

## **APS WK#1: Multi-modal X-ray Imaging using multiple APS beamlines. Current status and future upgrades**

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Biological, chemical, geological, archeological, cultural heritage and material science samples come with heterogeneous composition and characteristics which are impossible to evaluate using only one x-ray imaging tool. Combination of modalities enables comprehensive sample analysis and unveils deep scientific questions. The APS, and soon the APS-U, offers variety of x-ray imaging instruments, such as X-ray Fluorescence Microscopy, X-ray Diffraction Imaging, Bragg CDI, ptychography, laminography, small-angle x-ray scattering, and differential phase contrast imaging. Beamlines operate in hard X-ray regime often enable in-situ and operando studies in areas ranging from energy harvesting materials (photovoltaic absorbers) to energy storage applications (batteries and fuel cells). In conjunction with flexible sample environment and advance X-ray focusing optics, integrating more than one technique specific detectors at a given beamline or transferring sample between beamlines is possible to allow multimodal characterization in micro- or nano- scale. Generally speaking, conducting high resolution multimodal characterization and / or micro- to nano- scale correlation analysis is often challenging, due to variation between beamlines, signal contrast (signal to noise ratio), and sample geometry / thickness constraints for various X-ray microscopy techniques. In many cases, proper sample preparation, selection of micro- and nanoscopic features, and efficient use of beamtime for variety of samples, such as tissue sections, cathode or catalysis material, solar cells, and soil aggregates require wider range and options than a single beamline may be able to offer. Fortunately, sequential measurement at two or three beamlines, such as 8-BM, 11-ID, 20-ID, 13-ID, 2-ID-D/E, 9-ID-B, 34-ID-C, and 26-ID with increasing resolution, expanded modalities, and possible sample modification, allows for integrated sample measurement, more comprehensive identification and characterization of micro features within large samples, and highly improves efficiency of measurements. This workshop will demonstrate ongoing progress in multi-modal X-ray Imaging research, including data collection, sample handling and guided modification, as well as developments in sample holders design and visualization software, which all together will significantly improve user experience with multi-beamline imaging. In addition, we will reveal new instruments, capabilities and improvements, which are enabled by the APS-Upgrade. We expect to familiarize broader user community with available X-ray Imaging options at APS and provide ideas for efficient data collection strategy on current APS as well as for upgraded APS beamlines.