

Coherent Diffractive Imaging Experiments at FLASH

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Abstract:

FLASH (the Free-electron LASer in Hamburg) at DESY is the first operating free-electron laser (FEL) in the XUV energy range [1]. In my talk I will give an overview of recent experiments performed by our group at FLASH focused on coherent x-ray diffractive imaging (CXDI) on a periodic [2] and non-periodic biological samples [3].

CXDI for the reconstruction of a two-dimensional (2D) finite crystal structure with a single pulse train of FLASH radiation at 7.97 nm wavelength was demonstrated [2]. This measurement shows an advance on traditional CXDI techniques by applying it to a periodic structure. It is also significant that this approach paves the way for the imaging of the class of specimens which readily form 2D, but not three-dimensional crystals. We show that the structure is reconstructed to the detected resolution, given an adequate signal to noise ratio.

In our next experiment [3] we employ CXDI using FLASH in a *non-destructive* regime to compare images of a biological sample reconstructed using different, single, femtosecond pulses of FEL radiation. We demonstrated that images obtained from statistically different FEL pulses contain the same amount of structural information up to the measured resolution. This result is especially important for the success of a single molecule imaging approach [4]. Furthermore, for the first time, we demonstrate CXDI, in-line holography and Fourier Transform Holography (FTH) of the same unicellular marine organism using an FEL and present diffraction data collected using the third harmonic of FLASH, reaching into the water window. We provide quantitative results for the resolution of the CXDI images as a function of pulse intensity, and compare this with the resolutions achieved with in-line holography and FTH.

References:

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- [4] K.J. Gaffney, *et al.*, Science **316**, 1444 (2007).