INL's Dave Petti

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DOE Pulse

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Research Highlights . . .

Radiation detectors monitor state line

A radiation detection technology developed by scientists and engineers at DOE's Lawrence Livermore National Laboratory is being employed by state and local governments to monitor for nuclear materials that could be part of a "dirty bomb" or nuclear device. The adaptable radiation area monitor (ARAM) has been licensed to Textron Defense Systems Corp. ARAM detectors are now deployed at vehicular entrances to a state in the Western United States. The ARAM system can detect concealed radioactive material about the size of a grain of sand moving at 45 miles per hour. And in New Jersey, a fleet of SUVs with the ARAM technology, patrols highways and streets for nuclear materials.

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INL reaches hydrogen production milestone

In September, DOE's Idaho National Laboratory scaled up its hydrogen production experiment and started making hydrogen at the highest rate achieved so far. The high-temperature electrolysis (HTE) project uses technology originally developed for solid oxide fuel cells and is a significant improvement over the conventional method of passing an electric current through water. Combined with a next-generation nuclear plant, HTE could produce hydrogen at 45 to 55 percent efficiency. Hydrogen is required to make gasoline and diesel fuel from unconventional fossil reserves. Future research will focus on fine-tuning the fuel cells to make them more durable and designing the machine for a larger scale.

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IMPACTS: DOE moves to predict abrupt climate change

William Collins of DOE's Lawrence Berkeley National Laboratory leads IMPACTS (Investigation of the Magnitudes and Probabilities of Abrupt Climate Transitions), a six-lab project sponsored by the Climate Change Prediction Program of DOE's Office of Biological and Environmental Research. Most people think of climate change as something gradual, but climate change has occurred with frightening rapidity in the past and will almost certainly do so again. Marine ice-sheet instability, ecosystem triggers in the Far North, unstable methane hydrates, and Southwestern megadroughts are targets for accurate predictions before abrupt climate change strikes again.

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Back to basics beam line to probe origins of the universe

The Fundamental Neutron Physics Beam Line has opened its shutter to receive neutrons for the first time, adding basic studies in nuclear physics to the suite of capabilities at the Spallation Neutron Source. The DOE's state-of-the-art neutron science facility at Oak Ridge National Laboratory has an eventual ensemble of 25 instruments planned, but this will be the only one to focus on the neutron itself. Questions to be addressed include the details of the internal structure of the neutron as well as a careful study of the way in which the free neutron decays. Such experiments have important implications for fundamental questions in particle physics and cosmology.

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DOE Pulse highlights work being done at the Department of Energy's national laboratories. DOE's laboratories house world-class facilities where more than 30,000 scientists and engineers perform cutting-edge research spanning DOE's science, energy, national security and environmental quality missions. *DOE Pulse* (www.ornl.gov/news/pulse/) is distributed every two weeks. For more information, please contact Jeff Sherwood (jeff.sherwood@hq.doe.gov, 202-586-5806).

PPPL Team Develops Novel Lithium Dropper

You could call it a performance enhancer for the National Spherical Torus Experiment (NSTX) at the DOE's Princeton Plasma Physics Laboratory (PPPL).

The lithium powder dropper recently developed and tested by an NSTX team improves both plasma performance and duration. Plasma is a hot, gaseous state of matter used as the fuel to produce fusion energy —the power source of the sun and the stars.

Lithium, used for years in fusion devices as a coating on vacuum vessel walls, increases plasma performance by reducing impurities sputtering into the plasma. This benefit, though, is sometimes short-lived. Since lithium deactivates quickly, it sometimes loses its ability to boost the plasma performance during an entire discharge—or shot.

The problem is how to re-supply lithium halfway through and to the end of the plasma shot. "How do you keep the party going?" asks PPPL physicist Dennis Mansfield.

That's where the dropper comes in, shaking lithium into the plasma during the shot. Researchers tested the dropper at the end of NSTX operations last year, using pure lithium with thin coatings of carbonate. Pure lithium powder ignites in air and must be coated for stabilization for such experiments.

"The dropper concept is something fellow researcher Lane Roquemore and I were intrigued with a year or so ago," says Mansfield, who joined Roquemore in leading a team to explore the concept.

The group loaded a Lithium Powder Dropper with stabilized lithium metallic powder—spherical particles that don't stick together—for the experiments. It then dropped the 50-micron particles in a systematic and reproducible manner using a computer-controlled piezoelectric bending actuator operating at an acoustic resonance. Mansfield says researchers manipulate lithium at acoustic frequencies, which keeps the particles from "getting into traffic jams." The team demonstrated the controlled dropping with a laser diagnostic. The results: plasma confinement and shot length increased while the level of impurities shrank. The dropper allowed the plasma to receive a lithium boost during and toward the end.

Mansfield is developing proposals for the next NSTX campaign and plans to present a poster about the results at the November American Physical Society-Division of Plasma Physics meeting.

"It was a technical success. It was scientifically interesting and showed a glimmer of performance and a great deal of potential."

Submitted by DOE's Princeton Plasma Physics Laboratory

LONG-TERM RESEARCH PAYS OFF

Dave Petti

Science doesn't happen overnight, and Dave Petti, a fellow at DOE's Idaho National Laboratory, knows that better than many. As INL's technical director for TRISO fuel research, Petti and his team weathered a long dry spell before their project was resurrected in 2003 and reached an important milestone last month.

Tri-isotopic fuel, or TRISO fuel, is a specialized nuclear fuel intended for high-temperature gas reactors. TRISO fuel is a spherical particle with uranium dioxide or uranium oxycarbide at its core. The core is coated with layers of carbon and silicon carbide — the TRISO coating — which act as "the primary containment" of fission products.

The tiny particles, about one millimeter in diameter, are then embedded in graphite. TRISO fuel is unique because it can be fabricated with very few defects, survive severe accident conditions and — most importantly — fission far more uranium (called "burnup") than seen in previous research.

As of early September, the TRISO fuel in INL's Advanced Test Reactor for more than 18 months had achieved 12.5 percent burnup — light water reactor fuel generally achieves no more than 3 or 4 percent burnup.

This breakthrough didn't come easy. TRISO fuel testing was largely abandoned internationally in the early 1990s. The United States began having difficulties in that research area, and budget cuts effectively ended work toward solutions. The project was left for dead until 2003, when climate change and next-generation reactor goals prompted renewed interest in nuclear energy.

"[Generation IV research] was the spark plug that started it," Petti said.

Petti and his team were instructed to pick up TRISO research where they left off. They gleaned information from German records documenting 1980s breakthroughs to help them overcome barriers that had stalled the research.

The overall aims of the TRISO project are within reach now, Petti said. INL hopes to achieve 16 to 17 percent burnup in June 2009, after which the fuel will go in for testing under accident condition simulations.

"The goal of the project is to qualify fuel for use in gas reactors," Petti said. "So four to five years from now [it] should be well on its way."

Submitted by DOE's Idaho National Laboratory