The SXP instrument

EuXFEL Call12 virtual information meeting
10 October 2023

Manuel Izquierdo on behalf of the SXP group

Patrik Grychtol
Laser specialist

David Doblas
Data Analyst

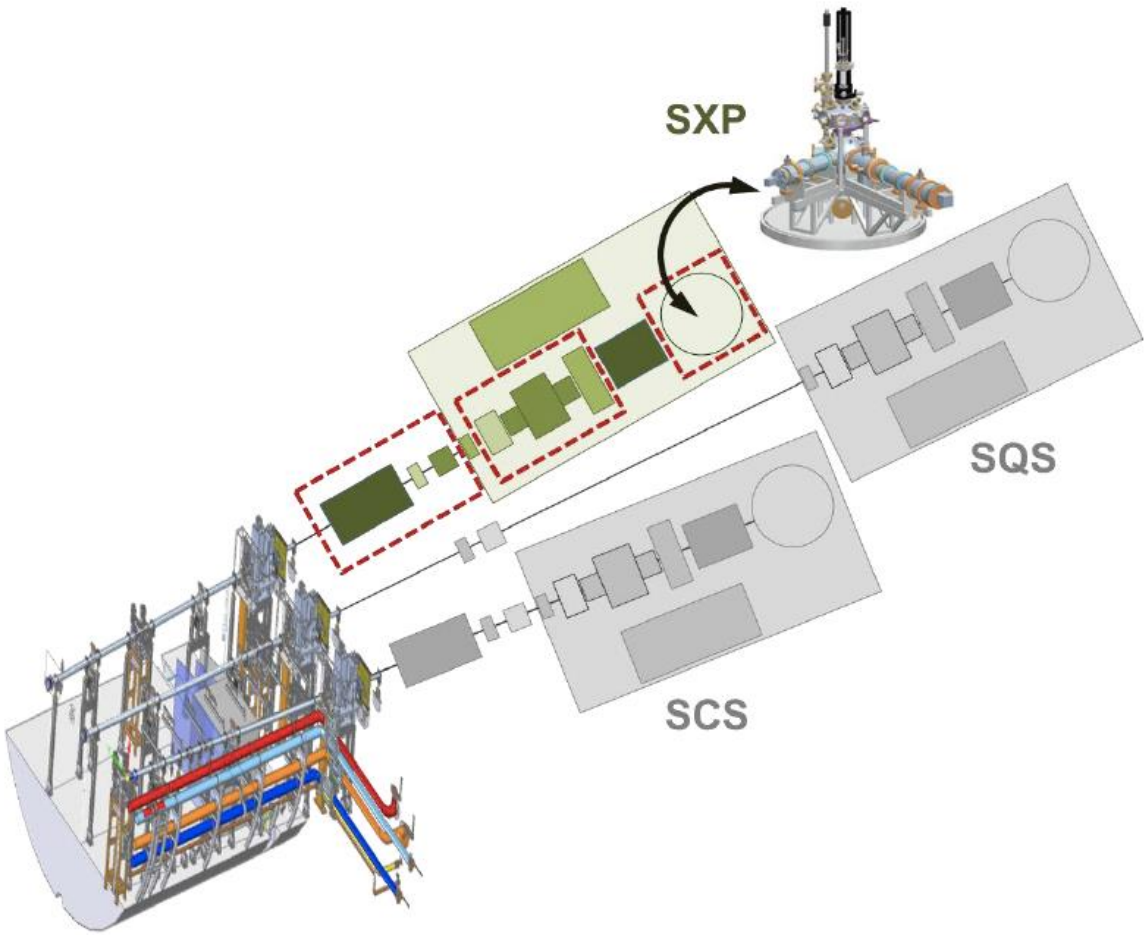
Vahagn Vardanyan
Mechanical Eng.

Ekaterina Tikhodeeva
PhD

Joshua Ohnesorge
Vacuum Eng. (1/3)

Maria Peter
Adm. Assistant

The 7th instrument SXP (Soft X-ray Port)

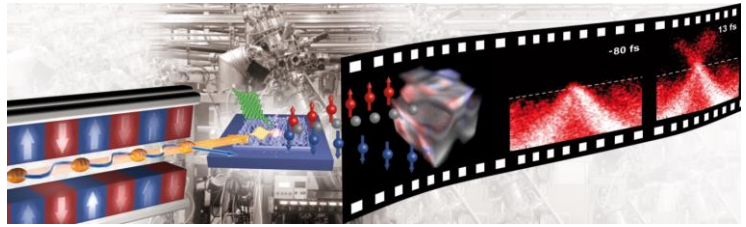


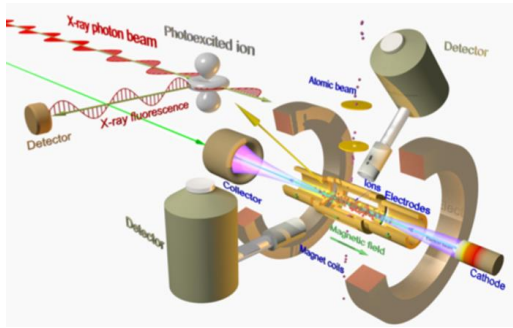
Complete Time-resolved X-ray Photoelectron spectroscopy

TR-XPES

K. Rossnagel
(Uni-Kiel/DESY)

G. Schönhense
(Uni. Mainz)





Laboratory for Astrophysics, atomic physics, fundamental research with highly charged ions

HCI

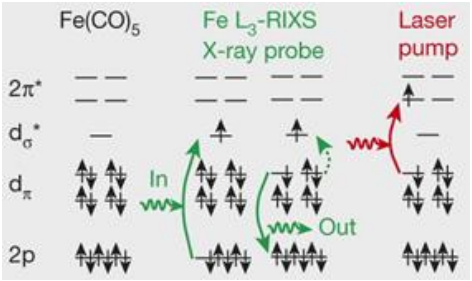
J. Crespo (MPI Heidelberg)

M. Meyer, T. Baumann (EuXFEL)

Understanding Catalysis and biochemistry by studying Chemical Bond Activation

CBA

P. Wernet (Uni. Uppsala)

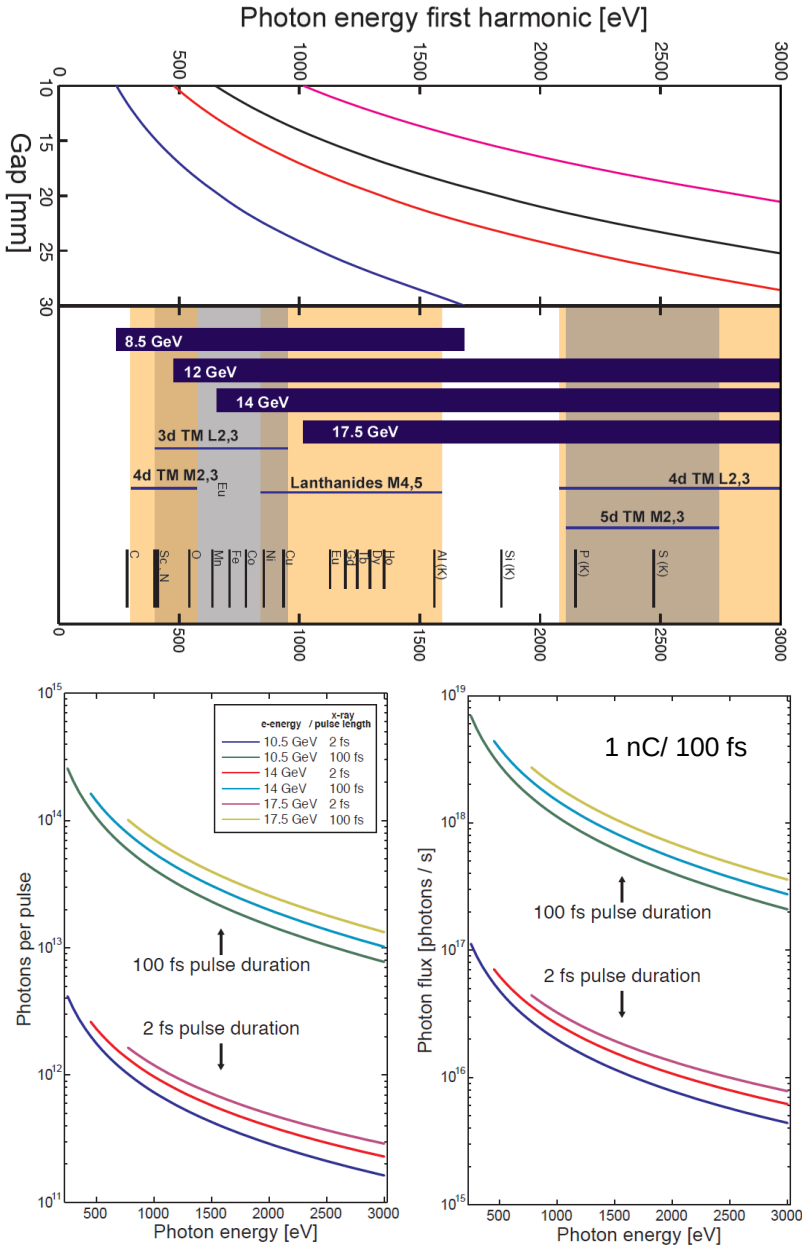


https://xfel.tind.io/record/2647?ln=en

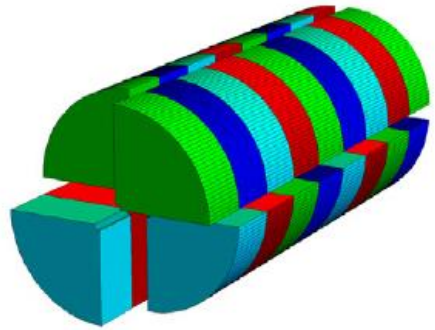
SXP in a nutshell

X-rays

- SASE 3 source (0.25 – 3 keV)
  - > 0.4 keV
  - Pulse energy up to 10 mJ
  - Pulse duration ~ 20 – 25 fs
  - 1.1 MHz / 4.5 MHz: 352 / 800 pulses
- Variable polarization
  - Afterburner installation
- Monochromatization
  - 50 l/mm RP 3000
  - 150 l/mm RP 10000



Variable polarization: APPLE-X

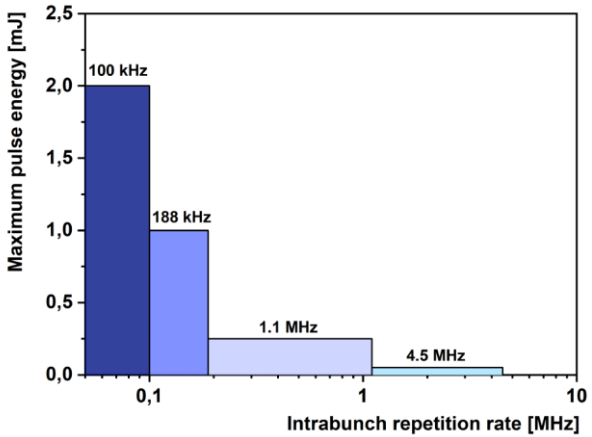


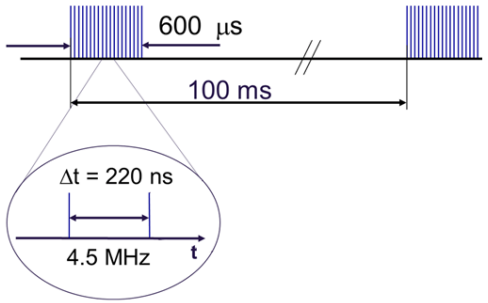
From SCS CDR

SXP laser capabilities: PP laser

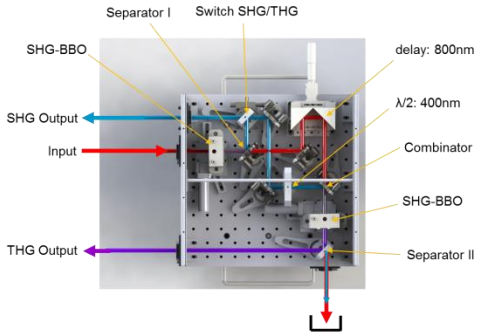
Output lines

- 800 nm = 2 mJ @ 15 – 300 fs
- 1030 nm = 40 mJ @ 1 ps – 500 ps





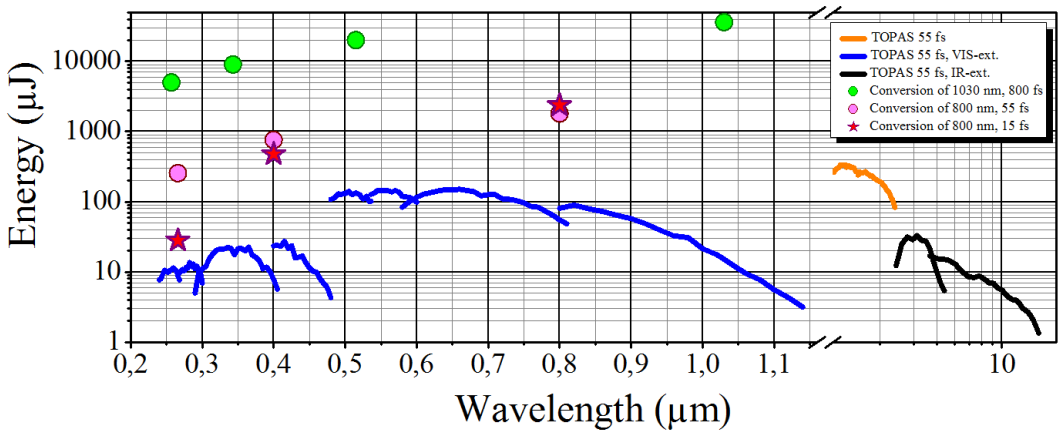
High Harmonic Generation (HHG)



Optical Parametric Amplifier (OPA)

TOPAS prime
Light Conversion
http://lightcon.com/

HHG and OPA at 100 kHz mode



Laser Input Parameters:

- OPA
  - 800 nm = 1.8 mJ @ 55 fs
- HHG
  - 800 nm = 1.8 mJ @ 55 fs
  - 2.4 mJ @ 15 fs
  - 1030 nm = 40 mJ @ 1 ps

Pergament *et al.*, Optics Express **22**, 22202 (2014) & **24**, 29349 (2016)

SXP laser capabilities: AFS 60W

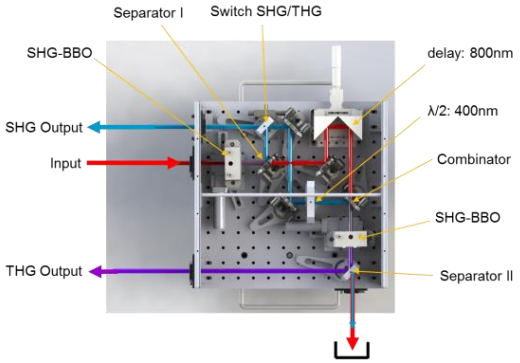
Active Fiber Systems 60W laser amplifier

http://www.afs-jena.de/

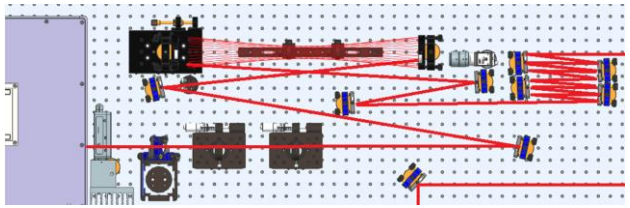
- Delivering 1030nm, 200fs, 200µJ pulses @ 300kHz!
- Continuously adjustable repetition rate up to 20MHz.
- Acousto-optic modulator to mimic 10Hz bunch structure.
- Same seed oscillator as NOPA, thus synchronizable.
- Installed and commissioned

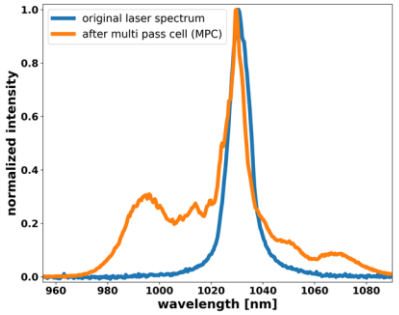
- Compression to 40 fs Heriot-type Multi Pass Cell (collaboration with Christoph Heyls group @DESY and LAS@XFEL)

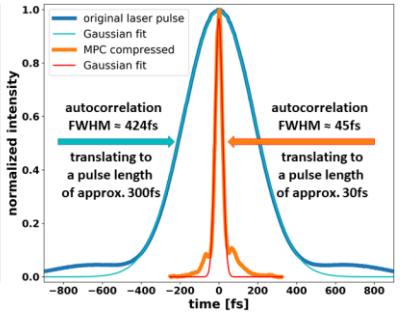
4^{th} harmonic generation 257.5 nm (4.8 eV)



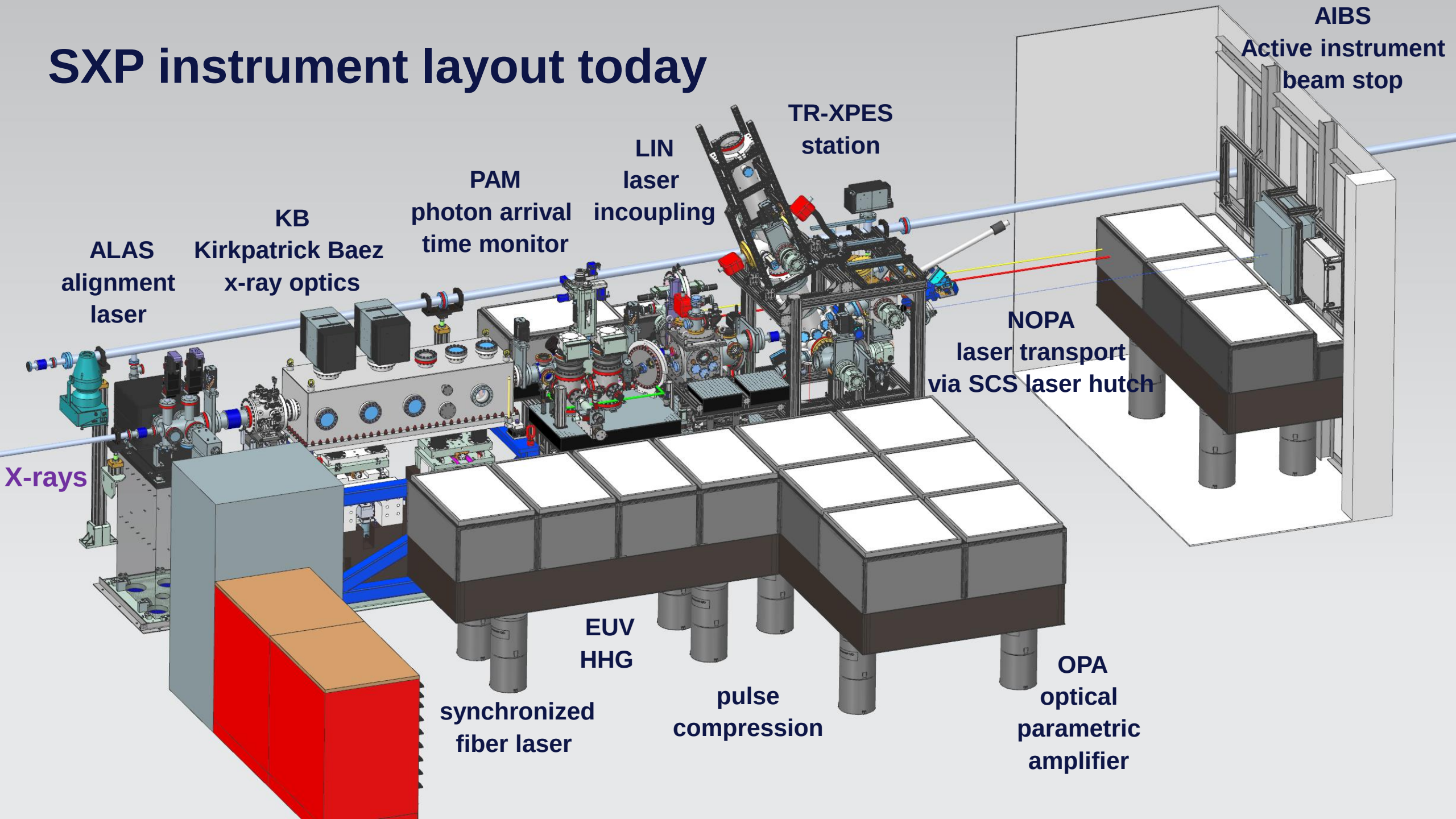
Pulse compression to 40 fs



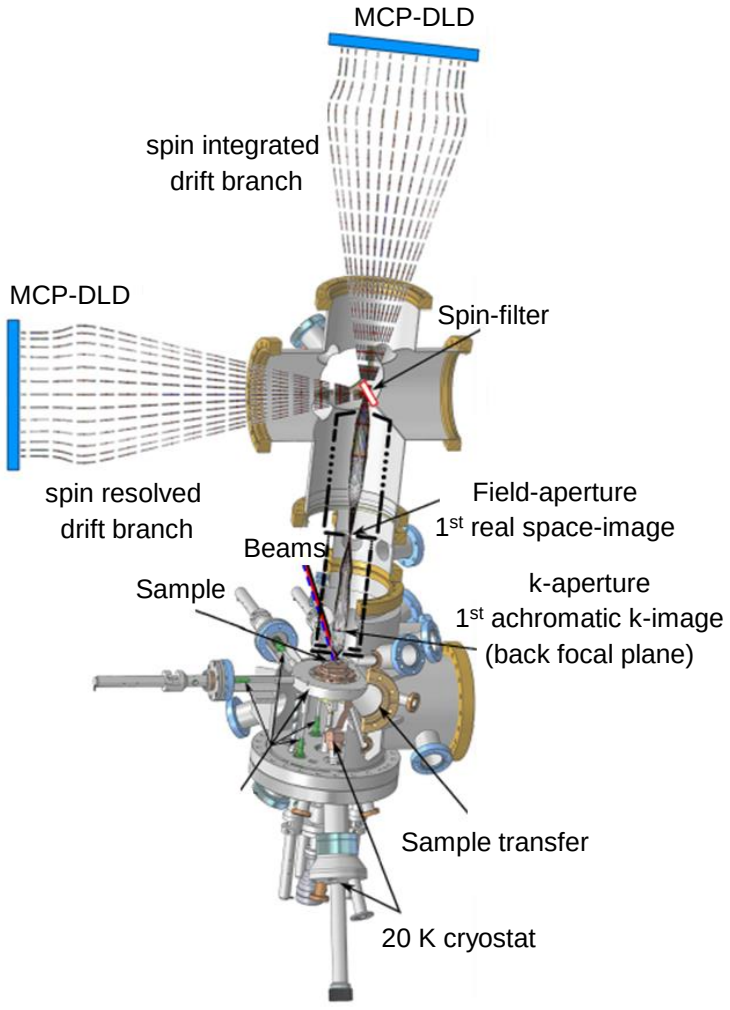




SXP instrument layout today

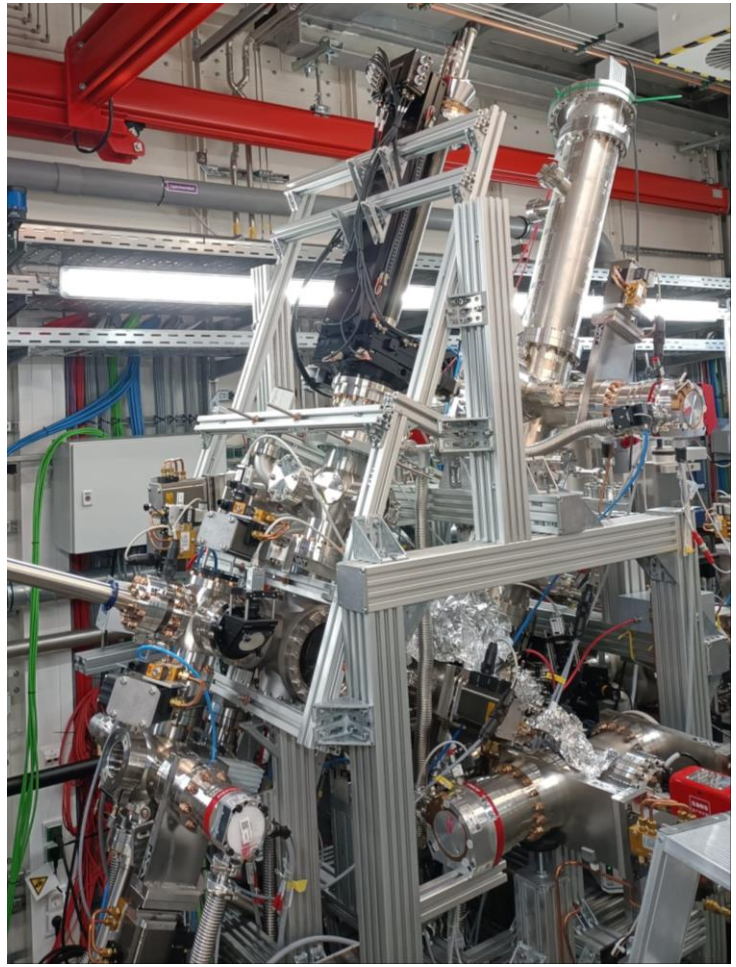


SXP – Time-resolved photoelectron spectroscopy standard configuration



Review of Scientific Instruments **91**, 013109 (2020)

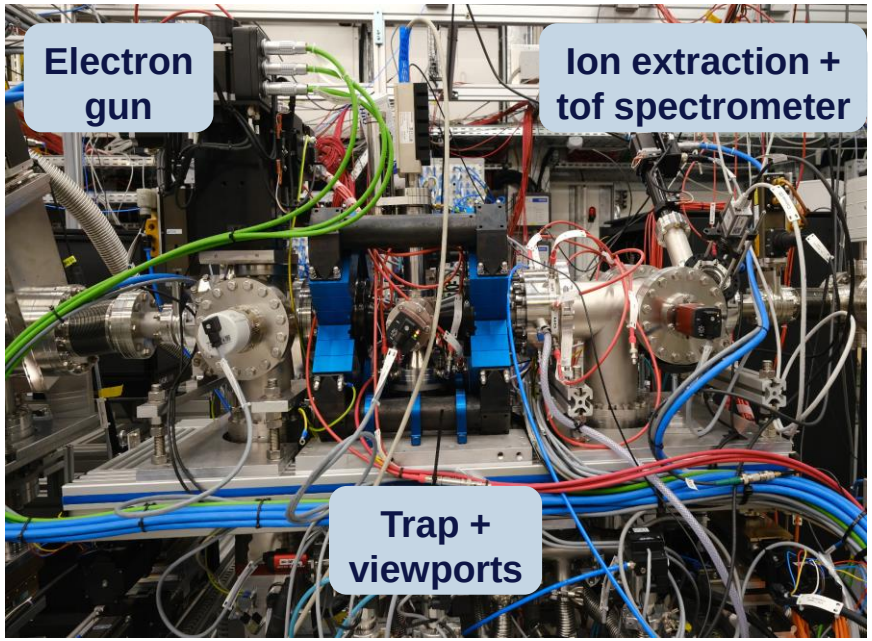
TR-XPES station



- Momentum microscope spectrometer
  - No spin
  - Large angular cone ~ 40º
  - Delay line detector
  - ΔE ~ 130 meV
  - Δk ~ 0.06 $Å^{-1}$
- Photon parameters
  - Energy: 0.4 – 3 keV
  - 352 pulses @ 1.1 MHz
  - 800 pulses @ 4.5 MHz
- Beam size on sample
  - 3 - 500 µm
  - default ~ 2 x 30 µm
- Omicron type mount for solid samples
- Load lock/ vacuum suitcase port preparation chamber

EBIT (Electron Beam Ion Trap)

SQS R&D project:
collaboration J. Crespo, MPIK Heidelberg



Compact EBIT source

Production of highly charged ions

→ H-like up to Fe, He-like up to Xe

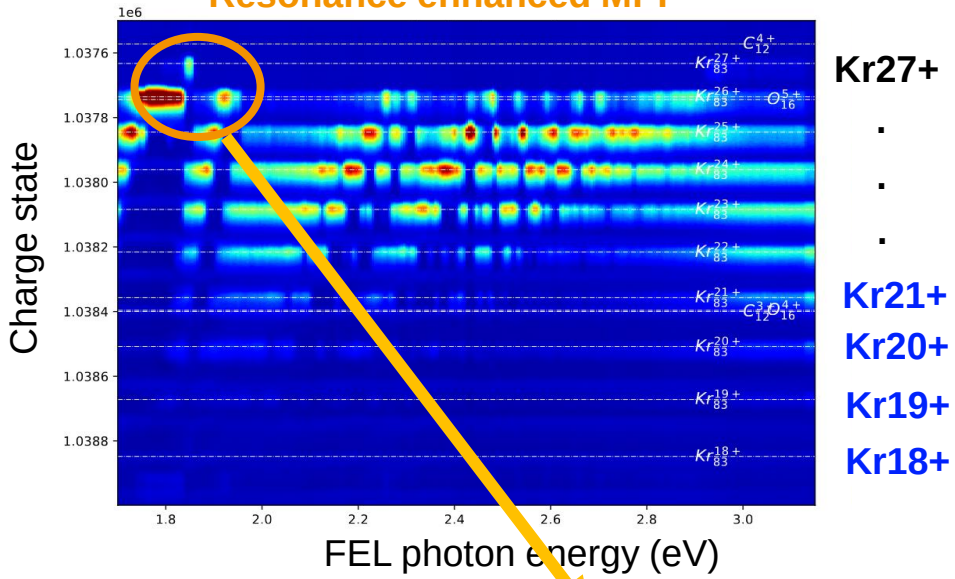
Fluorescence or ion time-of-flight detection

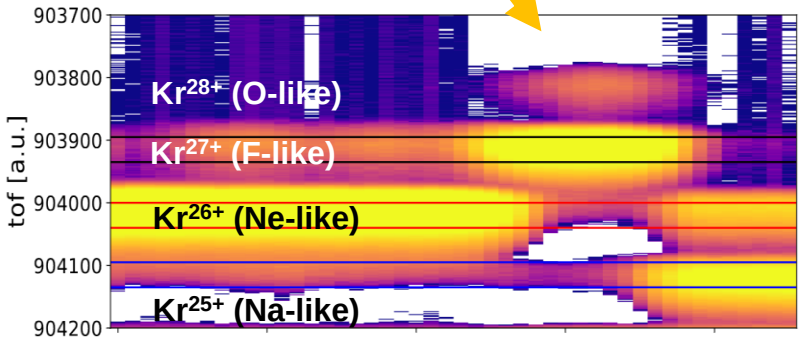
Also available at SQS!!

thomas.baumann@xfel.eu/ michael.meyer@xfel.eu

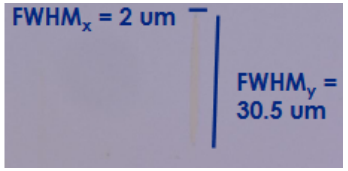
First user experiment at SQS (May 2023)

Resonance enhanced MPI

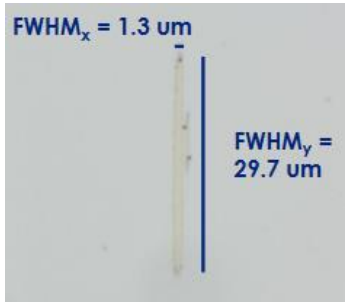




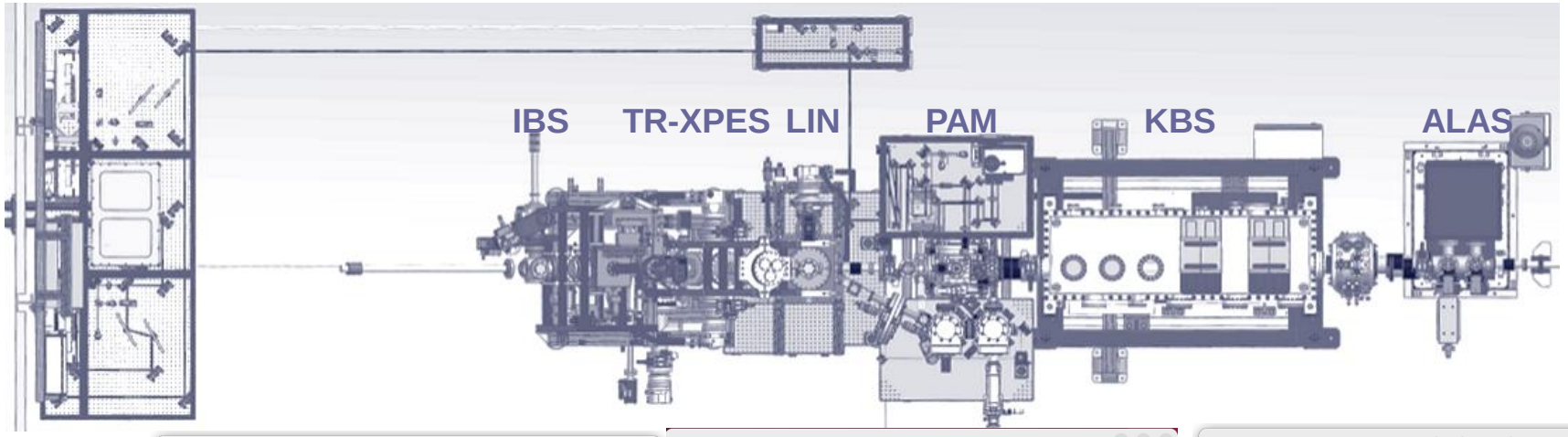
SXP X-rays transported to the experimental station

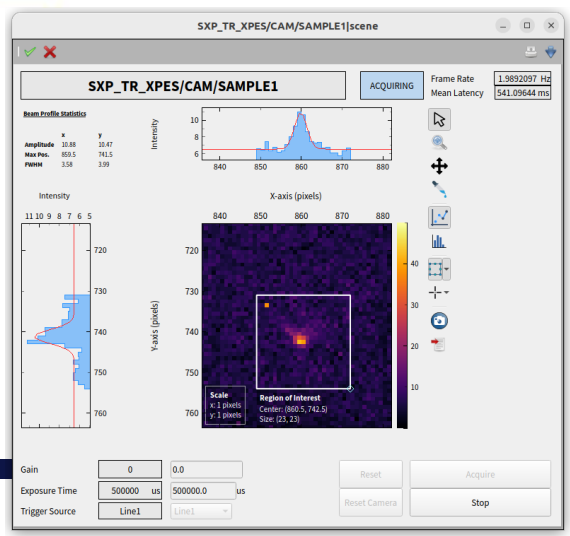


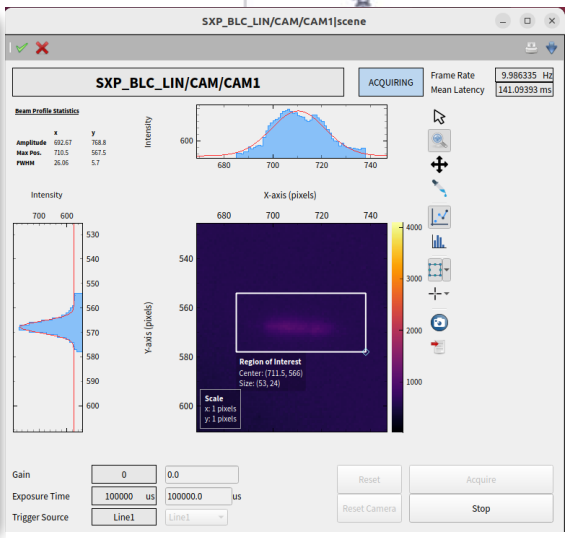
1 keV

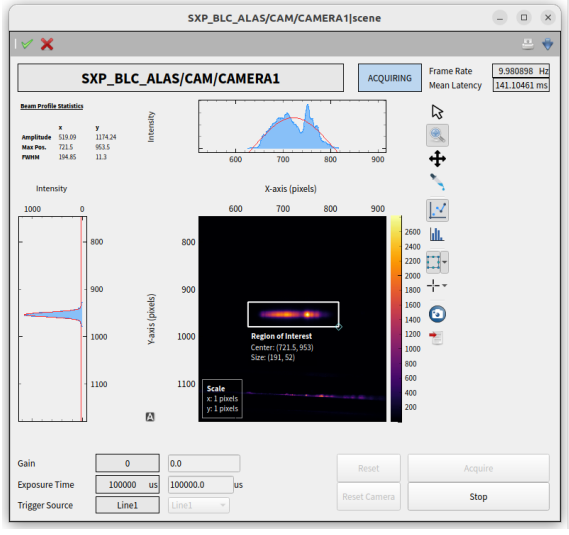


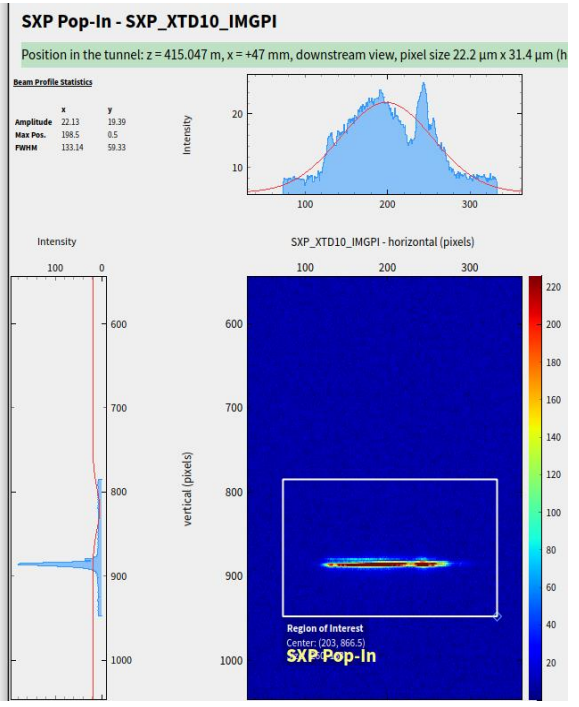
2.5 keV



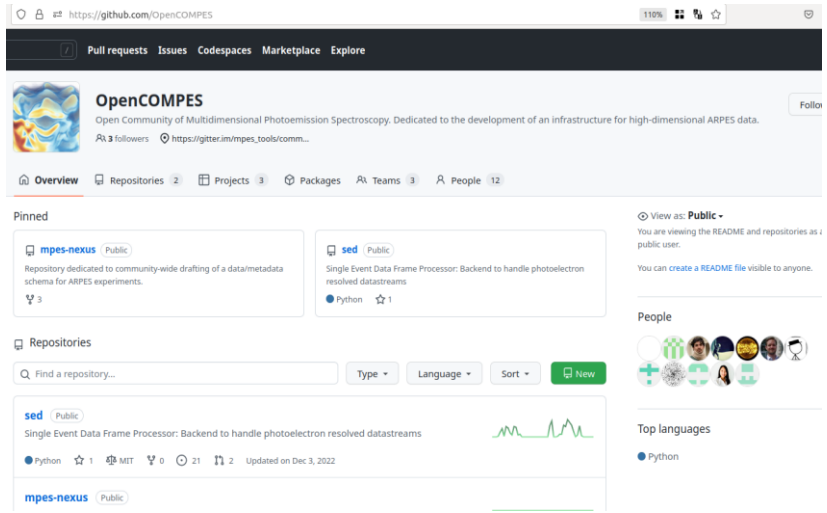








SXP updates: data analysis



Single **E**vent **D**ataframe Processor Library

mpes

hextof

Implemented into XFEL data structure

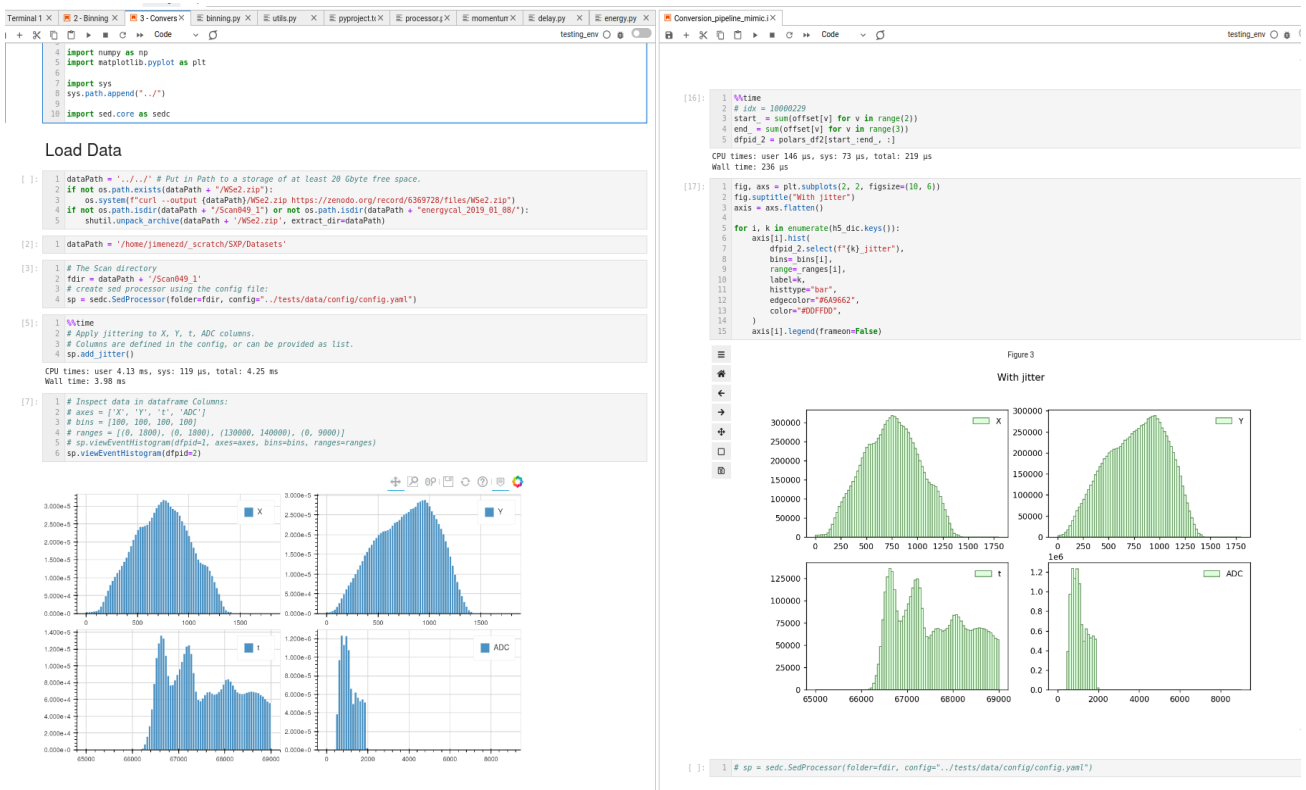
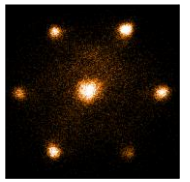


Image Corrections



SXP status

- TR-XPES proof of principle experiment done in August 2023

  - Time-resolved data analysis: on-going

- 2023 user program: 3 community proposals

Id	Title	Proposer	Proposer email	Principal investigator
4515	Bulk ferroelectricity coupled to	Dr. Vladimir N. Strokov	vladimir.strocov@psi.ch	Prof. Dr. Claude Monney
4461	Community Proposal: Twisted	Dr. Markus Scholz	markus.scholz@desy.de	Prof. Dr. Kai Rossnagel
4316	Community Proposal on ultrafast	Dr. Giancarlo Panaccione	panaccione@iom.cnr.it	Dr. Tommaso Pincelli

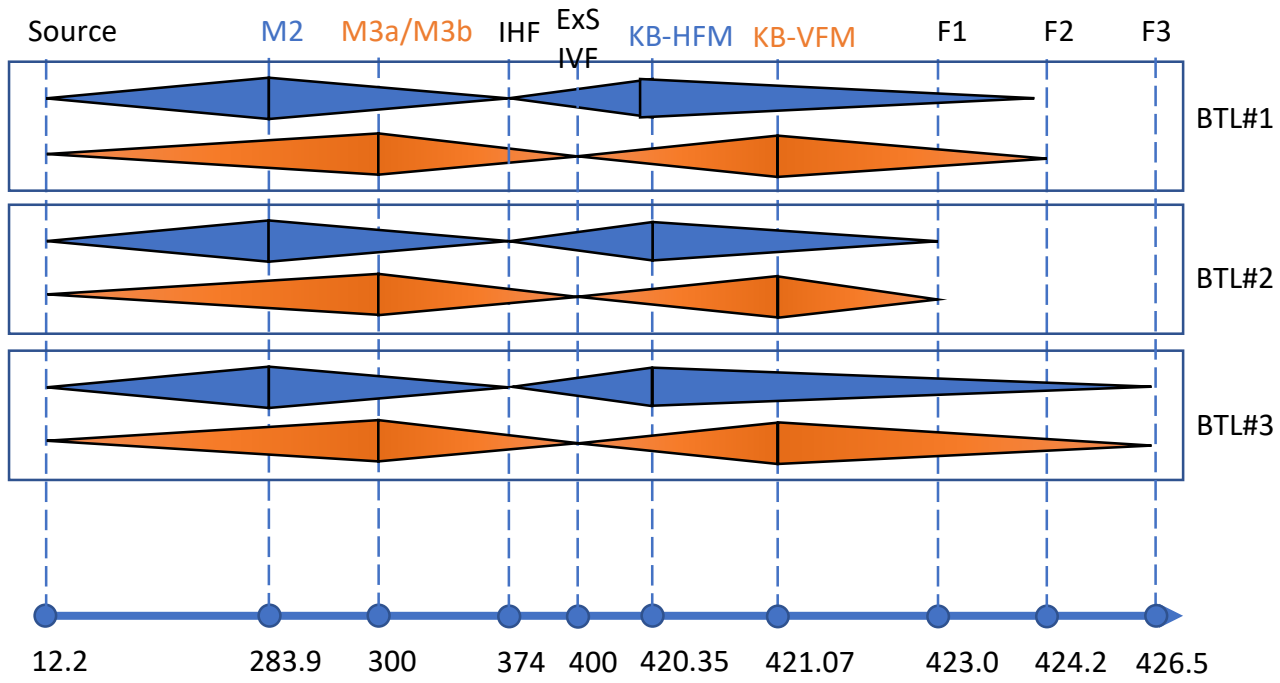
4515: Bulk ferroelectricity coupled to electron and lattice dynamics in GeTe

4461: Twisted bilayer MoS_2 and Au nanoparticles on TiO_2

4316: Ultrafast screening dynamics and collective excitations in hybrid plasmonic heterostructures

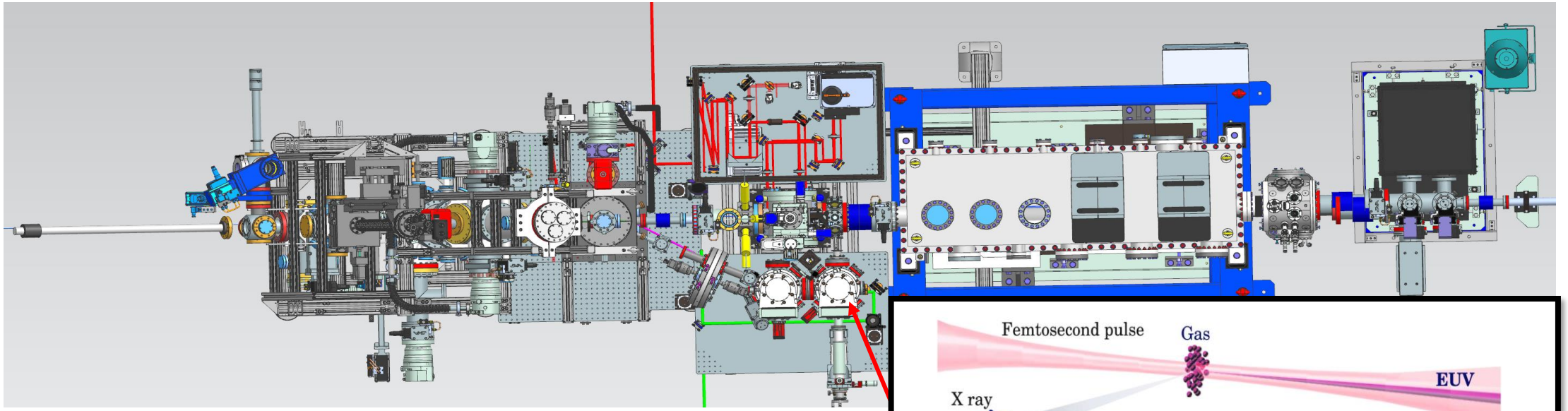
SXP upgrades: bendable KB system

- Mirror delivery December ➔ implementation latest S2 2024



HF @ 0.3 KeV	VF @ 0.3 KeV
2.08	1.39
2.64	2.78
4.37	5.09

SXP upgrades: HHG source



- Active Fiber Systems 60W laser amplifier
  http://www.afs-jena.de/
- R&D position, 3 years: Open Positions (xfel.eu)

We are hiring!

Suggestions during proposal writing

- Limited available time ➔ ideally 3 days per experiment
- Consider societal challenges in your **scientific case**
- Less is more ➔ a **sound scientific case** with a very **concise scope**
- **Select carefully** your parameter space ➔ **FEL hν, fluence, rep rate up to 4.5 MHz, laser parameters**
- Be explicit ➔ write down ALL values of your ideal parameter space
- Add preliminary data ➔ synchrotron, lab experiments, theory …
- Think of the whole process ➔ theory and all
- Contact us: sxp@xfel.eu

Thank you for your attention!

- Contact:
  - sxp@xfel.eu or manuel.izquierdo@xfel.eu
  - Webpage: Scientific Instrument SXP (xfel.eu) or browse for SXP XFEL