Multimodal Imaging Using Lyncean's Compact Synchrotron Source

Benjamin Hornberger, Lyncean Technologies, Inc., benjamin_hornberger@lynceantech.com

Laboratory-based X-ray imaging systems with conventional electron-impact sources can provide resolutions from hundreds of microns down to below 50 nm. They are commercially available and widely used for a broad range of applications. However, the limited brightness, monochromaticity, tunability and coherence of such sources require relatively long imaging times (especially at high resolution) and limit their applicability for quantitative, spectroscopic or phase contrast imaging applications. These applications are served well by synchrotron radiation sources with their extremely high brightness, tunability and monochromaticity. However, synchrotrons are very large and expensive, and typically operated as national user facilities with limited access.

An Inverse Compton Scattering (ICS) X-ray source can bridge this gap by providing a narrow-band, high flux and tunable X-ray source that fits into a laboratory, at a cost of a few percent of a large synchrotron facility. It works by colliding a high-power laser beam with a relativistic electron beam, in which case the back-scattered photons have an energy in the X-ray regime. This presentation describes the working principle and unique beam properties of the Lyncean Compact Light Source, a storage-ring based ICS source, and its applicability to X-ray imaging applications. Together with a beamline and two endstations developed by researchers at the Technical University of Munich (TUM), it forms the Munich Compact Light Source (MuCLS). We provide recent application examples from the MuCLS that demonstrate synchrotron-like capabilities in a laboratory setting, including propagation-based phase contrast, grating-based phase- and darkfield contrast, and K-edge subtraction imaging. Furthermore, we explore how such an X-ray source can advance laboratory-based micro- and nano-CT by enabling high throughput or spectroscopic imaging applications.

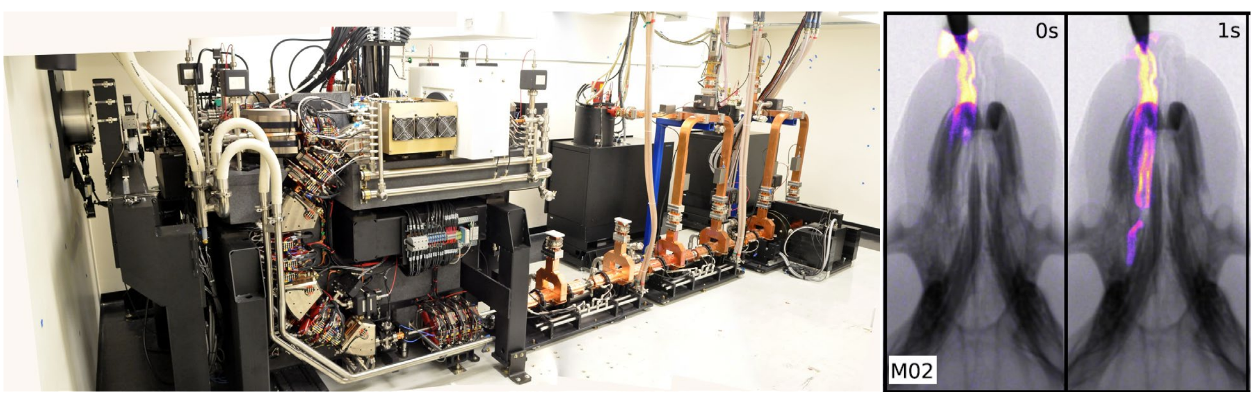

Figure 1: Left: Photograph of the Lyncean Compact Light Source. Right: Example of a dynamic *in vivo* imaging application, showing delivery of liquid instillations to the nose of a mouse [1].

[1] Gradl, Regine, et al. "In Vivo Dynamic Phase-Contrast X-Ray Imaging Using a Compact Light Source." Scientific Reports 8 (May 2018): 6788. https://doi.org/10.1038/s41598-018-24763-8