



# Neutrons for New Discoveries and Solutions

Breakthroughs in medicine, energy, technology, and industry follow advances in the understanding of materials. Oak Ridge National Laboratory is the US epicenter of one of the most powerful techniques for exploring the nature of materials—neutron scattering.

ORNL hosts two of the world's most powerful sources of neutrons for research: the Spallation Neutron Source (SNS) and the High Flux Isotope Reactor (HFIR), which produce beams of neutrons by two different processes. Because neutrons have no electrical charge, they can easily pass through a sample of material without harming it, revealing information about the material's structure and properties.

Neutron scattering is used in many industries—including automotive, aerospace, steel, defense, industrial materials, energy storage, data storage, and biomedicine—to address many of the major scientific challenges of the 21st century.

## Ensuring US Leadership

The Proton Power Upgrade (PPU), planned for completion in 2025, will increase the SNS' neutron flux and significantly increase its capacity to support the US research community. The PPU is necessary to support a Second Target Station that will maintain US competitiveness in materials development as new European and Asian neutron facilities come online.



*The Second Target Station (illustration on left) will complement existing SNS and HFIR capabilities.*

**643**

Scientific publications  
in CY 2021\*

**685**

Unique users  
in FY 2021

**95,469**

Hours of beam  
time in FY 2021

**1,190**

Total experiments  
in FY 2021



"We can work together and really push our understanding of the world."

**Bianca Haberl,**  
*Physicist*

\*443 instrument publications and 200 other scientific publications  
by ORNL's neutron science staff

# Impacts and Collaborations

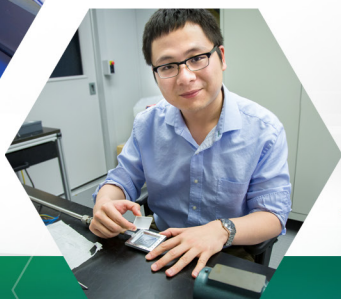
- **Space flight:** NASA researchers used HFIR to study stresses in 3D-printed materials for use in space flight. The team studied a 3D-printed version of an engine component that could save years in building a flight-ready engine.
- **Infrastructure:** Columbia University researchers used neutrons at SNS to study small breaks in suspension bridge cable wires and how they affect the overall strength of the cable—and ultimately the bridge. SNS allowed nondestructive study of the wires to develop safe, cost-effective cable repair methods.
- **Stronger glass:** Researchers from Corning use neutrons to study how silica behaves as it heats and cools. Better understanding means better durability for products such as mobile devices, windshields, and TV screens.
- **Drug discovery:** Neutron analysis at HFIR helped researchers better understand a protein implicated in the replication of HIV, the retrovirus that causes AIDS. The enzyme is a key drug target for HIV and AIDS therapies.
- **Better batteries:** Researchers used HFIR to study a solid-core garnet, a material used in lithium batteries, that could be a key to safer, more reliable energy storage. Neutrons allowed them to directly observe battery behavior to explore ways of extending battery life.
- **Fuel injection:** HFIR was used to make the first neutron images of cavitation (gas bubble formation) inside an operating gasoline fuel injector. The HFIR data will enable improvements in injector design.
- **Reliable aircraft:** NASA and Honeywell Aerospace used neutrons at SNS to examine nickel alloy samples containing a type of weld used in turbines. The measurements will help in designing and manufacturing more reliable aircraft components.



*SNS is an accelerator-based facility that provides the world's most intense pulsed neutron beams for scientific research and industrial development. SNS delivers short pulses of protons—60 times a second—to a target system where neutrons are produced through a process called spallation.*



*HFIR uses highly enriched uranium-235 as the fuel to generate 85 megawatts of power for the highest neutron flux (continuous flow of neutrons) available in the United States.*



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