Construction of Bending Magnet Beamline at the APS for Environmental Studies

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Research Objective

To help satisfy the growing need for synchrotron radiation based environmental research, it is proposed to carry out the design and construction of a bending magnet (BM) beamline at the Advanced Photon Source (APS) by the Pacific Northwest Consortium-Collaborative Access Team (PNC-CAT). The line will be optimized for various forms of x-ray absorption spectroscopies (XAS). Environmental and cleanup issues are a major focus of the fundamental research to be performed on the BM beamline. The beamline will share the PNC-CAT experimental facilities to be fabricated for the neighboring Undulator A Insertion Device beamline to utilize the experimental techniques of x-ray absorption spectroscopy for both bulk and surface studies, with spatial and time resolution and elemental imaging, on toxic and radioactive samples. These capabilities have been cited in a recent DOE workshop report as most desirable for future environmental research.

Synchrotron radiation studies of materials at the molecular scale can make important contributions to the understanding of the basic science issues underlying environmental cleanup efforts. A recent DOE workshop report "Molecular Environmental Science: Speciation, Reactivity, and Mobility of Environmental Contaminants" (July 5-8, 1995) emphasizes the important role to be played by synchrotron techniques, especially in the hard x-ray range. This view is confirmed by the increasing numbers of environmental programs which are employing synchrotron techniques, and the report also concludes that the available beamtime for such experiments is likely to be saturated in the near future. It is equally important that the beamtime be accompanied by the appropriate support for environmental studies, such as the capabilities for handling radioactive samples. To address these issues the Pacific Northwest Consortium-Collaborative Access Team (PNC-CAT) is proposing to build the optics and beam transport of a bending magnet beamline to deliver x-rays to an experimental enclosure. The beamline will be located at sector 20 of the Advanced Photon Source (APS), and will share important environmental support facilities with an insertion device beamline already under construction.

The PNC-CAT is a consortium of researchers from Universities in Washington State, Canada, and the Pacific Northwest National Laboratory (PNNL) in Richland, Washington. The PNC-CAT was formed to develop a sector at the Advanced Photon Source (APS), a third-generation synchrotron radiation x-ray source under construction at Argonne National Laboratory. This source will be completed in 1996-1997, and its distinguishing feature will be the use of insertion devices such as undulators which increase source brightness by orders of magnitude over previous generation synchrotrons. The PNC-CAT will employ this source brilliance to develop a unique x-ray microbeam of unprecedented flux density with beam size and resolution down to ~0.1 micron, and tunable over the range 4-25 keV for a variety of research projects. Equipped with an x-ray microprobe, advanced fluorescence detectors, radioactive sample facilities, and surface scattering and XAFS equipment, the PNC-CAT beamlines provide unique facilities for basic research into environmental problems.

The University of Washington (UW) has recently recognized its special responsibility because of its geographic location, to help in solving the clean-up problems at the badly contaminated Hanford, Washington, site. The University Administration has been encouraging Faculty involvement in this activity (see Letter in Appendix A). In particular, as stated in the Letter, "The University of Washington will match all awards received through the EMSP program at the level of 10%." The facilities in this research will not only give unique capabilities to investigate the research problems proposed here,

but also will be of use to the programs of other researchers, including collaboration with researchers from UW and PNNL as outlined in Section D. For example, a number of ongoing Environmental Management (EM) problems will be addressed by the basic research planned for the beamlines. These include:

- Improved waste processing and separation technologies.
- Alternative waste forms capable of better handling of problematic species such as Ti or phosphates.
- Verification of modeling for the transport of contaminants under geologic conditions.
- Chemical speciation of tank wastes.
- Atomic scale structure of active sites in metallo-enzymes proposed for bio-catalytic reduction of actinides, metal contaminants and chlorinated hydrocarbons.
- Adsorption and catalytic interactions at mineral surfaces.
- Radiation induced structural changes in waste forms.
- Improved sensors for monitoring contaminants.

The estimated number of key personnel who will be utilizing this instrumentation consists of the following: senior personnel, 37; post-docs, 10; graduate students, 20; and undergraduates, 5. The members of the PNC-CAT cover a broad spectrum of interest. All are interested in the fundamental properties of "materials" but differ in the materials being investigated and the areas of application of this basic knowledge. The unifying element is the PNC-CAT and the experimental capabilities that its facilities will present. As has been the experience at other synchrotron sources, the PNC-CAT is expected to catalyze interactions between governmental and industrial researchers, graduate students, professors and post-docs from different fields which would not have occurred otherwise.