1st SRIS Colloquium
TOHOKU FORUM for CREATIVITY
- Thematic Program 2026 Pre-event -

Pulse-Resolved Full-Field Imaging at XFEL Sources

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Abstract

The X-ray full-field imaging performed in a pulse-resolved manner opens new possibilities for visualizing matter in motion. Large-scale X-ray facilities, such as synchrotrons (e.g., ESRF, APS, Spring-8) and XFEL sources, deliver ultra-short pulses (~200 ps to ~20 fs) at megahertz repetition rates. The latest generation of X-ray sources XFELs offers three orders of magnitude more photons per pulse compared to previous generations. This exceptional performance, combined with MHz repetition rates, enables unique opportunities to study fast stochastic phenomena, with object velocities reaching ~km/s. Recently, we proposed and demonstrated X-ray microscopy in the phase contrast regime, sampled at MHz rates, and developed dedicated instrumentation that is accessible to broad user communities through user proposals at the EuXFEL. However, the limitations of 2D projection imaging constrain a comprehensive understanding of dynamic systems. Processes such as cavity formation and collapse, shockwave emission during cavity annihilation, and other phenomena require 3D temporal information (4D imaging) for a complete analysis. To address this challenge, we have introduced a novel X-ray optical scheme and developed a MHz tomoscopy prototype. This innovative system enables up to six angular projections for each individual X-ray pulse using crystal splitters, providing an advanced framework for 4D imaging of dynamic phenomena. I will present recent state of the art development and discuss further prospects and possibilities for MHz X-ray microscopy.

February 26, 2025, 13:30 – 14:30

SRIS Building, Entrepreneur Hall

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