

*Radiation damage in protein crystallography at X-ray free-electron lasers*

Karol Jan Nass<sup>1</sup>

<sup>1</sup>SwissFEL / PSI, Villigen, Switzerland

E-mail: karol.nass@psi.ch

The ultrafast radiation damage begins with photoionization, followed by impact ionization by photo- and Auger electrons. The ionization of atoms develops with time, ultimately causing lattice disorder and Coulomb explosion of the crystal. Due to very short pulse duration, it has been proposed that diffraction can be recorded before significant structural changes occur. This has been termed "diffraction-before-destruction". However, achieving sufficient scattering signal for measuring nanocrystals or non-crystalline single particles requires higher power densities than those used in microcrystallography experiments.

In order to explore whether undamaged crystal structures can be obtained with higher power densities at the sample, we used two colour x-ray FEL pulses (15 fs) with variable (0-100fs) time delay from the Linac Coherent Light Source (LCLS). These pulses were focused to approximately 100 x 100 nm<sup>2</sup> to study radiation damage processes in protein crystals in a time-resolved fashion.

It is expected that a significant fraction of atoms in the crystal become highly ionized during exposure to the tightly focused x-ray FEL pulse. Indications of global and specific radiation damage and observation of correlated movement of atoms in the structure will be discussed.

Full Author list:

Karol Nass 1\*, Sébastien Boutet 2, Andrew Aquila 2, Thomas R.M. Barends 1, R. Bruce Doak 1, Lutz Foucar 1, Mario Hilpert 1, Mark S. Hunter 2, Jason Koglin 2, Gabriela Kovacsova 1, Mengning Liang 2, Christopher M. Roome 1, Robert L Shoeman 1, Ilme Schlichting 1

1 Max-Planck-Institut für Medizinische Forschung, Jahnstraße 29, 69120 Heidelberg, Germany

2 Linac Coherent Light Source, SLAC National Accelerator Laboratory, Sand Hill Road, Menlo Park, CA, 94025, USA

\* Current address: Paul Scherrer Institute, 5232 Villigen PSI, Switzerland

**Keywords:** [radiation damage XFEL](#)