High sensitivity and flexibility of the Edge Illumination phase contrast approach implemented with coherent sources

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X-ray phase contrast imaging plays a central role in the analysis and characterization of materials in a wide range of applications, such as biology, medicine and material science. The current availability of highly coherent synchrotron sources has driven the development of several direct and indirect x-ray imaging methods, one of the mainly aim being the achievement of better contrast and phase sensitivity.

We recently developed a new quantitative x-ray phase contrast imaging method based on the edge illumination principle [1], which allowed the detection of x-ray refraction angles with an angular resolution of few nanoradians [2]. This unprecedented sensitivity was demonstrated theoretically and experimentally.

This method was then adapted to exploit the capabilities of high-resolution detectors, available at many synchrotron facilities. This enables avoiding the use of detector masks or slits, and the consequent need to acquire more than one frame to perform quantitative retrievals: in a recent study [3], we have shown the possibility to quantitatively extract the absorption, refraction and ultra-small angle scattering signal (which is related to inhomogeneity of the sample transmission function on a scale smaller than the resolution of the system) from single frames.

Finally, we developed a new method that merges the idea presented in [3] with the phase retrieval techniques characteristic of coherent diffractive imaging, through a one-dimensional ptychographic approach [4]. This method, at the cost of a more complex and computational demanding phase retrieval procedure, improves the achievable resolution, providing higher sensitivity to the high frequency part of the sample transmission function.

All these methods were experimentally validated at the I13 beam line (coherence branch) of the Diamond Light Source facility (Didcot, UK). After briefly describing the basic principles of the methods, this talk will review the obtained results and discuss future plans for further improvements.

References:

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