Biomedical X-ray imaging at the Munich Compact Light Source

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Synchrotron radiation in the lab? High-brilliance X-ray sources based on multi-GeV accelerators have allowed scientists to push the frontiers of X-ray imaging towards nanometer-scale resolutions and extremely high sensitivities. The coherence properties of third-generation synchrotrons, e.g., have enabled phase-sensitive imaging techniques with improved contrast for weakly-absorbing materials like soft tissue. However, for many of the developed techniques, the transfer from the synchrotron back to preclinical or even clinical imaging is not straightforward. This is mainly due to the rather different characteristics of the X-ray tube sources typically employed in the latter cases. The Munich Compact Light Source (MuCLS) bridges this performance gap and aims at providing an X-ray source that allows to apply modern synchrotron techniques in translational clinical research setting. This is achieved through inverse Compton scattering of infrared laser photons at relativistic electrons, which allows to generate brilliant quasi-monochromatic X-rays of 15 keV to 35 keV with a storage ring of just a few meters in size [1].

Biomedical applications at the Munich Compact Light Source We have designed and commissioned two experimental endstations for the MuCLS, with a strong emphasis on – but not limited to – biomedical applications. These applications utilize the unique source properties [1] of the MuCLS: The narrow tunable spectrum allows not only to perform quantitative computed tomography (CT) without beam-hardening artifacts [2], but also to employ K-edge imaging in various applications, e.g. coronary angiography [3]. The high flux density enables high-resolution micro-CT and fast dynamical imaging, e.g., for investigating respiratory processes [4]. Finally, the partial coherence of the source is essential for phase-contrast and dark-field imaging applications: In the far experimental hutch, the large field of view of several centimeters in diameter is used for grating-based phase-contrast radiography [5] and tomography [6] of larger specimens, as well as for (directional) dark-field imaging [7]. In the near experimental hutch, propagation-based phase-contrast imaging experiments, e.g. small-animal studies [4], are performed.

References

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