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Ultrafast X-ray Diffraction at the LCLS

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The recent commissioning of the Linac Coherent Light Source (LCLS), the first hard X-ray femtosecond laser, opens up new and exciting opportunities for biological structure determination. It has been proposed that femtosecond X-ray pulses can be used to outrun damage processes by using single pulses so brief that they terminate before the manifestation of damage to the sample. X-ray crystallography provides so far the vast majority of macromolecular structures, but the success of the method relies on growing crystals of sufficient size. The high intensity femtosecond X-ray pulses generated at the LCLS allow using nanocrystals or even single particles for biological structure determination. During the first biological imaging beamtimes at the LCLS we have collected millions of snapshot diffraction patterns from membrane protein nanocrystals and single virus particles. New methods for injecting biomolecules/nanocrystals into the X-ray beam as well as new data analysis algorithms had to be developed. I will describe these experiments and their challenges.[2,3]

[1]R.B. Doak, J.C.H. Spence, P. Fromme, Arizona State University; H.N. Chapman, Centre for Free-Electron Laser Science, DESY; S. Boutet, SLAC National Accelerator Laboratory; J. Hajdu, Laboratory of Molecular Biophysics, Uppsala University.
[2]Chapman, H.N., et al., Femtosecond X-ray protein nanocrystallography. Nature, 2011. **470** (7332): p. 73-U81.
[3]Seibert, M.M., et al., Single mimivirus particles intercepted and imaged with an X-ray laser. Nature, 2011. **470** (7332): p. 78-U86.