

TR+: Time-Resolved Photons for Life Science at MAX IV

Gabriela C. Schröder, Andrius Jurgilaitis, Oskar Aurelius, Cecilia Casadei, Tomás S. Plivelic, Kajsa Sigfridsson Clauss, Marjolein Thunnissen, Selma Maric, Dean Langan, Yang Chen

MAX IV Laboratory, Lund University, Lund, Sweden

Time-resolved (TR) experiments are essential for understanding the structural dynamics and function of biological molecules across a wide range of timescales, from femtoseconds to seconds. At MAX IV Laboratory, the TR+ matrix has been established to promote and support time-resolved life science research by integrating capabilities across multiple beamlines and fostering a collaborative user community. A central goal of TR+ is to lower the barrier for performing time-resolved experiments, particularly for new users, by providing coordinated support, method development and access to advanced sample environments and delivery systems.

TR+ brings together complementary techniques available at the MicroMAX, CoSAXS, Balder, BioMAX and FemtoMAX beamlines. The matrix will enable experiments spanning ultrafast to millisecond regimes using approaches such as time-resolved serial crystallography, SAXS/WAXS and X-ray spectroscopy. Structural changes in biomolecules can be studied under physiologically relevant conditions using pump–probe and reaction-triggered approaches, where dynamics are initiated by optical, THz, or chemical triggers and probed with X-rays at defined time delays. Recent applications demonstrate the breadth of TR+ capabilities, including femtosecond X-ray studies of protein dynamics, millisecond time-resolved crystallography of membrane pumps, laser induced activation of caged compounds to trigger and track dynamics and time-resolved scattering and spectroscopy of biomolecular and environmental processes.

The TR+ matrix exploits the high coherence and brilliance of MAX IV to advance research in dynamic structural biology and enable new insights into biomolecular mechanisms. In parallel, TR+ promotes knowledge transfer within MAX IV and strengthens collaboration with the Nordic and Baltic life science communities. We highlight the existing and developing technical capabilities, workshops, and training opportunities available for performing time-resolved synchrotron experiments at MAX IV.

