

SPECTRUM

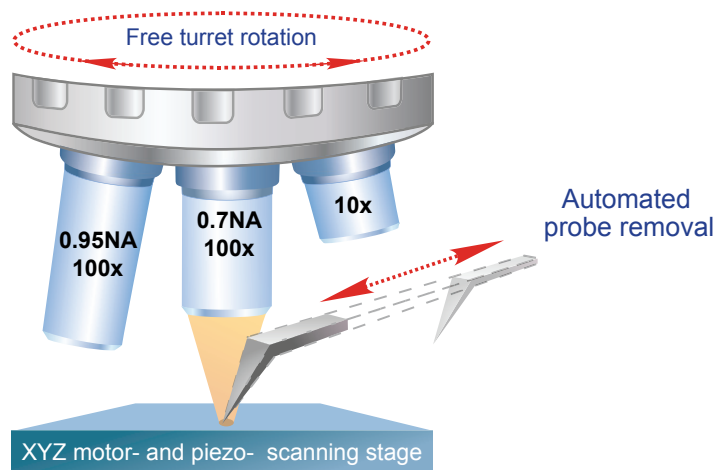
AFM ♦ Confocal Raman ♦ SNOM ♦ TERS
The World's first fully automated Raman AFM



The first fully integrated & automated AFM – Raman – SNOM – TERS system

- Simultaneous AFM and confocal Raman imaging using different objectives (up to 100x).
- Free rotation of microscope turret (up to 4 objectives) with AFM probe on the sample.
- Automated removal of AFM probe (for low working distance objectives or when AFM probe is not required).
- HotSpot – Automatic location of active TERS* region on the probe.
- Fully automated and easy to use operation.

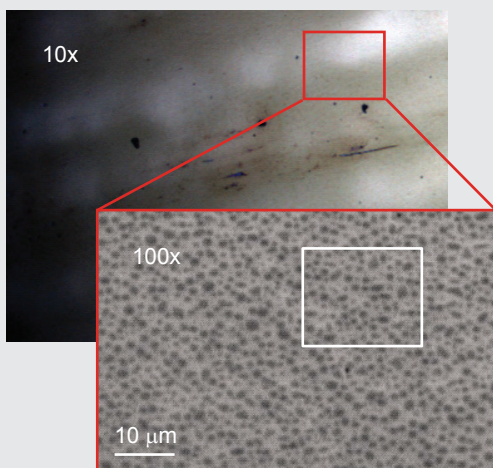
* Tip Enhanced Raman Scattering.



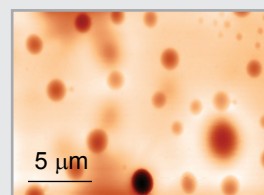
TWO SIMPLE STEPS IN AFM & RAMAN/FLUORESCENCE IMAGING

Step 1 Sample survey (with cantilever removed).
High resolution and wide field of view.

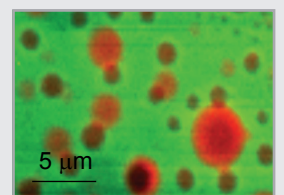
Step 2 Simultaneous AFM and confocal
Raman/Fluorescence imaging of selected area.



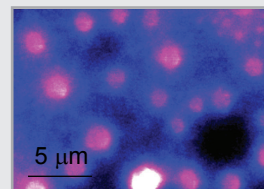
Cantilever automatically
moves to the working
position and lands



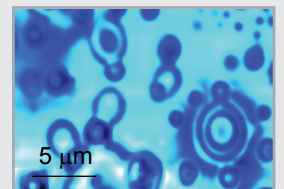
Topography



Overlap of Raman maps,
PS and PVAC bands



Surface potential



Rayleigh scattering

Up to 4 objectives can be installed into the turret
of the commercial optical microscope.
All standard imaging modes are supported.

Some AFM modes may require different cantilevers.
Easy probe exchange and automated approach allows
any advanced AFM mode (>30 modes) to be readily
used together with Raman.

Features

Automation

- Sample movement.
- Laser/Photodiode system alignment.
- Automatic probe holders removal (for low working distance objective).
- Probe approach & retraction.
- Fully motorized tip approach.
- Scanning parameters adjustment.

Unique SPM capabilities

- Low noise . Sample scanning with resolution down to atomic.
- Large sample size (up to 50mm*50mm). Special sample holder for slides (75mm*25mm).
- AFM, STM, Liquid and Tuning fork tip holders.



Tuning fork tip holder



AFM tip holder



STM tip holder



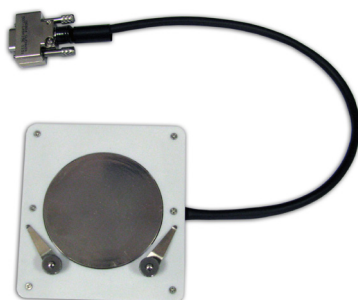
Holder for work in liquid

Unique integration of SPM with optics for AFM - Raman - SNOM - TERS

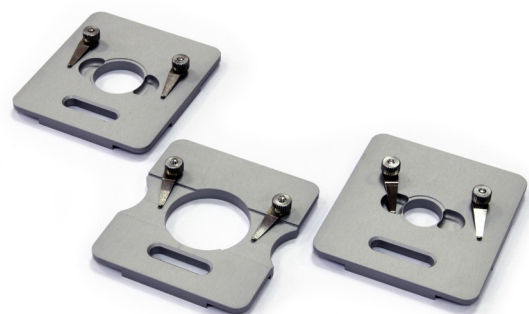
- Upright or Full Transmission configuration.
- Upright microscope with 4 position revolving turret. Possibility to install up to 4 different objectives starting from the lenses for large area visualization to high numerical aperture objectives for high optical resolution,
- Scanning by laser spot. This option is provided by very stable scanner-mirror with closed loop capacitance sensors. Latter allows to position the laser spot with a high precision on the tip apex.
- Fiber or direct input/output of the excitation laser/registered signal. Specially designed optical mechanical unit allows to input the incident laser by using high transmission optical fiber and output the collected signal through the fiber directly to the monochromator. Otherwise it is possible to couple directly Spectrum system with commercially available spectrometers (Solar, Renishaw).
- SNOM. Due to Full Transmission configuration it is possible to perform aperture and apertureless SNOM using cantilever or fiber probes.

Accessories

- Temperature control. Heating up to 150 degrees.
- Different, easy exchangeable sample holders.
- Probe exchange accessory.



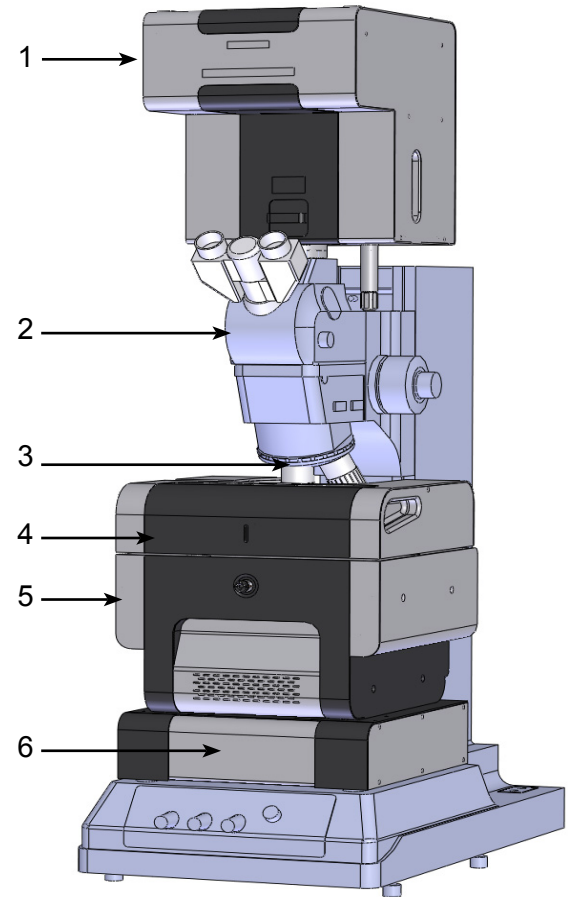
Heating stage



Different sample holders

System design

1. Specialty designed confocal unit equipped with scanning mirror viewing system and scanner-mirror
2. Mitutoyo Upright microscope
3. 4 position turret with different objectives
4. SPM head with different tip holders (cantilever AFM, STM, tuning fork, liquid). OBD system (for cantilever AFM)
5. SPM base with includes:
 - Piezo Scan Stage ($100 \times 100 \times 10 \mu\text{m}$)
 - Motorized Stage ($35 \times 35 \text{ mm}$)
 - Manual positioner of SPM head ($3 \times 3 \text{ mm}$)
 - Motorized and Piezo drives for objective focusing (optional)
 - Heating stage (optional)
6. SNOM unit (optional)

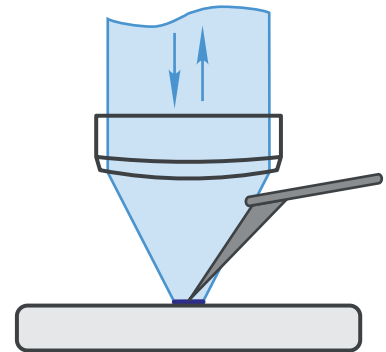


Different optical configurations

Upright, with scanning mirror (Standart configuration)

Dual Scanning system (3 independent closed-loop scanning axes by sample + 2 by laser spot)

- Designed for nontransparent samples
- Optical resolution down to 400 nm simultaneously with AFM
- Signal collection is performed by high numerical aperture objective simultaneously with AFM
- Laser scanning for automatic location of active TERS region on the probe
- Equipped with heating stage

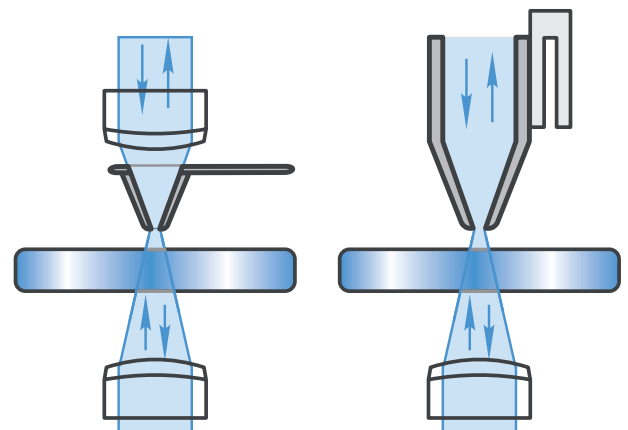


Configuration SNOM unit (Optional)

Special unit for fiber input/output, and motorized Z-drive for bottom objective. Precise focusing by CL Z-piezo. Objectives with different magnifications can be used

2 modes:

Transmission mode - detection with PMT of the signal collected by the bottom objective,
Collection mode - Excitation with laser from the bottom, collection of the signal with cantilever aperture and registration with the spectrometer detectors.



Cantilever based SNOM

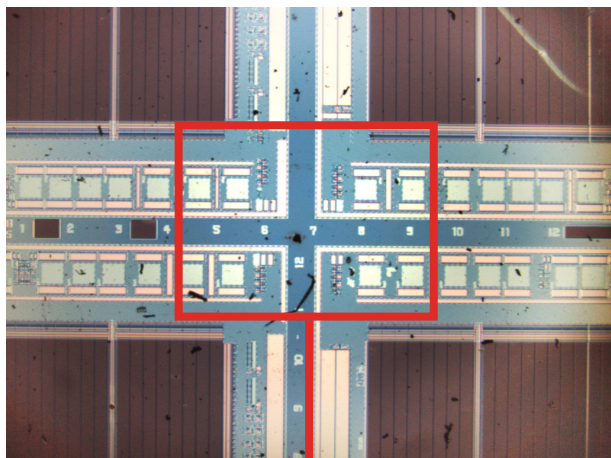
Fiber based SNOM

Multi Scan

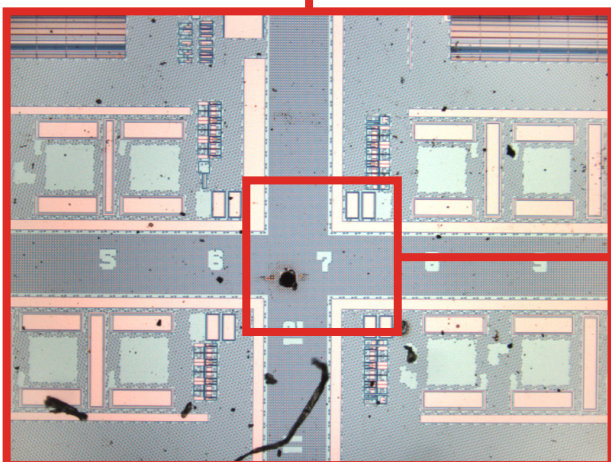
Sample overview with high resolution.

Automated high resolution AFM - Raman imaging without limitations of the piezo-scanner range.

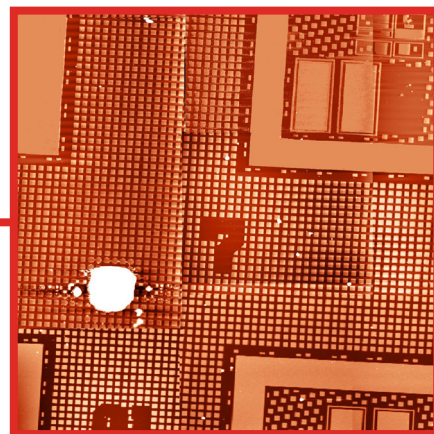
1. Choosing area on the sample (any size, no limitations of the scanner).
2. Automated AFM probe approach.
3. Simultaneous measurement of AFM and confocal Raman/fluorescence maps from multiple areas (automated).
4. Image stitching (automated).



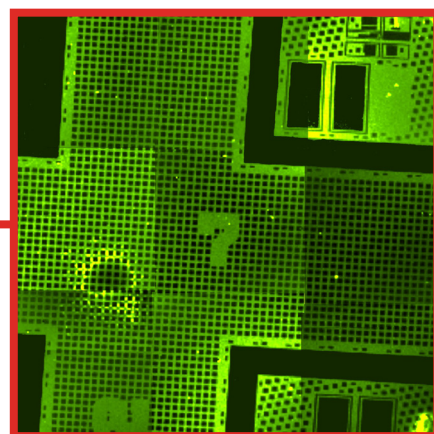
4x



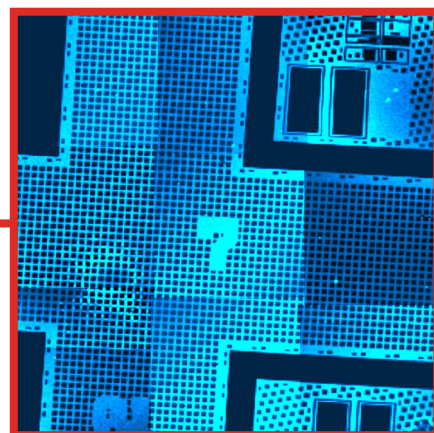
10x



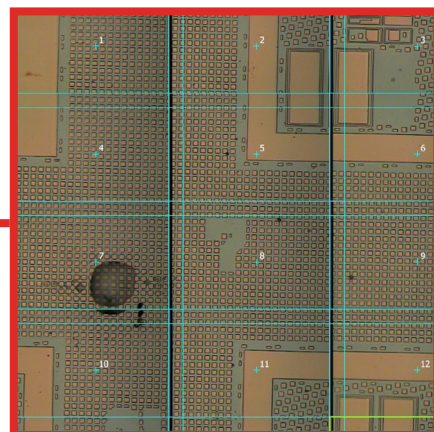
Multiscan
AFM topography



Multiscan
Raman map, Si peak intensity



Multiscan
Raman map, Si peak mass center



Multiscan
High resolution bright field image

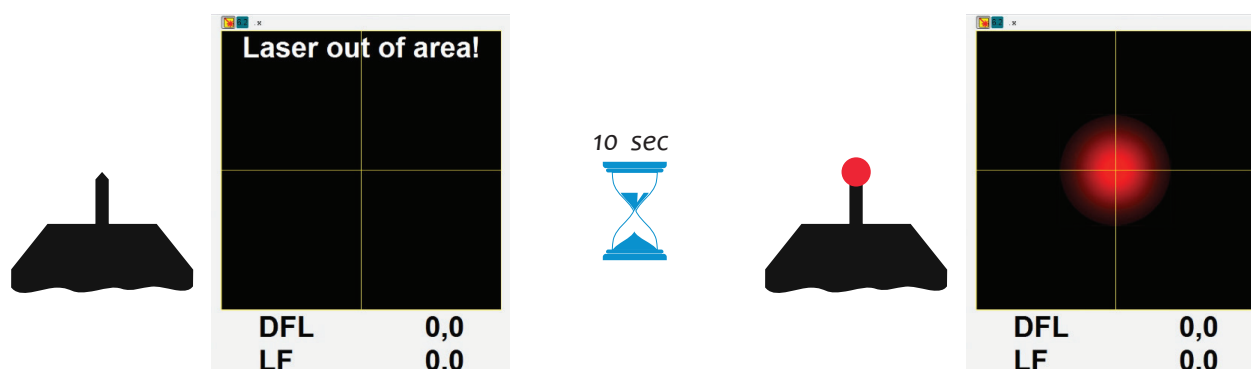
Automation

Automated sample positioning (35mm×35mm)*

High precision positioning motors equipped with optical sensors allow automated AFM-Raman imaging of any sample areas (within 35mm×35mm travel range).

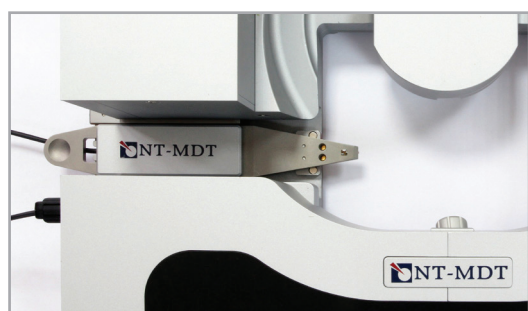
Cantilever deflection system auto alignment.

In several seconds get the laser aligned to the tip and photodiode position optimized. Special algorithms give a high precision and high speed of cantilever deflection system alignment.

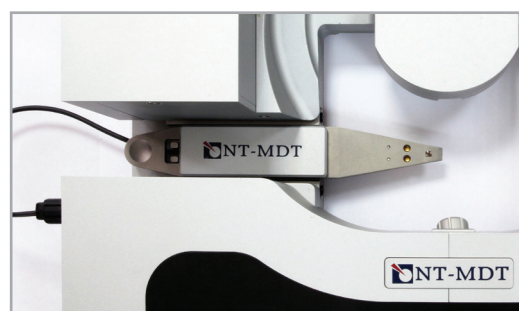


Automated probe removal.

AFM probe is automatically removed - when low working distance objective has to be used or when AFM is not required. The probe exchange procedure became simpler. Special AFM tip holder design and motorized probe holder positioner makes it easy to exchange any probe (AFM, STM, SNOM).



AFM holder removed



AFM holder in a working position

Fully motorized approach by tip.

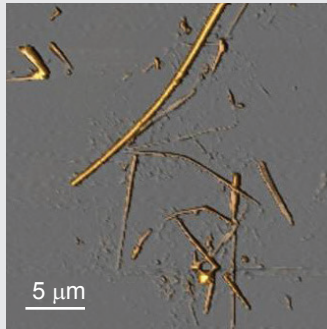
Preliminary approach is done by high precision motors. Soft approach by piezo. NT-MDT developed phase sensitive algorithm that guaranties gentle probe approach.

* The movement range is automatically exchanged to 5mm×5mm when the bottom objective is used.

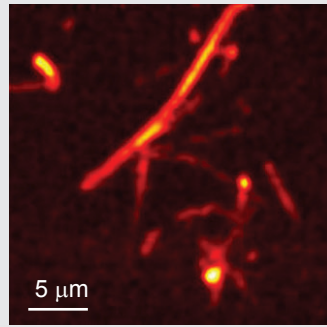
Applications

Nanowires

Mo oxide nanowires

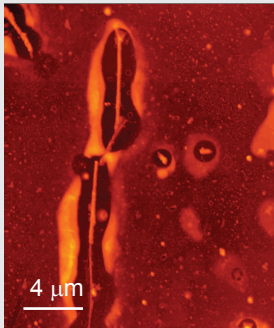


AFM

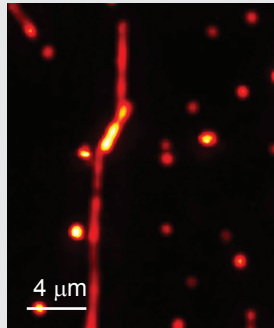


Raman map, Mo oxide peak

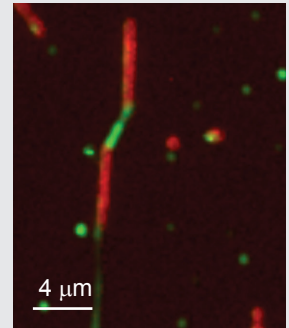
CdS nanowires



AFM

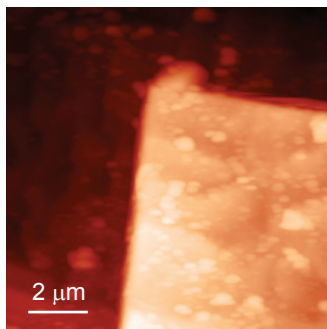


Fluorescence map

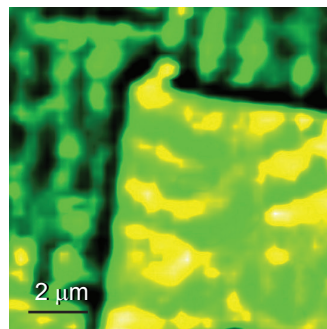


Overlapped Raman maps,
CdS and PANI bands

Artificial diamond characterization

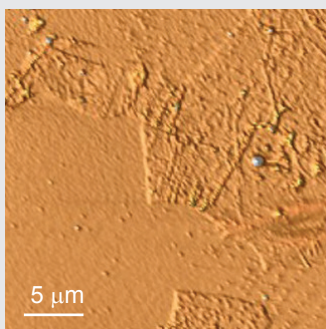


AFM

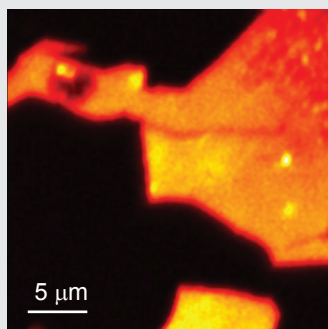


Raman map, 1333 cm⁻¹ band

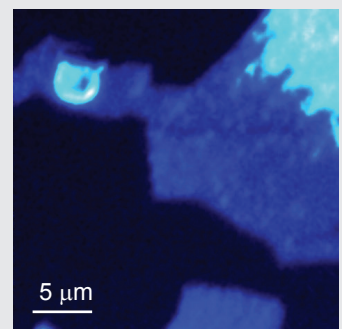
Graphene



AFM



Raman map, 2D-band



Raman map, G-band

Specifications

Measuring heads

- AFM, STM and Tuning Fork
- Cantilever deflection system, with automated adjustment and targeting

Sample

- **Dimensions:** up to 50/10 mm in diameter/height
- **Sample weight:** up to 2 kg
- **Heating:** from RT to 150 °C

Scanning system

- **Scanning type:** by sample
- **Range:** 100×100×10 µm (CL)

Resolution

- **Noise XY:** no more 0.3 nm (with closed loop sensors)
- **Noise Z (RMS, 10-1000 Hz bandwidth):** 60 pm (typical)

Sample positioning system

- **Movements:** automated, binded with the videomicroscope
- **Range XY:** 35×35 mm; 5×5 mm while using with the bottom objective
- **Min step:** 0.35 µm
- **Repositioning precision:** 3 µm

Approach

- Automated approach by tip
- **Range:** 10 mm

Optical parts

- **Spectral range:*** 450-1050 nm
- **Spectral resolution:** Depends on the grating and spectrometer used
- **Objectives:**
 - 100x 0.7NA
 - 10x 0.28NA
- **Detectors:****
 - TE cooled (down to -100 °C) CCD camera.
 - EMCCD camera is optional.
 - Photon multiplier (PMT) or avalanche photodiode (APD) in photon counting mode or other type of CCD camera (UV, IR)
 - Photon multiplier for fast confocal laser (Rayleigh) imaging
- **Confocal resolution:**
 - with the probe, for blue laser with 100x 0.7NA
 - XY: <400 nm
 - Z: <800 nm
 - without the probe, for blue laser with 100x 0.95NA
 - XY: <250 nm
 - Z: <500 nm

Bottom objective (optional)

- **Movements:** motor and piezo (optional)
- **Range:** 25mm by motor, 100 µm by piezo
- **Min step:** 0.1 µm by motor, 3nm by piezo

Vibroisolation

- Active vibration isolation system
- Optical table (optional)

*Other spectral range available upon request

**Depends on the system configuration