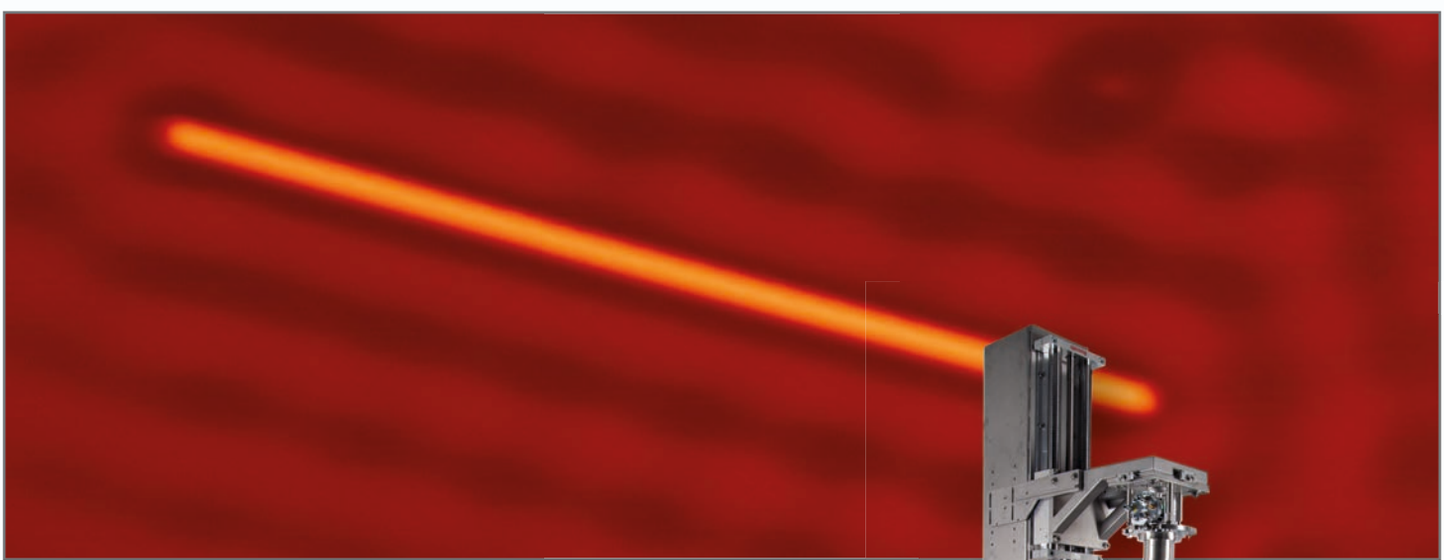
Fermi DryCool™ SPM

Highest Performance Cryogen-Free LT STM/AFM

scientaomicron



- Unlimited measurement time
- No helium consumption
- Independent tip and sample temperature control (<10K to 400K)
- Superior drift performance
- Picometer stability for long-term spectroscopy
- STM and advanced spectroscopy
- Scienta Omicron QPlus AFM technology

The Scienta Omicron DryCool™ Technology

Easy and convenient access to low-temperature STM and QPlus AFM

The Fermi DryCool™ SPM combines a cryogen-Free cooling system with a state-of-the art SPM head for high resolution STM and QPlus imaging and spectroscopy in UHV for extended operations at low (<10K) and variable temperatures.

The highest performing scanning probe microscopes have historically been cooled with LHe. Given the steadily increasing price of LHe, the safety concerns related to the handling of cryogens, and the desire for extended (months-long) low temperature operation, Scienta Omicron has integrated an alternative cooling method into our SPM's.

Our unique DryCool™ technology integrates a closed-cycle, cryo-free cooling element to the SPM, while simultaneously decoupling the mechanical and acoustic impact. The result is a scanned probe system that performs with extremely low drift and picometer stability, providing an excellent platform for long-term experiments such as scanning tunneling spectroscopy (STS), inelastic tunneling spectroscopy (IETS) and atom manipulation.

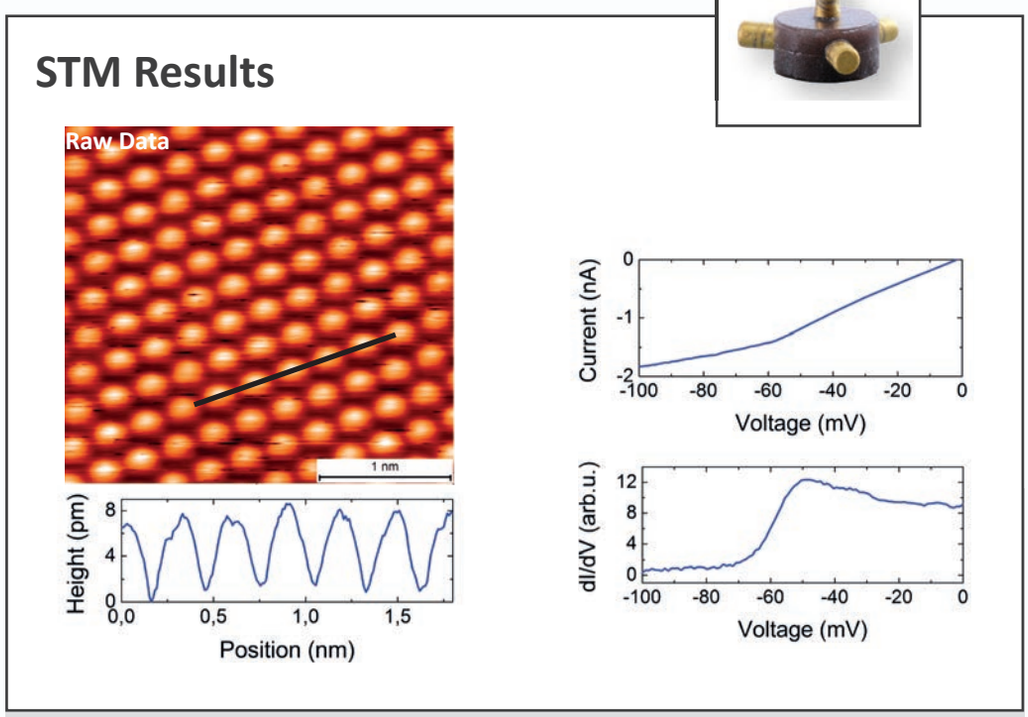


Fig. 1 (left): STM measurement and corresponding line profile along the black line on Ag(111) at T = 9.8 K with running cooler.
Fig. 2 (insert): STM sensor

Fig. 3 (right): High resolution scanning tunnelling spectroscopy on Ag(111) with running cooler.
(a) I/V spectrum clearly shows the onset of the surface state at -67 meV. (b) dI/dV spectrum of (a)

Our special design enables operation anywhere in the temperature range from below 10 K to 400K, with the unique feature of independent temperature control of the tip and the sample. This approach paves the way for scientists to continuously perform low and variable temperature STM, STS and QPlus nc-AFM experiments.

The low thermal, mechanical and acoustic noise of the DryCool™ technology results in a stability level comparable to SPM´s using conventional cooling techniques (see Fig. 1).
The superior drift performance in x/y/z of <0.2 Å/h provides an ideal platform for long-term spectroscopy experiments (ref. Fig. 3).

QPlus AFM Results

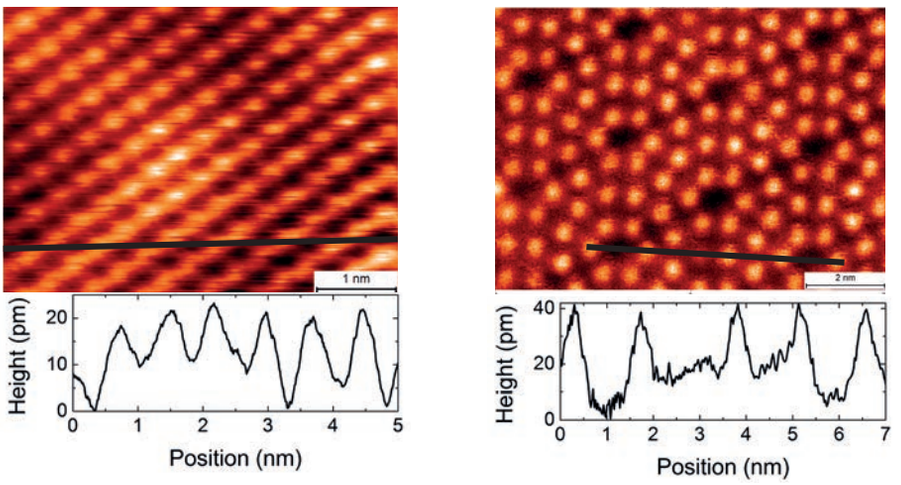


Fig. 4 (insert): QPlus sensor
Fig. 5 (left): Atomically resolved NaCl(100).
Fig. 6 (right): Topography of a Si(111) 7x7 reconstructed surface.

The Fermi DryCool™ SPM employs the Scienta Omicron leading QPlus AFM technology.

An essential part of successful Qplus AFM operation is the sensor construction technology. Scienta Omicron has long been the recognized leader in providing the highest quality, most reliable Qplus AFM sensor technology. We have now developed an advanced, automated manufacturing process that ensures high yield sensors with sharp resonance frequencies and high quality-factors. This excellence is demonstrated by Scienta Omicron instruments being used in the vast majority of Qplus AFM peer-reviewed publications.

Implementing this same level of performance in a closed-cycle cooled system is an engineering challenge due to the sensitivity of the quartz tuning fork.

The Fermi DryCool™ mechanical system is designed to enable high performance QPlus AFM operation in all experiments. With our sophisticated ex-situ preamplifier technology and the high performance PLL in the Matrix 4 SPM controller, performing QPlus experiments is both easier and more powerful when compared to any other QPlus AFM platform.

Stability of the system - from µm to sub-pm

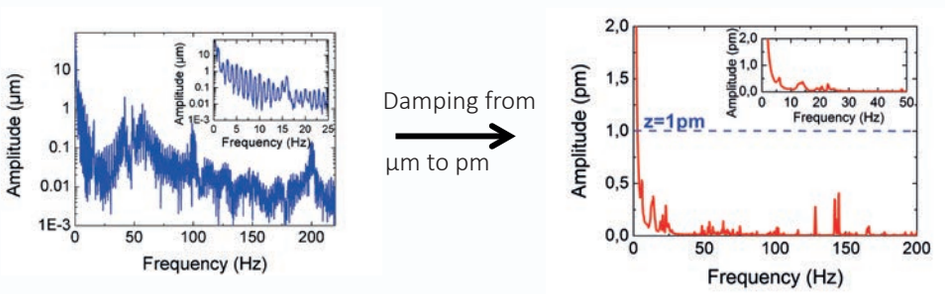
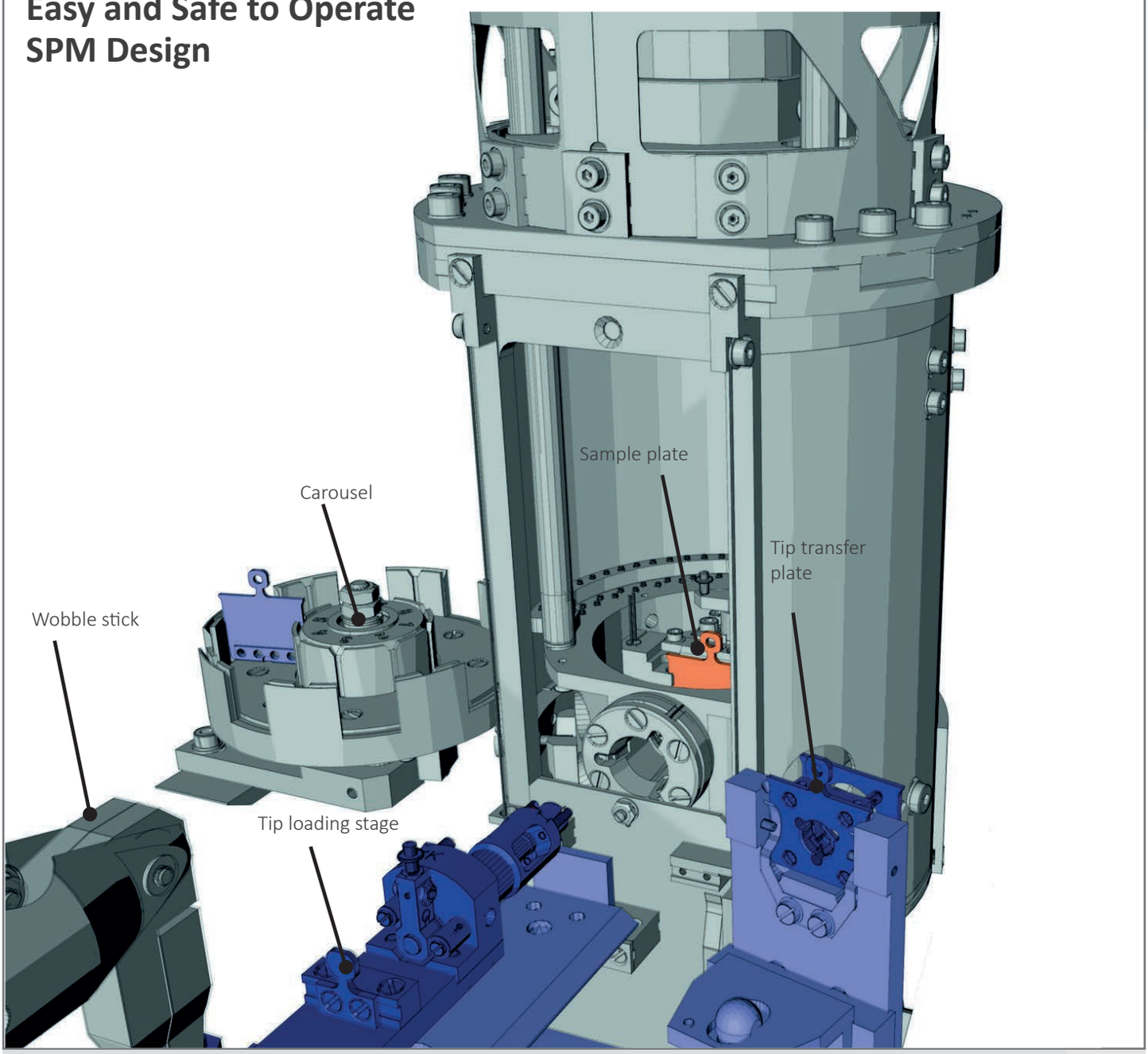


Fig. 7 (left): Vibration spectrum of the closed cycle cooler.
Fig. 8 (right): No remaining vibrations of the closed cycle cooler.

A main development goal for the Fermi DryCool™ SPM was to achieve the known stability level of z = 1 pm of low-temperature SPM´s with conventional cooling techniques such as flow- or bath cryostats. As shown in Fig. 7 & 8, we had to damp the vibrations by 6 orders of magnitude from the µm-range (Fig. 7 - blue curve) to the pm-range (Fig. 8 - red curve). To proof the stability level, we recorded a power spectrum in point mode with feedback switched off.
As shown in Fig. 8, all frequencies are well below the z = 1 pm level (Fig. 8: blue dashed line) which demonstrates the effective decoupling of the closed cycle cooler from the SPM.

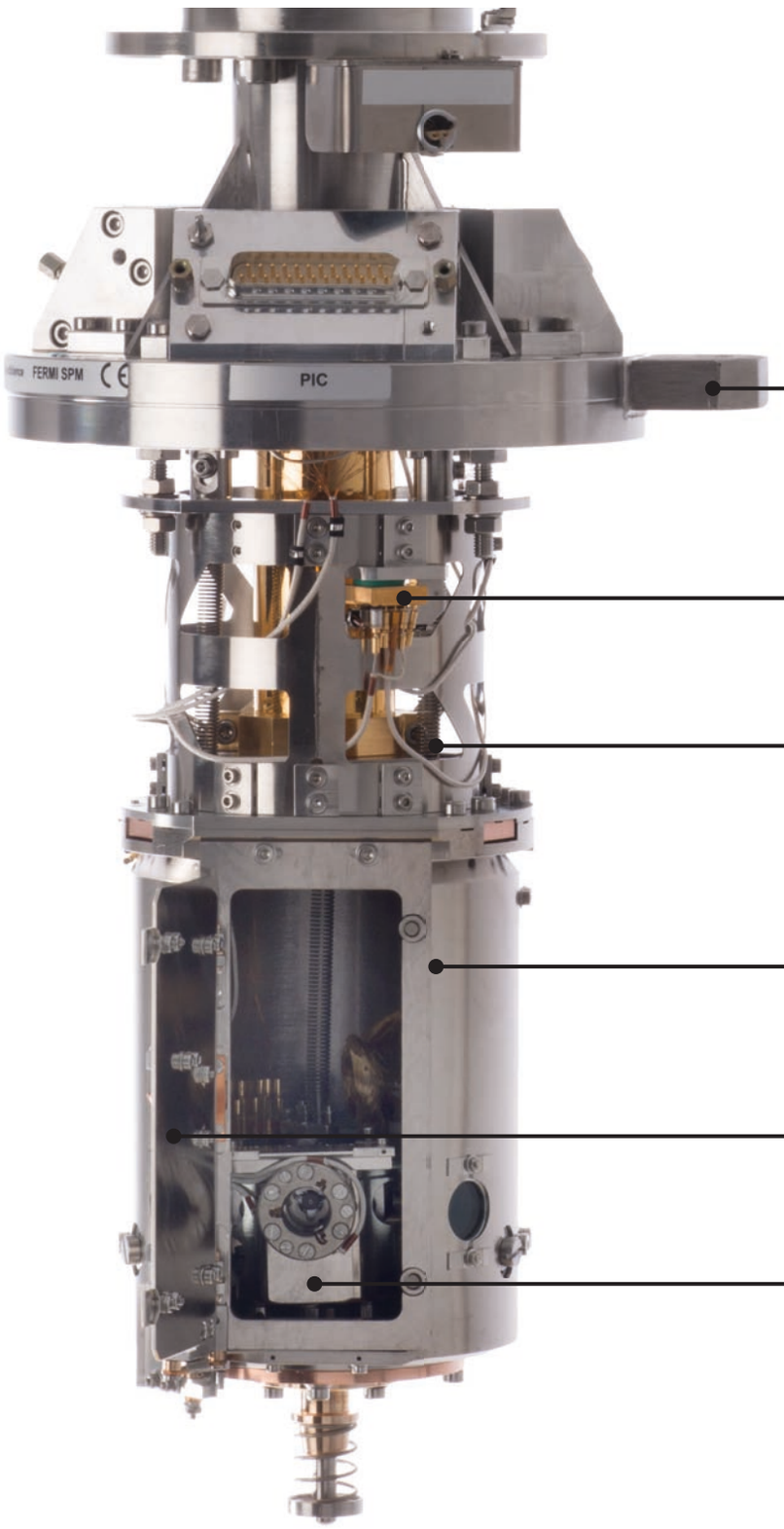
Easy and Safe to Operate SPM Design



The distinctive tip exchange mechanism of the Fermi DryCool™ SPM keeps the sample at low temperature while the tip is quickly and safely exchanged.

The wobble stick moves STM tips or QPlus AFM sensors from the carousel to the loading stage. Loading on to the scanner uses a bayonet locking mechanism and takes just seconds. This design ensures that there is no risk to damage the scanner during the exchange process.

Features of the SPM Head



The Fermi DryCool™ SPM is mounted on a small DN100 flange offering a compact and cost effective platform for low temperature SPM.

The in-vacuum I/V converter provides superior signal to noise, low tunnelling currents and spectroscopy.

The internal spring suspension with eddy current damping ensures unparalleled vibration isolation.

Thermal shields maintain tip and sample at the same temperature, guaranteeing low thermal drift.

Large thermal shield door enables quick and easy tip or sample exchange. The sample can remain in place at low temperature during tip exchange.

A compact scanner design with ultra-light tip carriers enable high stability and high speed scanning.

Independent
tip and sample temperature

The Fermi DryCool™ SPM is a compact and cost effective solution for UHV SPM in a temperature range from 10 K to 400 K.

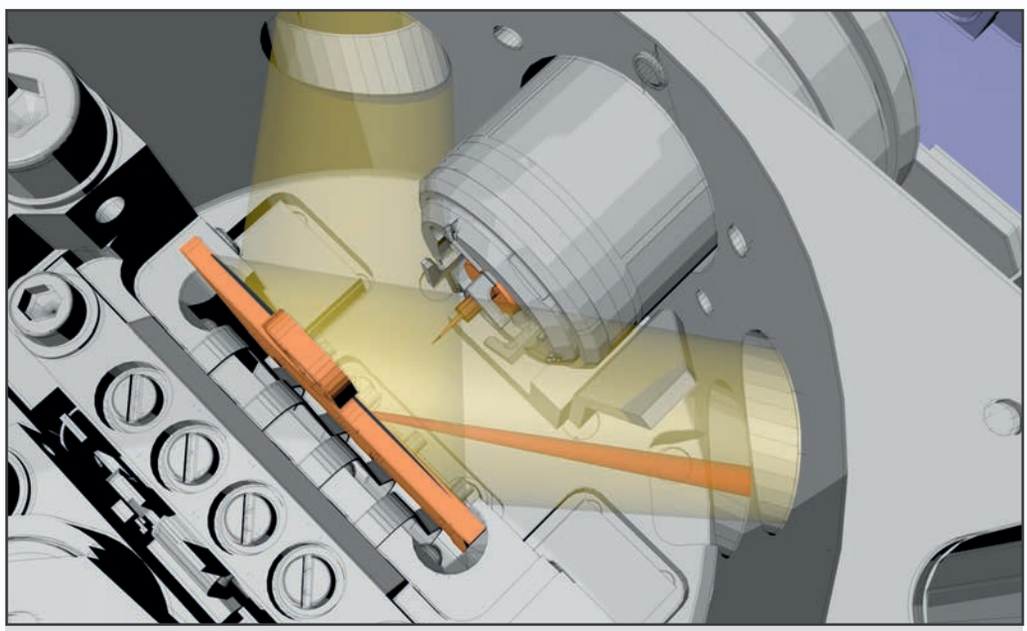
The compact design with closed cycle cryostat and thermal shields keeps the tip and sample at the same temperature during experiments. This guarantees low thermal drift and makes the Fermi DryCool™ SPM an ideal and cost effective solution for imaging, tunnelling spectroscopy and atom manipulation experiments.

Due to the unique design of the SPM head the temperature of the tip and the sample can be fixed independently from each other.

It includes in-situ tip exchange, sample coarse positioning and integral eddy current damping for the most effective vibration isolation.

The compact scanner design and ultra-light tip carriers offer high stability and the capability for highest scan speed. QPlus AFM operation is optionally available.

For STM operation the instrument employs a proven pre-amplifier with in-situ I/V converter and a tunnelling current range from < 1 pA to 330 nA.



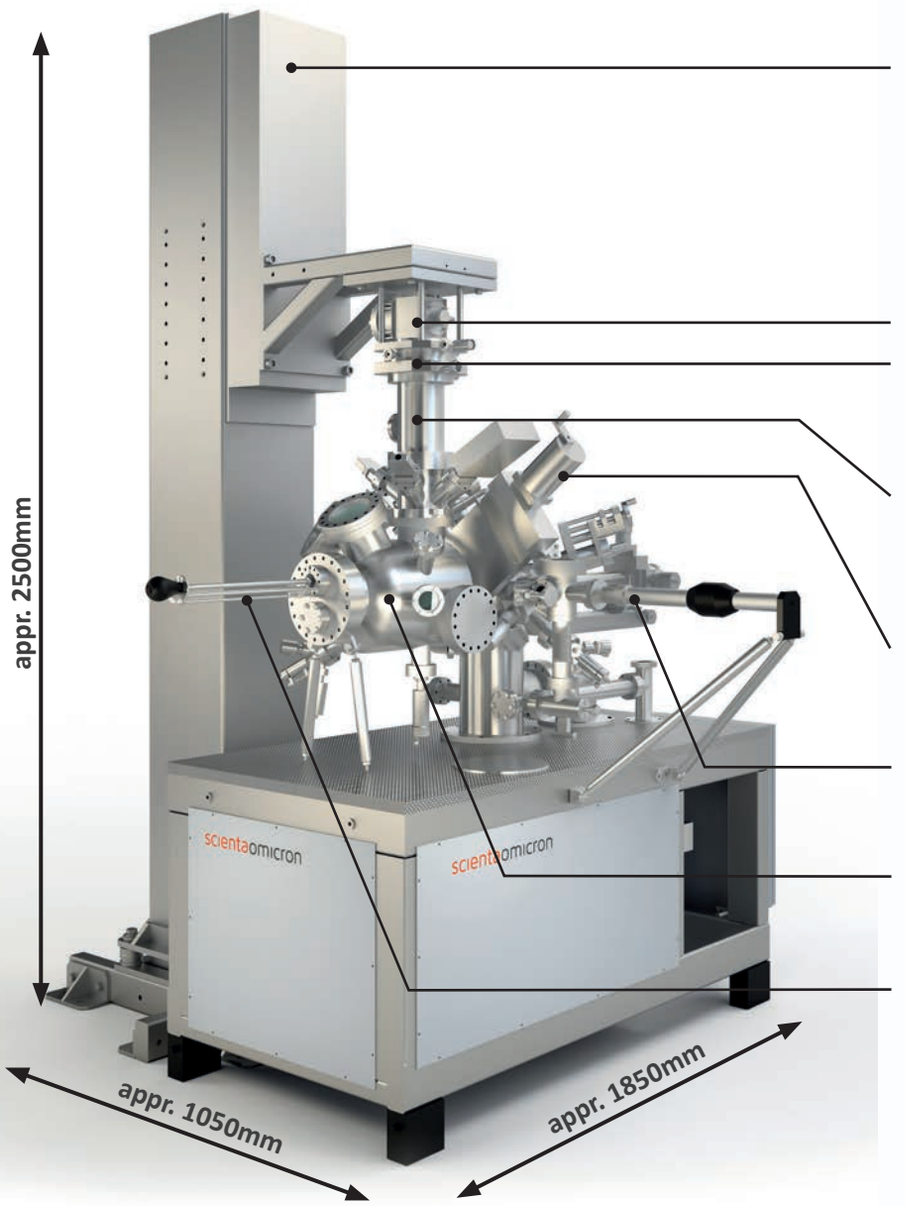
Ultra compact scanner design for high stability and high speed scanning. Yellow marked: optical access.
Orange marked: in-situ evaporation.

Piezo inertia motors allow for sample coarse positioning in x and z directions.

The Fermi Dry Cool™ SPM is provided as a part of a compact turnkey UHV system.

Scanner design
A new ultra-compact and rigidly mounted scanner with light weight tip carriers enables high stability and high speed scanning. The sample is mounted on the coarse positioning device for sample movement in x and z direction. Four electrical sample contacts are available as an option.

Features of the System



Rigid frame for closed-cycle cooler support and isolation. Guided alignment provides an easy and safe conversion between cooling and bake-out position for the cooler.

Closed cycle cooler in cooling position.

Initial damping stage to eliminates all major mechanical vibrations closed-cycle cooler.

2nd damping stage eliminates residual mechanical and thermal noise induced by the closed-cycle cooler.

Seperate, gated analysis and preparati-on chamber provide system flexibility.

Proven fast entry lock design offers expansion capabilities.

Eight position storage carousel for tips, probes and samples.

Dual shaft wobble stick for fast tip and sample transfer.

Scienta Omicron‘s 30 years of experience and know-how in the SPM business is embodied in the new Fermi DryCool™ SPM. The famous MULTIPROBE system design has proven itself in over 1,000 installations and forms the core module for multi-technique Ultra-High-Vacuum (UHV) applications.

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

Technical Data

The DryCool™ Fermi provides all the benefits of conventional low-temperature SPM´s without their disadvantages.

Measurement modes:
- STM
- STS
- nc-AFM (QPlus)

Temperature:
- Temperature range: T = 10-400 K
- Tip and sample temperature can be set independent from each other

Drift:
- x/y/z drift: <0.5Å/h (typical <0.2Å/h)

Coarse motion:
- Sample coarse motion: 6mm

Stability:
- z-stability <2pm (typical <1.5pm)

Cryostat:
- Closed cycle cryostat cooled by a Gifford McMahon cooler

Scan range:
- at room temperature: 2.9µm x 2.9µm x 0.9µm
- at base temperature: 0.8µm x 0.8µm x 0.3µm

How to contact us:
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