ST 2: Biomedical Imaging I

Zeit: Dienstag 14:00–16:15 Raum: RW 2

ST 2.1 Di 14:00 RW 2

Optimization of x-ray speckle tracking phase contrast imaging — •Marie-Christine Zdora, Irene Zanette, and Franz Pfeiffer — Department of Physics (E17), Technische Universität München, 85748 Garching, Germany

X-ray phase contrast imaging using speckle tracking is an emerging technique, which combines the advantages of high sensitivity, easy setup and relatively low temporal coherence requirements.
In x-ray speckle tracking a random diffuser with micrometer-sized structures, e.g. a piece of sandpaper or a filter membrane, is placed in the beam. The scattering of x-rays off the structures in the diffuser and the following interference of the scattered rays lead to the formation of a so-called "speckle pattern" in the detector plane. When a sample is introduced into the beam, either upstream or downstream the diffuser, the speckle pattern is distorted by the sample and the phase information can be obtained from the displacement vector of the speckles in the observation plane.
So far, most studies on this topic are of experimental character and parameters (e.g. pore size, x-ray energy, propagation distance etc.) are determined empirically. We present numerical simulations and preliminary experimental results for this technique. Variation of different parameters is performed to optimize speckle contrast and image sensitivity.

ST 2.2 Di 14:15 RW 2

X-Ray Phase-Contrast Imaging at PETRA III — •Alexander Hipp, Julia Herzen, Pavel Lytaev, Thomas Dose, Felix Beckmann, and Andreas Schreyer — Helmholtz-Zentrum Geesthacht, Geesthacht, Germany

Conventional absorption-based imaging often is lacking in good contrast at special applications like visualisation of soft tissue or weak absorbing material in general. To overcome this limitation, several new X-ray phase-contrast imaging methods have been developed at synchrotron radiation facilities. Our aim was to establish the possibility of different phase-contrast imaging modalities at the Imaging Beamline (IBL) and the High Energy Material Science Bemaline (HEMS) at Petra III. Here we present the instrumentation and the status of the currently successfully established phase-contrast imaging techniques. First results from measurements of biomedical samples will be presented to demonstrate the currently available range of applications at those two beam lines.

ST 2.3 Di 14:30 RW 2

Current State of the Art of Grating-Based Laboratory X-ray Phase-Contrast Computed Tomography — •Lorenz Birnbacher[1], Marian Willner[1], Mathias Marschner[1], Jan Meiser[2], Julia Herzen[3], Michael Chabior[1], and Franz Pfeiffer[1] — [1]Department of Physics (E17) & IMETUM, Chair of Biomedical Physics, Technische Universität München, D-85748 Garching — [2]Karlsruher Institut für Technologie (KIT), Institut für Mikrostrukturtechnik, D-76021 Karlsruhe — [3]Institute of Materials Science, Helmholtz-Zentrum Geesthacht, D-21502 Geesthacht

X-ray phase-contrast computed tomography (PC-CT), which was initially performed with highly coherent, monochromatic synchrotron radiation, provides improved soft tissue contrast. With the development of a three-grating Talbot-Lau interferometer, PC-CT is also available at conventional laboratory X-ray sources. This offers better access and a larger field of view at the cost of lower spatial resolution in comparison to synchrotron sources.
New grating production techniques and grating designs as well as advanced reconstruction algorithms could improve the performance of laboratory PC-CT setups. Optimized measurement techniques could further reduce the measurement time and increase the setup sensitivity.
We show the current state of our grating-based PC-CT setup with recently acquired imaging results of biomedical samples using a rotating anode and a single photon counting Pilatus II detector. Thereby, we are able to retrieve fine differences in electron density, which offers new possibilities of soft matter investigation.

ST 2.4 Di 14:45 RW 2

Improving Image Quality in Phase-Contrast Computed Tomography through Statistical Iterative Reconstruction — •Mathias Marschner[1], Dieter Hahn[1], Marian Willner[1], Lorenz Birnbacher[1], Andreas Fehringer[1], Peter Noël[2], Michael Chabior[1], and Franz Pfeiffer[1] — [1]Department of Physics (E17) & IMETUM, Chair of Biomedical Physics, Technische Universität München, 85748 Garching, Germany — [2]Department of Radiology, Klinikum rechts der Isar, Technische Universität München, 81675 München, Germany

Phase-contrast X-ray computed tomography (PCCT) provides additional soft-tissue contrast in biomedical samples. However, non-ideal measurement conditions and parameters, e.g. undersampling and a limited dynamic range can introduce artefacts into the tomographic reconstruction. Furthermore, low frequency noise dominates in the images due to the differential signal. These problems cannot be solved by conventional reconstruction algorithms e.g. filtered backprojection. Recently, more advanced methods have been proposed to improve the image quality of these tomographic images. We present results from an iterative reconstruction algorithm for PCCT. This algorithm uses statistical information of the initial measurement as well as complementary information from the attenuation and dark-field signals. These are concurrently obtained with grating-based phase-contrast imaging. This additional information mitigates the effects of non-ideal measurement conditions. We demonstrate that this algorithm improves the image quality by lowering the noise level and reducing artefacts.

ST 2.5 Di 15:00 RW 2

Grating-based helical-CT phase contrast imaging — •Max Schuster[1], Florian Bayer[1], Wilhelm Haas[1,2], Florian Horn[1], Manuel Kraus[1], Georg Pelzer[1], Jens Rieger[1], André Ritter[1], Andrea Zang[1], Thomas Weber[1], Thilo Michel[1], and Gisela Anton[1] — [1]ECAP - Erlangen Centre for Astroparticle Physics, Universität Erlangen-Nürnberg, Erwin- Rommel-Straße 1, 91058 Erlangen — [2]Lehrstuhl für Mustererkennung, Universität Erlangen-Nürnberg, Martensstraße 3, 91058 Erlangen

Tomographic imaging is far established in the field of grating based Talbot-Lau X-ray interferometry. In this contribution we present results of helical phase-contrast CT. Helical-CT scans of phantoms and mice were performed with a 25 keV design energy Talbot-Lau interferometer operated with a 40 kVp tungsten anode spectrum. 360LI and 360MLI interpolation algorithms have been tested. Slice reconstruction was carried out for attenuation, differential phase and dark-field signals.

ST 2.6 Di 15:15 RW 2

Energy weighting in grating-based x-ray phase-contrast imaging — •Georg Pelzer[1], Thomas Weber[1], Gisela Anton[1], Florian Bayer[1], Wilhelm Haas[1,2], Florian Horn[1], Manuel Kraus[1], Jens Rieger[1], André Ritter[1], Ina Ritter[1], Andrea Zang[1], Thomas Weber[1], and Thilo Michel[1] — [1]ECAP - Erlangen Centre for Astroparticle Physics, Universität Erlangen-Nürnberg, Erwin- Rommel-Straße 1, 91058 Erlangen — [2]Lehrstuhl für Mustererkennung, Universität Erlangen-Nürnberg, Martensstraße 3, 91058 Erlangen

By using an energy-resolving photon-counting detector in grating-based x-ray phase-contrast imaging it is possible to reduce the necessary dose. We derived energy weighting factors for phase-contrast imaging. Evaluation measurements with the hybrid photon-counting detector Dosepix were performed. The concept of energy binning implemented in the pixel electronics of this detector allows counting of photons in 16 energy channels. With this technique the spectral information can be obtained pixel wise from one single acquisition. The results presented in this contribution demonstrate the advantages of spectroscopic photon-counting in differential phase-contrast imaging.

ST 2.7 Di 15:30 RW 2

Energy correction for phase-contrast in Talbot-Lau X-ray imaging — •Manuel Kraus, Georg Pelzer, Gisela Anton, Jens Rieger, André Ritter, Ina Ritter, Johannes Wandner, Thilo Michel, and Thomas Weber — ECAP - Erlangen Centre for Astroparticle Physics, Universität Erlangen-Nürnberg, Erwin- Rommel-Straße 1, 91058 Erlangen

In grating based x-ray phasecontrast imaging the use of energy-resolving photon-counting detectors offer the opportunity not only to

optimize the signal-to-noise-ratio for the phase-contrast images, but also to get quantitative values from the corrected phase-contrast images. Energy dependent correction factors were derived for the phase-contrast picture, tested with simulations and evaluated with measurements using the Dosepix detector.

ST 2.8 Di 15:45 RW 2

Simulation des Dunkelfeldsignals von Faserstrukturen — •Benjamin Zach, Florian Bayer, Thomas Weber, André Ritter, Gisela Anton, Florian Horn, Thilo Michel, Georg Pelzer, Jens Rieger und Andrea Zang — ECAP - Erlangen Centre for Astroparticle Physics, Universität Erlangen-Nürnberg, Erwin- Rommel-Straße 1, 91058 Erlangen

Der gitter-basierten interferometrischen Röntgenbildgebung wird großes Potenzial in der medizinischen Röntgenbildgebung und auch in der Zerstörungsfreien Prüfung von Werkstoffen zugesprochen. In diesem Vortrag werden Ergebnisse von Simulationen des Dunkelfeldsignals von aus Fasern bestehenden Objekte vorgestellt. Die Abhängigkeit des Dunkelfeldsignals von unterschiedlichen Parametern des Objekts wird diskutiert.

ST 2.9 Di 16:00 RW 2

Analysis Of A Deconvolution-Based Information-Retrieval Algorithm In X-Ray Grating-Based Phase-Contrast Imaging — •Florian Horn, Florian Bayer, Manuel Kraus, Georg Pelzer, Jens Rieger, André Ritter, Thomas Weber, Thilo Michel, and Gisela Anton — ECAP - Erlangen Centre for Astroparticle Physics, Universität Erlangen-Nürnberg, Erwin- Rommel-Straße 1, 91058 Erlangen

Grating-based X-ray phase-contrast imaging is a promising imaging modality to increase soft tissue contrast in comparison to conventional attenuation-based radiography. Complementary and otherwise inaccessible information is provided by the dark-field image, which shows the sub-pixel size granularity of the measured object.

In addition to the well-established image reconstruction process, an information retrieval process was introduced, which is based on deconvolution of the underlying scattering distribution within a single pixel revealing information about the sample. Subsequently, the different contrast modalities can be calculated out of the scattering distribution. The method already proved to deliver additional information by use of the higher moments of the scattering distribution and possibly reaches better image quality in consideration of an increased contrast-to-noise ratio.

We show analyses of the dependency of the iterative deconvolution-based method in regard of the dark-field image on different parameters such as dose, number of iterations and created dark-field signal. The results complete recently published numerical simulations.