Multimodal X-ray Tomography and auxiliary equipments at SAXSMAT beamline

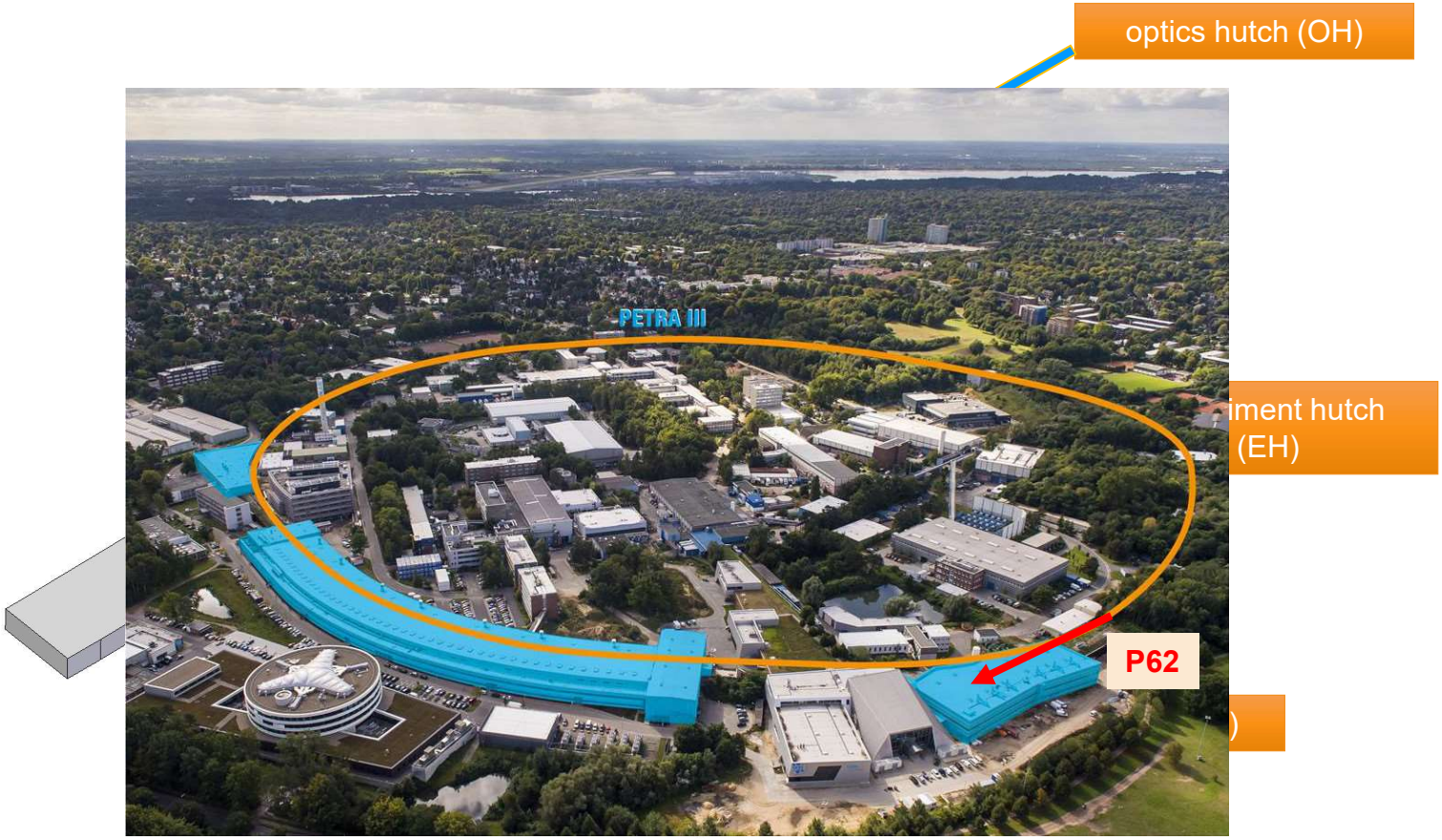
Dr. Andre L. C. Conceição

HELMHOLTZ RESEARCH FOR GRAND CHALLENGES

DESY.

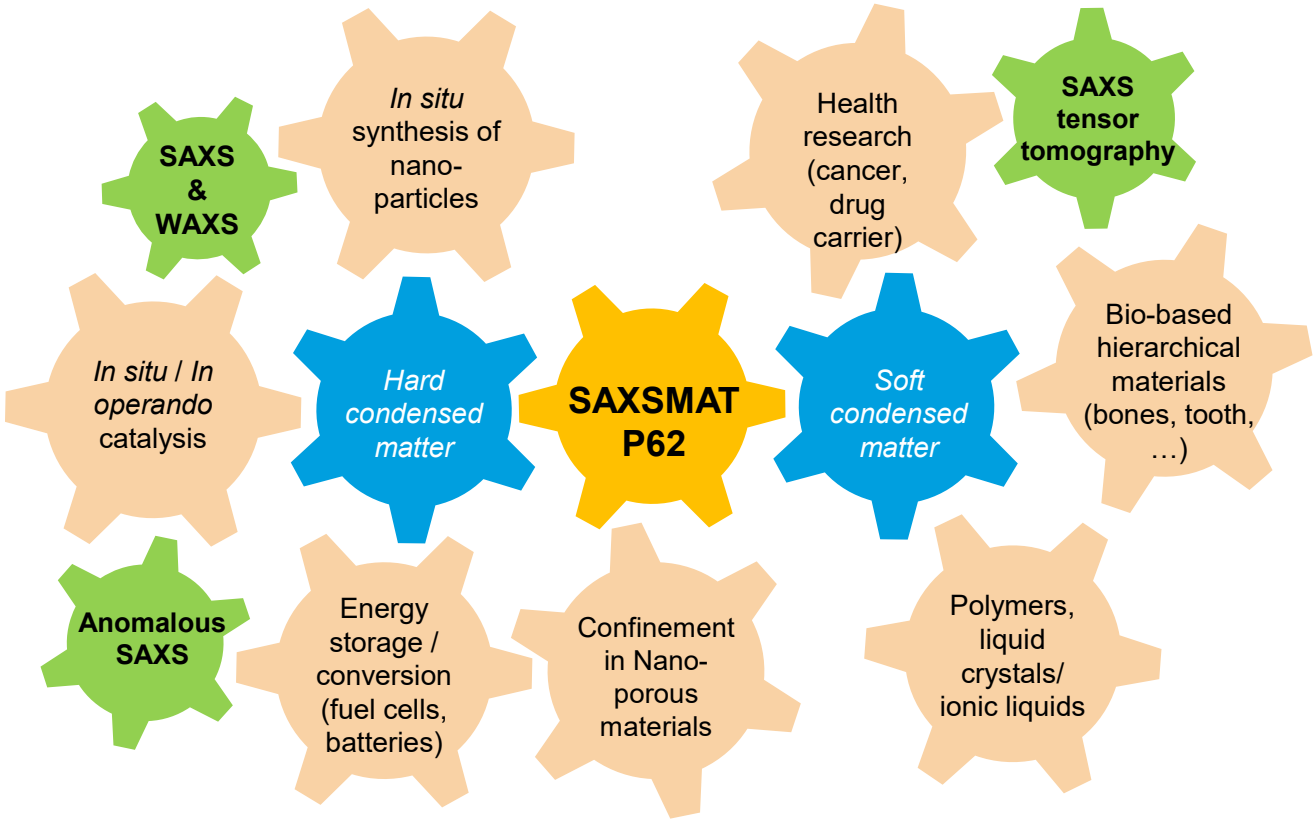
SAXSMAT beamline P62

Paul P. Ewald Hall (Hall North)



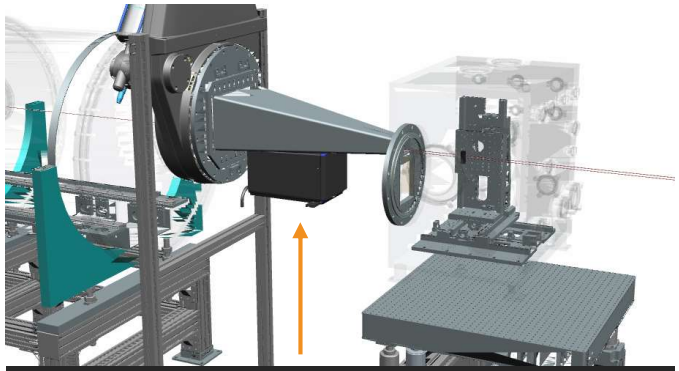
Science @SAXSMAT beamline

Key research activities and methods

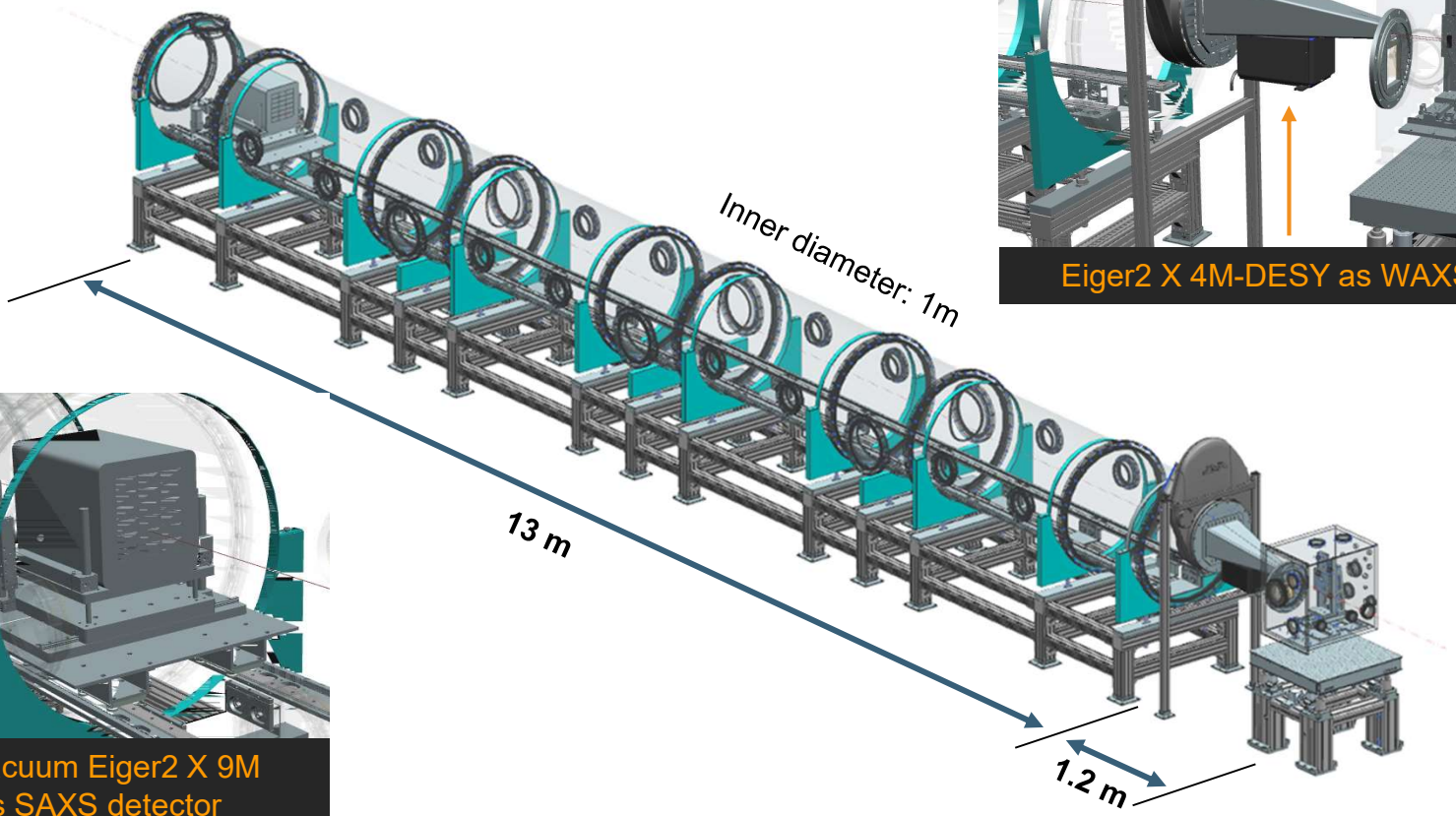


Experimental hutch

SAXS Instrument



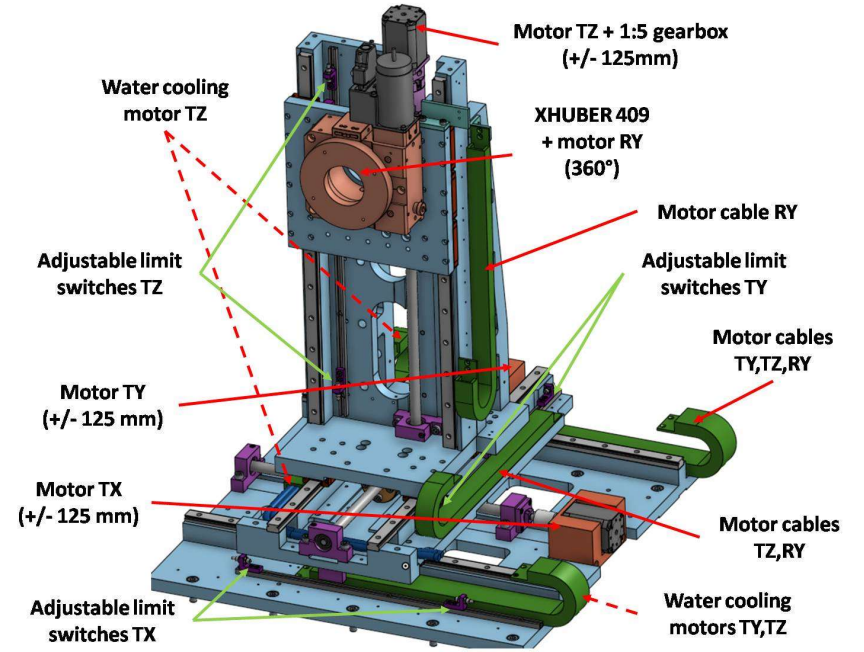
Eiger2 X 4M-DESY as WAXS detector



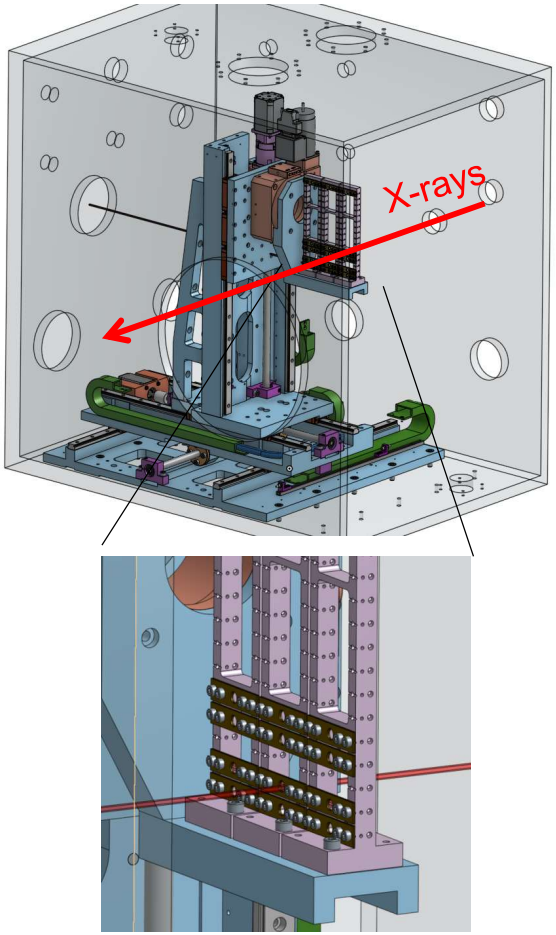
In vacuum Eiger2 X 9M
as SAXS detector

Sample environment

Standard sample environment ir air or sample chamber in vacuum

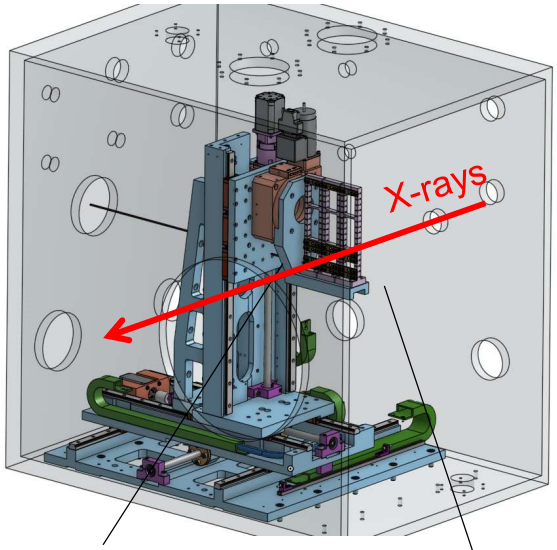


Standard coarse motion sample positioning tower



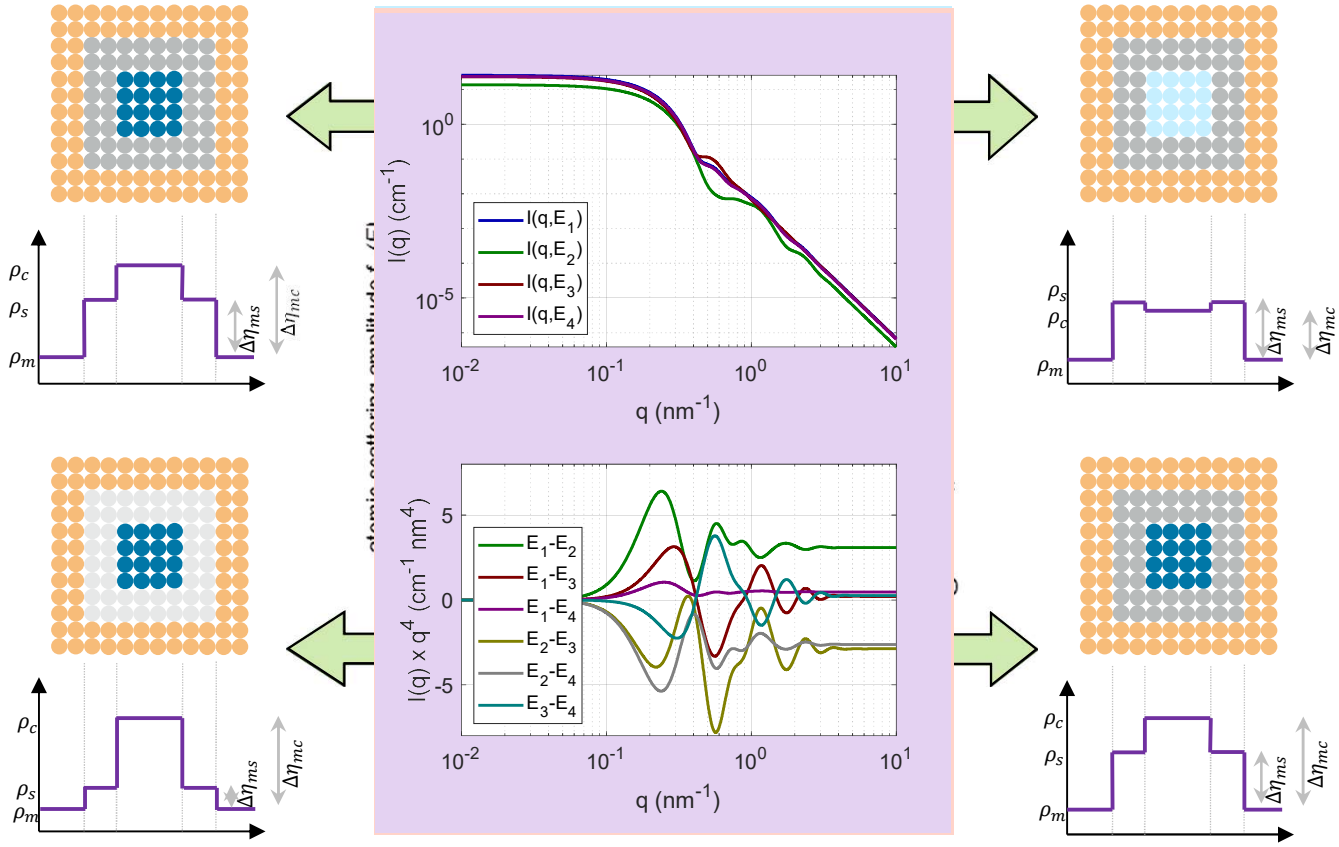
Techniques @SAXSMAT

High-throughput SAXS/WAXS



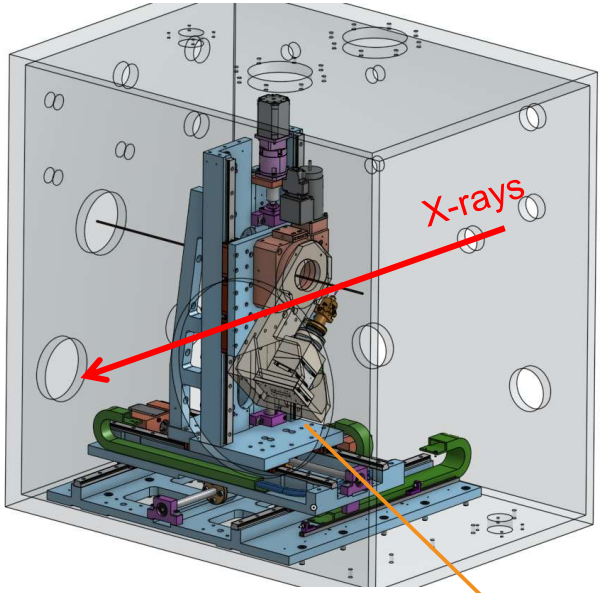
Techniques at SAXSMAT

Anomalous SAXS

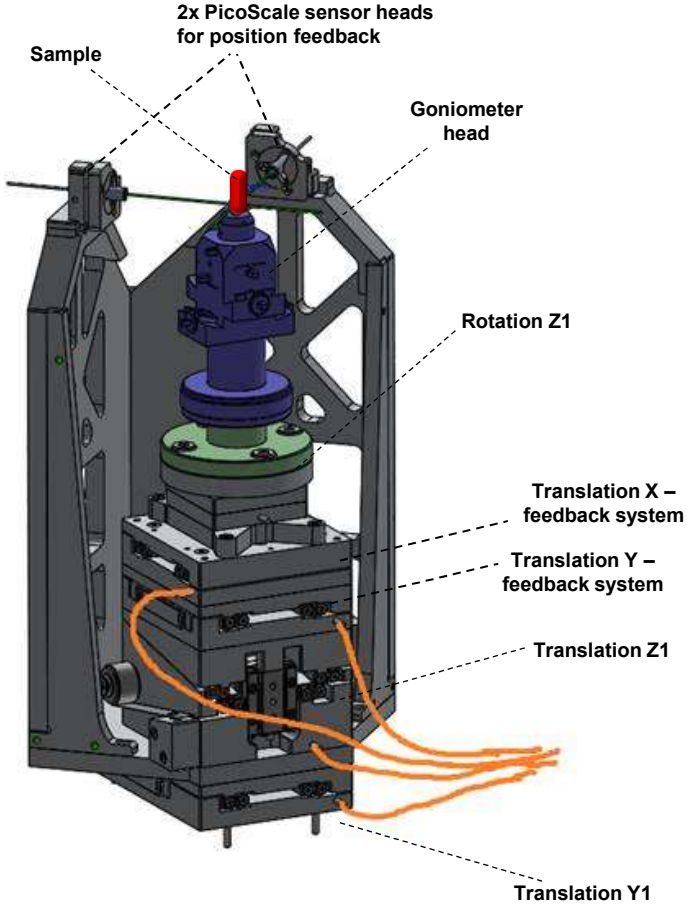


Techniques @SAXSMAT

SAXS/WAXS Tensor tomography

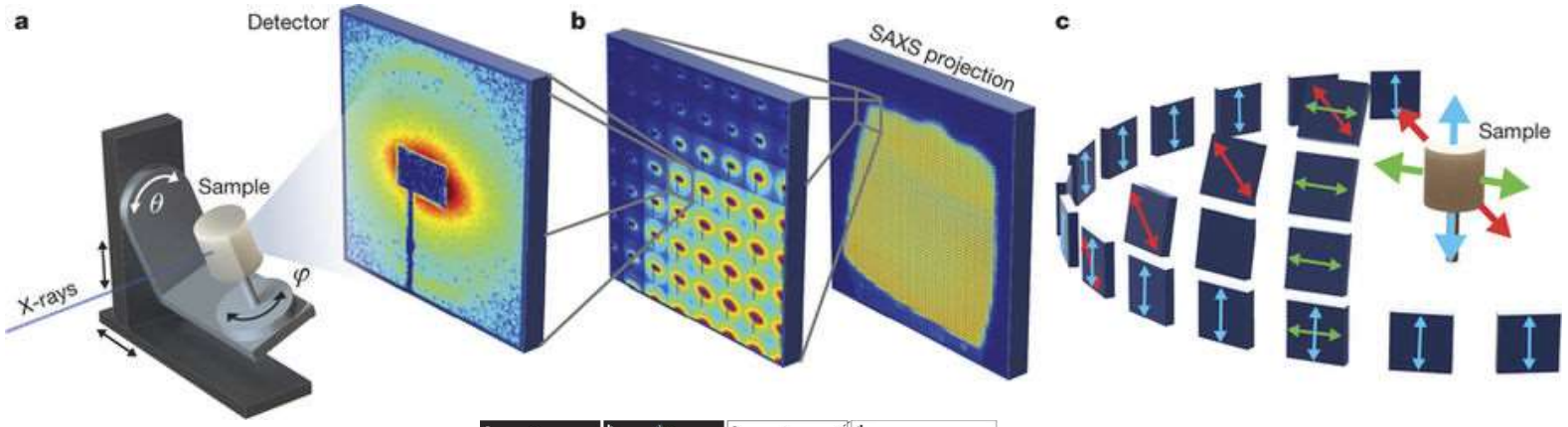


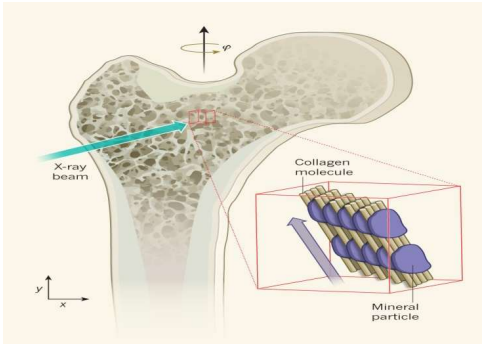
System is build by SmarAct.
Delivery is planned for end of May



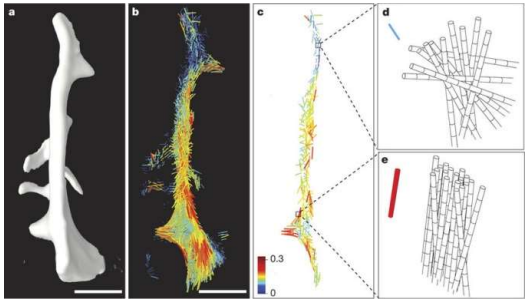
Techniques @SAXSMAT

SAXS tensor tomography / SAXS computed tomography

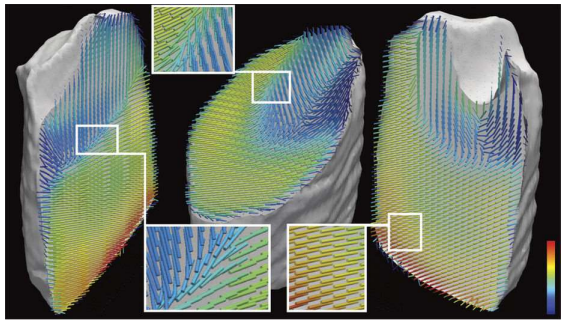




P. Fratzl *et al.* Nature, 527: 308-309, 2015



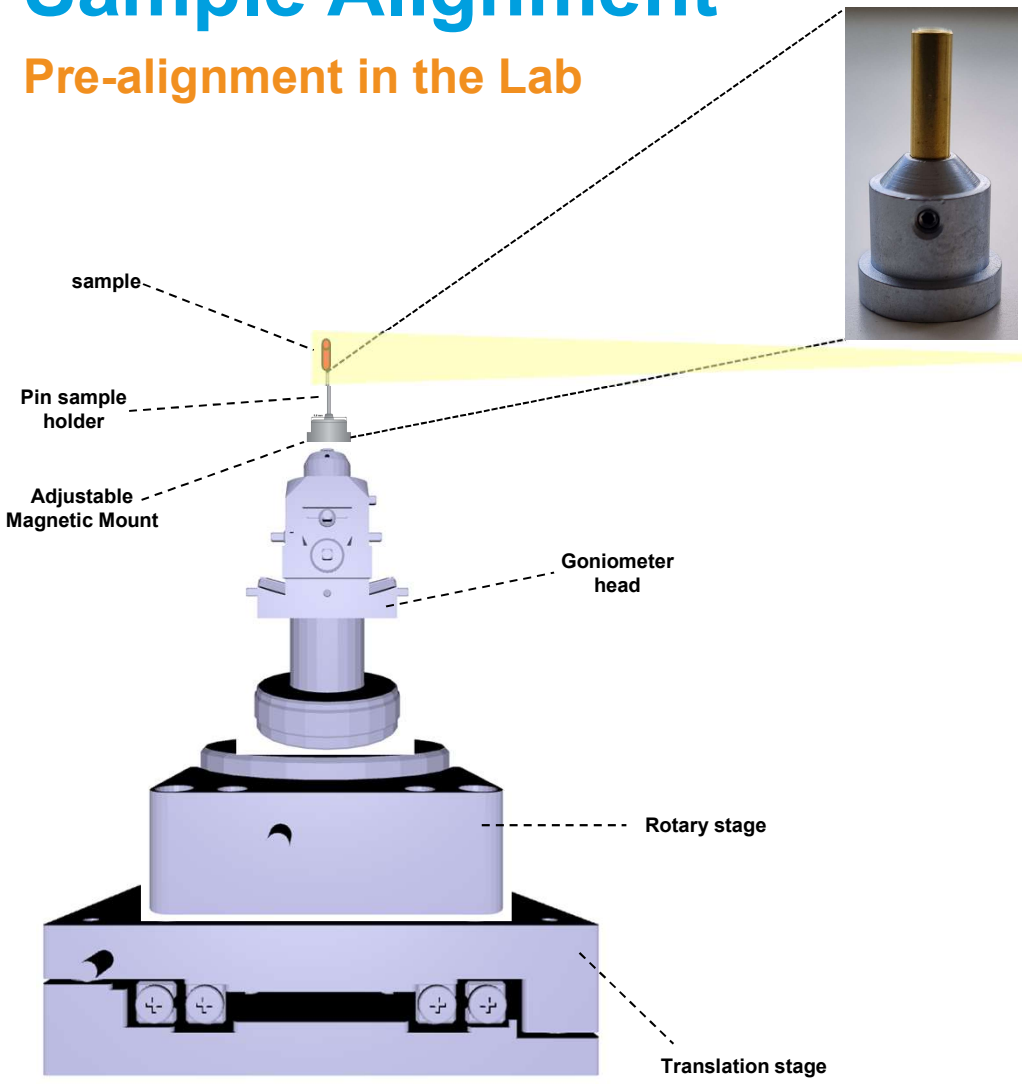
M. Liebi *et al.* Nature, 527: 349-353, 2015



F. Schaff *et al.* Nature, 527: 353-356, 2015

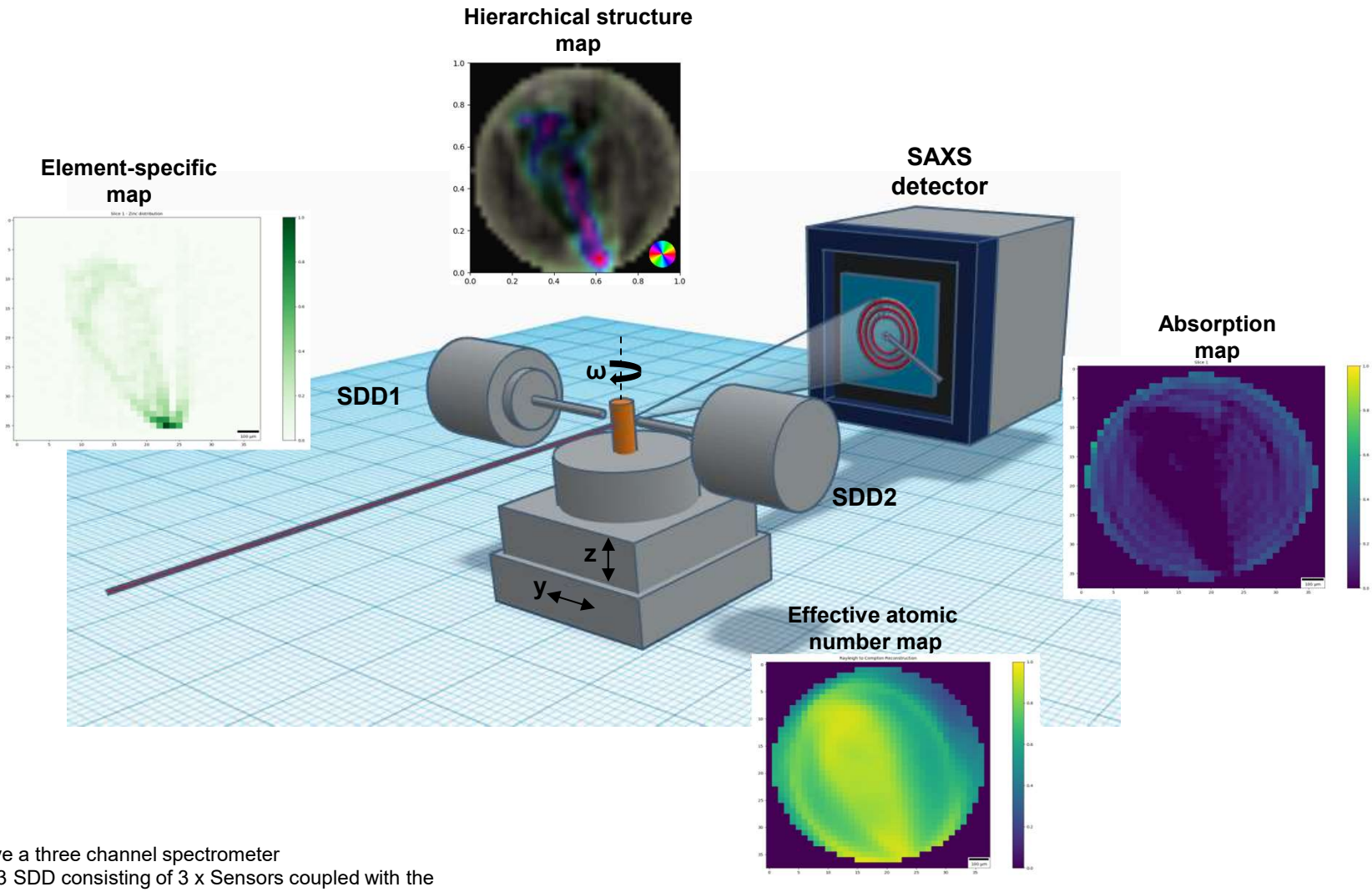
Sample Alignment

Pre-alignment in the Lab



X-ray Scattering and Emission Tomography

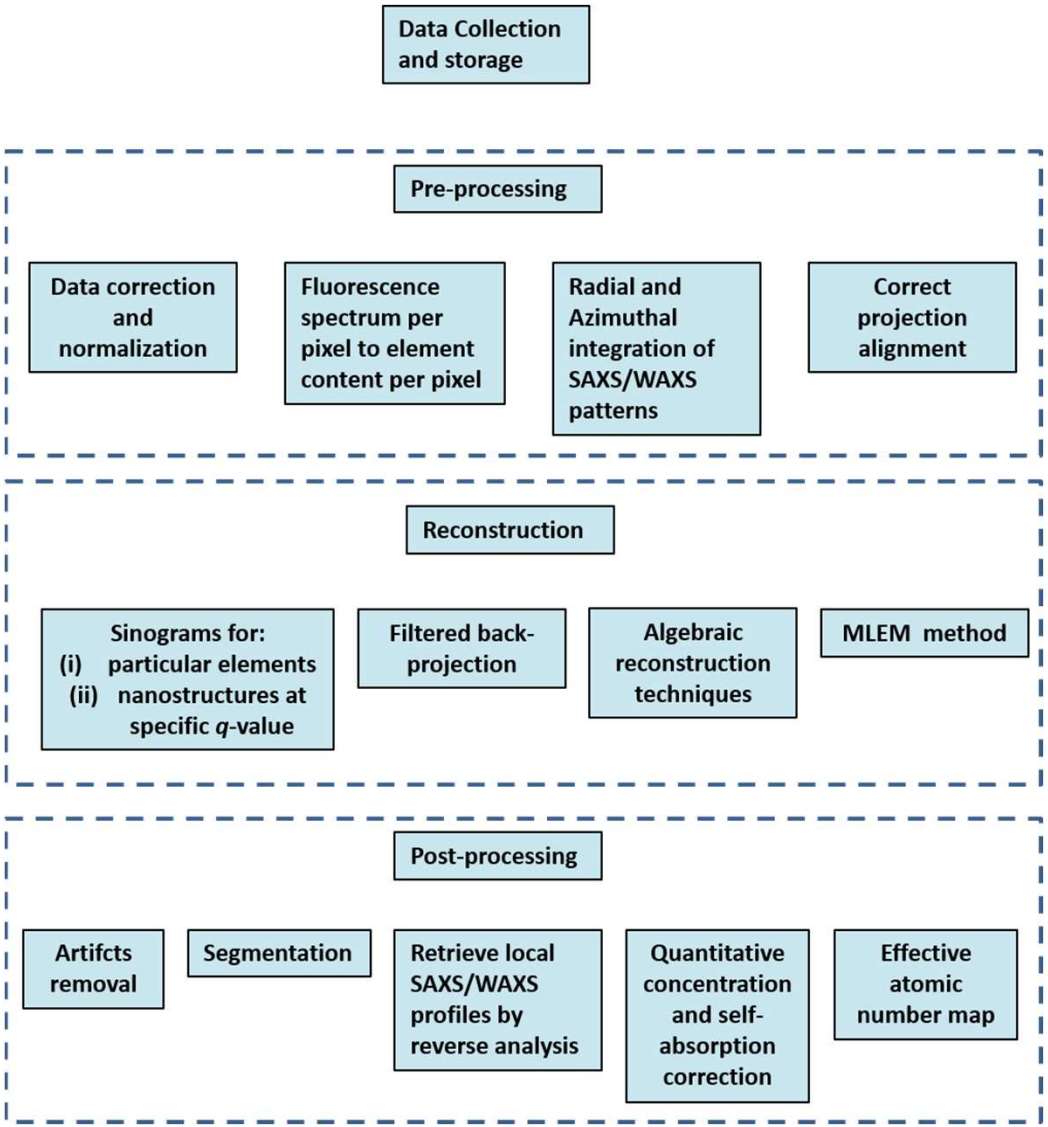
3D elemental-specific, electron density and hierarchical structure map

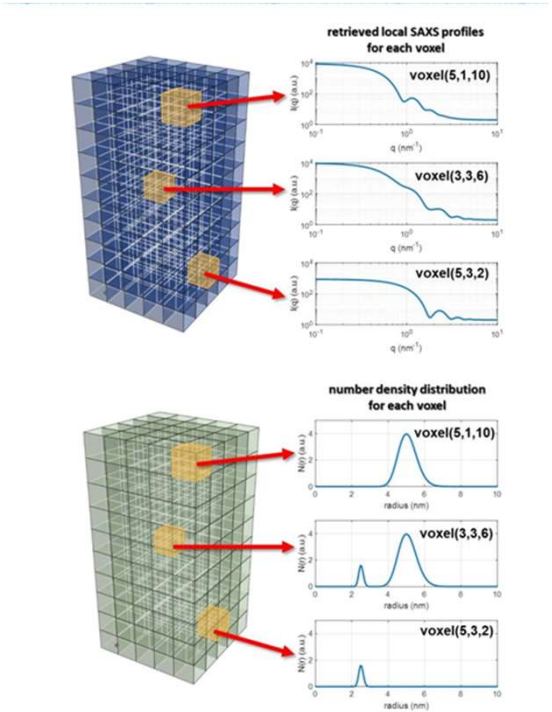


* Plan to have a three channel spectrometer Vortex®ME3 SDD consisting of 3 x Sensors coupled with the Readout system Xspress 3-channel

Ongoing pipeline for Multimode Tomography

SAXS/WAXS/XRF/Compton-CT pipeline for on-line reconstruction

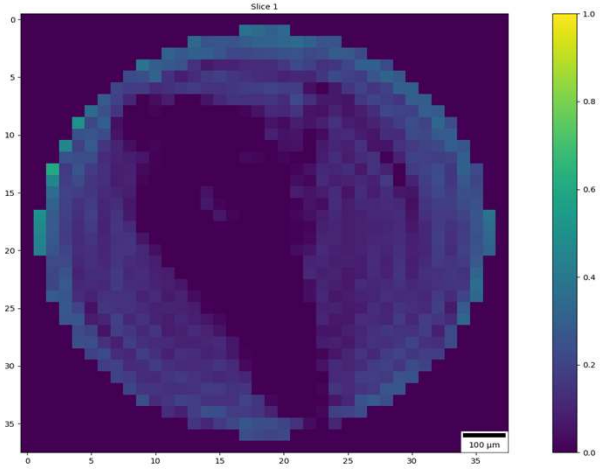




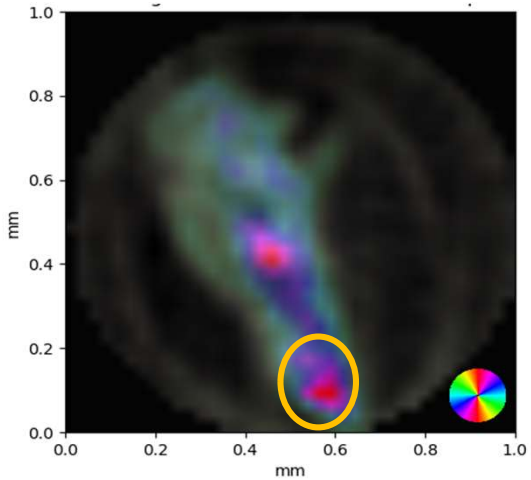
3D Multimodal X-ray Imaging

Correlation between collagen rearrangement and Fe, Cu and Zn accumulation

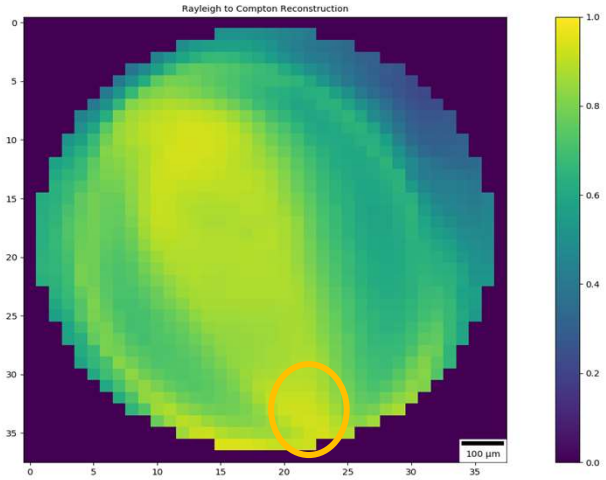
Absorption contrast



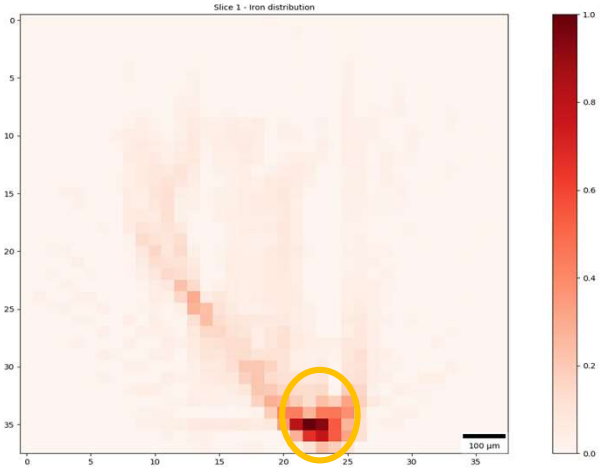
Collagen content and orientation



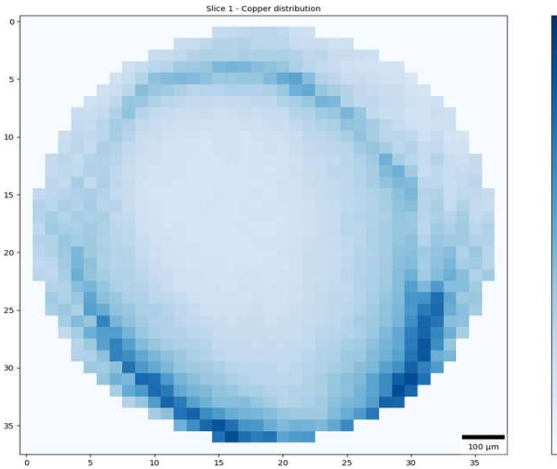
R/C tomogram



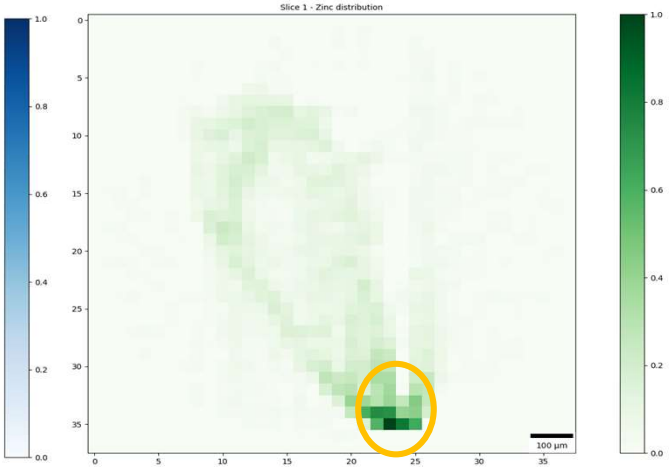
Fe distribution



Cu distribution

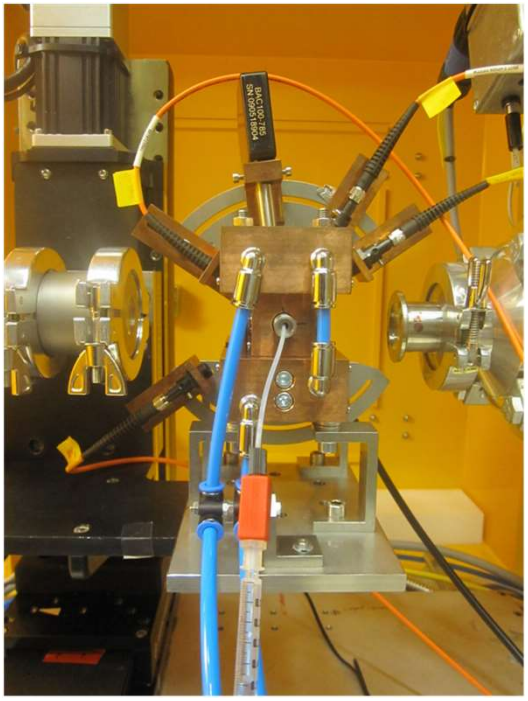


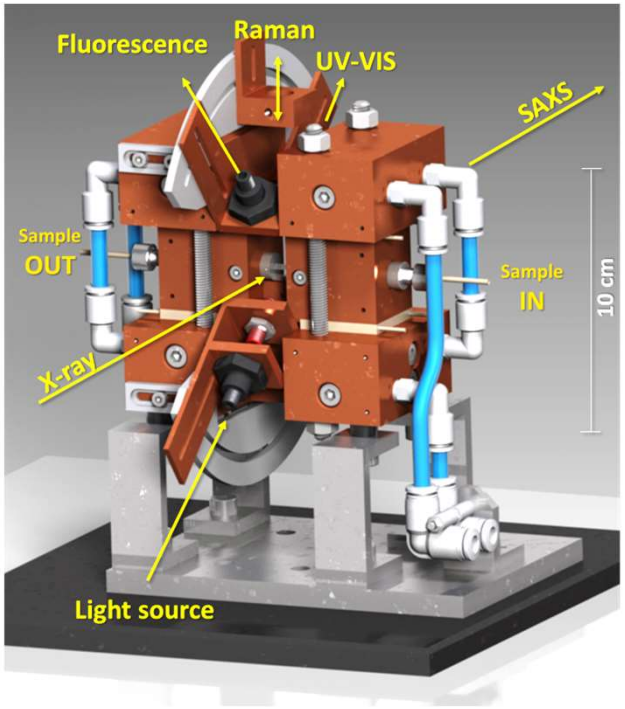
Zn distribution



Multiprobe @ SAXSMAT

in situ / operando SAXS & WAXS





S. Haas *et al.*, *Phys. Chem. B. 118(8)*, (2014), 2264-2273

UV-VIS spectroscopy	
Source 1:	100 Watt Xe Arc lamp
Source 2:	78 Watt Deuterium / 5 Watt Halogen lamp
Detector:	Oceans Optics – HR4000 200 nm – 1100 nm
Integration time:	3 ms - several minutes

Raman spectroscopy	
Source:	785 nm laser / 50 – 350 mW
Detector:	B&W Tek Inc. – i-Raman 175 – 3200 cm^{-1} (3 cm^{-1})

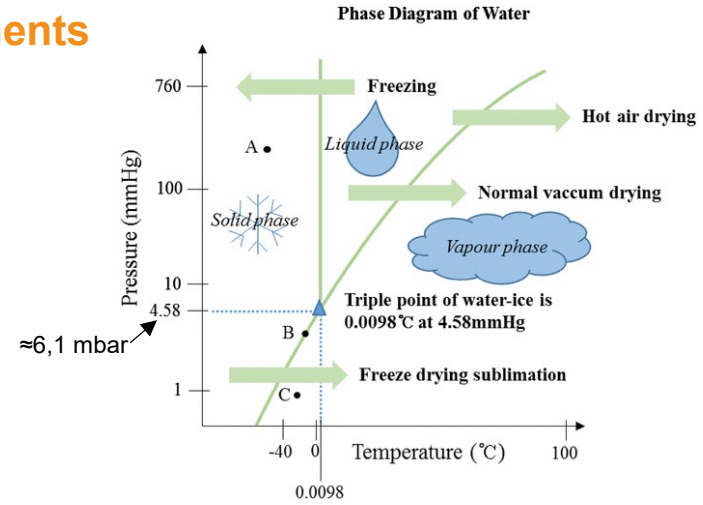
Fluorescence spectroscopy	
Source:	100 Watt Xe Arc lamp
Monochromator:	Newport Cronerstone 130 1/8 m Gratings: 1.) 185 nm – 650 nm , 250 blaze 2.) 200 nm – 1600 nm, 350 blaze
Detector:	Oceans Optics – QE 65 Pro 200 nm – 1100 nm
Integration time:	3 ms - several minutes

Temperature	
Active Heat/Cooling:	4 TEM modules (33 W each)
Heat sink:	Thermostat controlled water bath
Temperature range:	-50 °C – +150°C
Heat/Cooling rate:	max ~ 0.2 K/s

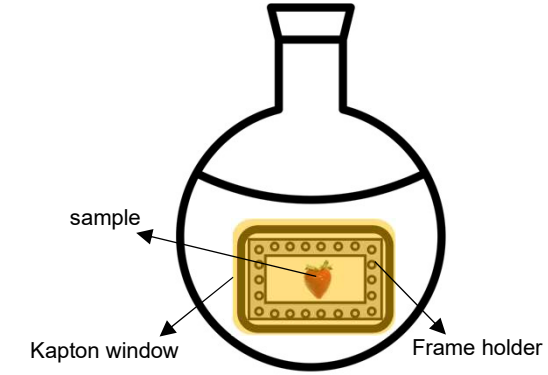
*RAC proposal submitted: low frequency Raman, humidity controler

Freeze-dryer

Sample preparation and "*in situ*" dehydration experiments



Sample environment for *in-situ* freeze-drying experiments



Control:
- cooling rate
- heating rate
- vacuum

Two-stage cooling system

Capacitor volumes	5,7 Liters
Condensor temperature	< -80°C
Condensor capacity	2kg / 24h
Max. ice capacity	3kg
Max. vacuum	2 x 10^{-3} mbar

Paraffin-Embedded **Freeze-dried**

VIA @SAXSMAT

Summary

- VIA is an interesting initiative which will be very helpful to all beamlines, in particular to the SAXSMAT beamline where multimode experiments are planned.

- So far, we have only the freeze-dryer to share.

- We hope in the near future to be contribute with other devices such as the SAXS/UV–vis/Raman multiprobe system.

Acknowledgements

SAXSMAT P62 team

Sylvio Haas
Team leader

M. Sc. Saskia Pfeffer
Beamline engineer

Dr. Xiao Sun
Beamline Scientist

Dr. Andre Conceicao
Beamline Scientist

Dr. Sergio Funari
Senior Scientist

Dr. Wenhai Ji
PostDoc (via Helmholtz-OCPC)