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Start-to-end simulations of partially coherent X-ray imaging experiments at synchrotron beamlines

In the last decade, coherent X-ray imaging techniques, such as ptychography and holography, have grown a large user base at third and fourth generation X-ray light sources. In contrast to conventional microscopy techniques, coherent imaging techniques do not directly project an image on a detector. Instead, the image of the object is retrieved algorithmically from interference patterns, usually under the assumption of a fully coherent illumination.

Real X-ray sources are not perfectly coherent, they can be simulated as stochastic sources emitting an ensemble of waves. These waves can be propagated from the source through the entire x-ray beamline ending at the detector. The simulated interference patterns can then be treated with the same phase retrieval algorithms as experimental data. The simulation is thus a digital twin of the entire image formation process at the synchrotron beamline.

Here, we present our extensions to existing established simulation software (OASYS / SRW) that permit the user to perform such start-to-end simulations with relative ease. We will present simulated data sets of ptychographic and holographic experiments, and discuss the computational demands of such simulations.

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