BP 13: Bioimaging and Spectroscopy II

Time: Tuesday 9:30–11:00 Location: HÜL 386

Invited Talk BP 13.1 Tue 9:30 HÜL 386

X-ray imaging of Cells and Tissues — •Tim Salditt — Georg-August-Universität Göttingen, Institut für Röntgenphysik, Friedrich-Hund-Platz 1, 37077 Göttingen

X-rays can provide information about the functional (interior) architecture of unstained biological cells and tissues. However, this potential of hard x-rays in view of penetration power, high spatial resolution, quantitative contrast, and compatibility with environmental conditions has to date not been fully developed, mainly due to significant challenges in x-ray optics. With the advent of highly brilliant radiation, coherent focusing, and lens-less diffractive imaging this situation has changed. We show how nano-focused coherent x-ray synchrotron beams can be used for scanning as well as for full field holographic x-ray imaging.

Following an introduction to the basic concepts of lensless x-ray imaging, different recent examples of biological imaging are presented, ranging from bacterial and eukaryotic cells, to the level of tissue and organs.

BP 13.2 Tue 10:00 HÜL 386

(Nanoscale) 3D virtual histology of neuronal tissues — •Mareike Töpperwien[1], Martin Krenkel[1], Kristin Müller[1], Benjamin Cooper[2], Jürgen Goldschmidt[3], and Tim Salditt[1] — [1]Institute for X-Ray Physics, Göttingen, Germany — [2]Max Planck Institute for Experimental Medicine, Göttingen, Germany — [3]Leibniz Institute for Neurobiology, Magdeburg, Germany

Studies of the brain cytoarchitecture in mammals are routinely performed by classical histology, i.e. by examining the tissue under a light microscope after serial sectioning and subsequent staining of the sections. The procedure is labor-intensive and the threedimensional (3d) anatomy can only be determined after aligning the individual sections. Hard x-ray computed tomography (CT) is a promising alternative due to the potential resolution and high penetration depth, allowing for non-destructive imaging of the sample. However, in classical CT contrast formation is based on absorption of the x-rays, leading to a weak contrast for soft tissue like the brain and therefore diminishing the resolution. In order to visualize also weakly absorbing samples, the phase shift induced by the sample in the (partially) coherent beam can be used instead. As the optical constants leading to this shifted phase are up to 1000 times larger for soft tissues, contrast is increased. We use free-space propagation behind the object to convert this phase shift to a measurable intensity image. As contrast formation is based on interference of the disturbed wave fronts, the original phase distribution has to be reconstructed from the intensity images using suitable phase retrieval algorithms. In this work, we present x-ray phase-contrast tomography of neuronal tissues at our recently upgraded waveguide-based holo-tomography instrument GINIX at DESY. This setup allows for high resolution recordings with adjustable field of view and resolution, down to voxel sizes in the range of a few ten nanometers. We optimize for contrast and resolution by comparing different preparation techniques and recording strategies, reaching sub-cellular resolution in mm-sized tissue. Further, we show that even compact laboratory CT at an optimized liquid-metal jet microfocus source combined with suitable phase retrieval algorithms and preparation protocols enables single cell sensitivity in large reconstruction volumes of mouse brain which are consistent with classical histology results.

BP 13.3 Tue 10:15 HÜL 386

Brillouin Microscopy: A non-invasive way of studying elasticity in biological tissue — •Dmitry Richter[1,2], Alba Diz-Muñoz[1], and Robert Prevedel[1] — [1]European Molecular Biology Laboratory, Heidelberg, Germany — [2]Heidelberg University, Heidelberg, Germany

In order to map the elastic properties of cells and tissues, a spatial resolution in the order of the diffraction limit and access to internal structures is required. Up until now elastography has employed insufficient methods; techniques such as atomic-force microscopy require mechanical contact or invasion, giving no information about the internal structure. On the other hand, macroscopic methods like ultrasound imaging are unable to resolve cellular/subcellular components.

A possible alternative is Brillouin spectroscopy. It is based on the inelastic scattering of light on thermally induced, low frequency phonons, enabling a non-contact, high resolution study of elastic properties [1, 2]. Here, we discuss Brillouin microscopy as an imaging tool, highlighting its potential applications in biology as well as its inherent challenges and limitations. Moreover we show preliminary experimental results on single cells and multicellular organisms.

[1] G. Scarcelli, S. H. Yun, Nature photonics (2008)
[2] F. Palombo et al, Analyst (2014)

BP 13.4 Tue 10:30 HÜL 386

Three-dimensional surface reconstruction and panoramic optical action potential mapping of mammalian hearts — •Johannes Schröder-Schetelig[1], Tariq Baig-Meininghaus[1], Daniel Hornung[1], and Stefan Luther[1,2,3] — [1]Max Planck Institute for Dynamics and Self-Organization, Göttingen, Germany — [2]Institute for Nonlinear Dynamics, Georg-August-Universität Göttingen, Germany — [3]Department of Pharmacology, University Medical Center, Göttingen, Germany

We describe experimental setup and methods for 3D panoramic optical mapping of small to big mammalian hearts to study various dynamic electro-physiological properties of the healthy and diseased heart. Whole hearts of rabbits and pigs were excised and kept alive in a Langendorff-perfusion system, immobilized by excitation-contraction decoupler and stained with voltage-sensitive dye. Four high-speed cameras were positioned around the perfusion bath and their optical mapping calibrated. The 3D epicardium was reconstructed as a triangular mesh. Images from all cameras were projected onto the mesh and combined into a 2D texture image, for which a suitable mapping to the unit sphere was established. The system facilitates accurate measurement and analysis of the dynamic excitation wave propagation on the 3D heart surface during regular and irregular activity. Knowledge of the coordinate mapping between 2D texture images and 3D curved surface allows for computation of properties like curvature-corrected conduction velocity. Alignment with CT-scan of the heart is used for analyzing the correlation between surficial activity and underlying structure.

BP 13.5 Tue 10:45 HÜL 386

Investigations of squamous cell carcinoma cells and dysplastic oral keratinocytes — •Maja Strugačevac[1], Susanne Steeger[1], Jan Lietz[1], Julia Kristin[2], Marcel Glaas[2], Jörg Schipper[2], and Mathias Getzlaff[1] — [1]Institute of Applied Physics, Heinrich-Heine-Universität Düsseldorf — [2]Hals-Nasen-Ohrenklinik, Universitätsklinikum Düsseldorf

The aim of this study is to develop new, alternative, cell-selective treatment strategies for squamous cell carcinoma of the head-neck area. As one of first steps mechano-elastic properties of oral carcinoma cells (HNSCC) were examined using Atomic Force Microscopy (AFM). The Young's Modulus calculated by the Hertzian Model was determined in order to quantify the elasticity of the cells. As known the differences between elasticities of carcinoma and benign cells can - in part - be attributed to the modified cytoskeleton of cancer cells.

Squamous cell carcinoma cells as well as oral keratinocytes are examined by confocal fluorescence microscopy in order to obtain more information about physical cell properties. Different markers allow us to highlight specific cell organelles including cell membranes and cytoskeleton. This contribution focuses on staining optimization and investigation of differences between both cell lines.