CAPRES A/S

Andrea Ceccacci

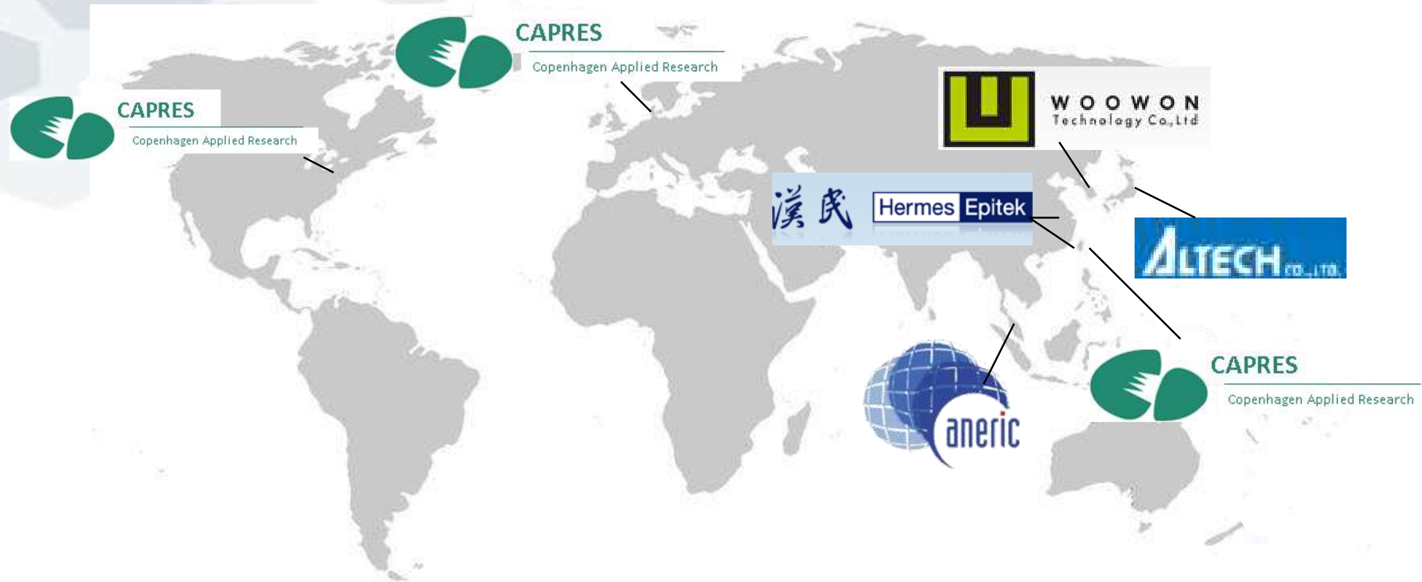
Consortium meeting- Leuven- 20th April 2018

CAPRES A/S

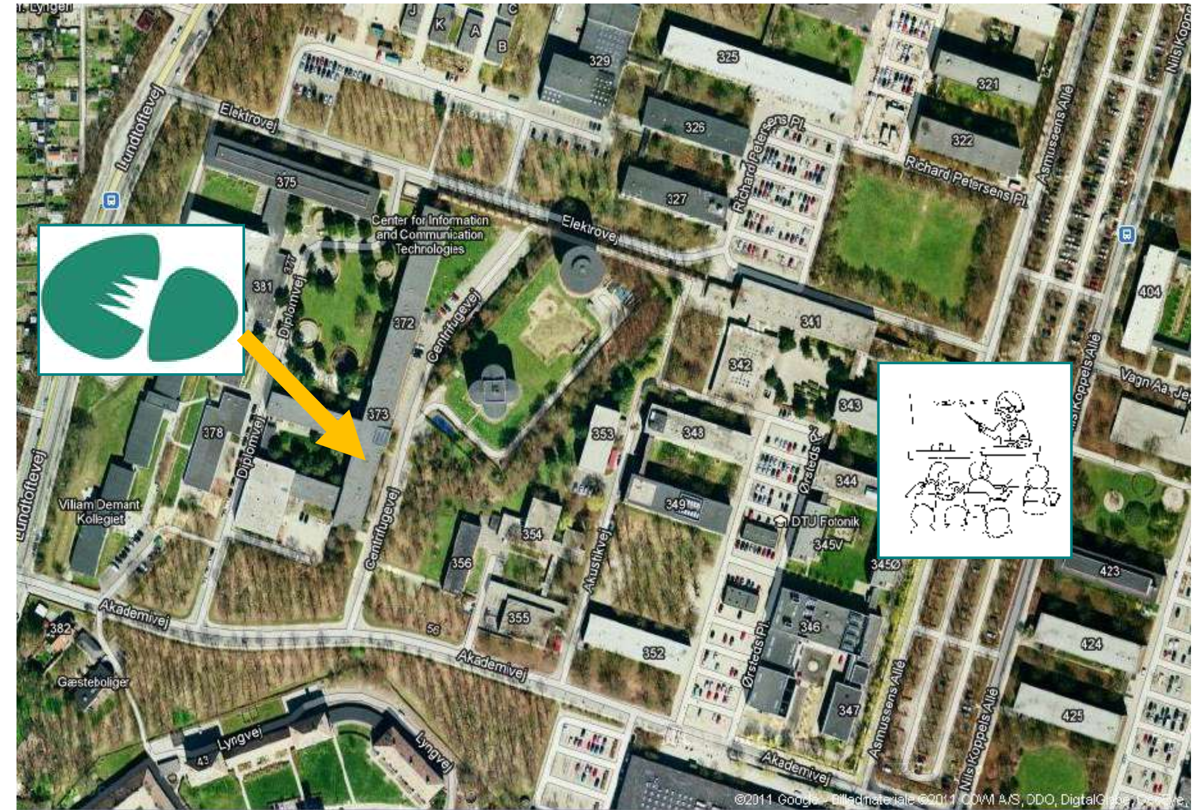
COPENHAGEN APPLIED RESEARCH

CAPRES A/S

COPENHAGEN APPLIED RESEARCH



Where we are



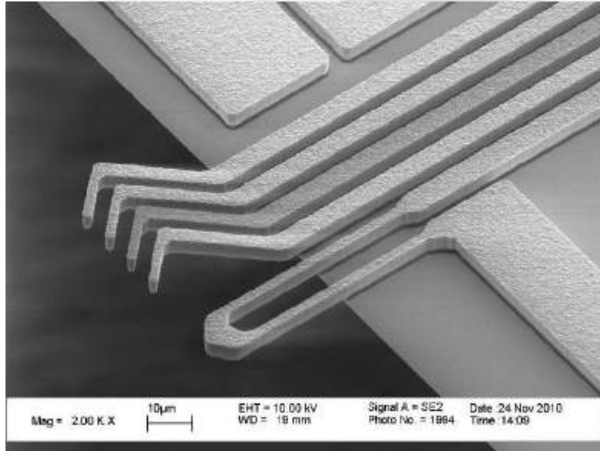
ECSEL JU

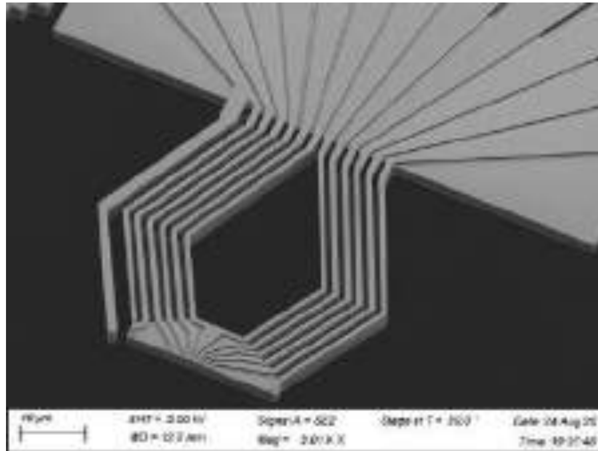
Automatic and manual tools

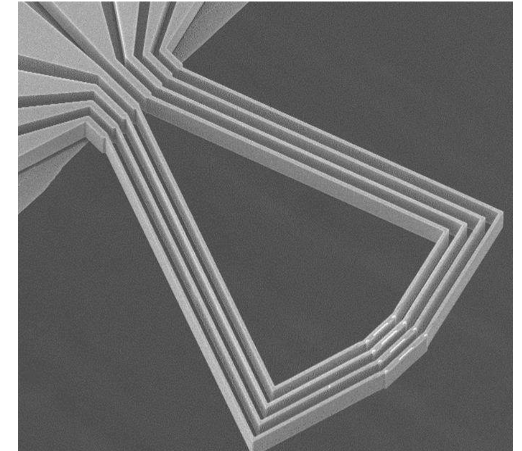
CAPRES A/S
COPENHAGEN APPLIED RESEARCH

ECSEL JU

Agenda





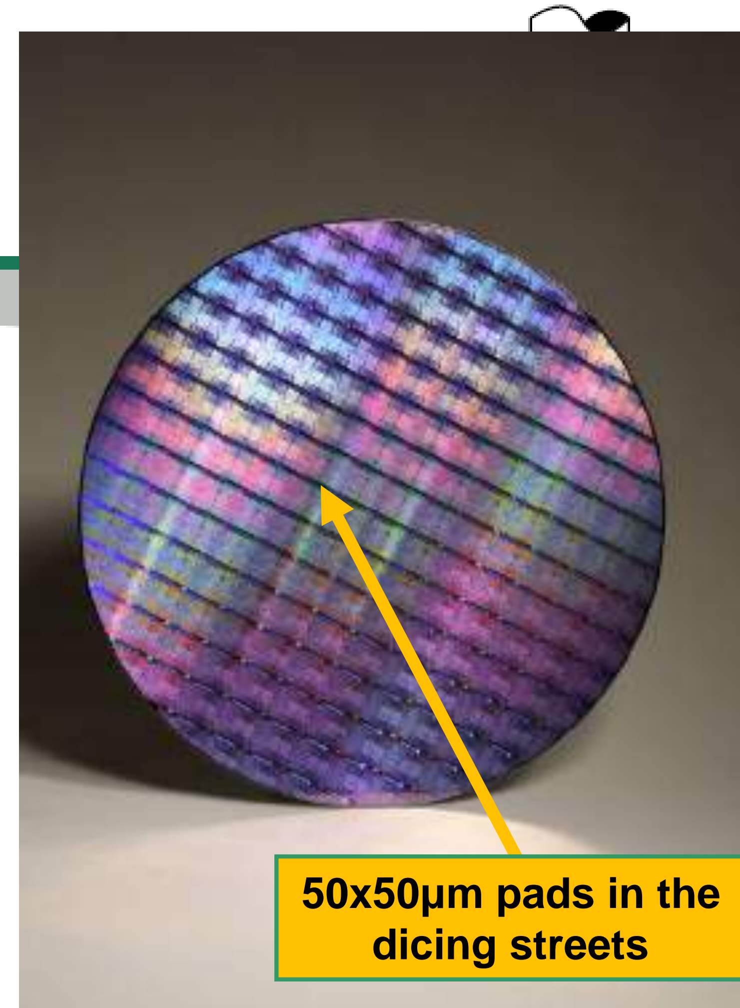


- Micro 4 Point Probe
- CIPTech-Probe

Fin-FET
Resistance Measurement

ECSEL JU

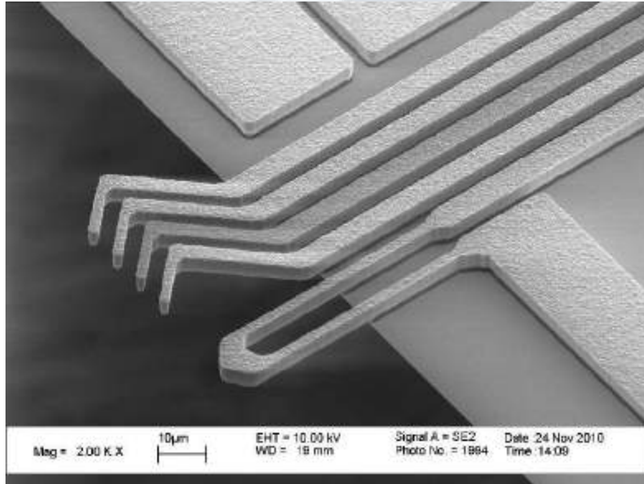
Background



Engineering Challenges
- Eliminate cantilever position errors
- Production of micro probe
- High accuracy surface detection
- Reduction of vibrational noise

Advantages
- Measures near-surface properties
- Measures accurate R_s with µm resolution
- Measurements on small structures

Micro 4 Point Probe

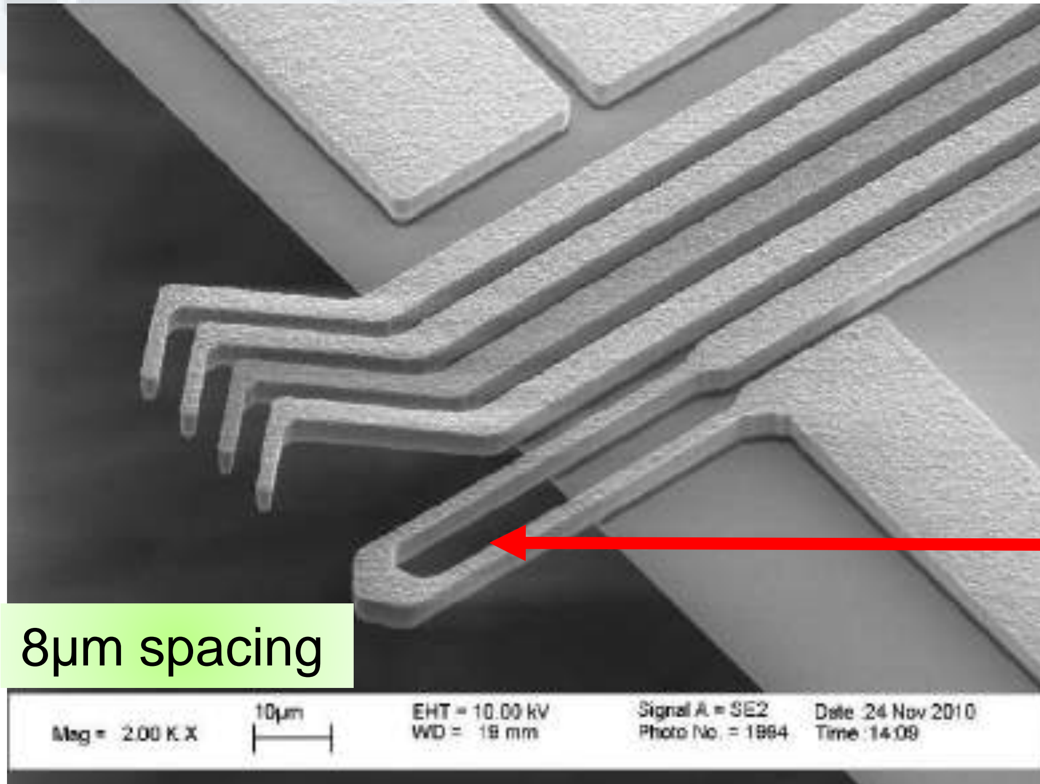


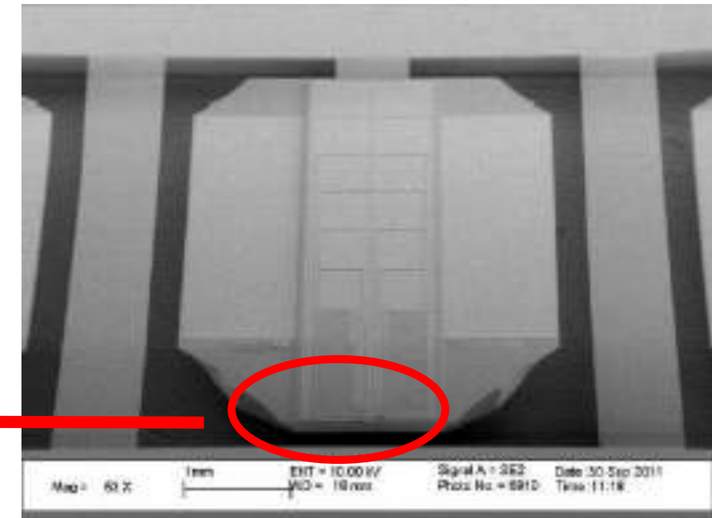
- Micro 4 Point Probe

- Optimized cantilever shape
- Measurements on USJ and Hall Mobility

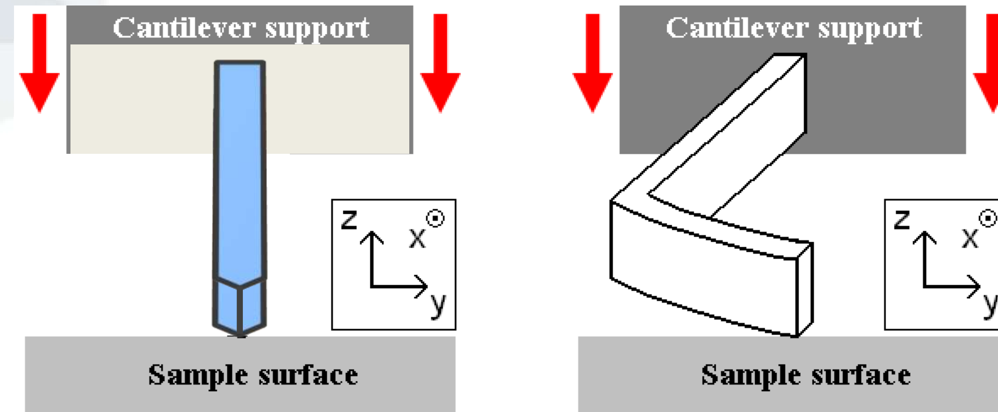
ECSEL JU

The micro 4 Point Probe





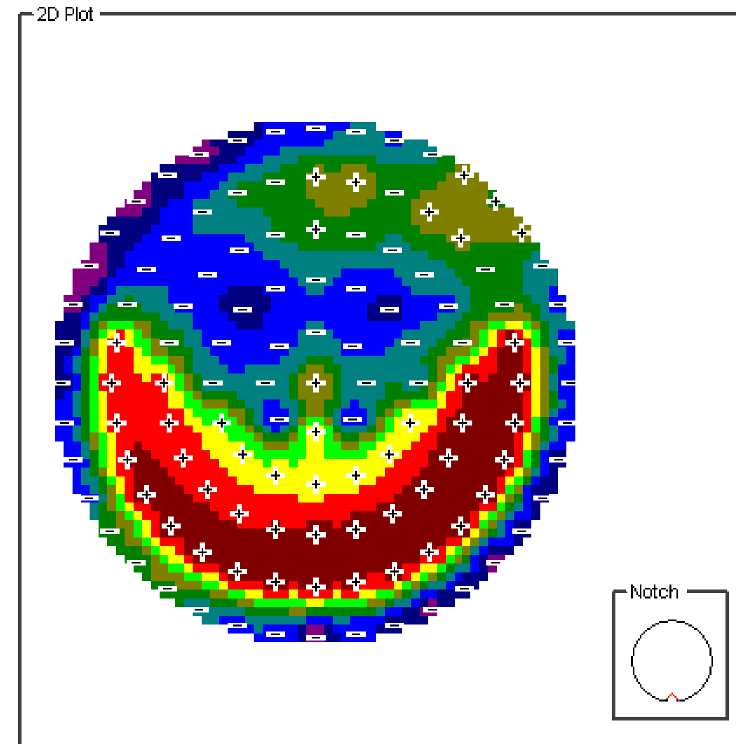
L-shaped cantilevers



- L shape cantilever ensures steady contact point through 3-way flexible cantilevers.
- Relatively large vibrations (~50nm and above) can be absorbed without loosing contact or sliding.

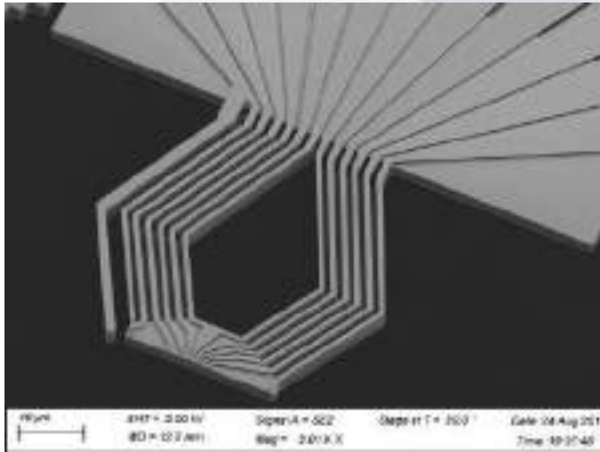
Sheet Resistance mapping of a 300mm blanket wafer

Blanket wafer
USJ, doped and annealed



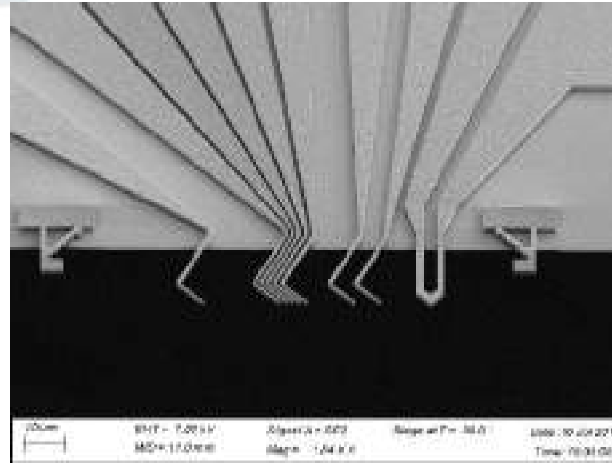
ECSEL JU

Probes for characterization of MTJ films



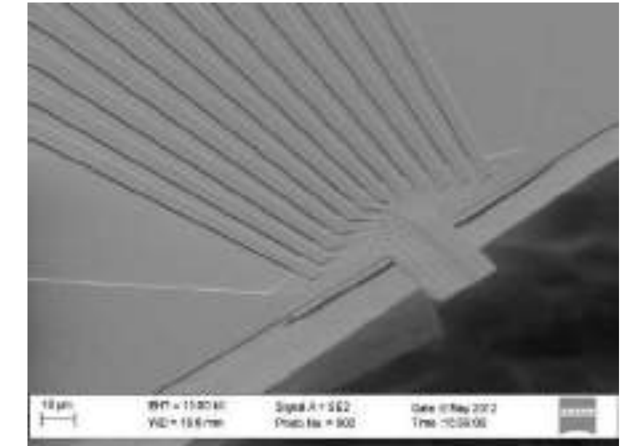
Min Pitch 0.5µm

Electrical surface detection
Excellent vibration absorption



Min Pitch 1.5µm

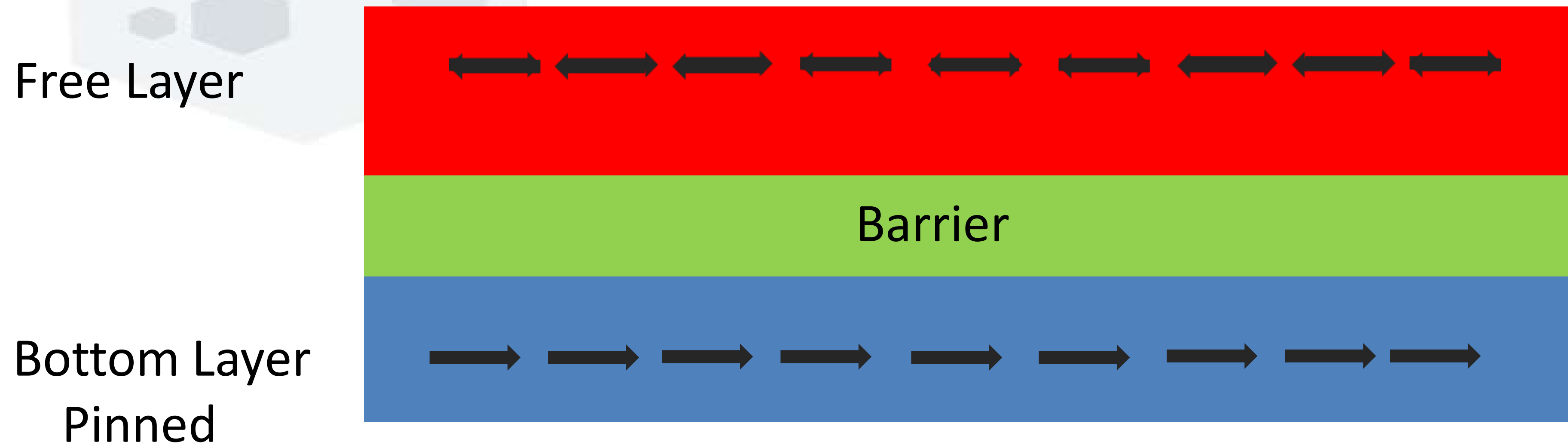
Mechanical surface detection
Excellent Vibration absorption



Min Pitch 0.75 µm

Electrical surface detection
Poor vibration absorption

Magnetic Tunnel Junction



Parallel Spin → Low resistance

Anti-Parallel Spin → High Resistance

ECSEL JU

Probes for characterization of MTJ films

Free Layer

Barrier

Bottom Layer
Pinned

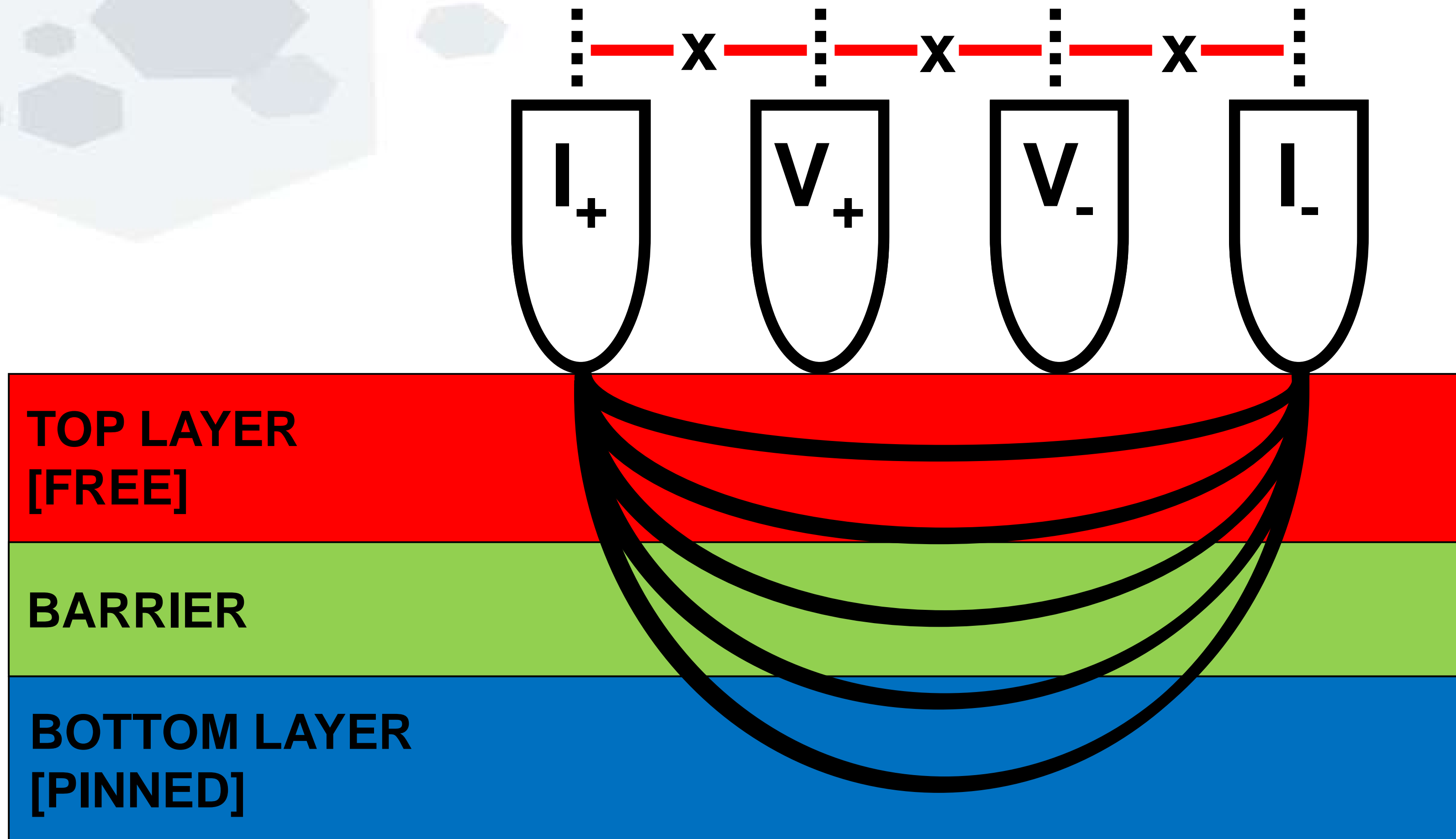
MTJ parameters:

- Top layer sheet resistance- Rt
- Bottom layer sheet resistance – Rb
- Barrier resistance area product – Ra
- Magnetoresistance – MR

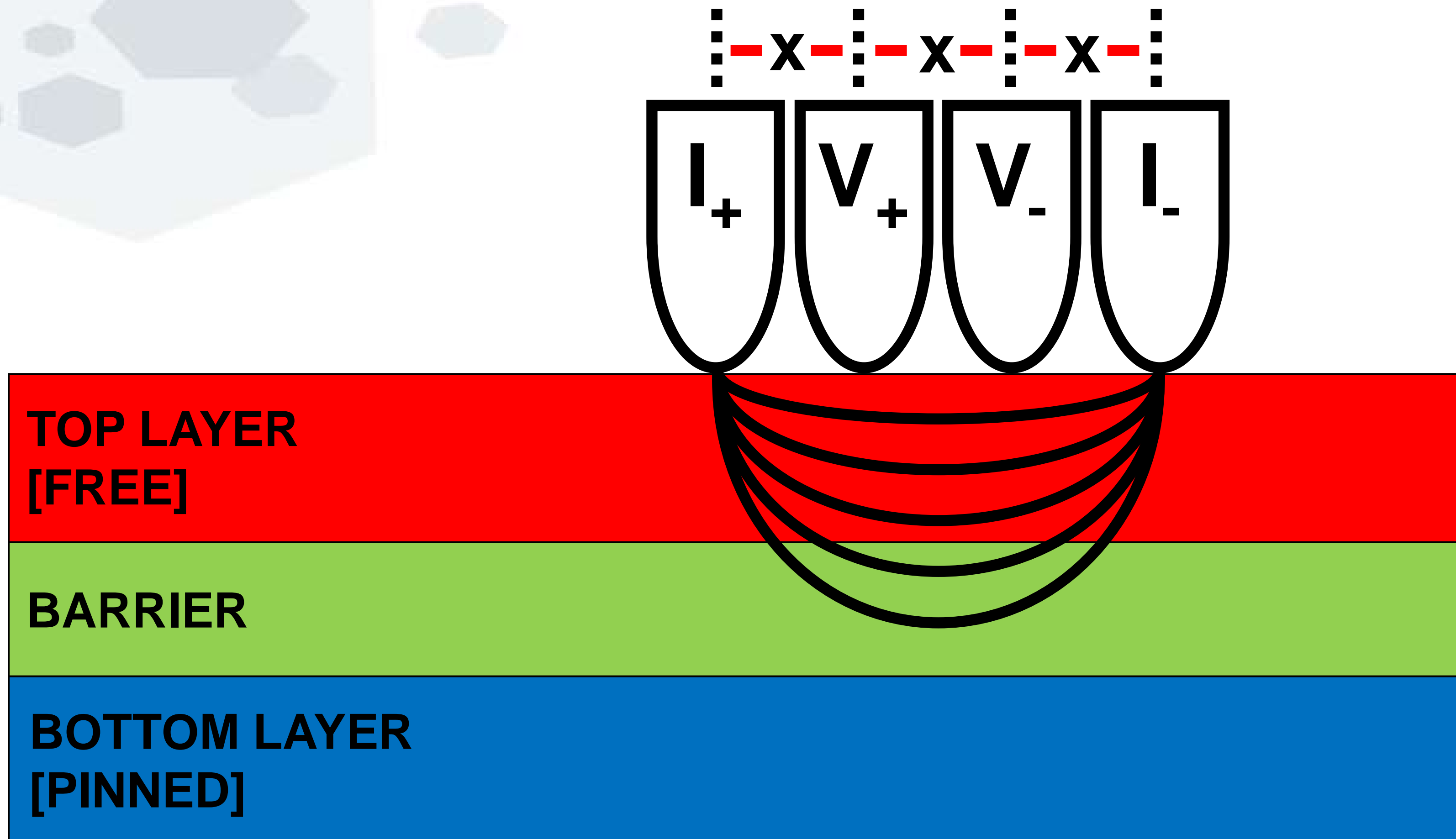
$$MR = \frac{Ra_{high} - Ra_{low}}{Ra_{low}}$$

ECSEL JU

Multiple pitches on a single probe

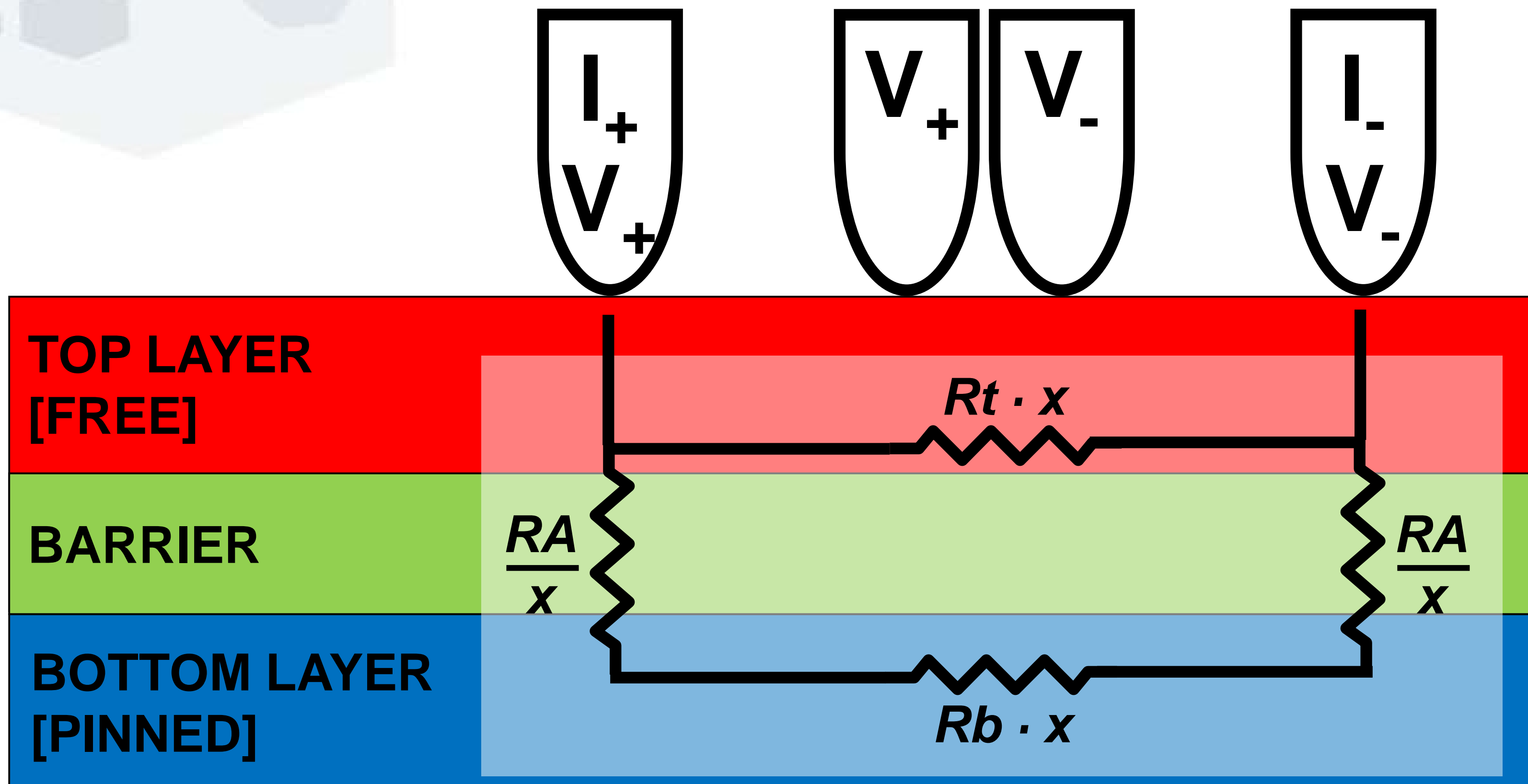


Multiple pitches on a single probe



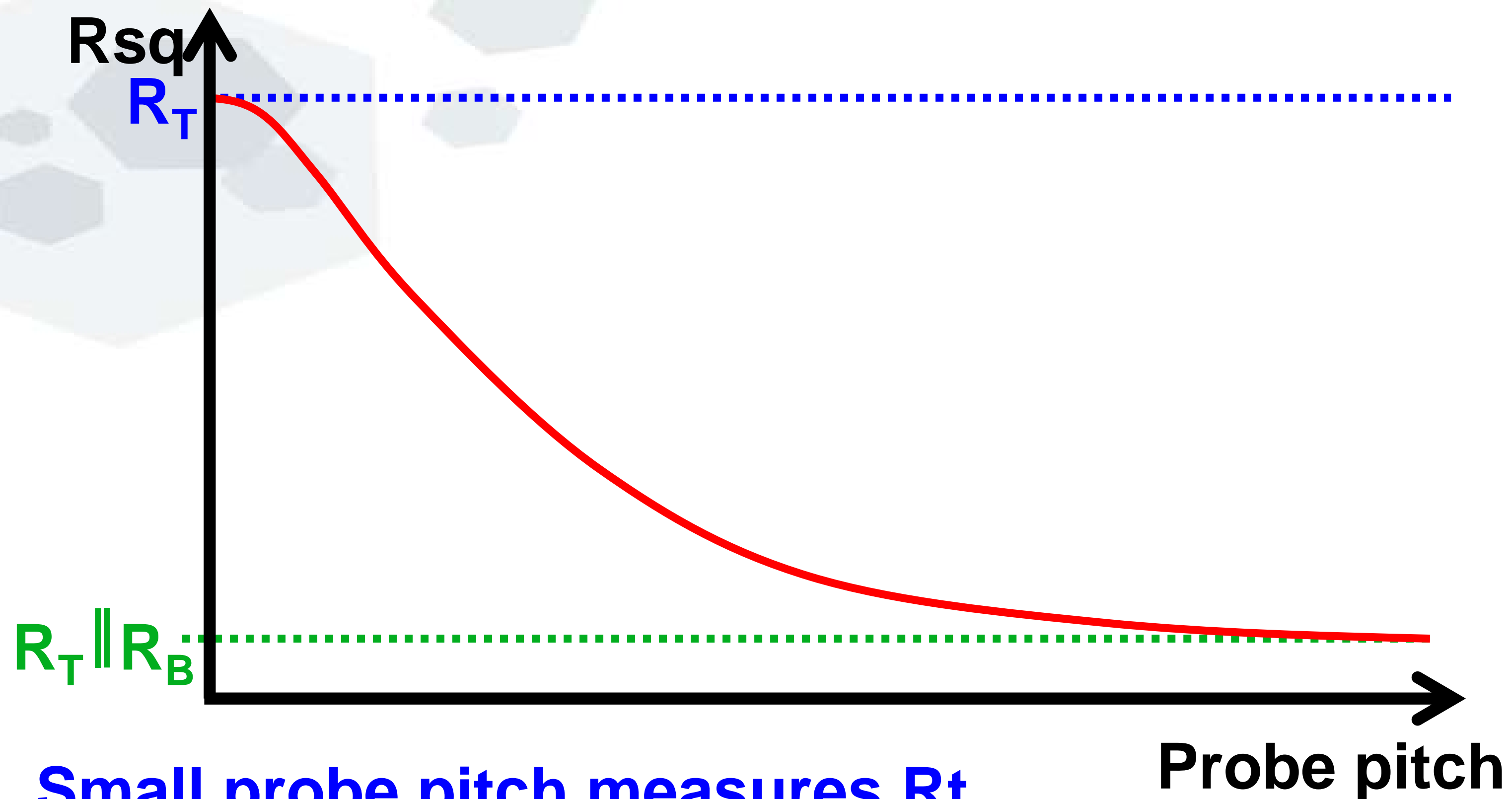
ECSEL JU

Multiple pitches on a single probe



ECSEL JU

Magnetic Tunnel Junction



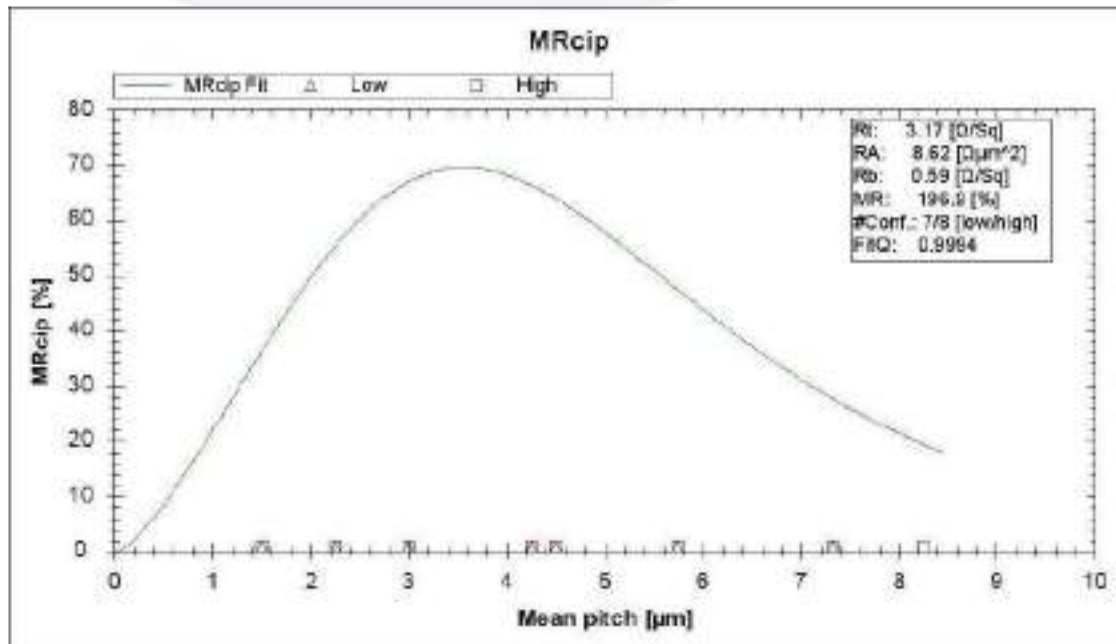
Small probe pitch measures Rt

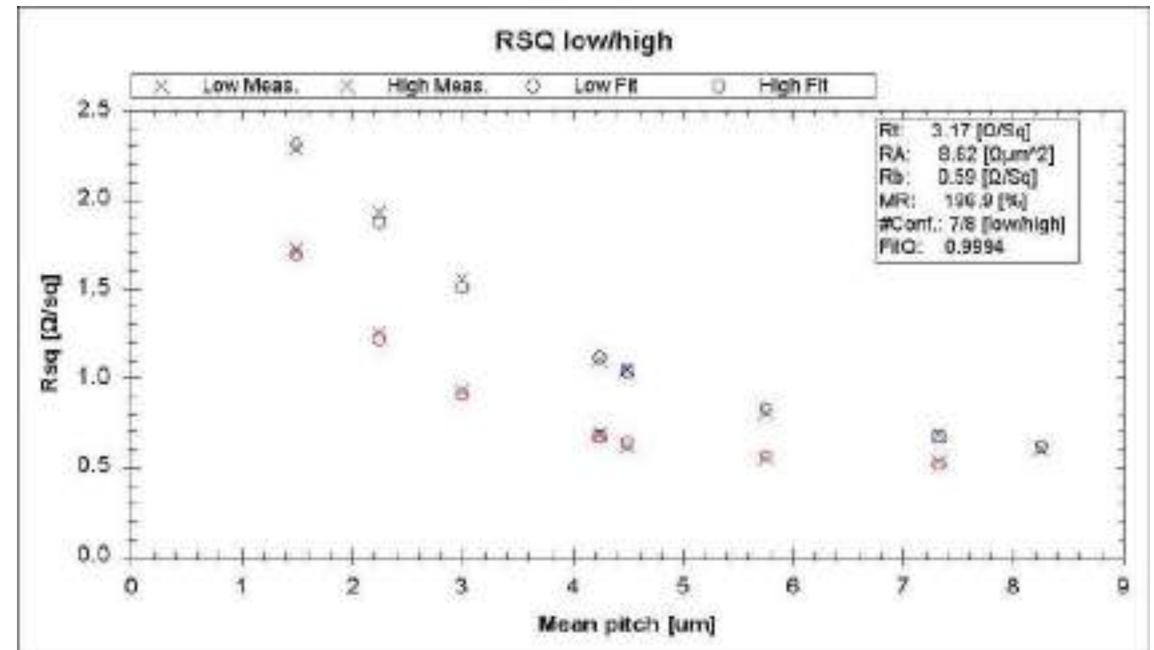
Intermediate probe pitch measures RA and MR

Large probe pitch measures $R_T \| R_B$

ECSEL JU

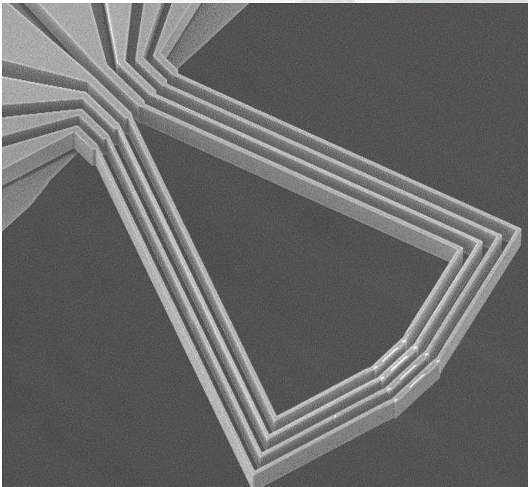
Measurements on MTJs



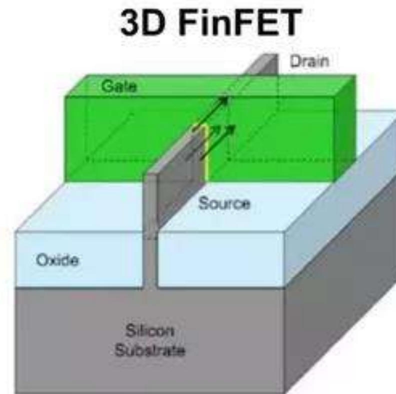


ECSEL JU

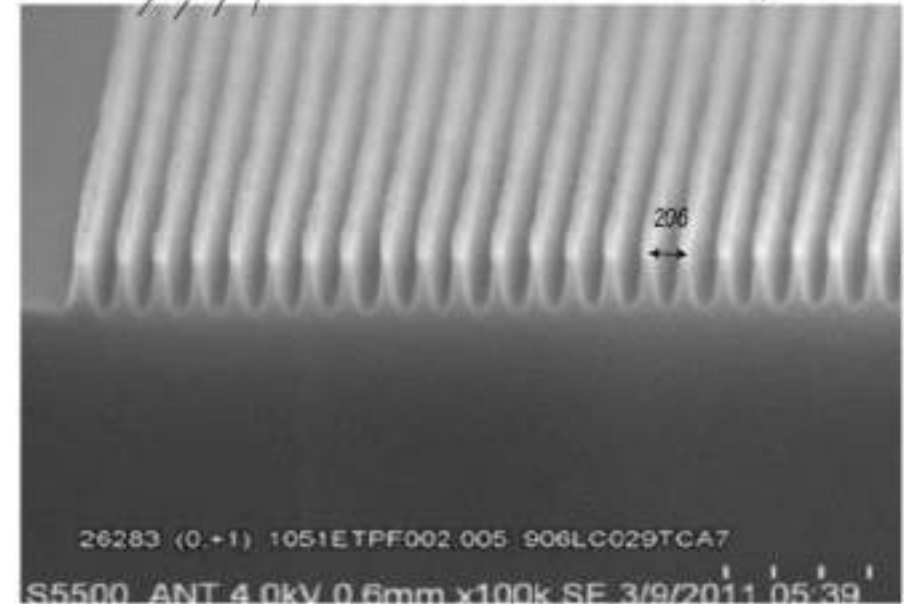
Resistance Measurements of fins and nanowires



Fin-FET
Resistance Measurement



3-D Tri-Gate transistor form conducting channels on three sides of a vertical fin structure, providing "fully depleted" operation

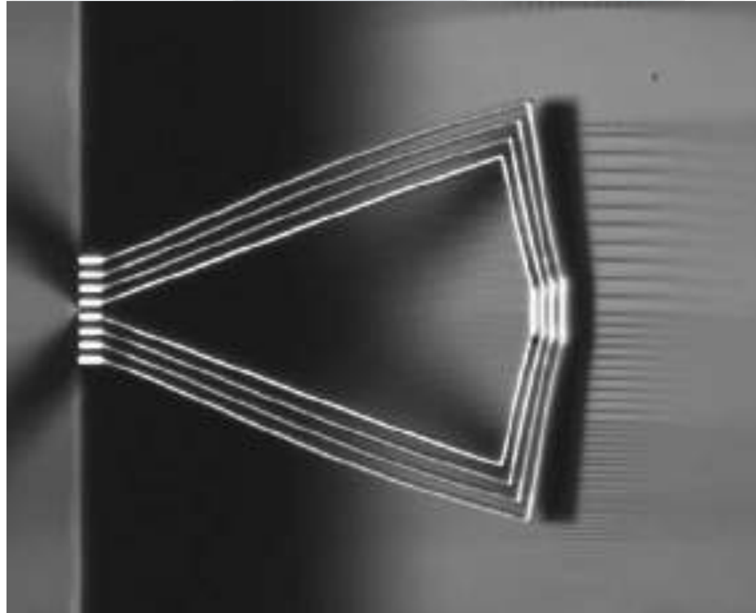


Metrology goals:

1. Non-destructive
2. High measurement yield
3. High accuracy (1% σ)

ECSEL JU

Direct 4pp measurements on fins



Non-destructive

High measurement yield

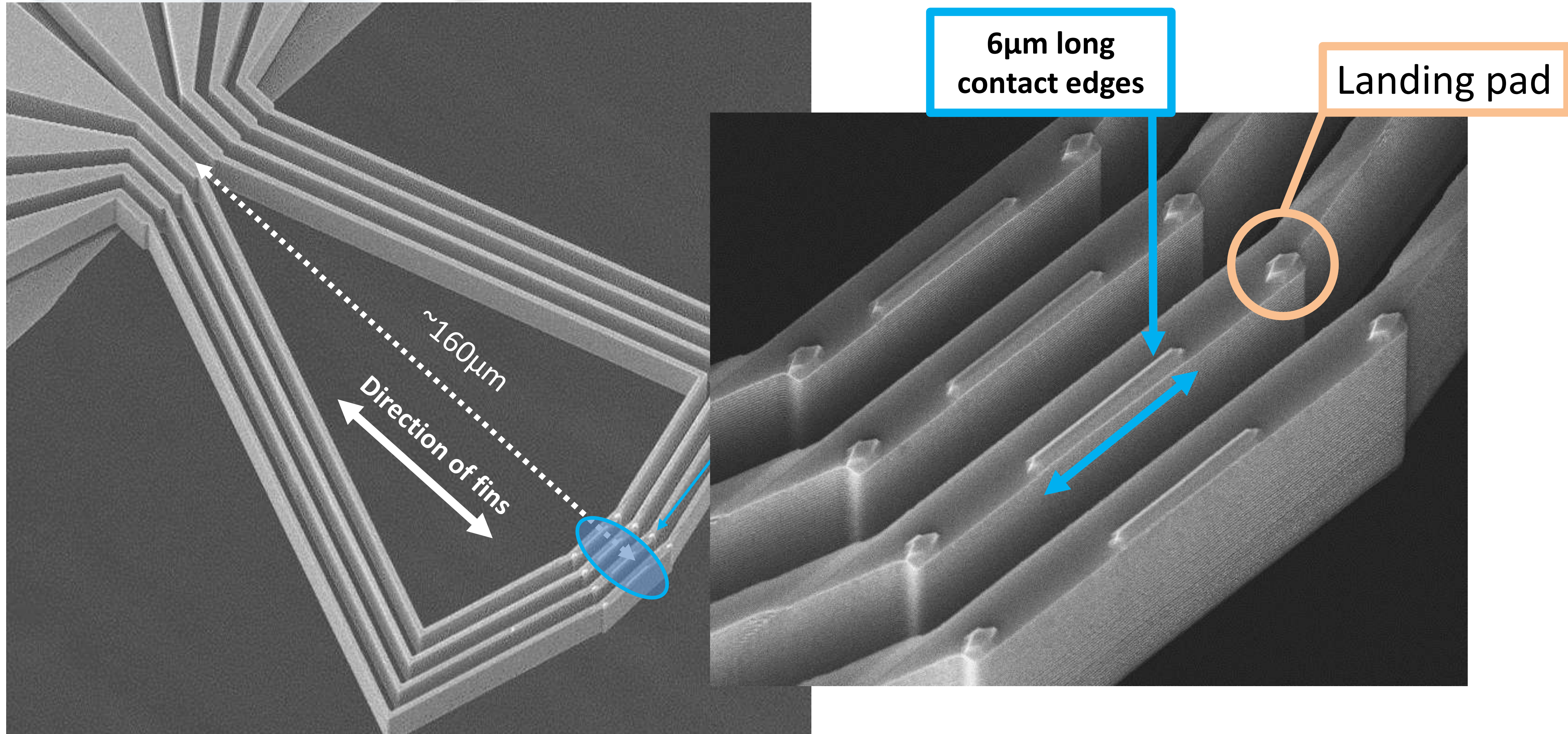
High accuracy (~1% σ)

Destructive

Medium-low measurement yield

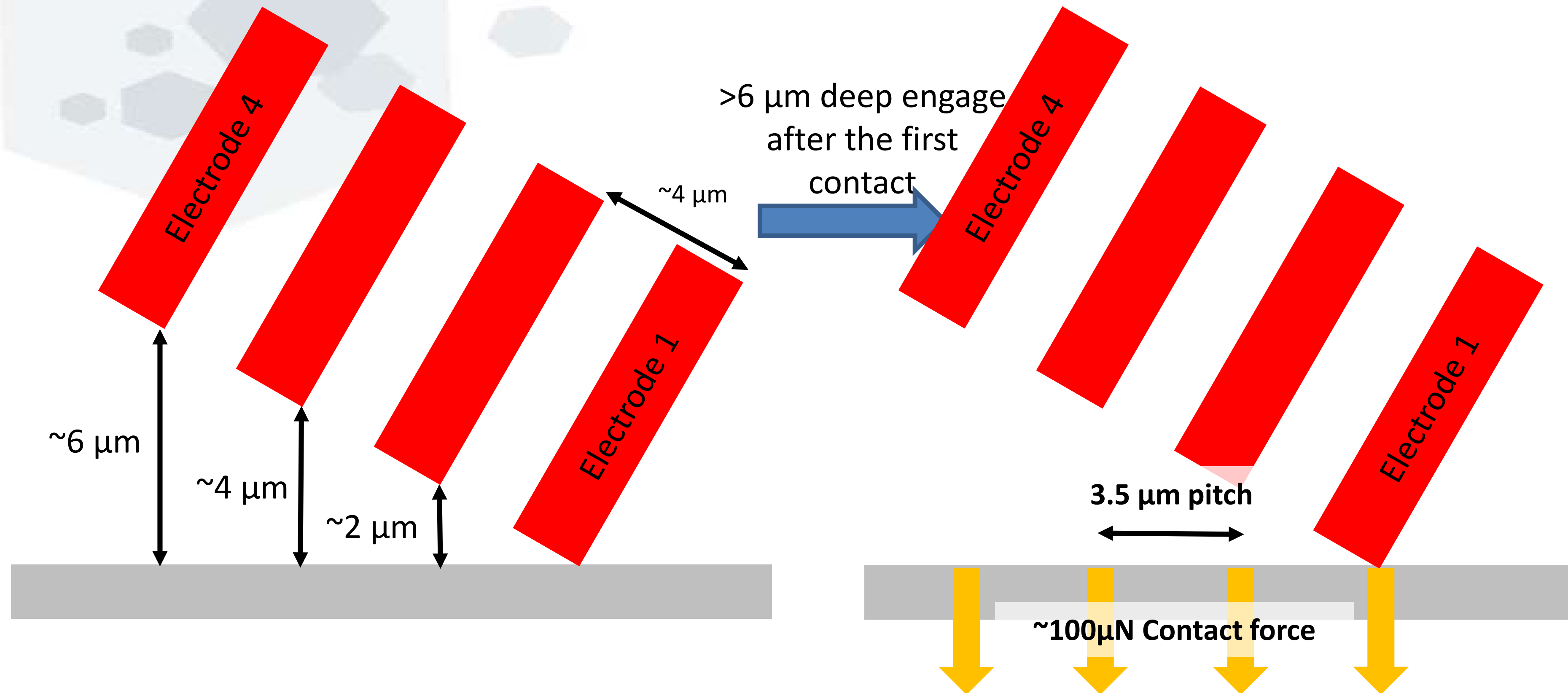
Lower accuracy (>1% σ)

Design concept, the LOOP probe



ECSEL JU

Probe engage – side view



Zero lateral forces:

- Symmetry of the cantilevers in the Y direction → no damage to the fins.
- Cantilevers designed for zero forces in the X direction → no sliding.

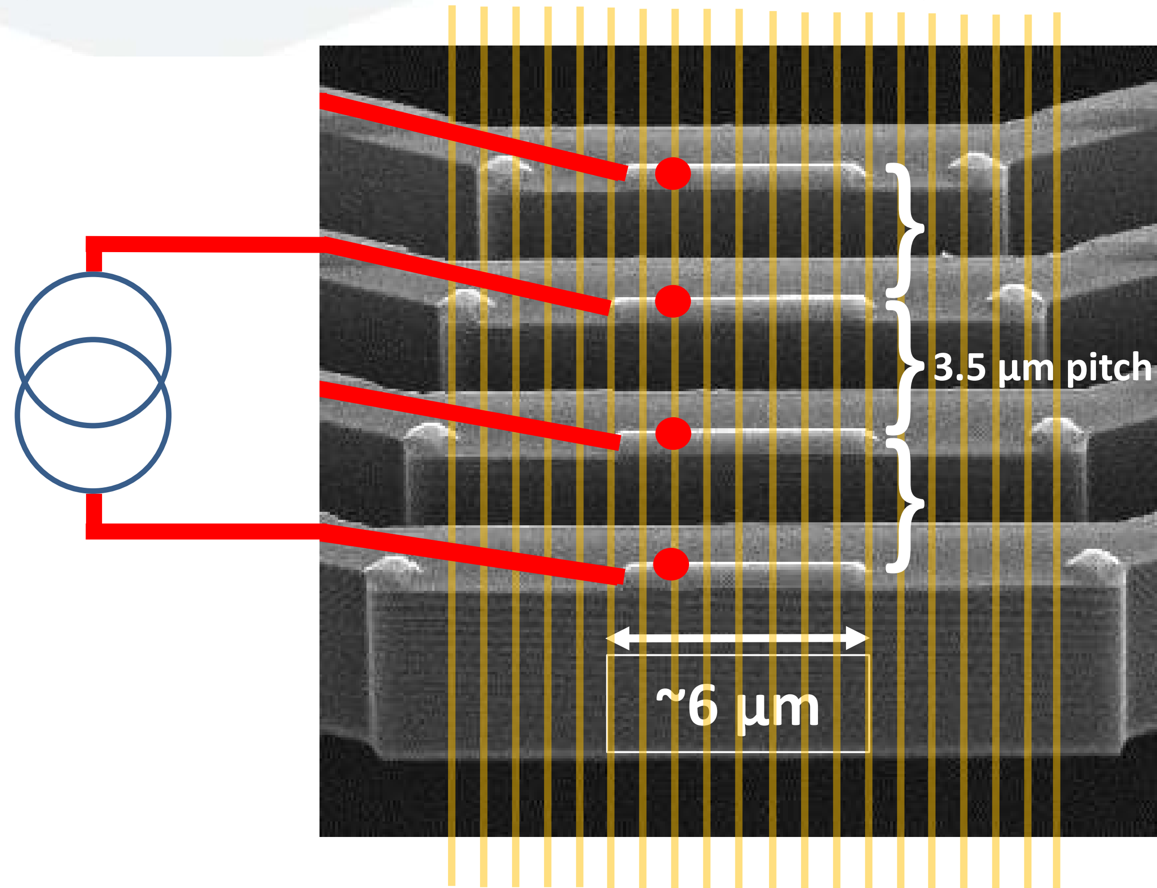
ECSEL JU

Electrical interface and measurement quality

- **Mechanical contact to large number of fins**

  But… no electrical contact without punch through!

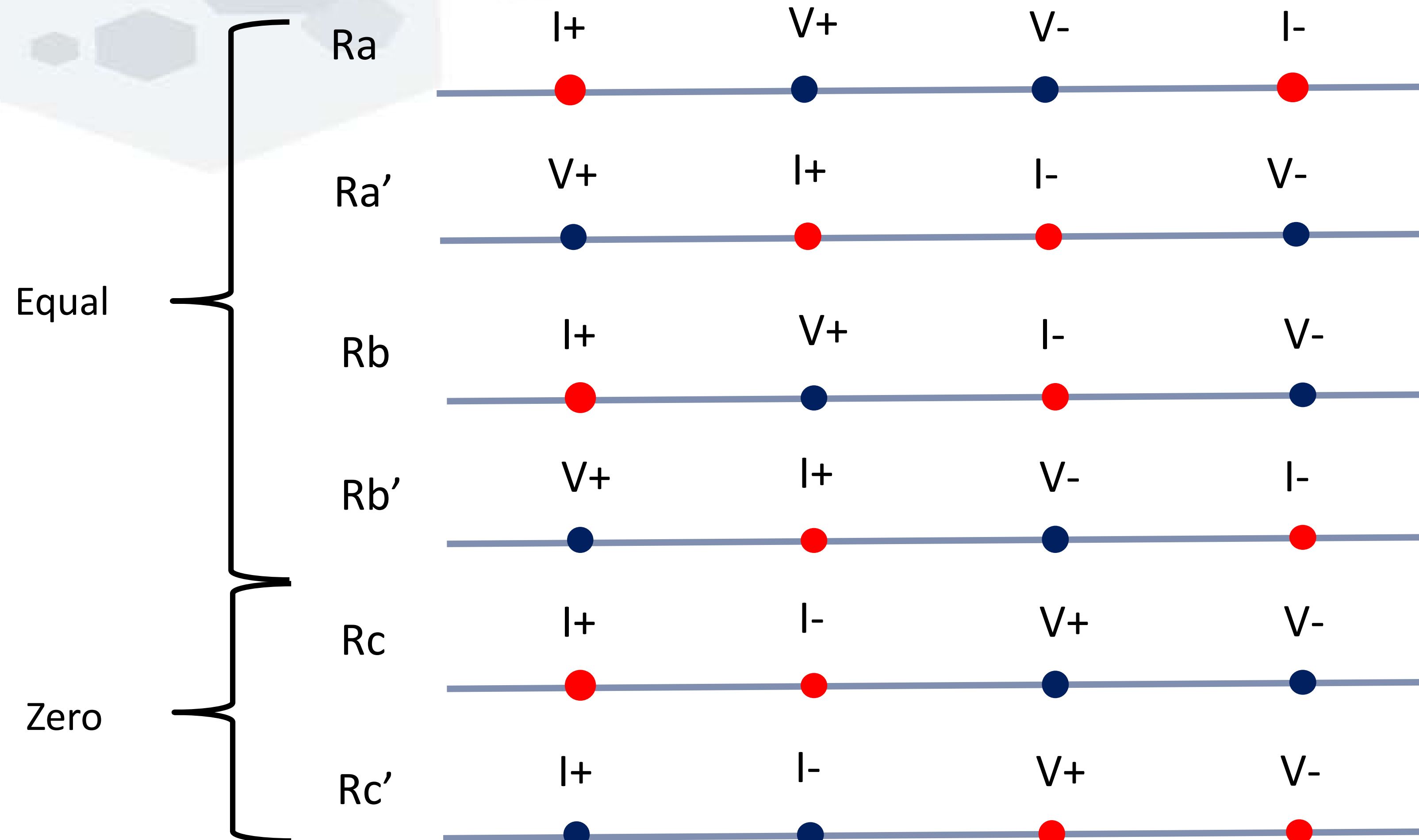
- **A single fin is ”selected” by the punch through process.**



ECSEL JU

Measurement validation

Based on a sequence of different configurations

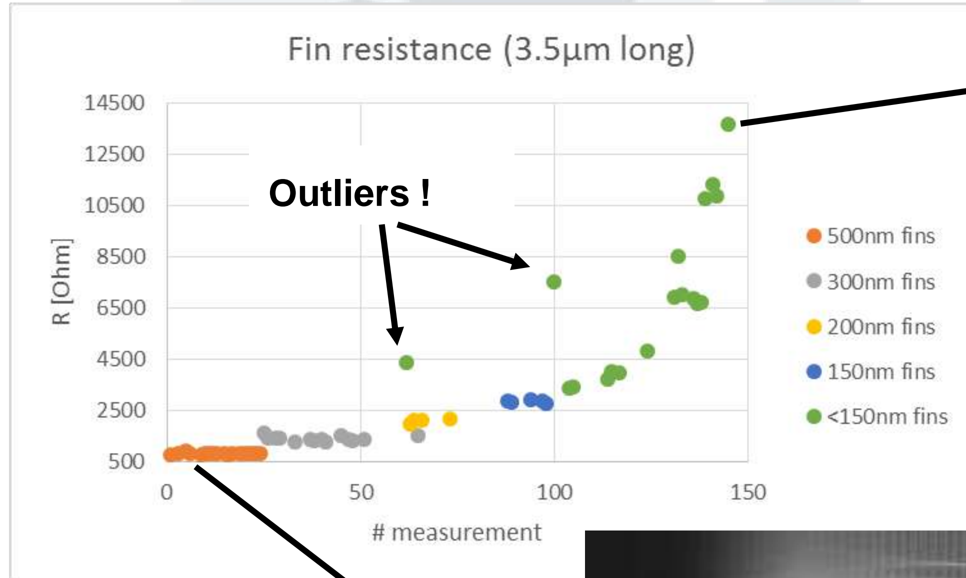


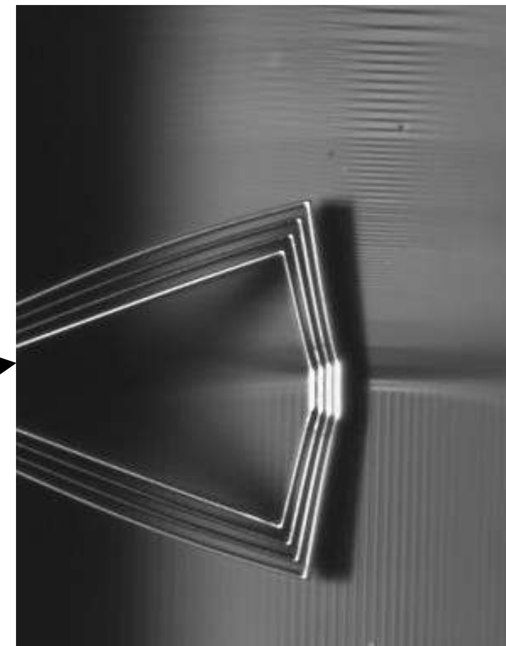
ECSEL JU

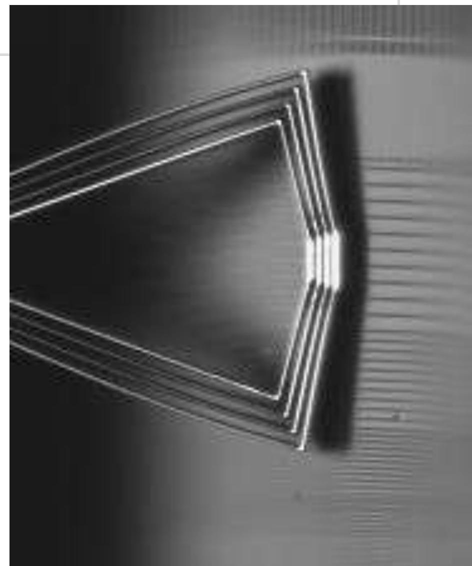
Test run 2

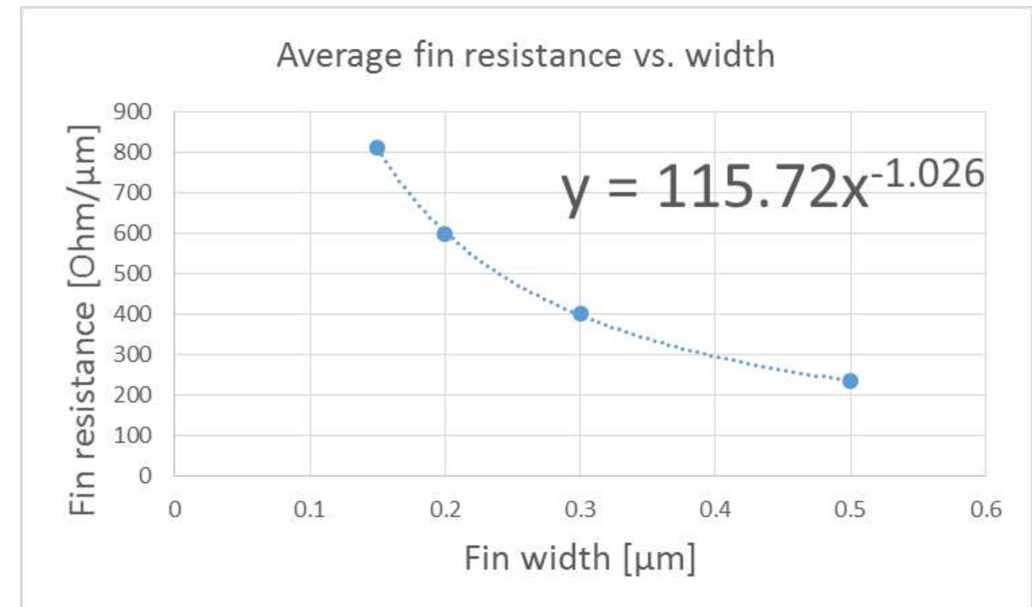
59 out of 149 data points are validated

Standard deviations are in a range of 1-3%





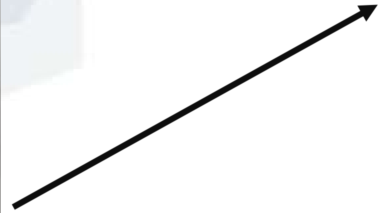


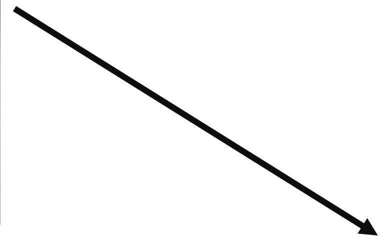


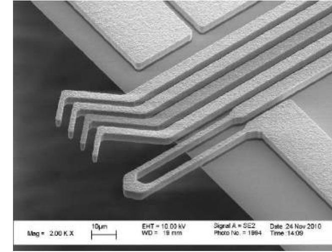
ECSEL JU

Summary

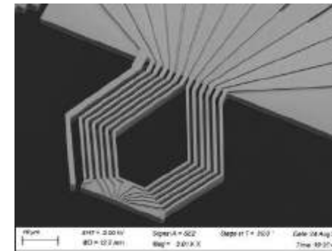
Automatic Tool



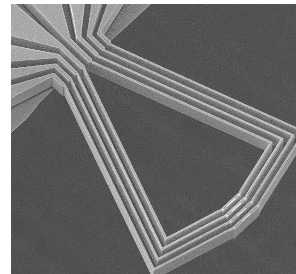




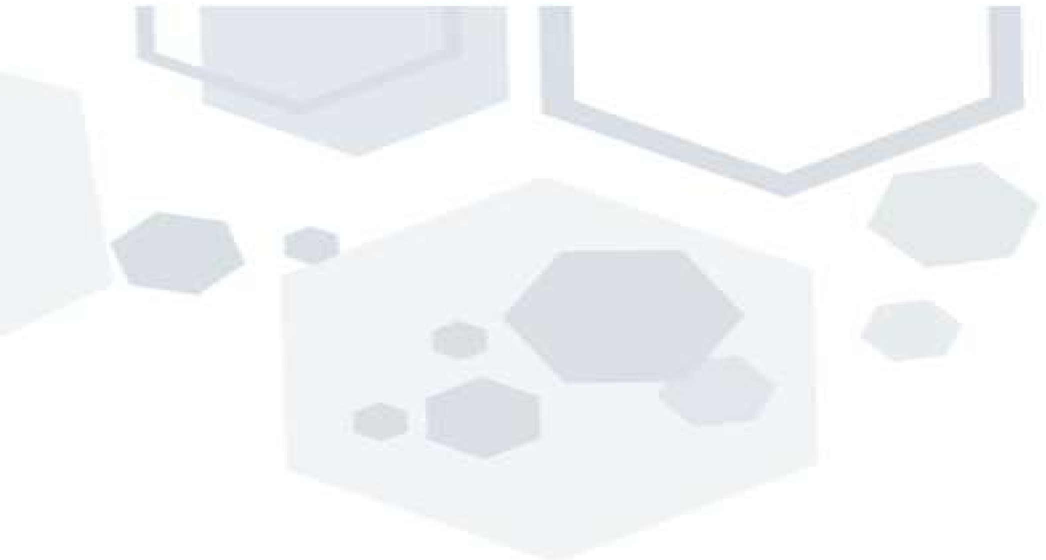
- Micro 4 Point Probe



- CIPTech-Probe



- Fin-FET
  Resistance Measurement



Thank You!

ECSEL JU