

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

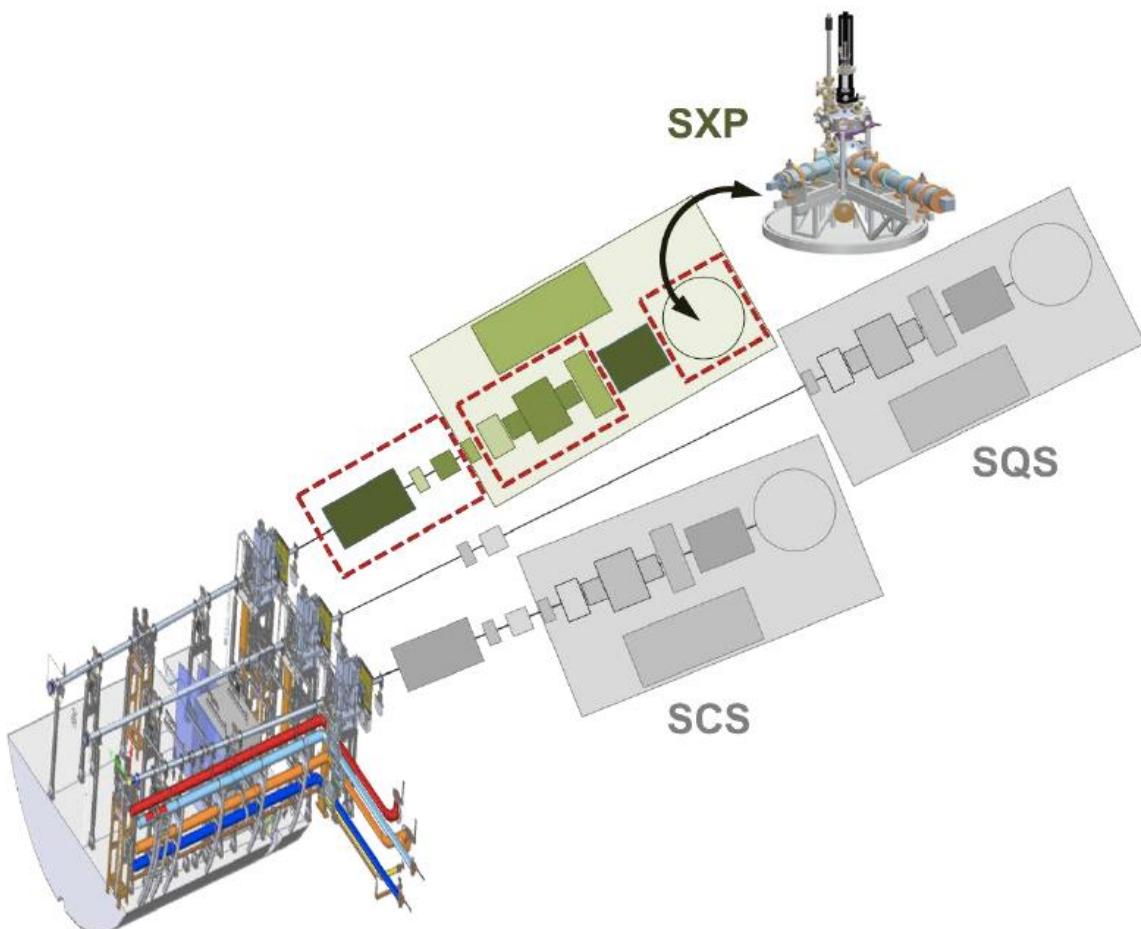


Joshua Ohnesorge
Vacuum Eng. (1/3)



Maria Peter
Adm. Assistant

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

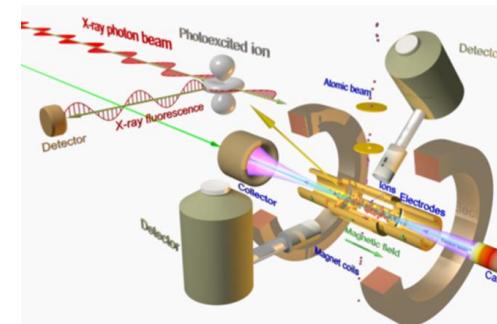
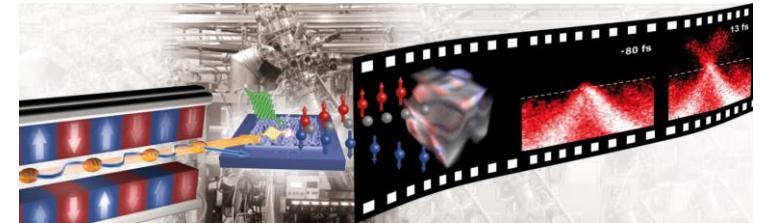


Complete Time-resolved X-ray Photoelectron spectroscopy

TR-XPES

K. Rossnagel
(Uni-Kiel/DESY)

G. Schönhense
(Uni. Mainz)



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

HCI

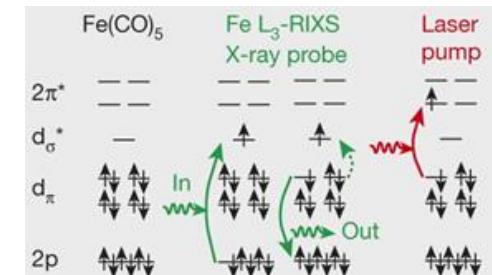
J. Crespo (MPI Heidelberg)

M. Meyer, T. Baumann (EuXFEL)

Understanding Catalysis and biochemistry by studying Chemical Bond Activation

CBA

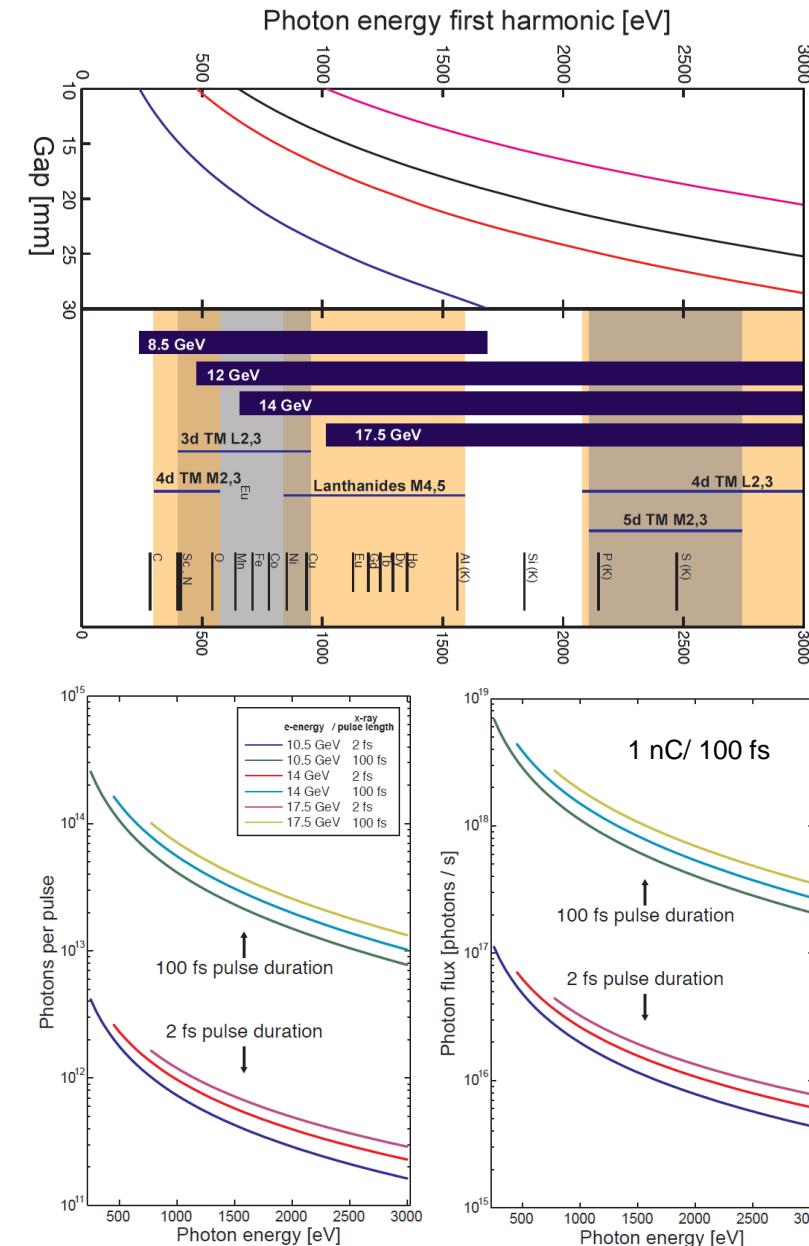
P. Wernet (Uni. Uppsala)



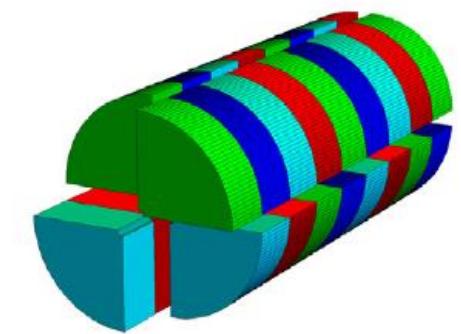
SXP in a nutshell

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
- European XFEL**



Variable polarization: APPLE-X

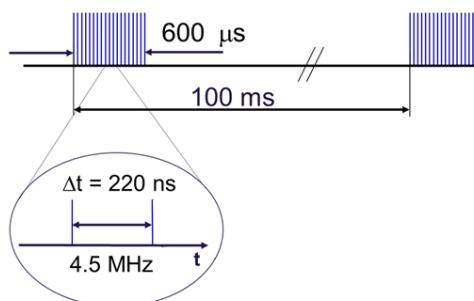
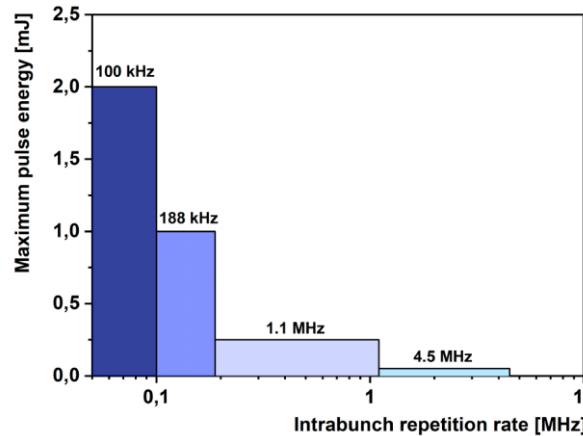


From SCS CDR

SXP laser capabilities: PP laser

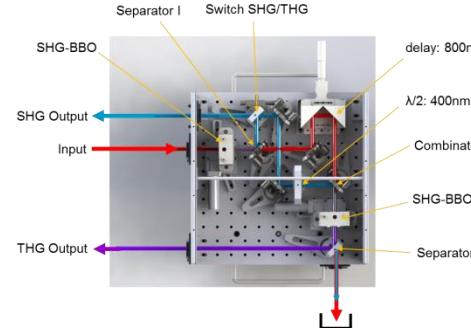
Output lines

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

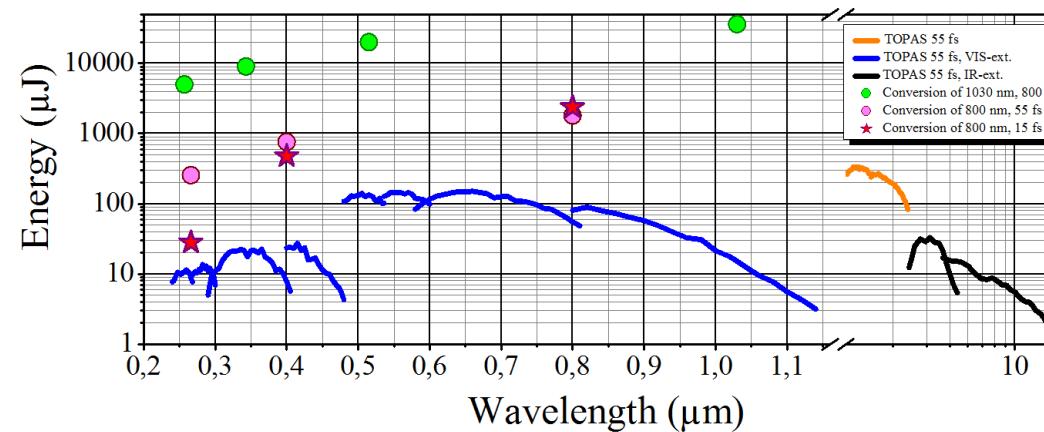


European XFEL

High Harmonic Generation (HHG)



HHG and OPA at 100 kHz mode



Optical Parametric Amplifier (OPA)

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



Laser Input Parameters:

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

SXP laser capabilities: AFS 60W

■ Active Fiber Systems 60W laser amplifier

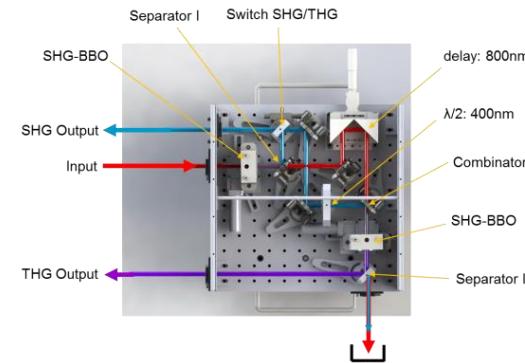


<http://www.efs-jena.de/>

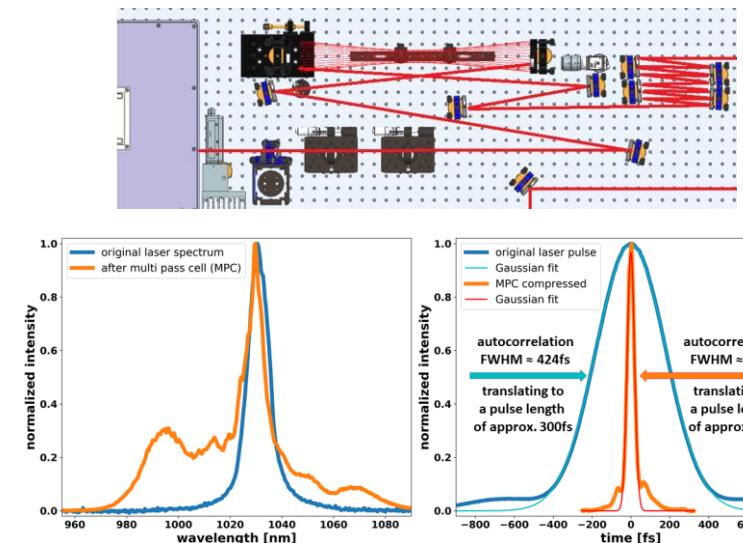
- Delivering 1030nm, 200fs, 200 μ J pulses @ 300kHz!
- Continuously adjustable repetition rate up to 20MHz.
- Acousto-optic modulator to mimic 10Hz bunch structure.
- Same seed oscillator as NOPA, thus synchronizable.
- Installed and commissioned

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

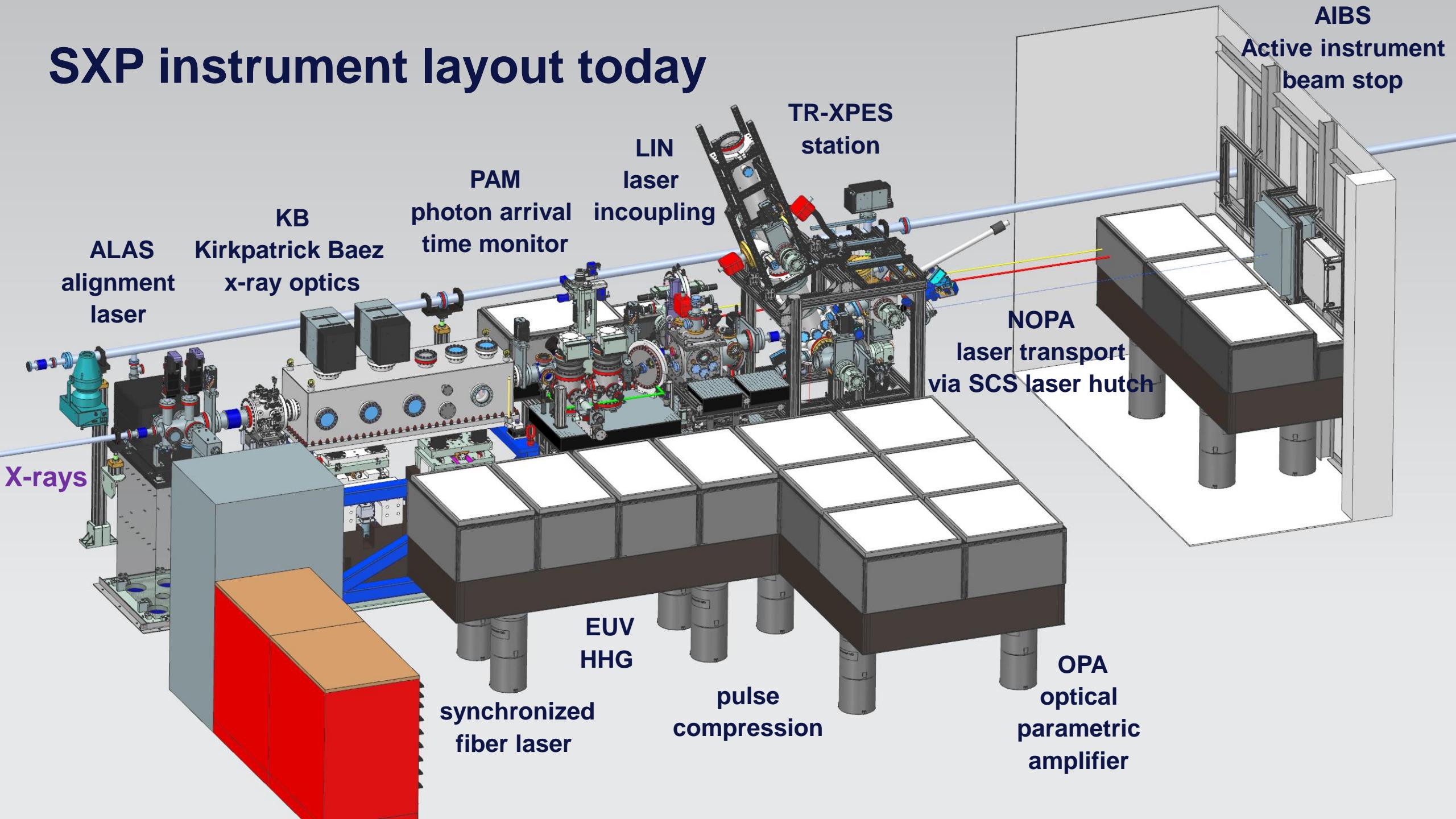
4th harmonic generation 257.5 nm (4.8 eV)



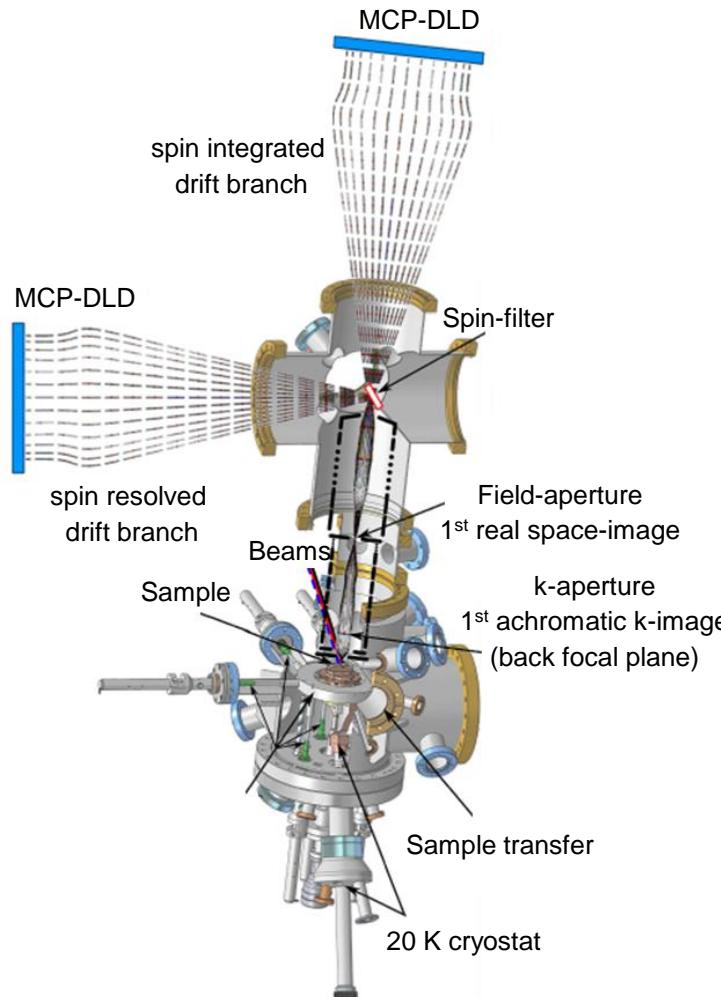
Pulse compression to 40 fs



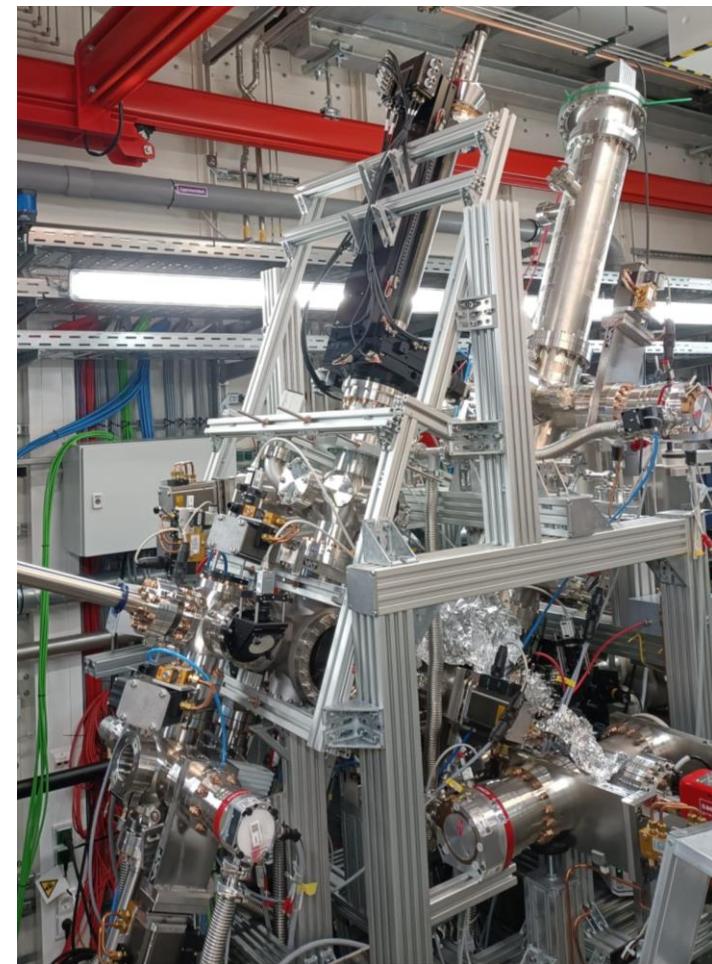
SXP instrument layout today



SXP – Time-resolved photoelectron spectroscopy standard configuration



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

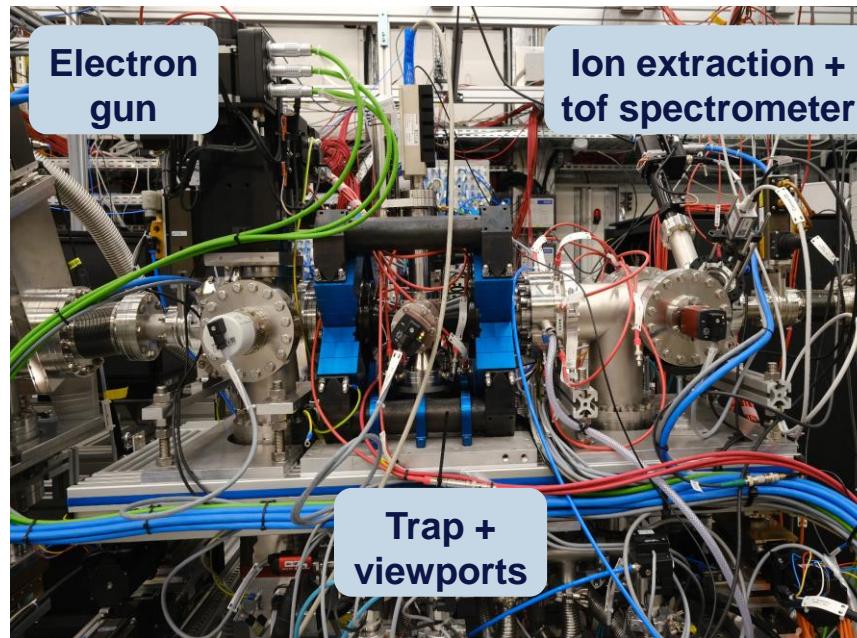


TR-XPES station

- Momentum microscope spectrometer**
 - No spin
 - Large angular cone $\sim 40^\circ$
 - Delay line detector
 - $\Delta E \sim 130$ meV
 - $\Delta k \sim 0.06 \text{ \AA}^{-1}$
- 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 $\sim 2 \times 30 \mu\text{m}$
- 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

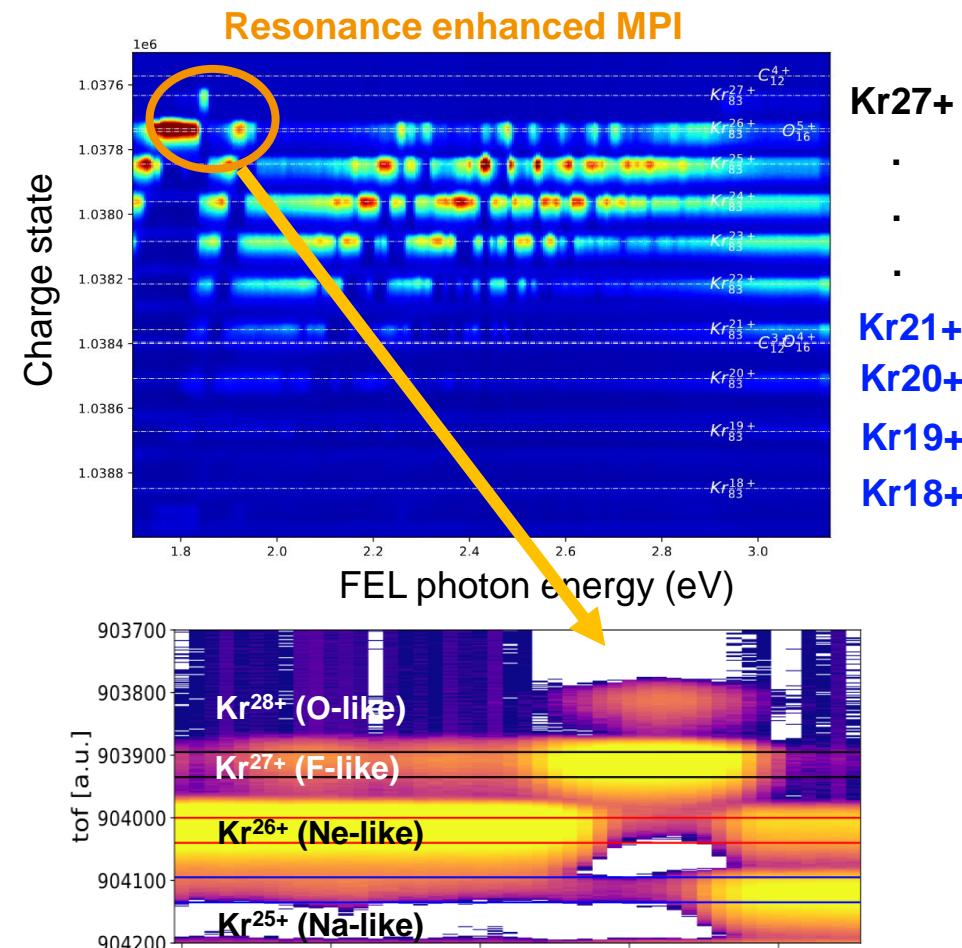
→ H-like up to Fe, He-like up to Xe

Fluorescence or ion time-of-flight detection

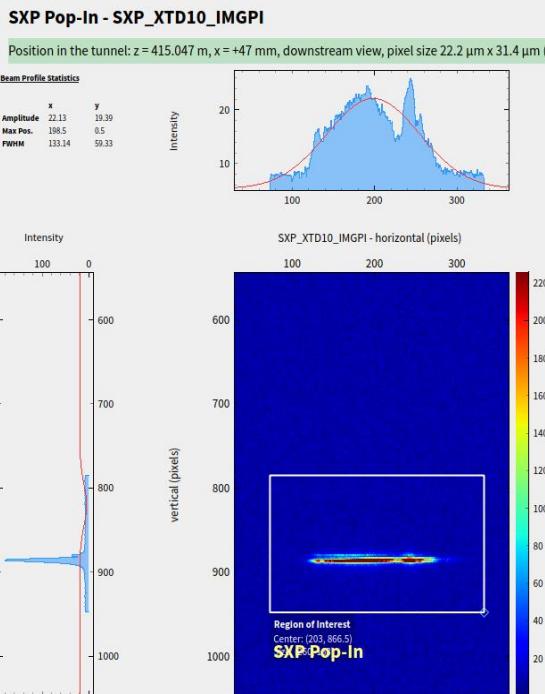
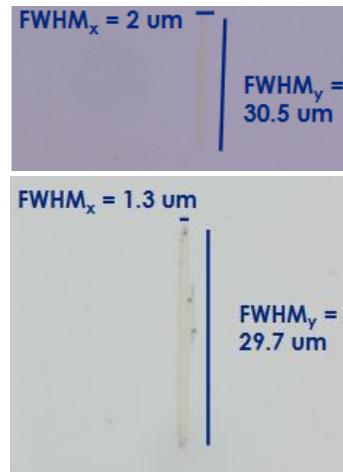
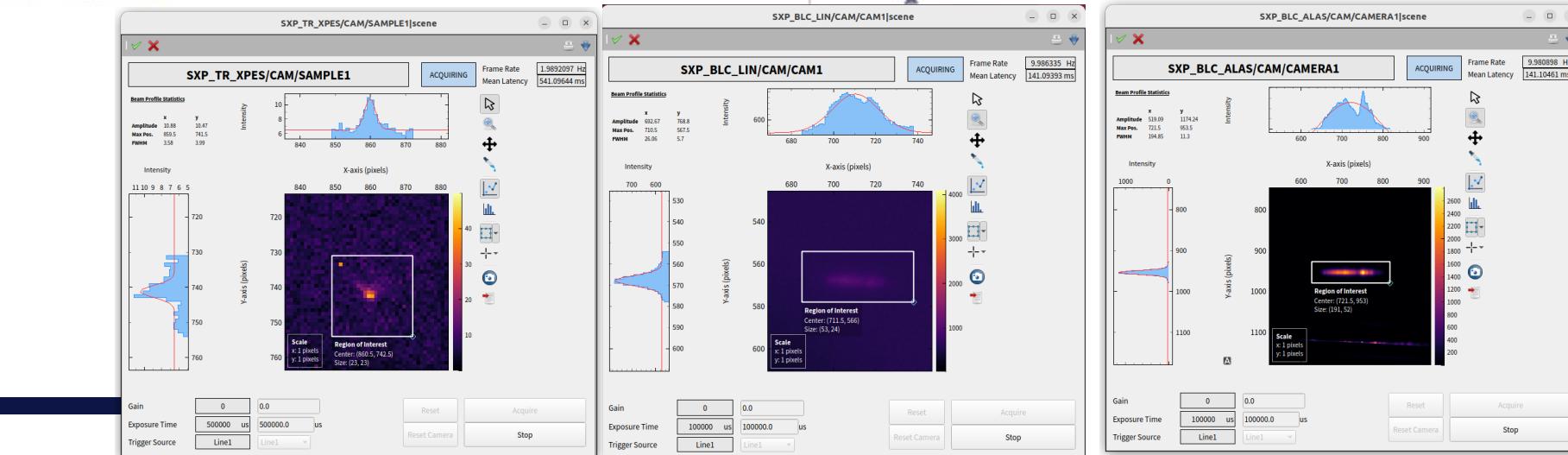
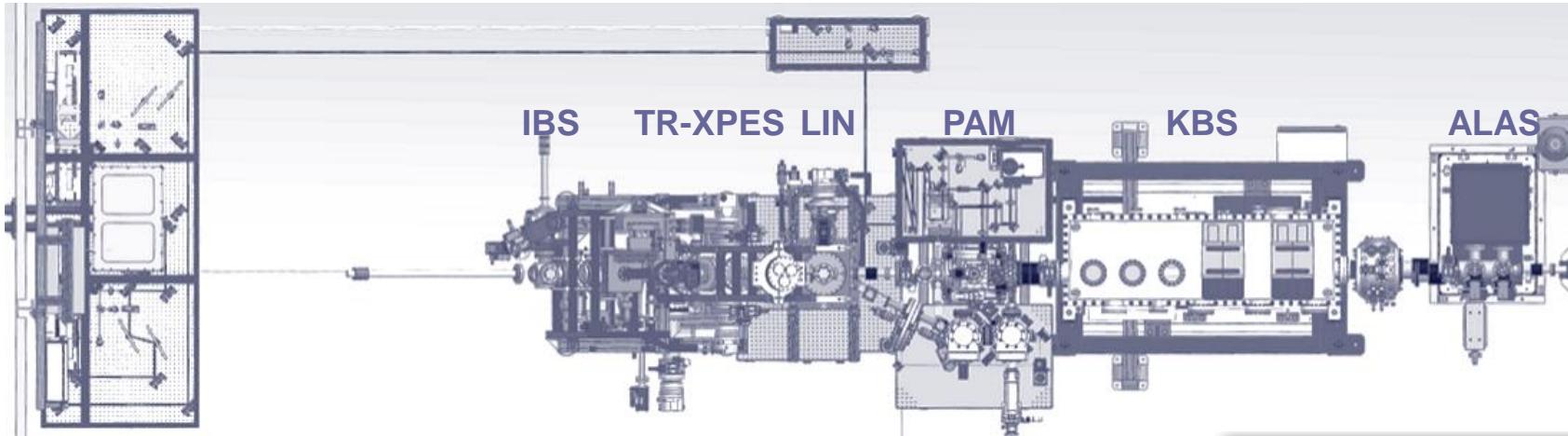
Also available at SQS!!

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

First user experiment at SQS (May 2023)



SXP X-rays transported to the experimental station



SXP updates: data analysis

<https://github.com/OpenCOMPES>

Pull requests Issues Codespaces Marketplace Explore

OpenCOMPES
Open Community of Multidimensional Photoemission Spectroscopy. Dedicated to the development of an infrastructure for high-dimensional ARPES data.

Followers 53 View as: Public You are viewing the README and repositories as a public user. You can create a README file visible to anyone.

mpes-nexus Public Repository dedicated to community-wide drafting of a data/metadata schema for ARPES experiments. Python 1 Star 3

sed Public Single Event Data Frame Processor: Backend to handle photoelectron resolved datastreams Python 1 Star 1

Repositories Find a repository... Type Language Sort New

sed Public Single Event Data Frame Processor: Backend to handle photoelectron resolved datastreams Python 1 MIT 0 21 Updated on Dec 3, 2022

mpes-nexus (Public)

Single Event Dataframe Processor Library

mpes hextof

Implemented into XFEL data structure

```

[1]: 1 #!/bin/bash
2 # Lids = 10000229
3 start = ${sum(offset[v] for v in range(2))}
4 end = ${sum(offset[v] for v in range(3))}
5 dfpid_2 = polaris.tdf[start:end,:]
CPU times: user 146 µs, sys: 73 µs, total: 219 µs
Wall time: 236 µs

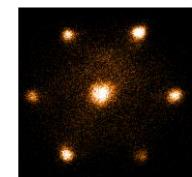
[16]: 1 #!/bin/bash
2 # lids = 10000229
3 start = ${sum(offset[v] for v in range(2))}
4 end = ${sum(offset[v] for v in range(3))}
5 dfpid_2 = polaris.tdf[start:end,:]

CPU times: user 146 µs, sys: 73 µs, total: 219 µs
Wall time: 236 µs

[17]: 1 fig, axs = plt.subplots(2, 2, figsize=(10, 6))
2 fig.suptitle("With jitter")
3 axs = axs.flatten()
4 for i, k in enumerate(h5_dic.keys()):
5     axis = h5_dic[k]
6     dfpid_2.select(f"({k}).jitter"),
7     bins = bin[1],
8     range=range[1],
9     label=label[1],
10    histtype="bar",
11    edgecolor="#00A6E2",
12    color="#00FFFF",
13 )
14 axs[1].legend(frameon=False)
Figure 3
With jitter

```

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

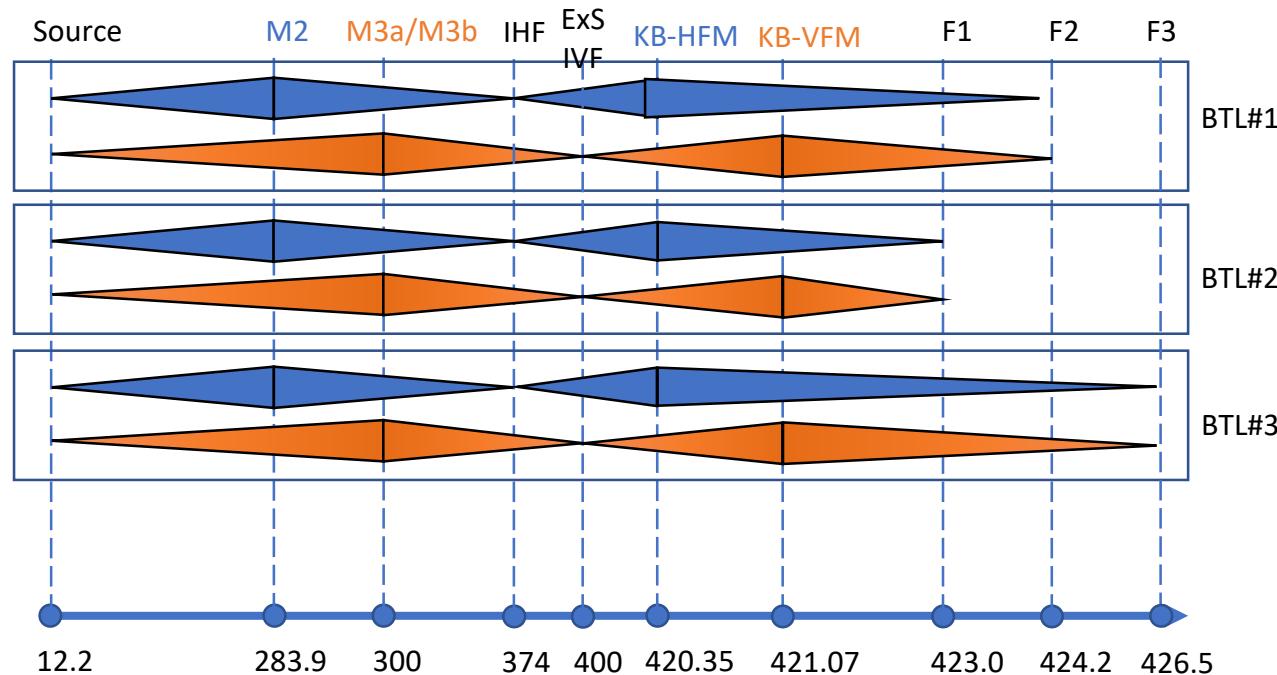
4515: Bulk ferroelectricity coupled to electron and lattice dynamics in GeTe

4461: Twisted bilayer MoS₂ and Au nanoparticles on TiO₂

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

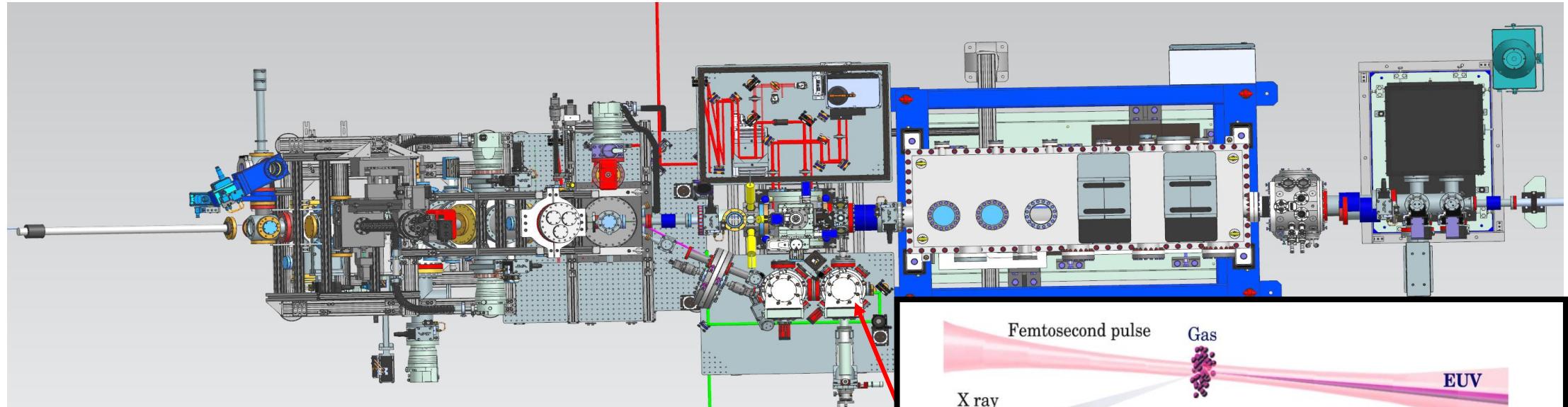
SXP upgrades: bendable KB system

- 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.efs-jena.de/>

- R&D position, 3 years: [Open Positions \(xfel.eu\)](http://openpositions.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 $h\nu$, 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 \(xfel.eu\)](http://Scientific Instrument SXP (xfel.eu)) or browse for **SXP XFEL**