

# TUNABLE LASERS: OVERVIEW



## Benchtop Systems • TXP Modules • OEM Modules

Thorlabs' tunable lasers are all based on external cavity tunable laser technology with tuning ranges up to 150nm. Since they are able to continuously tune or step between ITU grid wavelengths, Thorlabs' tunable lasers are ideal for both test and measurement as well as for research and development. Using our proprietary technology, all models exhibit mode-hop free tuning with wavelength resolution of 0.1pm and absolute wavelength accuracy within  $\pm 10\text{pm}$ . The highly stable output and quick tuning speed of our continuous tuning models allow the units to tune over their entire range in less than a second. The low source spontaneous emission (SSE) makes them an ideal source for testing fiber-optic components, spectroscopy, or basic research applications. Our tunable lasers cover wavelengths ranging from 770nm to 1650nm and are available with fiber output or with free-space collimated beams. The various models offer different features from benchtop units to OEM modules for integrating into larger applications.

### ECL Technology

Thorlabs' models are based on external cavity lasers (ECL), which are capable of delivering very high output powers in combination with a wide tuning range.

In addition, ECL technology has the advantage of continuous, mode-hop free, tuning. ECL lasers are comprised of a laser diode with high gain and a separate grating that is mounted on a pivoting arm to form the cavity (see figure 1). To tune the laser's wavelength, the angle of the grating is changed by turning the arm with an actuator. The positioning and alignment of the grating assembly and the actuator design are critical to optimal scanning performance.

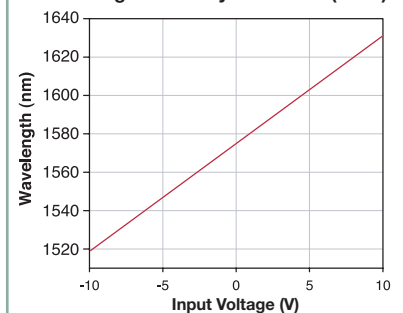
### Scanning Capabilities

The patented inductive motor design of our continuously tunable models enables a smooth and quick sweep over the full wavelength range in both directions with perfect repeatability. Optional step mode operation and true continuous linear tuning without any ripple result from this unique design.

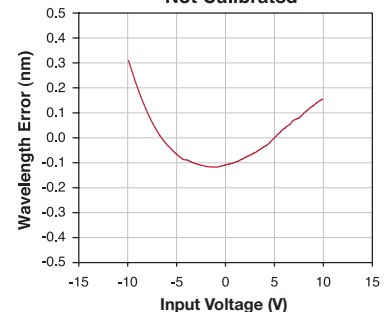
These lasers provide an excellent sweep performance while being robust and reliable at the same time.

The waveforms below show the excellent linearity of the ECL across the entire tuning range.

Wavelength Linearity of PICO D (OEM)



Not Calibrated



Calibrated

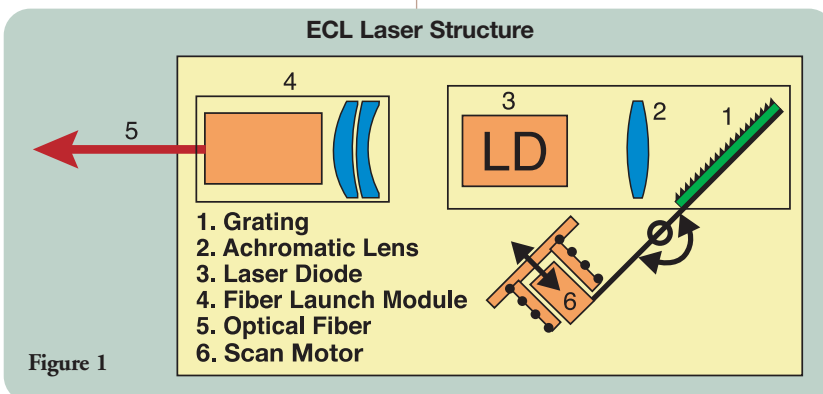
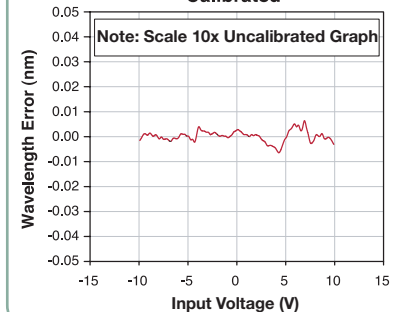


Figure 1

## Applications

### Heterodyne Interferometry

Optical Heterodyne Interferometry is an important measurement technique that benefit from Thorlabs' continuously tunable lasers.

Laser requirements for this high-precision measurement include smooth continuous tuning, high accuracy measurement, control of the wavelength, low noise, and narrow linewidth.

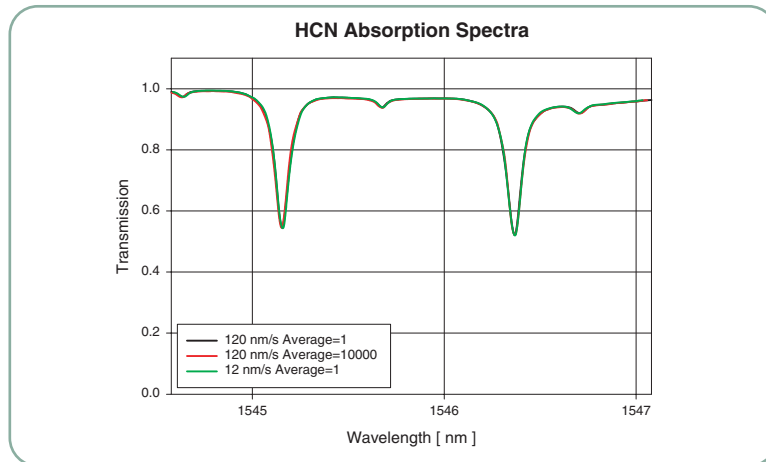
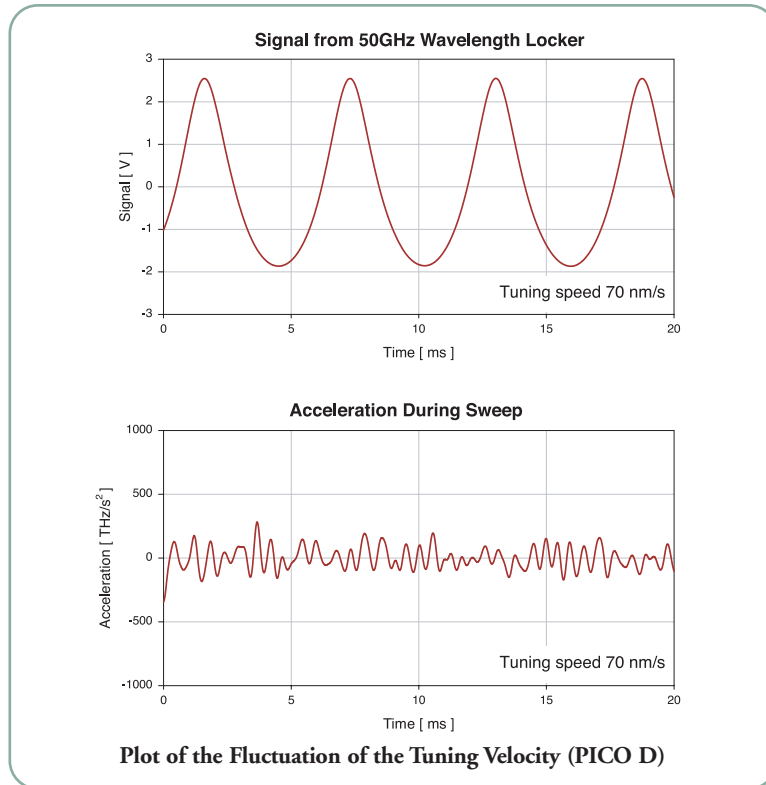
Our patented motor design enables a highly constant tuning speed. The constant sweep speed (low acceleration) makes these lasers suitable for interferometric and heterodyne measurements.

The acceleration during sweep (variation in the tuning speed) is measured using a wavelength locker (low finesse Etalon). The wavelength locker signal provides evenly spaced peaks (clock) in the frequency space (k-space). There are several methods to acquire data, which enables the calculation of the tuning speed and the acceleration. One method is to use the k-space clock to determine the tuning speed, and the time fluctuations of the k-space clock to determine the tuning speed variations (acceleration). In the figure to the right, we have used (in addition to the k-space clock) the knowledge of the finesse of the Etalon to improve the time resolution of the measurement. When using the knowledge of the finesse, the time resolution of the tuning speeds and the measurement of the acceleration is limited to the sampling frequency rather than the k-space clock.

### Spectral Monitoring

The ECL tunable lasers provide an outstanding building block in spectral measuring and monitoring. The waveform shows an HCN (Hydrogen Cyanide) scan using Thorlabs' ECL technology. See pages 851-857 for our gas cell products.

The impressive scan-to-scan repeatability allows the user to average spectral features without smearing (see figure to the right).



WAVELENGTH (nm)	TUNING RANGE (nm)	POWER (mW)	FIBER OUTPUT	MODEL
780	15	>5	—	INTUN
980	25	20	—	INTUN
1320	>110	>5* to >20	Yes	INTUN, PICO D ECL5000
1560	>130	>5* to >20	Yes	INTUN, PICO D ELC5000, $\mu$ ECL

\* For the fiber coupled versions

LASER SELECTION TABLE	PICO D	ELC5000DT	INTUN-T	INTUN-B	ELC1525
Mode-Hop Free Tuning	***	***	***	***	***
Fiber Output	***	***	**	**	***
Swept Wavelength Applications	***	***	***	*	*
Step and Measurement	*	*	*	***	***
Digital Interface		***		***	***
ITU References					***

**Legend**    \*\*\* Best    \*\*Selected Models Only    \*Standard

Tunable Lasers

Femtosecond Laser

WDM Laser Sources

Benchtop  
Laser Sources

HeNe Lasers

ASE Sources

Terahertz

Electro-Optic  
Modulators

# INTUN™ Continuously Tunable Benchtop Lasers (770nm-1650nm)

## Features

- Wavelength Ranges From 770-1650nm
- Optical Power: 5mW to >20mW
- 16 Models
- Instantaneous Linewidth: 120kHz (Minimum)
- SM or PM Fiber Output Available on Selected Models



Thorlabs offers a family of tunable lasers designed for demanding applications such as spectroscopy. With sixteen models spanning the wavelength range of 770nm to 1650nm, this family covers the widest spectral range of any of our tunable products. The heart of the INTUN system is based on the same technology used in the high performance PICO D tunable laser.

The T series is designed for swept wavelength applications and has the same patented motor design as the PICO D Series. These lasers have an analog interface of both wavelength and optical power for fast integration in the lab. The scaling factor for the wavelength calibration is -1V to +10V (minimum to maximum wavelength) and for power is -1V to +10V (0 to full output power). The T Series comes with an intuitive control box that enables the user to sweep the laser over the desired tuning range and to control the optical power without any external equipment.

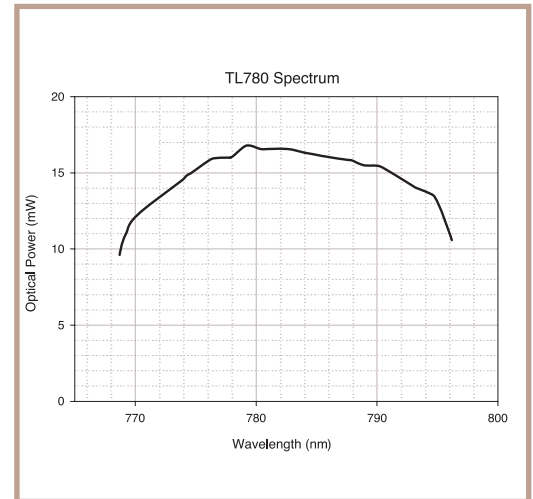
All lasers in the INTUN family have reduced spontaneous emission to further improve the laser performance. The INTUN has an SM1 compatible thread on the output port and mounting holes for our 30mm cage system to allow ease of use with our optomechanical equipment. The output is a collimated free-space beam.

Selected models of the T and the B series are available with fiber optic output. These models have a built-in isolator to reduce the sensitivity to external reflections and are available in both PM and SM versions with FC/APC output.

The INTUN B has the means to lock the wavelength to an external wavelength reference such as a gas cell or a frequency comb. This product is a complete turnkey solution without the need for additional electronic boxes. Contact [scandinavia@thorlabs.com](mailto:scandinavia@thorlabs.com) for more information on this application (see pages 851-857 for our selection of gas cells).

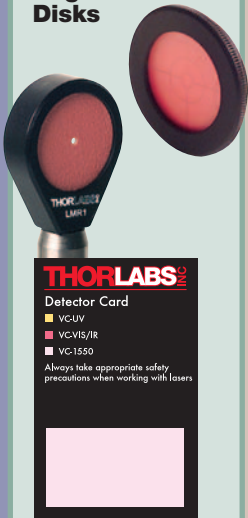
## Applications

- Characterization of Optical Components
- Spectroscopy
- Polarization Measurements
- Real-Time Process Monitoring
- General R&D



Plot of TL780 INTUN Laser Showing Optical Power as a Function of Wavelength

## IR Cards & Alignment Disks



See Page 497

## The INTUN Family is available with optional Fiber Optic Output.

ITEM#	CENTER $\lambda$ (nm)	TUNING RANGE (nm)	PIEZO TUNING RANGE (GHz)	OPTICAL POWER TYPICAL (mW)	\$	£	€	RMB
TL780-B	780	15	300	>5	\$ 20,880.00	£ 13,154.40	€ 19,418.40	¥ 199,404.00
TL780-T	780	15	300	>5	\$ 20,880.00	£ 13,154.40	€ 19,418.40	¥ 199,404.00
TL980-B	980	25	200	>20	\$ 20,880.00	£ 13,154.40	€ 19,418.40	¥ 199,404.00
TL980-T	980	25	200	>20	\$ 20,880.00	£ 13,154.40	€ 19,418.40	¥ 199,404.00
TL1300-B	1320	>110	200	>20	\$ 20,880.00	£ 13,154.40	€ 19,418.40	¥ 199,404.00
TL1300-T	1320	>110	200	>20	\$ 20,880.00	£ 13,154.40	€ 19,418.40	¥ 199,404.00
TL1300-B-SM	1320	>110	200	>5	\$ 22,280.00	£ 14,036.40	€ 20,720.40	¥ 212,774.00
TL1300-T-SM	1320	>110	200	>5	\$ 22,280.00	£ 14,036.40	€ 20,720.40	¥ 212,774.00
TL1300-B-PM	1320	>110	200	>5	\$ 22,800.00	£ 14,364.00	€ 21,204.00	¥ 217,740.00
TL1300-T-PM	1320	>110	200	>5	\$ 22,800.00	£ 14,364.00	€ 21,204.00	¥ 217,740.00
TL1550-B	1550	>150	175	>20	\$ 20,880.00	£ 13,154.40	€ 19,418.40	¥ 199,404.00
TL1550-T	1550	>150	175	>20	\$ 20,880.00	£ 13,154.40	€ 19,418.40	¥ 199,404.00
TL1550-B-SM	1550	>150	175	>5	\$ 22,280.00	£ 14,036.40	€ 20,720.40	¥ 212,774.00
TL1550-T-SM	1550	>150	175	>5	\$ 22,280.00	£ 14,036.40	€ 20,720.40	¥ 212,774.00
TL1550-B-PM	1550	>150	175	>5	\$ 22,800.00	£ 14,364.00	€ 21,204.00	¥ 217,740.00
TL1550-T-PM	1550	>150	175	>5	\$ 22,800.00	£ 14,364.00	€ 21,204.00	¥ 217,740.00

# INTUN™ Continuously Tunable Benchtop Lasers (770nm-1650nm)

## Electric and Interface Specifications INTUN-T

DC Input	+5V/10W and ±15V/5W*
Wavelength Set Input	±10V
Wavelength Fine Tune Input	±10V
Output Power Set Input	-1V to +10V
Digital Control	0-5V
Digital Status	0-5V
Electrical Connectors	DC Input Voltage: 6-Pin Digital and Analog I/O: 40-Pin Wavelength Output: BNC
Operating Temperature Range	15-30°C
Dimensions	170 x 87 x 142mm

Power supply and all required cables included.  
\* The controller supplies all voltages when used.

**INVISIBLE LASER RADIATION**  
AVOID DIRECT EYE EXPOSURE  
CLASS 3R LASER PRODUCT  
1150-1700nm <50mw  
IEC 60825-1 EDITION 1.2 2001-08

**INVISIBLE LASER RADIATION**  
AVOID EXPOSURE TO BEAM  
CLASS 3B LASER PRODUCT  
700-1000nm <500mw  
IEC 60825-1 EDITION 1.2 2001-08

**LASER RADIATION**  
DO NOT VIEW DIRECTLY WITH  
OPTICAL INSTRUMENTS  
CLASS 1M LASER PRODUCT  
1454-1650nm <50mw  
IEC 60825-1 EDITION 1.2 2001-08

Tunable Lasers

Femtosecond Laser

WDM Laser Sources

Benchtop Laser Sources

HeNe Lasers

ASE Sources

Terahertz

Electro-Optic Modulators

## Electric and Interface Specifications INTUN-B

DC Input	+48V/20W
Analog Modulation Input	2V <sub>p-p</sub>
Analog Wavelength Output	0-4V
Electrical Connectors	DC Input Voltage: Rear Panel Socket Digital Status: 0-5V Interlock: DB9 Communications: DB9 Null Modem Analog Inputs: BNC
Operating Temperature Range	15-30°C
Dimensions	242 x 87 x 142mm

Power supply and all required cables included.

LabVIEW™ is a trademark of National Instruments Corporation.

## APC Fiber Patch Cables

Thorlabs offers an extensive line of patch cables and connectors for your convenience in standard and custom lengths, FC/PC and FC/APC terminations. See Page 1058



Single Mode & Polarization  
Maintaining 1310 to 1550nm

## Optical Specifications

Parameter	-T	-B
Wavelength Resolution	1pm	0.1pm
Wavelength Repeatability	1pm	1pm
Absolute Wavelength Accuracy	±50pm	±50pm
Wavelength Stability (1h/24hr)	±2pm/±10pm	±2pm/±10pm
Power Resolution	0.1µW	25µW
Spectral Linewidth	150kHz Max*	150kHz Max*
Effective Linewidth	120MHz	1.5MHz
Coherence Control	1GHz or 2GHz	1GHz or 2GHz
Side Mode Suppression Ratio (SMSR)	45dBc Min	45dBc Min
Signal to Source Spontaneous Emission Ratio (SSE)	70dB/nm**	70dB/nm**
Signal to Total Source Spontaneous Emission Ratio (STSSER)	65dB	65dB
Optical Isolation (Fiber-Coupled Versions)	60dB***	60dB***
RIN	-140 (dB/Hz)	-140 (dB/Hz)
Tuning Speed Continuous		
TL780	0-30nm/s	0-15nm/s
TL980	0-30nm/s	0-15nm/s
TL1300	0-100nm/s	0-50nm/s
TL1550	0-130nm/s	0-50nm/s
Optical Output:	Collimated Free-Space Beam PM or SM fiber (FC/APC)	

\* Measurement time <1ms.  
\*\* All fiber-coupled versions  
\*\*\* Peak isolation

## GUI for Intun B Series Lasers

The B series has a serial interface, providing remote digital functionality. For ease of use, the B series includes application software to allow operation over the RS-232 interface. Also, LabVIEW™ drivers are available for integration into customer software.

