DATELINE LOS ALAMOS

COUNTERFEIT CURRENCY IS NO MATCH FOR LOS ALAMOS TECHNOLOGY

NEAR-INFRARED SPECTROSCOPY IDENTIFIES PHONY BILLS

→ Native American artists who sell their jewelry under the portal of the Palace of the Governors in Santa Fe are required to vouch for the authenticity of their materials. But in other places, shoppers may not have that kind of guarantee.

Imagine a foolproof way of telling funny money from the real thing. Or plastic turquoise from the genuine gemstone. Researchers at Los Alamos have found that a technology used to characterize rubber and plastic in radioactive waste can also distinguish bona fide articles from phony ones.

The Laboratory uses near-infrared spectroscopy to analyze the contents of decades-old barrels of radioactively contaminated waste bound for storage or further study. In near-infrared spectroscopy, light just beyond the visible spectrum shines through a fiber optic cable onto a material sample. Sensors pick up the reflected light at many wavelengths and convert their varying intensities into electrical signals that are then

Researcher Don Burns uses near-infrared spectroscopy to analyze radioactively contaminated plastics and rubber inside the glove box. Burns applied the same technology to real and counterfeit currency and picked out the funny money 100 percent of the time.

digitized and fed into an accompanying computer. Since every material creates its own unique reflectance pattern from those wavelengths, the computer can analyze the reflected light pattern, or "fingerprint," match it against stored patterns, and provide an analysis of the sample's composition.

Because near-infrared spectroscopy is noninvasive and nondestructive, the technology lends itself to a variety of applications. For example, it has been used to analyze paper for several years, which led researcher Don Burns to wonder if the technology could be used to identify counterfeit currency.

It takes 65 complicated and distinct steps to print a dollar bill, but as computers and optical scanners improve, so does the quality of the counterfeiter's product. According to the Secret Service, the division of the U.S. Treasury Department charged with enforcing currency law, American money is the easiest and most profitable to fake. In 1993,

DATELINE LOS ALAMOS

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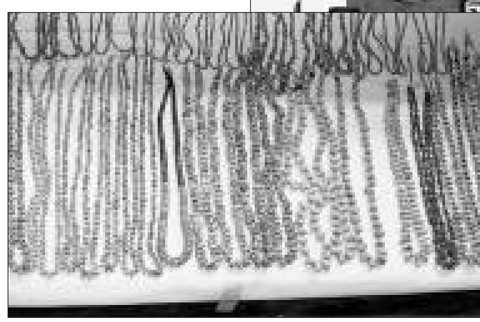
DATELINE: LOS ALAMOS

federal agencies seized $120 million in counterfeit American cash overseas, up $90 million from the year before.

The Secret Service, interested in near-infrared spectroscopy's potential, sent Burns several high-quality counterfeit $20 bills which were indistinguishable from the real thing to the naked eye. Burns analyzed both real and fake bank notes and discovered dramatic differences in their reflectance patterns. He had a 100-percent success rate in identifying the phonies. As a result of Burns' tests, the Secret Service has asked the Laboratory to work on counterfeit deterrence.



A local news story about fake Indian arts and crafts turned Burns' attention to another lucrative scam that might be thwarted by near-infrared spectroscopy. The popularity of southwestern silver and turquoise has led some unscrupulous jewelry makers to increase their profit margins by substituting plastic for the gemstone, in spite of state laws forbidding such fraud. Some of the plastics look so real they even fool experienced dealers. And then there are the stones that are "stabilized" with plastic polymers and resins, leaving anxious tourists unsure about the quality of their investments.

← Real turquoise or a plastic facsimile? Near-infrared spectroscopy may soon be the best way to tell whether your southwestern jewelry is worth what you paid for it.

One way to test turquoise — literally putting a torch to it to see if it melts — struck Burns as archaic. Because he has a computer library of many different plastics, he can analyze the infrared light reflected off a sample stone and see if it matches any of the plastic patterns in his archive. If it does, there is almost no doubt that the stone is not what it seems. Burns has already had calls from Native American jewelers eager to use the technology to authenticate their raw materials.

Burns has applied for patents to use near-infrared spectroscopy to distinguish between counterfeit and genuine currency and between fake and real turquoise.

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DATELINE: LOS ALAMOS

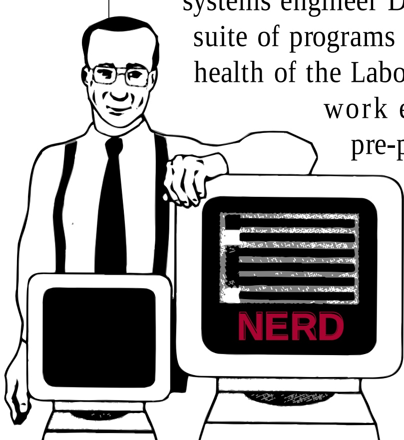
EVERY COMPUTER NEEDS A N.E.R.D.

LOS ALAMOS DEVELOPS A UNIQUE TOOL TO MANAGE COMPLEX COMPUTER NETWORKS

Anyone responsible for managing a large computer network could probably use a NERD — a Network Event Recording Device, that is.

Los Alamos National Laboratory's computer network is one of the largest and most complex computing resources in the world. It serves more than 9,000 users on a variety of supercomputers, mainframes, minicomputers, and workstations as well as file storage devices, communications interfaces, routers, bridges, and terminals. The magnitude of the system and the importance of protecting it from security breaches were driving forces behind the development of NERD.

A one-of-a-kind computer monitoring tool, NERD was developed by systems engineer David Simmons, now at Sun Microsystems, as a suite of programs that run simultaneously to monitor the overall health of the Laboratory's computer network. By logging all network events as they happen, NERD responds to pre-programmed instructions and alerts operators to trouble before the system crashes.



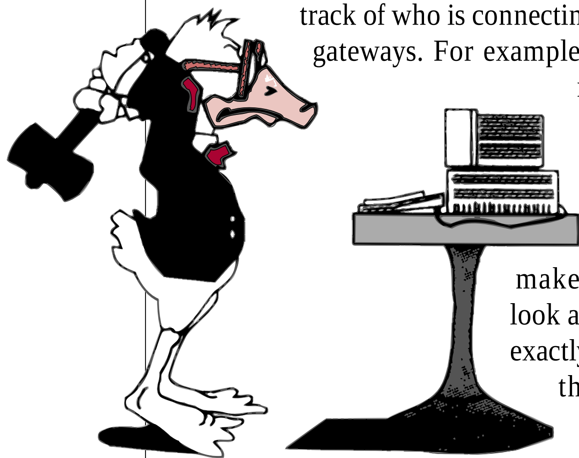
System managers can count on NERD to tell them everything they always wanted to know about their computer networks.

It has always been possible for network and security managers to review computer log files for evidence of irregularities after the fact. NERD is the first network management system that provides access to log information in real time. With NERD, system operators can see what's going on as it happens and actively troubleshoot the system.

When something goes wrong, NERD notifies network managers via electronic mail, digital pager, or, if the system requires immediate attention, synthesized speech over a public address system. The timely notification feature means system operators can act immediately to avert costly and time-consuming system crashes. It also means operators don't have to be on-site at all times; a computer-generated message can bring them back in an emergency.

DATELINE: LOS ALAMOS

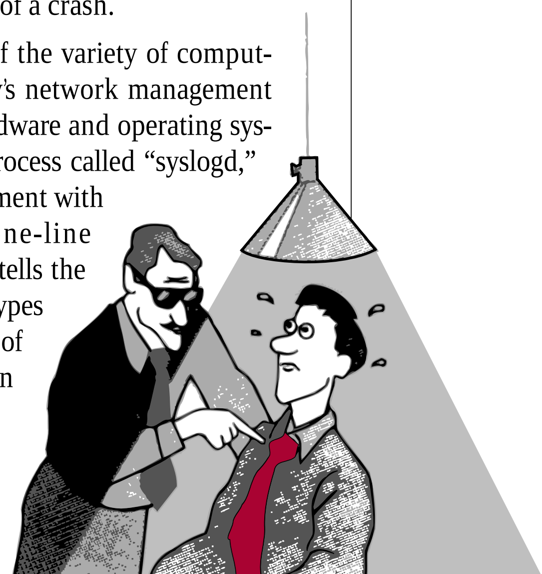
Because so many systems in the Los Alamos network process classified material, the Laboratory must be concerned about computer security. NERD enhances system security with an auditing feature that keeps track of who is connecting and disconnecting through which gateways. For example, it allows system managers to see repeated failed attempts to log on.



↑ NERD warns computer operators of a system crash before the hammer hits.

NERD backs up all log files in a single location to ensure an accurate archive of network data. If the system crashes, NERD makes it much easier for operators to look at the system's history and figure out exactly what happened. It also maintains the integrity of network data in the event of a crash.

Because of the variety of computing systems at Los Alamos, the Laboratory's network management system has to be blind to differences in hardware and operating systems. Using a common network logging process called "syslogd," NERD can be used in any network environment with UNIX-based computers by making a one-line change to a configuration file — a file that tells the computer software where to send different types of messages. NERD requires no distribution of specialized software, a huge advantage when NERD is ready for the marketplace.



↑ System managers don't have to sweat over network security with NERD.

NERD is operational at Los Alamos. Many other sites, including universities and other national laboratories, have expressed interest in the system. Although NERD is still under development, researchers hope to make it available commercially in the near future. More information about NERD is available at http://info-server.lanl.gov:52271/usr/u111241/nerdpaper.html on the World Wide Web.

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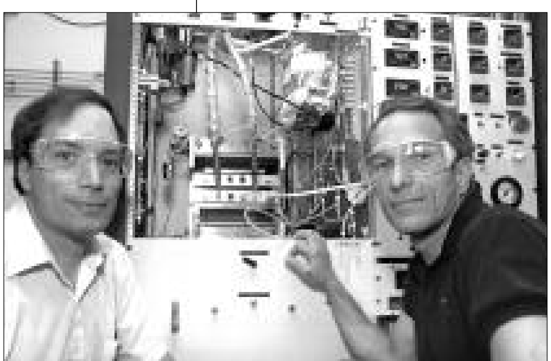
DATELINE: LOS ALAMOS

THE ELECTRIC CAR MOVES CLOSER TO A COMMERCIAL REALITY

AUTOMOTIVE-SCALE FUEL CELL TESTED

The race to produce an electric car speeds up as researchers begin testing a realistic model of a fuel cell developed as a result of a collaboration between Los Alamos, the Department of Energy, and General Motors.

Fuel cells convert chemical energy to electrical energy without combustion. They have been fairly common in the space program, but until now they have not been able to provide enough sustained power at a reasonable cost and size for use in the automotive industry.



← Kirk Weisbrod of Los Alamos (left) and Jeff Rock of General Motors designed this operational automotive-scale fuel cell as part of a joint research program to build a car that runs on methanol, releasing only carbon dioxide and water as byproducts.

DOE awarded a $35 million contract to the government-industry team to complete the project's second phase, a 30-month effort. Phase one of the project was completed recently at Los Alamos with the development of a 10-kilowatt gross output engine. An electric vehicle's engine will require between 30 and 50 kilowatts to perform as well as today's gas-powered automobiles.

To reach the wattage goal, project researchers are designing an electrochemical engine that runs on stacks of proton-exchange membrane fuel cells and the liquid fuel methanol. An onboard fuel processor converts the methanol into hydrogen and carbon dioxide. The fuel cell electrochemically combines the hydrogen with oxygen from outside air to produce direct current electricity. The electricity, in turn, powers the traction motors that turn the car's wheels.

In many ways a fuel cell operates like a car battery except that reactants are fed to the cell as it needs them, whereas a conventional battery requires recharging when its electrical output falls.

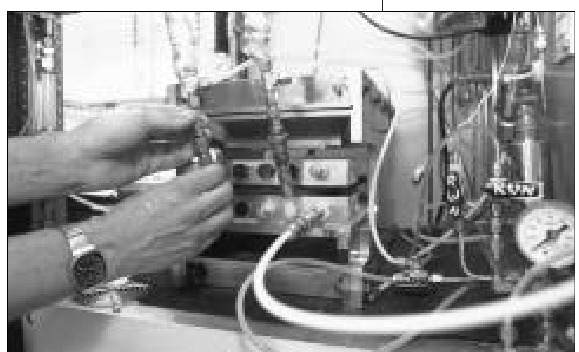
The first generation 30-kilowatt fuel-cell stack will have a volume of about 50 liters — about half the size of a microwave oven. Initial testing of cells involves determining voltage output as the electrical load and the hydrogen- and air-feed conditions vary. By the end of the project

DATELINE: LOS ALAMOS

phase, the fuel-cell stack will be incorporated into a complete methanol-to-electric engine. Researchers will then test the new engine over simulated driving cycles and demonstrate engine-fuel economy with fewer emissions.

Another research milestone in the program is a recently developed fuel processor that promises to respond quickly to changing fuel demands during acceleration and hill climbing and minimizes the need for necessary battery backup to accommodate startup. Previous fuel processors, a vital part of the electrochemical engine, have been slow to start and slow to adjust fuel to meet power demands.

Another advantage of the engine design is that it uses methanol, a relatively benign and inexpensive liquid fuel. Methanol, or wood alcohol, is better for the environment than gasoline because its byproducts are carbon dioxide and water. Because it is derived from agricultural wastes or natural gas, it promises to be a nearly limitless resource.



↑ This fuel cell is currently being tested as part of a joint project with General Motors. Initial testing of cells involves determining voltage output as the electrical load and the hydrogen/air feed conditions vary. By the end of the project phase, the fuel-cell stack will be incorporated into a complete methanol-to-electric engine.

The electrochemical engine offers attractive advantages over an all-electric battery-powered system. Unlike a battery-powered vehicle that requires long recharging stops and has a limited driving range, a car equipped with an electrochemical engine will be able to refuel quickly and have nearly the same driving range and performance as a conventional four-cylinder car.

The overall goal of the joint development project is to more than double a car's fuel economy and reduce federally regulated emissions such as nitrogen oxides, hydrocarbons, and particulates by more than 90 percent and reduce carbon dioxide emission by more than 40 percent.

On a national scale, converting gas stations to methanol would be less expensive than building battery recharging stations and power plants to support a large number of all-electric, battery-powered cars.

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DATELINE: LOS ALAMOS

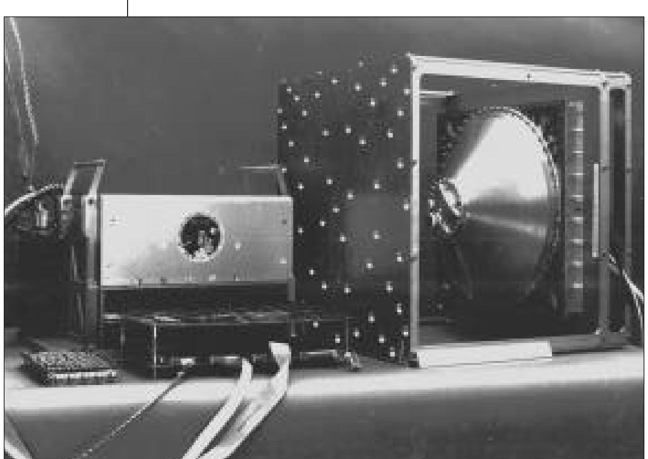
U.S. AND RUSSIA DEVELOP "MOXE" TO MONITOR THE SKY'S X-RAY SOURCES

INSTRUMENT TO BE LAUNCHED ABOARD INTERNATIONAL SATELLITE LATE NEXT YEAR

An instrument being developed jointly by U.S. and Russian scientists to monitor X-ray emissions from across the sky is in its final stages of development and on schedule for delivery to Russia this year for launch in late 1997.

The instrument, called MOXE (pronounced "MOX-EY") for Monitoring X-Ray Experiment, is one of 11 instruments to be carried onboard the Spectrum-X-Gamma satellite, a major astrophysics observatory that involves 16 nations in all and is being built under the leadership of Russia's Space Research Institute.

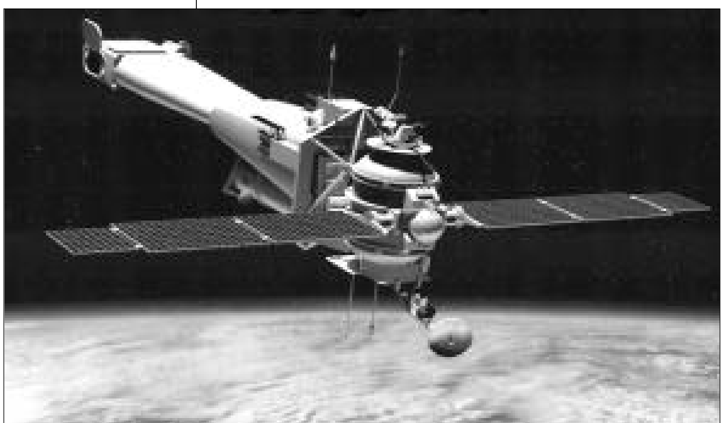
MOXE will monitor several hundred of the sky's brightest X-ray sources. It will also, in a sense, serve as a scout for the other onboard instruments because its six pinhole cameras will stare continuously at nearly the entire sky. MOXE's wide-eyed view will enable it to alert the spacecraft's other instruments — which have narrow fields of view — if sudden X-ray activity appears from some point in the sky. Scientists from Los Alamos, NASA's Goddard Spaceflight Center, and the Russian Space Research Institute are collaborating on the instrument.



An engineering model of MOXE, which passed a series of complicated acceptance tests, was sent to Russia in 1993.
Photo courtesy of NASA Goddard Spaceflight Center.

MOXE's development included initial delivery in early 1992 of a model that was subjected to thermal, vibrational, and static load testing. That was followed by an engineering model delivered to Russia in November 1993, which passed a series of complicated acceptance tests. The MOXE team is now

DATELINE: LOS ALAMOS



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MOXE is one of 11 instruments to be carried onboard the Spectrum X-Gamma Spacecraft. The satellite is scheduled for launch in late 1997. Illustration courtesy of Sandia National Laboratories.

completing a flight model of the system that will be launched into orbit with the satellite. The flight model is due in Russia this winter.

MOXE's detectors are sensitive to X-ray energies of between 2,000 and 25,000 electron-volts. At these energies, the sky is dominated by emissions from X-ray binary stars in our galaxy and from the centers of active galaxies or a hot gas that pervades some clusters of galaxies.

X-ray sources typically flare into view, then rapidly subside. MOXE will be especially sensitive to these types of rapid changes in the sky, providing a real-time alarm for transient phenomena such as X-ray and gamma-ray bursts and novae.

The alarm capability allows the more sensitive and narrowly focused instruments onboard Spectrum-X-Gamma to be put into play to study a transient phenomenon in detail within 48 hours. Astronomers working with other space-based instruments and optical and radio astronomers working from the ground can also study a transient event before it fades away, provided the time scale is sufficiently long. Such studies have found scientists' best candidates for black holes.

In addition to serving as an alarm, MOXE will allow scientists to develop a long-term archival record of the sky's X-ray behavior. Such data make it possible to conduct long-term studies of celestial movement, including star rotation and orbit.

Los Alamos' first X-ray monitor was launched in 1969 on the Vela 5B satellite for nuclear weapons treaty verification. In 1973, Los Alamos sensors on Vela discovered gamma-ray bursts, an enigmatic high-energy astrophysics phenomenon that remains unexplained.

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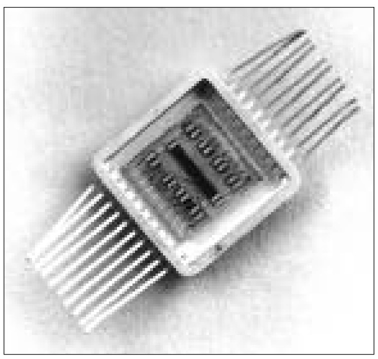
DATELINE: LOS ALAMOS

LOS ALAMOS COORDINATES RESEARCH TO MAKE A SMALLER, BETTER SEMICONDUCTOR

DOE SIGNS AGREEMENT WITH INTEGRATED CIRCUIT INDUSTRY



Coordinated research by industry and the national labs will keep American-made semiconductors like this dime-sized example at the forefront of integrated-circuit technology.

Three national laboratories, including Los Alamos, have joined forces with the semiconductor industry and leading universities to keep future generations of American-made semiconductors competitive in a world market.

The Semiconductor Research Corp., a consortium of more than 60 companies and government agencies, and the Department of Energy have signed a $100 million, 5-year cooperative research and development agreement. Los Alamos, Sandia, and Lawrence Livermore laboratories will use their high-performance computing capability to improve industry's ability to model and simulate semiconductor materials, devices, systems, and manufacturing processes.

The SRC, a non-profit organization, was created in 1982 by industry giants like Intel, Texas Instruments, and Motorola to fund long-term research that might be applicable to future commercial semiconductor devices. Under the new agreement, the DOE has established the Center for Semiconductor Modeling and Simulation at Los Alamos to coordinate work done at the three national laboratories.

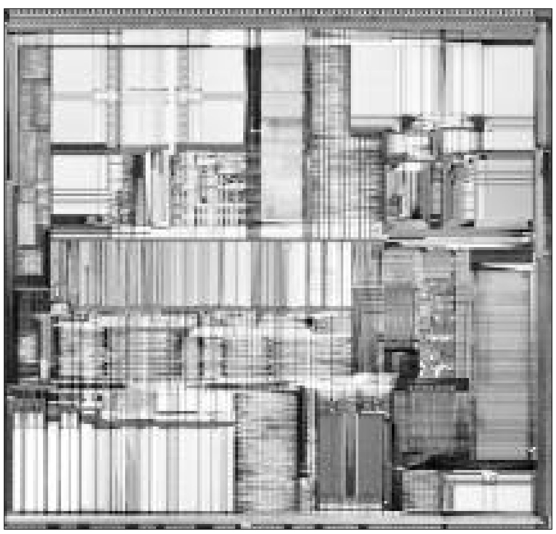
The process of manufacturing semiconductors takes more than a hundred steps. Hundreds of copies of an integrated circuit are deposited on a single wafer by forming eight to 20 layers that create electrically active regions in and on the wafer surface.

Manufacturers want to put faster circuitry on smaller chips to achieve better performance and lower cost per chip. But the increasing complexity of etching ever-smaller features into silicon means that predictive modeling and simulation are imperative to avoid costly errors in the design of faster chips.

The national laboratories are at the forefront of these technologies. Researchers will use new advanced computational algorithms to model complex, three-dimensional chip structures and manufacturing processes. They also are developing a combined equipment-wafer simulator that will describe how surface topography is affected by the deposition and etching phases of the circuit-manufacturing process. The laboratories also will develop better simulation tools to predict electron behavior in semiconductors and better ways to predict failure in interconnects.

The end result will be increased miniaturization of circuits, perhaps even to atomic sizes, and vast improvements in manufacturing techniques and materials composition.

This year, the worldwide market for semiconductor-based electronics is about $800 billion, and industry projections are for sales to reach $1.3 trillion by the year 2000. The integrated circuit technology developed under this agreement should move into the marketplace by 2007. Close collaboration between the companies that make integrated circuits and research laboratories like Los Alamos will guarantee the U.S. semiconductor industry's competitive edge well into the next century.



➔ A magnified look at Intel's Pentium® chip illustrates the increasing complexity of manufacturing faster, smaller semiconductors at lower cost. Photo courtesy of Intel.

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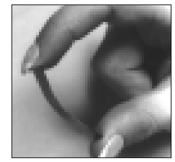
DATELINE: LOS ALAMOS

BRIEFLY ...



Los Alamos and potential industrial partners are working on a strategy to take the high-temperature superconducting tape developed by the Laboratory into the marketplace. At a recent conference, Los Alamos offered U.S. companies the opportunity to sign access agreements to study the promising technology and non-exclusive license agreements to commercialize it. More than 40 representatives from industry and other research organizations attended the meeting to find out more about the three-layer metal-ceramic tape that can carry more than one million amperes of electricity per square centimeter at liquid nitrogen temperature. The current $1.5 billion market for superconductors is expected to grow to as much as $12 billion by the year 2000, and to $200 billion by 2020. Los Alamos will continue to help the U.S. superconductor industry maintain a competitive position in the global market. (See the August 1995 issue of *Dateline: Los Alamos* for more information on the high-temperature superconducting tape.) CONTACT: RANDOLPH TREMPER, INDUSTRIAL PARTNERSHIP OFFICE, (505) 665-2134.

IN THIS ISSUE:

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