High-throughput high-resolution inelastic x-ray scattering beamline

Developers:

Yuri Shvyd'ko[1] (PI), Deming Shu[1], Lahsen Assoufid[1], Stephen P. Collins[2], Clement Burns[3]

[1] *Advanced Photon Source, Argonne National Laboratory, Illinois, 60439, USA (shvydko@aps.anl.gov)*
[2] *Diamond Light Source Ltd, Didcot Oxfordshire OX11 0DE, UK*
[3] *Western Michigan University Kalamazoo, MI 49008, USA*

Abstract

We propose a beamline for inelastic x-ray scattering (IXS) that will simultaneously provide dramatically increased signal strength, reduced measurement times and unprecedented resolution compared to all present-day and planned facilities. This will become possible by using novel "echo"-type spectrometers, whose operational principle does not rely on the monochromaticity of the x-rays. The small source size and vastly increased brilliance of the APS-U machine will be especially beneficial for echo-type spectrometers, whose performance relies on defocusing and refocusing of x-rays. The new spectrometers will allow, either, up to $\simeq$ 1000–fold reduction in measurement time for experiments at presently available $\simeq$1 meV/1 nm^{-1} resolution, or an unprecedented $\simeq$0.1 meV/0.1 nm^{-1} resolution with a up to $\simeq$ 10-fold improved signal strength. These capabilities will break the barriers of existing IXS and push the exploration of condensed matter and materials. In particular, it will enable studies on a few tens of nanograms of material in thin-film systems (superconductors, thermoelectrics, lithium ion batteries, etc.); studies at extreme conditions (up to 3000 K and 400 GPa); a clear investigation of mesoscopic liquid dynamics, etc., that have not been previously reachable.

The proposal, especially the science case, has been written with contributions from:

Arun Bansil, Alfred Baron, John Budai, Clement Burns, Sow-Hsin Chen, Stephen Collins, Alexander Chumakov, Takeshi Egami, Kenneth Finkelstein, Raphaël Hermann, Hawoong Hong, Ho-Kwang Mao, Steven May, Mathieu Le Tacon, Alexei Sokolov, Viktor Struzhkin, Dmitry Reznik, Stephan Rosenkranz, and Frank Weber.