8 Spallation Neutron Source

8.1 Activities at TUNL

8.1.1 Workshop on Fundamental Physics with Pulsed Neutron Beams

C.R. Gould, G.L. Greene¹, F. Plasil² and M. Snow³

Low-energy neutrons from reactor and spallation neutron sources are of great interest as experimental probes for the study of important questions in nuclear, particle, and astrophysics. While the primary focus of such sources are materials science studies through neutron scattering, there is a solid tradition of their productive and symbiotic use for nuclear and particle physics at facilities such as the Institut Laue Langevin, the National Institute of Standards and Technology Cold Neutron Research Facility, and the Los Alamos Neutron Science Center. There has been and continues to be an active and energetic United States community engaged in this area of research, including a number of excellent younger scientists. The scientific opportunities in this field include the elucidation of important issues in a number of areas, including:

1. Nature of time reversal non-invariance and the origin of the cosmological baryon asymmetry,

2. Nature of the electroweak theory and the origin of parity violation,

3. Nature and description of the weak interaction between quarks,

4. Origin of the heavy elements, and other issues in stellar astrophysics,

5. Investigation of quantum mechanics and precision measurements with neutron interferometry.

In each of these areas, there are specific opportunities that can best be addressed using a pulsed spallation neutron source. The proposed Spallation Neutron Source at Oak Ridge National Laboratory will provide the highest peak flux neutron source in the world and offers the United States scientific community an unmatched opportunity in nuclear, particle, and astrophysics for the next decade.

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To explore the opportunities associated with pulsed neutron beams, a workshop FPPNB 2000 “Fundamental Physics with Pulsed Neutron Beams” was held June 1-3, 2000 at Research Triangle Park, North Carolina.

The workshop was sponsored by four institutions: Triangle Universities Nuclear Laboratory (TUNL), Los Alamos National Laboratory (LANL), Oak Ridge National Laboratory (ORNL) and Indiana University and the Indiana University Cyclotron Facility (IUCF). Approximately sixty scientists from the US and abroad attended the meeting. The local organizing committee consisted of Werner Tornow and Calvin Howell (Duke and TUNL), Carl Brune and Art Champagne (UNC and TUNL) and David Haase and Gary Mitchell (NC State and TUNL).

The proceedings have been published by World Scientific Publishing Company. The contents of the proceedings are listed below:

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Workshop Summary: Fundamental Neutron Physics in the United States: An Opportunity in Nuclear, Particle, and Astrophysics for the Next Decade  
*G. Greene, W.M. Snow, C. Gould and F. Plasil*
8.1.2 Fundamental Neutron Physics Beamlines at the Spallation Neutron Source

T.V. Cianciolo\textsuperscript{1}, C.R. Gould, G.L. Greene\textsuperscript{2}, P.E. Koehler\textsuperscript{1}, W. Lu, F. Plasil\textsuperscript{1}, and W.M. Snow\textsuperscript{3}

Low-energy neutrons have been employed in a wide variety of investigations that shed light on important issues in particle physics, nuclear physics, and astrophysics. The Spallation Neutron Source (SNS) under construction at ORNL will be the highest peak-flux pulsed neutron source in the world and offers the scientific community an important and unique opportunity to carry these investigations to an unprecedented level of precision. In support of this effort, the organizers of the FPPNB2000 workshop submitted a Letter of Intent (LoI) to the SNS proposing construction of a dedicated beamline on the first target station for the purpose of pursuing fundamental neutron physics research. Earlier this year,

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure8.1-1.png}
\caption{Neutron fluxes from IB simulations of a 15 m long neutron beam line and the SNS target station one cold moderator. The maximum flux is obtained with a straight guide in the 1.0–2.2 m region feeding into a two degree bender starting in the shutter region at 2.2 m and having an overall length of 4 m. The lowest flux is for a 2 m long bender without a feeder section close to the moderator. The guide size is 10 cm wide by 12 cm high with m = 3.5 supermirror surfaces having reflectivity R\textsubscript{0m}=1.}
\end{figure}

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\textsuperscript{2}Los Alamos National Laboratory, Los Alamos, NM.
\textsuperscript{3}Indiana University, Bloomington, IN.
the LoI was favorably reviewed by the SNS Science Advisory Committee, and design work has now begun.

We are modeling a cold neutron beamline with reference to four “flagship” experiments: neutron lifetime measurements using UCN’s from a superthermal helium source, polarized neutron decay correlations, “weak” neutron spin rotation in hydrogen and helium, and “weak” neutron capture on hydrogen. The technical approach is to develop physics models for these experiments and appraise beamline requirements using standard Monte-Carlo codes like NISTASS etc. The cold beamline will view the liquid hydrogen moderator and is expected to be similar to the liquid reflectometer line already designed by the Argonne IPNS group. We will take advantage of many of the design elements that already exist. Our first major milestone will be the physics design of the cold beamline, and the approximate cost associated with it. A similar effort will be undertaken for an epithermal beamline for astrophysics experiments and symmetry experiments using polarized beams and polarized targets. The epithermal beamline is expected to view the water moderator and so should be significantly less complicated than the cold-neutron beamline. An LDRD proposal was submitted to Oak Ridge to support these efforts.