ and repetition rates of up to 100Hz are available. The Nano T can be configured with a stable, telescopic or Gaussian resonator, and can be fitted with an intra-cavity aperture to give a TEM00 output.



NANO OEM MODELS

Any of the aforementioned laser heads can be provided on an OEM basis. There is also a member of the range that is even more compact than the Nano S, but affords the user the same output and performance capabilities. The Nano O is the smallest laser head in the range measuring just 230mm x 78mm x 55mm. It has been designed specifically for incorporation into customer's equipment. It offers the user energies of up to 100mJ per pulse and repetition rates of up to 50Hz, although the maximum power loading on the lamp will determine the maximum energy and repetition rate for a given application. It is the only model in the range that does not have an electronic safety shutter as this is often unnecessary in OEM applications.

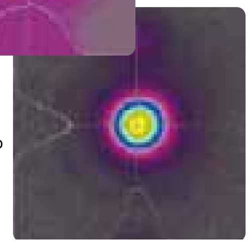
Resonator Types

STABLE RESONATOR

A stable resonator provides the greatest flexibility in terms of output energy and repetition rate, as both parameters can be varied with minimal effect upon the alignment of the system. In general, the output of such systems is multi-mode. With the addition of an intra-cavity aperture, a TEM00 output can easily be realised, but at the expense of overall efficiency.

TEM_{oo}

Near field beam profile of Nano S with stable resonator at 1064nm.



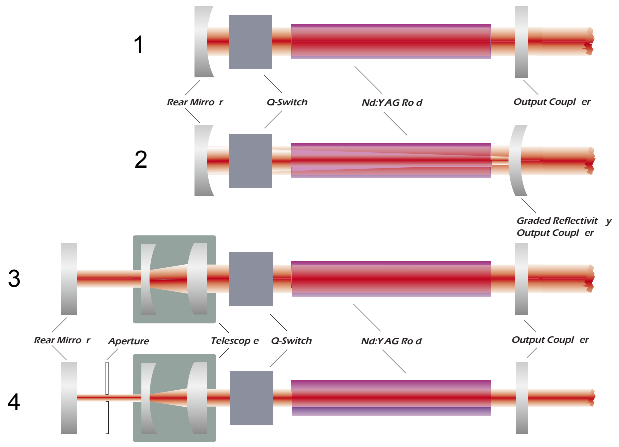
Near field profile of Nano L running TEM_{oo} at 1064nm.

GAUSSIAN RESONATOR

In a Gaussian system, graded reflectivity mirrors are used, and form part of an unstable resonator. Such systems give a high energy single transverse mode with a low beam divergence. However this optical configuration does have drawbacks. The thermal lens formed by the laser rod is part of the optical arrangement. Such systems will therefore only work properly at one repetition rate, when the thermal loading on the laser rod is constant. As a direct result of this, the laser is factory set at one pulse repetition frequency and output energy. To overcome these limitations, which are governed by the physics of the system, Litron offers two options. The first option, the pulse repetition rate divider, allows the user to divide the set repetition rate by 2, 4, 8 or 16. This works by allowing the flashlamp to pulse at a set frequency, thus maintaining almost the same thermal lens on the laser rod, but only switching the Pockels cell on the desired pulses (i.e. every other pulse for divide by two operation). The second option is a motorised variable optical attenuator. By the use of an extra-cavity polariser and half-wave plate, the output energy of the laser can be attenuated, whilst maintaining the beam quality and divergences required.

Multimode

In a system fitted with Gaussian optics, the pulse length tends to be shorter than in a conventional stable resonator. This increases the peak power density that is seen by the resonator optics and subsequently by any beam handling optics that may be used.



Schematics showing oscillator design.
1) Stable
2) Gaussian
3) Telescopic Multimode
4) Telescopic TEM_{oo}

Distribution of the output energy per pulse for 500 consecutive shots. Range of histogram ± 1% of mean value. Standard devitaion ~0.3%.

TELESCOPIC RESONATOR

To obtain high energy low divergence beams, the preferred method is the use of a telescopic resonator. In this configuration, an intra-cavity telescope is used to reduce the beam diameter in the rear leg of the resonator. This has the effect of making the resonator appear longer, increasing the losses in the higher order modes, leading to a superior output beam with very low divergence. With no optical adjustment at all, the laser can be varied over a wide range of pulse energies and repetition rates, whilst maintaining a high quality, low divergence beam. With slight adjustment to the telescope (a simple procedure) the full range of energies and repetition rates from single pulse to the maximum can be achieved. For high energy TEM_{00} beams, an intra-cavity aperture can be fitted behind the telescope. Varying the sizes of these apertures allows output beams that are to within 15% of the diffraction limit to about 2.5 times the diffraction limit. That is from an almost pure Gaussian TEM_{00} to full energy in a uniform spatial profile. The output from a telescopic resonator is longer and smoother temporally, making it the system of choice for pumping dye lasers or optical parametric oscillators. Such arrangements, by virtue of the longer pulse length, are much less prone to optical damage than Gaussian systems.

OSCILLATOR AMPLIFIER SYSTEMS

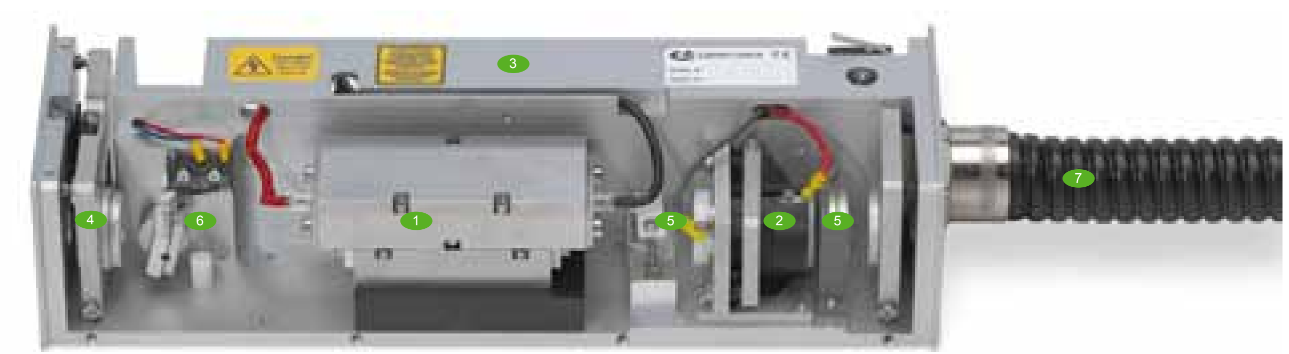
In order to generate high energy laser outputs, or to generate medium energy outputs at very high repetition rates, the use of an amplifier stage is often beneficial. An oscillator amplifier is advantageous over a single high energy oscillator for several reasons. In an oscillator, the energy that can be extracted is governed by the Q-switch hold off, parasitic oscillations and amplified spontaneous emission. In an amplified system, the oscillator is not usually run at its maximum output (as dictated by the maximum stored energy of the laser rod), therefore the peak powers are lower through the cavity optics and Pockels cell, leading to longer life and more reliable service. When using an oscillator and amplifier to obtain output energies greater than about 500mJ, the near field spatial profile is usually better, containing less structure than an equivalent single oscillator yielding the same output.

A range of amplifiers can be fitted to the Nano series, in an oscillator amplifier arrangement, the oscillator is typically one of the standard Nano range. The output is then folded to pass through the amplifier rod. The amplifier design uses a single lamp pumped rod housing, of the same design as those used in the oscillators. With the use of a suitable amplifier stage, outputs of >1200mJ are available from the Nano series.

HARMONIC GENERATION

Litron offers a full range of harmonic generation and separation modules, giving the customer access to 532nm, 355nm, 266nm and 213nm. There are two types of harmonic housing available: a short form housing and a long form housing. These can be added and removed as required and can usually be retrofitted. The short housing is ideal for applications which require only 532nm, this contains a frequency doubling crystal and dichroic separation mirrors. The long harmonic housing can hold a frequency doubler, or a frequency doubler and tripler, or a frequency doubler and quadrupler, and dichroic separation mirrors. Typically KTP or LBO are used as frequency doublers, LBO or BBO are used as frequency triplers and BBO is used as a frequency quadrupler. Temperature stabilisation of the crystals is available.

The Nano Uncovered



1 PUMPING CHAMBER

The most important requirement for high beam quality, both in terms of spatial profile and pointing stability, is that the pumping chamber is designed properly. Litron's pumping chambers are machined from solid 316 grade stainless steel. They contain two extremely close coupled diffuse ceramic reflectors, which give rise to a highly uniform pumping of the laser rod, something not achieved with elliptical specular reflectors. The laser rod and the flashlamp are separated by a tough ionic glass filter that totally absorbs all of the UV radiation emitted by the flashlamp. Such radiation is of no use in pumping the laser rod, but can damage the rod over a period of time. The result of such a design is a system that will work reliably for many years with no problems. The flashlamp can be removed and replaced within 5 minutes, with no need for optical realignment at all.

DPSS · LPSS Laser

2 POCKELS CELL

The Q-switch in the Nano S is KD*P. The crystal is totally sealed within a rugged housing and immersed in an index matching fluid. Such a design of Pockels cell is well proven and it has the added benefit of protecting the hygroscopic KD*P from any moisture that it may encounter during the flashlamp change procedure, or if the laser head is uncovered in a humid laboratory. Avalanche transistors are used to switch the necessary quarter-wave voltage onto the crystal, and this can be achieved at repetition rates of up to 1kHz with electronic jitter of <500ps with respect to the direct access trigger input.

3 RESONATOR HOUSING

The laser body is machined from a solid piece of aluminium. Its rigid design, approximating to an I-section with ends gives exceptional mechanical rigidity, and a thermal stability as good as that of a self supporting invar structure.

4 MIRROR MOUNTS

The mirrors are held in aluminium mounts connected to the laser body by high tension steel springs. Adjustment is made by two fine-pitch ball-ended screws giving independent horizontal and vertical adjustment, making alignment very easy. The mirrors be firmly locked in position, eliminating any risk of the alignment changing. For Gaussian optics the graded reflectivity output coupler is mounted in a precision x – y mount.

5 QUARTER-WAVE PLATE AND POLARISER

Hold-off is achieved by means of a polariser and a quarter-wave plate. Light passes through the polariser and is horizontally polarised, it passes through the Pockels cell, which with no bias voltage applied does not affect the polarisation. As it passes through the quarter-wave plate it is resolved into two polarisations, one of which undergoes a 90˚ phase shift with respect to the other. The light leaving the quarterwave plate is thus circularly polarised. Upon reflection from the rear mirror, the light once again passes through the quarter-wave plate and again one polarisation undergoes a further 90˚ phase shift, leading to vertically polarised light exiting the quarter-wave plate. This light passes back through the Pockels cell and is reflected out of the cavity by the polariser, preventing any pulse build up. When bias volts are applied to the Pockels cell, an additional 90˚ phase shift in one polarisation is added in each pass, this leads to a total phase shift of 360˚ or 0˚, and therefore horizontally polarised light is returned and passes through the polariser allowing the laser pulse to build up. An advantage of this method, over using the Pockels cell itself as a quarter-wave plate (by biasing it and then removing the voltage at the peak inversion), is that there is no chance of post-lasing as the bias voltage is applied to the Pockels cell for only long enough for the Q-switched pulse to emerge.

6 ELECTRONIC SAFETY SHUTTER

All Nano models (with the exception of the Nano O) come with a solenoid driven safety shutter. This shutter automatically closes when the laser turns off; therefore when the laser is started the shutter will be closed. This makes the laser safer when used in a laboratory. As a further safety measure, the position of the shutter is monitored by the system control. Should the actual position of the shutter and the required position of the shutter not be in agreement the laser will automatically turn off.

7 RUGGED STEEL CLAD UMBILICAL

All of the Nano range are fitted with rugged PVC covered steel clad umbilicals to carry the necessary services to the laser head. The umbilical diameter on the Nano O and Nano S heads is 25mm and on the Nano L and Nano T heads is 33mm.

APPLICATIONS INCLUDE

- SPECTROSCOPY
- REMOTE SENSING
- PHOTOCHEMISTRY
- NON-LINEAR OPTICS
- OPO PUMPING
- ABLATION
- PIV
- ESPI
- LIDAR
- LIBS
- LIF

Applications

PARTICLE IMAGE VELOCIMETRY (PIV)

PIV has over the last few years become a commonplace technique, both industrially and in research establishments. A full range of PIV laser systems is available with outputs from 20 – 100mJ per pulse, and adjustable pulse separations of sub microsecond to milliseconds. PIV laser systems use two laser oscillators with orthogonal polarizations, the beams are combined with dielectric polarisers and then frequency doubled.

CUSTOM LASER SYSTEMS

Due to the pseudo modular design of the Nano range of laser systems, custom laser systems are often configurable from existing parts. For this reason, along with our experience in the manufacture of laser systems, if a product does not exactly meet your required specification, we will gladly discuss providing you with one that does. This is often achievable with little or no extra cost.

Other laser media such as erbium glass (1.5μm), erbium YAG (2.94μm), holmium YAG (2.01μm), ruby (694nm), and neodymium glass laser systems are also available upon request.

SAFETY

Perhaps the single most important aspect of any equipment is its safety. Litron's laser systems have been designed with safety as one of the prime constraints. All covers are interlocked, so that the laser cannot be run if any cover is removed. This reduces the risk of stray radiation from within the device causing damage. All high voltages are covered with insulating covers, within an interlocked case. The system cannot be run when any high voltages are exposed to the user. An electronic safety shutter with additional verification is standard on all 'end user' systems, so when the laser is started it will not emit any radiation. An external interlock is standard and can be connected to a laboratory door, so that the laser system will switch off should the door be opened. This interlock can be overridden in situations when an external interlock is not a requirement.

LPU200R fully integrated power supply and cooler in 3U 19" rack mounting unit.

Litron's laser systems are designed to comply with BS EN 60825-1 (Safety of Laser Products – Equipment Classification, Requirements and User's Guide) and BS EN 60101-1 (Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use).

Power Supplies

Litron offers a complete range of fully featured power supplies, with output powers from 200W up to 2kW from a single charger. All power supplies utilize the latest resonant IGBT switching technology for maximum efficiency. The flashlamps in all systems are fully simmered and the Pockels cell is driven using avalanche transistors. The system control contains a suite of latched interlocks, allowing quick and easy fault diagnosis.

LPU500 integrated power supply and cooler.

The smallest power supply in the range, the LPU250, measures only 202mm (wide) x 320mm (high) x 382mm (long) and contains a 250W capacitor charger, simmer, Q-switch driver, all system control and an integral water to air heat exchanger. The LPU250 is fully power factor corrected and will run off any mains input between 90 and 260V. Control of the laser is via a remote control box, which allows control of all of the system features, these are: laser start and stop, pump on and off, pulse repetition rate, output energy and shutter position. Standard TTL controls give access to Q-switch and lamp synchronisation and triggering, allowing quick and easy integration into almost any set up. An optional RS232 interface and computer software suite gives complete system control from a PC.

The LPU500 has all of the features of the LPU250 but contains a 500W capacitor charger and a more powerful cooler.

The LPU1000 is again a fully featured power supply containing a 1kW capacitor charger. This power supply has been designed such that slave charger units can be added to increase the power capability of the unit. This allows very high energy or high repetition rate systems to be constructed with ease.

LPU250 integrated power supply and cooler.

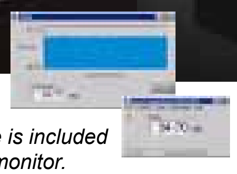
OEM power supplies are supplied in standard 19" rack mount modules. The smallest of these is a 200W complete power supply which includes a full closed loop cooling system, all contained in a unit that is just 3U (133mm) high.

All power supplies (up to 1kW) can be supplied to optionally run off DC inputs of 24 – 100VDC, making them ideally suited to airborne applications or field use, where a DC supply from batteries is available.

For custom systems, the power supplies can easily be modified to give higher capacitor charge rates or specific system control requirements.

Litron's range of photodiode laser energy monitors, with 30mm and 50mm input apertures allow accurate measurement of laser performance.

LPM530 Transfer energy monitors allow accurate in-line energy monitoring of system performance.



A full software suite is included with every energy monitor.

Accessories

VARIABLE OPTICAL ATTENUATION

In certain circumstances where the pump energy and repetition rate of the laser system are fixed (e.g. in a Gaussian resonator), adjustment of the laser output energy may be necessary. For this reason a variable optical attenuator is offered as an option on all of our laser systems. By the use of a half-wave plate and polariser, the axial beam energy can be varied. The residual energy can either be dumped safely or utilized in some way.

Additionally a variable optical attenuator is useful if the temporal profile of the pulse needs to be maintained at different output energies. As the pump intensity is reduced, the gain of the laser rod decreases, this leads to a longer Q-switched pulse at lower energies. By keeping the output at a given level, and using a variable optical attenuator, all pulses will be temporally of similar length.

MECHANICAL AND OPTICAL MOUNTS

A range of mechanical mounts to attach the laser to an optical table and optical mounts such as steering mirror mounts are available, giving the user maximum flexibility in handling and using the laser output. All accessories are designed to interface with standard optical tables. Optical breadboards of up to 600mm x 600mm with M6 holes on a 25mm pitch, along with a complete range of optical mounts to facilitate the user's experimental set-up, can be purchased from Litron either with a laser system or as accessories.

OPTIONAL FAST PHOTODIODE

A fast 50Ω terminated photodiode is available as an option on all of the laser heads in the range. This allows monitoring of the temporal profile of the Q-switched laser output when used in conjunction with a suitable oscilloscope.

CO-AXIAL DIODE LASER

An optional diode laser can be fitted behind the rear mirror of the laser to provide a visible aiming beam for the laser output.

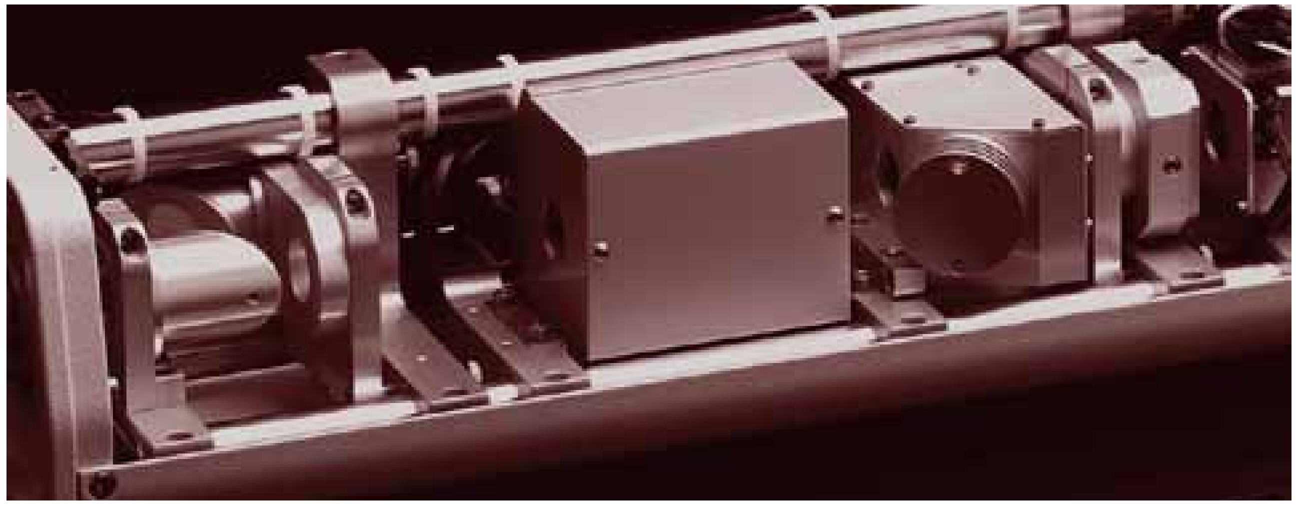
ENERGY MONITORING

Litron manufactures a comprehensive range of laser energy monitors. These are photodiode based instruments and allow extremely accurate analysis and measurement of laser performance.Litron's range of photodiode laser energy monitors,
with 30mm and 50mm input apertures allow accurate
measurement of laser performance.Unlike conventional energy measurement devices, Litron's range of monitors can measure every pulse from the laser system, rather than averaging the energy as many calorimetric devices do. This leads to unrivalled accuracy and flexibility of measurements. Typically the pulse to pulse measurement repeatability of these devices is better than 0.2%. The damage threshold of these energy monitors is extremely high, as the optics train scatters rather than absorbs the light. The input optic is ground fused silica, and is arranged such that easy removal is possible should it be damaged for any reason.

All energy monitors feature a bright 4 digit display and an RS232 output, which allows data-logging of the laser performance. A comprehensive software suite is provided as standard. For further information on Litron's range of energy monitors please refer to the specific data sheets.

High Power DPSS Q-switched CW Lasers for Industrial Applications

LDY10/60CW



High Power DPSS Q-switched CW Lasers for Industrial Applications
The LDY10/60(T) Series Diode Pumped CW Nd:YAG Lasers

APPLICATIONS

- Metal Marking
- Plastics Marking
- Cutting
- Precision Scribing

FEATURES

- High Power
- Rugged Industrial Design
- True TEMoo Option
- RS232 Control
- Invar Stabilised

The LDY series is a family of DPSS, high power Q-switched CW lasers for industrial applications. These systems are Q-switchable at repetition frequencies of up to 100kHz and can be configured to give a true TEM$_{oo}$ output with a resulting M^2 of <1.2.

Built to deliver true 24/7 operation in industrial environments the LDY series is suited to applications such as marking and cutting.The laser head is based around our rugged selfsupporting invar space frame that gives industry leading mechanical and optical stability.

The LDY series is controlled via an LCD interface and also via a supplied software suite giving total control of the laser and Q-switch. With full computer control the system can easily be integrated into handling equipment with the full software suite that is supplied.

The power supply and integrated chiller are enclosed in a compact rackmounted unit.

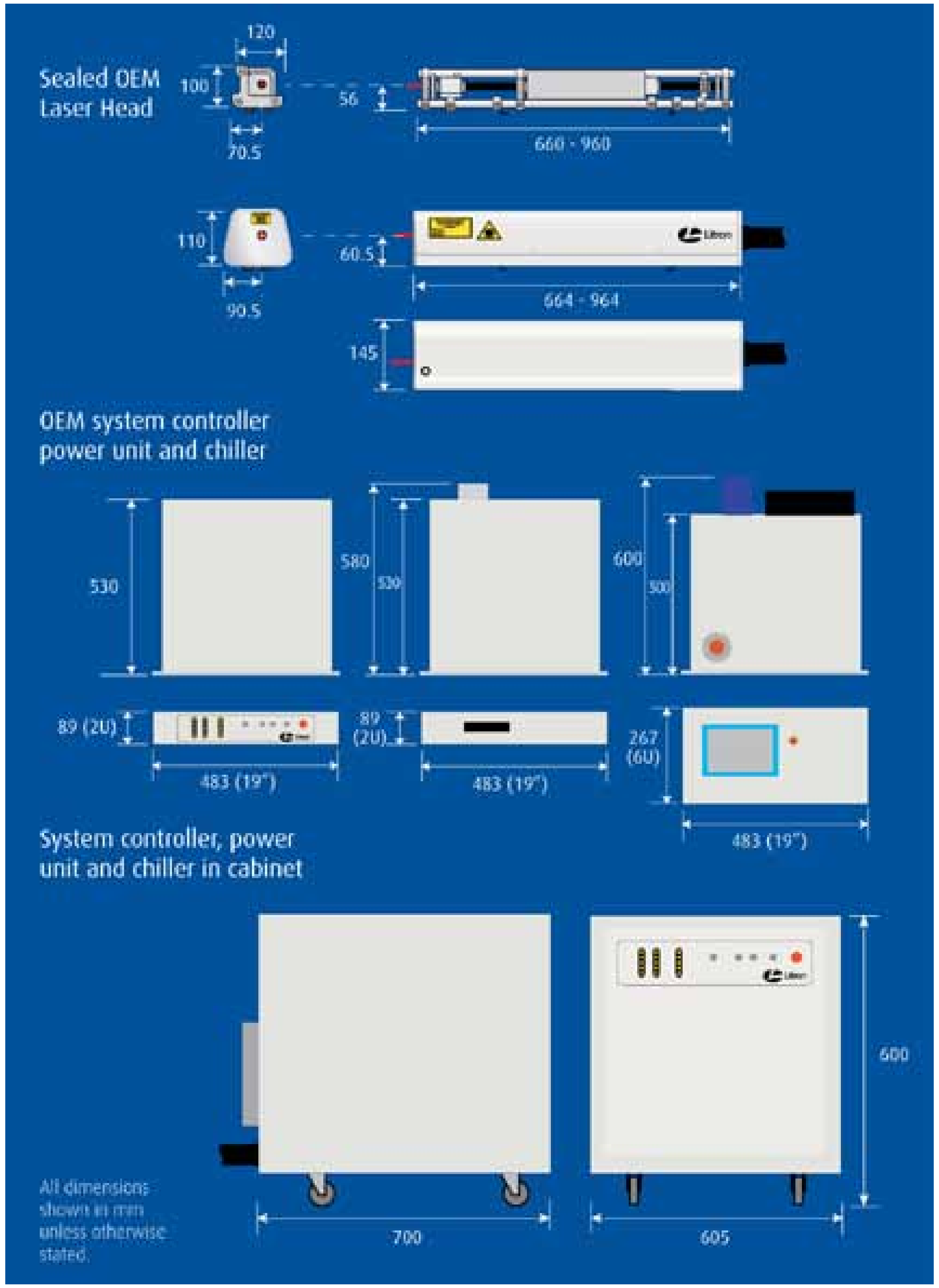
TSC
www.toptical.com.tw 02-2346-1510 toptical@ms17.hinet.net

The LDY10/60(T) Series Diode Pumped CW Nd:YAG Lasers

Technical Data

Model	LDY10(T)	LDY20(T)	LDY40(T)	LDY60(T)
Repetition Rate (kHz)	0-100	0-100	0-100	0-100
Wavelength (nm)	1064	1064	1064	1064
Output Power @ 10KHz (W)				
MM	10	20	40	60
TEM_{00} (T)	3	6	12	16
Beam Diameter (mm)	3	3	4	4
Divergence (mrad)	5	5	6	6
Pulse length (ns)	100	100	120	120
M^2				
TEM_{00}	<1.2	<1.2	<1.2	<1.2
Control	RS232	RS232	RS232	RS232
Warm-up time (mins)	5	5	5	5
Services				
Voltage(1) (VAC)	220-250	220-250	220-250	220-250
Frequency(2) (Hz)	50 or 60	50 or 60	50 or 60	50 or 60
Ambient(3) (˚C)	5-40	5-40	5-40	5-40
Power	Single Phase	Single Phase	Single Phase	Single Phase
Power Supply	10U Rack	10U Rack	10U Rack	10U Rack

(1) 110VAC option requires autotransformer to be specified on order
(2) 50 or 60Hz to be specified on order.
(3) 0-80% non condensing atmosphere

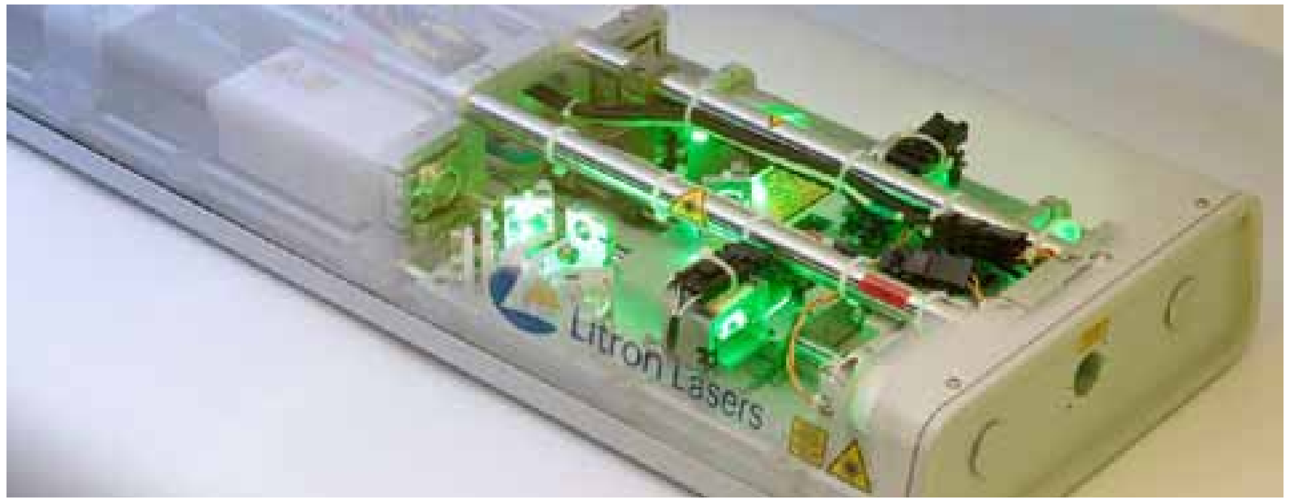


DPSS · LPSS Laser

Spectroscopes
CCD Cameras · Imaging
Semiconductors · Communications
Solar Cells · Lighting
Tests · Instruments
Detection · Sensors
Components · Mechanics · Positioning
Lasers · Light Sources

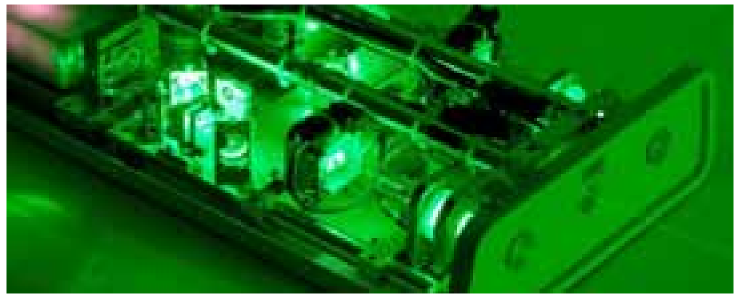
High Repetition Rate Lasers for Time-Resolved PIV Applications

LDY300 PIV

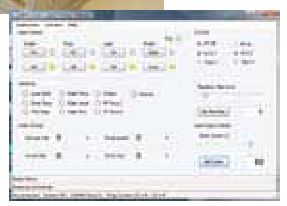


High repetition rate lasers for time-resolved PIV applications
The LDY300 PIV Series Dual Head Diode Pumped Q-switched Nd:YLF Lasers

APPLICATIONS
- PIV
- Particle Sizing
- Ti:S Pumping



FEATURES
- High Energy at 527nm
- Rugged industrial design
- Field replaceable pump module
- Dual cavity system
- 0-10kHz continuously variable

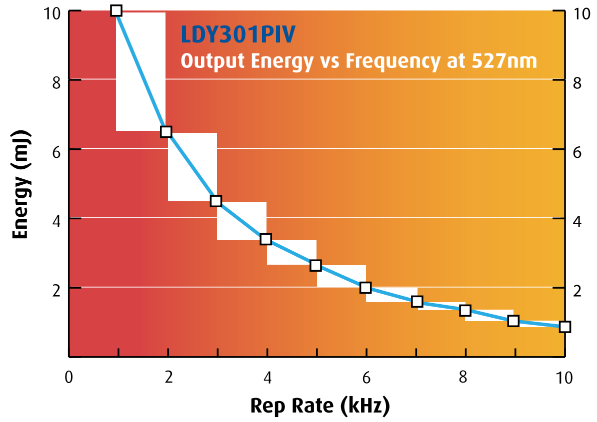


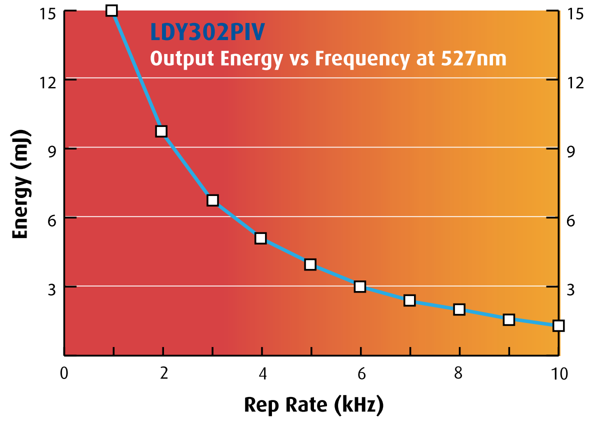
The LDY300 series are diode pumped, dual cavity, Nd:YLF laser systems ideally suited to imaging applications such as PIV and to pump applications. Output energies of up to 20mJ, 527nm per cavity at 1kHz are available. The lasers are built around a rugged self supporting invar rail that bestows excellent mechanical and optical stability.
This, coupled with the proprietary resonator design, leads to excellent output beams that are spatially and temporally extremely smooth and stable, giving rise to light sheets that offer almost identical shot to shot illumination.

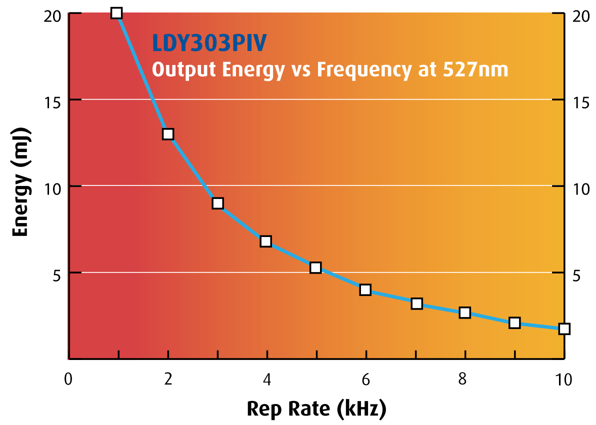
The robust design of these lasers suits them to the harshest of industrial applications and research applications alike.

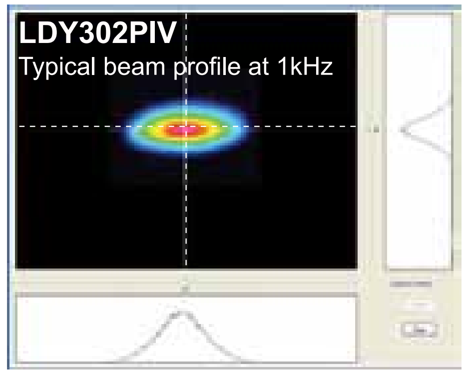
The power supply and closed-circuit chiller are all housed in a compact 10U or 12U rack. The system can be controlled either by the in-built LCD interface or via RS232 with the supplied software suite or dll, and external triggering of the lasers is accessible via a TTL interface.

Performance Data









Spectroscopes
CCD Cameras · Imaging
Semiconductors · Communications
Solar Cells · Lighting
Tests · Instruments
Detection · Sensors
Components · Mechanics · Positioning
Lasers · Light Sources

Technical Data

Model	LDY301	LDY302	LDY303	LDY303HE	LDY304
Repetition rate (each cavity) (kHz)	1-20	1-20	1-20	1-20	1-20
Output Energy at 1kHz at 527nm					
per laser head per pulse (mJ)	10	15	20	22.5	30
Pulse - pulse stability (±%)	1	1	1	1	1
Beam diameter (mm) (4)	5	5	5	5	5
Beam divergence (mrad) (5)	<3	<3	<3	<3	<3
Pulse width @ 1kHz (ns)	~150	~150	~150	~150	~150
M^2x, M^2y	12, 7	12, 7	12, 7	12, 7	12, 8
Services					
Voltage(1) (VAC)	220-250	220-250	220-250	220-250	220-250
Frequency(2) (Hz)	50 or 60	50 or 60	50 or 60	50 or 60	50 or 60
Power	Single Phase	Single Phase	Single Phase	Single Phase	Single Phase
Ambient(3) (˚C)	5-40	5-40	5-40	5-40	5-40
Consumption (W)	1000	1800	2700	2700	2700
Power Supply	19" 10U Rack	19" 12U Rack	19" 13U Rack	19" 13U Rack	19" 13U Rack
Weights					
Head (kg)	35	35	35	35	35
PSU (kg)	75	80	80	80	80

(1) 110VAC option requires autotransformer to be specified on order

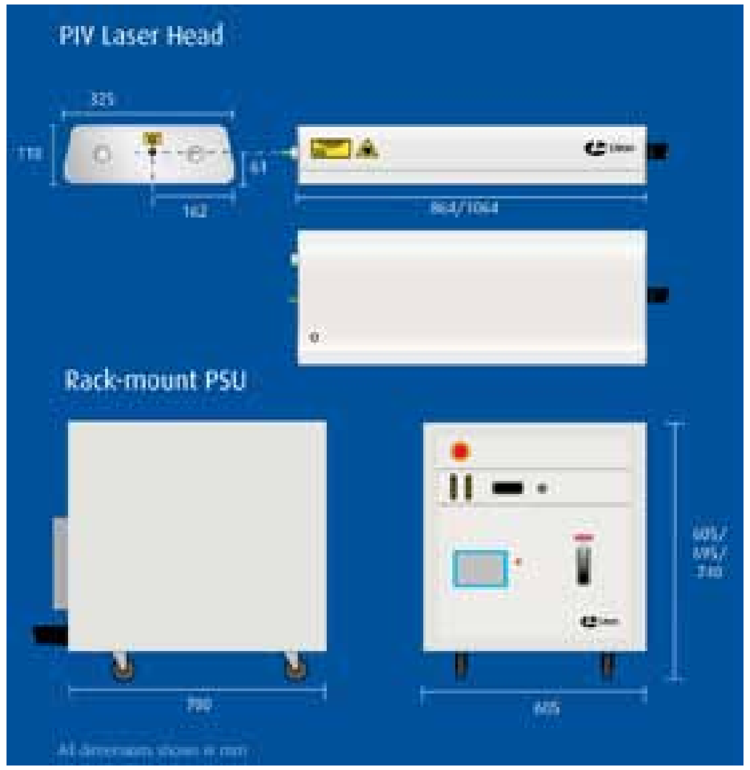
(2) 50 or 60Hz to be specified on order.

(3) 0-80% non condensing atmosphere

(4) Beam diameter is achieved with output telescope. Standard diameters quoted. Other diameters are available on request. In all cases M^2 is unchanged.

(5) At specified beam diameter.

(6) M2 values differ in the x and y directions. Beam rotation optics are available as an option to allow the thinnest light sheets to be formed in any plane.



High Energy Pulsed Nd:YAG Lasers

LDY10/60CW

- Spectroscopy
- Remote Sensing
- Photochemistry
- Non-Linear Optics
- OPO Pumping
- Ablation
- PIV
- ESPI
- LIDAR
- LIBS
- LIF

High Energy Nd:YAG lasers for industry and research.

The LPY600/700 series of pulsed Nd:YAG lasers have been designed to suit almost any industrial of research application in which a high-energy or high-specification Nd:YAG laser is required. Based around a fully self supporting invar rail the LPY600/700 series exhibit both exceptional mechanical and thermal stability. A Ôno-compromiseÕ design approach is evidenced in the build quality, a parameter that sets these lasers well apart from any of their competitors.

The modular design of the laser head allows a wide variety of resonator configurations to be offered, from single rod oscillators to fully birefringence compensating twin-rod-oscillator, twin-rod-amplifier systems. Furthermore, a choice of stable, stable-telescopic or unstable Gaussian-coupled resonators is available, allowing the customer to specify a system that suits their requirements. Harmonic generation and separation assemblies are fully integrated onto the invar rail and therefore require no user alignment. With a choice of power supplies, q-switched outputs of up to 3J are available and output repetition rates of up to 200Hz.

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Engineering Excellence

MECHANICAL

The invar rail provides the basis for all of the LPY600/700 series laser heads. It is a fully self supporting structure and is extremely stable. The fact that it is self supporting means that all components are mounted on the rail, as opposed to other arrangements where only the mirrors are mounted on a rail which is in turn mounted on a breadboard that holds all of the other components. Clearly the latter is far less robust. A self supporting invar structure has been well proven as a basis for industrial laser systems, yielding the strength, stability and reliability that is necessary for such applications. The completely modular structure provides the ideal basis for a scientific system as the resonators are Ôfield-reconfigurableÕ, allowing for example a telescopic resonator to be re-configured as a Gaussian-coupled resonator. Such features, coupled with the ease of operation and integration set the LPY600/700 series of lasers apart.

At the heart of the laser system is the pumping chamber. The correct design of this is crucial for good beam quality. The pumping chamber is machined from 316 surgical grade stainless steel, and houses a pair of close coupled ceramic reflectors. The pumping chamber is thermally decoupled from the resonator resulting in good thermal stability even at high flashlamp power loadings. The ceramic reflectors allow very uniform pumping of the laser rod, and as a direct consequence exceptional output beam quality. Other aspects of beam quality, such as pointing stability are affected by the efficiency with which the laser rod is cooled. By ensuring the laser rod is cooled before the flashlamp, and by ensuring a large turbulent flow over the laser rod, the pulse to pulse stability and the pointing stability of the LPY600/700 series are amongst the best available. Also the serial flow ensures very uniform cooling of the laser rod and flashlamp, leading to a longer flashlamp life, as there are no voids in the cooling as are commonly seen in parallel flow arrangements, where flashlamps may even distort due to extreme localised heating.

De-ionised water is corrosive, the cooling system therefore comprises entirely of hard plastic or stainless steel parts which are totally inert to de-ionised water. As a result there is no risk of contamination from the cooling system compromising laser performance, and further there is no need to worry about draining or running the laser system should it stand idle for protracted periods of time. An easily changeable de-ioniser cartridge is standard on all power supplies. The cooling system in all of the power supplies is a closed loop with a water to air heat exchanger. This means that the entire laser system is totally self contained with no need for an external coolant supply.

OPTICAL

Optically the KD*P pockels cell is mounted in a fully sealed housing, eliminating any possibility of crystal damage due to moisture or dirt. All optics are coated with hard dielectric coatings that have extremely high damage thresholds. The diffuse cavity reflectors are arranged to give the highest pump uniformity of the laser rod, and therefore the best beam quality.

In any optical system, inevitably there is the need to periodically clean the optics. To this end, all optics are fully demountable for cleaning. Alignment of the laser system is by two adjustable mirror mounts that can be firmly locked in place. Whilst cleaning of the optics and system alignment should not normally be necessary, the design of the system allows the customer to undertake such procedures quickly and easily, without the need for any expensive service visits or protracted periods of down time.

Resonator Types

STABLE RESONATOR

A stable resonator provides the most flexibility in terms of output energy and repetition rate, as both parameters can be varied with no effect upon the alignment of the system. In general, the output of such systems is multi-mode. With the addition of an intra-cavity aperture, a TEM00 output can easily be realised, but at the expense of overall efficiency.

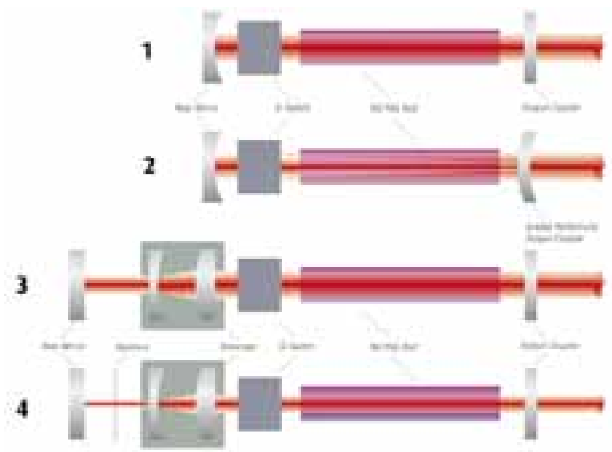
GAUSSIAN OPTICS

In a gaussian system, graded reflectivity mirrors are used, and form part of an unstable resonator. Such systems give a high energy single transverse mode with a low beam divergence. However this optical configuration does have drawbacks. The thermal lens formed by the laser rod is part of the optical arrangement. Such systems will therefore only work properly at one repetition rate, when the thermal loading on the laser rod is constant. As a direct result of this, the laser is factory set at one pulse repetition frequency and output energy. The repetiton rate can be divided by 2, 4, 8 or 16 by means of the repetition rate divide control. The output energy on a Gaussian-coupled system is adjusted by varying the q-switch delay.

In a system fitted with gaussian optics, the pulse length tends to be shorter than in a conventional stable resonator. This increases the peak power density that is seen by the resonator optics and subsequently by any beam handling optics that may be used.

TELESCOPIC RESONATOR

To obtain high energy, low divergence beams, the preferred method is the use of a telescopic resonator. In this configuration, an intracavity telescope is used to reduce the beam diameter in the rear leg of the resonator. This has the effect of making the resonator appear longer, increasing the losses in the higher order modes, leading to a superior output beam with very low divergence. With no adjustment at all, the laser can be adjusted over a wide range of pulse energies and repetition rates, whilst maintaining a high quality, low divergence beam. With slight adjustment to the telescope (a simple procedure) the full range of energies and repetition rates from single pulse to the maximum can be achieved. For high energy TEM$_{00}$ beams, an intracavity aperture can be fitted behind the telescope. Varying the sizes of these apertures allow output beams that are to within 15% of the diffraction limit to about 3.5 times the diffraction limit. That is from an almost pure gaussian TEM$_{00}$ to full energy in a uniform spatial profile. The output from a telescopic resonator is longer and smoother temporally, making it the system of choice for pumping dye lasers or OPOÕs. Such arrangements, by virtue of the longer pulse length are much less prone to optical damage.



Schematics showing oscillator design.
1) Stable
2) Gaussian
3) Telescopic Multimode
4) Telescopic TEM$_{oo}$

TWIN ROD OSCILLATORS

The twin rod oscillator design compensates for the strain birefringence in the rod, which becomes a problem at very high output energies or very high repetition rates and with large diameter laser rods. In a laser with just one oscillator rod, as the beam propagates the thermally-induced strain-birefringence will cause the beam passing through the rod to become partially de-polarised. The degree to which this depolarisation occurs depends upon the strain-birefringence, which is in turn a function of the mean flashlamp pump power. Therefore at higher output energies the depolarisation increases. The light whose polarisation has been changed will be rejected by the intra-cavity polariser. This leads to a loss in efficiency and a less uniform beam.

In a twin-rod oscillator, the beam exiting the first laser rod is passed through a 90o rotator before passing through the second laser rod. As the beam passes through the second rod, the birefringence is in the opposite sense, this has the effect of returning the beam to its original polarisation. Therefore almost no light is rejected by the polariser. This leads to a more uniform beam and a higher efficiency. This is the best way of efficiently extracting large amounts of stored energy from the laser rods.

OSCILLATOR AMPLIFIER SYSTEMS

In order to generate high energy beams of more than 1000mJ, or to generate lower energy outputs at high repetition rates, the use of an amplifier stage can be employed. An oscillator amplifier is advantageous over a single high energy oscillator for several reasons. In a single oscillator, the energy that can be extracted is governed by the q-switch hold off, parasitic oscillations and amplified spontaneous emission. In an amplified system, the oscillator is not usually run at its maximum output (as dictated by the maximum stored energy of the laser rod), therefore the peak powers are lower through the cavity optics and pockels cell, leading to longer life and more reliable service.

A range of both single-rod and twin-rod amplified systems allow fundamental outputs of up to 3J per pulse and repetition rates of up to 200Hz.

Quality by Design

The LPY600/700 series have been designed with quality as the prime constraint. Implicit in this is the production of a reliable, rugged, user friendly system that will work continuously with no need for anything other than standard routine maintenance. Some of the more important design aspects of the LPY600/700 series are as follow.

INVAR RAIL

The invar rail is the basis for all of the laser heads in the LPY600/700 series. It provides an extremely rugged, thermally stable base upon which a multitude of options can be built.

PUMPING CHAMBER

The most important requirement for high beam quality, both in terms of spatial profile and pointing stability is that the pumping chamber is designed properly. LitronÕs pumping chambers are machined from solid 316 grade stainless steel. They contain two extremely close coupled diffuse ceramic reflectors, which give rise to a totally uniform pumping of the laser rod, something not achieved with elliptical specular reflectors. The laser rod and the flashlamp are separated by a tough ionic glass filter that totally absorbs all of the UV radiation emitted by the flashlamp, such radiation is of no use in pumping the laser rod, but can damage the rod over a period of time. The result of such a design is a system that will work reliably for many years with no problems. The flashlamp can be removed and replaced within 5 minutes, with no need for optical realignment at all.

Q-SWITCH ASSEMBLY

The Q-switch in LPY600/700 series are KD*P. The crystal is totally sealed within a rugged housing and immersed in an index matching fluid. Such a design of Pockels cell is well proven and it has the added benefit of protecting the hygroscopic KD*P from any moisture that it may encounter during the flashlamp change procedure, or if the laser head is uncovered in a humid laboratory. Avalanche transistors are used to switch the necessary quarter wave voltage onto the crystal, and this can be achieved at repetition rates of up to 1kHz with electronic jitter of <500ps with respect to the direct access trigger input.

Holdoff is achieved by means of a polariser and a quarter waveplate. Horizontally polarised light incident upon the quarter waveplate is circularly polarised, upon reflection from the rear mirror, there is a 180o phase shift, changing the sense of the circular polarsation. Upon passing back through the quarter waveplate the light is vertically polarised and is rejected by the polariser, giving hold off. During the flashlamp pulse, a quarter wave voltage is applied to the Pockels cell at the peak population inversion and the Pockels cell and quarter waveplate form an effective half wave plate. This is double passed, with the polarization returned to horizontal at the polariser, thus allowing pulse build up. An advantage of this method, over using the Pockels cell itself as a quarter waveplate (by biasing it and then removing the voltage at the peak inversion), is that there is no chance of post-lasing as the bias voltage is applied to the Pockels cell for only 1-2µs.

MIRROR MOUNTS

The mirrors are held in aluminium mounts connected to a bracket that also serves to tie the invar bars together. Adjustment is made by two fine pitch ball ended screws giving independent horizontal and vertical adjustment, making alignment very easy. The mirrors can be firmly locked in position, eliminating any risk of the alignment changing. For gaussian optics the graded reflectivity output coupler is mounted in a precision x Đ y mount.

ELECTRONIC SAFETY SHUTTER

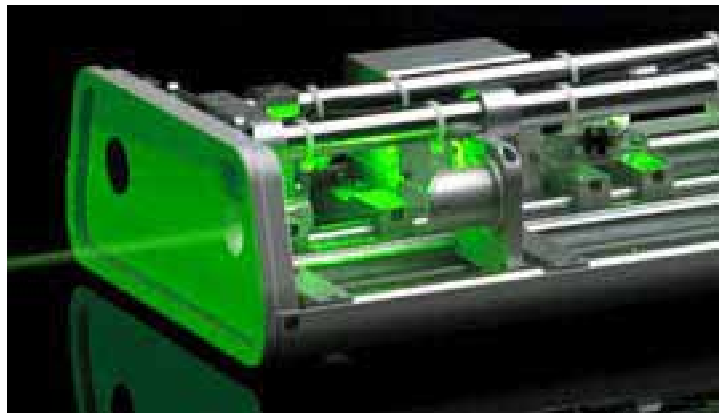
All models feature a solenoid driven safety shutter. This shutter automatically closes when the laser turns off, therefore when it is started up the shutter will be closed. This makes the laser safer when used in a laboratory. As a further safety measure, the position of the shutter is monitored by the system control. Should the actual position of the shutter and the required position of the shutter not be in agreement the laser will automatically turn off.

Options & Accessories

A range of options and accessories are available, either at the time of purchase or for retro-fitting.

HARMONIC GENERATION AND SEPARATUION

Frequency generation of the 2nd, 3rd, 4th and 5th harmonics is offered. All harmonics on the LPY600/700 series are fully temperature controlled. The harmonic crystals and dichroic separation optics are all fully mounted on the invar rail, negating the need for any user alignment. The 5th Harmonic is separated by means of a pair of pellin-broca prisms.



LINE NARROWING

Line narrowing etalons allow the linewidth of the laser output to be reduced, leading to increased coherence lengths. In a stable resonator, the use of an output coupling etalon gives a linewidth of about 0.3cm^{-1} and an additional intra-cavity etalon will reduce the linewidth to about 0.06cm^{-1}.
In an unstable Gaussian-coupled resonator an intracavity etalon will reduce the linewidth to about 0.15cm^{-1}.

INJECTION SEEDING

With the addition of an injection seeder output linewidths of 0.001cm-1 are possible.

VARIABLE OPTICAL ATTENUATION

In certain circumstances where the pump energy and repetition rate of the laser system are fixed (eg in a gaussian resonator), adjustment of the laser output energy may be necessary. For this reason a variable optical attenuator is offered as an option on all of our laser systems. By the use of a half wave plate and polariser, the axial beam energy can be varied. The residual energy can either be dumped safely or utilized in some way.

Additionally a varible optical attenuator is useful if the temporal profile of the pulse needs to be maintained at different output energies. As the pump intensity is reduced, the gain of the laser rod decreases, this leads to a longer q-switched pulse at lower energies. By keeping the output at a given level, and using a variable optical attenuator, all pulses will be temporally of similar length.

MECHANICAL AND OPTICAL MOUNTS

A range of mechanical mounts to attach the laser to an optical table and optical mounts such as steering mirror mounts are available, giving the user maximum flexibility in handling and using the laser output. All accessories are designed to interface with standard optical tables. Optical breadboards of up to 600mm x 600mm with M6 holes on a 25mm pitch along with a complete range of optical mounts to facilitate the users experimental setup can be purchased from Litron, either with a laser system or as accessories.

Litron's range of photodiode laser energy monitors, with 30mm and 50mm input apertures allow accurate measurement of laser performance.

ENERGY MONITORING

Litron manufactures a comprehensive range of laser energy monitors. These are photodiode based instruments and allow extremely accurate analysis and measurement of laser performance. Unlike conventional energy measurement devices, LitronÕs range of monitors can measure every pulse from the laser system, rather than averaging the energy as many calorimetric devices do. This leads to unrivalled accuracy and flexibility of measurements. Typically the pulse to pulse measurement repeatability of these devices is better than 0.2%. The damage threshold of these energy monitors is extremely high, as the optics train scatters rather than absorbs the light. The input optic is ground fused silica, and is arranged such that easy removal is possible should it be damaged for any reason.

All energy monitors feature a bright 4 digit display and an RS232 output, which allows datalogging of the laser performance. A comprehensive software suite is provided as standard. For further information on LitronÕs range of energy monitors please refer to the specific data sheets.

Stable Telescopic Resonators Range Specification

All LPY7xx series systems feature a birefringence compensating twin rod oscillator design.
The LPY6xx series are single rod oscillators / oscillator-amplifiers

Model		LPY704	LPY706	LPY664	LPY674	LPY764	LPY604T	LPY642T
Parameter	Condition							TEM_{00} output
Pulse energy at wavelength (mJ)[2]								
1064nm	Up to 10Hz	400	650	850	1000	1250	80	350
532nm		200	325	425	500	625	40	150
355nm		80	100	150	180	225	20	70
266nm		50	75	95	110	125	15	40
1064nm	Up to 20Hz	380	600	800	850	1000	70	300
532nm		190	300	400	425	500	35	100
355nm		70	90	130	150	140	15	50
266nm		45	65	75	80	90	10	30
Beam Dia.(mm)	Nominal	6.4	8	8	9.5	8	6.4	6.4
Power supply unit	Up to 10Hz	LPU1000	LPU1000	LPU2000	LPU1000	LPU2000	LPU350	LPU1000
	Cooling system	Air	Air	Water	Water	Water	Air	Air
	Up to 20Hz	LPU1000	LPU1000	LPU2000	LPU2000	LPU2000	LPU1000	LPU2000
	Cooling System	Air	Water	Water	Water	Water	Air	Air

Notes
(1) Insertion loss due to etalon is <20%.
Energy stability is reduced by up to a factor of 2
(2) Inserion loss of seeder is about 10%.
Third harmonic output is increased by about 20%
(3) Timing jitter with seeder is <1ns
(4) Please specify required voltage at time of order
(5) M2 of TEMoo systems is <1.3.

Parameter	Condition	Wavelength (nm)	All Models
Pulse width (ns)	Nominal ±2ns	1064	6 to 13
		532	5 to 12
		355	5 to 11
		266	5 to 10
Energy stability (±%)		1064	<2
		532	<4
		355	<6
		266	<10
Beam divergence (mrad)	Fullangle for >90% of energy		0.8
M^2 (Focussability) [5]		1064	<3.5
Linewidth (cm^{-1})	No line-narrowing	1064	<1
	With Etalons [1]	1064	<0.06
	With Seeder [2]	1064	<0.003
Pointing stability (μrad)	Full angle		<70
Timing jitter [3]	w.r.t direct access		<500ps
Lamp life (pulses)			10 million

Services	
Electrical Supply [4]	Single phase 220-250VAC 50/60Hz or 100-120VAC 50/60Hz
Water Supply (Where necessary)	<20°C, >2bar

CE

Our policy is to improve the design and specification of our products. The details given in this brochure are not to be regarded as binding.

Gaussian Coupled Resonators Range Specification

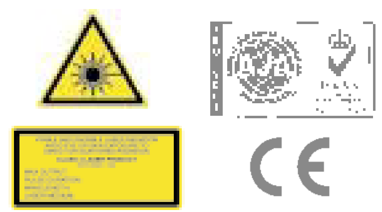
All LPY7xx series systems feature a birefringence compensating twin rod oscillator design.
The LPY6xx series are single rod oscillators / oscillator-amplifiers

Model		LPY704G	LPY706G	LPY707G	LPY674G	LPY764G
Parameter Condition						
Pulse energy at wavelength (mJ)[2]						
1064nm	Up to 10Hz	400	650	800	1000	1250
532nm		200	325	400	550	625
355nm		90	100	150	260	300
266nm		50	70	90	100	120
1064nm	Up to 20Hz	380	600	725	850	1000
532nm		190	300	350	425	500
355nm		70	90	110	150	140
266nm		45	65	75	85	90
Beam Dia. (mm)	Nominal	6	8	9.5	9.5	9.5
Power supply unit	Up to10Hz	LPU1000	LPU1000	LPU1000	LPU2000	LPU2000
	Cooling system	Air	Air	Air	Water	Water
	Up to 20Hz	LPU1000	LPU1000	LPU1000	LPU2000	LPU2000
	Cooling System	Air	Water	Water	Water	Water

Notes
(1) Insertion loss due to etalon is <20%.
Energy stability is reduced by up to a factor of 2
(2) Inserion loss of seeder is about 10%.
Third harmonic output is increased by about 20%
(3) Timing jitter with seeder is <1ns
(4) Please specify required voltage at time of order

Parameter	Condition	Wavelength (nm)	All Models
Pulse width (ns)		1064	6 to 9
		532	5 to 7
		355	4 to 6
		266	3 to 5
Energy stability (±%)		1064	<2
		532	<4
		355	<6
		266	<10
Beam divergence (mrad)	Fullangle for >90% of energy		0.5
M^2 (Focussability)		1064	<2
Linewidth (cm^{-1})	No line-narrowing	1064	<1
	With Etalons [1]	1064	<0.15
	With Seeder [2]	1064	<0.003
Pointing stability (μrad)	Full angle		<70
Timing jitter [3]	w.r.t direct access		<500ps
Lamp life (pulses)			10 million

Services	
Electrical Supply [4]	Single phase 220-250VAC 50/60Hz
Water Supply	<20°C, >2bar None for LPY604G - LPY606G



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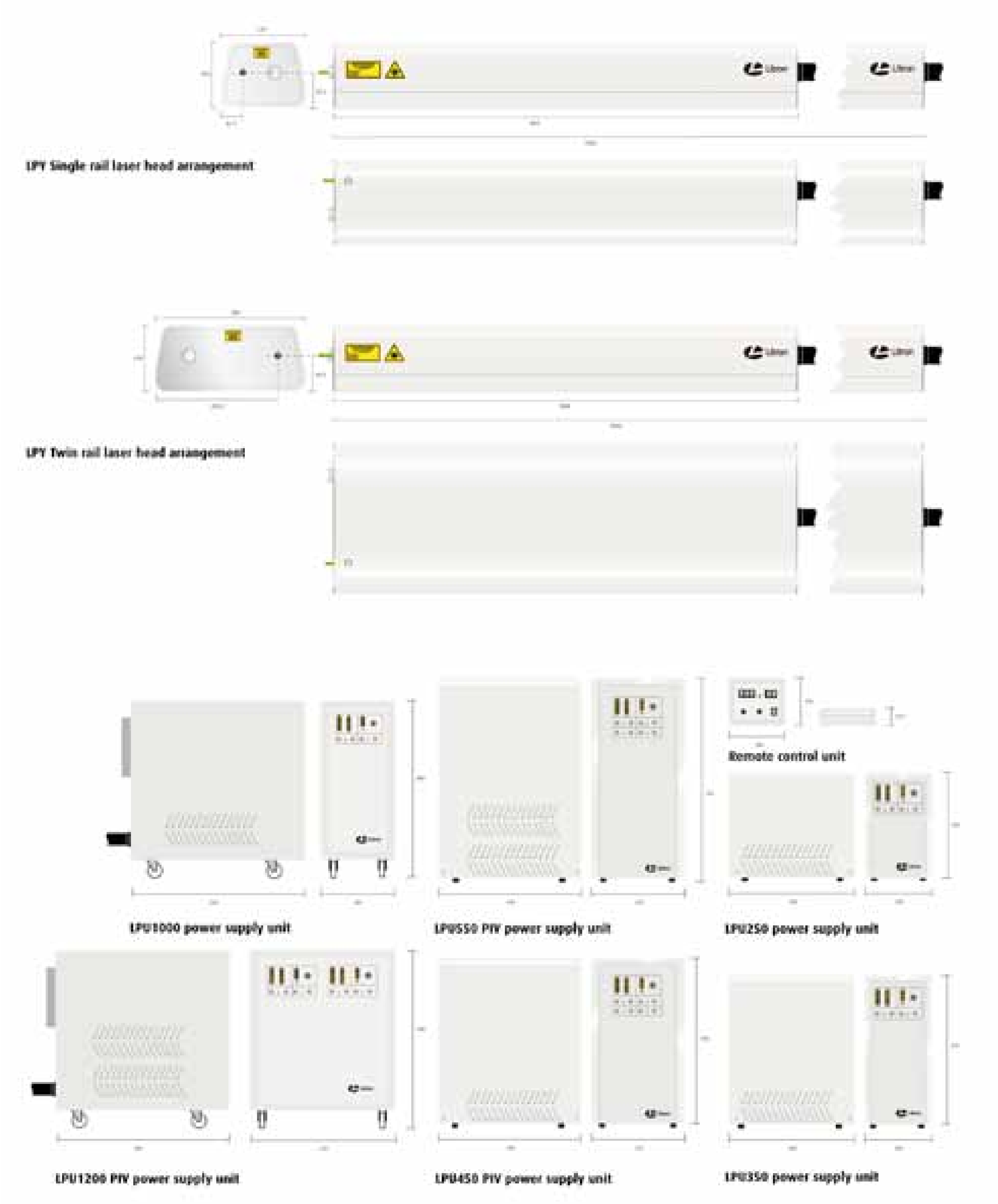
Spectroscopes
CCD Cameras · Imaging
Semiconductors · Communications
Solar Cells · Lighting
Tests · Instruments
Detection · Sensors
Components · Mechanics · Positioning
Lasers · Light Sources

The Litron High Energy Pulsed Nd:YAG laser range

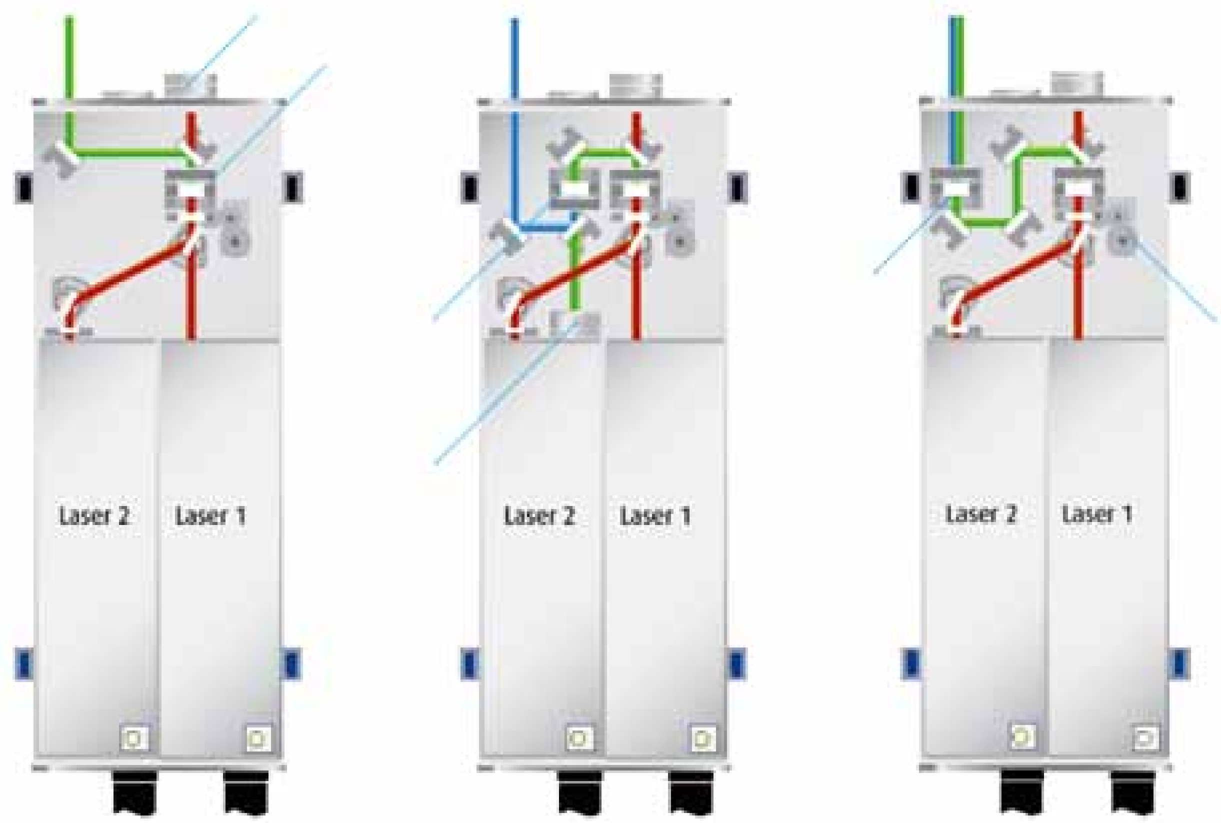
All dimensions in mm.



Nano TRL 25-250 PIV Lamp Pumped Q-switched Nd:YAG Lasers

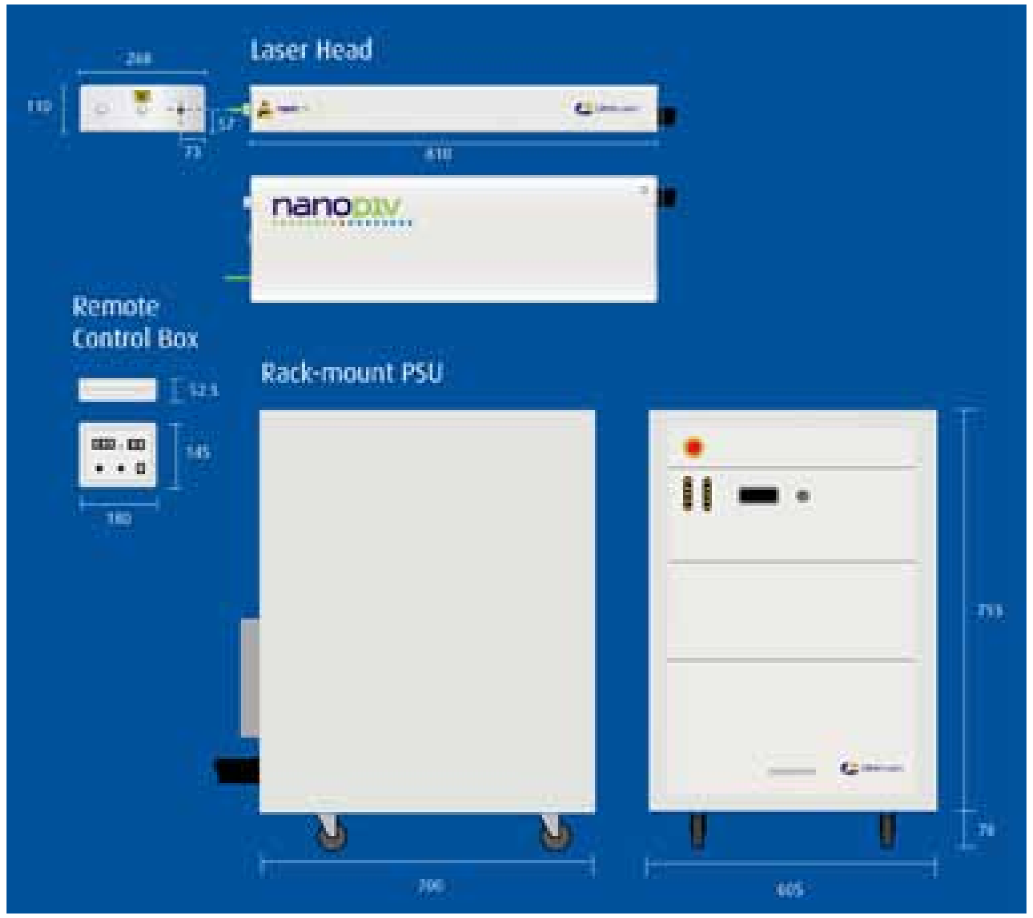
Nano TRL PIV

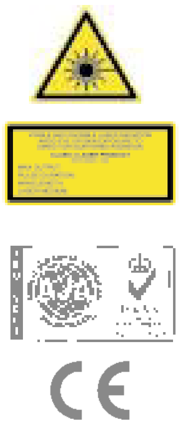
Laser Head Design
Nano PIV Series Harmonic Generation Options



TECHNICAL DATA

Model	Nano TRL 25-250 PIV
Repetition rate per laser head (Hz)	250
Output energy per cavity (mJ)	
532nm	25
335 nm	8
Parameter	
Stability(+/-%)	2
Beam Diameter (mm)	4
Pulse Length (ns)	<15
Pointing Stability (μrad full angle)	100
Power Supply	19” Rack
Services	
Power Requirement (VAC)	220-250
Cooling	Water





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High Energy Compact Pulsed Lasers for Research & Industry

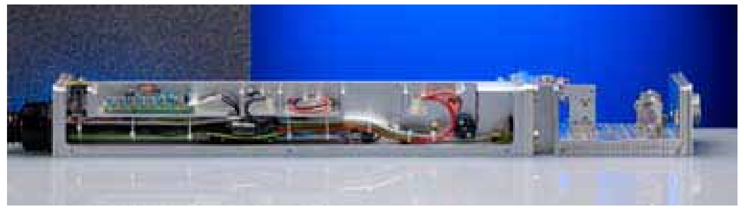
Nano TRL

The Nano TRL Series High Energy, High Repetition Rate, Nd:YAG Lasers

Built for Rugged Applications, Designed for High Energy Output

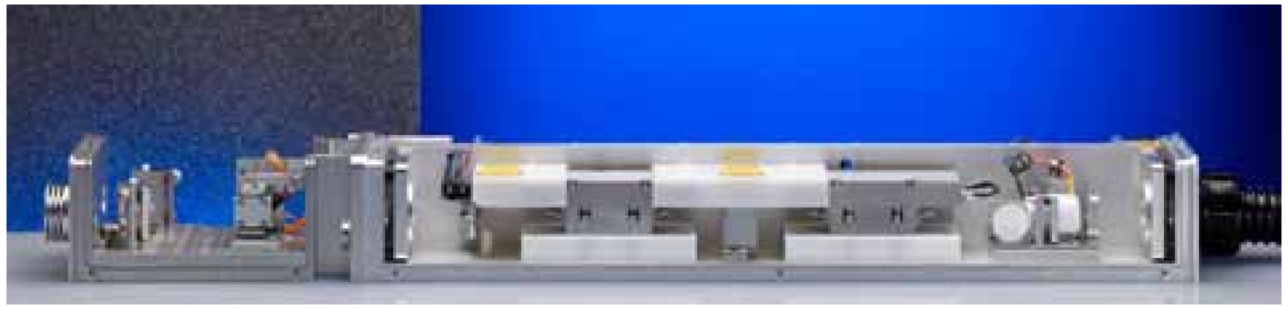
FEATURES

- Output Energies of up to 850mJ
- Repetiton Rates of up to 200Hz
- Twin-rod Architecture for Birefringence Compensation
- Rugged Industrial Design



APPLICATIONS INCLUDE

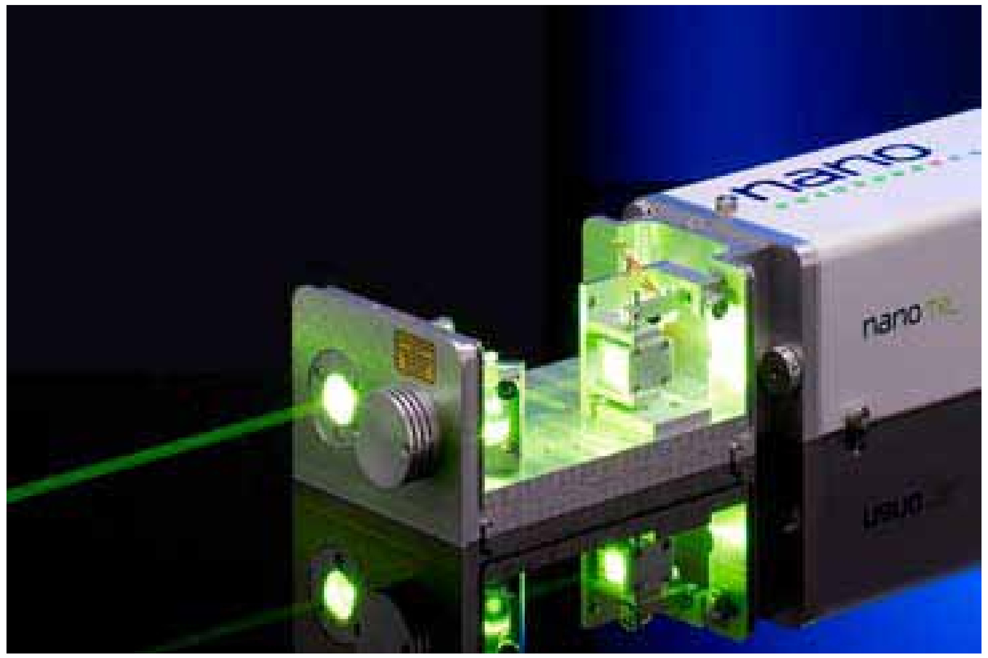
- PIV
- OPO Pumping
- Ti:S Pumping
- Dye Laser Pumping
- Deflashing
- Cleaning
- Spectroscopy
- LIBS



Building on the success of the Nano series of compact pulsed Nd:YAG lasers, the Nano TRL is a fully birefringence compensated pulsed laser system offering both high energy and high repetition rate outputs. It's twin-rod architecture ensures high beam homogeneity even at very high average power outputs. The Nano TRL is designed to suit demanding industrial applications with a sealed laser head machined from solid aluminium, ultrastable mirror mounts and industry leading lamp lifetimes.

Resonator options include unstable Gaussiancoupled, stable and stable-telescopic configurations allowing for a multitude of applications. Harmonic wavelengths are realised by 'bolton' modules that can be added and removed as required.

Power supplies for the range include state-ofthe- art IGBT switching into the flashlamp, giving increased efficiency and stability as well as significantly prolonging lamp life due to the much lower currents.



TECHNICAL DATA Nano TRL Gaussian-Coupled Resonators

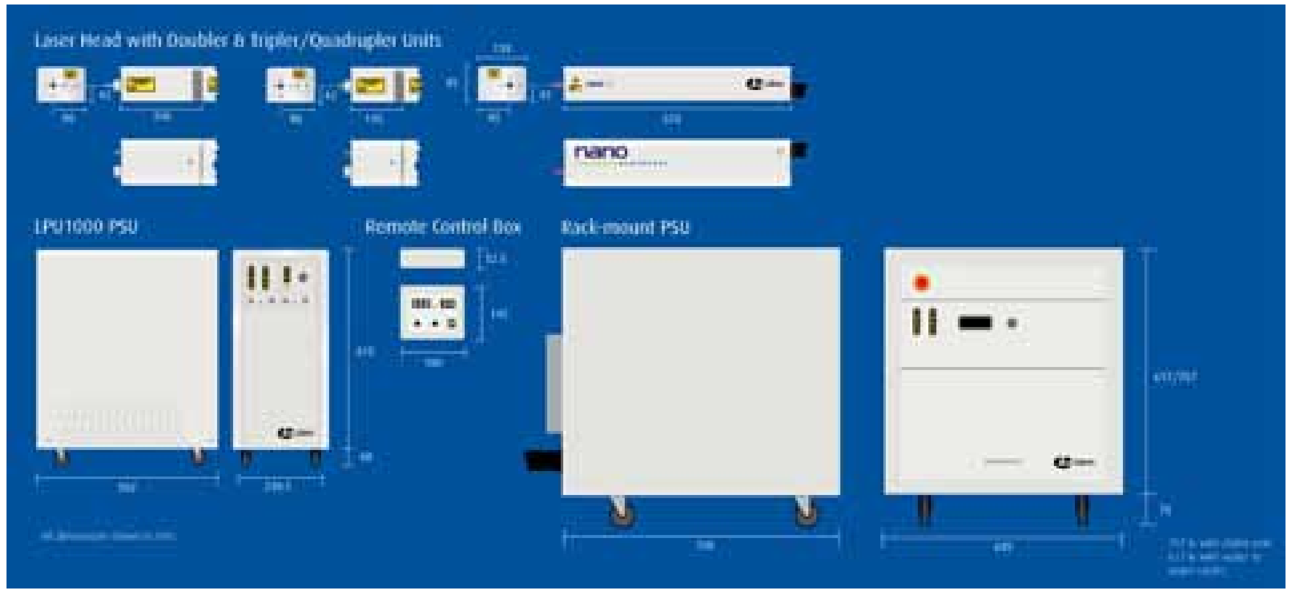
Model	Nano TRL 850-10	Nano TRL 750-20	Nano TRL 650-30	Nano TRL 650-10	Nano TRL 600-20	Nano TRL 550-30	Nano TRL 420-10	Nano TRL 380-20	Nano TRL 350-30
Repetition Rate (Hz)	10	20	30	10	20	30	10	20	30
Output Energy (mJ)									
1064nm	850	750	650	650	600	550	420	380	350
532nm	425	375	325	325	300	275	210	190	175
355nm (1)	150	130	110	110	100	90	80	75	70
266nm	95	80	65	70	60	60	50	45	40
Parameter									
Stability(±%)(1)	2	2	2	2	2	2	2	2	2
Beam Diameter (mm)	9.5	9.5	9.5	8	8	8	6.35	6.35	6.35
Pulse Length (ns)	5-7	5-7	5-7	5-7	5-7	5-7	5-7	5-7	5-7
Pointing Stability (μrad full angle)	50	50	50	50	50	50	50	50	50
M^2	~2	~2	~2	~2	~2	~2	~2	~2	~2
Divergence (mrad full angle)	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
Power Supply	LPU 1000	19" Rack	19" Rack	LPU 1000	LPU 1000	19" Rack	LPU 1000	LPU 1000	LPU 1000
Services									
Power Requirement (VAC)	220-250	220-250	220-250	220-250	220-250	220-250	220-250	220-250	220-250
Cooling (2)	Air	Water	Water	Air	Air	Water	Air	Air	Air

(1) At 1064nm
(2) Chiller option available to negate the need for water

TECHNICAL DATA Nano TRL High Repetition Rate Stable Resonators

Model	Nano TRL 320-50	Nano TRL 100-100	Nano TRL 250-100	Nano TRL 80-200	Nano TRL 120-200
Repetition Rate (Hz)	50	100	100	200	200
Output Energy (mJ)					
1064nm	320	100	250	80	120
532nm	160	60	130	45	65
355nm	60	20	45	15	20
266nm	30	10	20	7	9
Parameter					
Stability(+/-%) (1)	2	2	2	2	2
Beam Diameter (mm)	6.35	5	6.35	5	6.35
Pulse Length (ns)	10-12	10-15	10-15	10-12	10-15
Pointing Stability (μrad full angle)	100	100	100	100	100
Power Supply	19" Rack	LPU 1000	19" Rack	19" Rack	19" Rack
Services					
Power Requirement (VAC)	220-250	220-250	220-250	220-250	220-250
Cooling (2)	Water	Air	Water	Water	Water

(1) At 1064nm
(2) Chiller option available to negate the need for water

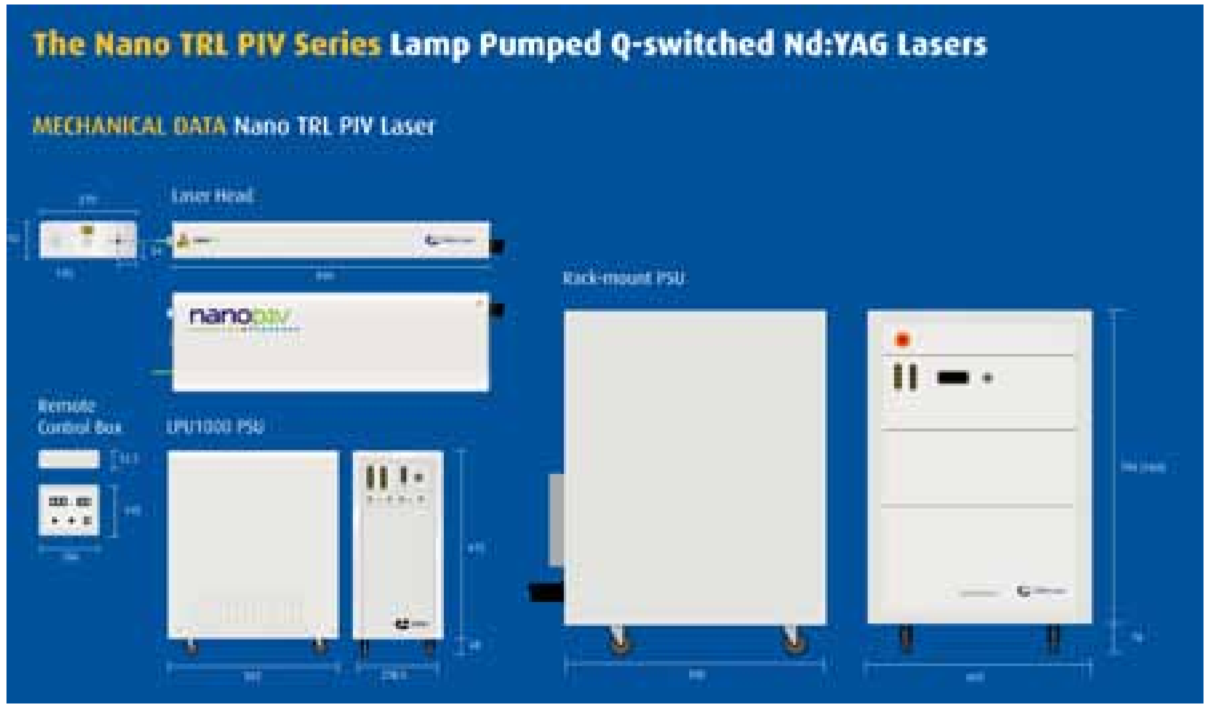


Nano TRL 25-250 PIV Lamp Pumped Q-switched Nd:YAG Lasers

Nano TRL PIV

The Nano TRL PIV Series Lamp Pumped Q-switched Nd:YAG Lasers

Model	Nano TRL 250-20 PIV	Nano TRL 325-15 PIV	Nano TRL 300-20 PIV	Nano TRL 425-10 PIV	Nano TRL 400-15 PIV	Nano TRL 400-20 PIV
Repetition Rate (Hz)	20	15	20	10	15	20
Output Energy per cavity (mJ)						
532nm	250	325	300	425	400	400
Parameter						
Stability (+/-%)	2	2	2	2	2	2
Beam Diameter (mm)	6.35	8	9.5	9.5	9.5	9.5
Pulse Length (ns)	5-7	5-7	5-7	5-7	5-7	5-7
Pointing Stability (μrad full angle)	100	100	100	100	100	100
M^2 at 532nm	~7	~7	~7	~7	~7	~7
Power Supply	2 x LPU1000	2 x LPU1000	19" Rack	2 x LPU1000	19" Rack	19" Rack
Services						
Power Requirement (VAC)	220-250	220-250	220-250	220-250	220-250	220-250
Cooling	Air	Air	Water	Air	Water	Water

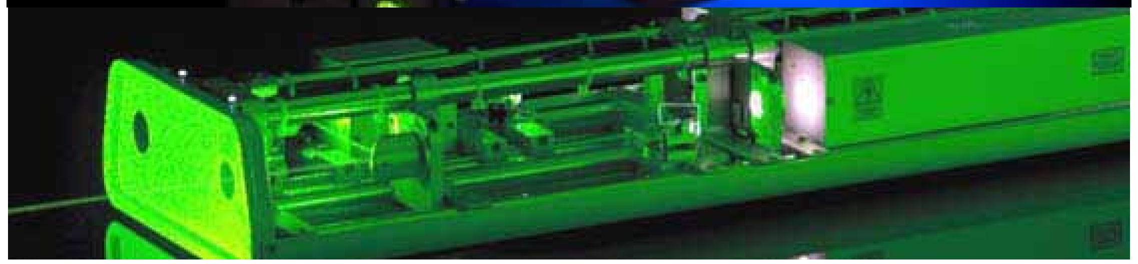


Lamp Pumped Lasers for PIV Applications

PIV Lasers


Litron offers an extensive range of flashlamp pumped PIV laser systems with output energies of up to 1J per pulse and repetition rates of up to 200Hz. All of the systems are twin head devices, meaning that the PIV laser head contains two totally independent lasers. The range of PIV systems is based around both the ultra-compact Nano series and the larger invar stabilised LPY series. The overriding factor that sets Litron's products apart is quality. This is evidenced not only in the design and construction of the product, but also in its performance. In any imaging application the beam quality is of paramount importance as this completely determines the light sheet quality. By choosing a suitable resonator configuration the output beam quality can be controlled to give a very smooth spatial profile which remains homogeneous as it propagates right into the far field. Such resonators are almost always of a stable or stable-telescopic configuration. Unstable Gaussian-coupled resonators are not in general ideal for visualisation applications. Such resonators yield output beams that contain very high spatial frequencies in the near field, and as they propagate a hole appears in the centre of the beam (a 'donut' beam profile). This is typical of any such resonator and is a result of the physics of the system. It is therefore quite clear that if the beam is to be used in the near or intermediate fields (within 10 metres of the laser output) the light sheet formed is unlikely to be uniform, as the laser beam is not.

It is our philosophy to provide a laser system that suits an application. A 'one system fits all' approach, as offered by most manufacturers, does not allow the customer to optimise their process. For applications such as PIV Litron has developed resonators that will yield extremely uniform light sheets whose pulse to pulse structure remains extremely constant. These are all based around our stable or stable- telescopic resonators.

Compact Lasers for PIV Applications
The Nano Series

NANO PIV FEATURES

- Compact dual head design
- Dedicated PIV laser head
- Telescopic versions for low divergence
- Rugged for industrial installation
- 3rd or 4th harmonics available for LIF and dual colour PIV
- Rep. rates to 100Hz
- Energies to 200mJ @ 532nm

Nano PIV

The construction of the Nano series of PIV laser systems is extremely robust. They have been developed as industrial tools that can be handled without worry of misalignment or damage. The PIV head is formed by an aluminium gauge-plate onto which two standard Nano series heads are mounted. The output beams are combined by dielectric polarisers and then frequency doubled, and if desired can be frequency tripled, quadrupled or quintupled. Many of the Nano PIV systems are powered by a single power supply unit, making the overall package both powerful and portable.

There are two twin power supplies available, the LPU450- PIV and the LPU550- PIV, the latter allowing outputs of 200mJ at 532nm at 15Hz from each laser. The laser system is controlled via a remote controller. All trigger and synchronisation signals are TTL compatible, and each laser is controllable entirely independently. All Nano laser heads have a verified electronic intracavity safety shutter as standard, which ensures that the lasers cannot be started with the shutter open – an important safety feature. The Nano L PIV range also includes high repetition rate models giving energies of 50mJ per pulse at 100Hz from each laser from a power supply that is completely air cooled.

The Nano T PIV range has been designed incorporating stable telescopic resonators, giving very low divergence output beams that allow thinner light sheets to be formed than from conventional stable resonators.

For large area illumination, high energies are achieved with the birefringence compensated Nano TRL range which achieves output energies of up to 450mJ per pulse at 532nm, 10Hz. The footprint of the head is an extremely compact 850mm x 260mm. All Nano series PIV lasers are available with the third and fourth harmonics.

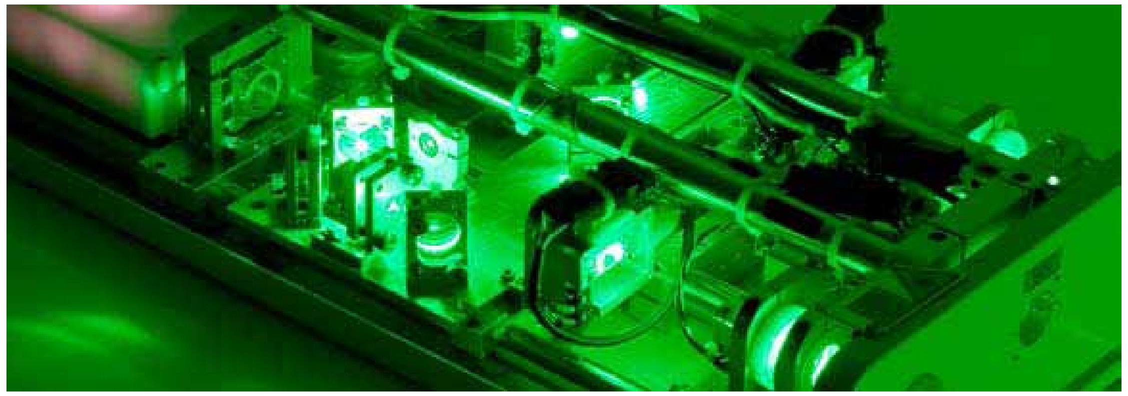
High Energy & High Repetition Rate Lasersfor PIV
The LPY Series

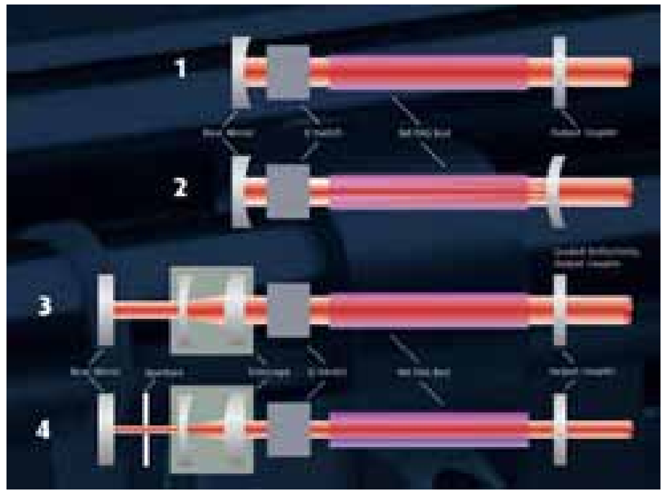
LPY PIV FEATURES

- Dedicated PIV Laser Head
- Frequencies up to 200Hz
- High Pulse Energy to 1J
- True TEM00 output available
- Stable resonator design
- 355nm & 266nm available for LIF and dual colour PIV
- Low profile INVAR optical rail
- Line narrowed versions
- Rugged industrial design

LPY PIV

For higher energy systems or systems where very low divergences are required Litron offers twin configurations of its invar stabilised LPY series.
Output energies of up to 1J per pulse of 532nm at repetition rates of up to 20Hz are available as standard, as are outputs of 100mJ at 532nm at 200Hz.
The LPY PIV series are based around a rugged, self supporting, invar rail. This imparts both a large degree of mechanical and thermal stability to the system suiting them to use in both research and industrial applications with little need for maintenance.
Several of the LPY PIV series include an intra-cavity telescope yielding low divergence outputs. All LPY700 series systems feature a birefringence compensating twin-rod design to give the best possible beam homogeneity, essential for the formation of uniform light sheets.
The modular construction of the LPY series laser heads allows for easy customisation of systems.
Options including variable optical attenuation, line-narrowing etalons and injection seeding are available upon request.





Schematics showing oscillator design.
1) Stable
2) Gaussian
3) Telescopic Multimode
4) Telescopic TEM_{00}

Resonator Design
The Heartofthe Litron System

Stable Resonator

A stable resonator provides the most flexibility in terms of output energy and repetition rate, as both parameters can be varied with minimal effect upon the alignment of the system. In general, the output of such systems is multi-mode. With the addition of an intracavity aperture, a TEM_{00} output can easily be realised at the expense of overall energy.

Gaussian Optics

In a Gaussian system, a graded reflectivity output mirror is used as part of a geometrically unstable resonator. Such systems give a high energy single transverse mode with a low beam divergence. The thermal lens formed by the laser rod is part of the optical arrangement. Therefore, Gaussian systems work best at a constant average input power (i.e. lamp energy and repetition frequency). As such, the laser is factory set at one pulse repetition frequency and output energy. To increase flexibility, Litron offers two options. The first option, the pulse repetition rate divider allows the user to divide the set repetition rate by 2, 4, 8 or 16. This works by allowing the flashlamp to pulse at a set frequency, thus maintaining almost the same thermal lens on the laser rod, but only switching the Pockels cell on the desired pulses (i.e. every other pulse for divide by two operation).

Telescopic Resonator

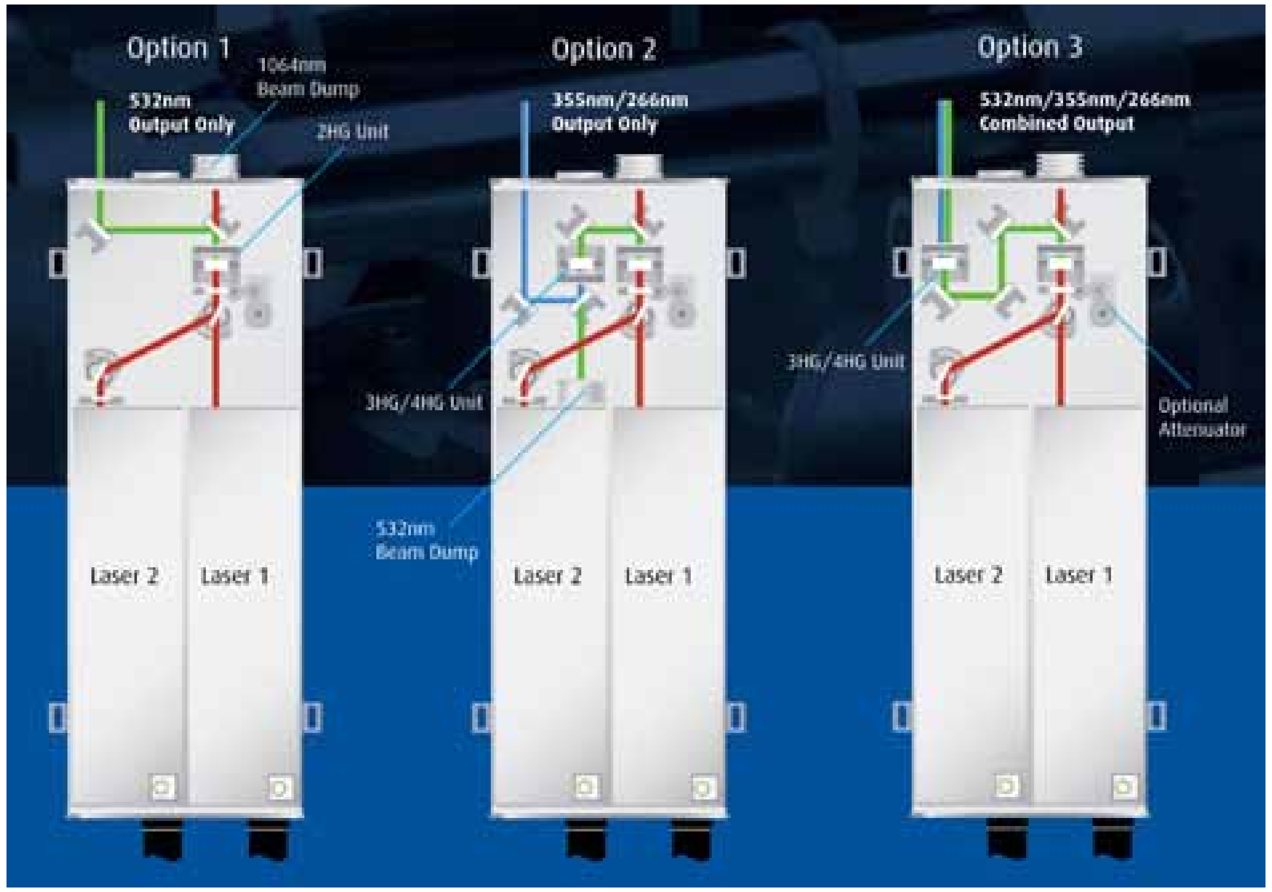
To obtain high energy, low divergence beams, the preferred method is the use of a telescopic resonator. In this configuration, an intra-cavity telescope is used to reduce the beam diameter in the rear of the resonator. This makes the resonator appear longer, increasing the lower order mode volumes, leading to a superior output beam with very low divergence. With no optical adjustment at all, the laser can be varied over a wide range of pulse energies and repetition rates, maintaining a high quality, low divergence beam. With slight adjustment to the telescope (a simple procedure) the full range of energies and repetition rates from single pulse to the maximum can be achieved. For high energy TEM00 beams, an intra-cavity aperture can be fitted behind the telescope. Varying the sizes of these apertures allow output beams that are to within 15% of the diffraction limit to about 3.5 times the diffraction limit. That is from an almost pure Gaussian TEM_{00} to full energy in a uniform spatial profile, giving a high degree of control over light sheet characteristics.

Optical Attenuator

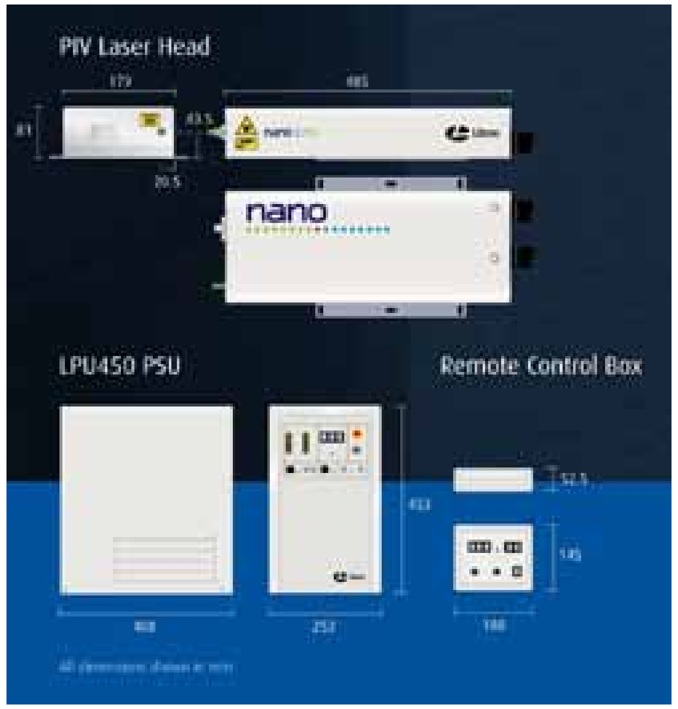
Energy output can be controlled via the variable optical attenuator. The output energy of the laser can be attenuated by the use of an extra-cavity polariser and half wave plate, whilst maintaining the beam quality and divergence.

This also has the advantage that the pulse to pulse stability is maintained even at very low output energies.

Laser Head Design
Nano PIV Series Harmonic Generation Options



The Nano S PIV Pulsed Nd:YAG Laser System



Model	**Nano S 30-15 PIV**	**Nano S 30-30 PIV**	**Nano S 50-20 PIV**	**Nano S 65-15 PIV**
Repetition Rate				
per Laser Head (Hz)	0-15	0-30	0-20	0-15
Output Energy at 532nm				
per Laser Head (mJ)	15	30	50	65
Parameter				
Pulse - Pulse Stability (±%)	2	2	2	2
Beam Diameter (mm)	3	3	4	4
Beam Divergence (mrad)	~2.0	~2.0	~2.5	~2.5
Pulse Length @ 1064nm (ns)	5-8	5-8	6-8	6-8
Pointing Stability (μrad)	<100	<100	<100	<100
Resonator Type	Stable	Stable	Stable	Stable
Lamp Life (pulses)	>5x107	>5x107	>5x107	>5x107
Timing Jitter (ns)	<0.5	<0.5	<0.5	<0.5
Services				
Voltage (VAC)	90-250	90-250	90-250	90-250
Frequency (Hz)	47-63	47-63	47-63	47-63
Power	Single Phase	Single Phase	Single Phase	Single Phase
Ambient(1) (˚C)	5-35	5-35	5-35	5-35
Consumption (W)	<350	<350	<350	<350
Power supply	LPU450	LPU450	LPU450	LPU450

(1) 0-80% non condensing atmosphere

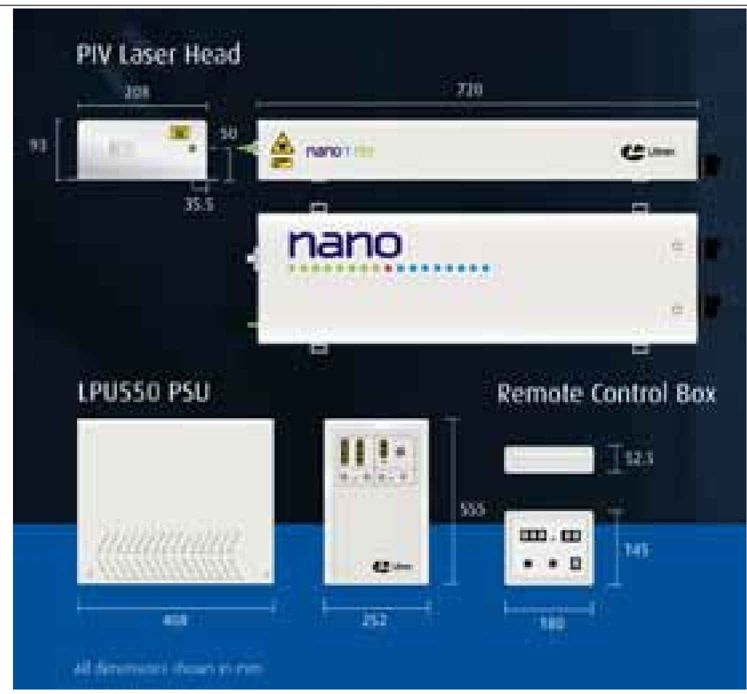
The Nano L PIV Pulsed Nd:YAG Laser System
Technical Data

Model	Nano L 200-15 PIV	Nano L 135-15 PIV	Nano L 50-50 PIV	Nano L 100-50 PIV	Nano L 50-100 PIV
Repetition Rate					
per Laser Head (Hz)	0-15	0-15	0-50	0-50	0-100
Output Energy at 532nm					
per Laser Head (mJ) (1)	200	135	50	100	50
Parameter					
Pulse - Pulse Stability (±%)	2	2	2	2	2
Beam Diameter (mm)	6.5	5	4	4	4
Beam Divergence (mrad)	~3	~3	~2	~2	~2
Pulse Length @ 1064nm (ns)	6-9	6-9	5-8	5-8	5-8
Pointing Stability (μrad)	<100	<100	<100	<100	<100
Resonator Type	Stable	Stable	Stable	Stable	Stable
Lamp Life (pulses)	> $5x10^7$	> $5x10^7$	> $5x10^7$	> $5x10^7$	> $5x10^7$
Timing Jitter (ns)	<0.5	<0.5	<0.5	<0.5	<0.5
Services					
Voltage (VAC)	90-250	90-250	90-250	200-250	200-250
Frequency (Hz)	47-63	47-63	47-63	47-63	47-63
Power	Single Phase	Single Phase	Single Phase	Single Phase	Single Phase
Ambient(2) (˚C)	5-35	5-35	5-35	5-35	5-35
Consumption (W)	<800	<650	<800	<2500	<2500
Power Supply	LPU550	LPU550	LPU550	2xLPU1000	2xLPU1000

(1) At maximum rep. rate. (2) 0-80% non condensing atmosphere.

The Nano T PIV Pulsed Nd:YAG Laser System
Technical Data

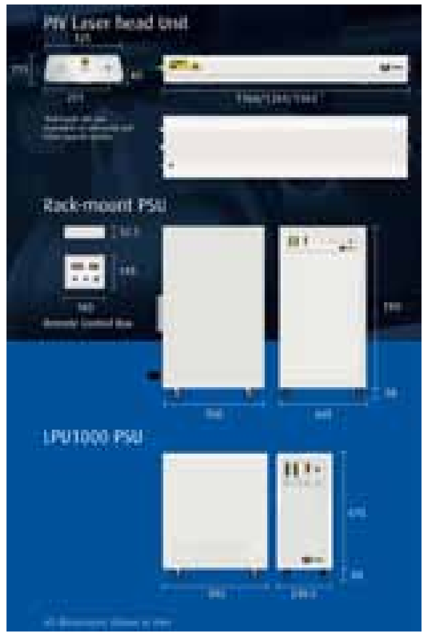
Model	Nano T 180-15 PIV	Nano T 135-15 PIV
Repetition Rate Per Laser Head (Hz)	15	15
Output Energy at 532nm Per Laser Head (mJ)	180	135
Parameter		
Pulse - Pulse Stability (±%)	2	2
Beam Diameter (mm)	6.35	5
Beam Divergence (mrad)	0.8	0.8
Pulse Length @ 1064nm (ns)	7-9	7-9
Pointing Stability (μrad)	100	100
Resonator Type	Telescopic	Telescopic
Lamp Life (pulses)	$5x10^7$	$5x10^7$
Timing Jitter (ns)	0.5	0.5
Services		
Voltage (VAC)	90-250	90-250
Frequency (Hz)	47-63	47-63
Power	Single Phase	Single Phase
Ambient(1) (˚C)	5-35	5-35
Consumption (W)	<800	<650
Power Supply	LPU550	LPU550
(1) 0-80% non condensing atmosphere		



The LPY PIV High Energy Pulsed Nd:YAG Laser System
Technical Data

Model	LPY 706-20PIV	LPY 707-20PIV	LPY 704-30PIV	LPY 706-15PIV	LPY 707-15PIV
Repetition Rate					
per Laser Cavity (Hz)	20	20	30	15	15
Output Energy at 532nm					
per laser head (mJ)	300	400	200	325	425
Parameter					
Pulse Stability @ 532nm (±%)	<3	<3	<3	<3	<3
Beam Diameter (mm)	8	9	6.5	8	9
Beam Divergence (mrad)	0.8	~3	0.8	0.8	~3
Pulse Length @ 532nm (ns)	7-11	7-11	7-11	7-11	7-11
Pointing Stability (μrad)	<70	<70	<70	<70	<70
Lamp Life (pulses)	5×10^7	5×10^7	5×10^7	5×10^7	5×10^7
Timing Jitter (ns)	<0.5	<0.5	<0.5	<0.5	<0.5
Services					
Voltage[1] (VAC)	200-250	220-250	220-250	220-250	220-250
Frequency[2] (Hz)	47-63	50 or 60	50 or 60	50 or 60	50 or 60
Power	Single Phase	Single Phase	Single Phase	Single Phase	Single Phase
Water Temp Max. (˚C)	Air cooled[3]	20	20	20	20
Inlet Pressure (bar)	<2	<2	<2	<2	<2
Power Supply	2 x LPU1000	18U Rack	18U Rack	18U Rack	18U Rack

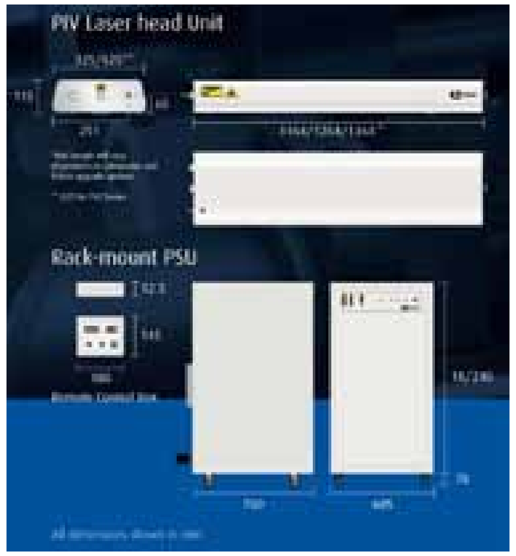
(1) 110VAC option requires autotransformer to be specified on order.
(2) 50 or 60Hz to be specified on order.
(3) Ambient Temperature 5-35˚C. (0-80% non condensing atmosphere.)



The LPY PIV High Rep. Rate Pulsed Nd:YAG Laser System
Technical Data

Model	LPY 704-100PIV	LPY 703-200PIV	LPY 742-100PIV	LPY 742-200PIV
Repetition Rate				
per Laser Cavity (Hz)	100	200	100	200
Output Energy at 532nm				
per laser head (mJ)	100	50	200	100
Parameter				
Pulse Stability @ 532nm (±%)	<3	<3	<3	<3
Beam Diameter (mm)	6.5	4	6.5	6.5
Beam Divergence (mrad)	~3	~3	~3	~3
Pulse Length @ 532nm (ns)	10-12	10-12	10-12	10-12
Pointing Stability (μrad)	<70	<70	<70	<70
Lamp Life (pulses)	10^8	10^8	10^8	10^8
Timing Jitter (ns)	<0.5	<0.5	<0.5	<0.5
Services				
Voltage[1] (VAC)	220-250	220-250	220-250	220-250
Frequency[2] (Hz)	50 or 60	50 or 60	50 or 60	50 or 60
Power	Single Phase	Single Phase	Single Phase	Single Phase
Water Temp Max. (˚C)	20	20	20	20
Inlet Pressure (bar)	<2	<2	<2	<2
Power Supply	18U Rack	18U Rack	24U rack	24U Rack

(1) 110VAC option requires autotransformer to be specified on order.
(2) 50 or 60Hz to be specified on order.



LPM 230 Series Photodiode Laser Energy Monitors

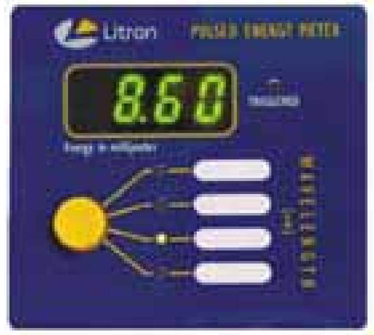
LPM 230


State of the Art Energy Monitoring Devices for Laser Users.

The LPM230 series of energy monitors are extremely compact, portable, photodiode based instruments. They have been designed to facilitate the easy, accurate measurement of pulsed laser output energy, and to allow detailed performance monitoring of laser systems. Their small size makes them ideal for laser test and service engineers.

The detection electronics gives exceptional linearity over the entire dynamic range of the device, and gives rise to repeatability errors of less than 0.2%.

The type of detection diode that is chosen allows for different spectral ranges to be covered accurately. The maximum measurable pulse length is user selectable up to 50ms via theincluded software suite. The optional oscilloscope output allowsthe temporal profile of the laser pulse to be observed. It can beconfigured either as a 50Ω output or as an integrated output with a time constant of 500μs.



The head contains a 4 digit LED display, allowing the unit to be used as a 'stand-alone' device. The inclusion of a serial interface is standard on all models and allows full data logging and statistical analysis of the laser output with the software package included. Fully automatic re-calibration can be performed in conjunction with our in-line transfer standard meter. Our proprietary, patent pending, optical configuration gives a high uniformity in the reading over the whole of the 30mm input aperture, as well as giving the device a low angular sensitivity, minimising the effects of small misalignments. We are happy to discuss your custom requirements should one of our standard range detailed overleaf not be suitable for your application.

FEATURES

- Pulse energies from 10μJ to 30J
- Very compact size
- 400nm - 1650nm (typically depending on the choice of the detection photodiode)
- Accurately temperature stabilised photodiode
- Pulse repetition rates of up to 1000Hz
- Exceptional linearity
- Repeatability errors of less than 0.2%
- High damage threshold - greater than 3J/cm2 Q-switched
- Rugged design with integrated 4 digit energy display
- Traceable calibrations available at 1535nm, 1064nm, 694nm and 532nm
- Comprehensive software suite with datalogging capability for use with Microsoft® Windows®
- RS232 interface


The Litron LTM 530 In-line Energy Monitor Series

LPM 230 Series Photodiode Laser Energy Monitors SPECIFICATIONS

Model	Photodiode Type	Wavelength Range (nm)	Energy Range[1,7] Output	scilloscope Input Frequency	Maximum Pulse Pulse Length	Maximum Input	Calibration Available at (nm)
LPM230-1	Silicon	400-1100	0.01-60 mJ	See Note 2	See Note 3	See Note 3	1064, 532, 694
LPM230-2			0.1-600 mJ				
LPM230-3			1-3000 mJ				
LPM230-4			10 mJ - 30 J				
LPM231-1	InGaAs	900-1650	0.01-60 mJ	See Note 2	See Note 3	See Note 3	1535, 1064
LPM231-2			0.1-600 mJ				
LPM231-3			1-3000 mJ				
LPM231-4			10 mJ - 30 J				

ALL MODELS

Input Aperture Diameter	30mm
Damage Threshold	>50J/cm^2 (normal mode pulses) 3J/cm^2 (Q-switched pulses)
Absolute accuracy at calibrated wavelength[4]	±3% or 1 digit whichever is greater
Error in repeatability[6]	Better than ±0.2%
Positional accuracy across input aperture[5]	±5% from centre to edge
Display type	4 digit green LED
Dimensions (mm)	125 L x 76 W x 65 H
Weight (g)	880
Outputs	RS232, optional 50Ω or integrated oscilloscope output
Power requirements	6V DC, 1A (Adaptor supplied)

NOTES

1. The maximum average power loading in free air is 10W. Custom energy ranges are available.
2. An oscilloscope output is available on all models. For an output that is integrated with a time constant of about 500μs append -A to the model number and for a 50Ω output capable of resolving 500ps pulses append -B to the model code.
3. The maximum pulse width is user settable up to 50ms. The device works by integrating the incident energy over the set period. The maximum input frequency is therefore a function of the maximum pulse width. For a 50ms maximum pulse width, the maximum repetition rate is 18Hz and for a 500μs pulse width the maximum repetition rate is 1kHz.
4. Input beam incident upon centre of aperture and normal to surface. Energy >10% of full scale reading.
5. 4mm diameter input beam across the central 28mm of the input aperture. Larger input beams may give rise to a less uniform response.
6. For integration time <2ms and energies >10% of full scale reading.
7. Full scale energy may vary for different wavelengths with a given device due to the spectral response of the detector and optics.

LPM 250 Series Photodiode Laser Energy Monitors

LPM 250

State of the Art Energy Monitoring Devices for Laser Users.

FEATURES

- Pulse energies from 10μJ to 65J
- 400nm - 1650nm (typicallydepending on the choice of the detection diode)
- Accurate temperature stabilised photodiode
- Pulse repetition rates of up to 1000Hz
  * Exceptional linearity
- Repeatability errors of less than 0.2%
- High damage threshold -greater than 3J/cm2 Q-switched
- Rugged design with integrated 4 digit energy display
- Traceable calibrations available at 1535nm, 1064nm, 694nm and 532nm
- Comprehensive software suite with datalogging capability for use with Microsoft® Windows®
- RS232 interface
- Large 50mm input aperture

The Litron
LTM 530 In-line Energy
Monitor Series

The LPM250 series of energy monitors are photodiode based instruments. They have been designed to facilitate the easy, accurate measurement of pulsed laser output energy, and to allow detailed performance monitoring of laser systems. The detection electronics gives exceptional linearity over the entire dynamic range of the device, and repeatability errors of less than 0.2% may be achieved.

The type of detection diode that is chosen allows for different spectral ranges to be covered accurately. The maximum measurable pulse length is user selectable up to 50ms via the included software suite. An oscilloscope output is an option that allows the temporal profile of the laser pulse to be observed. This can be configured either as a 50Ω output or as an integrated output with a time constant of 500µs.

The head contains a 4 digit LED display, allowing the unit to be used as a ‘standalone’ device. The inclusion of a serial interface is standard on all models and allows full data logging and statistical analysis of the laser output with the software package included. Fully automatic re-calibration can be performed in conjunction with our in-line transfer standard meter.

Our proprietary, patent pending, optical configuration gives a high uniformity in the reading over the whole of the 50mm input aperture, as well as giving the device a low angular sensitivity, minimising the effects of small misalignments.

We are happy to discuss your custom requirements should one of our standard range detailed overleaf not be suitable for your application.

LPM 250 Series Photodiode Laser Energy Monitors SPECIFICATIONS

Model	Photodiode Type	Wavelength Range (nm)	Energy Range[7]	Fan		Oscilloscope Output	Maximum Pulse Input Frequency	Maximum Input Pulse Length	Calibration Available at (nm)
					Append				
LPM250-1	Silicon	400-1100	0.01-60 mJ	Optional	-F	See Note 2	See Note 3	See Note 3	1064, 532, 694
LPM250-2			0.1-600 mJ	Optional	-F				
LPM250-3			1-6000 mJ	Optional	-F				
LPM250-4-F			10 mJ - 65 J	Standard					
LPM251-1	InGaAs	900-1650	0.01-60 mJ	Optional	-F	See Note 2	See Note 3	See Note 3	1535, 1064
LPM251-2			0.1-600 mJ	Optional	-F				
LPM251-3			1-6000 mJ	Optional	-F				
LPM251-4-F			10 mJ - 65 J	Standard					

ALL MODELS

Input Aperture Diameter	50mm
Damage Threshold	>50J/cm^2 (normal mode pulses) 3J/0cm^2 (Q-switched pulses)
Absolute accuracy at calibrated wavelength[4]	±3% or 1 digit whichever is greater
Error in repeatability[6]	Better than ±0.2%
Positional accuracy across input aperture[5]	±5% from centre to edge
Display type	4 digit green LED
Dimensions (mm)	195 L x 96 W x 82 H (no fan) 195 L x 100 W x 82 H (with fan)
Weight (kg)	1.9
Outputs	RS232, optional 50Ω or integrated oscilloscope output
Power requirements	6V DC, 1A (Adaptor supplied)

NOTES

1. The maximum power loading in free air is 20W. The addition of a fan allows power loadings of up to 50W continuously.
2. An oscilloscope output is available on all models. For an output that is integrated with a time constant of about 500µs append -A to the model number and for a 50Ω output capable of resolving 200ps pulses append -B to the model number.
3. The maximum pulse width is user settable up to 50ms. The device works by integrating the incident energy over the set period. The maximum input frequency is therefore a function of the maximum pulse width. For a 50ms maximum pulse width, the maximum repetition rate is 18Hz and for a 500µs pulse width the maximum repetition rate is 1kHz.
4. Input beam incident upon centre of aperture and normal to surface. Energy >10% of full scale reading.
5. 4mm diameter input beam across the central 42mm of the input aperture. Larger input beams may give rise to a less uniform response.
6. For integration time <2ms and energies >10% of full scale reading.
7. Full scale energy may vary for different wavelengths with a given device due to the spectral response of the detector and optics.

LPY Series High Energy Pulsed Nd : YAG Lasers

LPY Lasers

LPY Range Specification Stable and Stable Telescopic Resonators

Model	LPY 704-10	LPY 706-10	LPY664-10	LPY674-10	LPY764-10	LPY704-20	LPY706-20	LPY664-20	LPY674-20	LPY764-20	LPY704-30	LPY706-30	LPY764-30
Repetition Rate (Hz)	**10**	**10**	**10**	**10**	**10**	**20**	**20**	**20**	**20**	**20**	**30**	**30**	**30**
Output Energy (mJ)													
1064nm	420	650	850	1000	1250	380	600	800	850	1000	380	550	900
532nm	210	325	425	500	675	190	300	400	425	500	190	225	450
355nm (1)	80	100	130	160	200	70	85	110	130	140	50	80	150
266nm	50	70	95	110	120	50	65	75	80	90	45	60	80
Pulse Stability (±%)													
1064nm	2	2	2	2	2	2	2	2	2	2	2	2	2
532nm	3	3	3	3	3	3	3	3	3	3	3	3	3
355nm	4	4	4	4	4	4	4	4	4	4	4	4	4
266nm	6	6	6	6	6	6	6	6	6	6	6	6	6
Parameter													
Beam Diameter (mm)	6.5	8	8	9.5	8	6.5	8	8	9.5	8	6.5	8	8
Beam Divergence (mrad) (2)	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8
M^2 @ 1064nm	<3.5	<3.5	<3.5	<3.5	<3.5	<3.5	<3.5	<3.5	<3.5	<3.5			
Pulse Length @1064nm (ns)	6-10	6-10	6-10	6-10	6-10	6-10	6-10	6-10	6-10	6-10	8-10	8-10	8-10
Pointing Stability (μrad) (3)	<70	<70	<70	<70	<70	<70	<70	<70	<70	<70	<70	<70	<70
Lamp Life (pulses) (4)	$5x10^7$	$5x10^7$	$5x10^7$	$5x10^7$	$5x10^7$	$5x10^7$	$5x10^7$	$5x10^7$	$5x10^7$	$5x10^7$	$5x10^7$	$5x10^7$	$5x10^7$
Timing Jitter (ns) (5)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Services													
Voltage(6) (VAC)	200-250	200-250	220-250	220-250	220-250	200-250	220-250	220-250	220-250	220-250	220-250	220-250	220-250
Frequency(7) (Hz)	47-63	47-63	50 or 60	50 or 60	50 or 60	50 or 60	50 or 60	50 or 60	50 or 60	50 or 6z	50 or 60	50 or 60	50 or 60
Power Phase	Single	Single	Single	Single	Single	Single	Single	Single	Single	Single	Single	Single	Single
Water Temp Max. (˚C)	Air Cooled (8)	Air Cooled (8)	20	20	20	Air Cooled (8)	20	20	20	20	20	20	20
Inlet Pressure (bar)	n/a	n/a	2-5	2-5	2-5	n/a	2-5	2-5	2-5	2-5	2-5	2-5	2-5
PSU Type	LPU1000	LPU1000	16U Rackmount	16U Rackmount	16U Rackmount	LPU1000	16U Rackmount	16U Rackmount	16U Rackmount	16U Rackmount	16U Rackmount	16U Rackmount	16U Rackmount

LPY Range Specification Stable and Stable Telescopic Resonators

Model	LPY704-50	LPY742-50	LPY702-100	LPY704-100	LPY742-100	LPY702-150	LPY732-150	LPY702-200	LPY732-200	LPY604T-10	LPY604T-20	LPY642T-10 True TEM_{00} Output	LPY642T-20	LPY642T-30
Repetition Rate (Hz)	**50**	**50**	**100**	**100**	**100**	**150**	**150**	**200**	**200**	**10**	**20**	**10**	**20**	**30**
Output Energy (mJ)														
1064nm	300	450	100	230	400	90	280	70	200	80	70	350	300	250
532nm	150	225	50	115	200	45	140	35	100	40	35	175	150	125
355nm (1)	40	80	20	20	70	12	30	10	30	20	15	80	70	65
266nm	20	35	10	15	20	7	18	6	10	15	10	40	30	25
Pulse Stability (±%)														
1064nm	2	2	2	2	2	2	2	2	2	2	2	2	2	2
532nm	3	3	3	3	3	3	3	3	3	3	3	3	3	3
355nm	4	4	4	4	4	4	4	4	4	4	4	4	4	4
266nm	6	6	6	6	6	6	6	6	6	6	6	6	6	6
Parameter														
Beam Diameter (mm)	6.5	6.5	6.5	6.5	6.5	5	5	6	6	6.5	6.5	6.5	6.5	6.5
Beam Divergence (mrad) (2)	2.5	2	2.5	2.5	2	2.5	2	3	2.5	0.8	0.8	0.8	0.8	0.8
M^2 @ 1064nm										<1.3	<1.3	<1.3	<1.3	<1.3
Pulse Length @1064nm (ns)	8-10	8-10	10-12	15-18	15-18	15-18	15-18	15-18	15-18	6-10	6-10	6-10	6-10	6-10
Pointing Stability (μrad) (3)	<70	<70	<100	<100	<100	<100	<100	<100	<100	<70	<70	<70	<70	<70
Lamp Life (pulses) (4)	$1.5x10^8$	$1.5x10^8$	$1.5x10^8$	$1.5x10^8$	$1.5x10^8$	$1.5x10^8$	$1.5x10^8$	$1.5x10^8$	$1.5x10^8$	$>10^7$	$>10^7$	$>10^7$	$>10^7$	$>10^7$
Timing Jitter (ns) (5)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Services														
Voltage(6) (VAC)	220-250	220-250	220-250	220-250	220-250	220-250	220-250	220-250	220-250	220-250	220-250	220-250	220-250	220-250
Frequency(7) (Hz)	50 or 60	50 or 60	50 or 60	50 or 60	50 or 60	50 or 60	50 or 60	50 or 60	50 or 60	50 or 60	50 or 60	50 or 60	50 or 60	50 or 60
Power Phase	Single	Single	Single	Single	Single	Single	Single	Single	Single	Single	Single	Single	Single	Single
Water Temp Max. (˚C)	20	20	20	20	20	20	20	20	20	20	20	20	20	20
Inlet Pressure (bar)	2-5	2-5	2-5	2-5	2-5	2-5	2-5	2-5	2-5	2-5	2-5	2-5	2-5	2-5
PSU Type	16U Rackmount	16U Rackmount	16U Rackmount	16U Rackmount	16U Rackmount	16U Rackmount	16U Rackmount	16U Rackmount	16U Rackmount	16U Rackmount	16U Rackmount	16U Rackmount	16U Rackmount	16U Rackmount

All LPY700 series systems feature a birefringence compensating twin rod oscillator design. The LPY600 series are single rod oscillator/oscillator-amplifiers.
(1) Higher conversion efficiency into 3rd harmonic available using Type 1 doubler.
(2) Full angle for 90% of the output energy. (3) Full angle. (4) Typical lifetime.
(5) Jitter is measured with respect to the Q-switch trigger input. (6) 110VAC option requires autotransformer to be specified on order.
(7) 50 or 60Hz to be specified on order. (8) Ambient Temperature 5-35˚C. (0-80% non condensing atmosphere.)

LPY Range Specification Gaussian Coupled Resonators

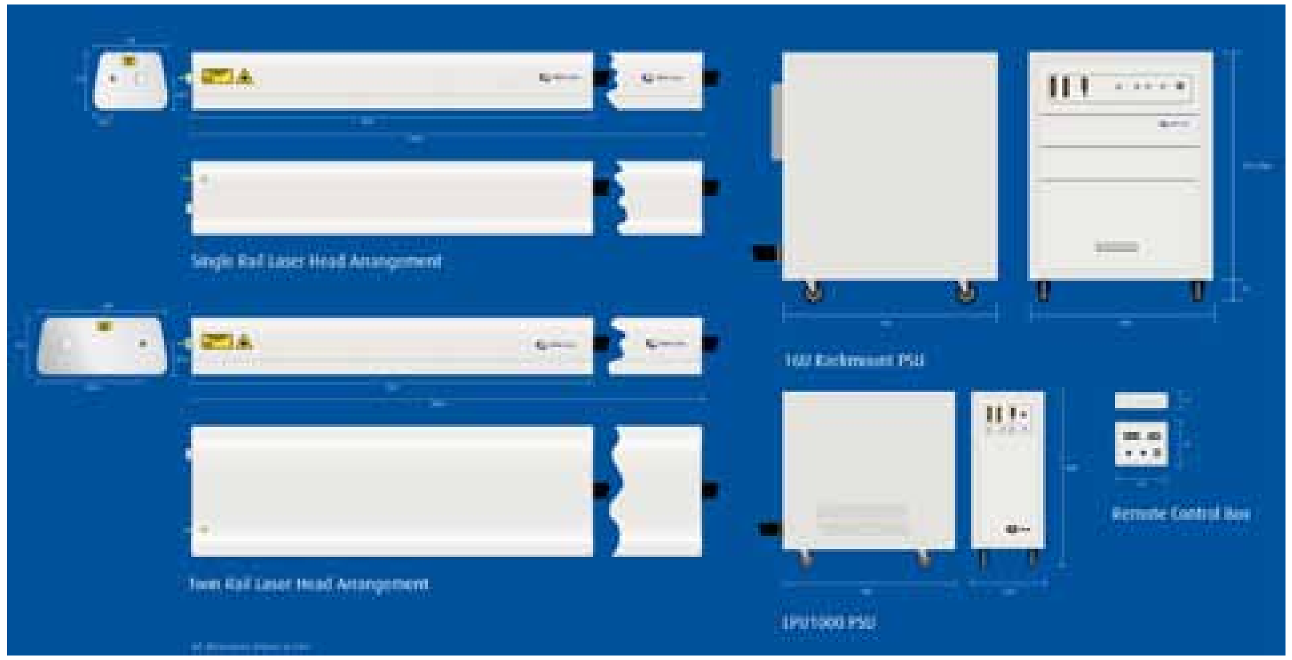
Model	LPY 704G-10	LPY 706G-10	LPY 707G-10	LPY 674G-10	LPY 764G-10	LPY 776G-10	LPY 787G-10	LPY 704G-20	LPY 706G-20	LPY 707G-20	LPY 674G-20	LPY 764G-20	LPY 776G-20	LPY 787G-20
Repetition Rate (Hz)	10	10	10	10	10	10	10	20	20	20	20	20	20	20
Output Energy (mJ)														
1064nm	400	650	850	1000	1250	1600	2000	380	600	800	850	1000	1400	1800
532nm	200	325	425	500	675	800	1000	190	300	400	425	500	700	900
355nm (1)	80	110	150	180	225	320	400	70	90	130	150	140	280	380
266nm	50	70	95	110	125	160	195	45	65	75	80	90	140	180
Pulse Stability (±%)														
1064nm	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
532nm	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4
355nm	<6	<6	<6	<6	<6	<6	<6	<6	<6	<6	<6	<6	<6	<6
266nm	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Parameter														
Beam Diameter (mm)	6	8	8	9.5	9.5	9.5	12.5	6	8	9.5	9.5	9.5	9.5	12.5
Beam Divergence (mrad) (2)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
M^2 @ 1064nm	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Pulse Length @1064nm (ns)	6-9	6-9	6-9	6-9	6-9	6-9	6-9	6-9	6-9	6-9	6-9	6-9	6-9	6-9
Pointing Stability (μrad) (3)	<70	<70	<70	<70	<70	<70	<70	<70	<70	<70	<70	<70	<70	<70
Lamp Life (pulses) (4)	>5x10^7	>5x10^7	>3x10^7	>3x10^7	>3x10^7	>3x10^7	>3x10^7	>5x10^7	>5x10^7	>3x10^7	>3x10^7	>3x10^7	>3x10^7	>3x10^7
Timing Jitter (ns) (5)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Services														
Voltage (6) (VAC)	200-250	200-250	220-250	220-250	220-250	220-250	220-250	220-250	220-250	220-250	220-250	220-250	220-250	220-250
Frequency (7) (Hz)	47-63	47-63	50 or 60	50 or 60	50 or 60	50 or 60	50 or 60	50 or 60	50 or 60	50 or 60	50 or 60	50 or 60	50 or 60	50 or 60
Power Phase	Single	Single	Single	Single	Single	Single	Single	Single	Single	Single	Single	Single	Single	Single
Water Temp Max. (˚C)	Air Cooled (8)	Air Cooled (8)	20	20	20	20	20	Air Cooled (8)	20	20	20	20	20	20
Inlet Pressure (bar)	n/a	n/a	2-5	2-5	2-5	2-5	2-5	n/a	2-5	2-5	2-5	2-5	2-5	2-5
PSU Type	LPU1000	LPU1000	16U Rackmount	16U Rackmount	16U Rackmount	16U Rackmount	16U Rackmount	16U Rackmount	16U Rackmount	16U Rackmount	16U Rackmount	16U Rackmount	16U Rackmount	16U Rackmount

Y Range Specification Gaussian Coupled Resonators

Model	LPY704G-30	LPY706G-30	LPY764G-30	LPY774G-30	LPY787G-30
Repetition Rate (Hz)	30	30	30	30	30
Output Energy (mJ)					
1064nm	380	550	900	1200	1500
532nm	190	225	450	600	750
355nm (1)	50	80	150	260	300
266nm	45	60	80	120	150
Pulse Stability (±%)					
1064nm	<2	<2	<2	<2	<2
532nm	<4	<4	<4	<4	<4
355nm	<6	<6	<6	<6	<6
266nm	<10	<10	<10	<10	<10
Parameter					
Beam Diameter (mm)	6	8	9.5	9.5	9.5
Beam Divergence (mrad) (2)	0.5	0.5	0.5	0.5	0.5
M^2 @ 1064nm	<2	<2	<2	<2	<2
Pulse Length @1064nm (ns)	6-9	6-9	6-9	6-9	6-9
Pointing Stability (μrad) (3)	<70	<70	<70	<70	<70
Lamp Life (pulses) (4)	$>3\times10^7$	$>3\times10^7$	$>3\times10^7$	$>3\times10^7$	$>3\times10^7$
Timing Jitter (ns) (5)	<0.5	<0.5	<0.5	<0.5	<0.5
Services					
Voltage(6) (VAC)	200-250	220-250	220-250	220-250	220-250
Frequency(7) (Hz)	47-63	50 or 60	50 or 60	50 or 60	50 or 60
Power Phase	Single	Single	Single	Single	Single
Water Temp Max. (˚C)	Air Cooled(8)	20	20	20	20
Inlet Pressure (bar)	n/a	2-5	2-5	2-5	2-5
PSU Type	LPU1000	16U Rackmount	16U Rackmount	16U Rackmount	16U Rackmount

All LPY700 series systems feature a birefringence compensating twin rod oscillator design.
The LPY600 series are single rod oscillator/oscillator-amplifiers.
(1) Higher conversion efficiency into 3rd harmonic available using Type 1 doubler.
(2) Full angle for 90% of the output energy.
(3) Full angle.
(4) Typical lifetime.
(5) Jitter is measured with respect to the Q-switch trigger input.
(6) 110VAC option requires autotransformer to be specified on order.
(7) 50 or 60Hz to be specified on order.
(8) Ambient Temperature 5-35˚C. (0-80% non condensing atmosphere.)

LPY Range Dimensions



Pulsed Nd:YAG Micromachining Lasers for Industrial Applications

LPY802

High Energy, High Rep. Rate Pulsed Nd:YAG Micromachining Lasers
The LPY802/3(T) Series from Litron

APPLICATIONS
- PCB stencil cutting
- Medical stents
- Diamond wafers
- Ceramic cutting
- Precision metal component machining

FEATURES
- Invar stabilised
- TEM00 option
- Ultra-stable pulse energy
- 500million shot lamp life

The LPY802 series of lasers are industrial, high repetition rate, high energy lasers for micromachining applications.

These systems are available with pulse repetition frequencies of 1kHz and 2kHz, and can be configured to give a true TEM_{00} output with a resulting M2 of <1.2, allowing cuts to near micron precision.

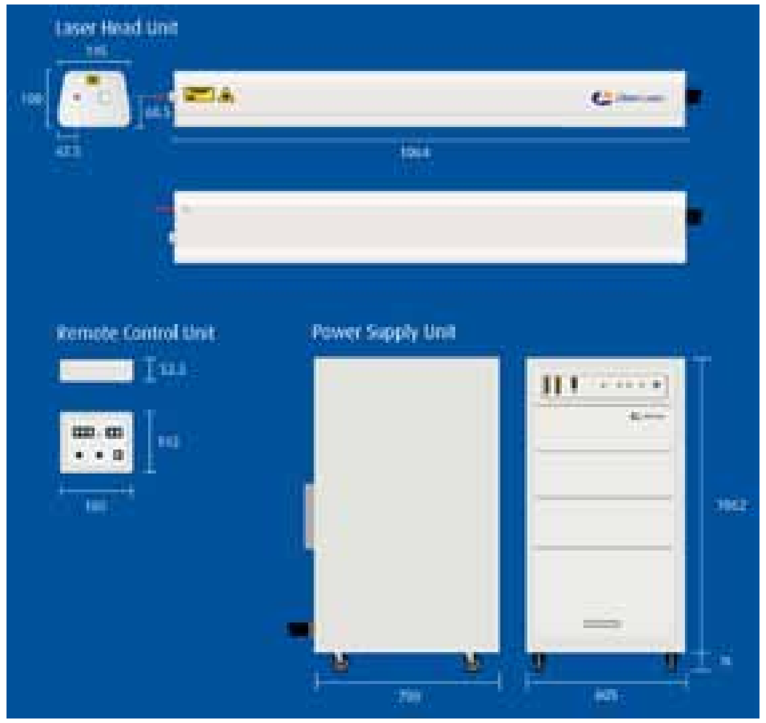
Built to deliver true 24/7 operation in industrial environments the LPY802 is suited to applications such a stencil or stent cutting, or any micromachining of ceramics or metals such as stainless steel. The laser head is based around our rugged self-supporting invar space frame that gives industry leading mechanical and optical stability.

The power supply features direct transistor switching into the flashlamp for the best possible efficiency and lamp lifetime, which is typically in excess of half a million shots.

The LPY802/3(T) Series Pulsed Nd:YAG Micromachining Lasers
Technical Data

Model	LPY 802(T)-1000	LPY803(T)-2000
Repetition Rate (Hz)	1000	2000
Wavelength (nm)	1064	1064
Output Energy (mJ)		
MM	50	50
TEM_{00} (1)	8	8
Pulse Width (us)	20-50	20-50
Pulse Stability p-p (±%)	2	2
Typical Lamp Life (pulses)	500 million	500 million
Beam Diameter (mm)	3	3
MM	4	4
TEM_{00}	1.2	1.2
Control	RS232	RS232
Services		
Voltage (VAC)	220-250	220-250
Frequency (Hz)	50-60Hz	50-60Hz
Power Phase	Single	Single
Water temp (˚C)	20	20
Inlet pressure (bar)	2-5	2-5
Power Supply	22U 19” Rack	22U 19” Rack

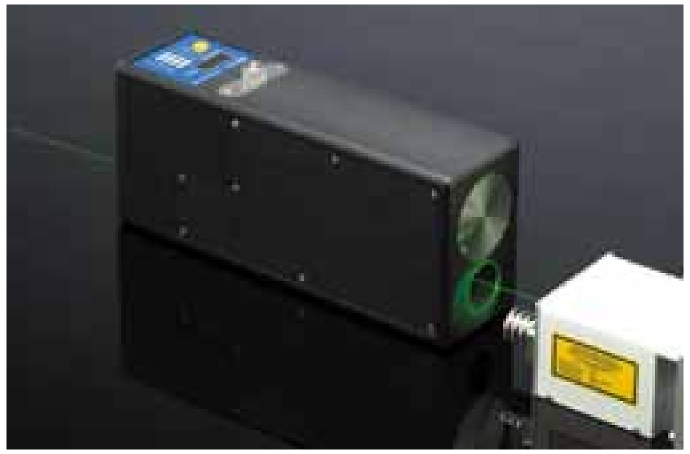
(1) Model LPY802T only



TSC
www.toptical.com.tw 02-2346-1510 toptical@ms17.hinet.net

LTM 530 Series Photodiode Laser Energy Monitors

LTM 530



State of the Art in-line Energy Monitoring Devices for Laser Users.

The Litron
Energy Monitor Family

FEATURES

- Pulse energies from 10µJ to 65J
- 400nm - 1650nm
(typically depending on the choice of the detection photodiode)
- Pulse repetition rates of up to 1000Hz
- Repeatability errors of less than 0.2%
- High damage threshold - greater than 3J/cm2 Q-switched
- Exceptional linearity
- Rugged design with integrated 4 digit energy display
- Comprehensive software suite with datalogging capability for use with Microsoft® Windows®
- RS232 interface

The LTM530 series of transfer standard heads are state of the art in-line energy monitoring devices. Extremely low noise detection electronics leads to repeatability errors of less than 0.2%. Such accuracy makes these devices ideal as laboratory meters in the calibration of other energy monitoring devices, or by use of the serial port, in the process monitoring of pulsed laser system performance.

The mechanical construction, machined from solid aluminium, gives the devices great optical stability, eliminating such sources of error from long term energy monitoring. In conjunction with any of Litron's other photodiode energy monitors, the LTM530 series can be used for independent checking of laser energy in critical processes. In-line energy monitors are often used in conjunction with standard meters in calibration facilities. In instances such as these it is often necessary to add attenuation to the device, or to filter a specific spectral region. The LTM530 series are fitted with a removable filter holder for such applications.

The type of detection diode that is chosen allows for different spectral ranges to be covered accurately. The maximum measurable pulse length is user selectable up to 50ms via the included software suite. The optional oscilloscope output allows the temporal profile of the laser pulse to be observed. It can be configured either as a 50Ω output or as an integrated output with a time constant of 500µs.

We are happy to discuss your custom requirements should one of our standard range detailed overleaf not be suitable for your application.

LTM 530 Series Photodiode Laser Energy Monitors
SPECIFICATIONS

Model	Photodiode Type	Wavelength Range (nm)	Energy Range	Oscilloscope Output	Maximum Pulse Input frequency	Maximum Pulse Input Length
LTM 530-1	Silicon	400-1100	See Note 5	See Note 2	See Note 3	See Note 3
LTM 531-1	InGaAs	900-1650	See Note 5	See Note 2	See Note 3	See Note 3

ALL MODELS

Input Aperture Diameter	40mm / 30mm useable
Damage Threshold	>500J/cm^2 (normal mode pulses) 3J/cm^2 (Q-switched pulses)
Error in repeatability[4]	Better than ±0.2%
Display type	4 digit green LED
Dimensions (mm)	270 L x 76 W x 116 H
Weight (kg)	2.9
Outputs	RS232, optional 50Ω or integrated oscilloscope output
Power requirements	6V DC, 1A (Adaptor supplied)

NOTES

1. The maximum average power loading in free air is 10W. Custom energy ranges are available.
2. An oscilloscope output is available on all models. For an output that is integrated with a time constant of about 500µs append ĐA to the model number and for a 50Ω output capable of resolving 500ps pulses append ĐB to the model code.
3. The maximum pulse width is user settable up to 50ms. The device works by integrating the incident energy over the set period. The maximum input frequency is therefore a function of the maximum pulse width. For a 50ms maximum pulse width, the maximum repetition rate is 18Hz and for a 500µs pulse width the maximum repetition rate is 1kHz.
4. For integration time <2ms and energies >10% of full scale reading.
5. Full dynamic range is achieveable by means of adjustable attenuator.

Nano Series Ultra Compact Pulsed Nd:YAG Lasers

Nano Lasers

Product Range Specification

Nano Range Specification

Model Stable & Stable Telescopic Resonators	Nano O 60-0.5	Nano O 60-30	Nano O 100-20	Nano S 60-30	Nano S 30-50	Nano S 120-20	Nano S 130-10	Nano L 90-100	Nano L 150-50	Nano L 200-10	Nano L 200-20	Nano L 200-30	Nano L 290-20	Nano L 320-10
Max. Repetition Rate (Hz)	0.5	30	20	30	50	20	10	100	50	10	20	30	20	10
Output Energy (mJ) (1)														
1064nm	60	60	100	60	30	120	130	90	150	200	200	200	290	320
532nm	30	30	50	30	15	60	65	50	75	110	110	110	145	200
355nm	10	10	15	10	6	20	25	15	30	40	40	40	40	45
266nm	5	6	12	6	3	12	16	10	15	25	25	25	25	30
213nm	1	1	2	2	1	3	3	2	3	4	3	3	5	5
Parameter														
Pulse - Pulse Stability (±%) (2)	2.5	2	2	2	2	2	3	2	2	2	2	2	2	2
Beam Diameter (mm)	3	3	4	3	3	4	4	4	4	5	5	5	6.5	6.5
Beam Divergence (mrad) (3)	<2.5	<2.0	<2.5	<2.0	<2.0	<2.5	<2.5	<1.5	<1.5	<2.0	<2.0	<2.0	<1.5	<2.0
Pulse Length @ 1064nm (ns)	4-6	5-7	6-8	6-8	6-8	6-8	6-8	7-9	7-9	6-9	6-9	6-9	7-9	7-9
Pointing Stability (μrad)	<70	<70	<70	<70	<70	<70	<70	<70	<70	<70	<70	<70	<70	<70
Resonator Type (5)	Stable	Stable	Stable	Stable	Stable	Stable	Stable	Stable	Stable	Stable	Stable	Stable	Stable	Stable
TEMoo (mJ) @ 1064nm (6)	n/a n/a	n/a	10	10	15	20	20	20	40	40	40	30	40	
Lamp Life (pulses)	5x10^7	5x10^7	5x10^7	5x10^7	5x10^7	5x10^7	5x10^7	5x10^7	5x10^7	5x10^7	5x10^7	5x10^7	5x10^7	5x10^7
Timing Jitter (ns) (7)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Services														
Voltage (VAC)	90-250	90-250	90-250	90-250	90-250	90-250	90-250	200-250	200-250	90-250	90-250	200-250	200-250	200-250
Frequency (Hz)	47-63	47-63	47-63	47-63	47-63	47-63	47-63	47-63	47-63	47-63	47-63	47-63	47-63	47-63
Power	Single Phase	Single Phase	Single Phase	Single Phase	Single Phase	Single Phase	Single Phase	Single Phase	Single Phase	Single Phase	Single Phase	Single Phase	Single Phase	Single Phase
Ambient (8) (˚C)	5-35	5-35	5-35	5-35	5-35	5-35	5-35	5-35	5-35	5-35	5-35	5-35	5-35	5-35
Consumption (W)	<300	<300	<300	<300	<300	<300	<25	<850	<850	350	650	650	<450	<350
PSU Type	LPU250 (9)	LPU250 (9)	LPU250 (9)	LPU250 (9)	LPU250 (9)	LPU250 (9)	LPU250 (9)	LPU1000	LPU1000	LPU250 (9)	LPU350	LPU1000	LPU1000	LPU1000

Nano Range Specification

Model Stable & Stable Telescopic Resonators	Nano T 100-50	Nano T 250-10	Nano T 250-20	Nano T 290-20	Nano T 310-10
Max. Repetition Rate (Hz)	50	10	20	20	10
Output Energy (mJ) [1]					
1064nm	100	250	250	290	310
532nm	50	125	125	145	155
355nm	20	45	45	50	55
266nm	15	30	30	30	30
213nm	2	4	4	4	5
Parameter					
Pulse - Pulse Stability (±%) [2]	2	2	2	2	2
Beam Diameter (mm)	5	5	5	5	6.35
Beam Divergence (mrad) [3]	<0.8	<0.8	<0.8	<0.8	<0.8
Pulse Length @ 1064nm (ns)	7-11	7-11	7-11	7-11	7-11
Pointing Stability (µrad)	<70	<70	<70	<70	<70
Resonator Type [5]	Telescopic	Telescopic	Telescopic	Telescopic	Telescopic
TEMoo (mJ) @ 1064nm [6]	30	50	50	50	50
Lamp Life (pulses)	$5x10^7$	$5x10^7$	$5x10^7$	$5x10^7$	$5x10^7$
Timing Jitter (ns) [7]	<0.5	<0.5	<0.5	<0.5	<0.5
Services					
Voltage (VAC)	200-250	90-250	90-250	90-250	90-250
Frequency (Hz)	47-63	47-63	47-63	47-63	47-63
Power	Single Phase	Single Phase	Single Phase	Single Phase	Single Phase
Ambient [8] (˚C)	5-35	5-35	5-35	5-35	5-35
Consumption (W)	<650	<350	<650	<650	<650
PSU Type	LPU1000	LPU250 [9]	LPU350	LPU350	LPU250 [9]

1. Variable by mean of lamp voltage control. Energy stability remains within specification from 20% to 100% of output energy. The maximum energy is quoted for a system having a 15 minute warm-up period.
2. At 1064nm.
3. Full angle for 90% of the output energy.
4. Full angle.
5. With the addition of optional intra-cavity aperture.
6. Factory fitted option on the Nano S range, this is not customer removable. On the Nano L and Nano T ranges the TEM_{00} aperture can be added or removed as required.
7. Jitter is measured with respect to the Q-switch trigger input.
8. 0-80% non condensing atmosphere.
9. LPU250R option available as 4U 19" Rackmounted PSU.

Nano stable resonators and stable telescopic resonators

This Nano range allow a great deal of flexibility both in scientific and industrial applications.
The output of these systems is multiomde, however the telescopic resonators offer high energy beams with low divergences - comparable to those from unstable Gaussian coupled resonators but with a more uniform spatial profile, and a smoother temporal profile.
Such features lend these systems to the pumping of narrow band dye lasers and optical parametric oscillators. All Nano L and Nano T models can be fitted with intra-cavity apertures to give a true TEM_{oo} output.

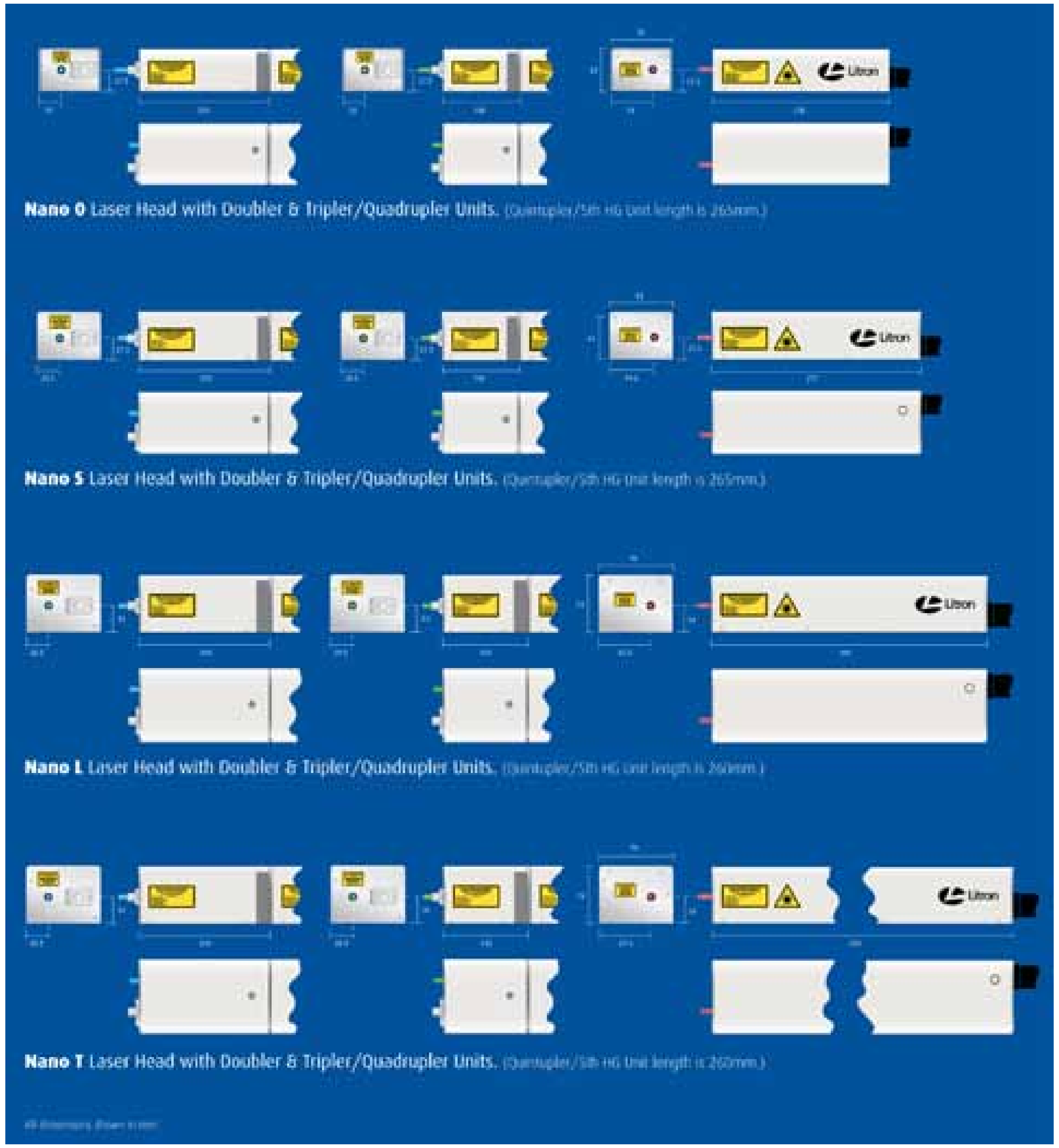
Nano Range Specification

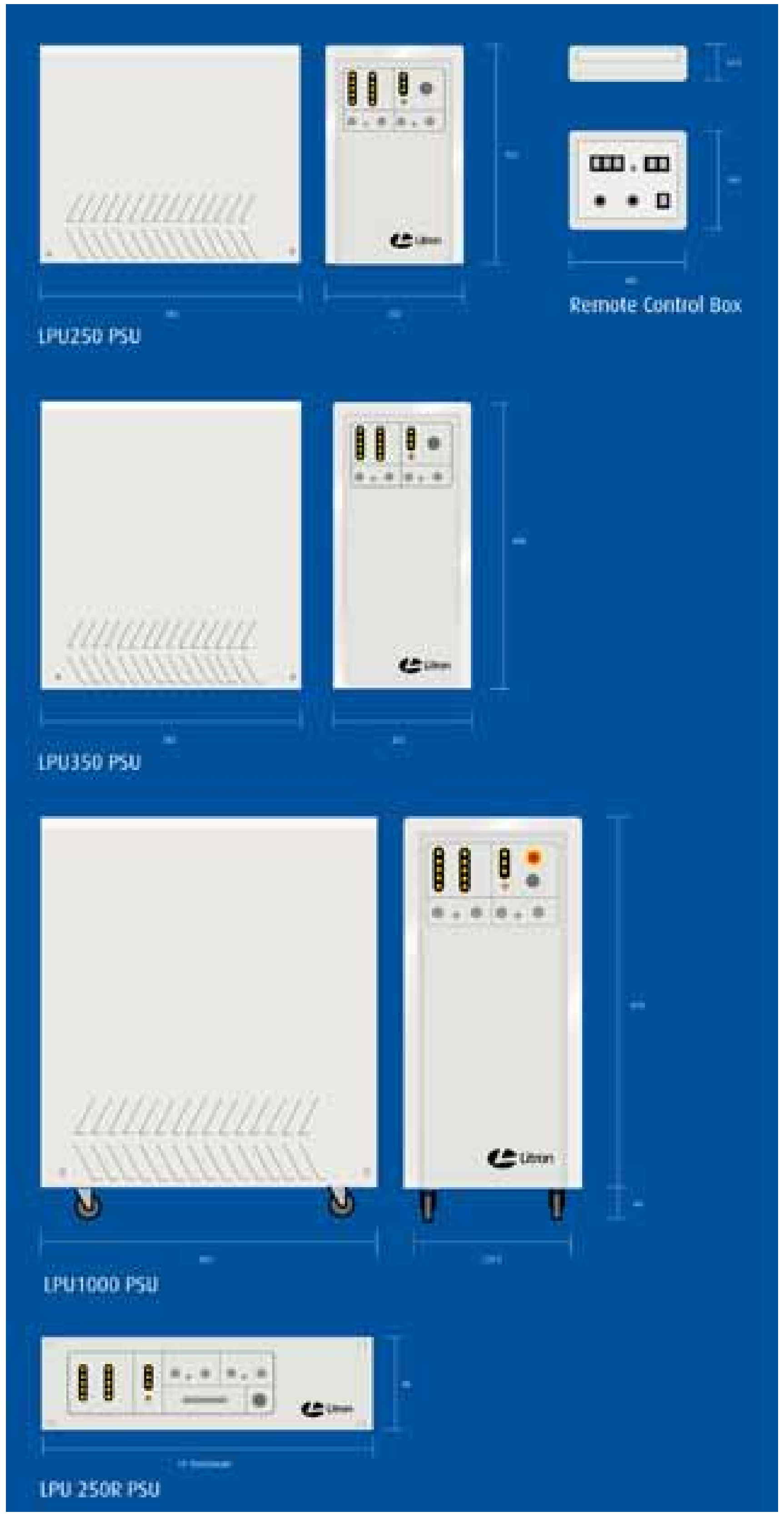
Model Gaussian Coupled Resonators	**Nano OG 60-0.5**	**Nano SG 60-30**	**Nano SG 120-20**	**Nano SG 150-10**	**Nano LG 250-10**	**Nano LG 300-10**	**Nano LG 3 20-10**	**Nano LG 200-20**	**Nano LG 250-20**	**Nano LG 300-20**	**Nano LG 150-30**	**Nano LG 130-50**
Max. Repetition Rate (Hz)	0-0.5	30	20	10	10	10	10	20	20	20	30	50
Output Energy (mJ)												
1064nm	60	60	120	150	250	300	320	200 250	300	150	130	
532nm	30	35	65	75	135	150	175	110	125	165	75	65
355nm	10	10	20	30	60	60	60	40	40	50	25	20
266nm	6	6	15	15	35	35/45 (4)	25	25	25	20	18	15
213nm	1	1	2	3	6	6	4	4	3	3	2	2
Parameter												
Pulse - Pulse Stability (±%)	2.5	2	2	2	2	2	2	2	2	2	2	2
Beam Diameter (mm)	4	4	4	5	5	5	5	5	5	5	5	5
Beam Divergence (mrad) (1)	<2.5	<0.5	<0.5	<0.7	<0.5	<0.7	<0.5	<0.5	<0.7	<0.5	<0.5	<0.5
Fit to Gaussian N/F Field (%)	70/95	70/95	70/95	70/95	70/95	70/95	70/95	70/95	70/95	70/95	70/95	70/95
M^2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Pulse Length @ 1064nm (ns)	4-6	6-8	6-8	4-6	4-6	4-6	4-6	4-6	4-6	4-6	4-6	4-6
Pointing Stability (μrad) (2)	<70	<70	<70	<100	<70	<100	<70	<70	<100	<70	<100	<100
Lamp Life (pulses)	>5x10	>5x10^7	>5x10^7	5x10^7	5x10^7	5x10^7	5x10^7	5x10^7	5x10^7	5x10^7	5x10^7	5x10^7
Timing Jitter (ns) (3)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Services												
Voltage (VAC)	90-250	90-250	90-250	90-250	90-250	90-250	90-250	200-250	200-250	200-250	200-250	200-250
Frequency (Hz)	47-63	47-63	47-63	47-63	47-63	47-63	47-63	47-63	47-63	47-63	47-63	47-63
Power	Single Phase	Single Phase	Single Phase	Single Phase	Single Phase	Single Phase	Single Phase	Single Phase	Single Phase	Single Phase	Single Phase	Single Phase
Ambient (5) (˚C)	5-35	5-35	5-35	5-35	5-35	5-35	5-35	5-35	5-35	5-35	5-35	5-35
Consumption (W)	<300	<350	<350	<350	<650	<400	<400	<650	<650	<650	<650	<650
PSU Type	LPU250 (6)	LPU250 (6)	LPU250 (6)	LPU250 (6)	LPU350	LPU350	LPU350	LPU1000	LPU1000	LPU1000	LPU1000	LPU1000

(1) Irreducible beam divergence measured full angle for cone containing 90% of energy.
(2) Full angle.
(3) With respect to Q-switch trigger input/sync output.
(4) Higher 266nm output option available.
(5) 0-80% non condensing atmosphere.
(6) LPU250R option available as 4U 19" Rackmounted PSU.

Nano geometrically unstable Gaussian coupled resonators
This Nano series is available with unstable Gaussian coupled resonators giving very low divergence single transverse mode output beams.

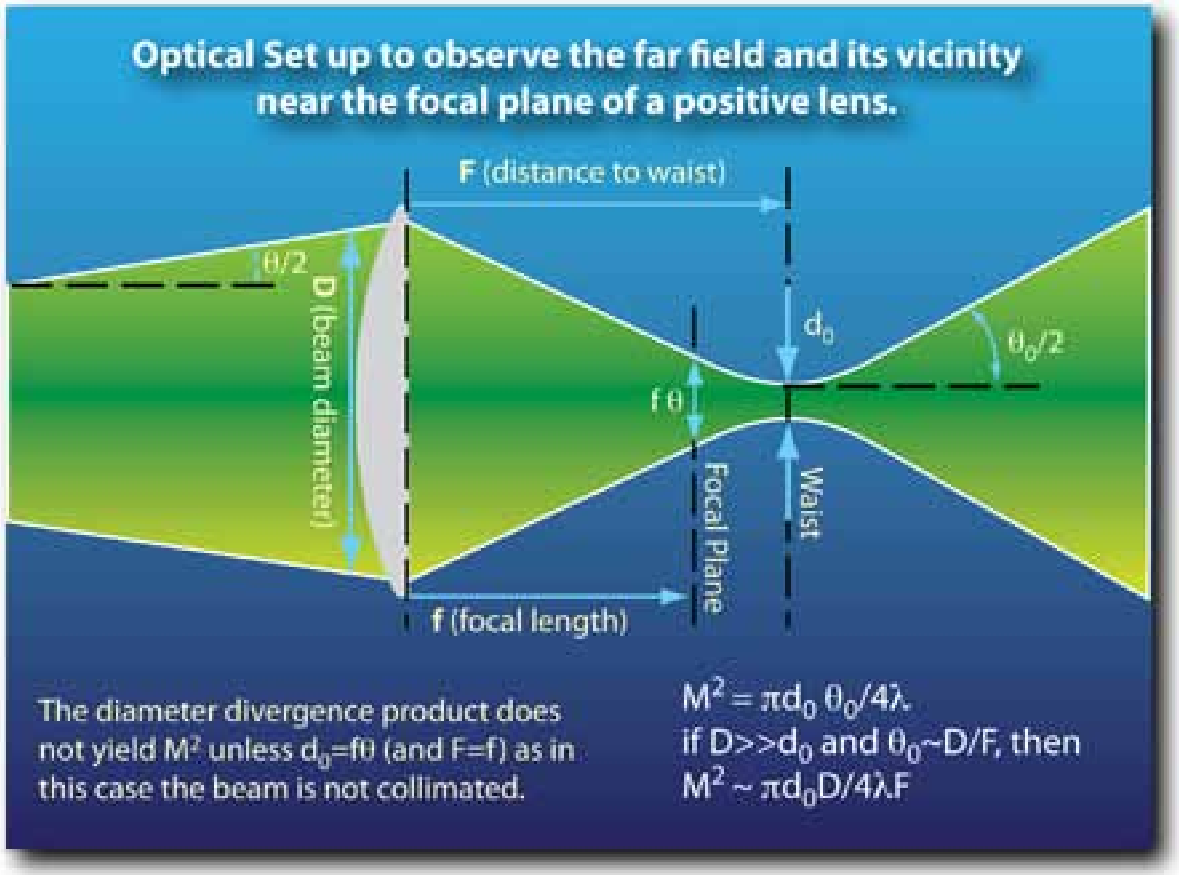
Nano Range Dimensions





Comparison of Beam Divergence, Beam Diameter and M^2

Why the Aperture – Divergence Product Doesn't Tell the Whole Story



A true measure of the quality of a laser beam is the parameter known as M^2, also referred to as a number of 'times diffraction limited'. It describes how a beam will diverge compared to a theoretically 'perfect' laser beam of the same wavelength and initial size that has the lowest possible divergence given by diffraction theory. A theoretically perfect laser beam must have a Gaussian intensity distribution whereas most real laser beams do not. We therefore have to make some approximations when talking about M^2. We measure the laser beam diameter as the diameter of a circle containing $1/e^2$ or about 87% of the power or energy and the divergence angle as the full angle of the cone containing the same power or energy. We use an ellipse to make the same figures where the beam is not nominally circular. Real lasers can have M^2 values ranging from very little more than 1 (the theoretical minimum) to several tens or even hundreds. Many practical applications require the lowest possible value.

The optical set up depicted here can be used to measure both the beam divergence and the M^2 value of a real laser. A lens of focal length 1 or 2m is typically used, along with attenuation optics and the beam is imaged using a CCD and software.

Measuring the beam in the focal plane of the lens yields the beam's 'raw' divergence, simply by dividing the beam diameter in the focal plane by the focal length. Since we only know for sure what the laser beam diameter is near its output aperture, this figure tells us little about the beam quality. We do not know the position of the waist of the original laser beam or its size. In many real lasers, it can be located behind the laser (or sometimes well in front of it) and is thus often smaller than the laser beam diameter measured at its output aperture. Only the true waist diameter can be combined with the divergence to give M^2.

By looking in the vicinity of the focal plane for a minimum diameter spot, the waist as transformed by the lens, we can gain much more useful information. For real lasers, the waist is usually located near the focal plane and usually a little way after it. Note that the original beam divergence is eliminated in the expression that gives M^2. It is expressed in terms of the beam diameter at the waist, the diameter of the beam at the lens and the distance of the waist from the lens. All these parameters are relatively easily measured. The focal length of the lens and the beam diameter at the lens need to be chosen such that the waist is much smaller than the beam diameter at the lens.

Technically speaking, to achieve accurate measurements, the waist must be much greater than its Rayleigh range from the lens. This value is given by $\pi d_0^2/4\lambda M^2$.

Beam Divergence: Irreducible and Reducible

In the discussion above, the beam divergence as measured in the focal plane of our lens frequently contains some reducible elements. These can include sphericity imposed by lensing in an amplifier after the rod (and not fully compensated by the beam expanding telescope) or sphericity resulting from improper collimation of an unstable resonator; with a fixed length and a finite number of resonator mirror curvatures, it is often impossible to achieve perfect collimation. With proper beam control after the laser, such as the transmitting optics in a LIDAR system, or the focusing lens in a machining head, this sphericity can be eliminated and the irreducible element, as predicted by M^2, will determine respectively the angular resolution of the LIDAR system or the spot size at a work piece.

In some cases, our waist will be located in the focal plane of the lens. Only then can we say that the laser is truly collimated and only then can the aperture – divergence product be used to determine the beam quality. In many practical cases, this does not hold true.

The irreducible divergence (full angle) is given by the expression $4M^2\lambda/\pi d$ where d is the diameter of the laser beam measured at its waist. For reasons given above, this figure is often lower than the 'raw' divergence of the laser beam itself. To a first order approximation, the above expression holds true even if the laser beam is expanded or reduced by telescopes and the like.

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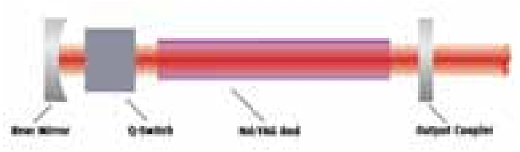
Different Resonator Options from Litron

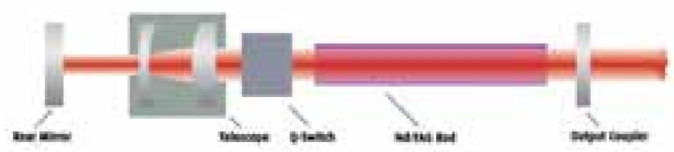
Litron offers five distinct resonator configurations. This is more than any other manufacturer and this article sets out to help customers identify which one is best for their needs.

Conventional Stable

This multimode resonator has been around the longest time and is the simplest in terms of design. Typical characteristics are excellent energy extraction (measured as the amount of stored energy in the rod emerging in the pulse) and beam uniformity but somewhat high divergence and M^2 values. Conventional stable resonators allow the user to vary parameters such as input energy (flashlamp voltage) and repetition rate with very little variation in beam quality.



Telescopic Stable

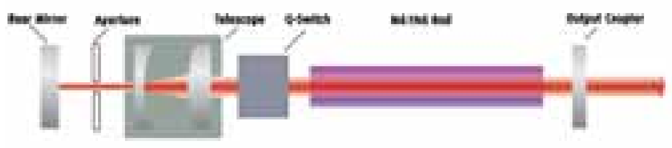


This variation on the multimode stable design places an intracavity telescope in the rear of the resonator. This has the two effects of compensating the thermal lensing in the laser rods and making the resonator appear considerably longer, without making it significantly more so, so reasonably short pulses are still obtained. The outcome is a laser beam with still very good spatial uniformity and efficient energy extraction but with much better divergence and M^2 characteristics than a conventional stable resonator. The resonator is still flexible in terms of input energy and repetition rate and can be made even more so by means of adjustments to the telescope.

Gaussian-Coupled Unstable

This resonator comprises a P-branch confocal unstable resonator with a graded reflectivity mirror (GRM) for the output coupler. The rear mirror curvature is chosen so as to compensate the thermal lens in the rod and provide a more or less collimated output. The GRM unstable resonator provides lower values still for divergence and M^2, with reasonable extraction efficiency but the downside is less uniform near field uniformity and much less flexibility in varying the input energy and repetition frequency.

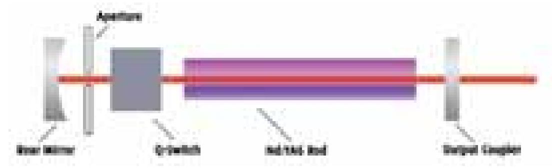
Telescopic Stable TEM_{00}



This is a variation on the telescopic stable resonator that additionally employs an intracavity aperture to suppress higher order transverse modes to allow the laser to give a beam with near diffraction limited, single mode TEM_{00} quality, with a uniform Gaussian profile. Input energy and repetition rate flexibility are similar for the telescopic stable resonator but extraction efficiency is relatively low, being between a third and a quarter of the multimode telescopic stable resonator. As an option, Litron offers a suite of apertures to allow a user to obtain a range of beam quality and energy trade offs from TEM_{00} to multimode.

Conventional Stable TEM_{00}

Compared to a telescopic stable TEM_{00} laser, a smaller footprint, shorter pulse duration and greater input energy flexibility are the main benefits. However, lacking the telescope, the extraction efficiency is lower still.



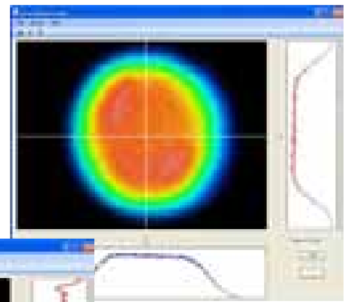
Comparison Table of Resonator Types

	Beam Quality (Uniformity)	Focusability (M^2)	Extraction Efficiency	Flexibility in Input Energy and Repetition Frequency
Conventional Stable	Excellent	Poor (>10)	Excellent (>90%)	Excellent
Telescopic Stable	Very Good	Very Good (3-4)	Very Good (80%)	Very Good
GRM Unstable	Poor	Excellent (~2)	Very Good (80%)	Poor
Telescopic Stable TEM_{00}	Excellent	Most Excellent (~1.2)	Poor (30%)	Very Good
Conventional Stable TEM_{00}	Excellent	Most Excellent (~1.2)	Very Poor (10%)	Excellent

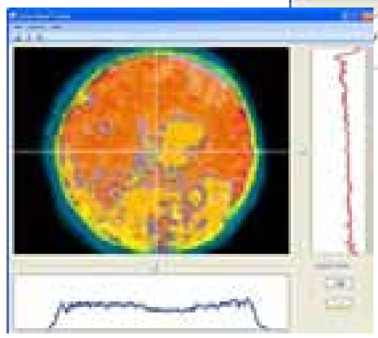
Litron LPY7000 Series

Beam Profile Information

GENERAL FEATURES
- Rugged Industrial Build
- Up to 3.5J @ 1064nm
- Telescopic or Gaussian Resonators
- Full Energy in <5 minutes at All Wavelengths
- Optional Seeder Package
- All Harmonics to 5th Available
- Full RS232 Software Control



LPY7864-30 Telescopic resonator. Beam profile measured at output of laser, giving 2J at 30Hz, 1064nm.



LPY7864G-30 Gaussian coupled resonator. Beam profile measured at output of laser giving 2J at 30Hz, 1064nm

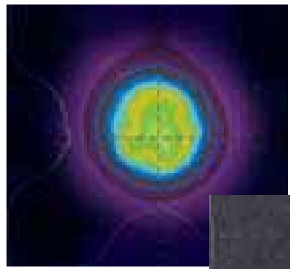
The LP7000 lasers offer extremely high Q-switched outputs at repetition rates of up to 50Hz. Based around our proven self-supporting invar frame their robust build quality suits them to both industrial and scientific applications. The lasers are provided in an oscillator, pre-amplifier, main-amplifier arrangement. The oscillator may be configured as a stable-telescopic resonator offering a low order multimode output with a smooth spatial and temporal profile, or as an unstable Gaussian-coupled resonator offering a single transverse mode output with slightly higher peak powers.

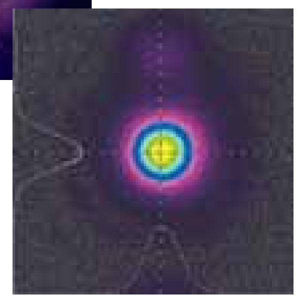
A Gaussian-coupled resonator whilst providing a very low divergence output beam also exhibits significant spatial modulation (ringing). The spatial modulation is due to Fresnel diffraction of the beam by the laser rod, this effect is similar to that seen in Fraunhofer diffraction by an aperture. It is significantly worse in Gaussian-coupled resonators due to the relatively high extraction efficiency, and therefore beam intensity, at the periphery of the rod. As the beam propagates the modulation intensity increases to a maximum in the intermediate field and ringing due to diffraction effects is visible in the near, intermediate and to some degree far field. In the far field the beam will resemble a Gaussian containing about 70% of the near field energy, the remaining 30% having been lost due to diffraction. This behaviour is the same for any Gaussian or Super Gaussian-coupled laser from any manufacturer.

Stable telescopic resonators offer low divergence outputs by the inclusion of an intra-cavity telescope. The use of the telescope is twofold, firstly it reduces the beam diameter in the rear leg of the resonator, having the effect of increasing its diffraction length and consequently lowering the number of transverse modes supported. Secondly it effectively compensates for the thermal lensing of the laser rod. Output beams from telescopic resonators are spatially much smoother than those from Gaussian-coupled resonators and during propagation do not exhibit any high degree of modulation as is seen in beams from Gaussiancoupled lasers. Typically the M2 from telescopic lasers is approximately 3, and from Gaussian-coupled lasers is about 2. The far field beam energy from a telescopic resonator will contain approximately 90% of the near field energy as opposed to only about 70% from a Gaussian system.

True TEM_{00} or Not?

Near field beam profile with stable resonator at 1064nm.





Near field beam profile of TEM_{00} at 1064nm.

Litron is one of the few laser manufacturers to offer Nd:YAG lasers with true TEM_{00} beam quality as standard. Some manufacturers claim to offer lasers with TEM_{00} output but a closer look will show that that is not always the case.

To generate a TEM_{00} beam requires a stable resonator and, usually, an aperture to suppress higher order modes. Litron typically employs its telescopic stable resonator as the intracavity telescope yields a TEM_{00} mode volume and hence energy that is about three times greater than a conventional stable resonator (but about four times less than the energy available from a multimode stable resonator or an unstable resonator).

Some manufacturers claim that the output from their graded reflectivity mirror, unstable resonators is in fact TEM_{00}. Litron knows that this cannot be true. It also manufactures lasers with graded reflectivity mirror unstable resonators but makes no assertions other than that the beam is a single transverse mode with an M^2 value of around 2, in common with most lasers of this design. Litron's true TEM_{00} lasers offer far better beam quality than can be obtained from any unstable laser, with typical M^2 values of around 1.15. Quite simply, TEM_{00} is the name of the fundamental Hermite-Gaussian mode of any stable laser resonator that supports such modes. An unstable resonator cannot support Hermite-Gaussian modes and therefore cannot give a TEM_{00} output.

A TEM_{00} beam has a spatial profile that is very nearly Gaussian (>95%) and that does not change as it propagates (i.e. from when it emerges from the laser right into the far field). An unstable laser with a graded reflectivity mirror produces a beam that is only a 70-80% fit to Gaussian in the near field, which is not very close if you consider that a top hat profile is nearly 70%. It then picks up diffraction structure as it propagates until finally about 70-80% of the energy is to be found in a Gaussian spot in the far field, the remaining energy having propagated with a larger divergence angle as a result of diffraction. Therefore 20-30% of the output energy is lost by diffraction in any system using an unstable resonator when considering the far field beam energy.

A laser oscillator with a 100mm long, 6.3mm diameter Nd:YAG rod is a fairly common arrangement. With either a stable resonator or a graded reflectivity unstable resonator, about 350mJ or so can usually be Q-switched out quite easily. Running the same laser with a true TEM_{00} output, the most that can be reliably achieved is about 80-100mJ. To reach 350mJ true TEM_{00} requires the use of an amplifier, which adds considerably to the cost of the laser.

Both resonator types have their advantages. Outputs from unstable resonators offer high energy beams that have a high focussability and therefore an inherently low divergence, making them ideal for non-linear processes. However beams from such systems exhibit a large degree of structure (spatial ringing) in their outputs and it is not until the far field (i.e. at the focus of a lens) that the profile is truly Gaussian. TEM_{00} lasers have output beams that are temporally longer and smoother and spatially exhibit little structure. Beams from such lasers can be used in the near and intermediate fields as their profile is always a Gaussian and the longer smoother pulses are ideal for OPO pumping, where a longer pump pulse offers more round trips of the resonator.

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Easier Stone Cleaning from a Compact Laser Package

The high energy ultra compact Nano TRL from Litron Lasers.
Ultra Compact, very robust, extremely easy to operate and totally portable.

The all new Nano TRL compact high energy pulsed Nd:YAG laser from Litron has made stone cleaning applications a lot easier thanks to its compact size, portability and ease of use.

Requiring only AC power and with a completely self contained cooling supply, this system is ideal for field use in areas such as ancient monuments, cathedrals and museum artifacts.

The Nano TRL offers energies up to 850mJ or repetition rates up to 200Hz. The unit is totally sealed against ingress and, thanks to the latest advances by Litron in mechanical design, is also extremely field rugged.