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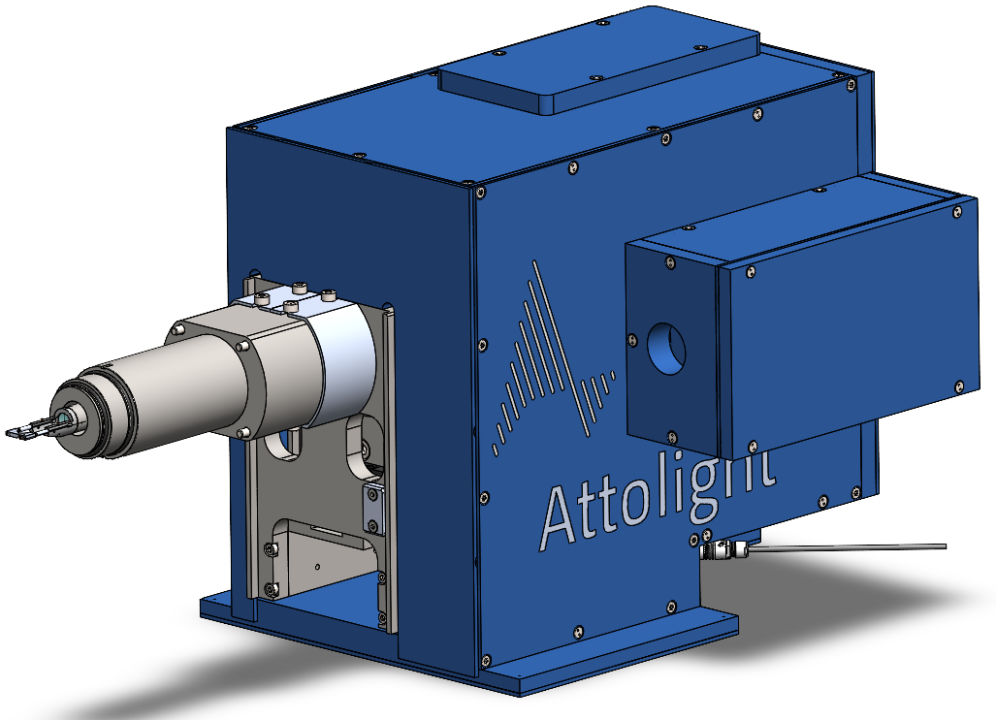
MÖNCH

Light Injection and CL Add-On for (S)TEM

Cathodoluminescence - Pump Probe - Gain Spectroscopy - Thermal Excitation



Benefit from a versatile system that includes both light collection and injection modes.

Reveal critical materials properties, including composition, structure, and defects.

Take advantage of an optimized, high-NA system with large collection angle.

Excite samples to reveal local behaviour under light/thermal excitation.

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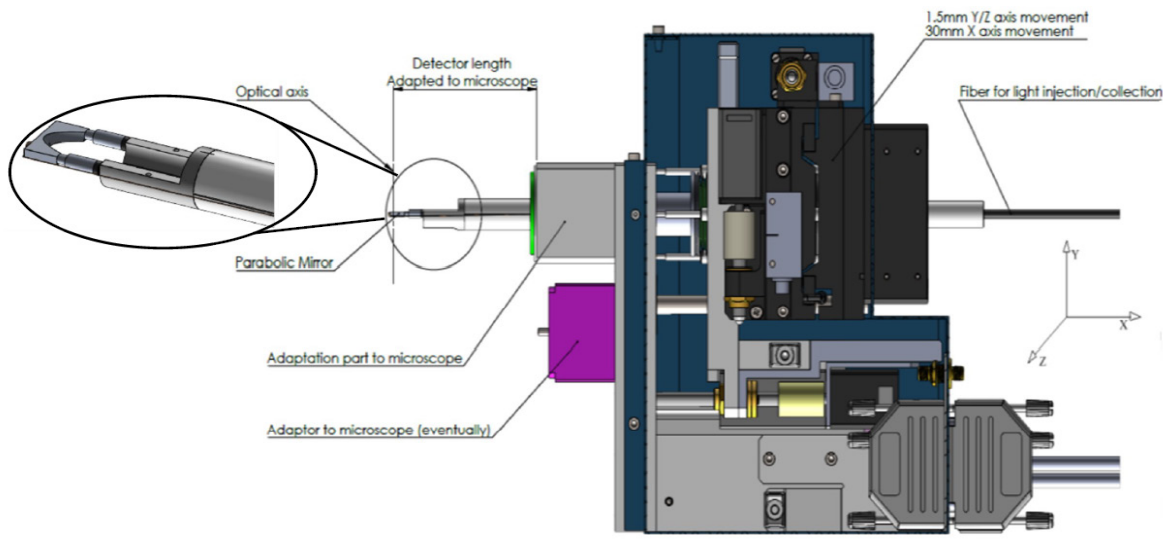
The Mönch is a powerful, user-friendly add-on for light collection and/or injection in (S)TEM thanks to:

- A **mirror that moves independently from the sample holder** allowing for perfect and stable alignment
- An absolute encoding system ensuring **high alignment precision and reproducibility** (100nm-precision)
- **Free space light injection** optics and **high-efficiency light collection** with an optical fiber
- **Easy swapping** between modes for ultimate experimental flexibility

System Overview



Light Collection Mode:

The Mönch has been carefully designed and optimized to achieve excellent signal-to-noise ratio thanks to:

- A **proprietary, high curvature parabolic mirror** designed to fit into the pole piece gap
- A **robust positioning system** with sub-µm precision for alignment of the mirror with respect to the sample
- A **large numerical aperture** (NA >0.7) for best possible collection efficiency
- A **working distance reduced to 300 µm** to minimize losses at low emission angles
- A **patented asymmetric optical fiber** designed to preserve brightness and spectral resolution

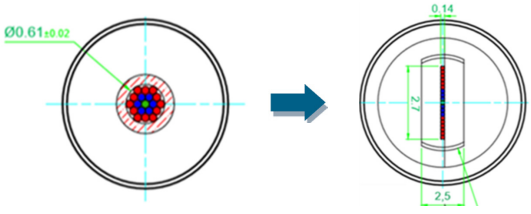
Light Injection Mode:

The Mönch achieves unprecedent performance and versatility thanks to:

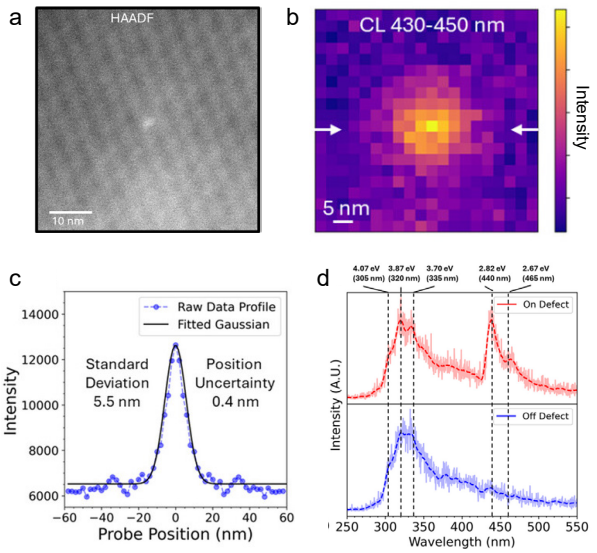
- A **laser spot size reduced to a few microns** for localized light/thermal excitation of samples
- **Straightforward and reproducible alignment** using optical feedback with an in-line detector
- **Compatibility with a wide range of light sources**, including pulsed and continuous lasers

Patented Optical Fiber:

The Mönch uses an asymetric optical fiber bundle with a rearrangement from concentric to parallel at the entrance slit of the imaging spectrograph. This enables excellent spectral resolution without compromising signal intensity, all while expanding the usable field of view on the sample.

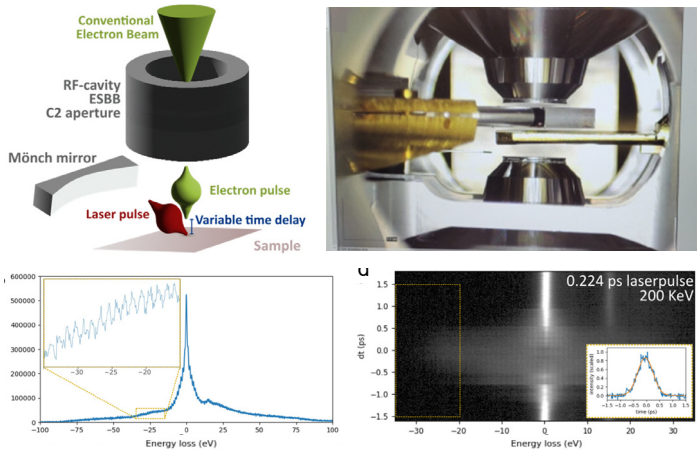


Light input Light output



CL study of individual quantum emitters in folded multilayers of hexagonal boron nitride (hBN). a) HAADF intensity map of an hBN single point defect. b) High magnification CL map of a localized quantum emitter. c) Gaussian fit of emitter in (b). d) CL spectra taken on and off a defect.

(Hou, H. et al. Adv. Mat. 2025, 37, 41, e01611, https://doi.org/10.1002/adma.202501611)



PINEM study to determine UTEM time resolution. a) Schematic diagram showing spatiotemporal overlap of electron and laser pulse. b) TEM chamber with Mönch inserted. c) PINEM sidebands with energy spacing of 1.2 eV. d) Time plot demonstrating an instrument response with FWHM of 0.7 ps.

(Bongiovanni, G. et al., Struct. Dyn. 12, 064303 (2025). https://doi.org/10.1063/4.0000782)

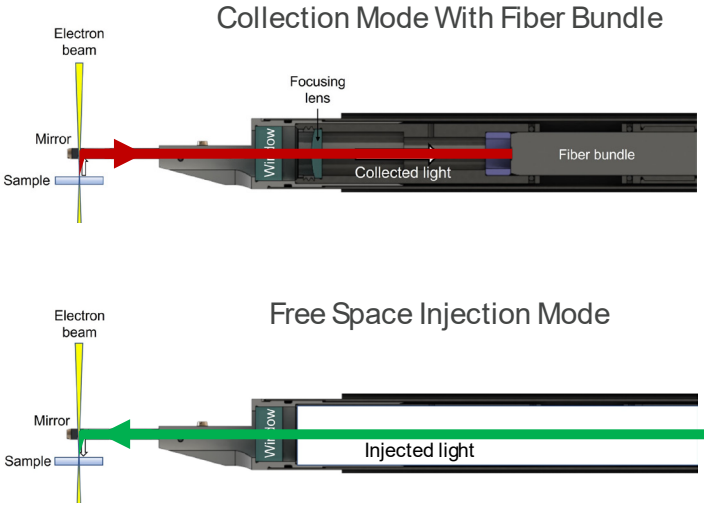
Swapping from Collection to Injection

The Mönch has been designed to **switch easily between light collection and injection modes**, allowing for ultimate flexibility in user workflows.

To swap, simply remove the fiber bundle rod and pop a single mirror into place. The rest of the light injection path stays fixed in position.

The Mönch injection package comes with an optical periscope used to steer the laser for proper alignment.

The Mönch is laser-agnostic, allowing the user to select the wavelength and type of laser (pulsed, continuous, etc.) that best suits their needs.



Materials Research Topics:

- Electronics & Optoelectronics (GaN, InP, SiC…)
- Photovoltaic cells (GaAs, CdTe, Perovskites…)
- Light emitting diodes (LEDs)
- 2D materials (Graphene, BN, WS2, diamond…)
- Noble metals (plasmonic)
- Quantum wells & quantum dots
- Minerals, glasses, ceramics and gemstones
- Inorganic coatings
- Organic, polymer samples
- Liquid chemistries

Mönch: Unique Light Collection/Injection Add-On for STEM

High spectral resolution · High collection efficiency · Fits into small pole piece gap
Injected spot size <10 µm · Mirror independant from the sample · Sub-micrometer alignment of mirror
No need for sample pre-aligment · Access entirety of sample surface · Compatible with almost any laser
Large choice of detectors · Fast hyperspectral map measurement time · Unprecedent signal-to-noise ratio
Switch easily between light collection and light injection · Compatible with other techniques (EELS, EDS…)

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Mönch Features

Specifications

Mirror
- High numercial aperture parabolic mirror (NA>0.7)
- Mirror reflectivity: >70% from 200 nm to 1.7 µm
- Compatibility for light collection and injection modes

Light collection mode
- Optical fiber with adapted insertion slot
- Collection light wavelength range: 270-1700 nm

Light Injection mode
- Free space to avoid loss of spatial coherence and degradation of signal power density
- Injection light wavelengths range: 250-2600 nm
- Laser spot size on specimen: down to 4 µm FWHM @ 532 nm

Easy switching between both modes

Detectors
- High speed UV-visible EMCCD camera (200–1100 nm)
- InGaAs NIR detector (900–1700 nm)
- Panchromatic detection (PMT; 200–900 nm)

Micro-positionning system
- Travel range: 30 mm (X), +/-1 mm (Y), +/-1 mm (Z)
- Retractable mirror with position reproducibility < 1 µm
- Absolute encoders
- Collison detection
- X-Ray protection (300 keV compatible)

Dispersive spectrometer
- 328 mm focal length
- Up to 4 turrets

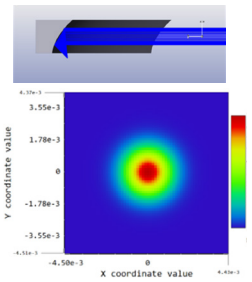
System control
- External scanning card
- Resolution: from 128x128 to 2048x2048 pixels
- Dwell times: from 1 µs to 5 ms for imaging
- Field of view: consistent with TEM internal scan system

Software
- Arm/mirror control software
- Acquisition/visualization software

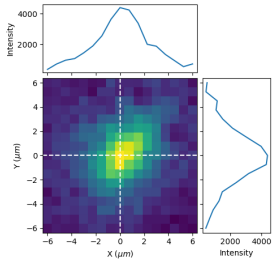
Light Injection: Spot Size

The specific mirror shape enables delivering a micrometer-scale beam spot size on the sample surface. Using a 532 nm laser, spot sizes down to 4 µm have been demonstrated with stable and reproducible performance. Alignment is facilitated using optical feedback from an in-line detector.

Optical simulation:



Experimental result:



STEM Compatibility:

- Compatible with most (S)TEM microscopes: TFS, JEOL, Nion, VG...
- Requires one available port on the octagon
- Retrofitting possible in some cases, depending on the TEM model
- Contact us at: contact@attolight.com to check the compatibility of your (S)TEM models

About Attolight AG:

Attolight AG started revolutionizing the field of cathodoluminescence (CL) by designing top-of-the-line CL-SEM instruments that deliver superior performance and maximum ease-of-use, making cathodoluminescence truly quantitative. The company firmly believes in the potential of cathodoluminescence for industry and academia alike. We aim to establish CL as a standard method across a range of scientific fields encompassing physics, materials science, biology, semiconductor manufacturing, and beyond.

Attolight AG is a company with global presence with systems across Europe, Asia, and North America. The company headquarters is located in Ecublens, Switzerland.

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