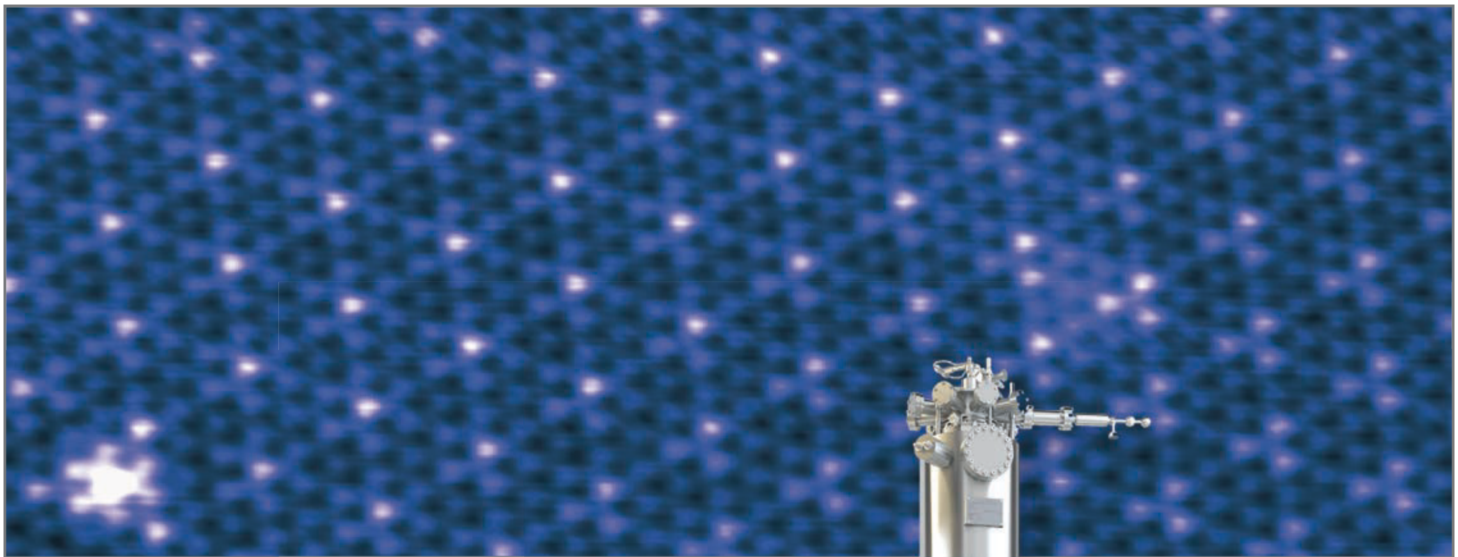
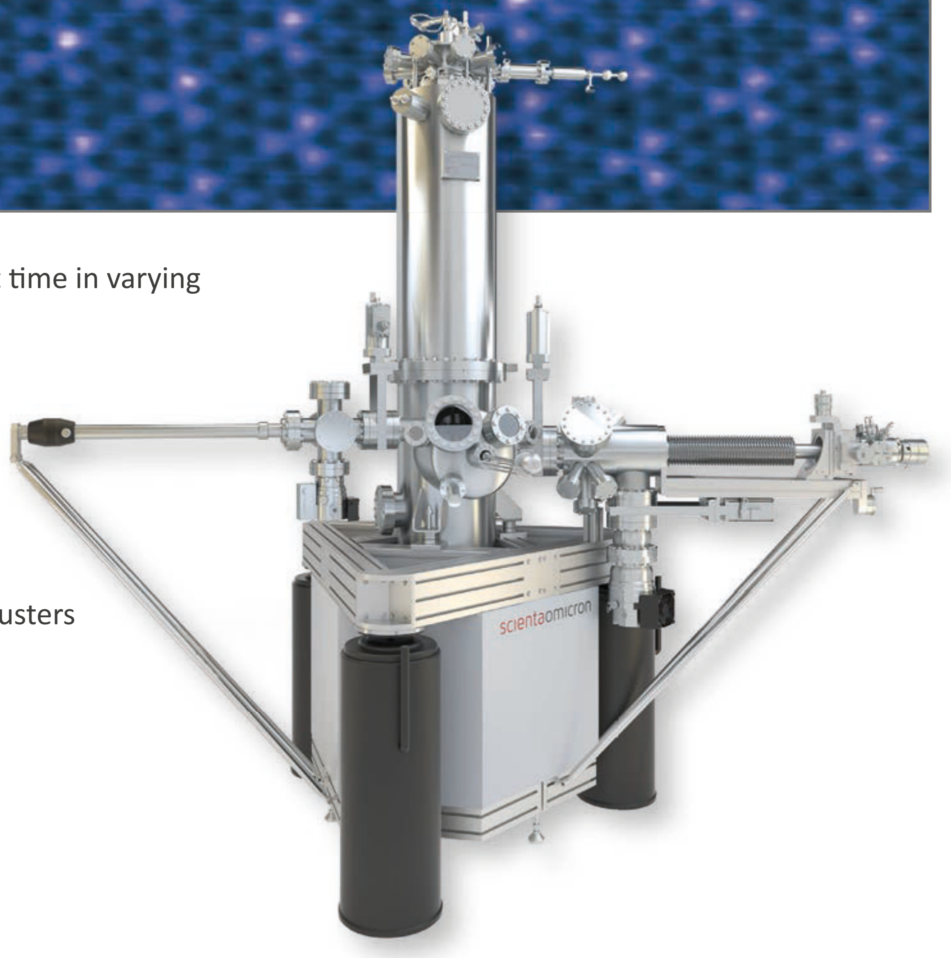
TESLA JT SPM

scientaomicron

Low Temperatures and Variable Magnetic Fields





- > 5 days uninterrupted measurement time in varying magnetic fields with only 11 L LHe
- Temperatures down to 1 K with ^4He
- Ultra low thermal drift
- Magnetic fields B_z > 3 T
- Optical access
- STM and QPlus AFM
- Ergonomic design & expandable to clusters

The Next Breakthrough

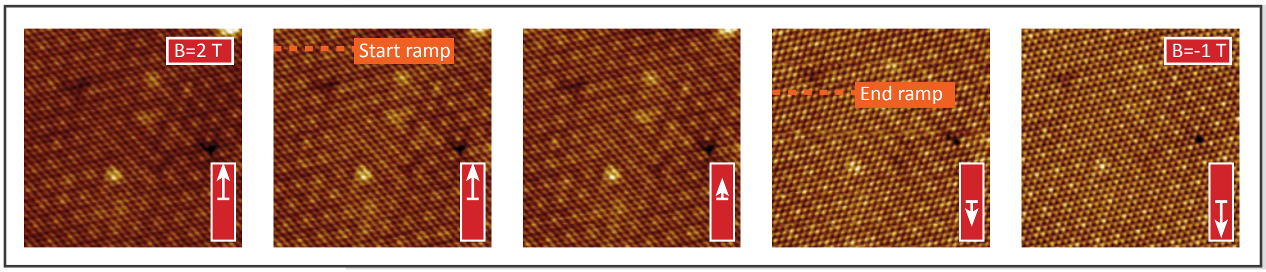
The TriLeg concept for the TESLA JT SPM

The TESLA JT SPM is the latest development in Scienta Omicron's long history of successful scanning probe microscopes. It is based on a strategic partnership with CryoVac GmbH, whose field proven, proprietary Joule-Thompson (JT) cooling and UHV magnet technology are united with our expertise in STM, advanced spectroscopy and QPlus AFM.

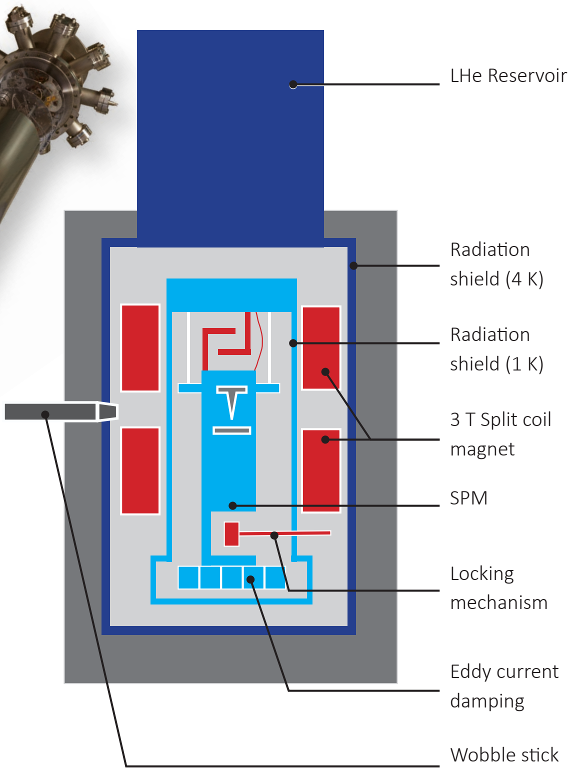
The TESLA JT SPM sets the standard in SPM performance in varying magnetic fields with picometer stability and thermal drift below 20 pm per hour. The system is based on a modern, ergonomic design that delivers dependable high performance SPM operation for successful scientific work. It fits perfectly into Scienta Omicron's comprehensive surface science technology portfolio and can be integrated into tailored UHV systems with thin film solutions (MBE) and electron spectroscopy, complimenting many techniques including ARPES, APPES, UPS and XPS.

TESLA JT SPM

- > 120 hrs hold time with 11 L LHe while running/ramping magnet
- Joule-Thompson cooling down to 1 K with ^{4}He, ^{3}He optional
- UHV magnet with 3 T vertical magnetic field
- Optical access and in-situ evaporation at low temperatures



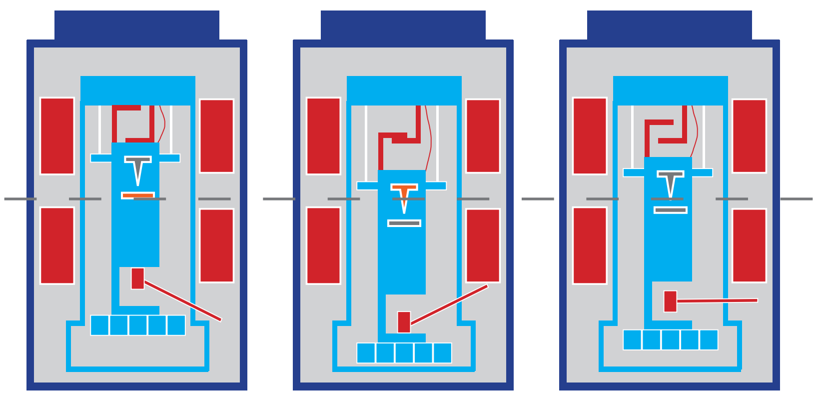
Continuous & stable imaging of $NbSe_2$ at T=1 K while ramping the magnetic field from 2 T to -1 T.



Cryostat & Magnet Technology

Cryovac‘s UHV cryostat technology ‚provides‘ 5 days uninterrupted SPM measurement time at low temperatures with exceptionally low LHe consumption of only 11 L. Operating and ramping the UHV magnet has virtually no impact on LHe hold time and consumption.

To achieve temperatures down to 1 K, the bath cryostat uses an LN_2 and LHe vessel and a Joule-Thompson cooling stage mounted below the LHe bath cryostat. Vapor-cooled shields at LN_2, LHe and 1 K temperatures enable optimal thermal shielding and can be opened and closed by a wobble stick. The TESLA JT stage uses an external He supply and can be upgraded to ^{3}He operation achieving temperatures of approximately 500 mK. A 3-stage locking mechanism provides convenient and safe sample & tip exchange. A separate thermal switch between the ^{4}He bath and JT stage allows for optimal cooling rates.



3-stage locking mechanism: Three positions for sample exchange, tip exchange and SPM measurement. Rigid mechanical and thermal locking of the microscopy during sample and tip exchange. Release of the microscope into the eddy current damping system for SPM operation.

UHV Magnet

A UHV superconducting split pair magnet provides vertical magnetic fields up to B_z = 3 T while allowing optical access at low temperatures. An optimized current lead set up consisting of Cu / HTS (High Temperature Superconductor) / LTS (Low Temperature Superconductor) ensures minimal heat load and exceptionally low consumption rates. The cryostat and magnet are fully UHV compatible and bakeable to 120° C.

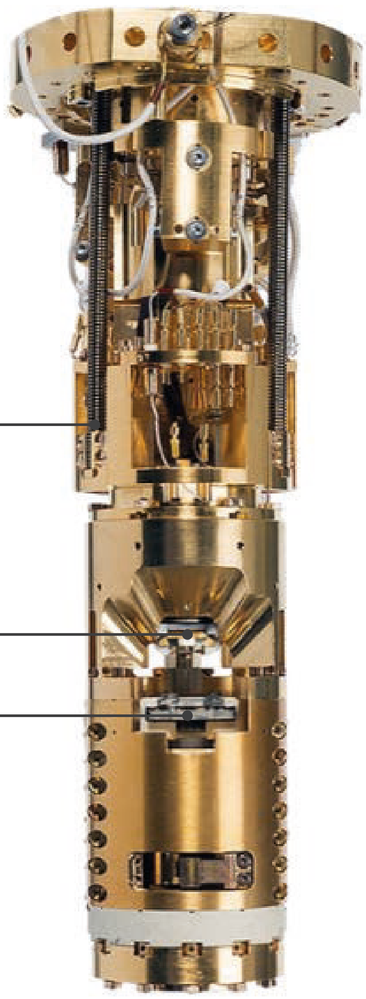
The TESLA JT SPM Microscope

Measurement modes: STM, non-contact AFM (QPlus) and complete set of spectroscopy modes including STS, IETS, and force spectroscopy.

Spring suspension

Scanner with spring-loaded tip carrier and 3 electrical contacts for QPlus AFM operation

Sample reception with coarse positioning and 4 electrical sample contacts



The TESLA JT SPM combines the ultimate intrinsic stability for continuous high resolution imaging and spectroscopy in varying magnetic fields.

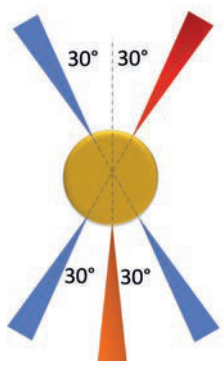
The strict use of non-magneitc materials allows for efficient spring suspension of the SPM head in magnetic fields. An eddy current damping stage is located below the microscope, sufficiently far from the super conducting magnet. The microscope provides optical access through four enabling ports for visibility of the tip position and approach, in-situ deposition and optical experiments, including laser illumination. As the microscope employs a 2D coarse motor for lateral sample positioning and approach, the SPM scanner remains fixed in space and therefore in focus for optical experiments. Four spring-loaded electrical sample contacts provide flexibility for experiments beyond standard SPM.

The microscope has been tailored for ease of use and safe operation by providing independent sample and tip exchange. The tip approach can be observed directly by a CCD camera and thereby reduces waiting times by allowing the user to find the optimal balance between manual and automatic tip approach.

Azimuthal angles are ±30° and ±150° and opposite ports provide mirror symmetry. All optical ports are positioned at a 10° angle from above with respect to the sample surface. The angle of incidence is limited by the magnet coil design. Steeper angles are available for magnets with reduced fields.

Optical access e.g. for laser, illumination, evaporation

Optical access e.g. for laser, illumination, evaporation



Optical access (CCD camera for observation of tip approach)

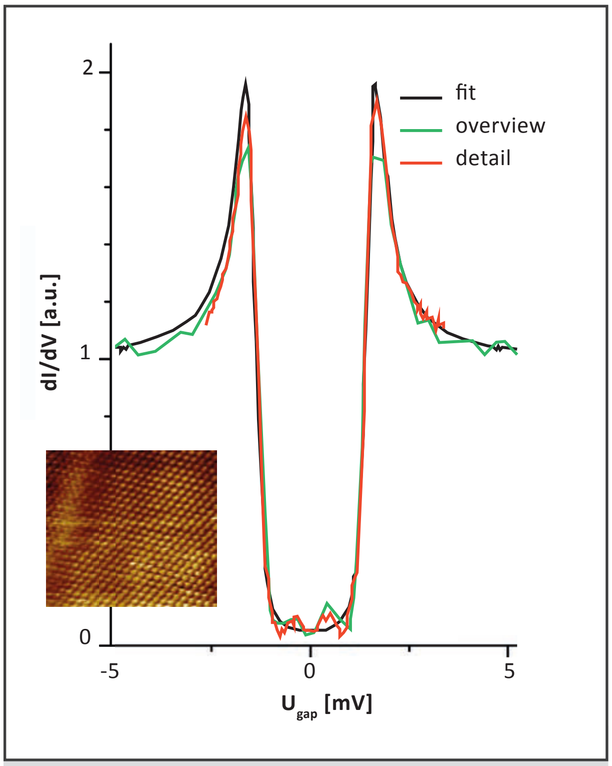
Optical access e.g. for laser, illumination, evaporation

Access for tip and sample exchange

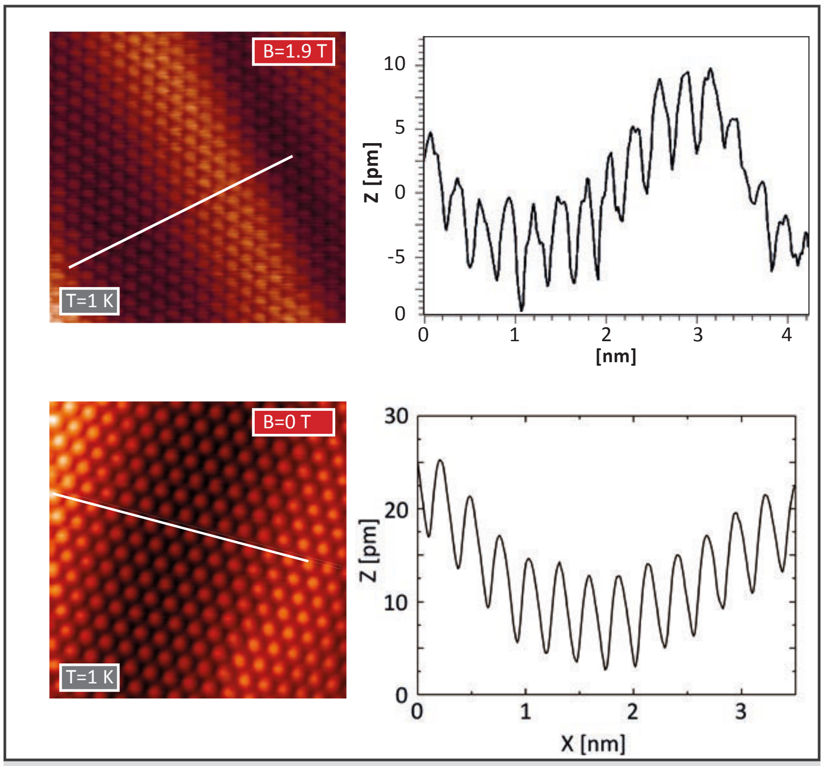
The Microscope at a glance:

- 4 optical ports
- Visibility of tip approach & position
- In-situ evaporation
- Independent sample & tip exchange
- Continuous SPM during magnetic field ramping
- Thermal drift < 20 pm/h
- Superior energy resolution

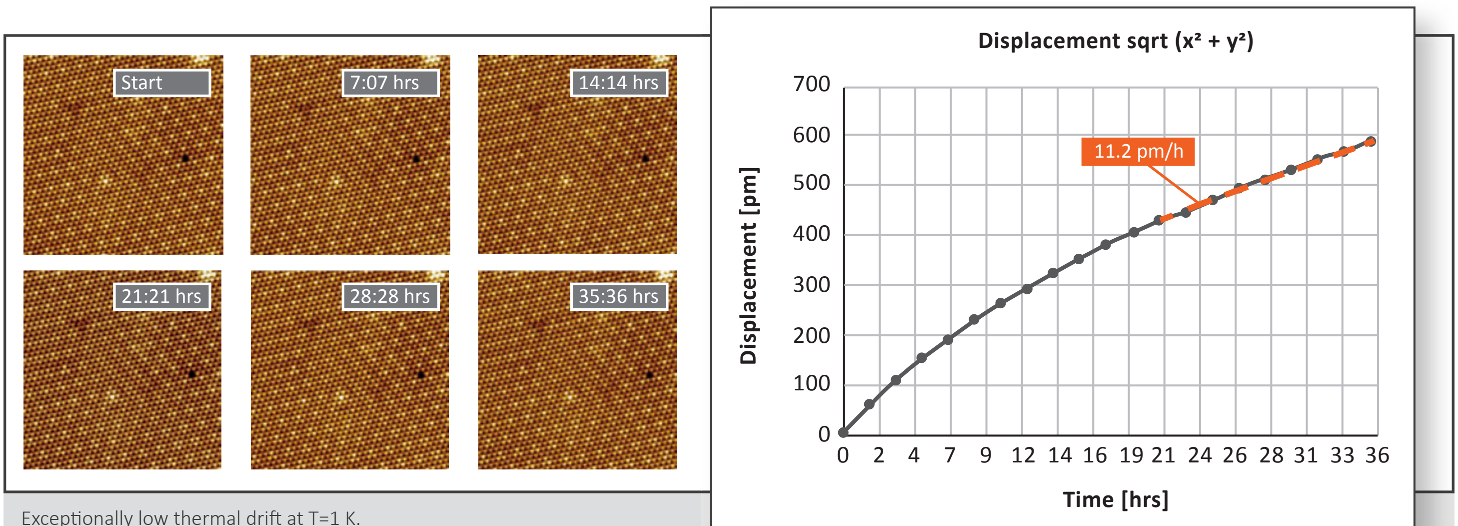
TESLA JT SPM
Excellent STM Performance



Superconducting gap with Nb tip at T=1 K. Gap width 3.05 meV acc. to BCS and confirmation of microscope temperature.
No instrumental energy broadening except U_{mod} (HF filters used).
Life time broadening of Dynes fit: 70 µV (Red: Data, Black: fit).



Atomic resolution STM on Au(111) at T=1 K showing corrugation in the picometer range and herringbone reconstruction. Inserts: Line profiles.
Top: B=1.9 T, 5x5 nm Scan range.
Bottom: B=0 T, 4 x 4 nm Scan range.

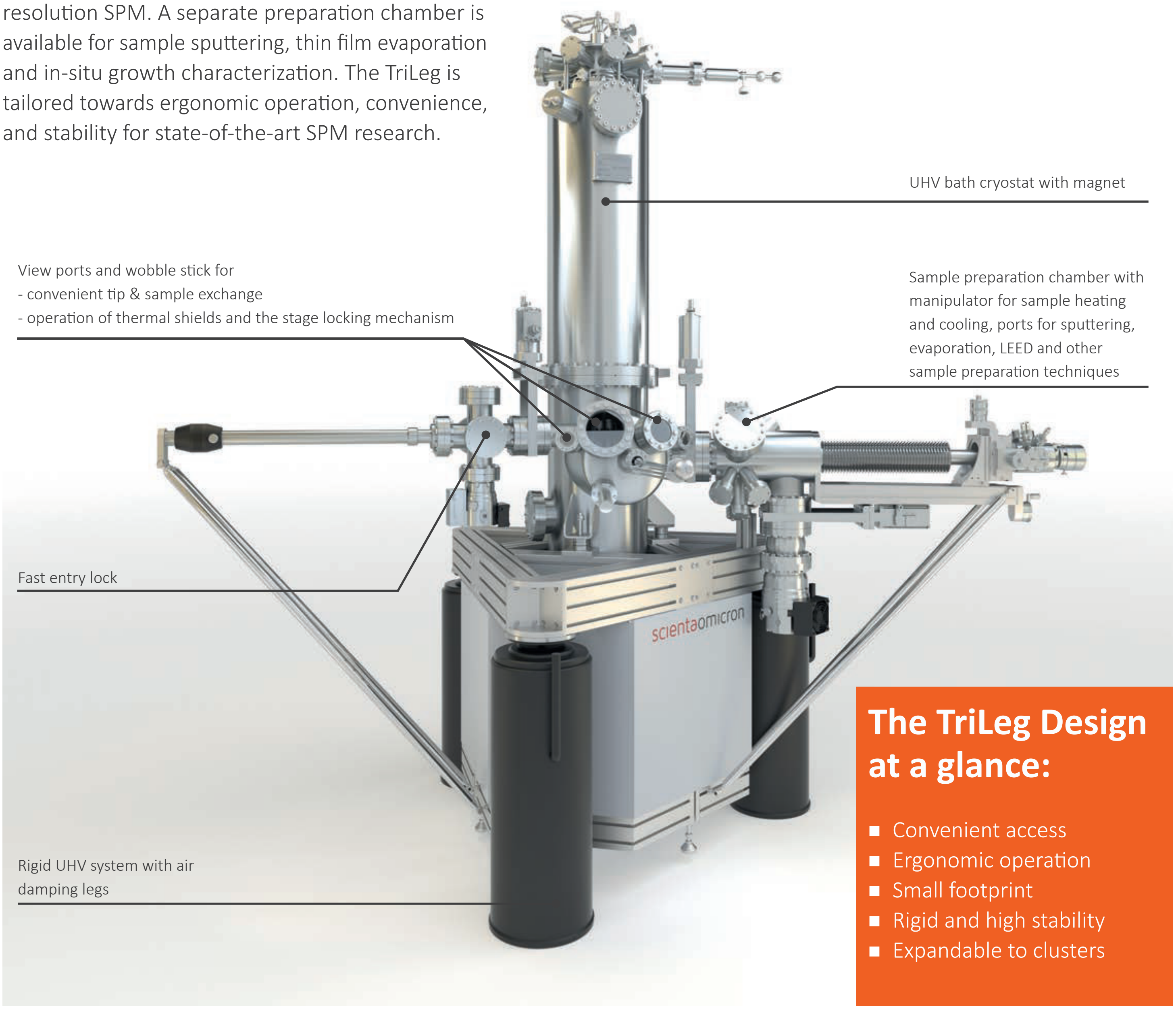


Exceptionally low thermal drift at T=1 K.
36 hours total acqusition time showing a thermal drift stabilising at 11.2 pm/h.

The TriLeg Design for the TESLA JT SPM

The devotion of Scienta Omicron to precision engineering and the experience of 30 years in the SPM business is embodied in the TESLA JT SPM.

The new TriLeg design is the platform for the TESLA JT SPM, a dedicated UHV system for high resolution SPM. A separate preparation chamber is available for sample sputtering, thin film evaporation and in-situ growth characterization. The TriLeg is tailored towards ergonomic operation, convenience, and stability for state-of-the-art SPM research.

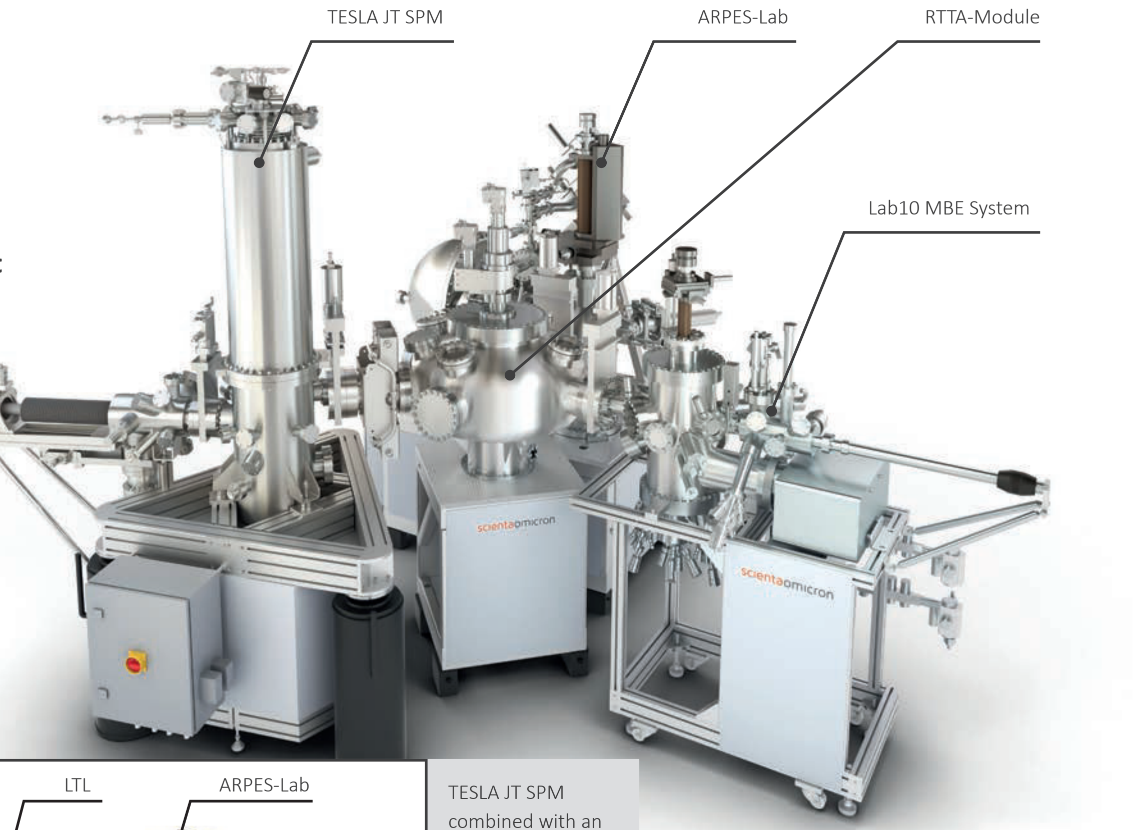


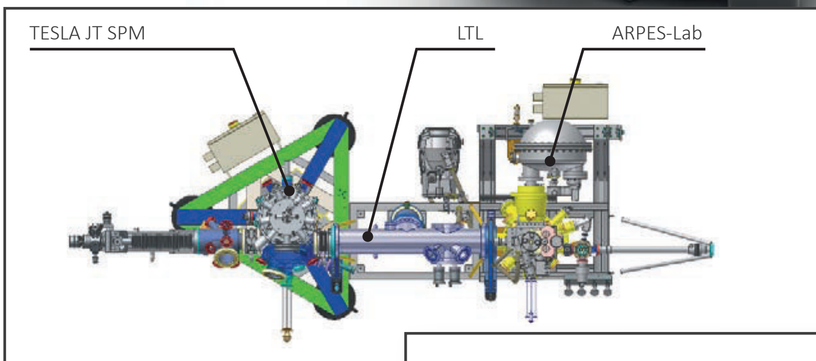
The TriLeg Design at a glance:

- Convenient access
- Ergonomic operation
- Small footprint
- Rigid and high stability
- Expandable to clusters

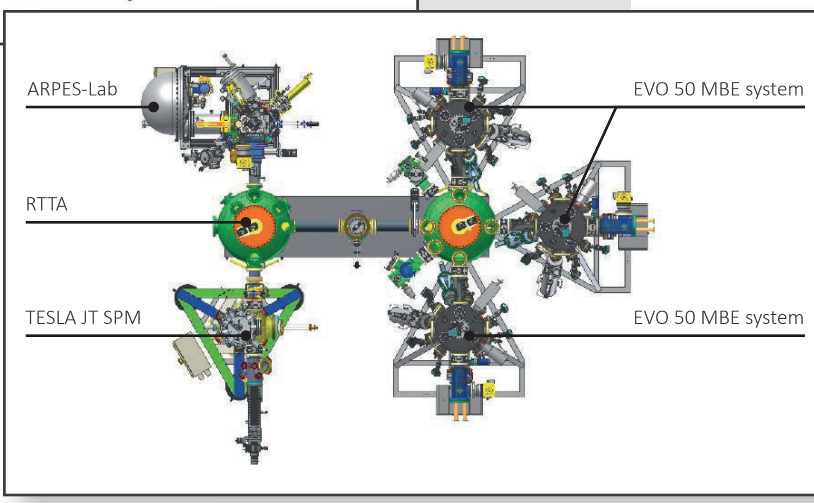
Modular System Concept

Today‘s research requires the complementary use of various surface analysis methods and thin film deposition techniques. Based on Scienta Omicron‘s vast expertise in engineering, UHV system solutions are tailored to the specific needs of the customer‘s experiment.
Due to its modular design, the TESLA JT SPM is expandable for new requirements - even after years.





TESLA JT SPM combined with an ARPES-Lab with R3000 ARPES spectrometer.
A LTL (Linear Transfer Line) is connecting the two systems.

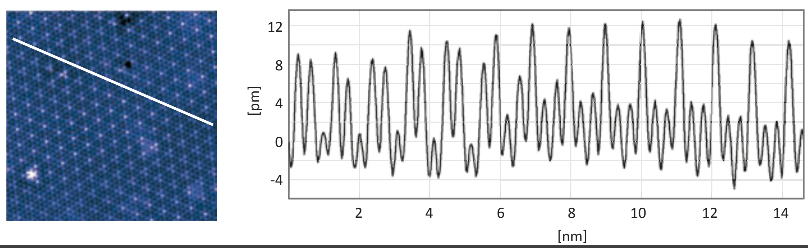


TESLA JT SPM combined with an ARPES-Lab with DA30 ARPES spectrometer and three EVO 50 MBE Systems.
Two RTTA (Radial Telescopic Transfer Arms) are used for safe transfer between the modules.

How to contact us:

America | Europe & Africa | Asia & Australia

We have agents and sales representatives around the world - and right next door. Please check our website for your local contact and partner. Many thanks.
www.scientaomicron.com



$NbSe_2$ at 1.01 K – Charge Density Wave, V_{gap} = 50 mV, I_T = 0.6 nA,B = 0 T, 14x14 nm

Technical Data

Microscope

STM resolution:	Atomic, Au(111)
QPlus AFM resolution:	Atomic, single crystal NaCl (100) or Si(111)
Scan range XYZ:	6.5 x 6.5 x 1.2 µm (300 K) 1.2 x 1.2 x 0.2 (1.5 K)
Electrical tip contacts:	3 (used for QPlus)
Sample coarse range:	XZ = 4 x 6 mm
Sample size:	10 x 10 mm
Electrical sample contacts:	4 (incl. one for GND or U_{GAP})
Gap voltage:	±1 V and ±10 V
Tunnelling current:	2 pA to 300 nA

Cryostat

Min. SPM temperature:	T_{MIN} < 1.2 K (^{4}He; ^{3}He optional on request)
LHe holding time:	> 120 hrs (magnet operation)
LHe cryostat volume:	11.3 l
LHe consumption	< 0.1 l/hr
LN_2 holding time:	> 120 hrs
LN_2 cryostat volume:	21.7 l
LN_2 consumption	< 0.2 l/hr
Bakeout temperature:	max. 120° with magnet (140° w/o)
Guaranteed base pressure:	$3x10^{-10}$ mbar

Optical Access

4 access ports	IR-filter windows
Azimuth angles:	±30° & ±150°
Polar angle:	10° to surface plane

Magnetic Field

Magnetic field:	B_z > 3 T (vertical)
Magnet type:	1D UHV superconducting split pair (other config. on request)

How to contact us:

www.ScientaOmicron.com
info@ScientaOmicron.com