Sample Delivery Methods and Instruments at SACLA

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Sample delivery tools are key components of experimental systems for X-ray free electron laser (XFEL), especially those using the “diffraction-before-destruction” approach; e.g., serial femtosecond crystallography (SFX) and coherent diffraction imaging (CDI). After the successful demonstrations of a liquid-jet injector with a gas dynamic virtual nozzle (GDVN) and a lipidic-cubic-phase injector at LCLS [1-3], similar injectors have also been applied to SFX at SACLA [4]. A standard liquid-jet injector at SACLA produces a sample beam with a diameter of 4–40 micrometers. Stable operation has been achieved in helium atmosphere. A viscous-carrier injector is also available in SFX to make a sample consumption small. Users have some choices to use appropriate carriers for their samples; e.g., LCP matrix, oil-based grease and hyaluronic acid [5,6]. The viscous-carrier injector can also be applied to pump-probe measurement, in which a relatively large volume of sample is irradiated by an optical laser with a spot size of about 100 um in full width at the half maximum. A sample stream has to be fast enough for the irradiated part to be replaced by a fresh one before the next pulse arrives. Recently a pulsed droplet injector has been applied to SFX [7]. A small liquid droplet (<0.1 mm in diameter) with protein crystals is ejected from a nozzle with a piezoelectric device. The droplet ejection is fully synchronized with XFEL. In addition to the standard injectors, users can install their own injectors to the SFX system of SACLA.

In the case of CDI, a fixed-target method is mostly used at SACLA. Sample particles are dispersed on a thin membrane, which is raster-scanned during exposure [8]. A data acquisition rate of 30 Hz is achieved with a fast scanning device.

In this talk, I will introduce sample delivery methods available at SACLA and new instruments under development.

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