An analysis of public policy issues and how they affect MRS members and the materials community...

Neutron and Synchrotron User Facilities for Materials Research Balance Need, Availability, and Cost

Neutron and synchrotron sources have become essential tools in materials research. The recent report of the Basic Energy Sciences Advisory Committee (BESAC) Panel on the Department of Energy (DOE) Synchrotron Radiation Sources and Science, co-chaired by R.J. Birgeneau and Z.X. Shen, said, "Synchrotron experiments contribute ubiquitously to materials research, ranging from fundamental issues to important practical problems." For example, measurements made using neutron and synchrotron sources have been crucial for our understanding of high-temperature superconductivity. Similarly, measurements of stress distributions in materials, the local environment around impurities, the average structure of surfaces, and buried interfaces have been important for a wide variety of materials problems. Over the past 50 years, DOE, its predecessors, and other government agencies have built a number of large user facilities. In the 1960s and 1970s they built neutron sources: the High Flux Beam Reactor (HFBR) at Brookhaven National Laboratory (BNL), the High Flux Isotope Reactor (HFIR) at Oak Ridge National Laboratory (ORNL), the National Institute of Standards and Technology (NIST) reactor, the Intense Pulsed Neutron Source (IPNS) at Argonne National Laboratory (ANL), and later the Los Alamos Neutron Science Center (LANSCE) at Los Alamos National Laboratory. In the 1970s–1990s they built synchrotron sources: the Synchrotron Ultraviolet Radiation Facility (SURF) at NIST, the Synchrotron Radiation Center (SRC) at the University of Wisconsin, the Stanford Synchrotron Radiation Laboratory (SSRL) at Stanford University, the Cornell High Energy Synchrotron Source (CHESS) at Cornell University, the National Synchrotron Light Source (NSLS) at BNL, the Centre for Advanced Microstructures and Devices (CAMD) at Louisiana State University, the Advanced Light Source (ALS) at Ernest Orlando Lawrence Berkeley National Laboratory (LBNL), and the Advanced Photon Source (APS) at ANL. As we approach the 21st century, an upgrade of LANSCE is in progress, and plans are being made for the Spallation Neutron Source (SNS) at ORNL. Research and development (R&D) is also underway on the next generation of photon sources in the form of free electron lasers. The number of scientists who rely on these facilities continues to expand both in number and in scientific discipline as new facilities become available. The number of users of the DOE facilities is presently almost 5,000 per year. (More information on user facilities is available on the DOE website http://www.doe.gov/html/servers/mlabtitls.html.)

The character and the needs of the user community are changing with time. Each of these fields started with a small number of enthusiasts who developed different techniques and built beam lines to meet their own scientific interests. Over the last decade new classes of users have appeared. For example, some materials scientists require the sensitivity of high-resolution powder diffraction or x-ray absorption spectroscopy as part of their research program but want to be users rather than builders of beam lines. The challenge is to find a balance between encouraging innovation in beam lines and providing access for this second group of users. At present the beam lines are either built and operated by the facility or are funded, built, and operated by outside groups (Participating Research Teams [PRT] at NSLS and Collaborative Access Teams at APS) in exchange for 75% of the available beamtime. The remaining 25% is then available for peer-reviewed general user proposals. After five years as chair of NSLS, I believe that an appropriate mix of facility and PRT beam lines maximizes the overall scientific output. In the end, a cost is associated with the building of new beam lines or with the operation and upgrading of existing beam lines. In 1994 Artie Bienenstock, then at SSRL (now Associate Director of Science at the Office of Science and Technology Policy), spearheaded successful support for a Scientific Facilities Initiative to provide funds for additional beamtime and to upgrade existing beam lines. The recent BESAC report on DOE synchrotron sources has recommended further increases in funds but has emphasized that the increases must not come at the expense of the core research programs in universities or government laboratories. DOE is already addressing these recommendations.

Unlike the synchrotron community, the needs of the neutron community have not been met in the United States. Although numerous committees have recommended upgrades to existing reactor- and accelerator-based neutron sources and the need for new sources, it has proven difficult to obtain the necessary funds. The proposal to build the Advanced Neutron Source at ORNL became too expensive partly because of increased safety and environmental concerns. In the wake of recent environmental concerns associated with a small tritium leak in the spent fuel pool at Brookhaven, Secretary of Energy Frederico Pena has established a process to assess the cost, scientific value, and the environmental risk of the HFBR in order to decide whether it should be restarted or be permanently closed. Although a consensus holds that both reactor- and accelerator-based neutron sources are necessary, environmental concerns are driving researchers to a reliance on accelerator-based sources and to upgrade LANSCE and to build the SNS. As a result many years will pass before the neutron scattering community in the United States will have the breadth of facilities that is already available to colleagues in Europe.

With the end of the cold war, numerous scientific leaders have indicated that future funding for science is dependent on all scientists demonstrating to the public and to political leaders the importance of their research. In recent years there has also been a growing discussion about whether the national laboratory system needs major restructuring. The Office of Energy Research in DOE funds about three times more basic research in the physical sciences than does the National Science Foundation, and therefore the outcome of this debate in Congress and elsewhere is of crucial importance to the many materials scientists who are funded by DOE and especially to those who use the DOE-funded neutron and synchrotron sources. It will increasingly fall to the users of these facilities to demonstrate to the public and to Congress the importance of the research carried out at these facilities. At the same time the scientific community and especially the materials science community will have to provide input to the funding agencies on the balance between the need, availability, and the cost of large user facilities. The issues surrounding major scientific facilities such as neutron and synchrotron sources mirror those facing the R&D community at large. Political decisions *will* be made that affect the future of the R&D enterprise in general and of facilities in particular. The scientific community, both as individuals and as groups, has a responsibility to provide input to the debate.

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