BLOCK

Boston Electronics

TUNABLE LASER TECHNOLOGY

AT THE HEART OF INNOVATION

MINIATURIZED QUANTUM CASCADE LASERS
FOR INSTRUMENTATION & RESEARCH

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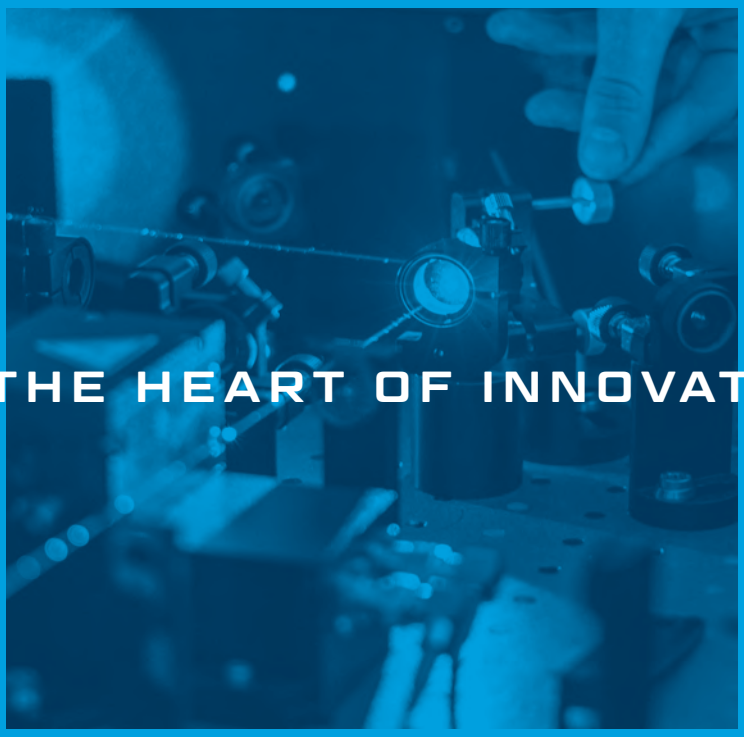
Boston Electronics



AT THE HEART OF INNOVATION

As a leader in high-performance mid-infrared (IR) spectrometers, we have leveraged our expertise to develop next-gen Quantum Cascade Lasers (QCL) used around the world in life science, safety and environmental applications.

Quantum Cascade Lasers (QCLs) are tunable lasers that can make controlled incremental shifts in wavelength output. This enables the incredible power of lasers to be applied to broad-band spectroscopy applications where previously there were no solutions. Block's external cavity QCLs are effective for producing widely tunable systems and providing broadband tuning at microsecond speeds while still compact and multi-modal.

Our QCLs operate in "pulsed" mode (as opposed to "continuous wave") for operating in a wide range of environments without requiring expensive and bulky external cooling. In addition to the first and only ruggedized QCL systems designed for manufacture and scalability, we also offer the expertise and collaboration to determine the best laser for your application.

LaserTune:

for research & development

- Benchtop, turnkey laboratory tool
- Use in optical experimentation or spectrometer development
- Fully-integrated solution
- Optional IR detector

mQCL:

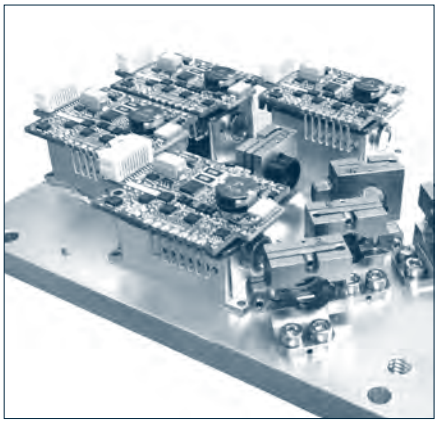
for OEM product integration

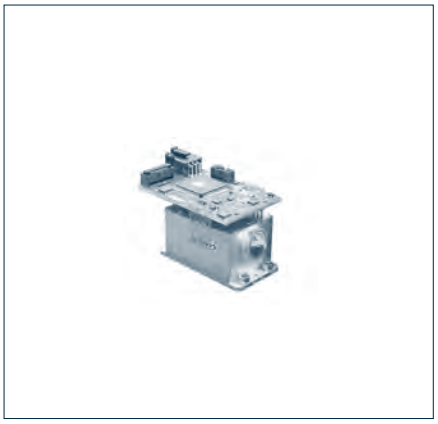
- Multi QCL optical module for system prototyping
- Broad wavelength applications
- Gap free tuning
- Noise sensitive measurements
- Trigger I/O for seamless integration

sQCL:

for portable OEM product integration

- Best in class ultra-miniature tuner and electronics
- Wide wavelength range in a single tuner
- OEM integration support
- Lowest cost in volume
- Command/Control SDK provided





LaserTune

Applications:

Research & Development

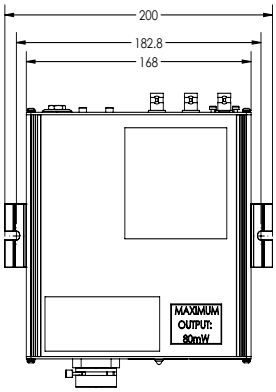
Product Specifications:

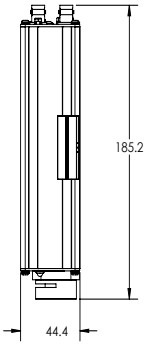
LaserTune-S: Dimensions: 9.3” x 6.6” x 1.75” Weight: 2.2 bs (1 kg)
LaserTune-M: Dimensions: 6.25” x 5” x 4.9” Weight: 4.5 lbs (2.04 kg)

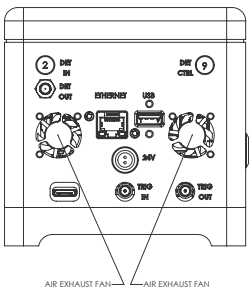
Tuner Selection (µm):

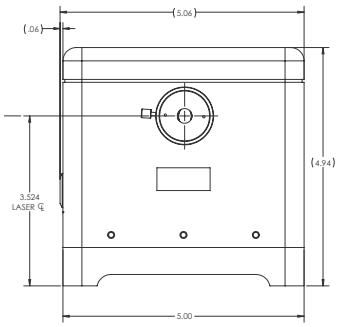
5.4–6, 6.1–7.3, 7.4–10.4, 9.9–12.8

Other ranges available, please contact us regarding your specific needs/requirements.









The LaserTune benchtop instrument comes ready out-of-the-box, with one to four mid-IR lasers that fulfill your gap-free wavelength requirements.

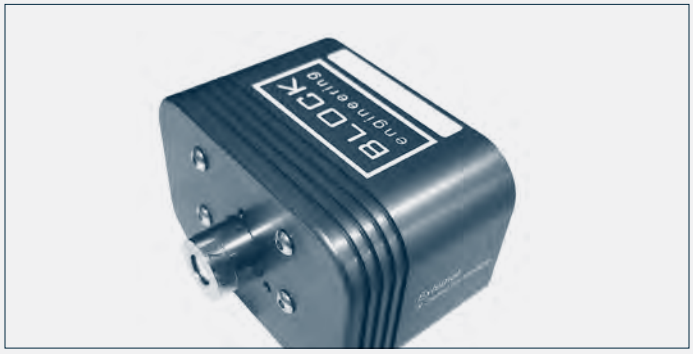
Product Highlights

- Complete turn-key system ready to work out of the box
- Configurable lasers to achieve desired gap-free wavelength range from 5.4-12.8 µm
- Wavenumber ramps, step functions, static wavenumber control
- Integrated software allows you to easily control the laser
- SDK provided to enable rapid integration

Both the LaserTune-S (single laser) and LaserTune-M (1-4 lasers) models have an intuitive software interface that is simple to set up and operate in one of 3 modes: Ramping smoothly through a range of wave numbers (WNs), stepping through discrete WNs, or residing at a single WN. The pulses can be internally triggered at regular intervals with an available sync-out signal, or can be initiated by your trigger input.

LaserTune's flexible programming platform provides an industry-leading sweep speed capability at 25 cm^{-1} per millisecond, a wide range of pulse durations, fast repetition rates, and a widely adjustable duty-cycle that may be dynamically varied. With a tightly collimated beam, industry-leading thermal/temporal stability, and exceptional spectral accuracy, this rugged system is a reliable tool on any optical bench.

The MCT detector option provides all-in-one spectrometer capabilities. On-board software allows you to easily control the laser and collect the detector signal to produce complete exportable spectra. The compact, rugged, plug-and-play design makes LaserTune a reliable instrument for your lab.



The MCT Detector for LaserTune

The MCT (Mercury-Cadmium-Telluride) Infrared Detector Module is a thermoelectrically cooled detector element and preamplifier package optimized for acquiring spectral data when coupled with LaserTune-M. The module operates at room temperature without requiring liquid nitrogen or other cooling techniques. Users can configure a spectrometer in a variety of ways for applications such as IR spectroscopy, and spectral data is acquired and available for analysis and storage.

The detector module is also optimized for the emission profile and fast scan rate of the LaserTune QCL system. Since the module represents the same hardware employed in Block's spectrometer system, users get maximum versatility without sacrificing system performance.

mQCL

Applications:

OEM Product Development

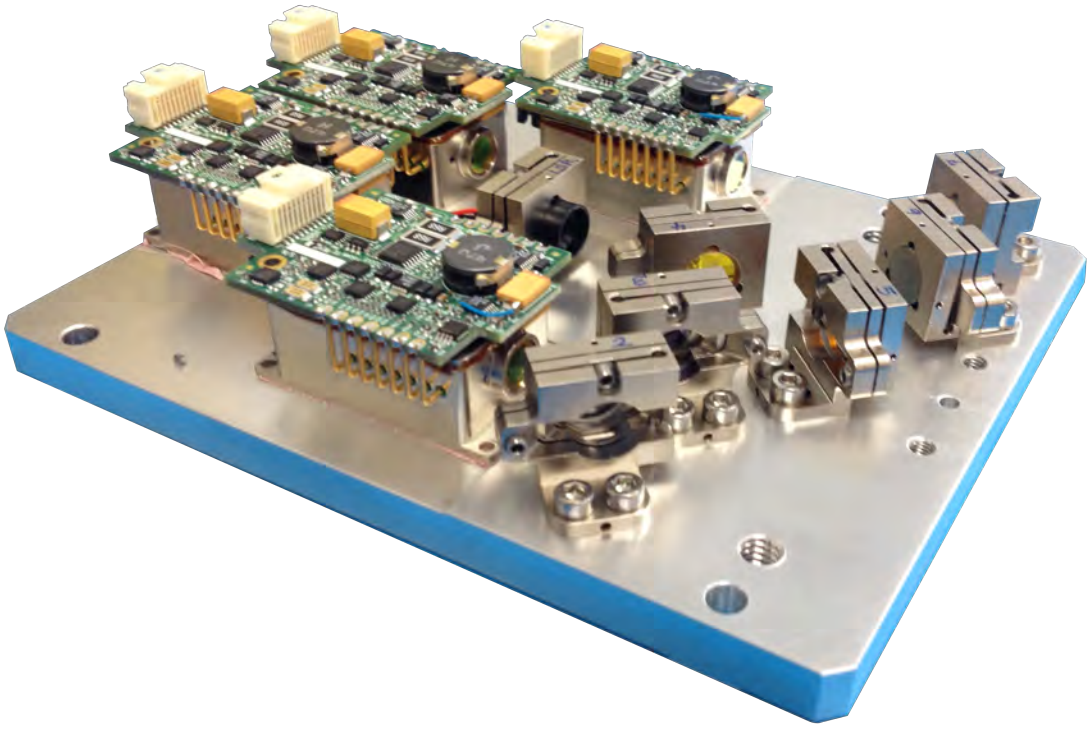
Product Specifications:

Dimensions: 7” x 5” x 5” Weight: 5 lbs (2.26 kg)

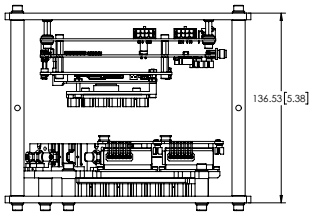
Tuner Selection (µm):

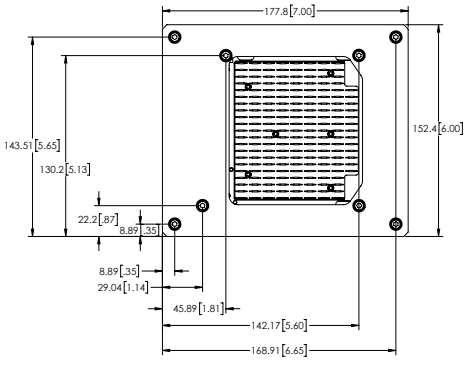
5.4–6, 6.1–7.3, 7.4–10.4, 9.9–12.8

Other ranges and combinations are available, please contact us regarding your specific requirements. The table below shows contiguous combinations of these individual WN lasers.



Number of Tuners	Wavelength Range
1-tuner	5.4 - 6.05 µm (1850 - 1650 cm-1) 6.1 - 7.30 µm (1635 - 1370 cm-1) 7.4 - 10.4 µm (1335 - 960 cm-1) 9.9 - 12.8 µm (1010 - 780 cm-1)
2-tuner	5.4 - 7.30 µm (1850 - 1370 cm-1) 6.1 - 10.4 µm (1635 - 960 cm-1) 7.4 - 12.8 µm (1335 - 780 cm-1)
3-tuner	5.4 - 10.4 µm (1850 - 960 cm-1) 6.1 - 12.8 µm (1635 - 780 cm-1)
4-tuner	5.4 - 12.8 µm (1850 - 780 cm-1)





The mQCL provides multiple lasers in a fully functional module for easy product development and integration.

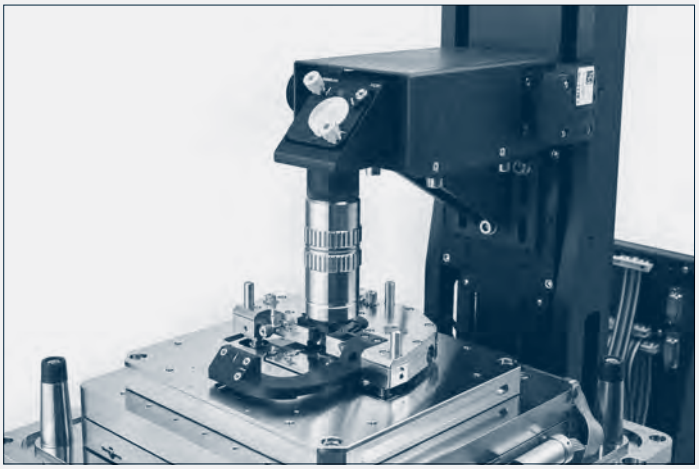
Product Highlights

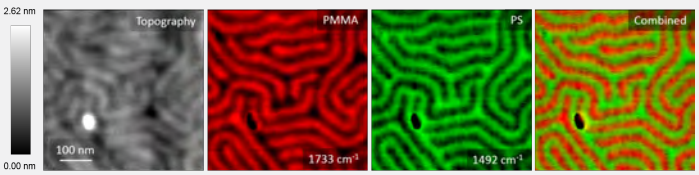
- OEM integration ready
- Configurable lasers to achieve desired gap-free wavelength range from 5.4-12.8 µm
- Wavenumber sweeps, step functions, static wavenumber control
- On-board software allows you to easily control the laser
- All the functionality of our LaserTune product in an OEM form factor and cost point
- Available SDK enables rapid integration

The system accommodates configurations of 1-4 QCL tuners where the tuners, beam combining and steering optics, and optional visible alignment laser are all affixed to the optics plate. The mQCL tuner modules are controlled by miniature driver electronics with trigger I/O to enable seamless system timing and widely flexible programming. The interface to the electronics ranges from SDK commands for hardware integration to a convenient GUI for experimenters.

The mQCL is used in a wide variety of real-time applications requiring a mid-infrared laser source, including surface inspections, biometrics, in-line process control, laboratory analytics, air quality monitoring, pharmaceutical development and various life science applications.

The module is designed to be integrated into a variety of spectroscopic instruments, including products used in the fields of Photoacoustic Spectroscopy (PAS), Cavity Ring-Down Spectroscopy (CRDS), Atomic Force Microscopy (AFM) and a range of dispersive and non-dispersive instruments. The mQCL is especially beneficial to IR microscopes and IR spectrometers that can conduct standoff, non-contact analysis due to the high spectral radiance of Block's QCLs.





"Integrating Block's QCLs into our atomic force microscope (AFM) has enabled us to acquire both topography, IR spectra and spectral mapping with ~ 5 nm spatial resolution, about 1000X better than the resolution of the FTIR microscopes."

– Sung Park, CEO, Molecular Vista

sQCL

Applications:

OEM Product Development

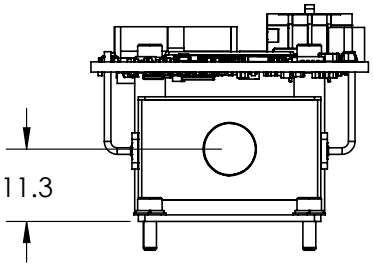
Product Specifications:

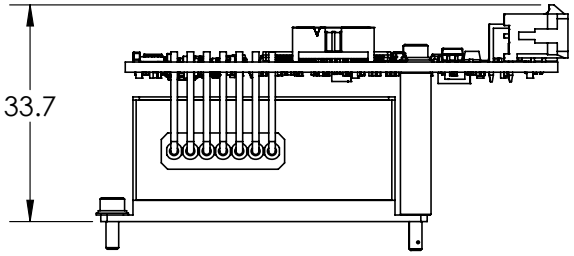
Dimensions: 2.9” x 1.7” x 1.4” Weight: 4.8 oz (136g)

Available Ranges (µm):

Variety of ranges within 5-13 µm (760-2,000 cm^{-1}).

See wavelength selection guide for details.





When low cost and extremely compact size are most important, the sQCL is the OEM integrators' tunable laser of choice.

Product Highlights

- Superior stability (thermal & temporal)
- OEM integration ready and cost effective solution
- Ultra-miniature footprint, including electronics
- Flexible trajectory creation & customization
- Power efficient for portable instruments
- Wide thermal operating range
- Wide choice of mid-IR lasers for desired wavelength range
- Wavenumber sweeps, step functions, static wavenumber control
- No active external cooling requirement

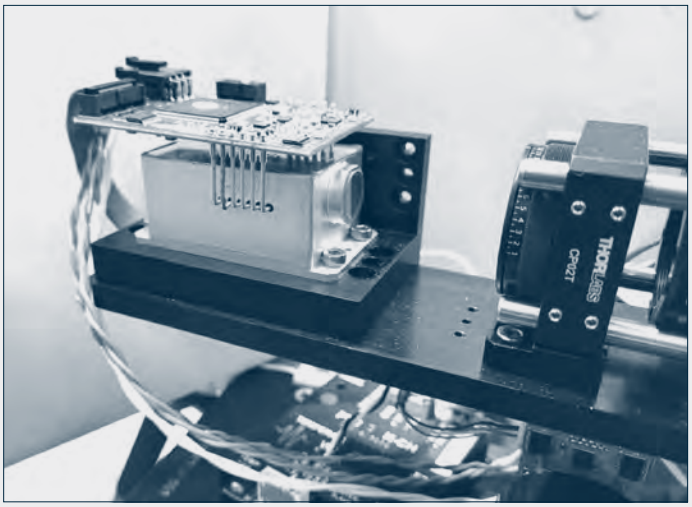
With power and trigger signals provided by your mother board, the lasers become a fully integrated component in your system.

Mechanical integration of the sQCL is similarly straightforward, using the four mounting holes on the base of the tuner. With Block's compact S-Controller circuit, the laser's voltage conditioning, internal thermal control, trigger interface, and safety interlocks are remote from the laser's miniature head, but seamlessly integrated. This allows for the QCL tuner to be located where it needs to be in the system with minimal design constraint.

Single Tuner Options

Blocks QCLs are supplied in numerous different wavelength ranges that can be selected based on the application requirements. While these ranges represent the standard tuners we offer, additional ranges are available upon request.

The sQCL begins as a ruggedized design with a wide thermal operating range. The systems are designed to work off of 12v-dc power and 3.3v triggers for use in handheld or portable systems.



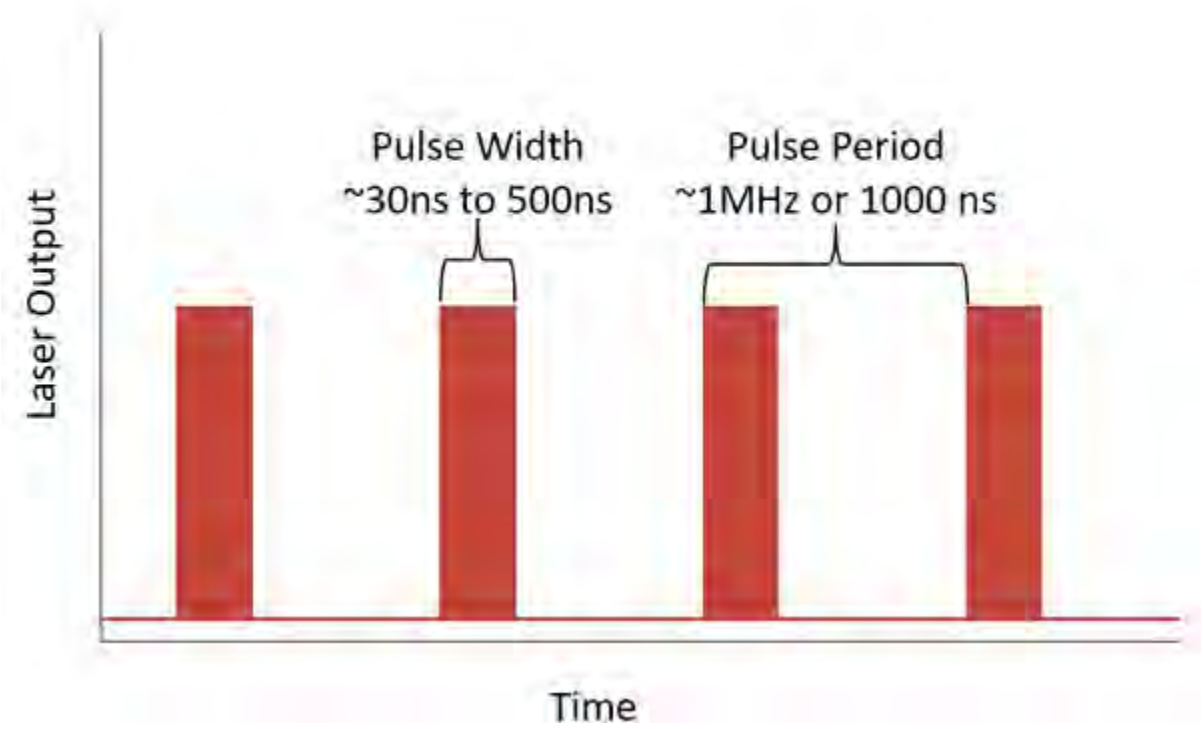
BLOCK LaserTune Specifications Summary

	LaserTune-Classic	LTune/mQCL Gen2	LaserTune-S	LaserTune-R New Electronics, Classic Mechanics	sQCL 2024 version LaserTune-S w/o box
Spectra Ranges Available, microns	ANY ONE, TWO, THREE or all of FOUR of 5.4–6, 6.1–7.3, 7.4–10.4, 9.9–12.8		ANY ONE of 5.4–6, 6.1–7.3, 7.4–10.4, 9.9–12.8		
Spectral Ranges Available, cm-1`	ANY ONE, TWO, THREE or all FOUR of 1850-1650, 1635-1370, 1386-960, 1010-780		ANY ONE of 1850-1650, 1635-1370, 1386-960, 1010-780		
Spectral stability versus temp	< 0.01 cm-1/°C	<0.007 cm-1/°C	<0.007 cm-1/°C	<0.007 cm-1/°C	<0.007 cm-1/°C
Spectral Resolution (Rayleigh criterion)*	<2 wavenumbers	<2 wavenumbers	<2 wavenumbers	<2 wavenumbers	<2 wavenumbers
Spectral scan rate, cm-1/second	25000 cm-1/sec maximum	TBD	~2000 cm-1/sec maximum	~2000 cm-1/sec maximum	~2000 cm-1/sec maximum
Spectrtal scan control	Sweep, step, static	Sweep, step, static + more in dev	Sweep, step, static + more in dev	Sweep, step, static + more in dev	Sweep, step, static + more in dev
Operation	Pulsed				
Rep Rate	10 kHz to 1 MHz				
Pulse length	30 ns to 150 ns				
Duty Cycle	8%	TBD (expect 15-25% chip dependent)	up to 15%, laser chip dependent	10%	up to 15%, laser chip dependent
Optical power AVERAGE (15% duty cycle)	peak > 45 mW (wavelength dependent)	peak >75 mW (laser chip and wavenumber dependent)	peak >75 mW (laser chip and wavenumber dependent)	peak >45 mW (laser chip and wavenumber dependent)	peak >75 mW (laser chip and wavenumber dependent)
Optical power PEAK (15% duty cycle)	Peak > 400 mW (wavelength dependent)	peak > 500 mW (wavelength dependent)	peak > 500 mW (wavelength dependent)	Peak > 500 mW (wavelength dependent)	peak > 500 mW (wavelength dependent)
Power stability pulse to pulse	< 5% Min-Max (typ)	< 1.5% standard deviation (typ)			
Power stability over 1 hour	< ±0.1%				
Optical Beam size (collimated)	2 x 4 mm				
Optical Beam divergence	< 5 mrad				
Polarization	vertical 100:1				
Software	Windows GUI at no cost				
Resident programing	Non-volatile on-board memory retains last loaded program instructions and can be repeatedly executed				
Custom Software	One exemplary script to customer requirement provided with each new instrument				
Software Developers Kit	C#, .Net	In development, likely python. Currently, command line interface available for			
SIZE	159x127x125 mm	TBD	236x169x45 mm		73x44x36 mm
Weight	2.04 kg	TBD	1 kg		136 g (EC QCL module)
Power		TBD	10W (Typ)	10W (Typ)	10W (Typ)
Warranty	1 year				
Temp. Operating	10 to 30 C	10 to >40 C			
Temp. Storage	-10 to 55 C				
Humidity	0 to 90% non-condensing				
Cooling	Integral fan		Integral fan		appropriate heat sink required

**The Rayleigh criterion states that it is not valid for gaussian outputs. In this case we have used the FWHM approach.*

Pulsed Versus Continuous Wave Lasers

Block Engineering's mid-infrared quantum cascade lasers are "pulsed" rather than "continuous wave." What do these terms mean? And what are the advantages of a pulsed laser?



Pulsed lasers emit light in extremely rapid bursts, or pulses, with pauses between pulses. The time period of a pulse is measured in nanoseconds (billionths of a second).

In Block's quantum cascade lasers, the time (or "width") of each pulse can be set between 30 nanoseconds and 500 nanoseconds.
By contrast, continuous wave lasers do not emit light in pulses. Instead, light is continually and uniformly released, much like a shining incandescent lightbulb.

Why Choose a Pulsed Laser?
The primary benefit of a pulsed design is that heat from the laser is given time to dissipate. Instead of keeping the laser "on" and "hot" continuously, the gap between pulses allows for significant conduction cooling.

In the case of Block's lasers, this means that bulky external air and water cooling systems are not needed to draw heat away from the laser.

In fact, Block's QCL packages are thermoelectrically cooled without any external fans or other moving parts. Because of that, our systems are extremely compact, less expensive than actively-cooled continuous wave (CW) lasers, and do not require power-hungry and mechanically vulnerable cooling systems.

Another benefit of reduced heat is that pulsed laser beams can protect the *target* of the laser from thermal damage. Because Block's lasers are often used to analyze delicate biological tissues, detect trace chemicals, and power infrared microscopes, this is important.

Tissue samples that might be damaged by a hotter CW laser can be interrogated gently over time by a cooler pulsed laser. The risk of thermal interference is also reduced, increasing the measurement accuracy of chemical signatures. Because Block's lasers are primarily used in spectroscopy, research, and biomedical analysis applications, pulsed beams are usually preferred by our customers.

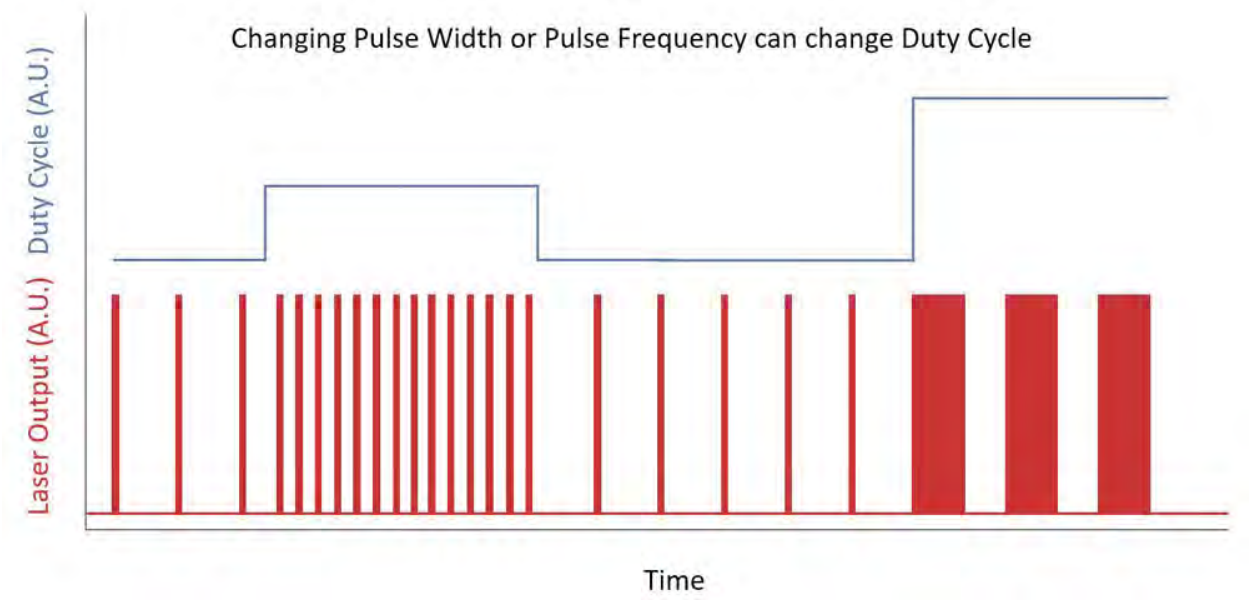
A Continuum

The choice between pulsed and continuous wave lasers isn't binary. Because pulse width and period can be programmed, it's possible to increase the number and width of laser pulses in time, effectively bringing a pulsed laser's duty cycle closer to CW.

We use the term "duty cycle" to describe the percent of time that the laser is emitting light while on. For a CW laser, the duty cycle is 100%. For a pulsed laser, the duty cycle might be tens or just a few percentage points, depending on how much optical power is required to analyze the sample while also considering heat dissipation requirements.

The duty cycle of Block's QCLs can be controlled through internal or external triggering, allowing for modification of pulses.

Some applications require greater light; others need less heat or thermal interference. The flexibility of pulses and duty cycles can help our laser customers find the ideal balance.



BostonElectronics

We are Infrared

- **IR Quantum Cascade Lasers (QCL)** - broad range of devices and packaging
- **QCL Extended Cavity Systems** - tunable
- **IR InAsSb detectors** - fast, high performance
- **IR thermopile detectors** - low price, high volume
- **IR imaging arrays** - low price, high volume
- **IRFPA HD cameras** - high performance
- **IR emitters** - CW and pulsed sources
- **IR LEDs** - wavelength specific sources

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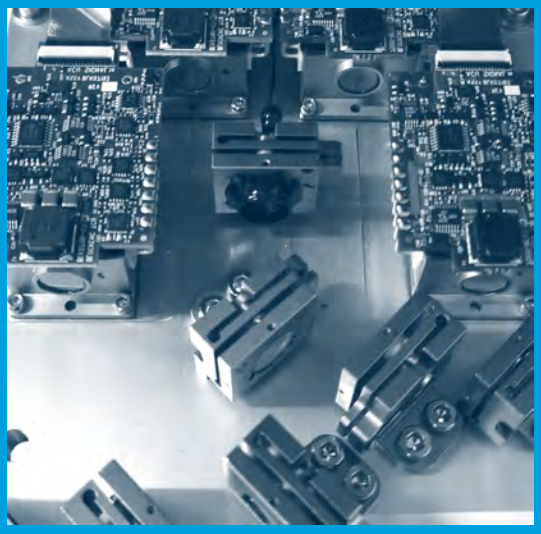

MILIPOL Paris Innovation Award

Photonics West Prism Award

Tibbetts Award: Small Business Innovation Research