High-resolution biomedical imaging with laboratory x-ray sources

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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 the last decades, enabling the design of high-resolution bio-imaging systems that exploit these x-ray properties. The progress towards sources with high brightness started at the synchrotron-radiation facilities and have since been followed by novel high-brightness laboratory sources.

We have developed a unique range of high-spatial-resolution biomedical imaging methods based on a high-brightness laboratory source, the liquid-metal-jet micro-focus source. The regenerative liquid-metal-jet anode allows operation with electron-beam-power density at least an order of magnitude higher than with stationary or rotating anodes. 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). The system enables observation down to cellular, and in some cases subcellular, detail within the context of the whole organ, animal, or specimen.