A large and growing user community

ORNL's neutron facilities attract many of the world's top materials researchers to conduct experiments they can't perform elsewhere. To date, these researchers represent 40+ countries, 500+ academic institutions, 70+ companies, and 90+ scientific institutions.

Partial list of research partners

Government

- Department of Defense
- DOE Laboratories
- DOE Office of Science
- Environmental Protection Agency
- National Aeronautics and Space Administration
- National Institute of Standards and Technology
- National Institutes of Health
- National Nuclear Security Administration
- National Science Foundation

Academic

- Duke University
- Georgia Tech
- Harvard University
- Johns Hopkins University
- University of California
- University of Florida
- University of Georgia
- University of Illinois
- University of Michigan
- University of North Carolina
- University of Pennsylvania
- University of Tennessee
- University of Texas
- University of Washington
- University of Wisconsin

Industrial, military, security, and consumer applications for neutrons

Scientists use neutron scattering techniques to study materials and solve big science challenges that spur the development of technologies and products vital to our economy, national security, and daily lives. These investigations have led to discoveries and enabled improvements in a wide range of technologies:

- Biotechnologies vital to health
- Polymers, colloids, and other complex liquids
- Consumer products, such as detergents, paints, and cosmetics
- Thin films, smart coatings, and sensors
- Solar energy
- Gas separation and toxic gas removal systems
- Quantum computing, data storage and handling
- 3D-printed composite materials, such as turbine blades for aerospace engines
- Engineered materials, such as strong, lightweight metal alloys
- Military armor
- Thermoelectrics for spacecraft, rovers, and probes
- Biofuels, batteries, and fuel cells
- Mobile phones
- Vehicle engine fuel injection systems and components
- Catalytic devices and materials
- Pharmaceutical drugs and biologics
- Superconducting wires and devices
- Nuclear materials for next-generation reactors

Contact

Oak Ridge National Laboratory
Neutron Sciences Directorate
One Bethel Valley Rd
Oak Ridge, TN 37831
865-574-0558
neutrons.ornl.gov

OAK RIDGE National Laboratory

Managed by UT-Battelle LLC for the US Department of Energy

U.S. DEPARTMENT OF ENERGY | Office of Science

18-G00907v2/jdh

Sustaining US Leadership in Neutron Sciences

Benefits of a Second Target Station at the Spallation Neutron Source

OAK RIDGE National Laboratory

Managed by UT-Battelle for the US Department of Energy

Second Target Station

New facility at ORNL Spallation Neutron Source will offer up to 1,000x higher performance

The Department of Energy in 2009 approved the Mission Need (Critical Decision 0) for the Second Target Station (STS) at Oak Ridge National Laboratory's (ORNL's) Spallation Neutron Source (SNS). The new facility:

- Maintains US leadership in the neutron sciences
- Enables new science capabilities demanded by the user community
- Permits faster data collection to study real-time processes
- Leverages ORNL's existing neutron facilities and expertise
- Responds to the 2016 Basic Energy Sciences Advisory Committee report that states the STS is *"absolutely central to contribute to world leading science."*

STS will enable breakthroughs in many areas of materials research and development and will be uniquely suited to explore complex materials. Studying complex structures from atomic- to nano-length scales requires larger quantities of long-wavelength neutrons, a broader range of wavelengths, and a higher peak brightness. The STS will produce more cold (long wavelength) neutrons, have a 4x greater range of wavelengths, and deliver a pulsed brightness 25x greater than currently available in the US—all to better investigate atomic structures, vibrations, and magnetic properties.

With a new suite of world-leading instruments boasting the latest advances in high-resolution optics, instrument design, and neutron spin manipulation, the STS will deliver instrument-specific performance gains 100x to 1,000x better than existing instruments.

Together, ORNL's three facilities (SNS' First Target Station, STS, and HFIR) will maintain our nation's leadership in neutron science and ensure that US industry, military, national security agencies, and universities have secure, priority access to the world's foremost neutron research facilities.

New neutron source urgently needed to maintain US leadership in neutron scattering

Other countries are designing and building more powerful neutron research facilities that will soon eclipse existing US capabilities, including Japan (2021 target), the European Union (early to mid-2020s) and China (date not announced).

STS will take about seven years to build. If the project does not move ahead now, the US will lose its lead in neutron sciences and groundbreaking science will be done outside the country. US scientists from academia, industry, and the federal government will have at best limited access to superior facilities abroad, jeopardizing America's ability to test and develop materials vital to the economy, public health, and national security.

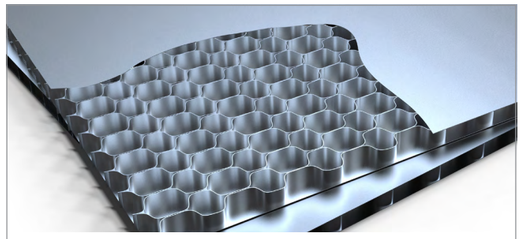
Neutrons: one of the world's most in-demand research tools

Oak Ridge National Laboratory has pioneered neutron research since 1945. Today, the laboratory operates the Spallation Neutron Source, which provides the most intense, pulsed accelerator-based neutron beams in the world, and the High Flux Isotope Reactor (HFIR), a reactor-based source of neutrons with the brightest continuous neutron beams for research in the US.

Neutron scattering is essential to provide information about atomic-, meso-, and nano-scale structures, forces, and activities that in many cases simply cannot be obtained using any other method.

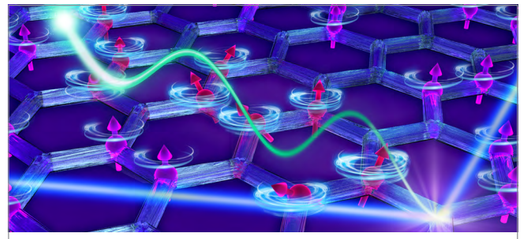
Unlike x-rays, neutrons are non-destructive, deeply penetrating, and uniquely sensitive to magnetism and lighter elements, such as hydrogen. ORNL's world-leading neutron sources, instruments, and sample environments enable a wide range of experiments under realistic conditions, as well as extreme and complex environments, such as high and low pressures, temperatures, and intense magnetic fields. These capabilities and more are why ORNL is the world leader in neutron research and attracts top materials scientists from every corner of the globe.

Key STS Scientific Capabilities



Engineered Materials

Neutrons can penetrate deeply into most materials, enabling observations of the interior structure and functionality of complex manufactured items such as batteries, engines, and aerospace parts, in real-time, without damaging them. This offers the most non-invasive means of studying operating devices.

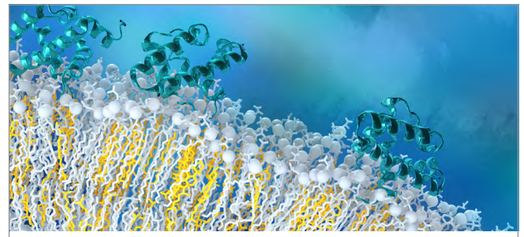


Quantum Materials (Magnetism)

One of the most exciting new areas of research is quantum materials with novel and exotic electrical and magnetic properties that could revolutionize energy, magnetic, and computing technologies—including quantum computers, high-density storage devices, and quantum cryptography.

Polymers and Soft Matter

Polymers and other soft matter are the foundation for many industrial and consumer products such as detergents, pharmaceuticals, cosmetics, films, and batteries. Neutrons are non-destructive, so they can probe and measure these materials without damaging them or changing their functionality.



Biological Systems

Neutrons are sensitive to light elements such as hydrogen, so they are essential for studying biological systems, from viruses, to cancer, to healthy cells. Brighter neutrons will enable observing the dynamic assembly of biological components in real-time. Plant studies are improving biomass conversion to biofuels.

ORNL Neutron Science: Important Facts (FY2017)

1,275 visiting researchers (unique users)

80 percent of users based in the US

135,062 hours of beamtime provided for research

1,355 user experiments

33 percent of proposals accepted because of high demand

704 total publications*

26 percent of instrument publications appeared in high-impact journals **

**472 instrument publications by users and 232 other scientific publications by ORNL's neutron science staff*

***Such as Nature, Science, Advanced Materials*