

## **SECTION 4: ANALYSIS OF RESPONSES TO QUESTIONNAIRE TO FACILITIES**

### **4.1. Nature of Facilities: National, Multinational, and Availability**

All but three of the 32 synchrotron X-ray and neutron facilities responding to the questionnaire identified themselves as national facilities (see Appendix 6 for list of facilities responding to the questionnaire). The three exceptions are ESRF and ILL in Europe and the Frank Laboratory of Nuclear Physics in Russia (a reactor-based neutron scattering facility). The remaining facilities responded that they are national facilities with construction and operating budgets provided by a single nation. In addition, most of the very large and important facilities soon coming on line in Asia are national facilities (e.g., J-PARC in Japan and CARS in China) (see Appendix 3).

Thus, this survey finds that, at least for synchrotron X-ray and neutron facilities, there is not a clear trend toward multinational or regional facilities and away from national facilities. This finding contradicts the findings outlined in the Report of the OECD Megascience Forum on “Access to Large Scale Research Facilities.” The OECD study reported that there is a “further concentration of research at a small number of very large research facilities that are built and operated on a regional or international basis...” While this trend towards regional or international facilities may be true in other fields of science, the questionnaire discussed in this report reveals that most new synchrotron X-ray and neutron facilities will be national facilities.

At the same time, ESRF, ILL, and the Frank Laboratory are very important exceptions because of their large size and the fact that they play such a significant role scientifically. For example, ESRF has 50 beamlines, and today has the largest proposal submission and acceptance program, the largest number of users, and the largest publication portfolio in major international journals (but not in all journals) of all synchrotron X-ray facilities in the world. Similarly, among neutron facilities, ILL has the largest number of instruments (indeed in 2007 only slightly less than the total at all US neutron facilities combined), the largest proposal and user programs, and the largest publication portfolio. ESRF and ILL also have some unique instruments and instruments which combine high beam intensity with excellent properties that make them the facilities of choice for many experiments. With the “Millennium Program” upgrades in progress at ILL since 2001 and the upgrades proposed for ERF, these two facilities are anticipated to remain world leaders for the next 10 years.

In addition to ESRF, ILL, and the Frank Laboratory, Elettra, HASYLAB, St. Petersburg, BESSY, and BSRF are multinational facilities. Also, among future facilities, the European X-Ray Free Electron Laser (XFEL) under construction in Hamburg and the European Spallation Source (ESS) are multinational facilities. Thus, it will be important for the United States to develop policies that will enable flexible access for US scientists to multinational facilities.

The difference between access policies of national and multinational facilities is set out in Section 6.1. The mismatch of bilateral policies and multinational facilities is also discussed in Section 6.1, as well as in Section 6.4.

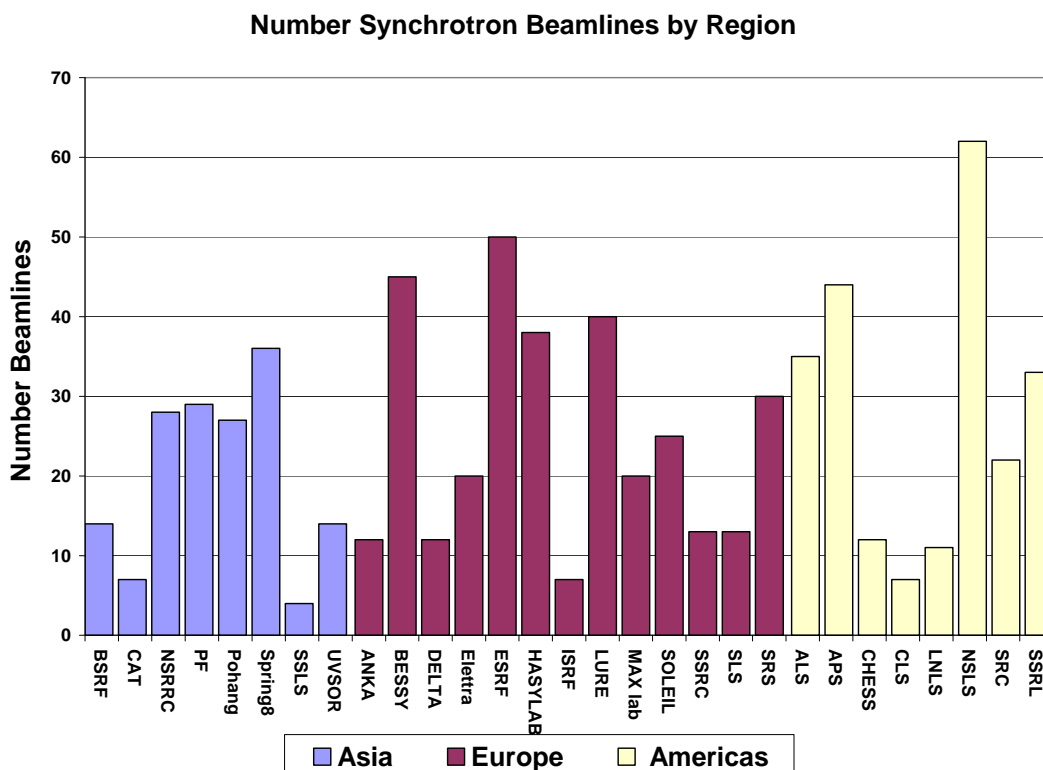
#### 4.2. Access by Scientific Proposal

All of the 32 facilities responding to the questionnaire stated that access to the facility was obtained by submitting a written proposal for beamtime. The proposals are reviewed by external review committees, with recommendations for beamtime made by the committees based on scientific merit. This access process is described further in Section 3.1.1. Scientific review by external committees is now clearly a universal, worldwide practice and is anticipated to continue. After the scientific review is completed, other considerations enabling or limiting access to beamtime may enter the decision-making process, as discussed below and in Section 6.1.

#### 4.3. Availability of Facilities

In Figure 4.1 (see below), the number of beamlines at synchrotron X-ray facilities and of instruments at neutron facilities is set out for the three regions, Asia, Europe, and the Americas. The goal is to give an impression of the distribution of availability of synchrotron X-ray beamlines and neutron scattering instruments throughout the world.

This figure includes the major facilities responding to the questionnaire (see Appendix 6 for this list). The figure also includes the other major facilities that could be identified in early 2007. In many cases, the number of instruments or beamlines was obtained from facility websites and/or by contacting the facility directly. It does not include some important facilities that opened very recently, such as Diamond.



### Number Neutron Instruments by Region

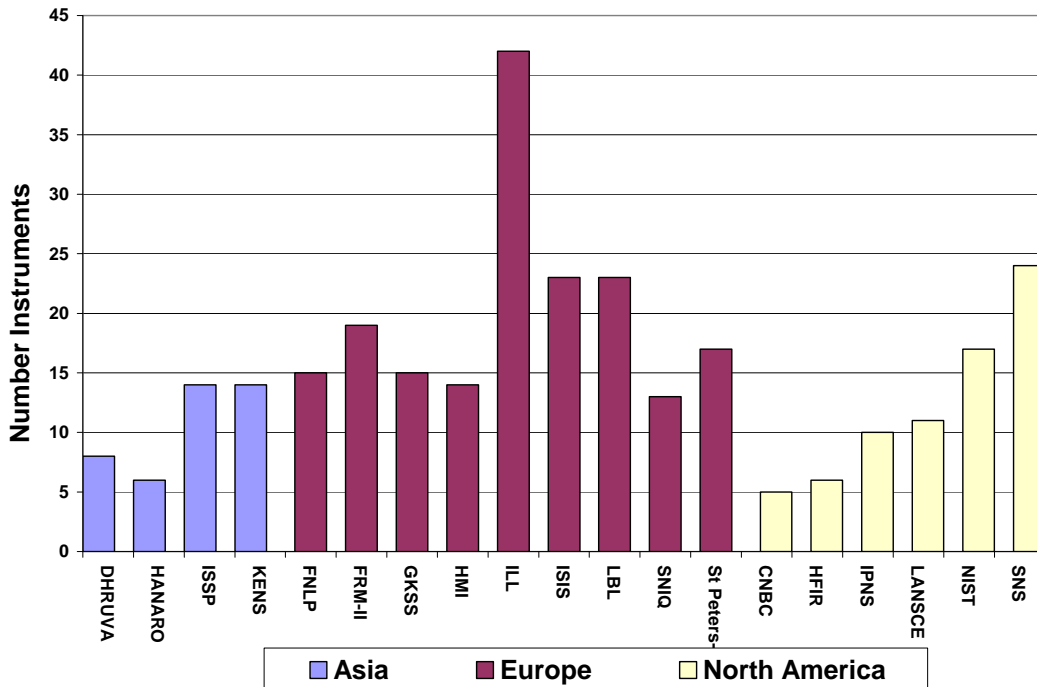


Figure 4.1. Number of synchrotron X-ray beamlines and neutron scattering instruments in 2007.

There is approximately the same number of synchrotron X-ray beamlines available in Europe and in North America (chiefly in the United States). From discussions with users, the availability of beamlines in the United States has been regarded as generally good. There has not been a significant drive by US scientists to seek beamlines abroad. For example, the percentage use of beamtime at ESRF by US scientists was approximately 3% in 2007.

The situation is quite different for the distribution of neutron scattering instruments. The number of neutron scattering instruments available in 2007 in the United States (approximately 70) is significantly less than that in Europe (approximately 200). Note that the 70 instruments listed for the United States include the 24 instruments planned for the SNS when the full suite of instruments at the first target station is completed.

In analyzing the availability of neutron facilities, factors beyond just the number of instruments are important. For example, with the high neutron beam intensity and the sophistication of the instruments at the SNS, the United States will make a significant step forward. At the same time substantial improvements in instruments are taking place elsewhere. In 2004 and 2005, scientific activity did scale well with the number of instruments (see below).

It is interesting to note that the current number of instruments at ILL (42) and ISIS (23) alone is comparable to the total number in the United States, including the 24 at SNS. In Europe, in addition to ILL and ISIS, there are several very significant, independent

facilities (e.g., LLB and FRM-II, see Figure 4.1). The number of inelastic neutron scattering instruments in the United States is particularly small.

In summary, it is anticipated that, for the next 10 to 15 years, there will remain more than twice as many neutron scattering instruments in Europe than in the United States. A similar conclusion was noted in the 2002 OSTP Report on neutron scattering facilities in the United States. Thus, the second target station at SNS, the new guide hall and instruments (5) at NIST, the new guide hall and instruments at HFIR, and the new instruments at LANSCE are highly welcome. The funding of guide halls, new instruments, and instrument upgrades yields large increases in facility availability. As discussed below, the present survey suggests that the number of users, the number of accepted proposals, and the number of publications, with some variations, all scale with the number of instruments. The emphasis on instruments has been the underlying reason for the success of NIST and ILL, and it is a primary reason for their large user programs. At NIST, for example, approximately 2/3 of the operating budget supports the guide hall and instruments, while 1/3 supports the reactor or neutron source.

#### 4.4. Number of Proposals Submitted and Accepted at Selected Facilities

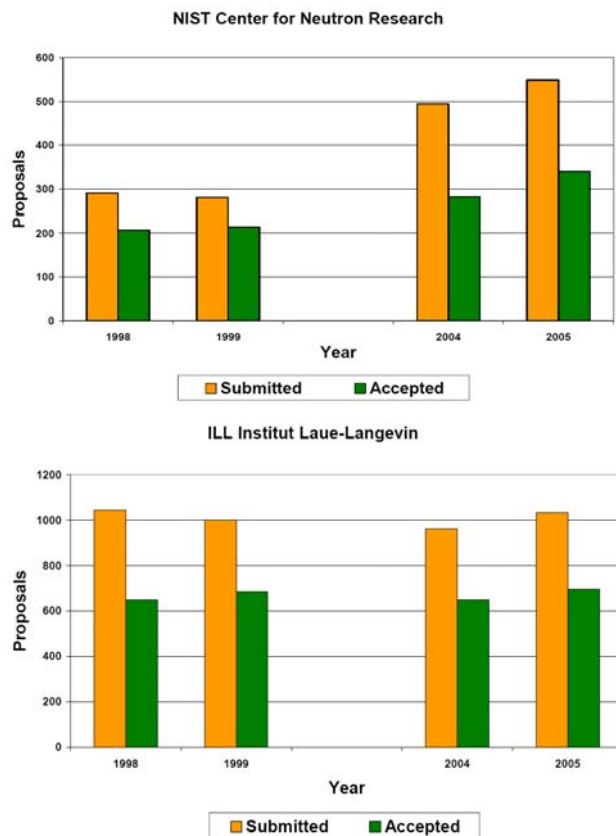


Figure 4.2. The number of submitted and accepted proposals at NIST and ILL.

Figure 4.2 shows the number of proposals submitted and accepted at the NIST Center for Neutron Research (NCRC) and at the Institut Laue Langevin (ILL), both nearly ten years ago and more recently. The increase in the number at NIST between 1998 and

2005 reflects two factors: the increase in number of instruments in the user program, from 13 to 17, and the increase in “instrument days delivered” between 1998 and 2005 (see the 2002 OSTP Report). At ILL, the number of proposals has changed little between 1998 and 2005, reflecting its stable operation. The ratio of accepted to submitted proposals is also similar at NIST and ILL, as it is also at other neutron scattering facilities. More data on how the number of accepted proposals, users, and publications scales approximately with the number of instruments are presented below.

Turning to a similar analysis for selected synchrotron X-ray facilities, the number of proposals submitted and accepted at the ESRF in Grenoble and at the NSLS at Brookhaven National Laboratory is shown below in Figure 4.3. These synchrotron X-ray facilities were selected for this analysis, because ESRF has the largest user program in Europe, and NSLS has one of the largest user programs in the United States. The operating budget of ESRF is 2.5 -3 times that of

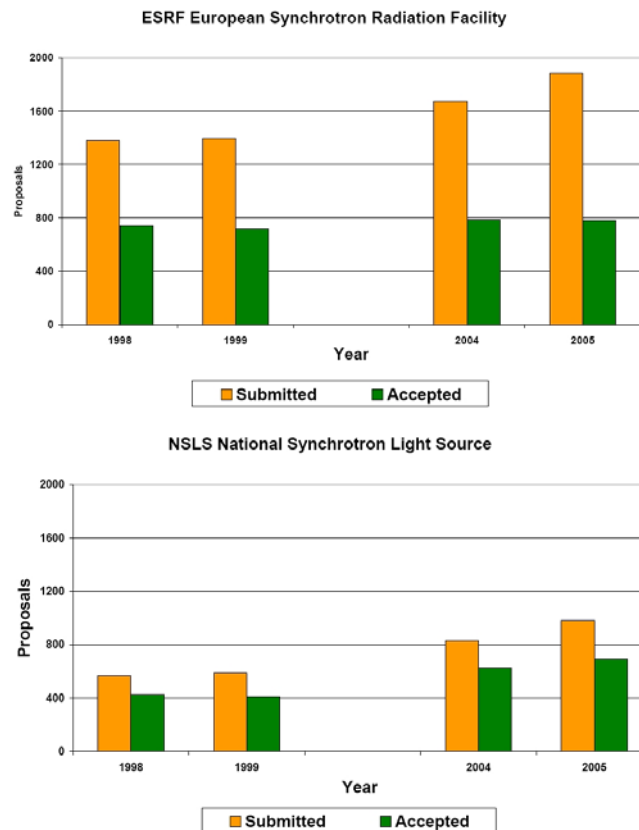


Figure 4.3. Number of proposals submitted and accepted at ESRF and NSLS.

NSLS. The number of proposals submitted and accepted at ESRF has increased significantly between 1998 and 2005, reflecting the continuing development of ESRF. The ratio of the number of proposals accepted to submitted has decreased between 1998 and 2005 showing a clear increase in competition for beamtime at ESRF. The ratio of accepted to submitted proposals in 2004, averaged over all synchrotron X-ray facilities, was 0.636 in Europe and 0.625 in the United States. For comparison, the

accepted-to-submitted ratio at neutron scattering facilities was 0.711 in Europe and 0.642 in the US.

The accepted-to-submitted ratio is not the same for all instruments. From discussions with users and facility directors, when the ratio of accepted to submitted proposals falls to the range of 0.5 to 0.3, users tend to turn to other research. On some instruments at APS and ESRF this ratio has dropped to as low as 0.15, unacceptably low.

#### **4.5. Level of Scientific Activity and the Number of Instruments**

The number of accepted proposals, the number of users, and the number of publications in select journals provide an indication of scientific activity at a facility. These indicators are useful both in comparing specific facilities and comparing facilities in different regions of the world. For example, the number of accepted proposals per year provides an estimate (a lower limit) of the number of experiments conducted per year.

The number of accepted proposals does not include experiments done within PRTs, because PRT experiments are outside the proposal program. It does not include experiments done by instrument scientists at facilities in which the facility allocates a percentage of time to instrument scientists, such as at ESRF and ILL. At some facilities, there are few or no PRTs (e.g., ISIS), and at some facilities, instrument scientists must submit proposals to conduct experiments along with external users (e.g., ISIS, NIST). At ISIS, for example, the number of accepted proposals provides a good estimate of the number of experiments conducted. There are generally more PRTs at synchrotron X-ray facilities than at neutron facilities.

Table 4.1 lists the number of proposals accepted, the number of beamlines or instruments, and the ratio of the two at the 32 facilities responding to the questionnaire, in Europe, the Americas (chiefly the United States), and Asia in 2004. The number of accepted proposals and beamlines and the ratio at synchrotron X-ray facilities is similar in Europe and the Americas. However, the number of accepted proposals at neutron scattering facilities in the Americas was approximately one third that in Europe in 2004. The competition for instrument time was also greater in the Americas (see ratio in Table 4.1) in 2004. The data in Table 4.1 for Asia is not representative, because only three synchrotron X-ray facilities and one neutron facility responded from Asia. Clearly, there was significantly more neutron scattering research done in Europe than in the United States in 2004. The data were similar in 2005.

**Ratio of Accepted Proposals to Beamlines or Instruments:  
2004**

<b>Synchrotron X-ray Facilities</b>			
	<u>Accepted</u>	<u>Beamlines</u>	<u>Ratio</u>
Europe	2,617	264	9.9
Americas	2,355	206	11.4
Asia	1,826	77	23.7
<b>Total</b>	<b>6,798</b>	<b>547</b>	<b>12.4</b>

<b>Neutron Facilities</b>			
	<u>Accepted</u>	<u>Instruments</u>	<u>Ratio</u>
Europe	2,337	203	11.5
Americas	833	49	17.0
Asia	226	14	16.1
<b>Total</b>	<b>3,396</b>	<b>266</b>	<b>12.8</b>

Table 4.1. Number of proposals accepted, number of beamlines or instruments, and the ratio of accepted proposals to beamlines or instruments at synchrotron X-ray and neutron facilities in 2004 by region of the world.

**Selected Ratio of Accepted Proposals to Instruments: 2004**

	<u>Accepted</u>	<u>Instruments</u>	<u>Ratio</u>
NIST	282	17	16.6
ILL	650	42	15.5
ISIS	665	23	28.9
Lujan	221	11	20.1
CNBC	63	5	12.6
LLB	323	23	14.0
<b>Total</b>	<b>2,204</b>	<b>121</b>	<b>18.2</b>

**Selected Ratio of Accepted Proposals to Beamlines: 2004**

	<u>Accepted</u>	<u>Beamlines</u>	<u>Ratio</u>
APS	538	44	12.2
SRS (Darsbury)	488	30	16.3
NSLS	694	62	11.2
ESRF	786	50	15.7
<b>Total</b>	<b>2,506</b>	<b>186</b>	<b>13.5</b>

Table 4.2. Number of proposals accepted, number of beamlines or instruments, and their ratio at selected synchrotron X-ray and neutron scattering facilities in 2004.

The number of accepted proposals per year appears to be set chiefly by the number of beamlines or instruments. The average ratio of accepted proposals per beamline at X-

ray facilities is 10-12 (see Table 4.1). For some synchrotron X-ray facilities, the ratio is as high as 15-20 (see Table 4.2). The ratio of accepted proposals per year per neutron scattering instrument in 2004 at a typical facility was 13-20. The ratio was similar in 2005, with a ratio of 20 at NIST and 17 at ILL. It is higher at ISIS, because nearly all instrument time is covered by proposal at ISIS, as noted above.

#### Selected Ratio of Users to Instruments: 2004

	<u>Users</u>	<u>Instrument</u>	<u>Ratio</u>
<b>NIST</b>	854	18	47.4
<b>Lujan</b>	262	11	23.8
<b>ILL</b>	1,164	42	27.7
<b>ISIS</b>	1,000	23	43.5
<b>Total</b>	<b>3,280</b>	<b>94</b>	<b>34.9</b>

#### Selected Ratio of Visitors to Instruments: 2004

	<u>Visitors</u>	<u>Instrument</u>	<u>Ratio</u>
<b>IPNS</b>	438	10	43.8
<b>Lujan</b>	450	11	40.9
<b>ILL</b>	1,679	42	40.0
<b>ISIS</b>	1,500	23	65.2
<b>Total</b>	<b>4,067</b>	<b>86</b>	<b>47.3</b>

Table 4.3. Number of users and visitors per year, the number of instruments, and their ratio at selected neutron scattering facilities in 2004.

The number of users and visitors per year, along with the number of neutron scattering instruments at selected facilities, is shown in Table 4.3 for 2004. A user is defined as a scientist who conducts an experiment at the facility but is counted only once per year, irrespective of the number of experiments conducted by the user per year. A visitor is defined as a user but each visit to the facility to conduct an experiment is counted.

There are typically 40 users per year per instrument at neutron scattering facilities. In 2002, the number of users per instrument was approximately 40 at ILL and NIST, and it was 60 at ISIS (2002 OSTP Report, p. 30). Similarly, there are typically 40-65 visitors per year per instrument (see Table 4.3).

The number of users and visitors per beamline at synchrotron X-ray facilities is definitely larger, 40-80 and 100-200, respectively (see Table 4.4). The larger number arises because the X-ray experiments are generally shorter because the beam intensity is higher and the teams conducting X-ray experiments are larger. There are typically 2.5 - 5 users per accepted proposal for synchrotron X-ray facilities and 1.5 - 2 for neutron scattering facilities. These larger numbers probably reflect the fact that synchrotron X-

ray experiments are currently less automated and more “hands on” than neutron experiments.

**Selected Ratio of Users to Beamlines: 2004**

	<u>Users</u>	<u>Beamlines</u>	<u>Ratio</u>
<b>APS</b>	2,773	44	63.0
<b>NLSL</b>	2,299	62	37.1
<b>ESRF</b>	4,008	50	80.2
<b>Total</b>	<b>9,080</b>	<b>156</b>	<b>58.2</b>

**Selected Ratio of Visitors to Beamlines: 2004**

	<u>Visitors</u>	<u>Beamlines</u>	<u>Ratio</u>
<b>APS</b>	8,459	44	192
<b>SRS (Daresbury)</b>	2,189	30	73
<b>SLS (Swiss)</b>	1,443	7	206
<b>ESRF</b>	5,488	50	110
<b>Total</b>	<b>17,579</b>	<b>131</b>	<b>134</b>

Table 4.4. Number of users and visitors per year, the number of beamlines, and their ratio at selected synchrotron X-ray scattering facilities in 2004.

It is interesting that the number of accepted proposals per instrument at ILL, NIST, and ISIS is 17, 19, and 25 respectively in 2004. These are very similar numbers. It is somewhat larger at ISIS than ILL, because, at ISIS, instrument scientists must submit proposals like everyone else to conduct experiments, and nearly all instrument time is covered by a proposal. NIST has a similar policy that all beamtime is allocated through proposals, with NIST scientists and NCNR instrument scientists having access to a separate proposal program. At ILL, 20% of all beamtime is allocated to instrument scientists outside the proposal program.

Based on these data, the number of accepted proposals seems to be a good measure of scientific activity—better than the number of users. For example, there is a significant variation in the number of users per accepted proposal (per experiment) among neutron scattering facilities (e.g. 1.2 at Lujan, 1.8 at ILL, and 3 at NIST) and between synchrotron X-ray and neutron facilities.

These data suggest the level of scientific activity, as indicated by the number of accepted proposals for experiments and the number of users, is set largely by the number of instruments or beamlines available at facilities. For comparable sources, the availability of neutron scattering and synchrotron X-ray facilities is highly correlated with the number of instruments.

If a policy goal is to expand availability and to increase the level of use of major facilities within the scientific community, then the most direct way to do this is to increase the number of instruments and to devote resources to new guide halls and instruments at existing facilities. In particular, some European facilities have created and maintained large user bases by devoting resources to major instrument upgrades and expansion throughout the life of the facility.

#### **4.6. Facilities Have User Organizations**

Most facilities responded that the scientists and engineers who conduct experiments at their facilities have a user organization (often referred to as a user group). Indeed of the 31 facilities that responded to this part of the questionnaire, all except six have user groups. The user groups usually operate quite independently of the facility. The goals of user groups and user societies, along with their characteristics and interests, are discussed in Section 5.

The six facilities that do not have user groups are LNLS, ILL, SINQ, Jülich, St. Petersburg, and IPNS. ILL and its users probably do not feel the need of a distinct user group, because ILL is closely coupled with the European Neutron Scattering Society and with other national neutron scattering societies of Europe. SINQ is closely coupled to the Swiss Neutron Society. IPNS did have a very active and large user group, indeed probably the first in the United States.

#### **4.7. Facilities Do Not Charge User Fees**

At all of the 32 responding facilities, use of the facility is free of charge for research that will be in the public domain. It can be said, universally and globally, that there are no user fees at either national or multinational facilities for research that will be published in the open literature. Experience worldwide at user facilities has shown that the facilities need an independent operating budget with users bringing science and people to the facility to conduct experiments and analyze the data subsequently at their home institutions.

#### **4.8. European Facilities Generally Pay User Expenses**

Globally, the response from facilities to the question of whether facilities pay expenses largely, partially, or not at all was a mixed response. As seen in Figure 4.4, 19 facilities pay expenses largely or partially, and 12 facilities pay none.

[Note: The original text says 11 facilities pay none, but the figure shows 12.]

However, when these responses are separated by region, we see that most facilities in Europe pay travel expenses, largely or partially, while most facilities in the United States do not. At the two large multinational facilities in Europe (ILL and ESRF) and at ISIS in the United Kingdom, the travel and accommodation expenses of users to conduct experiments at the facility are paid by the facilities. For multinational facilities, this applies to users from the participating nations.

The Europeans consulted as part of this study feel that paying travel expenses was most important in creating a large user community, especially for neutron scattering facilities, and that payment of travel expenses remains important in maintaining that large user community. In the United States, the payment of travel expenses does seem helpful for new users who may not yet have research support to conduct an experiment and who will have to fund it from other resources. This point is discussed further in Section 5.2.2.

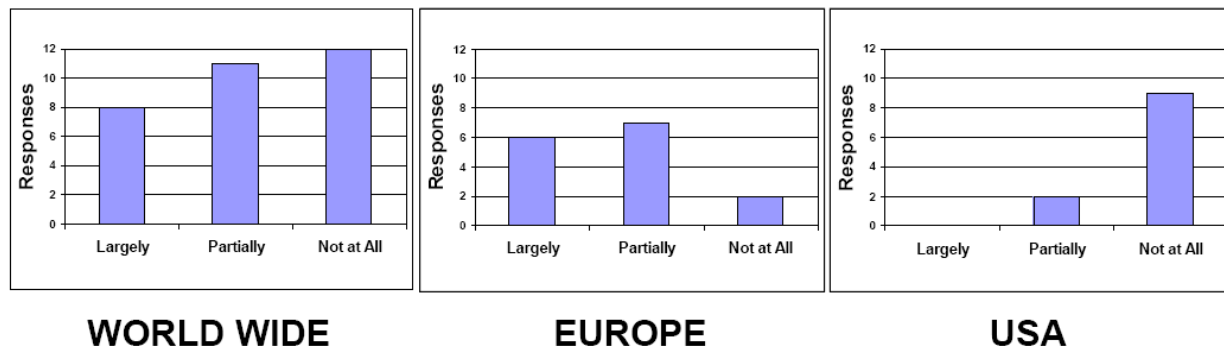


Figure 4.4. Number of facilities that pay users' expenses to conduct experiments, largely, partially, or not at all.

#### 4.9. Instruments Supported Through Participating Research Teams

To finance the construction and operation of beamlines and instruments, some facilities invite Participating Research Teams (PRTs) to construct and operate beamlines and instruments. A PRT is a consortium of users, often from a single institution, who form a team to raise the funds for and operate a particular beamline and/or instrument. In exchange for providing the financial support for the beamline or instrument, a fraction of the experimental time is dedicated to the PRT scientists.

Averaged across all the facilities responding to the questionnaire, in 2004/2005 about 20% of all beamlines and instruments were funded and operated by PRTs. The percentage ranges from as high as 100% (e.g., at ISSP) to 0% at a number of facilities. It is likely that the current percentage of PRT instruments at any given facility depends largely on historical factors and the philosophy used to build both the facility and the original instrument suite. The popularity of PRT-type funding to build instruments (or beamlines) has oscillated over the years.

Currently within the United States, the DOE is moving away from PRT-type support at some of their facilities, notably the APS. At the APS, it was found that to support a beamline effectively, the PRTs often consisted of a large consortium of institutions with diverse interests. This led to beamlines and instrumentation that were multipurpose, with natural compromises on optics to support a broad suite of instruments at a given beamline. As a result, there was much duplication of instrumentation across many

beamlines. By moving away from PRT-type support, particularly those with broad instrument suites, and instead dedicating beamlines to particular classes of instruments, the goal was to create more specialized and higher performance instrumentation, support staff, and, ultimately, science. An additional problem with PRTs was that, from one PRT-supported beamline or instrument to another, there was little universality of construction. This situation made it difficult to transfer samples from one beamline or instrument to another.

The percentage of experimental time on a PRT instrument that is allocated to PRT scientists and to other users, via the proposal program, in 2004/5 was, on average:

**48% for the PRT scientists group**  
**44% for other users, via the proposal program**  
**5% for others**

This finding is interesting, because it indicates that about half of the instrument time is typically set aside for the funding group (i.e., the PRT) and about half is set aside for general users (typically through a user program). Within these averages, there are significant variations, from a low of 6% being allocated to the PRT-type groups at SSRL and the Beijing Synchrotron to a high of 100% being allocated to the PRT-type groups at St. Petersburg Nuclear Physics Institute and the Frank Lab for Neutron Physics. Also, the time allocation ratio can vary between different PRT instruments, depending on the details of the agreement reached between the sponsoring PRT and the facility.

#### **4.10. Percentage of Beamtime Allocated to Facility Scientists**

The responses to the questionnaire also provided insight into the percentage of beamtime that is allocated to facility scientists versus that allocated to user programs and PRTs. On average, the percentage of beamtime allocated to facility scientists is 15-20%. This percentage has remained constant over the past eight years (see average values in table below). There are, however, some ambiguities in the results, because some very active user facilities (e.g., NCNR and ISIS) do not formally allocate any time to facility scientists outside of the proposal system (as noted earlier in Section 4.5).

<b>Year</b>	<b>Proposal or PRT</b>	<b>Facility Scientist</b>
<b>1998</b>	<b>65%</b>	<b>14%</b>
<b>1999</b>	<b>64%</b>	<b>19%</b>
<b>2004</b>	<b>66%</b>	<b>20%</b>
<b>2005</b>	<b>68%</b>	<b>19%</b>

#### **4.11. Proposal Review**

Proposals for beamtime are first reviewed for scientific merit, with a recommendation for beamtime based on this review. Of the 23 facilities that responded to this question, all facilities--except two--have a single review process. All proposals, regardless of country of origin, are reviewed using this single review process.

The two exceptions were: Jülich (which has a special international panel set up by a European body which reviews foreign proposals) and ISSP Japan (which requires that a Japanese collaborator must submit the proposal). (In the latter case, this is probably determined by language and local knowledge issues and seems understandable.)

Among those facilities that had a single process, four of them (Elettra, SRS, ILL and Pohang Light Source) reported that a “reasonable percentage” is allocated to foreign users, i.e. users from countries or institutions that are not members of the facility.

Twenty facilities reported that they have foreign scientists on their proposal review committees. Of those that did not, three were US facilities (CHESS, NIST, and HFIR), one was a European multinational facility (ILL), and the rest were in Russia or Asia (St. Petersburg, Siberian Light Source, Pohang, Beijing, BSRF, ISSP, and SPring-8).

#### **4.12. Award of Beamtime and Foreign Use of Facilities**

Five facilities (ILL, ESRF, CNBC, LLB, and HFIR) reported that, following the review and recommendation for beamtime based on scientific merit, there are some adjustments and balancing of actual time allocated among the member countries and associates. At multinational facilities, the aim of adjustments is to bring the percentage of time allocated to scientists from member nations approximately in line with the percentage of funding contributed to the facility budget from member nations. In multinational facilities, the need to award beamtime to users from member nations in approximate proportion to the budget provided makes it difficult to allocate time to non-member nations beyond an agreed upon percentage.

Eight facilities (APS, Siberian Light Source, IPNS, FLNP, Lujan, SSRL, SRS, Dubna, and St. Petersburg) reported that there were no adjustments. (Note, however, that half of the surveyed facilities did not respond to this particular question.)

In the majority of the facilities (23 facilities, including the Hamburg Synchrotron, CHESS, SRS, BESSY, SING, SLS, Pohang, SSRL, Lujan-LANSCE, ALS, Jülich, LNLS, NIST, MxLab, ESRF, APS, HMI, ILL, Spring-8, Elettra, LLB, HFIR, and CNBC), statistics are kept regarding the use of the facility by foreign (or non-consortium) scientists. The facilities that did not keep these statistics (with the exceptions of NSLS and IPNS in the United States) were in Russia, China, or Japan. In any case, the number of foreign users at this latter group of facilities is very small.

Access to foreign facilities can also be obtained by international collaboration. Indeed, the percentage of beamtime used by teams that have foreign nationals on them is reported to be large. In Europe, the results were: HASYLAB 50%, BESSY 50%, HMI

65%, SING 75%, SLS 75%, Jülich 43%, LNLS 15%, MAXLAB 70%, Elettra 52%, and LLB 38%. In North America, the results were: CNBC 40%, APS ~ 48%, SSRL 13%, HFIR 82%, and LANSCE 50%. In Asia, the results were Pohang 3% and SPring-8 5%. For those teams in which foreign nationals serve as spokespersons, team leaders, or primary investigators (PIs) on the proposals, the percentage of beamtime is somewhat lower. In Europe, the results were: BESSY 8%, HMI 50%, SING 45%, SLS 50%, Jülich 38%, LNLS 15%, MAXLAB 45%, Elettra 48%, LLB 27%, and SRS 2 %. In North America, the results were: CNBC 25%, SSRL 13%, HFIR 82%, and LANSCE 50%. In Asia, the results were: Pohang 3% and SPring-8 5%. Many facilities do not keep both statistics. ESRF and ILL did not report the percentage of foreign use, but access to each of these two facilities can be obtained by collaboration with a scientist from a member nation.

These numbers appear to show that use by foreign nationals is quite large at European facilities, where proximity among nations is a major asset. At US facilities, (e.g., at LANSCE, HFIR, and APS), most of the foreign nationals appear to be graduate students, post-doctoral associates, or other users from US institutions who are not US citizens. The percentage of users of US facilities who are from foreign institutions appears to be much smaller (e.g., 10 % at IPNS and 12 % at NIST). Thus, use of US facilities by foreign nationals from institutions abroad appears to be low. Use of Asian and Russian facilities by foreign nationals ranges from very low to non-existent.

The questionnaire asked for information about visa requirements at facilities, and the response was mixed. Twenty-two facilities said visas were required. Eight facilities (Siberian Light Source, St. Petersburg, Frank Laboratory of Nuclear Physics, Beijing Synchrotron Facility, Pohang, CHESS, ILL, and LNLS) said visas were not required.

It appears that national security issues have been an obstacle to some foreign participation, mainly at US facilities. The problem has been steadily increasing over the period from 2003 to 2005. National security issues were reported as the reasons for denying access in 2003/4/5 at the following facilities: SSRL (18) Lujan (17), ALS (9), APS (30), and HFIR (1). No other facilities reported such cases. Canadian Neutron Beam Centre requires local staff to accompany non-resident users to beamlines. HMI requires a security check for foreign users in non-guide hall areas. ESRF checks for “sensitive” countries.

#### **4.13. No Trend Toward Multinational Facilities**

Twenty-two facilities, including all those in the United States and Asia (with the exception of the Beijing Synchrotron Radiation Facility) and many in Europe, indicated that they did not see a future trend to multinational facilities. Of the nine facilities that said they thought there was such a trend, two facilities (ESRF, ILL) are already European multinational facilities, five facilities (Elettra, HMI, Hamburg Synchrotron, SRS, and BESSY) are in Europe, and one facility (BSRF) is in Asia. The data of this study and the list of future facilities in Appendix 3 indicates that, while current

multinational facilities will remain the largest and most productive for the coming 10 years and new ones are planned, there is not a trend toward multinational facilities.

#### **4.14. General Conclusions on Proposal Review and Foreign Use of Facilities**

Based on the questionnaire responses, some general conclusions about proposal review and foreign use of facilities are:

- Access to all facilities, whether national or multinational, can be obtained by collaboration with a scientist who is from that nation or from a member nation of the multinational facility.
- All proposals at all facilities, with one or two minor exceptions, are reviewed for scientific merit within the same proposal review program. Once reviewed, proposals at ILL and ESRF that do not include a scientist from a member nation are generally limited to 10 % and 5 % of total beamtime, respectively.
- At national facilities, there is apparently no declared limit to proposals without a domestic partner. However, essentially all facilities keep track of foreign use of their facilities.
- Use of facilities by foreign scientists from institutions outside the nation is high in Europe, often 50%. Use of facilities by foreign scientists from institutions outside the nation is significantly lower in the United States. Use of facilities by foreign scientists from institutions outside the nation is rare (only a few percent) in Asia and Russia, but this is expected to change significantly in the next 5-10 years.
- National security issues have been an increasing barrier for foreign users at US facilities during the period of this study (2003-2006).

#### **4.15. Limits to Access Arising from Limited Operating Budgets**

Access to a facility can also be significantly limited by an inadequate annual operating budget at the facility. Without an adequate budget to operate for a full period of time, to support instrument scientists, to maintain the facility and to make some upgrades, a facility cannot realize the full potential of its beamlines and instruments. Signals of an inadequate budget are:

- the facility operates for a limited time period during the year.
- funds for new instruments and upgrades of current instruments are redirected to support existing instruments. This postpones improvements and can result in instruments not being scientifically competitive with facilities elsewhere in the world.
- support for instrument scientists, e.g. hiring new or replacement instrument scientists, is reduced. This results in reduced operating time for some instruments or the instrument being completely removed from the user program.

Some of the major US facilities indicated that operating budgets are a major concern. They provided input on the opportunity cost of inadequate funding. For example, the NIST Center for Neutron Research estimates that their general user program is operating only at about 81% of current capacity. The APS has had to curtail operating

hours from about 5000 hours to 4448 hours in fiscal year 2008 (an 11% decrease) . The APS estimates the maximum number of operating hours per year is approximately 5500-5600, but this requires sufficient staffing to complete accelerator maintenance and improvements in the decreased downtime brought about by increased operations. The Lujan Neutron Scattering Center estimates that their operating time is at about 86% of the capacity for beamtime and operates at an overall capacity of about 60% of maximum for the facility.

Fully funding existing facilities so that they can operate to full beamtime capacity and upgrading and replacing instruments at the facilities is an effective and efficient method of enlarging access.