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Report of the Basic Energy Sciences Advisory Committee Subpanel Review of the Intense Pulsed Neutron Source (IPNS) at Argonne National Laboratory and the Manuel Lujan Jr. Neutron Scattering Center at Los Alamos National Laboratory

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Report of the Basic Energy Sciences Advisory Committee Subpanel Review of the Intense Pulsed Neutron Source (IPNS) at Argonne National Laboratory and the Manuel Lujan Jr. Neutron Scattering Center at Los Alamos National Laboratory

Kickoff Meeting

October 12-13, 2000
Gaithersburg, MD

Review

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Intense Pulsed Neutron Source
Argonne National Laboratory
Argonne, IL.

November 16-17, 2000
Manuel Lujan Jr. Neutron Scattering Center (Lujan Center)
Los Alamos National Laboratory
Los Alamos, NM.

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1. Executive Summary

In September 1999, the Chair of the Basic Energy Sciences Advisory Committee (BESAC), Geraldine Richmond, was charged by Martha Krebs, Director of the Office of Science at the Department of Energy (DOE), to review the Intense Pulsed Neutron Source (IPNS) at Argonne National Laboratory (ANL) and the Los Alamos Neutron Science Center (LANSCE) Manuel Lujan Jr. Neutron Scattering Center (MLNSC or Lujan Center) at Los Alamos National Laboratory (LANL). The charge (Appendix 1) calls for a full review of each facility in the context of the Spallation Neutron Source (SNS) due to be commissioned in the summer of 2006.

A BESAC Subpanel (Appendix 2) consisting of experts in the sciences enabled by neutron scattering, facilities' managers, and internationally known scientists was selected for the review. A two-day meeting (Appendix 3) was held October 12–13, 2000, in Washington, D.C., to lay out the national and scientific agenda for neutron scattering and to understand the roles of IPNS and LANSCE/Lujan Center. A detailed list of questions (Appendix 4) was sent to the directors of the facilities. The responses (http://lansce.lanl.gov/libraries/besac.htm and http://www.pns.anl.gov/ipnsbesac.pdf) were distributed to the Subpanel prior to the site visits (Appendix 5) that took place on November 13-17, 2000.

1.1 Findings

Given that the present national policy is to bring the U.S. into a leadership position in the use of neutrons for science, medicine, and national defense and with the flagship being the $1.41B Spallation Neutron Source (SNS), which will be commissioned in the summer of 2006 and reach full power in 2008, the Subpanel made the following findings, resulting in three recommendations:

- ***It is imperative that every spallation source in the U.S. is utilized to its full potential*** to assure that a sufficiently large and well-trained user community exists when SNS is fully operational in ~2008.
- ***It is essential to substantially increase the neutron user community*** in order to fully exploit the SNS. This will not occur in a timely fashion without an active program.
- ***IPNS is an extremely reliable source with a talented and experienced staff.*** However, the facilities (source and some instruments) are in need of improvements to make them more competitive and to maintain reliability.
- ***LANSCE/Lujan Center has a competitive source, and the facility could be world-class***. However, the governance is dysfunctional, and the management scheme is not compatible with effective stewardship and operation of a national user facility.

1.2 Recommendations

- ***Immediately enhance activities at the IPNS facility.*** The timely realization of the enhancement of the source, the instrument suite, and the level of scientific exploitation of IPNS are essential to the ongoing development of the user base in the ramp-up to the SNS (2006–2008).
- ***Restructure LANSCE/Lujan Center to deliver an internationally competitive user facility.*** In order to render LANSCE/Lujan Center a viable user center in time to generate the needed impact for the SNS ramp-up in 2006–2008, the governance and management of LANSCE/Lujan Center must be fundamentally restructured.
- ***Establish a program to expand the university user base for neutron scattering***. The only way to build the user base required to be internationally competitive is to enhance the participation from academic institutions. An immediate injection of funds to support the exploitation of pulsed neutron sources for science by the U.S. academic community is needed.

2. List of Acronyms

ALS	Advanced Light Source
ANL	Argonne National Laboratory
APS	Advanced Photon Source
DMR	Division of Materials Research
DOD	Department of Defense
DOE	Department of Energy
DP	Office of Defense Programs
HFIR	High-Flux Isotope Reactor
ILL	Institut Laue-Langevin
IPNS	Intense Pulsed Neutron Source
LANL	Los Alamos National Laboratory
LANSCE	Los Alamos Neutron Science Center
LDRD	Laboratory Directed Research and Development
LUG	LANSCE User's Group
MLNSC	Manuel Lujan Jr. Neutron Scattering Center
MSD	Materials Science Division
NAS	National Academy of Sciences
NE	Office of Nuclear Energy
NIH	National Institutes of Health
NIST	National Institute of Standards and Technology
NMSU	New Mexico State University
NNSA	National Nuclear Security Administration
NRC	National Research Council
NSF	National Science Foundation
NSLS	National Synchrotron Light Source
OBES	Office of Basic Energy Sciences
ORNL	Oak Ridge National Laboratory
OSTP	Office of Science and Technology Policy
PI	Principal Investigator
PRAD	Proton Radiography
PRT	Participating Research Team
PSR	Proton Storage Ring
RCS	Rapid Cycling Synchrotron
SANS	Small-Angle Neutron Scattering
SC	Office of Science
SDT	Spectrometer Development Team
SNS	Spallation Neutron Source
SPSS	Short-Pulse Spallation Source
UC	University of California
UCSD	University of California at San Diego
WNR	Weapons Neutron Research Facility

3. Introduction

3.1 The National Agenda for Neutron Scattering

The need for a strong neutron scattering program in the United States has been clearly documented in a number of reports including the Teal-Shull report on *Neutron Research on Condensed Matter* (1977), the Seitz-Eastman report on *Major Facilities for Materials Research and Related Disciplines* (1984), the Kohn report on *Neutron Sources for America's Future* (1993), and the *Report of the Basic Energy Sciences Advisory Committee on Neutron Source Facility Upgrades and the Technical Specifications for the Spallation Neutron Source* (1996).

The present national policy is to bring the U.S. into a leadership position in the use of neutrons for science, medicine, and national defense. The flagship of this endeavor will be the $1.41B SNS to be commissioned in the summer of 2006, reaching full power in 2008.

Accomplishing the national agenda of making neutron sciences in the U.S. competitive with the rest of the world will require not only the successful completion and utilization of SNS but also the enhancement and full utilization in the near term of existing neutron facilities. All the studies mentioned above document the scientific need for neutron scattering. A key issue for the Subpanel was how to increase the quality and quantity of users in the seven-year period before SNS becomes functional. This user population was used as a measure of the scientific base for neutron sciences. The requirement is to build a neutron user community of 4000 to 5000 scientists, starting with the current base of ~1000. This will require every neutron facility in the U.S. to operate in the most effective mode and a concerted effort to build the university user community.

A related issue on the national agenda is the governance of user facilities. It recently has been reported in *Cooperative Stewardship Model* [National Research Council (NRC) Report published by the National Academy of Sciences (NAS) in 1999] that the current governance models of U.S. user facilities are unsustainable. The Subpanel conducted their review in the context of expecting implementation of the cooperative stewardship model for both IPNS and the LANSCE/Lujan Center in the immediate future. Specifically, this model was taken as the benchmark for a rating of "Competitive" for the stewardship of the facilities which the Subpanel reviewed.

Two quotations acquired during deliberations of the Subpanel reflect the consensus of the Subpanel regarding the facilities it was asked to review. The first is from Thom Mason, Director, Experimental Facilities Division, SNS, on the topic of the relationship of IPNS and LANSCE/Lujan Center to the SNS:

> *"The most important thing these facilities can do is to run reliably, build a user base, and do good science—training scientists to utilize the unique instrumentation associated with a pulsed spallation source."*

The second quote is relevant to the Subpanel's conclusions about the operation of the facilities. It comes from the Committee on Science, Engineering, and Public Policy (NAS Press, 2000) report on *Experiments in International Benchmarking of U.S. Research Fields* and articulates the situation in the U.S. in the area of materials science:

> *"The panel found that the key to the nation's leadership is the flexibility of the materials science and engineering research enterprise, its innovation system, and its intellectual diversity. But the ability of the Unites States to capitalize on its leadership opportunities could be curtailed because of shifting federal and industry priorities, a potential reduction in access to foreign talent, and deteriorating facilities of natural materials characterization. Of particular concern is the lack of adequate funding to modernize major research facilities in the United States when facilities here are much older than in other countries."*

3.2 Neutrons as a Probe

Neutrons have a number of properties that make them an ideal probe of condensed matter systems:

- When the de Broglie wavelength of the neutron is comparable to typical atomic spacings in matter, the kinetic energy is similar to that of the atomic motions. Neutrons are therefore an ideal probe of both the ***structure*** and ***dynamics*** of matter. Neutron sources routinely offer wavelengths from 0.1 to 20 Å, allowing studies on the length-scale of the hydrogen atom wave function, through complex modern materials to macromolecules. Dynamical information can be obtained from the neV scale typical of polymer reptation, through the meV scale of lattice vibrations in solids, to the eV energies of excitations in the electronic structure of materials.
- Neutrons are scattered by the nucleus, rather than the electron cloud that scatters X-rays. Light atoms such as hydrogen or oxygen scatter just as strongly as heavier elements, allowing similarly precise measurements of the positions or motions of those atoms. The scattering cross section varies between isotopes of the same element, permitting isotopic substitution methods to highlight the structural or dynamical information from just one component of a system. This application is particularly important in polymer and biological sciences, where deuteration allows a selected component (or components) of complex systems to be highlighted and the remaining components masked via contrast matching; for example, a single macromolecule in a liquid polymer or a protein molecule in a membrane or virus.
- The neutron has a magnetic moment, and the scattering cross section from magnetic ions is similar to that from the nuclei. Solving the magnetic structure of a material is a routine task with neutrons. Neutrons are also unique as a probe to measure the spectrum of magnetic fluctuations, a knowledge of which permits the most sensitive determination of the magnetic interactions in a material.
- Neutrons only perturb the experimental system weakly. The neutron scattering cross section is determined by physical properties of the system alone, without the need for any corrections arising from the influence of the probe. The cross section is proportional to the static and dynamic correlation functions, so that straightforward reduction of the experimental data yields information of physical significance, such as a solved structure or the wave vector- and frequency-dependent spectrum of magnetic excitations.
- Neutron beams are highly penetrating—typically a few mm to several cm. They are a true probe of the bulk of a sample and are insensitive to surface imperfections. Experiments in complex sample environments, such as cryostats, furnaces, or high-pressure cells, are routine. Measurements of the strain deep in engineering components are possible.

3.3 Spallation Sources and Instrumentation

The traditional method of production of neutron beams is with constant power research reactors, which have been in use for over 50 years. Neutrons are produced by nuclear fission of ^{235}U in a sustained chain reaction, with the excess neutrons slowed by coming into thermal equilibrium with a moderator to produce a broad band of thermal wavelengths. For each available neutron, 190 MeV of energy is released. Research reactors are designed to maximize the neutron flux so as to provide the most intense beams for condensed matter experiments. The highest flux reactors generate several tens of MW of power in the core, and the heat dissipation is close to the limit set by present materials technology.

A more recent development has been that of accelerator-based sources of short-pulsed neutron beams. Neutrons are produced by bombarding a heavy metal target, such as uranium or tantalum, with pulses of high-energy protons. The proton pulse is typically 1 μs wide and repeats at 20–50 Hz. In this spallation process, some 20 neutrons are produced from each collision of a proton with a nucleus. The neutrons are slowed by collision in hydrogenous moderators to produce a spectrum of thermal and epithermal neutrons with a narrow pulsed structure. Typically, 30 MeV of energy is dissipated per neutron. The most powerful pulsed spallation source at present, the ISIS Facility in the United Kingdom, is rated at 160 kW. This corresponds to a time-averaged neutron production approximately 1/30th that of the highest flux reactors, but a peak flux exceeding that of the high-flux reactor of the Institut Laue-Langevin (ILL) in France. The key to exploitation of spallation sources is instrumentation that fully exploits the peak flux in the pulse.

Different experimental techniques are employed at the two types of sources. Reactor-based diffractometers generally select a narrow wavelength range from the broadband incident beam using a monochromator, such as Bragg reflection from a crystal. A single detector element is sensitive to just one lattice spacing d, through the relation $2d\sin\theta = \lambda$, where 2θ is the angle of deflection of the scattered beam and λ is the wavelength of the neutrons. On a pulsed source, the time of arrival of each scattered neutron at a detector element is recorded, and from the known flight-path from moderator to detector, the wavelength of each neutron and, hence, the lattice spacing are calculated. A single detector element therefore collects data from all lattice spacings. For energy analysis of the scattering cross-section, reactor-based instruments generally employ wavelength selection of the scattered as well as the incident beam of neutrons. At a pulsed source, a monochromator is only needed to select one incident or scattered wavelength of the neutrons. With the known flight paths, the times of arrival of the scattered neutrons in a detector element yield the unanalyzed wavelengths. The count-rate as a function of time-of-arrival therefore provides the scattering cross section as a function of excitation energy. In practice, hundreds or even thousands of detector elements are used to cover a wide scattering angle range and the maximum affordable solid angle.

In both diffractometry and spectroscopy, if the full time frame between pulses corresponds to a useful wavelength band, then the relevant quantity for comparison with a reactor is the peak neutron flux. If only a fraction of the full time between pulses contains useful data, then the figure of merit is reduced in proportion. In reality, comparison of instruments based at reactors and pulsed sources is not so straightforward because of techniques to enhance data rates that are particular to the type of source. Notable strengths of pulsed sources include (1) powder diffraction measurements (a simple example where the full time between pulses is utilized), (2) surveys of scattering in reciprocal space or momentum-energy space, and (3) experiments to measure excitation energies greater than ~100 meV or recoil from quantum fluids. Areas in which pulsed sources have historically been weaker are where coarse wavelength resolution is sufficient (e.g., small-angle scattering from macromolecules) or where only a limited region of momentum-energy space is of interest.

Figure 1 shows the historical trend of peak flux for both reactors and pulsed spallation sources. Whereas the flux at research reactors such as the High-Flux Isotope Reactor (HFIR) at the Oak Ridge National Laboratory (ORNL) and the ILL is close to the limit set by the thermo-mechanical limits of materials, accelerator technology is still rapidly developing. The SNS at ORNL, scheduled to begin operations in 2006, will have a design power of 2 MW. There is an upgrade path for this source and design projects in Europe and Japan for 4–5-MW sources, which will have peak neutron fluxes more than an order of magnitude greater than the highest flux reactors.

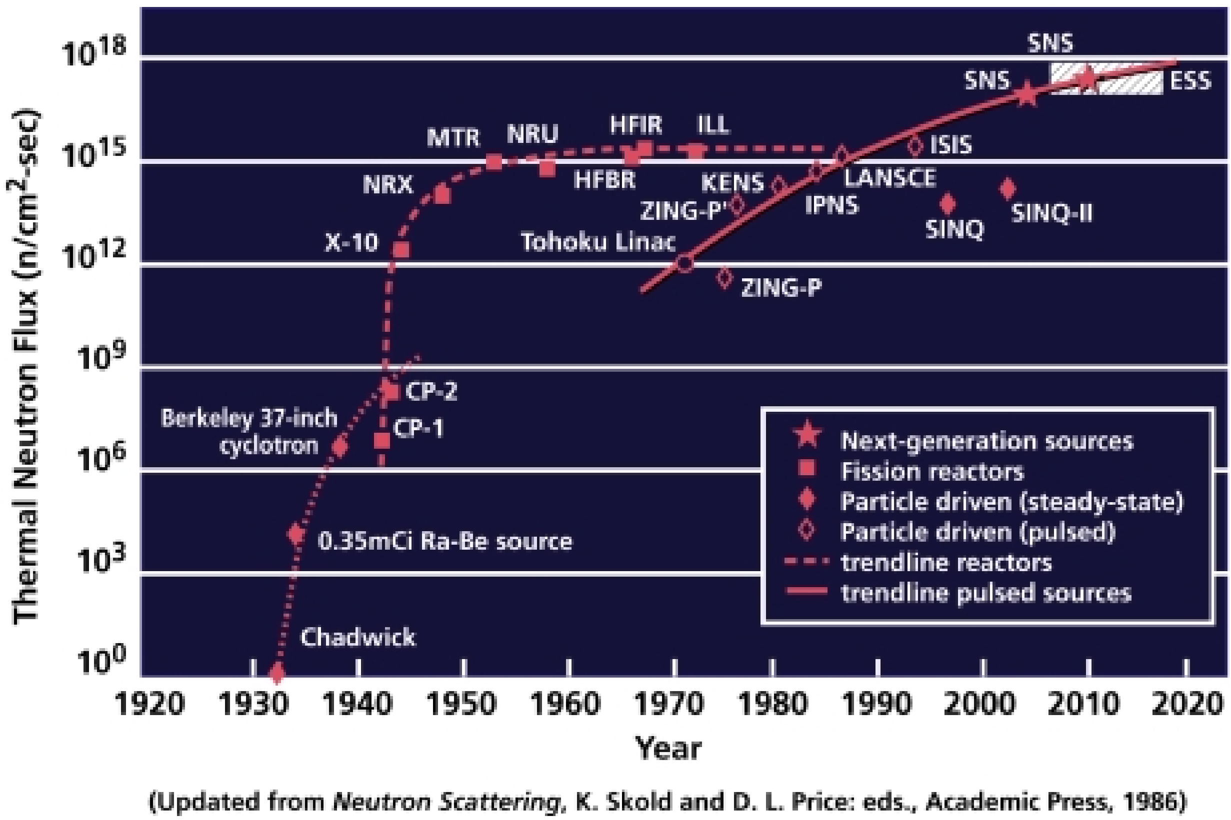

Figure 1: History of peak fluxes for both reactors and pulsed spallation sources

It is not simple to make a straightforward comparison of the technical performance of reactors and short-pulsed spallation sources, because instrumentation optimized for different dynamical ranges and resolution exploit the two types of sources in very different ways. A true comparison can only be achieved on an experiment-by-experiment basis. However, the benchmark facilities of each type, the ISIS spallation source (160 kW) and the reactor at the ILL (58 MW), are considered to be competitive. Each have their own particular strengths, but also a significant overlap in capabilities. Both are equivalently organized as user facilities, have similar numbers of users and instruments, and by output measures such as number of experiments and publications are very similar (see Table 1).

Table 1: Comparison of ISIS and ILL (data for 1998)

Measures	ISIS	ILL
Users/year	1280	1500
Experiments/year	645	800
Publications/year	437	414
Scheduled instruments	17	25

4. Review Procedure

An objective of the Subpanel was to set up a quantitative or semiquantitative method for evaluating the performance of these two user facilities. The matrix that the Subpanel adopted for this evaluation was presented at the kickoff meeting (Dr. Thom Mason), is used by ISIS, and is shown in Figure 2. The input is the power of the source, and the output is the scientific impact. With a user facility of this type, the output is a product of the efficiency of each component listed in the central box. If any single component is not functioning properly, it drags down the whole facility.

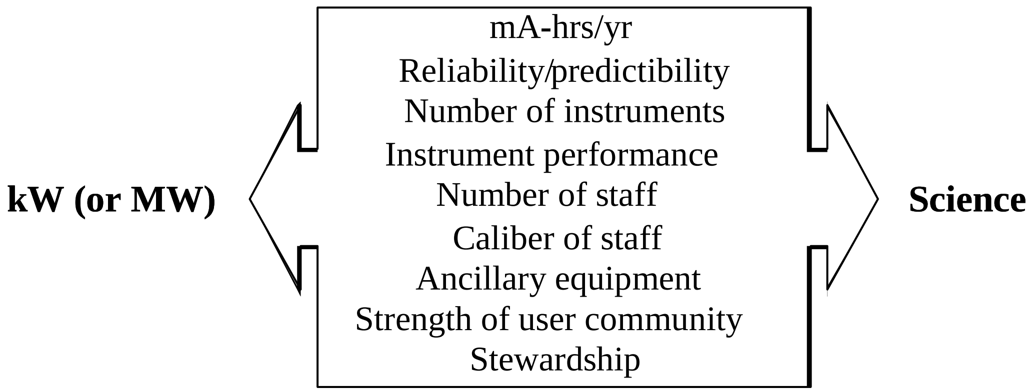

Figure 2: History of peak fluxes for both reactors and pulsed spallation sources.

Each facility was evaluated in nine different categories—Source, Reliability, Instrumentation, Support Facilities, Support Staff, Users, Cost Effectiveness, Stewardship and Management, and Impact. In each category, a grading system was used, ranging from Unacceptable to Outstanding, with Competitive being the acceptable score. The evaluation was based on the written response to our request for information (Appendix 4), the site visit presentations, previous reviews of the facility, private discussions at the site visit, and solicited information from experts.

In the opinion of the Subpanel, a successful Spallation Neutron User Facility should strive to be ranked Competitive in every category. Our recommendations based upon this assumption outline a plan for enhancing the impact of both of these facilities to the growth of neutron sciences in the U.S.

Given the national agenda of bringing the U.S. into a world leadership role in the broad area of neutron sciences, one of the most important questions posed by the panel concerned the role of each of these facilities. The key issue is how to get from the ~1000 present users to a level of 4000–5000 (needed to be competitive with Europe) in the time frame between now and when SNS is fully operational, ~2008. This question led the Subpanel to collect and digest information about the makeup of the present user base, the funding for university-based PIs, and modes for expanding the user community. All the recommendations are focused on addressing the national need in key science and technology areas which will require expanding the number and quality of users.

5. Findings

The findings of the Subpanel are reported in two sections. The first documents the evaluations and ranking of the capabilities of each facility using the matrix described in the review procedure (Section 4). The second section reports our findings concerning the user community. Because the education of new students rests primarily with the university component of the user community, we have looked at the trends in this community, both with respect to numbers and funding.

5.1 Evaluation Reports:

The Subpanel evaluated separately the following aspects of the performance of each of the user facilities

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1. Source
2. Reliability
3. Instrumentation
4. Support Facilities
5. Support Staff
6. Users
7. Cost Effectiveness
8. Stewardship and Management
9. Impact

In each category, the facility was rated, using a four-level rating system—Unacceptable, Needs Improvement to be Competitive, Competitive, and Outstanding. Our rating system assumed that the productivity of the facility was a product of all these different components. An Unacceptable ranking in any category should alert DOE that immediate action must be pursued! Needs Improvement means that the problems could be fixed with money and or reprogramming by the management. A great user facility would have a ranking of Competitive in all categories.

Table 2 displays our evaluations for both facilities, and the following sections give a detailed description of the facts that led to these ratings.

Table 2: Evaluation of the LANSCE/Lujan Center and IPNS in nine categories.

	LANSCE/Lujan Center				IPNS			
Category	**Unacceptable**	**Needs Improvement to be Competitive**	**Competitive**	**Outstanding**	**Unacceptable**	**Needs Improvement to be Competitive**	**Competitive**	**Outstanding**
Source			X			X		
Reliability		X						X
Instrumentation		X				X		
Support Facilities		X				X		
Support Staff			X				X	
Users			X				X	
Cost Effectiveness								
-Operation	X							X
-Science		X					X	
Stewardship								
-Management	X						X	
Impact		X					X	

5.1.1 Source

For each facility, the "source" consists of an accelerator complex for generating a pulsed proton beam, a heavy-metal target in which the incident protons generate neutrons by nuclear spallation, and moderators, which slow the fast spallation neutrons and tailor the neutron spectrum seen by individual instruments. The time-averaged neutron flux scales approximately with the power of the proton beam, although the peak flux is a more relevant figure of merit for the performance of some spectrometers (Table 3).

Table 3: Measure of the neutron flux in terms of effective time-averaged source power. For reference, the power at ISIS is 160 kW.

	Neutron Energy Range		
Facility	**Cold**	**Thermal**	**Epithermal**
Lujan Center	200 kW	80 kW	80 kW
IPNS	50 kW	15 kW	15 kW

LANSCE/Lujan Center

The accelerator complex supports several facilities, one of which is the Lujan Center. The accelerator system consists of a 750-keV preaccelerator, a half-mile-long 800-MeV linear accelerator, and the Proton Storage Ring (PSR). Pulses of protons from the PSR can be directed to the tungsten target at the Lujan Center; in normal operation, it provides a 100-µA beam at 20 Hz, with a power of 80 kW. While the beam power is half that at ISIS, the peak power is comparable. The moderators around the Lujan Center target include 4 water and 2 liquid hydrogen moderators, which provide 17 independent neutron beams. As a source of pulsed, thermalized neutron beams, the Lujan Center is currently Competitive. The use of coupled moderators boosts the effective power for cold neutrons to 200 kW. Recent upgrades to the PSR and the development of a new ion source will enable a potential doubling of the proton current; however, several major steps, including re-licensing, would be required before the target and moderator system could handle the increased power. The Subpanel has ranked the source as Competitive—it has the potential to become Outstanding, but this transition is not *the* priority for the Lujan Center at this stage in its development.

IPNS

The accelerator system consists of a 750-keV preaccelerator, a (40-year-old) 50-MeV linac, and the 500-MeV Rapid Cycling Synchrotron (RCS), which was built in 1979. This system produces proton pulses at a frequency of 30 Hz with a net current of 14 µA and a beam power of 7 kW. The target is currently depleted uranium, which produces a factor of 2 more neutrons than nonfissionable targets such as tungsten or tantalum. There are 3 moderators, 2 utilizing frozen methane and 1 with cold liquid methane, which provide 12 neutron beams. The solid methane moderators, which are practical at IPNS because of the limited incident flux, provide a flux gain of 3.6 relative to the liquid hydrogen moderators used for cold beams at facilities with higher beam power. Combining the target and moderator optimizations, the cold neutron flux for some instruments is comparable to that from a 50-kW source; nevertheless, the flux at thermal and epithermal energies is not competitive for some applications.

5.1.2 Reliability

Reliability on many time scales is key to the successful operation of a user facility. At a spallation neutron source, a range of systems including the proton accelerator, the target moderator system, neutron scattering instrumentation, sample environment, and data analysis capabilities must all function to produce useful data. A successful program requires that all these systems function simultaneously with a high level of reliability (>90%) on time scales ranging from hours to years.

LANSCE/Lujan Center

The Lujan Center has never been a reliable scientific facility for neutron scattering. The problem was recognized in the early 1990s, leading in 1994 to initiation of the LANSCE Reliability Improvement Project. Only half of the requested $70M was provided by the Department of Defense (DOD) in two phases. The years 1996–1997 showed that improvements in neutron production efficiency are possible at LANSCE/Lujan Center. The reliability of the Lujan Center source, defined as the ratio of neutron beam time delivered to time scheduled, grew to 85% and 90%, respectively, in those years. However, owing to frequent technical problems with several instruments and lack of adequate ancillary equipment, overall scientific productivity remained below potential. Nonetheless, the short period of improved source reliability stimulated considerable user interest indicating that there is a latent user community for a *reliable* Lujan center. Mainly as a result of an extended period required to obtain renewed DOE authorization to operate, the Lujan Center did not produce neutrons from February 1999 to June 2000. This downtime prevented the Lujan Center from contributing to a range of science and developments in pulsed source techniques that went on in that period. In addition, two prominent scientists decided to leave, and the expansion of the Lujan Center user community that the facility had worked so hard to accomplish suffered a setback. These are serious and predictable consequences of an extended shutdown. During the Subpanel's visit to LANSCE, the Lujan Center was operating at 80 kW as it has been with a reliability of 80% since June 2000. This encouraging development has taken a great deal of effort on the part of management and operational staff to accomplish. Unfortunately, only three instruments are operating in full user mode so that overall scientific productivity at the Lujan Center remains far below potential and the number of users served is small compared with other scattering facilities in the U.S. In addition, LANSCE operations project that source reliability is likely to decline to 75% in the next run cycle because consistent underfunding has left them behind in maintenance schedules and short on vital spare parts. A successful neutron scattering program cannot be built around a source with that level of reliability.

IPNS

The IPNS has demonstrated outstanding reliability as a source of neutrons throughout its lifetime. Not only is the average reliability over the last five years in excess of 95%, but reliability in the worst cycle since 1995 also exceeds 85%. The reliability of scattering instrumentation is also generally in excess of 95% such that the probability that a user gets data on a visit to IPNS probably exceeds 90%. Because of this performance, IPNS enjoys a reputation among users as a facility that delivers what it promises. An important element in this success is recognition by management and operational staff of the fundamental importance of high reliability in all systems needed to produce science. Looking to the future, the situation, as defined by current funding, is unfortunately less promising. IPNS is a 40-year-old facility that has been operating on a minimal maintenance budget for many years (<0.2% of the replacement cost per year). No matter how skilled, experienced, and motivated the operational staff is, source reliability will suffer as poorly maintained items fail and crucial spare parts run out. IPNS presented to the Subpanel an enhancement plan to turn around this situation (Appendix 8). It includes resources to carry out maintenance on crucial systems, replace obsolete units, build up the inventory of spare parts, and facilitate access to the target/moderator complex by redesigning the reflector. While the main goal of the enhancement plan is to enable continued reliable neutron production at IPNS, the proposed investment would also yield a factor of 2 increase in neutron flux. The improvements would come from the use of second-harmonic RF capture and acceleration in the proton synchrotron (30% increase in beam current) and replacement of the graphite reflector by a beryllium reflector that will produce an additional 30% increase in neutron flux.

5.1.3 Instrumentation

LANSCE/Lujan Center

The Lujan Center presently has six instruments in a position to be available to users with sufficient resources—three diffractometers, a reflectometer (which can be operated in unpolarized or polarized mode), a small-angle neutron scattering (SANS) machine, and the filter difference spectrometer. At present, only three are fully scheduled in the user program. The diffractometers and reflectometer are capable machines, rated as world-class or competitive within the United States. While the FDS has produced a number of high-quality papers (5 of the facility's top 20 publications), it has a limited range of applications. The SANS detector has data rate problems, which mean it cannot fully exploit the flux available at the source. A seventh instrument, a direct geometry chopper spectrometer, has in the past been scheduled, but for reliability reasons and restricted data rates (because of incomplete detector coverage and location), the scientific impact has been limited. Overall, the present suite of spectrometers is restricted in number and inadequately caters to inelastic scattering needs.

The problem of balance of the instrument suite is being addressed by the planned and funded construction of two spectrometers under the auspices of the SPSS Enhancement Program—one for quasi-elastic scattering and the other by re-siting the chopper spectrometer to a coupled moderator and increasing the detector area. If construction goes ahead, both instruments could be world-class spectrometers. Two diffractometers built under the same scheme will be commissioned in 2001—a high-throughput diffractometer and one dedicated to structural materials research—which also will be world-class. Together with a protein crystallography instrument, there will be a total of 11 spectrometers for neutron scattering research. The suite promises to be well-balanced, but the Subpanel is concerned that LANL did not present plans for funding the operation of the new spectrometers. At the same time, two development stations have received Laboratory Directed Research and Development (LDRD) funding—one for the development of polarized beam reflectometry and magnetic diffraction in high fields and the other (IN500) a test-bed for design concept suitable for a long-pulse spallation source. At the present state of development of the LANSCE/Lujan Center, the top priority must be to deliver a competitive scientific user program on a core suite of instruments.

IPNS

IPNS has 11 spectrometers fully scheduled in the user program (3 diffractometers, 1 liquid and amorphous materials instrument, 2 SANS, 2 reflectometers, and 3 inelastic spectrometers). The instruments constitute a well-balanced suite for a user facility. In addition, there are a high-intensity diffractometer and a spectrometer that are both outdated, the latter essentially unscheduled. All the scheduled instruments are useful research tools, but by virtue of the low power of the source, none of them are world-class. There is considerable scope for enhancement of the instruments in several cases by an order of magnitude (see Table 1 of Appendix 8), by modest investment. More importantly, the upgrades will take individual instruments out of the user program for only short periods of time. The IPNS instrument scientists have the experience and proven track record in instrument development to satisfy the Subpanel that given sufficient resources, the enhancement program will be implemented without risk.

5.1.4 Support Facilities

Support facilities for neutron scattering users generally include capabilities for the preparation and characterization of specimens, optimization of the acquisition of neutron scattering data, reduction and analysis of that data, and training. User facilities tend to emphasize the design, testing, and implementation of neutron scattering spectrometers and detectors, specialized sample environments, and computation (including algorithm development) for data reduction/analysis. Facilities for specialized sample environments are often generated both through in-house research programs and through collaborations with particular sets of external users. Facilities for sample preparation often rely heavily on the user's home institution and other in-house laboratory facilities at the National Laboratory operating the user facility. Training is usually accomplished by spectrometer scientists working "one-on-one" with new users and also via summer schools and workshops.

LANSCE/Lujan Center

The user organization ranks their sample and support laboratories, sample environment equipment, and facilities for data analysis as predominately either excellent or mostly satisfactory. New support laboratories for protein crystallography, chemistry, cryogenics, and magnetism are in the planning stages. Nevertheless, on an international scale, over both synchrotron x-ray and neutron scattering facilities, these support facilities were found to be less than satisfactory. Training received the least support from the users (largest number of unsatisfactory and lowest number of excellent ratings among the 12 categories evaluated).

IPNS

While IPNS does not have a formalized user's organization, the quality and quantity of their scientific output suggest that their support facilities for specialized specimen environments in particular areas are excellent, as well as those for data reduction/analysis. As user program and number of instruments have grown, engineering and technical support for ancillary equipment have slowly declined, so that the present effort lacks the strength to proceed with new ideas while maintaining existing equipment. On an international scale, these support facilities over the entire set of available spectrometers were found to be less than satisfactory. The recent summer school on x–ray and neutron scattering run by IPNS and the Advanced Photon Source (APS) has received high marks.

5.1.5 Support Staff

Staffing

Staffing of the science and users programs associated with facilities must respond to several needs; for example, experimental and mentoring support for users, driving new capabilities and infrastructure, pursuing research to maintain the quality of scientific expertise, exploring new science opportunities and opening new scientific frontiers, and providing infrastructure maintenance and administration/oversight. In meeting these needs, the staffing is divided into support for accelerator operations and maintenance, instruments, scientific and technical support, computer support, and administrative staffing. The vast majority of the support staff provides support for the operation of the accelerator and auxiliary infrastructure. It is generally felt that the current staff of both the LANSCE/Lujan Center and IPNS are dedicated and committed to the operation of their respective facilities in the best traditions for user facilities.

Accelerator Staffing

The current staffing levels for accelerator support at both facilities (i.e., 91 at LANSCE and 27 at IPNS) appear to be adequate under current operating scenarios, but it is likely that the current staffing will experience increasing pressure because of the age of both accelerator facilities. Many of the components and subsystems composing these accelerators are more than 40 years old with particular maintenance programs associated with their age (e.g., many subsystems and components are no longer commercially available and will require replacement as inventory of spare parts is depleted). Over the last decade, the IPNS accelerator support group has performed remarkably maintaining a 95% reliability record in support of user programs. It appears that the current staff of the IPNS accelerator group will have an increasing problem of maintaining this level of reliability without some focused attention given to upgrades and renewal of components and subsystems. At LANSCE, there has been a variety of problems which have negatively impacted the reliability of this facility with some due to accelerator problems. Thus, it appears that under current operational scenarios, there will continue to be unscheduled interruptions in user activities due to accelerator problems. Increased staffing of the accelerator support groups alone will not necessarily adequately address the critical needs in this area. Both facilities recognize the limitations of the current staff and have requested enhanced support in this area to improve or maintain acceptable reliability figures. To ensure high accelerator reliability when all the instruments at the LANSCE/Lujan Center are fully operational, the accelerator staff will have to be significantly increased. As a benchmark, the equivalent staff at ISIS is 126.

Table 4: Staffing in support of science and user programs.

	ISIS	ILL	LANSCE	IPNS
No. of Instruments	17	25	7	14
No. scientists-RA's/instrument	2.2	2.0	2.2	1.4
No. technicians/ instrument	1.0	1.0	0.5	1.0
No. engineers & support staff/instrument	0.6	2.0	1.2	0.25
Total staff/instrument	3.8	5.0	3.9	2.7

(Data provided in *ISIS: The Way Forward* report of a Review Panel to the Council for the Central Laboratory of the Research Councils, July 1998)

Scientific and User Support Staffing

Certainly, IPNS support staff is thin, and operations and user support could benefit with additional scientific and users support (see Table 4). In addition, there has been a negative impact on level of scientific effort and user support because of a decline in support for some individual and group research programs at DOE laboratories that are closely associated with each facility. In recent years, additional pressure on support for user programs has come from inadequately staffed instrument development efforts and commitments to the instrument development program for SNS. Since the nurturing of a vibrant user's community in anticipation of the completion of the SNS in 2006–2008 represents a national need and the realization that the neutron facilities at LANL and ANL must play a critical role in further developing and mentoring the user community, a careful assessment of the level of scientific and user support should be pursued to address needs in this area.

5.1.6 Users

LANSCE/Lujan Center

It is difficult to assess the full potential of the user community at the Lujan Center in the absence of a regularly scheduled user program. An attempt has been made here to separate users issues from source reliability as much as is possible. During the successful operations from 1995 to 1997, the Lujan Center served as many as 70 users per year. The LANSCE Users Group has a membership of almost 400, suggesting that the number of potential users of this source could be much higher. The mix of research is in some respects similar to that at IPNS, focusing on materials sciences, with a strong chemistry effort and an emerging life sciences component. Unique to Lujan Center is the fundamental nuclear physics effort, involving about a third of the users at the source. Users are represented by the LANSCE User's Group (LUG), which has been proactive in providing well-considered advice to laboratory and source management and in providing cohesion among the potential source users.

The Users Group involvement in decisions about instrument construction priorities serves as a model for other user organizations. Lujan Center management has taken user needs into account in setting priorities for instrument construction. Over time, users have become increasingly involved in source-sponsored initiatives for new instruments and, in the case of the HIPPO diffractometer, have even taken the lead in organizing user consortia and funds for instrument development. Groups of users have recently taken responsibility for raising funds and supervising the design of two new spectrometers, VERTEX and SABER. The emergence of this participating research team (PRT)-like model for instrument development was proven at the

National Synchrotron Light Source (NSLS) and APS to be a powerful leveraging of university and federal funds.

The Lujan Center has recently involved the University of California (UC) in identifying new users and seeding their efforts. The source has introduced a new and promising model for supporting academic users in providing half funding for an assistant professor at New Mexico State University (NMSU). This model might be productively employed at other neutron sources. Use of the Lujan Center by internal LANL researchers, in particular by the materials development effort in MST-10, seemingly presents an untapped resource.

Altogether, the user base at the Lujan Center seems remarkably strong, considering the persistent problems with reliability. However, this level of interest cannot be expected to persist indefinitely in the absence of a scheduled user program. While Lujan Center management clearly appreciates this, it is apparent that LANL management has little understanding of the priorities involved in running a facility for users external to the national laboratory system or that it places little value on this part of the Lujan Center's mission. Lack of clear administrative priorities on all levels has overloaded both the Lujan Center management and the facility scientists (see Stewardship and Management, section 5.1.8).

IPNS

IPNS has a core group of approximately 200 users, which has neither increased nor decreased appreciably in the past five years. About half the users are from U.S. universities; one third are from ANL; one sixth each are from other government laboratories and foreign institutions; and less than 5% are from industry. Materials sciences dominate the research interests, with a strong chemistry presence and an increasing emphasis on biomaterials. About 60% of the beam time is allocated to users by a proposal system oversubscribed by a factor of 2. The users are not represented by a formal user's organization, but management is clearly aware of and responsive to user needs. While there are a number of highly cited papers which result from work performed at IPNS, there was some sentiment that the average level of the work being performed at the IPNS could be substantially improved, even given the limitations of the source and instruments. The symbiotic relationship between IPNS and users from the MSD at ANL is a particular strength of the source and should receive further support.

The IPNS is one of several national facilities operated by ANL The laboratory management has a demonstrated commitment to these facilities and a practical appreciation for the support required to make them successful. Close cooperation of laboratory and source management is a key element of the success of the IPNS as a user facility.

A primary strength of the IPNS organization is a clear mandate, top to bottom, that user support and development are top priorities. The reliability of the source and a proactive staff accustomed to dealing with novice users are some of the reasons why IPNS has maintained a committed cadre of users.

IPNS and MSD scientists have an impressive record of graduate student and postdoctoral mentorship and have been quite successful in their university partnerships to achieve these results. The graduate student summer school is a good idea and has already seeded new experiments from alumni of the course.

IPNS must play an important role in the period leading to the commissioning of the SNS by providing a reliable source of neutrons for experiments, leading the way in new applications of neutron scattering, and mentoring new users. While there are a number of highly cited papers, which have resulted from experiments performed at IPNS (particularly involving internal ANL programs), an on-going effort must be made to involve external users and to raise the effectiveness of their programs at the facility. The recruitment of new staff as well as new users will be required to accomplish this.

An Enhancement Plan which will contribute to solving the user-related problems has been prepared by IPNS (Appendix 8). From the user perspective, the Subpanel urges that instrument upgrades be well focused on implementing new capabilities and in straightforward improvements of data rates, while minimizing impact on the availability of the source and the instruments. An increase in user support staff is crucial to ensure that the instrument scientists are not stretched so thinly that user support and development are compromised while the enhancement project is under way, as well as afterward given the anticipated substantial increase in user numbers.

5.1.7 Cost Effectiveness

The Subpanel used two figures of merit to measure cost effectiveness. Operational cost effectiveness is measured by the cost of a facility day. Scientific cost effectiveness is measured by the cost per peer-reviewed publication. These are admittedly highly aggregated figures of merit, but they suffice to make meaningful comparison of the LANSCE/Lujan Center and IPNS facilities to an international benchmark, which is taken to be ISIS. The metrics in Table 5 were used to evaluate each facility.

LANSCE/Lujan Center

The performance of the LANSCE/Lujan Center depends on how the calculations are done. One point of view is that the BES investment in LANSCE generates incremental benefit for incremental cost. Using this marginal-value-for-marginal-cost model, the Lujan Center exhibits a Needs Improvement level of operational cost effectiveness during 1999–2000 and a Competitive level of scientific cost effectiveness during this period. The Subpanel believes, however, that this is not a sensible figure of merit for the evaluation of the DOE investment in the LANSCE/Lujan Center. Specifically, the Center's share of the average operational cost of LANSCE must be included in the cost base. Using an operational scaling factor of 0.5 ($23.3 M/yr), one gets an operational cost effectiveness of Unacceptable and a scientific cost effectiveness of Needs Improvement for the 1999–2000 period. Thus, with a reasonable allocation of average costs, the low beam delivery to the LANSCE/Lujan Center during 1999–2000 results in Unacceptable costs. Moreover, upon inspection of the LANSCE management practices and plan, the Subpanel did not receive adequate assurance that the low beam delivery would not be repeated in the immediate future. An evaluation of the management and governance of LANSCE/Lujan Center is presented in the following section.

IPNS

IPNS has a Competitive level of scientific cost effectiveness and an Outstanding level of operational cost effectiveness.

Table 5: Figures of merit for the assessment of the cost effectiveness of IPNS and LANSCE/Lujan Center facilities. ISIS is the benchmark.

	LANSCE/Lujan Center				IPNS				Benchmark
FIGURES OF MERIT	**1997**	**1998**	**1999**	**2000**	**1997**	**1998**	**1999**	**2000**	
Total Costs ($M)									
BES	6.1	5.1	6.1	5.6	10.6	11.9	13.2	13.6	
Other	40.5	42.3	48.5	55.1	0	0	0	0	
Total*	46.6	47.4	54.6	60.7	10.6	11.9	13.2	13.6	34
Average+	23.3	23.7	27.3	30.3	NA	NA	NA	NA	NA
User Beam Time									
Scheduled (days)	150	0	108	39	164	175	179	175	168
Delivered (days)	135	0	30	31	157	171	163	167	153
Efficiency	90%	0%	28%	79%	96%	98%	91%	95%	91%
Cost Per Facility Day ($K)									
Marginal Cost (BES)	45.2	NA	203.0	181.0	68.0	70.0	81.0	81.0	NA
Average Cost	173.0	NA	910.0	977.0	68.0	70.0	81.0	81.0	222.0
Number of Scheduled Instruments	7	NA	6	3	12	12	12	12	18
Cost Per Instrument Day ($K)									
Marginal Cost (BES)	6.5	NA	40.7	60.2	5.6	5.8	6.8	6.8	NA
Average Cost	24.7	NA	182.0	326.0	5.6	5.8	6.8	6.8	12
Facility Output: Number of Refereed Publications	57	60	72	NA (27)	119	113	155	NA	428
Cost Per Paper ($K)									
Marginal Cost (BES)	107.0	85.0	85.0	NA	89.0	105.0	85.0	NA	NA
Average Cost	409.0	395.0	379.0	NA	89.0	105.0	85.0	NA	79.0

- *Operations plus all other costs.
- +Average costs for the Lujan Center were calculated by allocating f = 50% of the total LANSCE costs to the generation and usage of beam on user instruments in the Lujan Center. These numbers were consistent with the estimates given the Subpanel for the LANSCE/Lujan Center management.

5.1.8 Stewardship and Management

LANSCE/Lujan Center

The Lujan Center's performance as a user facility has been far below expectations. Major shortfalls include grossly inadequate beam time delivered to the Lujan Center, lack of correlation between articulated program priorities and funding flows, lack of focus on fewer, achievable high-priority projects, and inadequate management performance as reflected in lack of clear, inspectable problem-solving plans. Moreover, these issues have persisted over a prolonged period of time as may be ascertained from the previous reviews of the 2000 LANSCE Division Review Committee Report and the 2000 LANSCE User Group Executive Committee [Appendix 7]. While a broad range of new instrument activity has been pursued, there has been no underlying reliable performance of a core group of instruments. The Subpanel believes that many of these shortfalls are the direct consequence of a confusing, and often dysfunctional, governance process.

The *National Research Council (NRC) Report on Cooperative Stewardship* has strongly emphasized that responsibility for a user facility should rest with a single clearly identified federal agency. The multiple sponsorship of LANSCE, coupled with the erratic cycle of funding delivery, appears to have prevented achieving reliability of operation at the Lujan Center. At present, LANCSE reports simultaneously to LANL, DOE Office of Science (SC), Office of Defense Programs (DP), DOE Office of Nuclear Energy (NE), National Nuclear Security Administration (NNSA), etc. The management of this program, from the top to the bottom, is dysfunctional. The lack of a viable action plan to address this glaring problem gives the Subpanel no confidence that present LANL management is equal to the task.

IPNS

IPNS management, in contrast, has run a remarkably robust program which has won international recognition. The integration of a smoothly functioning users' program with strong in-house competence of neutron-based research activities is a model for the effective use of a national laboratory in the overall national research portfolio. The Subpanel particularly noted the enthusiasm with which both management and staff welcome their involvement with the SNS. Even though the internal management of IPNS is exemplary, the stewardship by DOE is not as enlightened. From the funding history of IPNS in recent years, the Subpanel concludes that DOE has not recognized the key role of IPNS in the advancement of neutron sciences in the U.S.

5.1.9 Impact

As an introduction to this section it is appropriate the set the stage by addressing the general issue of impact of US neutron scientists. The Research Department of the "Institute for Scientific Information" (ISI), the publisher of *Current Contents* has compiled a list of the 1000 Most Cited Physicists. The list is based on papers published between 1981 and June 1987, in all physics journals covered by Current Contents in Physical, Chemical and Earth Sciences. There are 11 names in the top 1000 clear identified with research using neutrons. Eight of the eleven are scientist associated with US institutions and five are from DOE national laboratories. The conclusions are; 1) neutron scattering experimentalists are having an impact on the physics community, 2) the US was a major player in the world, and 3) The DOE National Laboratories have had a major impact in this field. At the present time the five scientists associated with DOE laboratories are distributed in the following way; two at ANL, one at LANL, and two at BNL.

LANSCE/Lujan Center

The mesa is the home of a broad range of competence, which attracts scientists from most parts of the world. The impact of work from the facility in finding answers to questions about properties of materials and the development of neutron scattering techniques is modest. For example, over the past five years, the average number of papers published in refereed journals, written by staff and external users, is less than one-half of the corresponding figure for the IPNS facility. By and large, in terms of the impact made by pulsed sources of neutrons, the LANSCE/Lujan Center is overshadowed by the IPNS and sources outside the United States.

However, the relatively young staff at the Lujan Center has demonstrated potential promise. Notable examples are the fine work on properties of soft matter (e.g., polymer films) made with a reflectometer and the development of engineering strain instrumentation. LANSCE/Lujan Center staff have also developed technology that increases the performance of neutron scattering spectrometers; examples include the flux-trap target and coupled and backscattering moderators.

IPNS

For the purpose of this commentary, the IPNS facility is taken to include contributions made by staff attached to the MSD. In all the many areas of science to which IPNS has contributed, the impact of the published findings measured on an international scale has been significant. Indicators and metrics to substantiate this view are well documented and appear in the main body of the report. It would be invidious to cite specific publications since the body of work is of high quality. For example, the citation rating for papers published by MSD staff and their collaborators rivals that of the very best.

A measure of success of the facility not to be overlooked is the high standing of the staff; it is by no means an exaggeration to say that IPNS and MSD staff command a high international standing that is richly deserved. One sees this in the access to facilities in the U.S. and overseas that is granted to the staff.

The modest flux of neutrons from the IPNS facility means that access to other facilities is often required to achieve cutting-edge research. In such cases, work at the facility can provide the feasibility study, which is essential in making a successful case for access to the heavily oversubscribed instruments at the world's best neutron facilities.

However, in areas that include the study of structure, the IPNS has tools which are well-matched to the probes and enable work at the cutting edge of science to be accomplished. Reflectometry and powder diffraction are two such areas of activity.

The impact of work at IPNS is not limited to finding answers to questions about the properties of materials, for there has been a large impact on the development of neutron scattering techniques based on a pulsed source. This aspect of the work at the facility is similarly well documented.

5.1.10 Summary

LANSCE/Lujan Center

LANSCE/Lujan Center has the potential to be a world-ranking user facility. LANSCE, as a center of excellence in accelerator-based facilities, and Lujan Center, as a center for materials science, are poised to make vital contributions to the primary mission of the Laboratory, both directly and through the development of a user culture and user facility. There is good evidence of a latent user community, internally in the Laboratory and externally (particularly on the UC campuses) for a reliable Lujan Center. The quality of staff on the floor and particularly the recent user-led Spectrometer Development Team (SDT) show promise.

There is evidence of a commitment to success at all levels [e.g., the DP-funded upgrades and infrastructure investment; SC investment in state-of-the art instrumentation; progress on understanding the limitations of the accelerator complex and the development of a plan to achieve the required high reliability; and the enthusiasm of Lujan Center staff and of both internal and external users as to what might be achieved]. However despite the fact that many of the elements required for success exist, the lack of effective overall integration and the sense of a common purpose—at all levels from the DOE to the Lujan Center floor—have resulted in an ineffective user facility. Money alone will not solve this problem!

LANSCE/Lujan Center is overcommitted and (probably) underfunded. Governance is dysfunctional, and management does not have an integrated plan to address the myriad of problems confronting the LANSCE/Lujan Center. There is an ongoing history of exaggerated promises followed by failure to deliver. Gaps in management exist at all levels—from DOE downward. There is obvious distrust and no common understanding between the various internal and external stakeholders. This is compounded by conflicting goals of the DP programs at LANSCE (PRAD, WNR) and the SC user program at the Lujan Center. The entrepreneurial approach whereby the next enhancements are sought before the current ones are delivered has been endemic. Despite many reports and reviews—all delivering the same consistent message—no clear management plan has yet been developed.

A single clearly identified Steward with a DOE mandate to deliver a fully functional user facility competitive with international benchmarks must be appointed. Then and only then can LANSCE/Lujan Center be expected to meet the expectations of the neutron community, UC, the DOE Office of Basic Energy Sciences (OBES), LANL, the DOE DP (part of NNSA), the DOE NE, and NNSA.

IPNS

The IPNS facility delivers outstanding value per dollar spent. An impressively well-integrated team has kept an outmoded source operational at the highest level of efficiency and reliability and has delivered a remarkably competitive science program. With modest investment, this can be sustained and significant enhancements realized. The pioneering IPNS pulsed source instrument suite has in recent years suffered through chronic under-investment. Nevertheless, IPNS management has identified a realistic plan to deliver cost-effective upgrades to the instrument suite that will have immediate impact. Working in close collaboration with MSD staff, a world-class science program which will both raise the visibility of pulsed neutron scattering in the U.S. as an effective research tool and develop the potential user base for SNS can be realized.

IPNS is a reservoir of expertise with a track record of seminal developments in source and pulsed source instruments second to none. There is a window of opportunity to pass on this knowledge and train a new generation of instrument scientists not only by co-locating the SNS instrument activity at ANL but by fully exploiting IPNS for instrument development and science *now*.

The lasting impression is of a Laboratory fully committed from top to bottom to supporting a user program. The overtures being made by the newly appointed Laboratory Director to strengthen links with academe further reinforces this view.

For completeness, the findings as listed in the Executive Summary are also included here:

- ***It is imperative that every spallation source in the U.S. is utilized to its full potential*** to assure that a sufficiently large and well-trained user community exists when SNS is fully operational in ~2008.
- ***It is essential to substantially increase the neutron user community*** in order to fully exploit the SNS. This will not occur in a timely fashion without an active program.
- ***IPNS is an extremely reliable source with a talented and experienced staff.*** However, the facilities (source and some instruments) are in need of improvements to make them more competitive and to maintain reliability.
- ***LANSCE/Lujan Center has a competitive source, and the facility could be world-class***. However, the governance is dysfunctional, and the management scheme is not compatible with effective stewardship and operation of a national user facility.

5.2 The User Community

Second only to the successful construction of SNS is the need to grow an excellent user base in a broad range of scientific and technological areas. The international community, with whom we aspire to compete, sets the scale of this growth. A recent study (1997) of the European neutron user community (http://www.esf.org/ftp/pdf/Pesc/ENSA.pdf) reports 4400 users in Europe with 90% employed outside the facilities. Given that the European neutron community will continue to grow (estimated at 5000 this year), our task seems quite ambitious, to grow from ~1000 users today to 4000–5000 in 8 or 9 years.

Table 6 compiles the distribution of users at neutron facilities in the U.S. and compares the findings with ISIS, the European benchmark. In Europe, in general only 10% of the users come from the staff of the facilities and at ISIS it is only 3%. At the DOE laboratories, more than 40% of the users are from government laboratories, and at NIST the number is smaller (21%). In the ISIS document *The Way Forward*, the following statement about their university users appears: "The quality of the UK university department using the facility can be gauged from their ratings in the Funding Councils' Research Assessment Exercise: 74% of the Physics use of ISIS and 85% of the Chemistry usage comes from departments placed in the top three assessment categories. Equally well, the impact of the ISIS program on training cannot be overstated: some two thirds of UK researchers at ISIS are undergoing training at postgraduate or postdoctoral level, and 60% of UK users are aged 30 or under." ISIS and Europe are building their future in neutron sciences with students from the best research programs in Europe. It is clear from Table 6 that the same statement is not true for neutron facilities in the U.S. If the U.S. is going to move into a competitive position in the world of neutron sciences, it has to be through a strong university-based research program. In less than a decade, our user base must be expanded by a factor of 4, primarily through growth in the university sector. It should be clear to all that expanding the government's laboratory user base by a factor of 4 is not going to happen in today's climate.

Table 6: Distribution of user community in different facilities

Users	HFIR ORNL	Lujan LANL	IPNS ANL	NCNR NIST	ISIS
University	36%	42%	45%	43%	51%
Government Laboratories	48%	41%	41%	21%	3%
Industry	5%	2%	3%	11%	1%
Foreign	15%	13%	11%	25%	45%
Year	99	97	99	00	98
Number of Users	149	126	208	~800	1280
Graduate Students	19%	30%	22%	28%	60%
Postdocs	12%	11%	20%	10%	

5.2.1 Funding of Neutron Facilities in the United States

To set the stage for an evaluation of the health of neutron sciences in the U.S. and especially in the academic world, it is necessary to compare the funding of both facilities and individuals. First, in a comparison of the funding for operation of existing neutron facilities in the U.S. and in Europe, there are 8–9 neutron facilities in operation in Europe with an annual cost of ~$175M, which can be compared with the cost of ~$90M for 4 facilities in the U.S. The cost per facility is almost exactly the same, but there are twice as many facilities in Europe. For comparison, the GNP of the U.S. is greater than 1.5× larger than that of Europe.

With regard to the financial commitment for the future of neutron sciences in the U.S., SNS, funded by DOE, will be completed in June 2006 at a budget cost of $1.41B. The National Science Foundation (NSF) has funded a design study for a long-wavelength target station and is soliciting a $300M proposal to build this second target station at SNS, which would double the user capacity of SNS to ~4000.

5.2.2 User Capacity Prior to Commissioning of SNS

A key question is how large a user community can the U.S. accommodate prior to the opening of SNS. The Subpanel requested this information from each neutron facility, asking the following question. If your facility worked at capacity and all the upgrades you have proposed were funded, how many users could you accommodate in 2006? The answers are shown below

NCNR-NIST	15.–1.6 present user base	~1240
IPNS	2× present user base	~450
HFIR	With upgrade and SANS	~500
LANSCE/Lujan Center	Including Nuclear Physics Exp.	~1400
Total		**~3600**

These numbers may duplicate users among the facilities. However, with proper support of all U.S. existing facilities, by 2006, over three times the present number of users could be accommodated. If the SNS were commissioned today, the university-based neutron scattering community would be completely inadequate to fully exploit these new resources. If major changes are not made in our funding philosophy, this community will have no opportunity to grow.

5.2.3 Funding of Individual investigators

The severity of the problem is represented in Fig. 3, where the number of NSF and DOE/SC/ OBES awards to university-based investigators is plotted for the past 20 years. Included in Fig. 3 are all awards whose abstracts include the words "neutron scattering." It is estimated that approximately half these awards support the researchers who use neutron scattering as their primary investigative technique, while the remainder of the awards support researchers who make more than occasional use of neutron scattering, as well as neutron scattering conferences and training programs and one-time capital investments in major equipment. Approximately two-thirds of the NSF-supported research is in the materials research directorate, involving condensed matter physics and chemical applications. The remaining one-third comes primarily from the engineering and biological sciences directorates. DOE/SC/OBES supports university-based neutron scattering programs in condensed matter physics, chemical physics, and metallurgy and ceramics.

The Subpanel views this core group of approximately 40 neutron scatterers as absolutely critical to the success of the SNS. As in the past, they bear the primary responsibility for training the next generation of neutron scatterers. Their contributions to the scientific mission of the existing neutrons sources and, it is expected, to SNS are critical. Finally, these individuals comprise an increasing fraction of the overall neutron scattering community in the U.S., as funding for individual investigators at the DOE laboratories continues its steady decline (http://ww.sc.doe.gov/production/bes/budget.html).

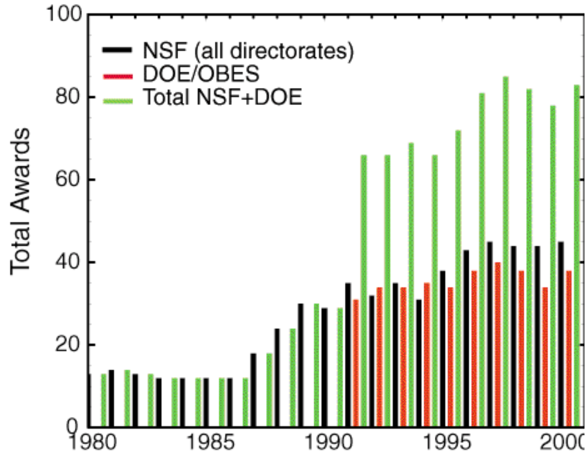

Fig. 3. Total awards made by NSF (all directorates) and DOE/SC/OBES to university-based neutron scattering programs. NSF data obtained from Fastlane. DOE/OBES data not available for pre-1991.

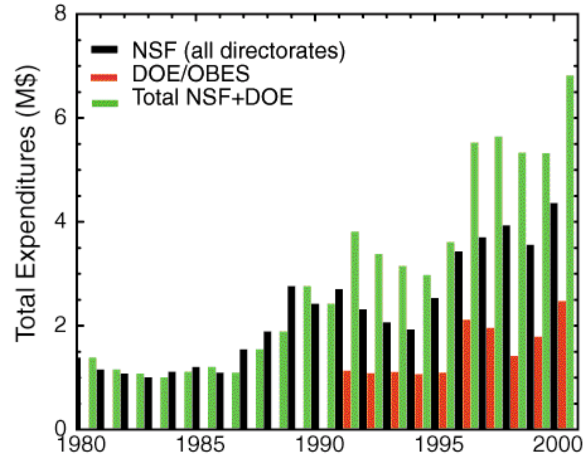

Fig. 4. Total expenditures for university-based neutron scattering programs in 1996 dollars.

Figure 3 shows that the number of these dedicated neutron scatterers has increased from near single-digit figures in the mid-1980s to its current level of approximately 40. Figure 4 shows the increased expenditures since 1985 which made this possible—$37M from NSF and $14M from DOE. The Subpanel believes that a steady-state user community of 3500 to 4000, largely based at universities, is required to fully exploit the SNS. The current level of funding is totally inadequate to fuel the desired growth in the university sector. It will take a concerted effort by all the federal funding agencies to create and sustain this new and broader pool of university-based neutron scattering researchers, a task made all the more difficult by its urgency.

5.2.4 Joint Appointments Between Government Laboratories and Universities

One of the most effective ways to immediately enhance the involvement of university professors, students, and postdoctoral associates in the neutron research being conducted at the national laboratories is through joint appointments. University professors will bring their students and postdoctoral associates to work at the laboratory, and laboratory staff with joint appointments will encounter students at all levels of education, spreading the word of the exciting research being conducted at National Facilities.

These programs exist at many of the laboratories, and the Subpanel compiled data on how many appointments there are and what impact they have on neutron sciences.

- The UC system created four half-time appointments as "ALS Professors" to enhance the research at the Advanced Light Source (ALS). The agreement was that UC would pay half of the salary to a department in one of the UC Campuses, and the Department would hire a Professor whose main research was to be done at the ALS. The other half of the funds comes from either the Department or the ALS.
- ANL has a small number (~5) of joint appointments, in addition to a large number of visiting faculty who do research at ANL for a few weeks to a year. The joint appointments are formalized and involve real sharing of cost on a continuing basis. Four of these joint appointments are to support the research at APS.
- ORNL has 9 jointly funded Distinguished Scientist positions and 20 Collaborating Scientist positions. At present, none of these appointments have been made to support the neutron scattering effort at ORNL.
- Brookhaven National Laboratory has a large number of visiting faculty, but does not have a formal program for joint appointments.

- NIST has a number of formal programs; however, they are not directly comparable to the DOE versions. Faculty appointments run from truly joint through Intergovernmental Personnel Act appointments to summer appointments to guest researchers.
- LANL has set up two LANSCE professorships which are basically a 50/50% arrangement between LANL/LANSCE and a university. A joint professorship at the assistant professor level has been established between the Department of Physics at New Mexico State University in Las Cruces and LANSCE. This is basically an endowed chair for an assistant professor. The University of California has created a LANSCE professorship at the distinguished scientist level at the campus in San Diego, which has just been filled.

Unfortunately, only one of these many DOE Laboratory positions has been designated for neutron scattering, the LANSCE professorships. The Subpanel was pleased to learn of the establishment of formal joint professorships between LANSCE and UC campuses. These positions should enhance the involvement of UC faculty at LANSCE and, hence, the quality of the overall user programs at the Lujan Center. The Subpanel was encouraged to hear that the UT/Battelle team that manages ORNL is in the process of recruiting Distinguished Scientists and Collaborating Scientists to strengthen the neutron materials program at ORNL.

This is one aspect of enhancing the user programs where laboratory management can immediately have a direct impact.

6. Recommendations

The Subpanel puts forth the following three-part plan, which is essential to enhance the neutron activities in the United States between now and the time SNS becomes a functional user facility. All three are equally important to achieve the goal of bringing the U.S. into an internationally competitive stature in this field.

6.1 Summary

❱ ***Immediately enhance activities at the IPNS facility***

The timely realization of the enhancement of the source, the instrument suite, and the level of scientific exploitation of IPNS are essential to the ongoing development of the user base in the ramp-up to the SNS. The Subpanel’s recommendations are

- Invest to maintain the excellent reliability
- Invest to enhance the IPNS source and instrumentation
- Expand operation of the user program to 30 weeks per year
- Strengthen scientific programs at ANL that develop the user base and scientific agenda for the SNS
- Explore the possibility of developing and operating first-class instruments at IPNS that can later be moved to SNS

Deliverables will be increased visibility of neutron scattering in the materials research community, seeding a broad user base in academia (namely those cognizant of the value of neutron scattering techniques), building a new generation of instrument scientists, and the testing and operation of new instrument technologies for the SNS.

The estimated cost is an additional $9M/year.

❱ ***Restructure LANSCE/Lujan Center to deliver an internationally competitive user facility.***

In order to render LANSCE/Lujan Center a viable user center in time to generate the needed impact for the SNS ramp-up in 2006–2008, the governance and management of LANSCE/Lujan must be fundamentally restructured. The plan for the restructuring should be presented at the

BESAC meeting in Washington, D. C., in February 26–27, 2001. The committee recommends implementation of the Cooperative Stewardship governance model as described in the National Research Council (NRC) 1999 report on this topic which stated that "Responsibility for design, construction, operation, maintenance, and upgrading of each facility core should rest with a single clearly identified federal agency—the steward."

The desired deliverables are:

- A single Steward of this facility must be appointed, incorporating all the different DOE offices and UC. The Steward is charged with single-point budget, policy, and priority responsibility.
- This Steward shall deliver an adequately funded actionable implementation plan for FY 2002, sustainable over the period 2002–2008, to generate a fully functional user facility, competitive with international benchmarks (e.g., ISIS).
- The plan must specify a ramp-up schedule for LANSCE/Lujan to fully functional status by FY 2003 in time to impact the SNS ramp-up in 2006.
- A fully functional neutron facility should have increased the LANSCE/Lujan user base to ~1000 by 2006.

❱ ***Establish a program to expand the university base for neutron scattering***

An immediate injection of funds is recommended for development of an enhanced user community, poised to fully exploit the SNS on commissioning in 2006. The cost of the previous two recommendations should not come at the expense of core funding for the national laboratories and universities. The recommended mechanisms are

- Well-funded facility-based user programs
- Joint University–Neutron Scattering Facility partnerships
- Development of a National Agenda for Enhancement of Neutron Scattering Research in the U.S.
- Strengthening the National Laboratory Neutron Scattering Groups

The desired deliverable is a three- to fourfold increase in the academic user base by the time SNS is functional.

6.2 Implementation

❱ ***IPNS***

IPNS presented a plan to enhance their scientific and human resource output in the ramp up phase to SNS. Their plan is outlined in Appendix 8.

- The Subpanel fully endorses this plan and recommends that BES and IPNS move expediently to implementation.

❱ ***LANSCE/Lujan Center***

The need for restructuring the governance and management of LANSCE/Lujan Center has been documented throughout this report. This must be handled carefully and in a constructive fashion so that the users and staff at this facility are not discouraged. The Subpanel offers the following suggested model for the governance of this facility.

- LANSCE/Lujan Center could be established as an NNSA national user facility using a governance model that maps directly from the recommendations of the NAS Cooperative Stewardship report. The UC system should have a major role in the governance to maintain the proper balance between internal Lab pressures from the Nuclear Weapons side and external pressures from the R&D communities.

❱ *Enhancement of the University User Base*

The recommendations to establish a program to develop the university user base come with a set of proposed mechanisms.

- The Subpanel recommends that OBES implement programs in collaboration with the relevant facilities and agencies. Suggested mechanisms are presented in Appendix 9.

APPENDICES

Appendix 1: Charge to the Committee

In September 1999, the Chair of the Basic Energy Sciences Advisory Committee (BESAC), Geri Richmond, was charged by Martha Krebs, Director of the Office of Science at the Department of Energy (DOE), to review the Intense Pulsed Neutron Source (IPNS) at Argonne National Laboratory (ANL) and the Manuel Lujan Neutron Scattering Center (MLNSC or Lujan Center) at Los Alamos National Laboratory (LANL). The charge is reproduced in the box below and posted on the BESAC website:

http://www.sc.doe.gov/production/bes/BESAC/charges.html)

> The first activity is a review of the IPNS and the MLNSC. As you know, BES has begun the construction of the Spallation Neutron Source (SNS) at Oak Ridge National Laboratory and is upgrading the MLNSC jointly with the Office of Defense Programs. When commissioned in 2005, the SNS will be the world's premier spallation source for neutron scattering research. However, during the interim and even past the time of the SNS commissioning, IPNS and MLNSC will be critical components of this country's capabilities in neutron scattering. Therefore, I would like BESAC to review the science and the user programs at IPNS and MLNSC. The group that you assemble for this task should, of course, contain experts in the sciences enabled by neutron scattering, but it should also contain members who will be able to address the effectiveness of the user program; user support; proposal review mechanisms; availability, dependability, and reliability; and the vision for the future of each facility. By analogy with the Birgeneau study of the synchrotron radiation light sources, the review should consider the full range of activities at IPNS and MLNSC regardless of whether they are supported by the BES program. I would like to have this report by July 2000. With the completion of this study and that already under way for the electron beam microcharacterization centers, BESAC will have reviewed all of the major BES facilities. These reviews represent an outstanding effort that is recognized throughout the scientific community. I want to thank and congratulate you for the thorough and professional way in which BESAC has conducted these reviews.

Because of circumstances at LANL (safety standdown, fire, etc.), the review was delayed until the fall of 2000.

Appendix 2: List of Panel Members

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Distinguished Scientist, ORNL Distinguished
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Appendix 3: Kickoff Meeting Agenda

IPNS/LANSCE Review Kickoff Meeting
October 12–13, 2000
Gaithersburg Marriott Washingtonian Center
9751 Washingtonian Boulevard
Gaithersburg, MD 20878

<u>October 12, 2000</u>

Continental Breakfast

Welcome and Introductions—Ward Plummer, The University of Tennessee, Panel Chair

Panel Charge and Proposed Direction for Review—Patricia Dehmer, BES / DOE; Iran Thomas, BES / DOE; Geraldine Richmond, BESAC Chair; Ward Plummer, Panel Chair

Pulsed Spallation Neutron Sources in a Global Context—Thom Mason, SNS / ORNL

Coffee Break

Neutron Scattering from Soft Materials—Lee Magid, The University of Tennessee

Lunch   Private —Panel and DOE Reps.

Highly Correlated Electron Systems—Andy Millis, Rutgers University

Soft Materials—Phil Pincus, Univ. of CA

Break

Structural Materials—John Parise, State University of New York

Magnetic Nanostructures—Sam Bader, Argonne National Laboratory

Wrap-up: Day 1 Discussion—Panel Only

<u>October 13, 2000</u>

Continental Breakfast

Re-Cap from Day 1 and General Discussion—Ward Plummer & Panel

LANSCE Overview—Roger Pynn (LANL) and staff

Coffee Break

IPNS Overview —Bruce Brown (ANL) and staff

Lunch

Final Discussion—Ward Plummer & Panel

Appendix 4: Information Requested from Centers

1) The Source:
   - A. Brief description of the existing facility
   - B. Performance of the source
     - i. How many days are available—scheduled for users
     - ii. Overall reliability of source
       - a. Linac
       - b. Synchrotron/storage ring
       - c. Target/moderator
     - iii. Slippage of actual running period with respect to advertised schedule
       Give trends over past 5 years—trends, specific problems, plans to solve these problems.
     - iv. Prepare a curve of mA-hrs per annum for common curve (measures quantity of beam), and frequency distribution of mA-hrs delivered per day (measures quality of beam).

2) Instruments:
   - A. Include a drawing of the floor plan, with a brief description of each instrument
     - i. Which community is served by each instrument
     - ii. Rank each of your instruments #1—world class, #2— useful research tool #3— outdated
     - iii. Rank quality of science on each beam line #1—world class, #2—competitive, #3— limited impact
   - B. Instrument loss times as percentage of instrument running, broken down as (i) losses in each category, summed over all instruments, and (ii) losses for each instrument, summed over all categories:
     - i. Hardware (choppers, etc.)
     - ii. Electronics and detectors
     - iii. Computing
     - iv. Sample environment
     - v. Other
   - C. Availability of beam time to different groups for each spectrometer:
     - i. External Users
     - ii. Instrument Scientists
     - iii. Director’s discretion
     - iv. Other internal usage (including calibration and commissioning)
   - D. Days requested and days delivered on each instrument, broken down by community: Physics, Chemistry, Biology, Engineering, Other.
   - E. Investment in instruments over past 5 years: new instruments, upgrades, maintenance.

3) Support facilities—sample preparation, computer analysis, etc.
   - A. What is available
   - B. What is planned.

4) Staff
   - A. Size of staff and assignments, give a breakdown of the staff
     - i. Accelerator
     - ii. Scientists
     - iii. Technicians
     - iv. Computing
   - B. Quality of the Staff.

5) Users

A. Quality of users:

i. List 20 top publications over the past 5 years, divided into at least four areas. Include Citation index and impact—These data should be summarized here and presented in 6.A.

ii. List awards by users and staff

B. Summary of user outside support: Who funds their programs and at what level?

B. Distribution of users according to fields

C. Reviewing process: A plot of the beam time allocations per year vs. the number of groups receiving this time allotment. Also: users/year, experiments per year, and proposals per year.

D. Measure of user satisfaction: A plot like the ISIS one sent to you or equivalent.

E. How is your facility increasing the neutron user base in the U.S.? What is being done to stimulate new science areas and broaden the user community?

6) Impact

A. The 20 most important papers over the past 5 years in which experiments were performed at your facility.

B. List of all publications in last 5 years, refereed journals only (to panel). This list should separate papers according to work performed (i) at the facility by users or staff (ii) at other facilities by staff. Separate out conference proceedings, and identify the field and the instrument used. The report should summarize this, but the panel should receive the complete list.

C. Plenary lectures and major awards.

D. Data for the common figure on publications per year with citations and papers per participating user. This is only for papers published using the facility.

7) Cost effectiveness

A. A plot like Roger Pynn prepared of all of the money that goes into the facility.

B. Cost per paper (like Bruce Brown showed)

C. Cost per delivered beam day

8) DOE milestones compared with performance

A. Last year’s outside review reports (will be put in Appendix)

9) The Future

A. What do you see as your role between now and when SNS comes on line

i. What upgrades have been approved for funding—source, instruments?

ii. How are you responding to problems identified by users?

iii. What are the needs for new instruments/upgrades in the next 2–3 years?

B. What is your plan for increasing the neutron user base in the U.S.?

C. What is your vision of life after SNS? What is the laboratories’ vision of this period? What is the justification for continued support?

Appendix 5: Agendas for Site Visits

LANSCE/Lujan Visit

Tuesday, November 14

7:30 - 8:00	Continental Breakfast, Lujan Center	
8:00 - 9:00	Opening	John Browne, DIR James Mercer-Smith, ALDNW Roger Pynn, LANSCE-DO
9:00 - 11:00	Science Presentations	
	Impact of Neutron Scattering On Interfacial Science Laboratory at UCSB	Tonya Kuhl, UC Davis
	Aging of He Binder Components	Bruce Orler, MST-7
	Deformation of Low-Symmetry and Materials	Don Brown, MST-8
	A Neutron Diffraction Study of Beryllium	Bimal Kad, UCSD
9:45 - 10:15	Break	
	Science Presentations (cont.)	
	Magnetization Reversal Asymmetry and Exchange Bias	Chris Leighton, UCSD
	Neutron Scattering Studies of Heterogeneous Catalysts	Kevin Ott, C-18
	Fundamental Nuclear Physics With Cold Polarized Neutrons	Shelley Page, Univ. of Manitoba
11:00 - 12:00	Tour ER-2	Joyce Roberts and Lujan Scientists
12:00 - 12:45	Working Lunch, Lujan Center	
	LANSCE and Lujan Operations	Earl Hoffman, LANSCE-DO
	Upgrades/New Capabilities	Geoff Greene, LANSCE-DO
12:45 - 2:15	New Instruments	
	HIPPO	Rudy Wenk, UC Berkeley
	SMARTS	Mark Bourke, MST-8
	Protein Crystallography Station	Paul Langan, B-N2
	VERTEX	Rob McQueeney, LANSCE-12
	SABER–A Silicon Backscattering Spectrometer for LANSCE	Paul Sokol, Penn State
	A Total Scattering Diffractom-eter at the Luan Center: The NPD Upgrade	Simon Billinge, Michigan State
2:15 - 2:30	Break	
2:30 - 3:00	Defense Science at LANSCE	Steve Sterbenz, NW-EP
3:00 - 4:00	Poster Session, Lujan Center and others	Geoff Greene, LANSCE-DO
4:00 - 5:00	Closed Session	LUG Executive Committee Members Division Review Committee Members
5:00 - 6:00	Executive Session	Closed - Panel Members only Others if requested
6:30 - 8:00	Dinner, El Nido	By Invitation Only

Wednesday, November 15

7:30 - 8:00	Continental Breakfast	
8:00 - 9:00	LANSCE's Role in Los Alamos Nuclear Weapons Program	Steve Younger, ALDNW
9:00 - 10:30	Executive Session	Closed - Panel Members only
	Discussion with Management	William Press and Tom Meyer
	Questions/Answers	

IPNS Visit

Thursday, November 16

8:45 am	Hermann Grunder, ANL Director	
	Frank Fradin-Assc. Lab. Dir.	Lab Management Perspective of IPNS
9:00 am	Bruce Brown	IPNS Report to BESAC
9:45 am	Jim Richardson (IPNS)	IPNS Enhancement Project
10:15 am	Break	
10:30 am	Science presentations	
	Simon Billinge (MSU)	
	Chun Loong (IPNS)	
	Brent Heuser (UIUC)	
12:00 pm	Lunch at cafeteria	
12:30 pm	Gian Felcher (MSD)	Lunch talk
		"What Can be Done About Nanostructures?"
1:15 pm	Jim Jorgensen (MSD)	Role of Materials Science Division at IPNS
	Ray Osborn (MSD)	Magnetic Inelastic Scattering
	Suzanne teVelthuis (IPNS)	Solving the Exchange Bias Problem
2:15 pm	Science presentations	
	Ray Teller (BP)	
	Jack Carpenter (IPNS)	
3:45 pm	Kent Crawford (IPNS)	The Role of IPNS in the SNS
3:55 pm	Gerry McMichael (IPNS)	Accelerator Improvements at IPNS
4:15 pm	Tour of IPNS and SNS facilities	
5:15 pm	Executive session	
6:30 pm	Reception-Freund Lodge	
7:00 pm	Dinner	

Friday, November 17

8:45 am	Science presentation	
	Sow-Hsin Chen (MIT)	
	David Price (MSD)	
9:15	Bruce Brown	Summary
		Questions/Answers
10:00	Executive session	
	Discussion with management	Hermann Grunder
		Frank Fradin
		Bruce Brown

ARGONNE NATIONAL LABORATORY

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11/3/00
Dear Ward,

At your request, I enclose the last report of the University of Chicago review committee on the Materials Science Division. I also include a copy of the "Neutron and X-ray Group" section from the previous 1998 report. On page 10 of the 2000 report you will find the section on the Neutron and X-Ray Scattering Group, which comprises the following staff scientists: Jim Jorgensen (group leader), Dimitri Argyriou, Gian Felcher, Ray Osborn, David Price, and Marie-Louise Saboungi. Incidentally, although the group's title and interest includes x-ray scattering, it is primarily a neutron scattering group. We also have a separate "Synchrotron Studies" group specifically in x-ray scattering.

You will see from these reviews why we are so proud of this group which provides a major fraction of the scientific output of IPNS. There has been a healthy symbiotic relationship with IPNS, but the funding erosion that we have seen is seriously threatening the future. There is no shortage of exciting ideas from the group for new applications of pulsed-neutron scattering to materials science. However, budget constraints have been stifling. I am including the last divisional review and response in its entirety (please maintain appropriate confidentiality) for two reasons. I would like you to see how the scientific role of the neutron scattering program is pivotal to many programs in materials science. In addition, you will learn of the serious funding issues which have affected this group, and the division in general. I would be happy to provide you with budget numbers on the neutron group, but in a nutshell the funding has been eroded in real dollars over the last decade. In inflation adjusted terms the budget has been cut by more than 1/3. This year, we have been given a 5% cut in the most recent financial plan. It strikes me as a serious mistake to allow the science of neutron scattering to erode so severely, whilst building the new Spallation Neutron Source. It would obviously be an excellent investment to add resources to our budget and allow us to recruit materials scientists with a neutron scattering background to build the base of users for SNS.

Obviously, your committee will judge, but I am sure you will share my conclusion that this group is an outstanding set of neutron scientists who, with modest investment, could be utilized to build the science base for SNS.

Sincerely

Murray

Murray Gibson

NEC

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July 1, 1999

Mr. Hugo F. Sonnenschein
President
The University of Chicago
5801 Ellis Avenue
Chicago, IL 60637

Dear Mr. Sonnenschein:

Enclosed please find the report of our review for the University of Chicago of the Intense Pulsed Neutron Source (IPNS) Division at Argonne National Laboratory (ANL). We would also like to take this opportunity to thank your staff at Argonne for the excellent arrangements made for the review.

Sincerely,

Gabriel Aeppli

GA:kah
Encl.

SUMMARY OF FINDINGS AND RECOMMENDATIONS

Over the last two years, the Intense Pulsed Neutron Source (IPNS) has continued its outstanding performance as the most reliable and cost-effective DOE-sponsored neutron user facility. The scientific output continues to be excellent, and the review committee was particularly impressed by the recent developments in soft condensed matter. In addition, a new instrument (QENSII) is nearly on-line, more APS (Advanced Photon Source) and other ANL collaborations are occurring, and IPNS has assumed responsibility for the instrumentation at the Oak Ridge Spallation Neutron Source (SNS). Considering the excellent value for money at IPNS, it is disappointing that the DOE has not funded the IPNS enhancement project which was presented to this review committee in 1997. The future of IPNS continues to be tied to the SNS and over the next 7-10 years, the key roles of IPNS will be to build the user program for SNS and to provide technical expertise, especially on moderators and instruments. IPNS needs to fill both of these roles well so that the SNS will develop the early scientific momentum required to justify its capital and running costs. Our main recommendations are:

1. The accelerator plant needs to be managed as a facility with a substantial life expectancy and a continued need for high reliability. The across-the-board flux gain and staff motivation which would follow very clearly justify the second harmonic rf cavity project.

2. The IPNS and SNS science and instrumentation groups should be managed as a single coherent entity. All scientists in both groups should be responsible for interacting with IPNS users, and the secondary spectrometers of many SNS instruments should be installed at IPNS.

3. Both because of tremendous future opportunities and Argonne's world-leading experience with cold neutrons, IPNS should play the leading role in the SNS second target station project.

STONY BROOK

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7 February 2000

Mr. Hugo F. Sonnenschein
President
The University of Chicago
5801 Ellis Avenue
Chicago, Illinois 60637

Dear Mr. Sonnenschein,

Enclosed is the report of the University of Chicago Review Committee for the Materials Science Division (MSD) at Argonne National Laboratory. This report, like the report of the previous review, is positive. The committee found that the quality of science produced continues to be outstanding, and we believe both the Division and its energetic new director, Dr. Murray Gibson, deserve commendation.

Dr. Gibson gave my committee substantive issues to chew over, based on his analysis of future expected funding which the Basic Energy Sciences (BES) division of the DOE can provide. His picture indicates that without creative action to improve funding, the MSD will die a slow death by attrition and aging. Although top priority is to benefit from new BES initiatives and to help BES enable new funding, nevertheless, it seems likely that steadily increasing supplemental funding from non-BES sources will have to be found. The committee found that the MSD staff generally agrees with this analysis. The committee strongly supports Dr. Gibson's aim to find the necessary funding.

Alternate sources of funding are inherently more volatile than BES funding, and less likely to provide secure support for the long term, curiosity driven research which has been MSD's traditional and successful research mode. However, the division remains vital and has already started moving toward the more flexible and entrepreneurial culture needed for survival in this new mode. Further cultural adjustments are no doubt in store for researchers and administrators. We hope that the laboratory as a whole, including administration from both the University of Chicago and the Department of Energy, can be similarly flexible in the future.

Lab management and the University of Chicago should do everything they can to help the MSD division succeed. This division seems to us especially critical to the laboratory.

Materials science and solid state physics are disciplines which are central to Argonne's mission and also to the mission of the Advanced Photon Source. The division is cultivating an increasing responsiveness to shifts in the scientific landscape and in scientific opportunities, and should be a valuable resource and model for Argonne as a whole in an unpredictable future.

The division director has suggested that since DOE has recently been reviewing programs at regular intervals, perhaps the University of Chicago reviews of the MSD could be held at two year intervals rather than at 1.5 year intervals as in the past. The committee is neutral on this, and therefore regards it as an issue which the University of Chicago and its STAC must decide.

Yours truly,

Philip B. Allen

The University of Chicago
Review Committee Report for the
Materials Science Division
At Argonne National Laboratory

Philip B. Allen, Chair
SUNY Stonybrook

Walter L. Brown
Lucent Technologies

Jerome Hastings
Brookhaven National Laboratory

Robert Hull
University of Virginia

Theodore E. Madey
Rutgers, The State University of New Jersey

Julia M. Phillips
Sandia National Laboratory

Ian K. Robinson (not able to attend)
University of Illinois

Ivan K. Schuller
University of California-San Diego

Howard K. Birnbaum
University of Illinois
Member, the UofC Scientific and Technical Advisory Committee
And Liaison to the MSD

January 5-7, 2000

I. SUMMARY

Murray Gibson has been in place as director of the Materials Science Division (MSD) for just one year now. His understanding of the research in the division, and of the budget and other administrative aspects of MSD was very impressive to the committee. We were also strongly impressed by his energy and optimism, and his commitment to improving the science of this outstanding division.

The division director indicated that long-term survival of the division requires actively acquiring funding from new sources, both inside and outside of the Basic Energy Sciences (BES) division of DOE. He expects that without creative action from the division, the steady erosion in core support which BES provides is very likely to continue. It will be necessary to benefit from new BES initiatives, to help BES enable new funding, and to cultivate new types of external funding. The committee finds that this analysis is generally accepted within the division, and strongly endorses Gibson's activist attitude. If alternate sources of funds are not found, then voluntary or involuntary terminations will occur. The long-term health of research demands that new hiring should not cease. Therefore a steadily increasing percentage of new funding is the only method to keep the division from dying slowly by aging as well as by attrition.

Non-BES funding will necessarily require a change in the culture of research in the division. Researchers must be more willing than they might prefer to respond quickly to new opportunities and then to abandon opportunities that fail to keep funding. Thus it would be best if new opportunities were identified and created from "the bottom up" rather than "the top down." The retreat scheduled for February will give the whole division an opportunity to start participating in this process.

Non-BES funding will also require a change in the culture of management, at the division, laboratory, and perhaps also DOE levels. As an example, the committee has anecdotal evidence that in the past, incentives to bring external funding were undercut by a practice of diminishing the core BES funding of the successful group. Positive incentives must be offered.

Involuntary terminations have occurred in the past and are expected to occur in the immediate future unless voluntary early retirements occur. The committee believes that the new director's policy of prompt disclosure of forthcoming problems is correct. Morale in the division has of course temporarily suffered as a consequence, but no one has said that the disclosure was wrong. In the short term the division should be as careful and protective of its personnel as possible, although in the longer term, it does not make sense to continue increasing the fraction of the budget designated for personnel. A related problem is the tendency for the ratio of PI's to support personnel to increase.

The largest fraction of the required non-BES funding may come from major initiatives which cross group boundaries. The division leadership has identified three areas where such initiatives may occur. In order of maturity of planning, they are (1) nanomagnets (and more generally, nanostructured materials), (2) aberration-free *in situ* electron microscopy (NTEAM), and (3) soft matter. The committee wishes to express strong support. In order for such initiatives to succeed, some reorganization (14 groups may be larger than the optimal subdivision?) and some new hiring seems essential. The fact that the 25-30% of researchers who are in "materials chemistry" are administered by the Chemistry division rather than MSD strikes us as less than ideal. Isn't there a better administrative solution?

The committee offers the following observations:

II. ACTION ITEMS

1. Successful pursuit of new initiatives will require redirecting research in creative directions and abandoning projects whose time is past.

   a) Granular matter provides a model of a new direction, which is already in place and working well. It is an emerging area of materials science, and may provide a new source of ideas for more established fields of materials research. It also links with engineering and applied science, and may offer further opportunities for diversification of funding.

   b) Nanomagnets have been chosen as a thrust area for new funding. It would improve the credibility of proposals in this area if the division's current outstanding but small effort in this area were enlarged.

   c) "Soft matter" is a very broad category which the division has identified as having growth potential. The challenge is to find niches where creative science can be cultivated. These should be attractive to division personnel, and should attract new funding. It may be hard to accomplish this without new hiring. The organic superconductivity group is making efforts in this direction, as are at least two other groups (neutron and x-ray scattering, and computational materials chemistry.) These efforts should coordinate and also compete in healthy ways. The division can afford to take risks provided there is also the flexibility to quickly stop and redirect efforts in the most promising directions.

   d) The organic superconductor effort is a good example of a productive, exploratory program that has gone on for a number of years in a high-risk area. At present it is not very vital, and the efforts of that group might be more profitably focused on other objectives. For example, synthesis of organic nanomagnets is a promising project that has already been started.

   e) The division might be wise to engage in new high risk projects (perhaps at a more modest scale) in exploratory synthesis of new materials of other kinds (exotic oxides, biomaterials, ...?)

2. Electron microscopy plays a less central role in the division than it could if the dedicated group were larger. Money must be found in the not too distant future for

new microscopes. These observations become particularly relevant in light of the director's ambitious idea for an initiative for a new kind of microscope ("NTEAM"). For such an initiative to succeed, new personnel with design expertise should be added, and existing personnel in related groups with needed skills should perhaps be redirected to provide support for this initiative.

3. The APS is now a reality. It seems to us possible that the division derives less than ideal benefit from it. Perhaps the groups most connected to the APS are insufficiently coupled to the division? Are there ways to increase the communication between outside users who visit to do experiments and the personnel of the division?

4. The possibility of creating a national user facility based on RIMS (resonance ion mass spectroscopy) instruments seems to us a valuable idea which should be pursued.

Agenda LANL

Los Alamos Neutron Science Center (LANSCE)
Division Review Committee
2000 Meeting
May 2- 4, 2000

<u>Monday, May 1</u>

7:00 - 9:00 p.m.	Opening Session (Hilltop House, Tyuonyi Room)	Roger Pynn
	• Meeting Agenda • Discussion of Committee Charge • Division Self-Assessment	

Tuesday, May 2

8:00 - 8:30	Continental Breakfast for committee at the Pinon Conference Room, TA-53, Bldg. 31, Room 201	
8:30 - 9:30	Executive Session	
	• Introductions	Welcome & Roger Pynn
	• Committee Process Update	Division Review Allen Hartford
	• Welcome	LANL Overview & Don Cobb
9:30 - 9:45	Introduction to LANSCE: Vision, Mission, Strategic Direction and Accomplishments	Roger Pynn
9:45 - 10:00	Introduction to the User Facility	Roger Pynn
10:00 - 10:15	Break	
10:15 - 11:00	Nuclear Physics & Neutron Scattering Highlights at the User Facility	Geoff Greene
11:00 - 11:45	SPSS Enhancement	Paul Lewis
11:45 - 12:30	Proton Radiography	Mary Hockaday
12:30 - 1:30	Working Lunch and Executive Session	
1:30 - 2:15	The LANSCE Safety Journey	Roger Pynn
2:15 - 2:45	Break	

Tuesday, May 2

2:45 – 3:45	Facility Operations	Earl Hoffman
3:45 - 4:15	Workforce Planning and Program Development	Stan Schriber
4:15 - 4:30	Break--Proceed to Hilltop House	
4:30 - 6:15	Poster Session at Best Western Hilltop House: Lujan S&T and HPM 5:30--6:15 Director Hosted Reception (by invitation)	Taos Room
6:30 - 8:30	Dinner (by invitation)	The Loft

Wednesday, May 3

8:00 - 8:30	Continental Breakfast for visitors at the Pinon Conference Room, TA-53, Bldg. 31, Rm. 201	
8:30 - 9:15	LANSCE-2	Daniel Fitzgerald
9:15 - 10:00	LANSCE-5	Carl Friedrichs Michael Lynch
10:00 – 10:15	Break	
10:15 - 11:00	LANSCE-9	Michael Fazio
11:00 – 12:00	LANSCE Budget & Issues Facing the Division	Roger Pynn
12:00 - 1:30	Working Lunch & Executive Session • LANSCE's Role at LANL • Initial Perceptions	 Bill Press Tom Meyer
1:30 - 2:45	Executive Session--(Presenters available for Q & A) Alan Leadbetter will join by phone at 2:00 p.m.	
2:45 - 3:00	Break	
3:00 - 5:00	Executive Session--(Presenters available for Q & A)	
6:00 - 9:00	DRC Committee Members Dinner	Hilltop House

Thursday, May 4

8:00 - 10:00	Executive Session, Continental Breakfast, TA-53	DRC Members
10:00 - 11:30	Executive Out-brief (by invitation only) (John Browne, Bill Press, Allen Hartford, Thomas Meyer, Jim Porter)	DRC Members
11:30 - 12:30	Open Out-brief	

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July 29, 2000

Dr. John Browne, Director
Los Alamos National Laboratory
Los Alamos, New Mexico 87545

Dear Dr. Browne:

Enclosed is the LANSCE Division Review Committee Report following our meeting of May 2-4, 2000. Several LANSCE DRC members were not able to attend this meeting, so our 'coverage' of all the science and technology issues presented is not as complete as we would like. Also, the terrible Los Alamos area fire occurred just a few days after the review. Recommendations for actions in this report, of course, are not able to reflect that singular event and its consequences for LANSCE/Lujan activities. However, recent emails from LANSCE have indicated that operations are returning and, in particular, delivery of beam to the Lujan Center has made great progress. We are very pleased with this, as much of the report focuses on the disposition of the Lujan Center and the imperative to deliver beam to the neutron scattering community.

The committee was very pleased with the presentations from LANSCE staff. They were generally of an outstanding quality and the interactions and discussions with the DRC were excellent. It is clear that the "safety stand down" at LANSCE extracted a heavy toll on LANSCE management and staff and lead to no beam for research at Lujan. Despite this, it must be said that the DRC was very impressed with the delivery of 5000 hours of beam to other activities at LANSCE—this is world-class operation and allowed a wide range of outstanding science to be carried out.

Our central recommendations deal with the Lujan Center and the absolute need to deliver neutrons for the neutron scattering community. The DRC feels strongly that this must be the central focus of near term activities at LANSCE. If the neutron scattering community (and its sponsors) are to return to Los Alamos, the Lujan Center must be operated safely, reliably and predictably. The focus should be on running a few instruments and getting science out. This will get people's attention!

If you have any questions regarding out report please do not hesitate to get in touch with me or any member of the LANSCE DRC.

Best regards,

Lee S. Schroeder
For the LANSCE DRC

LANSCE DIVISION REVIEW COMMITTEE REPORT
March 1999-April 2000

1 Introduction

The Los Alamos Neutron Science Center (LANSCE) Division Review Committee (DRC) met at Los Alamos National Laboratory from May 2-4, 2000, to conduct a review of the LANSCE Division. This review covers approximately the period from March 1999 through April 2000. Most of the DRC membership were in attendance; however, three members (Dr. Michael Anastasio, Prof. Mike Cornwall and Prof. Alan Leadbetter) were unable to attend. This affected the DRC's ability to adequately cover some of the LANSCE areas we were charged with reviewing (Note: Prof. Leadbetter did visit LANSCE prior to our meeting and did provide feedback to the DRC and LANCSE management). The full membership list is included as an appendix, along with the Charge to the Committee and the meeting agenda. This review covers a little over one year since the last review of LANSCE. This period involved significant events, such as the 'safety stand down,' with substantial impact to LANSCE and its programs. In addition, the present review took place just days before the disastrous May 2000 fire, in and around Los Alamos. This needs to be taken into account when the observations and recommendations contained in this report are being considered.

This year, as in the Committee's charge for its 1997 report, we were asked to award grades. We were requested to consider these in the context of the DRC's charter addressing the four review criteria specified by the University of California President's Council:

a) "quality of science"
b) "relevance to national needs and agency missions"
c) "performance in construction and operation of major research facilities"
d) "programmatic performance and planning."

This assessment reflects the case that the LANSCE facility has several important roles. It is a critical component of DOE's Stockpile Stewardship effort with emphasis on neutron capability to address important issues related to nuclear weapons and it aspires to provide a world-class neutron scattering capability for basic research in condensed matter, material research and other important research areas. Taken as a whole, LANSCE is the centerpiece of the laboratory's goal of Los Alamos being known as the "neutron laboratory."

The committee wishes to say a few words about this year's review. The meeting was very effective and all staff are to be congratulated for their presentations and willingness to 'fill in the details' when questions arose. There was a great deal of 'honesty' displayed in the course of the presentations and discussions—LANSCE management and staff didn't hold back, e.g., on such things as comments related to the 'safety journey' and its overall impact on LANSCE capabilities and relationships with the DOE. The poster presentations, while few in number, were excellent and committee members were able to have quality time with several staff members at that time. We learned a great deal from the posters about the LANSCE facility, its research program (DP and Science), the SPSS enhancement project and other elements of the LANSCE program. This year's Self-Assessment document was a great improvement over last year's and contained much useful information. For next year, the Committee would like to see more discussion on planning and overall context of the LANSCE facility, as part of such a document. The committee was pleased that Roger Pynn, during his presentation(s), responded to many of the comments and issues contained in last year's DRC report. We recommend that items such as the Self-Assessment document and responses to this year's report be sent out well in advance of the next meeting—this will be very useful to the next committee and can help focus the review.

2 Performance Assessment

Before discussing the specifics of our report, we present our overall assessment in the context of the University of California President's Council four review criteria. We do this taking into account the safety shutdown which affected LANSCE over the past year.

a) Quality of Science:

Despite the "safety stand down," the LANSCE facility, exclusive of the Lujan Center, performed at a very high level during the last year. The linac delivered over 5000 hours of protons for the DP program—this is world-class operation. It was a very successful year for DP activities, e.g., the proton radiography (PRAD) program performed spectacularly, a very substantial program was carried out at WNR and important science was conducted, including valuable studies related to the better understanding of the PSR and its ability to provide high currents for the Lujan Center. The outstanding operation of the linac, which directly contributes to the quality of LANSCE science, the great success with PRAD and WNR, warrant an outstanding to excellent score for LANSCE. The lack of operation of the Lujan Center tends to reduce the overall score.

b) Relevance to National Needs:

LANSCE offers unique capabilities to the national effort in the area of Science Based Stockpile Stewardship (SBSS). Its contributions to new capabilities, such as PRAD, and significant science measurements (for defense programs and non-classified basic research) at WNR (e.g., (n, 2n)) are outstanding. With the decrease of neutron capability (pre-SNS) throughout the United States (HFBR shutdown, NIST and HFIR off-line for source enhancements), it is absolutely essential that LANSCE succeed and be a steady, reliable neutron source. When operating, Lujan should be a principal source of student training, not only for today's science but also for developing a cadre of young researchers for SNS. The Isotope Production Facility (IPF) will be an important addition to the United States' capability to produce radioisotopes. Such isotopes are a 'strategic resource' for the United States. They are of great importance to the medical community, biological and life science researchers. LANSCE's potential to contribute to the national and international scene is truly outstanding. It demonstrated this during last year's operations.

c) Performance in the Const. and Operation of Major Research Facilities:

The review year was **mixed** for LANSCE in this area. On one hand, operation of the linac and the performance of the DP-aspects of the program were at a very high level, yielding significant new science and opening up new scientific opportunities. On the other, the 'safety stand down' did not allow operation of the Lujan Center, a keen disappointment to the LANSCE staff and the affected neutron scattering community. While the IPF appears to be behind its construction schedule, activities are planned which could alleviate and put it back on track.

d) Programmatic Performance and Planning:

Again, the year was **mixed** in this category. With the outstanding delivery of 5000 hours of protons by the LANSCE linac, the DP program was able to make substantial strides. Also, with the help of the LANSCE staff, elements of the DP research community (particularly WNR) were able to respond quickly to the availability of large amounts of beam time. However, given the critical need to repair infrastructure (the "run to failure" mode that will be addressed later in this report) it may have been appropriate and more opportune to have cut back on running time and put some of the (admittedly) limited resources into assuring reliability of the LANSCE accelerator complex.

The committee would like to make a general comment regarding last year's 'grading' which may be useful to the University of California (UC), the Department of Energy (DOE) and Los Alamos. Last year's scoring by UC and DOE were shared with the committee and we found this very useful in our discussions and deliberations. Both the UC and, in particular, DOE's grading of LANSCE were lowered relative to the DRC report. The DRC has no problem with this, but would like to point out that the periods covered by the various reports and their corresponding ratings **represent very different time frames**. In particular, last year's DRC report, did not and could not have reflected the events that occurred following the "safety stand down" at LANSCE. As a further example, the present report can not reflect consequences resulting from the terrible fire that occurred in the Los Alamos area immediately after our review. We hope that these comments are useful to the various parties as they pull together their own assessment reports in the future.

H. Other Remarks

Before moving on to the more specific elements of the charge for this review, a few remaining comments summarizing the sense of the committee are included below:

There is one principal message that the committee wants to impart to both LANSCE and Laboratory Management and staff. The primary goal for LANSCE over the next several months must be—**run Lujan! Run it safely, reliably and predictably.** We fully appreciate that LANSCE staff has been working hard toward this goal. As discussed, it was a very successful year (on a limited budget) for the DP program--a year that everyone can have a strong sense of pride in. To top this off, the success of Lujan has to be accomplished. Summer 2000 may represent the last opportunity to attract the neutron scattering community to Lujan and LANL. LANSCE and LANL can be the "neutron laboratory"—a success with Lujan is central to that theme. Our best advice is:

iii. run Lujan (through October)
iv. run three (3) instruments (concentrate on what you have, get the science out)
v. other things may have to be postponed or abandoned to accomplish this
vi. reliability and creditability at Lujan is uppermost
vii. a substantial, but not optimal, budget exists—you must perform within this constraint to gain credibility with your sponsors and user communities.

Having indicated the committee's sense above, we also realize that the "run to failure" mode of operation, identified in our last report, is still in place. As discussed later, potential failure points (e.g., RF tubes) are known. These exist because the LRIP project was really not completed; there is much more that needs to be done to the LANSCE infrastructure to guarantee long-term reliability and success of operation for the DP and Science programs. This indicates the need for additional Accelerator Improvement Projects (AIP) funding. Planning will be essential and both LANSCE and the laboratory will need to get behind this to make the strongest case to the sponsors. In particular, sufficient funds need to be provided by the DP program to realize fully the unique opportunities for SBSS that are present at LANSCE.

A final comment with regard to communications with DOE. The assessment document indicating DOE's S&T grading of LANSCE was a real eye opener. The committee believes that this is indicative of "broken lines of communication" between LANSCE and DOE/DP and possibly even more broadly. **This must be improved.** As one part of an effort to rectify this, the committee recommends that DOE representatives from the DP and BES program offices (and others as appropriate) be invited to attend the DRC meetings, as well as tours of the LANSCE facilities. More and better communication with DOE at all levels is essential to LANSCE's future.

August 7, 2000

Dr. John Browne, Director
Los Alamos National Laboratory
Los Alamos, New Mexico 87545

Dear Dr. Browne:

I would like to clarify a point regarding the reference to the LANSCE "safety stand down" that we made in our LANSCE Division Review Committee Report, forwarded to you on July 29, 2000 and also in the Report's cover letter. I understand that this phrase may be subject to misinterpretation and want to make sure that you understand the context in which it was used.

The term "safety stand down" should be viewed as an inclusive one. In this way, it was meant to include **several** safety-related events that occurred at LANSCE during the period between the DRC meetings. Specifically, it includes:

3 the safety shut down which occurred between Feb.'99 and Jun'99, after which the linac delivered 5000 hours of outstanding operation for LANSCE's DP program—PRAD, WNR, μCN neutrons, etc.

4 work required for the BIO activity and analysis of new potential hazards for the Lujan targets

5 activities needed to move toward a 'nuclear facility' classification, and

6 cleaning of the rad drains (a legacy issue) at the Lujan Center.

Much of the committee's concern was focused on getting the Lujan Center back up and running, so that we tended to lump all these items under one category—the "safety shut down," rather than breaking them out separately (which Roger did in his presentation of LANSCE's Safety Journey).

I'm sorry if this usage has led to some confusion—I trust that this brief note help's clarify it. I am very pleased to hear from Prof. Shenda Baker (DRC member), presently at Los Alamos, that protons are being delivered to the Lujan target and neutrons to Lujan instruments. This is what is needed to demonstrate to the neutron scattering community that LANSCE is a reliable place to get its neutrons.

Best regards,

Lee S. Schroeder
For the LANSCE DRC

LANSCE
Los Alamos Neutron Science Center

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Date: October 20, 2000

Refer to: LUO-2000-019

Dr. Roger Pynn
Division Director
Los Alamos Neutron Science Center
Los Alamos National Laboratory
Los Alamos, NM 87545

Dear Roger:

We write on behalf of the LANSCE User Group (LUG) to voice both support and concern for the user facilities and programs at LANSCE. We feel this letter is timely as both the Lujan Center and WNR emerge from recent upgrades, which position both facilities to make key contributions to the nation's productivity in basic and applied science and the Laboratory's primary mission of stockpile stewardship.

The LANSCE User Group Executive Committee's highest priority is that user facilities on the mesa, particularly the Lujan Center, achieve reliable, sustainable operation with an 8-month run cycle per annum. As you know, this is also the view of the 2000 LANSCE Division Review Committee (DRC). LANSCE has accomplished the prerequisites for this in (i) extremely reliable accelerator operation and (ii) aggressive upgrades of the storage ring, target station, Lujan instrumentation, and other supportive infrastructure. We recognize that these were accomplished in the face of difficult regulatory and authorization basis issues and have clearly born fruit in very successful 1999/2000 WNR and PRAD programs.

Clearly, consistent funding of the facility through LANL's Nuclear Weapons program has enabled these forward steps, and we recognize that the NW program's continued support of LANSCE is essential for viable user programs. We fully endorse LANSCE management's focused, rational response to safety and regulatory problems, which have arisen over the past two years. In addition, we strongly support LANSCE management's execution of a 6-month run cycle this year, as well as their proposal of an 8-month run cycle in 2001, as these choices directly address the users' and the DRC's first priority without compromising safety, reliability, and programmatic milestones.

While we view recent accomplishments in 1999 and 2000 with enthusiasm, we are concerned whether future budgets will enable LANSCE, particularly the Lujan Center, to realize its bright potential. A specific budget concern, which should be addressed by LANSCE sponsors in the short-term, is the extra annual cost needed to bear the regulatory burden of upgrading the Lujan target station to a class 3 nuclear facility. In addition, although our anxiety relates to user programs across the mesa, we have special concerns for the Lujan Center, which promises a significant positive scientific impact in the near future for both the Laboratory and an external user community badly in need of more neutron scattering capacity. We are particularly fearful that overly conservative Basic Energy Sciences (BES) support in recent years for Lujan will continue, or even that BES will terminate its sponsorship of Lujan altogether. The repercussions of this action would likely go beyond the Lujan Center and could result in the loss of other major sponsors of LANSCE programs.

It should be emphasized that our most compelling concern reaches beyond these specific budgetary issues. LANSCE has a more comprehensive mission than many other user facilities and consequently gets funding from multiple sponsors, who sometimes have conflicting interests. The LUG Executive Committee feels strongly that a simplification and / or restructuring of the relationship between LANSCE management and its sponsors is vital to achieving a stable, adequate budget for the future. LANSCE clearly needs this to maintain effective external user programs.

Our committee stands ready to assist LANSCE management to achieve the goals outlined above; we believe they are imperative for successful future operations. On behalf of the LANSCE User Group,

Sincerely,

Christopher J. Durning, Chair of LUG Executive Committee
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EXECUTIVE SUMMARY FROM THE LANSCE USER GROUP EXECUTIVE COMMITTEE MEETING JUNE 20-21, 2000

The following key issues were raised and discussed in the LUG Executive Committee (LEC) meeting held at the LANSCE division site on 20-21 June 2000. To reflect the primary intent of each statement, they are categorized as endorsements, recommendations, or points of concern.

Endorsements

1. The LANSCE Division Review Committee (DRC) met May 2-4, 2000 and suggested a number of key milestones for LANSCE to accomplish. Top priority was given to "reliable, sustainable" user facility operations, including the Lujan operation, with a target of an 8-month operation per annum.

2. The LEC congratulates LANSCE management and operations for accomplishing the successful delivery of protons to the Lujan target on 17 June in the face of a difficult regulatory environment. This sets the stage for reviving the Lujan user program. The very reliable performance of the accelerator over the past 8 months and the successful programs at WNR and PRAD were also impressive. Program support from Nuclear Weapons (NW) for WNR was acknowledged as absolutely crucial to its success. These accomplishments clearly are in line with the main priorities of the DRC for reliable operations.

3. Unequivocal, quantitative evidence of improved safety practices at the LANSCE division was presented.

4. The near-future operating schedule for the period from 15 June to 15 December proposed by LANSCE management prioritizes Lujan operation. A shutdown thereafter will allow hookup of a new cooling tower, IPF construction, and SPSS ion source enhancement. The LEC strongly supports this plan, as it addresses the primary concern of the LEC and of the DRC review - resuscitating the Lujan user program. In our view the proposed plan addresses this without unduly compromising other programs on the mesa and without extraordinary risks. The LEC expects to provide input on activities during the shutdown.

Recommendations

5. LANSCE is an accelerator facility, lending to more complexity than many other user facilities with narrowly focused missions. Compounding the difficult operation of LANSCE is the fact that the funding source is shared by multiple sponsors, who sometimes have conflicting interests. The LEC encourages a simplification of the relationship between LANSCE management and its sponsors.

6. A specific budgetary problem that needs to be recognized by LANL senior management, especially the NW program management, is the extra burden resulting from regulatory constraints on the Lujan target as a class 3 nuclear facility (approximately $1.7M per annum). This new burden cannot be absorbed into the current operating budget without seriously impacting LANSCE's programmatic responsibilities. LANSCE's budget needs to be adjusted, with the expense fairly distributed among the major sponsors. The LEC will bring this issue to the attention of LANL senior management.

7. A creative "attack" on LDRD funding for Lujan should be orchestrated between Steve Sterbenz's office and Lujan staff in order to address specific hardware and programmatic needs (e.g., SANS detector, equation-of-state, and high explosives technical programs).

8. The proposal process for instrument access at LANSCE was reviewed by comparing it to the one used by NIST. The draft of suggested revisions should be updated and finalized. A new streamlined experiment-reporting procedure should be considered.

9. WNR is in an excellent position to institute a more comprehensive, aggressive industrial user program. The LEC suggests Steve Wender draft details of a prototype program in consultation with David Londono. This could serve as a model for similar programs at other facilities on the mesa.

Points of Concern

10. Budgetary issues were reviewed. Serious concern was voiced about the level of funding at LANSCE. Evidence for this shortfall is apparent in LANSCE's operation, especially at the Lujan Center. The House's "mark up" of the President's proposed budget for the BES office of DOE, which recommends draconian cuts to the operating budgets of national user facilities, to the spallation neutron source (SNS) construction project, and to the nanotechnology initiative (NNI), is disappointing. The LEC is particularly fearful that BES support for the Lujan Center will be further reduced or even terminated. The repercussions of this action go beyond the Lujan Center, and apparently, the loss of BES sponsorship could result in some of the other major sponsors pulling out as well.

11. The sensitive country foreign national moratorium is still problematic to the user program at LANSCE. Recent security problems could exacerbate the situation. If this issue continues to be a problem, the LEC will address this in a letter to Tom Meyer. Instrument responsibles should be notified to contact users who will be on site in the near future to mitigate potential problems ahead of time.

Appendix 8: IPNS Enhancement Plan

The IPNS facility, run by the IPNS division in conjunction with the neutron scattering group in MSD, has a long tradition of excellence as a neutron scattering user facility. This has been marked by a consistent 95% operating reliability coupled with a user-friendly environment that has generated a very significant scientific output. It has also been marked by the continued excellence of the science performed at IPNS both by the IPNS and MSD staff as well as by the outside users.

With the new SNS neutron scattering facility planned to become operational in FY2006, it is important for Argonne and IPNS to play a key role in increasing the US neutron scattering community and to ready this community to effectively use the next-generation capabilities that will be available at SNS. This is even more important considering the recent loss of other neutron scattering capabilities within the US. Therefore, we propose a comprehensive plan to address this concern. This plan would commit to continued operation at the 95% reliability level, approximately double the scientific throughput and increase the number of users by ~50%. The user program would be structured to ensure that a significant portion of these increased capabilities would be used to bring in new users. It would also enable new areas of science at IPNS, thus expanding the user community to include new scientific areas that will be important at SNS. The plan requires broadening the research programs at US universities and continuing and expanding the excellent in-house scientific program at IPNS and MSD. This plan includes adding the staff and the capital funds to enable increased operation, improved source performance, and the instrument enhancements necessary to meet these commitments.

It is proposed that IPNS operation increase from the current 25 weeks/yr. to 30 weeks/yr. for science. In addition, a rapid and dramatic instrument improvement program coupled with new research programs are proposed.

Accelerator improvements and proper levels of spare parts would increase the proton current by 30% and are necessary to maintain the 95% reliability for at least the next ten years. This requires $1M/yr. of equipment funds plus 6 additional staff.

Table 1: Data rate gains from instrument enhancements

Instrument	Projected Gain	Instrument	Projected Gain
GPPD	5	LRMECS	6
SEPD	9	HRMECS	2
GLAD	2	QENS	32
HIPD/Midas	12	SAD	9
SCD	6	SAND	3

This will result in new scientific capabilities:

- Full S(Q,E) measurements on single crystals, glasses and liquids
- Polarized neutron SANS studies of magnetic nanostructures
- SANS on polymer and magnetic thin films
- Parametric studies on single crystals
- Powder diffraction studies of complex materials, e.g., pharmaceuticals
- Dynamics of low-dimensional magnetic systems

This instrument plan is front–end loaded and can be completed in 3 years at a cost (equipment plus staff) of $3.3M, $2.7M and $1.4M for a total of $7.4M.

The cost of increasing to 30 weeks/yr. for operating staff, scientists for the enhanced instrumentation, scientific support and M&S is $3,130K/yr.

The subtotal for these activities is:
Equipment funds for instruments: $7.4M over 3 years
Accelerator equipment funds: $1M/yr., ongoing
Additional staff $3.1M/yr., ongoing

IPNS would be prepared to undertake design and construction of one or more SNS-level world-class instruments (total cost ~$6M/instrument), to be installed and operated on a beam or beams at IPNS and then to be moved to SNS at an appropriate later time. This would enable user access to such modern instruments earlier than would be the case at SNS, and would allow the neutron scattering scientists and the user community to gain experience with such instruments before trying to operate them in the more intense environment at SNS. Only certain types of instruments would lend themselves well to initial operation at IPNS, and we feel that it would be important to consult with the user community before deciding what SNS instrument or instruments should be built at IPNS. Nevertheless, we feel that such an approach would offer some additional and unique opportunities to further expand the user community and to get a head start on instrumentation and science for SNS.

Optimal utilization of these new instrument capabilities requires initiation of neutron scattering research programs at universities and the labs in areas of science that will be fully enabled with the SNS. New science programs must be initiated now in order to build the community of users and the level of expertise that will match SNS capability. The specific objectives are to:

- Prepare for world-class science to be done at the SNS as soon as possible after startup.
- Expand the use of neutron scattering in the US into important areas of science that are presently not served or are under served.
- Increase the size and breadth of the US neutron community by mentoring graduate students and post docs who will become the next generation of neutron scatterers and recruit key new staff scientists into a rich scientific environment where they can begin pulsed-neutron scattering at IPNS immediately.

Argonne can play a significant role in initiation of new research programs. The Neutron and X-ray Scattering Group in the Materials Science Division has a long record of successes and scientific interest in those areas of science that are prime candidates for SNS and that will be most enabled by the IPNS instrument development plans. To initiate neutron scattering research programs that can be prepared for the full utilization of SNS capabilities and foster the required growth in the community will require a substantial infusion of funding at Argonne and elsewhere. We request new funding of $1345K in the first year and $2590K in the second year and thereafter to establish research programs in the following areas:

- Short-length-scale self-organized charge, spin, or structural ordering in bulk systems (e.g., ferroelectrics) through the use of diffuse scattering.
- Magnetism in complex bulk systems with dilute magnetic constituents.

- Magnetic structure of soft and hard magnetic composites, with the object of understanding and optimizing their performance by probing the behavior of nanoscopic hysteresis phenomena.
- Understanding quantum critical phenomena as the fundamental physics underlying a broad range of novel physical behavior.
- Structure-function relationships in large-cell structures (e.g., designer drugs)
- Structure and dynamics of soft biological materials, including the extension of isotope substitution methods to carbon isotopes.
- Grazing-incidence small angle scattering from working single biological membranes using spin-echo small angle scattering.

Table 2: The proposed budget for these activities is summarized as follows:

	FY2002 ($K)	FY2003 and beyond ($K)
New Staff	600 (3 FTEs)	1200 (6 FTEs)
Post docs	350 (5 PDs)	700 (10 PDs)
Students	75 (3 students)	150 (6 students)
M&S (including isotopes)	120	240
Equipment	200	300
TOTALS	1345	2590

Here, specific mechanisms to build the user base for the spallation neutron source in the limited time frame available are presented. All actions must be targeted at recruiting different groups of researchers new to neutron scattering and to accommodating both the relatively long times required to educate graduate students and the shorter times required for involving established faculty members. It is also imperative to keep the established neutron groups healthy and growing.

A.9.1 Facility-Based User Programs

Objectives: To attract new users to neutron facilities and to stimulate partnerships between neutron scientists at universities and national laboratories.

U.S. neutron scattering facilities are currently very limited in the amount of support that they provide for user travel and graduate students. Part of the success of the European facilities clearly lies with their commitment to strong user support. The differences between the two systems are striking: while ISIS spends ~$500K per year on these activities, IPNS currently budgets ~$20K. The shortfalls in user support in the U.S. are compounded by the pressing need to cultivate a new user base for the SNS.

The Subpanel recommends immediate funding of a facility-based user program that would cover living expenses at the facility for all users and travel for new or underfunded users.

Cost: This can be estimated using the ISIS numbers. IPNS would start at ~$100K and go to $200K when they have doubled their user base. HFIR would start at ~$80K and go to ~$200K when their user base increases to 500. LANSCE/Lujan Center would need $500K when they have reached a user base of ~1000. Funding this program would cost ~$180K next year and increase to ~$900K in 2006 if the recommendations of this Subpanel are adopted.

A.9.2 Joint University-Neutron Scattering Facility Partnerships.

Objectives: To immediately increase the presence of neutron scattering programs in universities and to bring more university participants to the neutron user facilities.

The model for these joint appointments already exists—the LANSCE professorships in the University of California (UC) system, the Distinguished Scientist and Collaborative Scientist Programs at ORNL, and the State-funded shared faculty positions in California to support the ALS. The Collaborating Scientist model could be expanded to include summer appointments and shared postdoctoral and graduate student fellowships.

The Subpanel recommends that this program be expanded and positions specifically designated for neutron scattering. It is also important to achieve a balance between joint appointments of established members of the community and young faculty. The Collaborating Scientist program between ORNL and its Partner Universities is an example of earmarking a program for young scientists.

Cost: To first order, these positions do not require new money, but they do require a commitment by laboratory management to the program. It is expected that senior appointments will fund their students and postdocs on outside grants or contracts, but junior faculty may require Laboratory support for jointly supervised graduate students.

A.9.3 Development of a National Agenda for Enhancement of Neutron Scattering Research in the U.S.

DOE should bring this critical need to the attention of the President's Science Advisor and the Office of Science and Technology Policy (OSTP). They could bring the National Institute of Health (NIH), NSF, DOD, and DOE to the table to discuss and define a solution to the need to simulate neutron science areas. One of the reasons that require "priming of the pump" is the fact that the U.S. has gone through a period of declining access to neutron facilities. HFBR at BNL has been closed. The reliability of LANSCE and even HFIR in the recent past has been disappointing. This decline in access has driven academic researchers away from neutron scattering and applications. The U.S. needs to bring these groups back and to create new groups.

The Subpanel offers several suggestions or models to enhance the neutron user community.

A.9.3.1 NSF-Focused Funding

An example is when NSF moved to establish several computational centers. Theorists could apply to the NSF program manager for supplemental support to use the facilities at the new computing centers, and with little effort, NSF awarded supplemental vouchers to support time on the machine. NSF and other agencies could offer a similar voucher program to current and future grant holders which would give them time on a facility and travel support. The funds would be directed to the facilities, and the facilities would use these funds to add support staff, upgrade instruments, and provide user travel. This puts the money in the hands of the facilities where it is needed to enhance their capabilities and broaden their access, and it opens the facilities to the user community through a very simple and easily executed voucher system.

A.9.3.2 Student Supplements for Single-Investigator Grants

The PIs of single-investigator grants from the NSF, NIH, and DOE with substantial neutron scattering components should be awarded supplementary support for graduate students, beyond the level customary for single-investigator grants. Not only will this strengthen efforts already identified as excellent by the peer review process, but it will also allow these groups new flexibility in pursuing innovative research directions aimed at exploiting the new capabilities of the SNS.

A.9.3.3 Establish a Competitive Postdoctoral Fellowship Fund

A fund devoted to the support of neutron scattering postdoctoral associates could be created and administered, similar to the NRC/NIST program. The postdoctoral awards would be made to individuals, applying in partnership with a mentor from any U.S. neutron scattering center or university. Stimulation of new partnerships between researchers at universities and national laboratories should be encouraged, and joint mentorship of postdoctoral associates should be regarded favorably. Proposals should be peer-reviewed to ensure high quality and competitiveness.

A.9.3.4 Establish a Faculty Development Fund

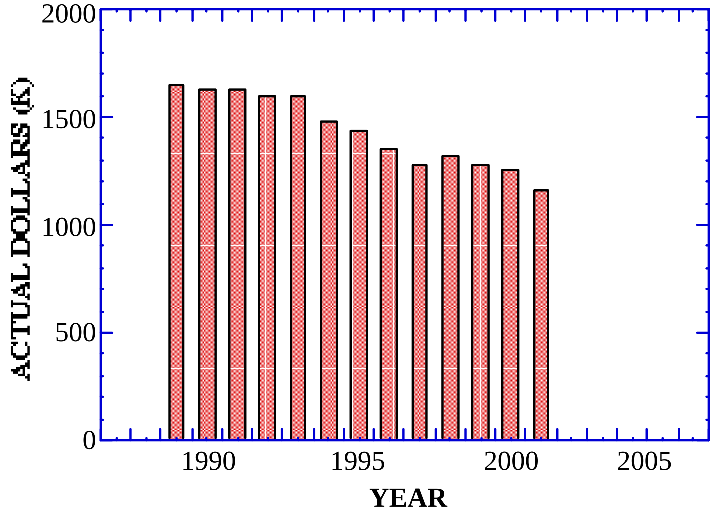
This initiative would be aimed at increasing the number and diversity of new university users in the shortest possible time. Funds would be awarded on a peer-reviewed basis to provide relief from academic responsibilities for faculty at all career stages who wish to introduce neutron scattering into their palette of research tools. Recipients will be resident at a U.S. or non-U.S. neutron source for one year and will be matched with an appropriate staff partner. Recipients must have no prior neutron scattering experience.

A.9.4 Strengthening the National Laboratory Neutron Scattering Groups

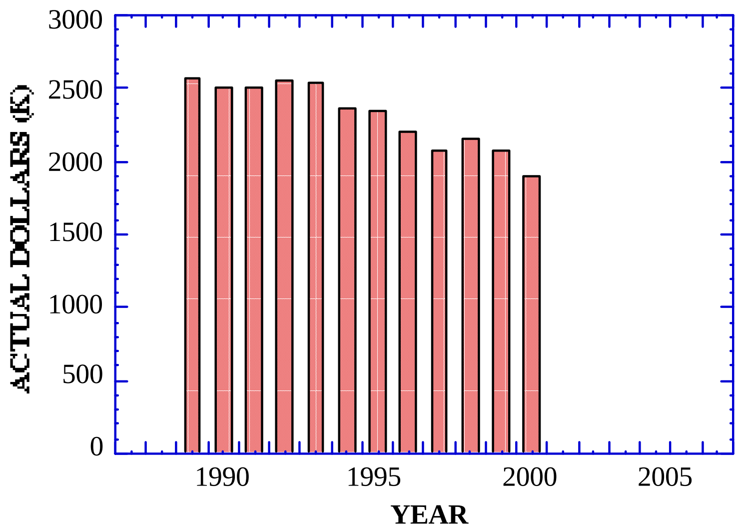
The core of the U.S. neutron scattering community has always been the research groups at the National Laboratories. It is clear that these groups will not nor should not expand sufficiently to satisfy the user requirements imposed by the benchmark with the European neutron community. On the other hand, they have to maintain their strength and grow as the importance of neutron scattering in the U.S. increases. In Section A.9.3.2, it is proposed to enhance the joint appointment between the National Laboratories and universities. This will require a strong in-house research program.

The steady decline in funding to three neutron research groups at ANL, BNL, and ORNL are shown in Fig. 1 below. This trend is frightening and unacceptable. It is obvious that if this trend continues, each of these groups will be reduced in size by nearly a factor of 2 by the time SNS comes on-line. The Subpanel recommends that this decline in support of Laboratory research in neutron scattering must stop. The enhancement plan for IPNS will solve the problem for the Materials Science Division at ANL, but equivalent action must be taken for both ORNL and BNL.

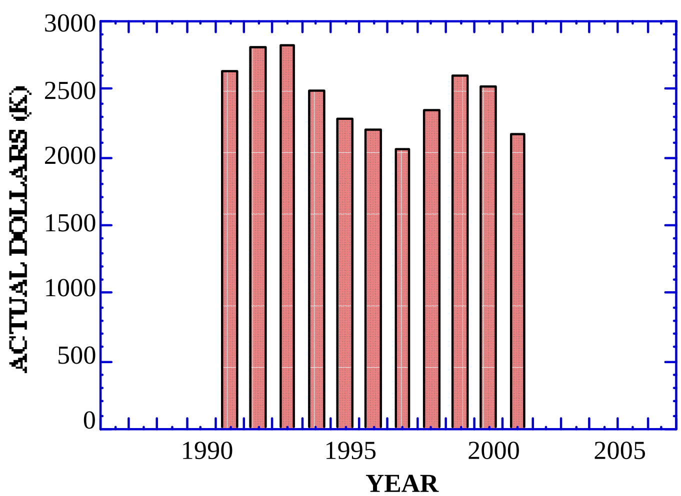
ANL Materials Science Division Neutron Scattering Group Budget



BNL Physics Division Neutron Scattering Group Budget



*ORNL Solid State Division Neutron Scattering Group Budget**



*Research funding only. Efforts associated with neutron scattering facility upgradeis not included.

Appendix 10: National and International Reports on Neutron Scattering Facilities

BESAC REPORTS

Report of the BESAC Subpanel on Neutron Scattering (Blume Committee) February 2000
http://www.sc.doe.gov/production/bes/BESAC/neutronrpt.pdf

Review Committee Final Report on the High Flux Isotope Reactor Upgrade and User Program (Crow Committee) October 1998
http://www.sc.doe.gov/production/bes/BESAC/hfir%20rpt.pdf

Report of the BESAC on Neutron Source Facility Upgrades and the Technical Specifications for the Spallation Neutron Source (Aeppli, Birgeneau, and Russell Committees) February 1996
http://www.sc.doe.gov/production/bes/BESAC/neutron%20source%20rpt.pdf

Neutron Sources for America's Future: Report of the BESAC Panel on Neutron Sources (Kohn Committee) January 1993
http://www.sc.doe.gov/production/bes/BESAC/Neutron%20source%20America%20Future.pdf

*Major Facilities for Materials Research and Related Discipline*s (Seitz-Eastman Committee) 1984
http://www.sc.doe.gov/production/bes/BESAC/major.pdf

OTHER REPORTS

Neutron Sources and Applications, edited by D. L. Price and J. J. Rush, U.S. DOE Office of Energy Research, Report No. DOE/ER--0607P (January 1994).

Cooperative Stewardship, Managing the Nation's Multidisciplinary User Facilities for Research with Synchrotron Radiation, Neutrons, and High Magnetic Fields, NAS Presses (1999)
http://bob.nap.edu/readingroom/books/cooperative_stewardship/

Experiments in International Benchmarking of US Research Fields, Committee on Science, Engineering and Public Policy. NAS Presses (2000)
http://www.nap.edu/books/0309068983/html/

"Institute for Scientific Information" (ISI), *Current Contents*, (http://www.sst.nrel.gov/citations.pdf)

INTERNATIONAL REPORTS

A Twenty Years Forward Look at Neutron Scattering Facilities in the OECD Countries and Russia, by D. Richter and T. Springer, February 1999
http://www.oecd.org//dsti/sti/s_t/ms/prod/scattering.htm

Neutron Beams and Synchrotron Radiation Sources, Megascience Forum (OECD Publications, Paris, France, 1994). ISBN 92-64-14249-5

ENSA Survey of the Neutron Scattering Community and Facilities in Europe (http://www.esf.org/ftp/pdf/Pesc/ENSA.pdf) (1998)

ISIS The Way Forward, Council for the Central Laboratory of the Reseach Councils

ISIS 2000, Council for the Central Laboratory of the Research Councils.

"Institute for Scientific Information" (ISI), *Current Contents*, (http://www.sst.nrel.gov/citations.pdf)