ANL's Mark Hereld

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DOE Pulse

Science and Technology Highlights from the DOE National Laboratories

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Research Highlights . . .

First plasma for LTX

Researchers at DOE's Princeton Plasma Physics Laboratory recently produced the first plasma on the Lithium Tokamak Experiment (LTX). The new device studies pure lithium metal on surfaces facing or contacting the plasma. LTX may herald a new regime of plasma performance with improved stability, lower impurity levels, better particle and temperature control, and more efficient operation. "Even in a small machine like LTX, we expect a dramatic change in plasma parameters, and that's what we're quite excited about," said Bob Kaita. He and Dick Majeski are the LTX co-investigators. This improved performance may be possible because the LTX plasma is enclosed in a heated, conductive shell coated with molten lithium on the inside, and shaped to conform to the boundary of the plasma.

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Paying less to tackle climate change

A new set of climate scenarios reaffirms that a mix of advanced technologies could significantly reduce the cost to stabilize the global climate by 2095. Researchers from the Joint Global Change Research Institute, a collaboration between DOE's Pacific Northwest National Laboratory and the University of Maryland, used PNNL's MiniCAM model to simulate the economic, energy, climate and terrestrial systems under various conditions. For example, the model balanced the demand for biofuel against the need to retain cropland. The work offers a richer set of scenarios for understanding how technology could evolve, the uncertainties involved and the interactions between technologies for reducing greenhouse gas emissions.

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Quantum dots could boost solar cell efficiency

Solar cells may soon be more efficient than previously thought possible, thanks to a recent result from the PULSE Institute for Ultrafast Energy Science, a joint institute of DOE's SLAC National Accelerator Center and Stanford University. The PULSE researchers confirmed the results of a Los Alamos National Laboratory experiment that measured one photon of light generating more than one electron of electricity in a so-called "quantum dot"—a sphere made of only a few thousand atoms. Scientists previously assumed that one photon could excite exactly one electron, limiting the efficiency of solar cells. Using a slightly different experimental method than previous such experiments, the PULSE researchers confirmed the Los Alamos findings and determined that a single photon can excite as many as three electrons in a quantum dot.

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Tracking cropland CO_2

For the first time, farmers have data that track at the county level carbon dioxide emissions associated with growing crops in the United States. This information is vital for examining changes in cropland production and management techniques and could play an even bigger role as more land is devoted to bioenergy crops, say researchers at DOE's Oak Ridge National Laboratory. By looking at changes in energy consumption and CO_2 emissions that take place with conventional and alternative crop production, planners can do a better job of measuring the effects of various carbon sequestration strategies. The information can also contribute to future policy directions for energy use and agricultural production."

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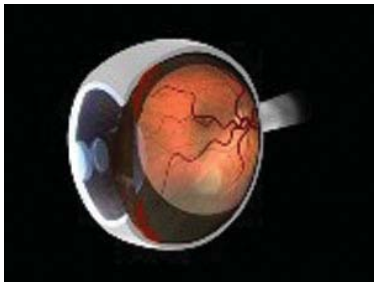
DOE Pulse highlights work being done at the Department of Energy's national laboratories. DOE's laboratories house world-class facilities where more than 30,000 scientists and engineers perform cutting-edge research spanning DOE's science, energy, national security and environmental quality missions. ***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).

Retina imaging project could save vision of millions

In the blink of an eye, people at risk of becoming blind can now be screened for eye diseases such as diabetic retinopathy and age-related macular degeneration.

Using a technology originally developed at DOE's Oak Ridge National Laboratory to understand semiconductor defects, three locations in Memphis have been equipped with digital cameras that take pictures of the retina. Those images are relayed to a center where they are analyzed and the patient knows in minutes whether he or she needs additional medical attention.

"Once we've taken pictures of the eyes, we transmit that information to our database, where it is compared to thousands of images of known retinal disease states," said Ken Tobin, who led the ORNL team that developed the technology. "From there, the computer system is able to determine whether the patient passes the screening or it provides a follow-up plan that includes seeing an ophthalmologist."



Already, this technology is making a difference as two patients at the Church Health Center in Memphis have been identified as needing laser treatment for moderate and severe diabetic retinopathy and macular edema, both conditions that can lead to blindness.

While some cameras have been installed, others will be installed at several rural and urban health care centers serving the Mississippi Delta. Another camera is planned for a federally funded health center in Chattanooga. Eventually, the goal is to have hundreds of cameras throughout the United States and beyond. If disease can be detected early, treatments can preserve vision and significantly reduce the occurrence of debilitating blindness.

This project takes advantage of ORNL's proprietary content-based image retrieval technology, which quickly sorts through large databases and finds visually similar images. For more than a decade manufacturers of semiconductors have used this technology to rapidly scan hundreds of thousands of tiny semiconductors to learn quickly about problems in the manufacturing process.

The researchers have published a number of papers, most recently in Retina, The Journal of Retinal and Vitreous Diseases. The paper, titled "Automated Retinal Diagnosis by CBIR," appears in Vol. 28, No. 10 (2008).

Submitted by DOE's Oak Ridge National Laboratory

ANL RESEARCHER MODELS SEIZURE-PRONE BRAINS

Mark Hereld

A brain scan of a person experiencing an epileptic seizure looks like the Great Plains during an early evening in midsummer. Fierce electrical storms pop up seemingly at random, proliferate over large areas and subside almost as quickly as they arose.

The complex interplay of microscopic physical and biological effects that govern the strange dynamics of epileptic seizures has long remained a mystery to scientists and doctors who seek to comprehend and treat this common and often life-threatening condition.

In order to enrich their understanding of why seizures occur and propagate, scientists at DOE's Argonne National Laboratory have created a life-like model of small areas in the brain using state-of-the-art high-performance computers. The conclusions that Argonne researchers draw from these models directly impact their collaborations with clinical and laboratory neuroscience researchers at the University of Chicago.

For many years, computer scientists have used complex models known as "neural networks" to model brain activity. These simulations use many separate data structures to represent individual brain cells, or neurons. Because each neuron can receive information—in the form of an electrical pulse—from thousands to tens of thousands of other neurons, scientists need an extremely powerful computer to handle all of the model's interconnections, said Argonne computer scientist Mark Hereld. But, he added, the brain's complexity prevents any current model from accurately representing more than small sections of it.

According to Hereld, models of neural networks provide a glimpse into epilepsy that complements information obtainable through clinical or laboratory studies. "There are some questions that simply can't be answered by examining a live patient or looking at a small piece of brain tissue in the lab," Hereld said. "Computing offers the possibility of changing any parameter to answer highly targeted questions about the fundamental causes of seizures."

Submitted by DOE's Argonne National Laboratory