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Compton microscopy with multilayer Laue lenses

S.Bajt[1,2], H.N. Chapman[1,2,3], T. Li[2], H. Fleckenstein[1], M. Prasciolu[1], J. L. Dresselhaus[2], N. Ivanov[1], O. Yefanov[1], W. Zhang[1], D. Pennicard[4], P. Villanueva-Perez[5], O. Gutowski[4], A.-C. Dippel[4]

1. Center for Free-Electron Laser Science CFEL, Deutsches Elektronen Synchrotron DESY, Hamburg, Germany;

2. Centre for Ultrafast Imaging, Universität Hamburg, Hamburg, Germany;

3. Department of Physics, Universität Hamburg, Hamburg, Germany;

4. Deutsches Elektronen Synchrotron DESY, Hamburg, Germany;

5. Synchrotron Radiation Research and NanoLund, Lund University, Lund, Sweden.

sasa.bajt@desy.de

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High resolution X-ray imaging of biological samples is usually limited by radiation damage. One way to overcome this limitation is to work at higher photon energies, where the dominant interaction with matter occurs through inelastic or Compton scattering. We calculated that the signal per dose for imaging biological samples is maximized at about 60 keV [1]. X-ray optics for such high energies were until recently limited to reflective mirrors and refractive compound lenses. However, wedged multilayer Laue lenses (MLLs) [3] offer high efficiency and very high resolution of a few nanometers and only limited by the effective source size and the bandwidth. With our own developed MLLs [4] we performed proof-of-principle experiments and demonstrated scanning Compton X-ray microscopy on biological objects at PETRA III synchrotron [2]. Recently, we optimized this method and obtained low dose images of several dried biological objects. We calibrated the scattering signals using well defined silicon objects, which enabled us to collect quantitative images of the projected densities of the biological objects. Compton microscopy in combination with diffraction-limited X-ray sources and large solid angle detectors have great potential for imaging of un-sectioned and unlabeled cells with lower dose than previously achievable.

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