TOPO

MIR Spectroscopy and Applications

MIR Spectroscopy

Cavity ringdown

Detector Characterization

Microcavities

Atom & Ion Trapping

TOPTICA PHOTONICS

TOPO
Widely Tunable High-Power Continuous-Wave OPO Laser System

Key Features

- 1.45 - 4.0 µm (2500 - 6900 cm^{-1})
- 300 GHz (10 cm^{-1}) mode-hop-free tuning range
- Narrow linewidth: 2 MHz ($1 \cdot 10^{-5}$ cm^{-1})
- Hands-free motorized tuning
- Easy all-digital DLC pro control
- Watt class power

Applications

- MIR Spectroscopy
- Cavity ringdown
- Detector Characterization
- Microcavities
- Atom & Ion Trapping

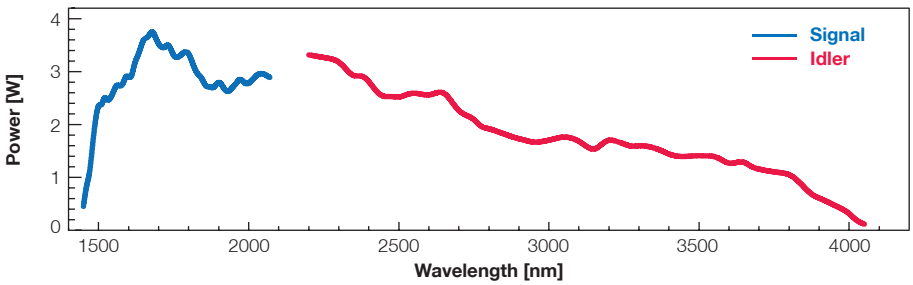
PRISM AWARDS WINNER

The revolutionary TOPO by TOPTICA stands alone as the only fully automated, continuous-wave, singly-resonant optical parametric oscillator laser source on the market. High resolution spectroscopy across 1.45 – 4.0 µm (2500 – 6900 cm^{-1}) has never been easier.

TOPTICA's unique optical design enables broadly tunable laser light. No module or mirror exchange is necessary. Additionally, the all-digital control electronics enable hands-free coarse tuning, and frequency locking. A wide mode-hop-free tuning range up to 300 GHz (10 cm^{-1}) enables visibility of full spectroscopic signatures. Simultaneously, the TOPO maintains a narrow linewidth (2 MHz, $1 \cdot 10^{-5}$ cm^{-1}) giving a solution that reveals narrow atomic and molecular features.

The full TOPTICA TOPO laser system integrates 4 key technologies (see Fig 1a): a DFB pro seed laser, fiber amplifier, optical parametric oscillator, and DLC pro digital control electronics, the same platform which is extensively used throughout TOPTICA's product lines. DLC pro allows simple hands-free operation through touchscreen, PC GUI interface, and through remote commands.

The wide wavelength coverage and low noise will make you explore further in molecular and biomedical spectroscopy, physical chemistry, and quantum technologies with the only widely-tunable MIR laser designed with top performance and ease of use in mind: the TOPO.

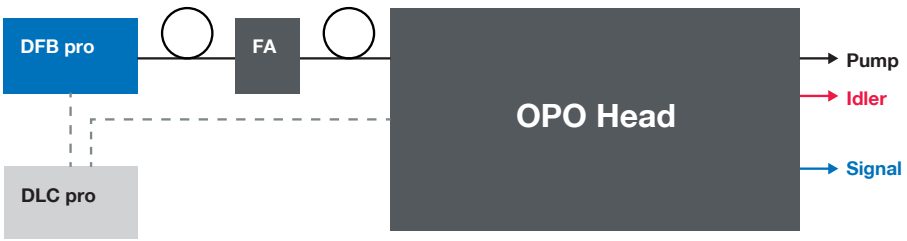


Characteristic Tuning Curve

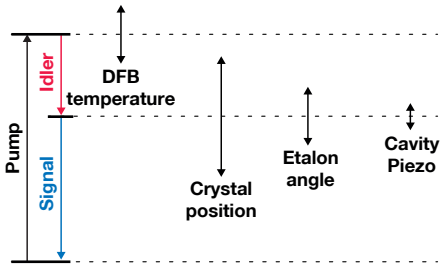
A singly-resonant OPO laser system can be tuned using a number of tuning mechanisms, see Fig. 1. In a simple photon picture (Fig. 1b), the pump photons are split up in a signal and an idler photon. The sum of signal and idler frequencies is given by the pump frequency through energy conservation.

The temperature-stabilized nonlinear crystal can be shifted for coarse tuning. The DFB pro seed laser provides low noise and wide mode hop free tuning in a compact fiber-coupled package. Idler frequency scans of several hundred GHz are typically accomplished without any mode hops. An etalon allows for stable single-longitudinal-mode selection. The etalon mount provides tilt-tuning of the resonated signal wave, and of the idler wave through energy conservation. Intracavity piezo tuning is used for fine tuning of the output around a target wavelength.

In case of the TOPO, all mechanisms are conveniently controlled through the DLC pro digital laser controller in order to allow full hands-off course and fine tuning and complete wavelength access. The performance of these mechanisms is given in the table below.



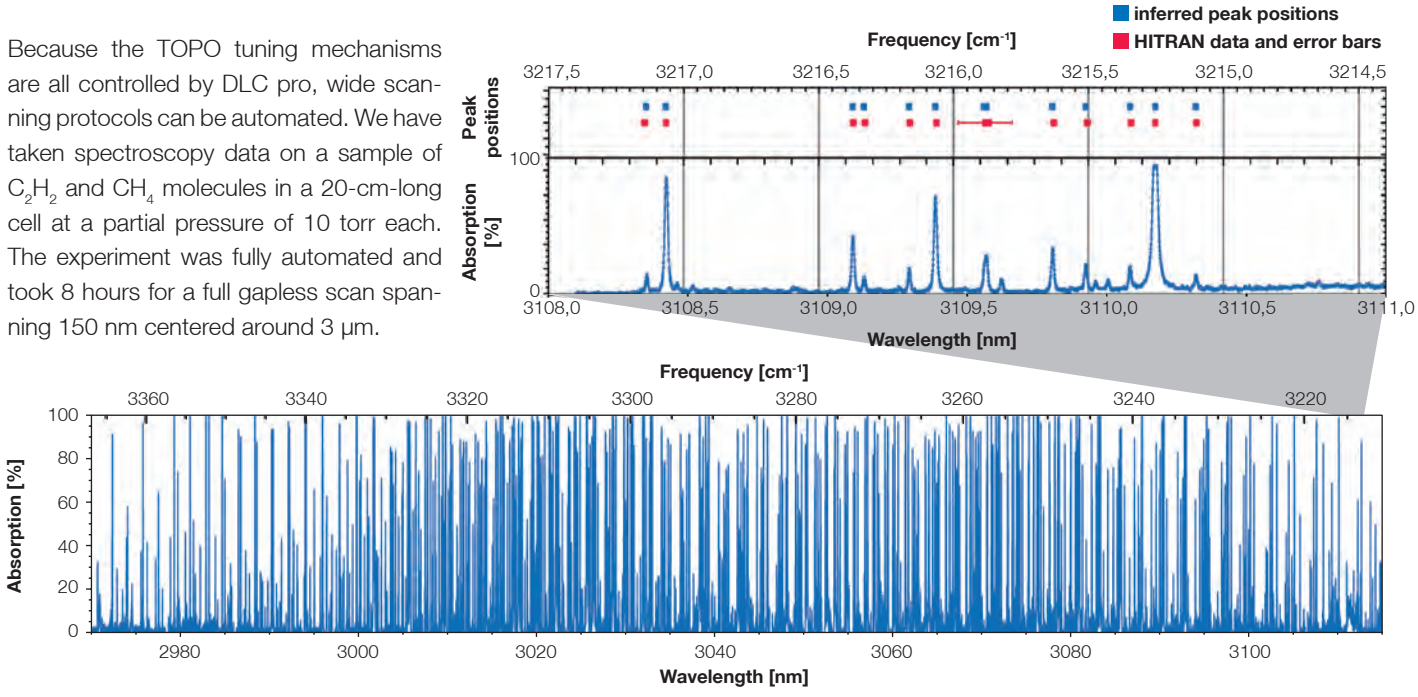
TOPO schematic overview (Figure 1a)



TOPO tuning mechanisms (Figure 1b)

Tuning Method	Output Affected	Range	Resolution	Mode-hop Free?
Intracavity Crystal position	Signal, Idler	Full System Range	1.3 THz	No
Pump Laser Temperature	Pump, Idler	30 - 300 GHz*	20 MHz/mK	Yes
Intracavity Etalon Angle	Signal, Idler	2 THz	30 GHz	No
Intracavity Piezo Voltage	Signal, Idler	500 MHz	100 kHz/mV	Yes
* Mode-hop free. Total tuning is 700 GHz over ΔT = 35 K.				

Because the TOPO tuning mechanisms are all controlled by DLC pro, wide scanning protocols can be automated. We have taken spectroscopy data on a sample of C_2H_2 and CH_4 molecules in a 20-cm-long cell at a partial pressure of 10 torr each. The experiment was fully automated and took 8 hours for a full gapless scan spanning 150 nm centered around 3 µm.



Automated High Resolution Spectroscopy

Class 4 Laser Product EN 60825-1:2014.
Visible and invisible laser radiation.
Avoid direct exposure to beam.

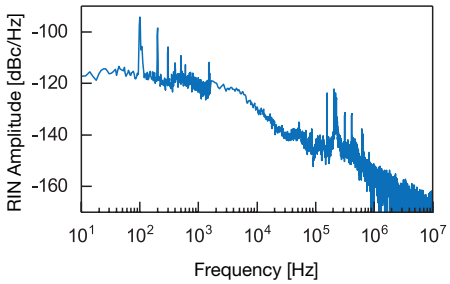
Laser Specifications			
	Signal	Idler	
Coarse tuning range*	1.45 - 2.07 µm	2.19 - 4.00 µm	2500 - 4570 cm^{-1} (idler), 4830 - 6900 cm^{-1} (signal)
Output Power**	2 W	1 W	
Linewidth	< 2 MHz	2 MHz	1 x 10^{-5} cm^{-1}
Mode hop free tuning range***	< 1 GHz	Up to 300 GHz****	Up to 10 cm^{-1} (idler)
Beam Quality Factor M^2**	< 1.2	< 1.2	
Frequency modulation and lock	PZT modulation	PZT modulation, Pump frequency modulation	
Control interfaces	DLC pro touchscreen, PC software, Ethernet, USB, analog remote control		

* Course tuning is established by full automatic crystal shifting and temperature control. No optics exchange necessary

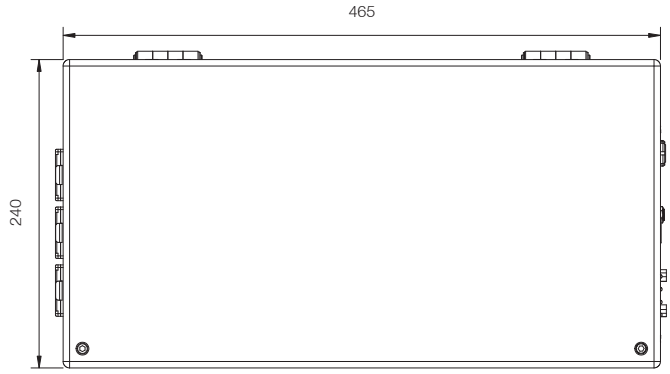
** Specifications valid 1.53 - 2 µm, 2.2 - 3.6 µm

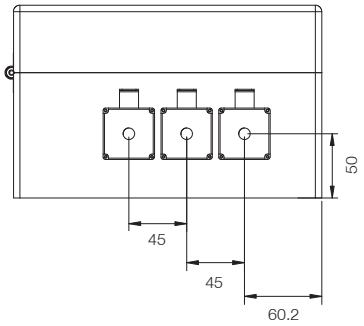
*** Fine tuning is established via pump tuning (idler) and PZT tuning (signal and idler)

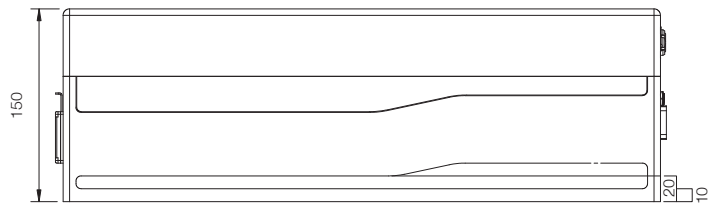
**** 30 GHz - 300 GHz, depending on output wavelength

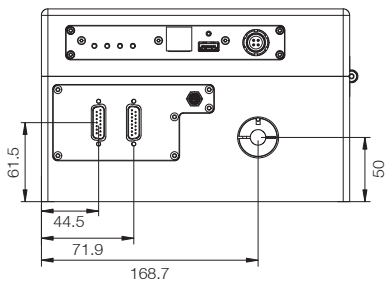


Signal at 1.7 µm: RMS 0.15 %









All dimensions given in mm.

TOPTICA Photonics AG · Lochhamer Schlag 19 · 82166 Graefelfing · Germany
T +49 89 85837-0 · **F** +49 89 85837-200 · sales@toptica.com · www.toptica.com