

Supplementary Material for

Three-dimensional nanoscale Reduced-Angle Ptycho-tomographic Imaging with Deep learning
(RAPID)

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This supplementary file includes:

Supplementary text

Figs. S1 to S4

In this supplementary document, we show the network architecture of the proposed RAPID method (Fig. S1), layer-wise visualization of the RAPID reconstruction from different number of angular scanning (Fig. S2) and different angular ranges (Fig. S3), power spectral density distributions of reconstruction results from different methods with $N = 21$ angles within $\theta = 140.8^\circ$ (Fig. S4).

Network architecture

Figure S1 (a) shows our encoder-decoder structure in detail with anisotropic atrous module inserted at the beginning of each hierarchical level in encoder. There are three different hierarchical levels in this encoder-decoder structure. The design of the anisotropic atrous module is shown in Fig. S1(b), which contains three anisotropic ASPP modules operating in three orthogonal planes, i.e., $x - y$, $y - z$, and $x - z$ planes, and one 3D convolution to capture features in 3D. The features extracted from these four branches are fused via concatenation and standard $3 \times 3 \times 3$ convolution kernels. All ASPP modules in these three orthogonal planes contain the atrous convolution with the rate of 6, 12, 18, as the original implementation. In order to emphasize the ambiguous cross-talking artifacts in the approximant and achieve isotropic volumetric resolution, we include two more anisotropic atrous convolution $a = a_1, a_2$ to address the severe feature residuals along the z direction for atrous convolution operated in $y - z$ and $x - z$ planes. Example of the anisotropic ASPP module in $y - z$ plane is shown Fig. S1 (c).

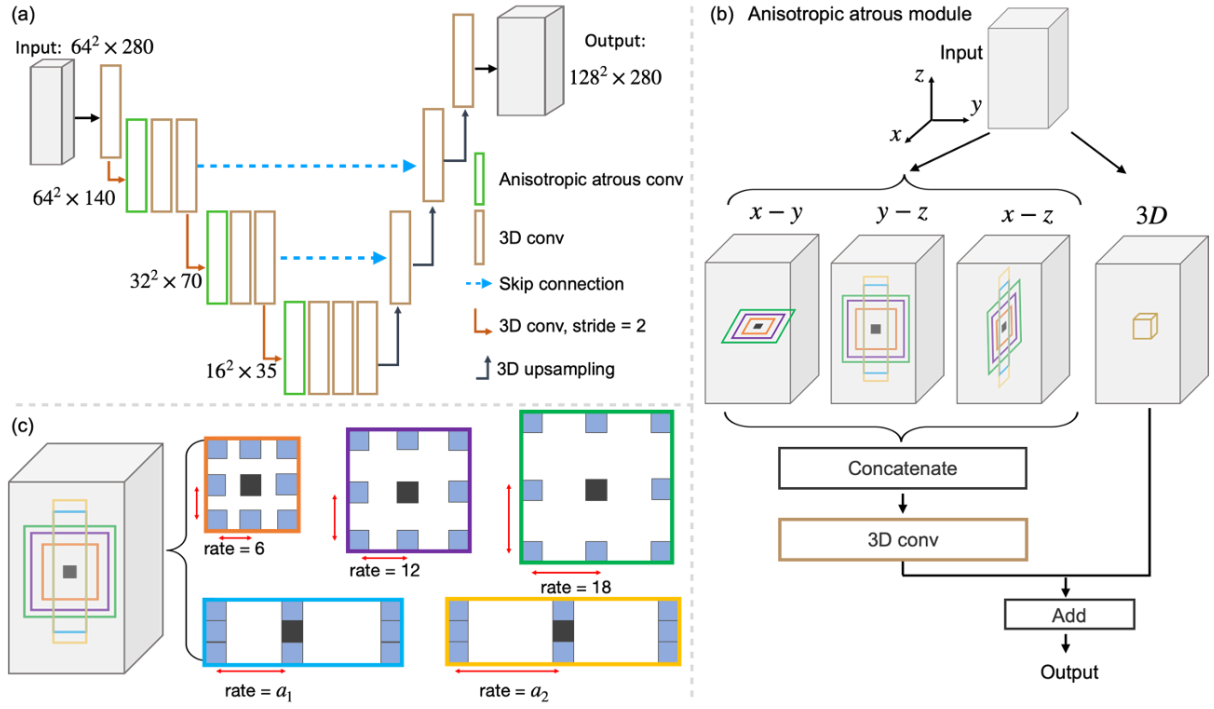


Fig S1. Network architecture of the proposed RAPID method. (a) The 3D encoder-decoder network architecture with anisotropic atrous module inserted in the encoder branch. (b) Anisotropic atrous module, which is consist of 3D anisotropic ASPP module operated in three orthogonal planes, i.e., $x-y$, $y-z$, and $x-z$ planes, and 3D convolution kernels to capture features in 3D. (c) 3D anisotropic ASPP module applied to the $y-z$ plane. Apart from 3D isotropic atrous convolution with atrous rate $a = 6, 12, 18$, two extra anisotropic atrous convolutions $a = a_1, a_2$ are applied to extract features in the z direction.

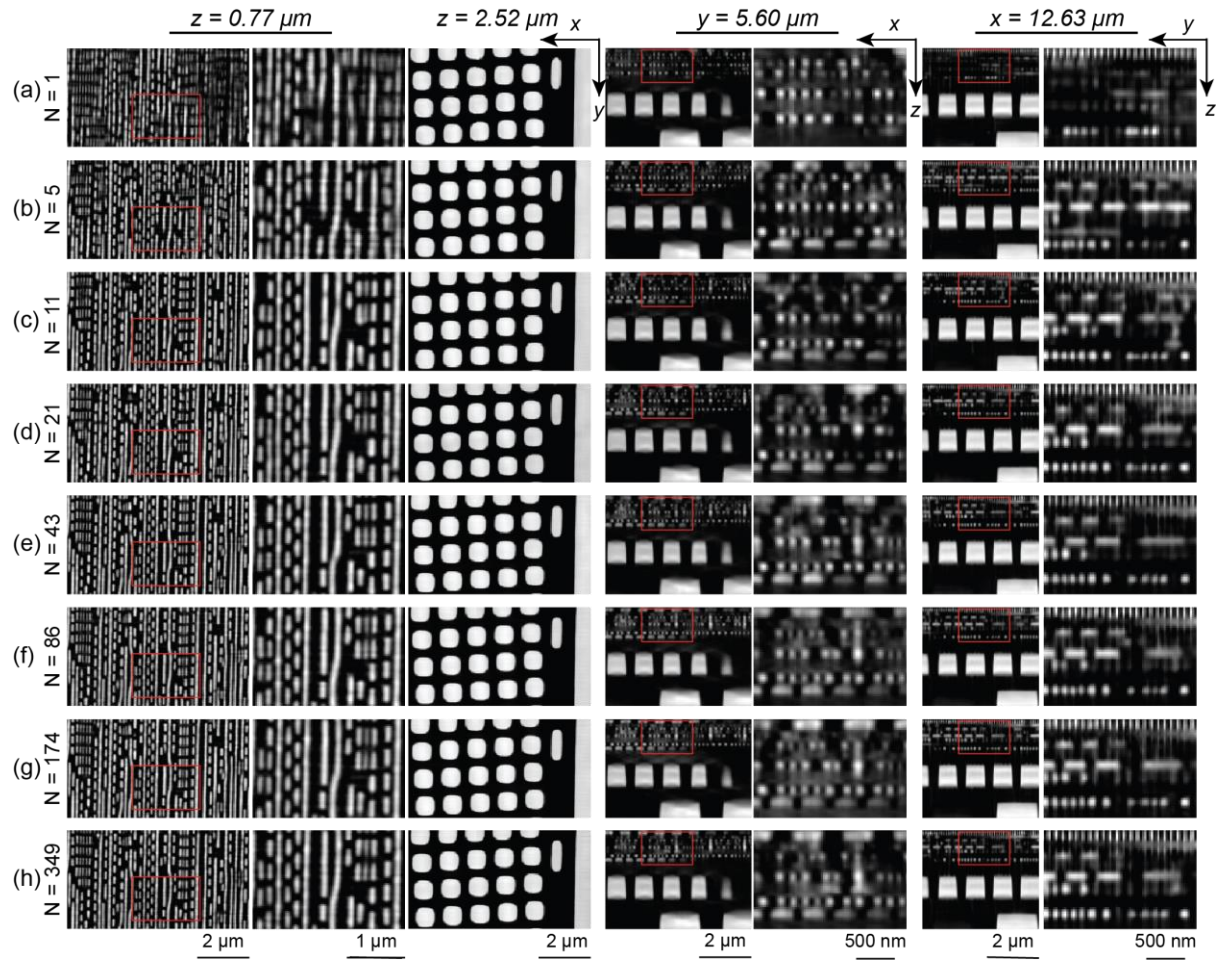


Fig. S2. Layer-wise visualization in terms of $x - y$ plane at two different depths, $y - z$, and $x - z$ planes for the reconstructions acquired from different number of angular scans.

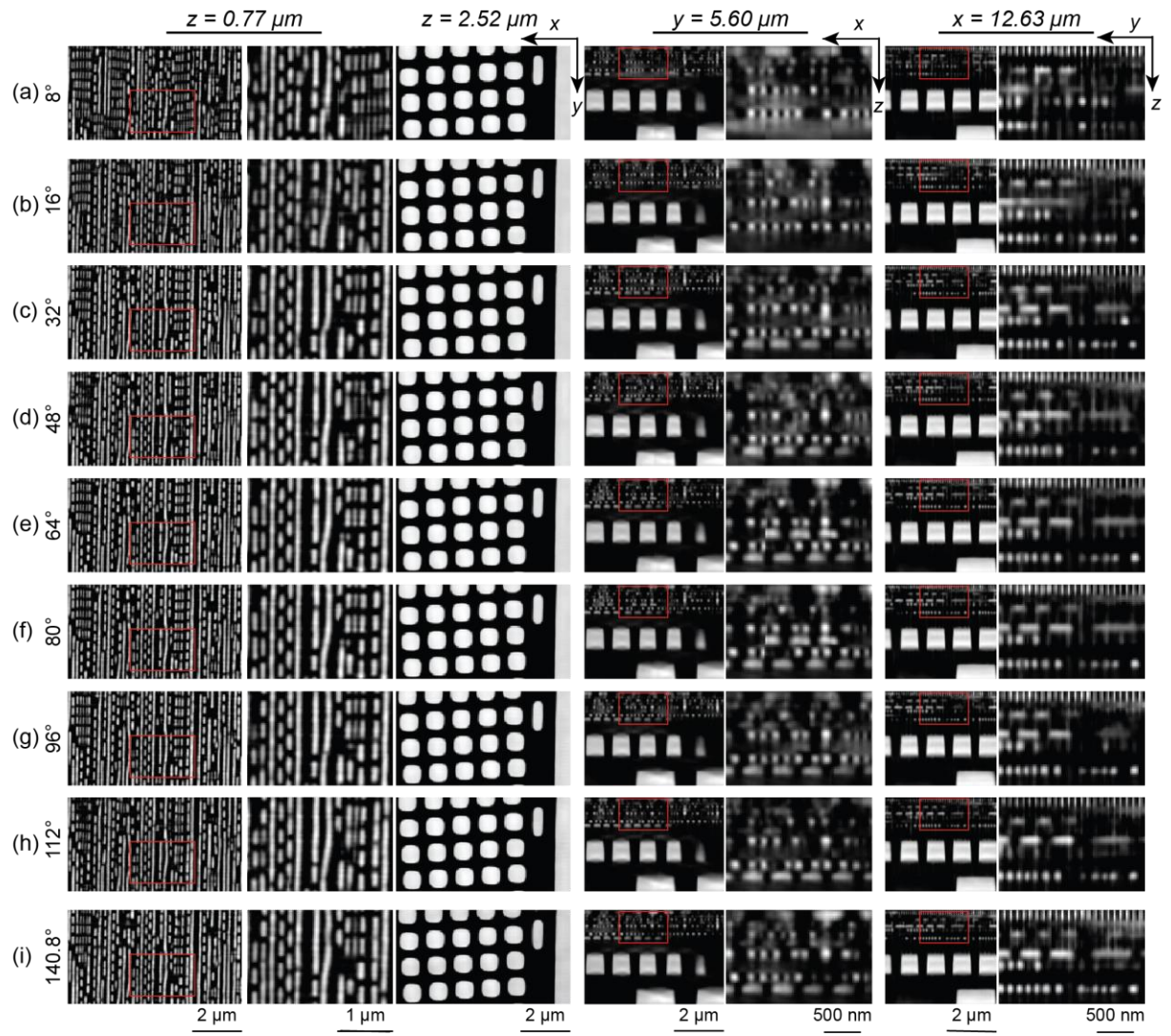


Fig. S3. Layer-wise visualization in terms of $x-y$ plane at two different depths, $y-z$, and $x-z$ planes for the reconstructions acquired from different angular ranges.

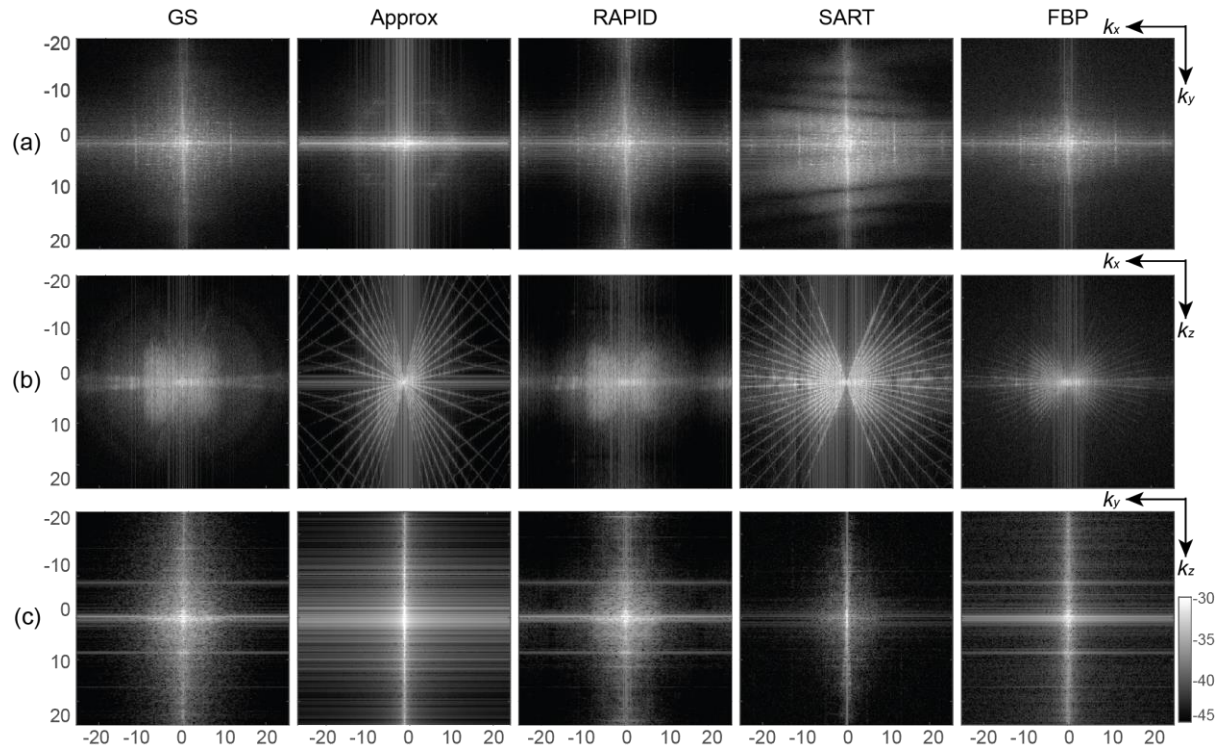


Fig. S4. Power spectral density distributions in terms of $k_x - k_y$, $k_x - k_z$, and $k_y - k_z$ planes for different approaches.