Dynamic Multiscale X-ray Microscopy: A facility for visualizing mesoscopic dynamics in hierarchical length and time scales

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Abstract: The physics of condensed-matter systems are largely determined by the dynamic interactions of separated phases; domains with distinct structural, magnetic, and electronic properties; and defects within ordered states. The extraordinarily high brightness per bunch of the proposed APS-U offers singular opportunities for exploring these systems with unprecedented flexibility across multiple length and time scales. We propose a canted beamline which will provide critical insight into emergent problems in condensed matter physics, materials science, atomic and molecular physics, and chemical dynamics in solution. One branch of the beamline will focus on dynamics probed with scattering experiments: by combining ptychography and full-field x-ray diffraction microscopy, we will capture the evolution of features with 10 nm and 100 ps spatiotemporal resolution. The other branch will perform high-resolution and high-flux spectroscopy techniques in conjunction with coherent scattering on molecules, clusters, and nanoparticles, providing critical information on element-specific structural dynamics.