CONF-831012--3

NOTE: This is a draft of a paper being submitted for publication. Contents of this paper should not be quoted nor referred to without permission of the author.

CONF-831012--3

DE84 001987

INTERACTION BETWEEN USERS OF LARGE AND SMALL RESEARCH REACTORS

R. M. Moon

DISCLAIMER

Solid State Division
OAK RIDGE NATIONAL LABORATORY
Operated by
UNION CARBIDE CORPORATION
for the
U.S. DEPARTMENT OF ENERGY
Oak Ridge, Tennessee 37830, USA

October 1983

INTERACTION BETWEEN USERS OF LARGE AND SMALL RESEARCH REACTORS

R. M. Moon

Solid State Division, Oak Ridge National Laboratory

Oak Ridge, Tennessee 37830, USA

ABSTRACT

An attitude of cooperation rather than competition should and does exist between large and small reactor centers with regard to neutron scattering. Two areas of clear mutual interest are the development of user communities and the development of improved instrumentation. The current situation in Europe and the United States is examined and contrasted for these two areas. A recommendation is advanced for increased cooperation in the U.S. between large and small reactor centers in the education and training of neutron scattering users.

A DEFINITION OF TERMS

In any rational approach to a discussion of this topic one must first decide on a definition of "large" vs "medium or small" when applied to research reactors. This is not a completely trivial question. Possible criteria could be total power, peak neutron flux in the reflector, number and diversity of experimental facilities, number of research staff, or total operating budget. The relative ranking of reactors would depend on the weight given to these various criteria.

The emphasis in this paper will reflect my personal background, which is in the field of neutron scattering. My criterion for largeness involves some combination of thermal neutron flux in the reflector and the number and quality of neutron beam facilities.

The large reactors become almost self-selecting on the basis of their names: the High-Flux Reactor (HFR) at the Institut Laue-Langevin, the High-Flux Isotope Reactor (HFIR) at the Oak Ridge National Laboratory, and the High-Flux Beam Reactor (HFBR) at the Brookhaven National Laboratory. On the European scene, few would argue with the designation of the HFR as the single large reactor, to be joined in the future by the 100 MW reactor under construction in Leningrad. Within the United States, I would like to elevate the National Bureau of Standards Reactor (NBSR) to the large category on the basis of its excellent neutron scattering facilities. This has the virtue of placing the dividing line between large and small reactors in the U.S. along the political line between national laboratories and universities. It follows that many of my remarks concerning national facilities will also be applicable to the pulsed neutron sources at Argonne and Los Alamos.

COOPERATION OR COMPETITION?

The organizers of this conference probably thought of me in connection with this topic because I have had some experinece as a user of a wide range of research reactors. My initial association with reactors came as a graduate student at the MIT reactor when it was operated at 1 MW. About half-way through my thesis work the power was raised to 2 MW and my subsequent experience has been at the Oak Ridge Research Reactor (ORR) which is operated at 30 MW, and at the HFIR which is operated at 100 MW. As a side comment on the experimental impact of higher source strengths, it is interesting to note that my initial experiments at the HFIR, in collaboration with T. Riste and W. C. Koehler, had smaller counting rates than any of my previous experiments at much smaller reactors. In graduating to more powerful neutron sources, the basic experimental urge is to do research which is impossible to do at a much weaker source, rather than more of the same, only faster. Within a scientific environment which contains reactors of various strengths, this basic urge leads to a natural selection process which tends to minimize the overlap of research programs at large and small reactors. My point is that large and small reactors can and do exist in an atmosphere of cooperation rather than competitiveness because of the natural tendency to use research facilities on problems which push against the limits of the available equipment.

As an example of this tendency, the gradual evolution of the neutron scattering program at ORNL is of interest. When I joined the ORNL staff in 1963, before the HFIR was operational, the neutron scattering research program consisted exclusively of magnetic and crystal structure determinations and measurements of magnetic diffuse scattering from ferromagnetic alloys—all elastic scattering experiments. At the present time these types of problems

constitute about 15% of the total effort. With the availability of a high-flux reactor our program shifted toward inelastic experiments, neutron polarization analysis experiments, and magnetic form factors of paramagnets. Magnetic structure determination remains a fertile field of research at low and medium flux reactors.

It would be misleading to suggest that the neutron scattering workers at a high-flux facility would reject an important experiment on the grounds that it could be performed at a low-flux reactor. That would be against human nature. However, in thinking of new research problems these same workers have a tendency to concentrate on problems that are different from those on which workers at a low-flux facility would concentrate.

DEVELOPMENT OF STAFF AND USERS

Having established that research programs at large and small reactors need not be highly competitive, we turn now to an area in which there is a very clear and mutually beneficial relationship—that of the education and training of a large group of scientists who regard neutron scattering as one of their principal experimental techniques.

Within the United States the need for a cooperative relationship between the small (university) and large (national laboratory) reactors has never been as clear as it is right now. In the recent past there have been a number of committees formed by various organs within our national government to examine the role of the national laboratories. A unanimous opinion of these committees is that a proper and useful role is for the national laboratories to provide large and expensive facilities for use by university and industrial scientists. The Department of Energy has responded enthusiastically with calls to the laboratories to strengthen existing user programs and initiate new programs. In the present climate it is clear that the future health of large reactors depends on developing a large group of users from universities and industrial laboratories. It is equally clear that the existence of strong user programs at the national laboratories strengthens the case for maintaining the university reactors as training centers for future users of the national facilities. The large reactors need the small reactors to help in building up the user population, and the small reactors need the large reactors, with open user policies, to provide incentives for students to enter the neutron scattering field.

Of course, the large reactor facilities also benefit more directly from university training centers when they have the opportunity to hire new staff members. At ORNL we now have four staff

members who did experimental theses in neutron scattering at MIT and one from Missouri.

The training function is not solely the responsibility of the university reactor centers. Students from many universities, including those with reactors, have done all or part of their thesis work at large reactors at the national laboratories. In the past year 51 students[1] have participated in neutron scattering experiments at the three large reactors and 26 more students have performed experiments at the university reactors. At ORNL our relationship with Iowa State University is particularly close and mutually beneficial. The Ames Laboratory operates three spectrometers at the ORR, and Iowa State students are frequent users of the HFIR spectrometers. In addition to educating students, the national laboratories and universities can help in building an active user community by holding special schools and workshops for prospective users. The Argonne National Laboratory has taken a leading role in activities of this type in connection with their pulsed neutron source.

The growth of the total U.S. user community in neutron scattering is illustrated in Fig. 1. The numbers represent individuals who have come to a reactor to do a neutron scattering experiment, including the in-house staff. Multiple visits in a single year are counted only once. The growth in recent years has been dramatic, increasing by more than a factor of two since 1978. Major factors contributing to this increase were the installation of

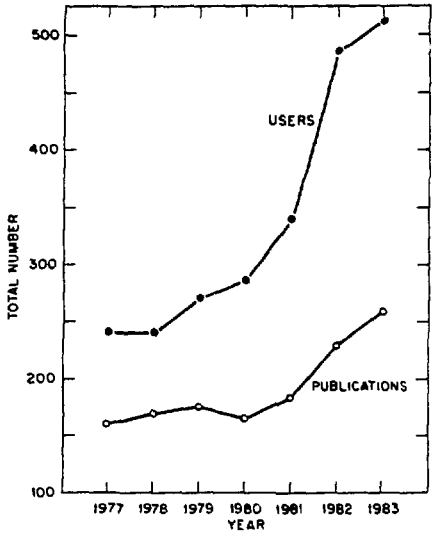

Fig. 1. Growth of neutron scattering users and refereed publications in the United States. Numbers include both reactor and pulsed-source research.

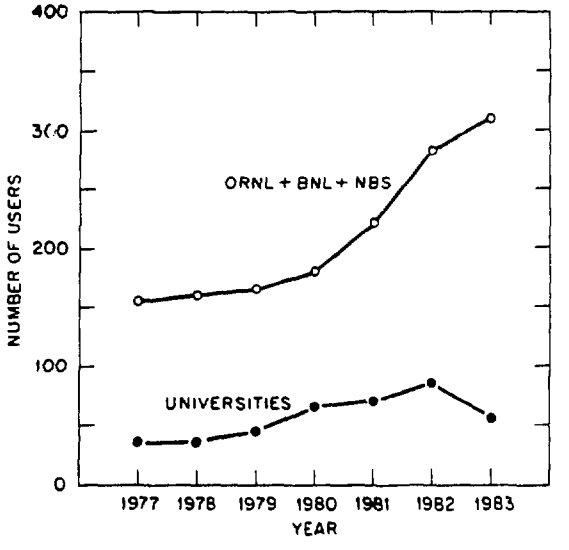

Fig. 2. Neutron scattering users at U.S. reactor centers.

small-angle instruments at ORNL, NBS, and Missouri, and the high-resolution powder instruments at NBS and at the Intense Pulsed Neutron Source (IPNS) at Argonne. A more open attitude toward users on the part of the national laboratories also was an important factor. This is particularly true at IPNS and at the National Center for Small-Angle Scattering Research (ORNL), both of which are operated as dedicated user facilities. In viewing Fig. 1 it is interesting to note that DOE did not have a clear policy toward users (no beam charges except for proprietary research) until late in 1979. The corresponding growth in the number of refereed publications is also shown in Fig. 1.

To focus more sharply on the subject of this paper, the user data for the large and small reactor centers are shown in Fig. 2. Much of the difference between the national laboratories and the universities can be attributed to the number of instruments (29 vs 11). The current DOE policy of not requiring beam charges at the national laboratories, provided that the research is published in the open literature, is another factor contributing to the difference shown in Fig. 2. If the financial base of the university reactors could be strengthened so that beam charges were unnecessary, an increase in university users and a stronger national program should result.

While the numbers in Fig. 1 are encouraging, the U.S. is far behind Europe in the magnitude of the user community in neutron scattering. Much of the credit for the European success must go

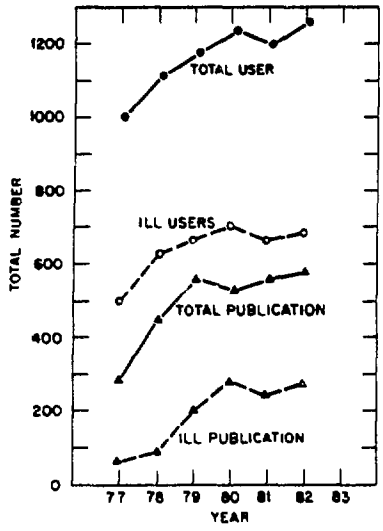

Fig. 3. Neutron scattering users and refereed publications in Western Europe.

to the Institut Laue-Langevin (ILL) which was conceived as a user-oriented facility. The excellent facilities at the ILL, the open user policy, and the practice of granting travel expenses along with beam time have combined to create a very strong user demand for experimental time at the ILL. Currently, the ratio of proposals accepted to proposals received is about 0.5.[2] Many of these proposals came from the staffs of small and medium reactor facilities in Europe so the small reactors help the ILL by generating users. At the same time, the great demand for beam time at the ILL serves as an obvious measure of the perceived value of neutron scattering and hence helps to create a supporting environment for the smaller reactors. Many of the research projects accepted by the ILL are continuations of projects already begun at smaller reactors and the investigators have been trained at the smaller reactors. The small reactors have thus contributed greatly to the success of the ILL user program, which in turn has caused a much greater awareness within the European scientific community of the merit and versatility of neutron scattering.

The user picture in Europe is summarized in Fig. 3. The magnitude and breadth of the ILL user community has resulted in a much more diverse scientific program than in the U.S. For example, more than half of the ILL publications in 1982 were in biology, polymer science, and chemistry. The U.S. program is still dominated by solid state physics, but there has been substantial growth in recent years in polymer science, materials sciences, and biology.

acquired at Oak Ridge. Future development will depend on the fate of plans being developed at Brookhaven and the NBS for new guide halls and at Oak Ridge for an advanced reactor.

A RECOMMENDATION FOR THE U.S. COMMUNITY

The development of a large and enthusiastic neutron scattering user community in the U.S. is important for assuring the future health of both large and small reactor centers. While the growth of users has been substantial in recent years, there is need for further growth if we hope to increase the total financial support for neutron scattering and research reactors. A positive step toward promoting such growth would be a continuing series of workshops or summer schools under joint sponsorship of the university reactor centers and the national laboratories. Such a program would have the dual purpose of educating more researchers in the use of neutron scattering techniques and of focussing attention on the availability of neutron scattering facilities. Joint sponsorship would minimize the financial and manpower burden for any single sponsor and would help to promote a spirit of cooperation among neutron scattering centers. This program would be consistent with the recommendations of the 1977 report sponsored by the National Research Council.[4]

ACKNOWLEDGMENT

This work was supported by the Division of Materials Sciences, U.S. Department of Energy under contract W-7405-eng-26 with the Union Carbide Corporation.

REFERENCES

1. The data on users, students, and publications were taken from a National Research Council committee report now in preparation, J. J. Rush, Chairman.

2. Private communciation, G. H. Lander.

3. "Report of the Review Panel on Neutron Scattering," October 22, 1980, Ames Laboratory, IS-4761, UC-25.

4. "Neutron Research on Condensed Matter: A Study of the Facilities and Scientific Opportunities in the United States," National Academy of Sciences, 1977.

acquired at Oak Ridge. Future development will depend on the fate of plans being developed at Brookhaven and the NBS for new guide halls and at Oak Ridge for an advanced reactor.

A RECOMMENDATION FOR THE U.S. COMMUNITY

The development of a large and enthusiastic neutron scattering user community in the U.S. is important for assuring the future health of both large and small reactor centers. While the growth of users has been substantial in recent years, there is need for further growth if we hope to increase the total financial support for neutron scattering and research reactors. A positive step toward promoting such growth would be a continuing series of workshops or summer schools under joint sponsorship of the university reactor centers and the national laboratories. Such a program would have the dual purpose of educating more researchers in the use of neutron scattering techniques and of focussing attention on the availability of neutron scattering facilities. Joint sponsorship would minimize the financial and manpower burden for any single sponsor and would help to promote a spirit of cooperation among neutron scattering centers. This program would be consistent with the recommendations of the 1977 report sponsored by the National Research Council.[4]

ACKNOWLEDGMENT

This work was supported by the Division of Materials Sciences, U.S. Department of Energy under contract W-7405-eng-26 with the Union Carbide Corporation.

REFERENCES

1. The data on users, students, and publications were taken from a National Research Council committee report now in preparation, J. J. Rush, Chairman.

2. Private communciation, G. H. Lander.

3. "Report of the Review Panel on Neutron Scattering," October 22, 1980, Ames Laboratory, IS-4761, UC-25.

4. "Neutron Research on Condensed Matter: A Study of the Facilities and Scientific Opportunities in the United States," National Academy of Sciences, 1977.