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Construction of Bending Magnet Beamline at the APS for Environmental Studies

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Research Objective

Design and construction of a bending magnet beamline at the Advanced Photon Source (APS) by the Pacific Northwest Consortium-Collaborative Access Team (PNC-CAT). The beamline will be optimized for x-ray absorption spectroscopy (XAS) studies with a major focus on environmental issues. The beamline will share the experimental facilities under development at the neighboring undulator based insertion device beamline. It will utilize these facilities for XAS of both bulk and surface samples, with spatial and elemental imaging, on toxic and radioactive samples. It will help meet the rapidly growing need for the application of these techniques to environmental problems.

Research Progress and Implications

This report summarizes progress after 1-1/2 years of a 3-year project. The original scope of the project was to build a basic bending magnet beamline. Since the start of the project we have obtained addition funding from DOE-BES for the PNC-CAT activities. This has allowed us to expand the scope of the original proposed bending magnet beamline. Additional items now planned include a full sized experimental enclosure separate from the first optical enclosure (FOE), a white beam vertically collimating/focusing mirror providing improved flux and focusing, and enhanced experimental capabilities. Construction of the FOE and new experimental enclosure are complete along with full sector utilities, and the FOE is currently undergoing validation for its radiation integrity. The major beamline components are still being funded by the original EMSP project, and their status is described below.

The preliminary design of the beamline has been completed and accepted by the APS. The final design report is nearly complete and will soon be submitted to the APS for approval. This has allowed us to begin component procurement. For the initial phase of operation we require a monochromator, beam stops and shutters, and beam transport. The main shutter/beam stop is an APS design. It has been ordered and will be delivered in the summer of 1998. Procurement of the major monochromator components has begun. The monochromator will be very similar to the monochromator currently undergoing testing on our insertion device beamline, and we are awaiting the outcome of these tests before the final design of the crystal mounts. We expect the monochromator to be complete in early 1999. At this time limited testing with monochromatic beam can start in the FOE. The beam transport components are mainly standard UHV pumps and valves, and their procurement will begin with the approval of the final design report. A filter assembly originally planned for the ID line will be modified to act as a white beam slit system to complete the first stage of beamline development. The basic beamline should be operational in the spring of 1999, approximately 6 months ahead of the original schedule. This is a result of the additional DOE funding which accelerated the enclosure construction, and allowed us to concentrate the EMSP funds on beamline components.

The beamline will utilize experimental equipment being developed as part of the larger PNC-CAT effort. Microfocusing optics based on tapered capillaries and Kirkpatrick-Baez mirrors are under devlopment on the ID line. The capillary optics have been used to produce images with 0.5 micron resolution. A prototype K-B mirror has been completed, and will be tested soon. It will produce a focus of about 20 micron, and can also be used in conjunction with short tapered capillaries to improve their performance. Once perfected we plan to build versions of these optimized for the characteristics of the BM line. Recently we have also commissioned a portable UHV-MBE system which can be used for surface-XAFS, x-ray reflectivity, and standing wave measurements.

Finally, procedures for handling sensitive and radioactive materials are being developed in consultation with the APS and the ANL chemistry department. The chemistry department is funded by DOE to provide support facilities for the use of radioactive samples at the APS. We plan to carry out the first measurements using sensitive materials on the ID line in Aug 1998.

Planned Activities

As outlined above the primary planned activity is to bring the bending magnet beamline to full operation. Some important milestone dates follow:

June 1998 complete FOE radiation validation, complete shutter/beam stop assembly, submit final design report
February 1999 complete monochromator assembly
April 1999 first mono. Beam in FOE
June 1999 install beam transport to experimental enclosure
August 1999 bring mono. beam into the experimental enclosure for shielding tests
September 1999 commission sagittal crystal bender for horizontal focusing

This will complete the EMSP project, and the line will be capable of a full range of experiments. In FY2000, the additional DOE funding will be used to add a white beam focusing/collimating mirror to increase the focusing capabilities and flux.

Other Access To Information

A publication which summarizes our tapered capillary and micro-XAFS activities is:

S.M. Heald, D.L. Brewe, B. Barg, K.H. Kim, F.C. Brown, and E.A. Stern, “Micro-XAS using Tapered Capillaries Concentrating Optics”, J. Phys. IV colloque C2, 297 (1997).