Air-cooled, diode-pumped, wavelength-tunable Q-switched laser for infrared spectroscopy

Q-TUNE-IR laser head

Q-TUNE-IR is a high-peak-power coherent light source designed for infrared spectroscopy, spectrophotometry, metrology, single-molecule vibrational microscopy and remote sensing applications.

The system is based on an Optical Parametric Oscillator (OPO) that generates tunable output across the 1380 – 4500 nm range with a linewidth below 10 cm^{-1}. A broadband configuration, offering linewidths up to 200 cm^{-1}, is available on request.

Three OPO coating options are available to optimize performance across different spectral regions. The -TC1 option provides the best performance over the full 1.38 – 4.5 µm range. The -TC2 option is optimized for enhanced output in the 1.45 – 1.65 µm and 3.5 – 4 µm regions. The -TC3 option delivers superior performance in the 2.5 – 3.4 µm range, eliminating the typical gap near 2.87 µm. Refer to the tuning curves (performance pictures) for a detailed comparison.

QLI's advanced air-cooled (water-free) pumping technology delivers a high-quality pump beam with pulse energies up to 100 mJ, eliminating the need for external chillers or bulky power supplies. All electronics are fully integrated into the Q-TUNE-IR housing, with only a compact external power adapter required (12 or 28 VDC, 50 – 150 W depending on the model).

Both the pump laser and the OPO are controlled via a single Ethernet interface using a built-in web server. No additional software installation is required – any computer or mobile device with a modern web browser can operate the system. An API is also available for seamless integration into user setups.

In addition to the tunable IR output, the system provides an auxiliary port for direct access to the pump laser beam.

Q-TUNE-IR

FEATURES

- Seamless laser and optical parametric oscillator (OPO) integration
- Remote control via PC
- Turnkey performance due to water-free pump laser design
- Guaranteed **> 2 G shot** pump-diode lifetime
- Microprocessor controlled operation with self-optimization, self-calibration capability
- Hands-free automated tuning **from 1380 to 4500 nm**
- **> 16 mJ** pulse energy at the peak of tuning curve
- **< 10 cm^{-1}** linewidth (broadband **~200 cm^{-1}** version is available)
- Up to **100 Hz** pulse repetition rate
- Air purging to remove water vapor absorption lines and extend optics lifetime
- Internal or external triggering modes
- Separate output port for access to pump laser beam
- Low power consumption – from 50 to 100 W depending on model
- Can be powered from +12 VDC or +28 VDC source

OPTIONAL EQUIPMENT

- Compact spectrometer for OPO wavelength and linewidth monitoring
- Attachable attenuator for pulse energy control

APPLICATIONS

- Infrared spectrophotometry
- Cavity ring-down spectroscopy
- Gas spectroscopy
- Single molecule vibrational spectroscopy
- Scanning near-field optical microscopy
- Remote sensing

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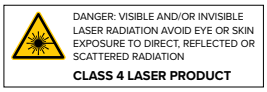
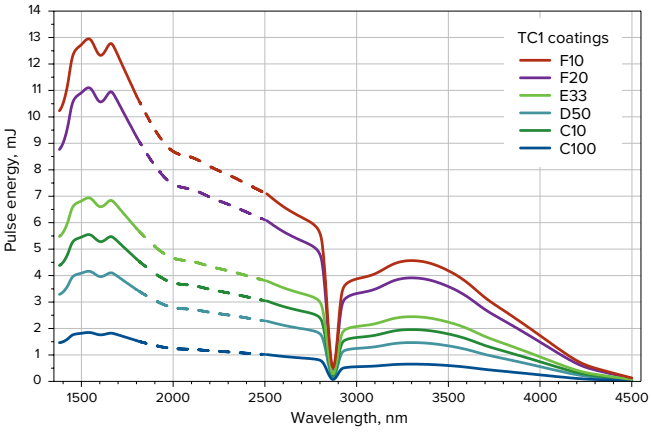
SPECIFICATIONS [1]

Model	Q-TUNE-IR				
	-C10	-C100	-E33	-F10	-F20
Wavelength range, nm [2]	1380 – 4500 nm				
Pulse repetition rate [3]	10 Hz	100 Hz	33 Hz	10 Hz	20 Hz
Pulse energy [4]					
-TC1	≥ 1.8 mJ	≥ 0.6 mJ	≥ 2.5 mJ	≥ 4.5 mJ	≥ 4 mJ
-TC2	≥ 1.8 mJ	≥ 0.6 mJ	≥ 2.5 mJ	≥ 4.5 mJ	≥ 4 mJ
-TC3	≥ 2.5 mJ	≥ 0.8 mJ	≥ 3.0 mJ	≥ 5.0 mJ	≥ 4.5 mJ
Linewidth [5]	< 10 cm^{-1}				
Pulse duration [6]	3 – 4 ns typical				
Pulse-to-pulse stability [7]	< 4.5 % RMS				
Power drift [8]	± 3.0 %				
Polarization	horizontal, linear				
Typical beam diameter [9]	3 mm		5 mm	6 mm	
Typical beam divergence [10]	< 7 mrad		< 5 mrad		
Jitter [11]	< 0.5 ns RMS				
Pump laser output					
Max pulse energy at fundamental wavelength [12]	30 mJ	15 mJ	50 mJ	70 mJ	60 mJ
Dimensions					
Laser head (W×L×H)	390 × 620 × 153 mm^3				
Power adapter (W×L×H) [13] [14]	192 × 178 × 46 mm^3				
Air-purging unit (W×L×H) [15]	482 × 460 × 106 mm^3				
Operating requirements					
Cooling requirements	air-cooled (water-free)				
Ambient temperature	15 – 30 °C				
Relative humidity (non-condensing)	10 – 80 %				
Mains voltage [14]	90 – 230 VAC, single phase, 47 – 63 Hz				
Average power consumption	< 50 W	< 150 W		< 80 W	< 120 W

1. Due to continuous improvements all specifications are subject to change. Unless stated otherwise all specifications are measured at 3300 nm and max pulse repetition rate. The parameters marked typical are not specifications. They are indications of typical performance and will vary with each unit we manufacture.
2. There are two wavelengths at the exit port in 1800 – 2500 nm range corresponding to signal and idler of OPO. TC3 option has 1430 – 4000 nm tuning range.
3. Factory-set pulse repetition rate in internal triggering mode. Pulse repetition rate can be divided-down to 1 Hz.
4. Pulse energy at 3300 nm. See tuning curves for typical pulse energies at other wavelengths.
5. Broadband version is available, with linewidth up to 200 cm^{-1}. Please inquire for details.
6. FWHM level at 1550 nm, measured with 350 ps rise time photodiode.
7. Measured during 30 seconds operation after warm-up.
8. Over 8 hour period after 20 minutes of warm-up, when ambient temperature variation is less than ± 2 °C. Power value is calculated once per second.
9. Beam diameter is measured 20 cm from laser output at the 4σ level at 1550 nm.
10. Full angle measured at 1550 nm at the 4σ level.
11. In respect to falling edge of pump-diode triggering pulse.
12. Laser pulse energy is optimized for OPO pumping may differ from stand-alone laser specifications indicated here.
13. Power adapter is integrated in air-purging unit's housing, both devices fit in the housing.
14. Laser can be powered from an appropriate 12 or 28 VDC power source, depending on model. Please inquire for details.
15. Air-purging unit is supplied with integrated power adapter.

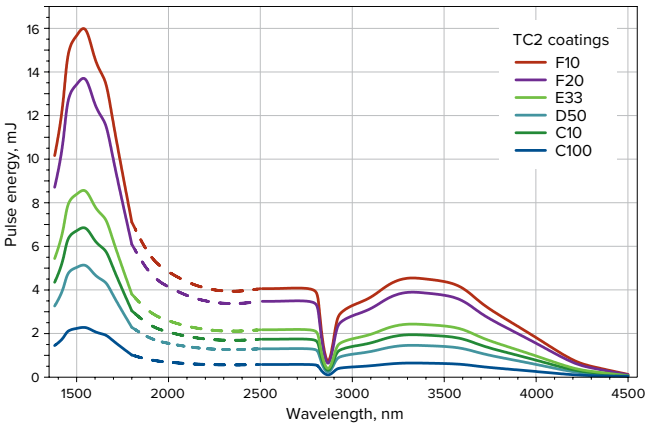


PERFORMANCE



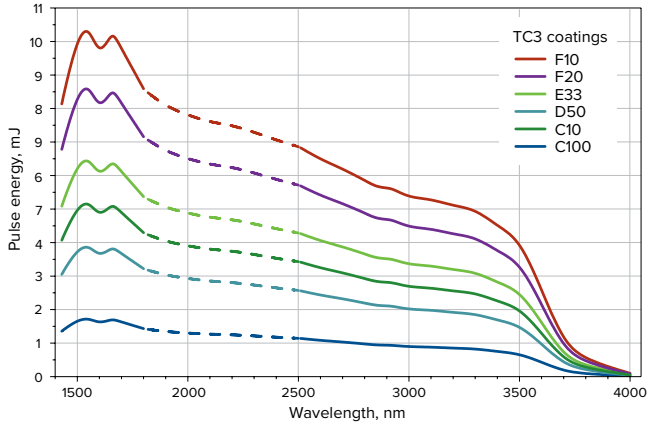
Q-TUNE-IR-TC1 tuning curves

Dashed lines show the range where signal and idler waves are spectrally unseparated.



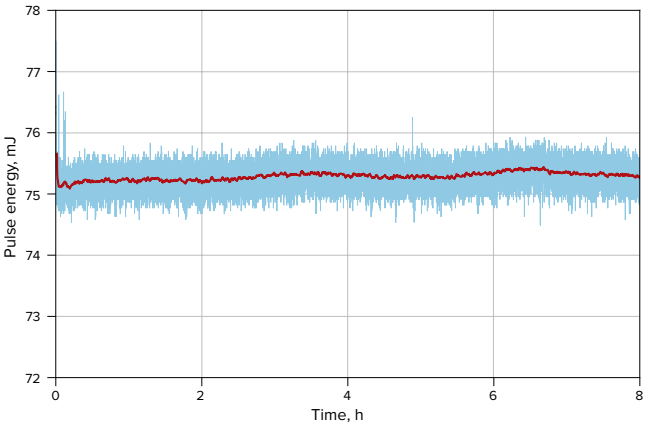
Q-TUNE-IR-TC2 tuning curves

Dashed lines show the range where signal and idler waves are spectrally unseparated.



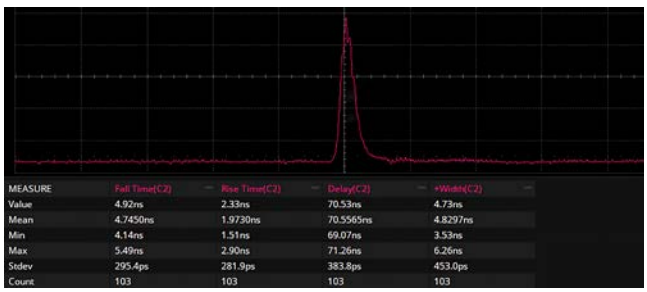
Q-TUNE-IR-TC3 tuning curves

Dashed lines show the range where signal and idler waves are spectrally unseparated.

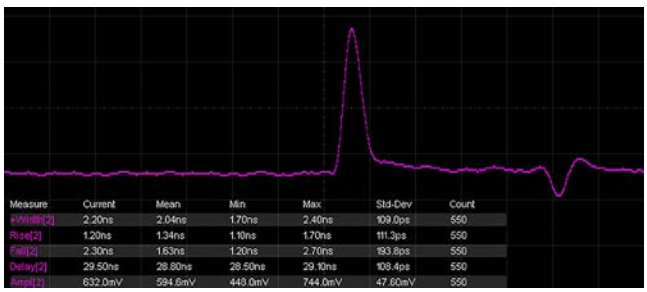


Long term stability Q-TUNE-IR-F20 @ 1st harmonic

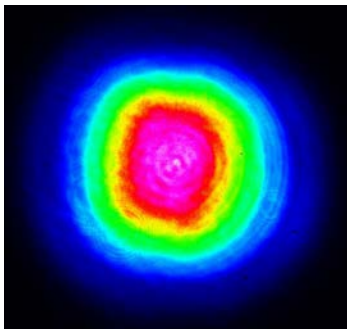
Power drift: +0.2 %; -0.17 %



Pulse duration of Q-TUNE-IR-F20 @ 1st harmonic

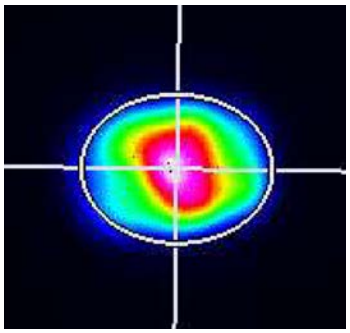


Pulse duration of Q-TUNE-IR-F20 @ 1550 nm



Q-TUNE-IR-F20 1st harmonic beam profile

Axis length (X, Y) – (3583.3,3471.1) µm,
effective diameter – 3527.7 µm, ellipticity – 96.9 %



Q-TUNE-IR-F20 beam profile

Axis length (X, Y) – (5152.7,4016.4) µm,
effective diameter – 4619.6 µm, ellipticity – 77.9 %,
wavelength – 1550 nm

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PART NUMBERS

Q-TUNE-IR-F10-TC1-AT/IR

Model

IR → OPO pump wavelength 1053 nm or 1064 nm

Pump laser energy level

C → > 20 mJ
D → > 40 mJ
E → > 60 mJ
F → > 80 mJ

Default pulse repetition rate in Hz

Optional items

AT/IR → motorized attenuator for 1400 – 1800 nm
FC/IR → fiber coupler for 1400 – 1800 nm
SPM3 → OPO wavelength monitoring in 700 – 900 nm range
EM/BB → pulse energy monitor for OPO output
APU2 → air-purging unit

Tuning range optimisation

TC1 → 1400 – 3300 nm
TC2 → 1550 – 3400 nm
TC3 → 2800 – 3200 nm

OPTIONAL ITEMS

WF	Stand-alone wireless router for wireless laser control
RS	Stand-alone adapter for laser control via RS-232 port
PC	Laptop computer for laser control
EXP	Stand-alone pulse generator for variable repetition rate
CT19	19” mounted controller with integrated AC/DC power supply
CTA19	19” mounted controller with air-purging unit
CTBR	Front/rear panel with brackets for standard controller
PS19	19” form factor AC/DC power supply
APU2	Stand-alone air-purging unit with integrated AC/DC power supply
CST	Custom model

IMAGES

Front view of Q-TUNE-IR laser head

Rear view of Q-TUNE-IR laser head

Front view of air-purging unit APU2

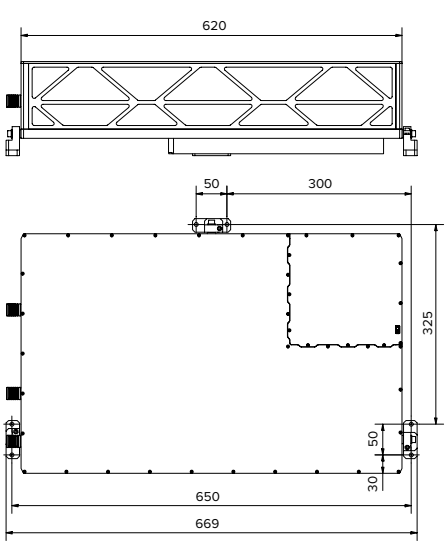
Rear view of air-purging unit APU2

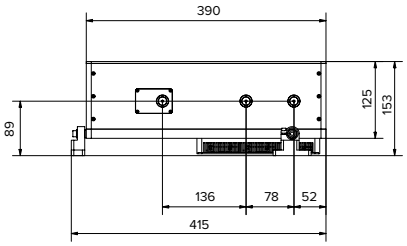
Fiber coupler FC

Motorized attenuator AT

Pulse energy monitor EM/BB

DRAWINGS





Outline drawings of Q-TUNE-IR laser head (dimension in mm)