

The pump-probe laser infrastructure of the SXP instrument at the European XFEL

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Overview of the SXP instrument as seen from top.

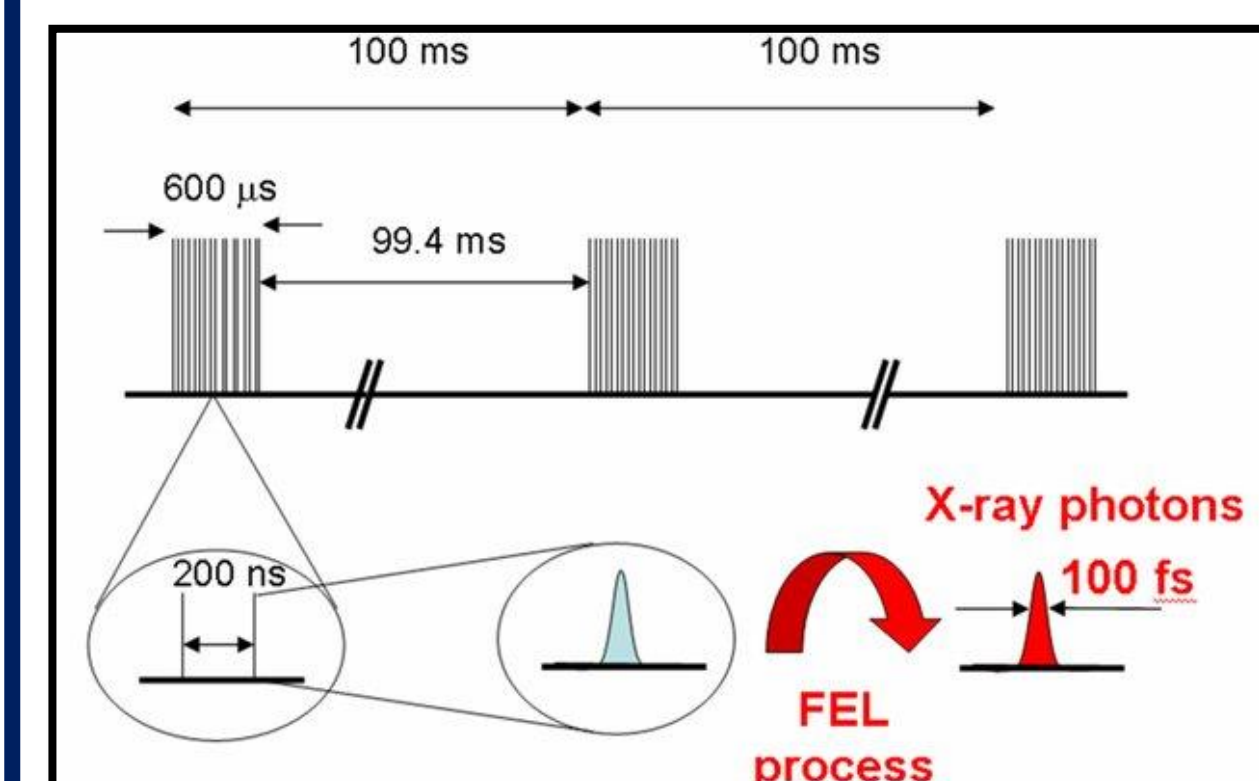
Scope of the Soft X-ray Port (SXP) Scientific Instrument

- Extending the portfolio of techniques available at SASE3 undulator:
- Complete spin- and time-resolved photoelectron spectroscopy.
 - Spectroscopy of biological and inorganic catalysts.
 - Fundamental research on highly charged ions.
 - Development of experimental techniques.

Laser Incoupling

- Compact design:
- Mechanically decoupled.
 - UHV piezo mirror mounts.
 - Carousel of 2inch mirrors.
 - Up to 10^{15} W/cm² on target.

Pump Probe Laser Concept



General pump probe laser requirements:

- Match XFEL pulse train: 10Hz burst mode and variable intra-bursts repetition rate (<4.5 MHz).
- Ultrafast and intense (down to the femto-second range with few mJ's pulse energy).
- Arbitrary pulse pattern selection.
- Frequency conversion from THz to XUV.

Non-collinear Optical Parametric Amplifier (NOPA)

Basic laser parameters and set points as of February 2020

Set point	f_{rep} [MHz] (within 600 μ s burst)	E_{pulse} [mJ] at 800 nm (15fs and 50fs mode)	E_{pulse} [mJ] at 1030nm
1	4.5	0.05	1
2	1	0.2	4
3	0.2	1	20
4	0.1	2	40

Optical Parametric Amplifier

- Commercial TOPAS Prime:
- Pumped by 2mJ 50fs pulses from NOPA pp laser.
 - Wavelength tunable from about 250nm to 15 μ m.
 - Delivering approx. 50fs short pulses @ 100kHz.

Photon Arrival-time Monitor

Spectral encoding of XFEL pulses:

- Monitoring relative arrival time between FEL & OL fs pulses.
- X-rays induce changes in the transmission of a membrane to map the relative delay onto a spectral coordinate.
- About 25fs RMS resolution within a 3ps time window.

Alignment Laser

Monitoring and aligning FEL position:

- Granite-based support for stable beam pointing.
- Coaxial propagation of alignment laser with FEL beam.
- Pre-alignment of beamline components to save time.

XUV Source

High Harmonic Generation:

- Compact and table-top design.
- Driven by 1030nm or 800nm fs pulses.
- Delivering sub 10fs XUV pulses.
- Spanning approx. 20-72eV.

Soft X-ray Optics

Kirkpatrick-Baez configuration:

- Two source points, i.e. monochromator & undulator.
- Cooled & bendable mirrors to reach three focal positions.
- Focus of about 1 μ m in diameter to deliver 10^{18} W/cm² on target.

External Pump Probe Laser

Commercial Yb fiber laser (1030nm):

- Delivering 250fs short, 200 μ J pulses @ 300kHz.
- Adjustable repetition rate from 50kHz to 80MHz.
- Seed oscillator in-loop synchronized to <10fs (rms).
- Bunch pattern selection with acousto-optic modulator.
- Compression to sub 40fs short, 100 μ J pulses planned.