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Coherent Diffractive Imaging at LCLS

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Soft x-ray FEL light sources produce ultrafast x-ray pulses with outstanding high peak brilliance. This might enable the structure determination of proteins that cannot be crystallized. The deposited energy would destroy the molecules completely, but owing to the short pulses the destruction will ideally only happen after the termination of the pulse. In order to address the many challenges that we face in attempting molecular diffraction, we have carried out experiments in coherent diffraction from protein nanocrystals at the Linac Coherent Light Source (LCLS) at SLAC. The periodicity of these objects gives us much higher scattering signals than uncrystallized proteins would. The crystals are filtered to sizes less than 2 micron, and delivered to the pulsed X-ray beam in a liquid jet. The effects of pulse duration and fluence on the high-resolution structure of the crystals have been studied. Diffraction patterns are recorded at a repetition rate of 30 Hz with pnCCD detectors. This allows us to take 108,000 images per hour. With 2-mega-pixel-detectors this gives a data-rate of more than 400 GB per hour. The automated sorting and evaluation of hundreds of thousands images is another challenge of this kind of experiments. Preliminary results will be presented on our first LCLS experiments. This work was carried out as part of a collaboration, for which Henry Chapman is the spokesperson. The collaboration consists of CFEL DESY, Arizona State University, SLAC, Uppsala University, LLNL, The University of Melbourne, LBNL, the Max Planck Institute for Medical Research, and the Max Planck Advanced Study Group (ASG) at the CFEL. The experiments were carried out using the CAMP apparatus, which was designed and built by the Max Planck ASG at CFEL. The LCLS is operated by Stanford University on behalf of the U.S. Department of Energy, Office of Basic Energy Sciences.