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Deep-learning assisted ptychography in the soft X-ray regime

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Quantum imaging methods, analogous to ptychography, have been recently proposed to assess the state of quantum systems. In ptychography, an overlapping illumination scans a sample and generates diffraction patterns that can be numerically converted to a high-resolution image of the sample. An ideal conversion demands precise knowledge of scan coordinates, low-noise measurements and illumination stability. In practice, the aforementioned criteria might not be completely achievable. Thus, the computational conversion inevitably fails to converge. We demonstrate an automatic differentiation based ptychography that optimises fluctuations leading to successful imaging for photon sources exhibiting shot-to-shot fluctuations, like X-ray free-electron lasers. Automatic differentiation is used in deep learning and optimisation as a set of techniques for evaluating derivatives. Various quantum imaging approaches can benefit from the proposed ptychography platform, like ghost imaging at soft X-ray free-electron lasers. We report on the results of our recent ptychography experiments at the FLASH2 facility at DESY.

Primary author: MEHRJOO, Masoud (Deutsches Elektronen-Synchrotron)

Co-authors: Mr KHARITONOV, Konstantin (DESY); Dr RUIZ-LOPEZ, Mabel (DESY); Dr KEITEL, Barbara (DESY); Mrs KREIS, Svea (DESY); PLÖNJES, Elke (DESY)

Presenter: MEHRJOO, Masoud (Deutsches Elektronen-Synchrotron)