LOS ALAMOS NATIONAL LABORATORY
WHERE SCIENCE MAKES A DIFFERENCE

DATELINE LOS ALAMOS

COMMUNITIES MONITOR LOCAL ENVIRONMENTS WITH NEWNET

SOLAR-POWERED, SELF-CONTAINED UNITS REACH FROM ALASKA TO LOS ALAMOS

The Neighborhood Environmental Watch Network is a partnership of public, government, and educational institutions that gives communities a way to monitor radiation, barometric pressure, humidity, temperature, and other environmental parameters around the clock.

NEWNET grew out of public concern regarding the radiation effects of nuclear testing. The first monitoring stations appeared around the Nevada Test Site near Las Vegas in the wake of the Three Mile Island nuclear accident in Pennsylvania.

In the absence of nuclear testing, NEWNET's present focus is on environmental monitoring around U.S. nuclear facilities, nuclear waste transportation routes, and environmental restoration sites. Los Alamos is providing the scientific and technological expertise to state agencies wishing to participate in the NEWNET program.

James Taylor, an instructor at the Santa Fe Preparatory School, teaches Chad Scherer (closest) and Robin Beck how to access NEWNET data over the Internet.

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Pete Goodwin, a former Los Alamos contractor, constructs a NEWNET monitoring station at Santa Fe Preparatory School.

If implemented on a national scale, then in the unlikely occurrence of a major nuclear accident, NEWNET provides immediate information to local residents and scientists who can use the data to verify computer models that predict atmospheric dispersion of radiation over long distances. The entire infrastructure of monitoring stations can also serve as a civilian early warning system for chemical or biological weapons of mass destruction.

The NEWNET monitoring stations extend from Point Hope, Alaska, to Los Alamos. The metallic 30-foot tall towers take periodic — typically every 15 minutes — environmental measurements that are displayed onscreen at the site and shipped via satellite to a national database at Los Alamos where the data is checked for electrical, mechanical, or transmission errors. Los Alamos presently monitors about 120 stations in the western United States. The stations include 19 from the NEWNET pilot program, 21 remote stations for the Environmental Protection Agency, 20 remote radiological monitoring stations on the Nevada Test Site, and 60 remote automatic weather stations.

Interested citizens, schools, or researchers can observe the results at local monitoring stations at any time. Anyone with a portable personal

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EDITOR
Diane Banegas

MANAGING EDITOR
Meredith Coonley
(505) 665-3982 • suki@lanl.gov

STAFF WRITER
Theresa Salazar

CONTRIBUTING WRITERS
Jim Danneskiold • Gary Kliewer

CONTRIBUTING PHOTOGRAPHERS
Kathy DeLucas • Krystyna Dziewinska
John Flower • Henry Ortega • Fred Rick

CONTRIBUTING ILLUSTRATOR
Edwin Vigil

PRINTING COORDINATOR
G.D. Archuleta

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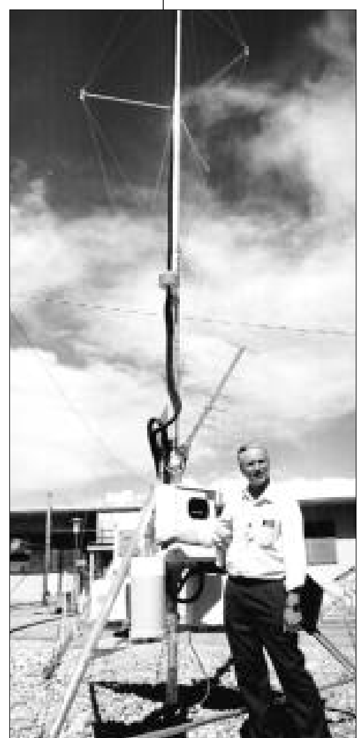
PUBLIC AFFAIRS OFFICE, MS P355
LOS ALAMOS, NM 87545

computer can plug directly into the station and download data recorded in previous days. The public also can view the information on the Internet by pulling up the NEWNET home page at http://newnet.jdola.lanl.gov/newnet.html on the World Wide Web.

Community monitoring stations are operated by members of the public trained by Los Alamos scientists in basic nuclear radiation and station maintenance. The station manager receives technical support as needed from participating state organizations, Los Alamos scientists, and members of other technical support organizations.

In addition to their monitoring capabilities, the NEWNET system provides schools with an excellent educational tool to teach students the basics of radiation and the connection between radiation, geology, and weather, and other factors. Los Alamos recently entered into a partnership with Enterlearn Technology, a private company, and the Santa Fe School District to develop a curriculum on the basics of radiation and risk. The partners plan to offer the course on the NEWNET home page at a future date.

The Los Alamos researchers believe the NEWNET system will not only give communities the technology to participate in the monitoring of their environment, but the information will help demystify radiation for the public and allow them to weigh the risks of not irradiating restaurant food and not having a way to dispose of high-level nuclear waste.



↑ NEWNET Project Leader Jim Ogle in front of a Los Alamos monitoring station.

To make the information available to members of the public who do not have access to personal computers, Los Alamos researchers are developing an "Environmental Teller Machine." The machine, which resembles the automatic teller machines used for personal banking, would be placed in a public location like a library or museum.

Los Alamos is seeking funding from outside organizations to secure NEWNET's future. The Laboratory also is interested in adding any communities to the network that wish to monitor their local environments and share the information with the rest of the country.

CONTACT: JAMES OGLE

NEWNET PROJECT LEADER

(505) 667-3893 • E-MAIL: ogle@lanl.gov

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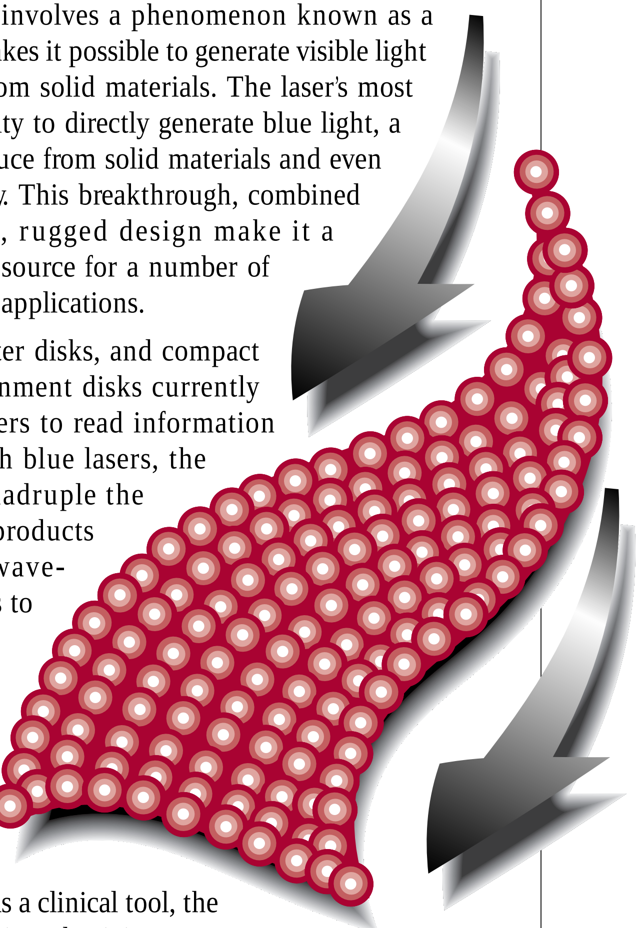
NEW SOLID-STATE LASER PRODUCES PRIMARY COLORS

SIMPLE, STURDY DESIGN GENERATES ENDURING BEAMS OF BLUE LIGHT

A serendipitous discovery in a Los Alamos laboratory led to a new all-solid-state laser design that offers extended life and reliability in a commercially viable four-color laser.

The discovery — which involves a phenomenon known as a "photon avalanche" — makes it possible to generate visible light efficiently and reliably from solid materials. The laser's most exciting feature is its ability to directly generate blue light, a color that is hard to produce from solid materials and even harder to produce reliably. This breakthrough, combined with the laser's simple, rugged design make it a promising coherent light source for a number of industrial and biomedical applications.



Manufacturers of computer disks, and compact audio and video entertainment disks currently rely on near-infrared lasers to read information stored on the disks. With blue lasers, the manufacturers could quadruple the storage density of their products because the shorter wavelengths of blue light focus to a much finer point.

The Los Alamos solid-state four-color laser could also replace the bulky, fragile, and inefficient gas or dye lasers currently used for biomedical applications. As a clinical tool, the Los Alamos laser could give physicians a compact and reliable means of locating and even treating tumors. Biochemists could use the laser in chemical analyses, cell sorting, and even sequencing of the human genome.

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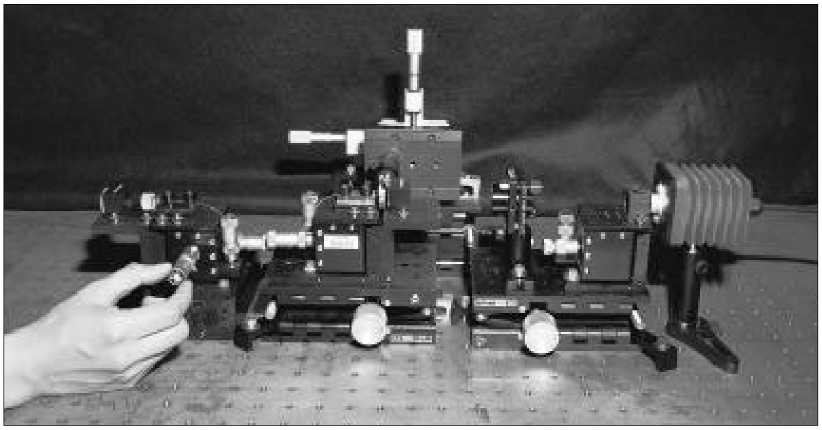

← The solid-state four-color laser designed at Los Alamos looks promising for a number of industrial and biomedical applications.

Color reprographic systems currently rely on three separate lasers to produce four-color illustrations. Because the Los Alamos laser can be tuned to different colors, it can serve as a single-component replacement for the three separate lasers. The Los Alamos laser would also similarly simplify laser-based image projection systems.

Los Alamos researchers discovered evidence of the photon avalanche mechanism while working on a related problem of light amplification. When they aimed a beam of near-infrared light through a fiber of zirconium-fluoride-based glass that contained two kinds of impurities — triply charged praseodymium and ytterbium ions — intense red laser beams shot out both ends of the fiber.

Many solid-state lasers require a source of "pump" light, preferably generated by a semiconductor diode laser that directly converts electrical energy into infrared light. Because of the extraordinarily efficient photon-avalanche mechanism, the Los Alamos laser needs a single laser wavelength — hence a single diode laser — to pump light into the impurity-laden fiber, instead of the two wavelengths required by other prototypes. The Los Alamos design incorporates a commercial aluminum-gallium-arsenide semiconductor-diode laser as an optical pump source.

Because the Los Alamos researchers were using only one pump wavelength in their initial experiment, they had expected the near-infrared pump beam to generate some amount of visible light in the zirconium-fluoride fiber, but not the enormous amount required to produce laser beams.

A similar experiment performed earlier in France had resulted in significantly less laser output, and only at red wavelengths, leading the researchers to suspect the key to their success lay in the concentrations

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of impurities contained in the zirconium fluoride — the most important variables that differed from the French experiment.

The Los Alamos experiment increased the concentration of ytterbium, or Yb^{3+}, ions from 2 percent to 3 percent, while increasing the praseodymium, or Pr^{3+}, concentration from 0.1 percent to 1 percent. The researchers hypothesized the ions were interacting with each other as well as with the incoming pump light to trigger the highly effective energy transfer phenomenon known as a photon avalanche.

Further experimentation proved their hypothesis and allowed the researchers to understand qualitatively how the phenomenon was brought about.

Yb^{3+} ions are essential to the photon avalanche process because they act as initial donors of energy to the Pr^{3+} ions. Yb^{3+} ions at ground state readily accept energy from the pump laser beam and jump up to an excited state. Excited Yb^{3+} ions then transfer their energy to neighboring Pr^{3+} ions, thus promoting them from their ground states to an intermediate energy level.

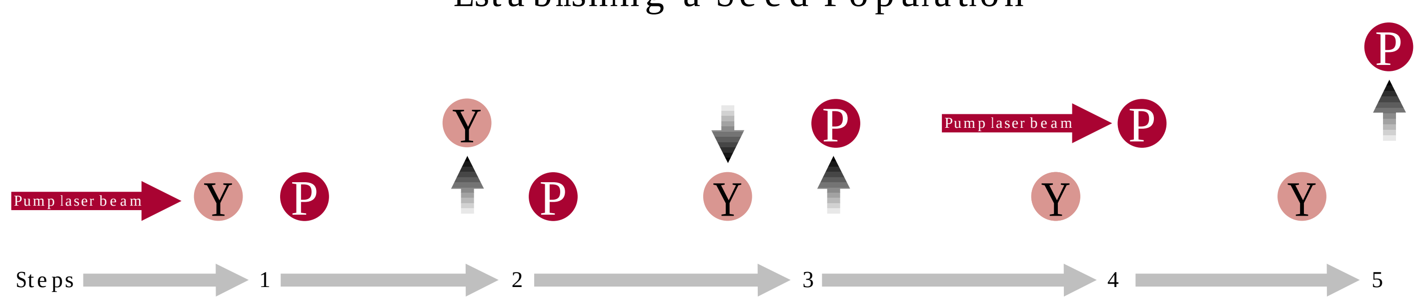
The pump laser further excites the elevated Pr^{3+} ions to a still higher energy level from which the ions can produce visible light. More importantly, these highly excited Pr^{3+} ions serve as a seed population that will initiate a photon avalanche.

A photon avalanche begins when a single, highly excited Pr^{3+} ion sacrifices some of its energy to one of its unexcited Yb^{3+} neighbors. The energy-transfer process is like a see saw with the spontaneous energy transfer between the high-energy Pr^{3+} and the low-energy Yb^{3+} ions resulting in two moderately excited ions.

The Yb^{3+} ion next transfers its energy to a ground-state Pr^{3+} ion, which results in two Pr^{3+} ions that can now strongly absorb photons from the

The pump laser beam strikes a Yb^{3+} ion (Step 1); it elevates to a higher energy state but the Pr^{3+} ion remains unaffected (Step 2); the Yb^{3+} ion then donates its energy to the Pr^{3+} ion and returns to ground state (Step 3); the Pr^{3+} ion now resides at a higher energy state where it can readily absorb energy from the pump laser beam (Step 4); the Pr^{3+} ion then jumps to its most highly excited state and becomes a member of the seed population that initiates the photon avalanche (Step 5).

Establishing a Seed Population



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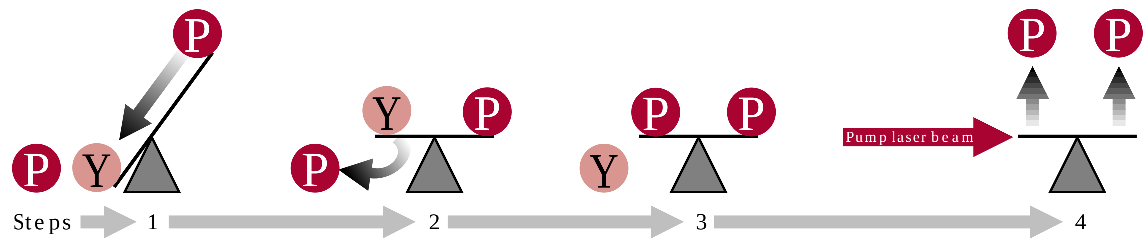
Photon Avalanche Mechanism



A highly excited Pr^{3+} ion sacrifices some of its energy to a ground-state Yb^{3+} ion (Step 1); once the Yb^{3+} and Pr^{3+} ions are at the same level of energy, the Yb^{3+} ion donates its energy to an unexcited Pr^{3+} ion and drops back to ground state (Step 2); the two medium-energy Pr^{3+} ions are now ready to accept a boost from the pump laser beam (Step 3); after being hit by the laser beam, the two Pr^{3+} ions jump to their highest energy state (Step 4).

diode pump laser. The laser energy boosts both Pr^{3+} ions to their highest energy level, where only one ion existed before. The avalanche progresses with the two high-energy Pr^{3+} ions sacrificing some of their energy to produce four-high-energy ions that in turn produce eight ions, and so on.

The highly excited Pr^{3+} ions release energy in the form of light as they drop down to lower energy states. Different colors of light result from transitions to different lower-lying states.

For example, a low-energy transition from the highest level to one of the next highest energy levels produces infrared light, while orange and green light result from drops to intermediate energy levels. A high-energy transition from the highest level to the lowest level produces blue light. Praseodymium is a versatile laser medium because of the rich array of energy states it possesses when introduced into solid materials as a triply charged ion.

The simple construction and all-solid-state design of the Los Alamos laser offer the extended life and reliability required of a business or industrial product. The researchers estimate the manufacturing cost of the all-solid-state four-color laser to be $5,000 based on current component prices.

The Los Alamos four-color laser design marks a major advance in solid-state laser development and shows promise as a key enabling technology for many of tomorrow's laser-based commercial products.

CONTACT: TIM GOSNELL
CONDENSED MATTER AND THERMAL PHYSICS
(505) 667-2265 • E-MAIL: gosnell@lanl.gov

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LOS ALAMOS USES ELECTRICITY TO TREAT TOXIC WASTE

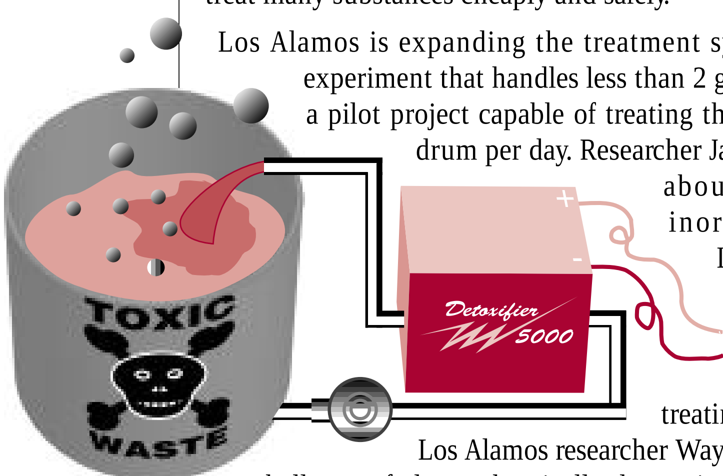
METHOD WILL HELP SMALL BUSINESSES ELIMINATE HAZARDOUS WASTE FROM PRODUCTION LINES

A simple method that uses electricity to treat hazardous waste may greatly reduce the volume of inorganic compounds stored at Los Alamos as well as help small businesses eliminate waste from their production lines.

The electrochemical process works at room temperature and low pressure and runs on familiar direct-current electricity. It does not produce toxic fumes or secondary waste. The process removes and recovers heavy metals, such as plutonium, while cyanides and other toxic organic compounds are broken down into harmless carbon dioxide and nitrogen. All the work is done by electrons flowing through the waste solution.

The system may prove to be a boon to hospitals and industries that produce small volumes of different kinds of hazardous waste. Developing separate treatment methods for each kind of waste is prohibitively expensive. The electrochemical process, in contrast, can treat many substances cheaply and safely.

Los Alamos is expanding the treatment system from a bench-top experiment that handles less than 2 gallons of waste per day to a pilot project capable of treating the contents of a 55-gallon drum per day. Researcher Jacek Dziewinski estimates about 90 percent of the inorganic mixed waste at Los Alamos could be treated using this method.



While Dziewinski spends most of his time treating inorganic mixed waste, Los Alamos researcher Wayne Smith has taken on the challenge of electrochemically destroying organic mixed waste. A treatability study with organic waste containing plutonium will soon begin at the Plutonium Facility in Los Alamos.

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↑ Los Alamos researchers Stan Marczak (left) and Jacek Dziewinski stand next to the equipment used for the electrochemical treatment of hazardous waste.

Faraday Technology Inc. of Dayton, Ohio, and Los Alamos have established a partnership to develop the treatment method. Faraday is optimizing the process for industrial waste streams, especially those with heavy metals, while Los Alamos is tailoring the technology to mixed waste containing radioactive materials.

Many electrochemical processes are standard technology in industry. But breaking down chemicals with an electric current, or electrolysis, has not been used on an industrial scale for waste treatment. According to Dziewinski and Smith, the major challenge lies in applying the method to waste management operations that require treatment to very low concentrations — micrograms per liter.

Running an electric current through a waste solution splits salts into acids and bases and extracts a heavy metal, causing it to fall out of solution and stick to graphite cathodes for easy removal. The system uses several electrochemical cells, each designed to break down a separate group of wastes. It recovers and recycles materials rather than merely immobilizing and disposing of them. Once treated for other toxic substances, the radioactive components of mixed waste can be handled by other processes.

Although Los Alamos has not produced high volumes of a single type of waste over the years, it is an ideal test site for the electrochemical system because years of varied research projects have generated small amounts — in some cases, quart bottles — of a large variety of toxic blends. Treatment is simple once the material is characterized.

The Los Alamos portion of this project is funded by the Laboratory's Environmental Management Program. The Advanced Research Projects Agency of the Department of Defense is funding research by Faraday Technology Inc.

CONTACT: JACEK DZIEWINSKI
WASTE TREATMENT AND MINIMIZATION
(505) 667-9792 • E-MAIL: jacek@lanl.gov

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SIXTH ANNUAL NEW MEXICO SUPERCOMPUTING CHALLENGE

HOME-SCHOOLED YOUTH AND ALBUQUERQUE TEAM WIN TOP HONORS

More than 800 students and teachers from 62 schools took part in the 1996 Supercomputing Challenge, researching scientific problems, writing programs, and running those programs on supercomputers at Los Alamos and Sandia national laboratories.

Supercomputing Challenge winner Andrew Bowker (seated center) is interviewed by Albuquerque Journal North reporter Doug McClellan (seated left). Also pictured are Anne Bowker, Andrew's mother and home-schooling instructor, and judges Shaun Cooper (far right) from New Mexico State University and Richard Morse from the University of Arizona.

Andrew Bowker won the top prize with his novel method of taking images of moon features from the Clementine satellite and using calculations of the shadows cast by those features to create a 3-dimensional moonscape inside his computer. Bowker is schooled at home near Edgewood, a small community east of Albuquerque.

A two-woman team from Highland High School in Albuquerque took second place with an analysis of the many mechanisms — such as light absorption and temperature changes during morphogenesis — that determine the colors of flower petals. Nguyen Van Anh and Nguyen Anh Thu did most of their programming on a computer won in an earlier Supercomputing Challenge by another Highland team.

Bowker and Highland High will receive Pentium-based computer systems for their achievements. Intel Corp. donated money to pay for the equipment. In addition, Bowker will receive a $1,000 savings bond and the two Highland team members each will receive $500 bonds, donated by Supercomputing Challenge cosponsor New Mexico Technet Inc.

Any New Mexico high school student is eligible to enter the Supercomputing Challenge. The goal of the year-long event is to increase knowledge and enthusiasm of science and computing in students, families, and communities. More than 3,300 students have taken part in the Supercomputing Challenge since its inception in 1990.

CONTACT: DAVID H. KRATZER
COMPUTING, INFORMATION, AND COMMUNICATIONS
(505) 667-2864 • E-MAIL: dhk@lanl.gov

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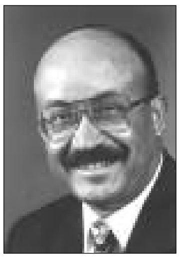
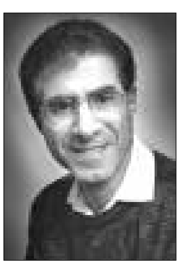
IN THE NEWS ...



Pete Miller

David Chen

Bruce Wienke



Irving Bigio

WARREN “PETE” MILLER HAS BEEN ELECTED TO THE NATIONAL ACADEMY OF ENGINEERING. The acting director of Los Alamos National Laboratory's Diversity Office recently was awarded one of the highest professional distinctions accorded to engineers. Membership in the academy is attained by individuals who have made important contributions to engineering theory and practice, and who have pioneered new and developing fields of technology. Miller was elected to the academy for his contributions to the theory of radiation transport and nuclear engineering education. Miller holds a doctorate in nuclear engineering from Northwestern University in Evanston, Illinois. He joined the Laboratory in 1974 and was director of the Science and Technology Base Programs Office before accepting his current assignment.

LOS ALAMOS RESEARCHER RECEIVES NIH APPOINTMENT. David Chen, leader of the Laboratory's DNA, Damage, and Repair Group, recently was appointed to serve as a member of the National Institutes of Health's Radiation Study Section. Chen, whose expertise lies in genetics and molecular biology, was selected on the basis of his demonstrated competence and achievement in his scientific discipline. As a member of the study section, he will review hundreds of research proposals yearly and recommend funding for those with the greatest potential to benefit science and the nation. Chen joined the Laboratory in 1978 after receiving a doctorate in genetics from the University of Missouri. His current research focuses on how cells repair their DNA once it has been damaged by radiation or other harmful agents.

TWO LOS ALAMOS SCIENTISTS CAPTURE TECH TRANSFER HONORS. Bruce Wienke and Irving Bigio were among 30 winners of the 1996 “awards for excellence in technology transfer” from the Federal Laboratory Consortium. Wienke was recognized for helping to establish and direct the Computational Testbed for Industry, a Department of Energy user facility that allows U.S. industry access to national lab supercomputing tools. Wienke also was recognized for helping set up the DOE's Industrial Computing Initiative, a three-year, $52 million agreement among DOE, Los Alamos and Lawrence Livermore national laboratories, and a consortium of 17 corporations, plus Cray Research Inc. and Thinking Machines Corp. Bigio was recognized for his work on two biomedical devices now undergoing clinical trials in the United States: the Biomedical Spectral Analyzer, which uses light directed through a fiber-optic probe to distinguish normal from malignant tissue, providing nearly instantaneous diagnosis; and the Indigo-830, which uses laser heat to shrink enlarged, noncancerous prostates (See related article in January 1995 *Dateline: Los Alamos*).

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BRIEFLY ...

LOS ALAMOS OFFERS INDUSTRY A FACILITY FOR HANDLING RADIOACTIVE ISOTOPES. Biomedical companies and other U.S. industries that work with radioactive isotopes now have access to complete production, processing, and analytical facilities at Los Alamos through a new user facility agreement. The Laboratory operates radioisotope laboratories and hot-cell facilities where highly radioactive materials can be handled remotely and processed chemically. A state-of-the-art counting facility is available for carrying out assays of radioactive materials. The agreement allows industry researchers to use the Lab's resources for a fraction of the cost of reproducing the facilities at a commercial site. Researchers also can profit from Los Alamos' 20 years of experience producing radioisotopes for medical and research purposes. Industry users are required to pay the entire cost of doing research at the facility as well as overhead expenses paid to the Department of Energy. CONTACT: RICHARD HEATON (505) 667-1141

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