SESAME – Kickoff Meeting

University of Wuppertal

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SESAME: Working Plan - University of Wuppertal

Year 1

- Upgrade of the field emission setup and implementation of SEY measurements
- Setup of a dedicated SEY experiment
- Laser polishing optimization for thin films and multilayers
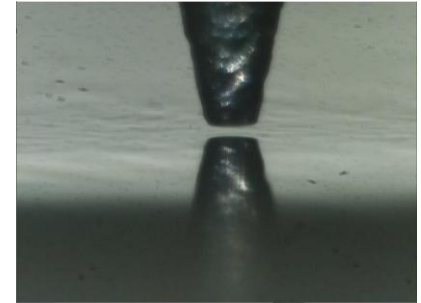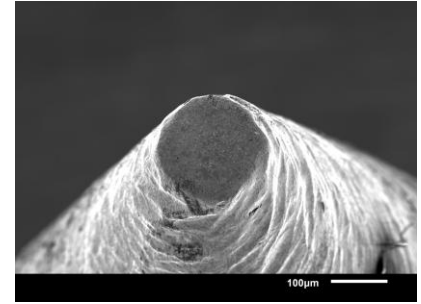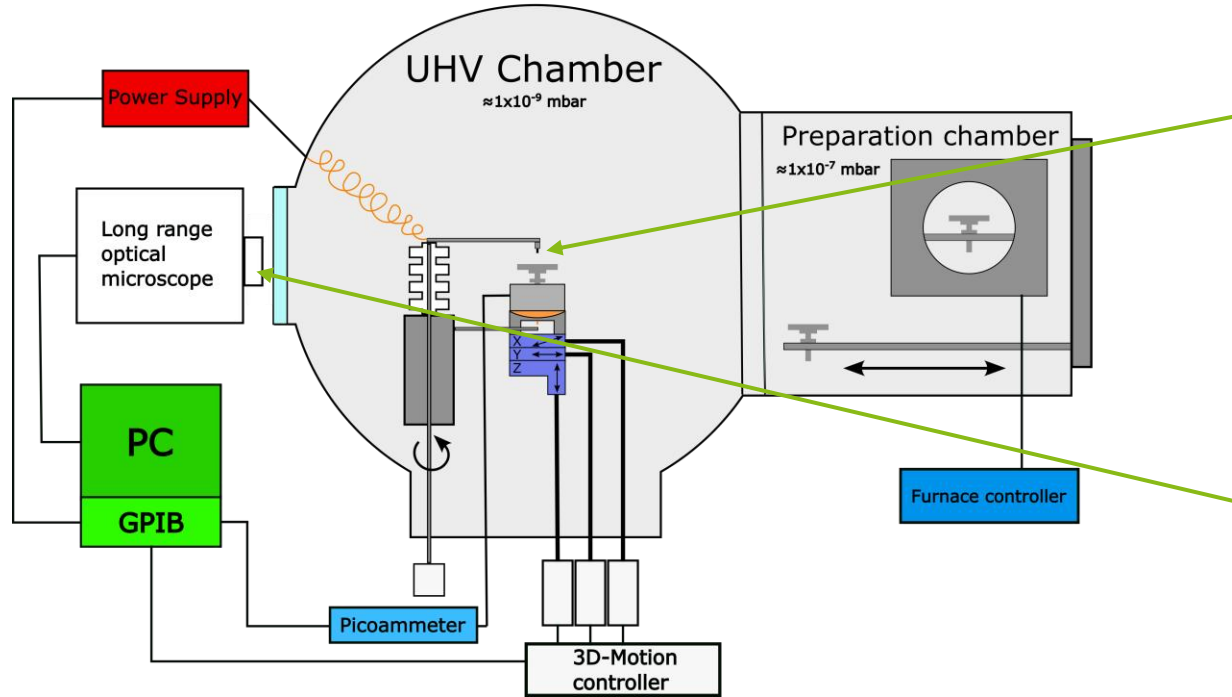- Initial surface characterization

Year 2

- Systematic laser polishing studies
- Optimization for novel materials and complex mulitlayer systems

Year 3

- Correlation of surface preparation with accelerating field strength and SEY
- Modeling, publications and conference contributions

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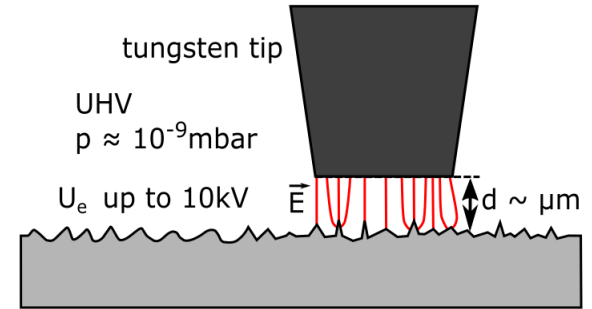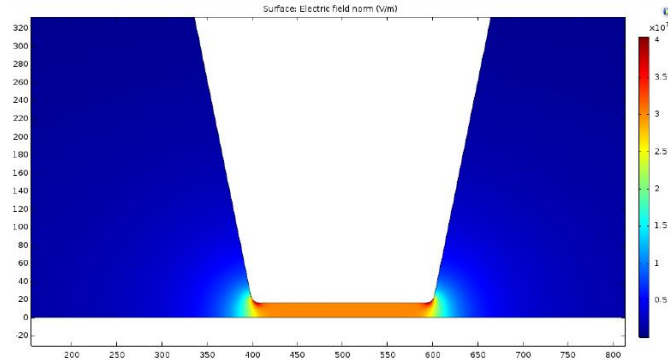# FESM

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Working Principle

Current flows after Fowler-Nordheim-Equation

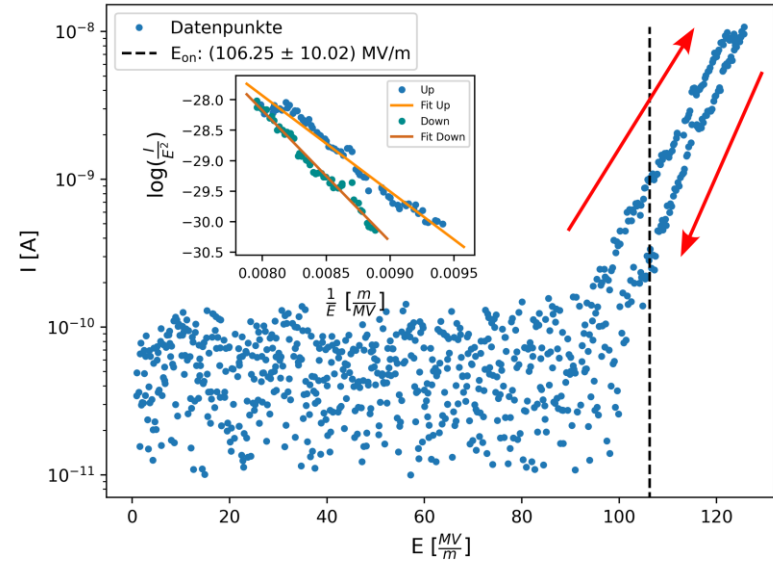$$I(E) = \frac{AS\beta^2 E^2}{\Phi} \exp\left(-\frac{B\Phi^{\frac{3}{2}}}{\beta E}\right)$$

With A/B as material constants ,Φ as work function, β as geometric filed enhancement factor and S as area of effective emittance

- Truncated Tips with a diameter up to 1 mm
- → No field enhancement of the tip
- → β yields field enhancement of the surface under the tip
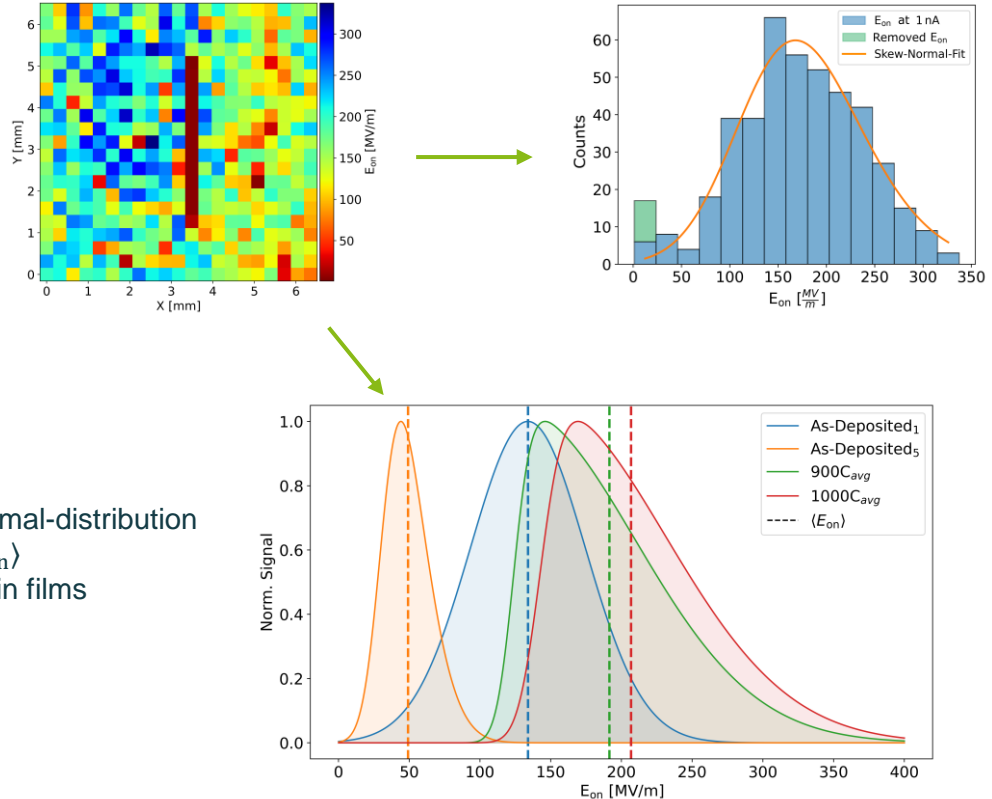
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Current-Voltage-Curve (I-V-Curves)

- Increasing voltage until current is measured (Up)
- Decreasing voltage until 0 V (Down)
- With Sample-Tip-Distance
  $\rightarrow$ calculation of electrical field E
- Onset-field E_{on} defined at 1 nA
- Plotting and fitting of $\mathrm{Log}\left(\frac{I}{E^2}\right)$ vs. $\frac{1}{E}$ yields $\boldsymbol{\beta}$, $\boldsymbol{S}$ and $\boldsymbol{\Phi}$
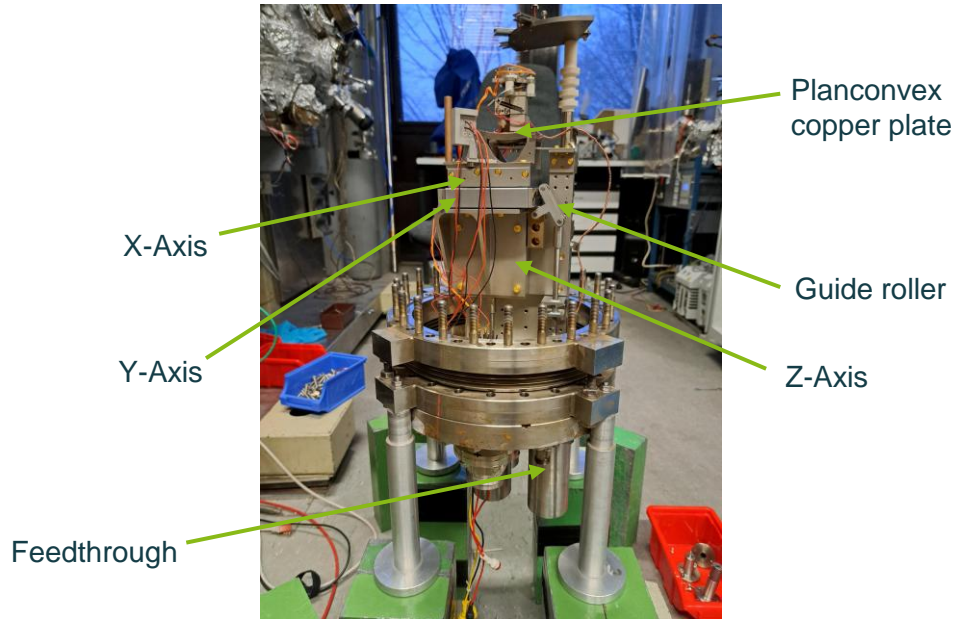
Constant Current Maps

- Mapping I-V-Curves over an Area
- → Creating Constant Current Map (CCMap)

- CCMaps show the onset-field distribution
- Reveals influence of
    - Topography
    - Chemical composition
- Plotting as histograms and fitting with skew-normal-distribution
    - Yields expected onset-field strength $\langle E_{on} \rangle$
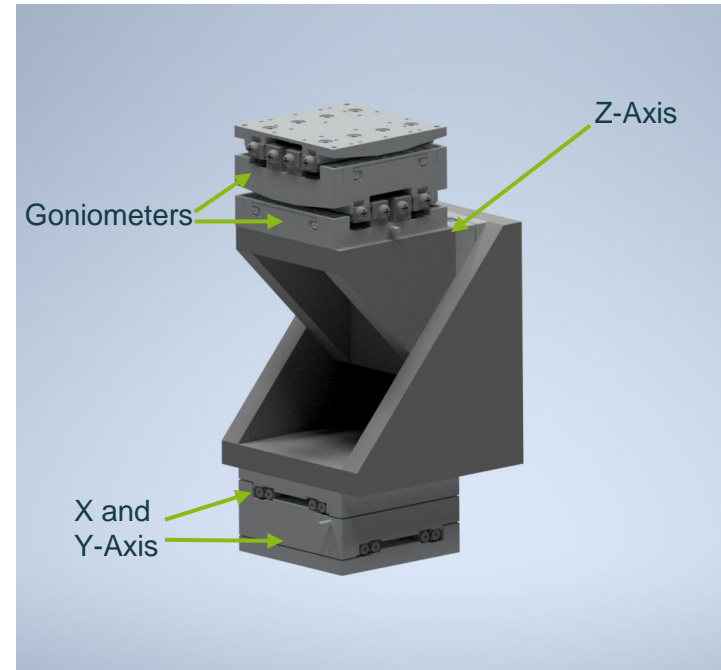- Example: as-deposited and annealed NbTiN thin films

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Upgrading the FESM

- Mechanical XYZ-Stage is old and worn
- Mechanical feedthroughs and guide rollers decrease positioning accuracy
  - Up to ±1 µm for X,Y,Z directions
- Sample leveling via plan convex copper plate
  - Manual and time-consuming alignment
  - Limited reproducibility
  - Additional leveling-induced uncertainty

→ Redesign of the XYZ-Stage and sample alignment

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Upgrading the FESM

- Goal: minimize positioning uncertainty and improve sample alignment
→ Piezo-Linear-Stages for X, Y and Z directions
  - Improving positioning accuracy to 40 nm
  - Travel up to 31 mm
→ Two Piezo-Goniometer-Stages
  - Repeatable positioning of 100 µ°
  - Travel up to 5 °
  - Software controlled
  → Allows for automatic alignment

- Delivery date expected in April
→ FESM measurements possible until April
→ Out of commission from April until approx. June

Conceptual CAD layout

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