MS01-04 | Ultra-Fast Raster-Scanning Synchrotron Serial Micro-Crystallography

Fuchs, Martin R. (National Synchrotron Light Source II, Upton, USA); Shi, Wuxian (National Synchrotron Light Source II, Upton, USA); Gao, Yuan (National Synchrotron Light Source II, Upton, USA); Andi, Babak (National Synchrotron Light Source II, Upton, USA); Jakoncic, Jean (National Synchrotron Light Source II, Upton, USA); Lazo, Edwin O. (National Synchrotron Light Source II, Upton, USA); Soares, Alexei (National Synchrotron Light Source II, Upton, USA); Myers, Stuart F. (National Synchrotron Light Source II, Upton, USA); Skinner, John (National Synchrotron Light Source II, Upton, USA); Liu, Qun (National Synchrotron Light Source II, Upton, USA); Bernstein, Herbert (School of Natural Science, Amherst, MA, USA); Nazaretski, Evgeny (National Synchrotron Light Source II, Upton, USA); McSweeney, Sean (National Synchrotron Light Source II, Upton, USA)

In recent years, serial micro-crystallography at synchrotrons has seen increases in beamline brightness and new sample delivery methods, greatly widening its appeal to structure determination of challenging proteins. The crystallography beamlines at National Synchrotron Light Source-II [1] provide beams of unprecedented brightness, stability and versatility. The Frontier MX-beamline, FMX, delivers 3.5×1012ph/s at 1Å into a 1×1.5µm focus. Its flux density surpasses current MX-beamlines by up to two orders of magnitude, with dose rates >500MGy/s.

The high dose rates cut measurement times for raster-scanning serial crystallography from hours to under a minute. To harness this new dose rate regime, we built the FastForward Goniometer, a high-speed goniometer with a unique XYZ piezo-positioner [2]. We obtained datasets up to the Eiger16M's maximum frame rate of 750Hz, with a shutter-open time under 20s [3]. Collecting rotation images, using a cluster analysis processing pipeline, required fewer crystals than still image measurements. Micro-patterned sample holders minimize background-scattering, enabling S-SAD phasing from 5µm crystals [3]. The high speed allows scanning any crystal distribution, to avoid loading crystals into a fixed-raster grid.

Complementing this for LCP-grown crystals, we established serial crystallography with a high-viscosity extrusion injector in a collaboration with Arizona State University [4].

This flexible sample delivery allows tailoring the experiment to a wide array of crystals – adding serial crystallography to the standard repertoire of the synchrotron MX community.

[1] Fuchs et al., AIP Conf Proc 2016
[2] Gao et al., JSR 2018
[3] Guo et al., IUCrJ 2019
[4] Weierstall et al., Nat Commun 2014