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Nanopositioning Support Laboratory Strategy Document

Strategy

The mission of the Nanopositioning Support Lab is to provide engineering and technical support to enable the world class performance of the nanopositioning instrument for APS operations and research as well as for APS Upgrade project. This mission is accomplished by pursuing the following goals:

- Maintain a world class nanopositioning instrument testing lab to support mechanical metrology needs with nanometer scale for APS Upgrade project and APS x-ray beamline operations and research
- Provide customized nanopositioning stages design to support XSD scientist's state of the art technologies that expand the impact of x-ray methodologies
- Provide leading-edge structural dynamics analysis based on experimental results in nanometer scale to support APS x-ray beamline operations and Upgrade project
- Pursue novel nanopositioning design, prototyping, and testing for DOE funded R&D project such as Cavity-Based X-Ray Free-Electron Laser project and Wavefront-preserving Optics project.
- Pursue national and international collaborations in the nanopositioning research and development through Argonne Strategic Partnership Projects.

Currently, with collaborations of APS staff from the optics group and other x-ray sciences groups, numerous novel customized precision nanopositioning stages have been designed, assembled, and characterized at the APS nanopositioning support lab, including new flexure stages for the hard x-ray nanoprobe instrument at APS 2-ID, alignment apparatus for multiple Fresnel zone plates intermediate-field stacking at APS 2-ID and 32-ID, multi-dimensional alignment apparatus for linear multilayer Laue lenses test-bed at APS 1-BM, and K-B mirror flexure manipulating stages for sub-50-nanometer scale hard x-ray focusing at APS 34-ID and 32-ID, as well as for K-B mirrors designed for the APS Upgrade project for 4-ID, 7-ID, 8-ID, 9-ID.

Five-year Goals

- Expand the capability of the laboratory for multi-axis nanopositioning instrument diagnostic and testing.
- Expand the capability of the laboratory for active vibration control in nanometer scale.
- Deploy modular/portable mechanical metrology tools with sub-nanometer resolution and stability.
- Deploy modern design and analysis tools for novel flexural stages design aligned with major scientific thrusts of the APS with upgraded source.
- Identify a new generation nanopositioning stages project aligned with needs of the APS new generation x-ray nanoprobe.

Goals for 2022

- Continue to design nanopositioning systems for x-ray KB mirror nanofocusing optics for the APS-Upgrade project.
- Continue to design, analyze, and test the nanopositioning system for DOE Cavity-Based X-Ray Free-Electron Laser project.
- Continue to design, analyze, and test the nanopositioning system for DOE Wavefront-Preserving Optics project.

- Continue to optimize the design of the existing flexural mechanisms for x-ray nanofocusing systems and sample stages for x-ray microdiffraction and/or x-ray microscopes at the APS sectors 2, 7, 8, 26, 32, 33, and 34.
- Continue to survey of ground vibration noise at the APS experiment floor and the new remote experiment station area for the APS Upgrade project.
- Continue to develop advanced ultrahigh-precision mechanisms for synchrotron radiation special monochromators and experimental instruments for ANL-LDRD, XSD and other APS users.
- Continue to improve the nanopositioning metrology techniques for APS beamlines operations and APS Upgrade project.
- Continue to pursue international collaborations in the nanopositioning research and development through Argonne Strategic Partnership Projects.