Multibeam X-ray ptychography for high throughput, large field-of-view imaging

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Ptychography is a robust coherent diffractive imaging (CDI) technique that relies on information redundancy resulting from the overlapping between scan points. This scanning modality allows for an extended field-of-view (FOV) that grows with the number of scan points. However, this comes at the cost of increased scanning time, which limits the throughput of ptychography and remains an obstacle for large FOV imaging.

Here we proposed a multiple beam ptychography method which permits simultaneous imaging of multiple locations by illuminating the sample with spatially separated, incoherent probes. Two sets of focusing optics that are separated by a certain distance are used to generate two probes on the sample plane. This separation distance needs to be larger than the transverse coherent length of the X-ray beam, so that diffraction patterns corresponding to two probes are incoherently summed on the detector plane, as shown in Fig. 1. We have demonstrated in simulation that two sets of objects that are illuminated by these two probes can be reconstructed simultaneously. Compared with single beam ptychography, the multi-beam method has no noticeable loss in imaging resolution as shown in Fig. 2, and it can increase the throughput by a factor corresponding to the number of probes, while leave the scan time and acquired data volume unchanged. The proof-of-concept experiment with this method is planned at the ptychography beamline at the Advanced Photon Source.

![Fig 1. An example diffraction pattern from a chip sample illuminated by two zone-plate focusing probes that are separated 500 µm vertically](image1.png)

![Fig 2. Ptychography reconstructions with simulation data. (a) and (b) are reconstructed phase images of two sample regions illuminated by two X-ray beams focused by Fresnel zone plates. (c) Conventional ptychography on the sample region as (a) using single beam, showing similar reconstruction quality compared with (a)](image2.png)