US begins construction of unique neutron imaging instrument to accelerate materials discovery

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"Neutron imaging is about contrast—seeing something behind something else or seeing the difference between one side of your sample and the other," says Hassina Bilheux, an instrument scientist at the US Department of Energy's (DOE) Oak Ridge National Laboratory (ORNL). ORNL reports that construction began last summer on VENUS, a state-of-the-art neutron imaging instrument, at the laboratory's Spallation Neutron Source (SNS).

Coupled with the SNS, a pulsed accelerator-based neutron source, VENUS will be the only open research facility platform in the United States to provide time-of-flight neutron imaging capabilities to national and international users from government, academia, and industry. Bilheux is a lead developer in the VENUS project.

The scientific capabilities of VENUS will support the research goals of DOE's Basic Energy Sciences program within the Office of Science as well as other DOE programs or offices such as Biological and Environmental Research, Energy Efficiency & Renewable Energy, and Nuclear Energy.

This new instrument will provide a platform for studying in real time the makeup and performance of a wide range of functional materials under varying environments, offering new state-of-the-art neutron radiographic and tomographic capabilities for materials research.

The ability to directly see the atomic fabric of materials provides pivotal information in accelerating the design and improving the performance of future technologies. Visualizing in real space the behaviors and dynamics of materials requires powerful probes and advanced instrumentation.

VENUS will benefit diverse research areas including the development of energy-related materials (e.g., batteries, nuclear fuels, biofuels); advanced engineering materials (e.g., additively manufactured alloys, aluminum and steel, carbon fibers, concrete, and glass); and studies of archeological and natural materials, providing insights into geological processes, biology, and plant physiology.

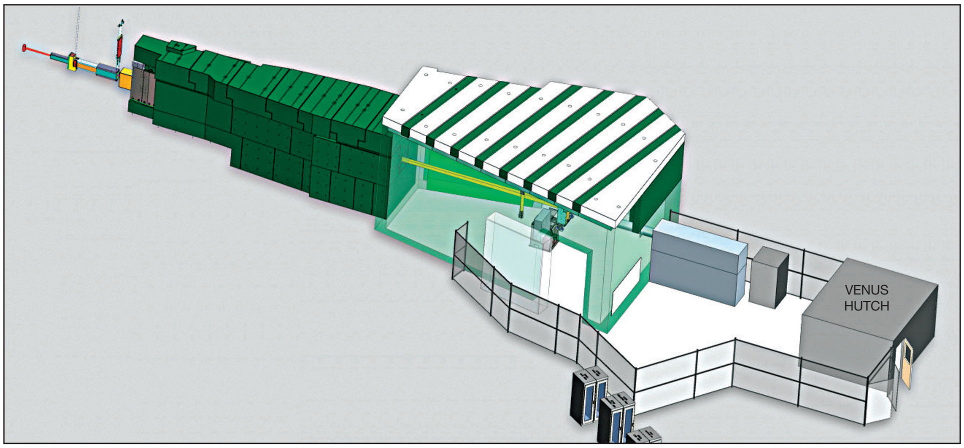
Researchers use neutrons to study the structure of matter—from the benchtop to the atomic scale—because neutrons are deeply penetrating, carry no charge, and are nondestructive, making them suitable for studying, for example, biological structures, metal stresses and defects, and magnetic behavior in quantum materials.

In conventional neutron scattering, as neutrons scatter in a material, they reveal information about an atom's location and behavior. Neutron imaging, on the other hand, measures in transmission—as neutrons pass through a material—to produce neutron radiographs, much like clinical x-rays.

"For example," Bilheux says, "if you want to see lithium as it's moving through the battery, you need contrast to isolate the signal coming from lithium ions."

Building the VENUS beamline at SNS will leverage the facility's accelerator-based neutron source and provide advanced imaging techniques that complement those currently available at the laboratory's steady-state neutron source, the High Flux Isotope Reactor. The SNS pulsed-source accelerator enables the time-of-flight technique, which uses time-stamped neutrons that can be adjusted and preselected across a range of energies. The technique provides the tunable contrast necessary for revealing structural information with low-energy neutrons using an approach called Bragg-edge imaging. It also pinpoints specific elements within a sample using high-energy neutrons with resonance imaging to better understand the material's functional properties and behaviors.

"For example, to distinguish between certain heavy elements such as europium, tantalum, gadolinium, and uranium, one needs higher energy neutrons, which SNS provides," Bilheux says. "Measuring with



Schematic representation of the VENUS instrument, providing time-of-flight neutron imaging capabilities, at the US Department of Energy's Oak Ridge National Laboratory (ORNL) in Tennessee. Credit: Jill Hemman, ORNL.

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VENUS will provide us with three-dimensional maps showing us where a heavy element is located within a sample, and we'll be able to switch between different heavy elements. That capability will be ... beneficial in optimizing the efficiency of novel nuclear materials, which is a high priority for DOE," she added. VENUS is on track to be completed in 2022 and is expected to be ready for users by 2023.

"VENUS will enable us to not only gather information about a material's structure but also how the structure is changing during applied load such as heat or pressure," Bilheux says. "We'll be able to do more experiments and get faster results, all without having to use multiple imaging instruments."

The construction of VENUS is supported by Basic Energy Sciences through funds that were appropriated by the US Congress in FY 2019 for accelerator improvement projects.

Jeremy Rumsey

New Zealand seeks comments to hydrogen plan

beehive.govt.nz

New Zealand is charting the pathway toward a more renewable energy system with the launch of a national vision for hydrogen, Energy and Resources Minister Megan Woods announced in early September.

"Reducing carbon emissions from our energy use is one of the key ways we can fight the long-term challenge of climate change. Today we are launching a Green Paper—*A Vision for Hydrogen in New Zealand*—that lays out the role hydrogen can play in New Zealand's economy, and what we can do to accelerate its use," Woods said.

The hydrogen plan addresses a national transition from fossil fuels to hydrogen as well as an international economic opportunity. In cooperation with Japan, New Zealand already has initiatives in place such as a joint venture between Ballance Agri-Nutrients Ltd. (New Zealand) and Hiringa Energy Limited (Japan) to produce hydrogen in Taranaki in New Zealand at the commercial level, and a partnership between Tuaropaki Trust and Japan's multinational Obayashi Corporation to build a hydrogen production facility using geothermal electricity near Taupō.

"Today's launch … sits alongside the government's decision to end new offshore oil and gas exploration, our investment in a National New Energy Development Centre in Taranaki, backing cutting-edge renewable energy technology, greater support for low emissions vehicles, and helping businesses to invest in low emissions industrial processing," Woods said.

The government seeks feedback from the community on the potential for hydrogen production, export, and utilization in New Zealand's economy. The Green Paper poses 27 questions in nine key areas:

- hydrogen production
- hydrogen electricity nexus
- hydrogen for mobility
- hydrogen for industrial processes
- hydrogen for seasonal power generation
- decarbonization of our gas
- hydrogen for export
- innovation expands job opportunities
- transitioning the job market

Woods said, "The paper is part of a renewable energy strategy work program which is also looking to address barriers to investment in new renewable energy as we work to reach 100% renewable electricity by 2035 and to transition to a clean, green, and carbon-neutral economy by 2050."

Submissions on the Green Paper close on October 25, 2019. Inquiries for the online submission form can be sent to hydrogen@mbie.govt.nz.

Report highlights Australia's opportunity in critical minerals

industry.gov.au

The Minister for Resources and Northern Australia Matthew Canavan has welcomed a new report that examines the market outlook for six critical minerals that hold significant potential for Australia: niobium, rare-earth elements, cobalt, antimony, magnesium, and tungsten.

The Outlook for Selected Critical Minerals: Australia 2019 report comes at a time when critical minerals are of great interest because of their pivotal role in many technologies, growing consumer markets, and limited diversity in production and processing.

"The boom in electric vehicle, battery, and magnet manufacturing is expected to add even further strength to the growing demand for Australia's critical minerals," Canavan says.

Canavan says the report detailed the market dynamics and consumption outlook for the six identified critical minerals. Australia is the largest rare-earth elements producer outside of China, with an infrastructure capable of being exploited to meet global demand, Canavan says. The country also has vast niobium deposits that can be developed for production and distributed to international markets. Furthermore, Canavan says, "As the third largest producer of cobalt, with more capacity in the pipeline, we have an incredibly important role to play in providing a secure and ethical cobalt supply to the world."

According to the Minister, Australia has an additional 80% of landmass that can be explored for mining.

"As a government, we are already targeting the three 'I's to help foster our critical minerals sector—investment, innovation, and infrastructure—to clear the way for more development," Canavan says.

The report was prepared by the Office of the Chief Economist of Australia. ☐

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