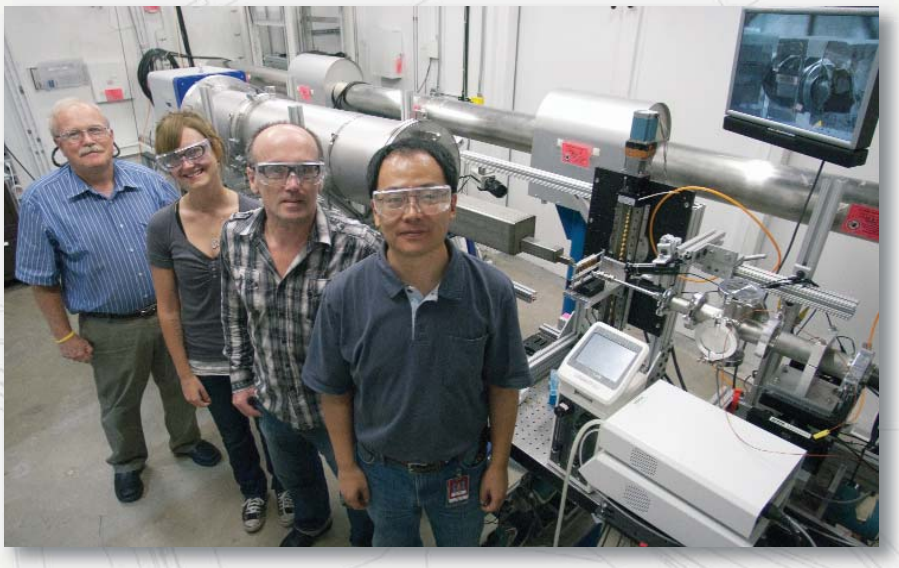
The Advanced Photon Source

Two Independent Beamlines for SAXS and Surface Scattering at 12-ID

For the last eight years, the demand for small-angle x-ray scattering (SAXS) beam time by users of X-ray Science Division (XSD) beamline 12-ID at the Advanced Photon Source (APS) consistently exceeded the available time by a factor of two. The existing SAXS facility had steadily grown to represent 50% of the usage of 12-ID. With the instrument configuration oversubscribed, the only way to support the growth of the SAXS community was to provide simultaneous operation of two 12-ID experimental stations by adding canted undulators and new beamline optics. This enhancement provides the APS with a dedicated SAXS beamline to better serve the general user community in a number of areas in materials science, chemistry, and biology. At least half of current 12-ID users are doing bioSAXS.

The increasing demand for SAXS beam time has been driven by research into the structure and dynamics of nanoscale materials (for which SAXS is an extremely valuable probe), an increased interest in soft matter, and increased usage of the 12-ID SAXS facility for time-dependent structural investigations. General-user experiments have included these areas, as well as the extensive use of the 12-ID SAXS instrumentation for biological research. The more than 400 users who have done experiments on the X-ray Science Division (XSD) Chemical and Materials Science (CMS) Group's SAXS instrument come from U.S. and foreign universities, national laboratories and government institutions and industrial research laboratories.



In the 12-ID-B enclosure with the new SAXS instrument. Left to right: XSD/CMS staffers Randy Winans, Senior Scientist/Group Leader; Janae DeBartolo, Scientific Associate; Soenke Seifert, Physicist; and Xiobing Zuo, Assistant Physicist.

Increasing interest in time-dependent SAXS experiments led the XSD Chemical and Materials Science (CMS) Group to add a pink-light mirror system to the 12-ID beamline. Installed in late FY2005, this addition enhanced the flux-on-sample by over three orders of magnitude, providing new time-resolved experimental opportunities for small-angle scattering experiments. With the development of dedicated instrumentation for anomalous grazing-incidence small-angle x-ray scattering at 12-ID, the beamline also serves as an important complement to the infrastructure for the Center for Nanoscale Materials at Argonne and further increases the demand for this beamline, enabling XSD to pursue options such as high-throughput SAXS, to be used for combinatorial materials studies.

Two installed undulators (a U30S and U33S) have been canted. In the future the U33S will be replaced with a U27 undulator, which is optimized for the energy range on the 12-ID-B beamline. One of the resulting undulator beamlines uses a more stable version of the current monochromator with an energy range of 4.5 to 35 keV and a mirror system that includes the existing pink-beam mirror. This beam will feed 12-ID-C/D and be used for anomalous, time resolved, grazing incidence SAXS in the C hutch, and surface scattering and metal organic chemical vapor deposition studies in the D hutch. The experiments in the C hutch will use a new mosaic large-area charge-coupled device detector built by XSD.

The second undulator feeds 12-ID-B as a dedicated SAXS station using a large offset monochromator (870 mm). This monochromator (Fig. 2) uses a cryo-cooled silicon [220] first crystal to provide an energy range of 7.4 – 13.9 keV. A Pilatus 2M large-area detector will be used in conjunction with a large vacuum-scattering chamber where the position of the detector can be changed automatically to access different Q ranges, and a wide-angle Pilatus 300K detector will be attached permanently to the front of the chamber. A two-dimensional detector with high linearity, dynamic range, stability, and low or no dark current is crucial for SAXS. The Pilatus detector has overwhelming capability in these respects, with a 20-bit dynamic range and no dark current. These detectors make 12-ID-B a very versatile SAXS beamline. *Correspondence: Randall Winans, rewinans@anl.gov*

For recent, interesting results from 12-ID see the online article: "Tuning the Collective Properties of Artificial Nanoparticle Supercrystals," Advanced Photon Source website science highlight, http://tinyurl.com/3gkonfx, which is based upon Paul Podsiadlo, Byeongdu Lee, Vitali B. Prakapenka, Galyna V. Krylova, Richard D. Schaller, Arnaud Demortière, and Elena V. Shevchenko, "High-Pressure Structural Stability and Elasticity of Supercrystals Self-Assembled from Nanocrystals," Nanolett. **11**(2), 579 (2011). DOI: 10.1021/nl103587u

Call for APS General-User Proposals

The Advanced Photon Source is open to experimenters who can benefit from the facility's high-brightness hard x-ray beams.

General-user proposals for beam time during Run 2011-3 are due by Friday, October 28, 2011.

Information on access to beam time at the APS is at http://www.aps.anl.gov/Users/apply_for_beamtime.html or contact Dr. Dennis Mills, DMM@aps.anl.gov, 630/252-5680.

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