APS Upgrade - Beamline Development Proposal White Paper

Structural Sciences Beamline Suite:

Pushing the Boundaries of Atomic Structure Analysis Across Multiple Time and Length Scales

We propose an optimized suite of instruments that, together, meet the expanding needs of the Structural Sciences community for atomic-scale structural insights to answer challenging questions relevant to diverse scientific and technological areas. These instruments probe the atomic structure of a variety of sample forms using reciprocal-space and real-space methods, spanning pair distribution function, single crystal diffuse scattering, diffraction tomography, ultrafast scattering, and powder diffraction. The proposed implementation of these methods within the suite addresses the need for high-resolution measurements, extended-duration measurements, in-situ/operando measurements, anomalous measurements and fast-time resolved measurements. The hard and high energy X-rays that are a strength of the APS and APS-U are exploited by all instruments. This suite recognizes the growing need for more than one tool to completely characterize complex materials architectures, while balancing the need for access to different measurement modalities. To realize this beamline suite, new instruments will be constructed, and existing beamlines/instruments will undergo major upgrades to enhance current capabilities. By assembling a suite of distinct instruments with complementary capabilities we create a highly capable *village* to address the most complex characterization problems and the most important scientific questions, while avoiding the compromises and inefficiencies that often afflict general or multi-purpose instruments.