

GnMeba 2020

Un nouveau membre dans la famille Gemini : Le Gemini 3



Stéphane Letheux et Jérôme Mialhe

Product & Application Sales Specialist Electron Microscopy, France

- 1** Introduction to the GeminiSEM Family
- 2** The Gemini Columns Explained
- 3** New Gemini 3 features
- 4** Two new Application major developments



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Gemini Technology Evolution

Enhanced the low-kV, low vacuum performance for surface sensitive imaging



GeminiSEM 360



GeminiSEM 460



GeminiSEM 560



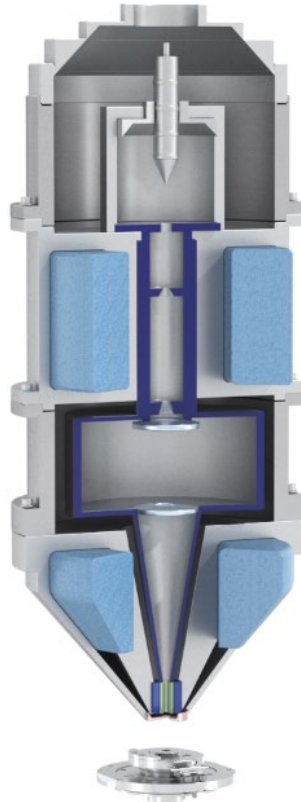
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Gemini 1



Gemini Design

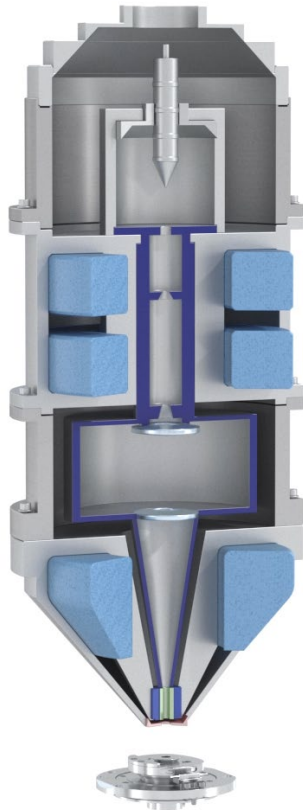
- Gemini lens design with inlens beam deceleration and **field-free** on sample
- High efficiency on-axis annular **inlens detections** SE and BSE
- **Energy selective BSE** detection for high resolution materials contrast
- **NanoVP** for high resolution imaging and analytical application

Gemini Technology Evolution

Enhanced the low-kV, low vacuum performance for surface sensitive imaging



Gemini 2



Double-condenser

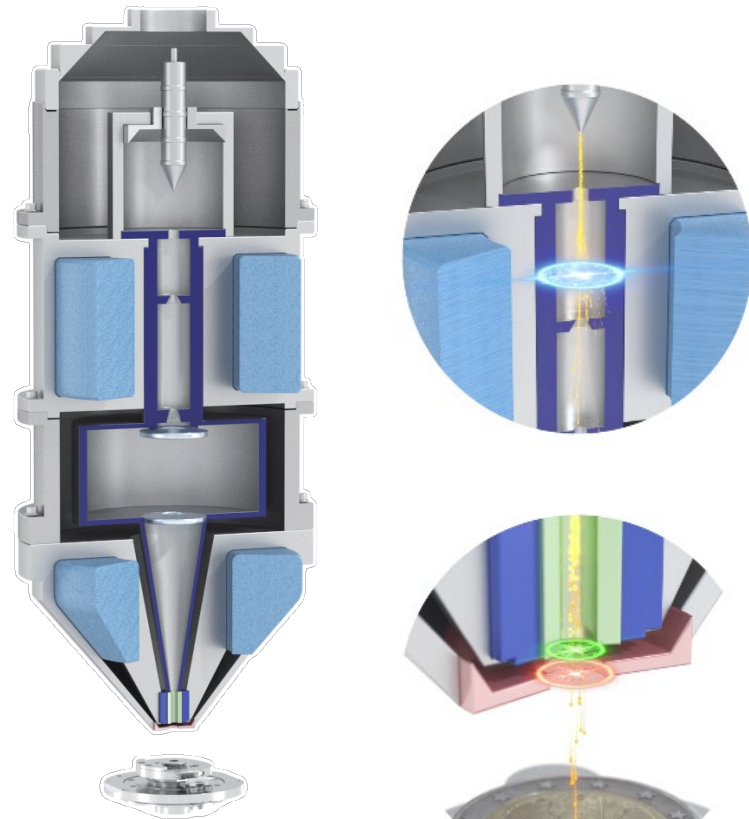
- **Fast switch** between imaging and analytical modes
- **High current high-resolution** imaging and analytical applications
- Low beam current for **beam sensitive samples**

Gemini Technology Evolution

Enhanced the low-kV, low vacuum performance for surface sensitive imaging

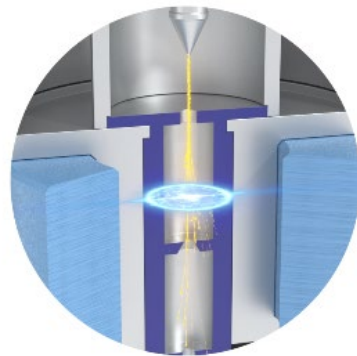


Gemini 3



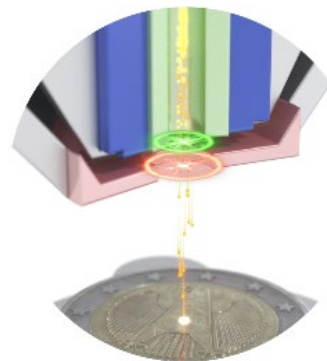
New EO Engine: Smart Autopilot

- Well optimized beam aperture at low-kV and **higher resolution**
- Ultrafast **AutoFocus** / AutoWobble
- **Overview** mode (FOV up to 130mm)



Nano-twin Lens

- Based on **proven Gemini design** combining both electrostatic and magnetic lenses
- Electron optical design **optimized for ultra high resolution at low-kV**





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GeminiSEM 560:

Your Ultimate Sub-nanometer Surface Sensitive Characterization SEM for Any Sample



New ultra high-resolution Gemini 3 column

0.8 nm @ 1 kV without TD or monochromator. 0.7 nm @ 1 kV with TD. Highest resolution SEM at every kV.

New EO Engine Smart Autopilot

(Patented AutoFocus*, AutoWobble** and new Overview Mode)

New versatile chamber

provides more flexibility and allows larger samples to travel with full travel range***. Largest chamber in class.

New standard VP mode and C2D detector

delivers superior contrast in VP modes*

New airlock control

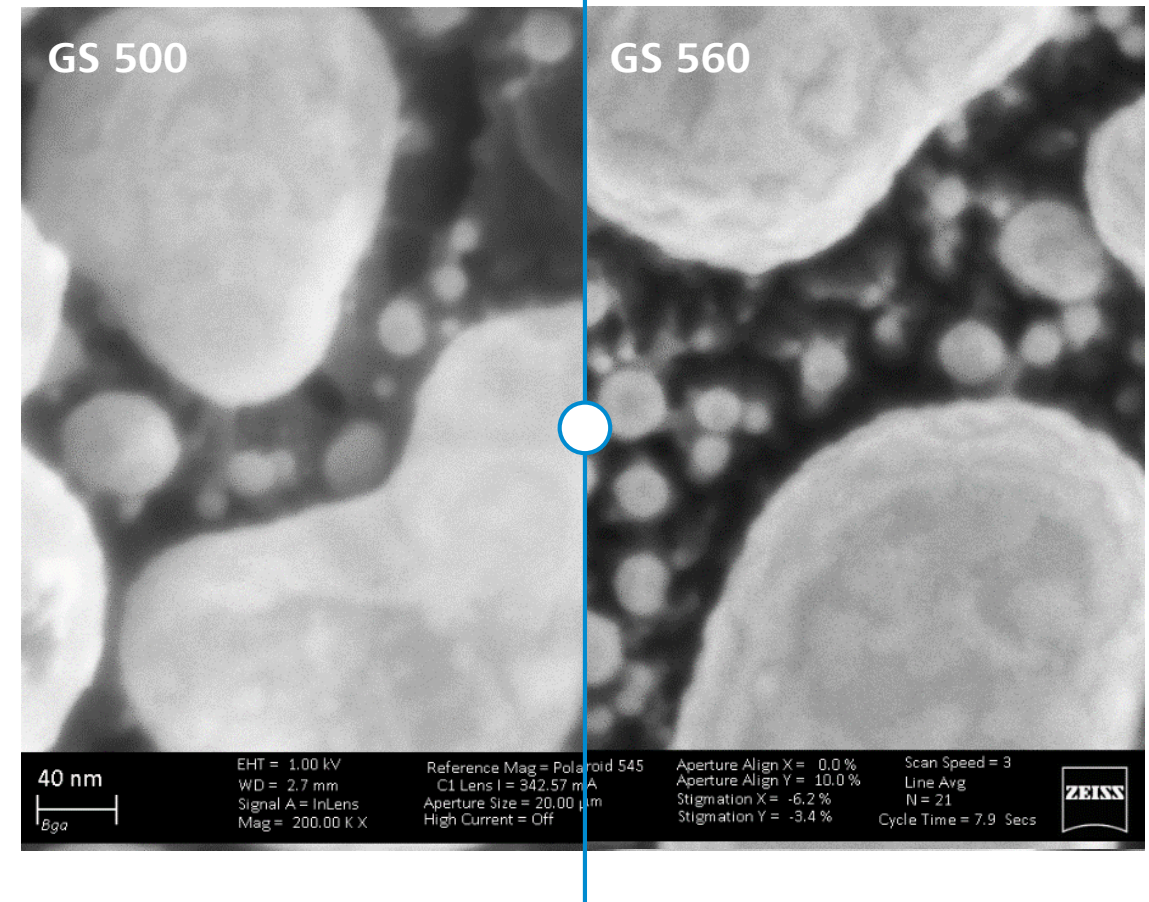
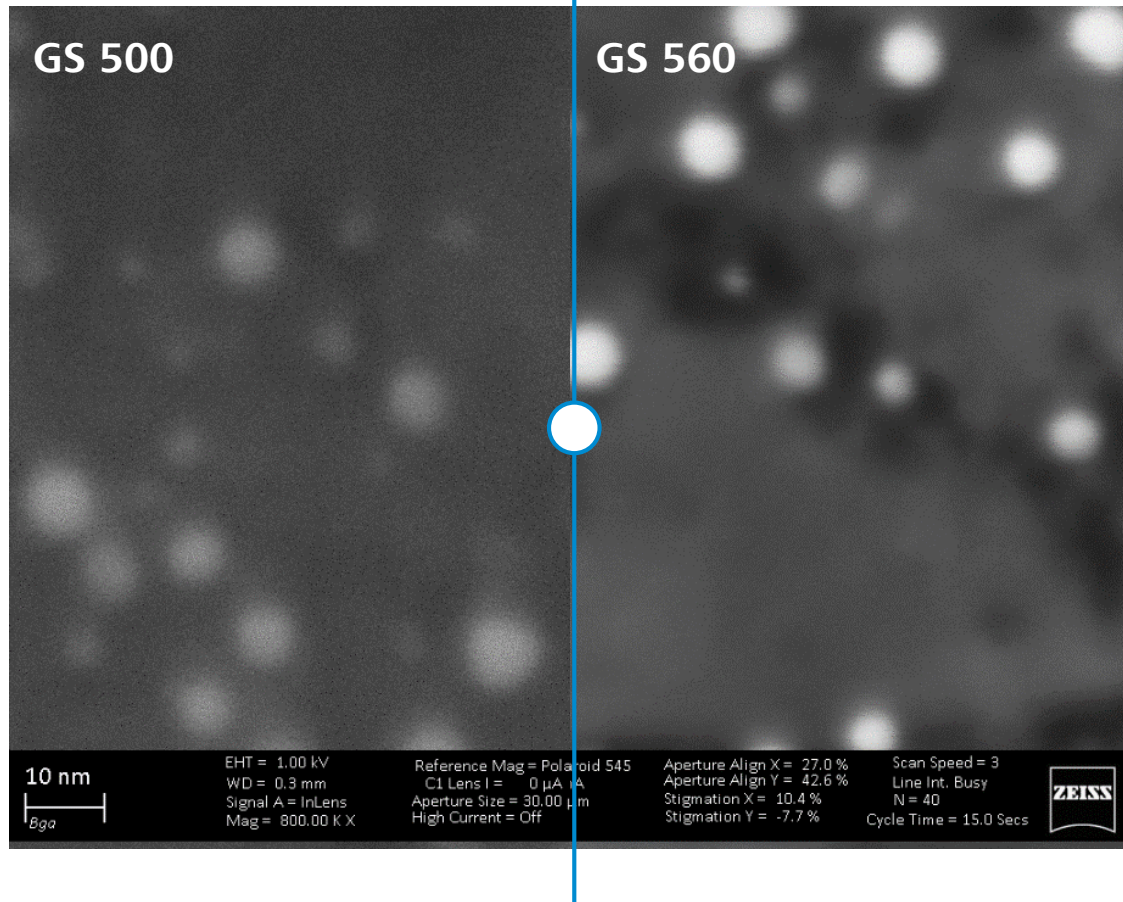
offers sample transfer under VP condition for vacuum sensitive samples**

New Python scripting API

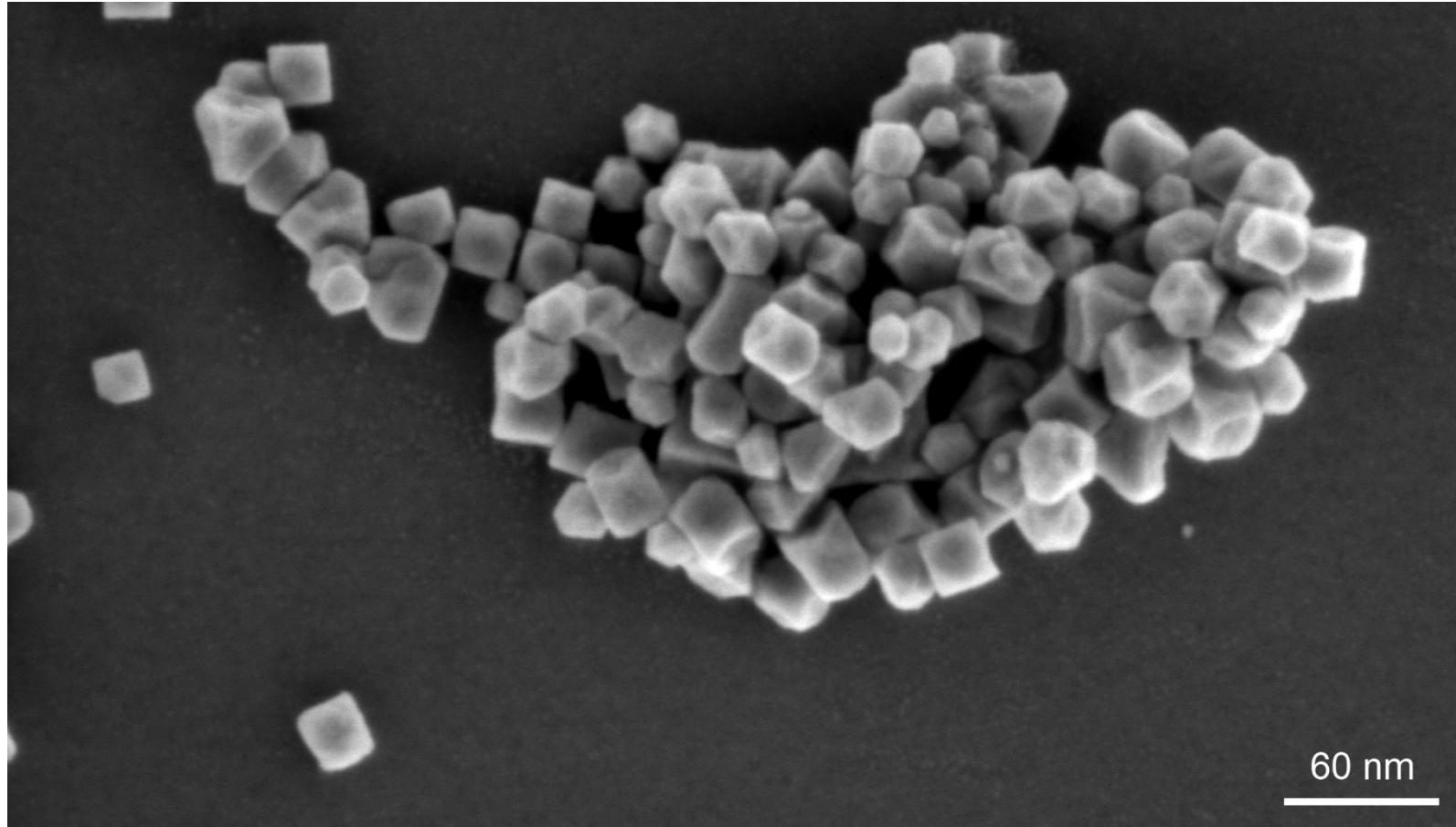
enables to configure and create automated experiments by customers themselves**

** Also available on GeminiSEM 360; **Also available on Sigma and other GeminiSEMs; ***Also available on GeminiSEM 360 and GeminiSEM 460*

Smart Autopilot improves the low-kV Resolution

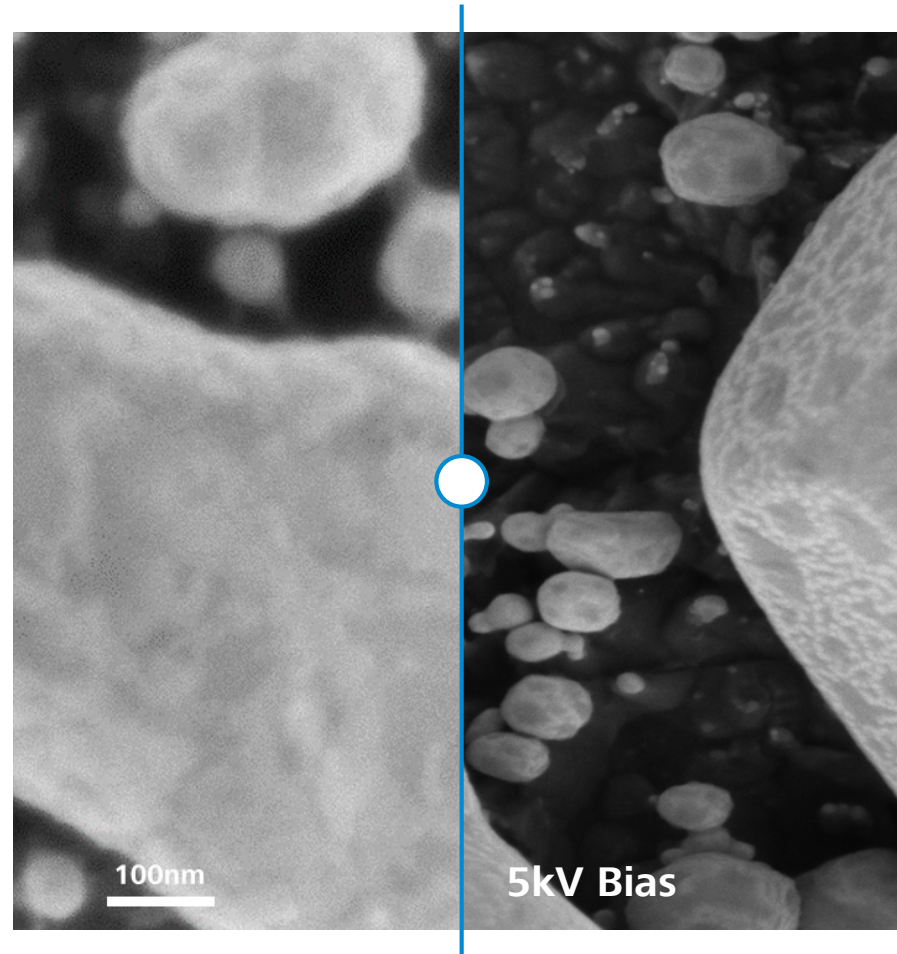


Low kV performances on magnetic sample

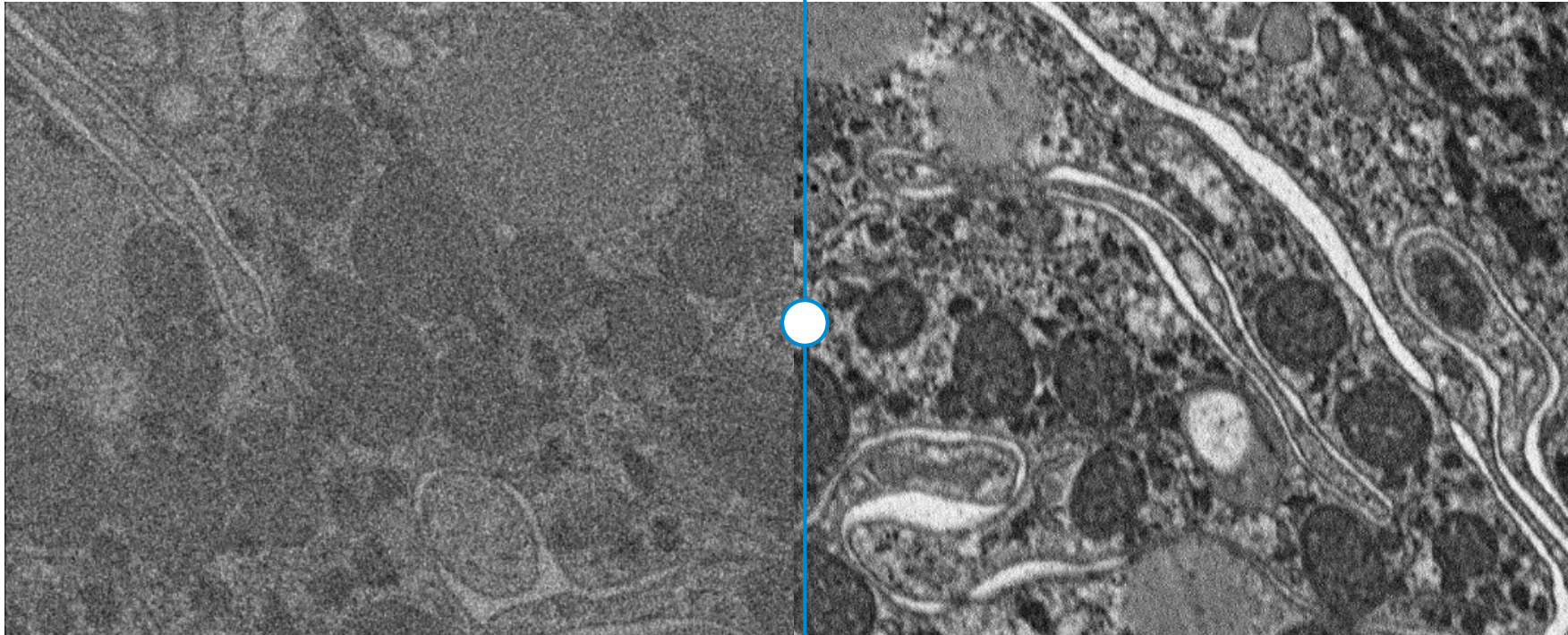


Magnetic PFeMn particles 1kV

Tandem Decel gives an Additional Boost



Imaging Frozen Cells on a Silica Wafer by an aBSD Detector without and with Tandem decel



No Tandem decel

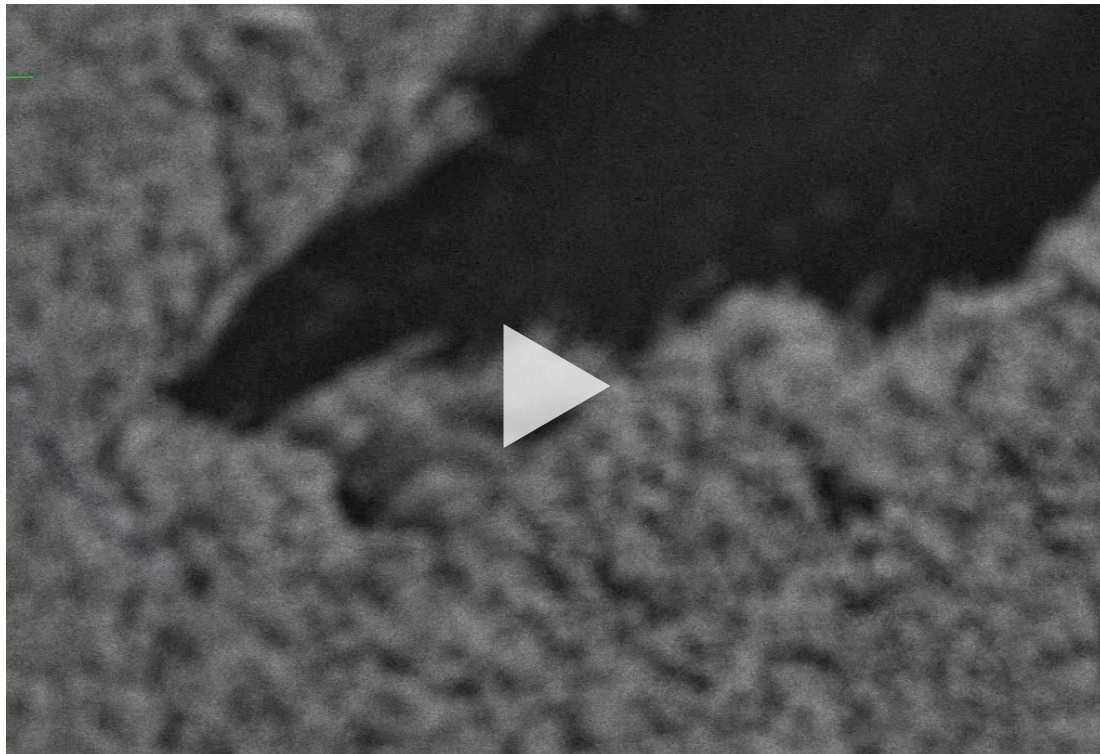
Dwell time: 0.6 μ s, Pixel size 6 nm

With Tandem decel

landing energy 1.5 kV, Dwell time:
2 μ s, Pixel size 4 nm

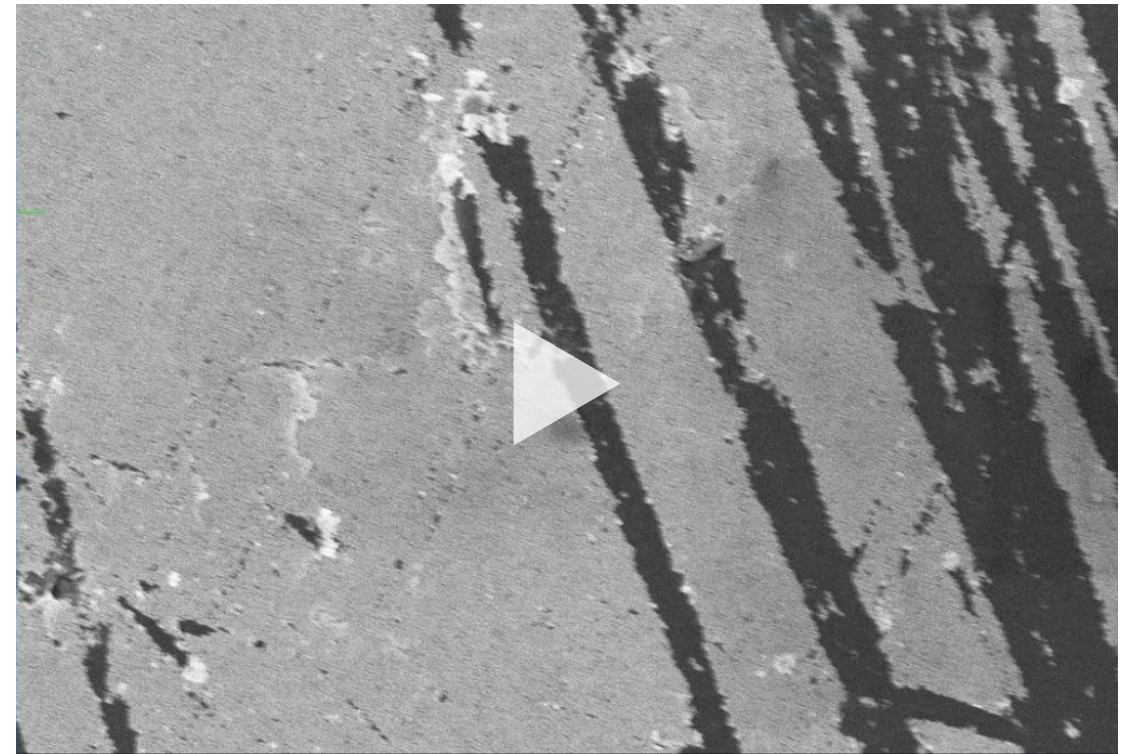
Tricellaria inopinata high pressure frozen and freeze substituted, serial sections, mounted on a silica wafer

Smart Autopilot accelerates AutoFocus and AutoWobble



3 μ m EHT = 5.00 kV Signal A = InLens Date: 24 Aug 2020
WD = 3.8 mm Mag = 3.61 K X

AutoFocus

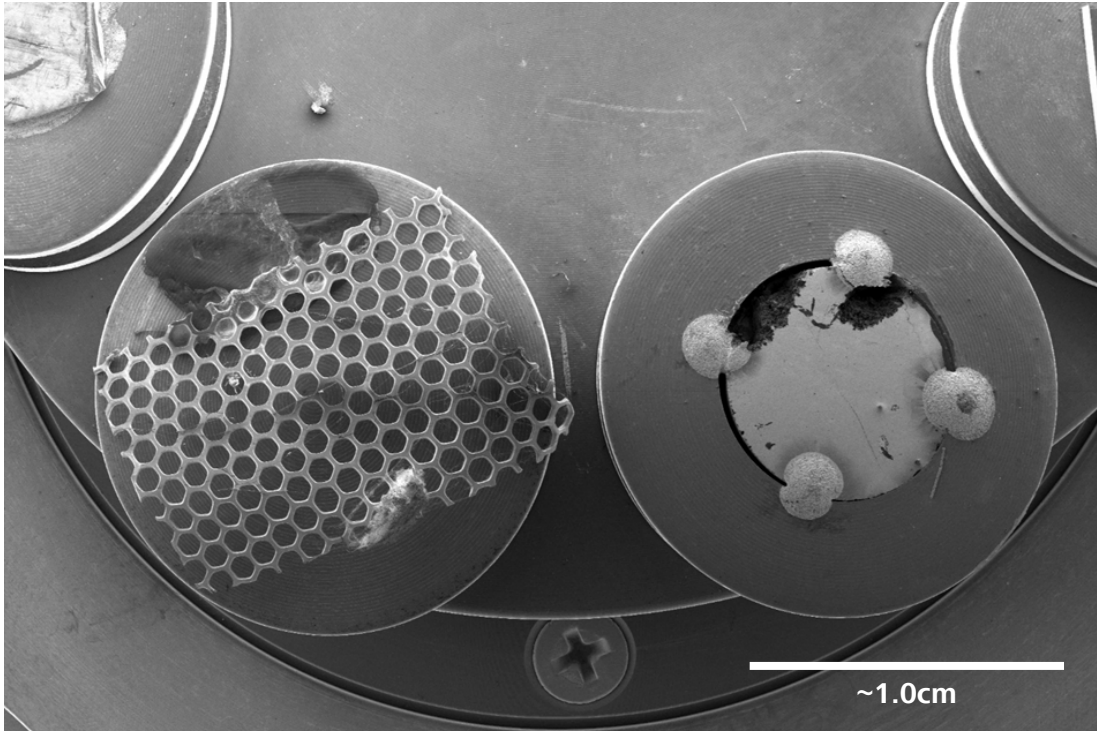


10 μ m EHT = 10.00 kV Signal A = InLens Date: 22 Jul 2020
WD = 5.0 mm Photo No. = 25030 Time: 17:05:19

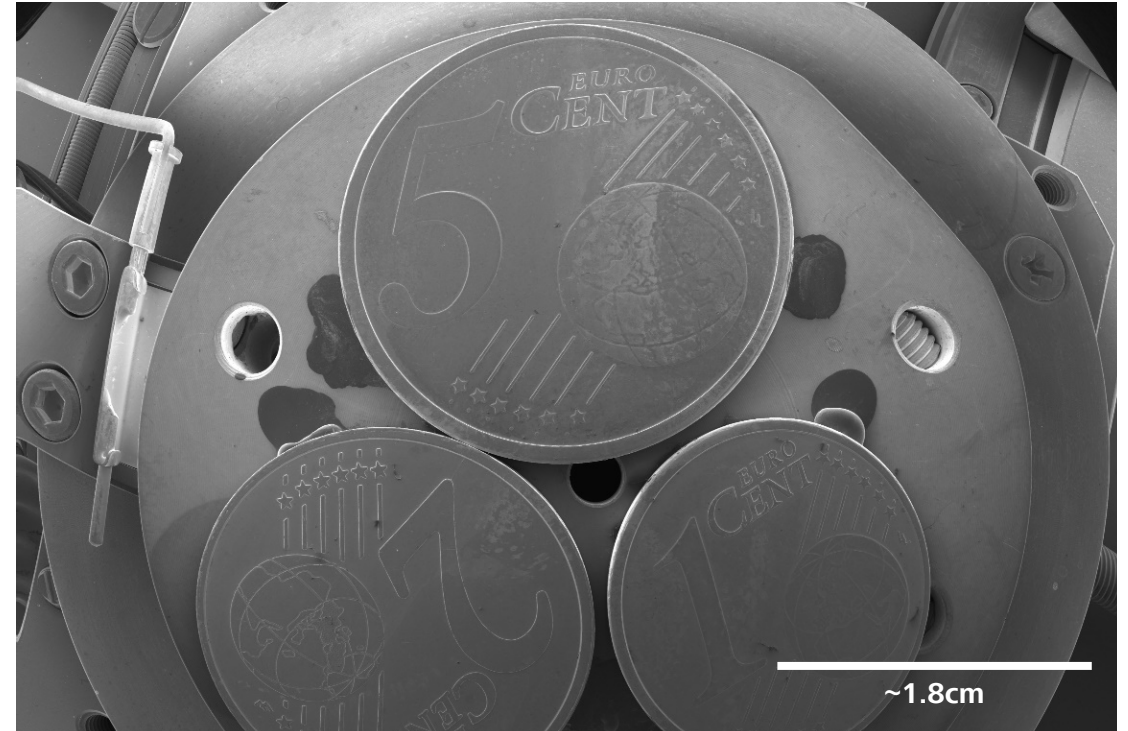
AutoWobble

Smart Autopilot Enables the Overview Mode in GS560

All Voltages and All Detectors from 1x to 2,000,000x / FoV 130mm



Inlens SE, 7 kV



ETSE, 5 kV

New GeminiSEM Chamber

Improved the analytical capability of GeminiSEM family



- **14 ports** for more versatile conf.
- **Versatile port** (Raman...)
- Diametrically opposite **dual EDS ports**

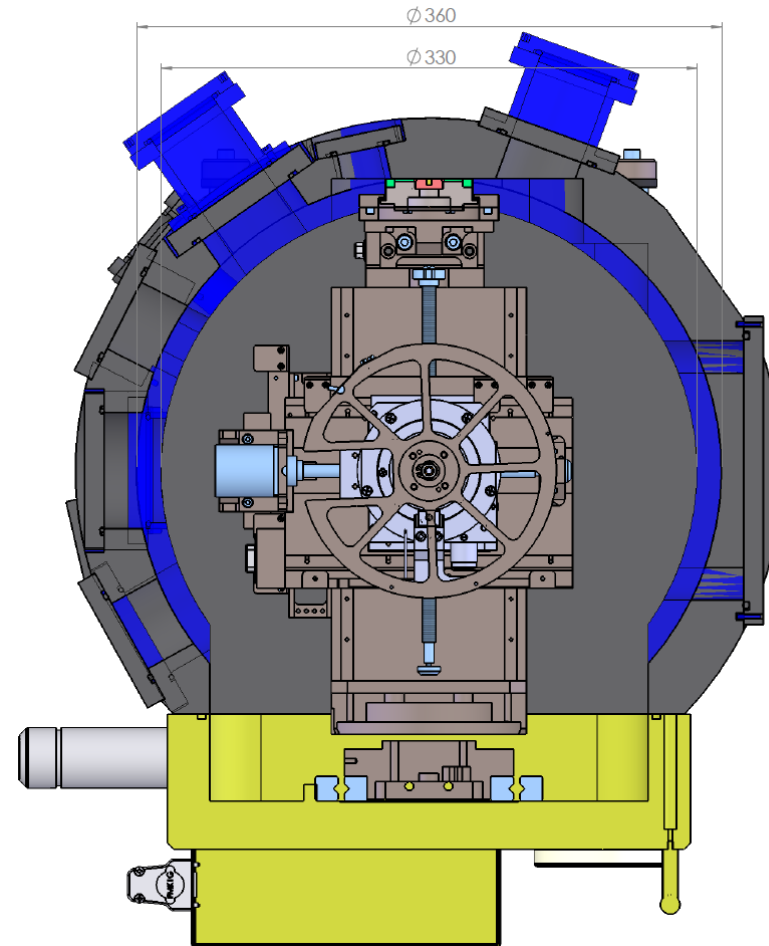
New GeminiSEM Chamber Outperforms the Market

Sample size matters



New larger chamber:

- Inner diameter **360mm**
- **179 mm** diameter is now visible
- **Larger** sample handling



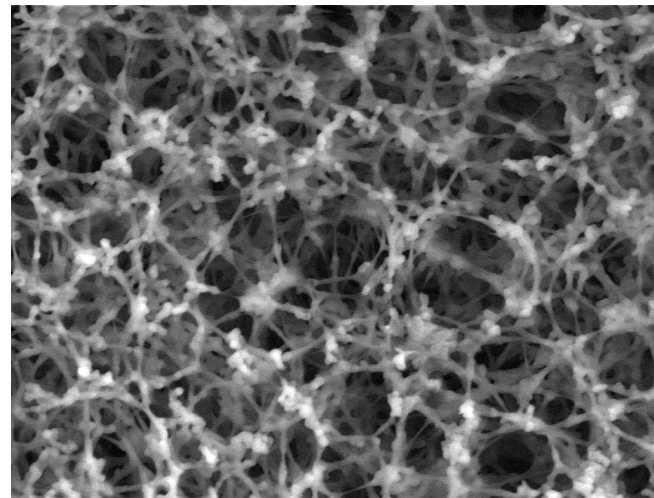
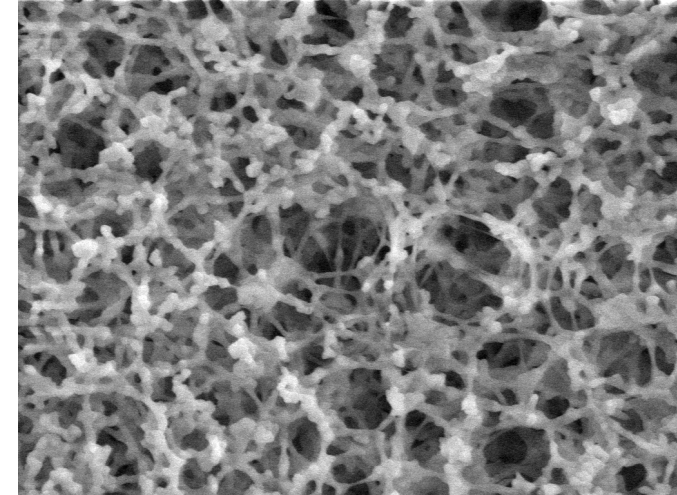
New C2D Detector for GeminiSEM Family

Higher imaging quality and usability



- **Smart detector** on GeminiSEM family: Plug and play detector for easy maintenance
- **Improved contrast and brightness** compared to VPSE G4
- **Automatic** brightness and contrast variation
- Automatic adaption to **changes in VP pressure**

VPSE G4

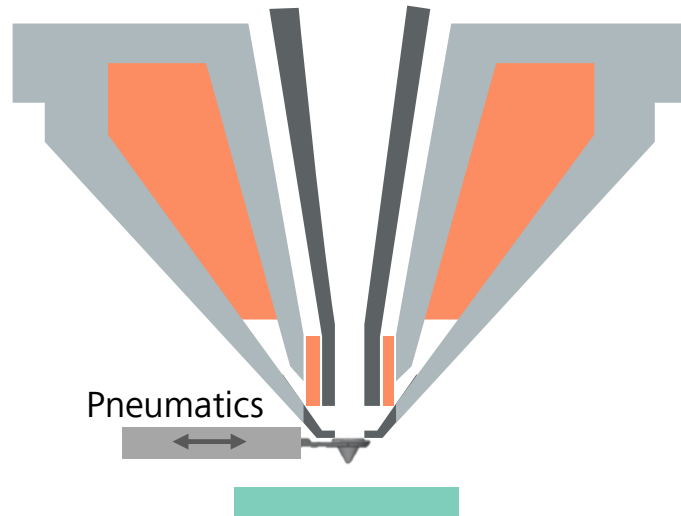


C2D

Sample: Face mask microstructure, highly non-conductive

Extended VP option

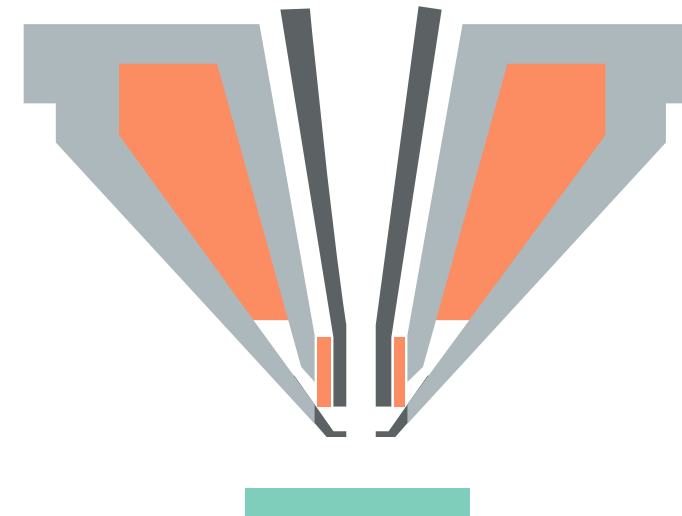
Standard VP for flexible configuration



NanoVP

- Very small GPL
- Inlens detections possible
- Up to 500 Pa
- BSD in beam sleeve

- Limited FOV (if beam sleeve inserted)



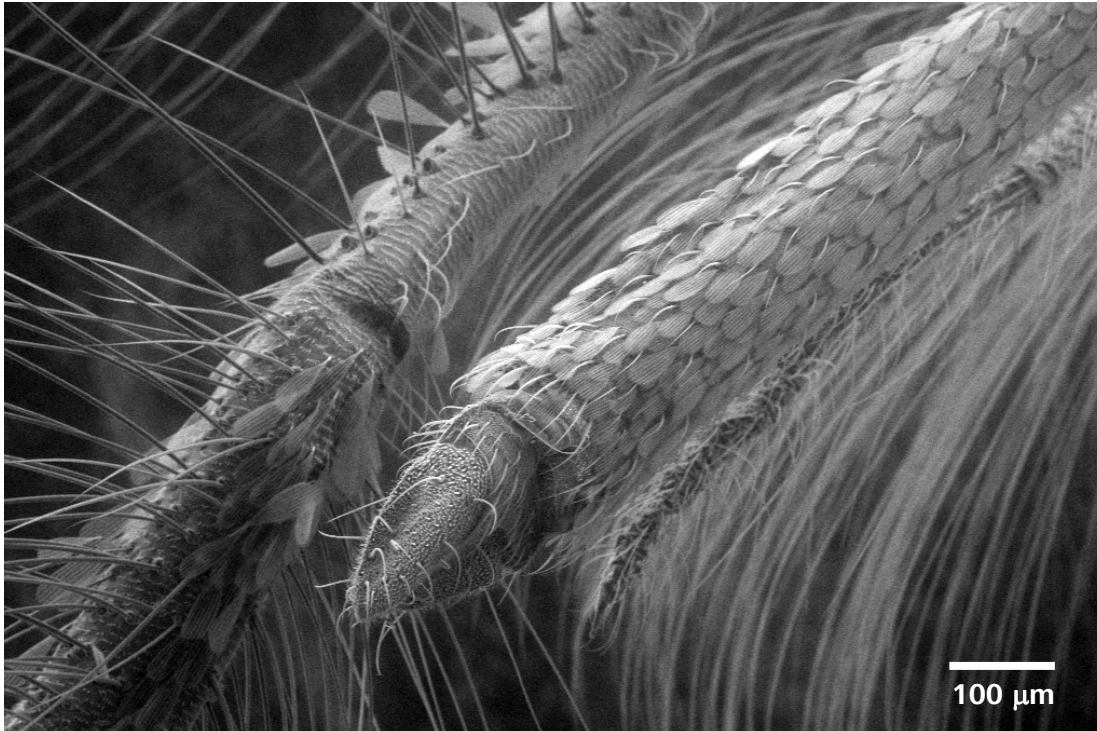
Standard VP **NEW**

- Large FOV
- Budget friendly
- AsB possible
- Upgrade path to NanoVP

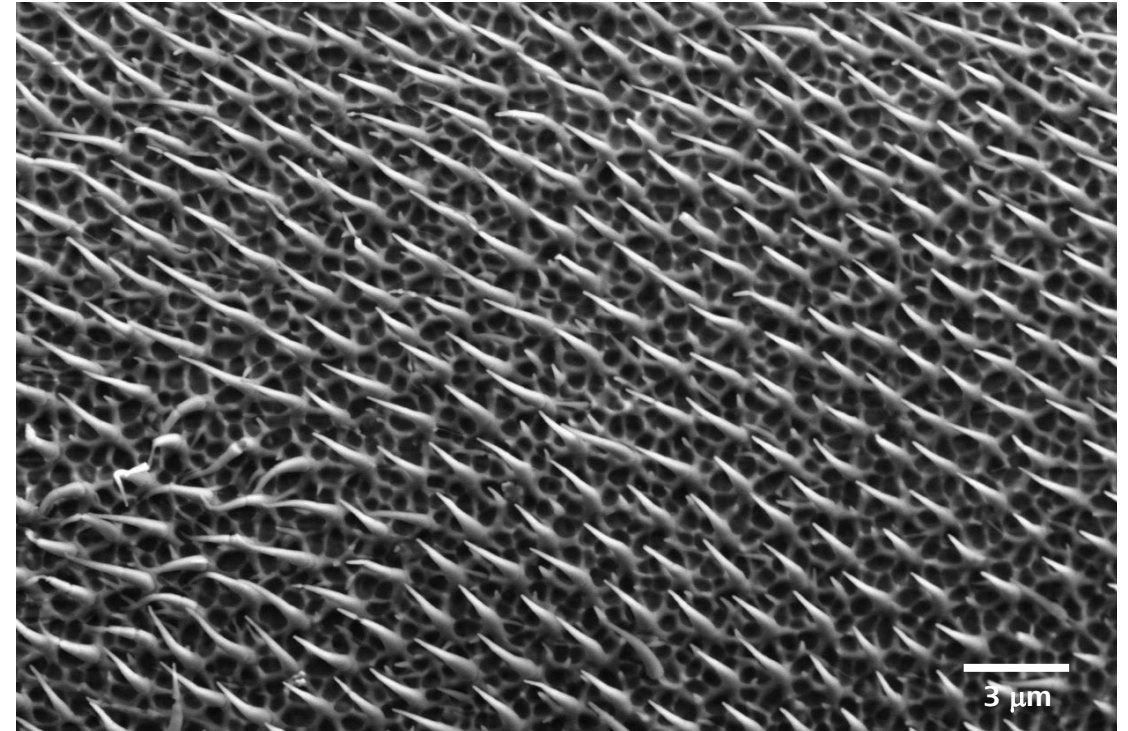
- Max. 60 Pa
- Larger GPL
- No inlens detection possible

New C2D detector for GeminiSEM Family

works for both Standard VP and NanoVP modes



Mosquitoes proboscis, at 5 kV, **Standard VP** mode 45 Pa, huge FOV.



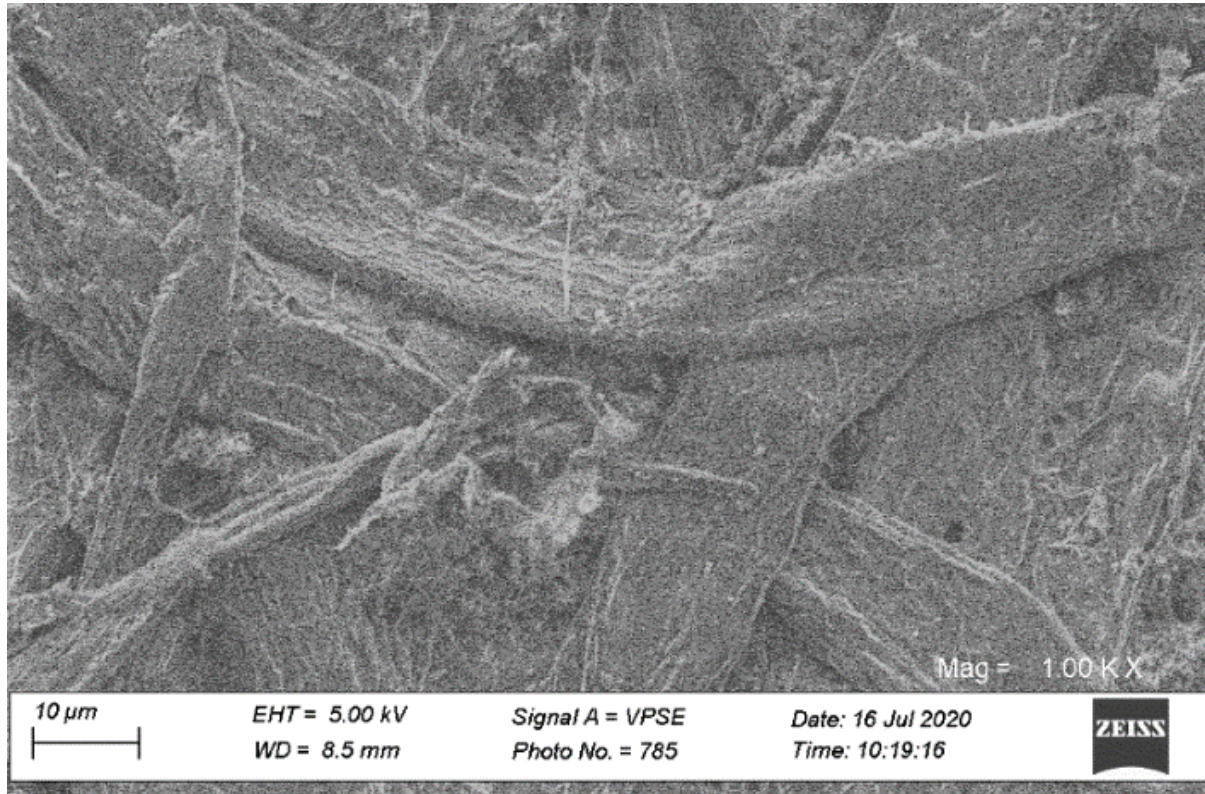
Bioinspired Replication of Gecko Skin Surface with Bactericidal Properties, without conductive coating. 3 kV, **NanoVP** 100 Pa, Excellent SNR and contrast.

Different Detector Performances of Standard VP and NanoVP

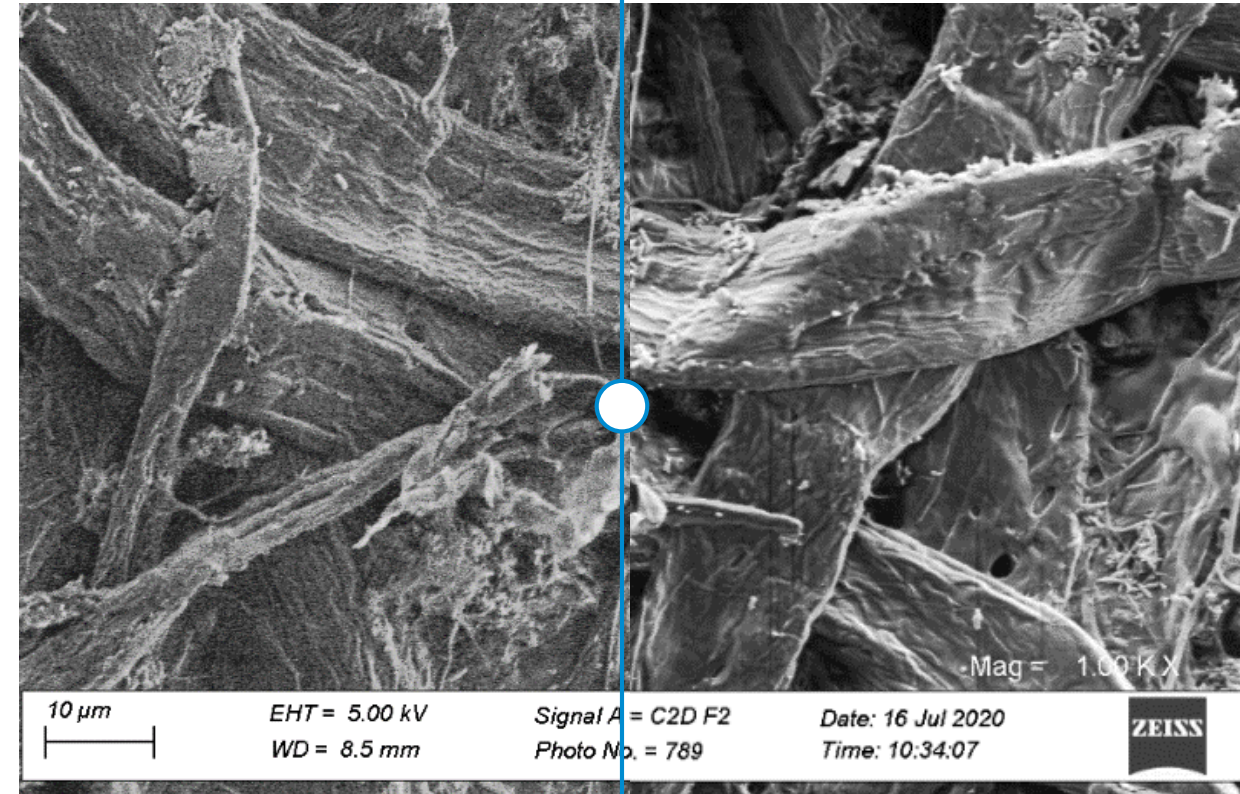


Short Gas Path Length (GPL) and new C2D is the key

Standard VP + VPSE



Standard VP + C2D

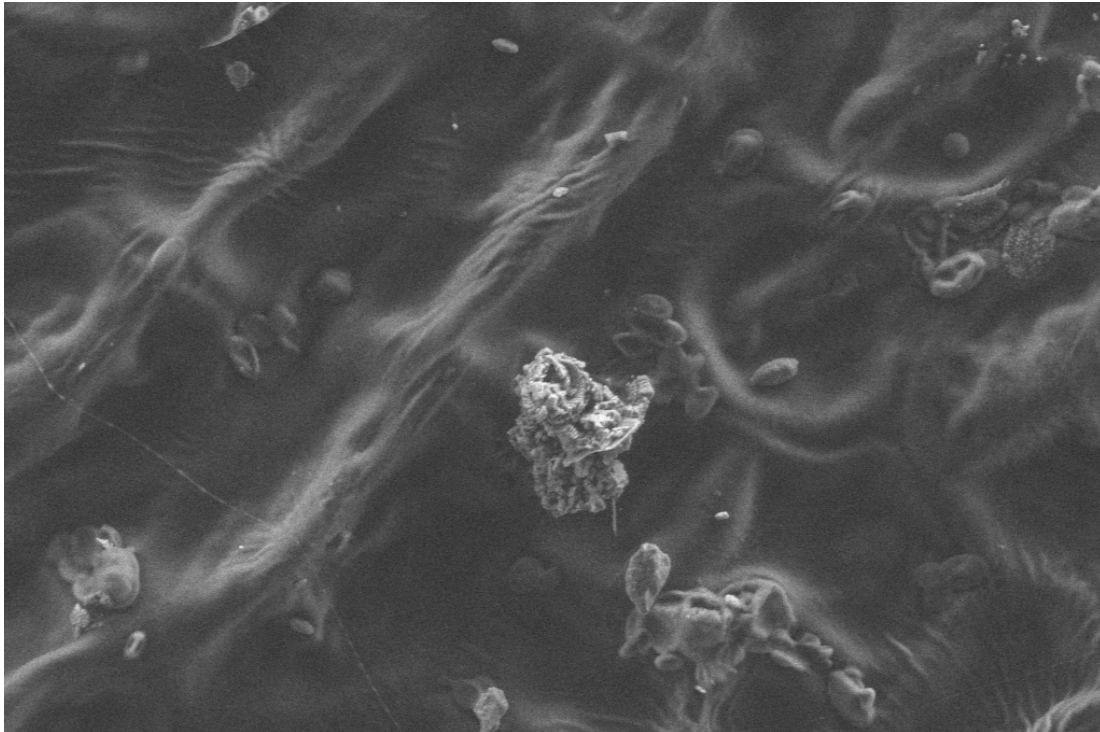


Nano VP + C2D

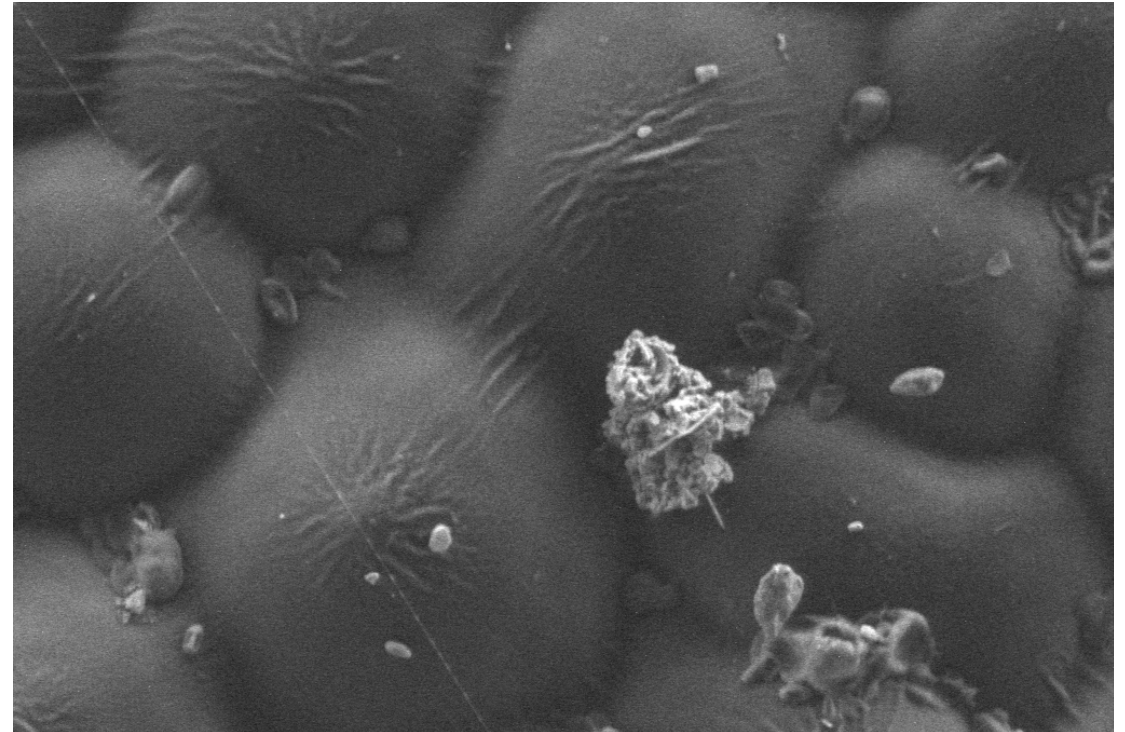
Non-conductive paper sample, 60 Pa

Extended VP option

VP Airlock for vacuum sensitive samples



Destroyed cell structure of a leaf sample after transferred under HV mode, 7.5 kV, imaged in VP mode



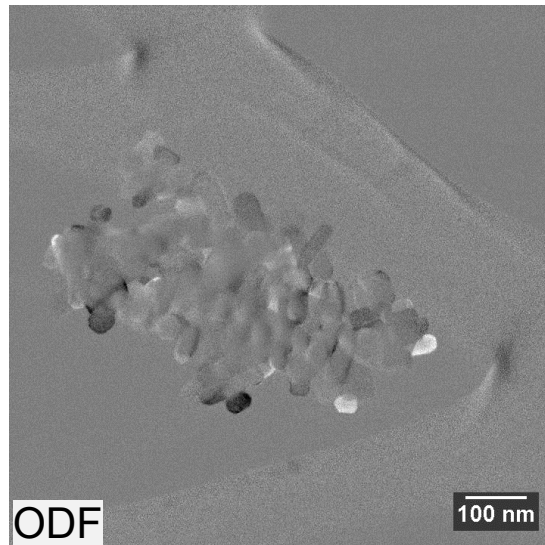
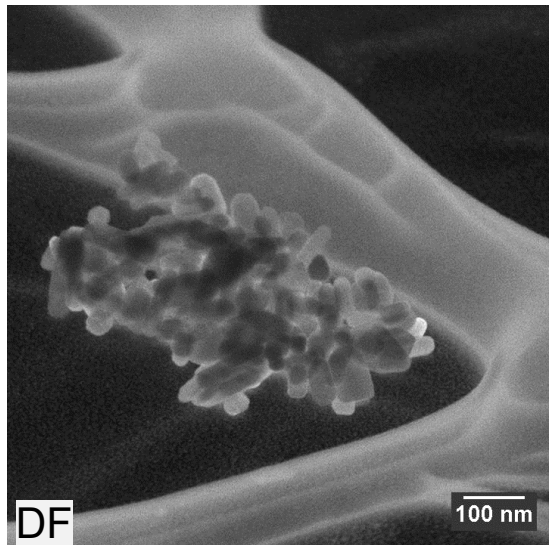
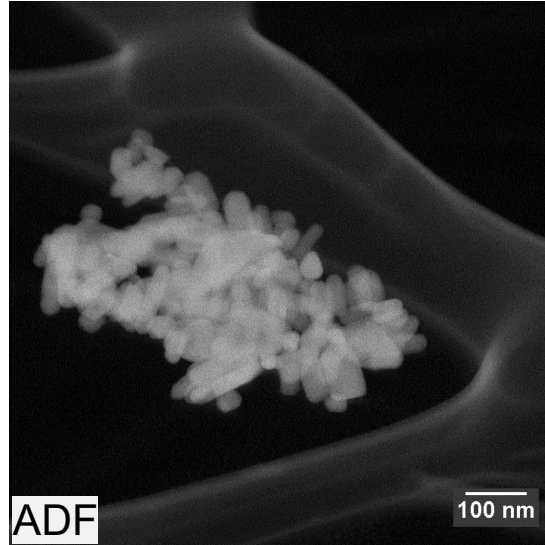
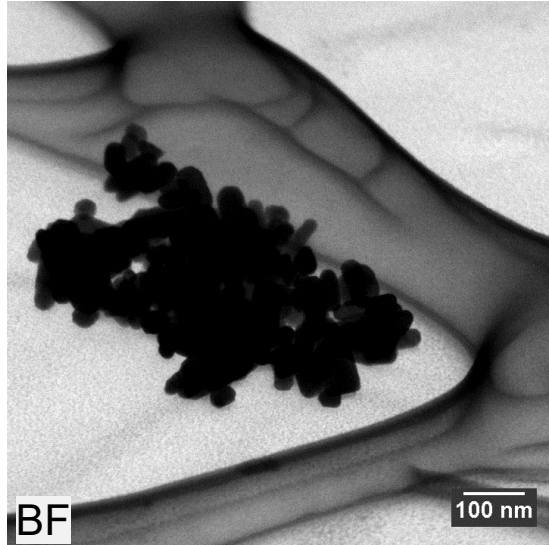
Preserved cell structure of a leaf sample after transferred under VP Airlock, 7.5 kV, imaged in VP mode



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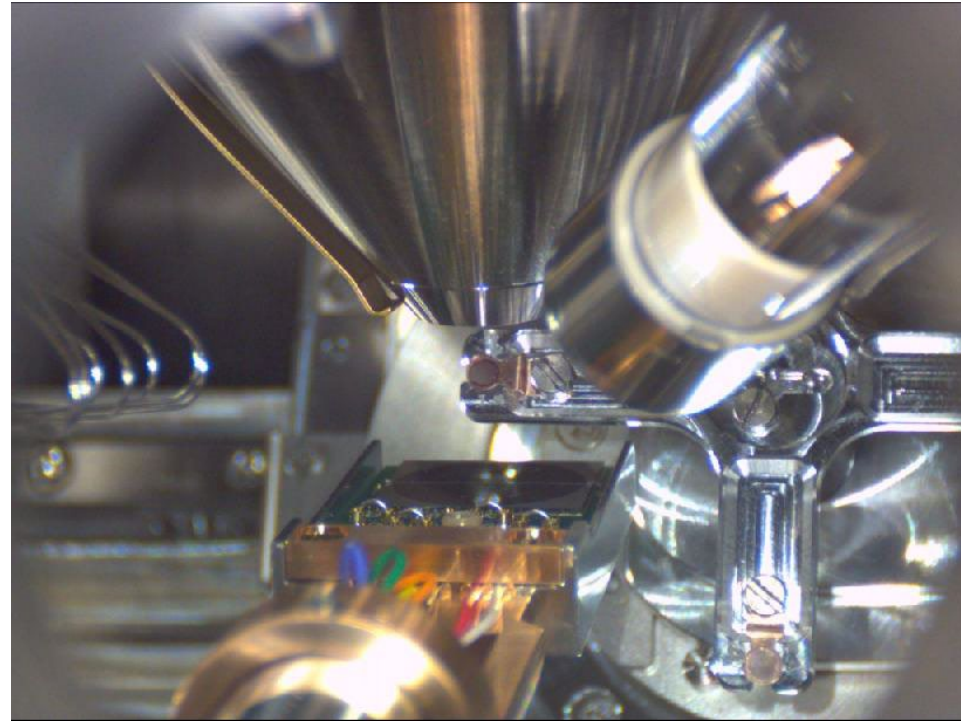
3D STEM (Voxel Dimension 2.0nm)

ZnO nano particles, 25kV STEM



STEM sample holder with rotation / tilt capability:

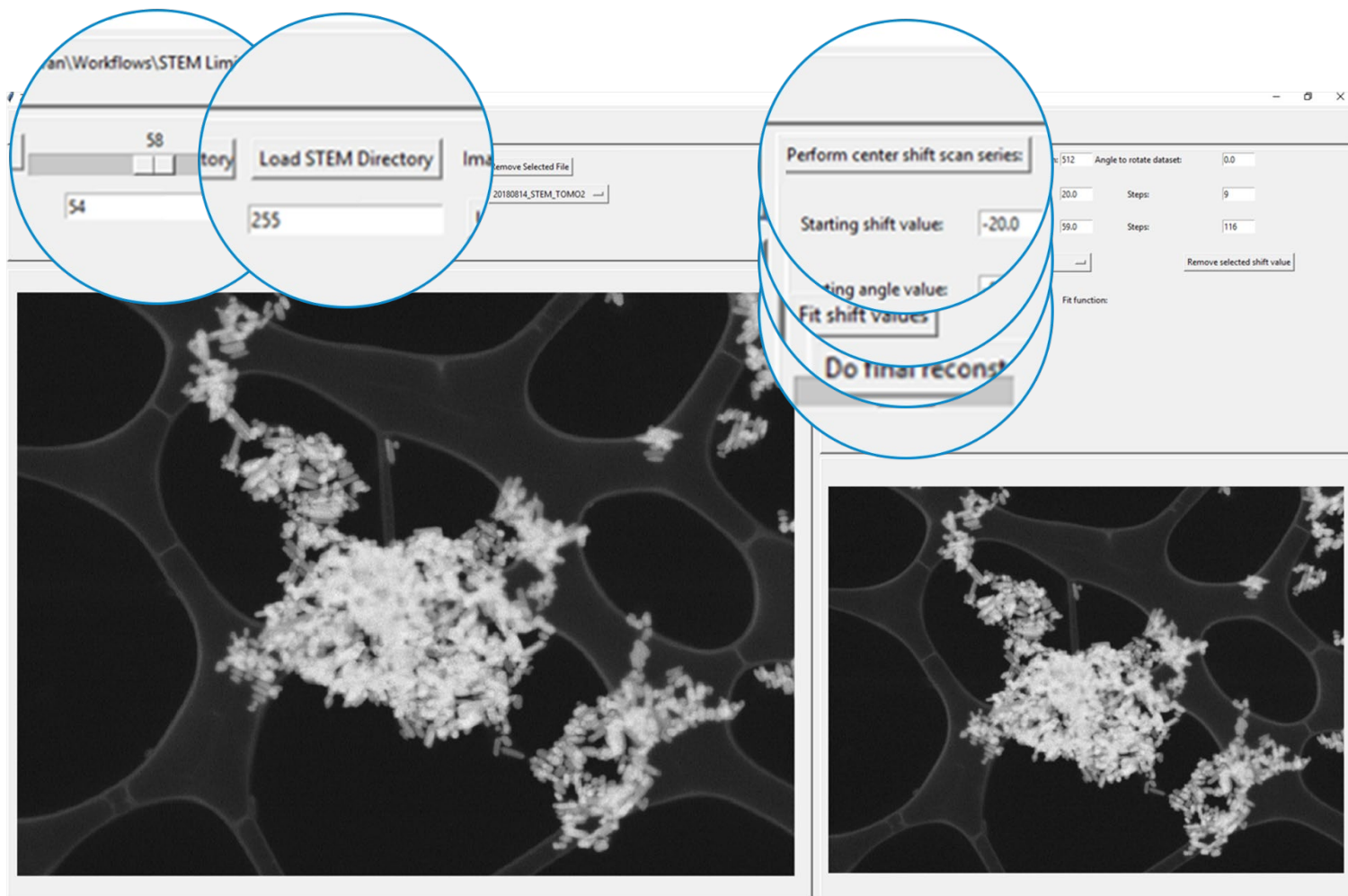
- 4 STEM samples
- Tilt up to 60° at WD 4mm
- Rotation around the STEM detector (> 180°)
- Potential for 3D reconstruction
- High capability for tuning channeling contrast
- Available for **all** FESEM



Source: Luyang Han

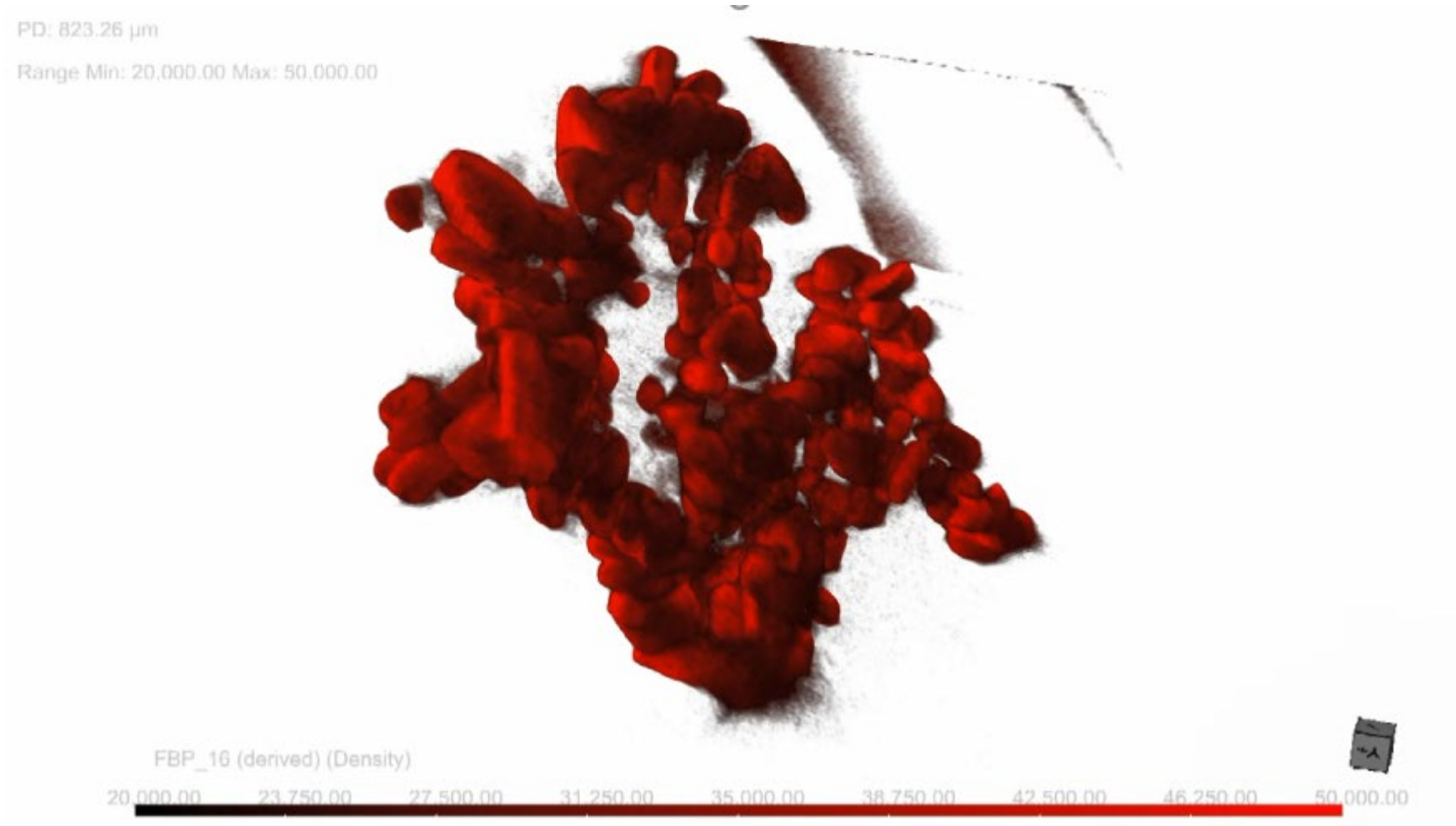
3D STEM Reconstructor

ZEISS Xradia Technology



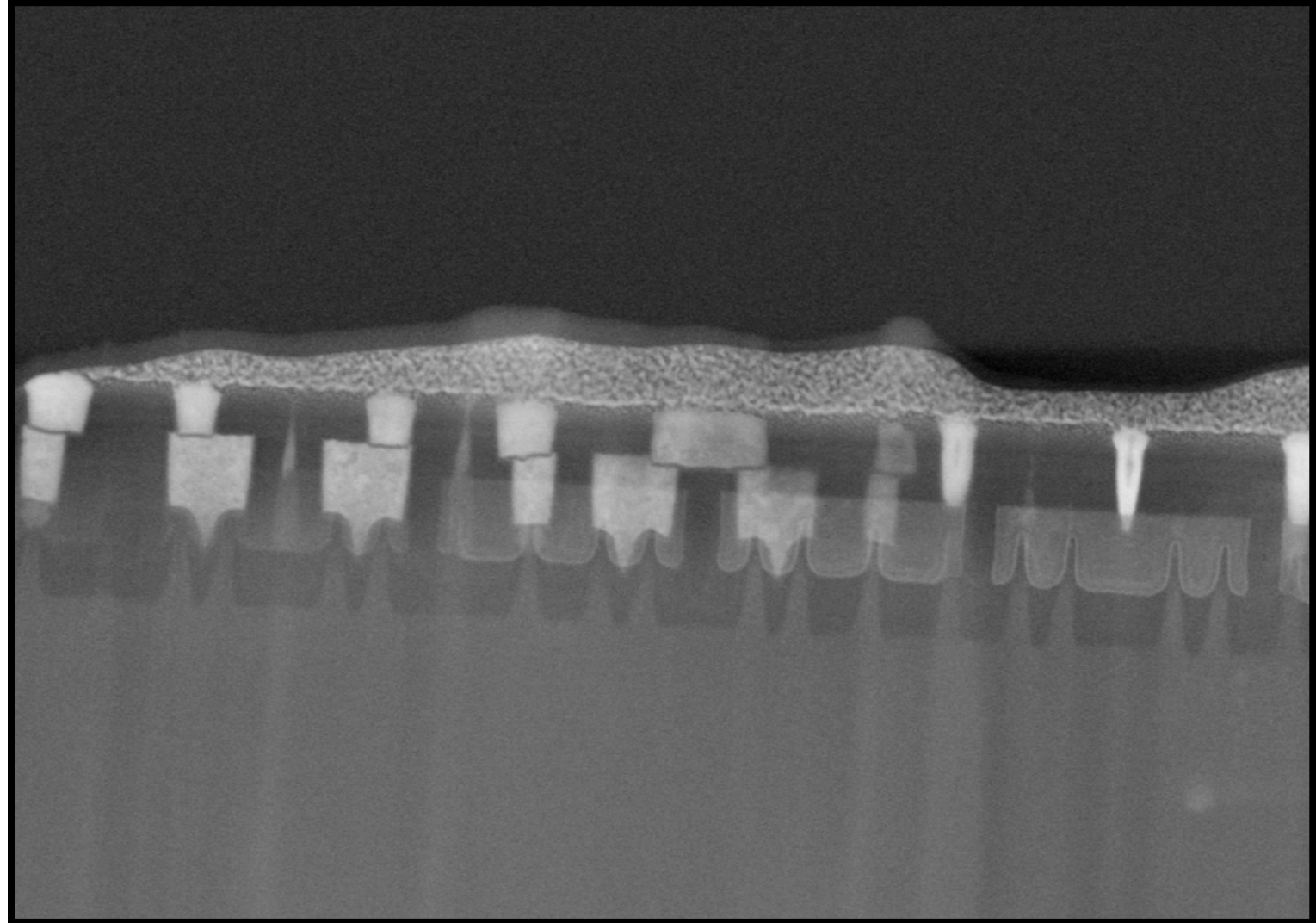
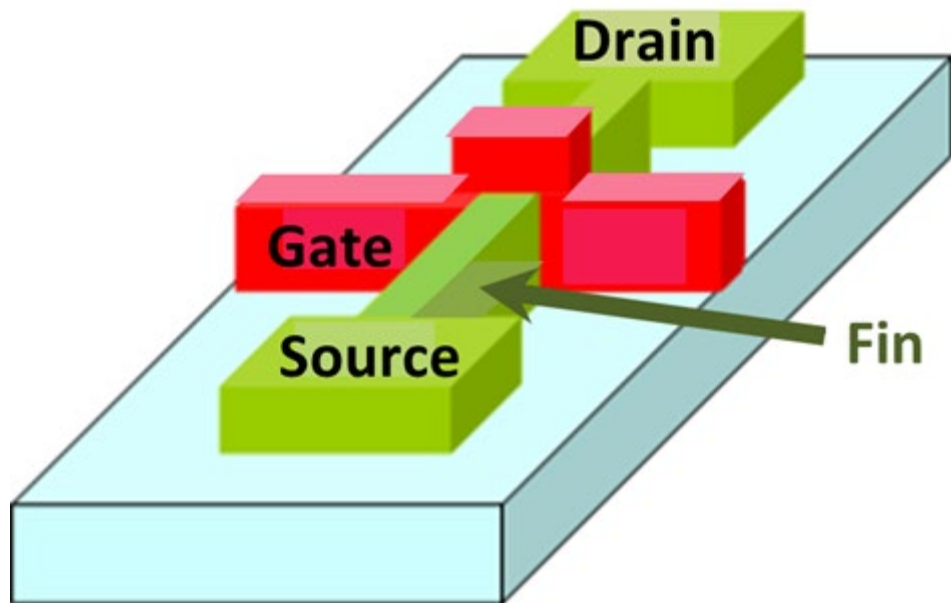
- 1 Load in folder with acquired images
- 2 Perform center shift scan series
- 3 Look through scan series and find optimal center shift value
- 4 Add optimal center shift value
- 5 After adding a few center shift values at different places in the dataset, fit the values
- 6 Perform the final reconstruction

Electron Tomography Tomogram ZnO Nanoparticles

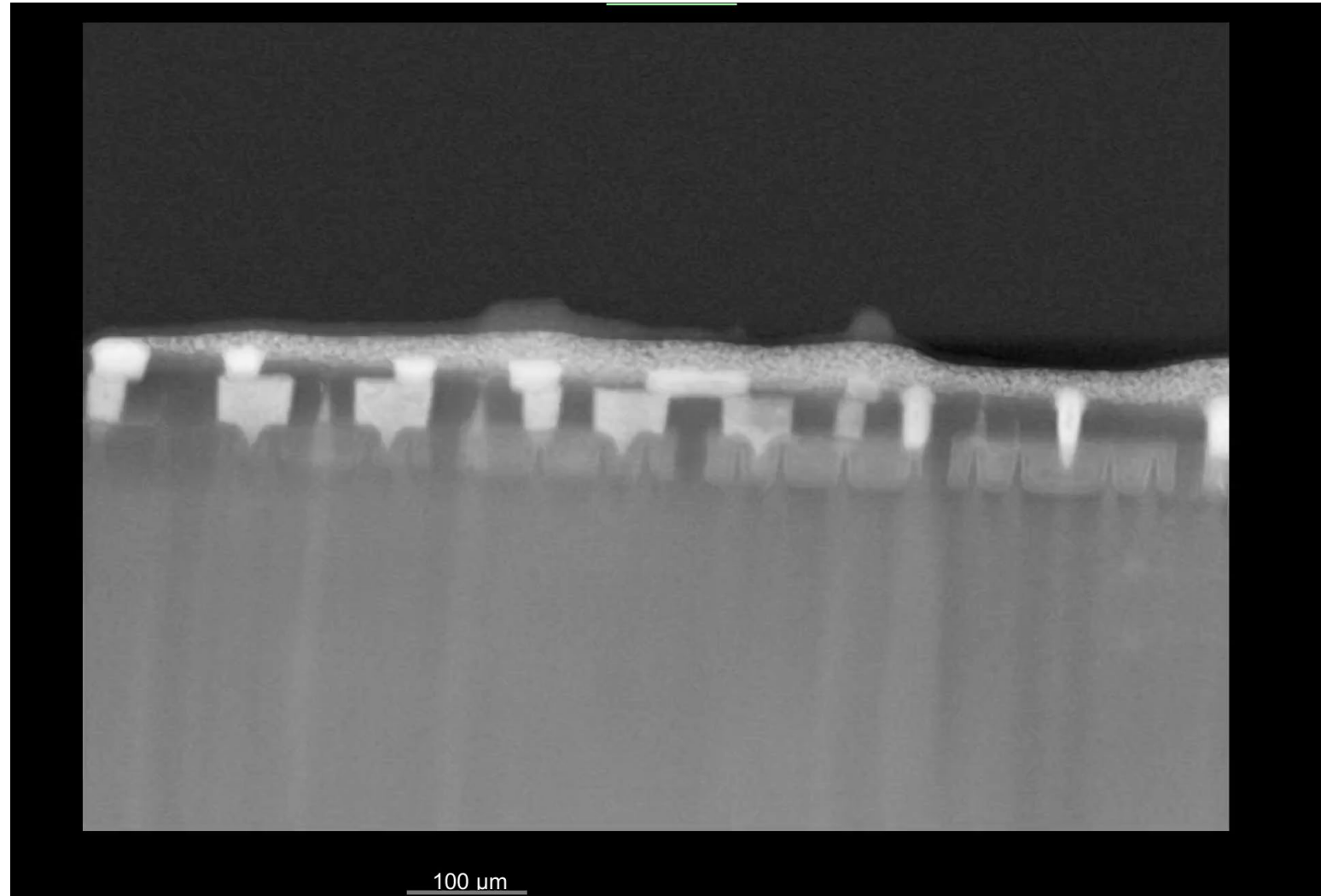


FINFET

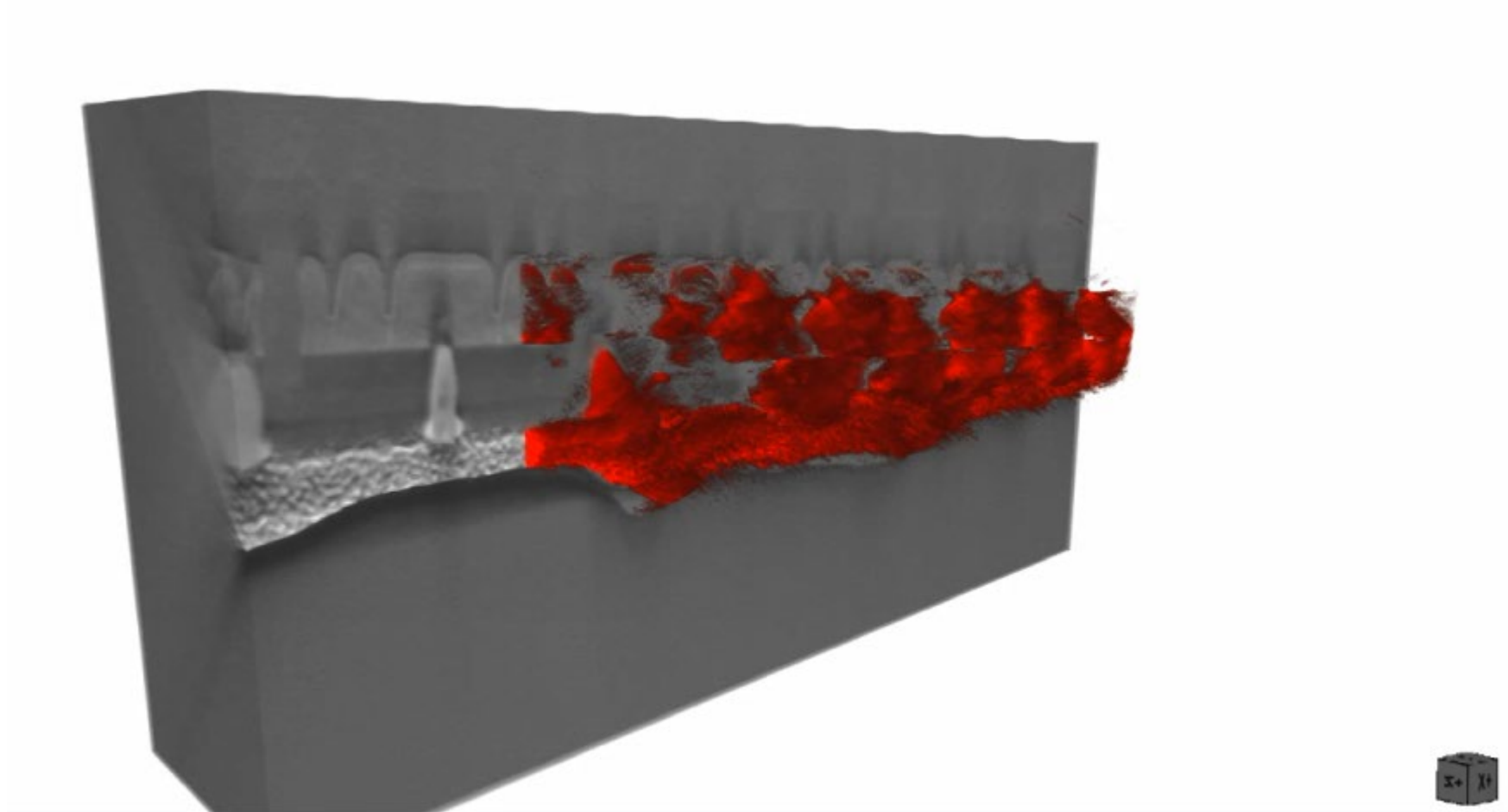
Example of STEM Single Image



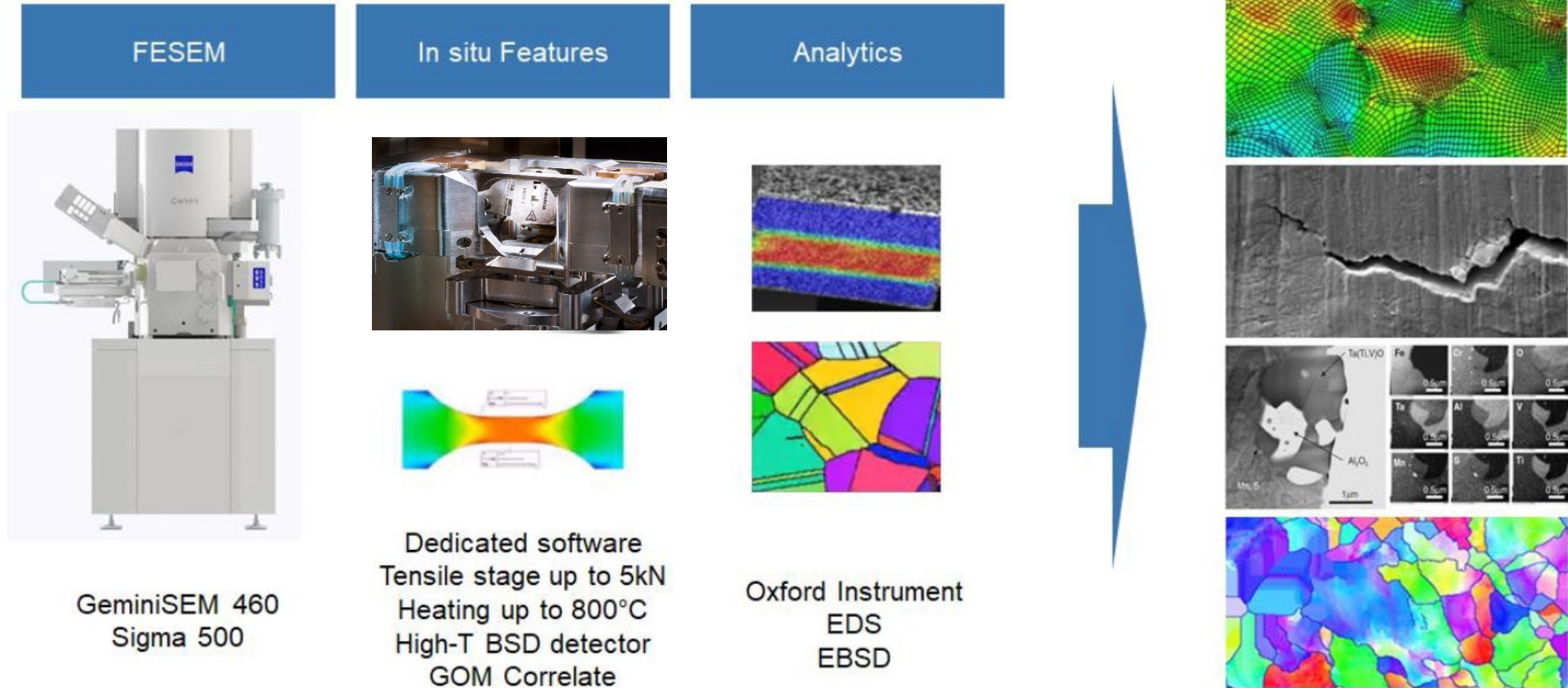
FINFET Aligned Tilt Series



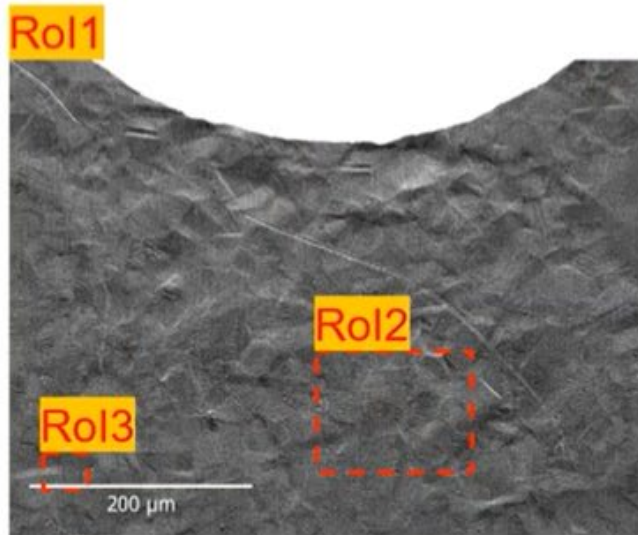
Electron Tomography Reconstruction: FINFET results



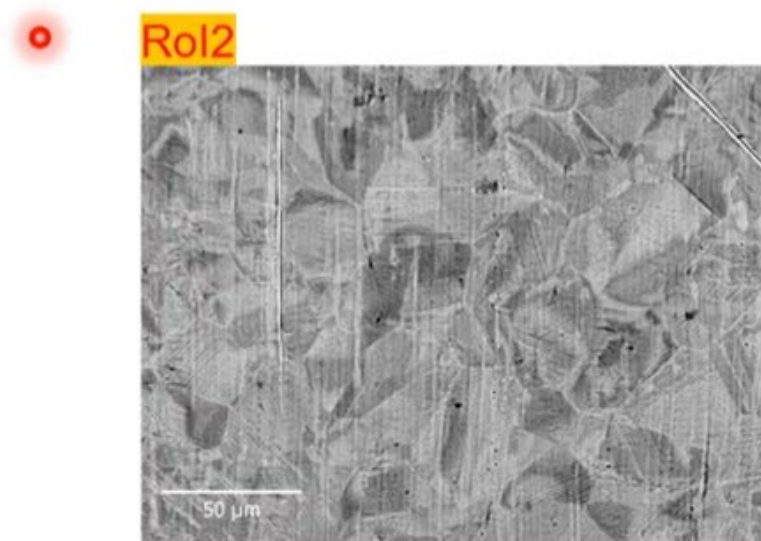
Automatically image and track ROI at each deformation step



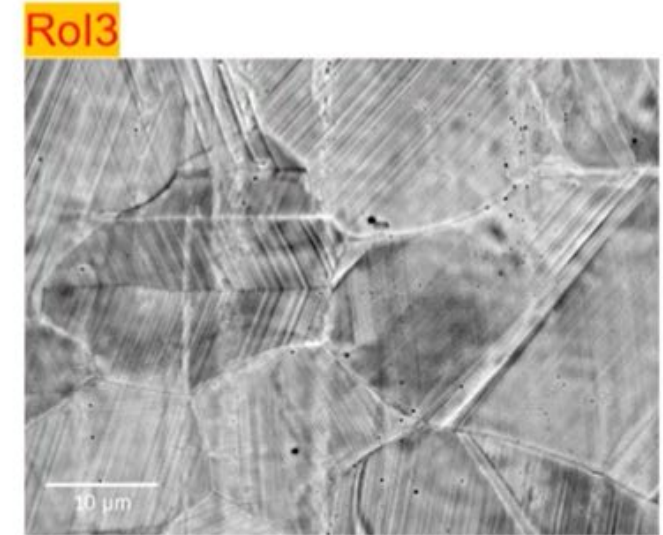
Automatically image and track ROI at each deformation step



200x mag, SE, 4k image



500x mag, BSE, 1k image



2000x mag, BSE, 1k image

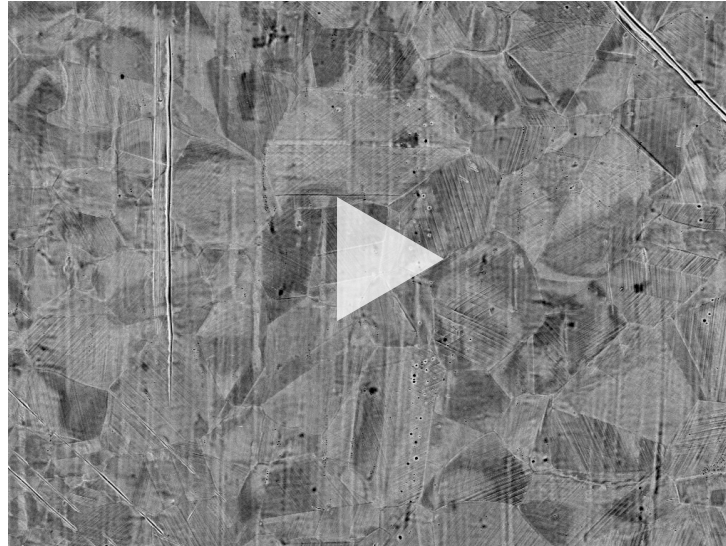
- Image sequence obtained in 3 different ROI with feature tracking.
- The feature stays almost centered in the FoV despite of strong deformation.

Automatically image and track ROI at each deformation step

RoI1



RoI2

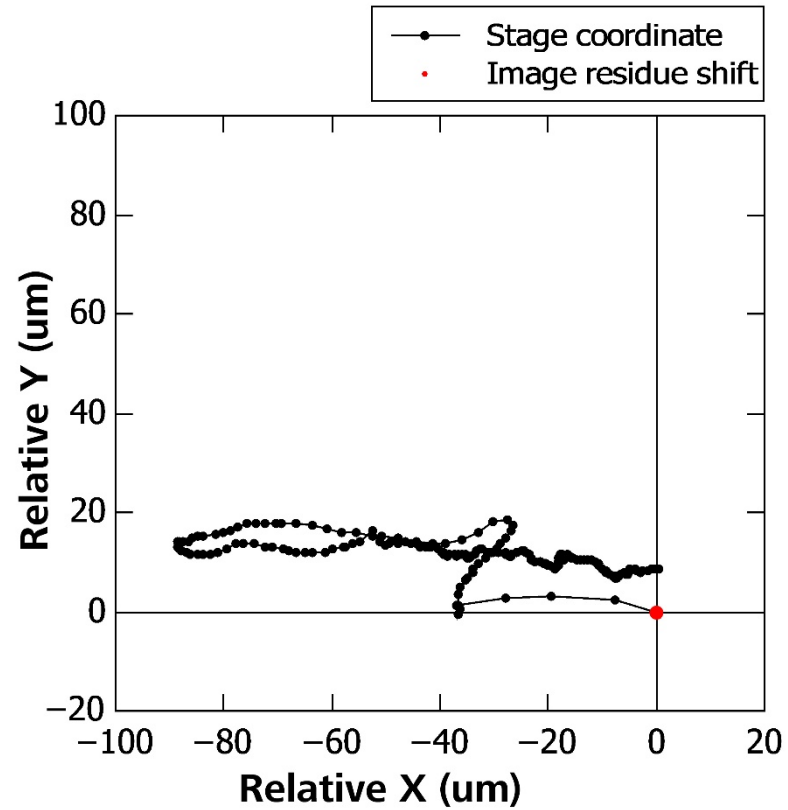


RoI3

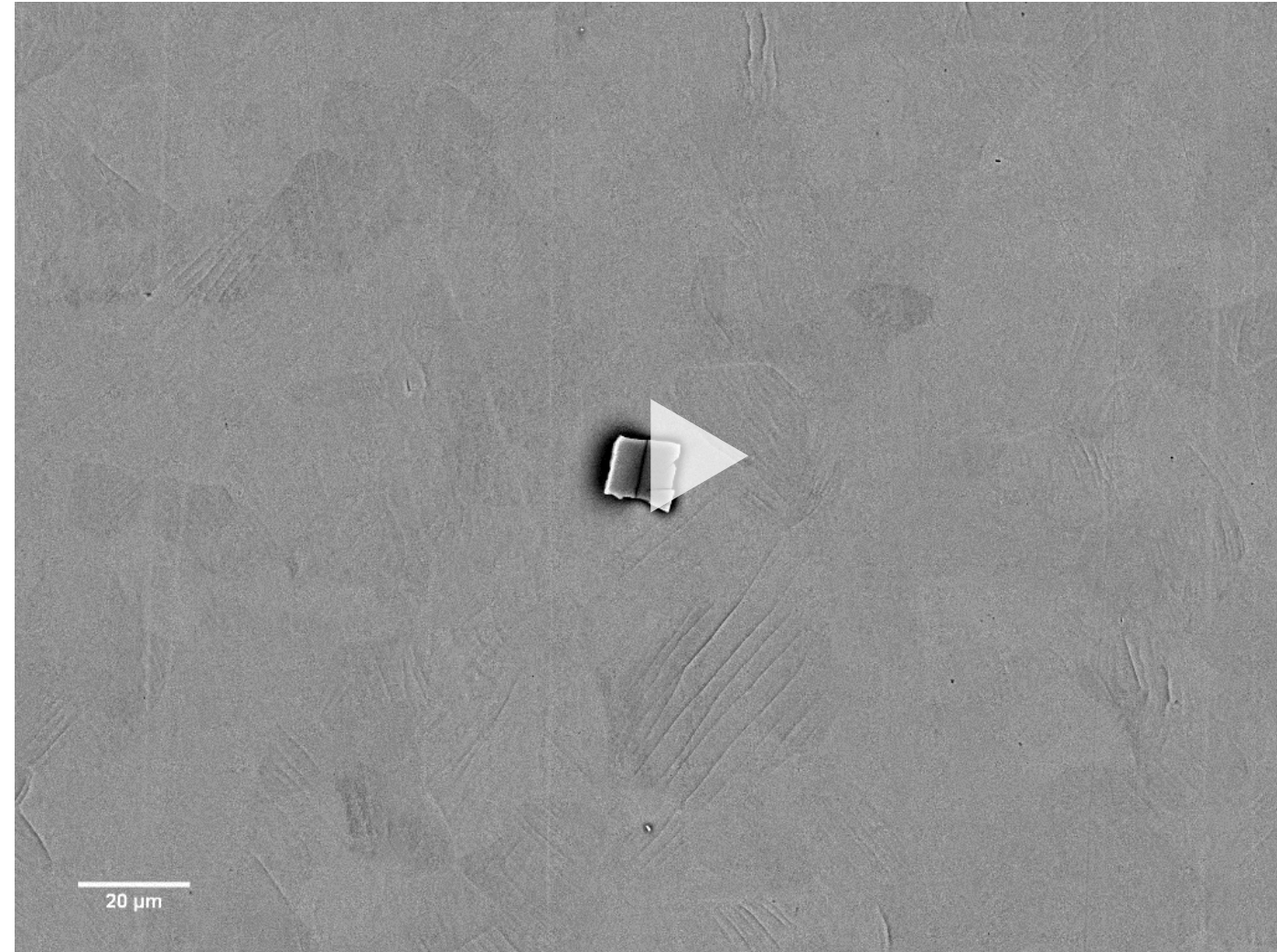


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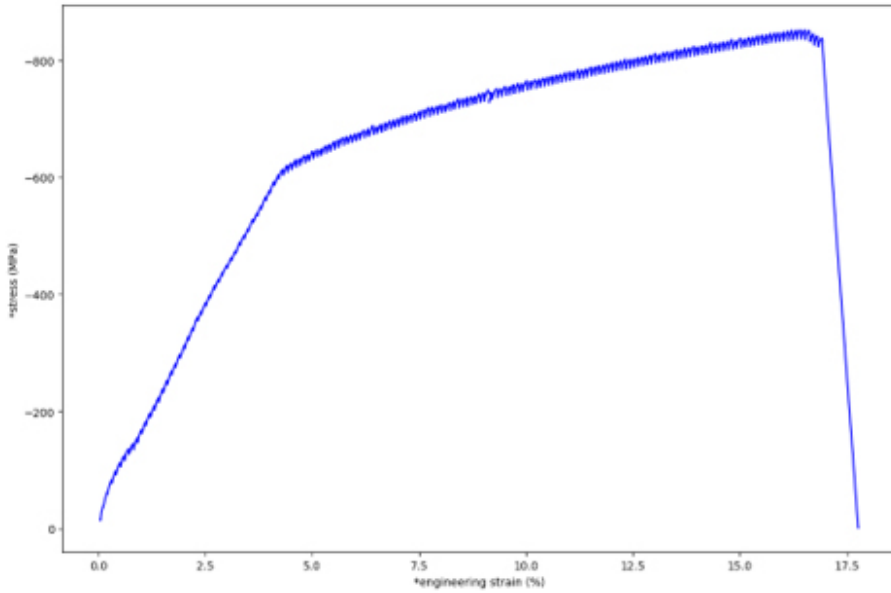
Automatic Feature tracking



- Automatic acquisition of 205 deformation steps, total deformation $\sim 2\text{mm}$ on specimen, total time 2.5 h without human intervention.
- ROI drifts up to $100\ \mu\text{m}$ locally. Final images show drift $< 1\ \mu\text{m}$.



Mechanical Testing of 3D printed high temperature super alloy

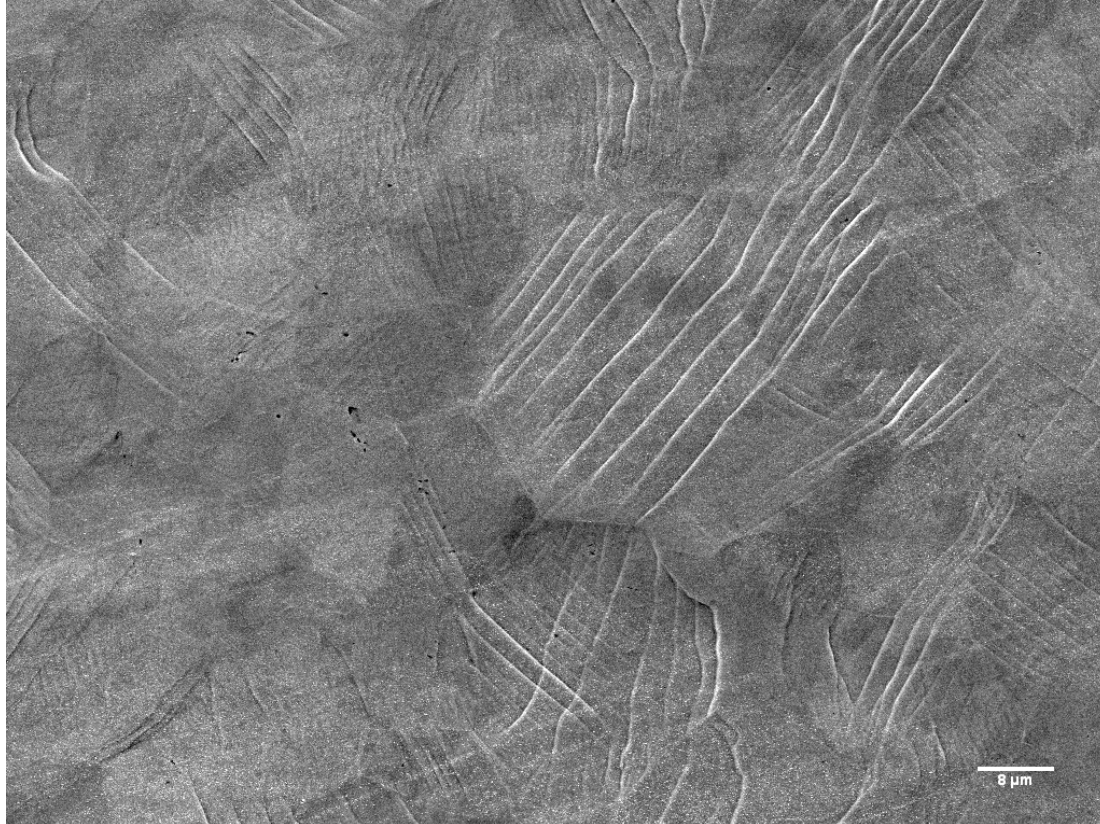


- SE image series.
- More than 200 steps, taken overnight without user attention.

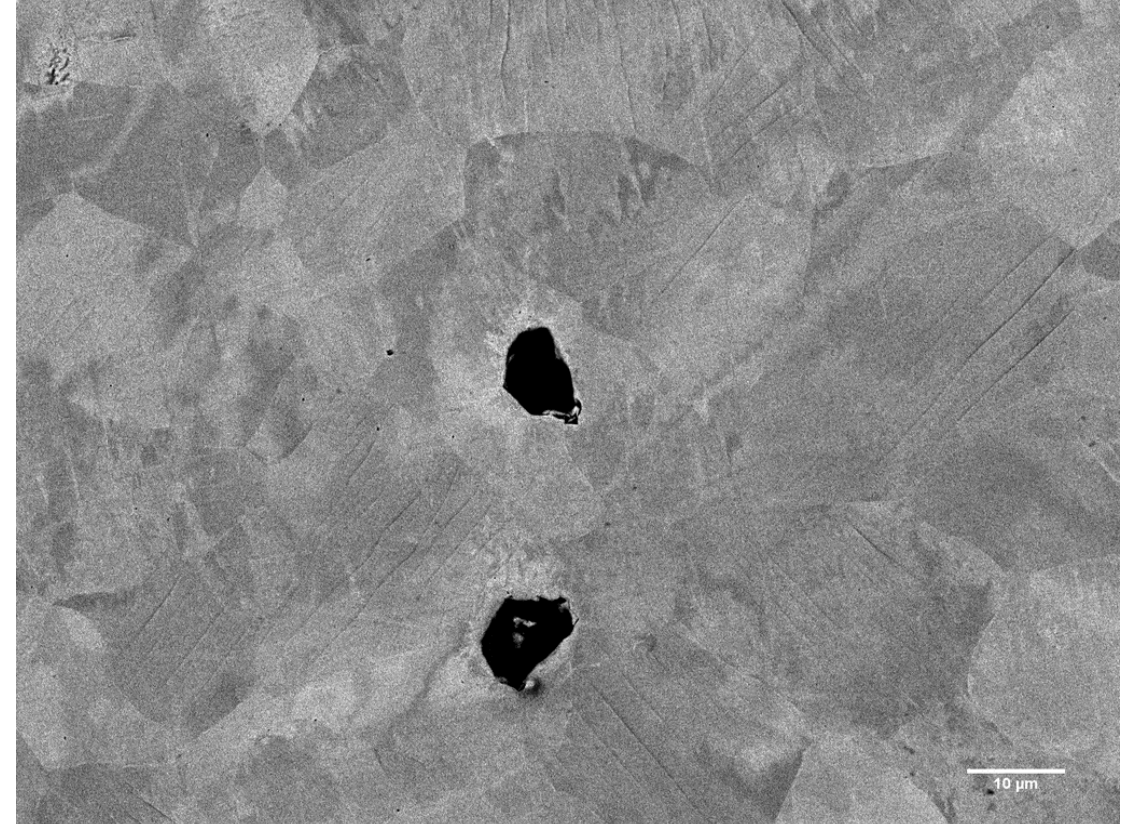


Test examples on steel sample at 600 °C

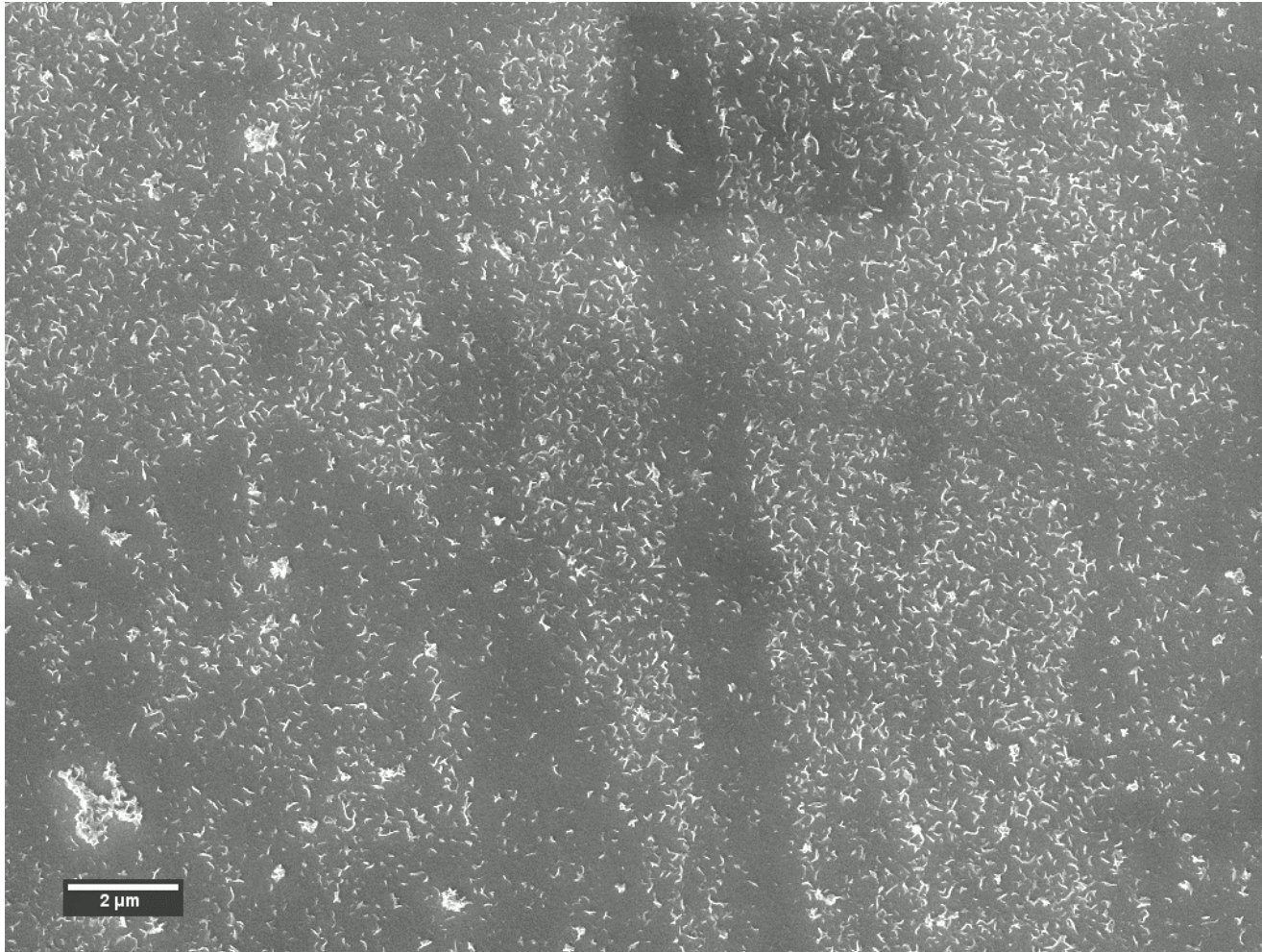
SE images



BSE images

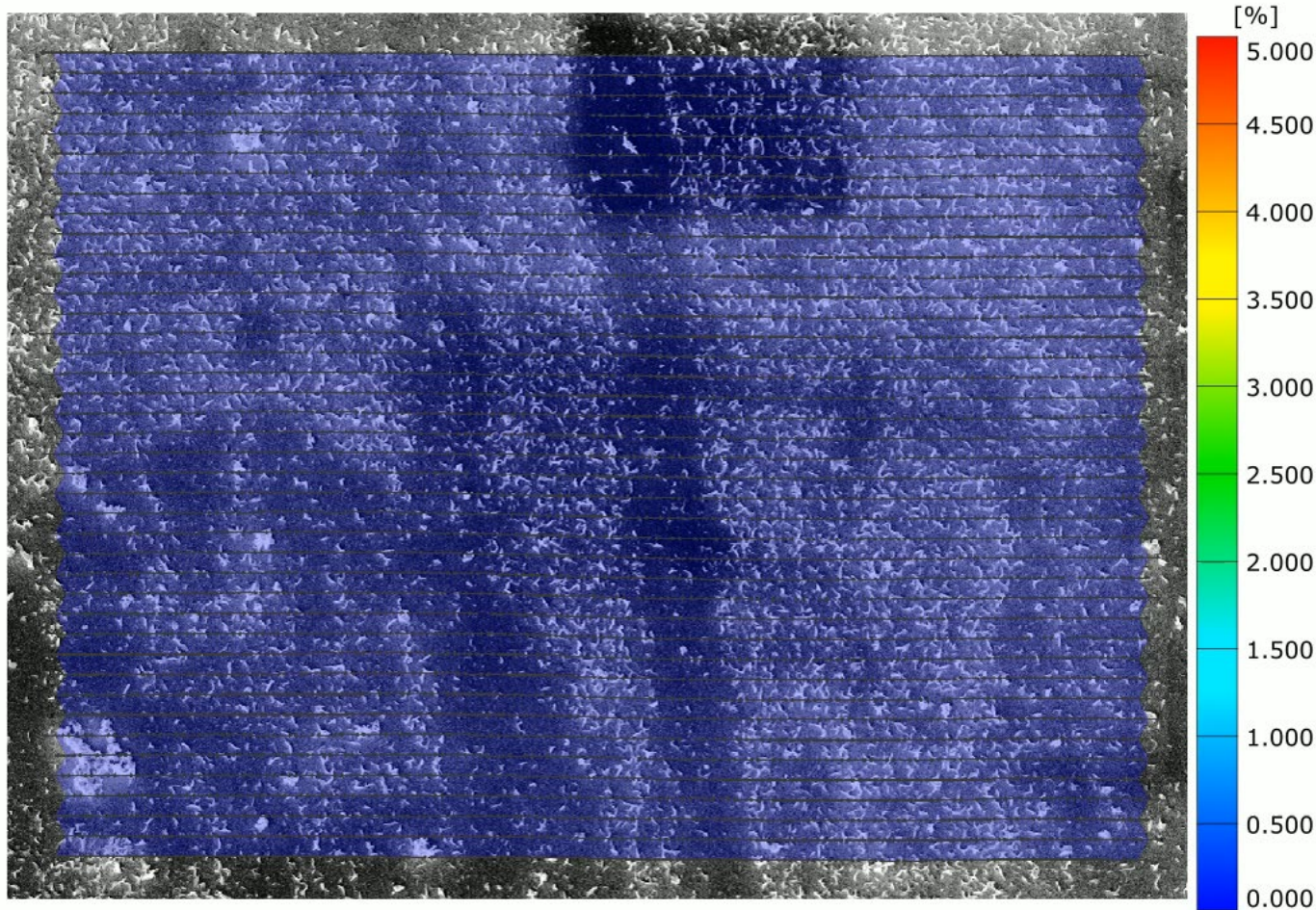


- Heating up the sample to high temperature creates lots of IR and visible radiation.
- Light guide and scintillators of SE detectors are coated with Al to block light.
- BSE detectors based on scintillators with cooling are used for BSE detection.



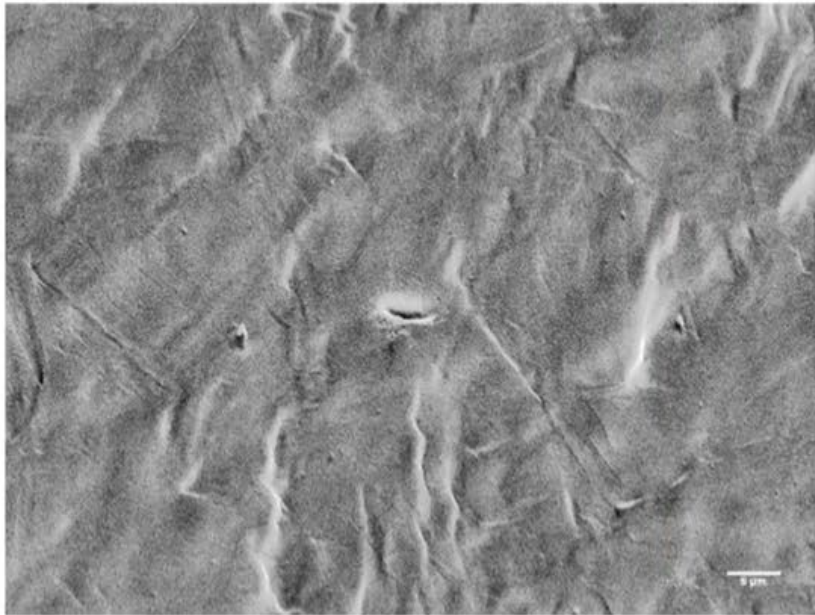
- Specimen: mild steel sample (S235JRC). Surface are polished. Small particles on the specimen surfaces are used as markers for DIC.
- SE images are imported to GOM Correlate for DIC analysis.
- The amplitude and direction of major strain are displayed in the image.

DIC analysis of In-situ tensile test in SEM

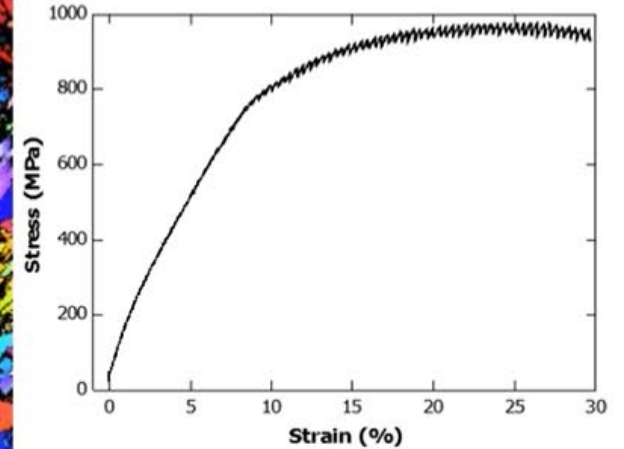
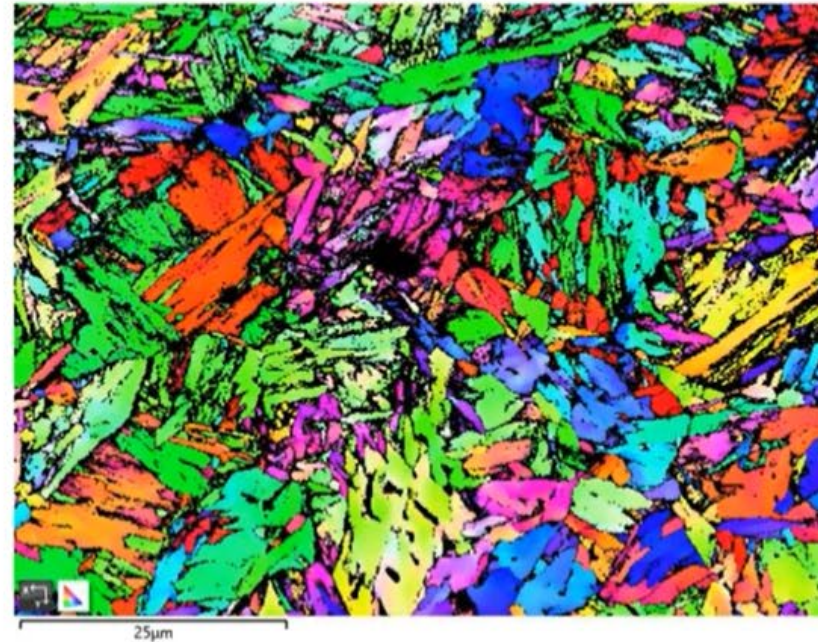


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- The amplitude and direction of major strain are displayed in the image.

SE image



EBSD map IPF X

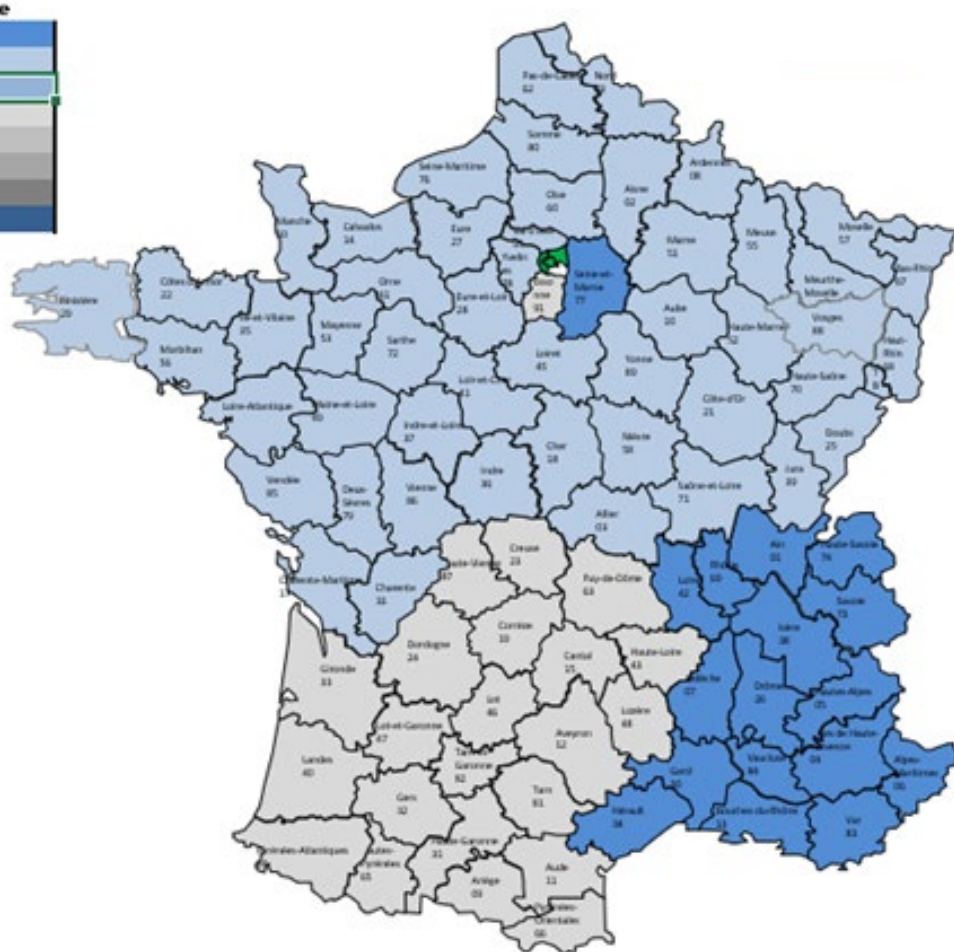


- Steel sample after heat treatment, composed of mainly martensite.
- In-situ tensile test at room temperature. EBSD map taken at each deformation step after feature tracking.
- Each EBSD map takes 3 minutes (1800 points per second). Due to long acquisition time and sample relaxation, the EBSD map is slightly distorted.



Seeing beyond

Légende



Deniz AKMAN :

- 06 47 10 16 46
- deniz.akman@zeiss.com

Stéphane LETHEUX :

- 06 33 33 44 38
- stephane.letheux@zeiss.com

Jérôme MIALILHE :

- 07 88 36 67 84
- jerome.mialilhe@zeiss.com



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