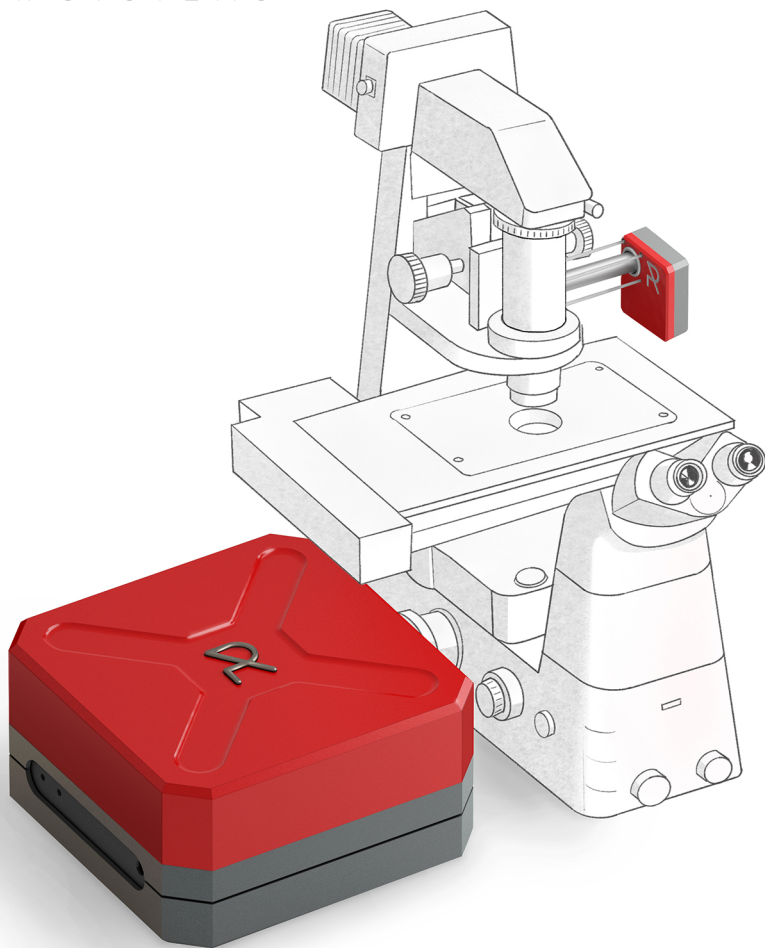


REFINED
LASER SYSTEMS

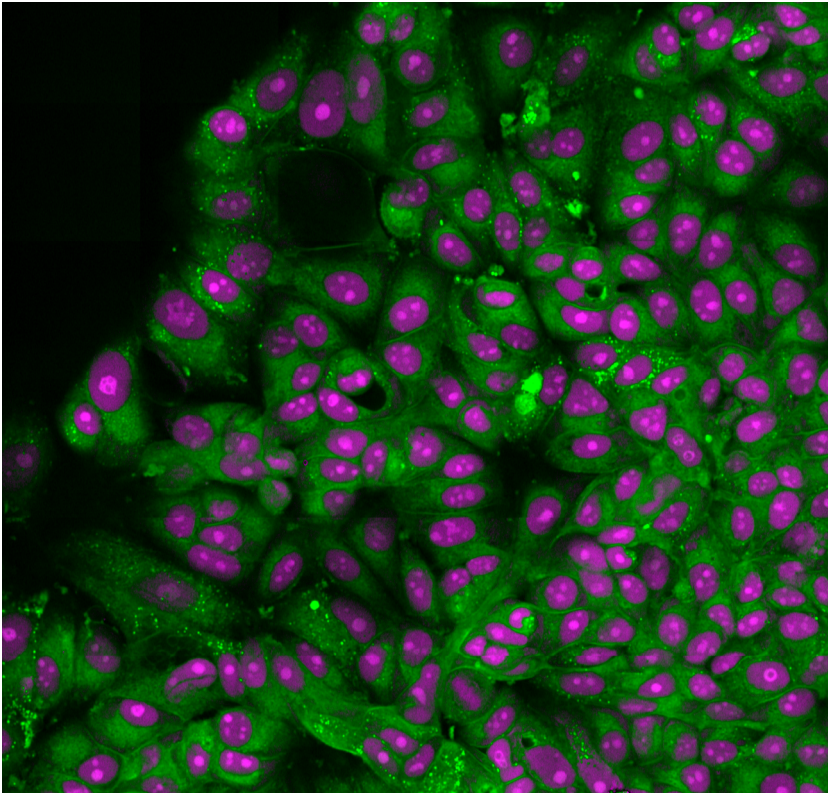


SEE BEYOND LIMITS

Discover label-free imaging
with highest contrast

LABEL-FREE IMAGING WITH HIGHEST CONTRAST

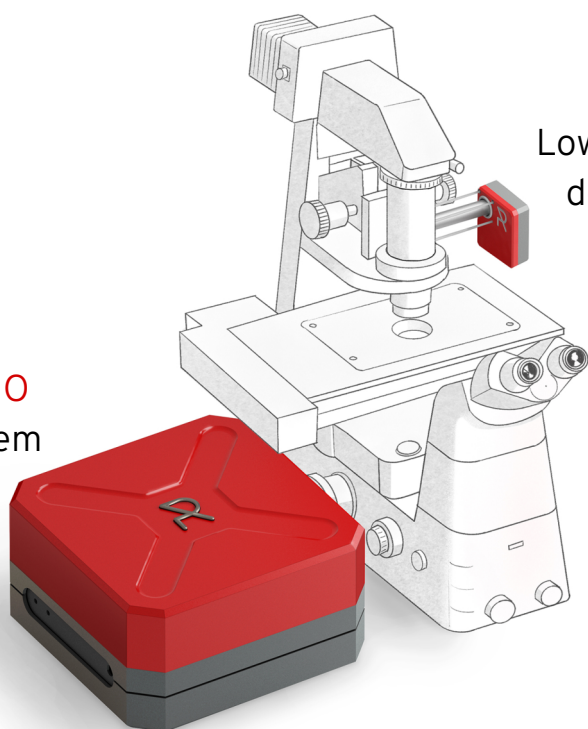
Our **NOCTUA stimulated Raman system** offers highly specific imaging of living cells without fluorescent labels. Image contrast is generated by exciting intrinsic molecular bonds in the specimen, opening new windows into cellular processes such as lipid metabolism or pharmacokinetics. Observe cellular dynamics in real-time or long-term without perturbations of photobleaching or labeling.



CONNECTS TO VARIOUS MICROSCOPES

- Intrinsically confocal for imaging 3D specimens
- Fully-computer controlled & adjustment-free
- Plug & play installation

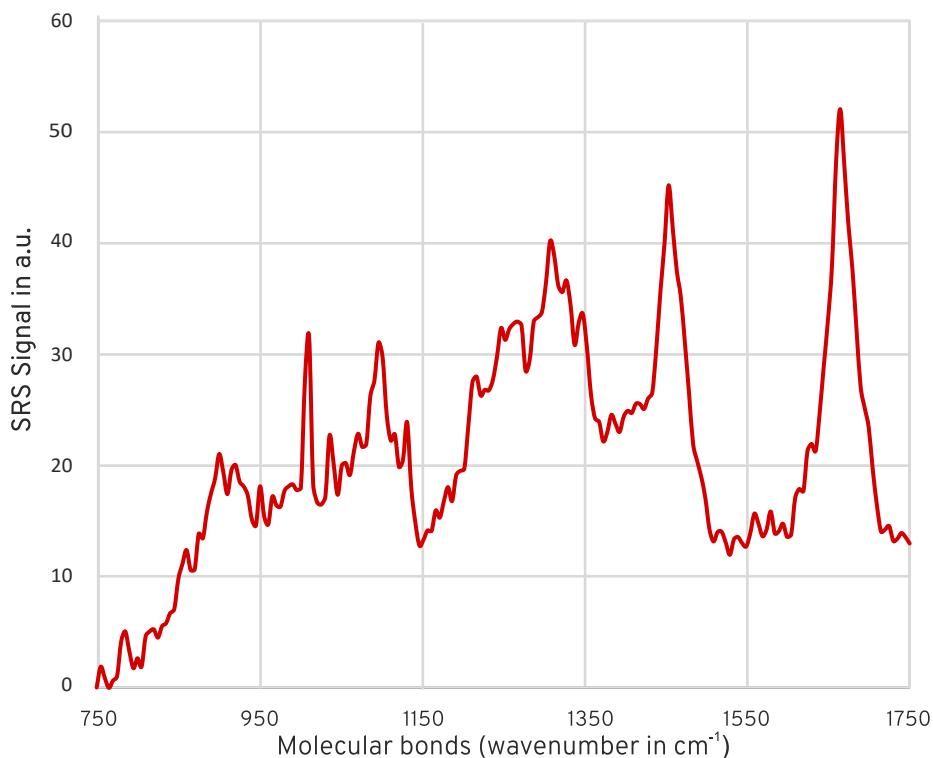
PICUS DUO
laser system



Low-noise
detector

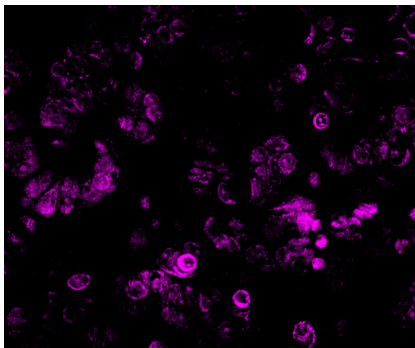
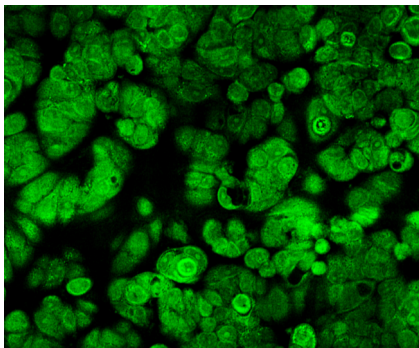
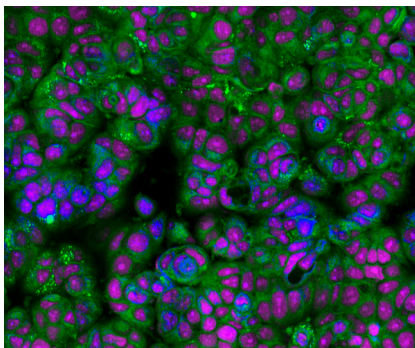
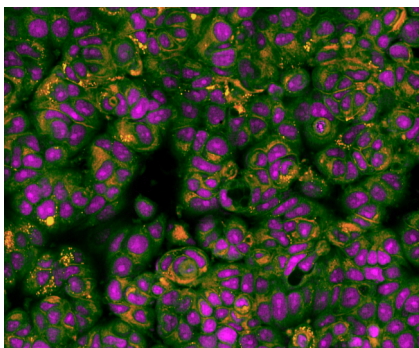
REVEAL NEW DIMENSIONS WITHOUT FLUORESCENT DYES

Below you can see a SRS spectrum of MCF7 cells acquired with the **NOCTUA stimulated Raman microscopy system**. This so called spectral fingerprint region contains a wealth of chemical information. Each peak represents a molecular bond, that can be imaged and probed as a biomarker. As an example the right side shows the distribution of triacylglycerols (yellow, imaged at 3015 cm^{-1}), Phenylalanine (blue, 1030 cm^{-1}), the Amide-I peak at 1660 cm^{-1} (green) and the level of lipid unsaturation (magenta, ratio of 1660 cm^{-1} and 1440 cm^{-1}) in MCF7 cells.



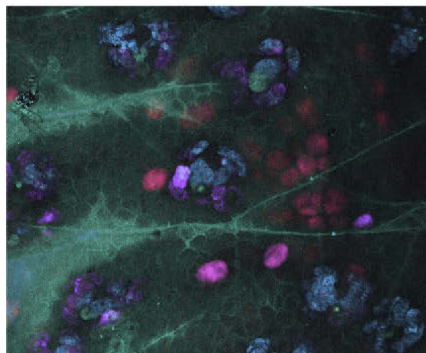
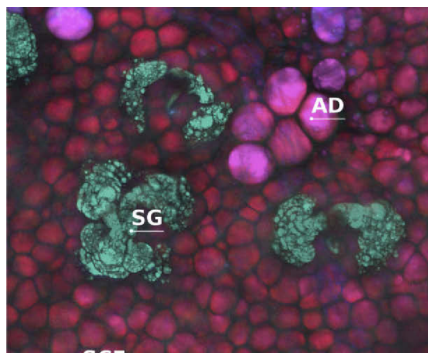
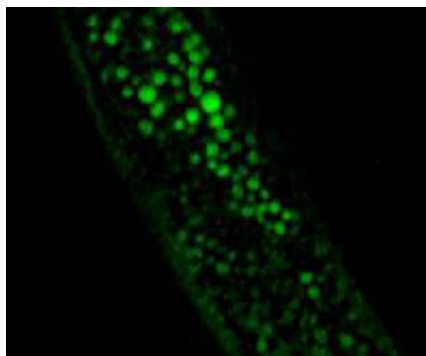
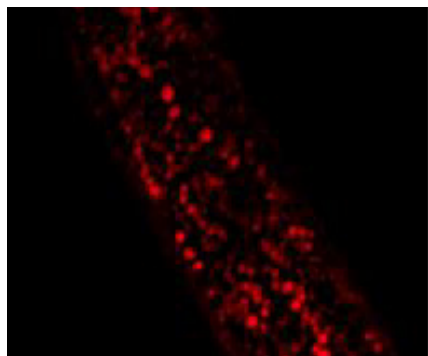
SRS IMAGING

- Rich chemical contrast
- No staining required
- Up to 300 color channels per image



REVEAL & EXPLORE THE HIDDEN STRUCTURES

Our **NOCTUA microscopy system** allows imaging structures and events in physiological relevant conditions, that are inaccessible with fluorescent labels. The SRS images below show unsaturated fatty acids and cholesterol in *C.elegans* (upper panel). The lower panel shows dermal structures, formed by lipids, in the skin of a mouse ear (left) and a topically applied, unlabeled drug penetrating through the skin (right).

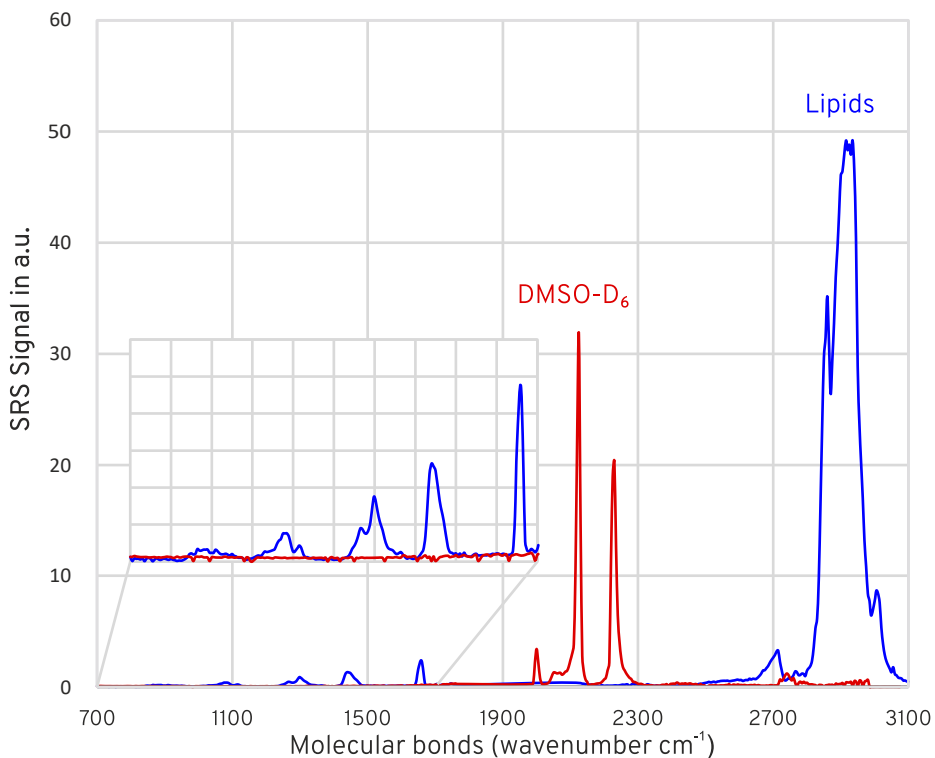


Upper panel: Courtesy of Prof. Cheng, Uni Boston; DOI: [10.1021/ACS.ANALCHEM.1C03604](https://doi.org/10.1021/ACS.ANALCHEM.1C03604)

Lower panel: Courtesy of Prof. Evans, MGH Boston; DOI: [10.1364/BOE.432177](https://doi.org/10.1364/BOE.432177)

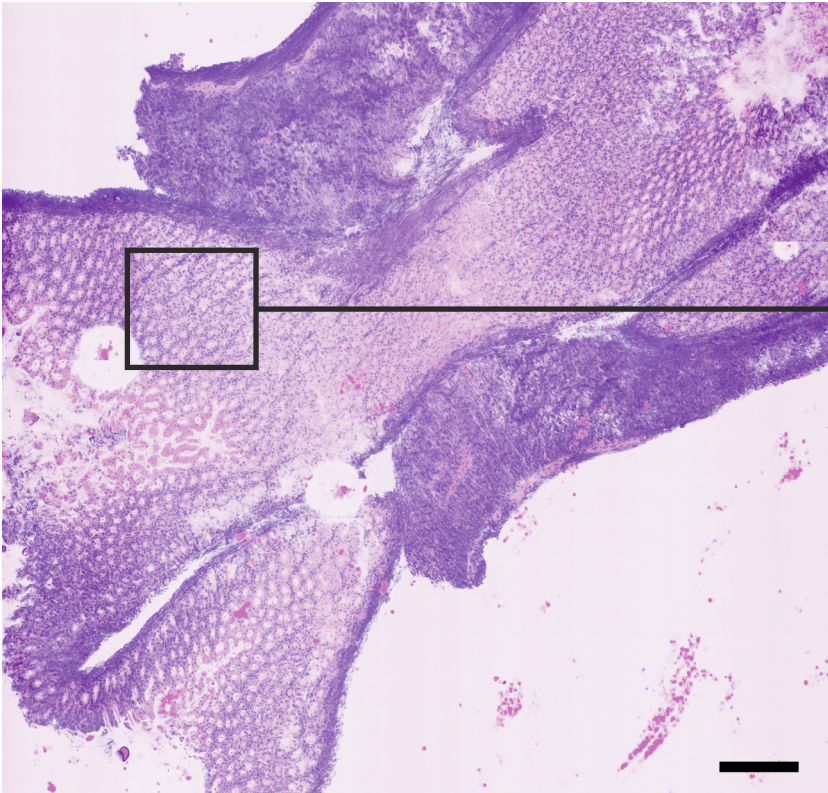
OPTIMIZED FOR HYPERSENSPECTRAL SRS

- Image molecular bonds across complete Raman spectrum from 700 - 3100 cm^{-1}
- Switch from fingerprint to C-H region in millisecc.



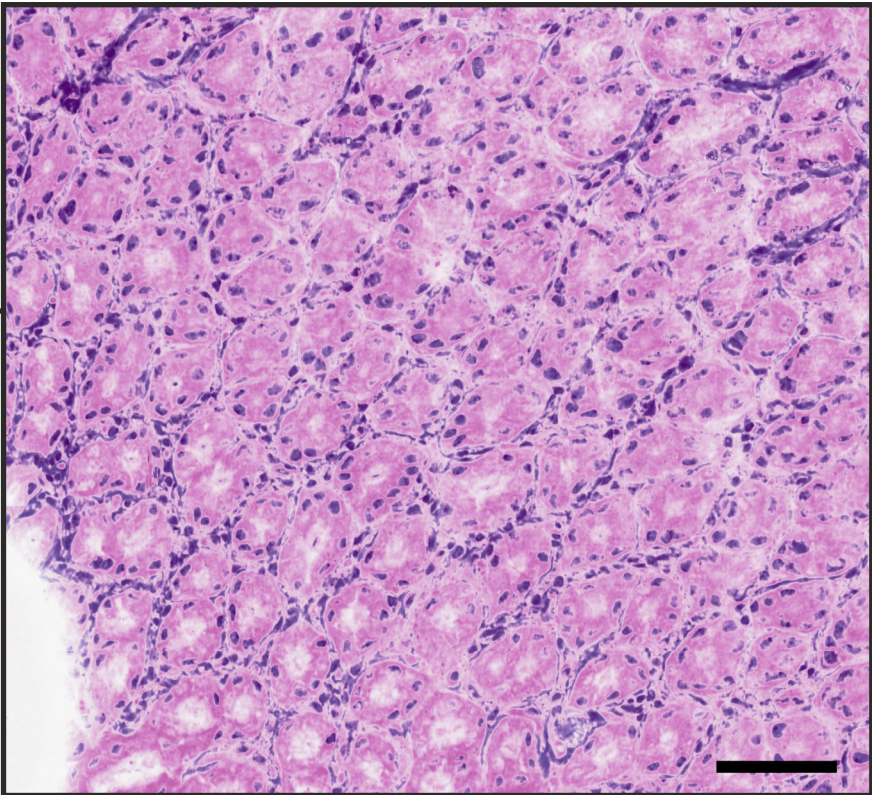
TISSUE DIAGNOSIS WITHIN MINUTES

Our **NOCTUA stimulated Raman microscopy system** allows pathological assessment of fresh, unprocessed tissue. Below you can see a label-free image of a mouse stomach section (scale bar = 200 μm). Molecular bonds were imaged within minutes to recreate a virtual H&E contrast, allowing for the identification of cell bodies and cell nuclei in the tissue. Conventional pathologic staining to create such contrast takes up to 10 hours.



VIRTUAL H&E CONTRAST

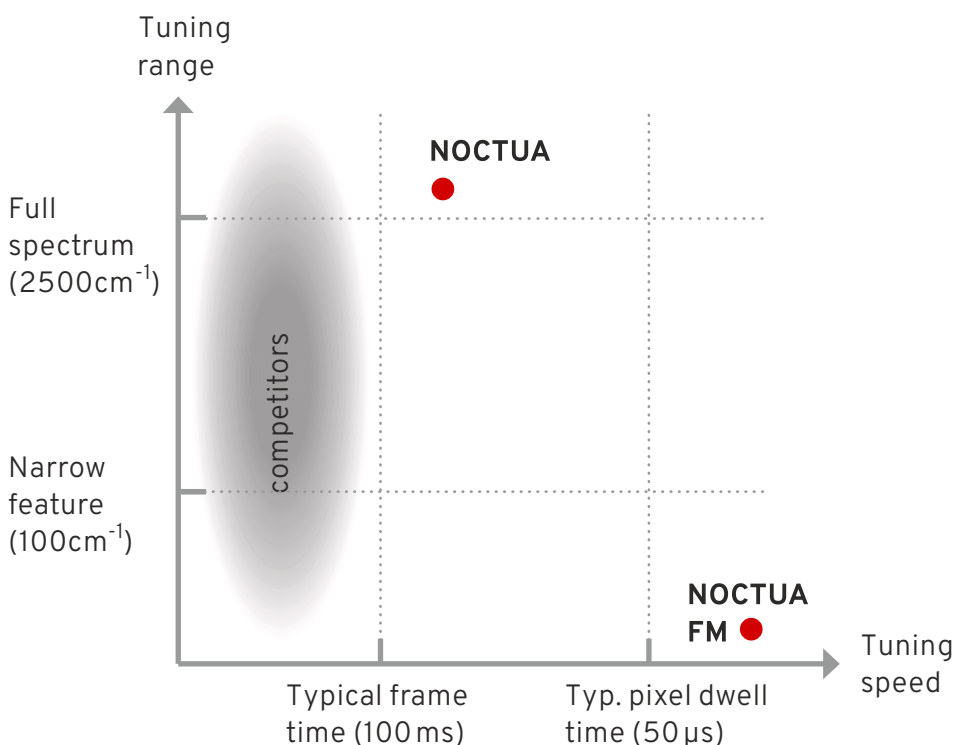
- Excellent agreement with conventional staining
- No sectioning or preprocessing required
- Seamless zoom down to 700 nm



HIGHEST AVAILABLE TUNING SPEED

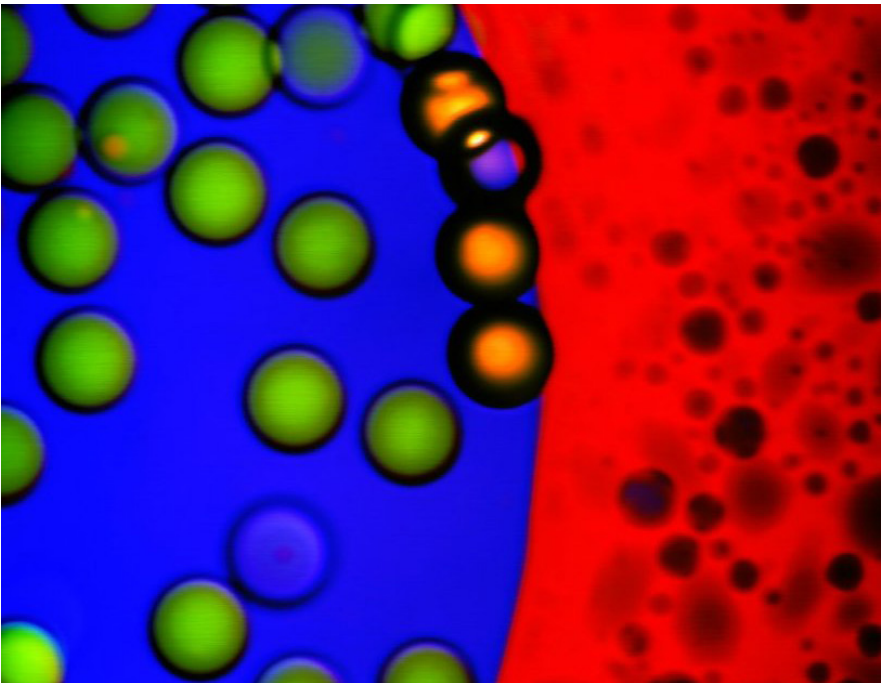
Our **NOCTUA** system offers a tuning speed of only milliseconds between 700 and 3100 cm^{-1} . The tuning mechanism allows sweeping and switching operation and requires no external delay.

The combination of wide tunability across the full Raman spectrum and fast tunability is unmatched by any conventional system. This makes our system the predestined solution for video-rate CARS and SRS imaging at multiple wavenumbers or the rapid acquisition of hyperspectral datasets. For live multicolor videos see www.refined-lasers.com or contact us.



HYPERSPECTRAL IMAGING 10 x FASTER

- Tuning between 700 and 3100 cm^{-1} in ms
- No external delay or modulator required
- [100 spectral points, 256*256 pixels, 10 μs dwell time] in just 1 minute



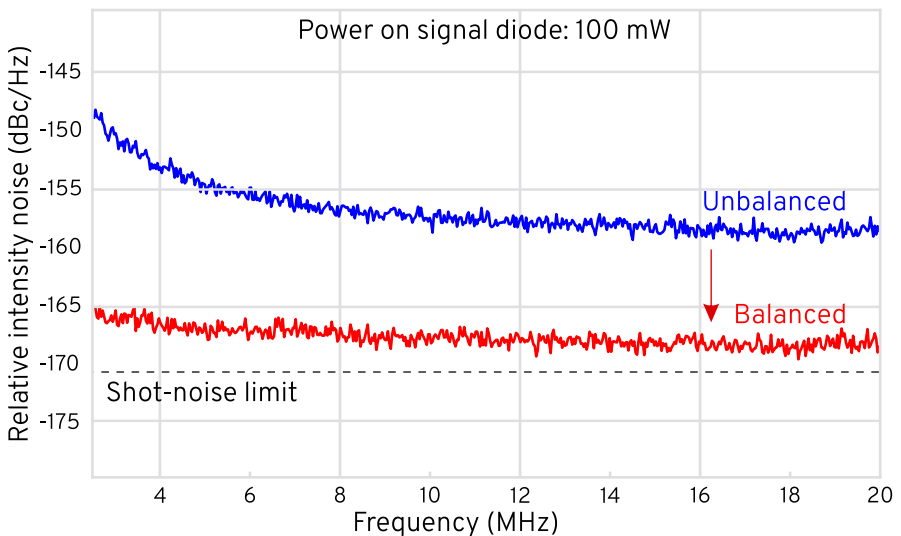
Courtesy of Prof. Fallnich, WWU Münster

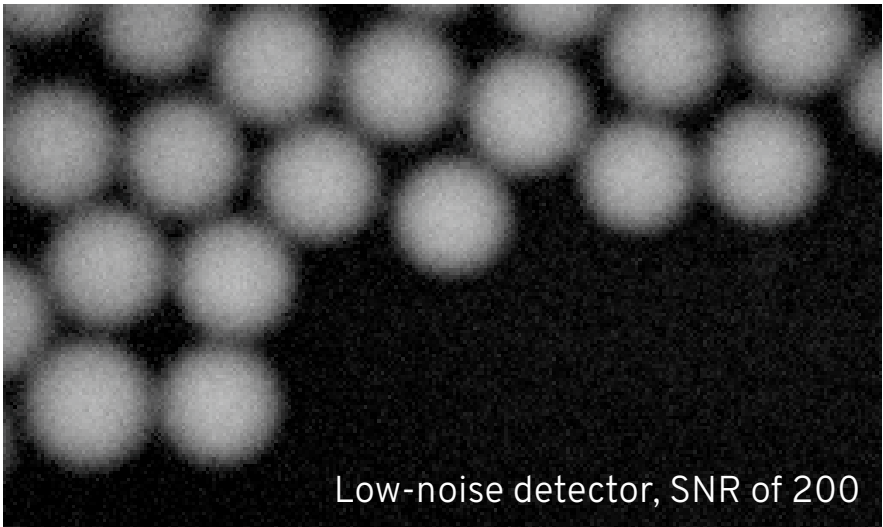
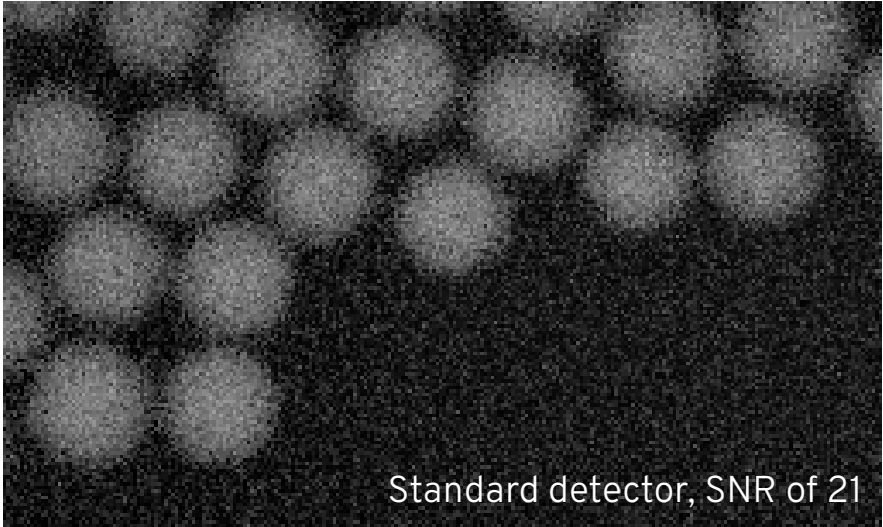
BALANCED DETECTOR

LOW-NOISE IMAGING

To overcome laser noise, which typically prevents imaging systems from reaching the theoretical shot-noise limit, we utilize a balanced detector. By measuring laser noise in a reference beam and subtracting it from the SRS signal after the sample, noise is canceled out, leading to an improved signal-to-noise ratio and increased imaging speed.

As shown below, we have achieved a noise suppression by 10 dBc with our fiber-coupled balanced detector. For illustration, the upper right-hand side shows an SRS image of plastic beads with a signal-to-noise ratio of 21 obtained with a standard detector. In contrast, the lower right-hand side shows the same image obtained with our low-noise detector with an improved SNR of 200.

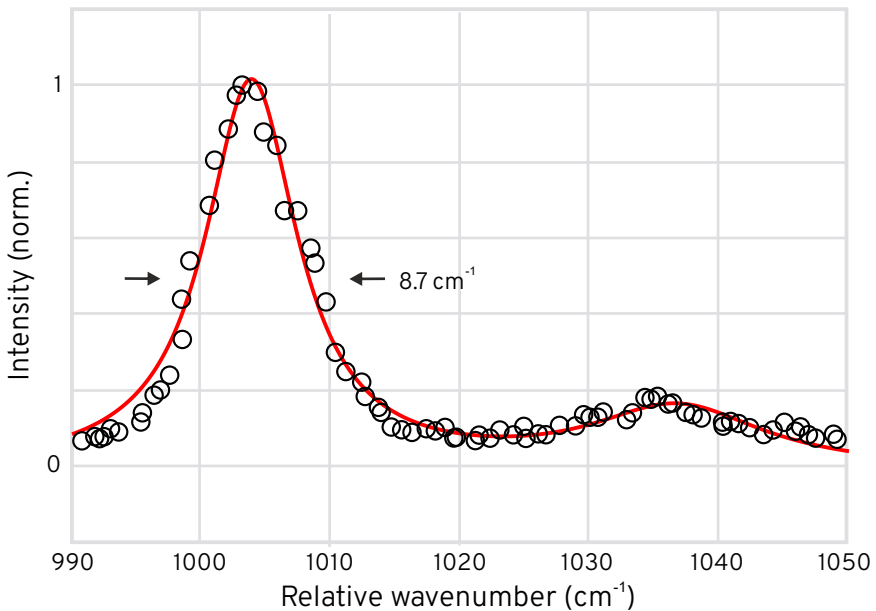




OBSERVE FINE DETAILS

HIGH-RESOLUTION SRS

Our **NOCTUA** **stimulated Raman microscopy system** features a low-noise spectral tuning mode to resolve sharp spectral resonances. This feature is especially helpful in the fingerprint spectral region. As an example, below you can see the well resolved polystyrene resonance at around 1000 wavenumbers with a width of about 9 wavenumbers.



Courtesy of Prof. Fallnich, WWU Münster

Reference list

- Ni H, Cheng J, et al., *High-content stimulated Raman histology of human breast cancer*, arXiv:2309.11642 (2023).
- Pence I, Kuzma B, Brinkmann M, Hellwig T, and Evans C, *Multi-window sparse spectral sampling stimulated Raman scattering microscopy*, Biomed. Opt. Express 12, 6095 (2021).
- Ni H, Lin P, Zhu Y, Zhang M, Tan Y, Zhan Y, Wang Z, and Cheng J, *Multiwindow SRS Imaging Using a Rapid Widely Tunable Fiber Laser*, Anal. Chem. 93, 15703 (2021).
- Würthwein T, Wallmeier K, Brinkmann M, Hellwig T, Lüpken NM, Lemberger NS, and Fallnich C, *Multi-color stimulated Raman scattering with a frame-to-frame wavelength-tunable fiber-based light source*, Biomedical Optics Express 12, 5939 (2021).
- Würthwein T, Brinkmann M, Hellwig T, Wallmeier K, and Fallnich C, *High-sensitivity frequency modulation CARS with a compact and fast tunable fiber-based light source*, Opt. Lett. 46, 3544 (2021).
- Brinkmann M, Fast A, Hellwig T, Pence I, Conor E, and Fallnich C, *Portable all-fiber dual-output widely tunable light source for coherent Raman imaging*, Biomedical Optics Express 10, 4437 (2019).

Laser specifications	Output A	Output B
Tuning range	780 – 980 nm	1025 – 1055 nm
Tuning speed	< 100 ms	
Average power	100 – 250 mW	> 300 mW
Covered wavenumbers	700 – 3100 cm ⁻¹	
Pulse duration	7 - 10 ps	2 - 3 ps
Spectral bandwidth	< 12 cm ⁻¹	
Repetition rate	40 MHz	

Microscope specifications

The available configuration depends on the region-specific IP regulations. The Noctua Imaging System is not available in the USA.

Mechanical dimensions (excluding microscope)

Table top laser	42 x 45 x 25 cm ³
Supply unit (off table)	43 x 45 x 26 cm ³

CONTACT

Refined Laser Systems GmbH
Dr. Max Brinkmann
Mendelstrasse 11
48149 Münster | Germany

brinkmann@refined-lasers.com
info@refined-lasers.com
www.refined-lasers.com