Time-resolved structural biology over longer reactions and including complementary methods, but with less sample

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X-ray free electron lasers (XFEL) sources enable new science, but require novel sample delivery methods that exploit the pulse sequence of the particular source, but do not waste sample between XFEL pulses. We developed acoustic droplet ejection (ADE) as a general, touchless, on-demand method that uses focused sound waves to eject picoliter to nanoliter volume droplets from one place to another. In our first applications, we collected SFX datasets from droplets launched in synchrony to intersect each XFEL pulse (Roessler et al 2016). We have also coupled ADE methods with a conveyor belt drive to enable time-resolved SFX (tr-SFX) at the LCLS. Our system is optimized for crystallography and X-ray emission spectroscopy (XES) measurements of photochemical reactions over a wide-range of time scales and illumination schemes (Young, Ibrahim, and Chatterjee et al 2016; Fuller and Gull et al 2017). Indeed, the combination of tr-SFX + XES, wherein both types of data are obtained from the same sample and X-ray pulse, provides important complementary information that impacts mechanistic insights. We are also exploiting the region on the belt between the ADE transducer and the X-ray interaction point to introduce additional experimental perturbations that study a range of enzyme reactions. I will discuss the potential impact to tr-SFX studies of many macromolecules operating under physiological temperature and pressure.

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