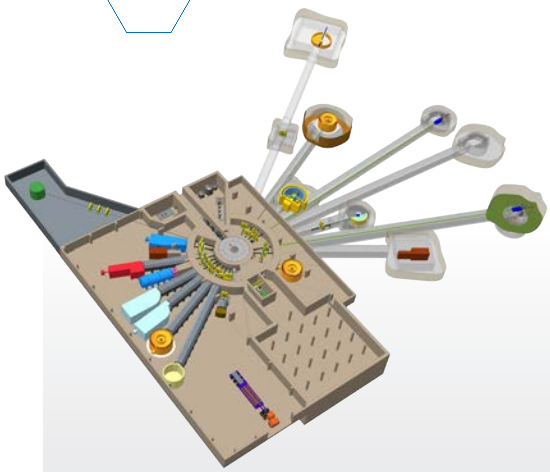
NEUTRONS: Three Sources

Third neutron source at ORNL to secure US leadership in neutron science



Neutron scattering is an essential technique for advancing materials research that supports the US economy and provides solutions to challenges in energy, security, and transportation. It provides information that cannot be determined using any other research method.

At Oak Ridge National Laboratory (ORNL), scientists from around the world can access two neutron sources with complementary capabilities to better understand the materials important in physics, biology, chemistry, materials science, and engineering. The Spallation Neutron Source (SNS) provides the most intense, pulsed accelerator-based neutron beams in the world, while the High Flux Isotope Reactor (HFIR) is the highest flux reactor-based source of neutrons for research in the United States and provides one of the highest steady-state thermal and cold neutron fluxes of any research reactor in the world.

These current facilities are seeing an unprecedented rate of use in a growing US neutron user community. To address emerging science challenges, ORNL is moving forward with a conceptual design for a third neutron source: the second target station at SNS.

Scientific Capabilities

The second target station will complement ORNL capabilities at the SNS first target station and HFIR by filling gaps in materials and research that require the combined use of intense, cold (longer wavelength) neutrons and instruments that are optimized for exploration of complex materials. Together these three facilities form an unbeatable combination that will maintain a US global leadership position in neutron science capabilities.

- Using the second target station, researchers will be able to simultaneously probe the structure and function of complex materials across broader length and time scales to gain greater understanding of the principles underlying their assembly and contribute to the design of novel complex materials.
- The second target station's neutron beams will be ideal for exploiting the magnetic interaction of neutrons with matter to unravel the structure and dynamics arising in complex magnetic materials. Many of its instruments will be designed to specifically support these types of measurements, which require preparation of polarized neutron beams in

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US Department of Energy

15-G01508/jdh

which one of two neutron spin states is selected.

- The high brightness of cold neutrons present at the second target station will be ideally suited for experiments that require focusing optics to enable measurements on smaller samples than what is currently possible using the SNS first target station. This capability will enable the study of emerging materials that can be obtained only in small quantities or in samples that are challenging to prepare such as large crystals.
- Second target station experiments will be complemented by other ORNL capabilities, such as high performance computing (HPC) that can contribute to all areas of research.

Conceptual Design

The original SNS plans included provisions for a second target station. Working closely with the science community, ORNL will continue to refine the conceptual design.

Accelerator:

The existing SNS accelerator was designed with the capacity to feed a second target station. Accelerator modifications will increase the power of SNS; the existing target station will receive 50 proton pulses per second while 10 pulses per second will be redirected down a new transport line to the second target station.

Target System:

The second target station will be a much brighter neutron source than the first target station. The proton pulses directed at the second target station will produce neutrons by hitting a tungsten target with a footprint about one-fifth the size of the first SNS target. To manage volumetric heating, the target will rotate during use so that only 5 percent is active at any one time. Advanced moderators adjacent to the active target portion will also increase neutron brightness. Together, the compact proton beam footprint on the target and advanced moderator designs will significantly enhance neutron brightness compared to the first target station.

Instruments:

A repetition rate of 10 pulses per second will enable operation of large bandwidth instruments. The range of wavelengths accessed in a single pulse will be six times greater at the second target station than the first target station. With input from the science community, up to 22 instruments will be selected at full operation.

Second Target Station Impact Examples

- Information technology devices and energy technologies will benefit from the second target station’s unique capabilities to probe quantum materials across a wider range of length and time scales to better understand their structure and dynamics.
- New biotechnology and biorefinery solutions to energy and environmental challenges will be possible because the second target station will help researchers gain a predictive understanding of the behavior of complex biological systems necessary to manipulate micro-organisms and their ecosystems.
- Improvements in materials technologies, such as polymer composite based tires with extended lifetimes and increased fuel economy will be possible through better understanding of complex material behaviors across a broad range of length and time scales, made possible by the STS intense and broadband neutrons.