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DOE Pulse

Science and Technology Highlights from the DOE National Laboratories

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Research Highlights . . .

Protons are round, right?

A recent experiment at DOE's Jefferson Lab suggests that the humble proton might not be round. A debate is underway over data collected that shows that quarks, the building blocks of protons, are moving at relativistic speeds and thus elongating as they move around. Tiny quarks could be moving at nearly light speed and thus stretching the proton like a rubber band might stretch. The results of this experiment will be tested in future experiments at Jefferson Lab that will either put this observation on the map or have scientists searching even further for the answers.

[Linda Ware, 757/269-7689, ware@jlab.org]

SSRL provides fertile clues

The Stanford Synchrotron Radiation Laboratory at DOE's Stanford Linear Accelerator Center enabled a Caltech research group to "see" their way, at a resolution of 1.16 Å, to understanding a key biological process important to world-wide food production.

About half the world's supply of nitrogen needed for growing plants is produced chemically at extreme temperature and pressure. In contrast, a remarkable enzyme called nitrogenase found in bacteria catalyzes the production of ammonia from dinitrogen and produces about half of the world's bio-nitrogen available for agriculture. The SSRL-enabled recognition of extremely fine and unexpected atomic details at the catalytic site of nitrogenase may help chemists design a more efficient method for producing ammonia from atmospheric nitrogen, saving global resources and ultimately increasing agricultural productivity.

[Tom Mead, 650-926-5133, tmead@SLAC.Stanford.EDU]

PNNL gathers most complete protein map of tough microbe

Scientists at DOE's Pacific Northwest National Laboratory have obtained the most complete protein coverage of any organism to date with the study of a radiation-resistant microbe known to survive extreme environments called *Deinococcus radiodurans.* Using a new, powerful mass spectrometry technique developed at PNNL, scientists observed a 61 percent coverage of the microbe's proteome. This is the most complete proteome reporting to date of any organism. *D. radiodurans* is of interest because of its ability to withstand high levels of radiation and its impressive DNA repair capabilities.

[Staci Maloof, 509/372-6313, staci.maloof@pnl.gov]

Compound may immobilize AIDs virus, radionuclides

Niobium heteropolyanions (HPAs), which could immobilize the AIDS virus or extract radionuclides from nuclear wastes, has been developed by researcher May Nyman at DOE's Sandia National Laboratories. Niobium HPAs are basic rather than acidic, which means they can survive longer in the generally basic or neutral environments of radioactive wastes and blood.

Preliminary work with Savannah River Site indicates that the new compounds selectively remove certain radionuclides from waste solutions. Also, research has shown that HPAs with small amounts of niobium have an especially strong binding effect with viruses, and since Nyman's HPAs are completely niobium and can survive in blood, they could inhibit the AIDS virus's ability to enter cells and damage them.

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

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).

In the eye of the beholder

As Jack Halow puts it, "A picture may be worth a thousand words, but a virtual environment visualization is worth a million numbers." Halow, director of the Simulation and Multi-phase Flow Analysis Division at DOE's National Energy Technology Laboratory (NETL), is excited about the completion of the lab's four-surface, virtual environment (VE) center: technology that immerses researchers in a synthetic environment generated with digital data from the lab's science and engineering research efforts.

"When it's fully functional, we'll move beyond our current visualization capabilities and into the world of virtual reality. We will not only see the data, but we'll hear it and interact with it in very natural, multi-sensory ways," Halow said.

In collaboration with Ames Laboratory, NETL is developing the CAVE-like facility into a science laboratory and engineering design center for the fossil-fueled energy plants of the future. And that future is closer than most people think. DOE program plans call for the first of the near-zero-emissions Vision 21 power plants to come on-line in about 2020.

Just as virtual design technologies brought the Boeing-777 to market in the mid-1990s and continue to bring new automotive designs to market in record cycle times, the NETL VE center will play an important role in finding science, engineering and design solutions critical to Vision 21 plant development.

The new plants will incorporate technology systems only now being developed. NETL will have the capability to predict dynamic responses of entire energy systems such as hybrid generating systems that use fuel cells in combination with advanced gas turbines, and coal gasification systems that incorporate processes to separate and sequester the greenhouse gas, carbon dioxide.

Fuel cell science in a virtual world

"At millions of dollars a pop, we can't build and test these technologies in the real world until we're pretty sure we've got a winner. Problem solving in the virtual world is much cheaper - and faster," said Halow.

Submitted by National Energy Technology Laboratory

SEQUENCING WIZARD: SUSAN LUCAS

Biologist Susan Lucas, associate director of DOE's Joint Genome Institute (JGI) in Walnut Creek, California, has seen gene-sequencing technology come a long way in a big hurry.

Susan Lucas

When Susan graduated from the University of Oregon and joined the bioscience staff at Lawrence Livermore National Laboratory in 1997, new sequencing techniques and technologies were just being introduced that opened the door to automated, "high-throughput" sequencing—faster, cheaper, and more accurate—enabling an international team of researchers to complete the draft sequence of the human genome in 2001, four years ahead of schedule.

Today, Susan manages one of the world's fastest and most productive genome sequencing operations, sequencing more than one billion base pairs (Gb) of DNA—the equivalent of one-third of the human genome—every month. Her goal is to hit two Gb by January 2003.

The JGI, a consortium of the three DOE laboratories managed by the University of California—Lawrence Livermore, Lawrence Berkeley, and Los Alamos— was responsible for sequencing chromosomes 5, 16, and 19, DOE's contribution to the Human Genome Project.

It wasn't just technology that made it possible for the milestone achievement of the Human Genome Project to be reached so quickly. It also took careful planning, dedication, and concentrated effort by people like Susan and her colleagues—spurred on by the desire to ensure that the "Book of Life" detailing the human genetic makeup would be freely available to researchers and the public.

"We worked really hard, because we wanted to see the public effort succeed," Susan says. "The whole staff had a can-do attitude—we all wanted to make it happen."

Submitted by DOE's Lawrence Livermore National Laboratory