

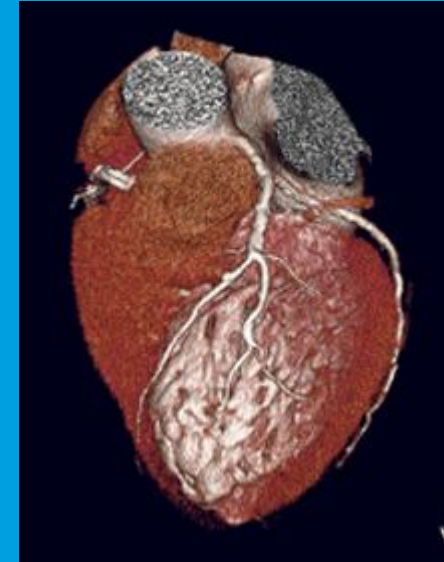
Tomographic Imaging of Microelectronic Devices

Summer Student Presentation, 5th September 2019

Student: John O'Sullivan
University College London, UK

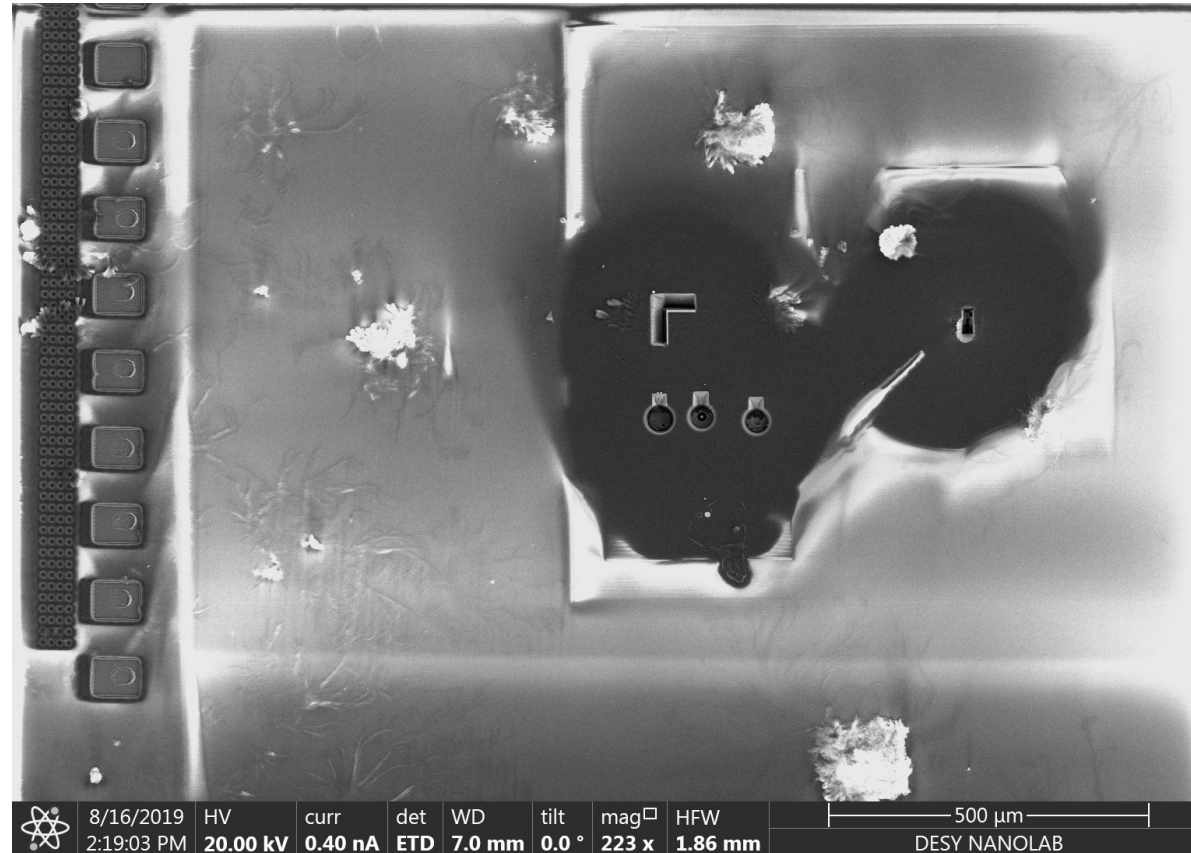
Supervisor: Priv.-Doz. Dr.-Ing. habil. Thomas F. Keller
DESY NanoLab

3D Tomography... What is it?



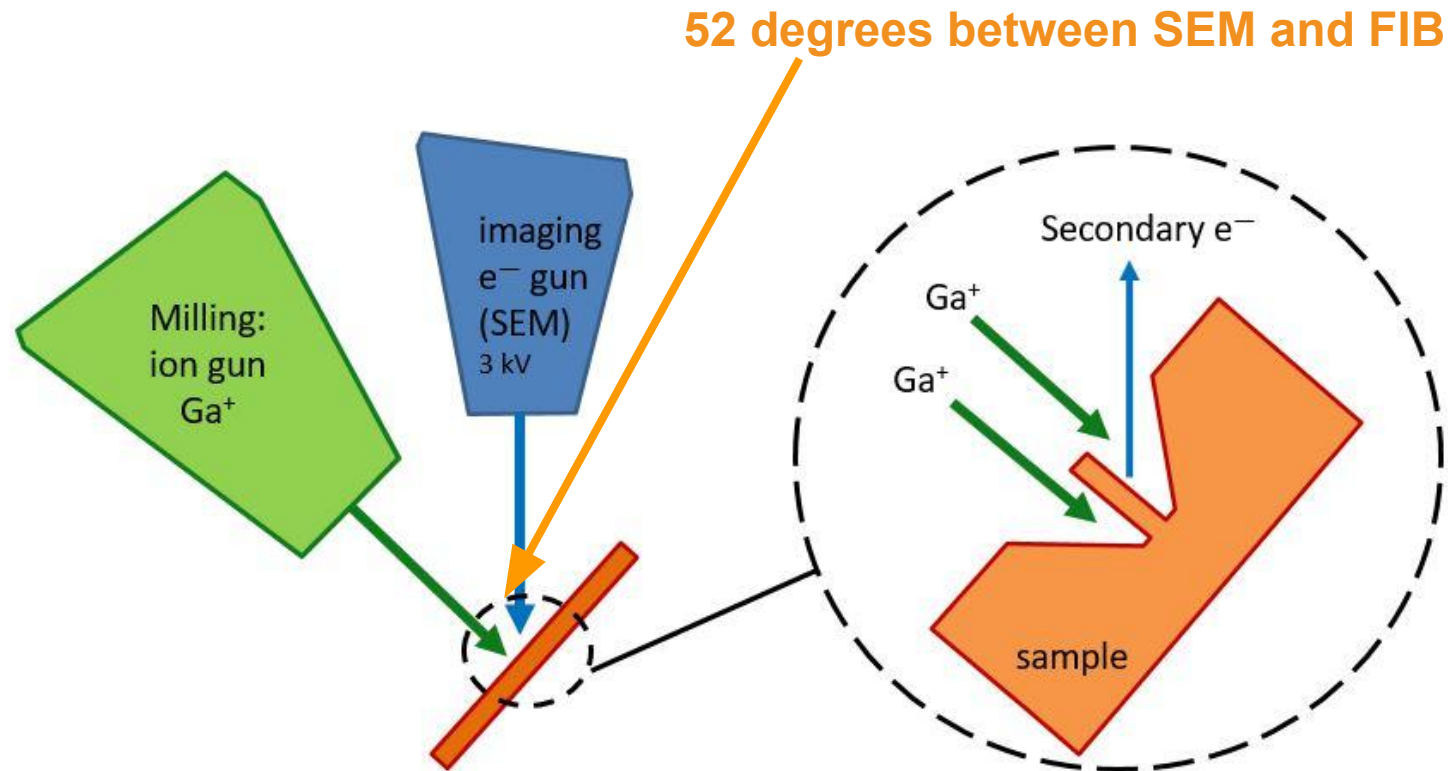
Visualising the Sample

Focused Ion Beam/Scanning Electron Microscope (FIB/SEM) Imaging of the Microchip



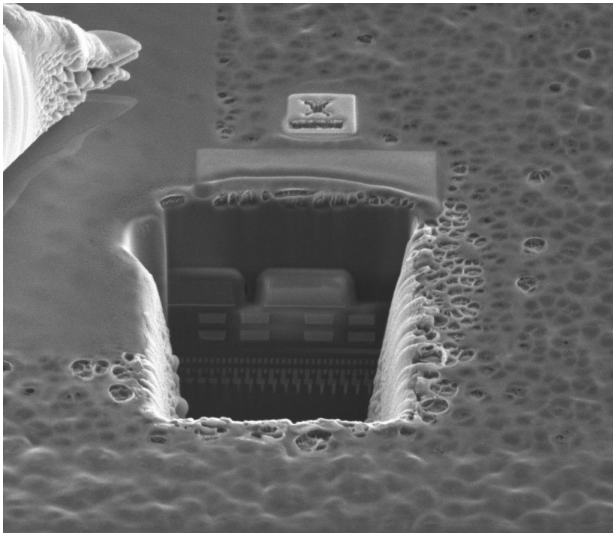
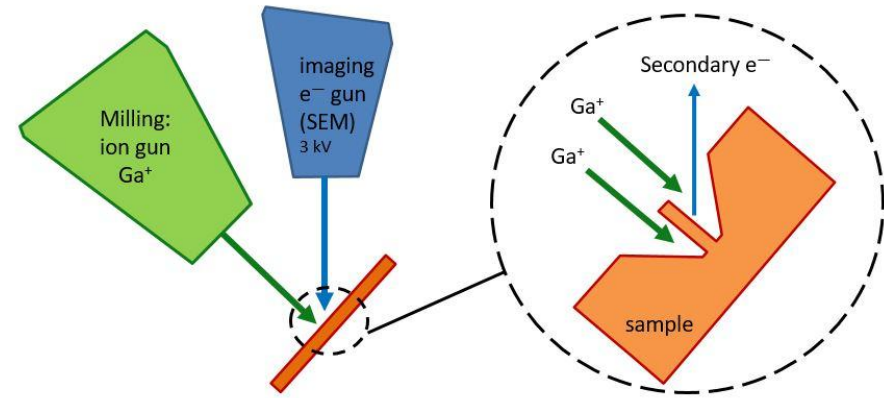
Visualising the Sample

FIB/SEM Imaging of the Microchip

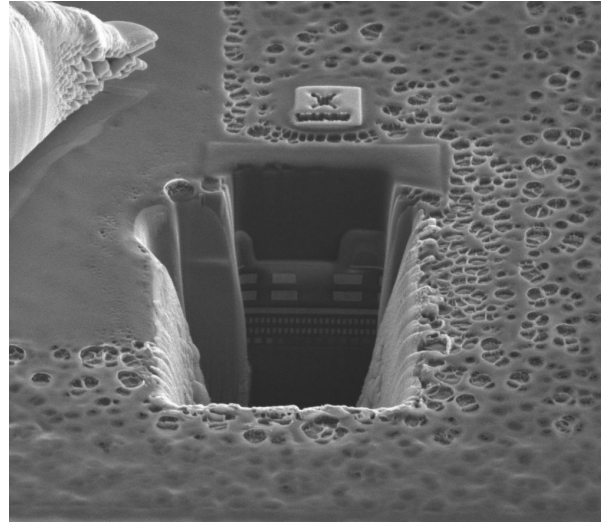


Visualising the Sample

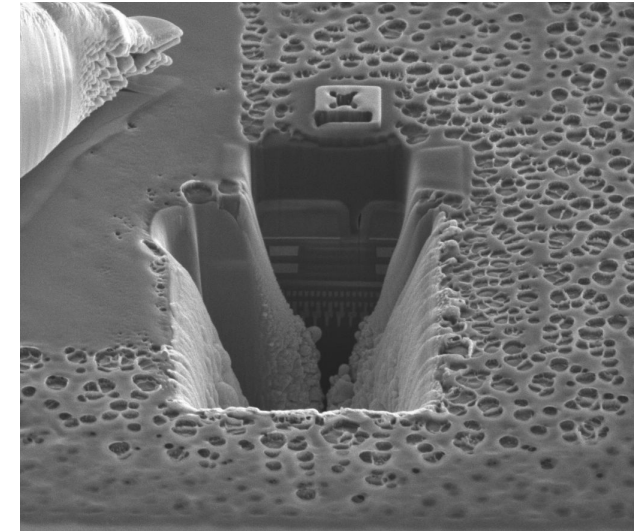
FIB/SEM Imaging of the Microchip



Slice 1



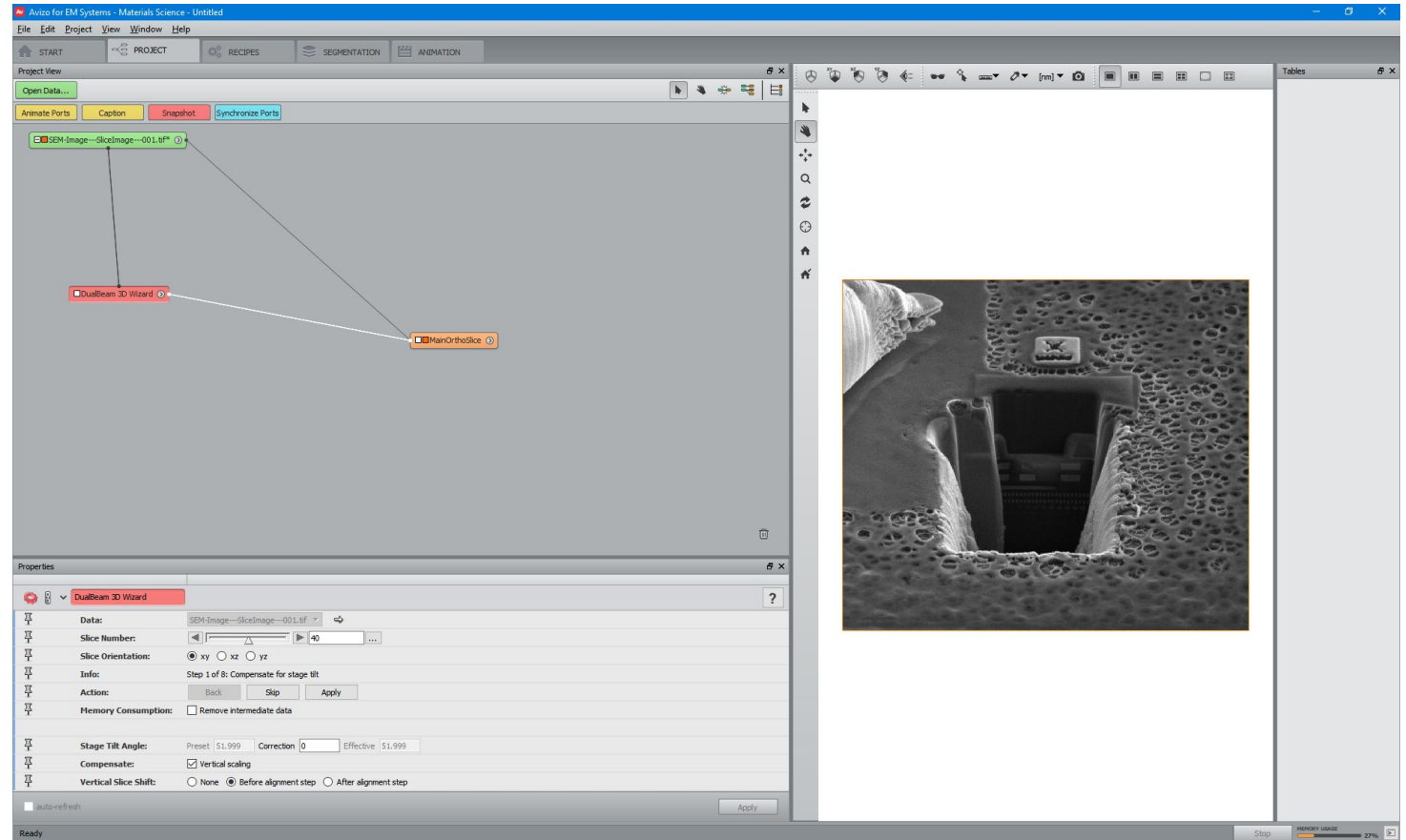
Slice 40



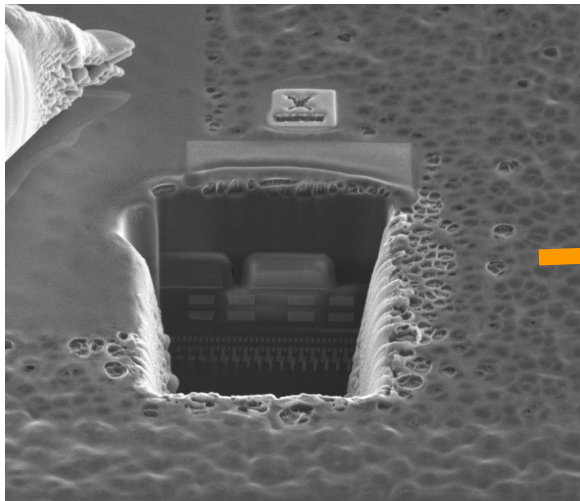
Slice 80



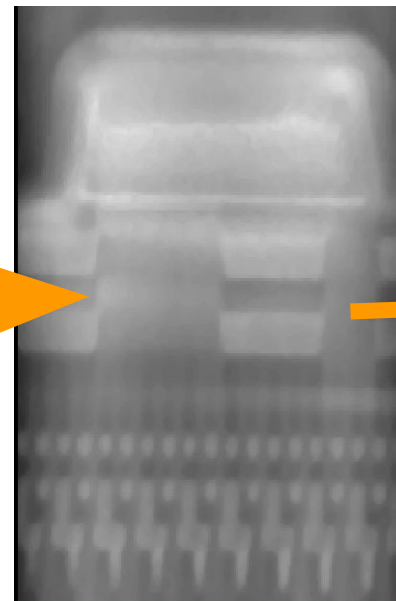
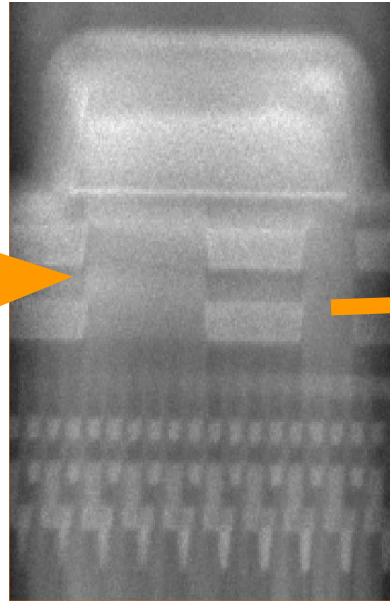
- Composite Filtering
- Medial, Sobel and Bilateral Filters
- Delineate and Arithmetic Functions
- **Image Segmentation**



Composite Filtering

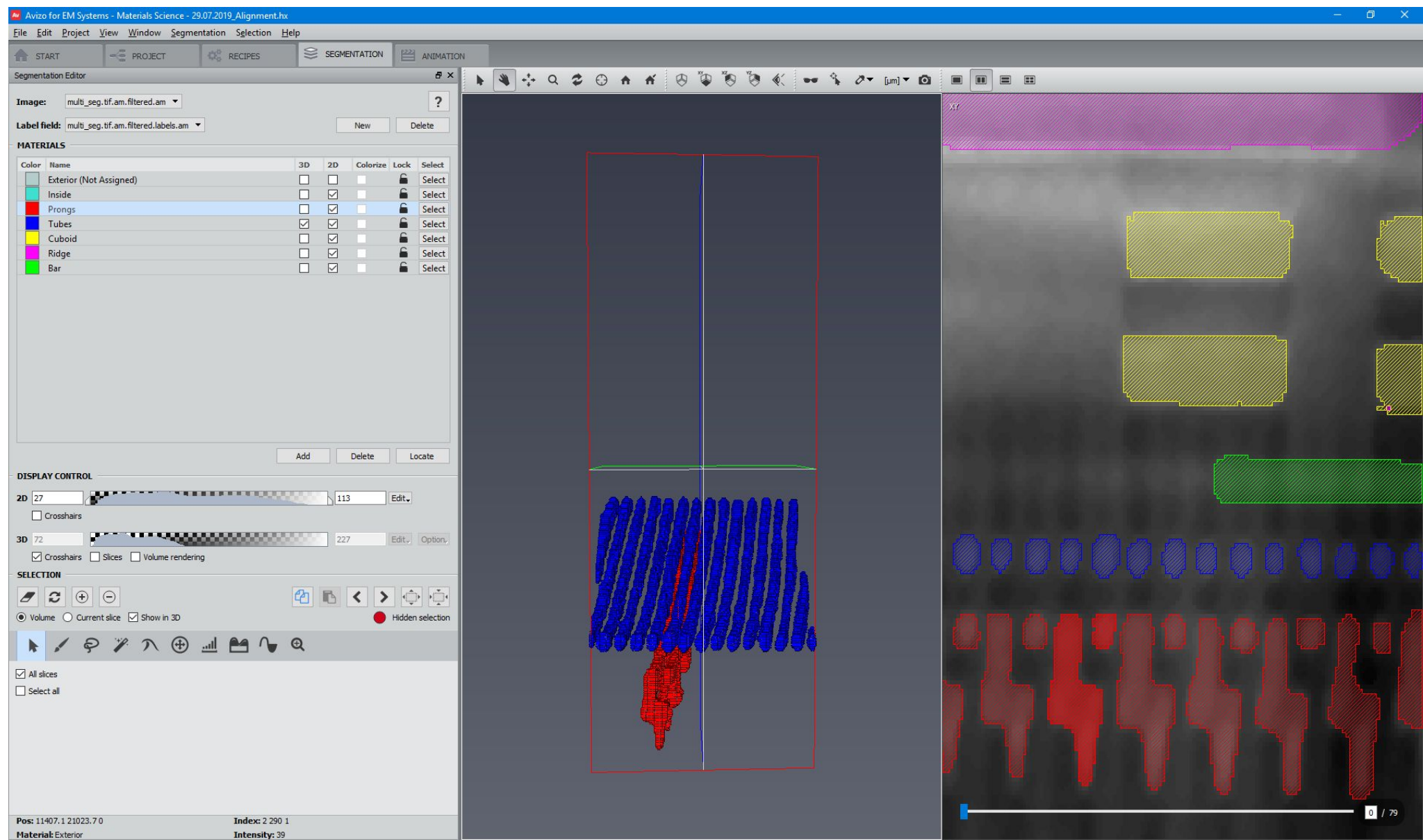


Unprocessed SEM Image



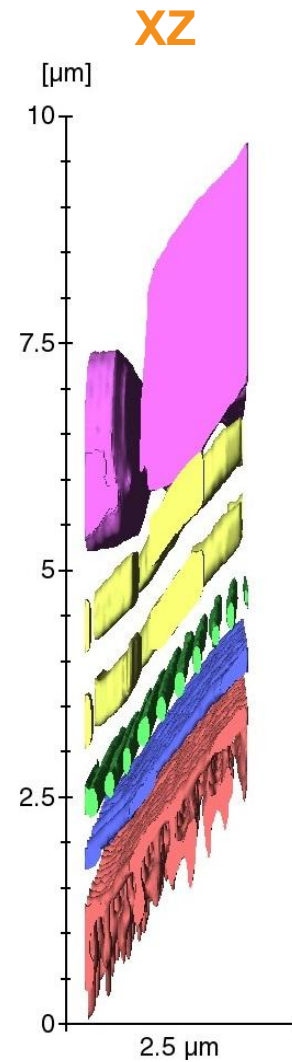
Composite Filtering Process

Segmentation



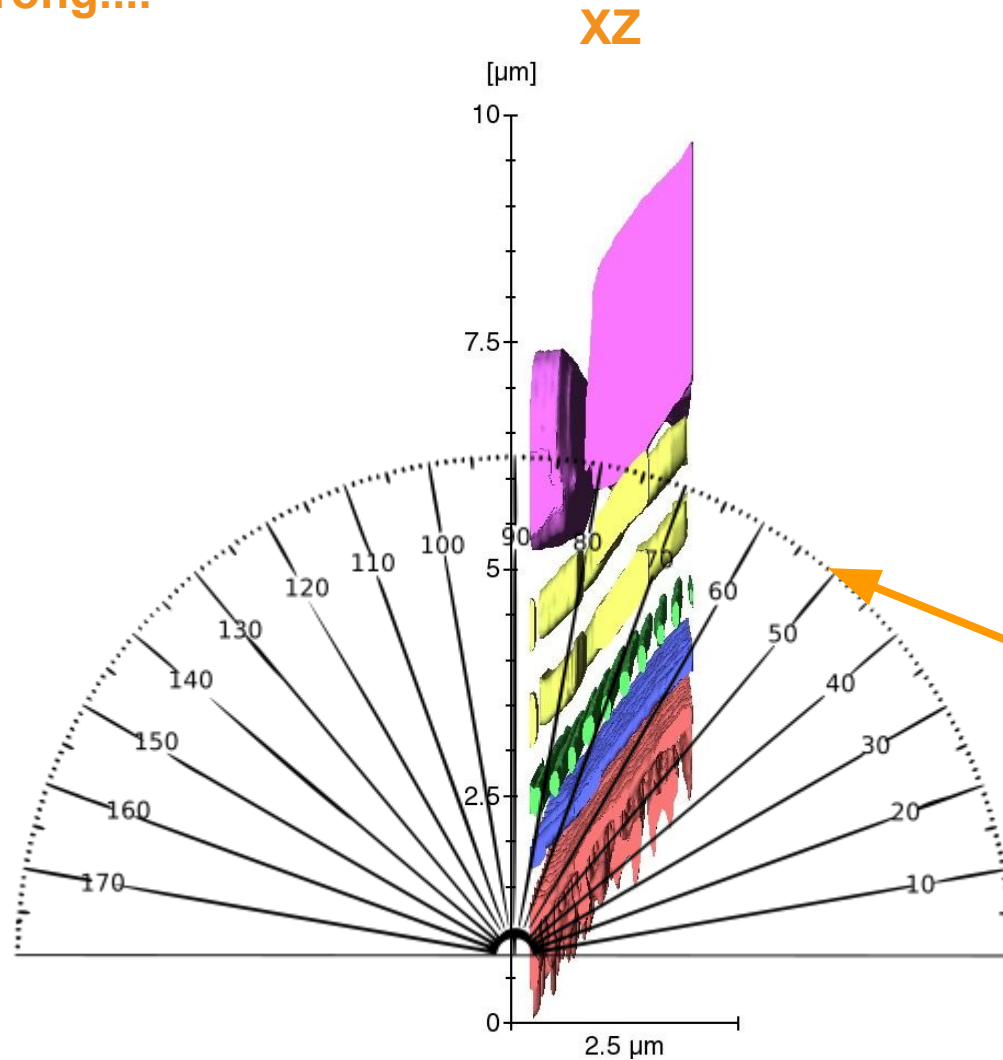
Initial Microchip Reconstruction

Something's wrong....



Initial Microchip Reconstruction

Something's wrong....

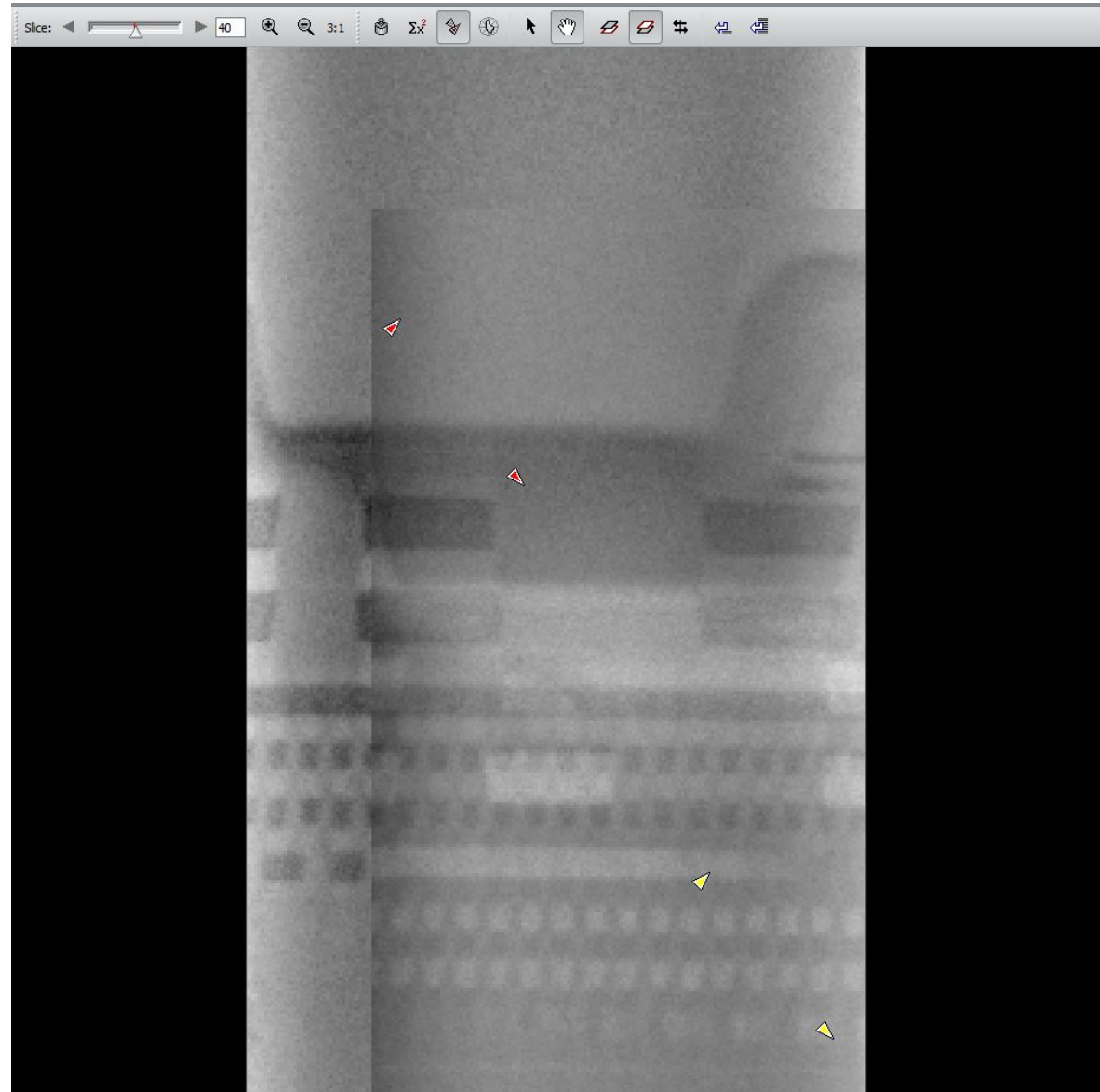


Angular drift of 52 degrees

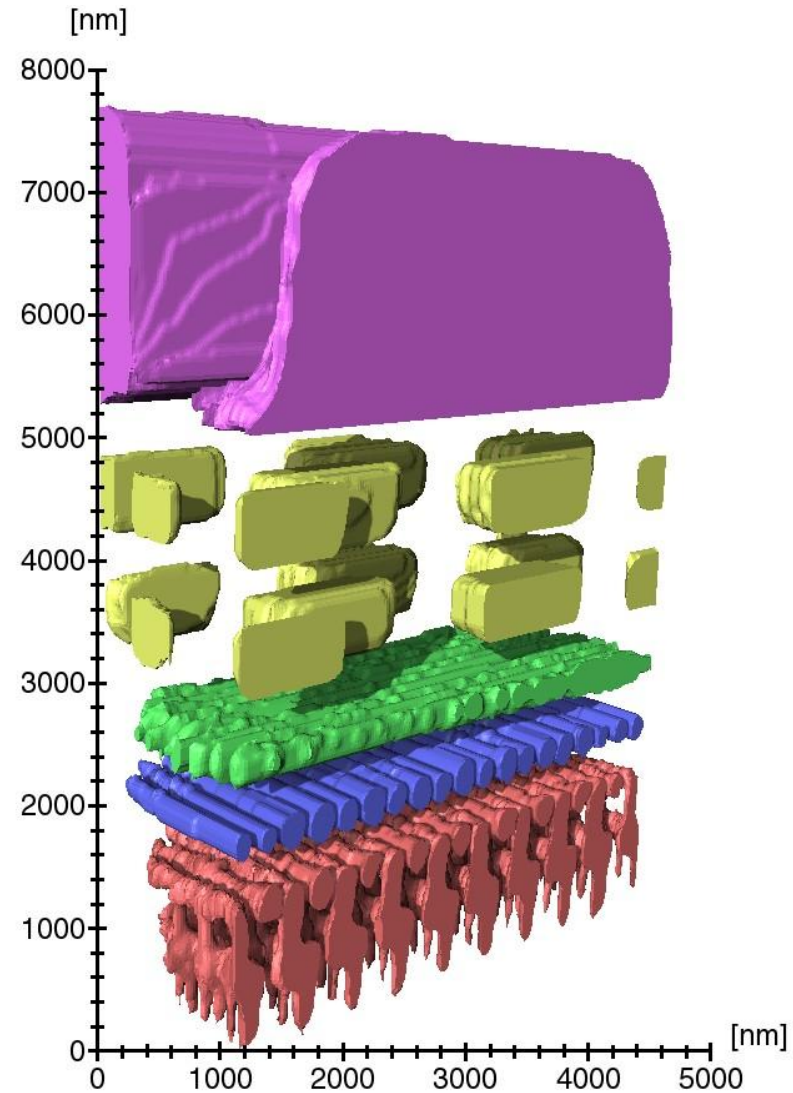
- Angle measured of the reconstruction exactly equal to the angle between the FIB and the SEM.

52 degrees

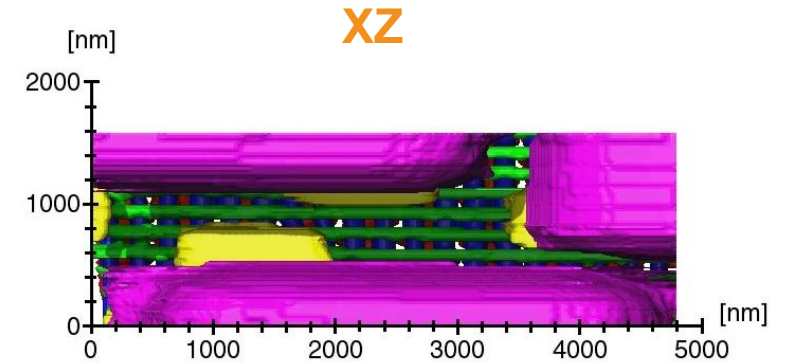
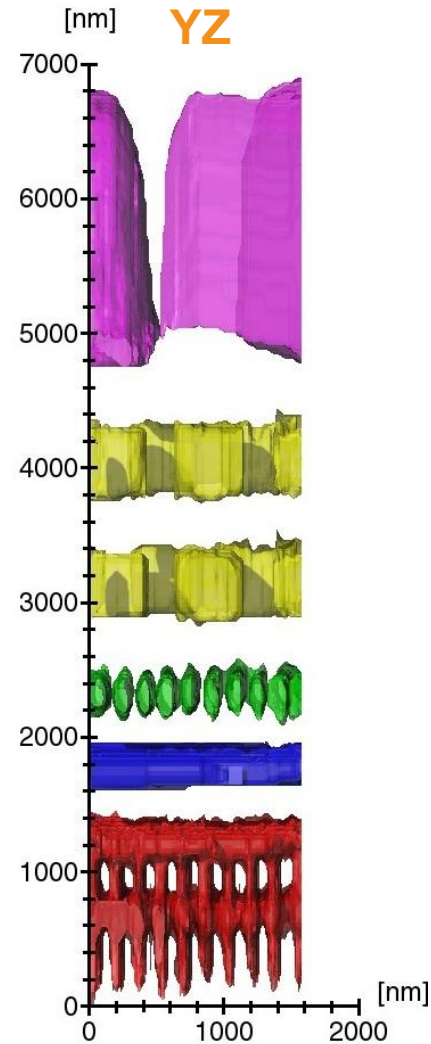
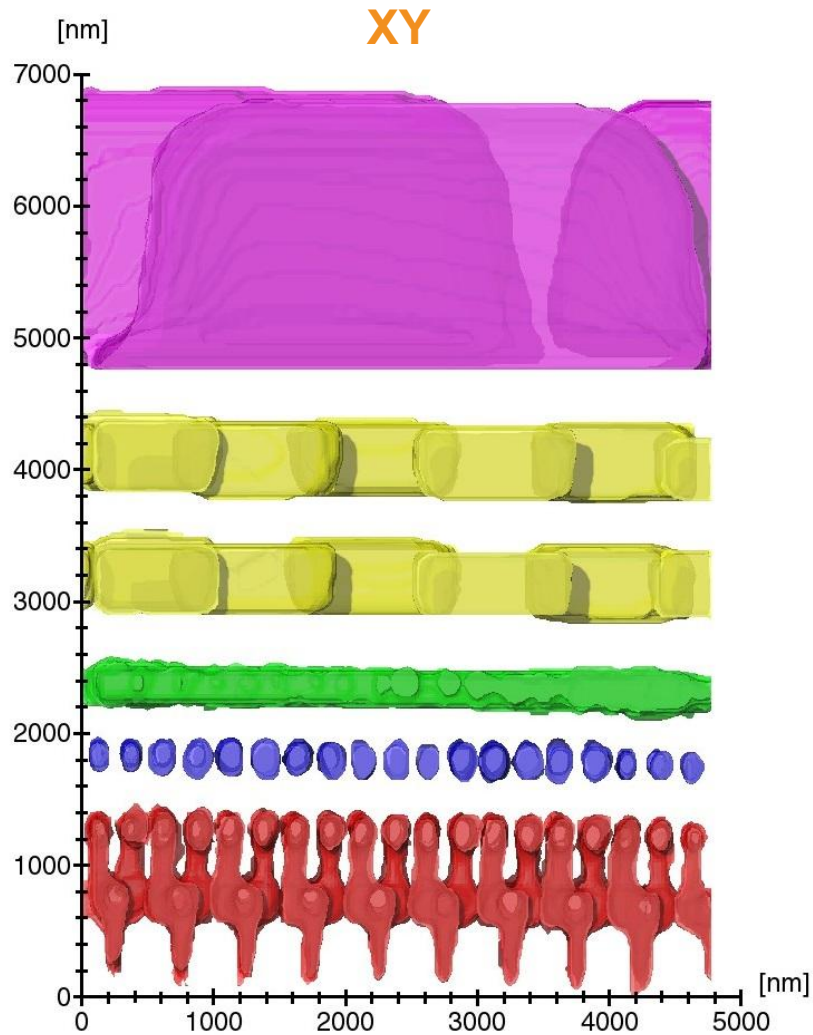
Alignment in Avizo

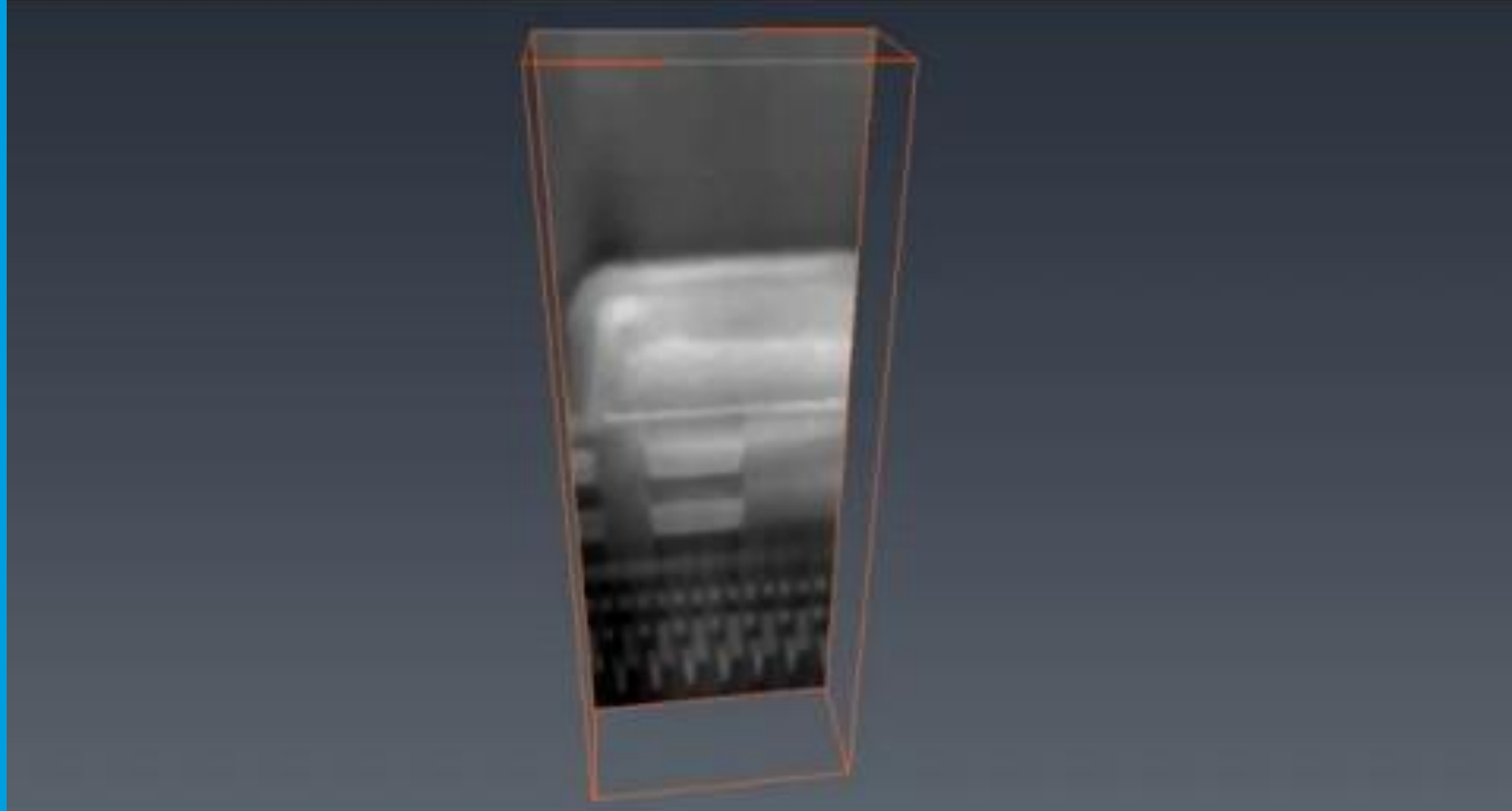


Aligned Sample Reconstruction



Aligned Sample Reconstruction





Pros and Cons of 3D Reconstruction

Pros

- Gives a representation of the 3D structure of the sample, which may have been otherwise unknown.
- Visualisation of interior structures possible.
- Separation of layers, conduct lines, interconnects and contact between areas can be identified.
- Looks nice



Cons

- High quality image segmentation and alignment be very time consuming
- Does not actually give any chemical information about the sample.



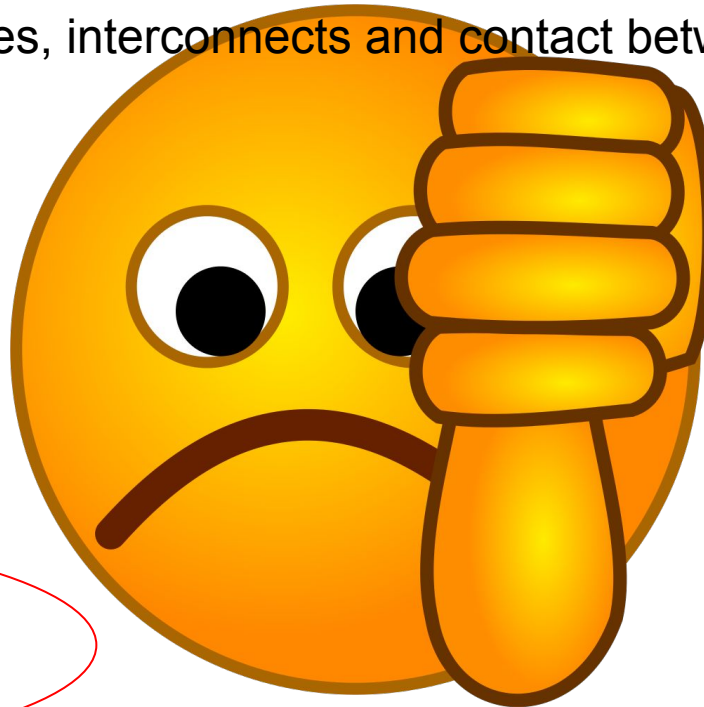
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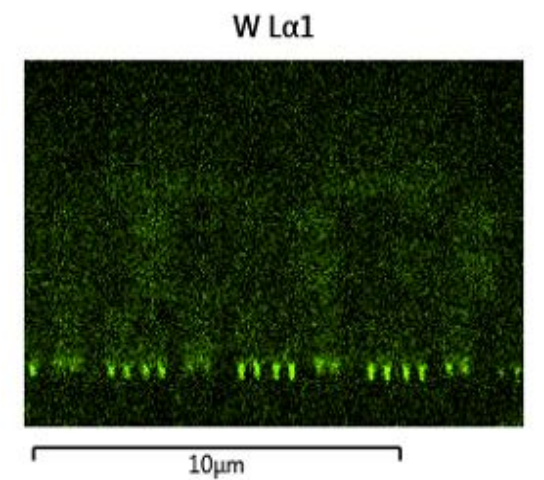
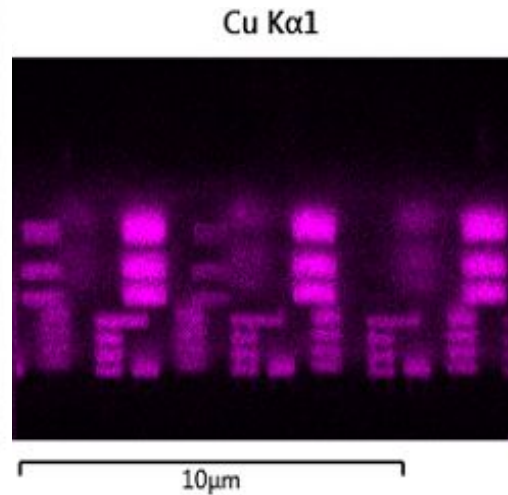
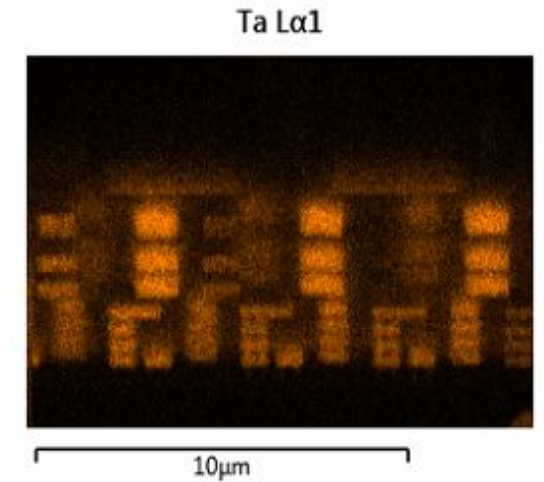
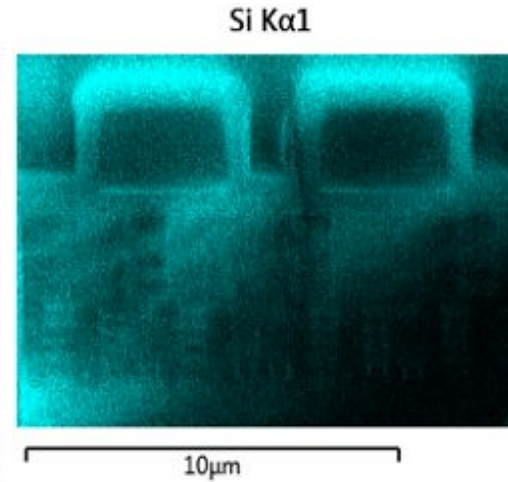
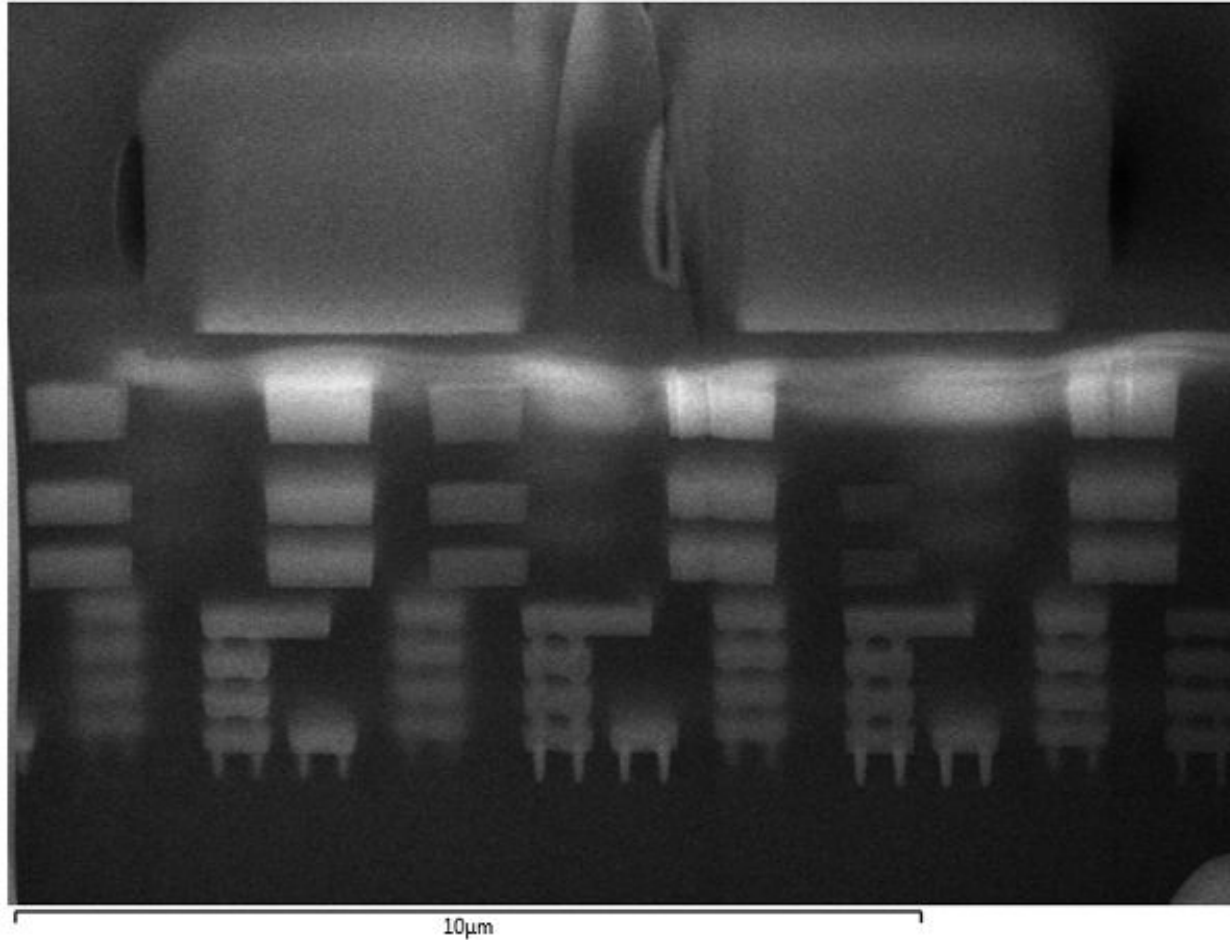
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Energy Dispersive X-Ray Spectroscopy (EDX)

Integrating 3D Reconstruction with Elemental Analysis - Next steps...

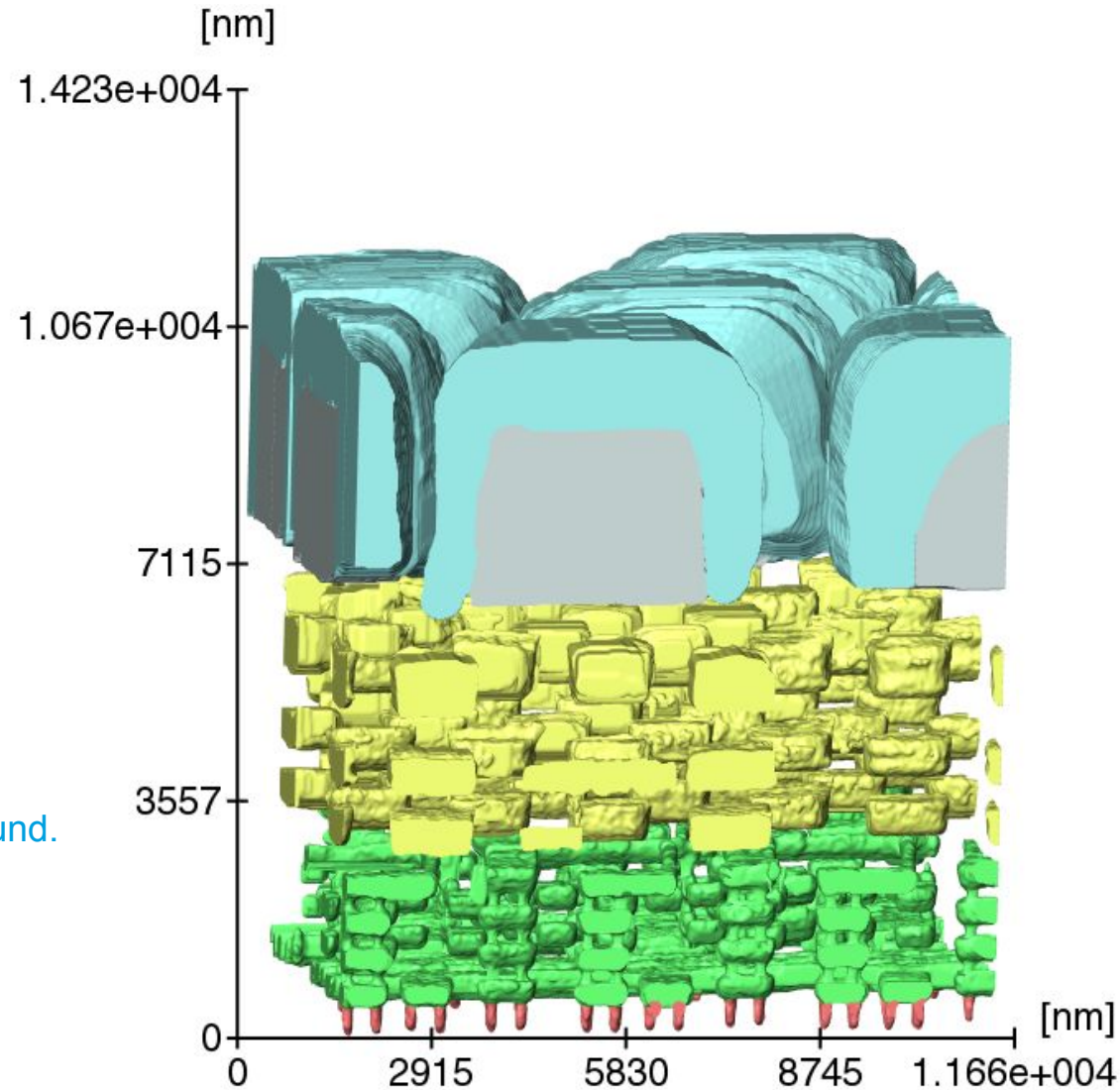


Energy Dispersive X-Ray Spectroscopy (EDX)

Combining the Data...

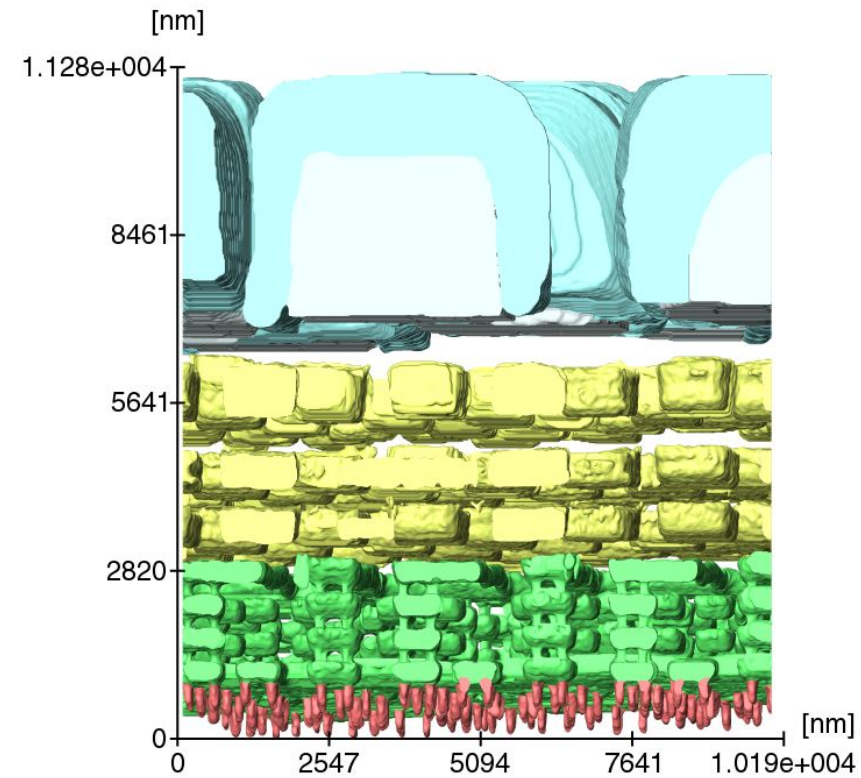
Key:

- Silver = Al.
- Blue = Si and O compound.
- Yellow, Green = Cu, Ta compound.
- Red = W

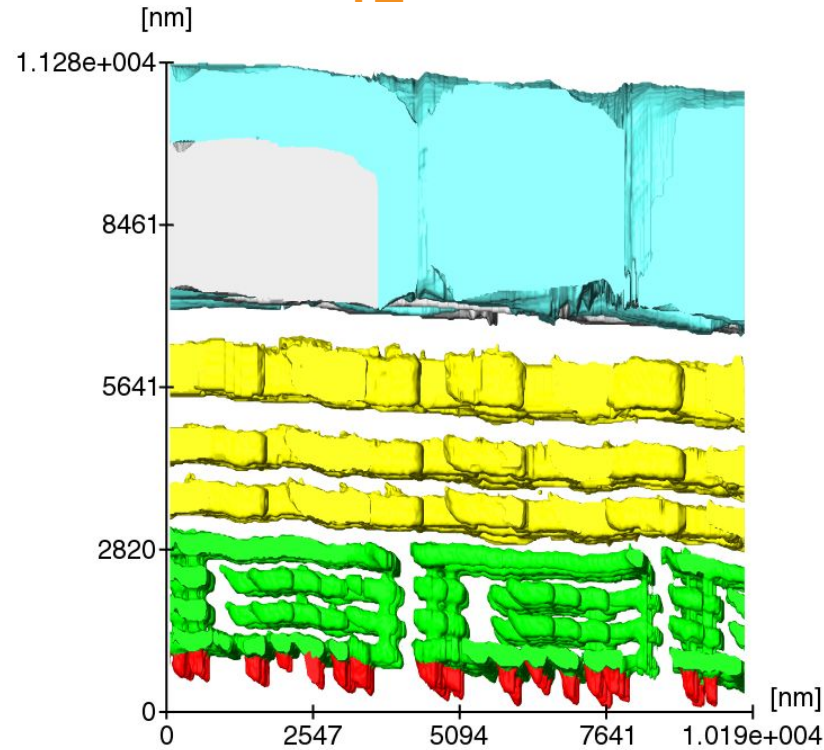


Aligned Sample Reconstruction

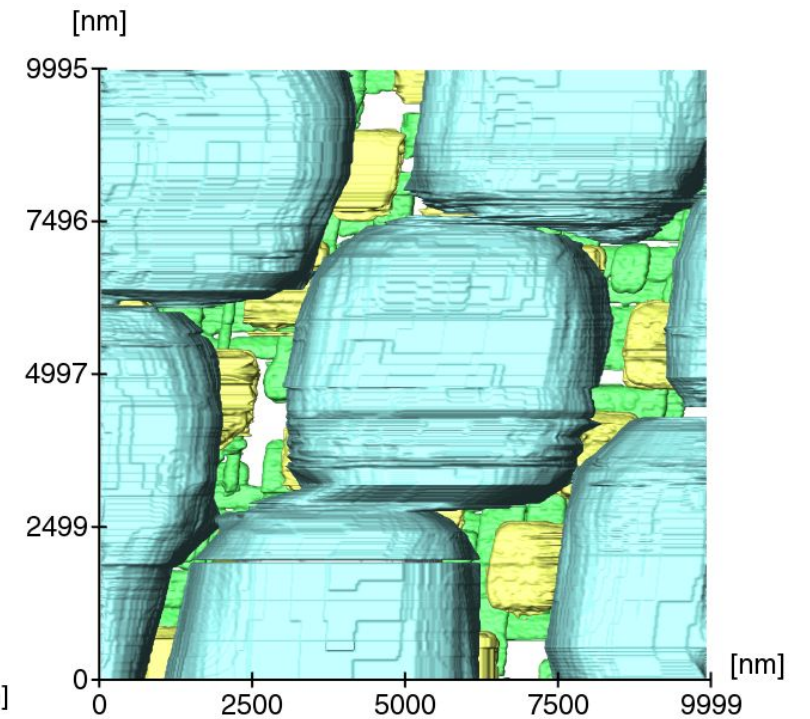
XY



YZ



XZ



Key:

- Silver = Al.
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Take home message...

- 3D Reconstruction is a valuable tool in analysing microelectronic devices.
- Further work needs to be done to accurately integrate EDX and 3D reconstruction data to provide full, elemental and physical reconstructions of the sample.

Danke!

Contact

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