ST 2: Advanced Diagnostic Imaging II

Time: Monday 15:00–17:00 Location: HFT-FT 101

ST 2.1 Mon 15:00 HFT-FT 101

X-ray Vector Radiography for Bone Micro-Architecture Diagnostics — •Andreas Malecki, Guillaume Potdevin, Thomas Biernath, Martin Bech, and Franz Pfeiffer — Department of Physics and Institute of Medical Engineering, Technische Universität München, 85748 Garching, Germany

The non-invasive estimation of fracture risk in osteoporosis remains a challenge in the clinical routine and is mainly based on an assessment of bone density by dual X-ray absorption (DXA). Although bone micro-architecture is known to play an important role for bone fragility, its visualisation implies an imaging resolution better than $100\,\mu$m, which limits the field of view and increases the necessary radiation dose. Here we describe a new method, X-ray Vector Radiography (XVR), based on X-ray scattering rather than absorption as contrast source, which yields information about the local orientation and degree of anisotropy of the bone micro-structure. This information is highly relevant for osteoporosis diagnostic. We demonstrate the feasibility by showing first experimental X-ray Vector Radiographies of human vertebra bone samples, yielding information on the trabecular structure.

ST 2.2 Mon 15:20 HFT-FT 101

Preliminary results from a first preclinical x-ray phase-contrast CT scanner — •Astrid Velroyen[1], Arne Tapfer[1], Martin Bech[1], Bart Pauwels[2], Peter Bruyndonckx[2], Xuan Liu[2], Alexander Sasov[2], and Franz Pfeiffer[1] — [1]Department of Physics and Institute of Medical Engineering (IMETUM), Technische Universität München, Germany — [2]Skyscan, Kontich, Belgium

Conventional absorption-based x-ray imaging of biomedical samples provides only weak soft-tissue contrast. This limitation can be addressed by phase-contrast imaging, which exploits the phase shift that x-rays undergo when passing through an object. The phase shift, apparent in a minimal angular refraction of the x-ray, can be measured by grating-based interferometric methods at laboratory x-ray sources. Using this technique, improved soft-tissue contrast can be achieved and great potential for medical imaging is anticipated. As a first step towards clinical implementation, we have developed a grating-based compact preclinical phase-contrast CT scanner with rotating gantry, from which we present the first results of soft tissue samples. In particular, the effect of the rotational movement of the gantry on the interferometric image acquisition is characterized and the consequent challenges for image preprocessing and image formation are presented. First scans of biological samples clearly show the improved soft-tissue contrast and hence prove the feasibility of phase-contrast x-ray tomography with a compact rotating gantry system.

ST 2.3 Mon 15:40 HFT-FT 101

Quantitative grating-based X-ray phase contrast tomography at 82 keV — •Marian Willner[1], Martin Bech[1], Julia Herzen[1], Dieter Hahn[1], Johannes Kenntner[2], Juergen Mohr[2], Irene Zanette[3], Alexander Rack[3], Timm Weitkamp[4], and Franz Pfeiffer[1] — [1]Department of Physics, Technische Universität München — [2]Karlsruhe Institute of Technology (KIT) — [3]European Synchrotron Radiation Facility (ESRF), France — [4]Synchrotron Soleil, France

Grating-based X-ray phase contrast imaging has increasingly aroused interest as the method has been successfully adapted to work with laboratory X-ray sources. The high potential to improve the soft-tissue contrast compared to standard absorption-based tomography and the quantitativeness of the technique have been demonstrated at energies below 35 keV. However, a broad spectrum of applications in industrial testing and medical imaging needs the operation at higher X-ray energies. Technical advances in the grating manufacturing process make it possible to continuously push the existing energy limitations. In this work we report on the results of a first quantitative phase contrast tomography analysis of a high-energy phantom at 82 keV. The phantom consists of well-defined solid materials covering a wide range of densities and atomic numbers and was scanned with high-resolution at a synchrotron radiation source. The absorption and phase contrast images are analyzed in terms of signal-to-noise ratio (SNR), and the material-specific mass absorption coefficients and refractive index decrements are determined and compared to theoretical values.

20 Min. Pause

ST 2.4 Mon 16:20 HFT-FT 101

Improved Diagnostic Differentiation of Renal Cystic Lesions with X-ray Phase-Contrast Computed Tomography — •Julia Herzen[1], Marian Willner[1], Peter Noel[2], Alexander Fingerle[2], Daniela Münzel[2], Dieter Hahn[1], Ernst J. Rummeny[2], and Franz Pfeiffer[1] — [1]Department of Physics & Institute for Medical Engineering, Technische Universität München, Garching, Germany — [2]Department of Radiology, Technische Universität München, Munich, Germany

The diagnostic value of X-ray phase-contrast computed tomography (PCCT) is one of the unexplored areas in medical imaging; at the same time, it seems to offer the opportunity as a highly sensitive diagnostic tool. Conventional computed tomography (CT) has had an enormous impact on medicine, but it is limited in soft-tissue contrast. One example that portrays this challenge is the differentiation between benign and malignant renal cysts. In this work we report on a study of characterizing renal cysts using PCCT. We imaged a renal phantom with grating-based PCCT system using a rotating anode X-ray tube and a photon-counting detector. The phantom consisted of a renal equivalent soft-tissue and cystic lesions grouped in non-enhancing cyst and hemorrhage series and an iodine enhancing series. We found that with PCCT an improved differentiation between hemorrhage renal cysts from contrast enhancing malignant cysts is possible without using any contrast agents.

ST 2.5 Mon 16:40 HFT-FT 101

Monochromatic computed tomography with a compact laser-driven synchrotron X-ray source — •Klaus Achterhold[1], Martin Bech[1], Simone Schleede[1], Guillaume Potdevin[1], Ron Ruth[2], Rod Loewen[2], and Franz Pfeiffer[1] — [1]Department of Physics (E17) and Institute of Medical Engineering (IMETUM), Technische Universität München, Germany — [2]Lyncean Technologies Inc., Palo Alto 94306, California, USA

We report the first quantitative computed tomography (CT) measurements using a laser-driven compact synchrotron X-ray source. Herein nearly monochromatic, tunable X-rays are produced by the inverse Compton scattering of infrared Laser photons. Quantitative CT results are obtained at 21 keV on mass absorption coefficients in a phantom sample. The phantom was a water-filled cylindrical plastic container. The monochromatic data are compared to results obtained from a rotating anode X-ray tube generator producing polychromatic radiation at various peak voltages. The findings confirm that a laser-driven compact synchrotron X-ray source can indeed yield much higher CT image quality, particularly if quantitative aspects of computed tomographic imaging are considered.