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#09-237 Applicability of large-area single-photon counting detectors Timepix for high-resolution and high-contrast X-ray imaging of biology samples

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High-resolution X-ray imaging techniques, usually known as micro-radiography and micro-CT, have become highly required and frequently used tools for biology, biomedical and pre-clinical research. State-of-the-art micro-CT scanners are capable of achieving spatial resolution of few micrometers or even less thanks to the constant development of compact micro-focus X-ray sources with simultaneous progress in detector technologies.

X-ray micro-CT is frequently used for phenotyping, study of zoomorphology, drug development and others. Moreover, it is nowadays used for non-destructive inspection of ex vivo soft biology tissue. Such technique has become known as virtual histology. High-resolution X-ray imaging currently becomes a competitor to conventional research techniques used in biology research like optical microscopy and histology.

The current standard in X-ray detection is a digital read-out chip coupled with a scintillation sensor. Such detectors are available in variety of different sizes, they are easy to use and relatively affordable. Nevertheless, the mentioned technology suffers from inherent technology limitations, like for example undesirable generation of dark-current, that compromise the quality of the provided data.

This work demonstrates the advantages of large-area hybrid-pixel photon-counting detectors Timepix for high-resolution X-ray imaging in biology research. Photon-counting detection technology provides dark-current-free quantum-counting operation. Therefore, enhanced contrast-to noise ratio is of the acquired data is achieved. Furthermore, the biased semiconductor sensor achieves almost ideal point-spread-function resulting in high spatial-resolution of images. And finally, the detectors are operated with user-adjustable detection threshold opening possibilities for energy-sensitive X-ray imaging. Abovementioned features make photon-counting detectors to be excellent tools for high-resolution X-ray imaging of samples with low intrinsic absorption contrast like for example soft biological tissue.

We evaluate the imaging performance of large-area Timepix detectors compared to widely used scintillation-based X-ray imaging detectors dedicated for high-resolution X-ray imaging. Further, we summarize and demonstrate the applied results in the field of biology and pre-clinical research achieved at Institute of Experimental And Applied Physics, Czech Technical University in Prague. The institute, as a member of Medipix Collaboration, has actively participated in the development of Timepix technology from its introduction. The presented data obtained in cooperation with Charles University demonstrate the versatility of the used detectors as it covers a wide range of samples from laboratory animals to single-cell marine organisms. Finally, practical experience from long-term usage is discussed and the limitations of Timepix technology for X-ray imaging are mentioned.

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