



SAMPLE ENVIRONMENTS AT A SYNCHROTRON

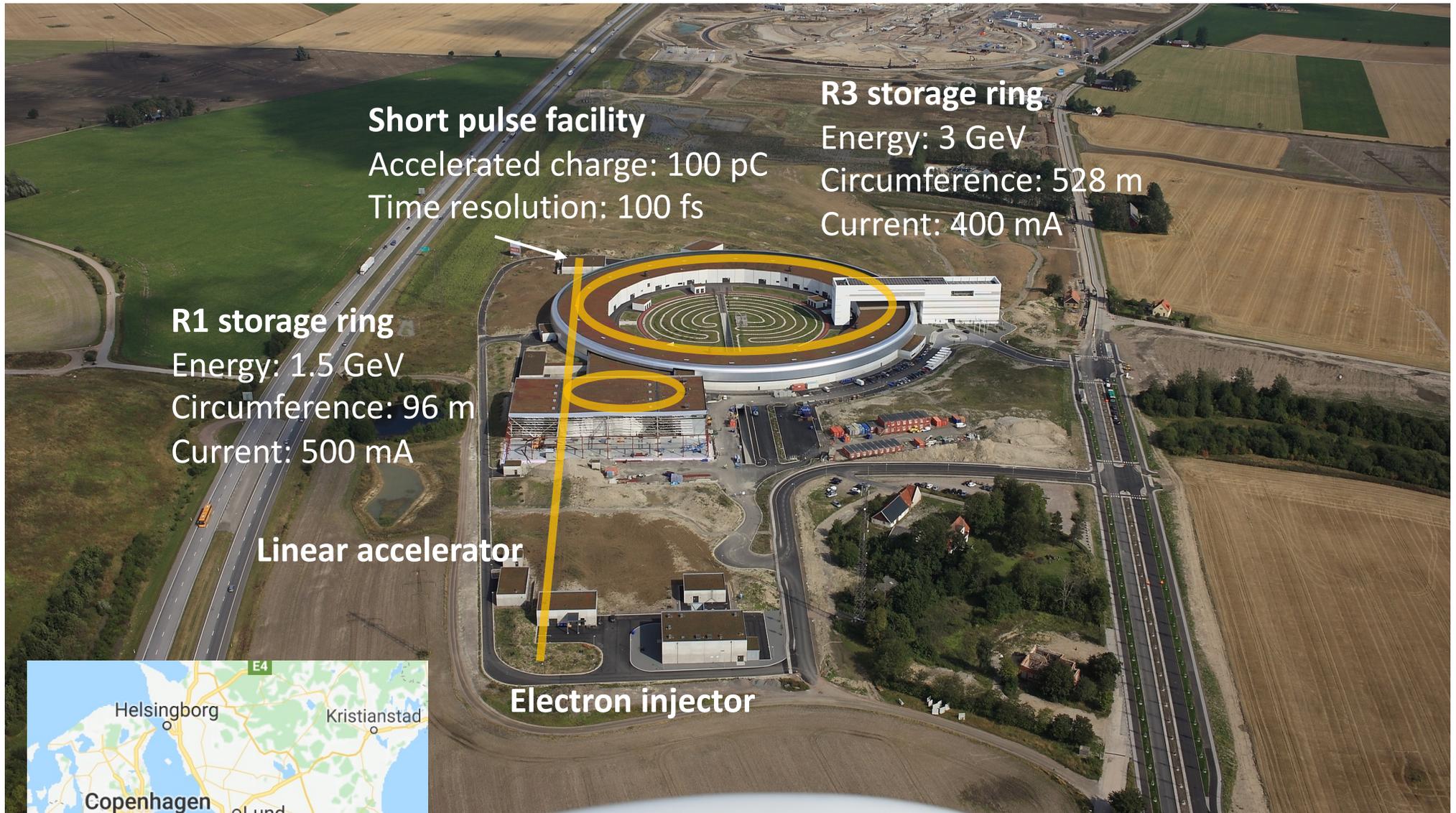
Part 2: Sample Environments at MAX IV

S. Carlson (MAX IV), K. Kiefer (HZB), M. Bartkowiak (PSI)



School on Synchrotron Light Sources and their
Applications, January 2026

The MAX IV Laboratory



Short pulse facility

Accelerated charge: 100 pC
Time resolution: 100 fs

R3 storage ring

Energy: 3 GeV
Circumference: 528 m
Current: 400 mA

R1 storage ring

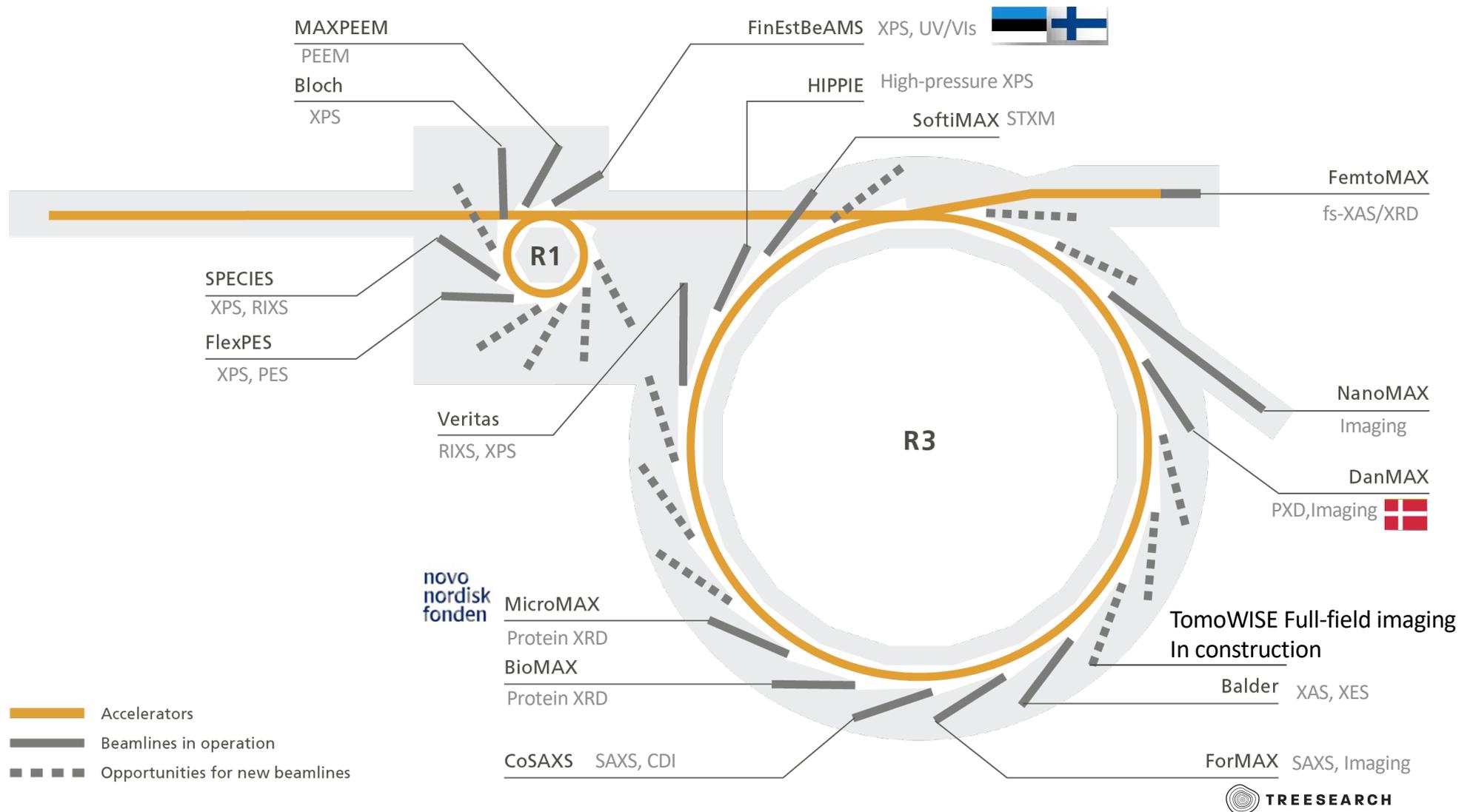
Energy: 1.5 GeV
Circumference: 96 m
Current: 500 mA

Linear accelerator

Electron injector



MAX IV beamlines

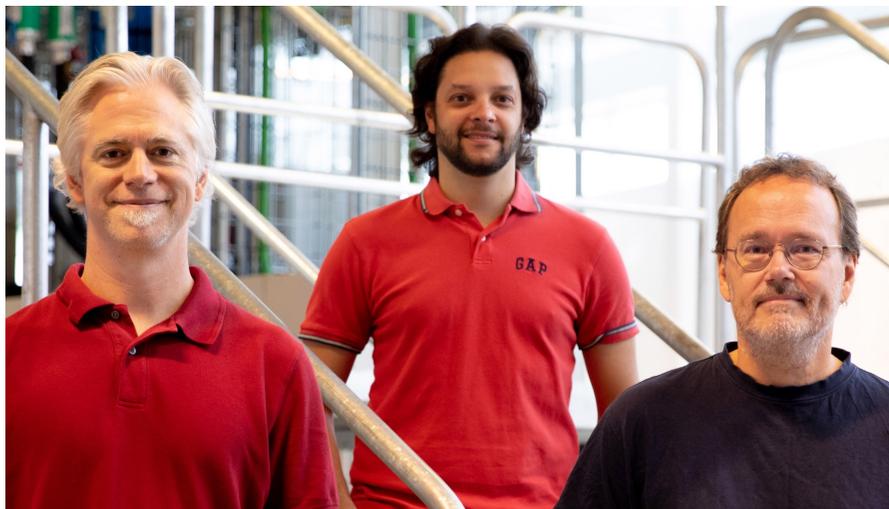


“4th generation” low-emittance storage ring
 16 beamlines in operation covering energies from 4 eV to 40 keV.



Sample-environment support at MAX IV

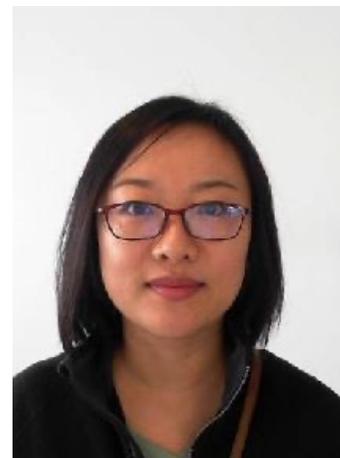
The Support Labs team



Chris Ward
Detectors
Electronics

Artur Domingues
Sample environments
Fast prototyping

Stefan Carlson
Sample environments



Yang Chen
Team leader
Chemistry labs



Anicée Guglielmi
Chemistry labs

Our responsibilities

- 5 Sample environment labs
- 5 Chemistry labs
- Instrumentation loan pool
- Consumables for labs and beamlines
- Project assistance at beamlines
- Sample environment development

Support labs for sample environments

Sample environment lab



Furnace, cryo, assembly

Test and detector lab



Detector test, X-ray test station

Fast prototyping lab



3D printers, milling, laser cutter

Beamline workshop



Open 24/7, Drilling machine, Tools

Sample Prelab



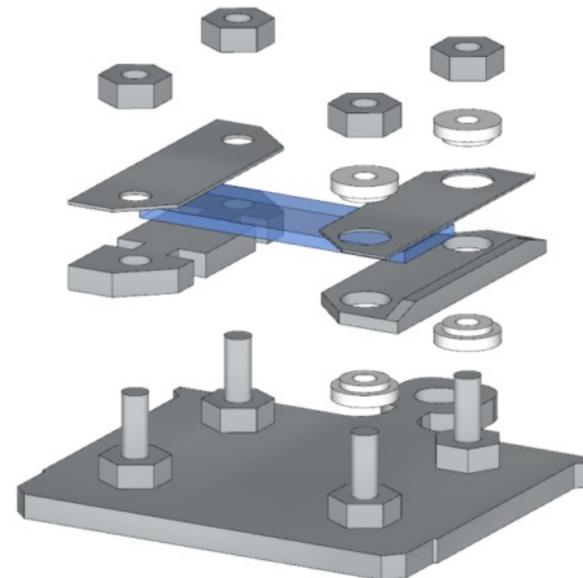
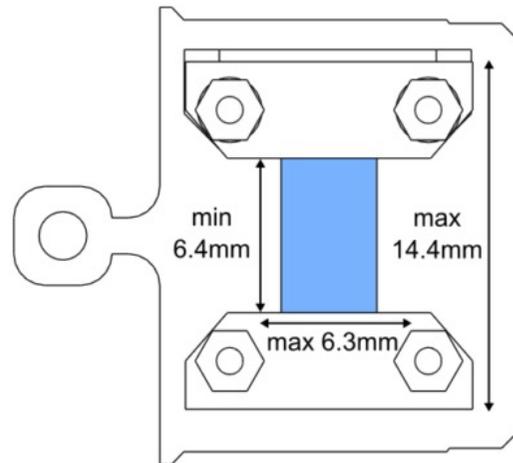
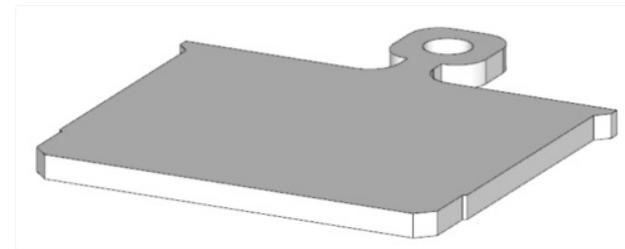
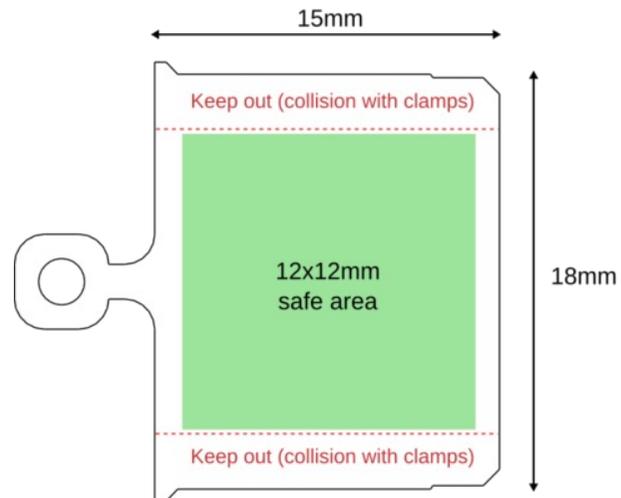
LAF tent, furnaces, DSC, polishing, coating



Standard sample holders

Sample-holder standards at MAX IV – Soft X-rays/UV

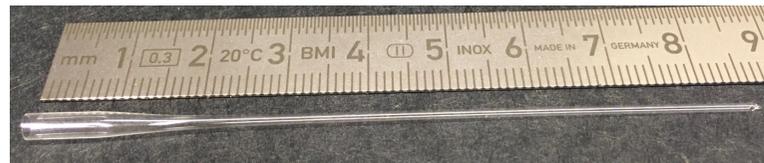
Soft X-ray (< 2 keV) surface science: “Flag-style” Omicron sample holder



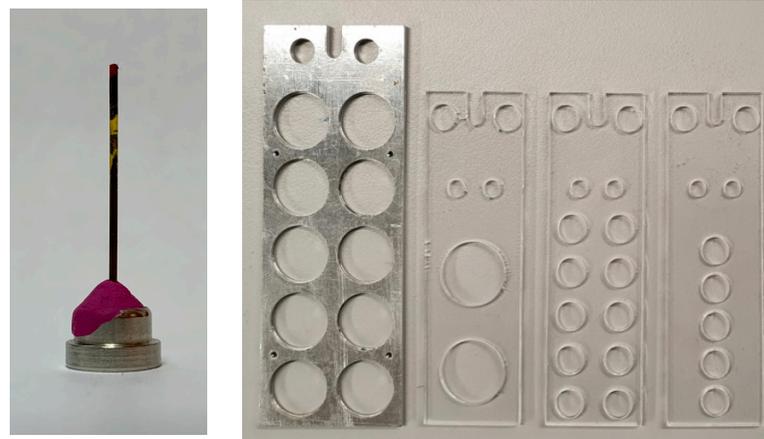
Sample-holder standards at MAX IV – Hard X-rays

Hard X-ray (> 2 keV) experiments: Several standards for different techniques.

Powder XRD: Capillaries



Crystals (XRD): Glass pins, “Spine” pins



XAS: Frames, tape, capillaries

Imaging with nano beams: TEM grids





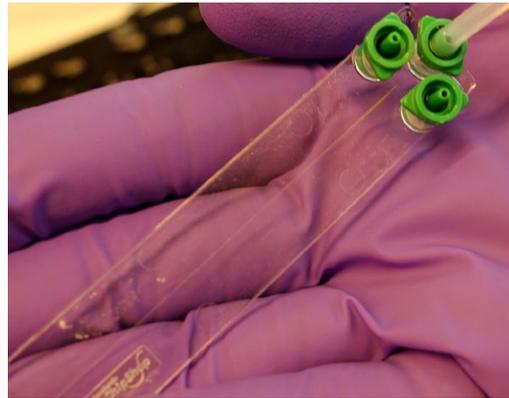
Examples

Microfluidics

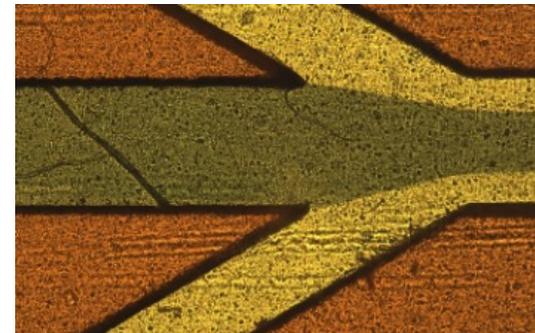
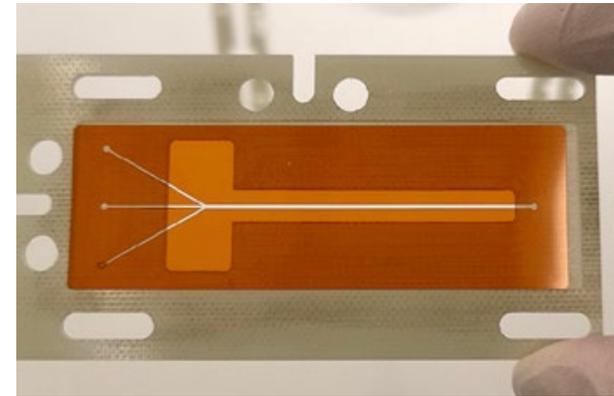
Project at Balder, CoSAXS, and MicroMAX:

Adaptable microfluidic flow-cell platform for sample delivery and fluid mixing.

20 – 300 μm channel diameters.



Commercial microfluidic cell used in the cell platform.

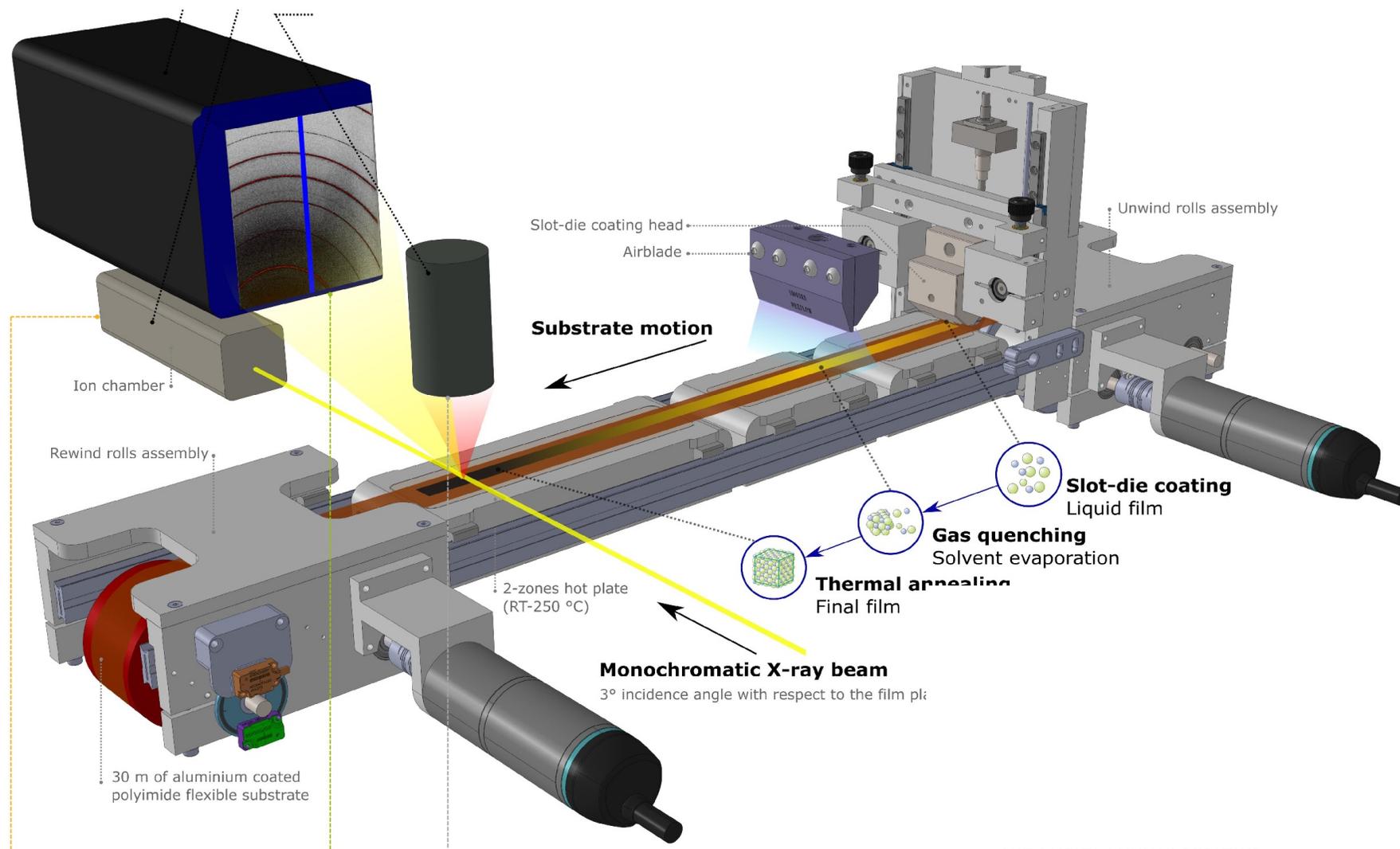


Flow focusing

Slot-die coating

In-situ formation of metal-halide perovskite thin films

Project at Balder by M. Ciambezi, J. Liu, J. Li, M. Ramakrishnan, E. L. Unger and J. Just



Protein crystallography at BioMAX and MicroMAX



Samples are mounted on
“Spine” pins

Multiple samples are stored
under liquid nitrogen in
“Unipucks”

Automatic sample transfer to
diffractometer using a robot.

- Both beamlines perform single-crystal macromolecular X-ray diffraction
- MicroMAX is optimised for high-throughput serial crystallography

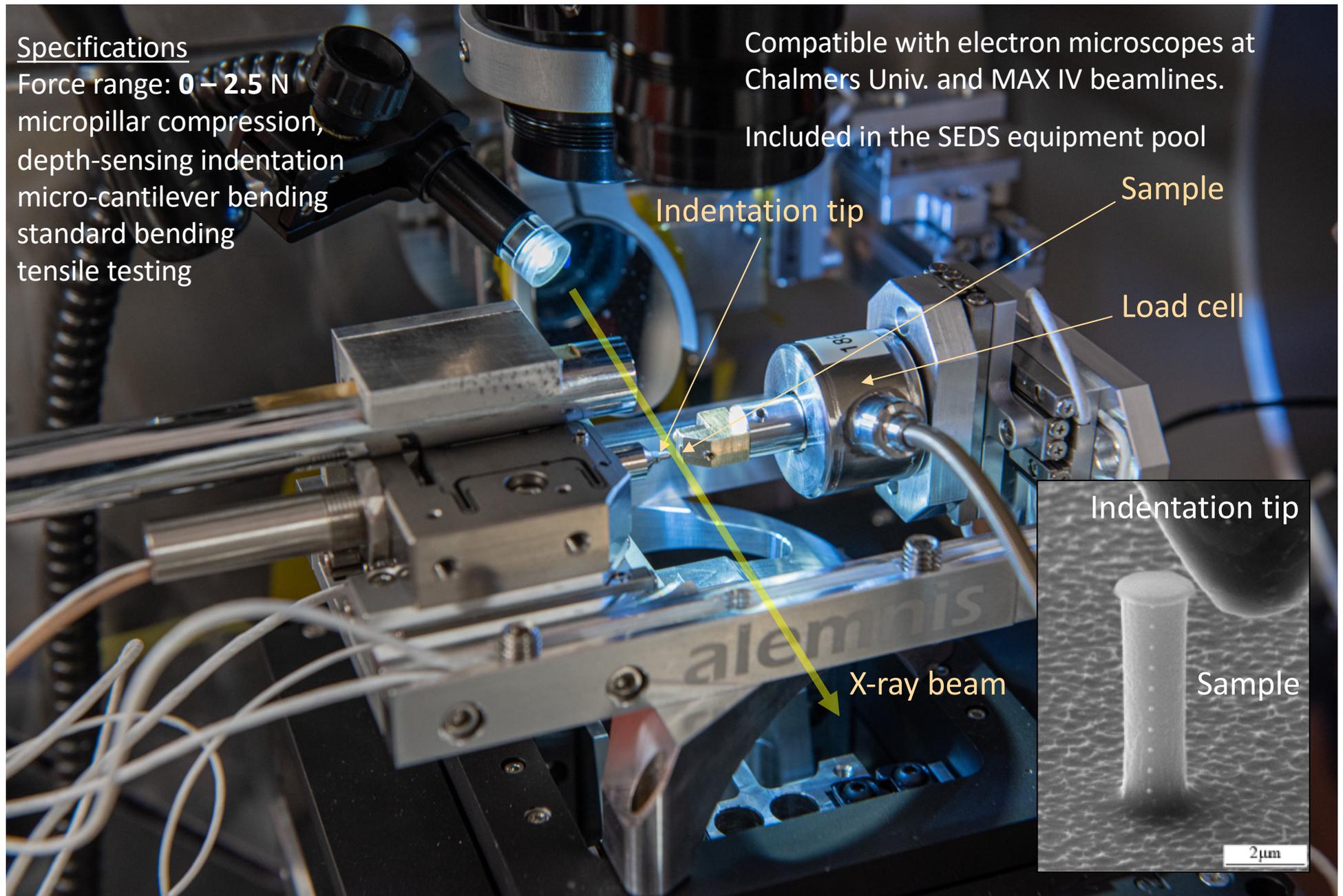
Nano-indentation at NanoMAX

Specifications

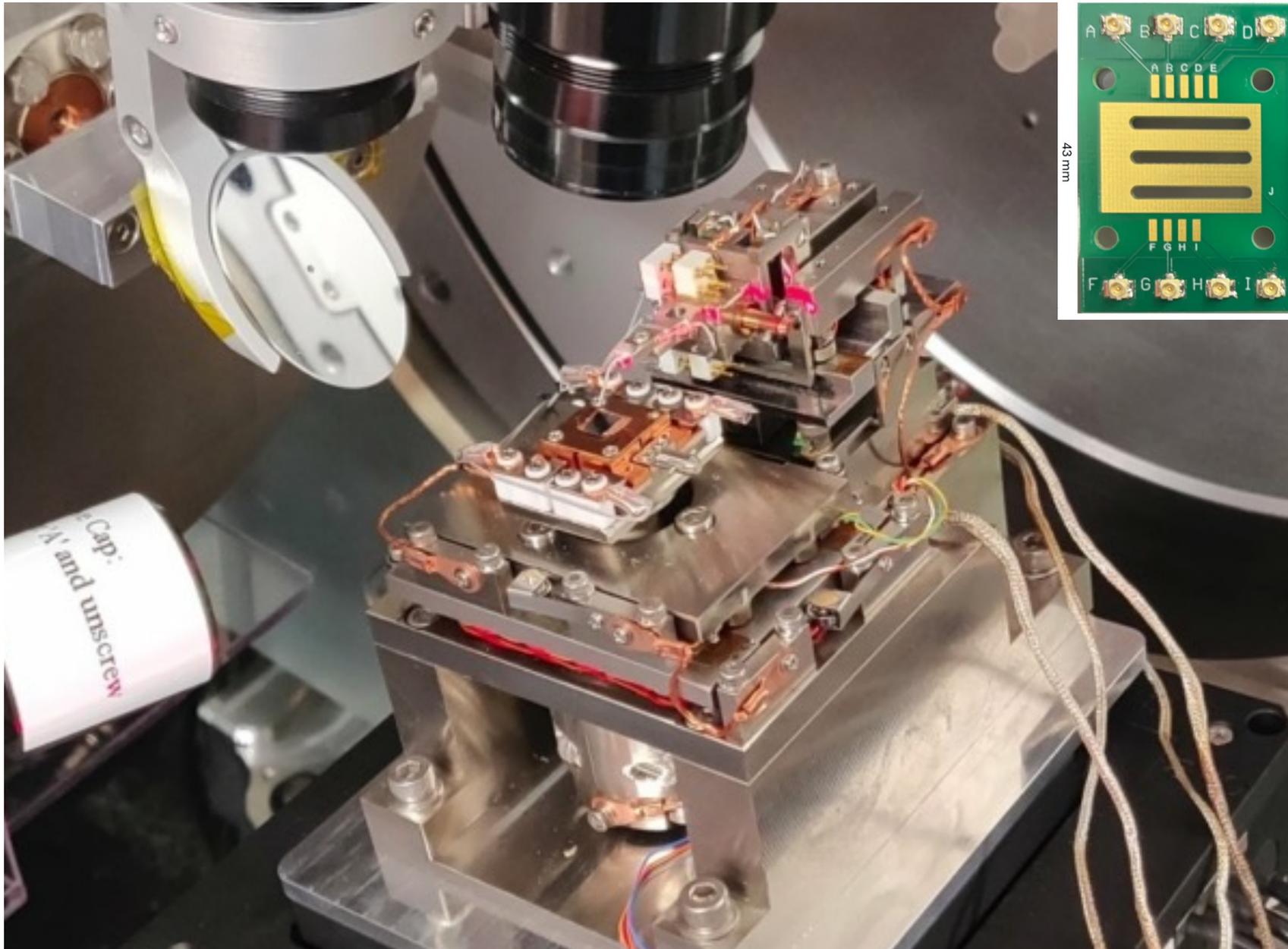
Force range: 0 – 2.5 N
micropillar compression,
depth-sensing indentation
micro-cantilever bending
standard bending
tensile testing

Compatible with electron microscopes at
Chalmers Univ. and MAX IV beamlines.

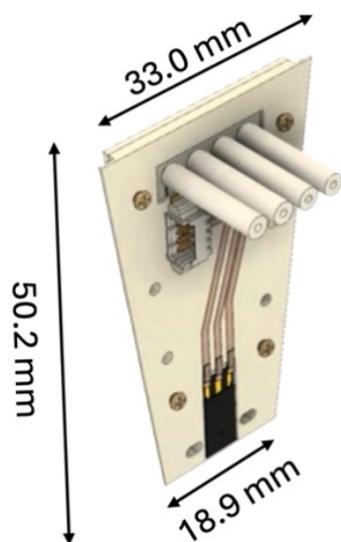
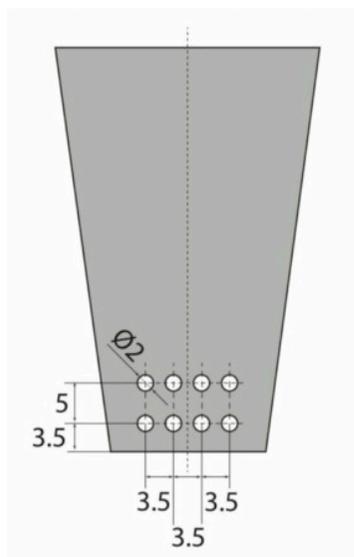
Included in the SEDS equipment pool



Printed circuit boards (PCBs) as sample holders at NanoMAX

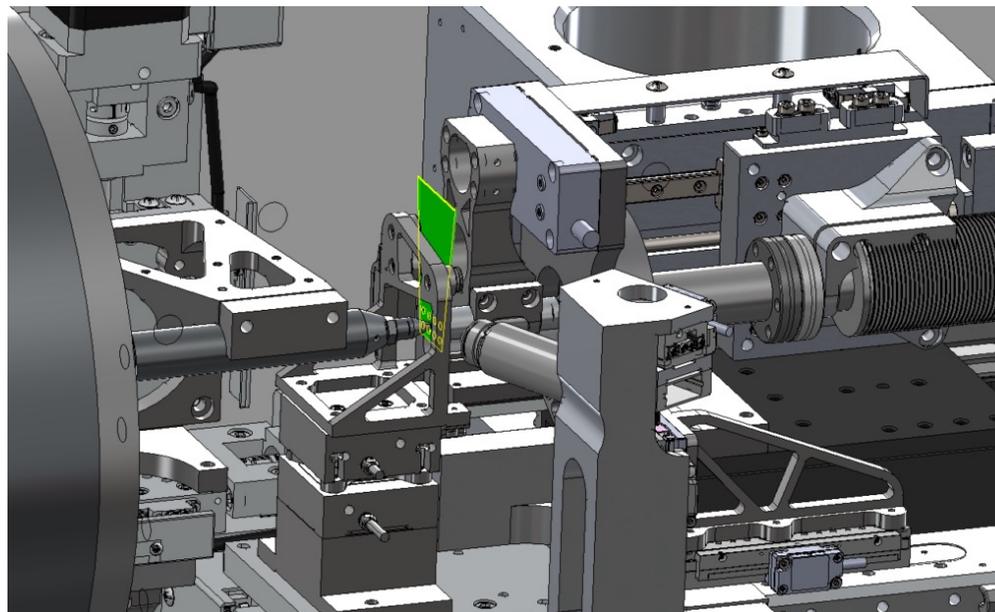


Standard sample holders at SoftiMAX

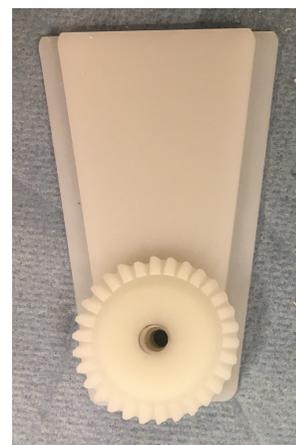


Electrochemical cell.

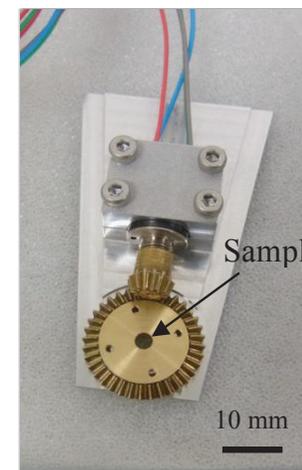
P. Ingino, H. Eraky, C. Zhang, A.P. Hitchcock & M. Obst. *Scientific Reports* **14** (2024) 24009. DOI: 10.1038/s41598-024-74768-9



SoftiMAX experiment station. Sample holder marked in green.



3D printed holder with azimuthal rotation

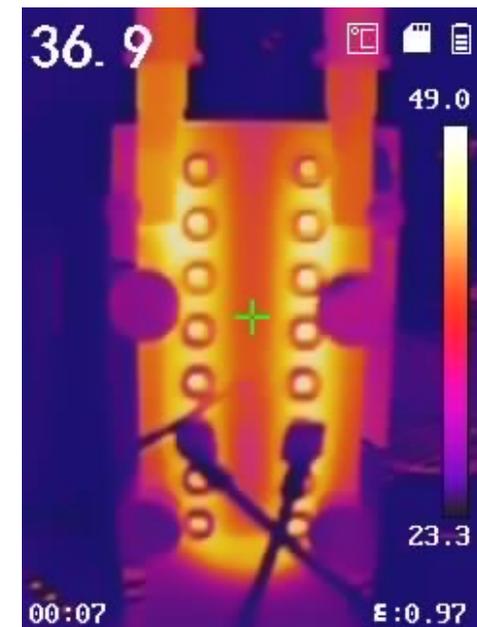
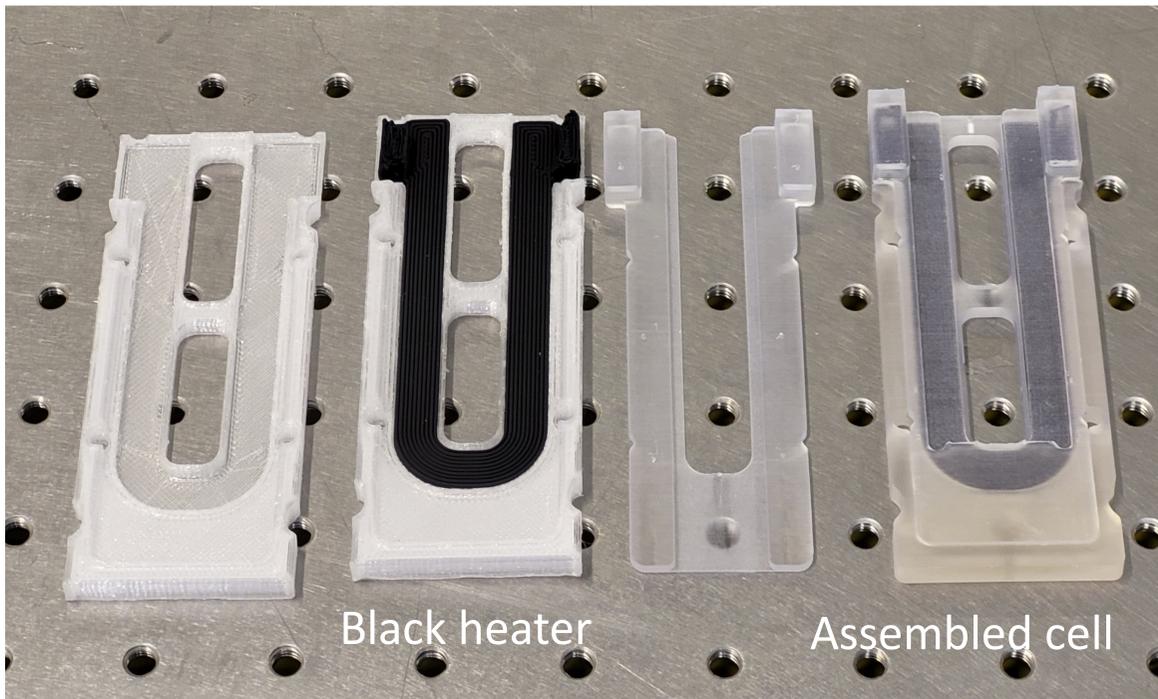


Takuji Ohigashi et al., AIP Conference Proceedings 1741, 050002 (2016)

Fast prototyping for CoSAXS

SAXS measurements on human-tissue material
Temperature at the sample must be controlled at 37°C

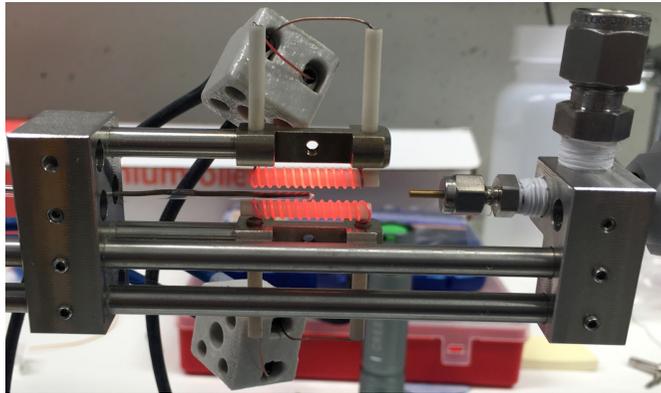
Thermally stabilized cell printed out with electrically conducting plastic heater



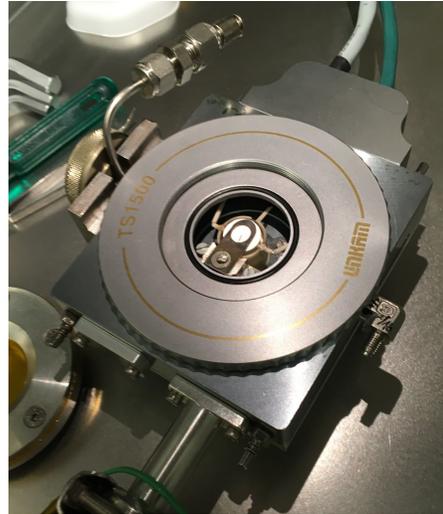
Thermal imaging of heater in operation

In-situ reaction cells

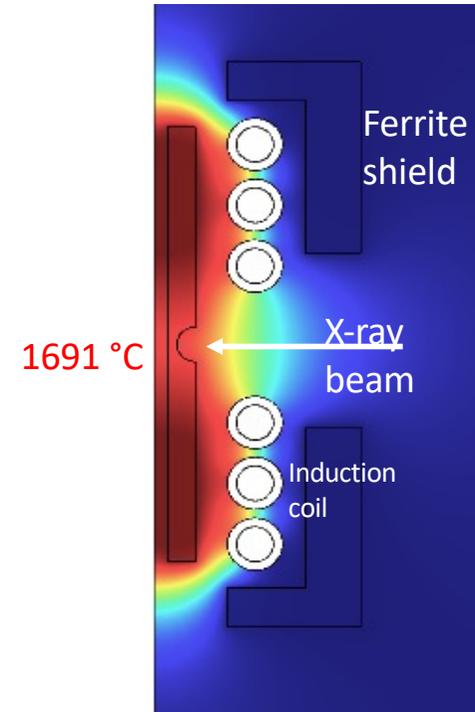
Capillary cell



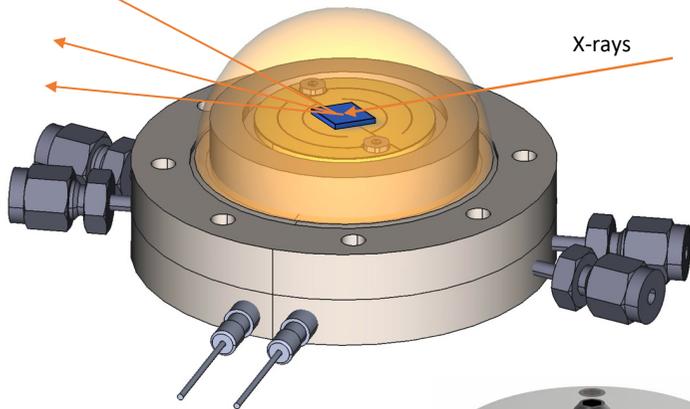
Linkam furnace



Induction furnace



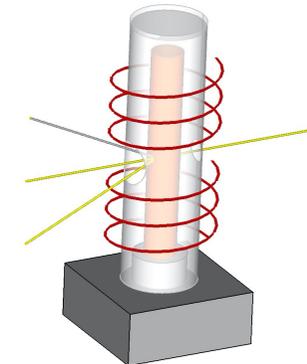
Dome cell



MAX IV catalysis cell



Diamond-anvil cells



Some conclusions

Sample environments are becoming more complex

Operando experiments, temperature, pressure, reactive gases and liquids, humidity, magnetic fields, strain/stress...

Sample environments are becoming more compact

Smaller beam sizes and more weight-sensitive experiment stations.

3D-printing is a great tool

Fast development of sample environments.

Laser micromachining and focused ion-beam etching

More and more common for prepare samples.

Finally: If you are into sample environments, check out the ISSE web and its forum (sampleenvironment.org). Connecting to the community may help to solve any technical problems that you encounter.



Thank you for your kind attention!

More info on www.maxiv.lu.se

MAXIV