User Science Report

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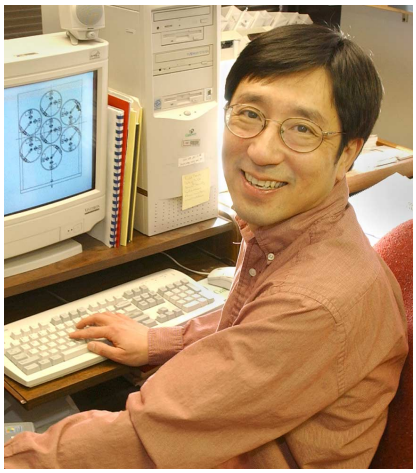
Organization and Mission



The User Science Division was established in late 2001 through reorganization of the NSLS. The mission of the division is to coordinate major facility activities related to users in order to:

- Be more effective in communicating with the user community
- Strengthen existing scientific programs
- Foster the growth of new scientific programs
- Raise the visibility of the exciting science produced by our users.

The division consists of five sections: User Administration (Mary Anne Corwin), Information and Outreach (Lisa Miller), Beamline Development and Support (Steve Hulbert), Scientific Program Support (Ron Pindak), and Detectors and Controls (Peter Siddons).

2002 Activities

During 2002, with the help of many users, the User Science Division organized more than a dozen scientific workshops to promote the exchange and stimulation of new ideas. The topics of these workshops included research frontiers ranging from biology to materials science, and the development of new synchrotron experimental techniques. These workshops have been instrumental in helping us identify new scientific opportunities and user communities, guide the research/development effort and the allocation of resources within the division and the department, and formulate new funding proposals in collaboration with user groups. This effort has resulted in several new projects at the NSLS funded by the National Science Foundation (NSF), the Department of Energy (DOE), and the Department of Defense (DOD). These include a facility for advanced materials processing, a high-resolution infrared spectrometer, a high-resolution x-ray spectrometer, and a major nanoscience research program on soft condensed matter.

In addition, two multi-year NSF research resources, the Consortium for Materials Properties Research in Earth Science (COMPRES) and the Center for Environmental Molecular Science (CEMS), were established at Stony Brook University last year. The wide range of experimental capabilities at the NSLS and the close coordination of effort between the NSLS and user groups are crucial to the success of both resources. We expect that these two research resources, similar to the very successful National Institutes of Health (NIH) research resources at the NSLS, will form the focal point for the earth science and environmental science user communities in the development of new experimental techniques as well as in outreach and education activities. In order to meet the increasing demand for beamtime by these two user communities, the NSLS has initiated a major upgrade of the X17 superconducting wiggler beamline and the construction of a new x-ray microprobe endstation.

A program to upgrade the beamline controls infrastructure at the NSLS has begun. Prototype systems were built and tested in 2001, and a recommended set of hardware and software generated. The system is based on the Experimental Physics and Industrial Control Systems (EPICS) software used at several other synchrotron facilities, and leverages the large effort that has been coordinated by those institutions. During 2002, beamlines X1B, X12A and U5U were upgraded to this new EPICS-based control system, and components were ordered to upgrade beamlines X13 and X21. Beamlines X12B, X12C, X8C, X25, X26A and X26C were also upgraded using funds from other sources (mainly NIH). During 2003, beamlines X21 and X13 will be upgraded using components procured in 2002. Components will be procured for an X17 upgrade. Other beamlines will be upgraded as resources allow.

There is a real need for advanced detector development for synchrotron applications that is not currently met by commercial devices. We have started three

small efforts in this direction. One of them is a silicon detector designed to optimize EXAFS and XANES spectroscopy of dilute systems. To this end, it will have nearly 400 independent detector elements and associated counting chains, increasing by more than an order of magnitude the counting rate capability of such systems. The readout system is realized as a custom integrated circuit, with each chip handling 32 channels. The system is completely computer-controlled, and the user software is designed to minimize operator intervention in its calibration and setup. A prototype having 96 channels is operational and undergoing characterization at a beamline in order to develop the user interface and understand the limitations of the device. We have also targeted powder diffraction as an area where advanced detectors could bring benefits. We have built a high-speed curved gas detector that covers a 45-degree segment of the diffraction pattern, and is capable of acquiring events at more than 3 MHz (**Figure 1**). This device is also operational and waiting for beamline tests. Since silicon-based detectors and gas detectors all become inefficient at higher photon energies, we are performing R&D into higher-Z materials suitable for use as x-ray detectors. In particular, Cadmium Zinc Telluride is available with good quality and we have begun fabricating devices with this material. We hope to have useful detectors before the end of this year.

The macromolecular crystallography community at the NSLS has been extremely productive, as shown in the latest survey conducted for the BioSync report released in October 2002. This report emphasizes the importance of the NSLS as a national resource for structural biology and strongly recommends a major upgrade of the NSLS. However, in the short term, in order to provide more insertion device beamtime for users who are working on brightness-hungry experiments, the NSLS has been working on the development of in-vacuum small gap undulators for the past several years. Last year, a proposal to construct the X29 beamline, led by the Albert Einstein College of Medicine, the BNL Biology Department, and the NSLS, was jointly funded by NIH and DOE. This new, dedicated, undulator-based macromolecular crystallography beamline is expected to begin operation in 2004.

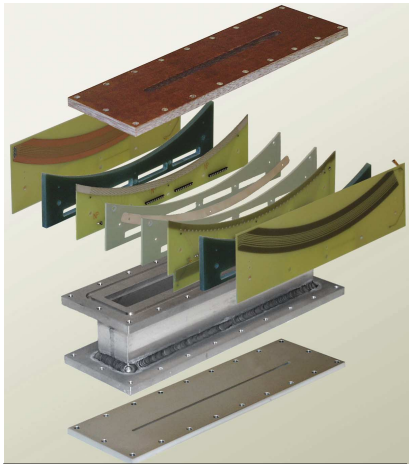


***Figure 1**. The NSLS curved blade detector, exploded view. The thin steel blade in the center is the anode. The other plates are spacers and cathode strip arrays. The cathode strips are read out through individual processing channels and a Digital Signal Processing (DSP) system is used to identify each event location.*

As synchrotron radiation matures and the use of synchrotron radiation spreads to the wider scientific community, we expect that new users of the NSLS increasingly will not be experts in synchrotron radiation techniques, and will need better training and support from the facility. This trend is going to be accelerated by the continued growth in life sciences, and the anticipated growth in the nanoscience user community. In response to this changing need, we have initiated the development of a new user access policy at the NSLS to ensure fair and open access to beamtime and provide better user support. This new policy, which is being developed in close consultation with the NSLS user community and other DOE synchrotron facilities, is expected to be in place by the summer of 2003. In parallel with this new user access policy, a long-term beamline operation and staffing plan is being developed. As a first installment, the department has added or reassigned a total of ten staff to the User Science Division in the last year.

Finally, we have taken the following more immediate steps to enhance user science at NSLS. First, a short course on EXAFS data collection and analysis was held with the help of many experienced users. The format of the workshop mimicked the very successful short course on "Rapid Data Collection and Structure Solving at the NSLS," which is organized by the NSLS and BNL Biology Departments for macromolecular crystallography. Feedback on the EXAFS short course has been so extremely positive that it will become an annual event, and more short courses will be organized. Second, a faculty-student research support program was re-instituted. This program provides funding for first time users, and/or new faculty members, to perform initial experiments. Third, the NSLS homepage now features exciting, new science highlight articles weekly that focus on recent publications by NSLS users and staff. Fourth, the NSLS website has been redesigned to incorporate a new section aimed at guiding new users through the process of choosing the proper technique, applying for beamtime, and accessing the NSLS for their experiment.