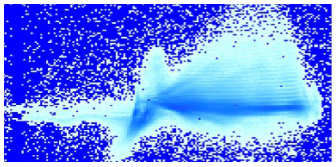

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MAX IV

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Deep learning 3D dynamical (4D) reconstructions from sparse projections

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The development of high-brilliance X-ray sources, such as the fourth-generation diffraction-limited storage rings and X-ray free-electron lasers, have opened up new possibilities for X-ray imaging. X-ray Multi-Projection Imaging (XMPI)1 is a novel technique that exploits the unique capabilities of the high-brilliance X-ray sources and enables volumetric information using single pulses. Unlike tomographic experiments which record projections by sample rotation, XMPI is a rotation-free technique that split the beam into beamlets and record simultaneously multiple projections from different angles. As a result, XMPI can acquire 3D movies (4D) at least three orders of magnitude faster than tomographic methods. However, it is extremely challenging to reconstruct 4D from highly sparse projections acquired by XMPI. Deep learning's advancement offers a potential solution to this problem. Current deep-learning implementations for X-ray imaging, on the other hand, face two major challenges. First, they usually work in a supervised manner, which requires paired training datasets. Second, the robustness and reliance of such methods is not guaranteed.

This presentation will discuss how deep-learning approaches can potentially address three-dimensional (3D) and four-dimensional (4D) reconstructions for XMPI experiments by exploiting the large amounts of data provided by high-brilliance X-ray sources. We will focus on ONIX2 and 4D-ONIX3, two self-supervised deep-learning methods that reconstruct 3D/4D information from sparse XMPI projections and enhance their reliance by including the physics of the image formation. ONIX is a novel 3D reconstruction method that learns the self-consistency of sparsely recorded radiographs using physics-based neural networks. It can retrieve volumetric information from less than ten projections at previously impossible quality levels without requiring any prior knowledge. 4D-ONIX is based on ONIX, it extends the capability of ONIX by including time as a 4th dimension and applying adversarial training to enforce consistency between the measurement and the reconstructions.

References

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