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Quantitative Interpretation of Ultra-Small Angle X-Ray Scattering in Grating Interferometry

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Grating interferometry (GI) is a well established phase sensitive X-ray imaging technique providing access to three complementary contrasts: absorption, differential phase and dark-field. It was recently demonstrated that the local unresolved distributions of scattering angles of the sample can be retrieved with an appropriate deconvolution procedure [1]. The three first moments of the retrieved scattering distributions correspond to the traditional contrasts, hence this method can also be considered as an alternative analysis procedure. Moreover, the retrieval of the scattering distributions allows higher moment analysis and therefore access to a large number of possibly complementary contrasts. However, the quantitative interpretation of the obtained scattering distributions remains an open question. The purpose of this work was to establish a connection between the retrieved scattering distributions and the physical subpixel structure of the sample. This was achieved by performing a correlation analysis between the retrieved signal and the known underlying structure of artificial samples. It was furthermore demonstrated that the higher moment contrasts can provide additional information about the subpixel structure of the sample. Finally, the possibility of using the new analysis method as an alternative to the standard procedure was investigated. A thorough comparison indicated that the new approach preformed better in terms of CNR for both differential-phase contrast and dark-field imaging.

[1] P. Modregger, F. Scattarella, B.R. Pinzer, C. David, R. Bellotti, and M. Stampanoni, Phys. Rev. Lett. 108, 048101 (2012).

Primary author: KAGIAS, Matias (Paul Scherrer Institut)

Co-authors: STAMPANONI, Marco (Paul Scherrer Institut); Dr MODREGGER, Peter (Swiss Light Source, Paul Scherrer Institut, Switzerland); PETER, Silvia (Paul Scherrer Institut); Dr GUZENKO, Vitaliy (Paul Scherrer Institut)

Presenter: KAGIAS, Matias (Paul Scherrer Institut)

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