

# Tensorial tomographic Fourier Ptychography with applications to muscle tissue imaging: supplementary document

## S1 Resolution and accuracy validation

To verify the polarization-sensitive resolution of  $T^2oFu$ , we imaged a birefringence USAF resolution target (R3L1S1B). We choice this target as it is highest resolution commercially available birefringence resolution target we currently can find. According to the product specification, this target only has reliable birefringence features in group 0 to 5<sup>1</sup>. However, upon inspection by imaging the target sandwiched between two cross polarizers with high magnification objectives (shown in Fig.S1(B)-(C)), we see that this target has resolvable birefringence features up to group 7, element 3 (3 $\mu\text{m}$  linewidth), which can be resolved in our reconstruction shown in Fig. S1(A) as well. As we suspect, the achievable resolution by our model is higher than demonstrated experimentally. Thus, we conduct additional simulation studies to explore the numerically achievable resolution limit by our 20 $\times$ , NA = 0.4 system. Figure S1 (D-E) show lateral views of ground truth and reconstruction result of a simulated birefringence resolution target. A center line profile (Fig. S1(F)) suggests the lateral full-pitch resolution cutoff is around 0.7 $\mu\text{m}$ . Figure S1 (G-H) show sagittal views of ground truth and reconstruction result of another simulated birefringence resolution target. The line profile of a few highlighted locations in Fig. S1(I) suggest that the axial full-pitch resolution cutoff is between 6 and 7 $\mu\text{m}$ . This agrees with the theoretical lateral half-pitch resolution  $\delta_{x,y} = \lambda/2(NA_{obj}+NA_{illum})$  and the axial half-pitch resolution  $\delta_z = \lambda/(2-\sqrt{1-NA_{obj}^2}-\sqrt{1-NA_{illum}^2})$  for scalar diffraction tomography. For our system with 0.4 objective NA and 0.4 illumination NA, the predicted half-pitch resolutions are 0.32  $\mu\text{m}$  in lateral, and 3.1  $\mu\text{m}$  in axial.

In addition, we evaluate the reconstruction accuracy of  $T^2oFu$  with numerical studies. FigureS2 (A)-(B) display lateral views of ground truth and reconstruction results of birefringence  $\Delta\epsilon$  and orientation  $\theta$  of an anisotropic sample. (C)-(D) display sagittal views of ground truth and reconstruction results of birefringence  $\Delta\epsilon$  and orientation  $\theta$  of another anisotropic sample. We see that the proposed method can give accurate orientation reconstructions. However, due to the elongation of reconstructions along axial dimension, our method can underestimate birefringence due to zero initialization of the inverse problem.

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<sup>1</sup>R3L1S1B Birefringent 1951 USAF Test Target; Thorlabs, Inc., NJ, USA

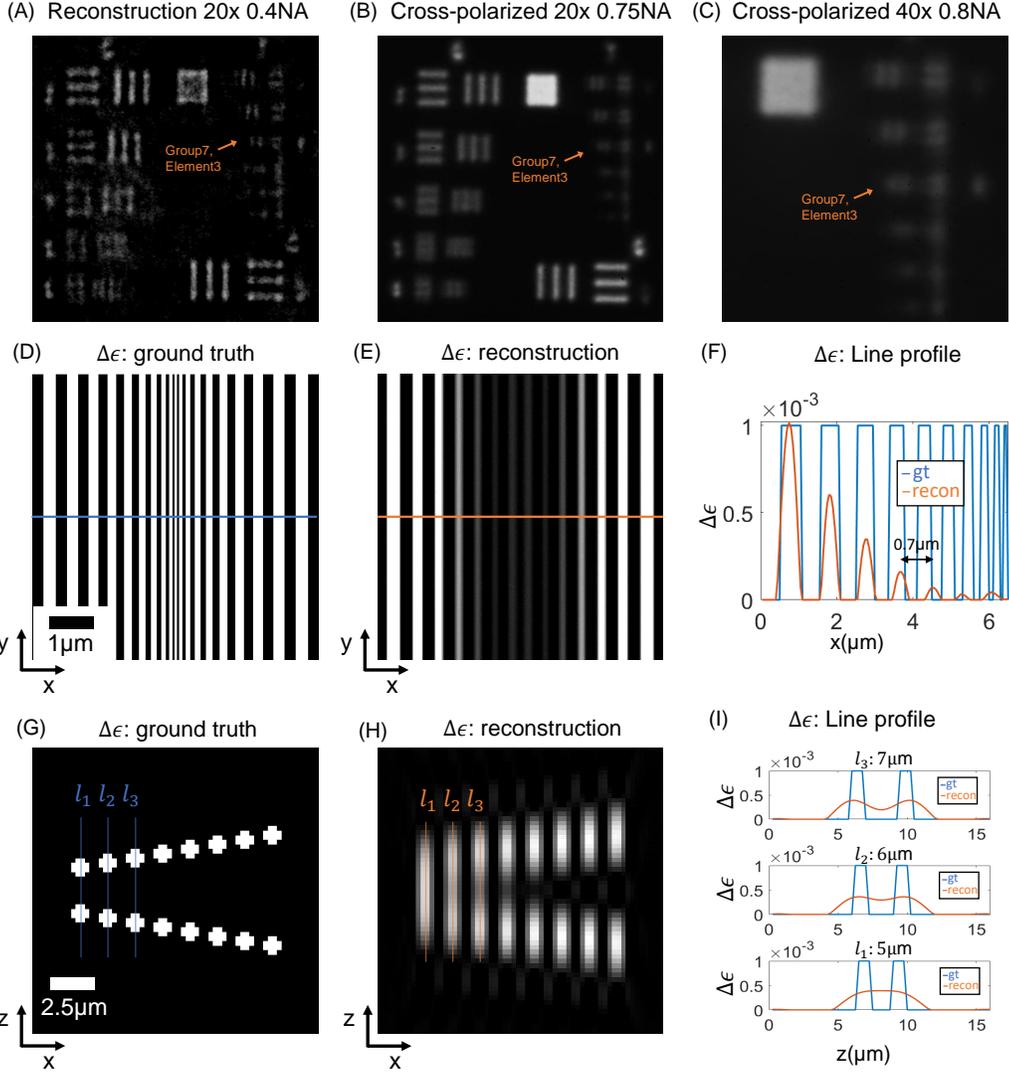


Figure S1: Resolution validation. (A) shows the reconstructed birefringence of a resolution target (R3L1S1B) based on experimental measurements. (B)-(C) show cross-polarized images of the target captured with high magnification objectives. (D)-(E) present lateral views of the ground truth and the reconstruction of a simulated birefringence resolution phantom. (F) plots the center line of the images highlighted in (D) and (E) along the x-axis. (G)-(H) display sagittal views of the ground truth and the reconstruction of another simulated resolution phantom. (I) plots a few lines from the images highlighted in (G) and (H) along the z-axis.

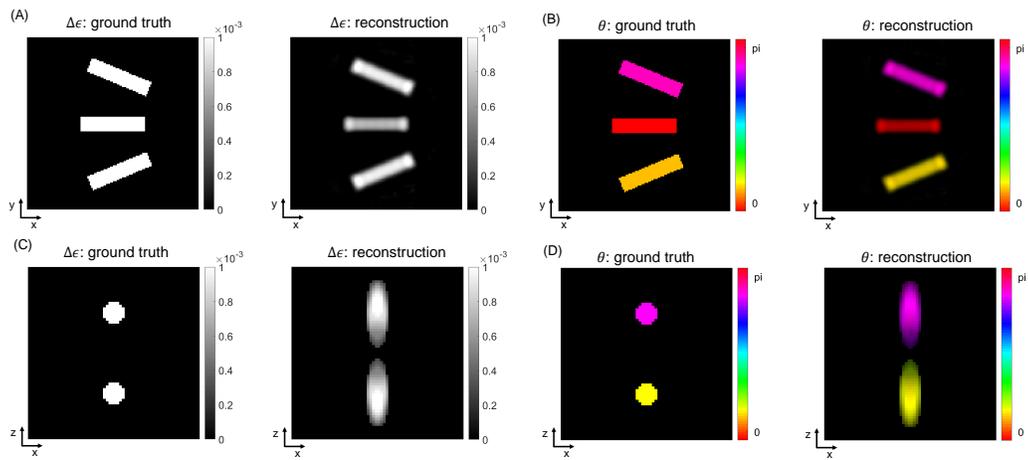


Figure S2: Reconstruction accuracy validation.(A)-(B) display lateral views of ground truth and reconstruction results of birefringence  $\Delta\epsilon$  and orientation  $\theta$  of an anisotropic sample.