David Erskine

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DOE Pulse

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Research Highlights . . .

Munitions-destruction system expands operations

Expected to eliminate just six munitions a year when conceived in 1998, the Explosive Destruction System (EDS) created by DOE's Sandia National Laboratories has already destroyed more than 100 munitions or bottles containing chemical agents. The four EDS self-contained units created to-date are intended for WWI- and WWII-vintage chemical munitions deemed unsafe to transport or store. The munitions are opened with an explosive charge in a leak-proof chamber and the contents are then neutralized with caustic chemicals and the effluent is disposed of in an environmentally sound manner. There are more than 100 possible buried munitions sites in the US requiring cleanup of aging and potentially unstable recovered munitions.

[Howard Kercheval, 505/844-7842; hckerch@sandia.gov]

Trickle injection technique yields flood of data

A new technique for increasing luminosity at The Stanford Linear Accelerator Center's PEP-II B-Factory looks promising. The former integrated luminosity record, 396 pb-1/day, was eclipsed on December 1, and on December 8 a whopping 481 pb-1/day were delivered to the *BaBar* detector. The key modification, known as trickle injection, is to continuously feed small numbers of positrons into the collider. Originally, larger numbers of positrons were injected about 25 times a day, during which the detector had to be turned off. The new approach maintains a steady number of positrons in the ring, and the detector can take data more of the time. Now, about 2 million events are recorded each day.

[Kate Metropolis, 650/926-8797; kate.metropolis@SLAC.Stanford.EDU]

Bringing the nucleon into sharper focus

New measurements taken at the DOE's Jefferson Lab are providing unprecedented details of quark behavior inside protons and neutrons. Quarks are one of the building blocks; the other is a particle called the gluon, which holds the quarks together. Each quark and gluon possesses a property called spin. The protons and neutrons themselves have spin that totals the individual gluon and quark spins. What percentage of the nucleon spin comes from quarks and what percentage comes from gluons is a mystery. Researchers, for the first time, have measured the distribution of spin of a neutron's quarks. Their results reveal the importance of once-neglected, near-light-speed orbital motions of quarks around the nucleon.

[Debbie Magaldi, 757/269-5102; magaldi@jlab.org]

Brighter sensors

Production of prototype sensors that combine living cells with integrated circuits could begin within a few months. Micro Systems Technologies recently licensed bioluminescent bioreporter integrated circuit technology developed by researchers at DOE's Oak Ridge National Laboratory and the University of Tennessee. These whole-cell living bioreporters are genetically engineered to generate light when they have taken up the targeted substance including chemical and biological agents in the air, water or soil in near real time. Micro Systems Technologies plans on using them for environmental contaminants monitoring, for detecting weapons of mass destruction and in medical care devices. Their low cost and small size make them ideal for use in areas where other analytical instruments would be impractical.

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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).

NETL researchers advance sulfur-tolerant hydrogen membranes

With an eye toward the nation's energy future, a team in the Office of Science and Technology at DOE's National Energy Technology Laboratory (NETL) is evaluating membranes that facilitate the production of hydrogen. As part of DOE's hydrogen program, NETL's hydrogen separation group, headed by Rich Killmeyer, is developing data that provides insight into how sulfur interacts with palladium copper (Pd-Cu) membranes and why the membranes are resistant to sulfur.

As the United States and other nations move toward the greater use of hydrogen as a possible energy carrier, such as in fuel cells for transportation, the production of hydrogen is expected to increase. As a near- and immediate-term source of hydrogen, coal can be used to produce large amounts of hydrogen mixed with carbon dioxide and other gases through the process of gasification.

By advancing gas separation technologies through improved membranes, hydrogen production via gasification can become more efficient and cost-effective, a key step for a future hydrogen-driven economy.

Using its in-house Hydrogen Membrane Test units, the NETL group evaluated Pd-Cu membranes because of their potential resistance to chemical impurities, such as sulfur, as they selectively remove hydrogen from mixed-gas streams. They found that sulfur resistance can be correlated with PD-CU crystalline structure, which is determined by the operating temperature and alloy composition.

The NETL work is important because it lays the groundwork for the further development of sulfur-tolerant membranes, which the researchers view as key to the ultimate production and distribution of pure hydrogen from coal. As a follow-up to their research, the NETL team is pursuing a patent based on the membrane findings.

For their presentation entitled "High-Pressure, High-Temperature Hydrogen Permeability Measurements of Palladium-Copper Alloys," the team earned a Best Poster Award at the 2003 AIChE Annual Meeting in San Francisco. The poster presentation was part of a session on "Advances in Membranes and Fuel Cell Technology."

Sumitted by the National Energy Technology Laboratory

A PHYSICIST'S SEARCH FOR PLANETS HAS LED TO MUCH MORE

David Erskine

It started as search for planets but has expanded into a system that can be applied in the fields of broadband high-resolution spectroscopy and the precision angular measurements of stars.

The externally dispersed interferometer uses a small, inexpensive interferometer with an external grating spectrograph for precision Doppler velocity measurements and high-resolution spectroscopy.

The idea started out as a pilot project put together by physicist David Erskine of the Physics and Advanced Technologies Directorate using white light velocity interferometry techniques from the Lab's two-stage gas guns and combining it with astronomical spectroscopy.

The motion of a planet around a star causes a Doppler shift in the wavelength of light. Light passing through the periodic fringes of an interferometer (and then into the spectrograph) creates a moire pattern. The moire pattern shifts trans-versely, proportional to the Doppler velocity. Spectrograph distortions can prevent a precision measurement of the Doppler shift but by using the EDI the small Doppler shifts of expolanets can be measured.

After conducting bench top testing, he tested it on starlight at the Lick Observatory. "This instrument truly helped reduce the distortion of starlight and is much easier to transport to any observatory," Erskine said.

While thinking of other applications, he realized it could be used to boost the time resolution and stability of streak cameras recording high-speed phenomena, such as in shockwave physics experiments conducted at the National Ignition Facility. The time resolution boosting is analogous to a two-times spectral resolution boost he and his UC Berkeley collaborators have recently demonstrated at the Lick Observatory spectrograph.

Currently Erskine is intent on demon-strating a 10 times resolution boosting effect, using a modified interferometer with multiple delays.

Submitted by Lawrence Livermore National Laboratory