First photon diagnostics commissioning at the European XFEL

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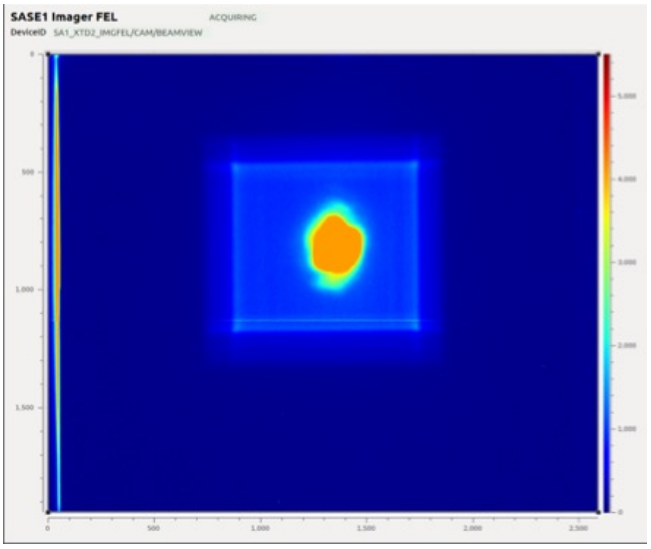
The European X-ray Free Electron Laser (European XFEL) is a new user facility in the metropolitan area of Hamburg, Germany. It offers ultra-short (femtosecond) and intense (GigaWatt) transversely coherent x-ray laser beams in the soft to hard x-ray domain at MHz repetition rate. Up to 2700 pulses per train will be delivered at 10Hz train repetition rate.

The x-ray diagnostics [in 1] serves the electron machine to achieve lasing by Self-Amplified Spontaneous Emission (SASE), supports the SASE tuning, and assists to align and commission the photon beam transport. Finally, it delivers non-invasive online beam diagnostic data to the users at the experimental end-stations.

In May 2017 the first undulator beamline, SASE1, was successfully commissioned with beam, and First Lasing was detected. This presentation describes the contribution of photon diagnostics during the distinct commissioning phases: Pre-beam checkout, first light from the bending magnets, x-rays from single undulator segments, SASE tuning with many undulator segments, First Lasing, optics alignment for FEL beam transport through the tunnel up to the experimental hutches, and finally beam delivery to first users. Assessed beam properties included per-pulse intensity, beam position, shape, lateral dimensions, and spectral properties. During this period, the machine provided up to 0.1 nm wavelength at up to 1.5mJ pulse energy, up to 300 FEL pulses per train, and up to 4.5 MHz intra-bunch train repetition.



Beam profile of the First Hard X-ray Lasing at 6 keV from the European XFEL undulator SASE1 as recorded by the FEL-imager during the first hours after successful SASE tuning. The round FEL beam in the center was saturating the YAG scintillator already at this early stage so that attenuators had to be inserted for further beam analysis. The strong synchrotron radiation background stemming from the 14 GeV electron beam was blocked outside the light blue rectangular area by the synchrotron radiation aperture (SRA) blades.

References

[1] T. Tschentscher, C. Bressler, J. Grünert, A. Madsen, A. P. Mancuso, M. Meyer, A. Scherz, H. Sinn and U. Zastrau, *Appl. Sci.* **2017**, *7*(6), 592; doi:10.3390/app7060592