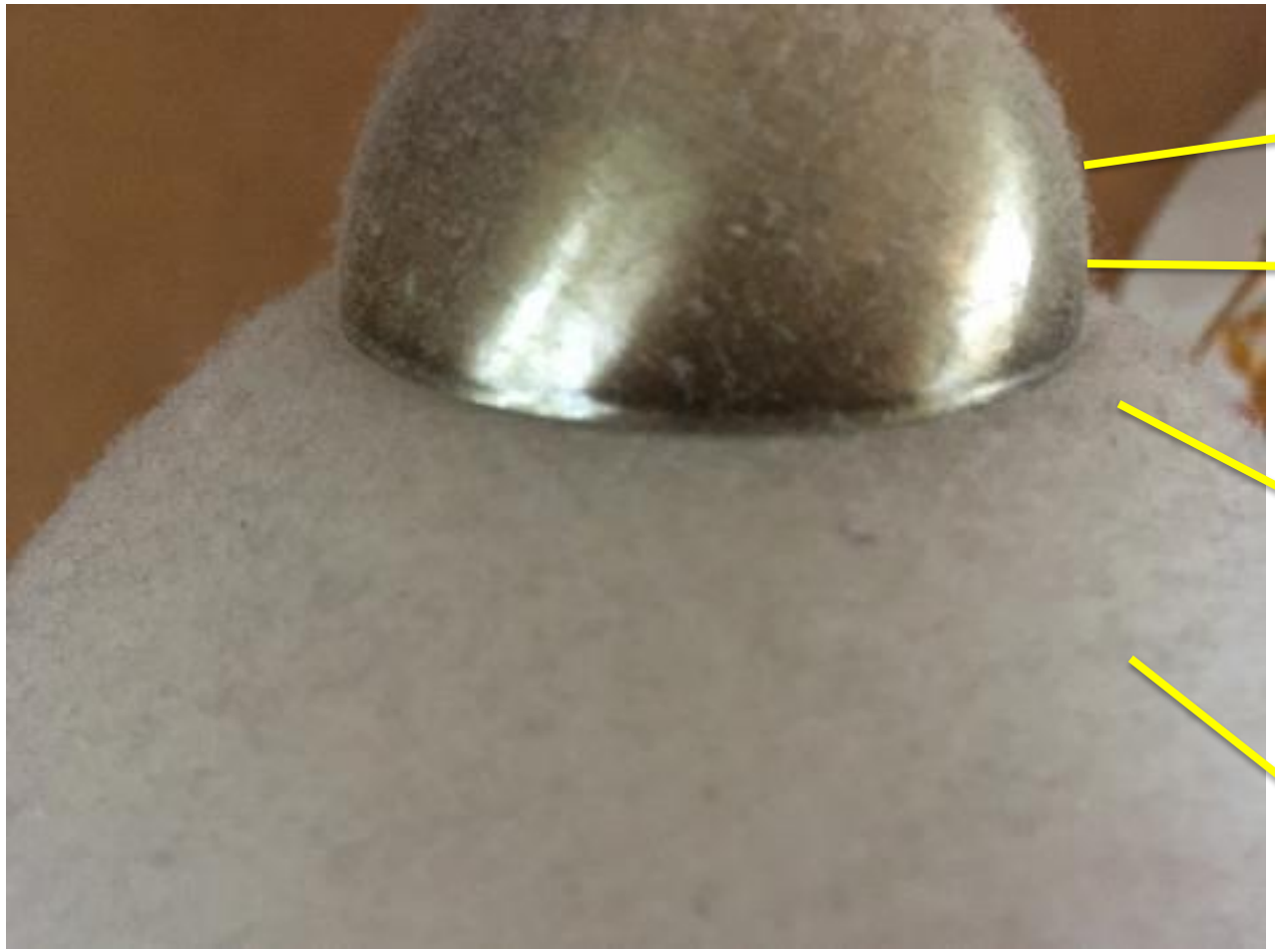
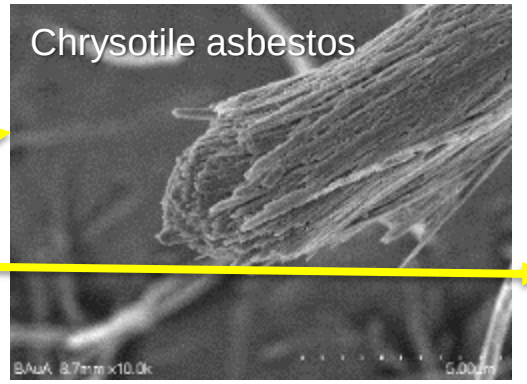
Bundesanstalt für Arbeitsschutz
und Arbeitsmedizin

Analysis of sampled airborne particles by correlative microscopy

J. Schumann, N. Dziurowitz, C. Thim, T. Peters, A. Meyer-Plath

Nano- and Microscale Fibres in the Workplace





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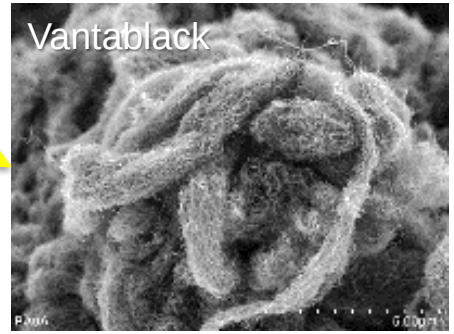
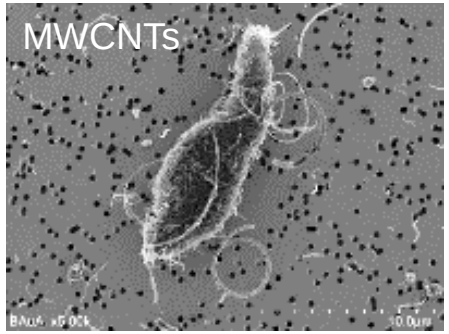
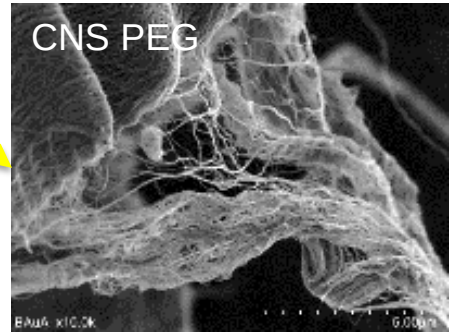
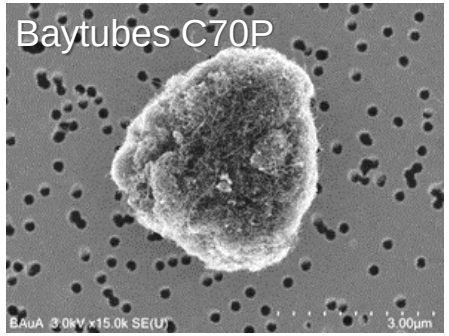


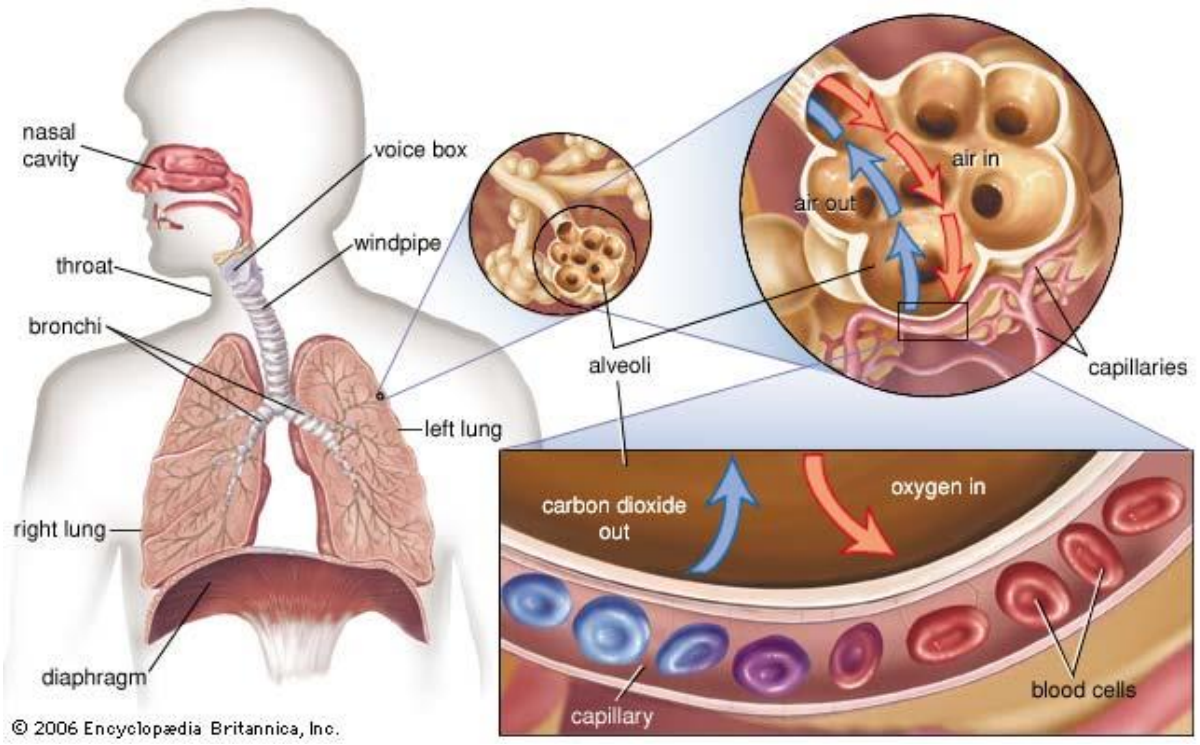




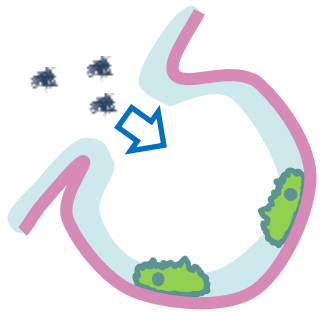


Suspicion of carcinogenic effect of rigid fibres

Alveoli-Clearance-Mechanism

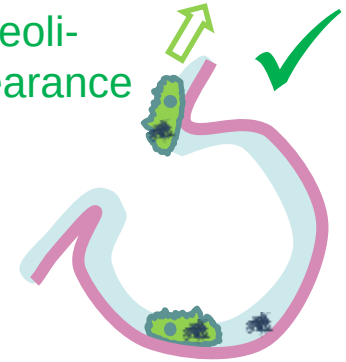


Particle-exposition

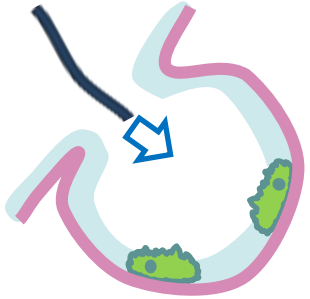


Macrophages

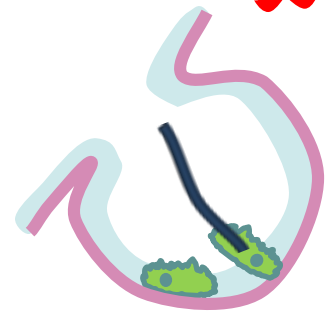
Alveoli-Clearance



Fibre-exposition



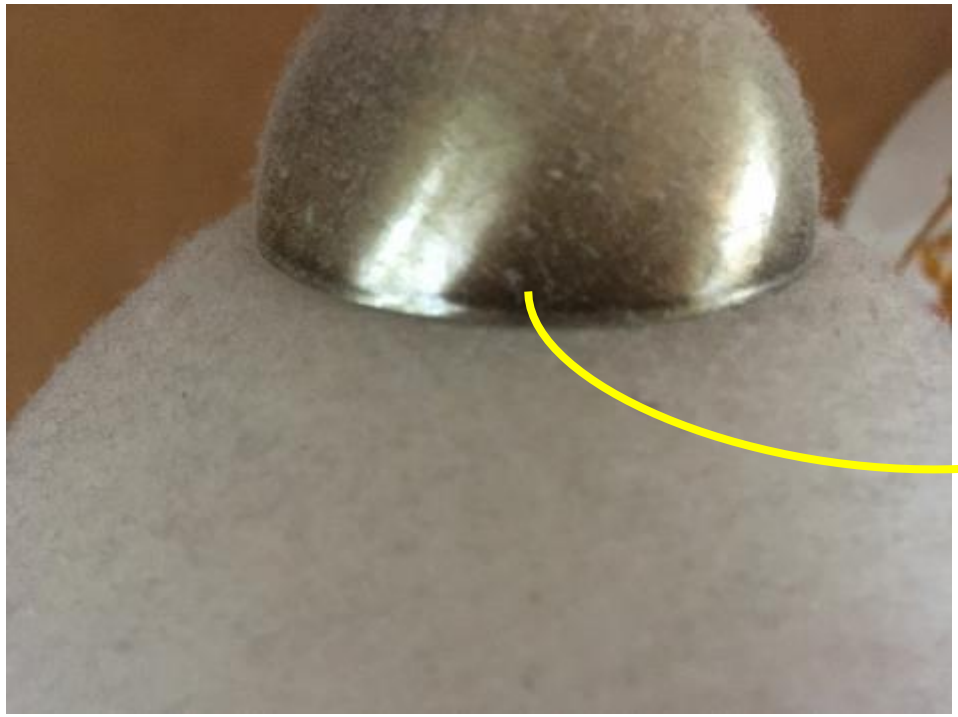
Fibre remains

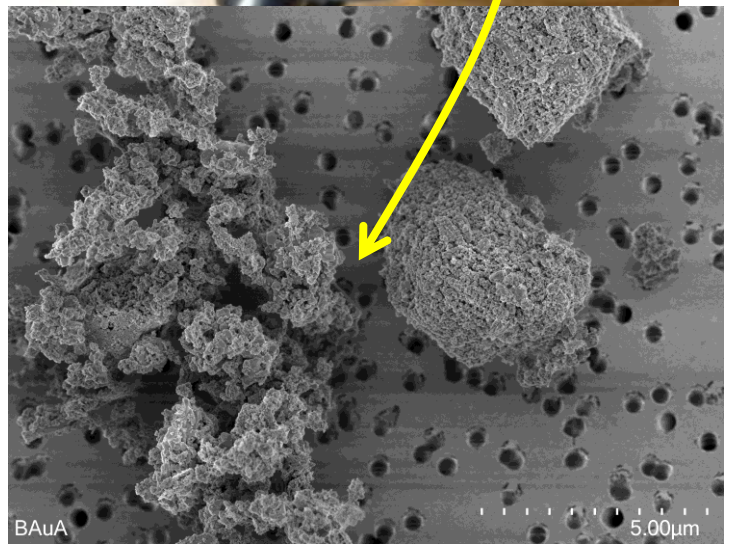


Fibre toxicological principle:

- Alveolar (Diameter < 3 µm)
- Disruption of the clearance mechanism (Length > 5 µm)
- Bio-durable

Collect Airborne Particles and Fibres

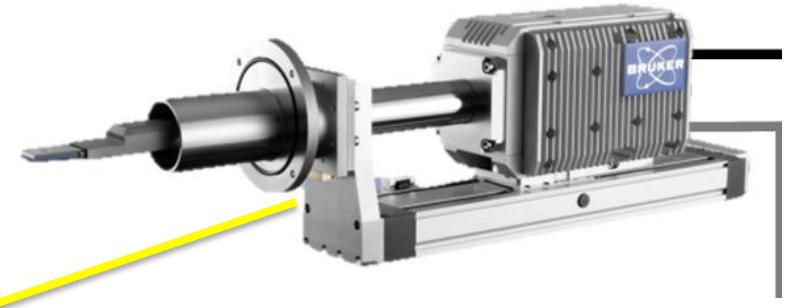




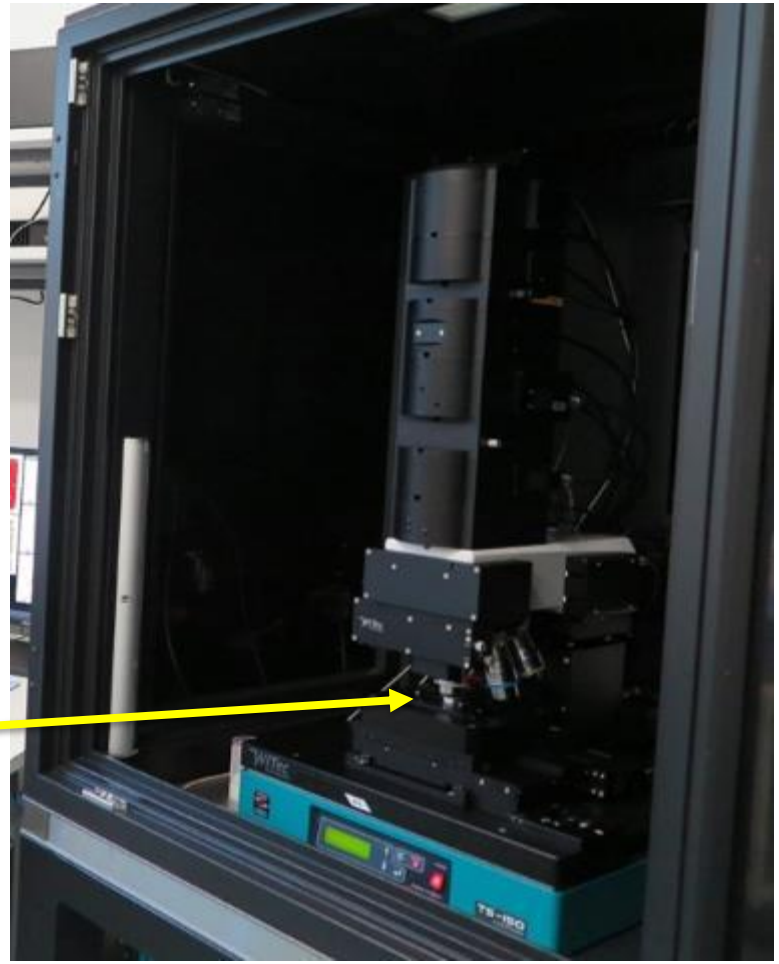
The path of dust to a track-etched membrane filter

BAuA Microscopes

SEM Hitachi SU8200

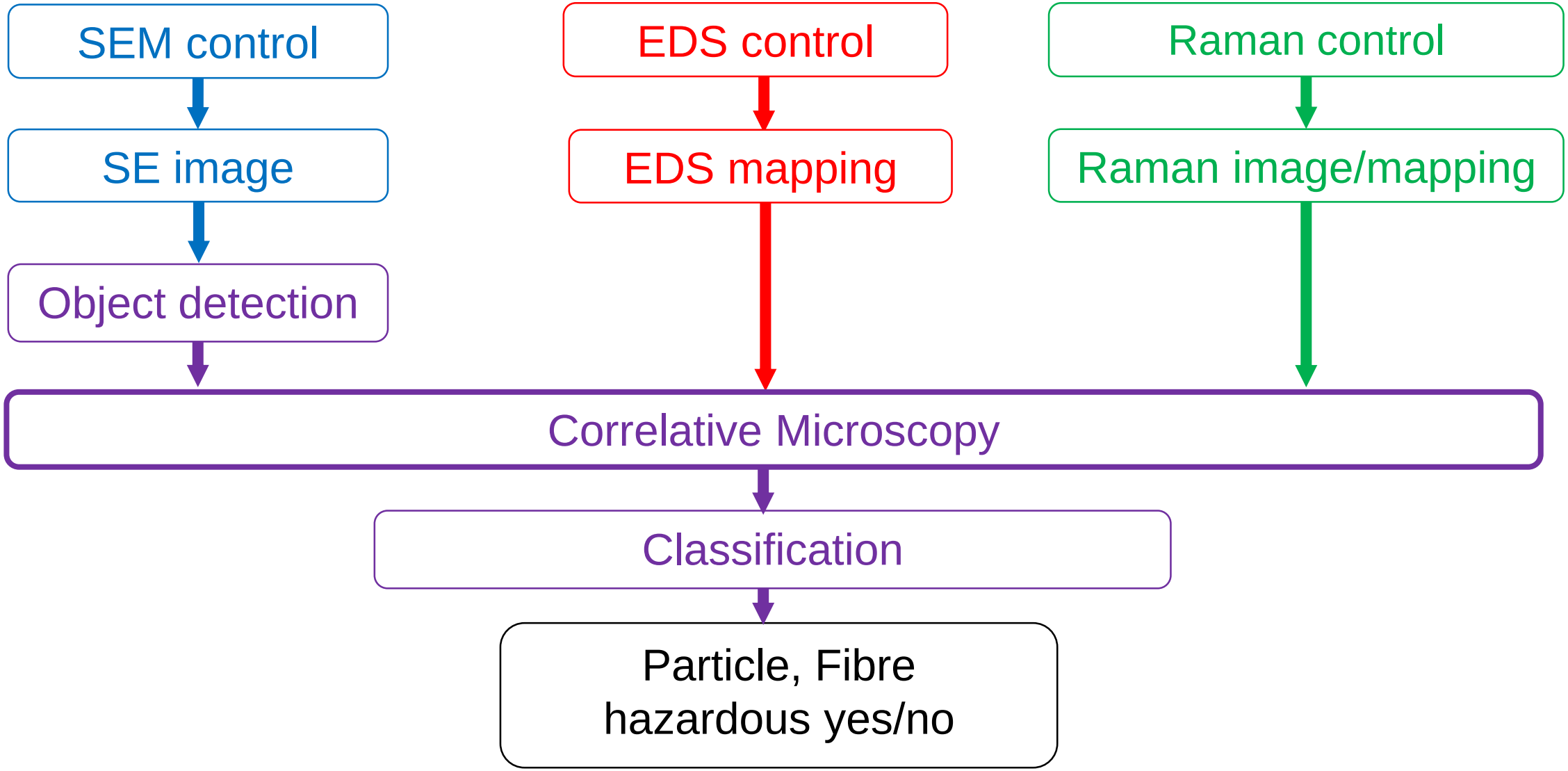


Bruker FlatQUAD EDS-Detector

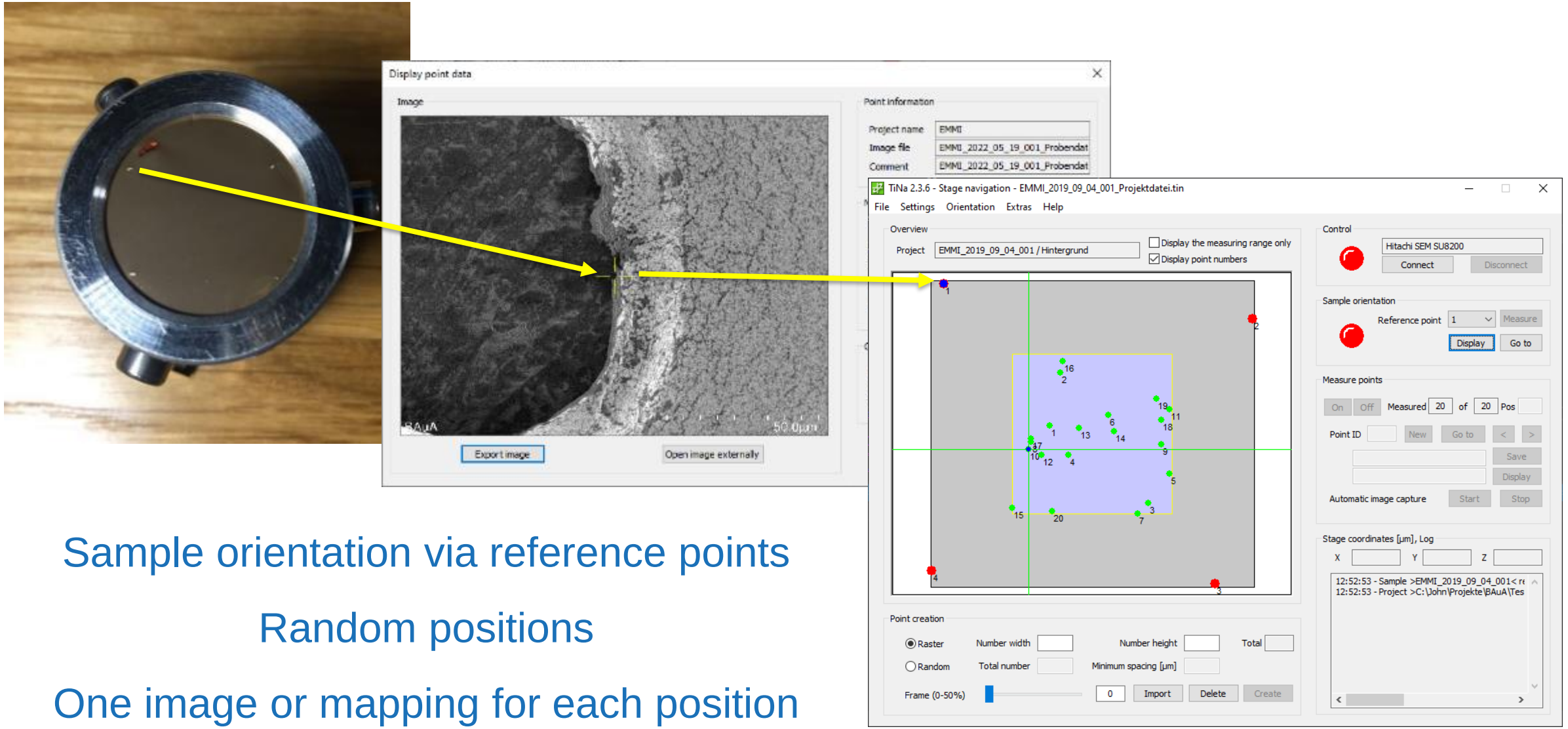


Raman WITec apyron 300 RA

Filter Analysis



SEM, EDS, Raman Control: Software TiNa

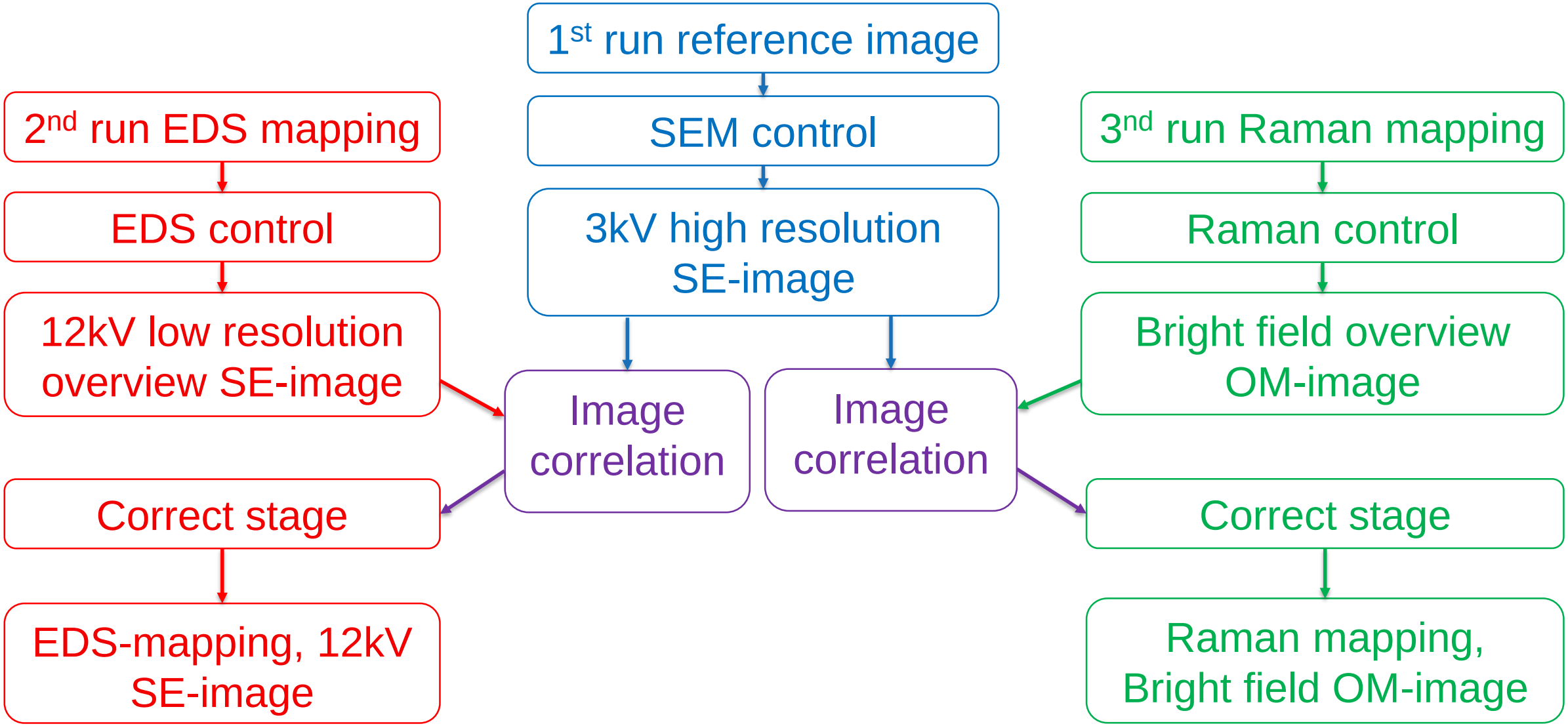


Sample orientation via reference points

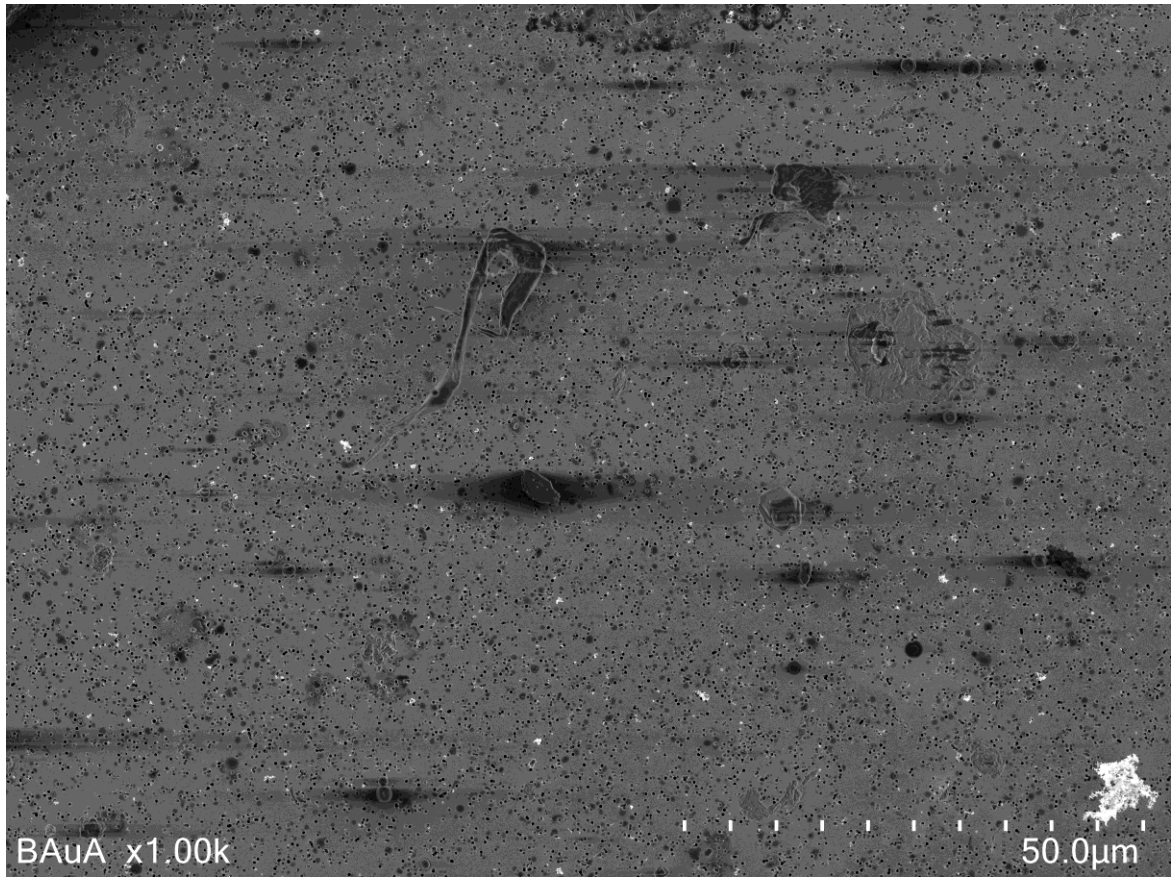
Random positions

One image or mapping for each position

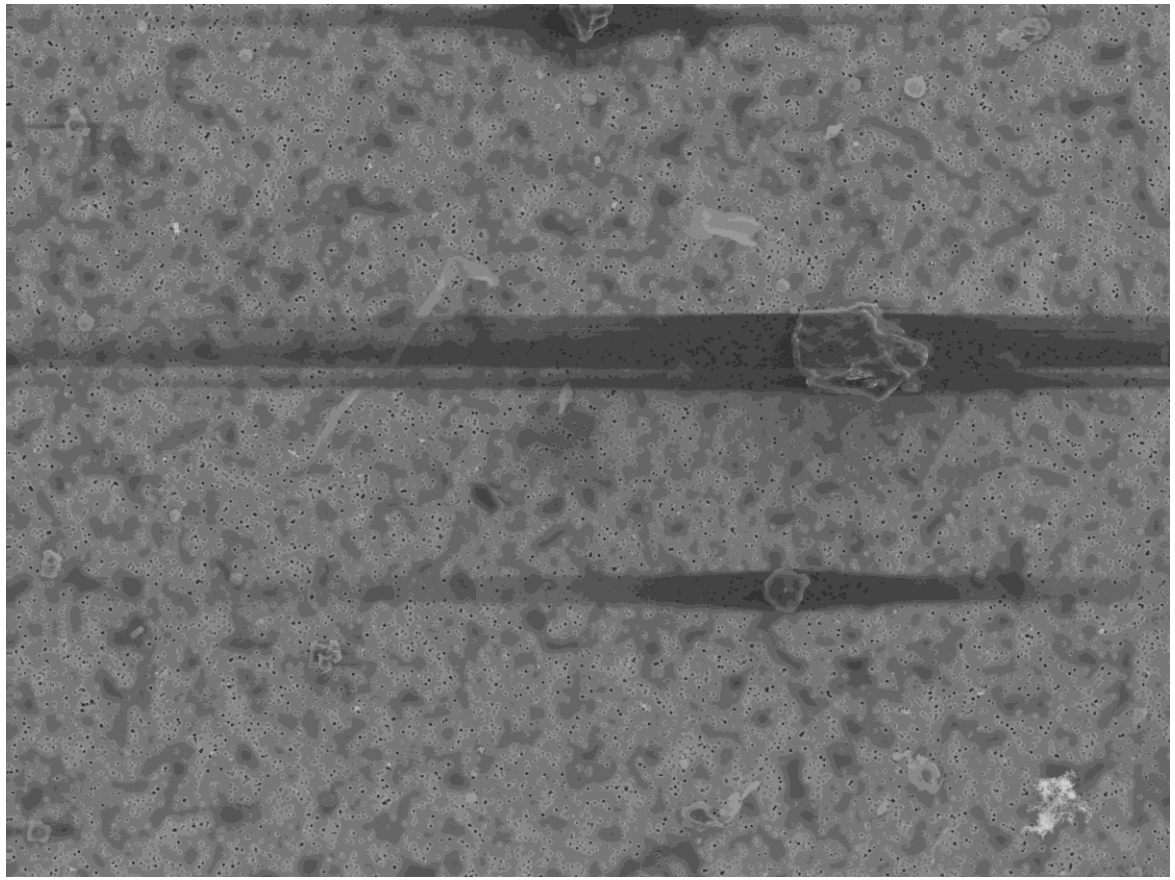
Automatic Stage Correction



SEM-SE Images



Hitachi SE Image 3kV high resolution



Bruker SE Image 12kV with EDS-Mapping

Image Correlation: Constellation Comparison

1st image
3kV SEM SE

2nd image
12kV EDS SE

Edge detection

Edge detection

Search for pores/circles

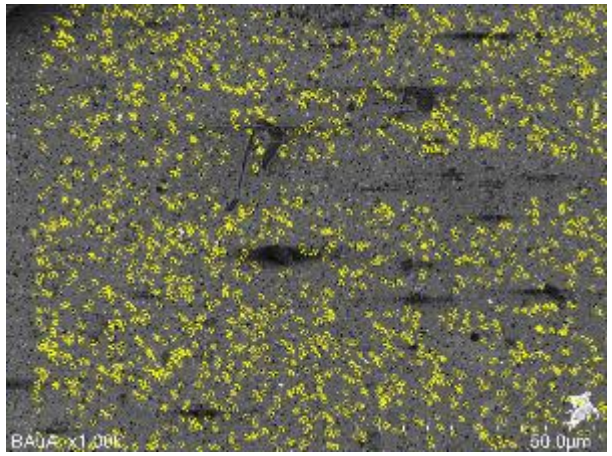
Search for pores/circles

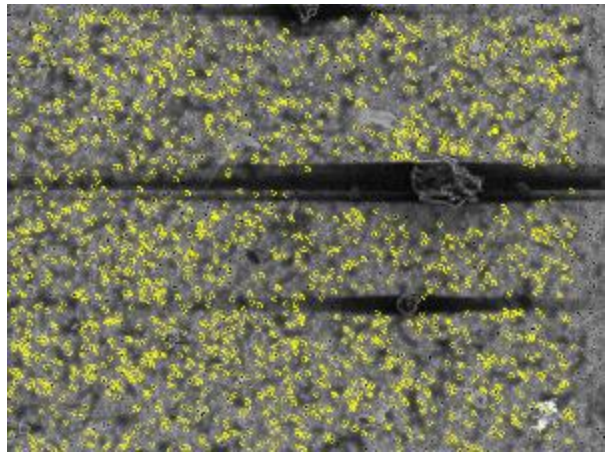
Coordinate list A

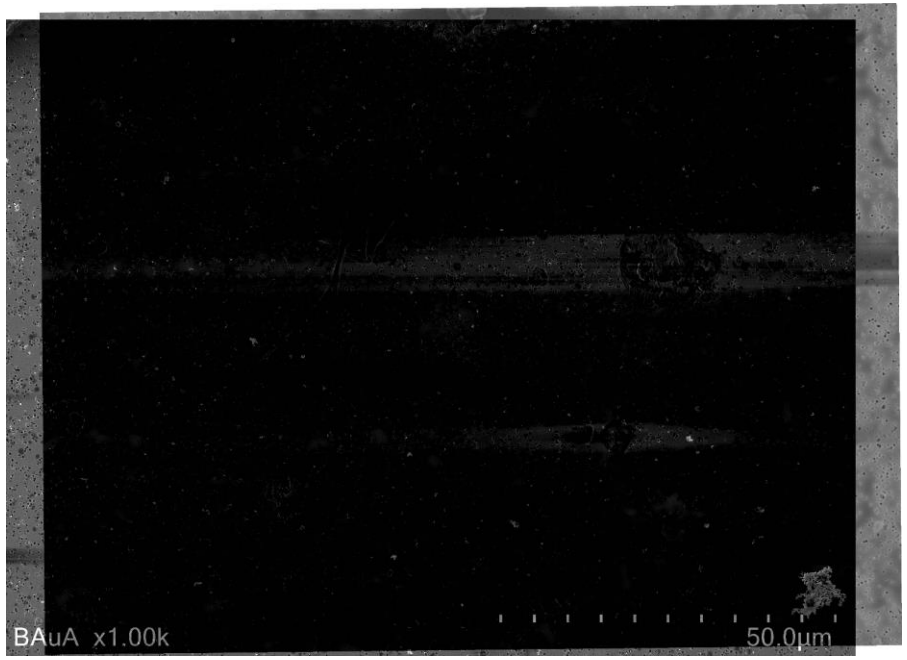
Coordinate list B

Compare Constellation A^B

Calculate parameters of affine transformation

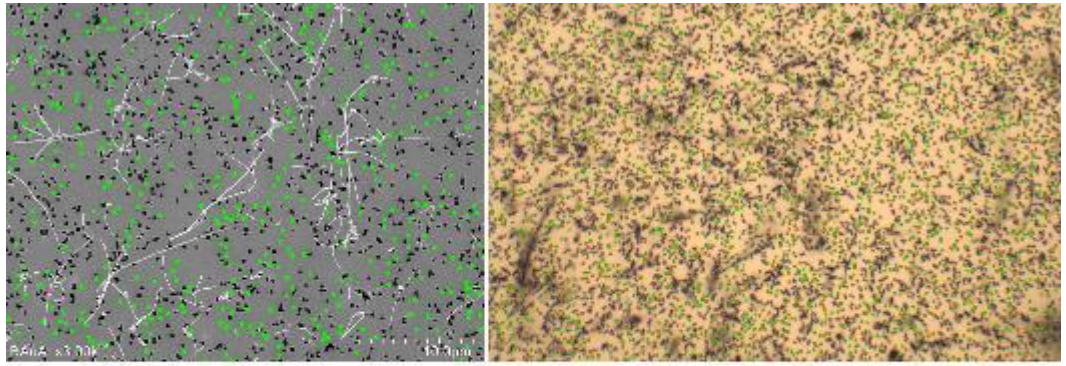




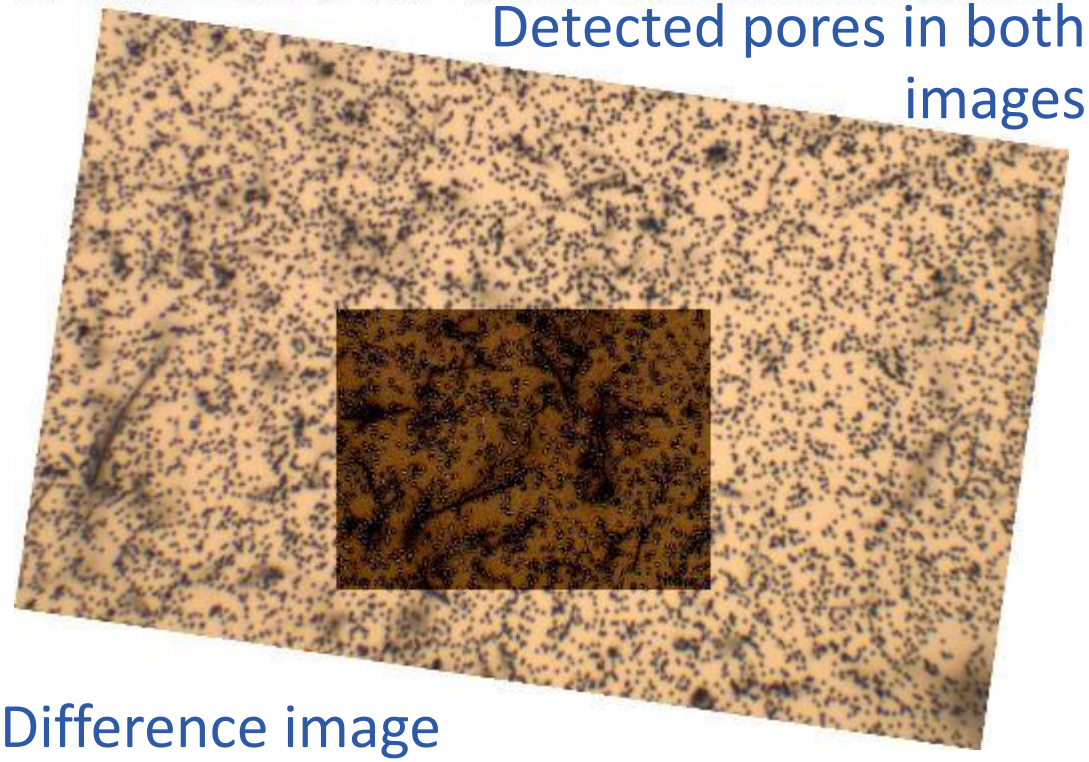


Found tie points and difference image

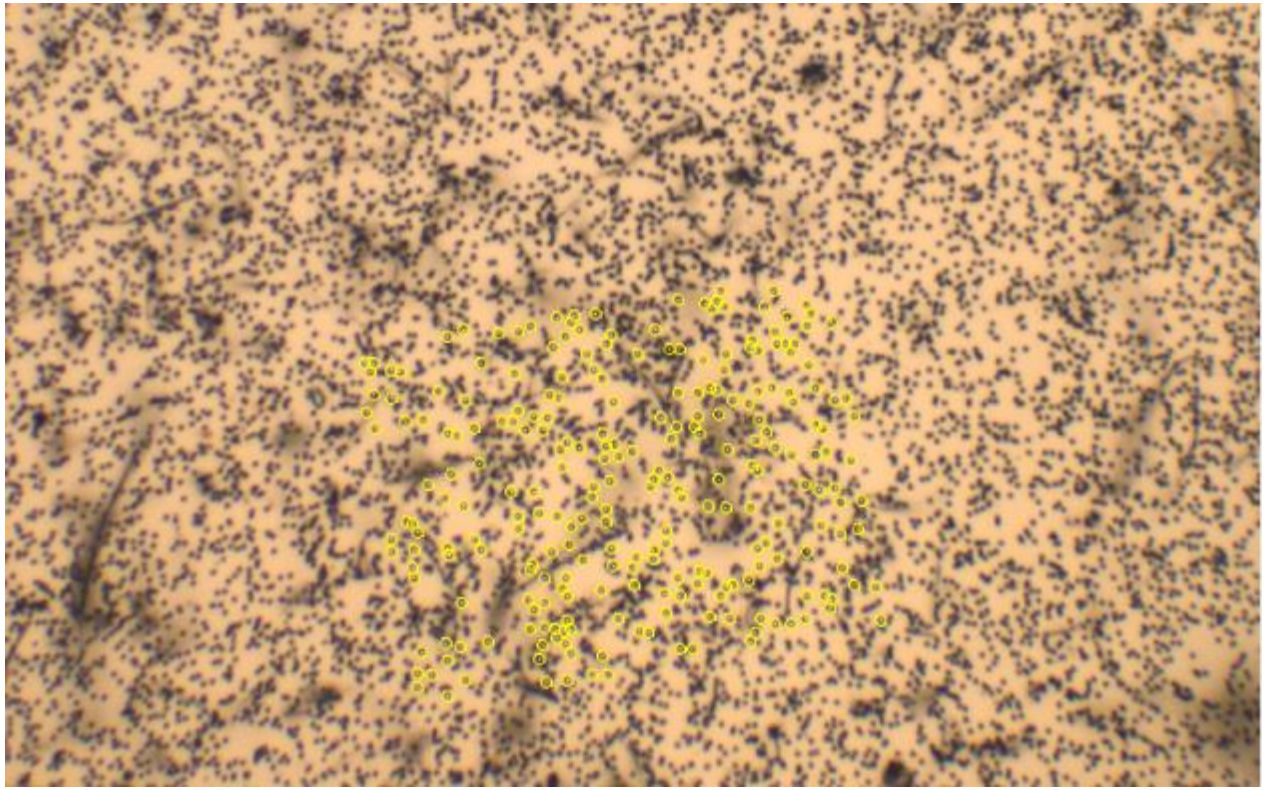
Image Correlation: SE and Raman OM Image



Detected pores in both images

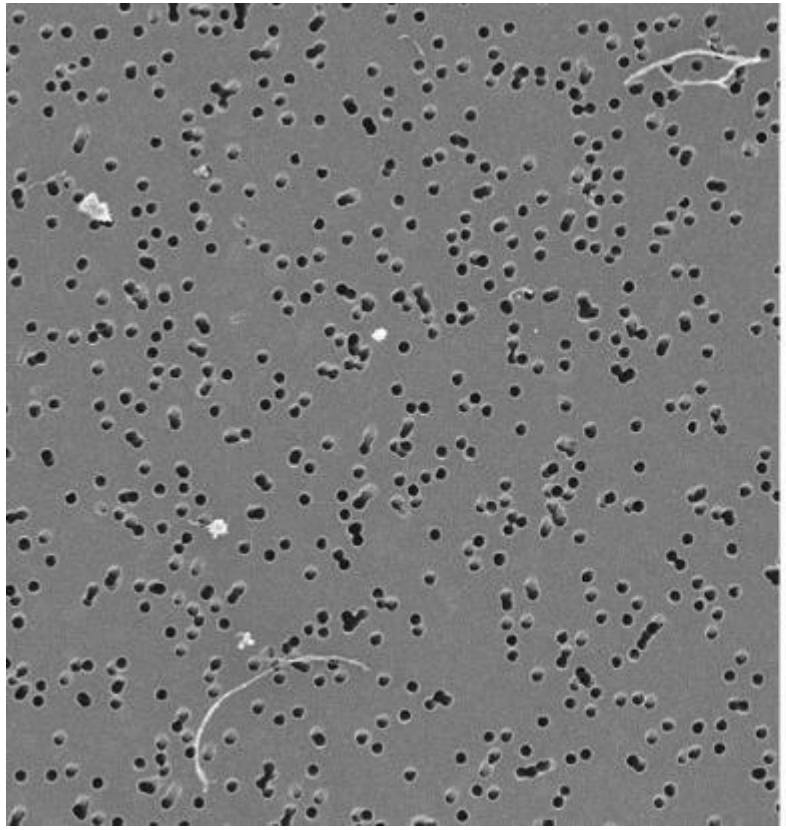


Difference image

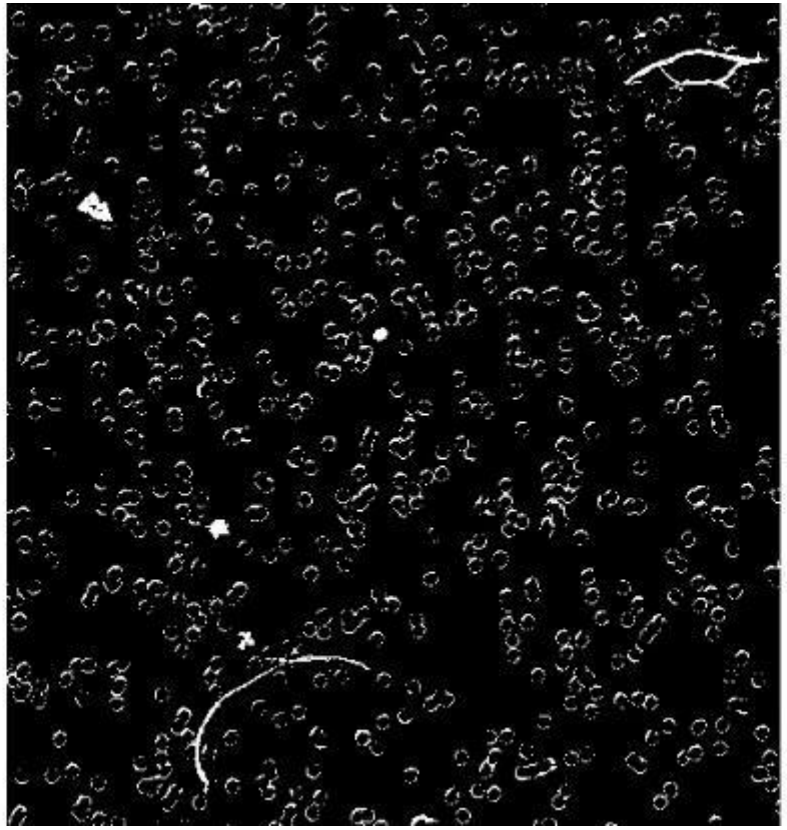


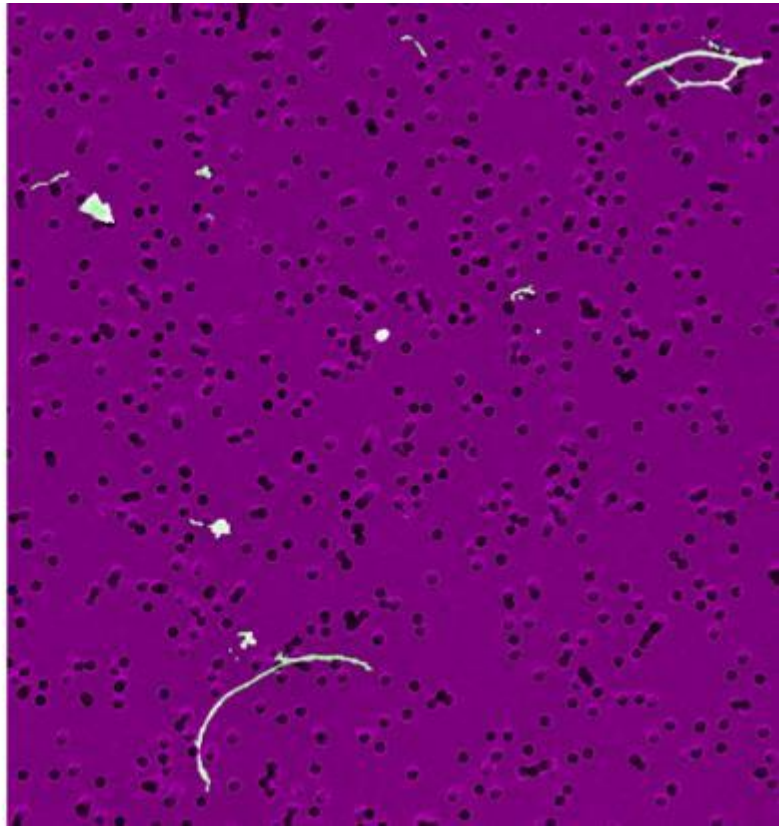
Tie points from circle centres

Object Detection



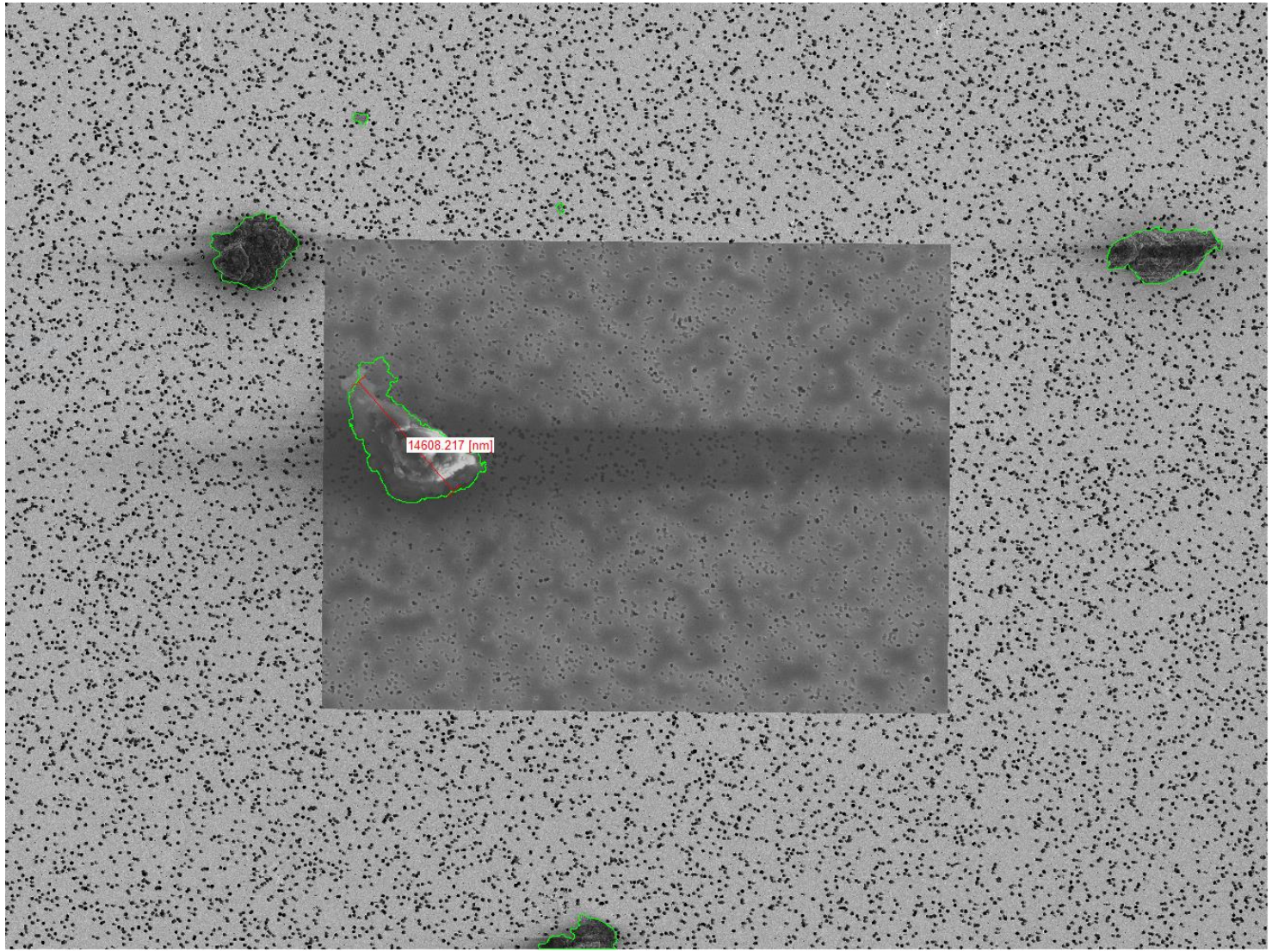
Original SEM-SE image





Segmentation with:
classical image processing algorithms, artificial neural network

Overlay Images and Object Shapes



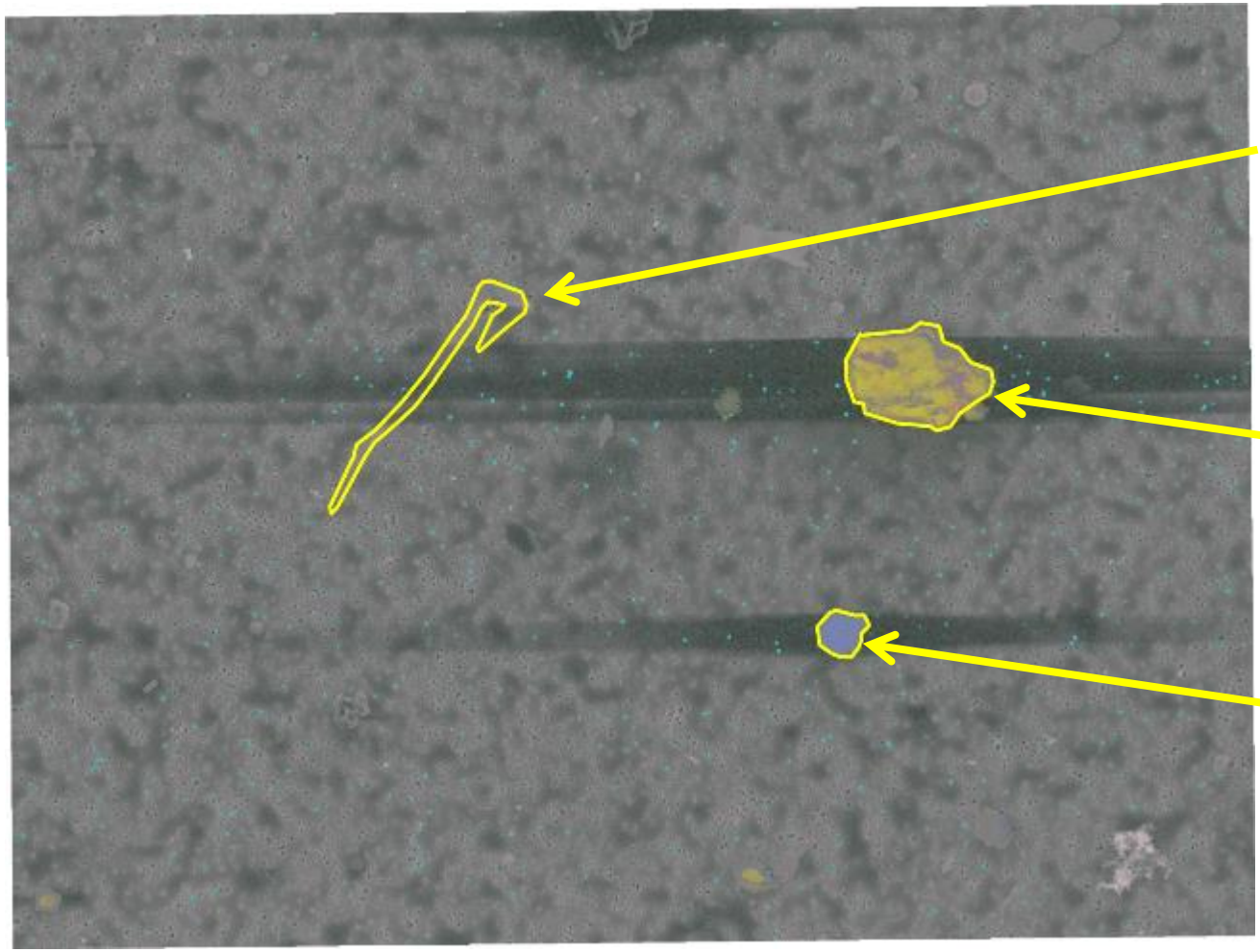
Hitachi SEM-SE 3kV high resolution:
Overview and object detection

Bruker EDS-SE 12kV low resolution:
Image – mapping correlation

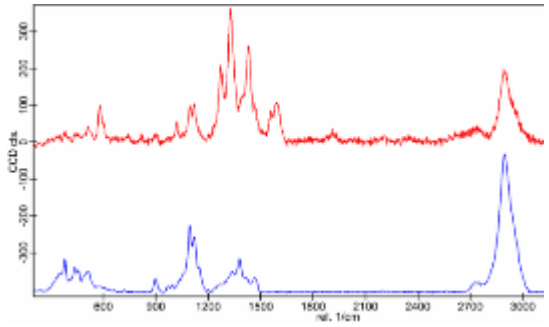
Detected objects

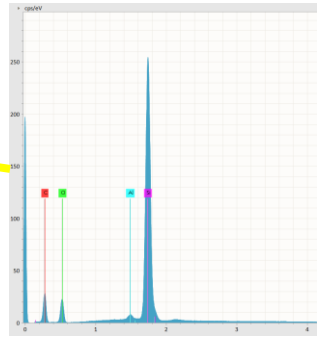
Outlook: Object Classification

Automatically recognise known materials in their composition and shape

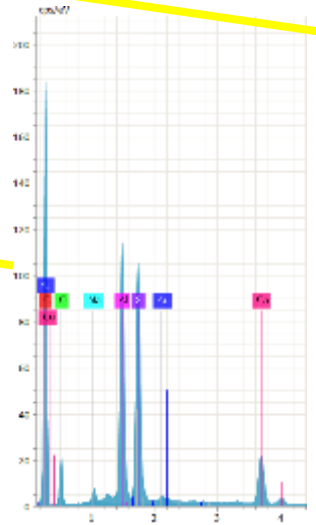


Cellulose fibre ?





Sand particle ?



Aluminium particle ?

Conclusion

Correlative microscopy for material assessment

Automatic image acquisition of microscope images and EDS/Raman spectra enables automatic detection and classification of particles hazardous to health!