Synthetic aperture ptychography: coded sensor translation for joint spatial-Fourier bandwidth expansion: supplemental document

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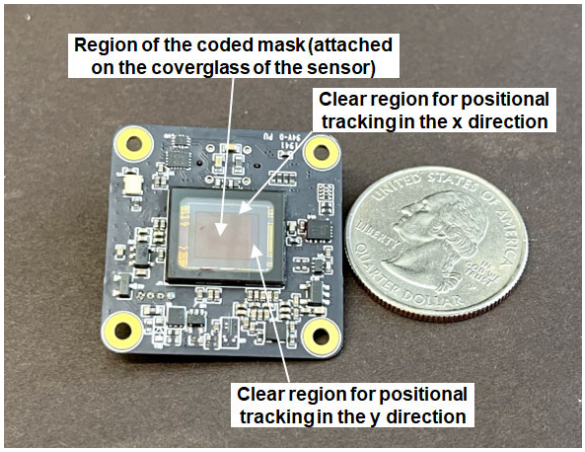

Figure S1. The layout of the coded image sensor. The size of the coded mask is smaller than the size of the active pixel array. The top 250 rows from the clear region are used for positional tracking in the x direction. The right 600 columns from the clear region are used for positional tracking in the y direction.

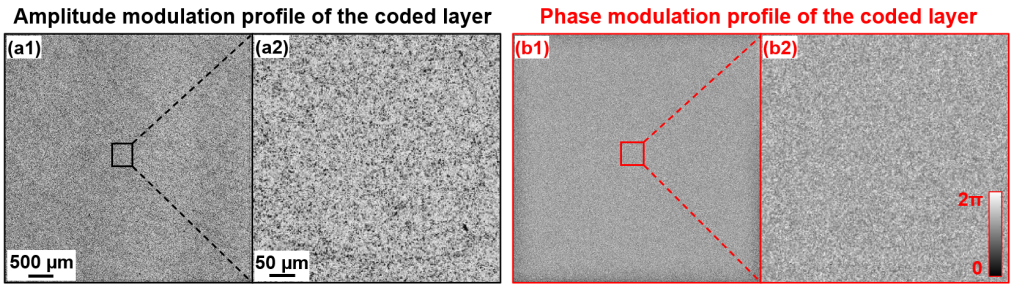

Figure S2. The transmission profile of the coded layer on the image sensor. The coded layer was made by coating a thin and dense layer of microbeads on the sensor's coverglass. The size of the coded layer is ~5 mm by ~5 mm, with a pixel size of 1.85 μm. In a calibration experiment, we used a blood smear sample as the object and recover this coded layer using 1500 measurements. In all subsequent experiments, the same coded layer profile was enforced in the reconstruction process. With the known transmission profile of the coded layer, the number of measurements needed for reconstruction can be reduced to 50 to 400. (a) The recovered amplitude modulation profile of the coded layer. (b) The recovered phase modulation profile of the coded layer.

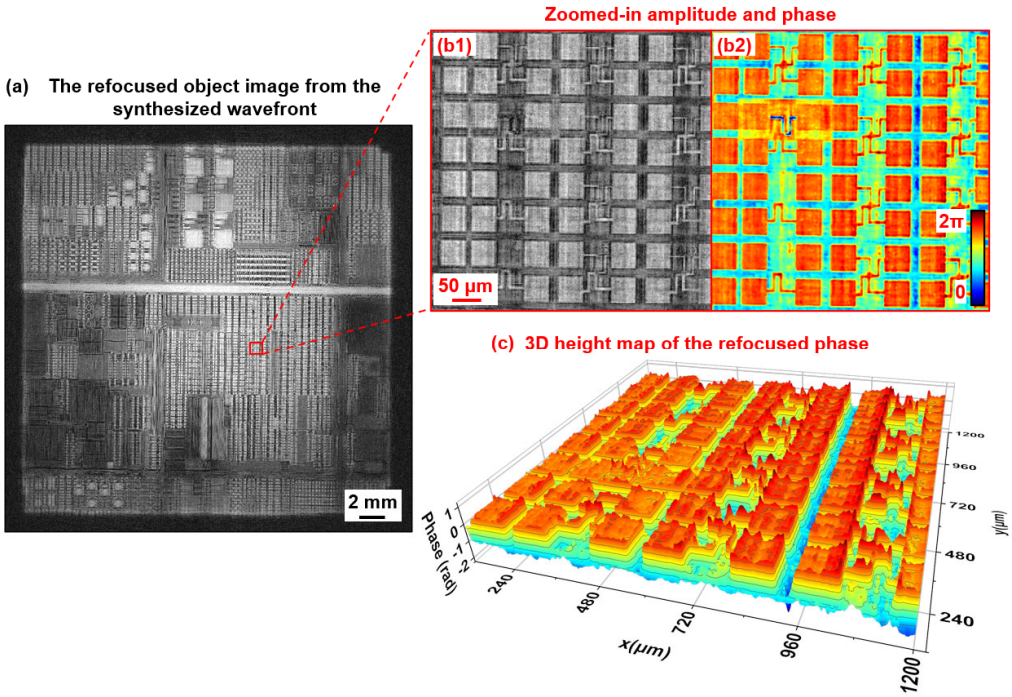

Figure S3. Imaging a microchip using the reflection configuration of SAP. (a) The recovered object image using the synthesized wavefront at the intermediate aperture plane. The size of this image is 20 mm by 20 mm, with a pixel size of 1.85 μm. A zoomed-in view of the amplitude (b1) and phase (b2) of the microchip. (c) The height map of the phase image.

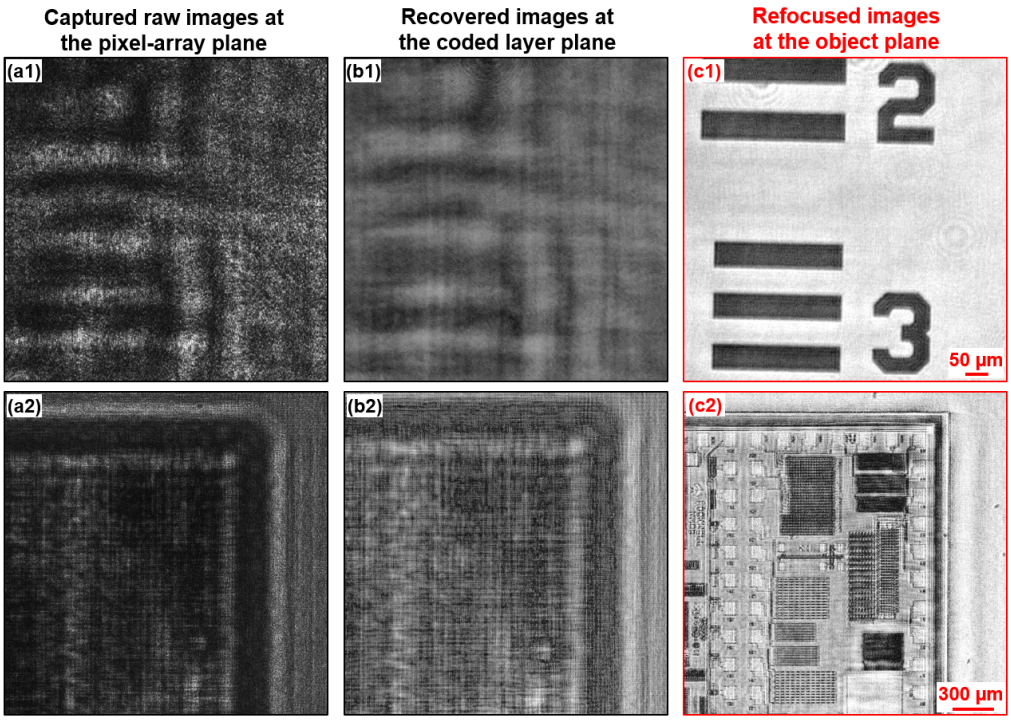

Figure S4. Captured images and SAP reconstructions at different planes. (a) The captured raw images at the pixel-array plane. (b) The synthesized images at the intermediate aperture plane (the plane of the coded layer). (c) The refocused images at the object plane. (a1)-(c1) show the results of the transmission resolution target. (a2)-(c2) show the results of the reflection microchip.

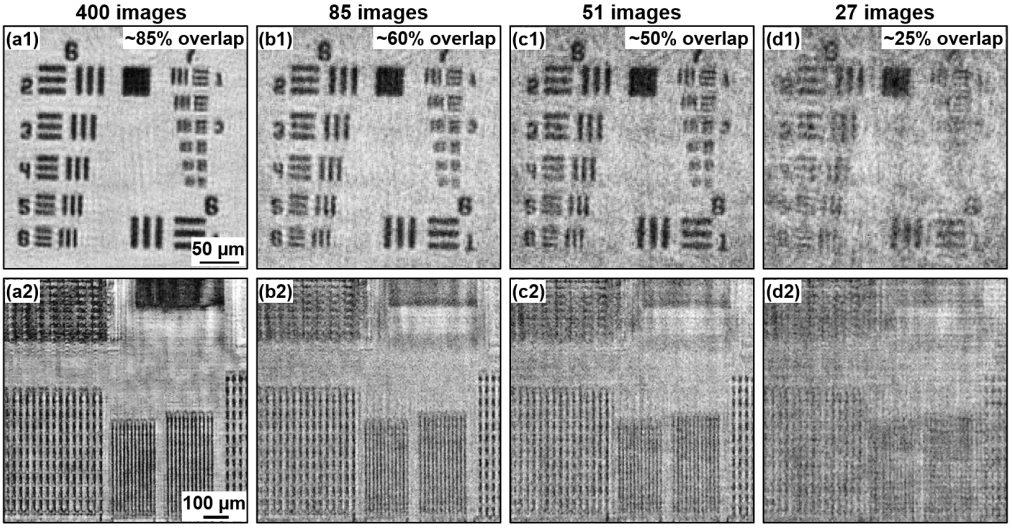

Figure S5. The effect of spatial overlap for SAP reconstruction. During the coded sensor translation process, we can assign different step sizes for image acquisition. A larger step size corresponds to less spatial overlap in-between adjacent measurements. It also means a lower data redundancy for ptychographic reconstruction. SAP reconstructions using 400 images with 85% spatial overlap in-between adjacent measurements (a), 85 images with ~60% spatial overlap (b), 51 images with ~50% spatial overlap (c), and 27 images with ~25% spatial overlap (d). We can see that a large spatial overlap helps to improve the reconstruction quality. The achieved resolution, on the other hand, remains largely unaffected when we reduce the overlap. (a1)-(d1) show the results of the transmission resolution target. (a2)-(d2) show the results of the reflection silicon microchip.

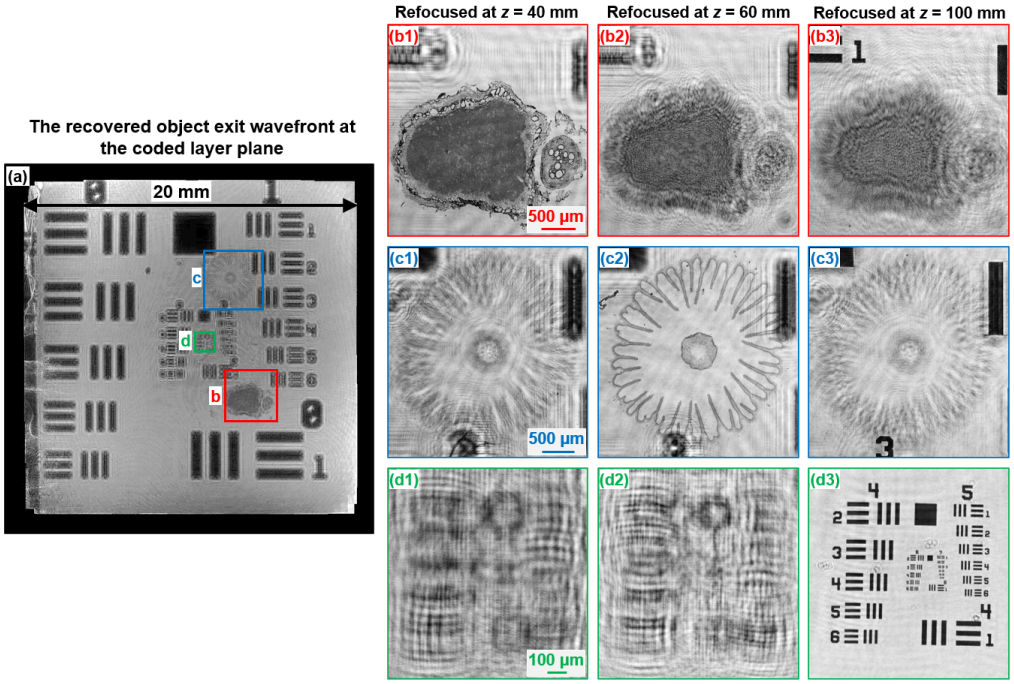

Figure S6. Imaging an axially extended object using SAP. (a) The recovered wavefront $W(x, y)$ at the intermediate aperture plane. (b) The first microscope slide is in-focus at z = 40 mm. (c) The second microscope slide is in-focus at z = 60 mm. (d) The resolution target is in-focus at z = 100 mm.