



Beetle

UHV VT AFM / STM



RHK Technology
Imaging the Future of Nanoscience

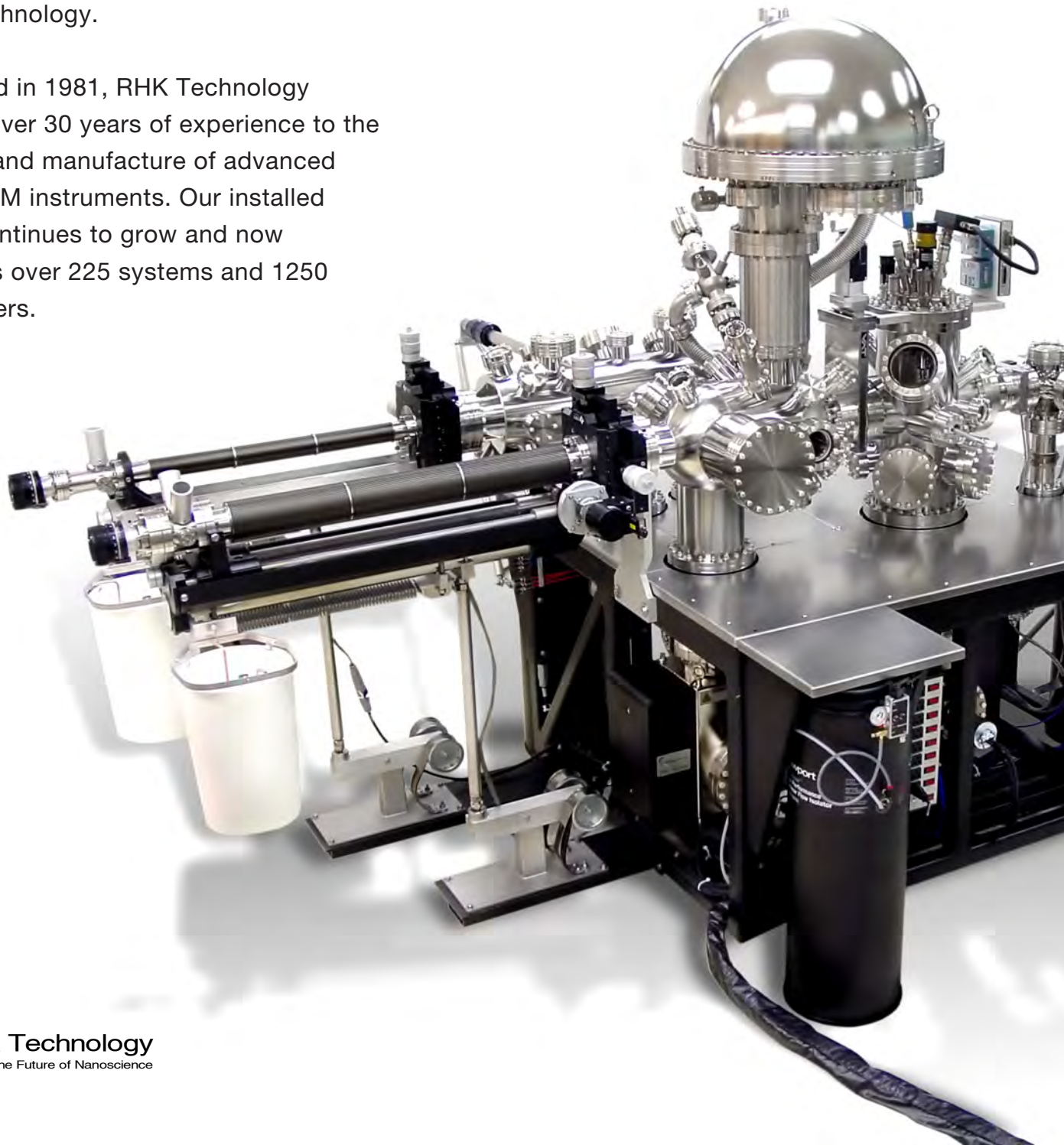
Beetle

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Engineered Excellence

Everyday, in university and government labs around the globe, RHK research platforms lead to new discoveries in nanotechnology.

Founded in 1981, RHK Technology brings over 30 years of experience to the design and manufacture of advanced UHV SPM instruments. Our installed base continues to grow and now includes over 225 systems and 1250 controllers.



RHK Technology
Imaging the Future of Nanoscience

The Trusted Nano-Tech Workhorse

UHV VT AFM/STM

Time-Tested - Proven, Refined Design

Lowest Drift for Variable-Temperature Sample

Image 30K – 1000K sample temp, even in AFM mode.

Accurate sample temperature measurement

STM + Cantilever Beam-Deflection AFM

All Modes: STM, STS, NC-AFM, MFM, KPFM, Contact /
Conductive AFM, LFM/Friction, etc.

Sophisticated Optional Capabilities:

Optical access to tip/sample junction

VMF (Variable Magnetic Field)


Microwave to tip or sample

SEM

RHK's surface science systems integrate only the best analytical and preparation instruments from top industry suppliers. To further advance products and performance, we consult top scientists on our Technical Advisory Board as well as customers confronting new research challenges.

RHK systems are carefully configured for your specific research requirements:

STM or AFM/STM, VT from 30K to 1500K, specialized chamber designs, and sophisticated surface preparation and analytical instruments.



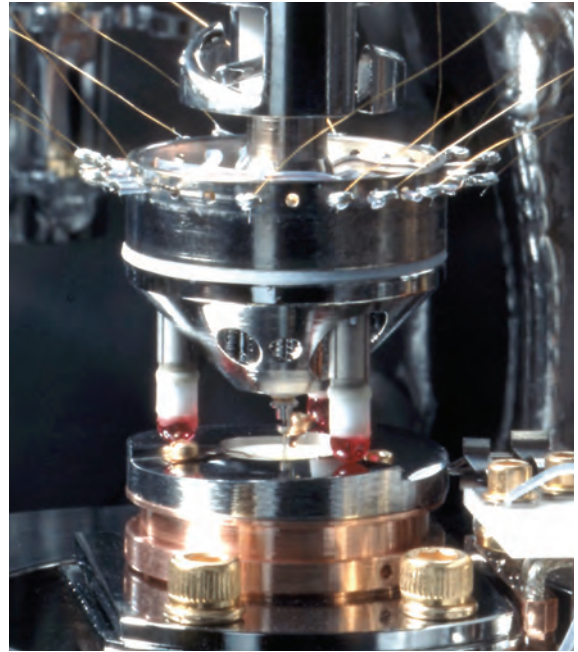
S. Tait, Indiana University:
Multi-Technique Analysis Chamber with XPS,
LEED, XYZR manipulator, and separate Low-
Temperature, Organic Deposition Preparation
Chamber with XYZR manipulator

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Beetle AFM/STM Scan Head

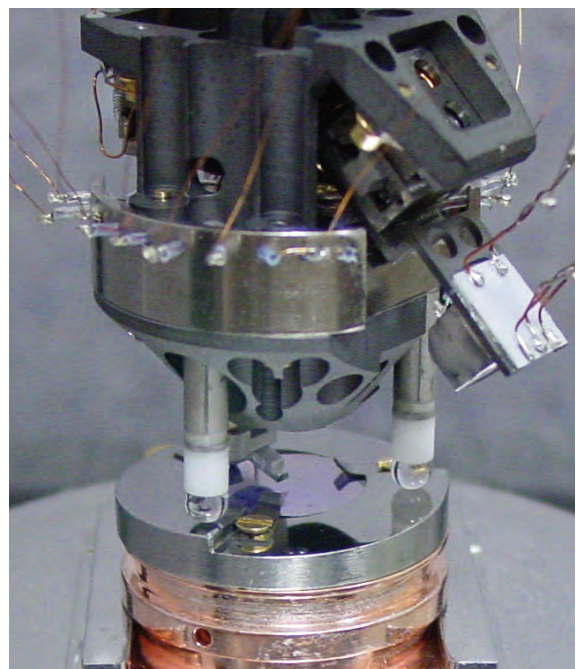
Based on the field-proven “Johnny Walker” Beetle™ design, RHK’s Beetle is the most mechanically and thermally stable VT SPM on the market today. Beetle’s superb Work-Horse performance comes from its inherent mechanical and thermal stability due to a small mechanical and thermal loop, inherently stiff and compact Beetle design, and symmetrical geometry. With thermal drift $<1 \text{ \AA}/\text{min}$, Beetle is ideal for spectroscopy and prolonged observation of a particular feature. Image from 30K to 1000K for STM, and now image to 1000K for AFM with our new Beetle Therma AFM.



Beetle STM Scan head

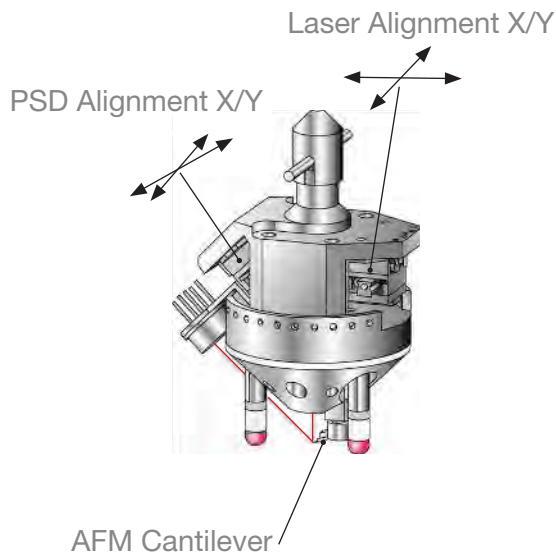
Laser & PSD Alignment

Beetle AFM/STM heads are based on our laser-deflection PSD feedback design. This enables the full AFM range: Normal Force, Lateral Force, Non-Contact, Near Contact, Constant Height, CAFM, MFM, simultaneous AFM/STM, and more. RHK further refined this design to ensure fast, efficient orthogonal alignment and positioning, without the frustrations of other brands. The unique RHK design also ensures that laser optics, alignment, head and optics are scanned as a unit, ensuring true quantitative lateral force (LFM and nanotribology) measurements can be made and artifacts are eliminated.



Beetle AFM/STM Scan head

Beetle AFM Advantages



Direct Line of Sight Laser Spot Positioning

Straightforward orthogonal alignment and positioning

No Mirrors or Lenses

Easily Align Laser at Center of PSD

Cantilever mounting not critical

True Lateral/Friction Force Imaging

Quantitative AFM Measurements

Easy to null Normal & Lateral force signals (optimal alignment of photodetector)

Laser and PSD relationship is maintained during scanning

Conductive Probe Atomic/Friction Force Microscopy

Conductive probe atomic/friction force microscopy on silicon pn junction - Topographic, current, and friction images taken at the sample bias of +4V and -4V in contact AFM mode.

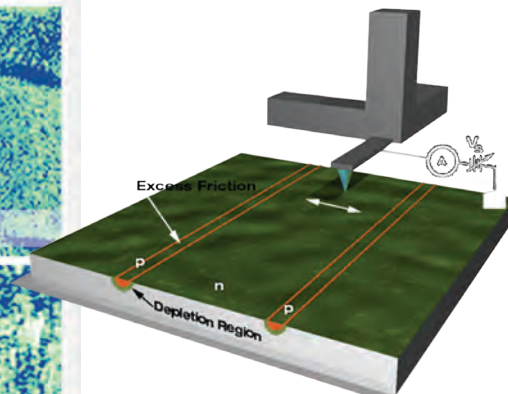
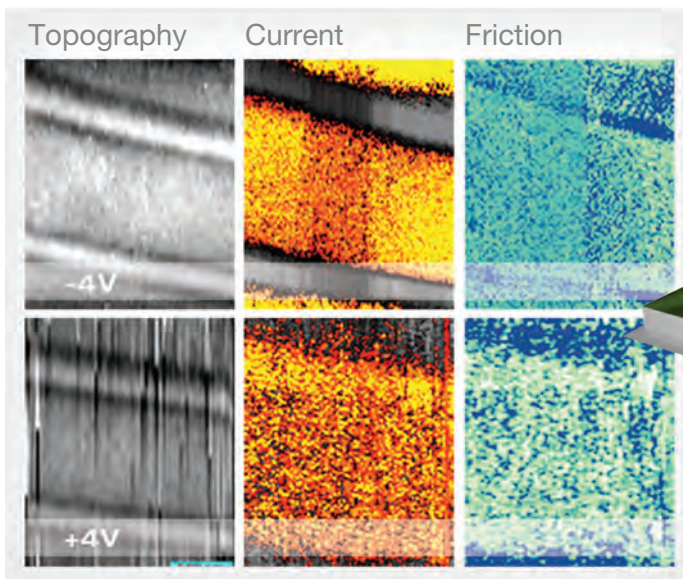


Image Credits:

Jeong Young Park, Yabing Qi,
D. F. Ogletree, P. A. Thiel, and M. Salmeron
Lawrence Berkeley National Laboratory
University of California, Berkeley

Beetle

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Variable Temperature

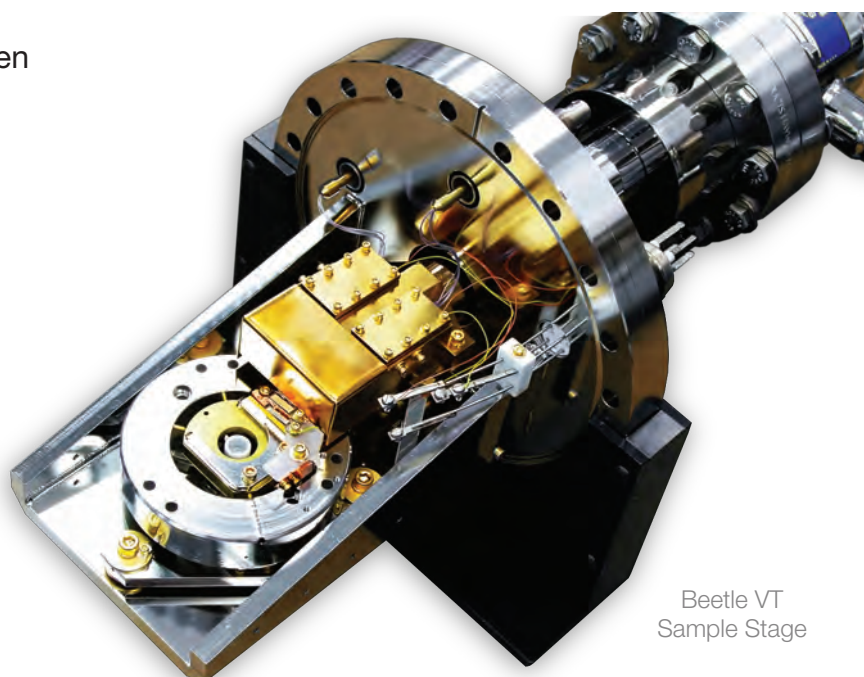
Our VT design is implemented intelligently: True sample temperatures are measured with thermocouples in direct contact with the sample, eliminating unreliable indirect readings. Sapphire mounts minimize thermal transfer during heating yet maximize it for cooling. Electrical isolation provides low-noise measurement of tunneling current and allows e-beam heating for sample preparation.

Each of our uniquely designed sample holders works across the full range of extreme temperatures. For cooling, choose either LN₂ to reach below 100K, or LHe to achieve 30K or less. For heating, sample holders are equipped with built-in direct current, radiative, and e-beam capabilities and can provide temperatures above 1500K, using a tungsten filament for radiative or e-beam heating, or a quartz lamp for reactive gases or under pressure.

Beetle Therma AFM



The new Beetle THERMA AFM is capable of operating at temperatures ranges between 30K and 1500K during sample preparation, and temperatures between 30K and 1000K while scanning, even with AFM.

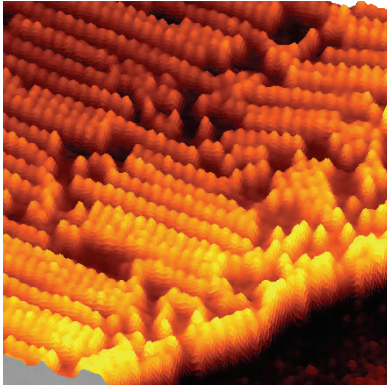


Beetle VT
Sample Stage

Variable Temperature Capabilities

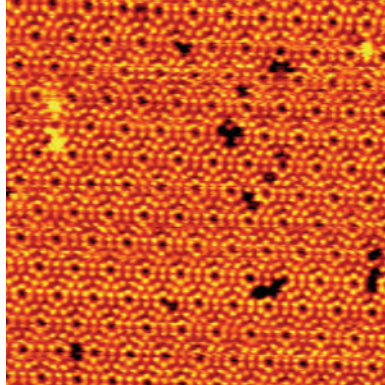
Variable Temperature Performance

LN₂ Cooling Stage: ~100K



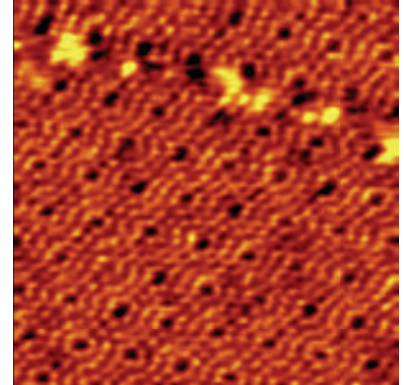
Co(II) tetraphenylporphyrin and Co(II) phthalocyanine on Au(111), imaged at 176K. Courtesy of D. Barlow and K.W. Hipps, Washington State University.

LHe Cooling Stage: ~30K

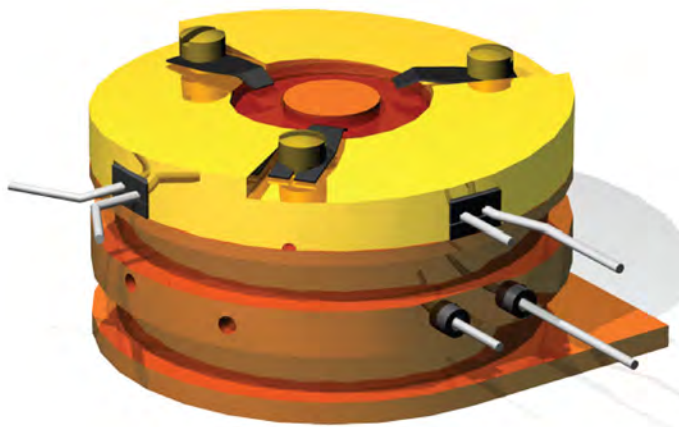


Atomic resolution Si(111) imaged at 28K with LHe cooled UHV STM

VT Sample Holder: ~1000K



UHV 300 STM image of atomically resolved Si (111) surface at 1000K. Courtesy of J. Krim, North Carolina State University.



6 Contact Sample Holder
With Thermocouple

**Each Sample Holder Provides:
Radiative, Resistive, & E-Beam Heating**

6 Contacts to Sample

**Thermocouple in direct contact with
sample surface for true, accurate
temperature measurements**

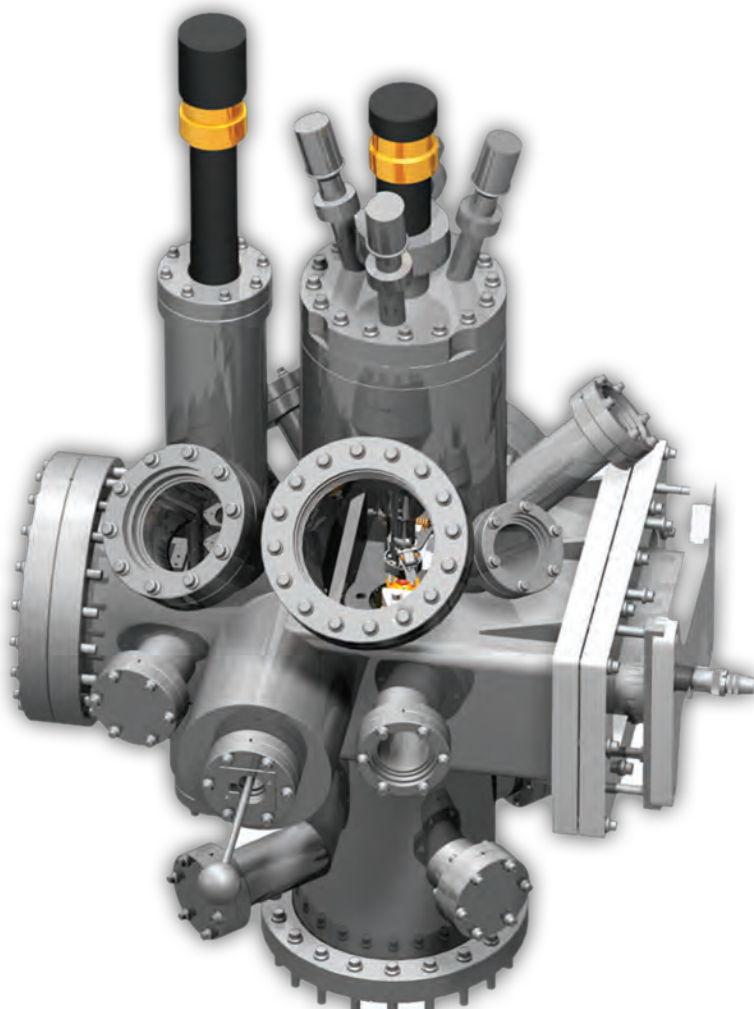
**Available ceramic button heater or
quartz bulb for heating in reactive gas**

Beetle

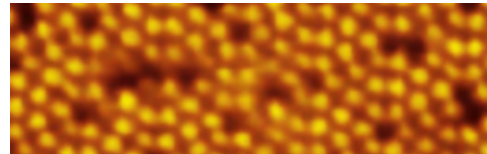
UHV VT AFM / STM

Variable Magnetic Field

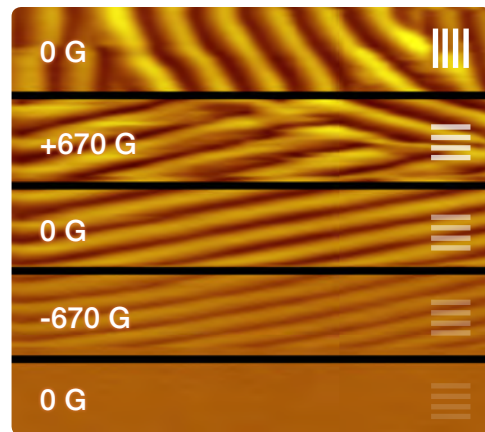
RHK's unique electromagnet design delivers a reversible and continuously variable field up to >3000 Gauss in-plane with a sample size of up to 1 cm. No compromise is made in resolution, drift, stability, or vibration isolation. The field can be varied real-time while imaging without retracting the probe from the sample.



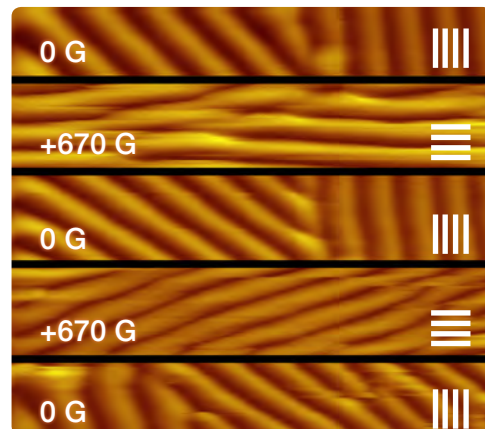
VMF Beetle
Chamber Design



No Compromise in Resolution
Sample: Si (111) 7x7

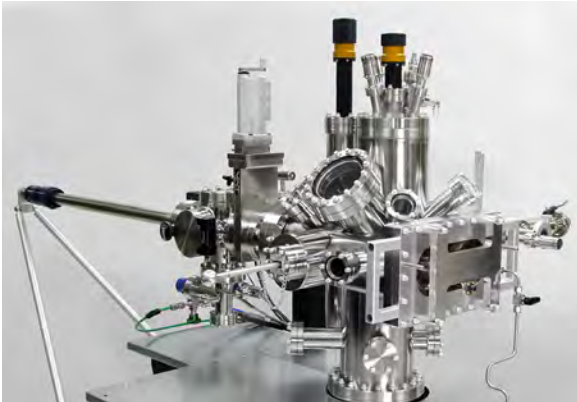


VMF at Work: The RHK VMF AFM/STM remains at a very low temperature while the magnetic field is intensified in real-time. The increase in magnetic field "fades" the magnetic strip.



VMF at Work: The VT capability of the RHK VMF AFM/STM is used to cool down the LCMO sample in order to increase the visual magnetic properties. The sample is placed under a magnetic field that is switched on and off resulting in physical changes in the sample.

Variable Magnetic Field (VMF)



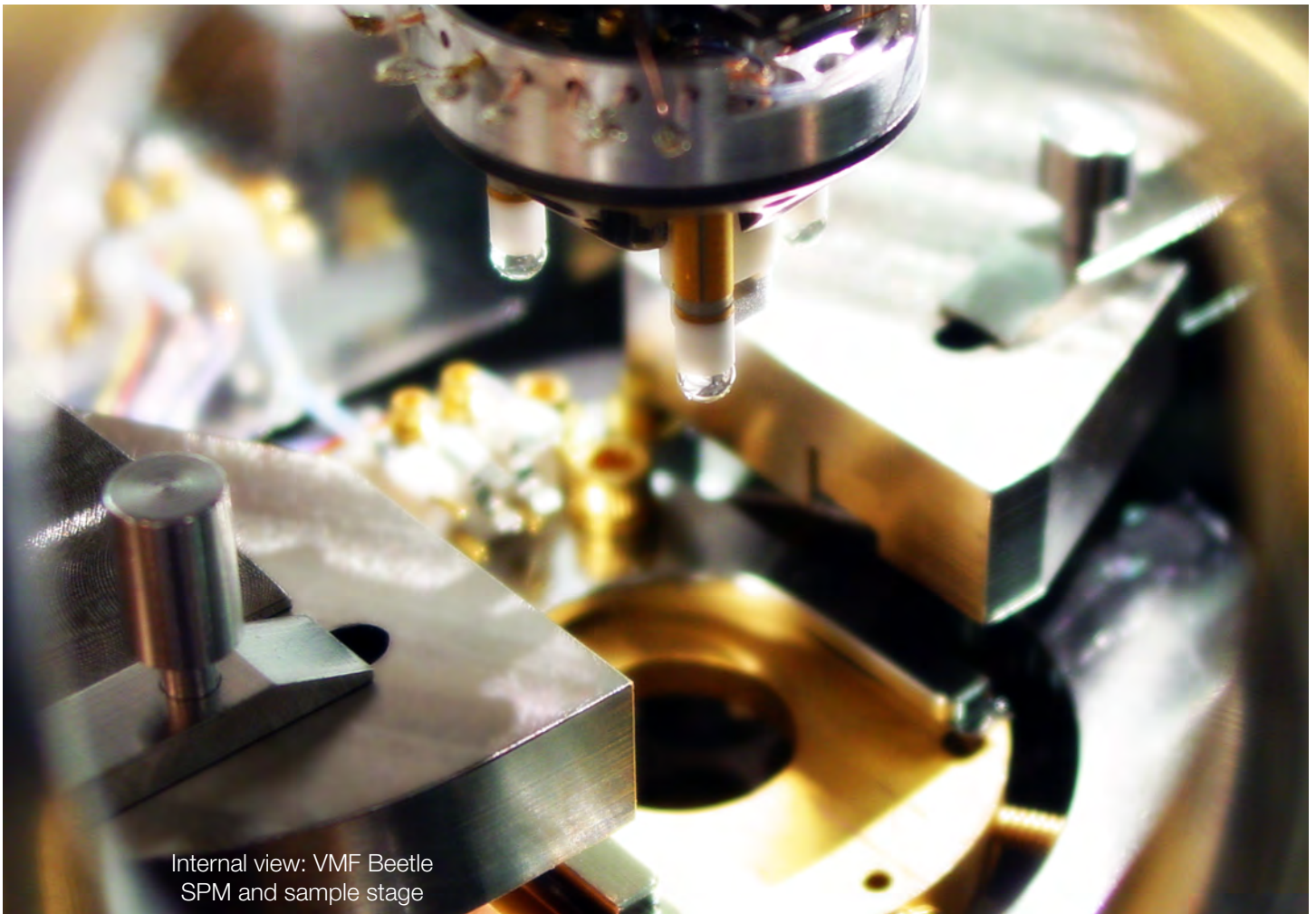
VMF Beetle System

Up to 3000 Gauss magnetic field in sample plane

Ex-vacuum convectional electromagnets require no cooling and provide continuously variable & reversible fields

Optional out-of-plane magnetic field

No compromise in SPM resolution, drift, or stability



Internal view: VMF Beetle
SPM and sample stage

Beetle

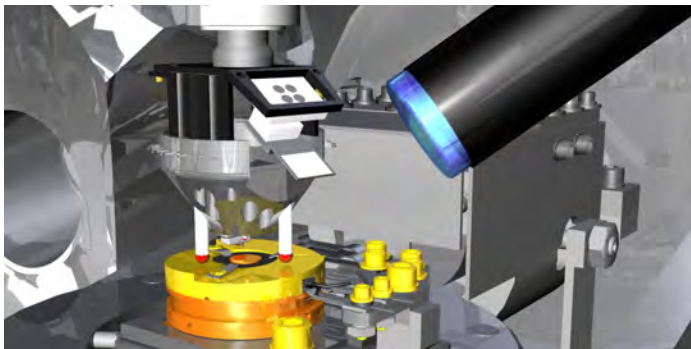
UHV VT AFM / STM

Visual / Optical Access

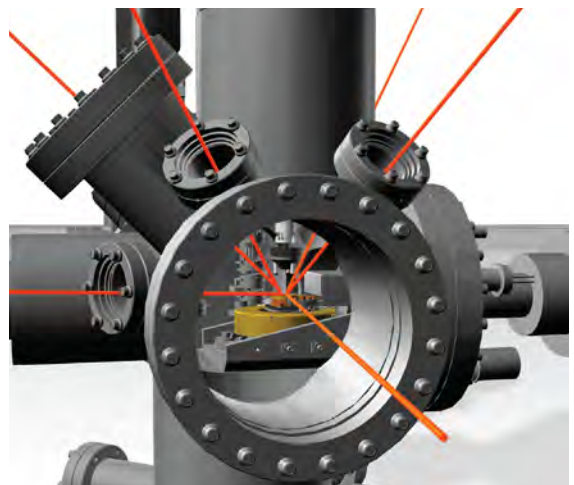
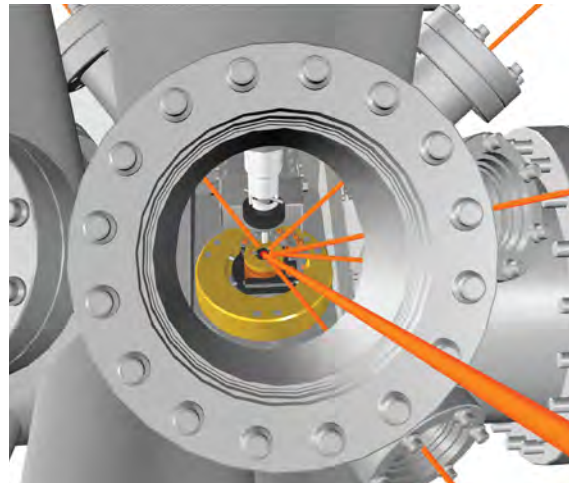
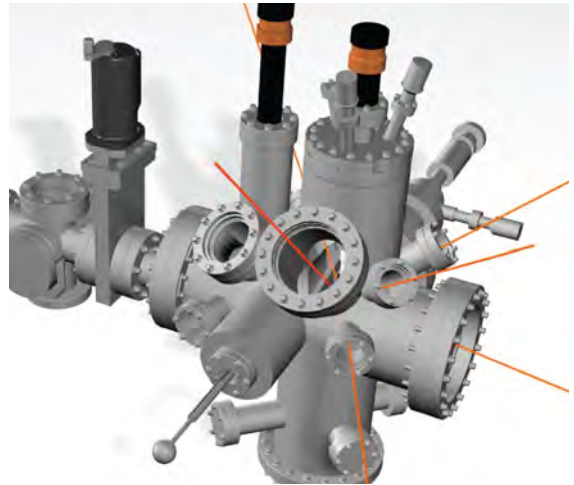
In addition to the modular design used for the Beetle SPM systems, exceptional optical/visual access has been designed into every Beetle model. This design enables unrivaled ease of use and supreme flexibility, to allow for the unique aspects of your SPM system.



Optional Inverted View-
port Optical Access

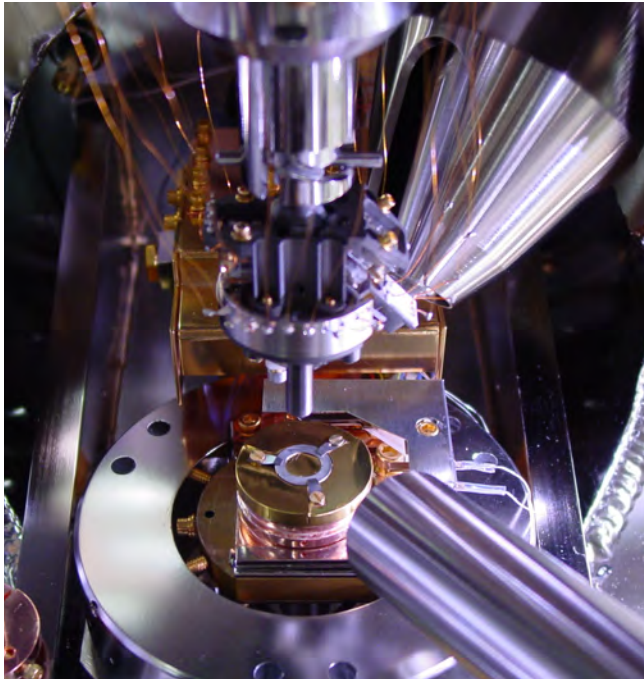


Standard Viewport Access (orange)



Unrivaled Sample Access

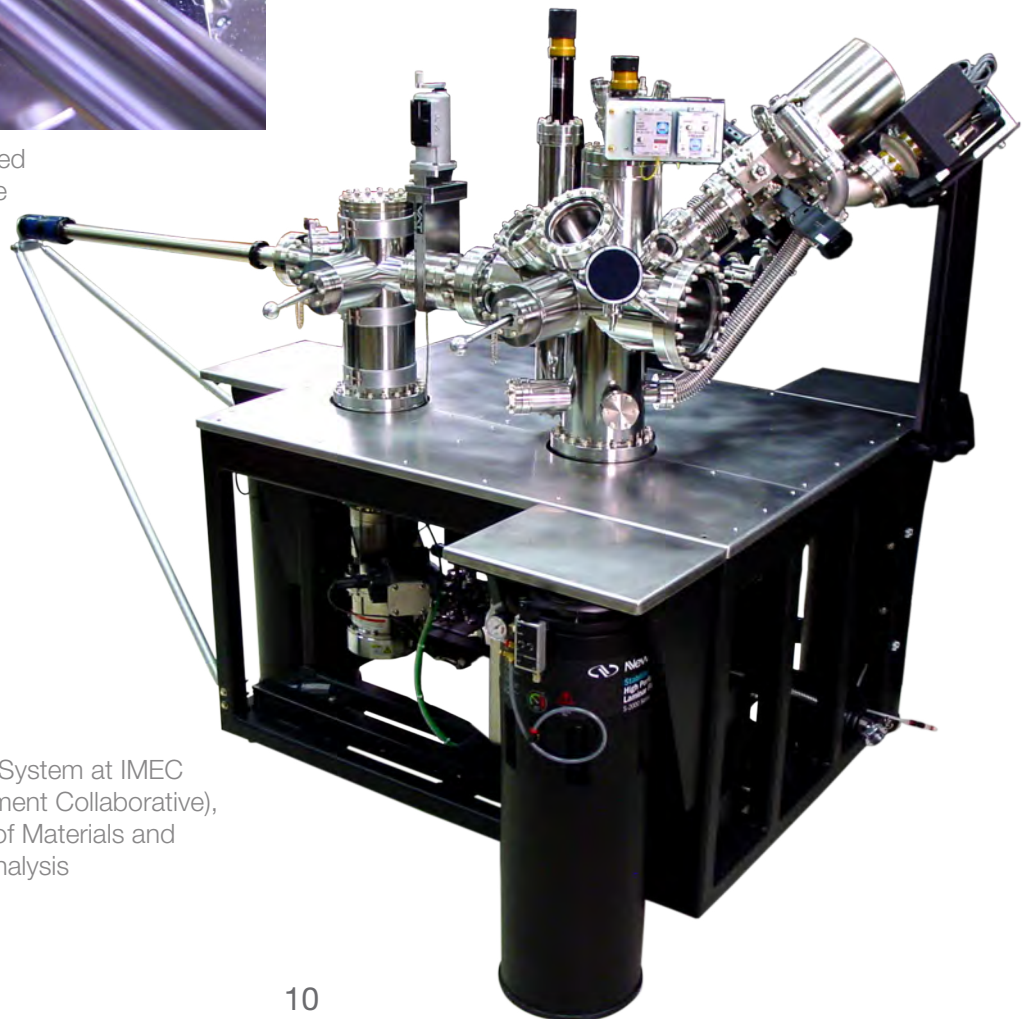
SEM-Ready Configuration



View Of Sem And Detector Aimed at a Beetle AFM Sample Stage

RHK unites the speed and convenience of SEM-guided probe placement with uncompromised VT AFM/STM performance and resolution.

Enjoy more results in less time: With both sample and probe in the SEM's outstanding field of view, navigating tip to feature is fast and sure



Beetle AFM/STM + SEM System at IMEC
(International Medical Equipment Collaborative),
Leuven, Belgium, Dept. of Materials and
Components analysis

Beetle

Technical Specifications



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AFM/STM 5 μm Scan Head for UHV or Ambient:

0.5 \AA X,Y & 0.1 \AA Z resolution

6 μm X,Y & 0.3 μm Z scan ranges with $\pm 150\text{V}$ control

8 μm X,Y & 0.5 μm Z scan ranges with $\pm 215\text{V}$ control upgrade

Coarse Motion: 5 mm x 5 mm x 0.5 mm. Larger ranges available

Beam deflection; orthogonal laser and PSD alignment

Laser Fiber Optic and Cantilever all scanned together, as a unit

Laser diode with fiber optic pigtail

Laser fiber feedthrough with lens

4-quadrant PSD

High-stability, small mechanical loop Besocke-Beetle design

Thermal Drift < 1 $\text{\AA}/\text{min}$.

Sample Heating and Cooling:

Sample cooling SPM stage: 30K - 35K (LHe), (based on model) / 100K (LN2)

Sample heating on SPM stage: 1,500K

Sample cooling on Prep stage: 100K

Sample heating on Prep stage: 1,500K

SPM Imaging from 30/35K up to 1000K in STM and AFM (THERMA)

Thermocouple in direct contact with sample surface for true sample temperature measurement

Electrical contacts:

6 contacts on sample holder; on SPM stage; and on Prep chamber stage

Tip/Sample Storage in SPM:

3x probes, 3x sample holders, each with full heating-cooling range

Sample size:

up to 10 mm diameter

Vibration Isolation:

Internal spring suspension with eddy current damping; external air legs

Specialty Beetle system: fixed-mount sample stage, viton cushioning; external air legs

