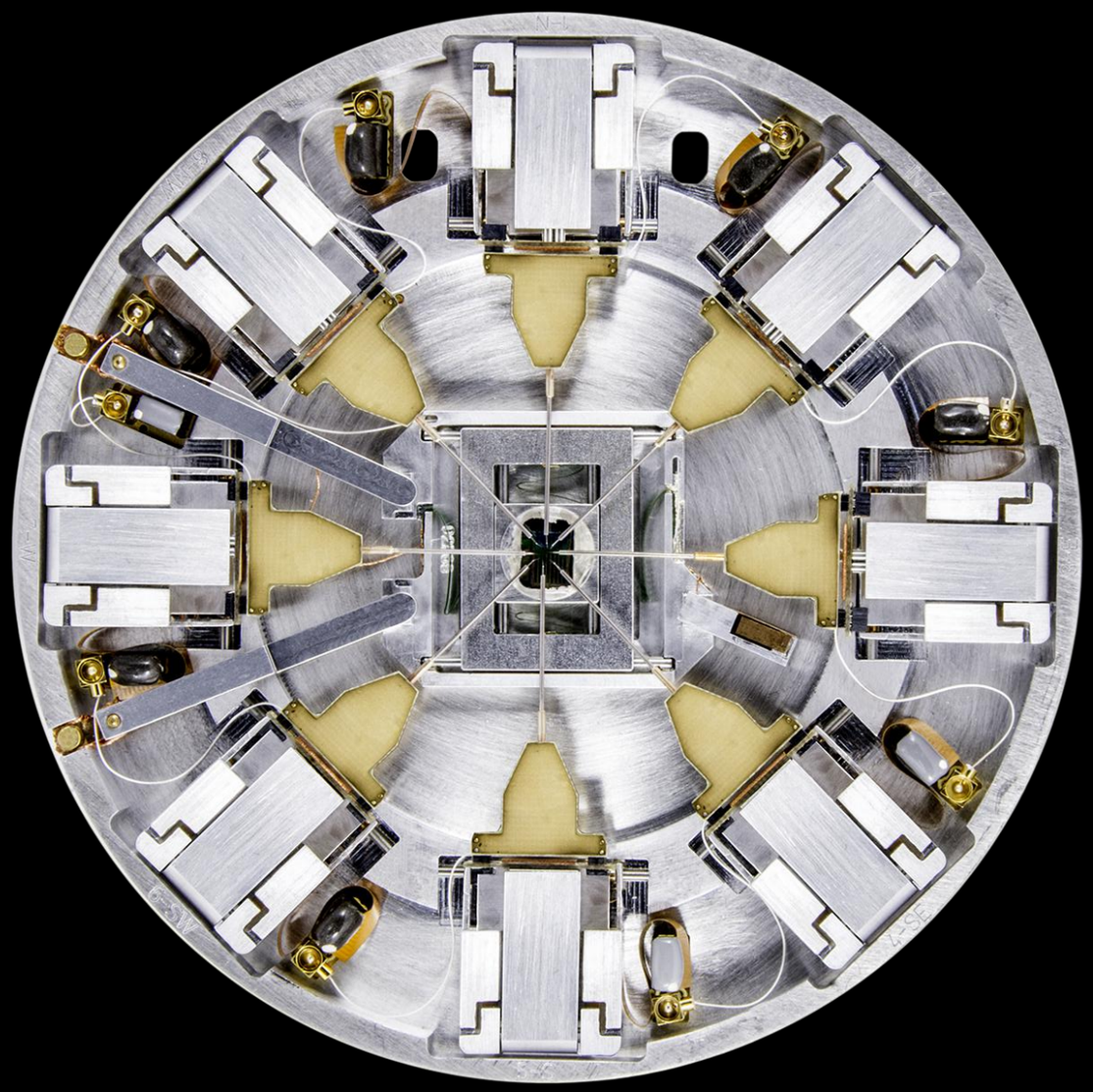
kleindiek nanotechnik



Advanced Failure Analysis

Challenges with nano probing

- positioning accuracy
- safe (soft) landing on contacts
- reliable probe tips with appropriate tip radii
- clean environment: chamber, sample, probe tips
- low sensitivity to vibrations
- dampening of acoustic noise
- drift compensation
- circuit edit / delayering: operation at FIB angle

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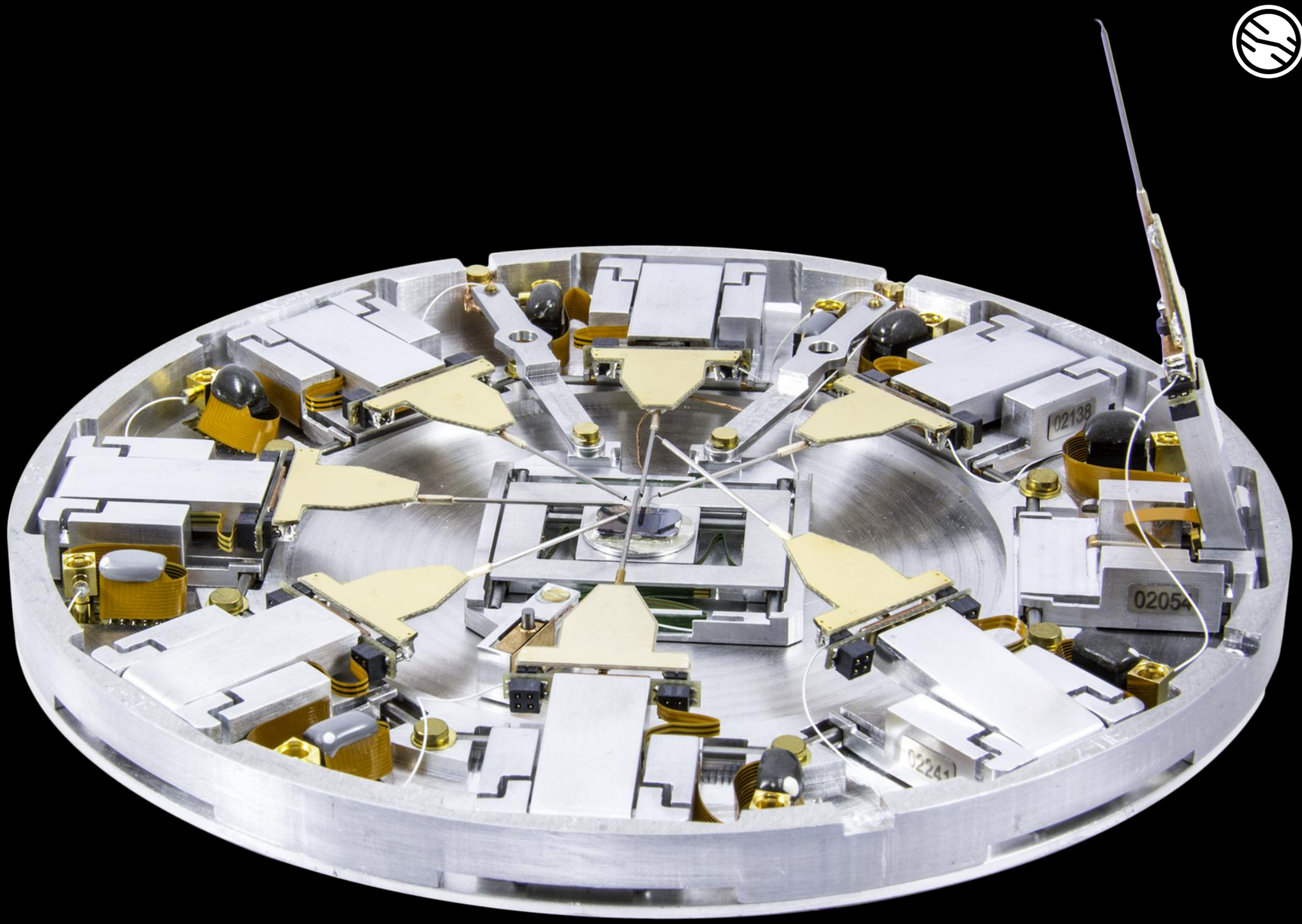
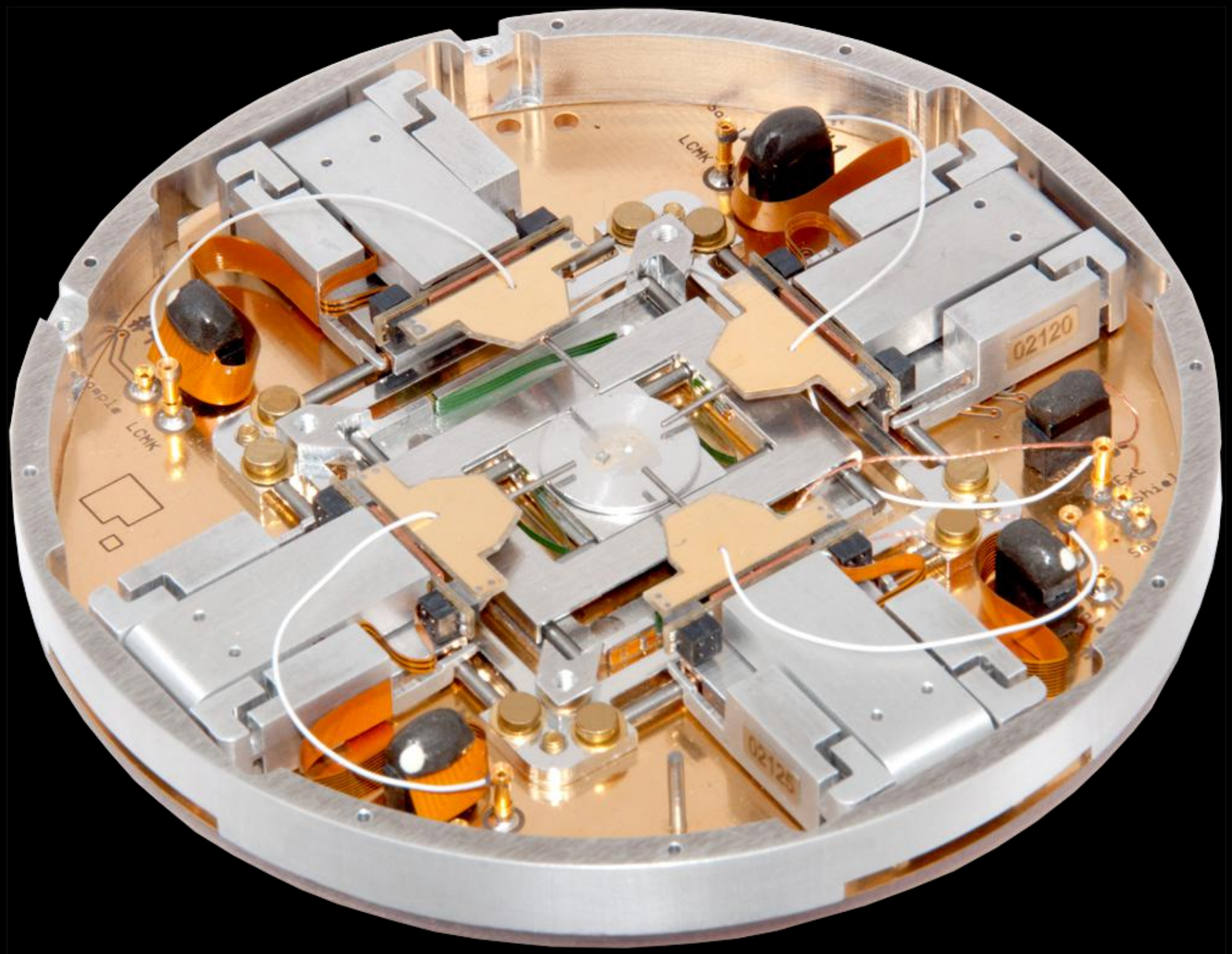


Prober Shuttle with eight probes

(and three-axis substage)

27 piezo-driven axes - 0.25 nm resolution



Prober Shuttle with four probes

(and three-axis substage)

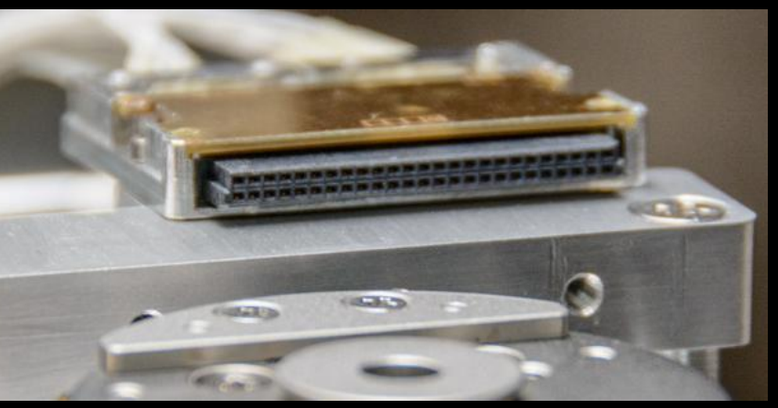
15 piezo-driven axes - 0.25 nm resolution

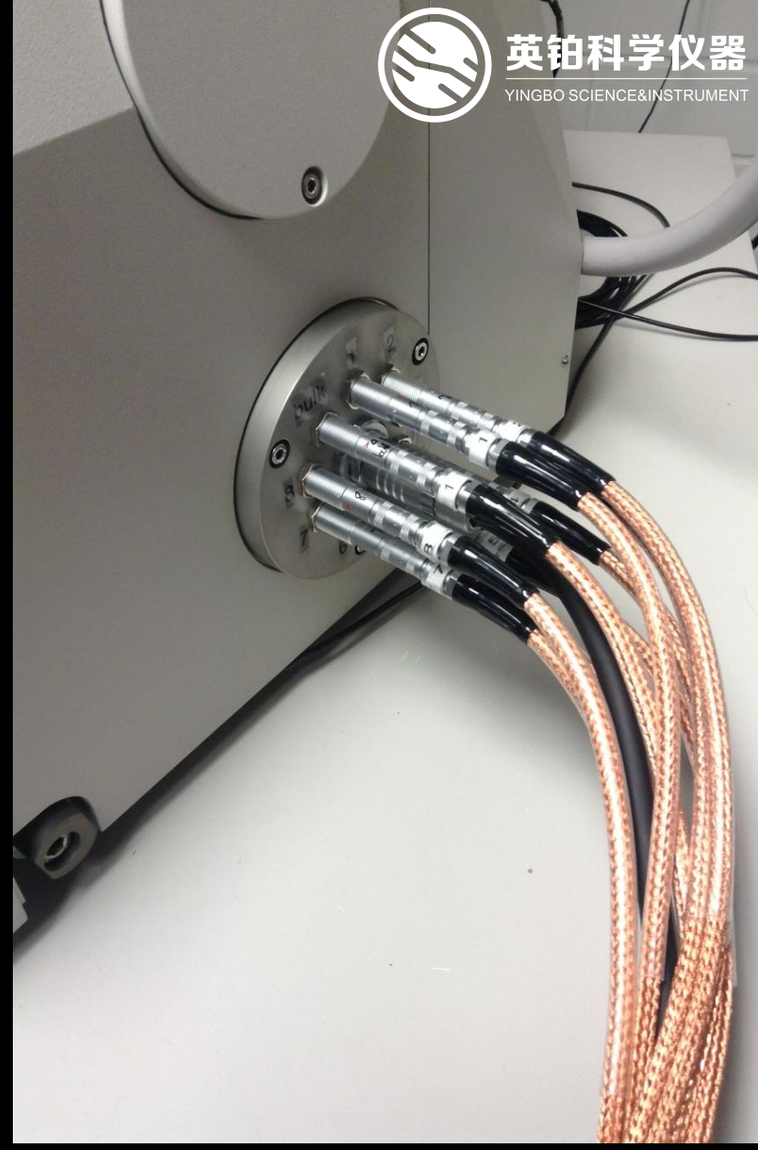
100 mm diameter - 10 mm height

Loadlock compatible

Loadlock compatible

Loadlock compatible





Clean cabling inside and outside the chamber
Low leakage (50 fA/V), low noise

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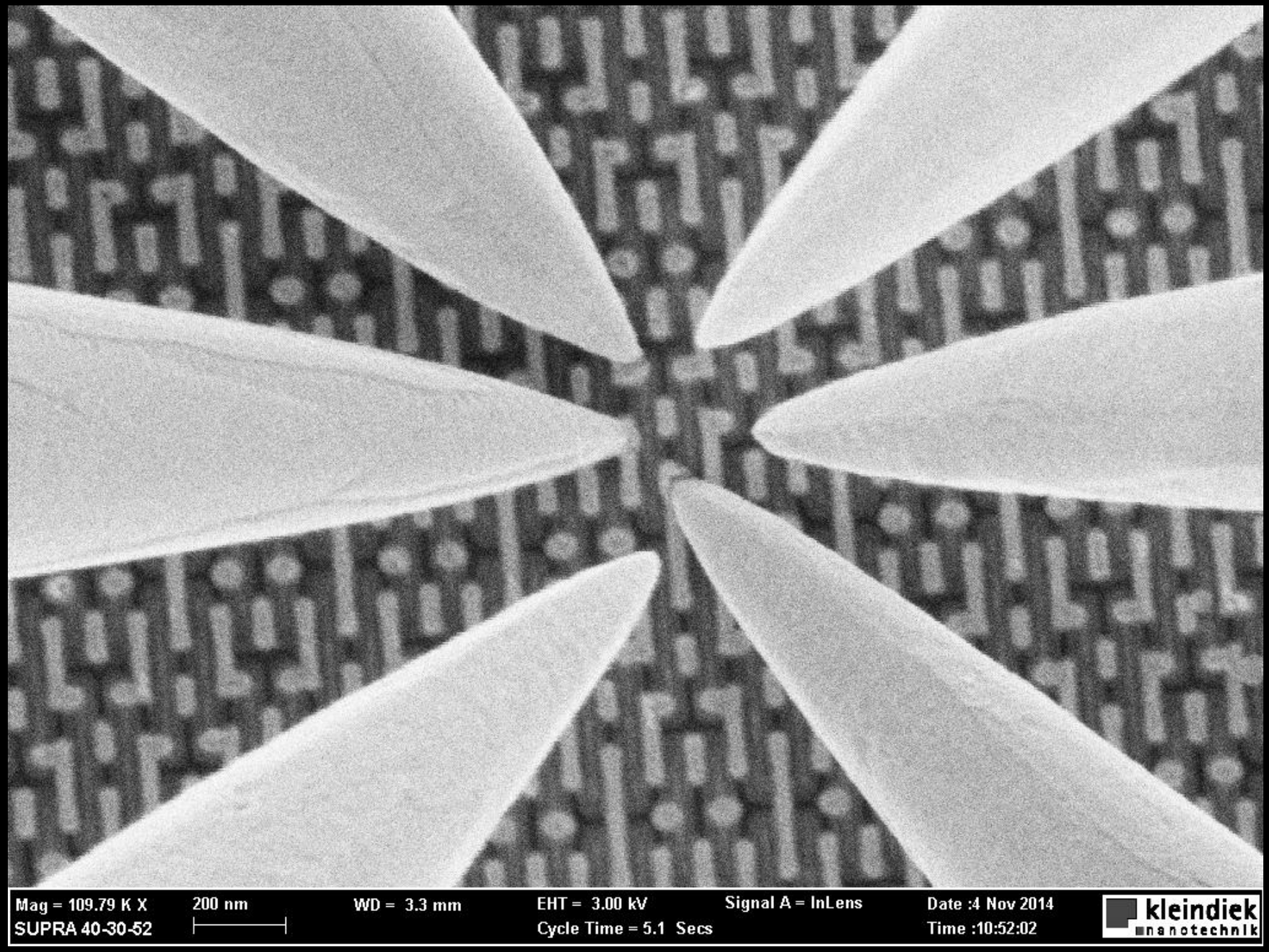
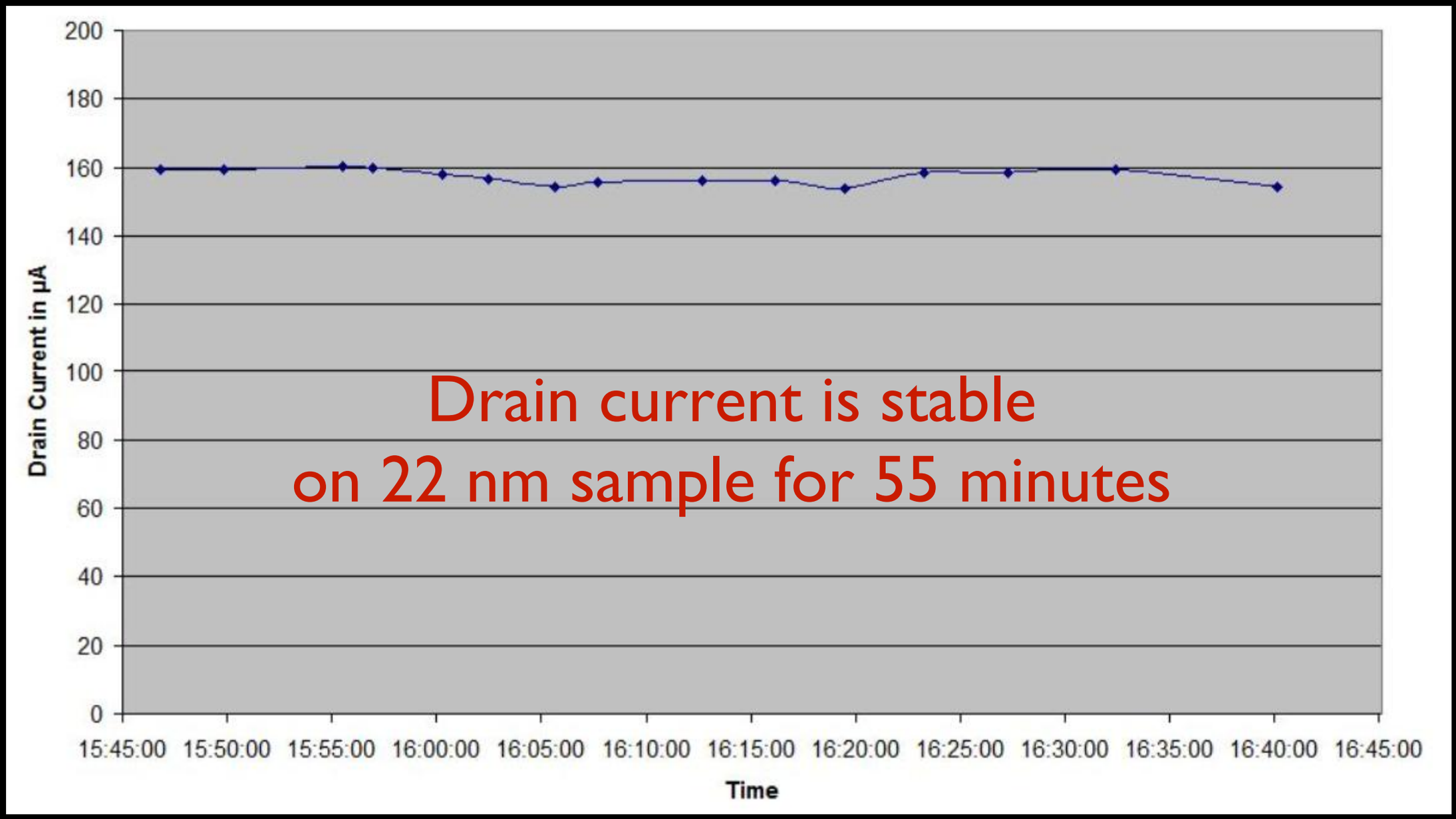
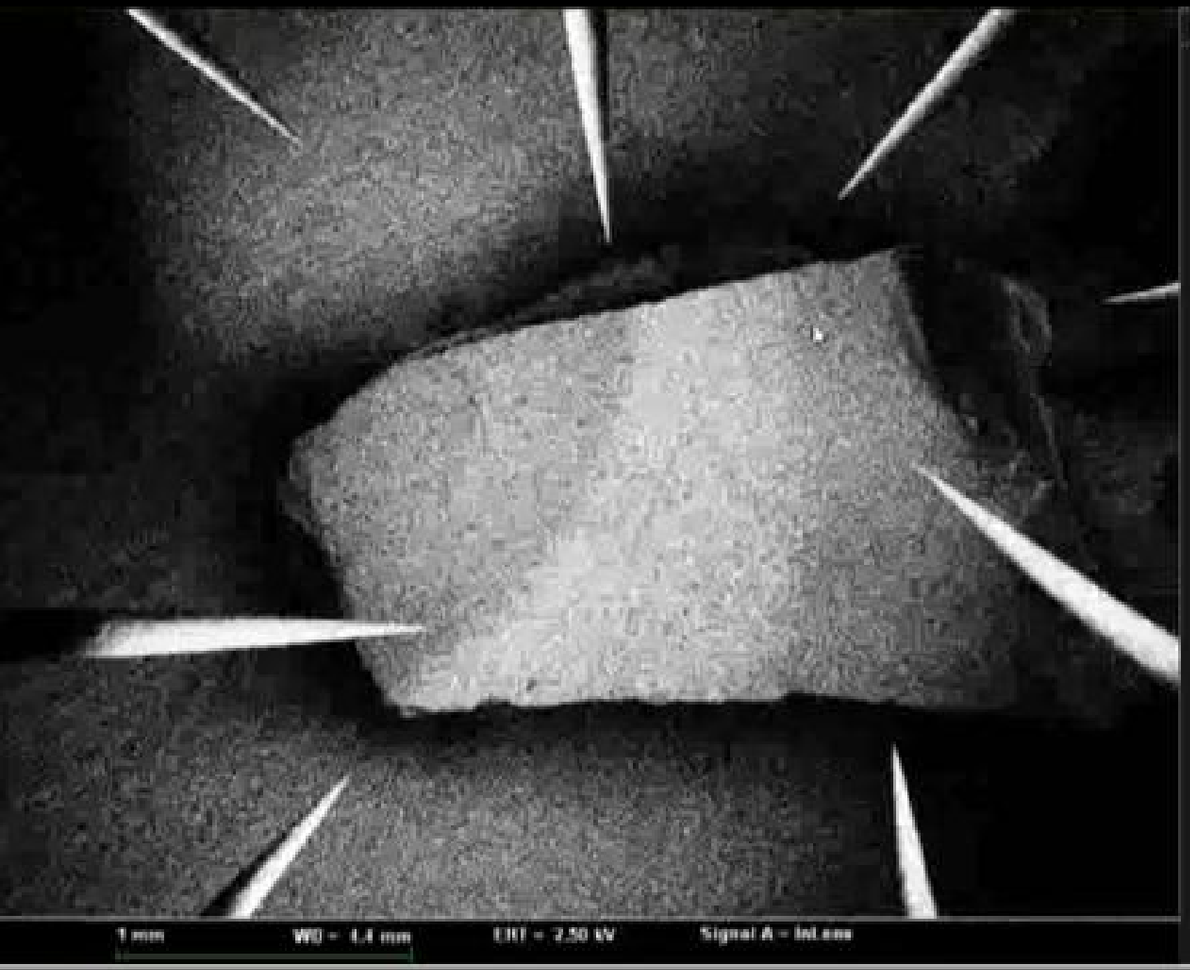
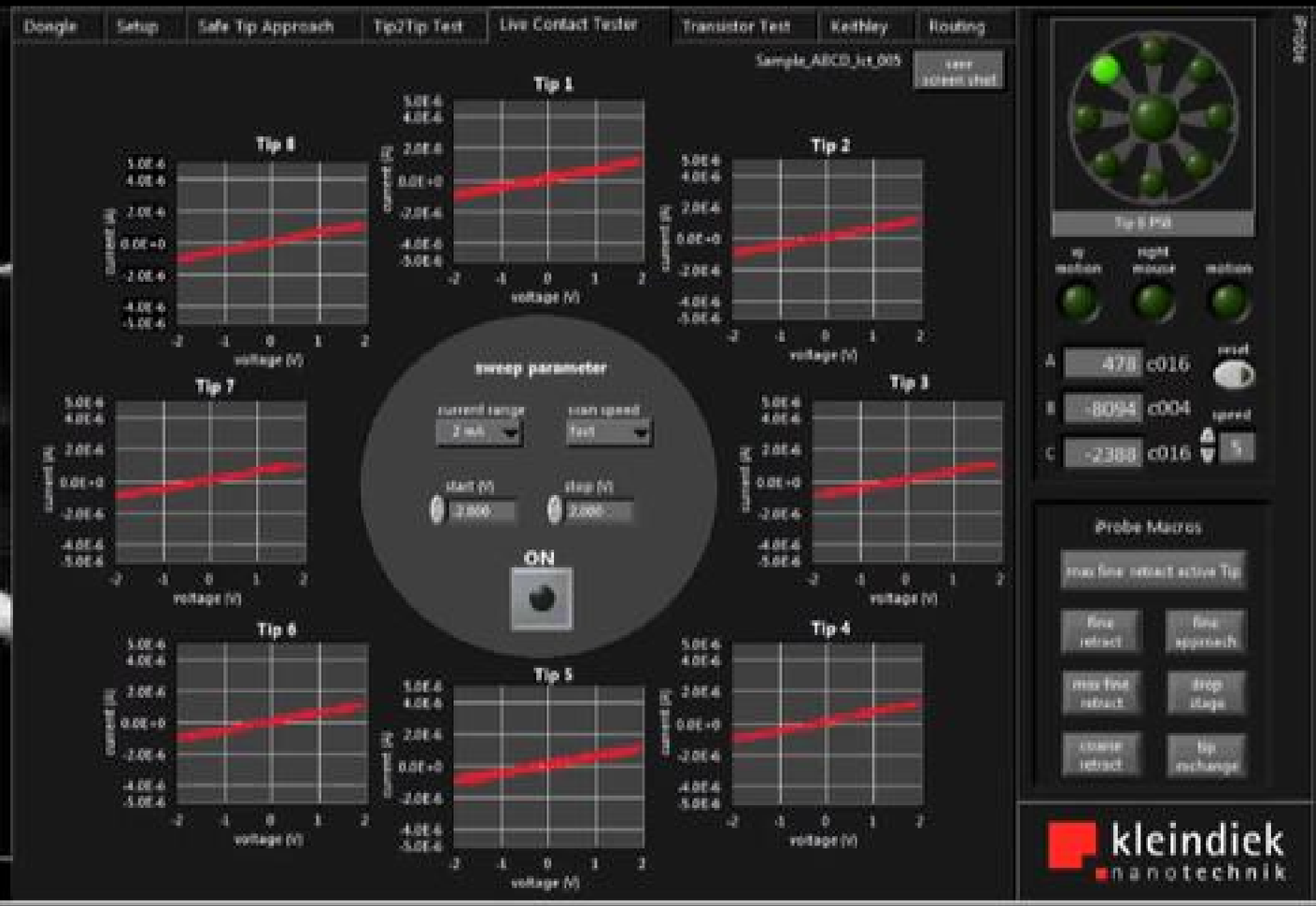


Touch the Sample!
It is all about Fast Results



Nanoprobing requires stability





SEM control interface

Advanced Probing Tools GUI

Advanced Probing Tools

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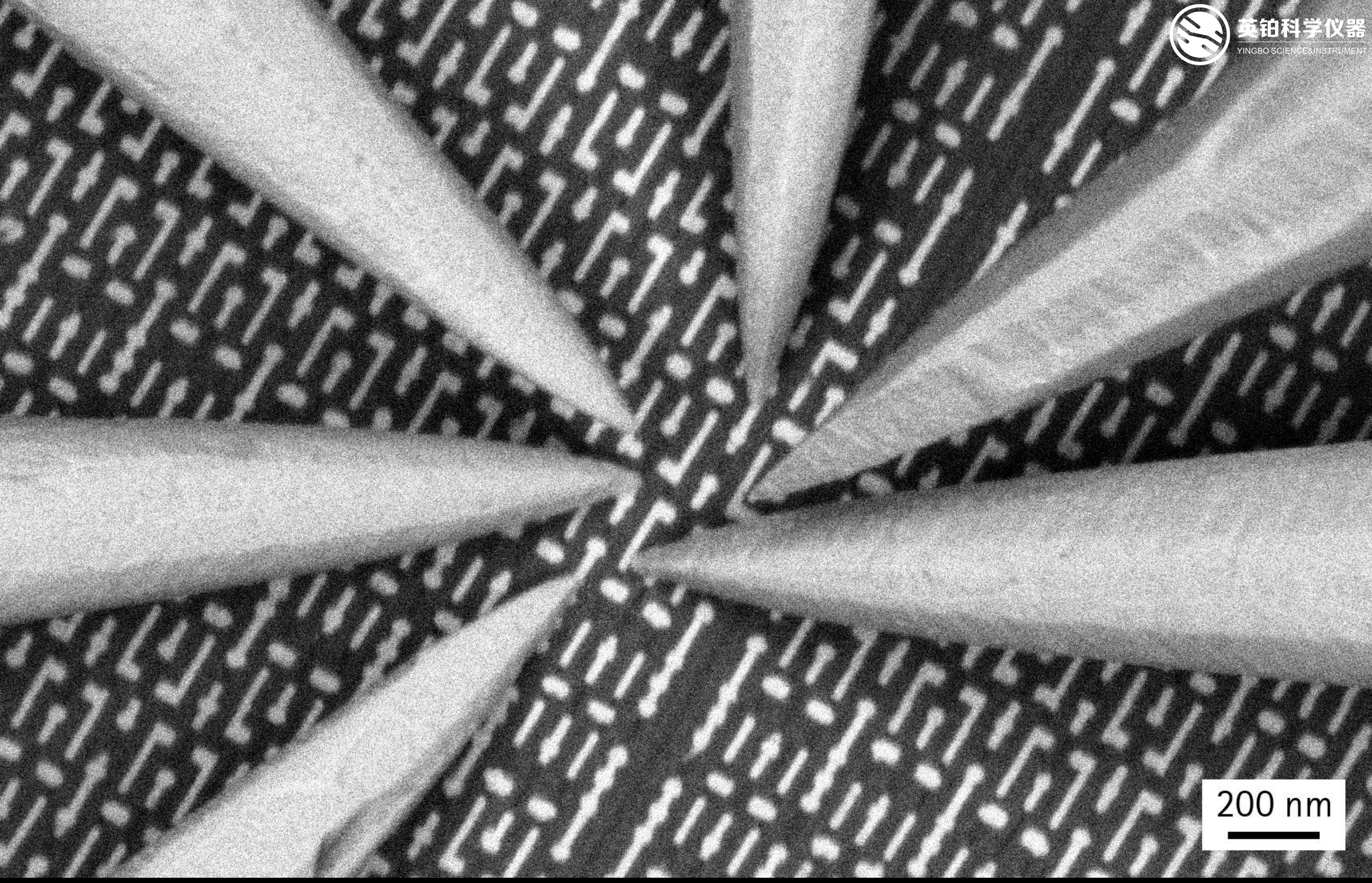
Probing on 14 nm - low profile system



Probing on 14 nm

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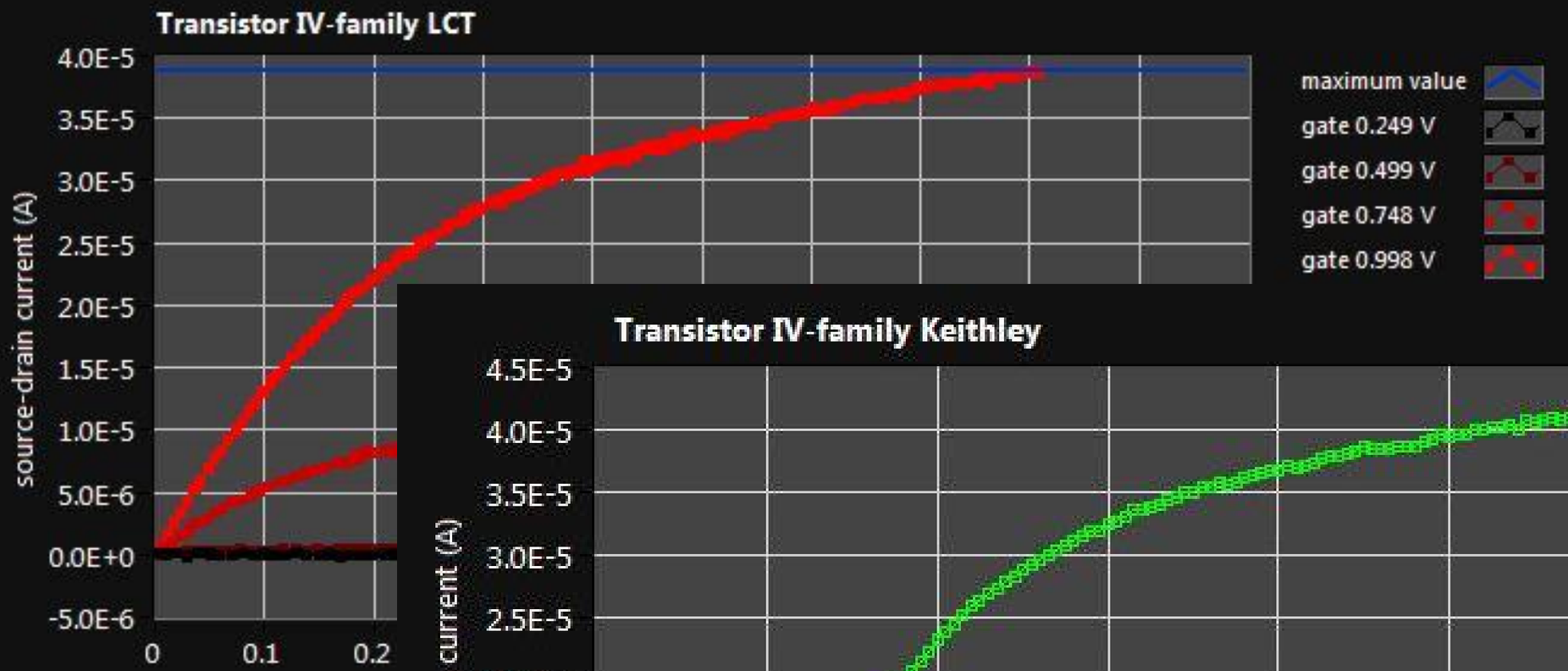
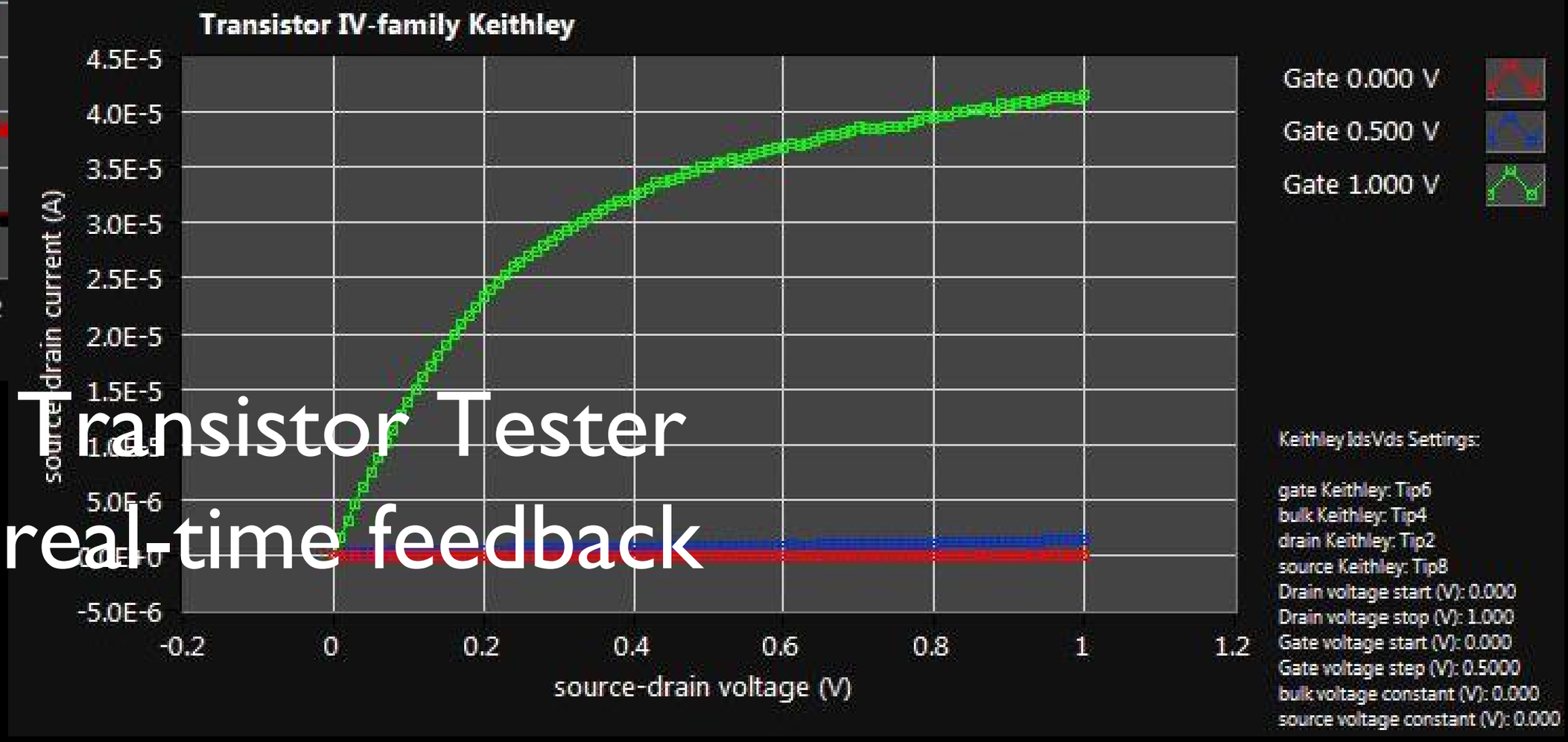
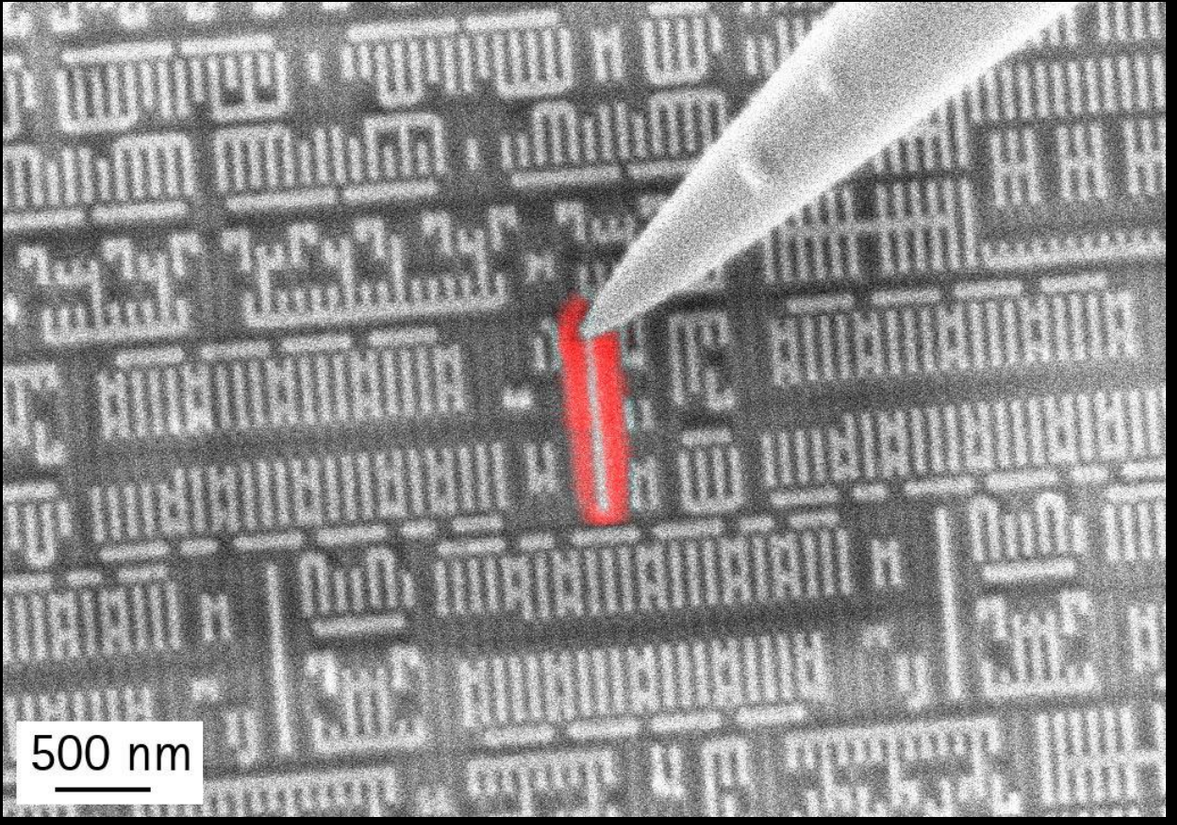


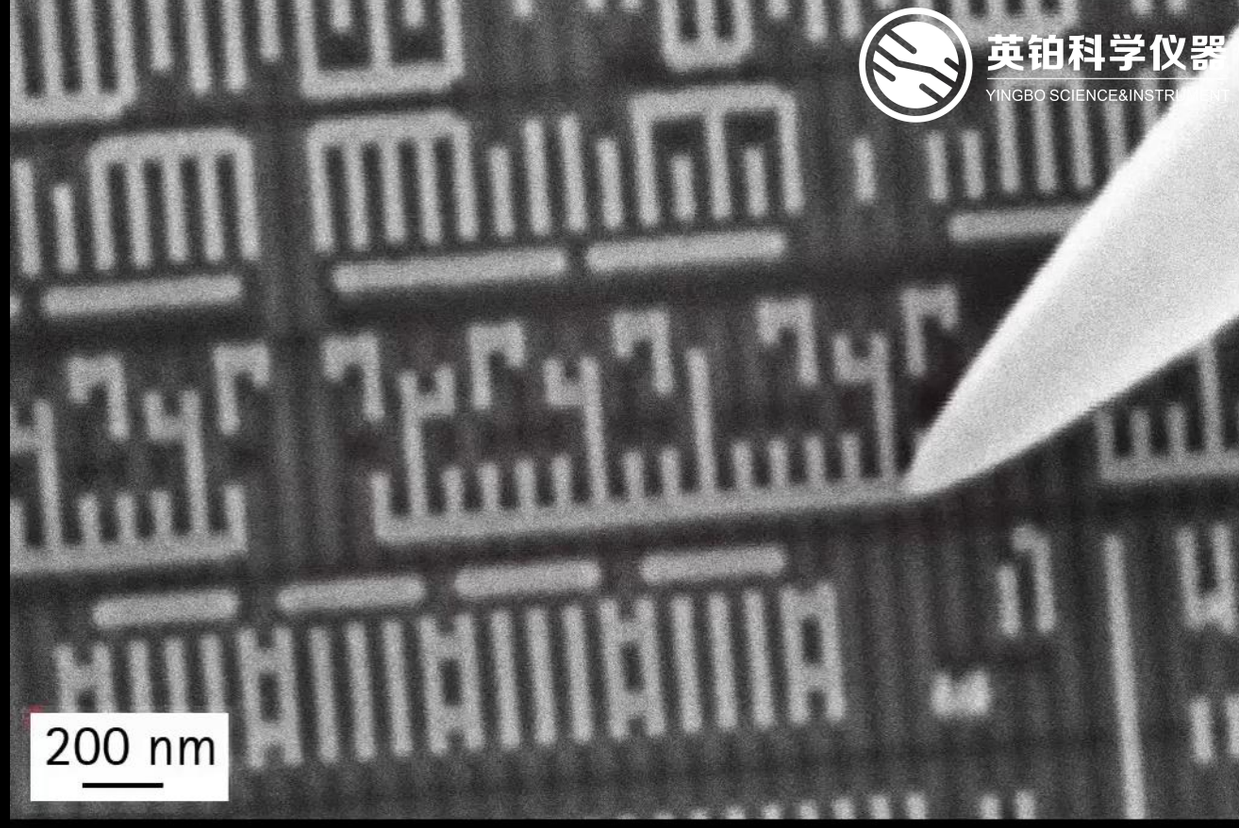


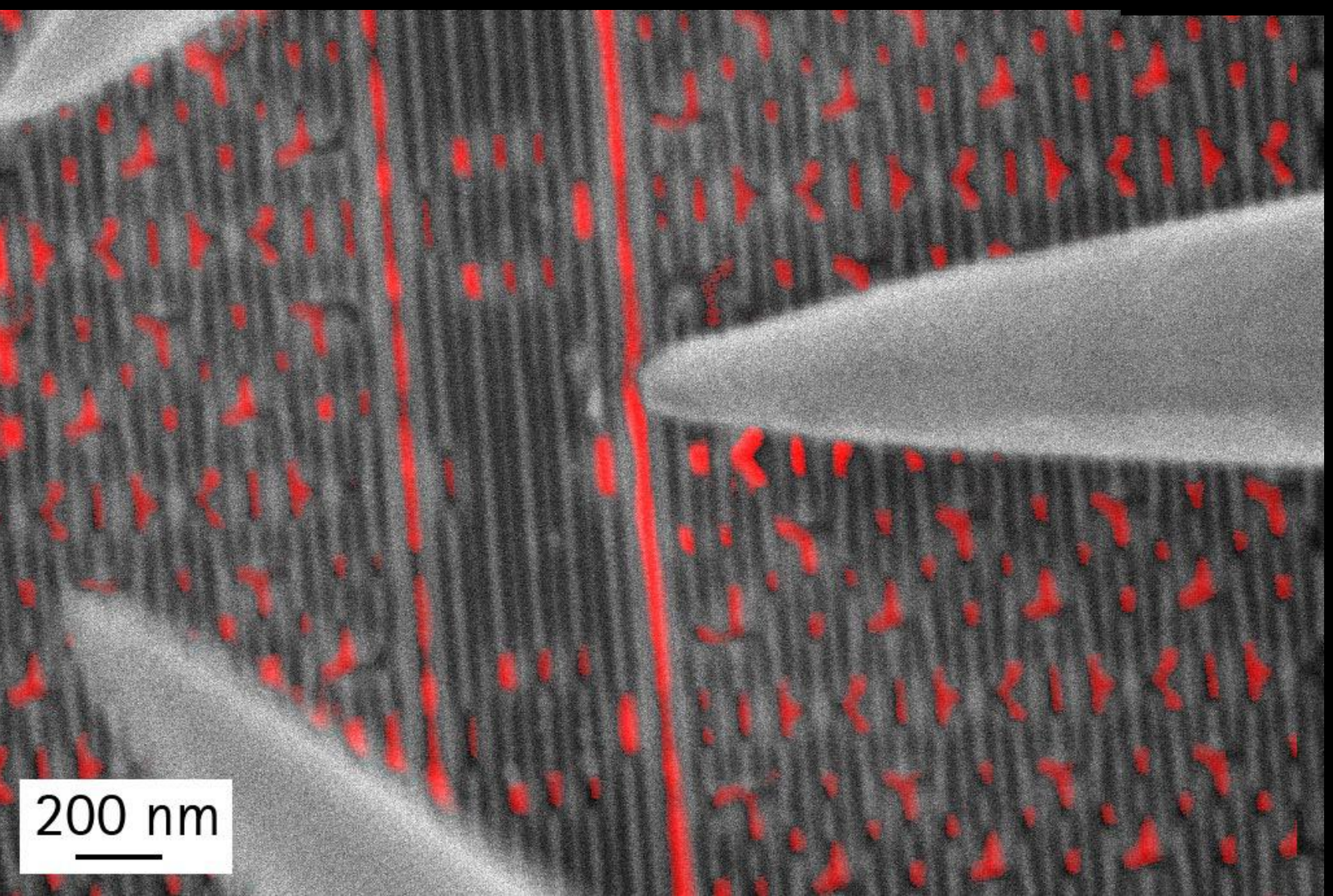
Transistor Tester
real-time feedback

Keithley 4200 result (APT GUI)

Probing results on 14 nm, 10 nm validated!







EBIC/EBAC
on 22 nm
1 MHz
1e8V/A

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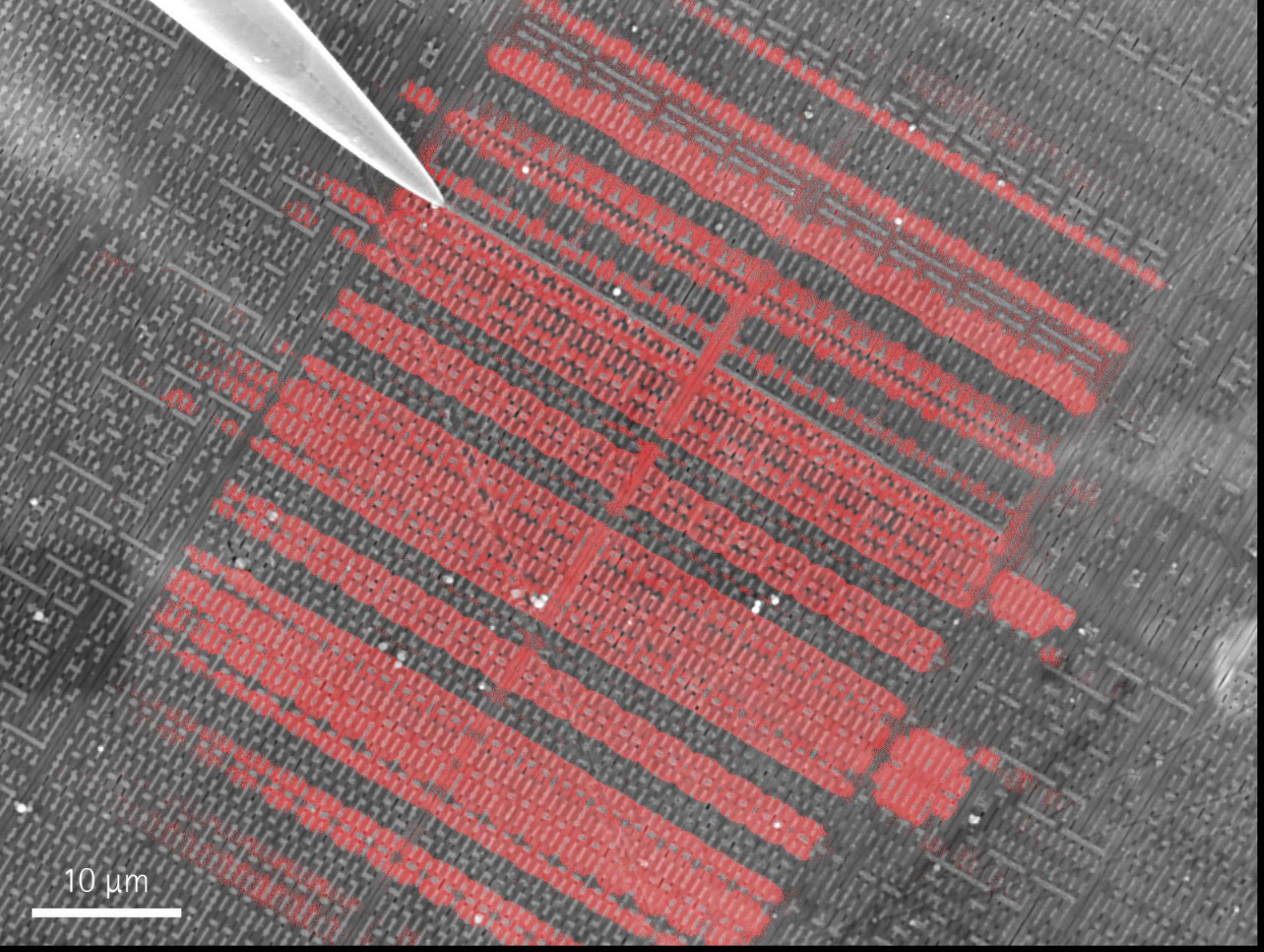
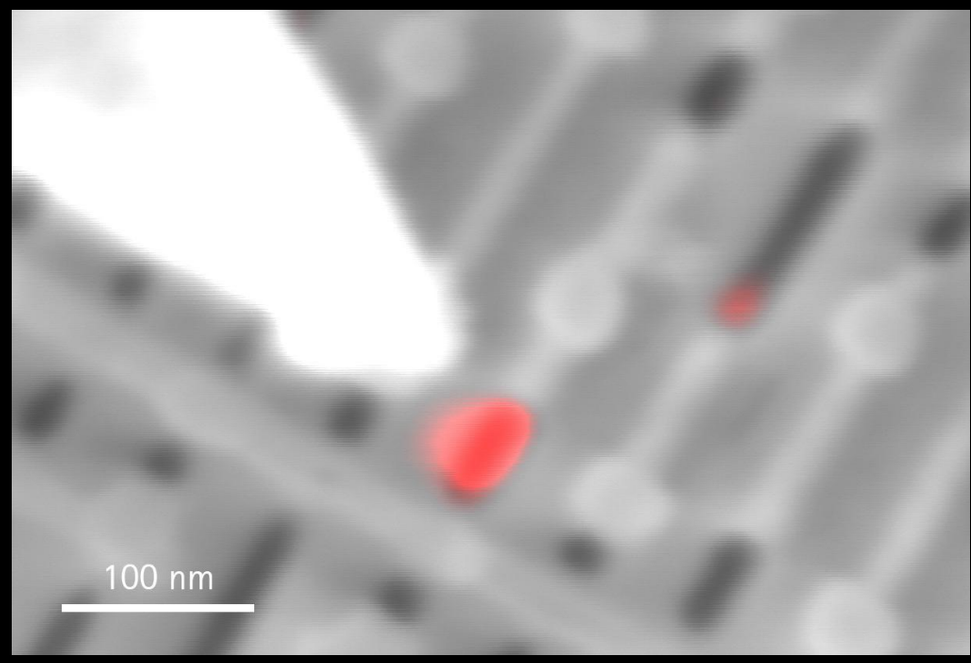
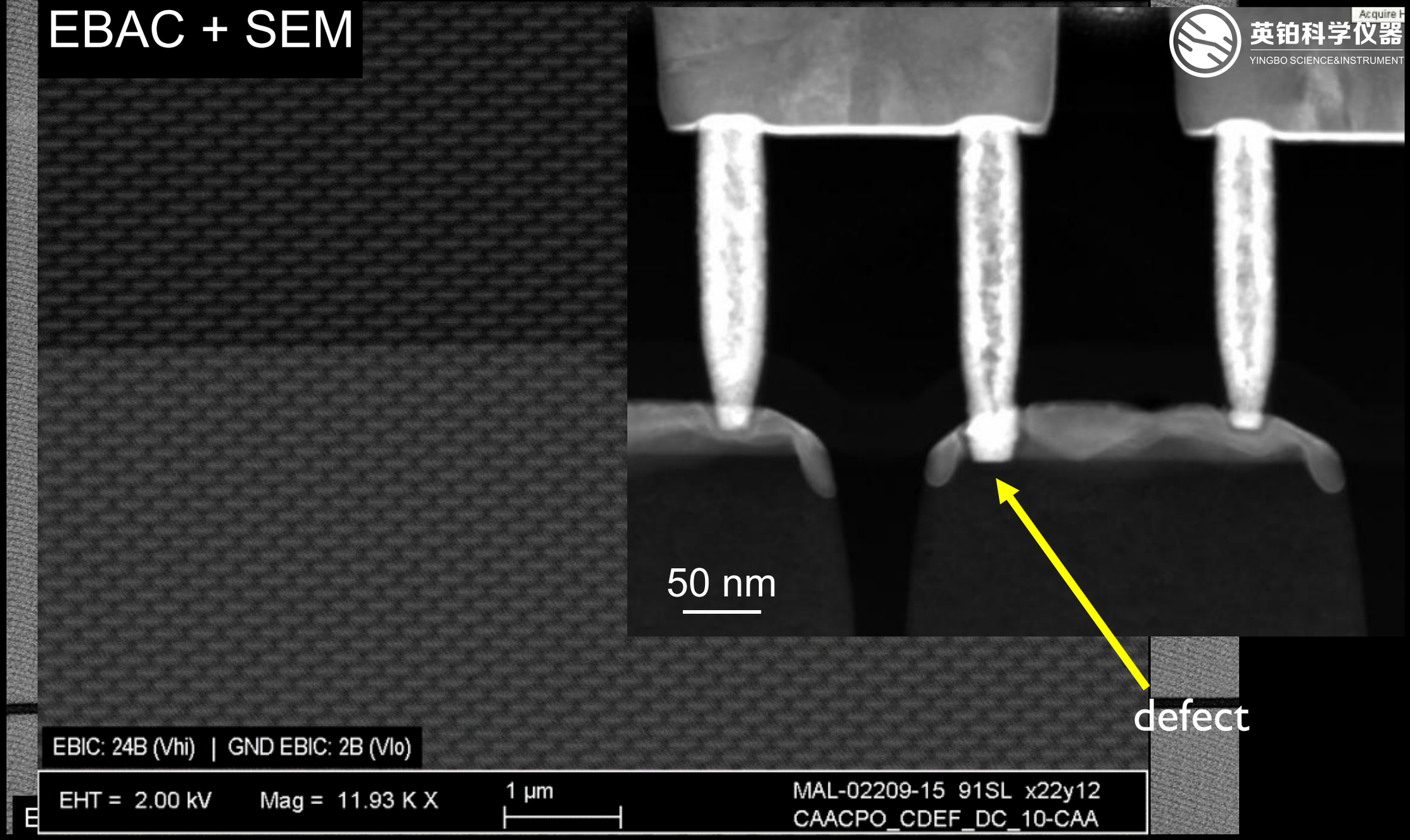




EBIC on 14 nm

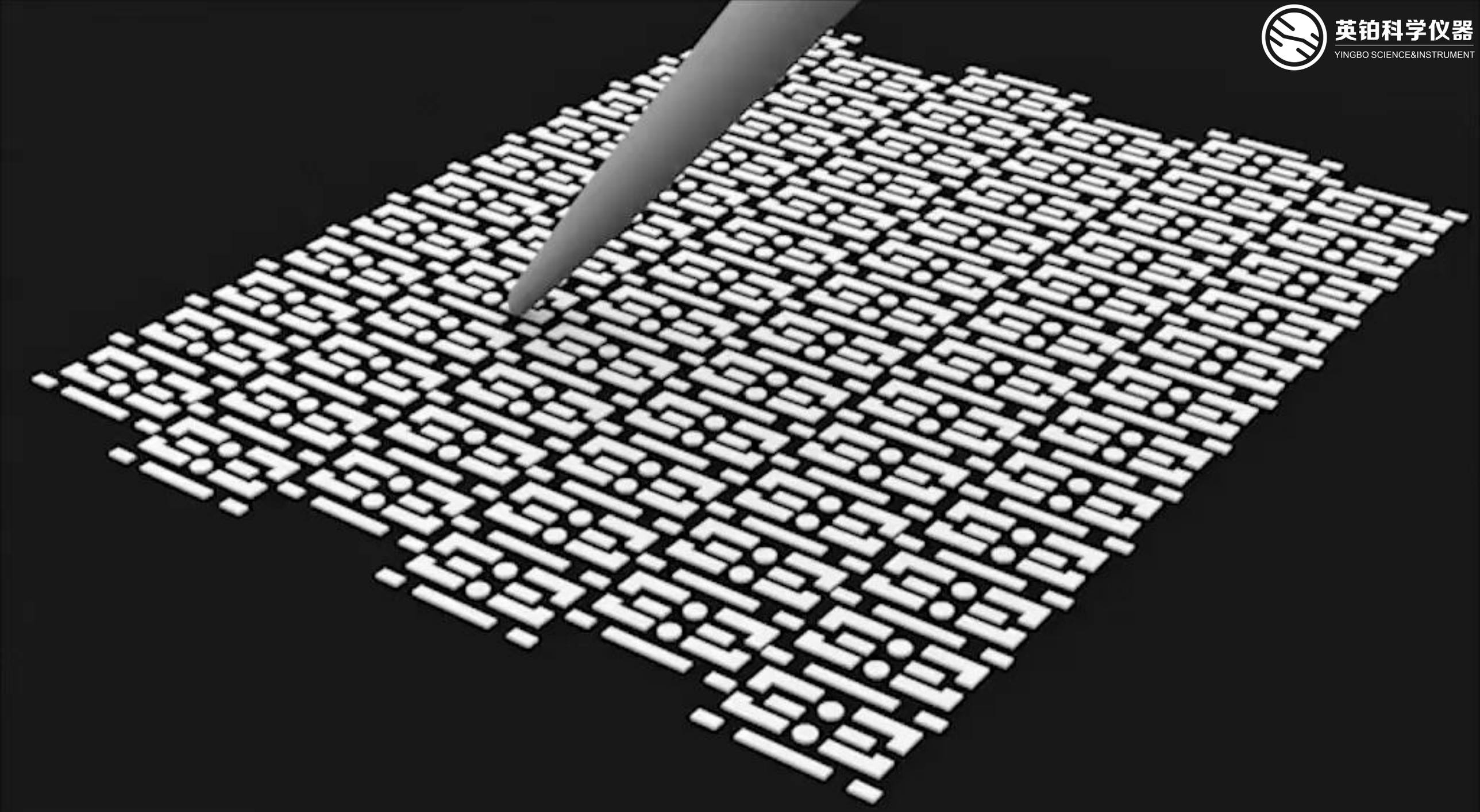


- High ohmic (non-open) defects detectable – good S/N in EBAC signal
- Zero sample drift

→ precise marking of defect location with e-beam spots becomes possible

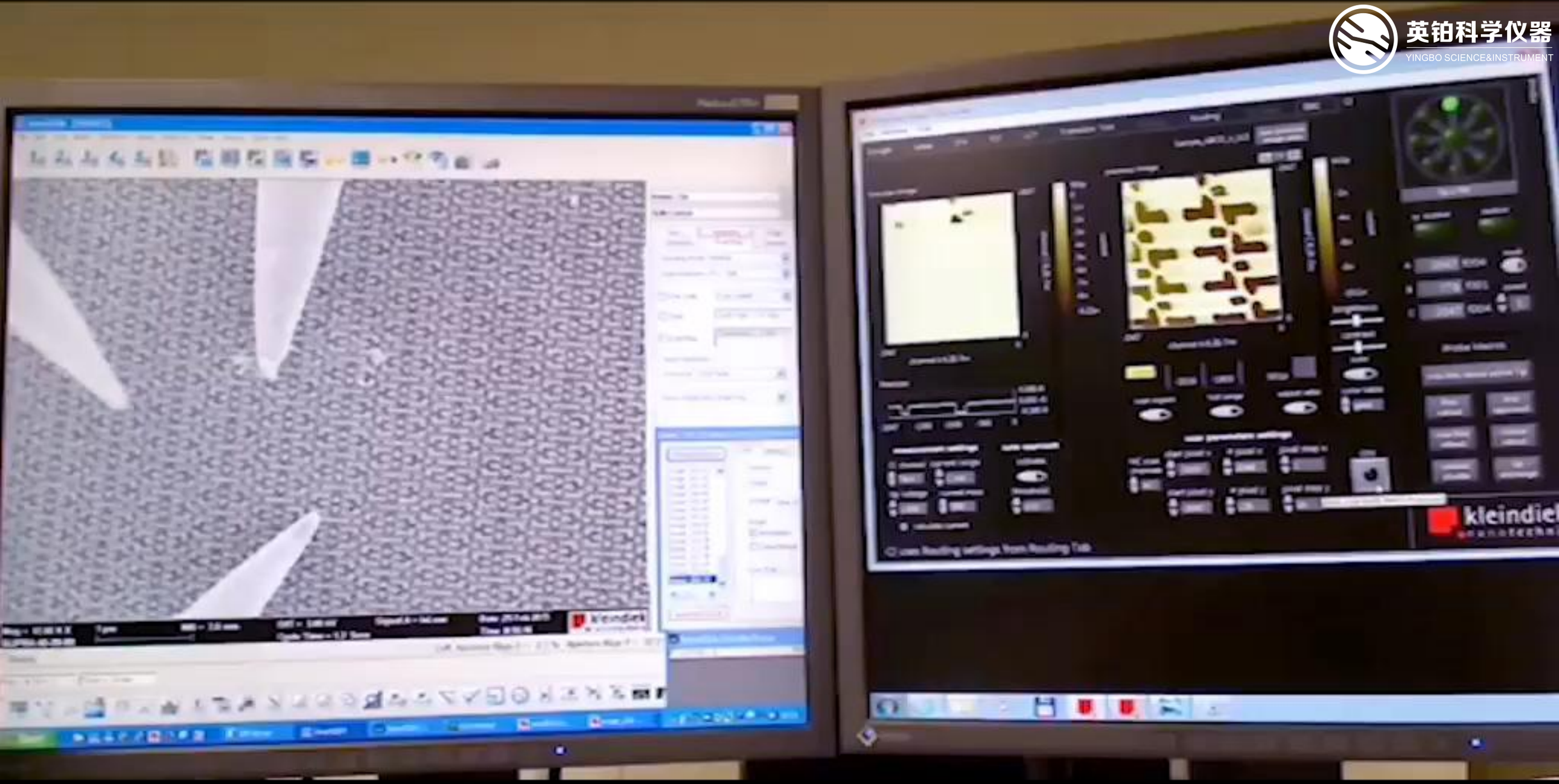
→ Uncertainty during target TEM preparation eliminated

EBAC – 28nm technology



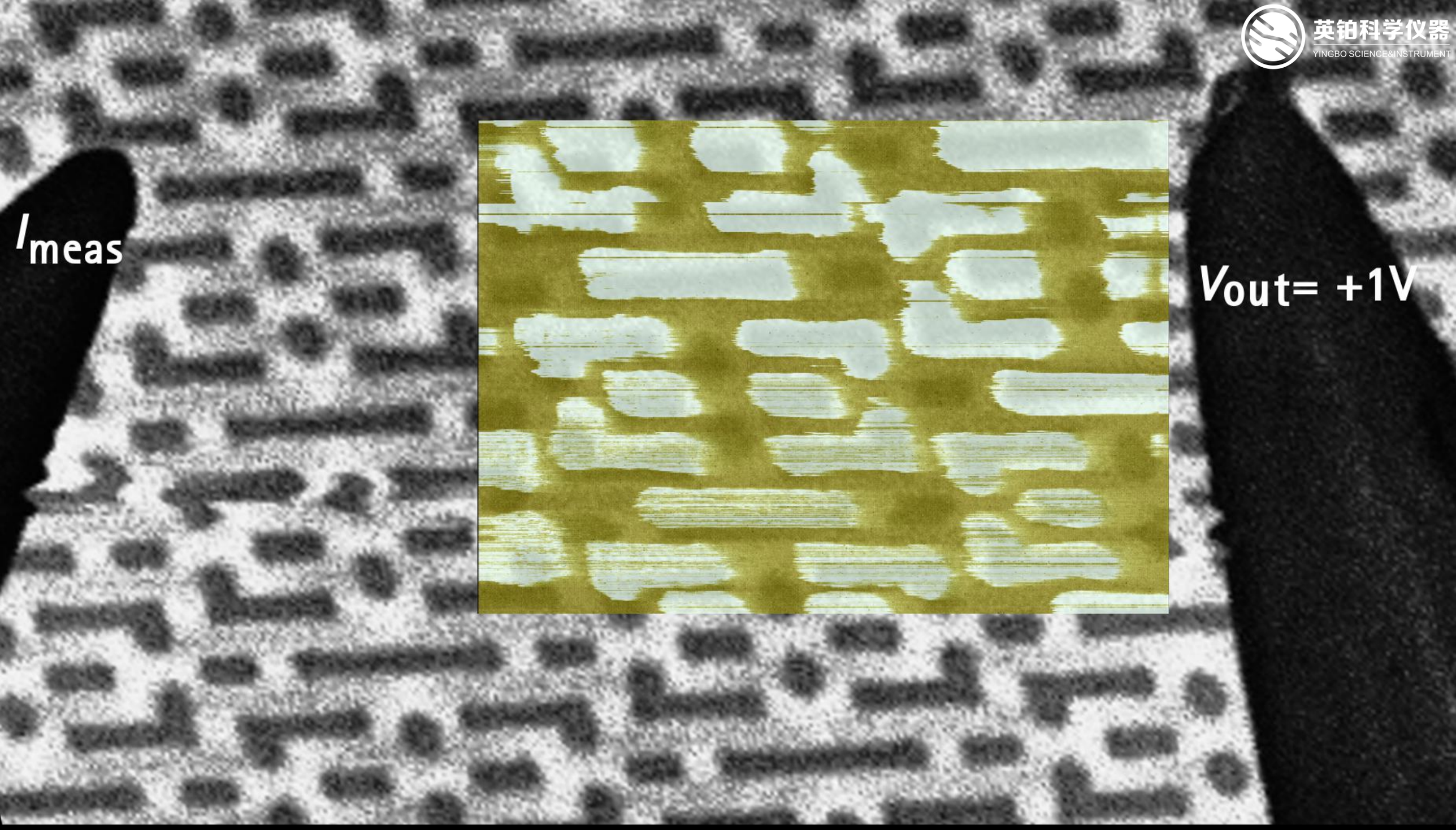
Current Imaging

Operating principle

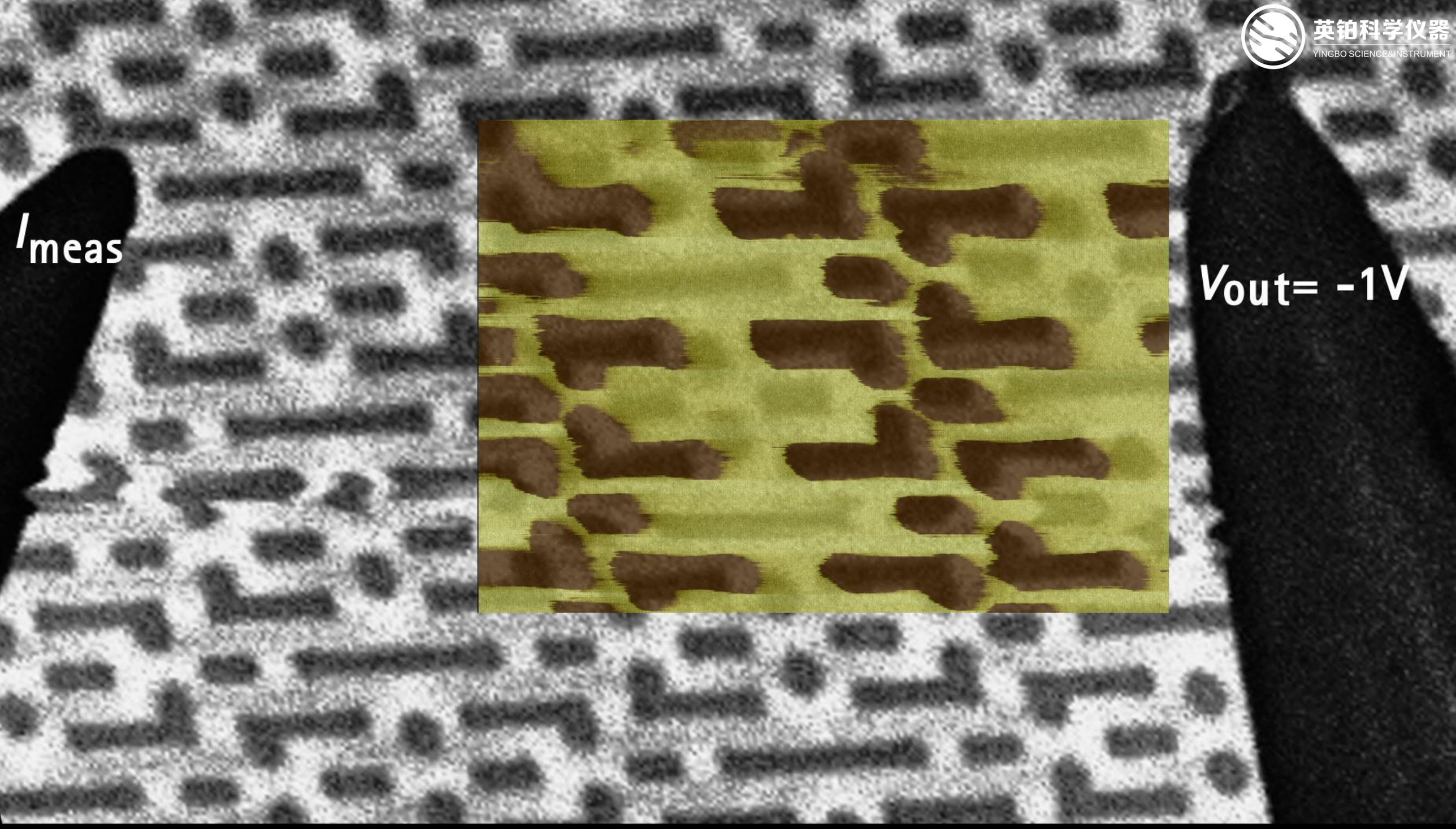


Current Imaging

Acquisition

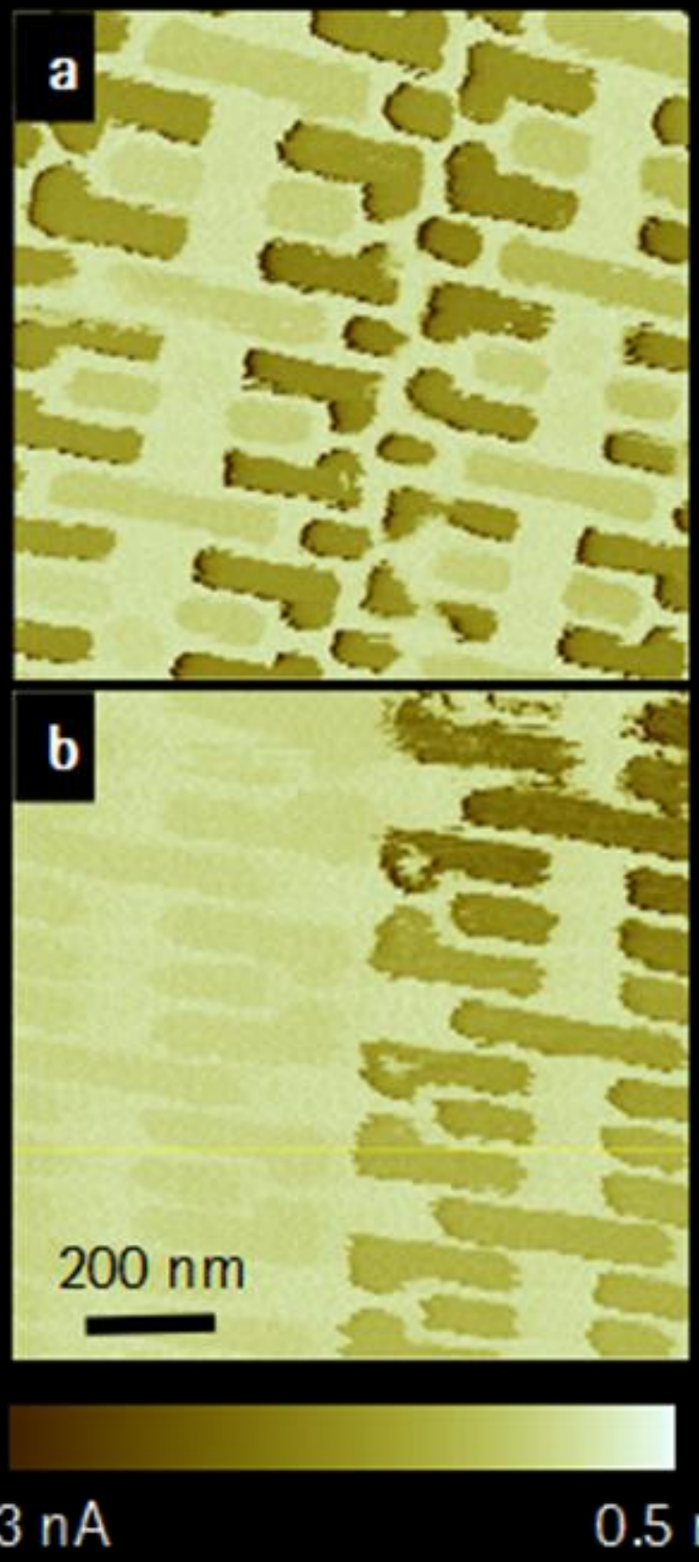


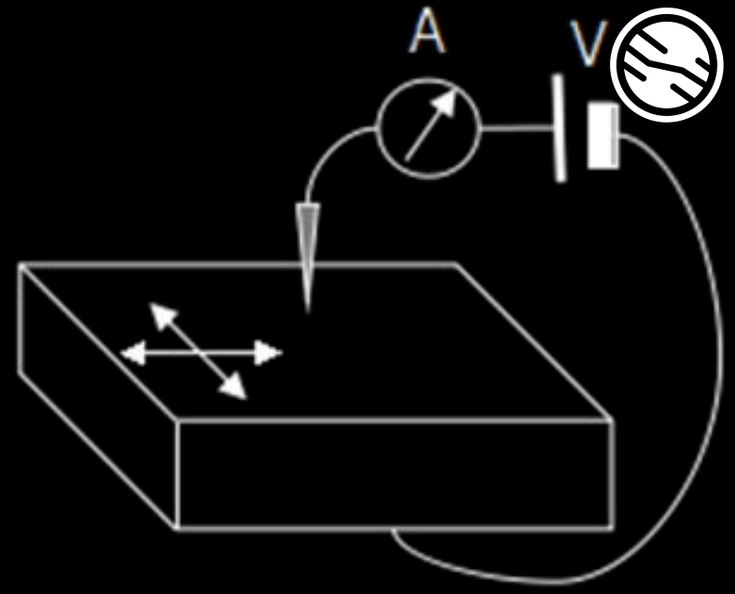
Current Imaging (Correlative Microscopy)

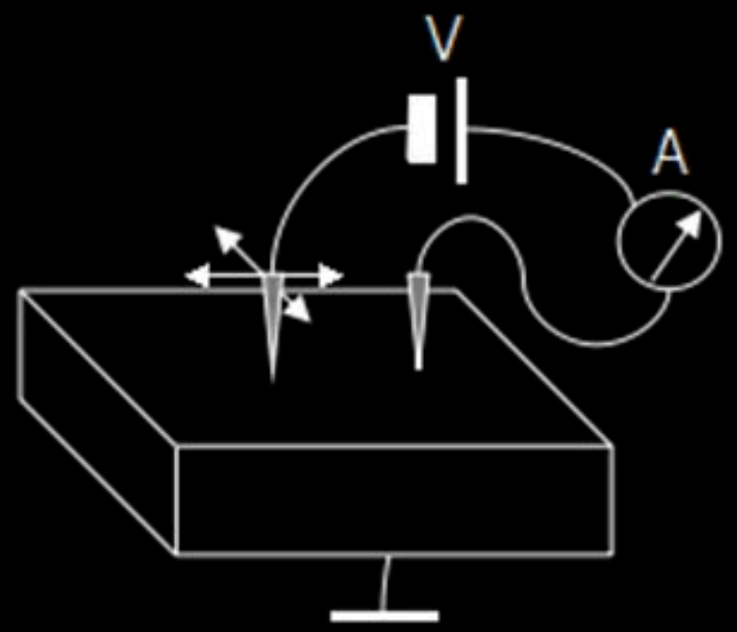


Current Imaging (Correlative Microscopy)

22 nm
technology







Current Imaging, different Current Paths

leaky
Gate

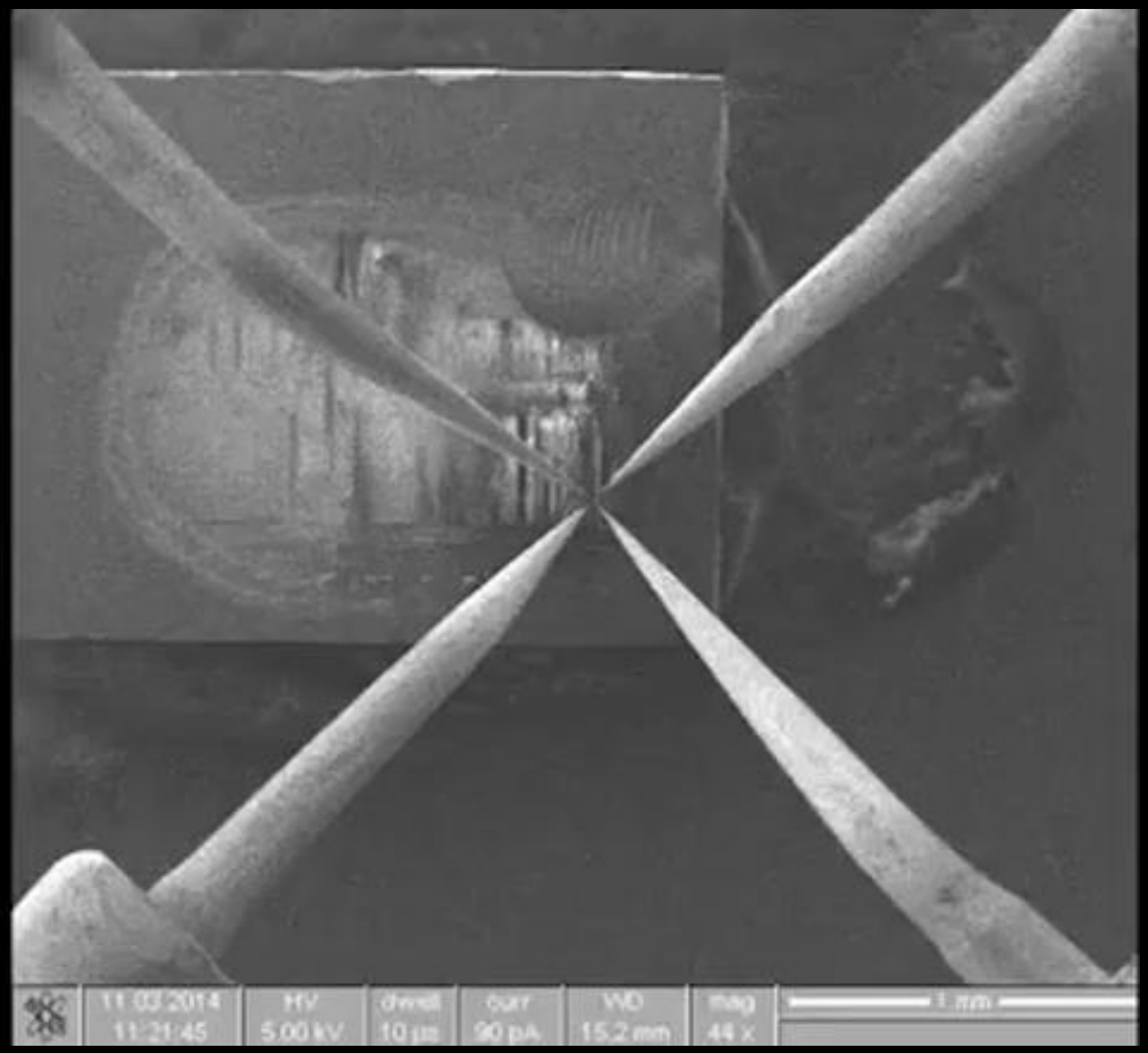
1 um

100 nm

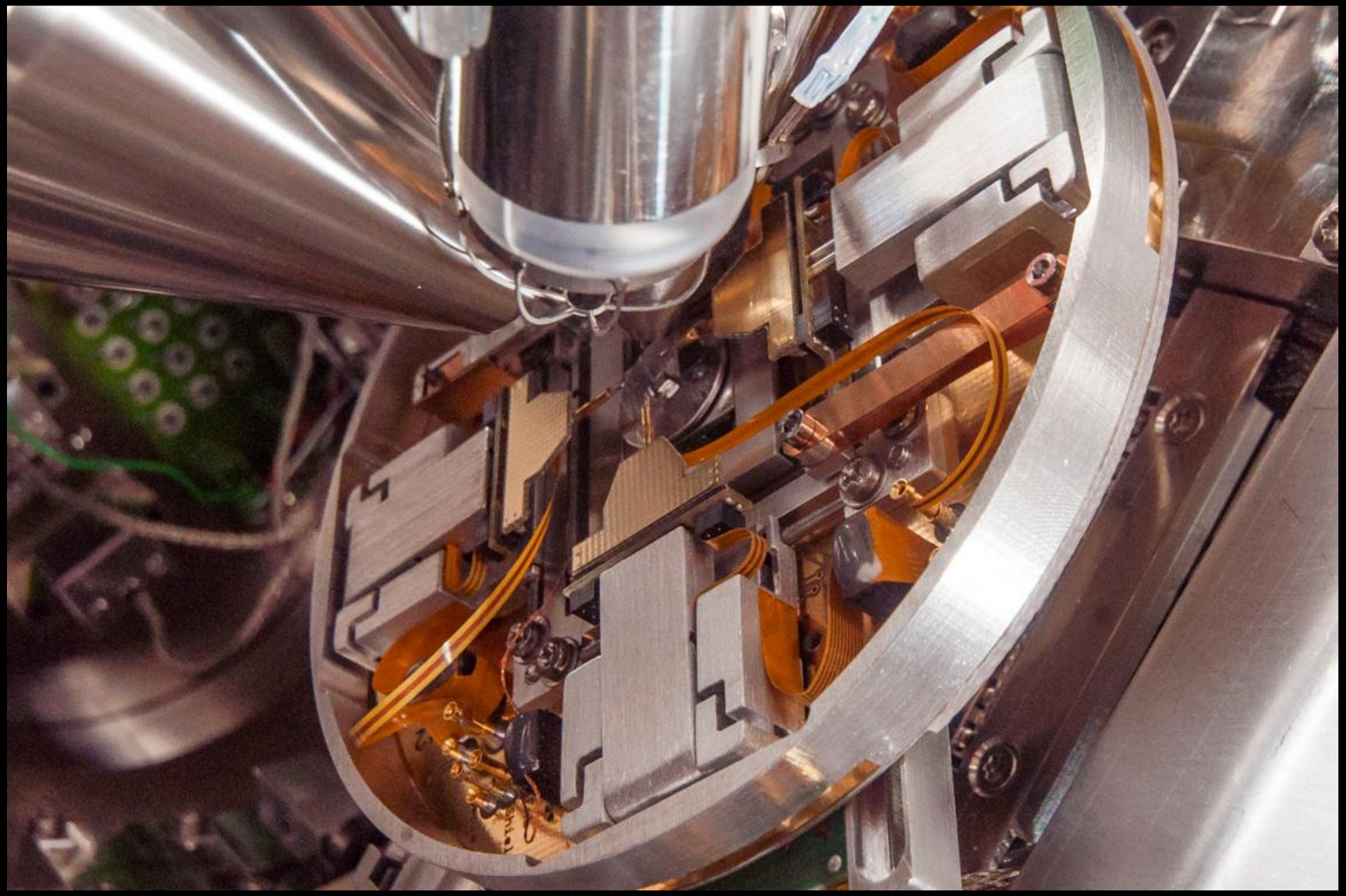
Current Imaging on 22 nm
Resolution complementary to LM and SEM

Advantages Current Imaging

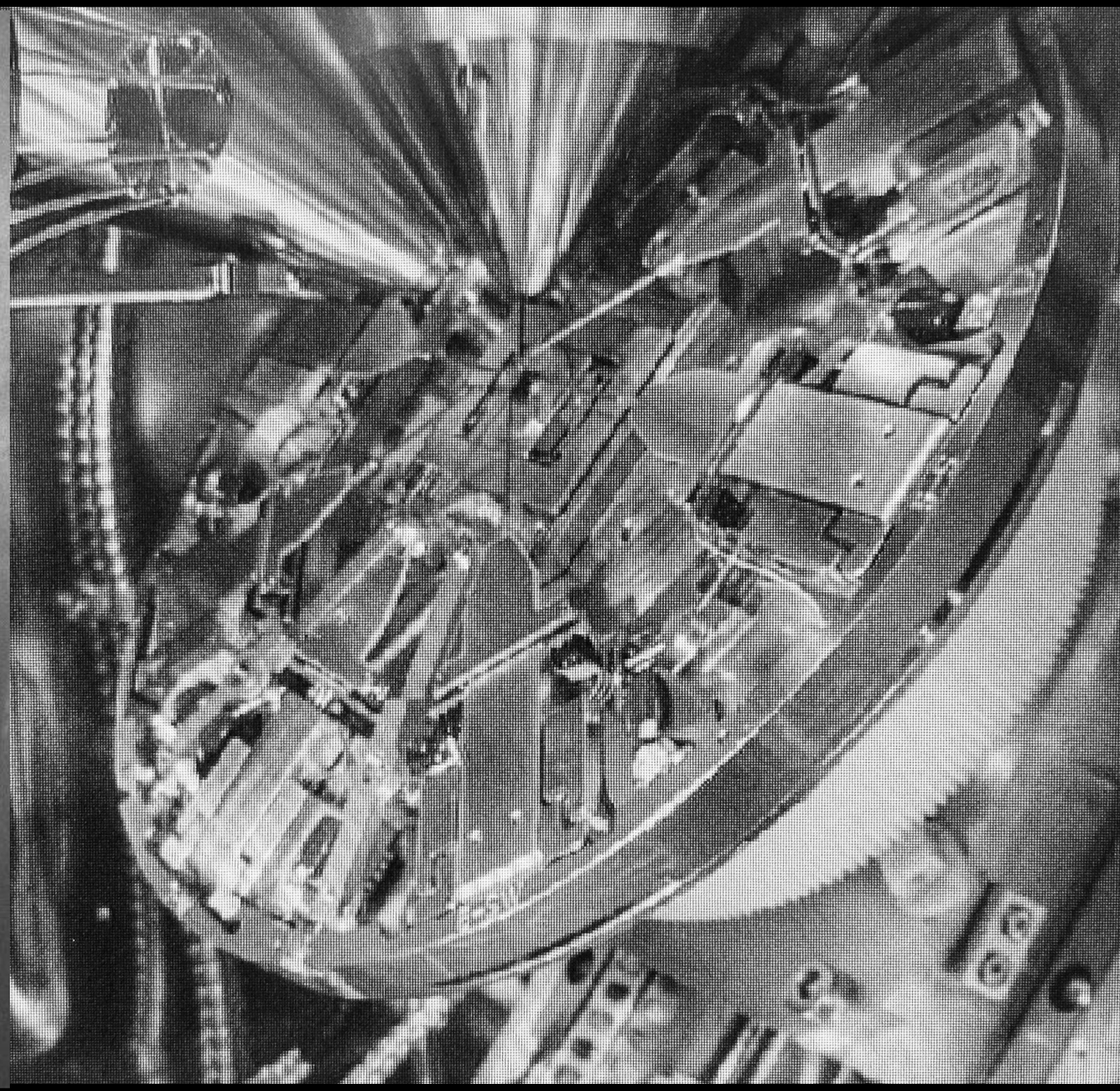
- fast image acquisition (~5 seconds per frame)
- no feedback control necessary leading to greater ease of use
- in situ application, the SEM can be utilised to identify the ROI
- works with standard tungsten probe tips
- picoamp resolution, identify Leakages
- contamination removal



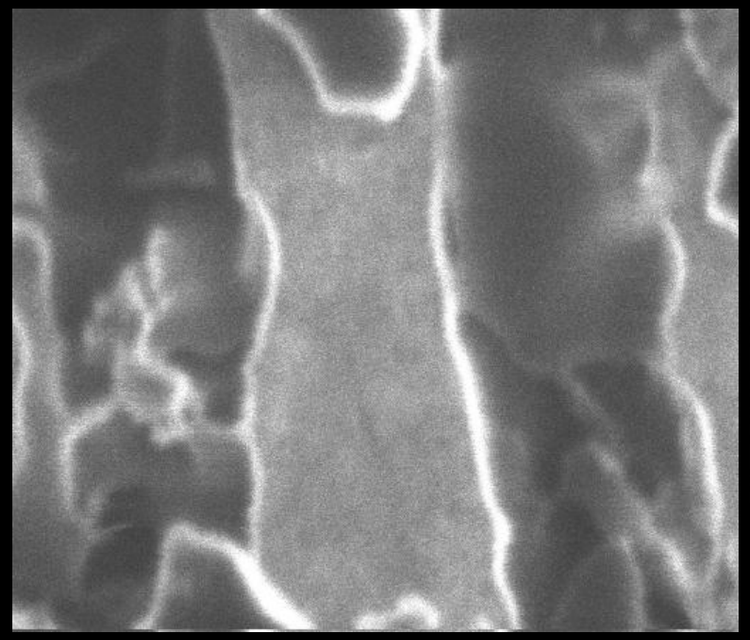
Tilt to 52 degrees
Key Factor for Probing during Circuit Edit

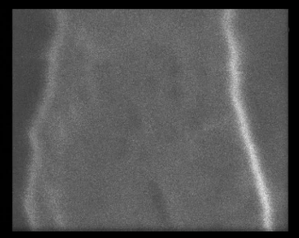


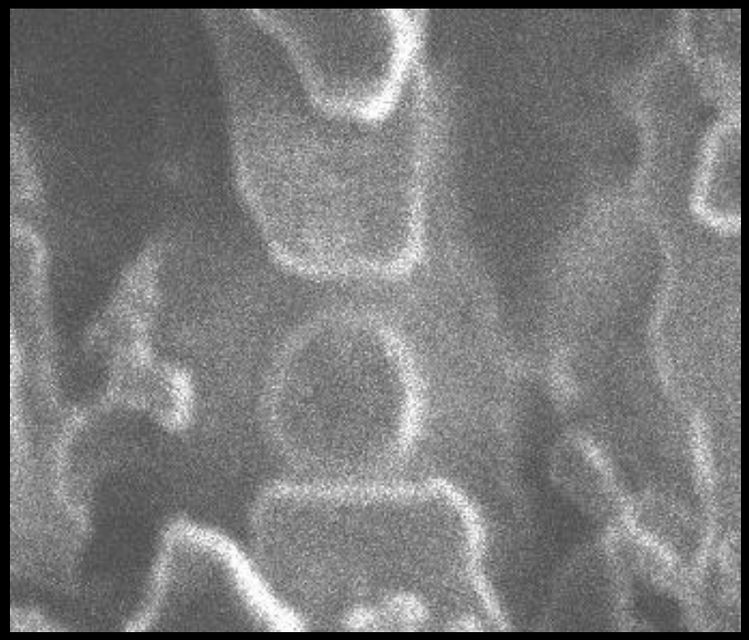
Probing at FIB tilt

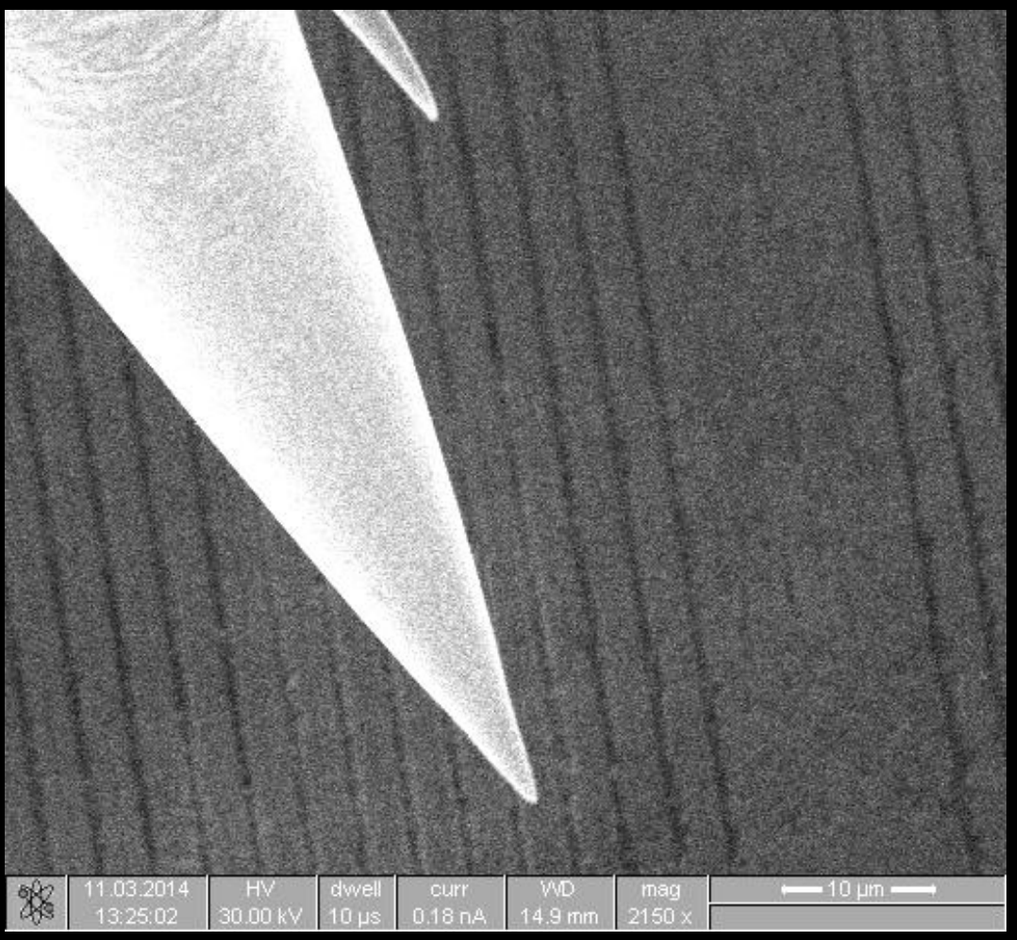


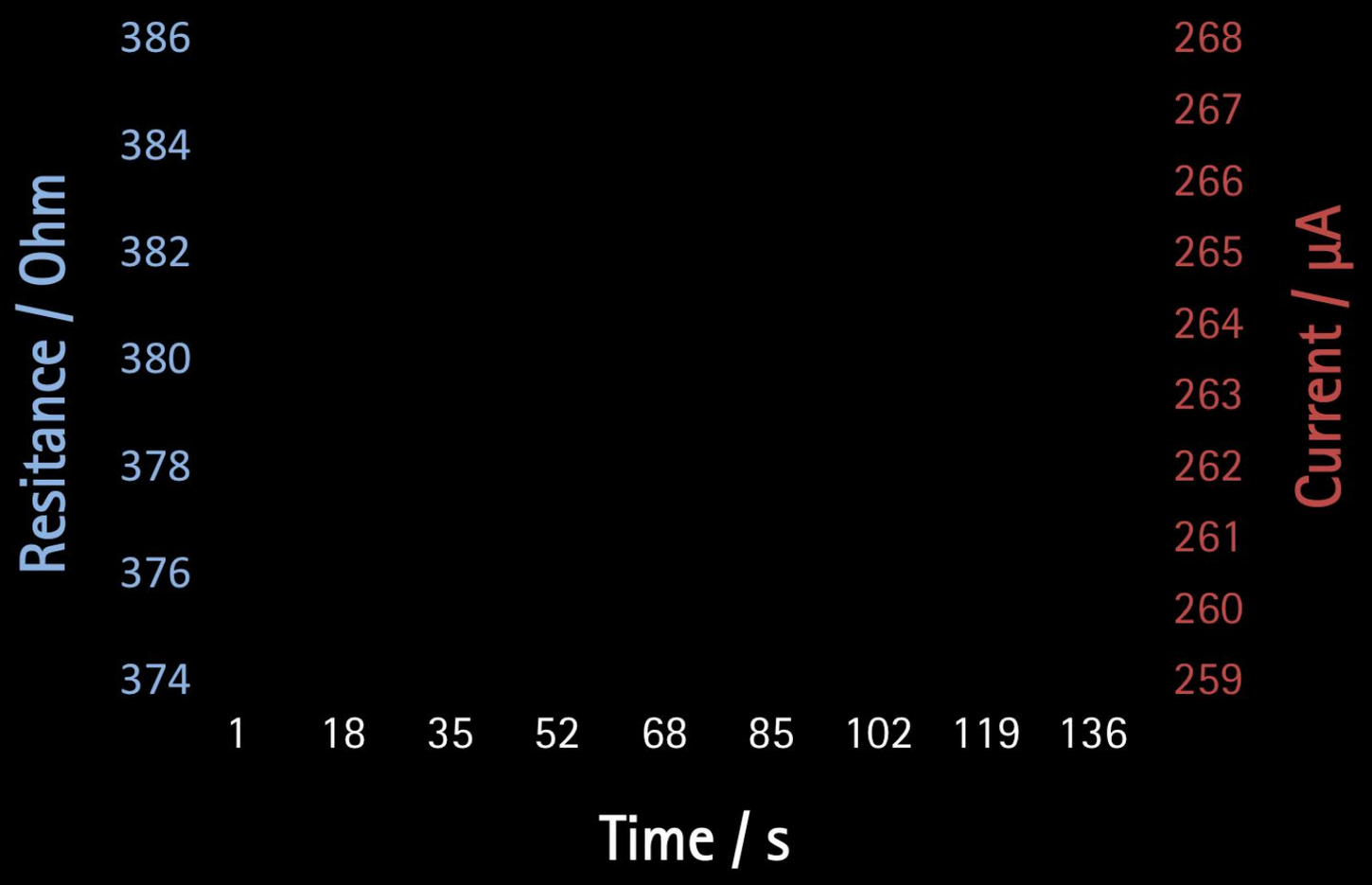
Probing at FIB tilt



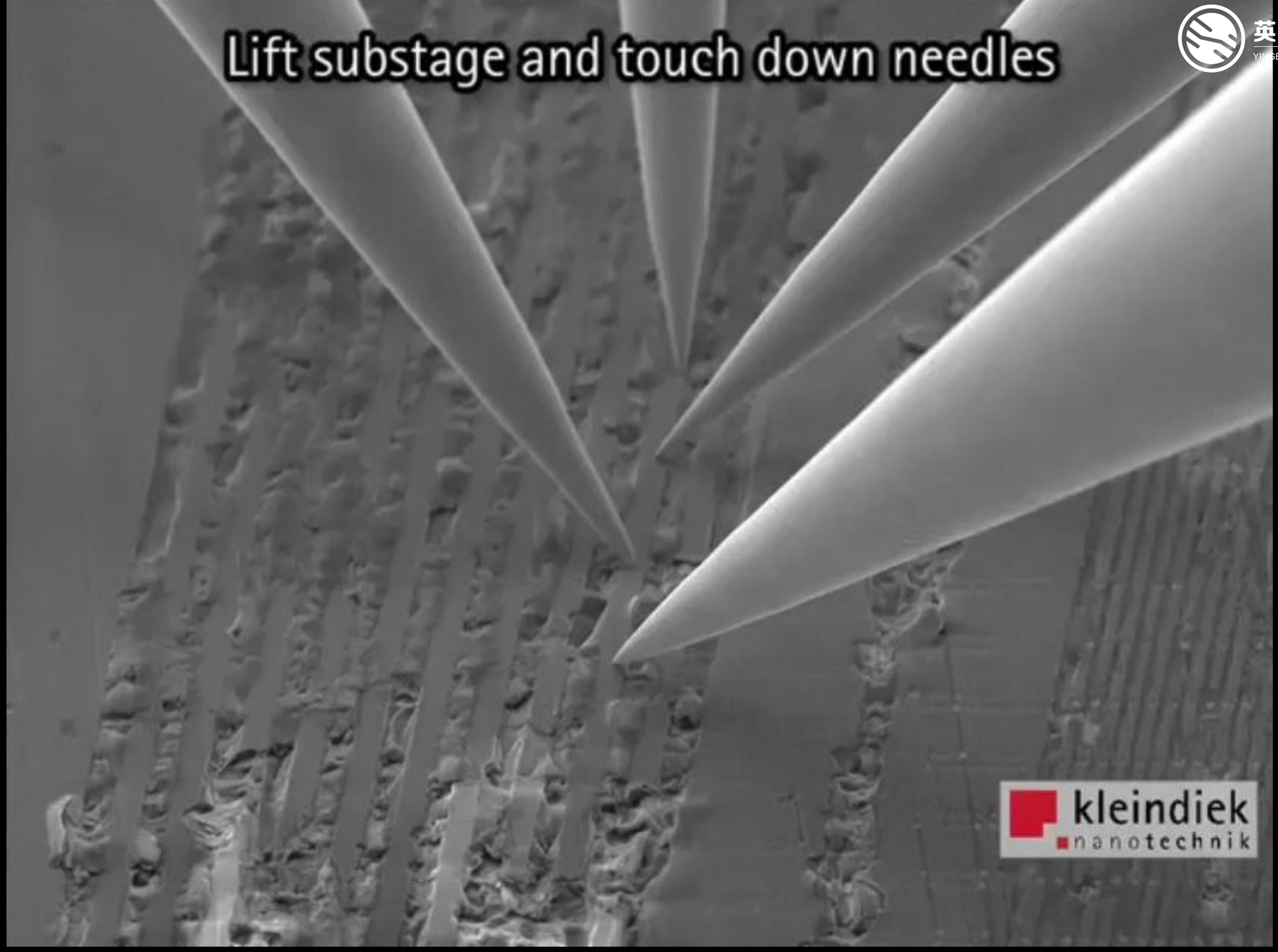




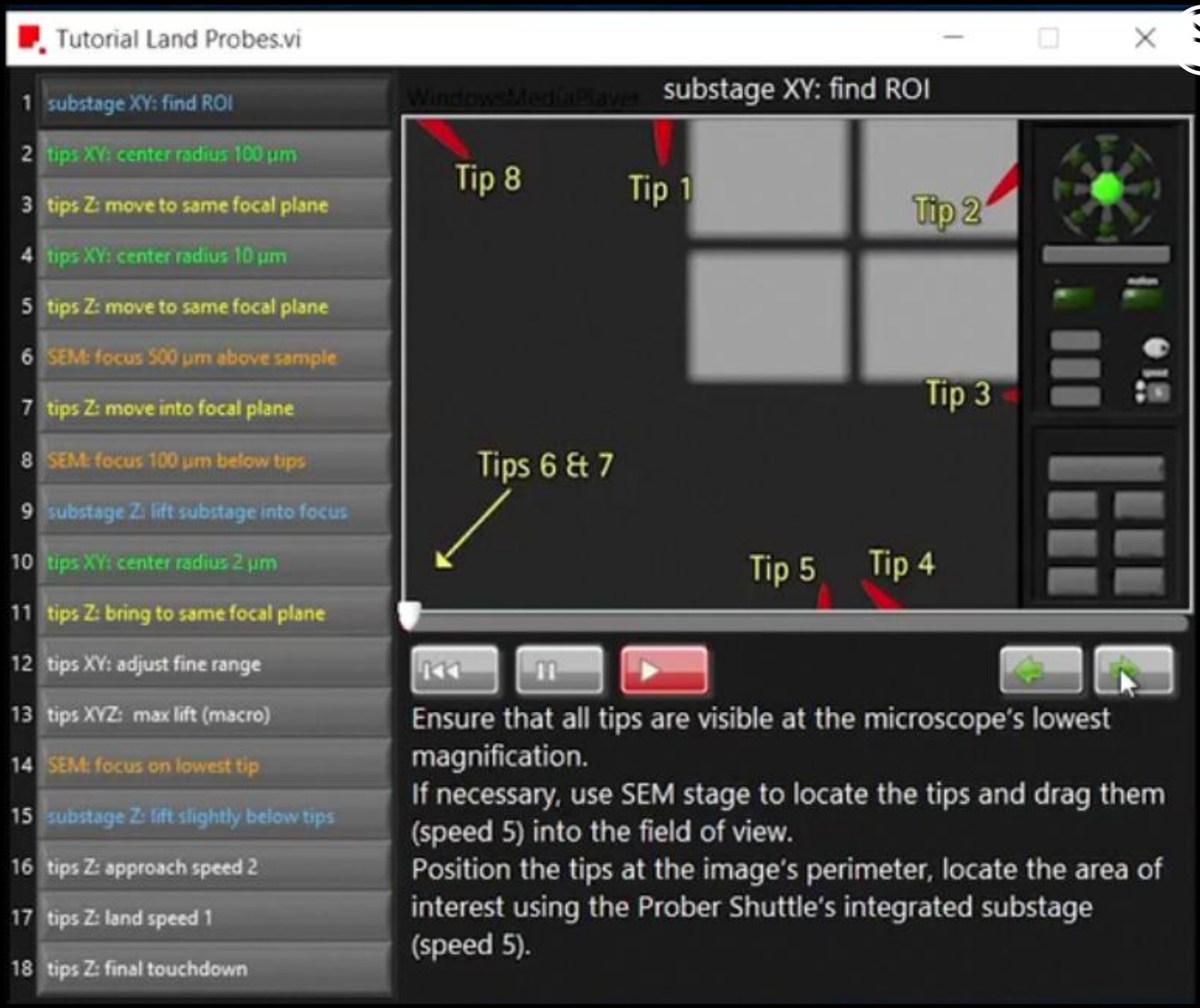




Probing during Circuit Edit



Circuit Edit with in situ monitoring



Probing Assistant

APT
Advanced Probing Tools

- fast workflow - adapted to your speed of perception and comprehension

- correlate light and electron microscopy, EBIC/EBAC, Current Imaging - get the whole picture

- find faults quickly (opens, shorts, leaky connections, faulty transistors, etc.)

Thank you