The Neutron Scattering Society of America

www.neutronscattering.org

March 5, 2012

National Science Foundation

Division of Materials Research

Dear NSF Materials 2022 Committee Members;

The **Neutron Scattering Society of America** was formed in 1992 and is an approximately1200 member organization which has interests related to neutron science covering a wide spectrum of disciplines. The purpose of the Society is for the advancement of neutron scattering research in the United States. Pursuant to this purpose, one of the Society's primary aims is to identify the needs of the American neutron scattering community, including future requirements for instrumentation and sources and to represent these needs to the appropriate neutron facilities and funding agencies.

Worldwide neutron scattering is undergoing a modern renaissance, particularly in the United States, with the Spallation Neutron Source (SNS) at Oak Ridge National Laboratory (ORNL) entering full user operations, the near-completion of the new guide hall and cold source at the National Institute of Standards and Technology (NIST) Center for Neutron Research (NCNR) in Gaithersburg MD, the expanded user program and operations at the cold neutron guide hall at the HFIR reactor at ORNL, and the continued operations and user program at the Los Alamos Neutron Science Center (LANSCE).

The United States is leading this approximately $7B worldwide re-investment in sophisticated neutron infrastructure, but indeed related major initiatives are underway in other countries with the development of new neutron capabilities at JSNS at J-PARC, Japan, the European Spallation Source in Sweden, as well as major new initiatives in China. *However, even with this investment, the US will still lag other industrialized countries, in Europe in particular, in access to the most powerful neutron scattering facilities.*

It is very important that the new US neutron investments be fully outfitted with the required instruments and have appropriate sample environment apparatus such that the science and technological payoffs for this major investment can be realized. An inventory of sample environment infrastructure which quickly and reliably attains a particular environmental condition is very important, as this allows the neutron beamtime to be used effectively. For example, such an inventory minimizes beamtime losses associated with waiting for samples to equilibrate at a particular setting of the environment. The scientific payoff for investments in extreme sample environments, apparatus enabling extremes in low and high temperatures, magnetic fields, shear and extensional flow and processing fields, electric fields, and applied pressures, for example, is very large. Such extreme environments, when combined with neutron scattering, can provide unique perspectives into complex states in materials which defy our current understanding. They enable progress which pushes our theoretical efforts, and this progress has the potential to underlie the technology of tomorrow. Indeed, beyond the importance to fundamental science, these investments also have an important impact on the competitiveness of US industries, especially nanotechnology, where neutron scattering can provide unique and critical characterizations of nanomaterials.

We recognize the critical role of the NSF-DMR in supporting our field. An example of a highly successful investment is the Center for High Resolution Neutron Scattering (CHRNS) located at the National Center for Neutron Research at NIST. Supported under agreement # DMR-0944772, and by NIST-NCNR, CHRNS develops and operates state-of-the-art neutron scattering instrumentation with broad applications in materials research for use by the general scientific community. In fact, CHRNS has the widest ranges of energy and length scales accessible at any neutron research center in North America and as such, the instruments are used by university, government and industrial researchers in materials science, chemistry, biology and condensed matter physics to investigate materials such as polymers, metals, ceramics, magnetic materials, porous media, fluids and gels, and biological molecules. Proposals for use of the CHRNS facilities are considered solely on the basis of scientific merit or technological importance and are very competitive as the beamline is highly oversubscribed. Continued NSF-DMR investment in this critical national resource is highly desired by the broad scientific neutron scattering community in the US.

The development of, and full instrumentation for, the proposed Second Target Station at SNS will be important. Loosely speaking, this initiative will double the scientific output of the SNS, by doubling the number of experiments which can be run simultaneously. But it would also enable a complementary set of new neutron measurements to be performed. These would take advantage of the lower frequency of the pulsed neutron source at the Second Target Station, and would primarily use cold neutrons for both spectroscopic and structural studies. This is a very cost-effective investment, as it builds on the original ~ $1.5B investment in the SNS, and takes advantage of the same accelerator and storage ring physical infrastructure. It will use a small fraction of the neutrons produced by SNS as a whole. The Second Target Station at SNS, and the related instrumentation, would likely be supported by the US DOE, but there would also likely be a very important role for NSF to play in the development of certain instruments and/or specialized sample environment which would enable qualitatively new materials science studies to be carried out.

The United States currently operates two reactor-based neutron sources and two spallation-based neutron sources. While significant investments in modern neutron scattering instrumentation have been made at the SNS and NCNR it is also important to invest in the rebuild of the neutron scattering infrastructure at LANSCE and at the HFIR reactor, ORNL. New instrumentation at these facilities should be planned to complement the capabilities of the SNS and NCNR, so as to provide a full suite of neutron instrumentation in the US that is internationally competitive.

Investments at LANSCE and HFIR will also play an important role as a staging ground for new sophisticated initiatives in neutron science related to, for example, sample environment, data analysis and visualization, and neutron optics.

New neutron science instrumentation, in particular that at spallation neutron sources, but increasingly at reactor-based sources as well, have taken advantage of large assemblies of pixelated two dimensional neutron detectors. These detectors have worked very well, but they have presented great challenges for data analysis and visualization. Support for improved infrastructure and technical assistance in this area is also a substantial need, as current data sets for a single set of measurements can easily exceed 100 GB, and cannot be easily visualized or manipulated by the same computing infrastructure which served our community well in the past.

Finally, we note that the advanced characterization of materials using neutrons typically comes at the end of a lengthy and involved process that takes a particular material from discovery, through synthesis and materials preparation, to basic characterization, to advanced characterization with neutron science techniques. Thus, investments in materials discovery, preparation, crystal growth, and basic characterization are also very important. High impact science in high profile publications results from this interconnected protocol, but all components to the protocol are important to the overall scientific success of such projects.

These types of science activities are often performed away from major neutron science facilities, and the capabilities to carry out such materials discovery and basic characterization are crucial to the success of a cutting edge program in materials science. The United States lags other scientifically-sophisticated countries, in particular Japan and Germany, but in some specific cases even China, in our ability to discover and prepare new materials in a form appropriate for advanced characterization with neutrons. These investments in materials preparation, crystal growth, and basic characterization are often best carried out in university laboratories, and this role is very well suited for NSF support.

We thank you for this opportunity to discuss the status and needs of neutron science in America. We are both proud of the myriad accomplishments of the US neutron science community over the last 50 years, and very excited about the immediate prospects for new science capitalizing on our recent investments. Please do not hesitate to contact us for further information or clarification on these and related issues.

Sincerely yours;

Bruce D. Gaulin

President, NSSA