Basic science turned toward healing.

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DOE Pulse

Science and Technology Highlights from the DOE National Laboratories

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Research Highlights . . .

Clues to matter-antimatter asymmetry

The international BaBar Collaboration at DOE's Stanford Linear Accelerator Center recently released initial results on the behavior of subatomic particles called B mesons. These are the best results yet obtained on the short-lived particles, expected to provide clues about why our universe contains far more matter than antimatter. A tiny difference between matter and antimatter was first discovered in 1964, but physicists have struggled ever since to find other examples. In a paper soon to appear in *Physical Review Letters, BaBar* physicists give the value of a key parameter—about twice as accurate as earlier measurements—that suggests a matter-antimatter asymmetry. More data will be needed to reach a definite conclusion.

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Enhancing manufacturing technology at FEL

One of the best ways to increase metal hardness, thereby increasing its wear and corrosion resistance, is a process called nitriding. It requires high vacuum, nitrogen gasses, and baking at high temperatures for at least 24 hours. A faster process may be on the horizon thanks to experiments taking place at DOE's Jefferson Lab using its Free Electron Laser. Researchers are conducting experiments using the FEL to replace the baking portion of the process. Tests are showing the FEL requires minutes rather than hours—saving time and money for manufacturers and end users.

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

Magnetic field fires 20 times faster than rifle

A magnetic field that accelerates pellets faster than anything except a nuclear explosion has been developed experimentally at the DOE's Sandia National Laboratories. The propulsion speed of 20 km/sec—almost three times that necessary to escape the gravitational pull of Earth (about 7 km/sec)—would send material from New York to Boston in half a minute. A rifle bullet is typically propelled at 1 km/sec. The machine that generates the field has been jokingly dubbed "the fastest gun in the West," but physicist Marcus Knudson, lead scientist on the project, says simply: "It's the fastest gun in the world."

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

Wind power's effect on grid modeled

Researchers at DOE's National Renewable Energy Laboratory are analyzing the impact of multiple wind turbines on weak electricity grids. Currently, researchers are studying existing grids with existing wind farms to maximize the efficient use of the existing grid for wind applications. Problems on these grids will be duplicated using computer simulation and solutions will be proposed to wind farms and utilities. New models eventually will be offered to utility planners for more accurate representation of wind turbines' impacts.

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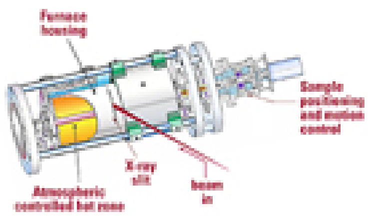
DOE Pulse highlights work being done at the Department of Energy's national laboratories. DOE's laboratories house world-class facilities where more than 30,000 scientists and engineers perform cutting-edge research spanning DOE's science, energy, national security and environmental quality missions.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

Portable furnace provides a better look at microstructures

A unique, compact furnace designed and built at the DOE's Ames Laboratory is giving researchers the unprecedented ability to directly record the chemical and structural changes of complex materials at high temperatures under real processing conditions.

The furnace uses an analytical technique known as X-ray diffraction in which an X-ray beam is focused on a small sample of material. The beam is diffracted by the crystal structure of each material, producing a unique pattern of concentric circles, called "Debye rings." By capturing images of the changes in the ring pattern as the material is heated and cooled, scientists gain a better fundamental understanding of what happens to the materialís crystal structure at various temperatures.



The device, built by Ames Laboratory's Engineering Services Group, is a scaled-down version of a standard laboratory tube furnace. It measures about 18 inches tall and 6 inches in diameter and is capable of heating samples to 1500 C (2700 F). The top has an indirect, magnetic coupling system that connects to a motor shaft, which can rotate the sample holder up to 1,000 times per minute. One end of the sample holder, a long pipette that can be capped, is placed in the coupling system while the end containing the sample is aligned with a 3-millimeter opening in the side of the furnace. The X-ray beam enters through the opening, and the diffracted rays emerge through a slot in the furnace.

Ames Laboratory scientist Matt Kramer, who helped design the furnace, said the new system is an improvement over high-temperature X-ray diffraction systems in which samples rest on a flat plate. This doesn't allow the sample to be rotated and sometimes causes the liquid and solid phases of the material to draw apart. Also, the samples don't always heat uniformly, producing large temperature variations in the material that make it difficult to correlate the temperatures with changes in the crystal structure.

"The excellent control we have with our furnace means that we can select an exact temperature setting for our measurement and know that the whole sample is that temperature," Kramer said. "And with the confined geometry, we can melt things and know that the liquid and solid aren't separating."

The furnace is housed at the Advanced Photon Source at DOE's Argonne National Laboratory in a sector of the beam reserved for the Midwest Universities Collaborative Access Team, which is operated by DOE's Ames Lab and Iowa State University. The device has also been used by researchers at DOE's Brookhaven National Laboratory, and the Ames Lab group is currently working on a new furnace design in conjunction with the Synchrotron Radiation Instrumentation Collaborative Access Team at Argonne.

Submitted by DOE's Ames Laboratory

BASIC SCIENCE MEETS MEDICINE

Weisenberger

The world of nuclear science research can lead to many new discoveries in the inner world of the nucleus—such as learning where mass comes from, and maybe why we can never see a quark—the smaller particles that make up protons and neutrons—by themselves.

DOE's Jefferson Lab is exploring this area as one of the newest nuclear physics facilities in the country. Since beginning taking data in 1994, the lab has been host to many researchers busy unlocking the mysteries quarks might hold. That should be enough for any research facility but not the researchers at Jefferson Lab.

One such researcher, Dr. Drew Weisenberger, a member of the JLab Detector Group, holds several patents for his work that have their technological beginnings in nuclear physics research but then go further and apply that technology to medical imaging.

Drew's interest in medical imaging came about by a circuitous route. He started studying astrophysics using light detectors for his undergraduate studies, his masters work focused on radio astronomy and after coming to Jefferson Lab in 1990 his expertise in gamma ray detectors was used to study the very small instead of the very far away.

His interest at Jefferson Lab eventually turned to biophysics—the area of study for his doctorate. That expertise was applied with his colleagues to the medical imaging area where patents followed using equipment originally thought to only have usefulness in nuclear physics research.

One project could reduce the need for breast biopsies. In a clinical study being conducted with the local hospital system, a new imaging system patented by Drew and his colleagues could reduce the number of false positives associated with conventional mammography.

Asked what he is proudest of so far in his life, though, and he smiles and says it's his two red-headed daughters waiting to greet him every night.

Submitted by DOE's Jefferson Lab