
Time-resolved X-ray Spectroscopy at High Repetition Rates: Applications to Chemistry and Biology

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X-ray spectroscopy allows a unique combination of electronic and structural information to be obtained from a variety of different sample types (solid, liquid, gas). In recent years it has been used in a pump-probe scheme, where the sample is photoexcited with light and then probed after a controlled time delay using an X-ray pulse. These methods can measure dynamics over a broad range of timescales, allowing them to probe everything from slow protein dynamics to ultrafast charge carrier relaxation in functional materials. With the introduction of X-ray free electron lasers (XFELs), time-resolved X-ray techniques have focussed heavily on the ultrafast timescales of electron and nuclear motion (femtosecond to picosecond), but these measurements are often only complementary to longer timescale measurements, which is where the majority of chemistry and biology dynamics take place. For these longer timescale measurements, a storage ring is often an ideal source of X-rays, not only since the native pulse duration of the photon pulses is of the order of hundreds of ps, but also the facilities themselves are a stable, tuneable source of photons, in contrast to XFELs where the pulse stability often limits the achievable signal-to-noise of the experiments. The Paul Scherrer Institute has the advantage of having both types of X-ray facilities available, allowing researchers to choose the facility based on the timescales of interest and providing synergy between the facility beamlines. This talk will present an introduction to the two X-ray facilities at PSI: the Swiss Light Source storage ring and the SwissFEL XFEL. It will introduce the beamlines and experimental stations available, along with some examples of complementary time-resolved experiments that have been or will be performed at both facilities. The talk will conclude with a brief overview of where we would like to go with time-resolved measurements at PSI and how the SLS 2.0 storage ring upgrade will factor into these plans.