

Combined single-shot Small Angle X-Ray Scattering and Phase Contrast Imaging in ultra-intense laser-matter interactions at euXFEL

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The High Energy Density (HED) instrument at the European XFEL provides a platform to study hot and warm dense matter. The Helmholtz International Beamline for Extreme Fields (HiBEF) is the User Consortium supplying HED with two laser systems (the high-intensity ReLaX laser, by Amplitude Technologies, and the high-energy Dipole-100X laser, by STFC), Diamond Anvil Cells setup and high-pulsed magnetic fields. These tools in combination with the XFEL beam enable the investigation of relativistic laser plasmas, strong-field QED phenomena, high-pressure astro- and planetary physics as well as magnetic phenomena in condensed matter.

The commissioning of the ultra-short pulse high-intensity relativistic laser at XFEL, ReLaX, provides new unique opportunities in the plasma and high-field physics fields. ReLaX is a double CPA Ti:Sa laser delivering 100 TW pulses on target, reaching intensities up to 10^{20} W/cm².

Small-Angle X-Ray Scattering (SAXS) without the need of a beamstop was first commissioned at HED in September 2019. Two high-annealed pyrolytic graphite (HAPG) crystals were used to reflect the SAXS photons onto a detector while allowing the main XFEL beam to go through. In April and May 2021, Small-Angle X-Ray Scattering (SAXS) and Phase Contrast Imaging (PCI) were simultaneously demonstrated in pump-probe experiments at HED.

In this talk, we discuss the challenges on combining these X-Ray techniques in the harsh environment generated by the laser-matter interaction. We will also show results on the combined SAX and PCI measurements of hole boring in wire targets.

Primary authors: LASO GARCIA, Alejandro (HZDR); TONCIAN, Toma (HZDR); HOEPPNER, Hauke (HZDR); PELKA, Alexander (HZDR); BAEHTZ, Carsten (HZDR); BRAMBRINK, Erik (European XFEL); NAKATSUTSUMI, Motoaki (European XFEL); SCHWINKENDORF, Jan-Patrick (European XFEL); PRESTON, Thomas (European XFEL); COWAN, Thomas (HZDR); ZASTRAU, Ulf (European XFEL); SCHLENVOIGT, Hans-Peter (HZDR); PRENCIPE, Irene (HZDR); KONOPKOVA, Zuzana (European XFEL)

Presenter: LASO GARCIA, Alejandro (HZDR)

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