Balder beamline

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Lund, 2018-02-15

Balder beamline

Balder is the god of light in Norse mythology

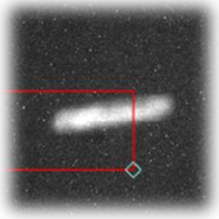
Technique:
X-ray absorption spectroscopy (XAS)
X-ray emission spectroscopy (XES)

Time resolution to sub-sec (Continuous scanning is now possible with 1keV range in 0.5 sec.)

Two “specialties”:

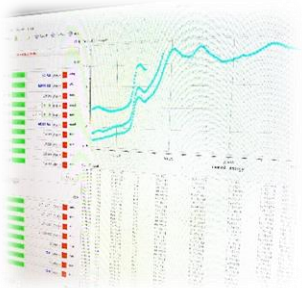
- *in operando/in situ* materials research
- XAS/XES on dilute sensitive samples (bio-geo-environmental)

First monochromatic light
8.4 keV



- March 2017

First XANES of Cu K-edge



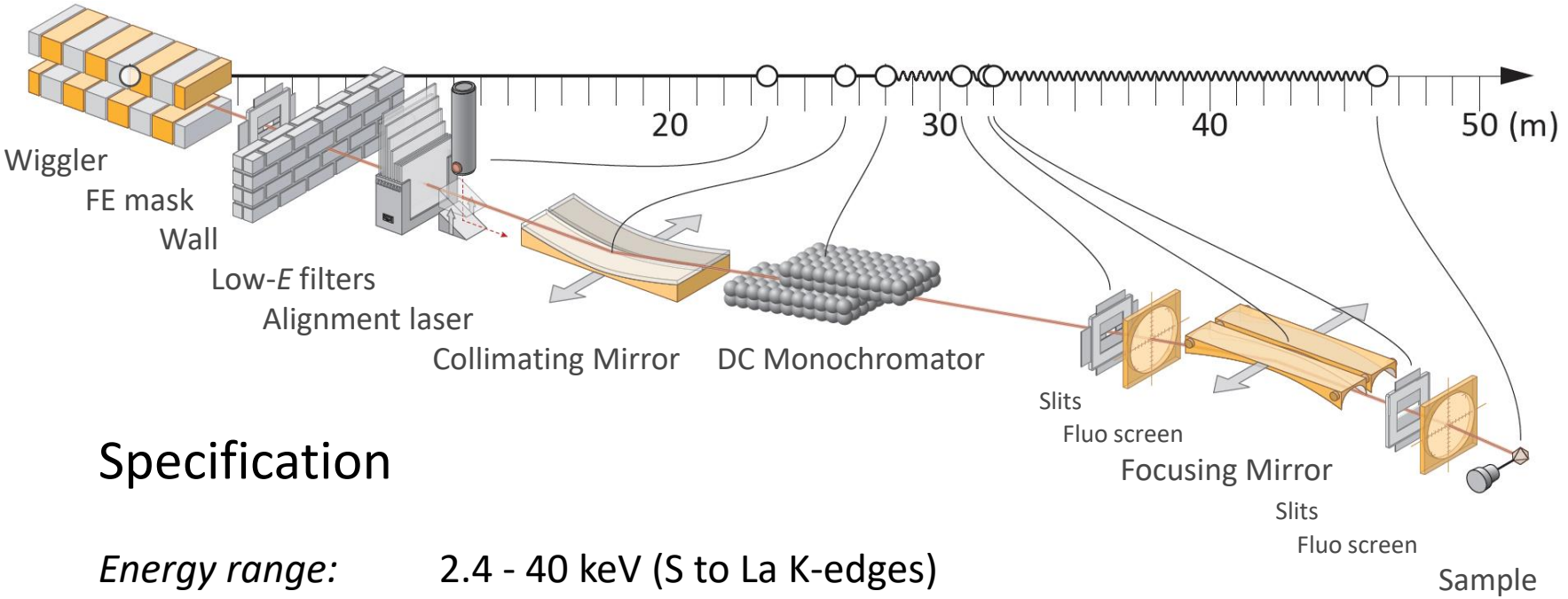
...in optics hutch - April 2017

Spring 2018
End-station commissioning with X-rays
(waiting for SSM permit)

Late Spring 2018
Commissioning users

Fall 2018
User operation

Balder beamline – XAS/XES

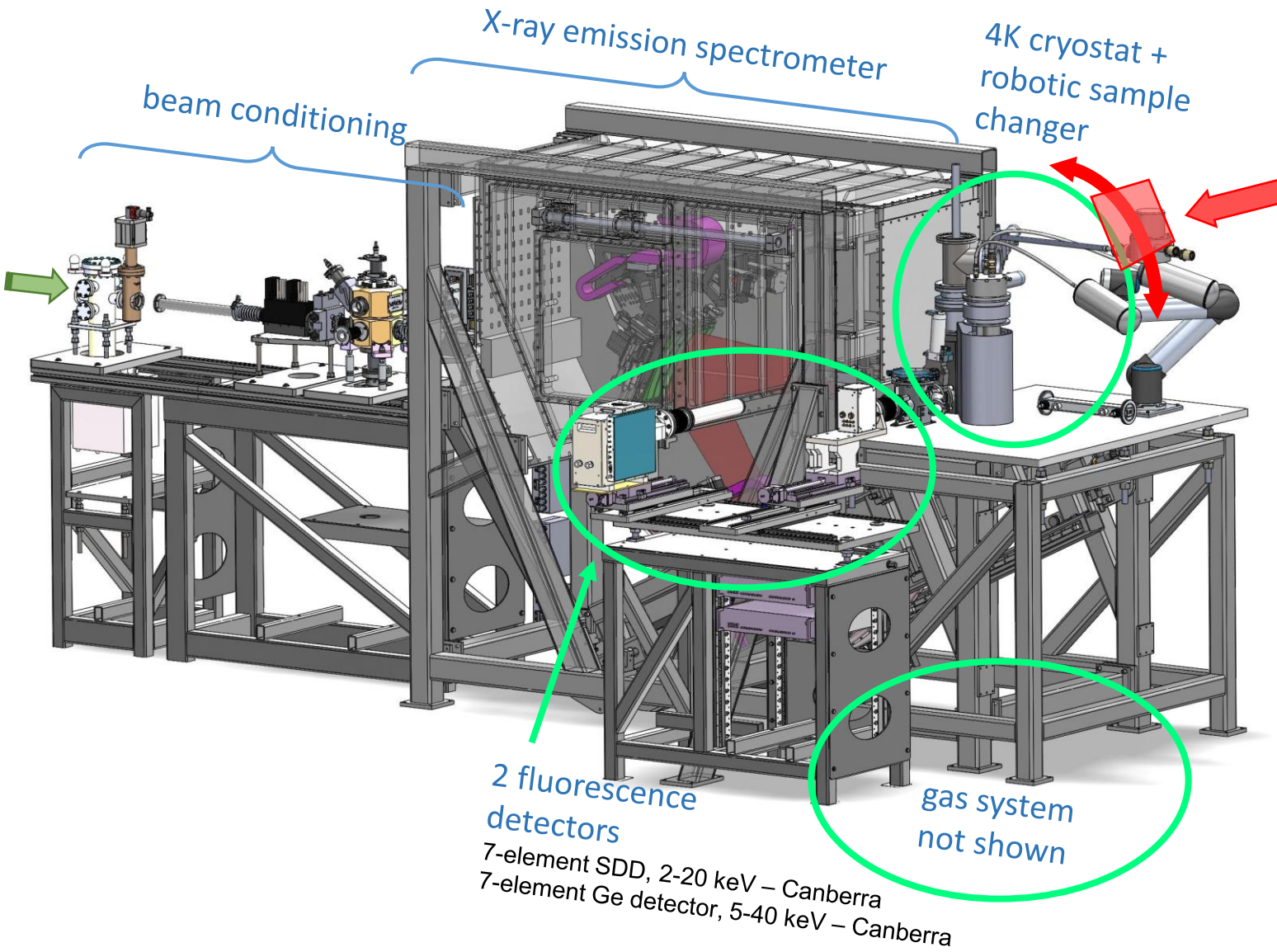


Specification

Energy range:	2.4 - 40 keV (S to La K-edges)
Flux:	10^{12}-10^{13} photons/s
Beam spot size:	focused ~100 x 100 µm^2 or defocused V ~0.1-2mm x H ~ 2-9mm

Suitable for time resolved studies (sub-sec) and dilute, radiation sensitive samples.

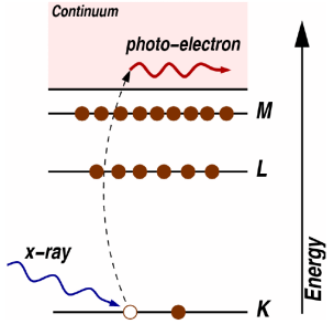
Balder beamline at MAX IV: end station



In-situ sample cells

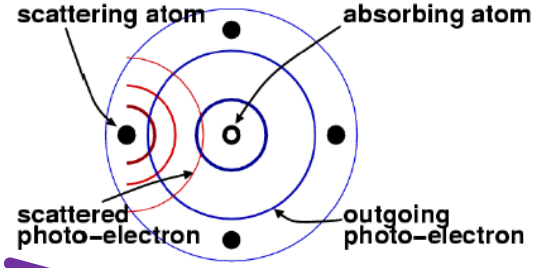
- 1000°C furnace and controller
- MAX IV gas-flow cell for catalysis research
- Microfluidic liquid flow cell

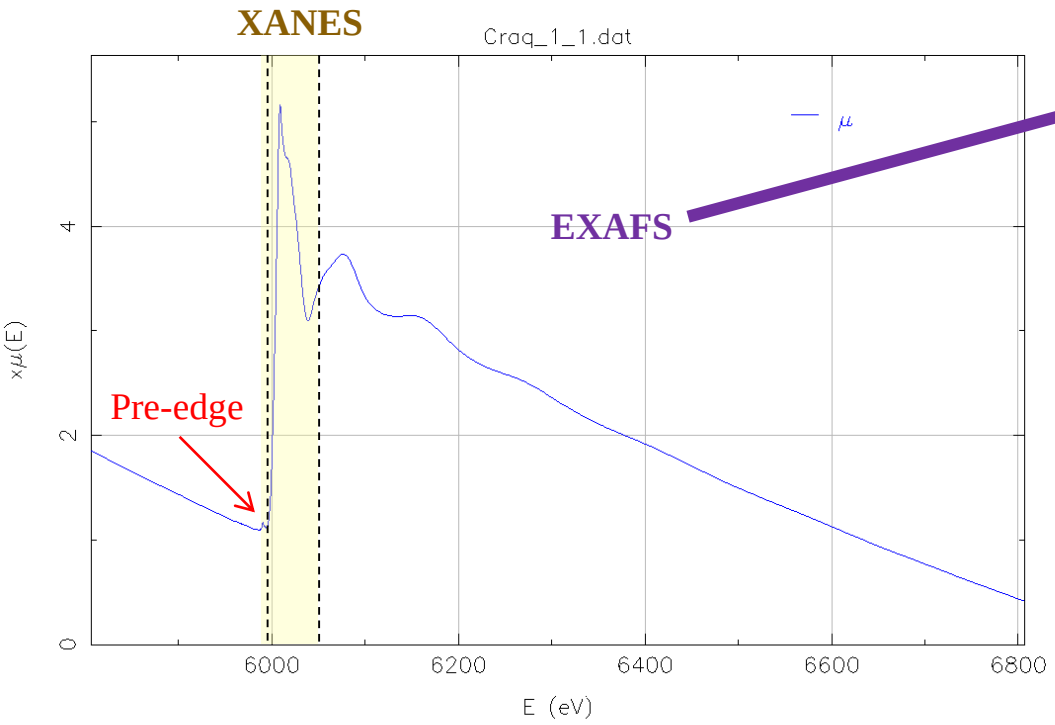
X-ray Absorption Spectroscopy



XAS probes **un**occupied electronic states

XANES = X-ray Absorption Near-Edge Structure
EXAFS = Extended X-ray Absorption Fine Structure



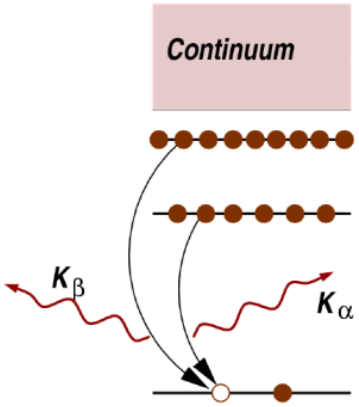


EXAFS Neighbor distance, Coordination number, Neighbor identity

XANES Coordination geometry Oxidation state

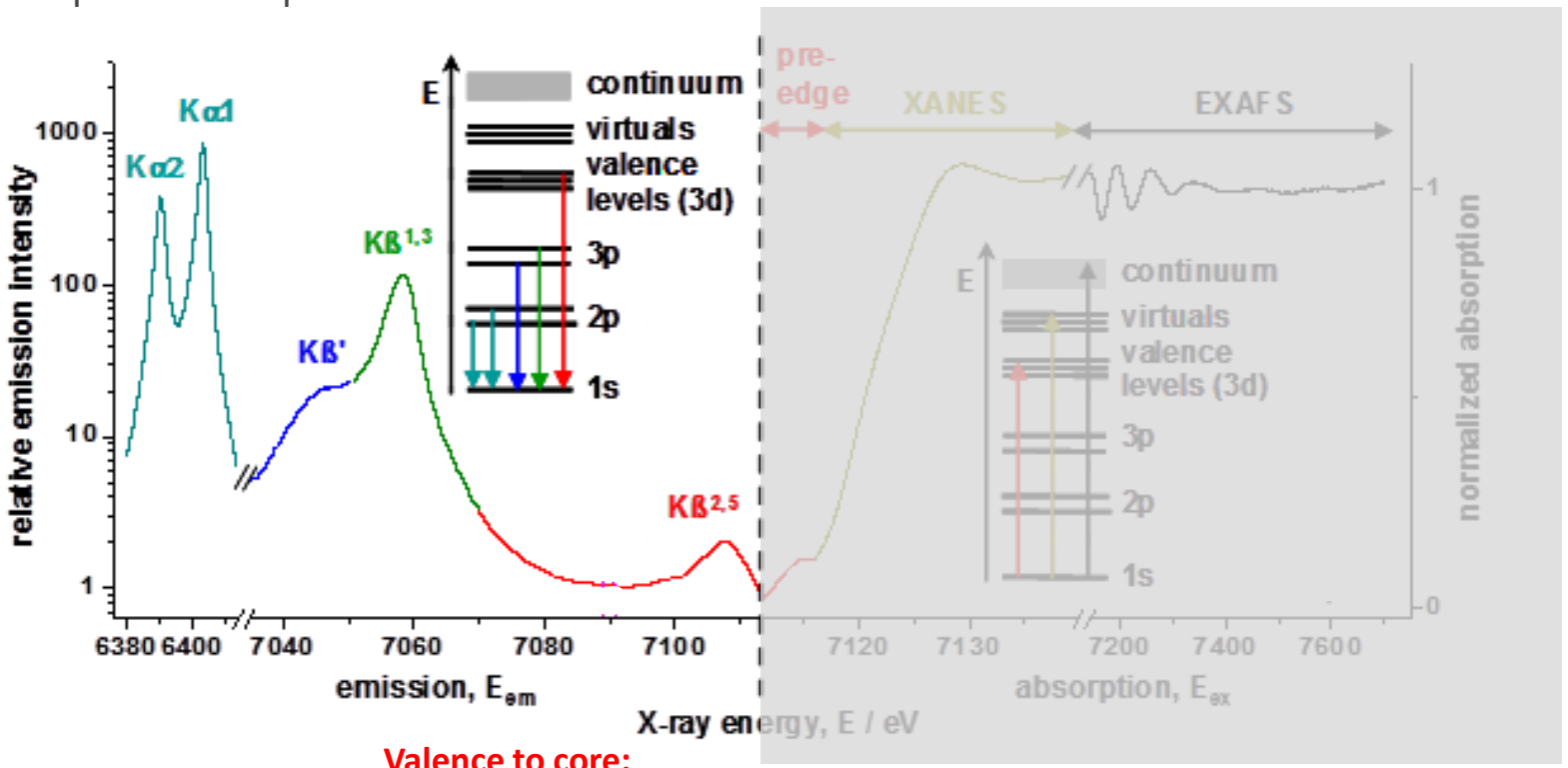
Pre-edge valence orbitals

X-ray Emission Spectroscopy



Photon-in Creating the 1s core hole - Excitation
Photon-out Filling of the 1s core hole - Emission

XES probes occupied electronic states



Kα Oxidation state
Kβ Oxidation state and
Spin state

Valence to core:
Ligand identity
Chemical bonding
Protonation state

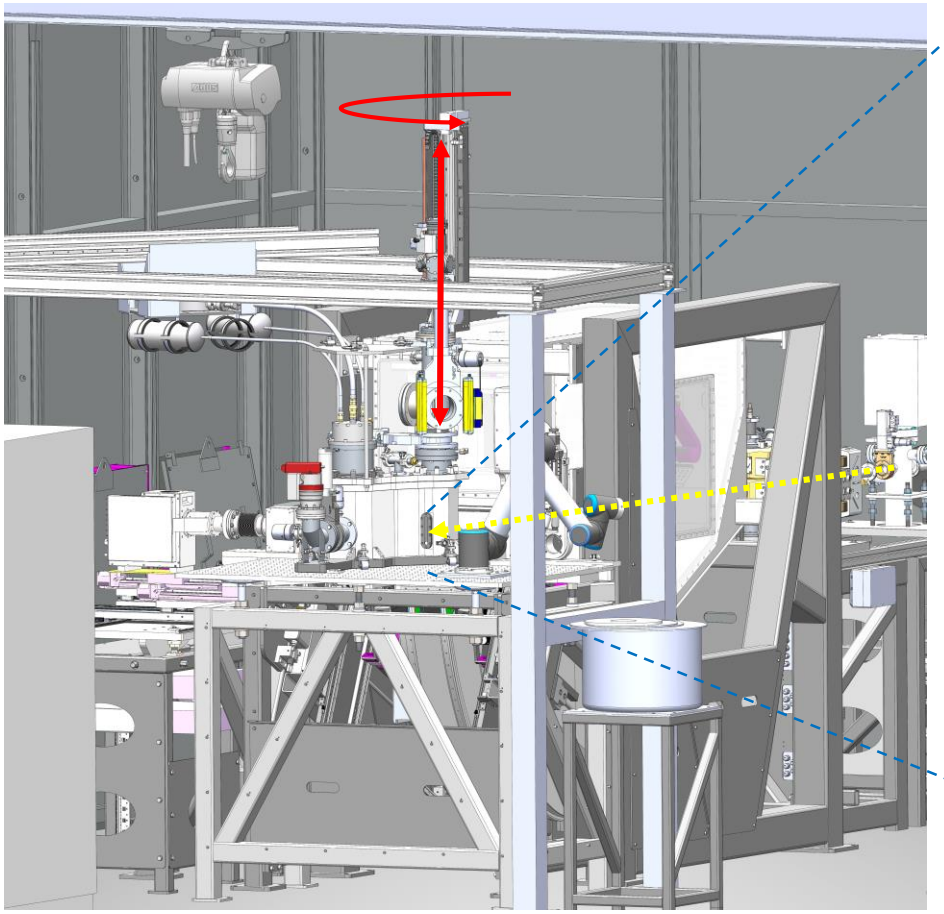
Possibilities for coarse XAS/XRF mapping

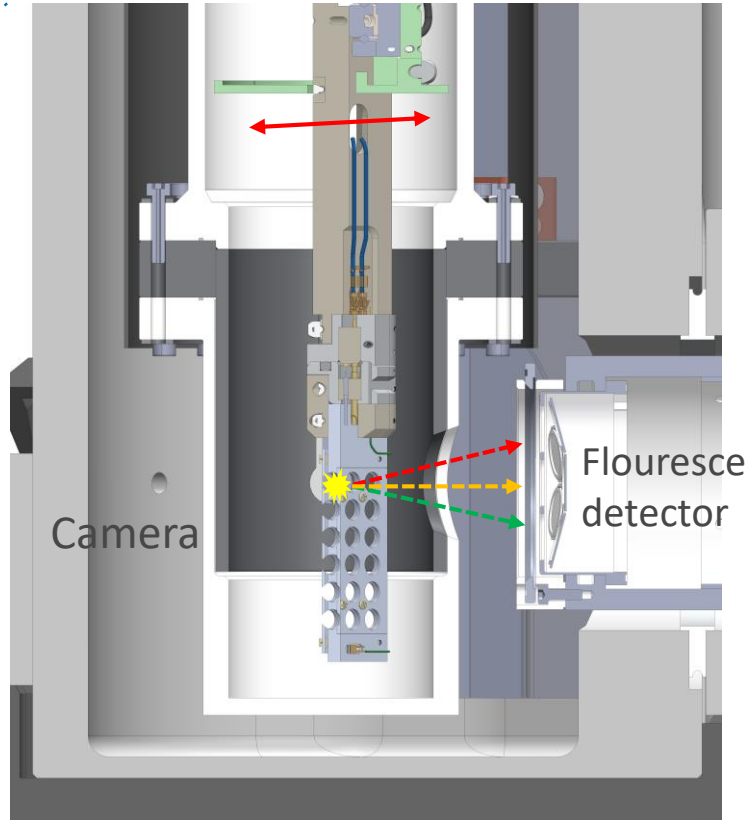
- 4 K cryostat with internal translation of sample
- Beam spot focused 100-70 µm
- Energi dispersive solid state fluorescence detectors;
  - 7-element SDD and 7-element Ge detector
  - X-ray Emission Spectrometer (rich chemical information)

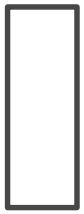
Cryostat project: Functions

- Optimized for measuring radiation sensitive sample at 4-10 K.
- High throughput with multiple samples mounting and automatized sample change.
- **Translation of sample inside cryostat**; horizontal, vertical and rotational. In order to keep optimized beam-detector orientation.
- Automatized mapping scans to be integrated in data acquisition macro for low beam exposure of sample.
- Camera to view samples
- Fast in operation to not consume valuable beamtime.

4 K Closed cycle cryostat







Sample plate
40 x 20 mm^2

When to use Balder?

- Element and orbital specific information
- Transition metals (K-edges), heavier elements (L-edges)
- ***Any type of sample and in air***
- Atomic/electronic structure of the average absorber in the bulk
- Learn about the;
  - Oxidation state and coordination geometry (XANES),
  - Neighboring atoms; number, identity, distance (EXAFS)
  - Electronic properties (pre-edge and XES)

Thank you!

Welcome to Balder in 2018/19

The Balder team

Dr. Konstantin Klementiev *Beamline manager*

Dr. Kajsa Sigfridsson Clauss *Beamline scientist*

Dr. Stuart Ansell Beamline Research engineer

Prof. Ingmar Persson *Spokesperson*

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