picoEmerald

Tunable | **Microscopy & Spectroscopy**
Two-Color |
ps Light Source |
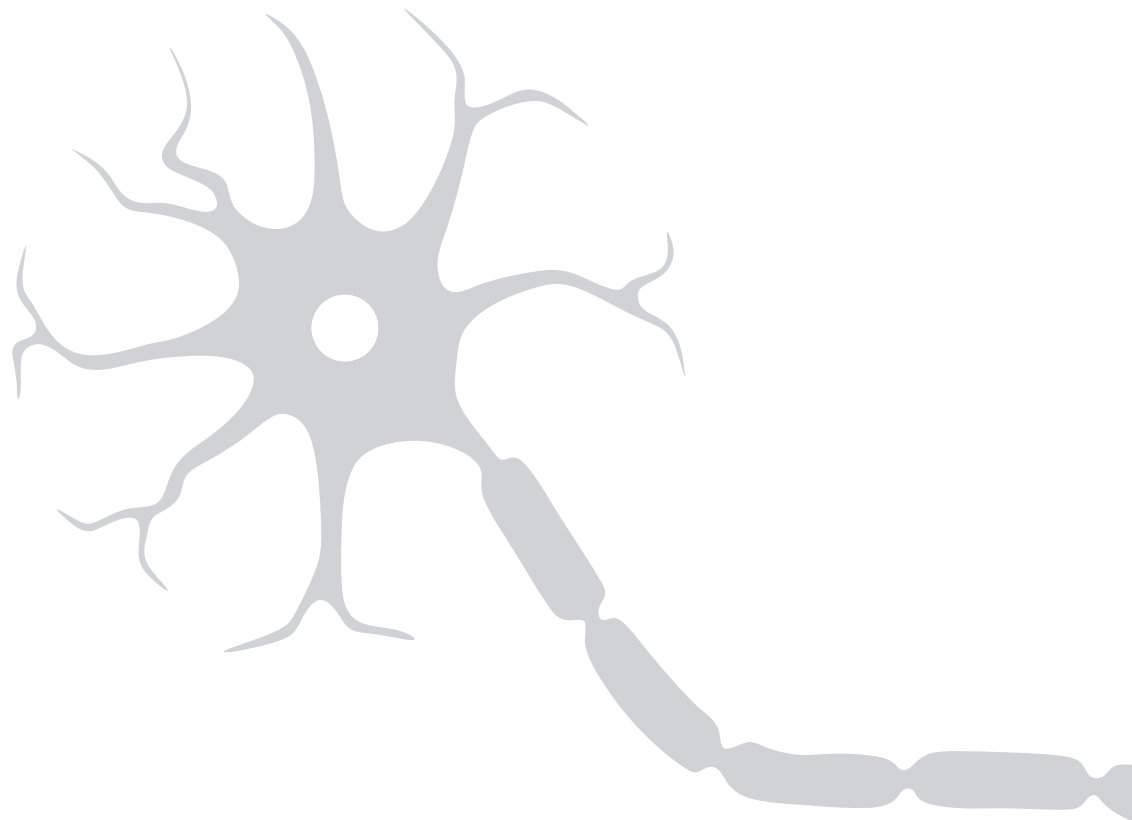
picoEmerald Two Colors in One Box

Microscopy and Spectroscopy with a Tunable Two-Color Source

- CARS and SRS microscopy have migrated from physics labs to life-science labs, so APE has responded with an easy-to-use and truly hands-off light source: picoEmerald.

- In a single-box, picoEmerald provides fully automated temporal- and spatial-overlapping ultra-short pulse trains: 1032 nm from the laser oscillator, plus the OPO Signal beam, and OPO Idler beam.

- Two-color turn-key system ideal for stimulated Raman microscopy up to video-rate speed
- Perfect temporal and spatial overlap of exit beams
- Tunable between 700 ... 1950 nm
- 400 ... 9000 cm^{-1} Energy difference
- 2 ps pulses with 10 cm^{-1} spectral width
- Completely automated and fully computer controlled
- Extremely low-noise compared to all-fiber laser systems
- Compatible with commercial microscopes and home-built setups
- Actively and passively stabilized, ideal for long time experiments

picoEmerald Applications

Application Examples

- Coherent Anti-Stokes Raman Spectroscopy (CARS)
- Stimulated Raman Spectroscopy (SRS)
- Second Harmonics Imaging (SHG)
- Pump-Probe Spectroscopy
- SRS Microscopy of Vibrational Probes
- Surface Enhanced Hyper Raman Spectroscopy (SEHRS)

Coherent Anti-Stokes Raman Spectroscopy (CARS)

- CARS microscopic imaging creates high imaging contrast without labeling. The technology involves two laser beams. CARS is sensitive to the vibrational modes of samples and visualizes the vibrational contrast of molecules. The samples, even living objects, remain almost unaffected.
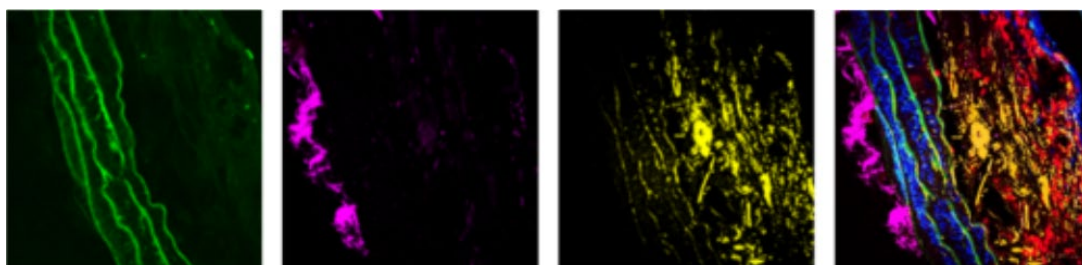

Image Courtesy: Sang-Won Lee & Joo Hyun Park.
Multimodal nonlinear microscopic images incl. TPEF, SHG, CARS and merged image.

Stimulated Raman Scattering Microscopy (SRS)

- SRS microscopy is facilitated via the picoEmerald system in combination with APE's inbuilt EOM (Electro-Optic Modulator). SRS microscopy provides almost background-free imaging contrast. It also allows simple spectroscopic identification of the samples' fingerprint region based on Raman spectra databases. Very short integration times allow imaging with video-rates.
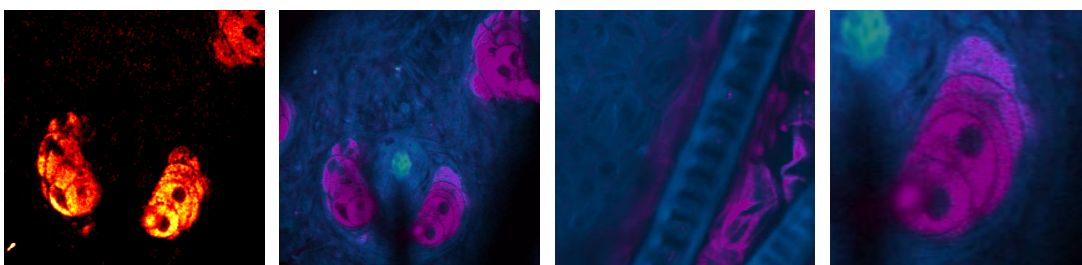

Image Courtesy: Wei Min and Lu Wei.
Live-cell bioorthogonal chemical imaging with Stimulated Raman Scattering Microscopy.

picoEmerald Turn-Key

Turning Complexity into a Turn-Key System

- The light source is the most crucial and complex component of a coherent Raman microscopy system. Proper setup and calibration are essential for accurate and reproducible imaging. picoEmerald is a turn-key system combining user-friendly automation features and the utility of open-architecture light sources in a single box.

- Excitation of coherent Raman microscopy requires two laser wavelengths, one of which must be tunable. The ❶1032 nm beam (2 ps Stokes beam) is generated at 80 MHz repetition rate. The pump beam is provided by the incorporated ❷OPO and is tunable from 700 to 990 nm and 1080 … 1950 nm. The spatial and temporal overlapping of the Stokes and pump beams are achieved via dichroic mirrors and a ❸delay stage inside the picoEmerald. The ❹sensors and the integrated beam management for the temporal and spatial overlap, and a ❺high resolution spectrometer secure the proper system calibration.
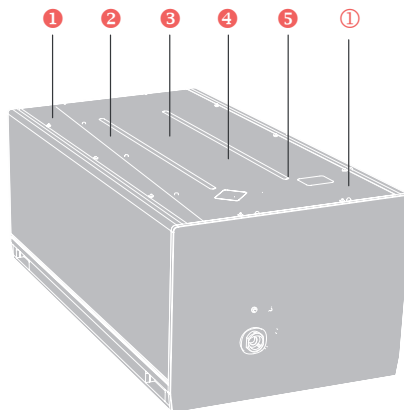
picoEmerald

Setup and Use with Microscopes

- By integrating CARS/SRS technology into Leica's confocal SP5/SP8 microscopy system, Leica Microsystems has tightly integrated the picoEmerald into their LAS AF system software. Similary tight software integration is also available with Thorlabs' multi-photon microscopes.

- Software integration into other third-party microscopes or home-built setups is also supported. Ethernet TCP/IP and serial RS232 interfaces are available with picoEmerald for this purpose.

- APE's user-friendly automation combined with a graphical user interface (GUI) also makes it convenient when using picoEmerald and microscope as independent instruments, without the need for software integration.

Compatibility (Examples)

- Leica SP-Series
- Olympus FV-Series
- Nikon Ti-U Platform
- Thorlabs Multiphoton
- Zeiss LSM-Series
- Horiba
- Home-built setups

picoEmerald is compatible with nearly all popular confocal microscope systems. The current publication list names at least those configurations mentioned above.

Additional Features

- Automated optical delay management to compensation for microscope dispersion
- Wavelength scan / sweep function for fast spectra acquisition
- Independent power control for 1032 nm beam and Signal beam
- Remote-service via LAN interface
- ☐ Optional: Wavelength extension from 210 nm - 10 µm
  (Realized by SHG, THG, FHG, or DFG; e.g. APE's HarmoniXX)

picoEmerald Specifications

Main Parameters

|	
Type of Source	Automated picosecond (narrow-band) tunable light source
Wavelength 1 1032 nm Beam	1032 ± 1.5 nm
Wavelength 2 OPO Signal	700 … 990 nm
Wavelength 3 OPO Idler	1080 … 1950 nm
Power 1 1032 nm Beam	> 700 mW (customized versions on request)
Power 2 OPO Signal	> 700 mW at 800 nm
Power 3 OPO Idler	> 400 mW at 1250 nm
Δν OPO Signal - OPO Idler	800 … 9000 cm^{-1}
Δν OPO Signal - Fundamental	400 … 4500 cm^{-1}
Pulse Width	2 ps (others on request)
Repetition Rate	80 MHz
Spectral Bandwidth Signal, 1032 nm beam	10 cm^{-1}

Beam

Beam Diagnostics	Integrated for Signal Wavelength, Power, Bandwidth, Beam position, Temporal overlap
Pointing Stability	< 100 µrad per 100 nm
M^2	< 1.2 (OPO Signal), typ. 1.2 (1032 nm beam)
Ellipticity	< 10 %
Polarization	Linear; Horizontal > 100:1
Beam Divergence	1.0 (± 0.2) mrad (at 800 nm and 1032 nm)
Beam Waist Diameter	1.2 (± 0.2) mm at 800 nm; 1.7 (± 0.2) mm at 1032 nm

Diagrams
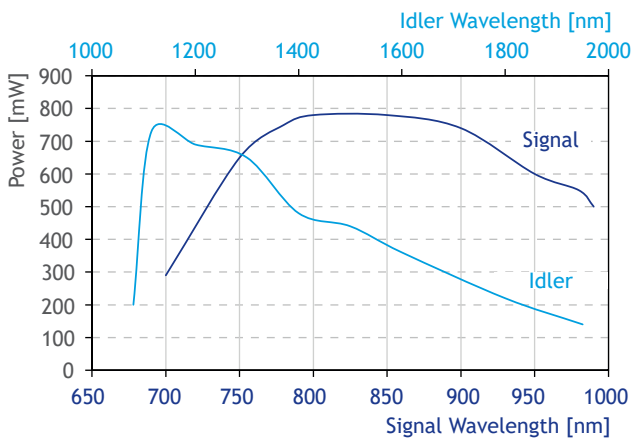
Typical Signal and Idler power vs. wavelength
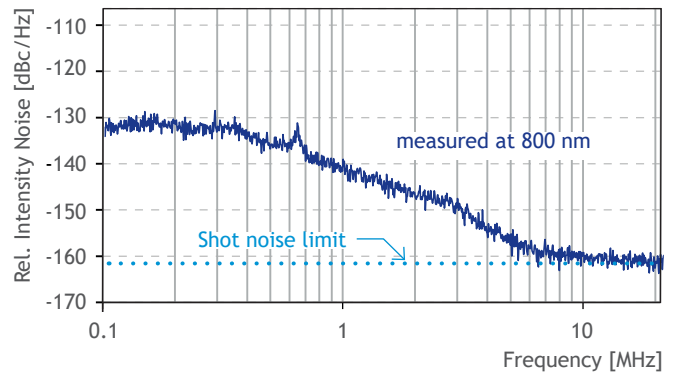
Relative intensity noise (RIN): Shot noise limited
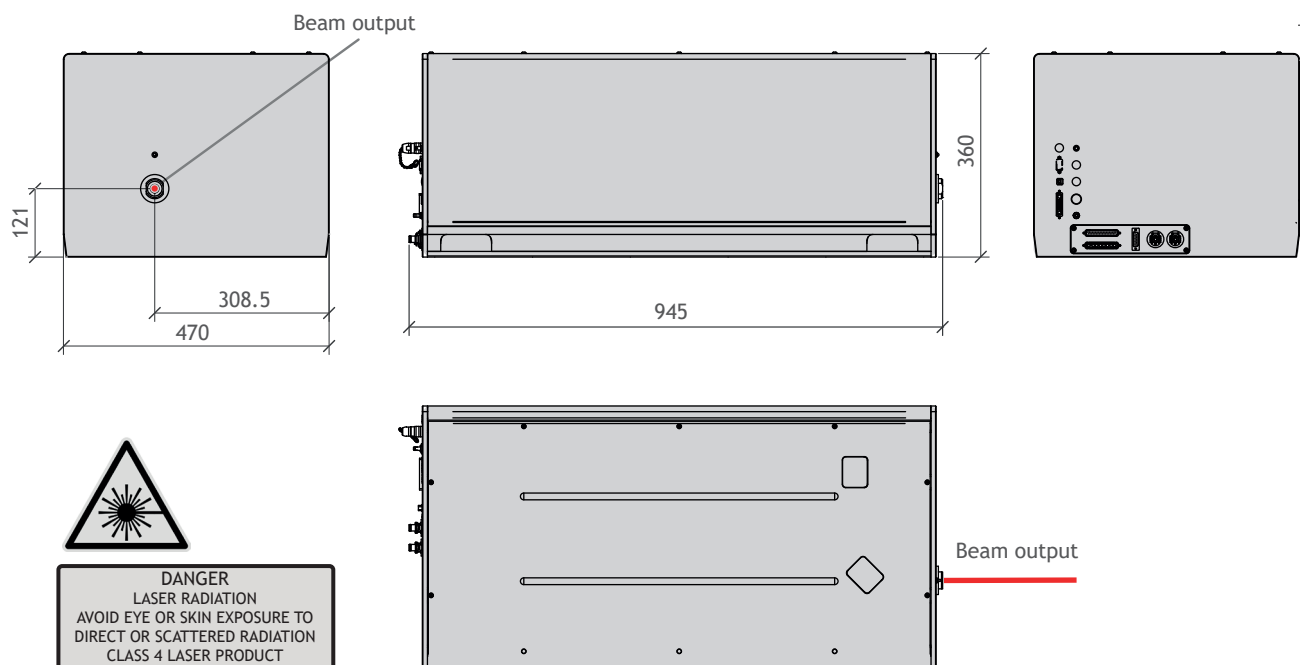OPO Signal output for frequencies > 10 MHz

... Specifications

Software

Software and Automation	Included
Wavelength Sweep Function	Start/End Function, User-defined Holding Time, Trigger Function, max. 2 nm step size, approx. 5 s per wavelength step
Remote Control	Possible via USB / Ethernet TCP/IP / Serial RS232

EOM Modulator (Optional)

Inbuild Modulator EOM	EOM with a resonant fixed frequency of 10 MHz (or 20 MHz) modulation frequency; Built into picoEmerald

Dimensions and Power

Dimensions	picoEmerald: 945 mm x 360 mm x 470 mm, 98 kg (see drawing for details) Panel PC: 234 mm x 41 mm x 128 mm, 2 kg Laser Control Unit: 19 inch (4 U), 11 kg Chiller: 197 mm x 330 mm x 279 mm, 10 kg
Power	100 ... 240 V, 50 ... 60 Hz, max. 600 W (Setup incl. PC) 100 ... 240 V, 50 ... 60 Hz, max. 600 W (Chiller)

Beam output

121
308.5
470
360
945

DANGER
LASER RADIATION
AVOID EYE OR SKIN EXPOSURE TO
DIRECT OR SCATTERED RADIATION
CLASS 4 LASER PRODUCT

Beam output

Contact

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Therefore, specifications are subject to change without notice.

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