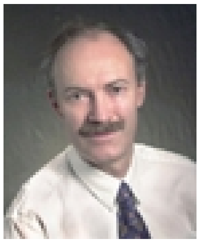

Los Alamos's secret-keeper.

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Research Highlights . . .

DOE Pulse

Science and Technology Highlights from the DOE National Laboratories

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Catching some solar wind

One of three instruments designed and built for NASA's Genesis space mission began capturing some of the sun recently. Genesis recently went into orbit around the Lagrange 1 point, a spot nearly one million miles from Earth where the gravities of the Earth and sun are in balance. Genesis will remain at Lagrange 1 for roughly two and a half years while the DOE–Los Alamos instruments take data with solar wind ion and electron monitors. Before returning to Earth, a instrument will take samples of the solar wind that may help scientists better understand the origin of the solar system.

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High-temp superconductor's "kink-iness" revealed

A study at the Advanced Light Source of DOE's Lawrence Berkeley National Laboratory has revealed that, contrary to what many scientists have argued, the physics behind the high-temperature superconductivity of copper oxides may be every bit as "kinky" as that behind their low-temperature metal counterparts. Stanford physicist Zhi-Xun led an international collaboration that identified a kink in the energy spectrum of low-energy electrons in three different families of copper oxide superconductors. This spectral kink is the signature of an interaction or "coupling" between an electron and a phonon, a vibration in the ions that form the lattice of a superconductor's crystal. Electron-phonon coupling is behind the low-temperature superconductivity of metal alloys.

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Team studies waste incineration options

A program managed at the DOE's Idaho National Engineering and Environmental Laboratory is evaluating a technology for treating certain waste streams without using incineration. The Transuranic and Mixed Waste Focus Area, sponsored by the DOE Office of Science and Technology, has chosen Virginia-based AEA Technology Engineering Service's "Silver II" method for further testing. The process chemically oxidizes molecules and operates at low temperatures, is easy to control, treats most organic wastes, reduces waste volume and produces no dioxins or low-emission volumes containing polyaromatic hydrocarbons. If the technology is successful in tests using surrogate mixed waste, the process will likely be tested and possibly used for several difficult waste streams. water and oil.

[John Walsh, 208/526-8646, jhw@inel.gov]

Virtual guide star shines

Scientists at DOE's Lawrence Livermore National Laboratory, in collaboration with the W.M. Keck Observatory, have created a "virtual" guide star over Hawaii. The "virtual" guide star, which achieved "first light" on Dec. 23, 2001, will be used with adaptive optics on the Keck II telescope to greatly increase the resolution of fine details of astronomical objects. The Keck adaptive optics system has enabled astronomers to minimize the blurring effects of the Earth's atmosphere, producing images with unprecedented detail and resolution. The adaptive optics system uses light from a relatively bright star to measure the atmospheric distortions and to correct for them.

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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).

SNS construction: Amazing facts

The Spallation Neutron Source is one of the largest scientific facility construction projects that the United States has undertaken in several decades. When it is complete in 2006, the SNS—a collaboration of DOE's Oak Ridge, Argonne, Lawrence Berkeley, Los Alamos, Brookhaven and Jefferson national laboratories—will be the world's premier facility for neutron research.

Currently, however, the SNS is a mammoth building site on a ridgetop in East Tennessee, buzzing with cranes, concrete trucks and hard-hatted workers. So what does raising a $1.4 billion neutron science facility involve?

Here are some facts and figures on the SNS construction project.

The 1.4 million cubic yards of earth moved for the facilities would fill the University of Tennessee's Neyland Stadium—which seats more than 100,000 fans in its double decks—to a level above the press box.

Project structures call for approximately 80,000 cubic yards of concrete, equivalent to a sidewalk three feet wide that would reach from Knoxville to Memphis (about 400 miles).

5,500 tons of rebar—reinforcing steel rods—will be used for project structures.

The target building's deep foundation contains 937 concrete pilings, reinforced with steel pipe. These pilings range from 35 to 181 feet deep in the earth and are seated 10 feet into bedrock. Nearly 20 miles of pilings are in place under the target building.

The initial concrete pour for a portion of the target building foundation was accomplished in just one very busy day. Concrete trucks, essentially all that were available in the region, delivered 78 loads to the construction site—at a rate of one truck every three minutes.

The target building will weigh as much as a conventional 40-story building of the same footprint.

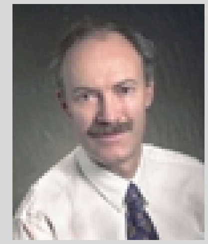
The SNS electrical substation capacity is 70 megawatts, or enough electrical capacity to supply electrical service to about 35,000 homes.

The SNS will fire an ion beam down its linear accelerator tunnel toward a mercury target; a beam that, at 80 percent of the speed of light, could reach the moon in 1.5 seconds. The resulting protons will bombard a mercury target, generating, or "spalling," the neutrons for use in research. Alignment of the tunnel and accelerator components is so critical that the curvature of the earth must be factored into construction.

But the most remarkable thing about the SNS is the science that will be performed there in the years ahead. When the facility is completed in 2006, researchers from the United States and abroad—an estimated 2,000 a year—will come to the SNS to study materials that will form the basis for new technologies in telecommunications, manufacturing, transportation, information, biotechnology and health. This broad range of scientific impact will strengthen the nation's economy, energy security and national security.

Submitted by DOE's Oak Ridge National Laboratory

Richard Hughes: keeping secrets secret



Richard Hughes

Physicist Richard Hughes knows how to keep a secret. Hughes is the leader of a team at DOE's Los Alamos National Laboratory exploring quantum physics for information science and the development of an ultimate secret keeper—a quantum cryptographic key distribution (QKD) system.

Cryptographic keys are used worldwide to encode or decode the streams of encrypted data that flow around the globe. Quantum physics has the potential to create unbreakable information encryption systems that use photons, tiny bits of light, to carry the cryptographic keys.

So far, the QKD team has made two major advances. In 1999, they set a world record by sending a quantum key through a 31-mile-long optical fiber. While this distance has proven far enough to create networks connecting closely spaced government offices or bank branches, at greater distances the signal loss in optical fiber increases to the point where the photons are absorbed. To achieve greater distances, Hughes and his colleagues recently developed a quantum cryptography system that allows keys to be sent through the air. The transportable, self-contained system—called a free-space system—can send quantum keys through the air for distances of six miles. The system was built from off-the-shelf hardware and is capable of continuous, automated transmission in both darkness and daylight.

The success of the free-space QKD system is likely to accelerate the development new encryption systems for ultra-secure satellite transmissions.

The Los Alamos system is intended to serve as a model for a global satellite QKD system. The current six-mile distance is significant because horizontally it is more than equivalent to the amount of interference encountered in the atmosphere between the Earth's surface and an orbiting satellite.

Submitted by Los Alamos National Laboratory