Selected research topics in Biomedical Engineering:
Medically Relevant Experiments with Synchrotron Radiation
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High-resolution biomedical imaging with laboratory and accelerator-based X-ray sources

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Abstract. Biomedical imaging technologies roughly divide into microscopy for high-resolution (sub-) cellular studies and macroscopic in-vivo whole-body imaging. Since the typical goal of any bio-imaging method is to observe the smallest possible detail in the context of the full and unperturbed environment, an ideal bio-imaging system would combine the whole-body observation power of the macroscopic imaging with the resolution and selectivity of the microscopies. X-rays have the generic properties to allow high-resolution imaging in thick samples, i.e., a short wavelength and appropriate scattering/absorption cross-sections. Furthermore, the brightness of X-ray sources has improved dramatically in the last decades, enabling the design of high-resolution bio-imaging systems. Progress towards sources with high brightness started at the synchrotron-radiation facilities and has since been followed by laboratory sources. We have developed biomedical imaging methods based on the liquid-metal-jet micro-focus source. Typically, we employ phase imaging or nanoparticle X-ray fluorescence for contrast and combine with tomographic reconstruction for 3D imaging. Examples include studies of whole animals (mouse, zebrafish), organs (lungs, muscles), microvasculature (kidney, ear, tumors), and virtual histology (human coronary arteries, tumors, mummies). In the present talk, I will introduce high-spatial-resolution X-ray imaging in biomedicine and address its importance as well as its constraints. We will show several imaging examples obtained with systems based on laboratory as well as accelerator-based sources, and discuss and compare the merits of the systems.

Curriculum. Hans Martin Hertz, born in Lund, Sweden, is the grandson of Gustav Ludwig Hertz and the great great nephew of Heinrich Hertz. Hans Hertz studied engineering physics and received his Ph.D. in optical physics from Lund University 1988. After a postdoc at Stanford University he returned to Lund to create his own research group dealing with X-ray science and technology, acoustics, nano-chemistry and cell biology. Present research interests are high-resolution phase-contrast X-ray imaging, X-ray fluorescence imaging, and X-ray microscopy, all motivated by biomedical applications, from cell biology to clinical applications. Previous track record includes pioneering the liquid-jet laser-plasma source, the liquid-metal-jet X-ray source, and laboratory soft X-ray microscopy, as well as starting spin-off companies. In 1997, Hertz was appointed professor in biomedical physics at KTH Royal Institute of Technology in Stockholm. Between December 2013 and June 2018 he was Chair of the Board of MAX IV, the first fourth generation synchrotron in the world. He is member of the Royal Swedish Academy of Sciences and the Royal Swedish Academy of Engineering Sciences.