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Simulation of grating-based hard X-ray imaging by combining Monte Carlo methods and wave optics

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Grating-based hard X-ray imaging is a recently established imaging technique which simultaneously provides absorption, phase and dark-field contrast. Numerical simulations can provide a deeper theoretical understanding of the image formation process which may be used for optimization of both experimental set-up and data analysis procedures. Since phase contrast relies on beam coherence and dark-field contrast is related to incoherent scattering, both particle and wave like behavior of the x-rays have to be considered. Particle-like properties are realistically simulated using Monte Carlo (MC) methods, but MC neglects coherent effects such as interference. Wave-like properties on the other hand are conveniently simulated using wave optics, in which, however, incoherent scattering cannot be modeled in a straight forward way.
A simulation package has been developed which combines MC with wave optics simulations. The simulation package was validated by comparison of simulated and measured tomographic images. The comparison showed good agreement. This model can now for instance be used for experimental data corrections or realistic investigations of the origin of the dark-field signal.

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