



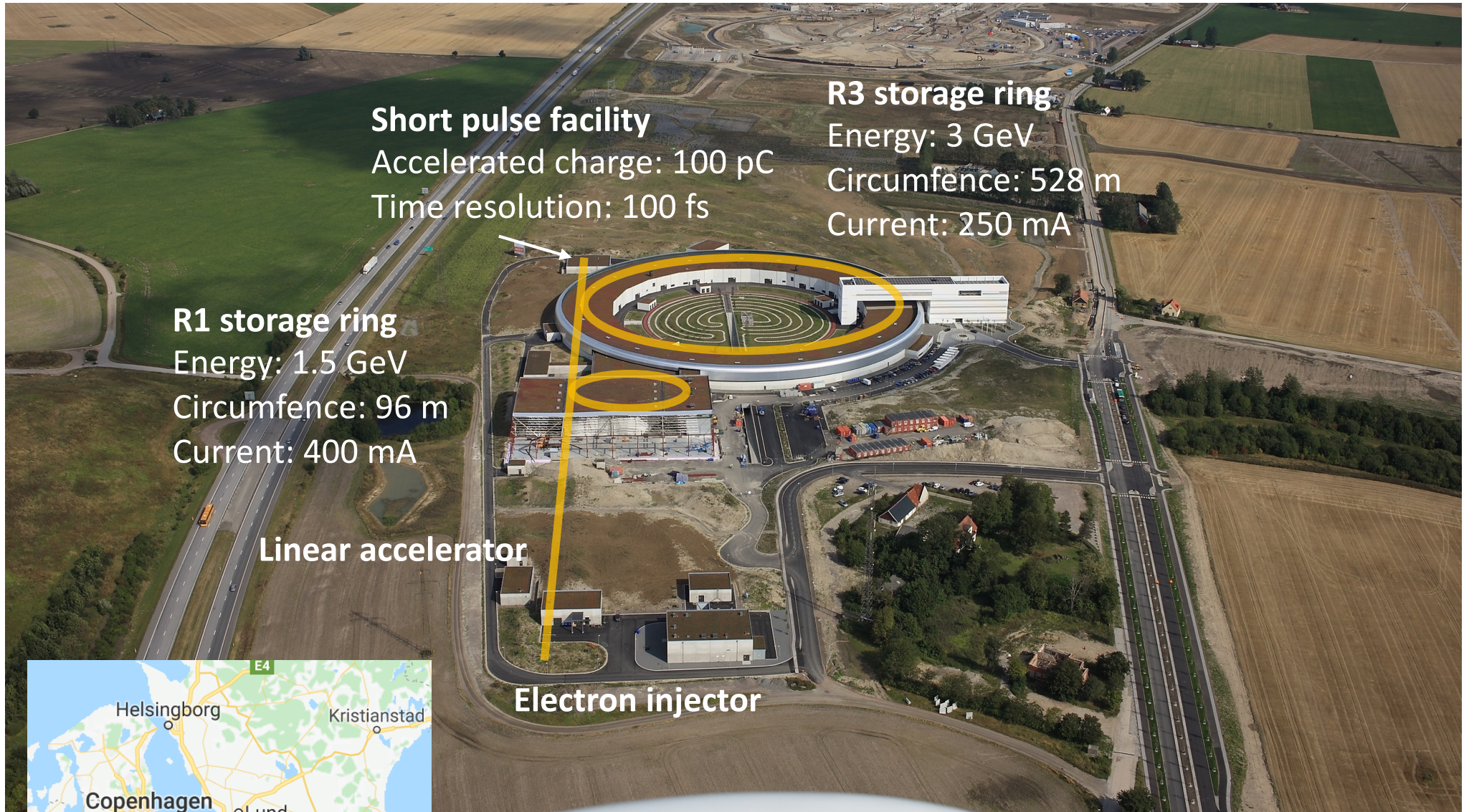
Sample Environments at the MAX IV Laboratory

Stefan Carlson

Sample Environment and Detector Support (SEDS) team



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: 250 mA

R1 storage ring

Energy: 1.5 GeV

Circumference: 96 m

Current: 400 mA

Linear accelerator

Electron injector



MAX IV beamlines today

User Operation
Commissioning
Construction

3.0 GeV Ring

NanoMAX
Nanofocus & coherence

DanMAX 
Imaging & diffraction

Balder
EXAFS & RIXS

ForMAX
Wood based material

CoSAXS
SAXS & coherence

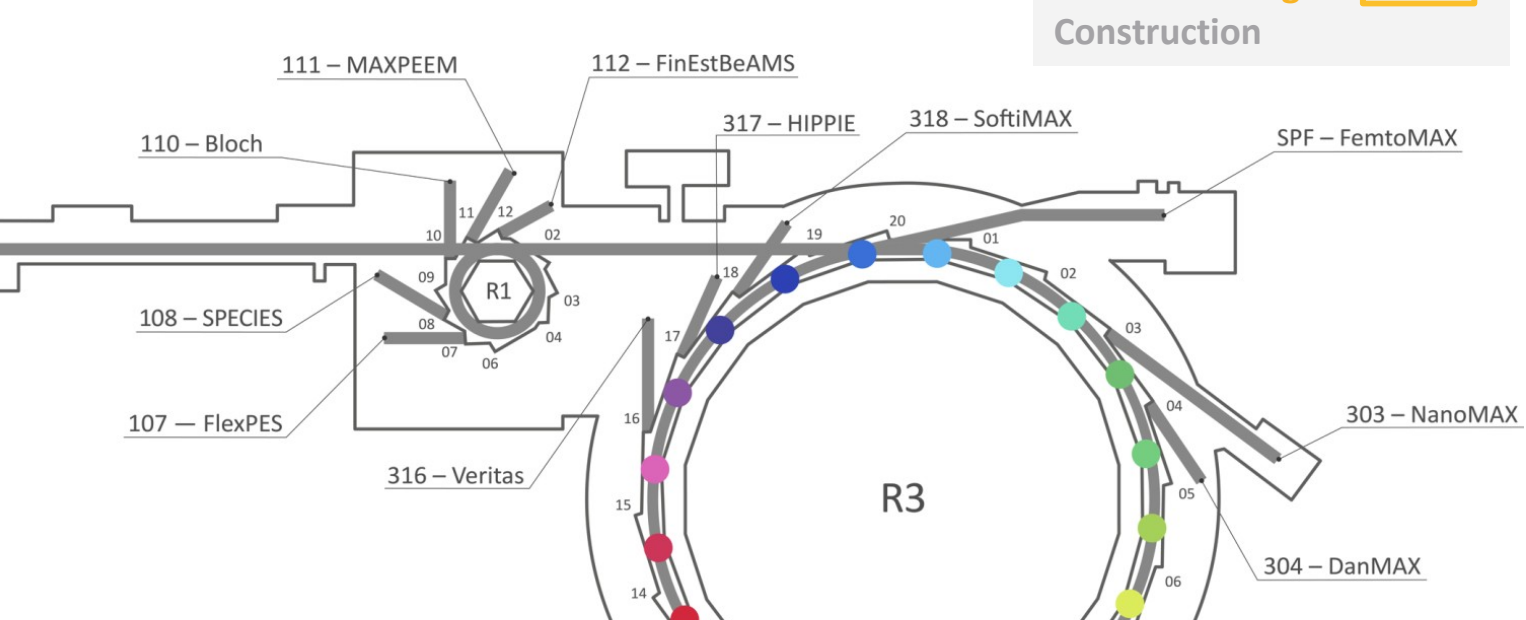
BioMAX
Protein structure

MicroMAX 
Protein structure

Veritas
Excitations in solids & liquids

HIPPIE
Operando spectroscopy

SoftiMAX
Microscopy & coherence



1.5 GeV Ring

FlexPES
Flexible photoemission

SPECIES
Photoemission & RIXS

Bloch
Electronic structure & surfaces

MAXPEEM
Microscopy of surfaces

FinEstBeAMS 
Gas phase & luminescence

LINAC @ 10 Hz

FemtoMAX
Ultrafast diffraction & spectroscopy



Sample Environment and Detector Support (SEDS)

Process lab



3D-printers, Furnace, sample environments

Assembly and detector lab



Detector test, X-ray test station

The SEDS team

Stefan Carlson

Team leader

Artur Domingues

Instrumentation and 3D-printing

Mathieu Leme

Installations and cryo-techniques

Vacant position

Detector support

Beamline workshop



24/7: 3D-printers, Drilling machine, Tools

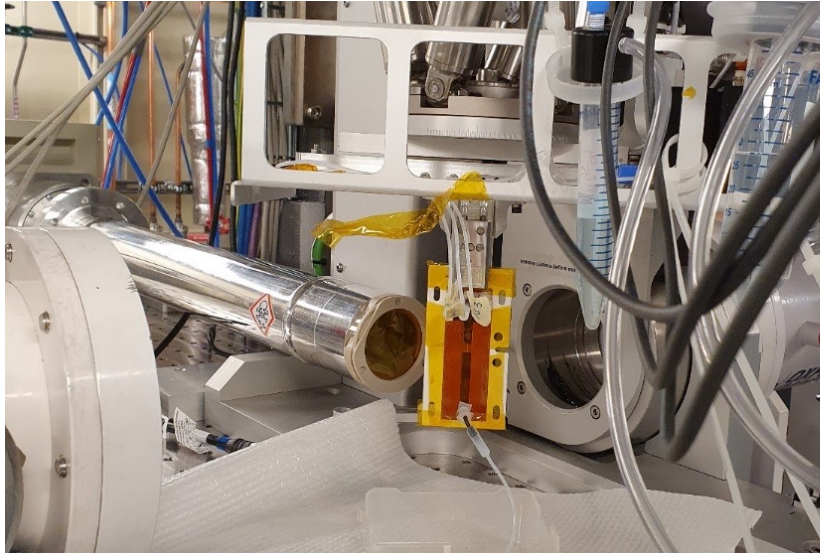
Sample Environments at MAX IV

Topics

1. Microfluidics
2. Nanoindentation
3. High pressure
4. Heated reaction cells
5. Sample holders/cells for nano beams
6. Low density matter
7. Beamline cryostat

If time allows...

1. Microfluidics



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

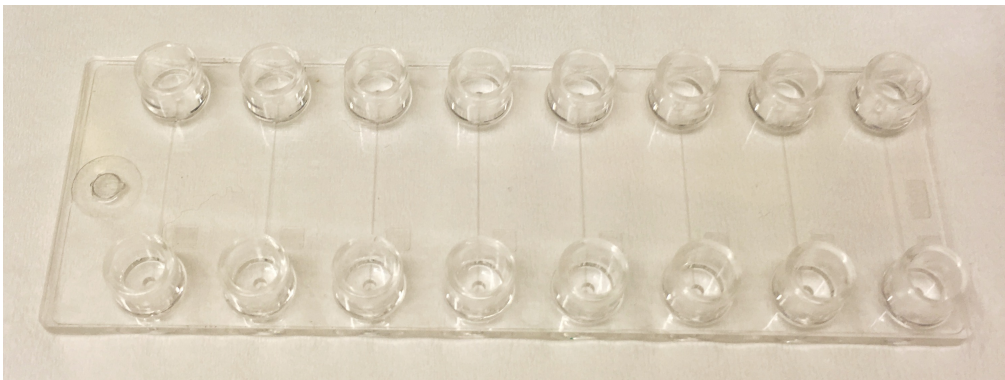
Aim: To create a protective buffer layer around the protein solution by “flow focusing”.

20 – 300 μm channel diameters

Flow focusing



Example of multi-sample microfluidic cell



Project team: Kajsa Sigfridsson Clauss (Balder), Ann Terry (CoSAXS), Pushparani Michael Raj (Postdoc Balder), Anna Fornell (Postdoc CoSAXS), Ross Friel (Microfluidics, serial crystallogr), Laurent Barbe (Microfluidic chip manufact), Dörthe Haase (SEDS), Yang Chen (BioLab)

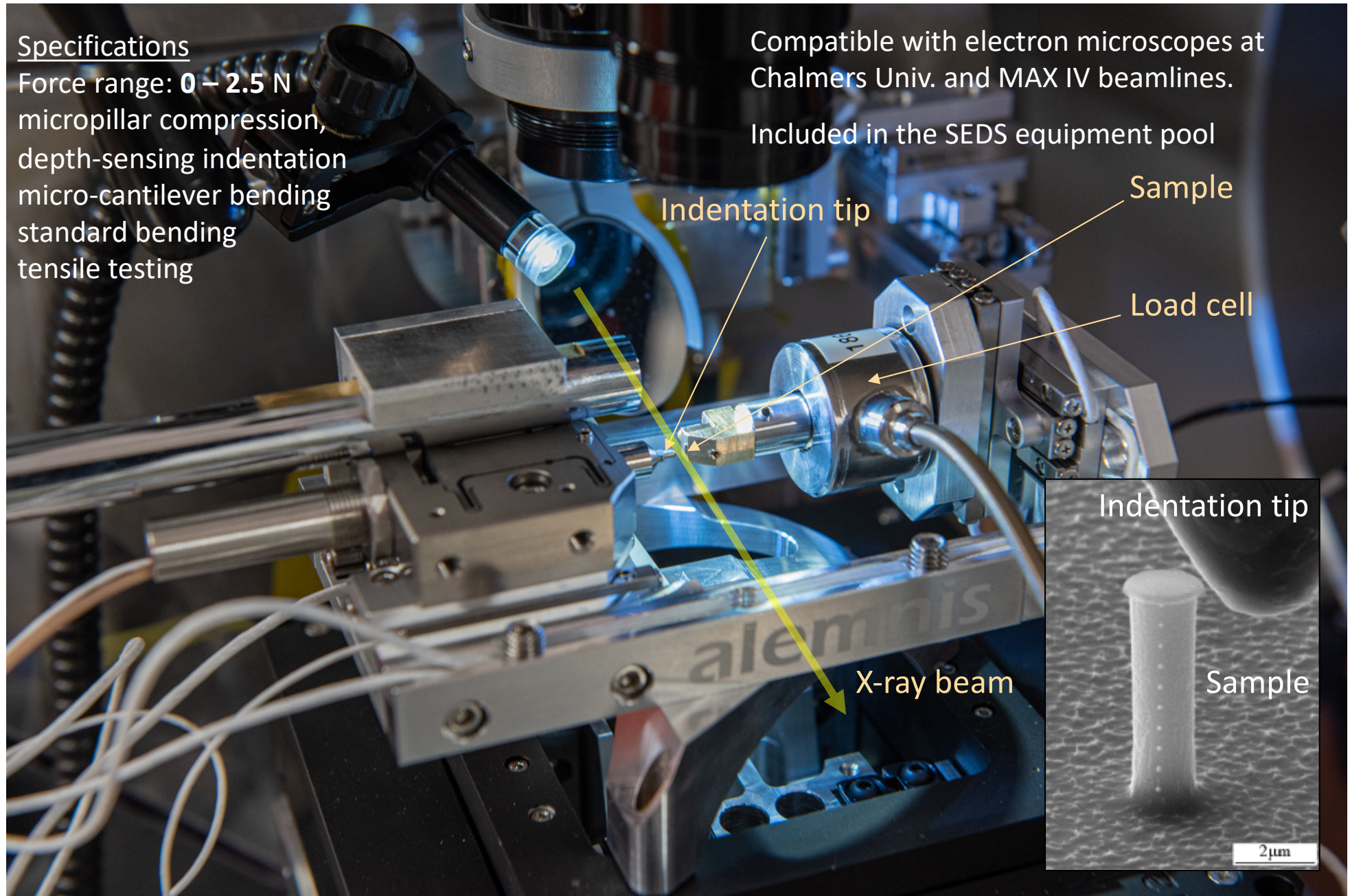
2. Nanoindentation

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



3. Diamond-Anvil Cell (DAC)

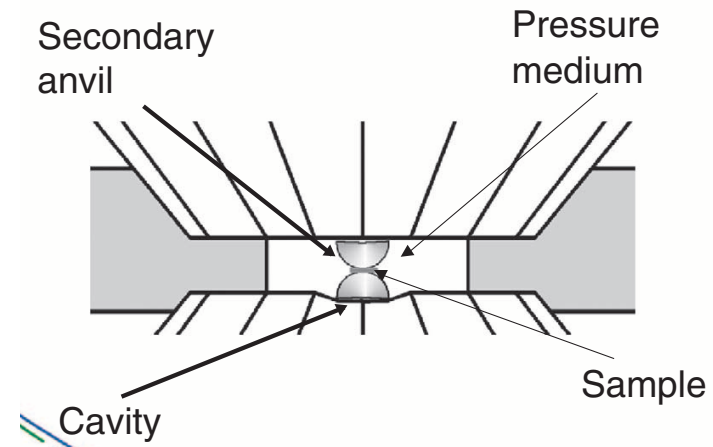
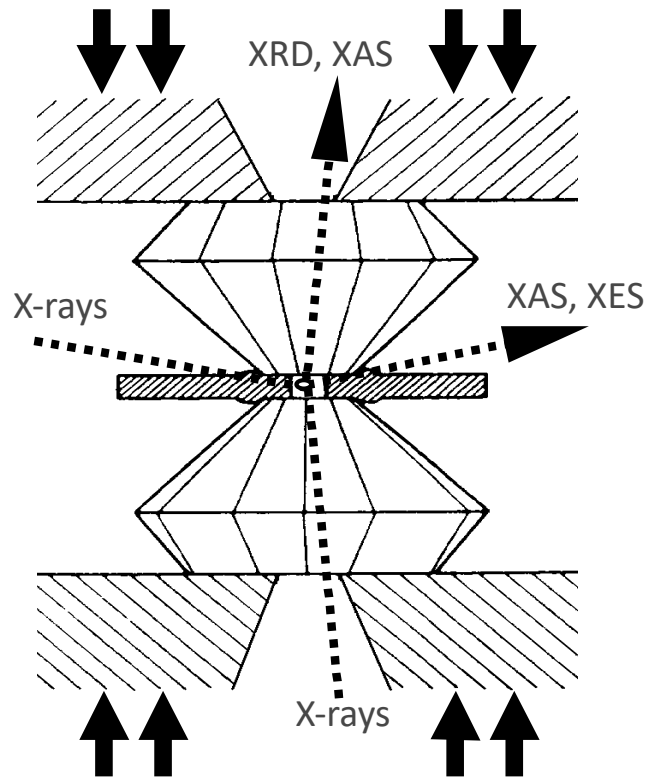
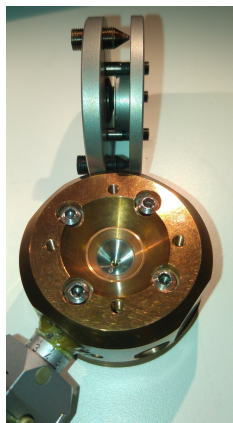


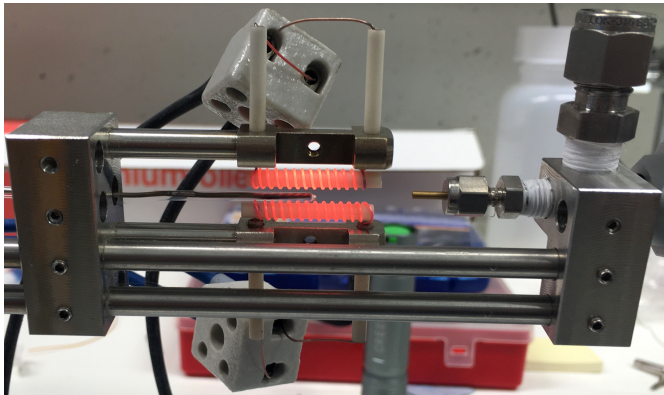
Image from: Dubrovinsky et al. Nature Communications DOI: 10.1038/ncomms2160

- Sample diameter: 10-100 μm
- Transparent windows (diamond)
- Highest pressure: 750 GPa (7.5 Mbar)
- Laser heating up to 6000 K.

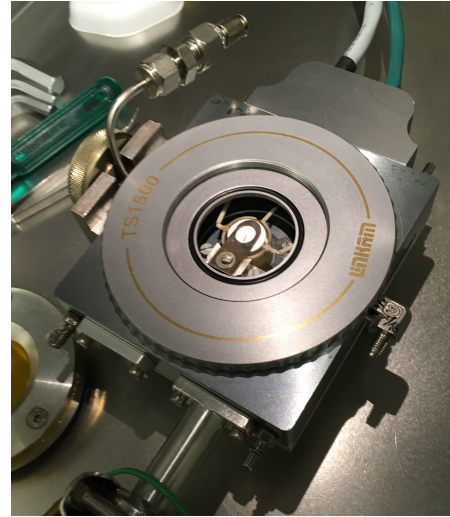


4. Heated reaction cells

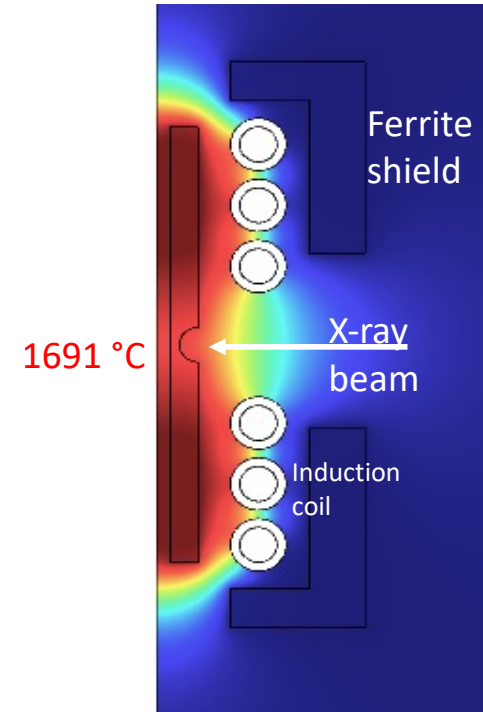
Capillary cell



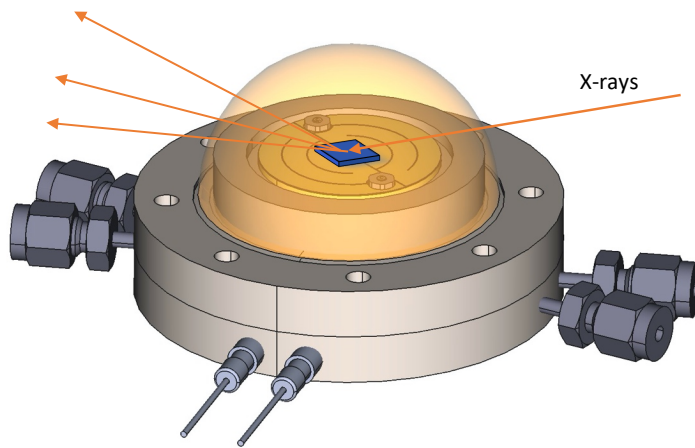
Linkam furnace



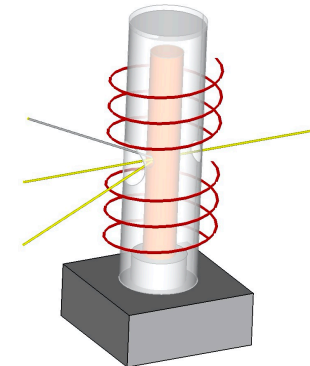
Induction furnace



Dome cell

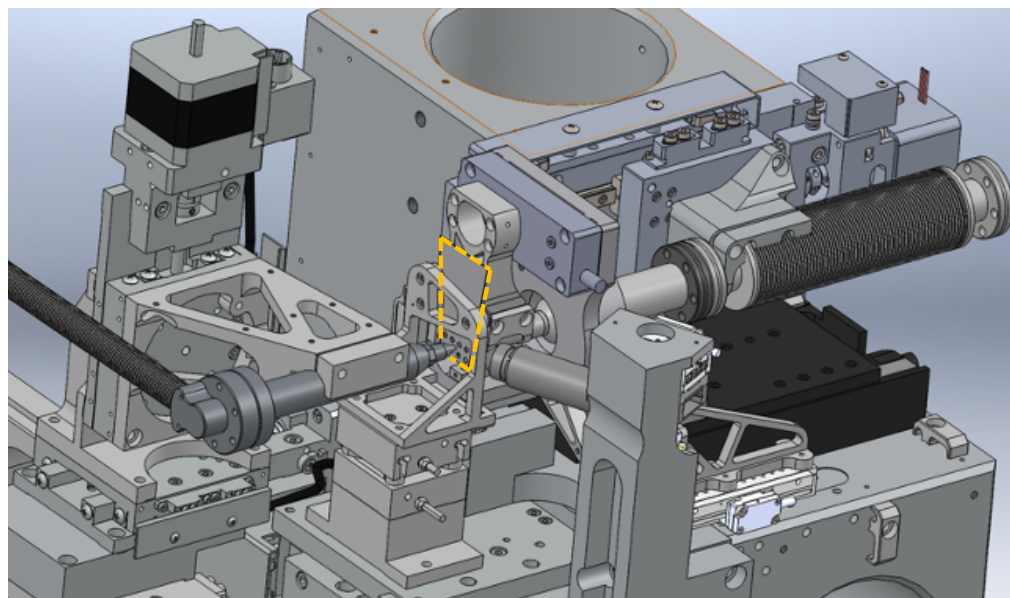


MAX IV catalytic cell

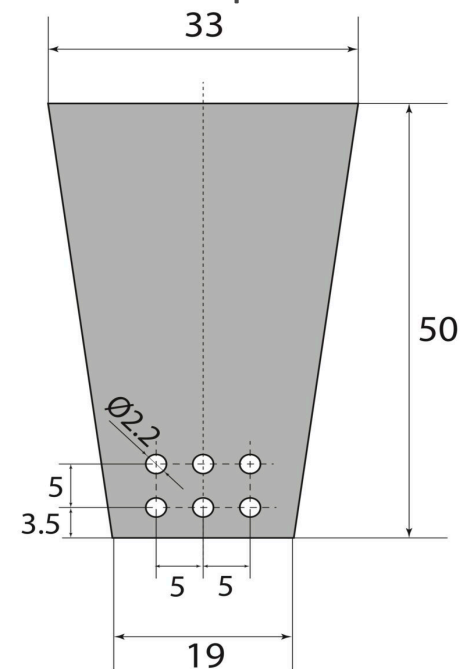


5. Sample holders for nano- and microbeams

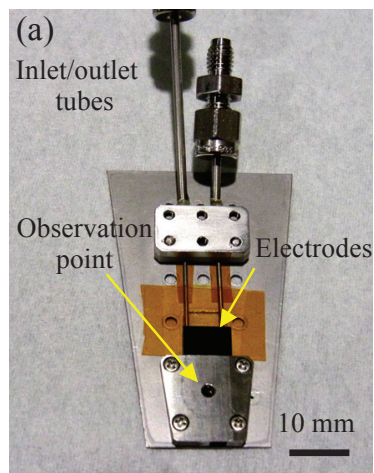
SoftiMAX endstation



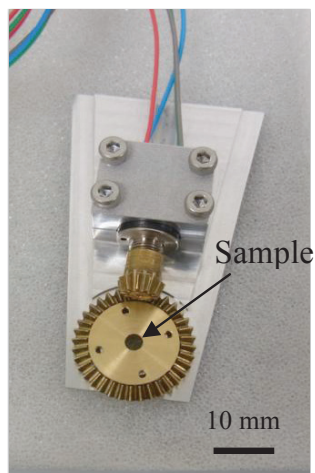
Generic sample holder



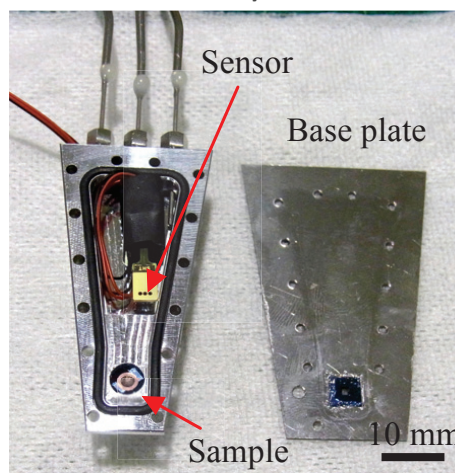
Electrochemical cell



Azimuthal cell



Humidity cell



TEM grid for samples





Thank you for your kind attention!

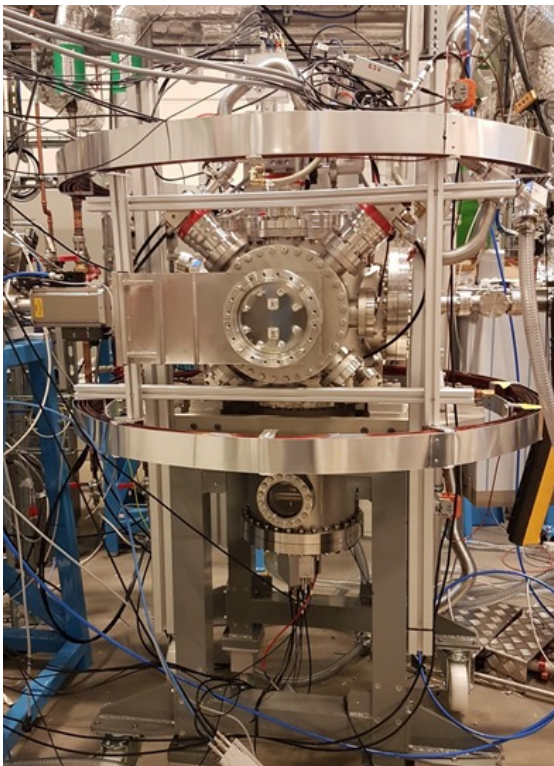
More info on www.maxiv.lu.se

MAXIV

6. Low Density Matter (LDM)

- Coincidence spectroscopy that requires a pulsed source (e.g. single-bunch mode)
- Mobile endstation: ICE (Ions in Coincidence with Electrons)
- Sample delivery with molecular spray (water-based sprays at 24 mbar)
- Quartz glass nozzles, typical opening diameter 20-25 μm

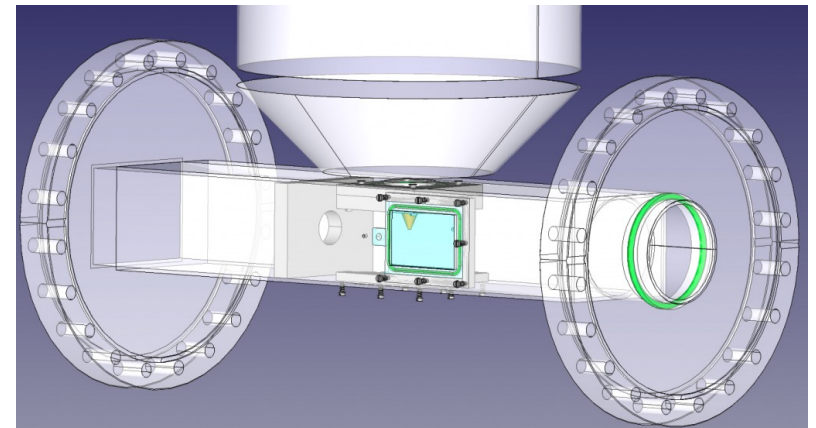
ICE endstation



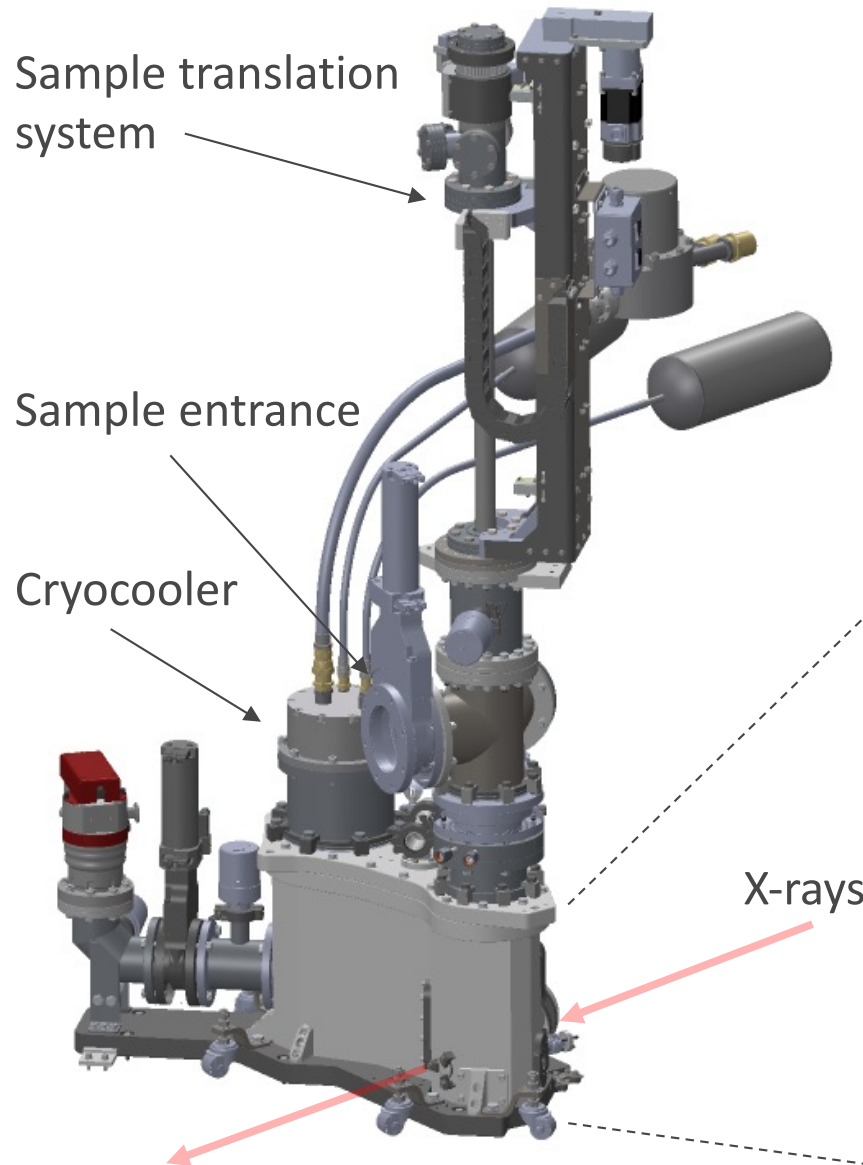
Veritas molecular spray nozzle



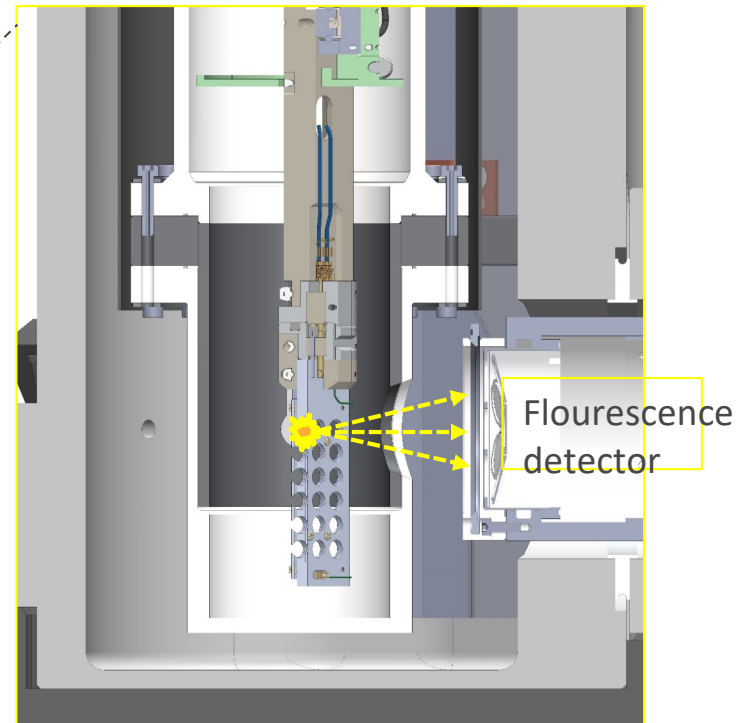
ICE differential pumping chamber



7. The Balder cryostat



- Cryomech PT420 pulse-tube cryorefrigerator
- Sample in He vapour
- Rotation and vertical translation
- Horizontal translation in sample holder
- Base temperature ≈ 10 K
- Automated sample change



In-house development:
SEDS, Balder team, MAX IV Design Office