PAUL SCHERRER INSTITUT

PSI

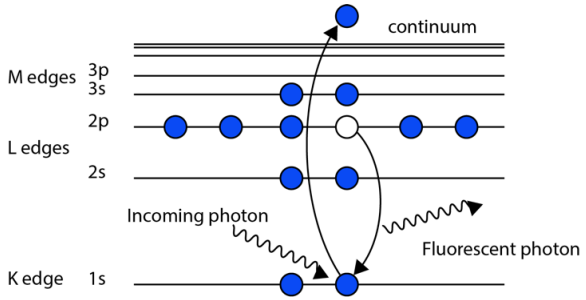
Elia Razzoli:: Furka Group:: Paul Scherrer Institute

Furka endstation: current status and goals for 2022

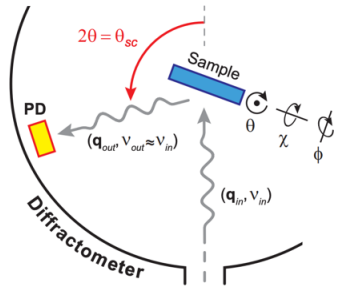
4th SwissFEL Performance Workshop - 26.01.2022

Furka @ ATHOS

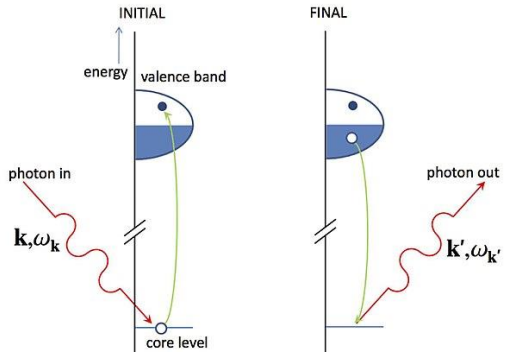
TR- X-ray absorption (XAS)



TR- X-ray diffraction (RXRD)



TR- Inelastic X-ray Scattering (RIXS)



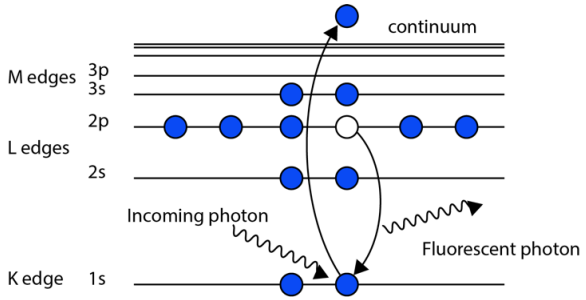
- Ultrafast pump-probe resonant spectroscopies to study correlated and quantum materials

Luc Patthey | Elia Razzoli | Cristian Svetina | Eugenio Paris | Hiroki Ueda | Ken Egli

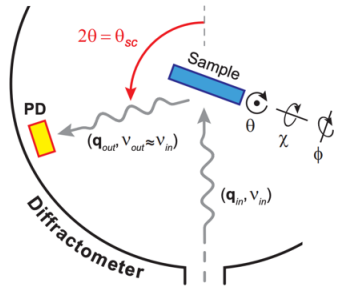
Biaolong Lui | David Mueller | Marcel Locher | Thierry Lachat | Thierry Zamofing | Claude Pradervand

Furka @ ATHOS

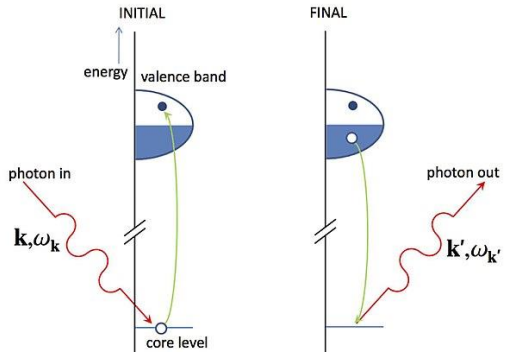
TR- X-ray absorption (XAS)



TR- X-ray diffraction (RXRD)



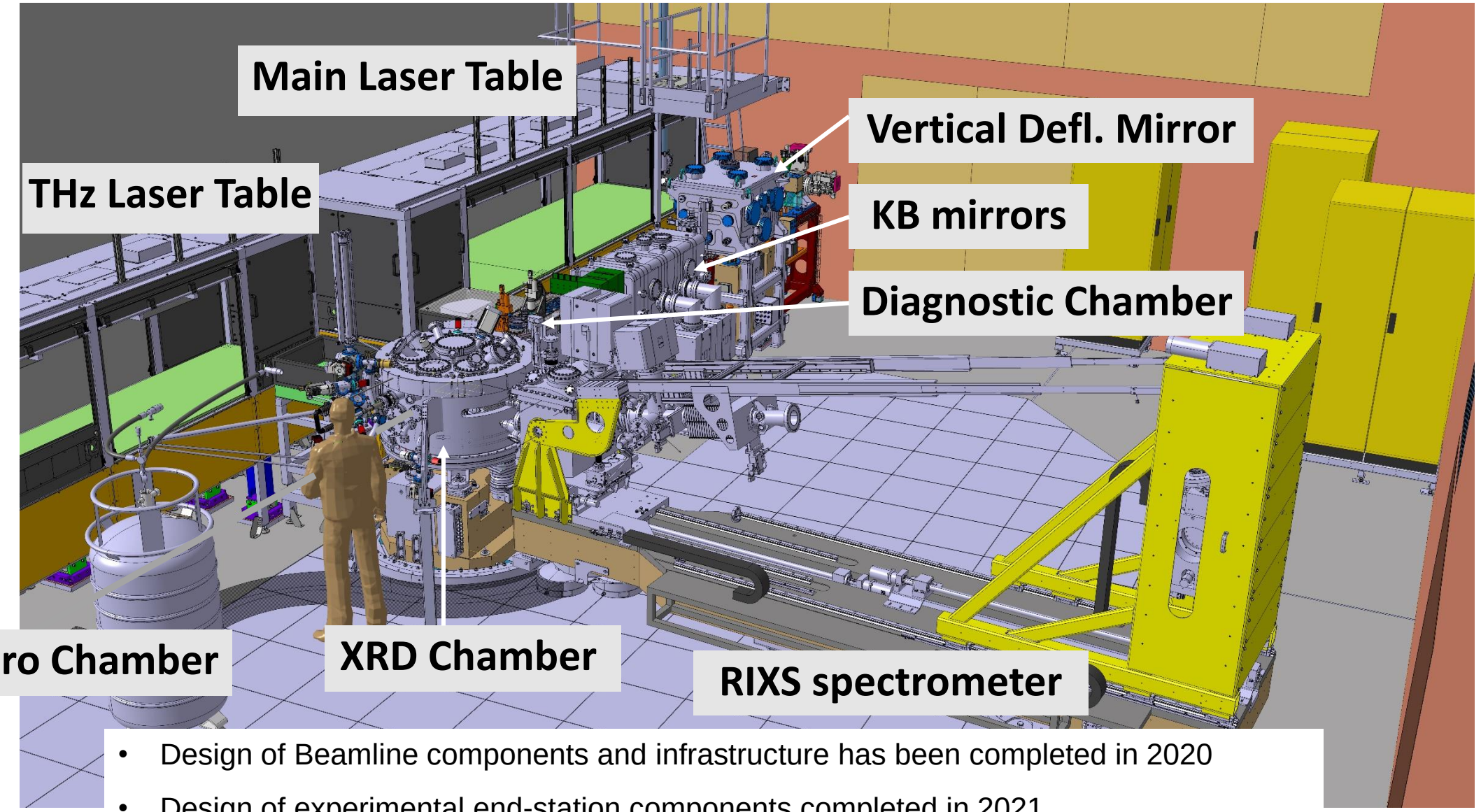
TR- Inelastic X-ray Scattering (RIXS)



New group name:

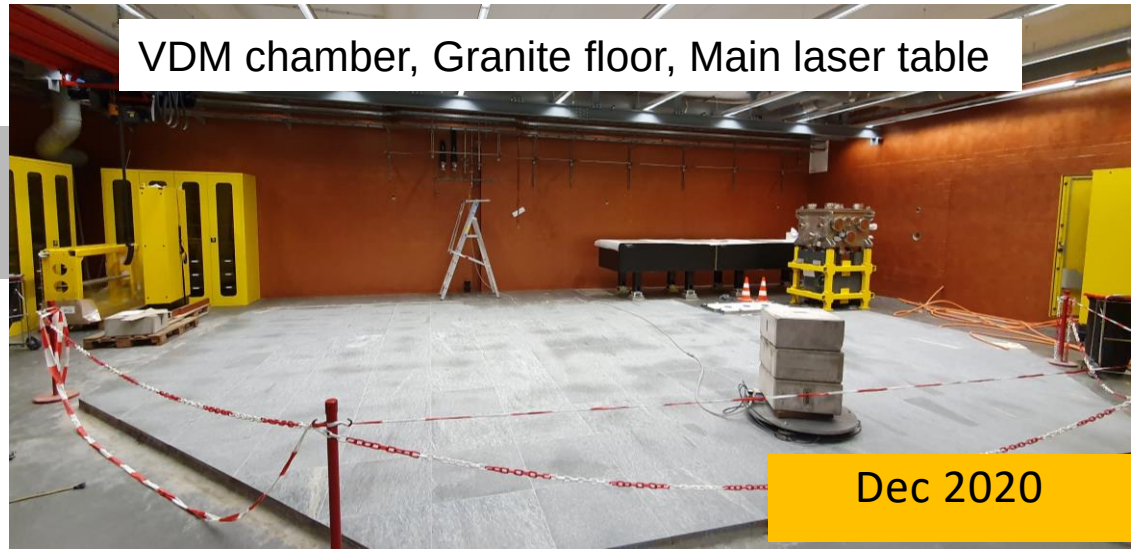
Ultrafast Spectroscopy of Condensed Matter

Furka endstation: experimental hutch



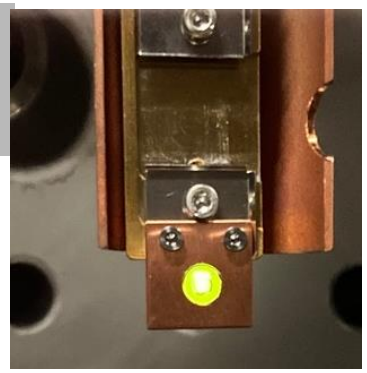
- Design of Beamline components and infrastructure has been completed in 2020
- Design of experimental end-station components completed in 2021

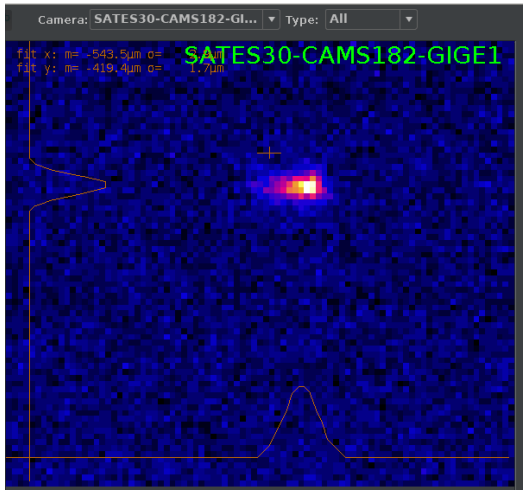
Furka time-lapse



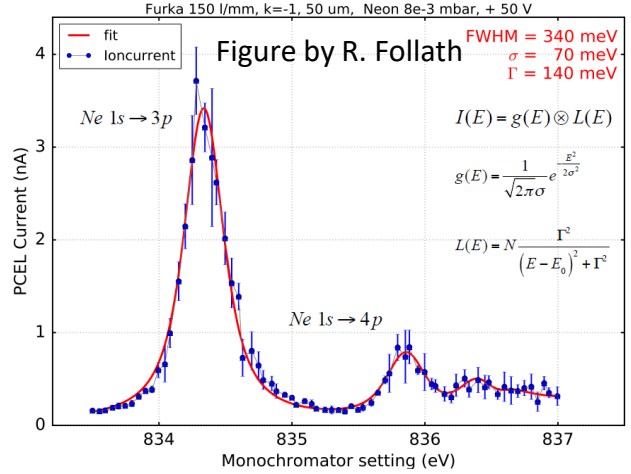
Retro' chamber commissioning

June 2021:
First light



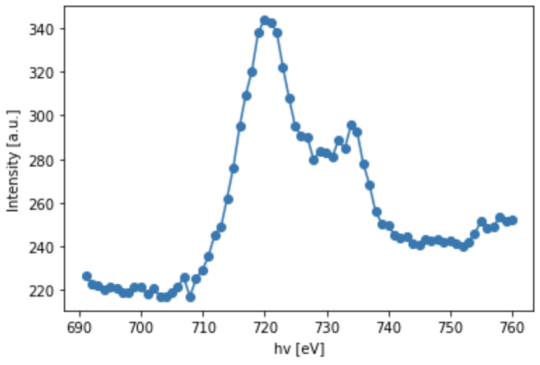


December 2021:
First monochromatic light and RIXS spectra

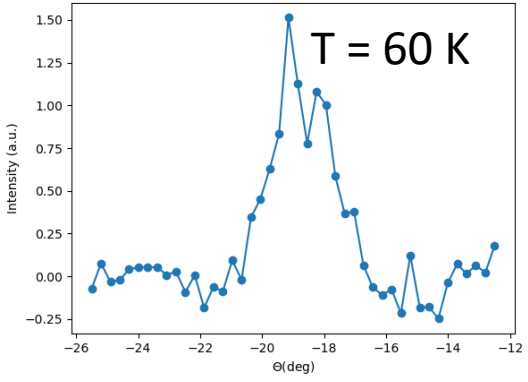


September 2021: First XAS and RXRD

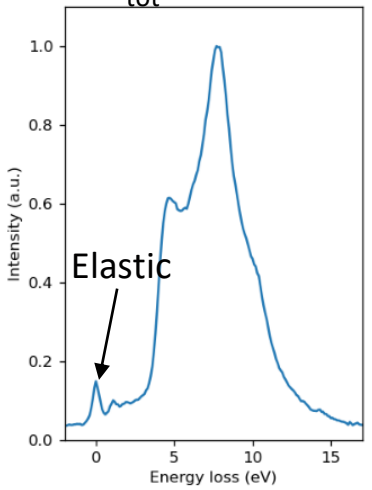
Fe L-edge XAS



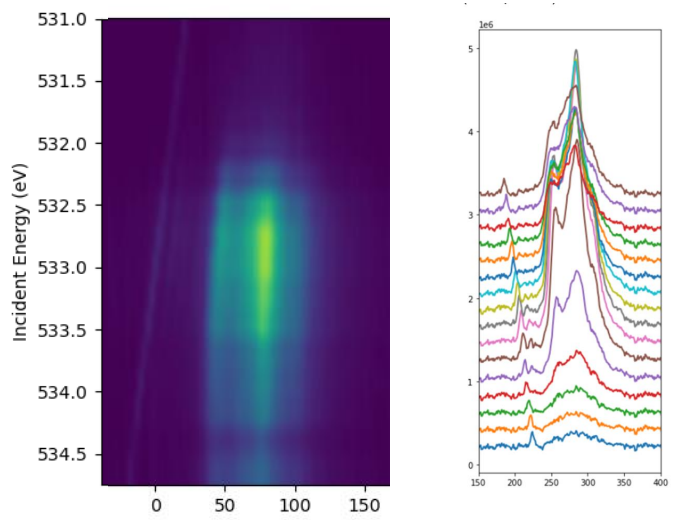
RXRD (Fe L-edge) AF reflection



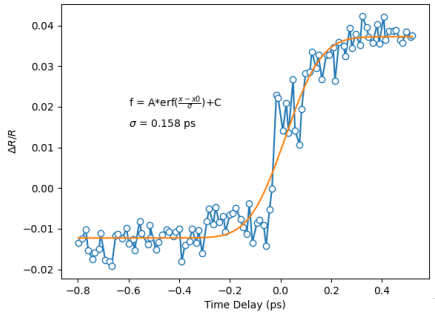
NiO RIXS
ΔE_{tot} = 450 meV

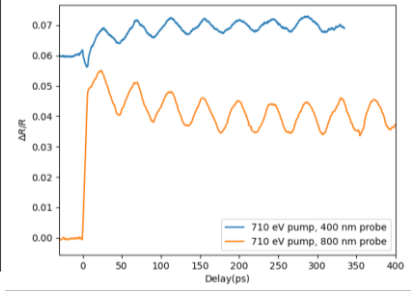


Incoming photon-energy map.



Feb. 2021:
Goal is 1st p-p spectroscopic measurements

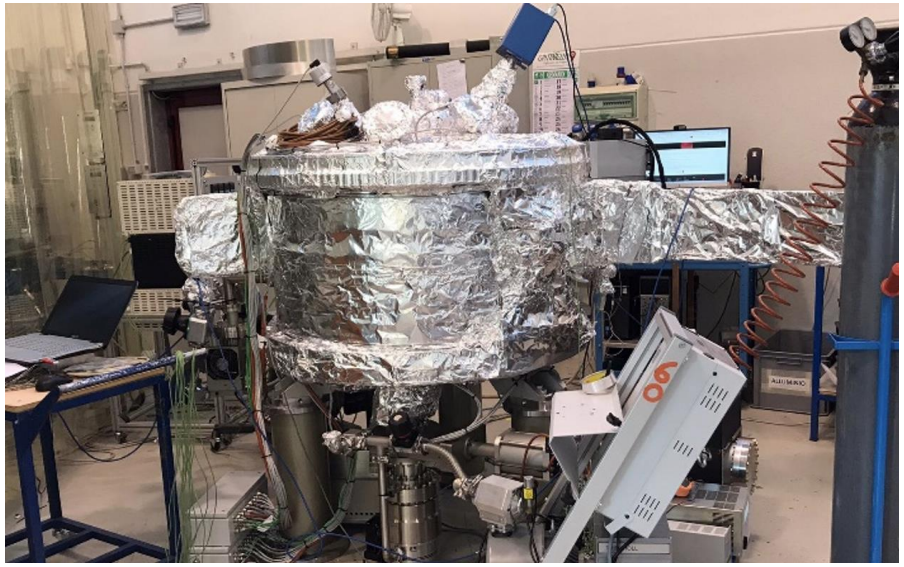




Many thanks to optics, controls & laser group @ SwissFEL and U. Staub & T. Schmitt groups @ SLS for their support

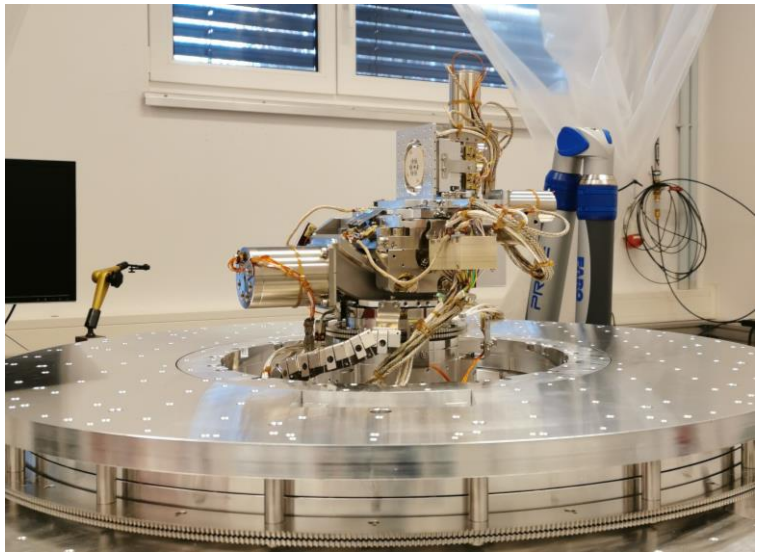
Furka: upcoming installations

XRD chamber (Cinel)



- **Sliding seal chamber delivery expected on 16th Feb. 2022**

UHV diffractometer (Bestec)



- **4-circles UHC diffractometer delivered**

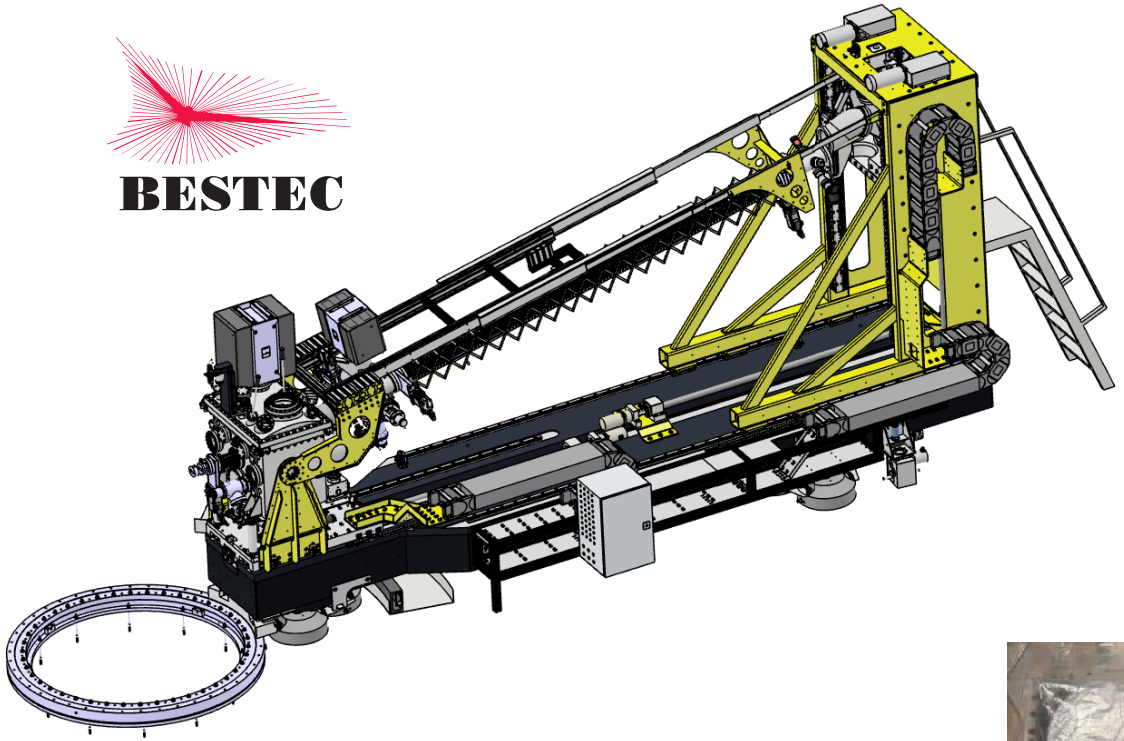
- **Installation March – April 2022**
- **Test from May 2022**
- **Pilots in 2nd half of 2022**

goals/challenges for XRD measurements (Q2-Q4 of 2022):

- hv=500-1000 eV in sase and **monochromatic mode**
- 30 fs rms, single color**, 100 Hz**, **Circ. & linear pol.**
- **high pulse energy after monochromator**
  (independence from Aramis in case for instance of LBW mode)

- Laser extension for NIR/VIS to mid-IR/Thz
- PCO-edge beam synchronous

Furka endstation: RIXS spectrometer



- Continuous rotation on air bearings
- Spectrometer length = 6 m
- Grating with 10’000 R.P. available
- Three interchangeable VLS gratings
- Recollecting optics for optimized throughput

Girder with linear guidance system

Welded support structure

Vacuum Vessels

Flange-mounted custom CMOS detector

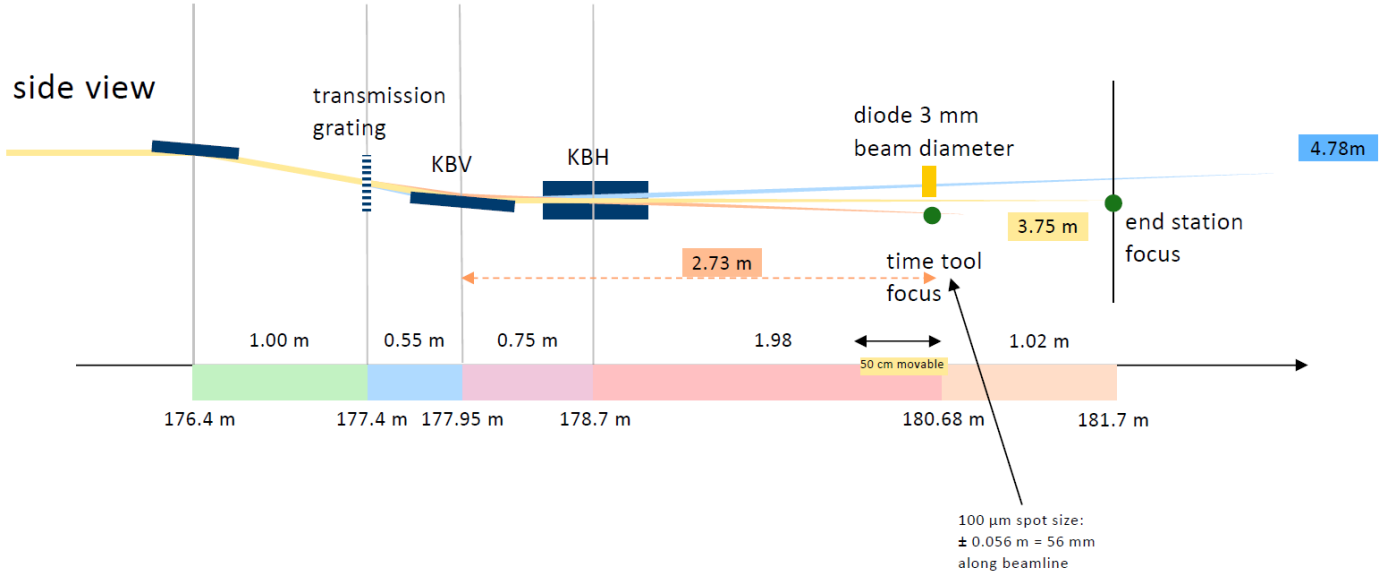
- **Construction underway**
- **installation from Aug 2022**
- **Test Q4/2022**

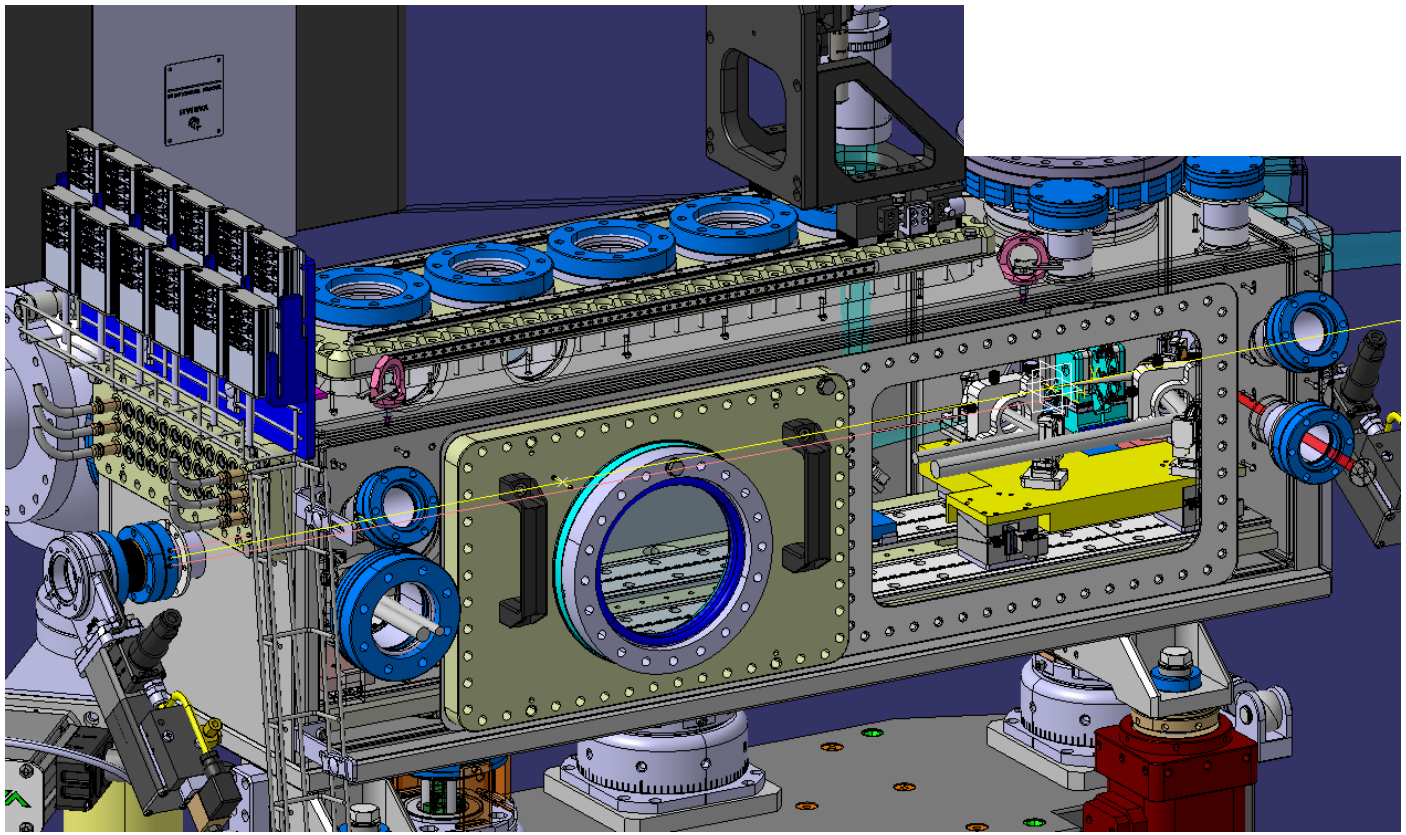
Challenges/goals

- **4 Mpix Cmos beam synchronous acquisition (with ROI)**
- **LGAD Jungfrau acquisition (once available)**

Diagnostic chamber

- C. Arrell
- A. Ammon
- H. J. Eckerlin

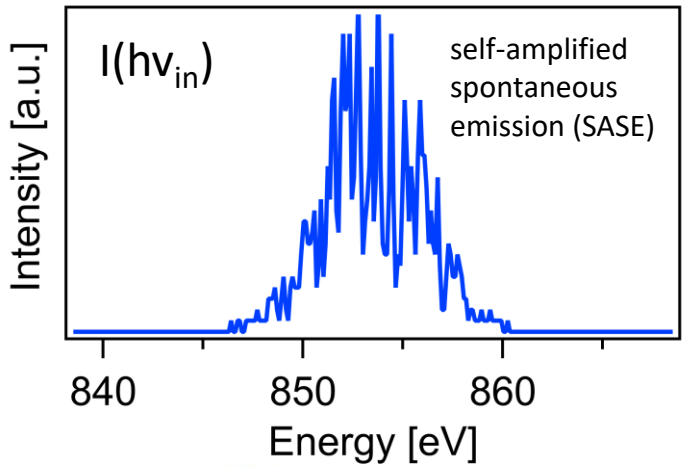


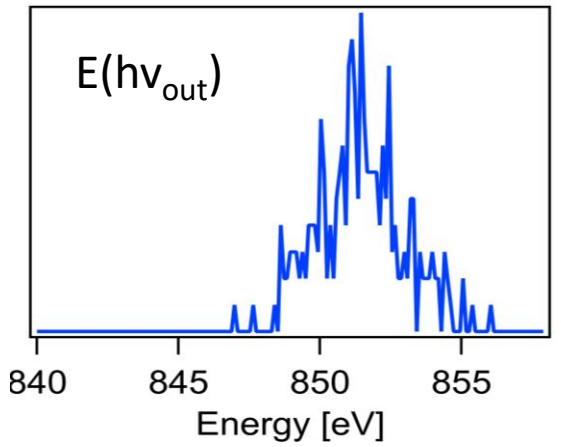


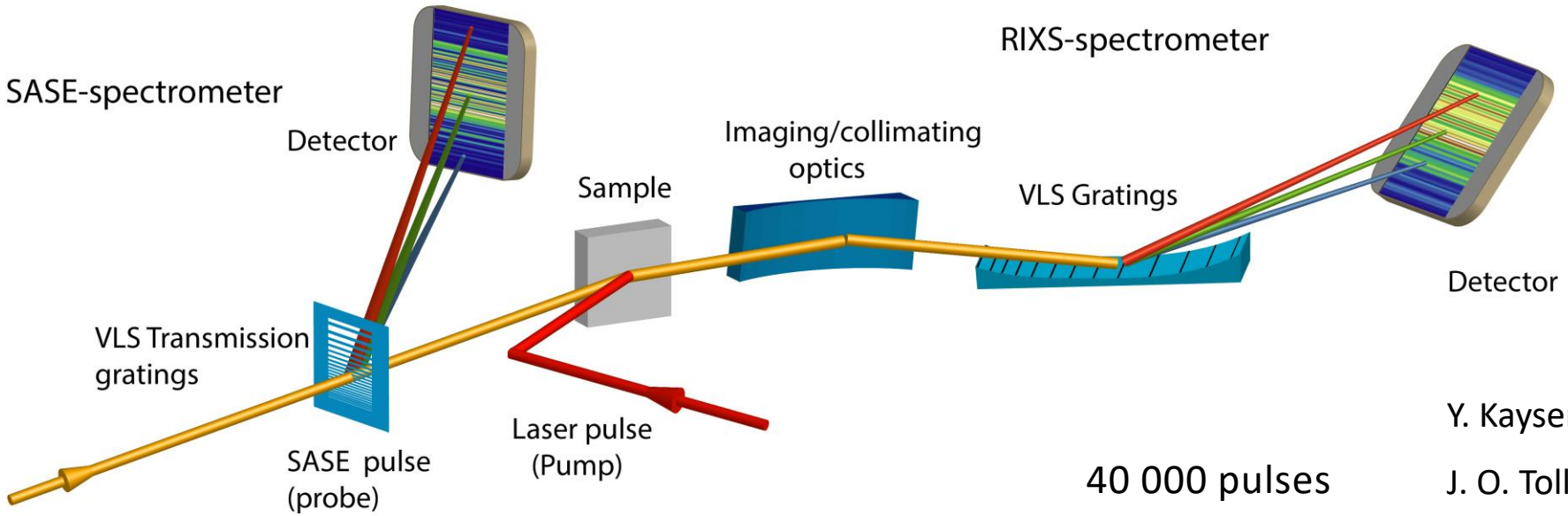
- Concept completer end of 2020
- Design completed completed May 2021
- Manufactory in AVOR, delivery in May 2022
- Procurements on in vacuum components ongoing

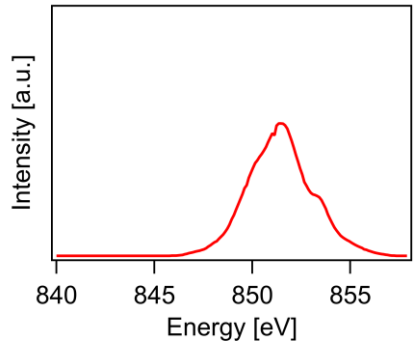
- Challenging to perform diagnostic after monochromator. High energy “narrow”-bandwidth pulse required

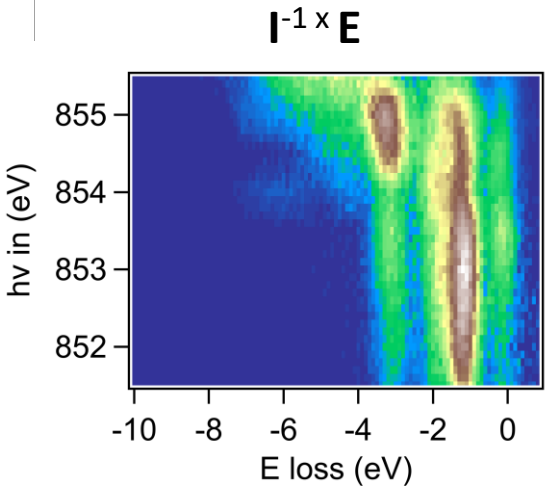
2D-SASE RIXS @ FURKA











40 000 pulses

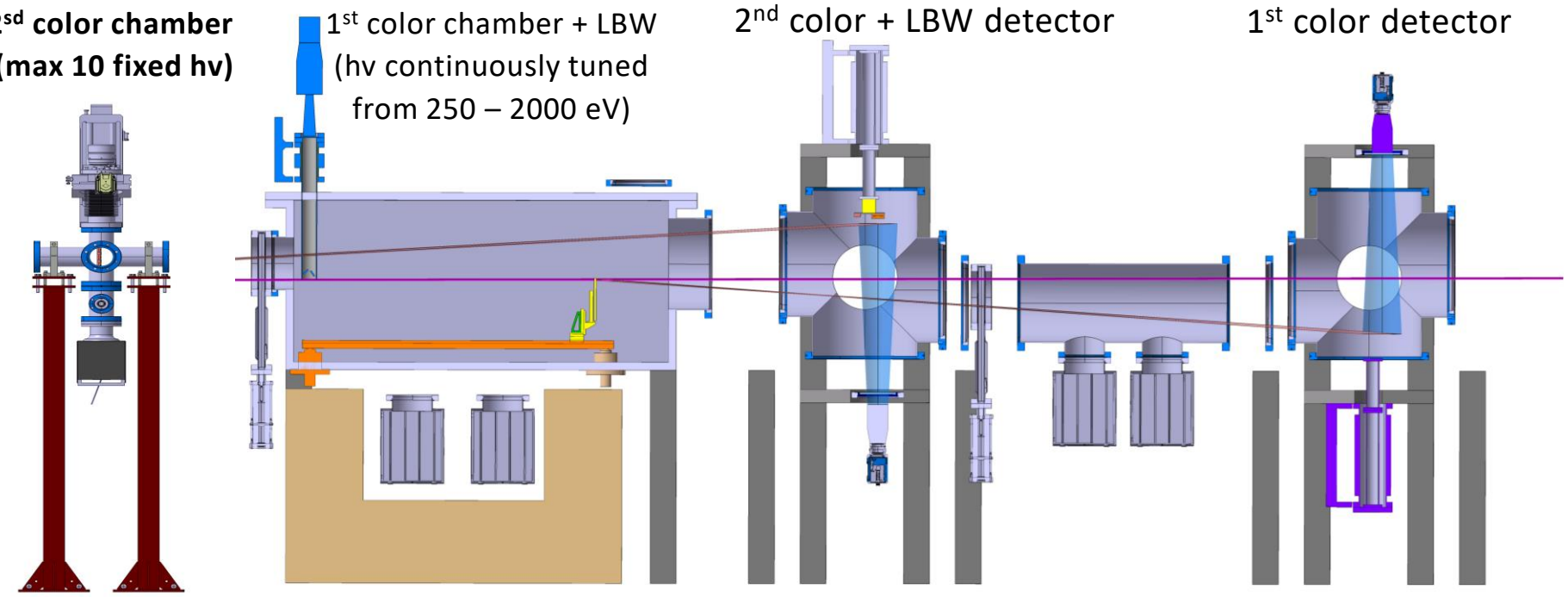
Y. Kayser et al., Nat. Comm. 10, 4761 (2019)

J. O. Tollerud et al., PNAS 116 (12) 5383 (2019)

Design by C. Svetina & D. Mueller

- Combination of two spectrometers for incoming (SASE-) and emitted radiation (RIXS-spectrometer)

SASE-RIXS spectrometer - update



- Concept including 2 colours and broad band
- Goal is to finalize the design by end of April
- Installation foreseen for Dec. 2022

Goals/challenges:

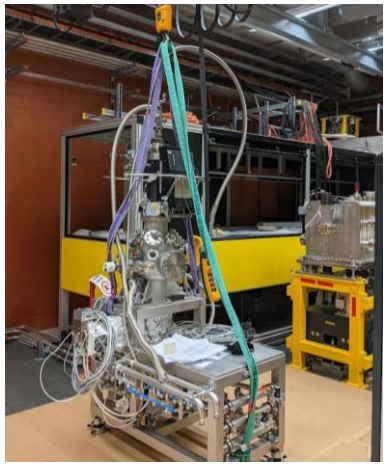
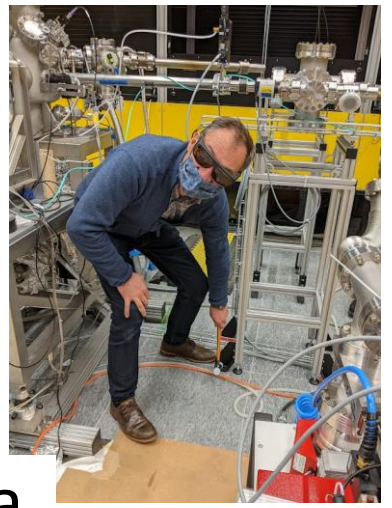
- Tunability of the spike structure of SASE beam is important for us (avg #spikes, energy separation etc.)
- It will require common effort to understand what needs to be tuned and how

Summary goals/challenges at Furka for 2022:

- Stable 100 Hz operation
- Circ. & linear pol. available
- high pulse energy in monochromatic mode (independence from Aramis in case for instance of LBW mode)
- Laser operation extended from NIR/VIS to mid-IR/Thz
- 2D cameras beam-synchronous acquisition (PCOs, 4 Mpix Cmos LGAD Jungfrau)
- Investigation tunability of the spike structure of SASE beam

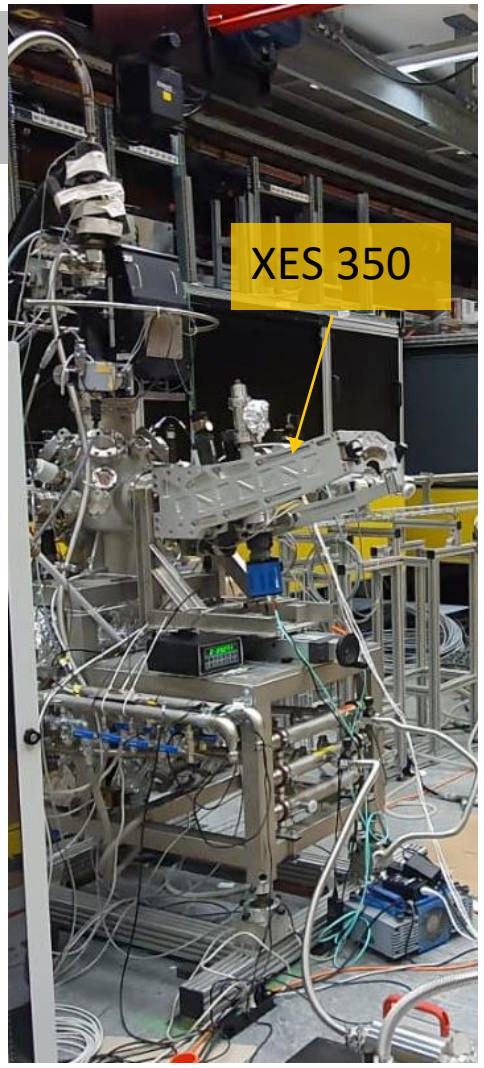
Beamline	Q3/2021	Q4/2021	Q1/2022	Q2/2022	Q3/2022	Q4/2022
Furka Retro	1st beam and test measurements					
Furka XRD	Construction		Installation	Test	Pilot	Pilot
Furka RIXS	Construction				Installation	Test
SASE-RIXS	Concept	Design		Construction		Installation

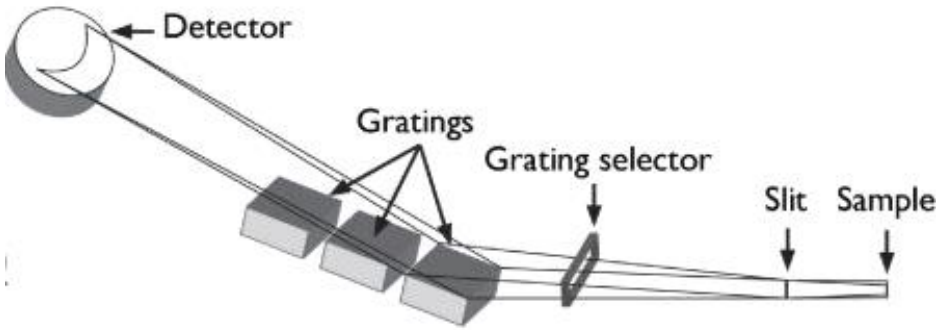


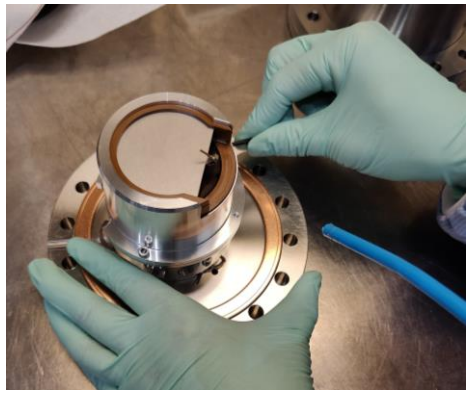
Early commissioning at Furka

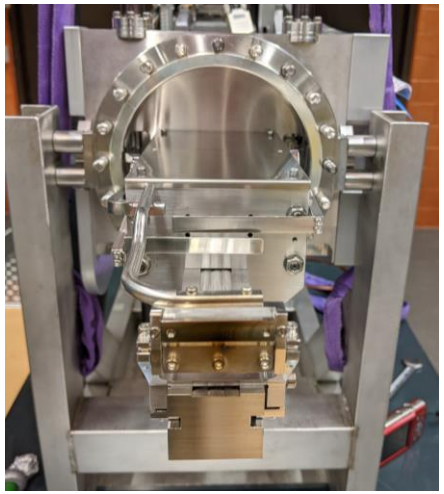
Installation, upgrade and commissioning of Scienta XES350 spectrometer





- Installed a new CsI coated MCP detector





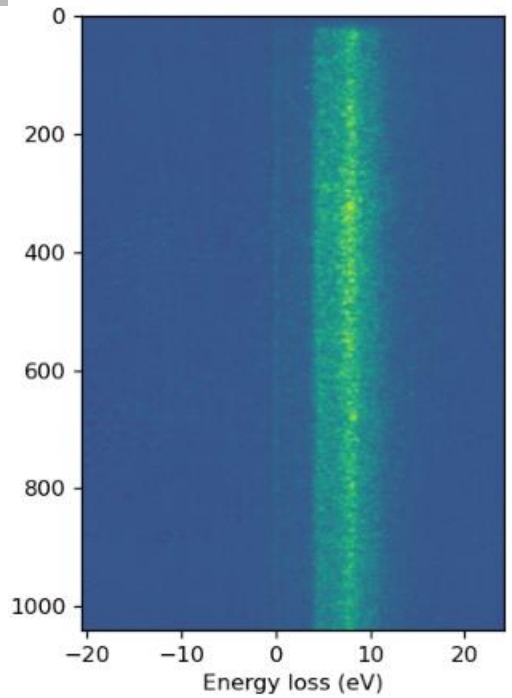
Front view of XES350, entrance slits

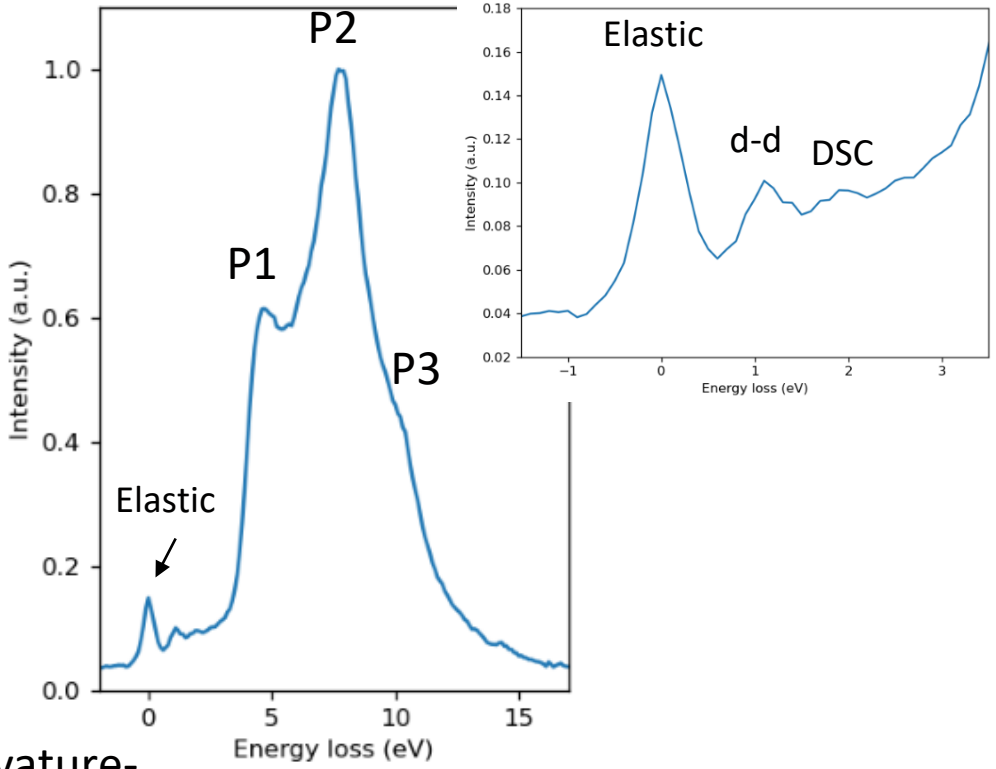
- Optimized MCP (bias voltages) and CMOS detection (dark counts)
- Focused at O K-edge (1st order, 1200 l*mm^{-1} grating).
- Resolving power ≥1’000 (FWHM 500 meV @ 530 eV)

Many thanks to **Thorsten Schmitt** for the support!

O K-edge RIXS on NiO (100)

- RIXS spectrum and low-energy excitations





- Image on CMOS, curvature-corrected, 5 min exposure

- Incoming photon-energy map