HIGH Q LASER
THINK ULTRAFAST!™

*pico*EMERALD

Automated all-in-one ultrafast tunable light source

The light-source for CARS and coherent Raman microscopy

*pico*EMERALD	Specifications	
Tuning ranges	Signal	720 - 990 nm
	Idler	1150 - 2030 nm
Energy difference	$\Delta\nu$ Signal - Idler	1350 - 9000 cm^{-1}
	$\Delta\nu$ Signal - 1064 nm	700 - 4500 cm^{-1}
Output power	Signal (750 - 990 nm)	750 mW
	Idler (1150 - 1350 nm)	600 mW
	Pump (1064 nm)	750 mW
General specifications	Repetition rate	80 MHz
	Pulse length 1064 nm / OPO (typical)	7 ps / 5 - 6 ps
	Spectral bandwidth (Signal, typical)	0.3 - 0.4 nm
	Time bandwidth product (Signal, Idler, typical)	0.6
	Beam diameter / divergence	1.2 mm / 1 mrad
	M^2 (OPO Signal, Idler and 1064 nm)	< 1.2
	Ellipticity	< 10 %
	Pointing stability	< 100 µrad / 100 nm
	Noise	< 0.5 % RMS @ 300 Hz - 1 MHz
	Polarisation	100:1, horizontal
	Interface	USB / RS 232
	Dimensions	860 x 470 x 225 mm^3
AOM Option	Amplitude modulation of 1064 nm train up to 10 MHz for SRS or heterodyne CARS	

Key features	
Automated, remote-controlled and hands free	Selectable power level with active stabilisation
Two colour output (signal/pump or signal/idler)	Picosecond pulses for best resolution
Perfect pulse synchronization	Designed for CARS- and coherent Raman microscopy
Active spatial beam overlap stabilisation	Active temporal pulse overlap stabilisation

HIGH Q LASER INNOVATION GMBH · 6830 Rankweil, Austria · Phone: +43 (0)5522 82 646 · sales@highQlaser.at www.highQlaser.at
HIGH Q LASER (US) INC. · Watertown, MA 02472 USA · Phone: (617) 924 1441 · sales@highQ-us.com www.highQ-us.com

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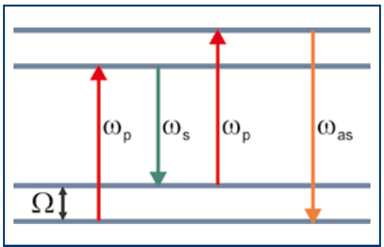
*pico*TRAIN™ **green** inside Picosecond oscillator

CARS image of individual Bacillus subtilis bacteria, measuring 1 micron by 5 microns in size.

Pof. Sunney Xie; Harvard University



CARS energy scheme

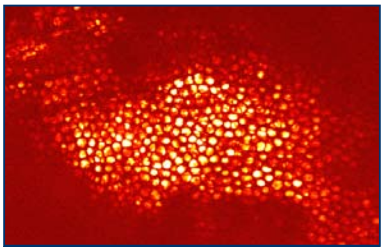


Image of subcutaneous fat in mouse ear skin. 20x, 2845 cm^{-1}. The image was taken about 110 µm deep in the tissue.

Pof. Sunney Xie; Harvard University

Application CARS microscopy

In CARS, a pump field at the frequency ω_p and a Stokes field at ω_s irradiates the sample and induce vibrations of molecules at the beat frequency $\omega_p - \omega_s$. The excitation of these vibrations is most effective if the difference frequency $\omega_p - \omega_s$ equals the characteristic Raman frequency Ω of the molecule. The anti-Stokes side band at the frequency $\omega_{as} = (\omega_p - \omega_s) + \omega_p$, the signal which is finally measured, is generated by a cubic nonlinear process ($\chi^{(3)}$ process). With the actively driven oscillations and the coherent signal generation it is possible to achieve much stronger signals with CARS as it is the case with conventional Raman scattering. The utilization of CARS for microscopic imaging is creating contrast without dyes and is yielding a strong spectrally blue shifted signal ω_{as}, which can be easily detected and discriminated from the excitation fluorescence background.

*pico***EMERALD** detailed information

The *pico***EMERALD** is especially designed for the needs in CARS and coherent Raman microscopy.
It comprises a high power (10W) picosecond oscillator, a frequency doubling to 532 nm and a synchronously pumped OPO in a single housing. The optical modules were optimized by finite element analyses and mechanical stability algorithms (misalignment stability optimization) to exhibit maximum passive stability. In addition an active cavity control is maximizing continuously the efficiency of the high power picosecond oscillator and the OPO.
The *pico***EMERALD** supplies three fully automated temporally and spatially overlapping ultrafast pulse trains:

- 1064 nm out of the laser oscillator,
- OPO Signal and
- OPO Idler.

Vibrational excitation modes have a typical bandwidth of ~10 cm^{-1} thus requiring ps excitation for best spectroscopic resolution. This system delivers 7 ps at 1064 and 5-6 ps from the OPO to match this requirement. Independent power adjustments of the 1064 nm beam and the OPO Signal and Idler, sensors for the spatial and temporal overlap and a high resolution spectrometer are included. 1064 nm pulses and OPO Idler pulses can be independently combined with the OPO Signal or blocked.

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