# ST 5: Biomedical Imaging II

Zeit: Mittwoch 16:30–19:00 Raum: Phys-HS P

ST 5.1 Mi 16:30 Phys-HS P

**Introduction to X-ray Talbot-Lau-interferometry** — •Andreas Wolf — Erlangen Centre for Astroparticle Physics, Universität Erlangen-Nürnberg, Erwin-Rommel-Str. 1, 91058 Erlangen

X-ray Talbot-Lau-interferometry is based on the self-imaging phenomenon of the Talbot effect. In this method, a periodic microstructure – typically a phase grating – is illuminated in order to produce an intensity reference pattern at the detector. A sample placed before the grating induces distortions of that pattern. On top of the conventional attenuation image, X-ray Talbot-Lau-interferometry can thus yield information about the refractive properties and the scattering power of the sample.

In this contribution, the physical principles of grating-based setups and the basic reconstruction method will be reviewed. In addition, possible applications as well as recent developments in the field will be addressed.

ST 5.2 Mi 16:45 Phys-HS P

**X-ray dark-field imaging of porcine lung tissue in different Talbot-Lau setups** — •Veronika Ludwig[1], Katharina Hellbach[2], Michael Gallersdörfer[1], Christian Hauke[1], Florian Horn[1], Georg Pelzer[1], Marcus Radicke[3], Jens Rieger[1], Maria Seifert[1], Sven-Martin Sutter[3], Thilo Michel[1], and Gisela Anton[1] — [1]ECAP Medical Physics Group, Friedrich-Alexander-University Erlangen-Nürnberg, Germany — [2]Institute of Clinical Radiology, Ludwig-Maximilians-University Hospital Munich, Germany — [3]Siemens Healthcare GmbH, Erlangen, Germany

Grating-based X-ray phase-contrast imaging provides the differential phase and the dark-field image, in addition to the conventional attenuation image. Lung tissue consists mainly of air-filled alveoli, such that the porous structure formed by many air-tissue-boundaries leads to a strong dark-field signal. Therefore, X-ray dark-field imaging seems to be a promising method for the diagnosis of lung diseases, while conventional X-ray imaging often lacks the required contrast. Aiming at the investigation of the different origins of dark-field contrast discussed in literature, we measured the same porcine lung using different interferometer setups. They differ by grating periods and inter-grating distances while the system-specific components focal spot size, magnification and detector pixel size are maintained. Furthermore, our measurements show that lung diagnosis by X-ray phase-contrast imaging is also feasible with large grating periods at a low dose.

ST 5.3 Mi 17:00 Phys-HS P

**Quantitative single-shot phase-contrast radiography at synchrotrons: A comparison between propagation-based and grating-based imaging on the basis of simulated data** — •Max Schuster, Maria Seifert, Andreas Wolf, Thilo Michel, Gisela Anton, and Stefan Funk — ECAP - Erlangen Centre for Astroparticle Physics, Universität Erlangen-Nürnberg, Erwin-Rommel-Str. 1, 91058 Erlangen

Both, propagation- and grating-based X-ray phase contrast imaging (pbPCI & gbPCI) enable the retrieval of the phaseshift imprinted on an X-ray wave by the interaction with matter. This offers sensitivity to local variations in the electron density distribution and thus provides improved contrast for soft tissue imaging. pbPCI is a well-established method for high spatial resolution measurements at synchrotron beamlines [1,2]. Single-shot pbPCI additionally enables measurements at high temporal resolution. This is of special interest for time-resolved measurements, e.g. studies of dynamic bio-medical processes at synchrotrons [1,3]. In the case of gbPCI, single-shot acquisition can be realized by means of Fourier imaging [4]. Here, a comparison of both techniques with regard to their imaging potential, in particular their capabilities to resolve overlapping structures as they appear in complex objects, is drawn on the basis of simulated data for a synchrotron scenario. [1] Kitchen, M. J., et al. Phys. Med. Biol. 60.18 (2015): 7259. [2] Baran, P., et al. Phys. Med. Biol. 62.6 (2017): 2315. [3] Lewis, R. A., et al. Phys. Med. Biol. 50.21 (2005): 5031. [4] Takeda, M., et al. JosA 72.1 (1982): 156-160.

ST 5.4 Mi 17:15 Phys-HS P

**Talbot-Lau scanning-setup for phase-contrast X-ray imaging** — •Michael Gallersdörfer, Veronika Ludwig, Georg Pelzer, Jens Rieger, Maria Seifert, Thilo Michel, and Gisela Anton — ECAP - Erlangen Centre for Astroparticle Physics, Universität Erlangen-Nürnberg, Erwin- Rommel-Straße 1, 91058 Erlangen

Using a grating-based Talbot-Lau X-ray interferometer, in addition to the conventional absorption image the differential phase-contrast image and the dark-field image are retrievable.
However, the size of the gratings needed therefore is limited due to the high demands on their properties. This makes the imaging of larger body parts difficult and thus poses a problem for clinical applications. In this contribution we present a scanning-setup, that is able to overcome this problem. By using a moveable sample tray, an area of 25 cm x 160 cm can be measured within 24 seconds obtaining a resolution in the object plane of 100 $\mu$m x 100 $\mu$m. With this setup chest radiography or even a full body scan is feasible.

ST 5.5 Mi 17:30 Phys-HS P

**Differenzierung von Kalzifikationen durch den quantitativen Vergleich von Schwächungs- und Dunkelfeldinformation** — •Mareike Weule, Jens Rieger, Georg Pelzer, Florian Horn, Andreas Artinger, Thilo Michel und Gisela Anton — ECAP - Erlangen Centre for Astroparticle Physics, Universität Erlangen-Nürnberg, Erwin-Rommel-Straße 1, 91058 Erlangen

In der gitterbasierten Phasenkontrast-Röntgenbildgebung gibt es neben dem herkömmlichen Transmissionsbild, das differentielle Phasenbild und das Dunkelfeldbild. Im Dunkelfeldbild erzeugen vor allem Objekte mit hoher Kleinwinkelstreuung einen starken Kontrast. Dadurch lassen sich poröse, schaumige oder körnige Strukturen besonders gut erkennen. Dies ermöglicht die Darstellung von Kalzifikationen, wie sie in Brusttumoren vorkommen können. Untersuchungen ergaben, dass sich mithilfe eines dunkelfeld-abhängigen Quotienten die Sorte des Mikrokalks und somit die Gutartigkeit des Tumors klassifizieren lässt [1]. Dies konnte jedoch in weiteren Messungen nicht bestätigt werden. Für ein besseres Verständnis wurden die Abhängigkeiten zwischen Quotient und Beschaffenheit der Kalzifikation simulativ untersucht und hier präsentiert. [1] Wang et al., Nature Communications 5, (2014): 3797

**15 min. break**

ST 5.6 Mi 18:00 Phys-HS P

**Exploring Gamma-detected MRI: Frist Setup Performance** — •Robin Engel[1], Magdalena Kowalska[1], Jean-Noël Hyacithe[2], Renaud Julivet[2], Walter Neu[3], Stavroula Pallada[1], Luis Frail[1], and Thierry Stora[1] — [1]CERN, Geneva, Switzerland — [2]Université de Genève, Geneva, Switzerland — [3]HS Emden/Leer, Emden, Germany

A 2016 publication (Nature 537.7622 (2016): 652-655.) presented the proof of principle on a new imaging method. It uses many concepts of traditional Magnetic Resonance Imaging, but replaces the detection of RF signals with that of the anisotropic gamma-emission of a hyperpolarized radioactive tracer, in this case 131mXe.

Since gamma-radiation is in comparison very easy to detect, this method is sensitive to sample concentrations that are many orders of magnitudes lower than those needed for conventional MRI. Therefore, it has the perspective of combining the advantages of nuclear tracers, as they are used in SPECT for their selective chemical properties, with the much higher spatial resolution of MRI.

Here, we present a new setup for this imaging approach, implementing an existing low-field MRI-scanner and Si-PMT based gamma detectors in combination with elements from a spin-exchange optical pumping setup developed for hyperpolarized MRI of stable Xenon. We have further created direct numerical simulations of the spin precession and nuclear emission behavior during the measurement sequence by a specially developed simulation software and hope to compare them to first results planned for February 2018.

ST 5.7 Mi 18:15 Phys-HS P

**HYPMED - Digital Hybrid Breast PET/MRI for Enhanced Diagnosis of Breast Cancer** — •Florian Müller[1], Federica Demattè[1], Thomas Dey[1], Pierre Gebhardt[1], Nicolas Gross-Weege[1], Patrick Hallen[1], David Schug[1], Björn Weissler[1], Laiyin Yin[1], and Volkmar Schulz[1,2] — [1]Department of Physics of Molecular Imaging Systems, Institute for Experimental

Molecular Imaging, RWTH Aachen University, Aachen, Germany — [2]Department of Molecular Imaging Systems, Philips Research, Aachen, Germany

The combination of Positron Emission Tomography (PET) with Magnetic Resonance Imaging (MRI) is a powerful research tool for cancer diagnosis and individualized cancer treatment (precision oncology). PET-MRI can provide unique information to guide precision oncology that includes measuring the regional expression of therapeutic targets, measuring drug pharmacokinetics, measuring therapy pharmacodynamics, and providing a marker of therapeutic efficacy that is highly indicative of outcome.

Current commercial PET-MRI systems are implemented as whole body imaging devices, although MRI is mostly used as an organ-based modality. The high complexity and cost of this young hybrid imaging modality, the tracer dose and the low image resolution are limiting future investigations in the fields of genomics, proteomics or metabolomics. The EU H2020 project HYPMED is addressing these limitations by developing a dedicated PET-RF insert to improve the diagnosis of breast cancer and personalized therapy control.

ST 5.8 Mi 18:30 Phys-HS P

**Commissioning of an Assembly Tool for High Resolution, DOI-Capable PET Detectors** — •Federica Demattè[1], Thomas Dey[1], Pierre Gebhardt[1], Nicolas Gross-Weege[1], Patrick Hallen[1], Florian Müller[1], David Schug[1], Björn Weissler[1], Laiyin Yin[1], and Volkmar Schulz[1,2] — [1]Department of Physics of Molecular Imaging Systems, Institute for Experimental Molecular Imaging, RWTH Aachen University, Aachen, Germany — [2]Department of Molecular Imaging Systems, Philips Research, Aachen, Germany

Positron Emission Tomography (PET) allows to analyze metabolic information in vivo. The two 511 keV gamma particles originating from the positron annihilation location are detected by scintillator based detectors. To attenuate the 511 keV gammas typically a thickness of 10 - 20 mm is used. The scintillator is often structured to confine the scintillation light to a bin size that suits the targeted spatial resolution. If the last one is smaller than the height of the scintillator, it is beneficial to be able to determine the Dept-Of-Interaction (DOI) of the gamma interaction.

The European project "HYPMED" aims to develop a PET/MRI which can diagnose even the smallest cancer foci in women breast. The targeted spatial resolution is sub-millimeter, outperforming any state-of-the-art whole-body PET.

This talk will introduce the developments of the assembly tool used to mount high-resolution, DOI-capable detector stacks. Some first performance evaluation results will be presented as well.

ST 5.9 Mi 18:45 Phys-HS P

**Inbetriebnahme eines asymmetrischen TOF-PET-Systems** — •Ole Brandt[1,2], Yonathan Munwes[3], Erika Garutti[1], Ties Behnke[2], and Milan Zvolsky[1] — [1]Universität Hamburg, Institut für Experimentalphysik, Luruper Chaussee 149, 22761 Hamburg — [2]Desy, Notkestrasse 85, 2607 Hamburg — [3]Universität Heidelberg, Im Neuenheimer Feld 227, 69120 Heidelberg

Im Rahmen des EndoTOFPET-US-Projekts wird ein neuartiges multimodales Gerät zur Ultraschall-Endoskopie und Positronen-Emissions-Tomographie (PET) von Prostata- und Pankreas-Karzinomen entwickelt. Das Gerät besteht aus einem miniaturisierten PET-Kopf, installiert auf einem komerziellen Ultraschall-Endoskop und einer externen Detektor-Platte, die in unmittelbarer Nähe zum Körper positioniert wird. Dieses nutzt die Flugzeit (TOF)-Information der detektierten Photonen, um Untergrund von naheliegenden Organen zu unterdrücken. Dazu wird eine Koinzidenz-Zeitauflösung von Durchschnittlich 250 ps Halbwertsbreite erreicht. Die Detektion der Photonen erfolgt mittels Szintillationskristallen, ausgelesen durch Silizium- Photomultiplier (SiPM). Die Verarbeitung der SiPM-Signale erfolgt durch den STiC-Chip (SiPM Timing Chip, Uni Heidelberg). Um das System zu vervollständigen wird zu der bereits bestehenden äußeren Platte ein PET-Kopf mit 64 Pixeln und einer Pixelgröße von 1x1 $mm^2$ hergestellt und charakterisiert. Weiterhin wird der Einfluss der Zeitauflösung und der Asymmetrie der Pixelgrössen auf Signal- zu Rauschverhältnis sowie auf die räumliche Auflösung des Systems untersucht.