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 Hard X-Ray Free-Electron Laser Oscillators 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 26-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, as well as for K-B mirrors designed for the APS Upgrade project.

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 2017

- Start to design a prototype of nanopositioning system for x-ray nanofocusing for APS-Upgrade project.
- Optimize the design of the flexural mechanisms for x-ray nanofocusing system and sample stages for x-ray microdiffraction and/or x-ray microscopes at the APS sectors 2, 8, 26, 32, and 34.
- Optimize the design for multiple zone plates precision alignment apparatus for hard x-ray focusing in twenty-nanometer scale for APS operations and Upgrade project.
• Complete the nanopositioning system design, analysis, and test for DOE APS XFELO project.
• Complete a survey of floor vibration noise at all sectors in the APS experiment hall,
• Continue to develop advanced ultrahigh-precision mechanism 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 857Y2 with European-XFEL, 85H21 with PAL-XFEL, 85E77 with SSRF, and 85J05 with BSRF.