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DOE Pulse

Science and Technology Highlights from the DOE National Laboratories

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Research Highlights . . .

APS detects bug 'breath'

Scientists at The Field Museum and Argonne National Laboratory have discovered a surprising new insect breathing mechanism that is similar to lung ventilation in vertebrates. Insects - the most numerous and diverse group of animals - don't have lungs. But this study demonstrates that beetles, crickets, ants, butterflies, cockroaches, dragonflies and other insects use rapid cycles of tracheal compression and expansion in their head and thorax to breathe. Up until now, it has not been possible to see movement inside living insects. This problem has been solved by using the Advanced Photon Source at Argonne, which produces the most brilliant X-rays in the Western Hemisphere, to obtain videos of living, breathing insects.

[Catherine Foster, 630/252-5580, cfoster@anl.gov]

New antibody library speeds search for new detection tools

Scientists at DOE's Pacific Northwest National Laboratory have extracted part of the human immune system and reconstituted it in brewer's yeast in a fashion that enables identification of new antibodies in days rather than the months it takes with current approaches. PNNL researchers built a library of 1 billion human antibodies and expressed them on the surface of yeast cells using a platform designed by an MIT collaborator. The combined technologies offer a more powerful, less expensive method for identifying antibodies. The advance could have major repercussions for fundamental biological science as well as industries that use antibodies for sensors, biodetectors, diagnostic tools and therapeutic agents.

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

Fermilab's DZero Detector goes global

A newly-developed Global Monitoring System in operation at the DZero particle detector at DOE's Fermi National Accelerator Laboratory enables more than 600 members of the experiment's world-wide collaboration to fulfill their requirements for taking part in the detector's control room shifts, monitoring physics data and detector performance, via computer from their home institutions. Experimenters have been taking control room shifts from as far away as India. Said DZero co-spokesperson John Womersley: "Tools that have been developed to improve collaborative work in high energy physics have turned out to be more broadly useful."

[Mike Perricone, 630/840-5678, mikep@fnal.gov]

Tiny device for telecommunications

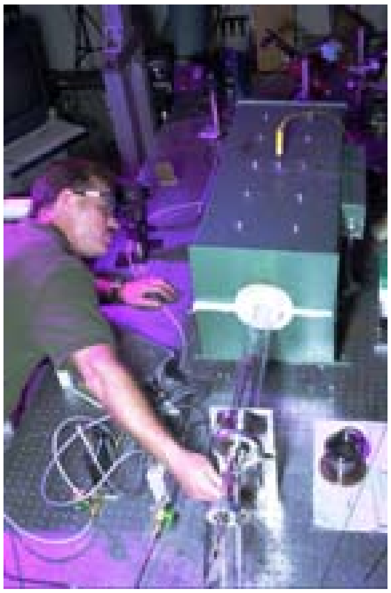
Scientists have built a new device used to correct signal distortions at high speed in optical fibers—the plastic or glass cables used to carry high-speed signals from television, computer, telephone and radar. The new device, which uses liquid crystals instead of the currently used lithium niobate, could make optical communications more affordable in the future. This research was funded by DOE and the National Science Foundation, and was conducted by scientists from DOE's Brookhaven National Laboratory and at Bell Laboratories, Lucent Technologies' Research and Development arm. The Bell Lab scientists are currently interacting with industrial partners to manufacture and commercialize the new device.

[Mona S. Rowe, 631/344-5056, mrowe@bnl.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).

Free-Electron Laser explores promise of carbon nanotubes

Scientists and technologists from DOE's Jefferson Lab, the College of William & Mary, and NASA are working together to explore the possibilities of an extremely strong and versatile cylinder—so tiny that millions, which in bunches look like an ebony snowflake, could fit easily on the head of a pin. The objects are known as carbon nanotubes, first discovered in 1991 as the elongated form of an all-carbon molecule.



Brian Holloway, William & Mary professor, prepares the nanotube oven, a component that helps produce nanotubes with light from JLab's Free-Electron Laser.

Sometimes called CNTs, nanotubes take up an extremely small space but can connect together materials with different properties, and their own properties can be adjusted depending on formulation. The tubes are very long but not wide and can be extended without sacrificing strength. CNTs have potential applications in molecular and quantum computing and as components for microelectromechanical sensors, or MEMS. The tubes could also function as a "lab on a chip," with attached microelectronics and components that could detect toxins and nerve agents in vanishingly small concentrations.

Researchers Brian Holloway, assistant professor at William & Mary, and Mike Smith, NASA materials scientist, are intrigued by the tubes' potential. The collaboration used Jefferson Lab's Free-Electron Laser (FEL) to explore the fundamental science of how and why nanotubes form, paying close attention to the atomic and molecular details. The collaboration has already produced tubes as good as, if not better than, those at other laboratories or in industry; and produced them in larger amounts and more cost effectively than what is currently possible through conventional, tabletop laser production methods.

Holloway and Smith are seeking funding from NASA and the Office of Naval Research for a three-year project with the goal of optimizing nanotube production with an upgraded FEL in order to manufacture large quantities quickly and cheaply.

Submitted by DOE's Jefferson Lab

Going to Take a Scientific Journey

Mark Gordon

"I wouldn't know what to if I wasn't doing research," says Mark Gordon, Ames Laboratory program director of Applied Mathematics and Computational Sciences. "I get up in the morning and go to bed at night thinking about science."

It's good he feels that way because a Fulbright Award will take him to the Australian National University in Canberra for a February-through-May science sojourn. While there, Gordon will focus on his favorite thing—quantum chemistry—a branch of physical chemistry that deals with explaining chemical phenomena by using the laws of quantum mechanics.

In one of several research efforts, Gordon will be working with ANU colleague Leon Radom on a new quantum chemistry method to predict the thermodynamic properties of complex systems, such as transition metal compounds, excited states and metastable species. "The method works really well, but one challenge will be to develop a clever way of extending it to much bigger chemical systems," Gordon says.

A second undertaking will highlight Gordon's ongoing efforts to enhance GAMESS, a software suite that does quantum chemistry electronic structure calculations. He will collaborate with ANU's Michael Collins to merge Collins' GROW code with GAMESS. GROW actually grows the potential energy surfaces for molecular systems containing four to seven atoms. "Generating the potential energy surface is a tremendous problem, but GROW does this automatically by telling GAMESS the points at which an energy should be calculated," says Gordon.

In another project, Gordon will work with ANU colleague Alistair Rendell to develop more parallel code for GAMESS that will be a combination of graphics and parallel programming.

Anticipating his stay in Australia, Gordon says, "For the most part, I can think just about science for four months. It's like getting to go to the World Series all the time," adds the avid baseball fan.

Submitted by DOE's Ames Lab