Biomedical Imaging Seminars
Time: April 4, 2-4 pm,
Location: Perseverance Room, Level 5, Enterprise Wing, CREATE, UTown

Hosted by Peter So of SMART BioSym and SMA-2 Programs

In vivo Optical Biopsies using Multiphoton/CARS Tomographs

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The novel certified medical tomograph MPTflex-CARS with its flexible optomechanical arm and compact 360° scan/detection head provides non-invasive and label-free optical skin biopsies with chemical information. Two near infrared laser beams are transmitted through an optical arm and spatially and temporally overlapped within the tissue to generate autofluorescence, SHG, and CARS signals. Lipids, water, and chemotherapeutics have been imaged as well as the fluorescence of elastin, collagen, melanin, NAD(P)H, and flavins with subcelluar resolution. The signals are detected by single photon counting, in part by time-correlated single photon counting (TCSPC). This method provides counts per pixel and opens a way to quantitative imaging. Intracellular concentrations can be determined based on calibration measurements on solutions, cell monolayers, phantoms, biopsies, and clinical data. Applications include space medicine, skin aging studies, early diagnosis of skin cancer and dermatitis, wound healing management, rapid histology in the operation theater, testing of nanoparticle safety, pharmacokinetics of cosmetics/pharmaceuticals in situ as well as cell/biopsy/tissue/small animal imaging.

Femtosecond Laser Microscopy of Stem Cells

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This presentation focuses on the application of multiphoton microscopy and tomography for the investigation of animal and human stem cells, one of the most interesting objects of cell biology, developmental biology, nanobiotechnology, and modern medicine. The hallmark of stem cells is their self-renewing ability and capability of generating specialized cell types/tissues. Stem cell differentiation was monitored without labeling with specially designed 5D multiphoton microscopes with submicron spatial resolution, picosecond temporal resolution, and 10 nm spectral resolution. Stem cell monolayers as well as stem cell clusters have been imaged and the biosynthesis of collagen and lipids has been detected. Furthermore, metabolic fingerprints of stem cells and reprogrammed stem cells were studied to discriminate between different epigenetic states of cells. Multiphoton microscopes were also applied for sub-wavelength three-dimensional nanoprocessing of living biological specimens. Ultrashort laser pulses are required. However, dispersive effects limit the shortest pulse duration achievable at the focal plane. We report on a compact sub-20 femtosecond near infrared laser scanning microscope for two-photon imaging and nanosurgery of stem cells. Femtosecond laser technology is a promising non-invasive tool for monitoring of clinical relevant stem cells. Optical highly efficient manipulation of stem cells is possible for applications in the field of regenerative medicine. *This work is supported by the German Science Foundation within the Priority Programme 1327 "Optically induced sub-100nm structures for biomedical and technical applications" (directors: Dr. K. König and Dr. A. Ostendorf)*