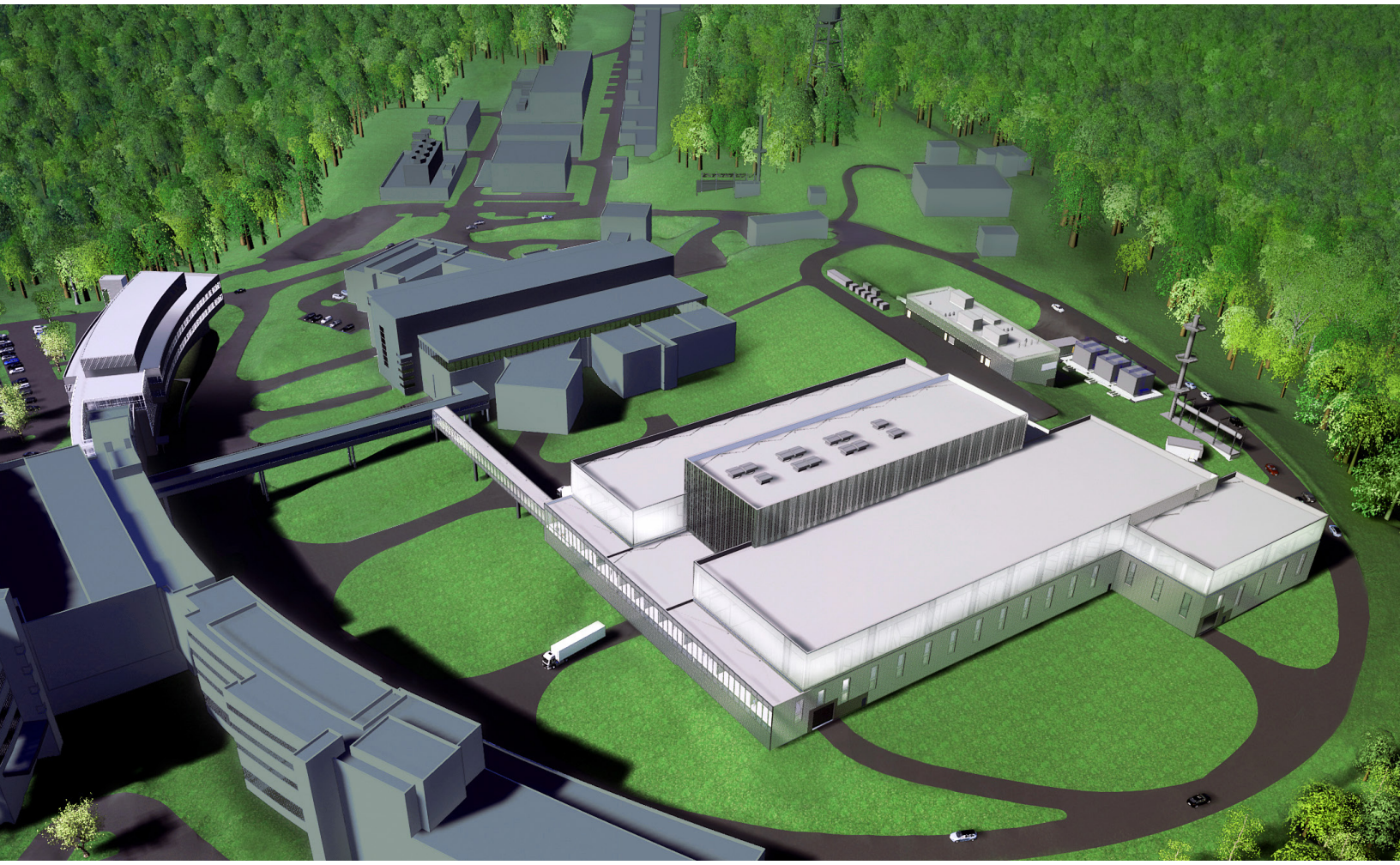
The Second Target Station at the Spallation Neutron Source:
Transformative new capabilities for discovery science



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OAK RIDGE National Laboratory

Second Target Station

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

The Department of Energy in 2020 approved the Critical Decision 1 (CD-1) for the Second Target Station (STS) at Oak Ridge National Laboratory's Spallation Neutron Source (SNS).

The transformative capabilities of the STS will enable breakthroughs in many areas of materials research and development needed to underpin the energy, economic, and national security of the United States.

Together, the SNS's First Target Station (FTS), STS, and the High Flux Isotope Reactor (HFIR) will sustain our nation's leadership in neutron science and ensure that US researchers have priority access to the world's foremost neutron facilities.

The new facility will:

- Provide new capabilities demanded by the US research community
- Enable faster data collection to study materials as they change
- Generate more intense, focused neutron beams to study smaller samples
- Maintain US leadership in the neutron sciences
- Leverage ORNL's existing neutron facilities and expertise
- Respond to the 2016 Basic Energy Sciences Advisory Committee report that states the STS is *"absolutely central to contribute to world leading science."*

A new suite of world-leading instruments boasting the latest advances in high-resolution optics, design, and neutron spin manipulation will deliver performance gains 100x to 1,000x better than existing instruments that use pulsed beams of long-wavelength (or cold) neutrons.

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

Other countries are designing and building more powerful neutron research facilities that soon will eclipse existing US capabilities, including Japan (2021 target), the European Union (early to mid-2020s) and China (date not announced). If the STS project does not move ahead now, the US will lose its lead in neutron sciences and the most impactful science will be done outside the country.

The three-source strategy for neutrons

ORNL is at the US epicenter for one of the most powerful techniques exploring the nature of materials and energy—neutron scattering.

ORNL has pioneered neutron research since the 1940s, and, today, hosts two of the world's most powerful sources of neutrons for research: HFIR and SNS. ORNL is moving forward with plans for a third neutron source, the STS, to address emerging science challenges and fill gaps in our ability to characterize materials.

Neutron scattering provides information that often cannot be obtained using other methods. Unlike x-rays, neutrons are non-destructive, penetrate deeply into bulk materials, and are 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, including extreme and complex environments such as high and low pressures, temperatures, and intense magnetic fields.

Key STS Scientific Capabilities

Polymers and Soft Materials

The capabilities provided by the STS promise to revolutionize our understanding of polymers and other soft materials, which are the foundation for many industrial and consumer products such as detergents, pharmaceuticals, cosmetics, membrane filters, and batteries. The STS's next-generation instruments will lead to breakthroughs in the development of new technologies such as next-generation polymers, making it possible to upcycle waste into new consumer products.

Quantum Matter

One of the most exciting new areas of research is quantum materials with novel properties that hold exceptional promise for the development of next-generation computers, high-density storage devices, high-precision sensors, new energy technologies and secure communications using unbreakable encryption. The STS will accelerate the transformation of quantum materials into new technologies with the potential to strengthen national security, create unparalleled computing power and enhance economic competitiveness.

Biology and Life Sciences

The STS will help provide insights into molecular and cellular processes that will enhance human health and quality of life, such as developing more effective drug treatments for disease. Neutrons are sensitive to light elements such as hydrogen, so they are essential for studying biological systems, from viruses to cancer to healthy cells. Plant studies are also improving biomass conversion to biofuels and increasing drought resistance in crops.

Materials Synthesis and Energy Materials

Research done at the STS will have a broad impact on development of new materials and chemical processes for applications in energy efficiency, production and storage including safer, longer-lasting batteries, and for securing access to clean water in an increasingly water-stressed world.

Structural Materials

Structural materials can be found everywhere in modern society, as key components in automobiles, airplanes, buildings and bridges. However, a big challenge is how to increase their strength without sacrificing toughness and flexibility. The capabilities of the STS are critical for the design of a new generation of more reliable, better-performing structural materials for transportation, construction and other applications.

Industrial, security, and consumer applications for neutrons

The neutron research that can be done at the Second Target Station is essential to the development of future technologies that will drive this nation's economy, impact our national security, and affect our daily lives, in areas including:

- Biotechnologies and health, for more effective drugs
- Consumer products, such as detergents, paints, and cosmetics
- Recyclable and upcycled plastics
- Membranes for gas separation and water purification
- Smart phones, quantum computing, data storage and secure communications
- Engineered materials, such as strong, lightweight metal alloys
- Thermoelectrics for spacecraft, rovers, and probes
- Biofuels, batteries, and fuel cells
- Aerospace products such as turbines and composites
- Advanced materials for extreme conditions and next-generation reactors

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A large and growing user community

ORNL 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.

Government research partners include:
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 research partners include:
Duke University; Georgia Tech University; Harvard University; Johns Hopkins University; University of California; University of Florida, University of Georgia; University of Illinois; University of Michigan; University of North Carolina.

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