Robert Nadeau studies California quakes. Page 2.

DOE Pulse

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Research Highlights . . .

Plasma campers explore magnetic fields

A trio of high school physics teachers recently gauged the effects of changing magnetic fields on plasma using the Current Drive Experiment-Upgrade (CDX-U), a small fusion machine at DOE's Princeton Plasma Physics Laboratory. Three of 14 teachers attending PPPL's "Plasma Camp" participated in the experiment: one operated the CDX-U with PPPL staff, the second evaluated the temperature and density of the plasma and the third analyzed plasma impurities with a soft X-ray pinhole camera. The Plasma Science and Fusion Energy Institute's camp is an intensive two-week summer program of lectures, lab work and curriculum design for high school physics teachers selected nationwide.

[Tony DeMeo, 609/243-2755, ademeo@pppl.gov]

Powerful tunable laser exceeds design goals

DOE's Jefferson Lab exceeded its design goal of 1,000 watts (a million times more powerful than the laser in a supermarket scanner) by producing 1,720 watts of infrared light from its Free Electron Laser (FEL) in July. At kilowatt levels, the Jefferson Lab FEL offers researchers a unique tool for science and industrial processing with light. The FEL may have a wide range of applications in manufacturing, including processing of plastics, more durable synthetic fibers, corrosion resistant metals and advanced materials and components for electronics and microtechnologies. Initial industrial experiments are investigating roughening plastics, creating hardened and corrosion-resistant metal surfaces, and machining miniature structures in ceramics.

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

Two-for-one special: Industrial enzymes and food grown in one plant

Some crops are grown for food while others are grown to produce consumer products, but a special group of potato plants now is doing both at once. Researchers at DOE's Pacific Northwest National Laboratory have developed the capability to direct desirable traits into a specific portion of a plant, allowing dual-use of one crop. The experimental potatoes have sprouted valuable enzymes in the vines that are used in pharmaceuticals, and specialty chemical and industrial products, while the tubers remain just plain old spuds to be baked, boiled or turned into fries.

[Susan Bauer, 509/375-2561, susan.bauer@pnl.gov]

Weapons designers turn talents to high-tech prostheses

The success of a fledgling program in which former Soviet nuclear weapons scientists helped develop an artificial foot has led to a second prosthetics project between DOE's Sandia National Laboratories and the Ohio Willow Wood Company. This one, to develop an artificial knee, is supported by a $1.4 million CRADA from DOE's Initiatives for Proliferation Prevention Program. The technologies are being developed by Sandia and Chelyabinsk 70. Ohio Willow Wood will define the requirements for parts and perform final laboratory and clinical testing. The Russians will design a titanium housing and Sandia robotics researchers will design the knee's internal workings and electronics.

[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).

DOE labs conduct experiments on high-speed Internet

What if supertankers moved at the speed of sound? Well, that's one way to think about the impact of the National Transparent Optical Network on data transmission. NTON is part of SuperNet, an essential component of the Next Generation Internet. Seeded by DARPA funding, and developed by the high-tech, West Coast R&D community including DOE labs like Lawrence Livermore and Lawrence Berkeley, NTON will eventually become self-sustaining through its mix of industrial, university and government-laboratory users.

Specifically, NTON provides a very high-speed, transparent, optical fiber network covering the San Francisco Bay Area. This advanced system will become a testbed for complex new technologies, a facility for development and demonstration of high-bandwidth network applications, and a platform for research and development of integrated network management. The Livermore and Berkeley Labs, Sandia National Lab, Stanford Linear Accelerator Center and others will be directly connected. NTON is being extended north to Portland and Seattle, and south to Los Angeles and San Diego. Access will eventually be extended to additional DOE Next Generation Internet research sites, Argonne and FermiLabs, and the University of Illinois at Chicago.

Leading the application deployment program is Bill Lennon, an engineer at DOE's Lawrence Livermore National who has successfully designed and developed three earlier high-speed optical networks. He explained that NTON will use eight separate wavelengths per fiber in a ring about San Francisco Bay for a total capacity over 20 billion bits of data per second in each direction, supporting connections about 1,000 times faster than existing networks. The extensions north and south will carry 10 billion bits of data per second on each wavelength, with two wavelengths being used initially.

In late July, NASA's Jet Propulsion Laboratory of Pasadena, Calif., signed on as the first National Transparent Optical Network user on the initial extension link to Los Angeles. JPL streamed interactive, scientific visualization data from Pasadena to San Francisco and back to test the practicality of using their video wall in collaborations between geographically distributed scientists. Their application used over one billion bits per second to drive the real-time video wall display.

Livermore's Lennon sees JPL's entrance as the first in a series of major new network milestones. Very soon, NTON will provide the backbone for four recently funded DOE projects for Next Generation Internet research. Additionally the fiber-optic network will both display at and provide the connectivity for "Supercomputing and Communications '99," the national supercomputer show scheduled for November in Portland.

Future applications should include remote medical diagnosis, distance editing of digital motion pictures and television in real time, video conferencing at full-motion video speed that will include a variety of audio visual and virtual reality tools, as well as the remote testing and diagnosis of future transportation systems.

For further information, contact LLNL's David Schwoegler, 925/422-6900, schwoegler1@llnl.gov.

Submitted by DOE's Lawrence Livermore National Laboratory

Ticking microquakes signal deep fault slippage

Ticking clusters of identical tiny earthquakes along a stretch of the San Andreas Fault reveal the rate at which two great tectonic plates are grinding past each other deep within the earth. Robert Nadeau, continuing work he began for his 1995 doctoral dissertation, and Thomas McEvilly, his former thesis advisor, have found that these "tickers" provide a new way to monitor the buildup of fault strain associated with larger earthquakes.

McEvilly

The two geophysicists are now colleagues in DOE's Lawrence Berkeley National Laboratory's Earth Sciences Division. They analyzed data from the Parkfield region of Central California, a long-time center of seismic study where magnitude 6 shocks have occurred every 22 years, on average, since 1857.

"Despite expectations, there hasn't been another big quake since 1966," Nadeau says. "However, a buildup of activity started in October of 1992 and persisted through 1994, including four events from magnitude 4.2 up to magnitude 5."

The researchers had earlier identified clusters of repeating small earthquakes at specific locations in the area, with virtually identical waveforms and very regular recurrence times. During the 1992-94 events, the recurrence times of these clusters accelerated.

Nadeau and McEvilly confirmed that faster recurrence in a cluster indicates accelerating slippage at particular sites deep underground. They found good agreement between the seismic data and direct measurements of slippage on the surface, made by creepmeters looking across the fault.

"It remains to be seen whether this kind of intriguing correlation exists in other fault zones, or whether it can be used over longer periods of time and space to warn us of damaging earthquakes," Nadeau cautions. "But preliminary results using small repeating earthquakes on the Hayward Fault in the San Francisco Bay Area are already showing promise."

Nadeau and McEvilly report their findings in the July 30, 1999, issue of Science magazine.

Submitted by DOE's Lawrence Berkeley National Laboratory