New Opportunities for Structural Biology Research at LCLS and SSRL

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Serial femtosecond crystallography (SFX) is an emerging method that expands the structural information accessible from very small or very radiation sensitive macromolecular crystals. Utilizing extremely bright, short-time-scale X-ray pulses produced by an X-ray free electron laser (XFEL), this method exploits a 'diffraction before destruction' phenomenon where a still diffraction image is produced by a single X-ray pulse before significant radiation induced electronic and atomic rearrangements occur within the crystal. Furthermore, methods originally developed for serial diffraction experiments at XFELs, are proving valuable at synchrotron sources to study protein dynamics.

Similarities in instrumentation, existing and new sample delivery systems, and software environments form the foundation of a synergistic relationship between micro-focus beam line 12-1 at the SSRL synchrotron and the Macromolecular Femtosecond Crystallography (MFX) instrument at the LCLS XFEL. General user facilities for SFX at MFX include equipment for liquid-crystal injector-based sample delivery and a goniometer-based setup which supports fully automated sample exchange and data collection at room temperature and controlled humidity or at cryogenic conditions. The goniometer setup provides a suite of efficient automated experimental strategies tailored to handle a variety of sample requirements, crystal sizes and experimental goals. These developments coupled with improvements in data processing algorithms make it possible to derive high resolution crystal structures using only 100 to 1000 still diffraction images. Advanced capabilities to support serial and time-resolved crystallography are available at the SLAC laboratories and SSRL beam lines including crystal injectors, equipment for single crystal UV-Visible Absorption Spectroscopy (UV-Vis AS) and anaerobic setups for crystal growth, characterization and mounting.