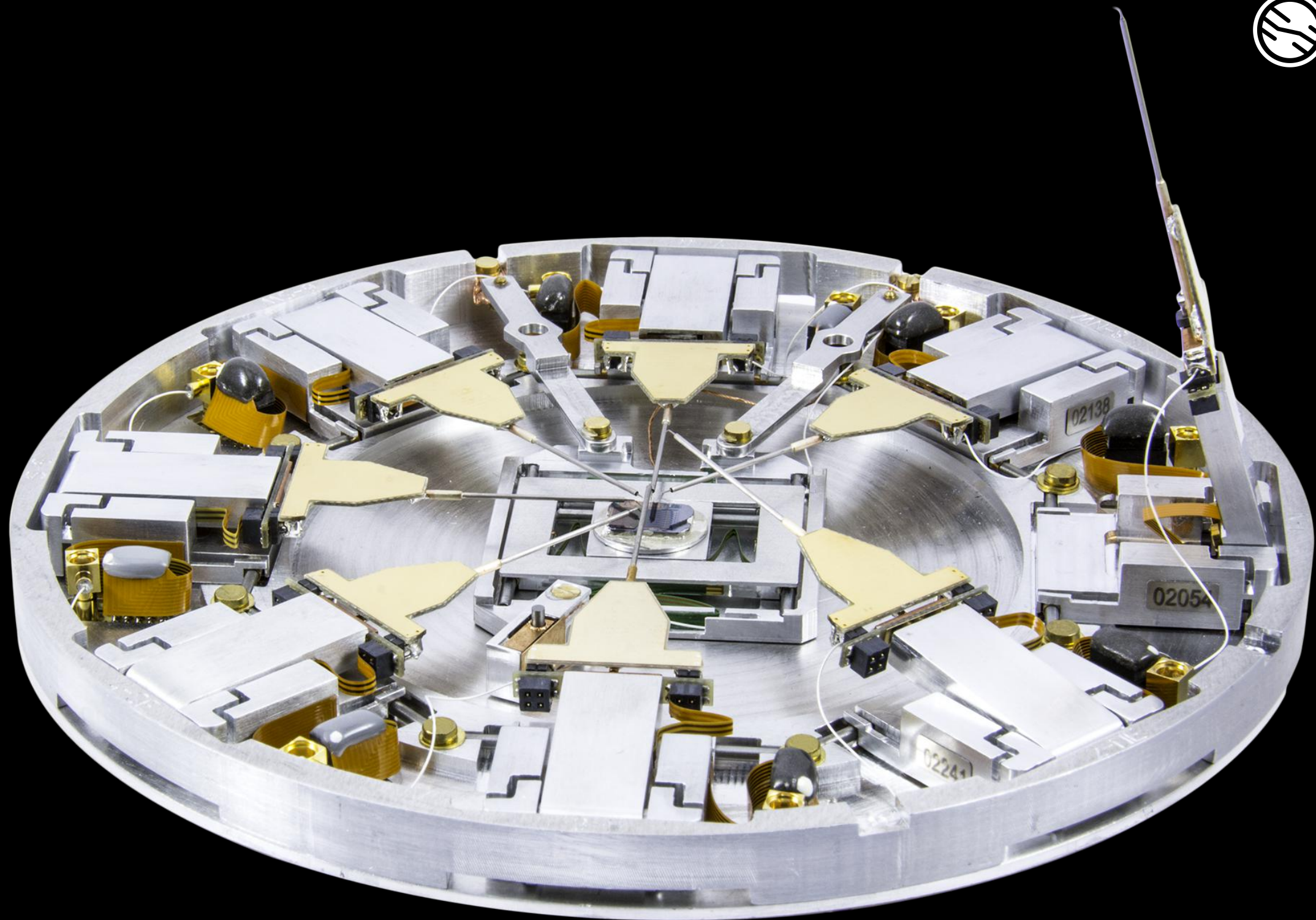


# Advanced Failure Analysis

# 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 FLB angle



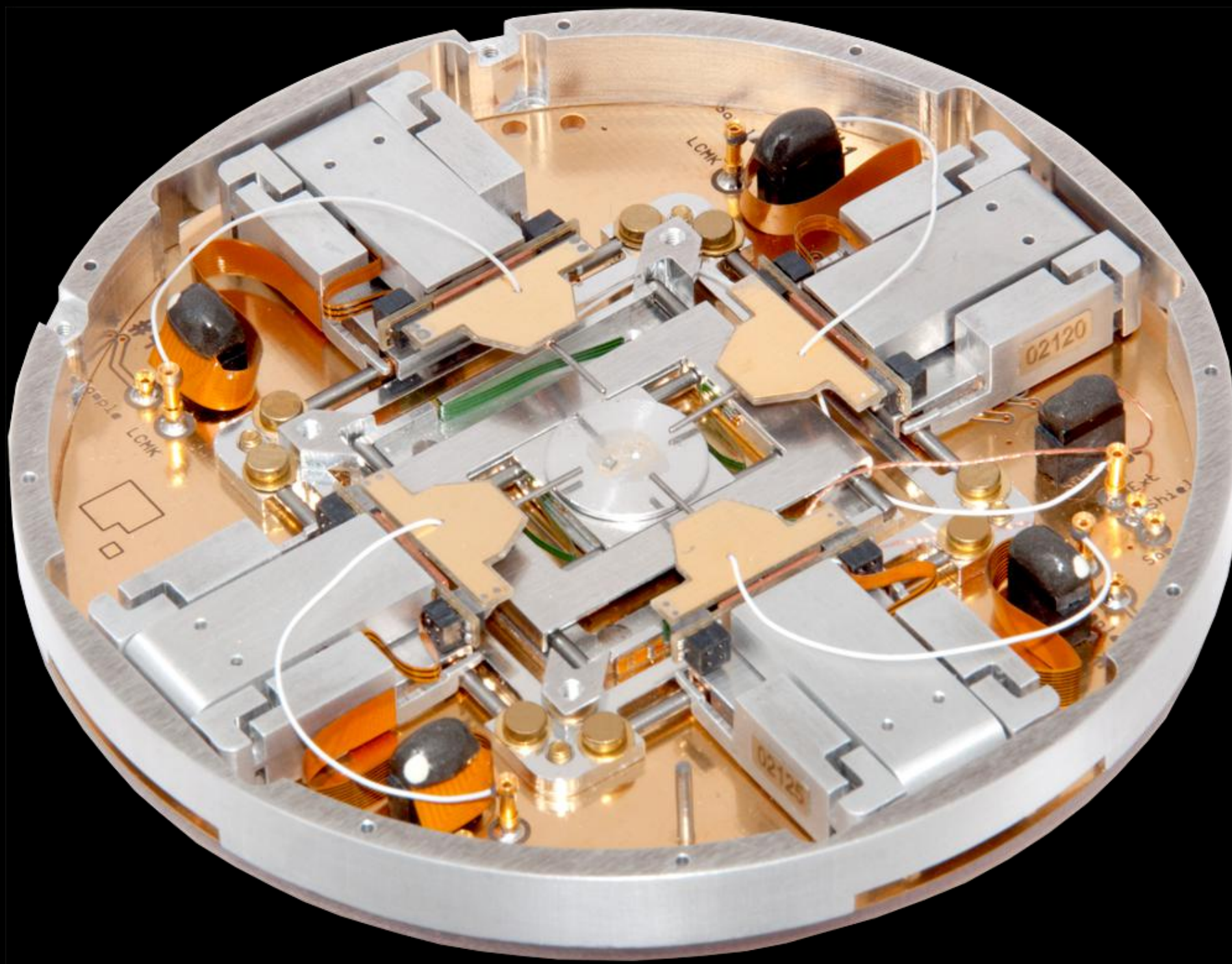


# Prober Shuttle with eight probes

(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

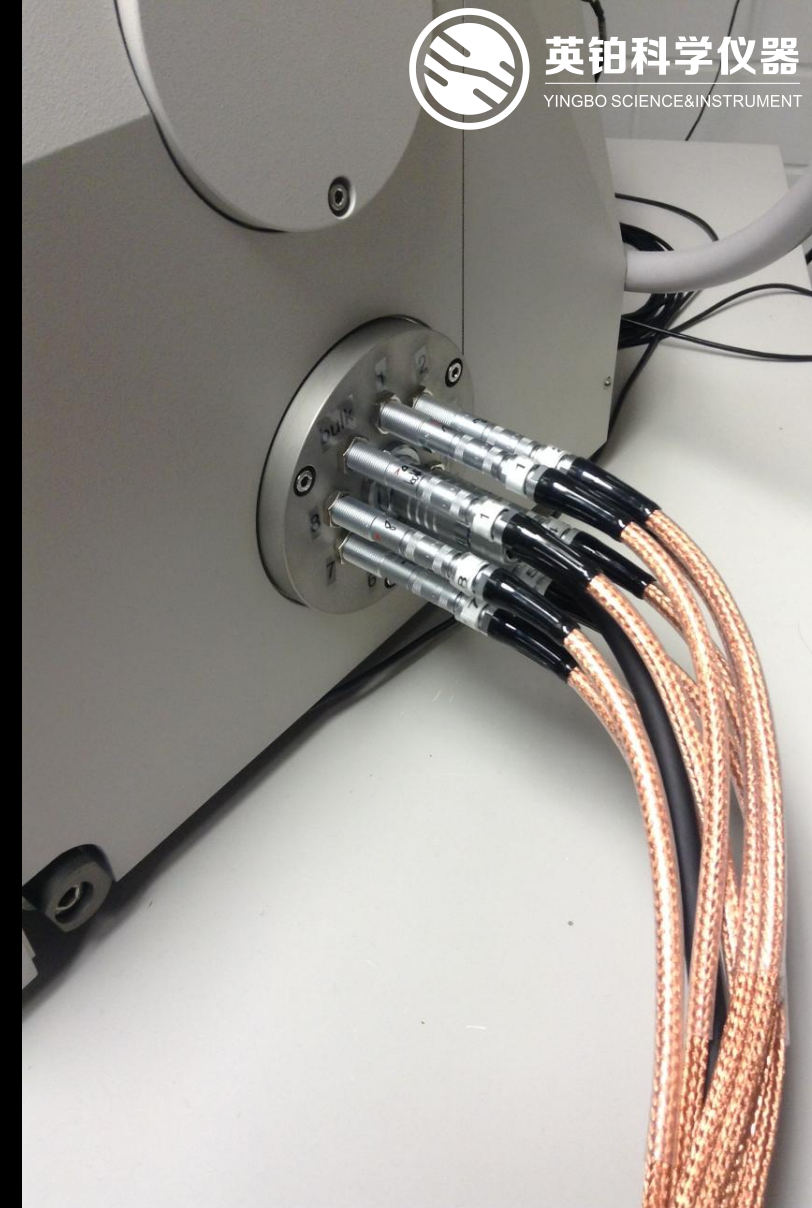


Loadlock compatible





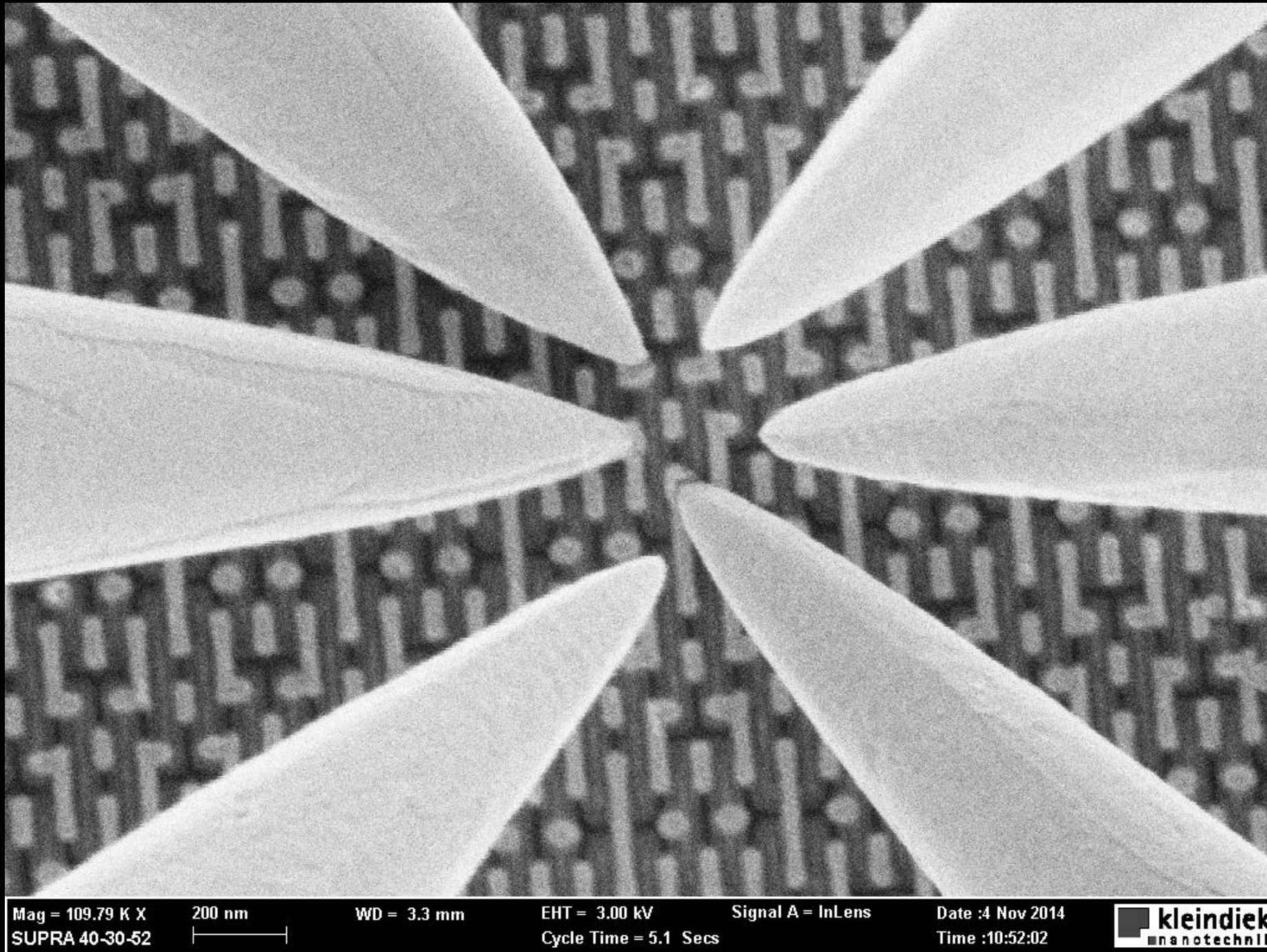
Loadlock compatible



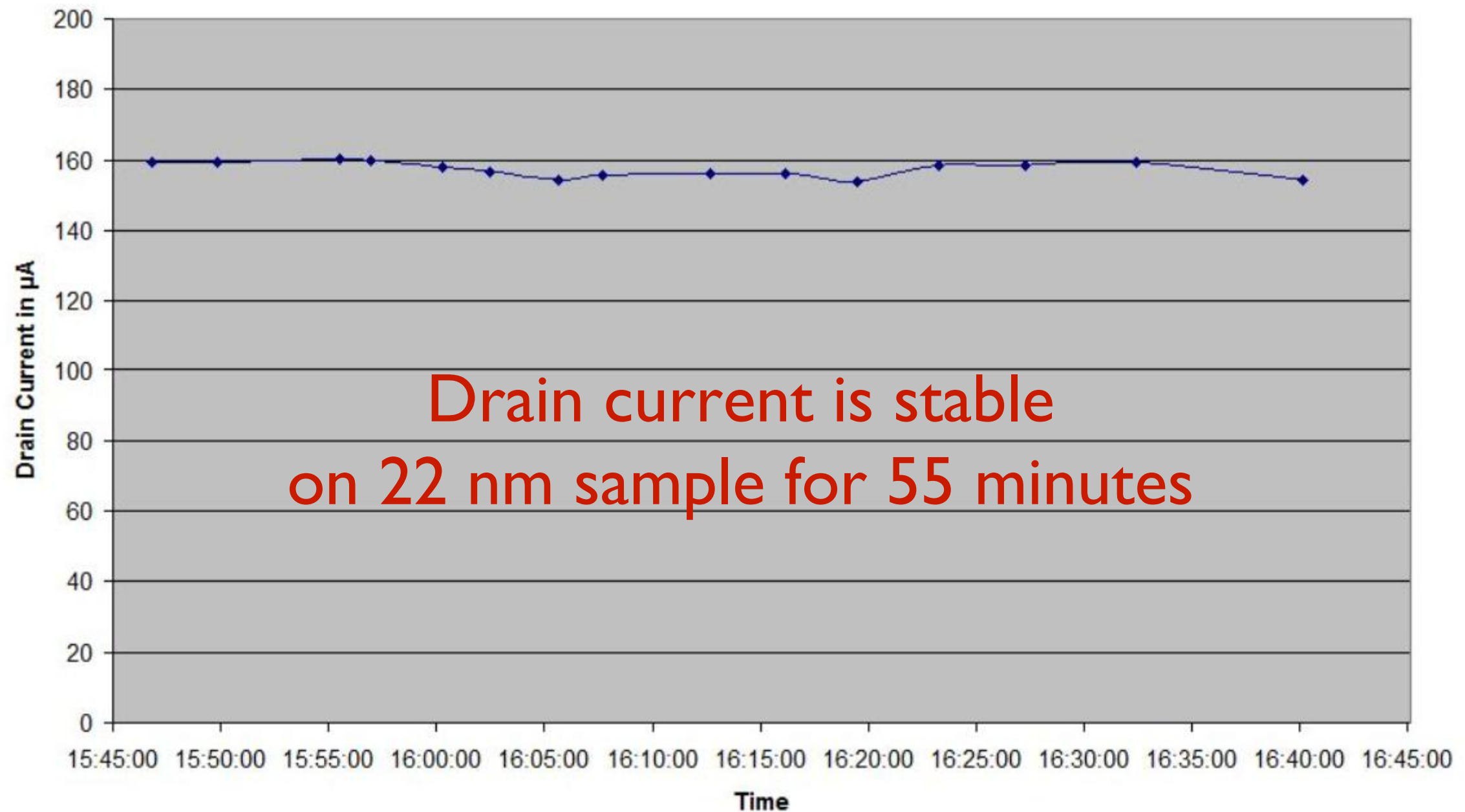
Clean cabling inside and outside the chamber

Low leakage (50 fA/V), low noise



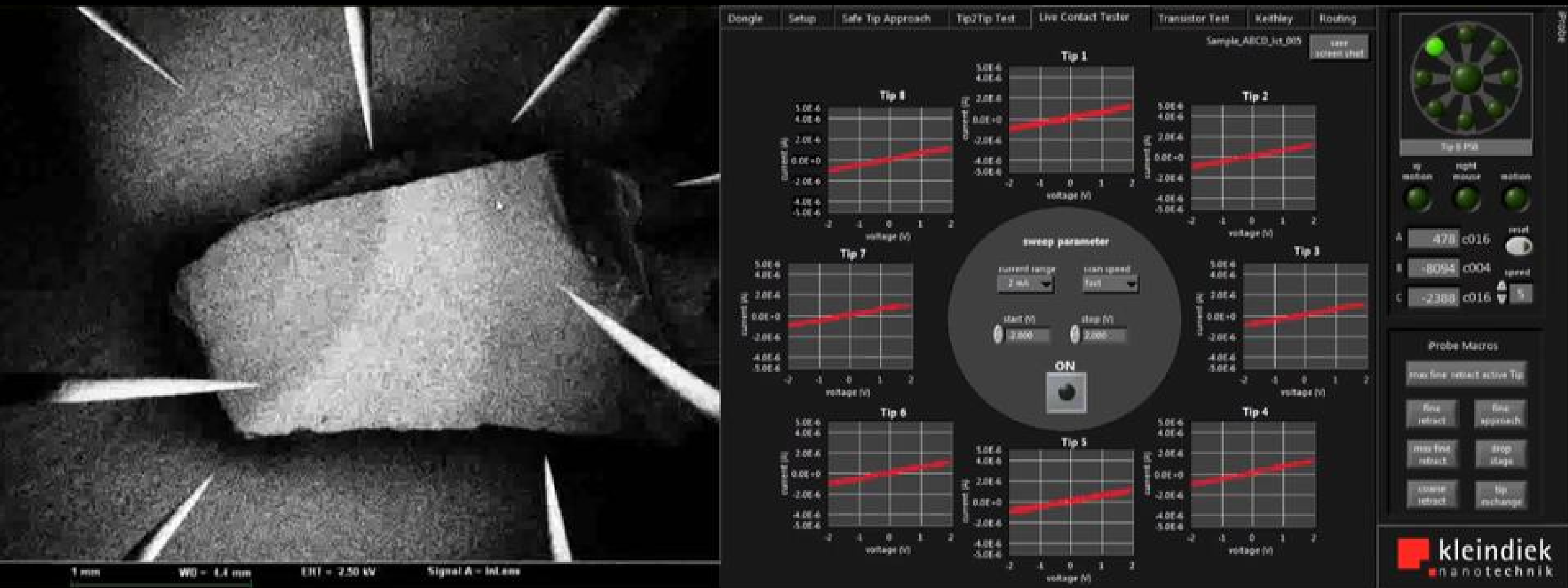


Touch the Sample!  
It is all about Fast Results



Nanoprobng requires stability

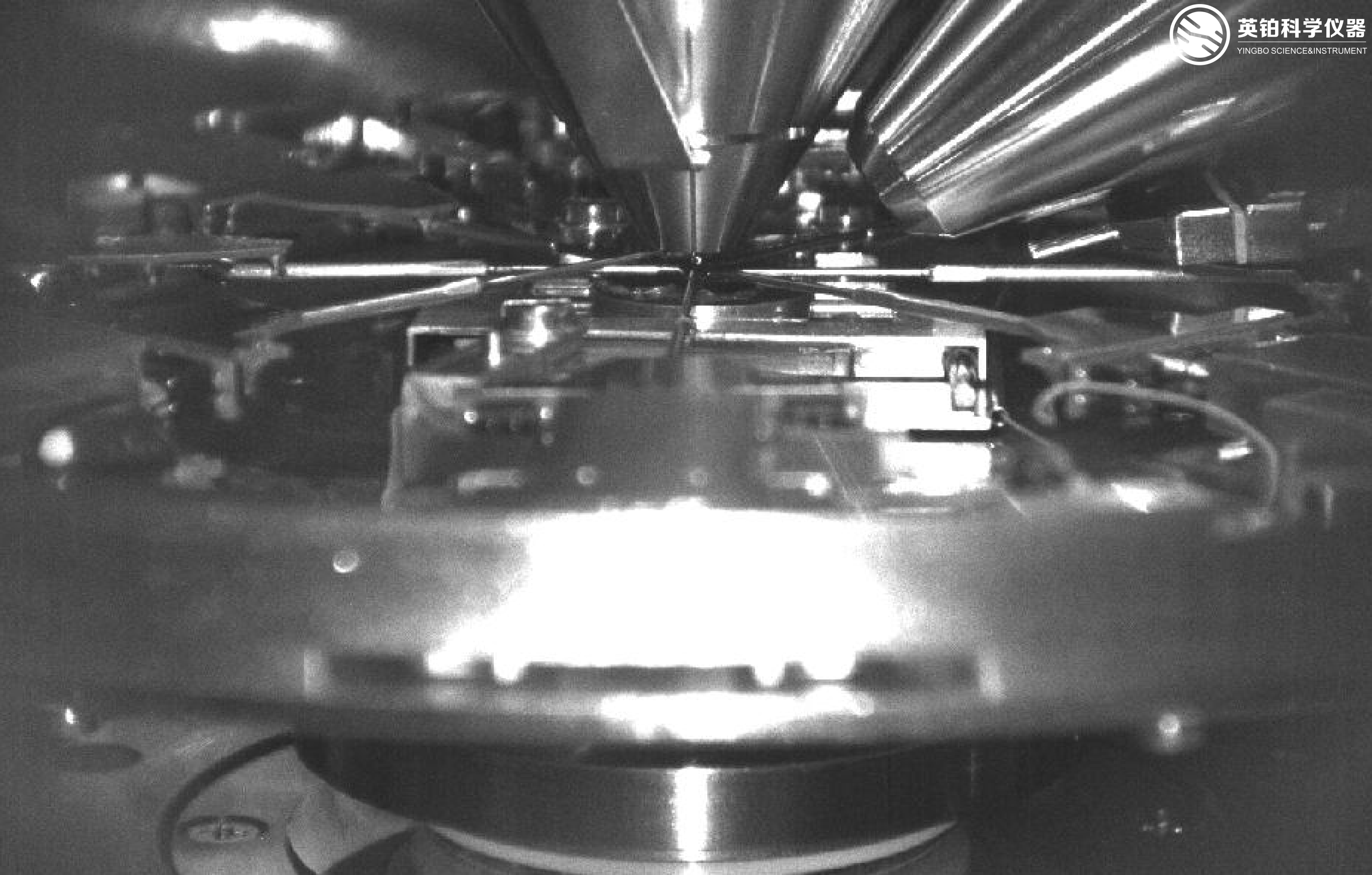




SEM control interface

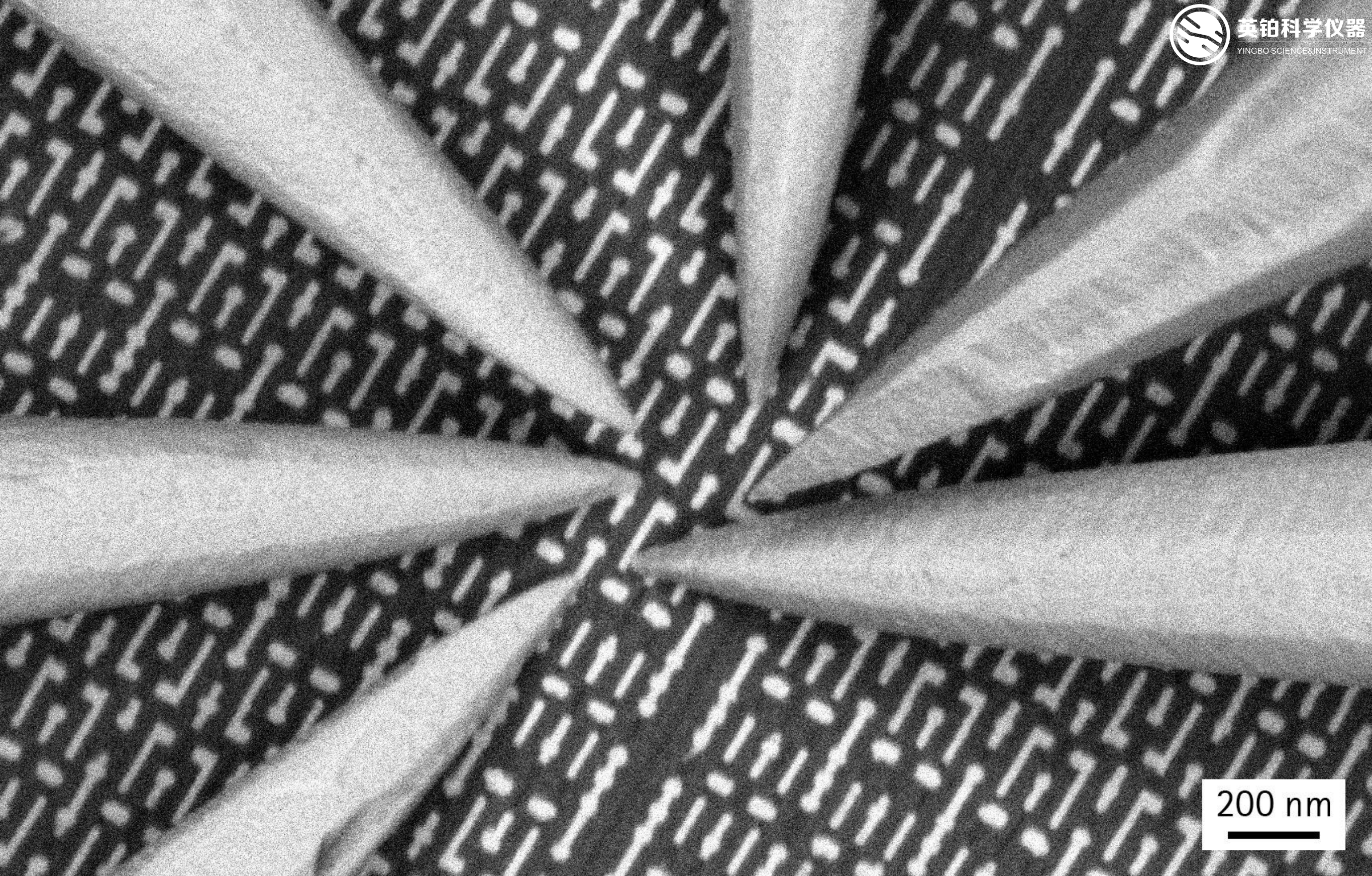
Advanced Probing Tools GUI

# Advanced Probing Tools



Probing on 14 nm - low profile system





Probing on 14 nm

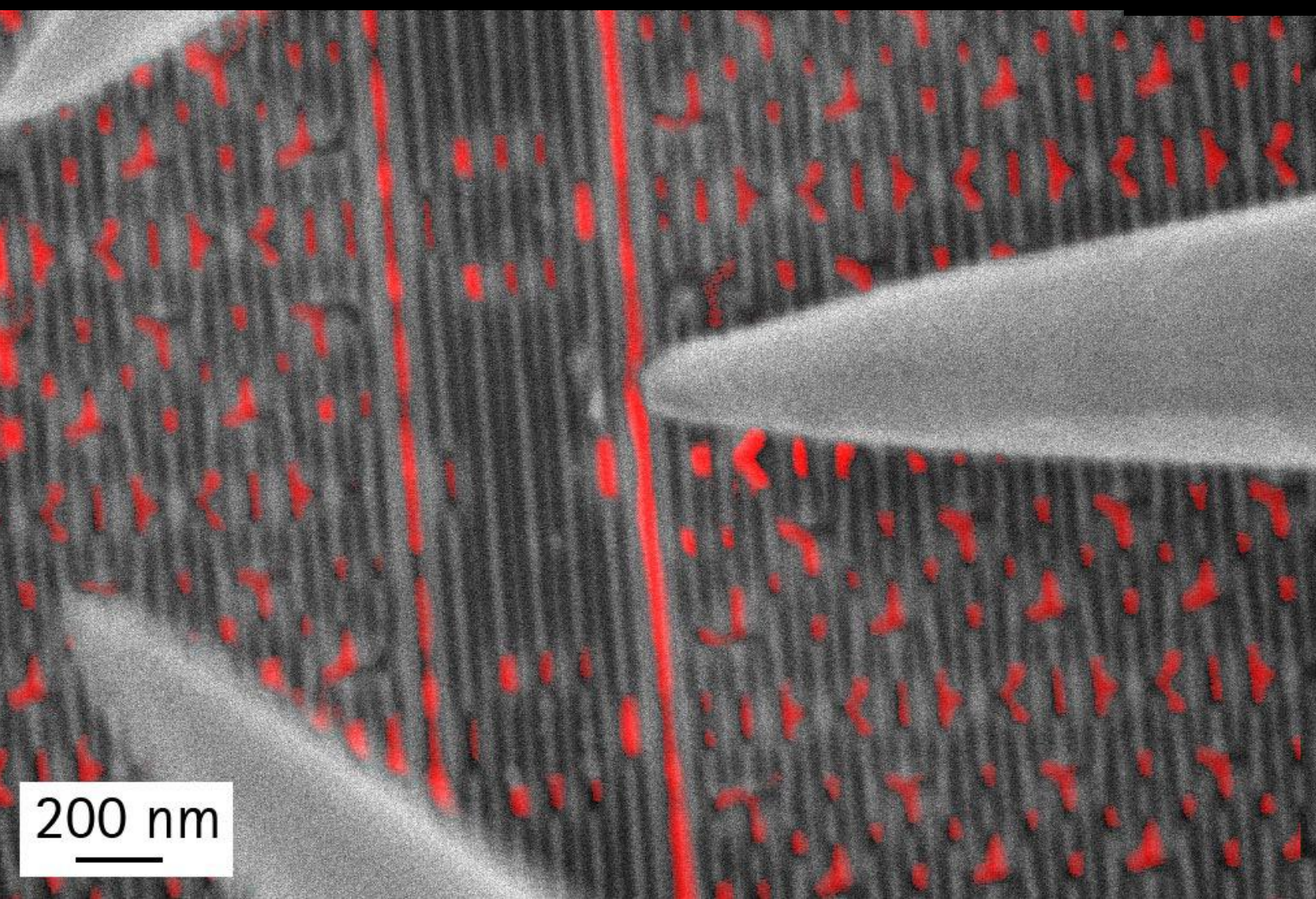
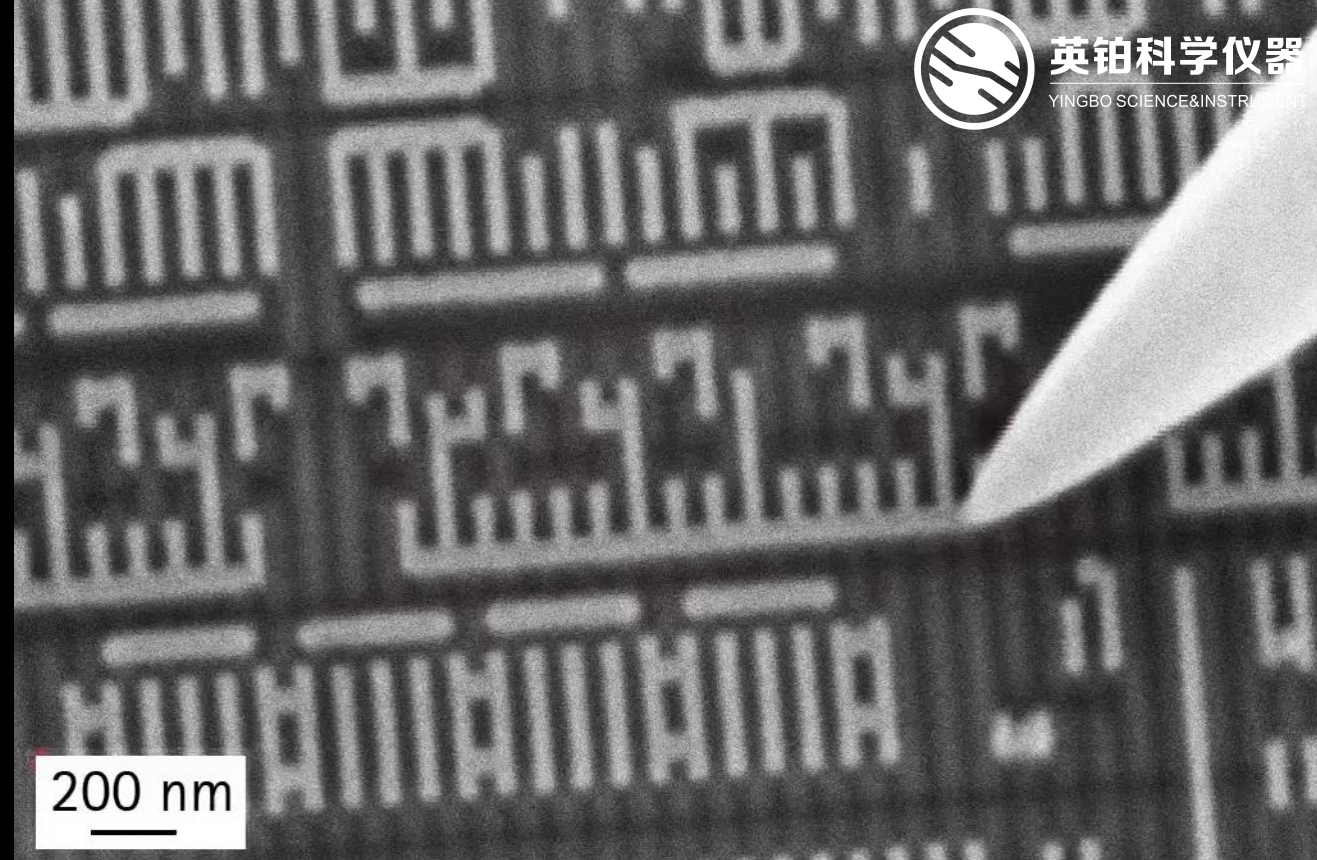
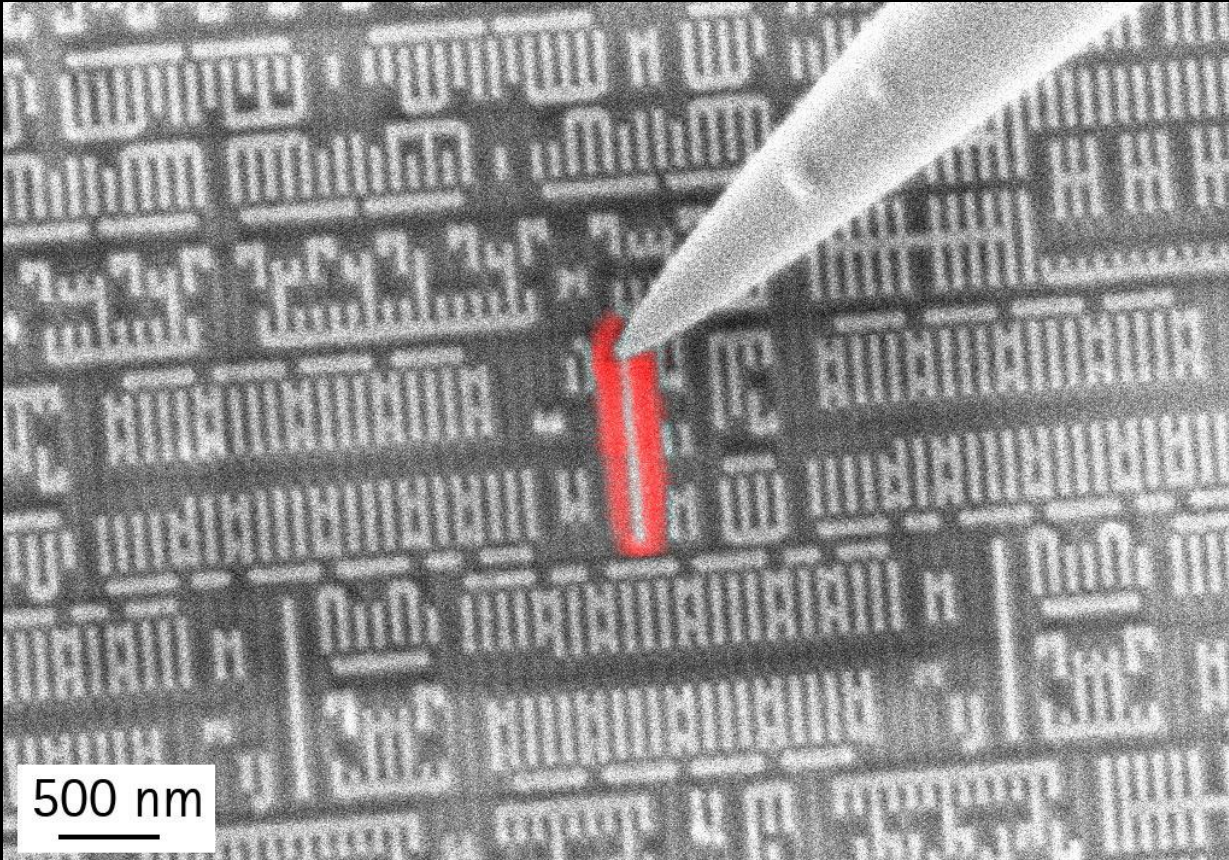




Keithley 4200 result (APT GUI)

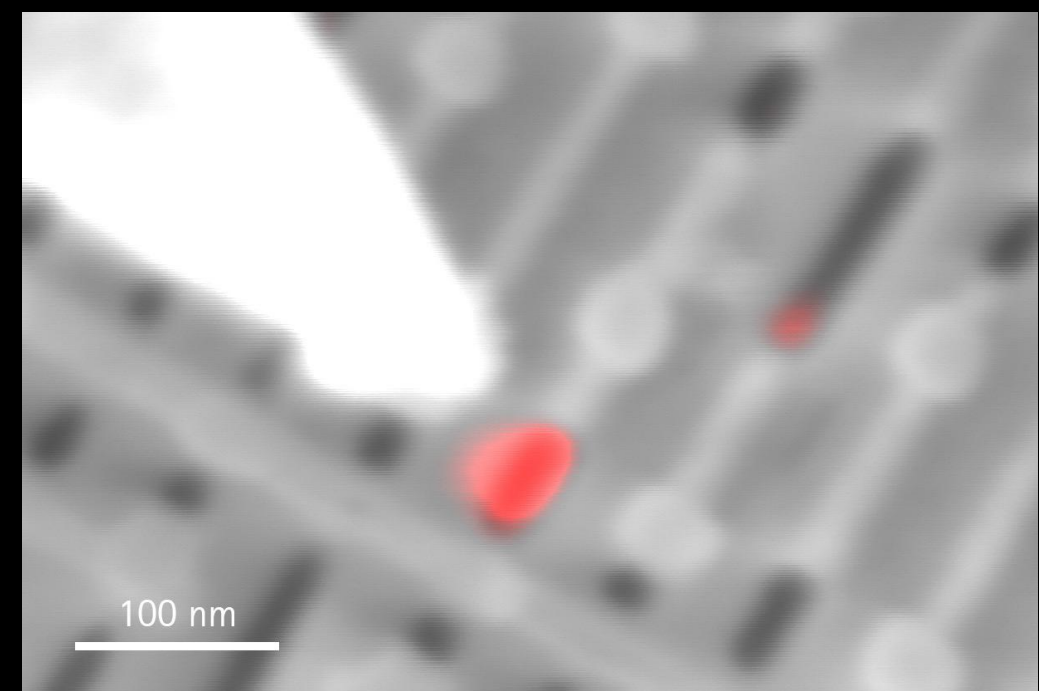
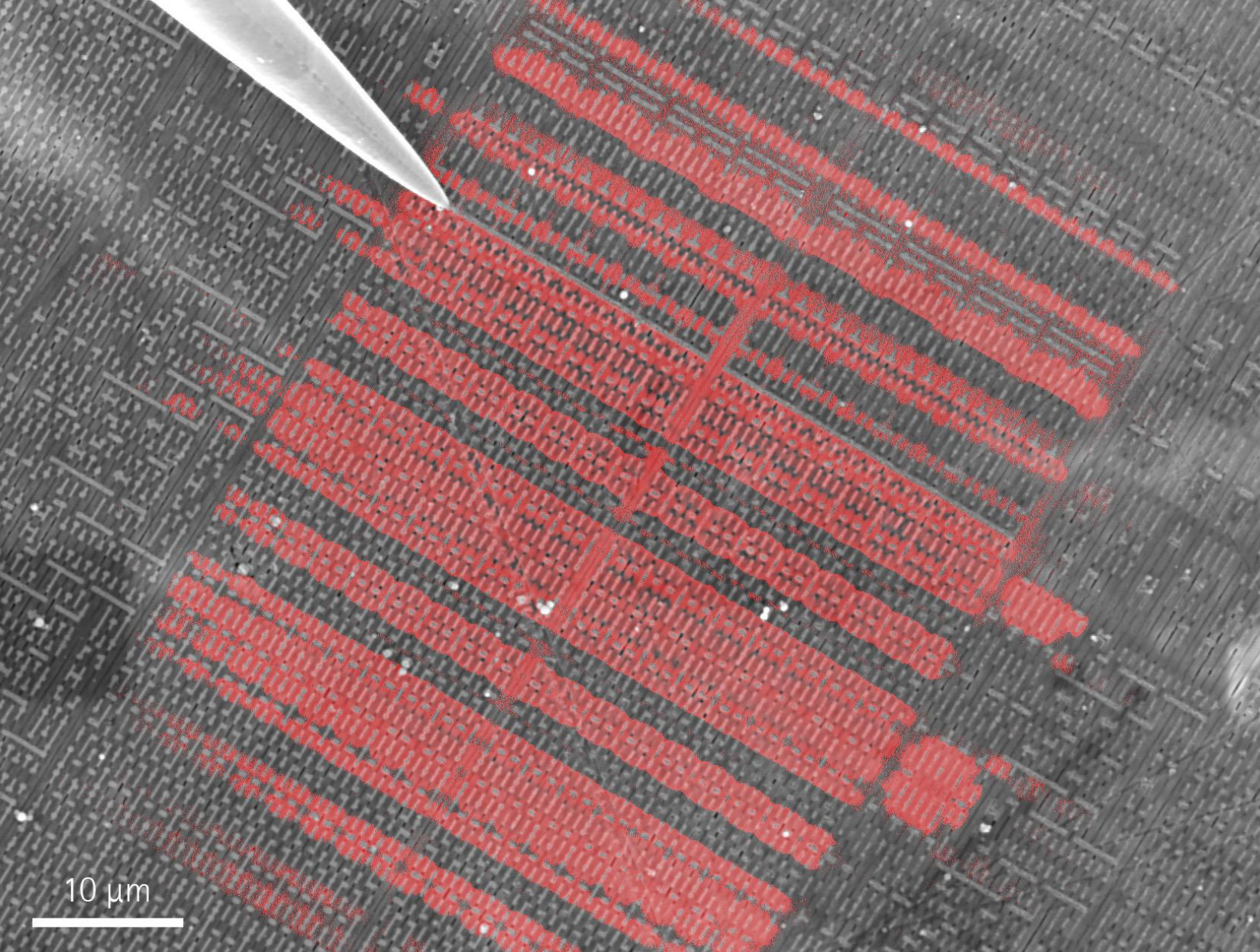
Probing results on 14 nm, 10 nm validated!





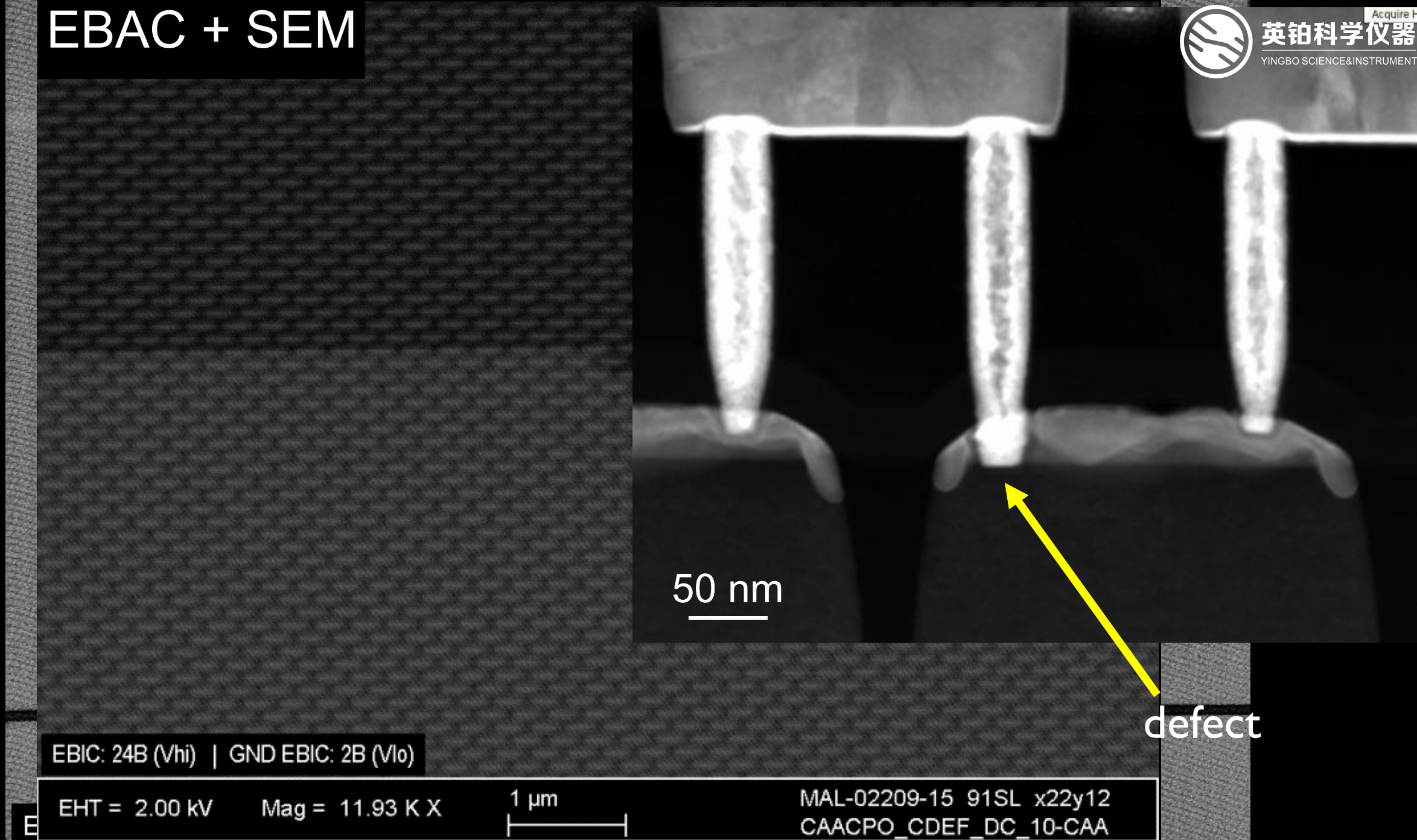
EBIC/EBAC  
on 22 nm  
1 MHz  
1 e8V/A





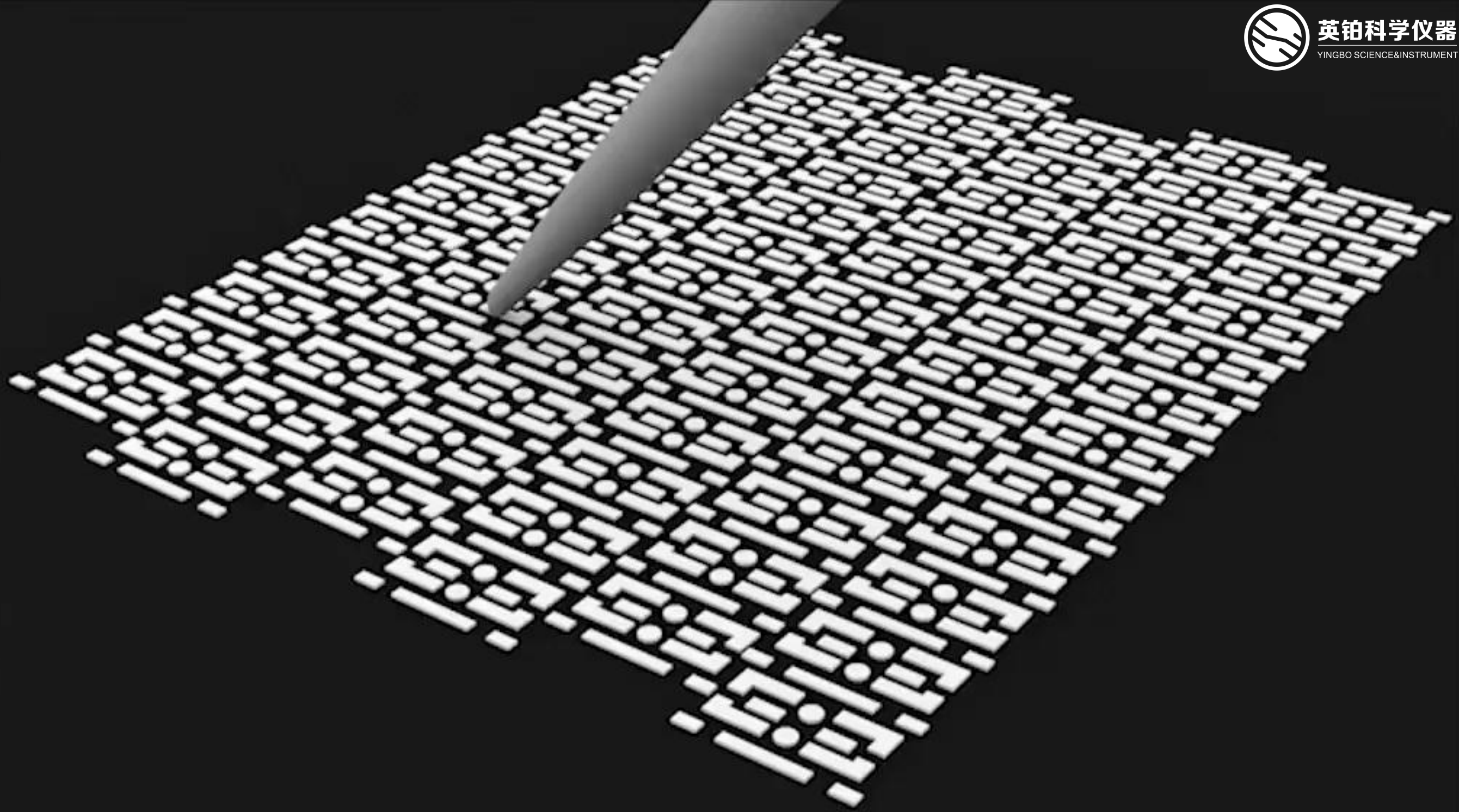
EBIC on 14 nm





- 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

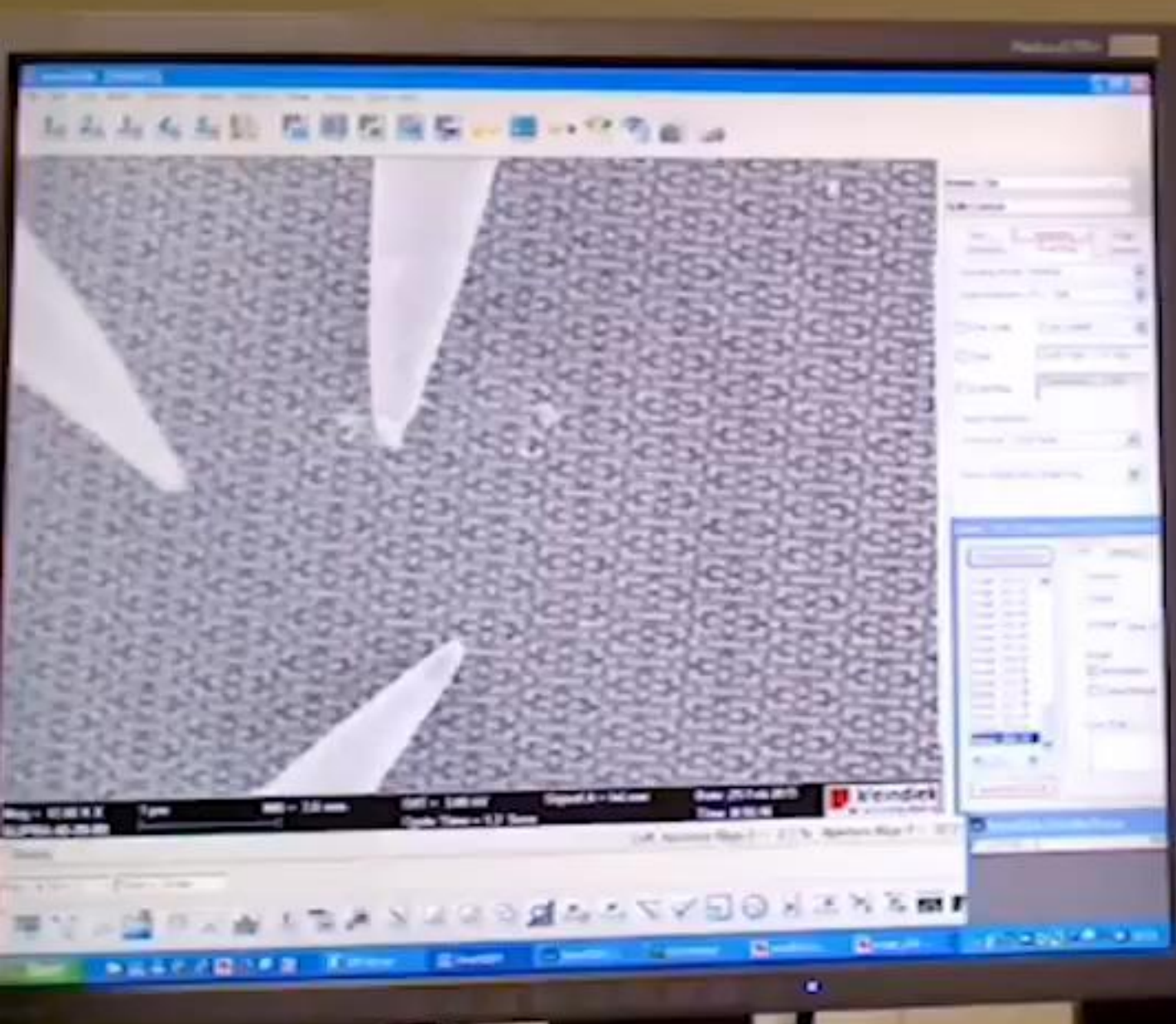
## EBAC – 28nm technology



# Current Imaging

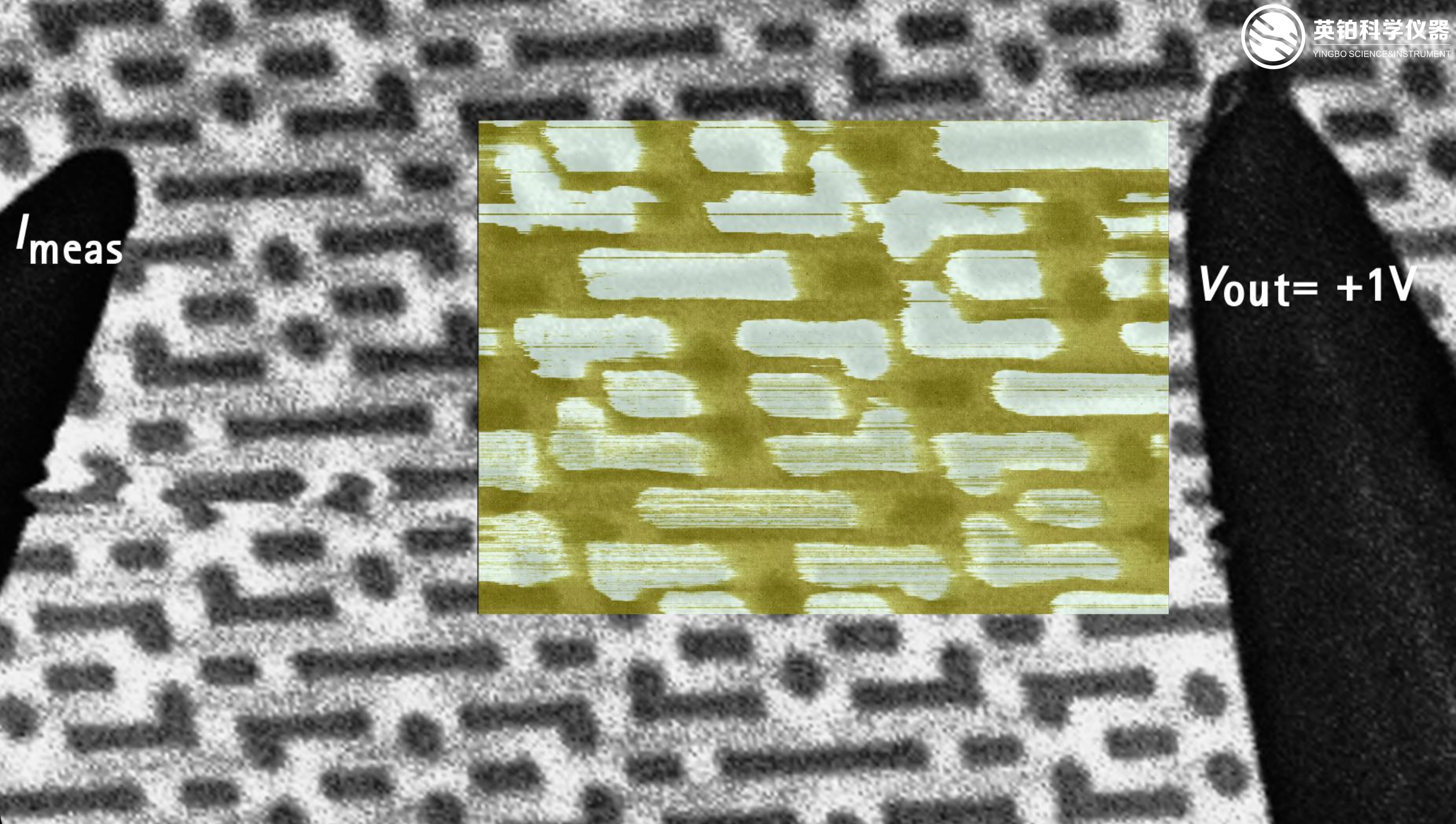
## Operating principle





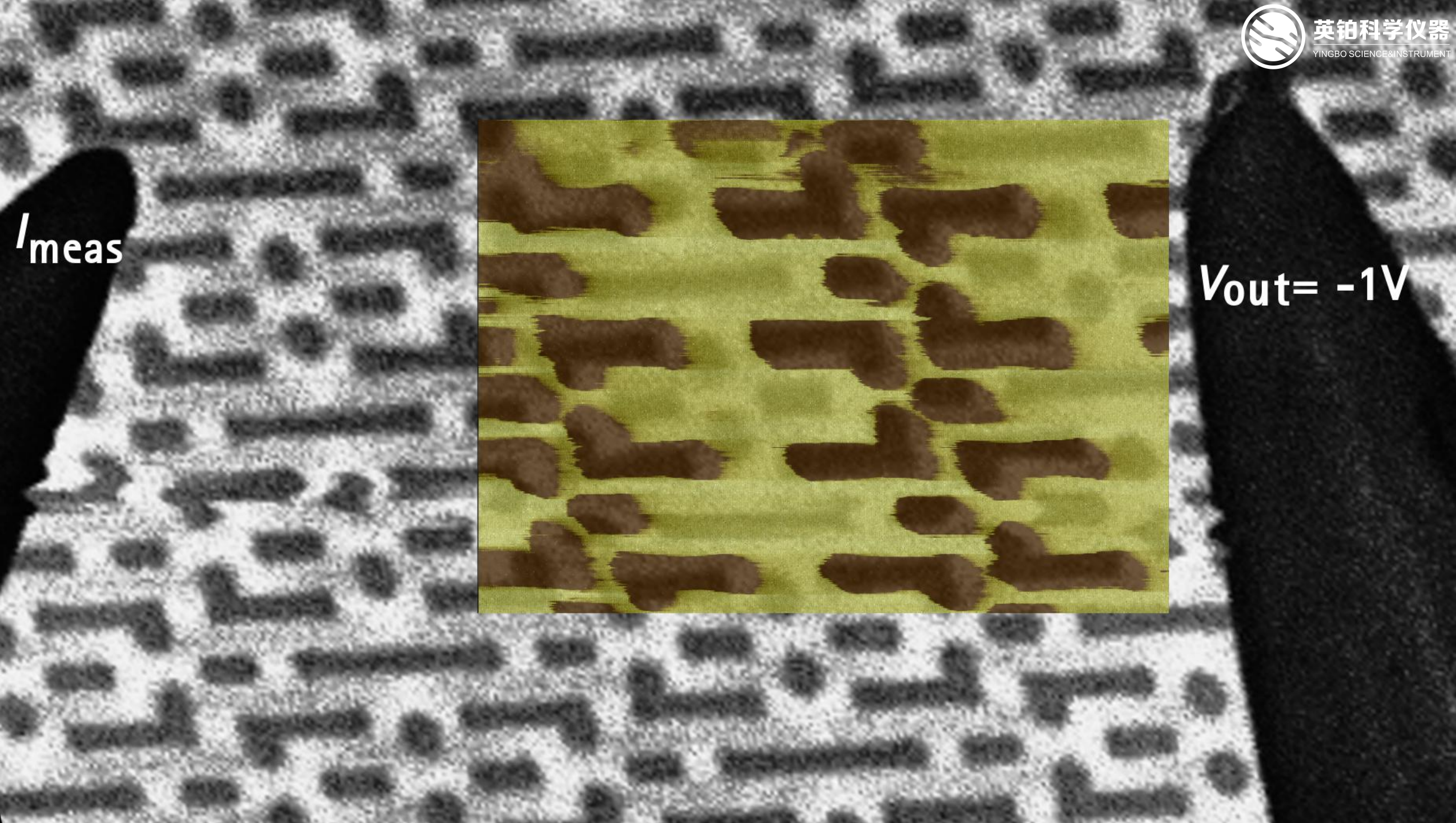
# Current Imaging Acquisition





# Current Imaging (Correlative Microscopy)

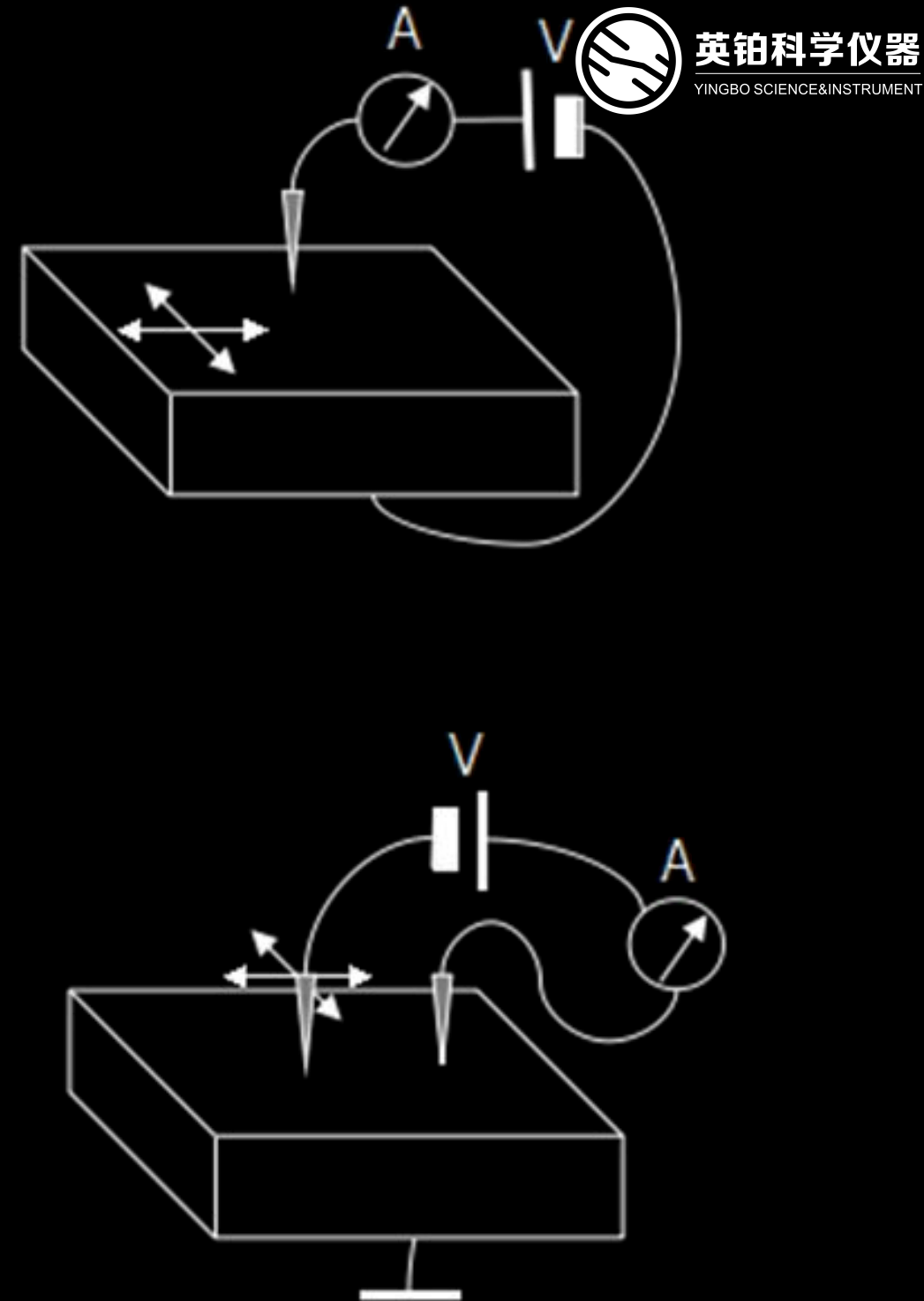
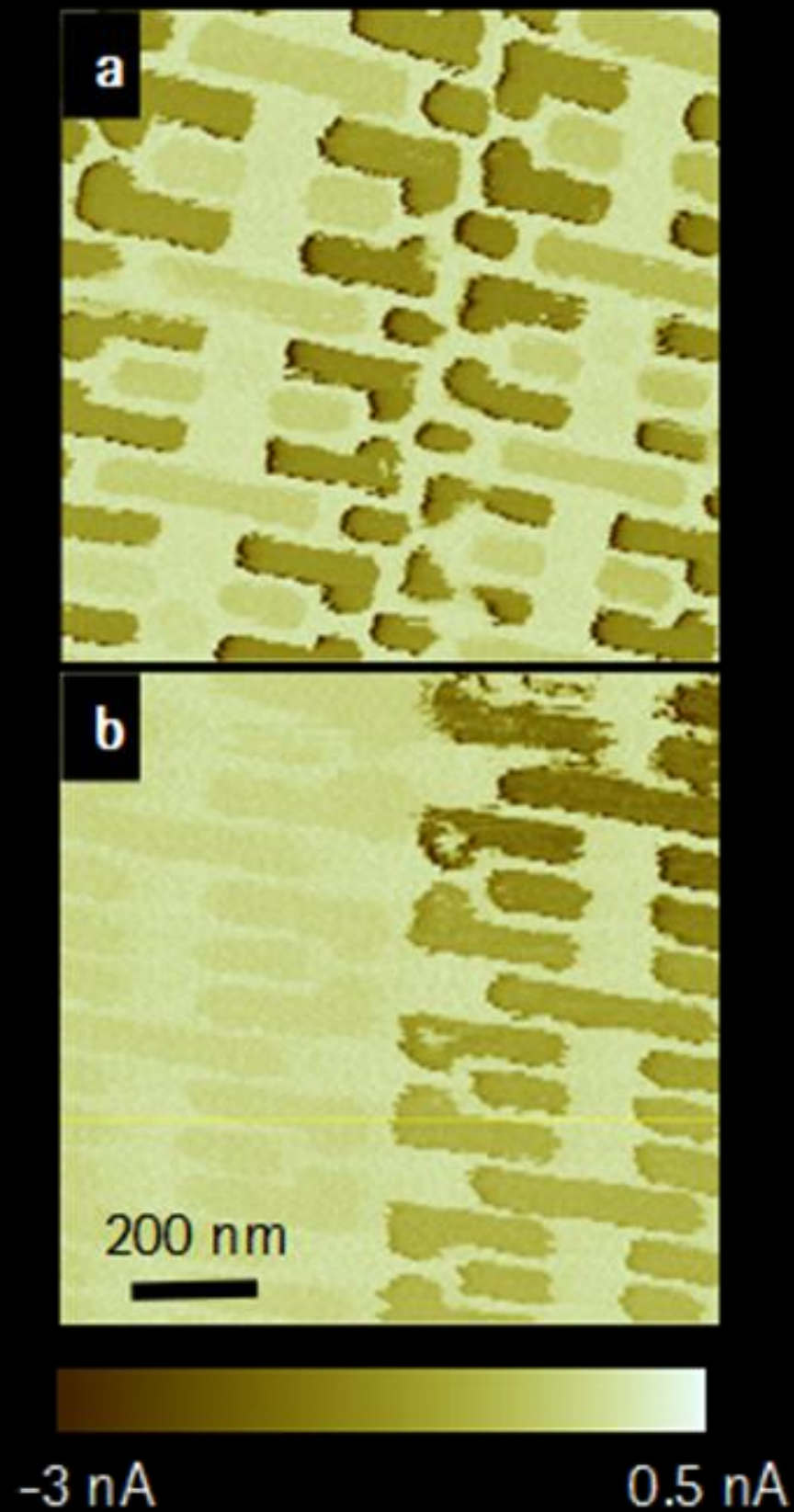




# Current Imaging (Correlative Microscopy)

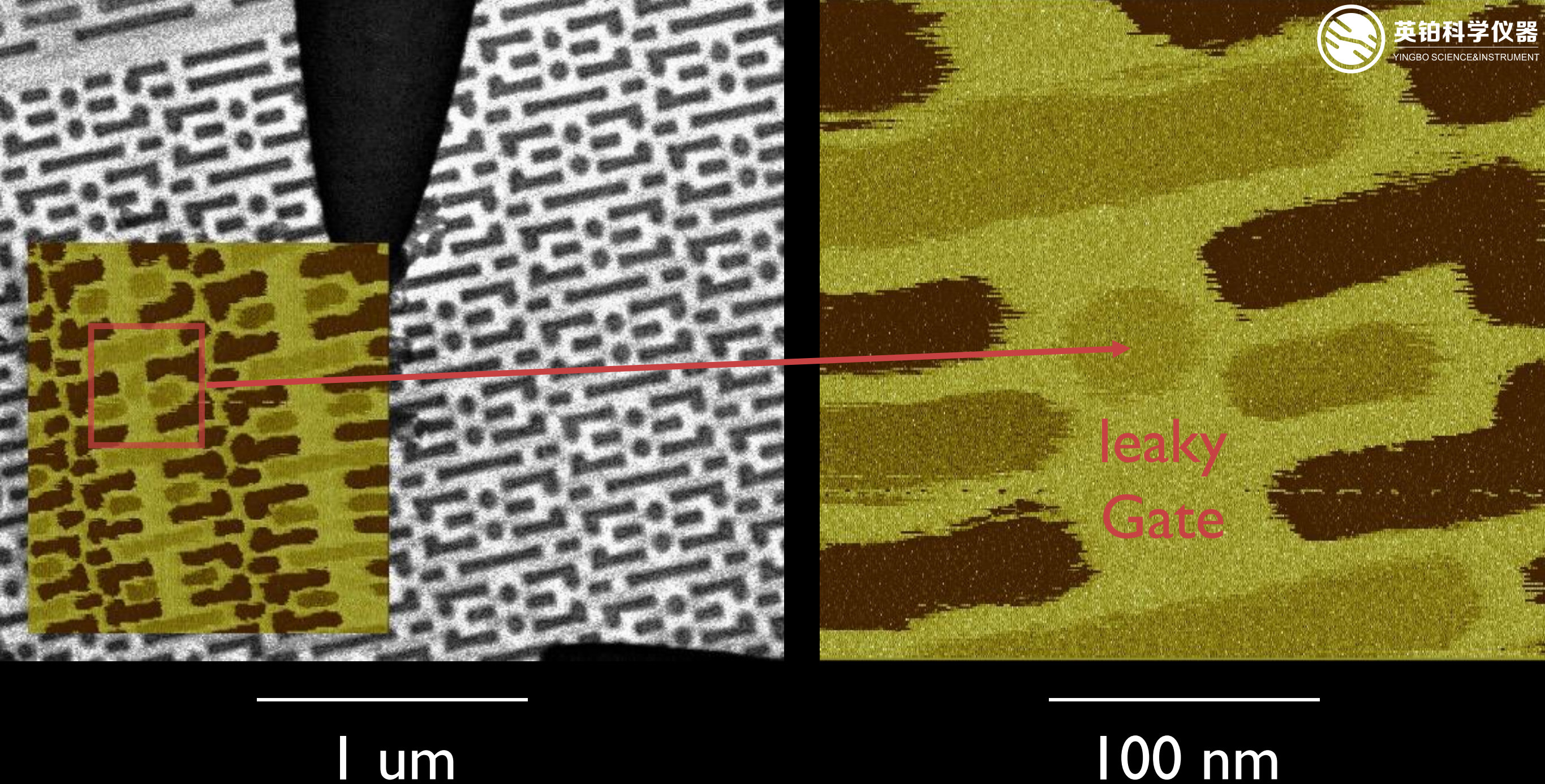


22 nm  
technology



Current Imaging, different Current Paths





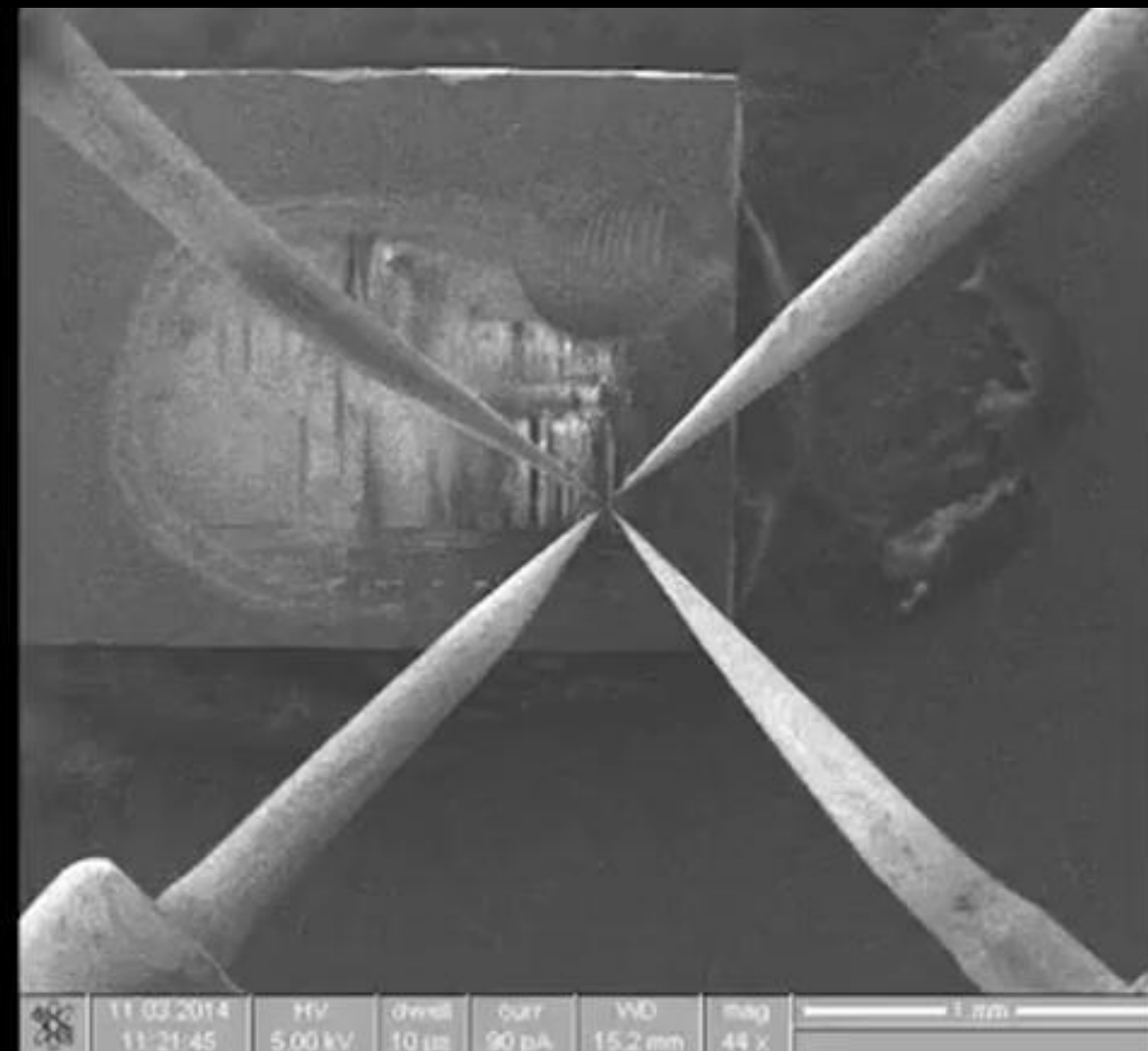
Current Imaging on 22 nm  
Resolution complementary to LM and SEM



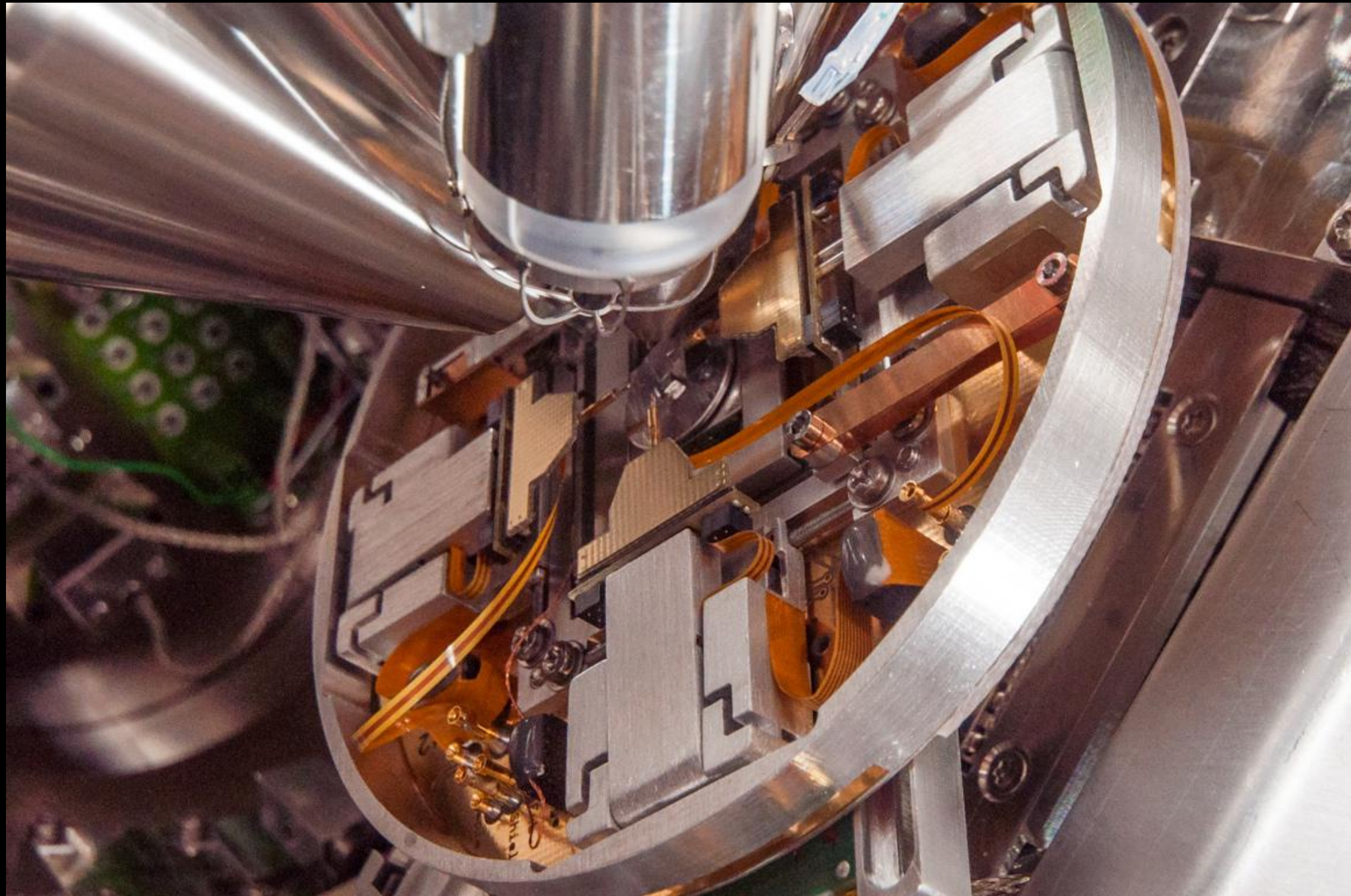
# Advantages Current Imaging

- 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



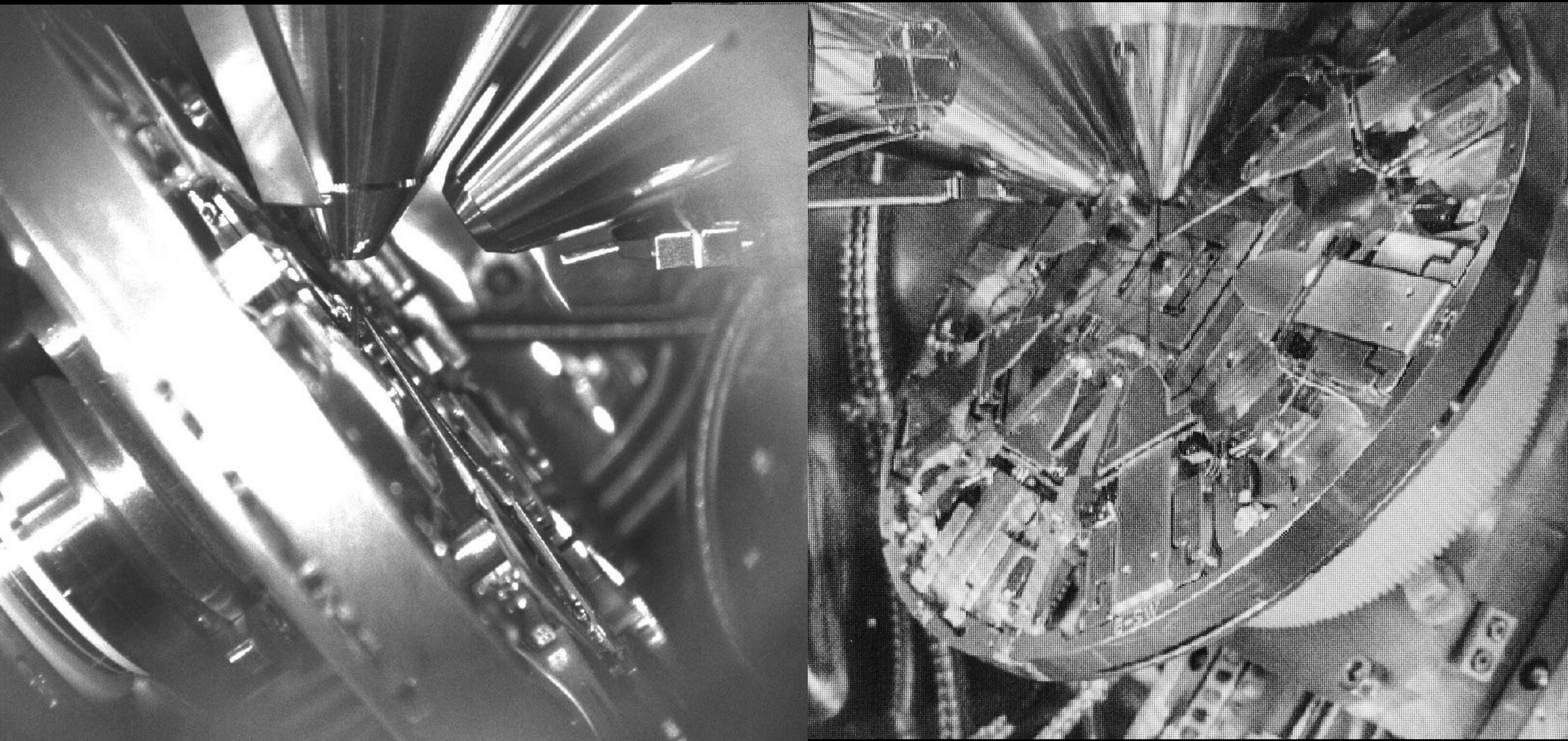


Tilt to 52 degrees  
Key Factor for Probing during Circuit Edit



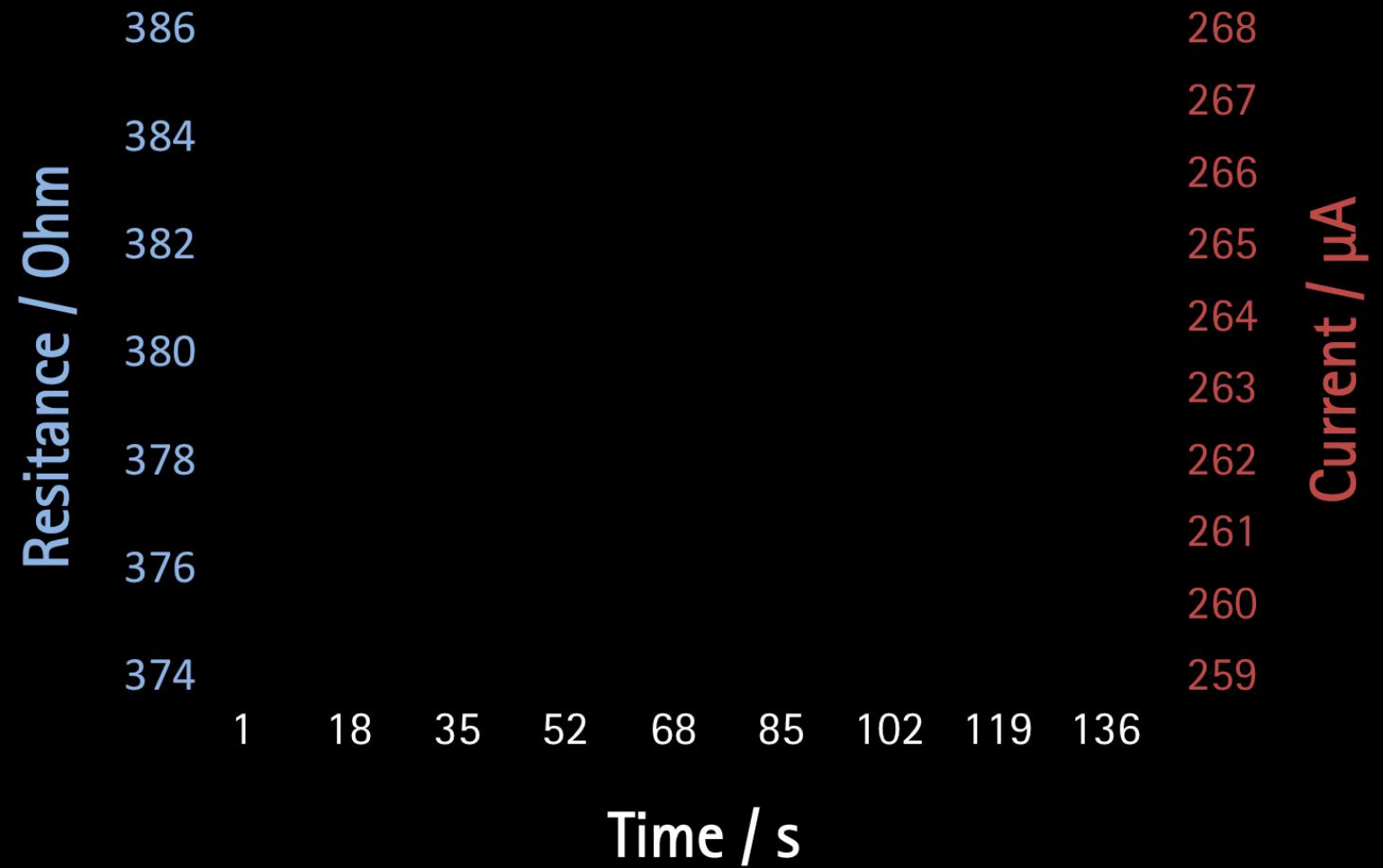
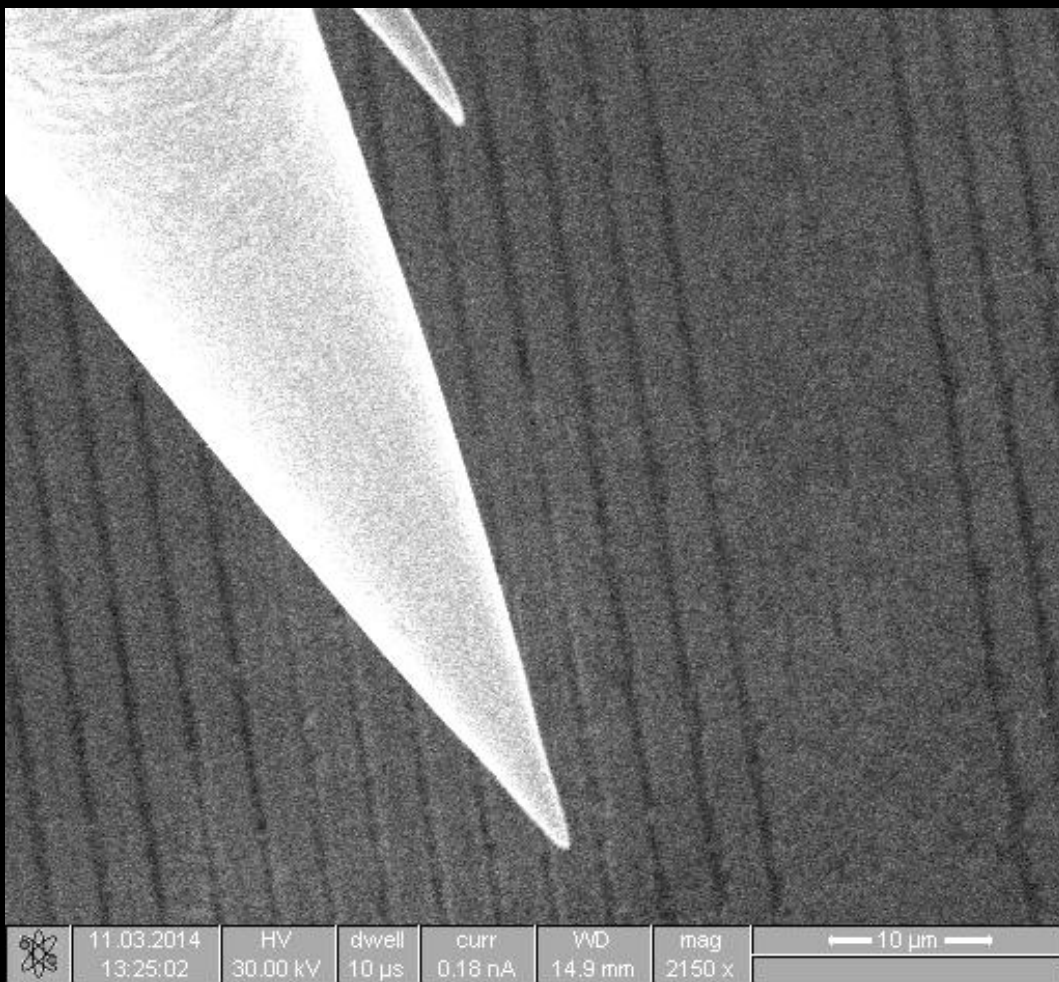
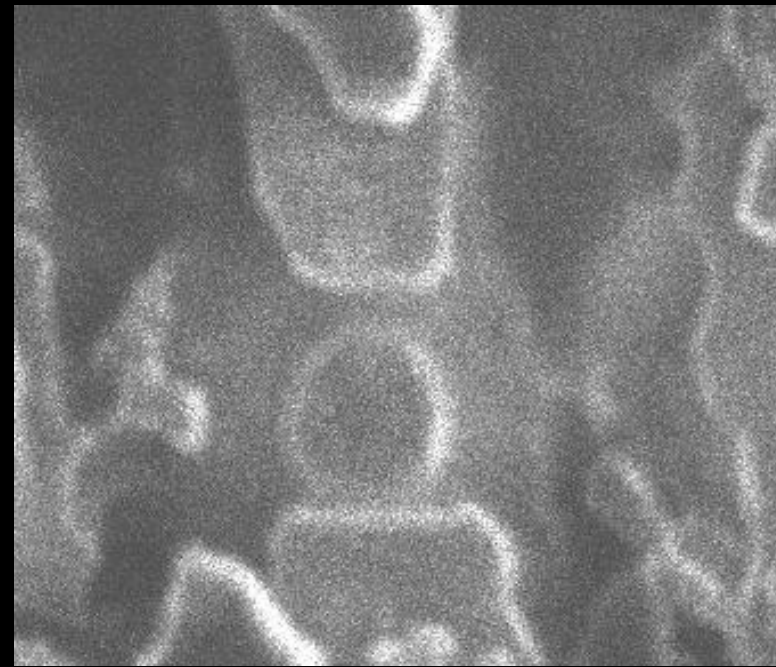
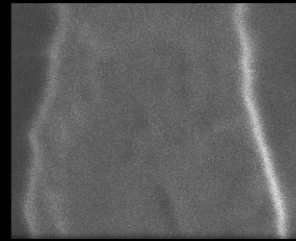
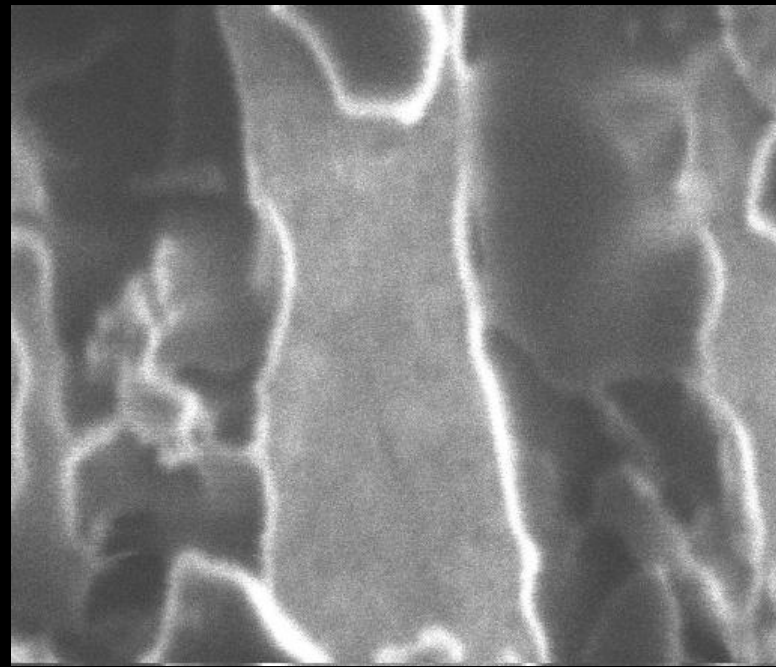
# Probing at FIB tilt





Probing at FIB tilt





# Probing during Circuit Edit



Lift substage and touch down needles

# Circuit Edit with in situ monitoring

substage XY: find ROI

Tip 8 Tip 1 Tip 2 Tip 3 Tip 5 Tip 4 Tips 6 & 7

1 substage XY: find ROI  
2 tips XY: center radius 100  $\mu\text{m}$   
3 tips Z: move to same focal plane  
4 tips XY: center radius 10  $\mu\text{m}$   
5 tips Z: move to same focal plane  
6 SEM: focus 500  $\mu\text{m}$  above sample  
7 tips Z: move into focal plane  
8 SEM: focus 100  $\mu\text{m}$  below tips  
9 substage Z: lift substage into focus  
10 tips XY: center radius 2  $\mu\text{m}$   
11 tips Z: bring to same focal plane  
12 tips XY: adjust fine range  
13 tips XYZ: max lift (macro)  
14 SEM: focus on lowest tip  
15 substage Z: lift slightly below tips  
16 tips Z: approach speed 2  
17 tips Z: land speed 1  
18 tips Z: final touchdown

WindowsMediaPlayer

Ensure that all tips are visible at the microscope's lowest magnification.  
If necessary, use SEM stage to locate the tips and drag them (speed 5) into the field of view.  
Position the tips at the image's perimeter, locate the area of interest using the Prober Shuttle's integrated substage (speed 5).

# 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

