ACCESS TO MAJOR INTERNATIONAL X-RAY AND NEUTRON SCATTERING FACILITIES

EXECUTIVE SUMMARY

The goal of this study is to explore how access to major international X-ray and neutron scattering facilities is evolving both in the US and internationally. A major facility is defined here as one that attracts users from at least across a nation, has an operating budget of $ 15 m or more and invites proposals for beamtime. Access means the opportunity to conduct an experiment at a major facility with assistance from the facility as needed to be successful.

To gather information we sent questionnaires to major facilities and to user groups and societies that support the fields of X-ray and neutron scattering worldwide. We also held discussions with many individuals both in the US and abroad. The conclusions of the study are presented in Section 7. In this Executive Summary we emphasize the factors setting and limiting access particularly as they affect US scientists.

Mechanisms of Access

A history of means of access to major X-ray and neutron facilities is presented in chapter 2. Today, access is chiefly via a written proposal to the facility to conduct an experiment. All of the 32 facilities responding to the study questionnaire have proposal programs and 60 -100 % of beamtime is allocated via proposals, depending on the facility. In all but two cases, all proposals, irrespective of origin, are reviewed for scientific merit by the same committees of peers. This mechanism and its variations globally are discussed in section 6.1. The user community is generally happy with the proposal access mechanism and it is expected to remain the chief mechanism. No facilities charge user fees.

Participating Research Teams (PRTs) (also denoted Collaborative Access Teams (CATs)) remain a productive access route, although somewhat out of favor at present in the USA. PRTs and CATs can both expand the number of beamlines/instruments at facilities and provide flexible access outside proposal program for Team members. They are well received where the PRT instruments are constructed and operated within strict facility criteria. For example at ESRF, where they are viewed as a success, PRTs (denoted CRGs in Europe) must demonstrate that the CRG beamline is unique and does not duplicate an existing beamline, will be constructed to conform to facility guidelines and will have adequate operating support. Although the number of PRTs in the US is dropping, typically 20 % of beamlines/instruments at European facilities are PRTs.

Foreign nationals have also been able to obtain funds in their countries to construct PRTs at US facilities. We could find no examples of US funded PRTs at foreign facilities.

- While the proposal system is expected to remain the major mechanism for access, establishing a funding mechanism in the USA for PRTs or CATs would greatly improve and expand this flexible component of access.

Experiments are done by research teams. Usually only a segment of the team goes to the facility to conduct an experiment. An increase in “Cyber Access” to the facility that would enable other team members to participate remotely would be an enormous step forward. Similarly access in which samples only are sent to facilities is increasing.

- Improvements in “Cyber Access” to instruments that would allow members of a research team not at the site to participate in the experiment remotely would be a major advance in access.

Visa restrictions remain a barrier in the USA. This barrier extends from the difficulty in admitting foreign graduate students and post doctoral associates into the country, to access for visa students at US facilities, to travel of visa students and associates abroad to conduct experiments. Some foreign scientists simply choose not to collaborate in the USA because of the difficulties inherent in the visa system. While we do not have a solution, visas and visa related security remain a barrier to access.

Access Mechanisms to Facilities abroad

Facilities abroad offer access and a means of expanding the research resources available to US researchers. Particularly, contact with and use of the best facilities in Europe and those emerging in Japan and China has proven rewarding for many US scientists.

The US policy on access to foreign facilities is an informal nation-to-nation policy: “we use your facilities and you use ours”. This generally operates well between national facilities. All US facilities are national facilities.

Europe and Russia, however, have both national and multinational facilities. At a multinational facility, several nations have come together to construct the facility and subsequently to provide the annual operating budget within a formal agreement. Specific examples are ILL and ESRF. When there is such a formal agreement, access is monitored by the supporting nations and each anticipates scientific access in approximate proportion to their support. In this environment, it is difficult for multinational facility to offer open access to scientists from nations that are not part of the consortium. In the case of the USA, there is a mismatch between the informal US policy “We use your facilities and you use ours” and the formal agreements at multinational facilities. This mismatch is discussed in section 6.1. The mismatch of the US informal policy and multinational facilities has been noted in other fields of science and is not unique to X-ray and neutron facilities (cf NSB Report 90-172 (1990) and OECD Megascience Forum Reports

(1998)). Negotiations to transcend this difference would enhance international cooperation.

Use of all foreign facilities, national or multinational, is always possible through collaboration with scientists from the nations supporting the foreign facilities (see section 6.3).

- Increased international collaboration involving neutron and synchrotron facilities in the U.S. and abroad would bring major benefits to U.S. researchers as well as increase the impact of all facilities.

Instrument scientists

As the user community continues to expand, it will naturally include many scientists who are less familiar with performing experiments using neutrons and synchrotron X-rays. The evolution of the community is discussed in section 6.5.3. In addition, the rate at which data are collected during experiments continues to increase. In this environment, users will depend increasingly on facility instrument scientists for (1) scientifically insightful planning of experiments, (2) distinguishing important discovery from spurious instrument effects (3) data reduction and (4) data analysis so that their "access" leads to a scientifically successful outcome (see section 6.5.3 and 6.6). Instrument scientists have always been the key contacts for users. The fraction of users who can conduct experiments largely independently and who require little assistance is expected to decrease. Specifically,

- Scientifically successful access today, especially for new users, depends on the active assistance and collaboration of facility instrument scientists at a scientific level. This requires an increased number of instrument scientists and ensuring that they can remain scientifically active. This depends on (1) the education and training of fresh instrument scientists within the universities (2) the creation of attractive job opportunities, good promotion prospects and a satisfying career path for instrument scientists within the facilities and (3) ensuring that they have time and resources to develop and maintain their own scientific program.

Support for investigators

Support for individual investigators or groups of scientists, their post doctoral associates and graduate students in universities who use X-ray or neutron facilities is essential in maintaining a vital user community. It is also these individuals or groups who train future instrument scientists. In the US, this support comes in the form of individual/group research grants or contracts that are used to pay associates and students and to conduct experiments. The support for individual investigator programs as a fraction of total support in agencies such as NSF continues to decrease. We believe that this trend will a

have deleterious long-term effect on the stability and health of the user community in the US and must be reversed.

- To create and ensure a world class and vital user community, support for the research programs of individual users in universities must remain strong and in reasonable balance with support for major facilities and other research centers.

At most European facilities (e.g. ISIS, Diamond, LLB, ESRF, ILL, DESY) user travel and accommodation expenses incurred in conducting experiments are paid through the facility. European scientists and facility direction find this practice important in supporting a user base.

Availability of facilities

Availability of facilities, particularly of X-ray beamlines and neutron scattering instruments on which experiments can be carried out, is central to access. The number of scientists seeking access to facilities in the US is increasing and when the success rate of proposals falls below roughly 30 %, scientists tend to move toward other research (see section 4.3)

The number of users and the number of accepted proposals for experiments at facilities is proportional to the number of instruments/beamlines and the time they are available. This is a central finding of the report (section 4.5). While raw beam intensity is important, it is also vital that facilities are fully instrumented with regular upgrades to all instruments. In addition to building new facilities such as LCLS and NSLSII, the user community can be enlarged by optimizing existing major facilities with beamlines, instruments and sample environment equipment. This represents a cost efficient way of expanding access for users. This finding agrees with that in the NRC Report, CMMP 2010, for both neutron and X-ray facilities.

- The number of users and the number of experiments conducted at a facility scales with the number of instruments (neutrons) or beamilines (X-rays) at the facility. The scientific access is maximized when all beam capacity is fully exploited and all beamlines are fully instrumented with modern instruments and associated sample environment equipment. The size of the US user community is currently limited by the number of instruments and beamlines.

- To enable world class, cutting edge science, it is important that beamlines, guide halls and instruments are regularly upgraded in a continuous program of facility instrument modernization.

In addition, availability can be further limited by the number of days that beamlines/instruments can be operated in the user program and by the number

of instrument scientists available to assist users. Instruments and beamlines that have not been recently upgraded are often symptoms of an inadequate operating budget.

The NRC Report, CMMP 2010, recommends that a national plan for constructing and supporting Synchrotron X-ray facilities be developed by the supporting agencies (DOE, NSF, NIH) through Interagency Cooperation. This report supports this recommendation and finds support for including neutron facilities in this planning. Specifically,

- Further planning for the support and upgrade of existing X-Ray and neutron facilities and the construction of new facilities would be most effective if it includes Interagency Cooperation. This planning could also be placed an international context, keeping a watching brief on developments abroad so that opportunities for international cooperation in facility use, upgrade or construction can be realized.

Features of outstanding facilities and international perspective

Investigators in universities who use synchrotron X-rays and neutrons operate in a highly competitive environment for research funds. One of their major concerns is to demonstrate research achievement within the 3-year period of a single grant. In this context, investigators favor facilities that: (1) are reliable, (2) have unique instruments, (3) have excellent sample environment facilities and (4) have competent technical personnel and laboratory support staff, in that order (see Section 5.2). Other factors are rated as less important.

The world's most productive neutron and X-ray users facilities (such as the NCNR and the APS in the U.S. and the ILL and the ESRF in Europe) have achieved their level of performance (usually after an extended start-up phase) by offering a wide range and a large number of modern beamlines and instruments, many of which are unique, combined with reliable operation and excellent, and again often unique, sample environment facilities.

There is a significant addition of world-class facilities in progress in the East: in Japan, in China and in Australia. This represents an important shift in major facilities.