MI 7: X-ray Imaging, Tomography and X-ray Optics

Time: Wednesday 9:30–10:45 Location: EMH 225

MI 7.1 Wed 9:30 EMH 225

XFEL nanobeam characterization by scanning coherent x-ray microscopy — •Andreas Schropp[1], Robert Hoppe[2], Jens Patommel[2], Frank Seiboth[2], Hae Ja Lee[3], Bob Nagler[3], Eric C. Galtier[3], Jerome B. Hastings[3], and Christian G. Schroer[1] — [1]DESY Photon Science, Notkestr. 85, 22607 Hamburg, Germany — [2]Institute of Structural Physics, Technische Universität Dresden, 01062 Dresden, Germany — [3]SLAC National Accelerator Laboratory, 2575 Sand Hill Road, Menlo Park, CA 94025, USA

The characterization of XFEL-nanobeams is often crucial for the correct interpretation of experimental results. To date, this step was primarily implemented by imprint techniques giving rather rudimentary postmortem information of the intensity distribution. In this contribution, we present results obtained by scanning coherent x-ray microscopy (ptychography) during different beamtimes at the MEC- and XPP-instrument of the LCLS. This method has the advantage that the full caustic of the nanofocused beam can be numerically retrieved yielding the complete information on the focused XFEL-beam. Additionally, the retrieved complex-valued wave field could be refined for individual XFEL-pulses.

In the future, we are planning to implement the technique as a real-time diagnostic to spatially characterize XFEL-nanobeams and a first step towards this goal was conducted by implementing a fast detector for the measurement of the diffraction patterns. In combination with fast data processing routines running on GPU's a real-time visualization of nanofocused XFEL-beams is within reach.

MI 7.2 Wed 9:45 EMH 225

Multi plane probe retrieval in X-ray nearfield imaging — •Johannes Hagemann[1], Anna-Lena Robisch[1], David Russell Luke[2], Carolin Homann[2], Thorsten Hohage[2], Peter Cloetens[3], and Tim Salditt[1] — [1]Institute for X-Ray physics, G. A. U. Göttingen — [2]Institute for Numerical and Applied Mathematics, G. A. U. Göttingen — [3]European Synchrotron Radiation Facility

The probe, i.e. the impinging X-ray beam on the sample, is the main actor in X-ray imaging experiments when it comes to image quality. Knowledge about the probe helps to characterize the optics in use and to circumvent problems associated with the standard flat field correction. Additionally we can characterize beam properties as the degree of coherence or the size of the focal spot. We present reconstructions of the probes of different ESRF beamlines (ID16, ID19, ID22) which were used for X-ray imaging experiments. Gaining information about the probe is an example of the phase retrieval problem which is solved here by multiple detector plane positions [1]. This experimental scheme yields reconstructions without using an additional test sample.

[1] Hagemann, J. et al. Opt. Express 22, 11552 (2014)

MI 7.3 Wed 10:00 EMH 225

Cone Beam X-Ray Imaging and Tomography with Anisotropic Source Sizes — •Malte Vassholz and Tim Salditt — Institute for X-Ray Physics, Georg-August-Universität Göttingen, 37077 Göttingen, Germany

Nanoscale x-ray imaging and tomography are important methods for analysing hard and soft matter. However, it requires x-ray probes with high brilliance and small source sizes and is therefore carried out at synchrotrons. Towards the goal of nanoscale resolution we have tested the applicability of x-ray waveguide optics. While two dimensional waveguides provide an excellent probe but insufficient flux, planar waveguides provide an anisotropic probe with sufficient flux. The central challenge is to get isotropic resolution from probes with anisotropic source sizes. We have investigated new data-aquistion schemes and advanced three-dimensional reconstruction methods for imaging and tomography with anisotropic sources.

MI 7.4 Wed 10:15 EMH 225

Lithographically fabricated waveguides for x-ray coherent imaging — •Sarah Hoffmann, Hsin-Yi Chen, Henrike Neubauer, Mike Kanbach, and Tim Salditt — Röntgenphysik, uni-Göttingen, Friedrich-Hund Platz 1, 37077 Göttingen

Nanoscale x-ray sources as provided by x-ray channel waveguides enable a multitude of novel applications such as diffraction, high resolution spectroscopy, microscopy and holography [1,2]. We report on imaging experiments and the fabrication process of these hard x-ray waveguides deployed at the synchrotron sources at DESY and ESRF. Among other techniques e-beam lithography, reactive ion etching and Silicon wafer bonding are involved within the fabrication of two-dimensional, sub-100 nm sized waveguide channels. Both waveguide geometry and material can be adapted to meet the requirements of a specific experiment, such as the photon energy (7.9-17.5 keV), the desired source size, or the application of a reference beam in a holography setup. As the tunability of the optical properties provided by the waveguides, such as the coherence of the beam, its divergence or the waveguide transmission, depends sensitively on the precise control over the (several) process steps, an iterative process of diagnostics and optimization is essential.

[1] A. Jarre et al., Phys. Rev. Lett. 94, 074801 (2005)
[2] C. Krywka et al., J. Appl. Cryst. 45, 85-92 (2012)
[3] A. Kohlstedt et al., Appl. Phys. A 91, 6-12 (2008)
[4] H. Neubauer et al., J. Appl. Phys. 115, 214305 (2014)

MI 7.5 Wed 10:30 EMH 225

Refraktive Röntgenlinsen aus Lamellen konstanter Dicke — •Jens Patommel[1], Frank Seiboth[1], Maria Scholz[1,2], Robert Hoppe[1], Felix Wittwer[1], Juliane Reinhardt[1,2], Jens Seidel[3], Martin Knaut[4], Andreas Jahn[4], Karola Richter[4], Johann W. Bartha[4], Gerald Falkenberg[2] und Christian G. Schroer[2,5] — [1]Institut für Strukturphysik, Technische Universität Dresden, 01062 Dresden — [2]Deutsches Elektronen-Synchrotron DESY, 22607 Hamburg — [3]Fakultät für Mathematik, Technische Universität Chemnitz, 09107 Chemnitz — [4]Institut für Halbleiter- und Mikrosystemtechnik, Technische Universität Dresden, 01062 Dresden — [5]Fachbereich Physik, Universität Hamburg, Luruper Chaussee 149, 22761 Hamburg

Herkömmmliche refraktive Röntgenlinsen bestehen aus Silizium, weil für röntgenoptisch besser geeignete Materialien wie Diamant oder Saphir keine geeigneten Ätzprozesse für die Mikrostrukturierung zur Verfügung stehen. Wir präsentieren ein Linsendesign, das es gestattet, die Linsen mittels Abscheidungsverfahren wie z.B ALD herzustellen, wodurch das Verwenden anderer Materialien als Silizium möglich wird. Diese sogenannten refraktiven lamellaren Linsen (RLL) bestehen aus einem Stapel von Lamellen konstanter Dicke, die derart gekrümmt sind, dass sie in der Projektion entlang der optischen Achse eine Parabelform ergeben und somit einer Sammellinse entsprechen. Simulationen und erste Experimente mit diesen Linsen aus Saphir haben gezeigt, dass sie kleinere Fokusse mit höherem Fluss als herkömmliche Siliziumlinsen erzeugen können.