INL's Michael Assante

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DOE Pulse

Science and Technology Highlights from the DOE National Laboratories

Number 255 February 25, 2008

Research Highlights . . .

INL researchers revamp nuclear simulations

Researchers at DOE's Idaho National Laboratory have developed nuclear reactor simulation capabilities, including a model of fuel performance. These simulations take advantage of computational tools like meshing, where structure is divided into smaller areas computers can model. Each area within the fuel mesh, for example, will contain a host of physical information; including temperature, the number of neutrons being created, and structural state. This simulation capability will eventually model a reactor from the scale of atoms to an entire reactor assembly, enabling a fundamentally different approach to nuclear simulation. The goal is a bottom-up nuclear reactor simulation with improved predictive capabilities, improving safety, boosting efficiency and helping researchers anticipate challenges.

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A first in microfluidic MRI

Visualizing gas-phase reactions with magnetic resonance imaging (MRI) could significantly improve the design of future microcatalytic reactors, including "labs-on-a-chip," and could also affect catalyst design. Alexander Pines of the Materials Sciences Division at DOE's Lawrence Berkeley National Laboratory led a team that developed enhanced MRI of microscale catalytic reaction products using hyperpolarized parahydrogen gas. MRI is unique for its ability to measure velocity- and spatially-dependent quantities, which the researchers demonstrated by tracking gases and liquids in microfluidic devices, as well as in the void spaces of a tightly packed catalyst reactor bed, without the use of tracer particles or gases.

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Livermore engineer Jim Candy's sound science

James V. Candy, Engineering Directorate chief scientist at DOE's Lawrence Livermore National Laboratory, is now applying his pioneering signal and image processing work in underwater acoustics to the detection of radioactive contraband for homeland security. Candy has developed "model-based signal and image processing techniques" that have improved acoustical detection and measurement for applications in national security, materials science and medicine. Applications include vibrational failure detection for prosthetic heart valves, target localization in ocean acoustics (i.e. submarines), communications in room acoustics, detecting and imaging flaws in materials for nondestructive evaluation and biomedical imaging for ultrasonic cancer detection.

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SNS sets a record

DOE's Spallation Neutron Source at Oak Ridge National Laboratory has been confirmed by the Guinness Book of World Records as the world's most powerful pulsed neutron spallation source. The SNS recently ramped up beam power to more than 300 kilowatts, producing 4.8 x 10e16 neutrons per second. The SNS is currently sending neutrons to five instruments of an eventual 24, and its first article has been accepted in *Physical Review Letters*. With an eventual beam power of 1.4 megawatts, every time the SNS ramps up, it will set a new neutron production standard.

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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).

Blast from the past

Michael Assante

It is a well-documented fact that modern society owes much of its success to the people of ancient Rome. From our numeric calendar system to the concept of public libraries and even the idea of a democratic government, much has been gained by studying this historic civilization.

For DOE's Idaho National Laboratory relationship manager Michael Assante, understanding how the ancient Romans developed and defended their massive aqueduct system could play a key role in identifying measures the U.S. can take to protect its infrastructure networks, in particular the electric power grid.

Protecting the nation's critical infrastructure systems from challenges such as aging, natural disasters and acts of terrorism is a complex task. Assante believes that studying the successes and failures of this past civilization could provide new insight and direction for protecting U.S. assets.

Assante recently authored an article for CSO Magazine in which he details a four-point strategy for electric grid protection based on lessons learned from ancient Rome's attempts to protect its aqueducts. The article was an excerpt from the paper "Infrastructure Protection in the Ancient World," which Assante wrote in December.

Since joining the laboratory in 2005, Assante has been highly regarded as one of the nation's leading experts in cyber and infrastructure security, and has been credited with raising international awareness with U.S. ally nations about infrastructure cybersecurity. He is a former naval intelligence officer and has also served as vice president and chief security officer for American Electric Power.

In 2007, he was asked to serve on the Commission for Cybersecurity for the 44th Presidency. The 31-member commission is developing a comprehensive national strategy for cybersecurity that will be presented to the newly elected president in January 2009.

Submitted by DOE's Idaho National Laboratory

Millions of computer hours for fusion research

William Tang, chief scientist at DOE's Princeton Plasma Physics Laboratory, has been awarded two million processor hours on the new IBM Blue Gene/P supercomputer at the Argonne National Laboratory. He and PPPL computational scientist Stephane Ethier will be using the time for fusion energy related research.

Tang heads one of 55 scientific projects recently awarded a total of 265 million hours by the DOE's Office of Science through the 2008 Innovative and Novel Computational Impact on Theory and Experiment (INCITE) program.

"The Department of Energy's Office of Science has two of the top ten most powerful supercomputers, and using them through the INCITE program is having a transformational effect on America's scientific and economic competitiveness," DOE Under Secretary for Science Raymond L. Orbach said.

Tang's project focuses on gaining a better understanding of turbulence as a primary mechanism by which particles and energy diffuse across the confining magnetic field in toroidal fusion systems. Results from these studies may have direct relevance to the future performance of the international fusion experiment called ITER being planned for construction in France. 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. This INCITE project will commence within the next month and extend over a year, with expected renewals in the subsequent two years.

"My colleagues and I are grateful for the INCITE award and are excited by the opportunity to use the new IBM Blue Gene/P at Argonne National Laboratory to accelerate the pace to fresh scientific insights about the complex nature of turbulence in hot thermonuclear plasmas," said Tang.

Ethier noted that a research project requiring two million processor hours would take 228 years to complete using a single processor. "With 100,000 processors working in parallel — the final configuration of the Blue Gene/P supercomputer at the Argonne National Laboratory — the same two million processor-hour calculations will take only 20 hours. The real challenge is to orchestrate the work and the communication among these 100,000 processors. If a single processor falls behind, it will slow down the others since they must work in unison. As the number of processors increases, keeping them in sync becomes quite arduous," he said.

Co-investigators on the project are Scott Klasky of DOE's Oak Ridge National Laboratory (ORNL) in Tennessee and Mark Adams of Columbia University in New York.

Submitted by DOE's Princeton Plasma Physics Laboratory