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Detector requirements for single mask edge illumination x-ray phase contrast imaging applications

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X-ray phase contrast imaging (XPCI) detects signals arising from the phase shifts suffered by x-rays as they traverse matter. Unlike other approaches, Edge illumination (EI) XPCI can be implemented with large focal spot and polychromatic (i.e. conventional) sources. It normally employs a pre-sample and a detector mask: the first splits the beam into a series of beamlets, and the second partially intercepts them. The detector mask redefines the pixel response, making it maximally sensitive to phase effects. However, multiple frames have to be acquired while displacing the pre-sample mask in two or more positions to retrieve signals relating to different physical properties of a sample, which increases the acquisition time, dose and potential errors in the acquired data, potentially hindering the translation of XPCI methods to "real-world"applications. Recent developments have focused on eliminating the detector mask by exploiting the advantages offered by state-of-the-art direct conversion detectors, i.e. increased efficiency, high-resolution, and sharper point spread functions (PSFs), while extracting multiple signals in a single shot. These "single mask"EI (SM-EI) approaches can be implemented in either the "position-sensing"(PS) or "beam-tracking"(BT) modes. The former uses the edge between neighbouring detector pixels to directly "sense"the beam position, and translates it into separated attenuation and refraction signals. A wave optics model of the PS set-up was developed and benchmarked against experimental data, which enabled studying the refraction sensitivity as a function of detector PSF. In order to retrieve an additional, complementary contrast channel (known as "dark-field"), however, detectors with higher granularity are required to "track"beam variations in more detail (BT setup). This approach has been demonstrated for both synchrotron and conventional sources, in both planar imaging and computed tomography applications. This talk will present an overview of the two SM-EI approaches and some of their key results.

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