

Coherent X-rays and Applications: CDI and Ptychography

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In this tutorial we will introduce the notion of coherence for X-rays, starting from the interference of electromagnetic waves. We will distinguish longitudinal coherence, which is set by the monochromaticity of the beam, from transverse coherence, which depends on the source size and distance, and we will see what coherence lengths can be expected at modern synchrotrons and XFELs.

We will then look at what happens when a sample is illuminated coherently: the far-field diffraction pattern becomes the Fourier transform of the object, producing speckle and, in principle, allowing an image to be reconstructed. Since only intensities are measured, we will discuss the phase problem and the iterative algorithms used to solve it.

Finally, we will present Coherent Diffraction Imaging, whose resolution is set by the extent of the measured scattering rather than by the optics, and Ptychography, which extends the approach to large objects.