LOS ALAMOS NATIONAL LABORATORY
WHERE SCIENCE MAKES A DIFFERENCE

DATELINE
LOS ALAMOS

VIRTUAL LABORATORIES

ROBOTICS, AUTOMATION, AND THE INTERNET WILL SPEED NEW CURES AND VACCINES

One day soon, scientists will be able to ship a life-threatening virus or potential miracle drug found in a remote jungle to an automated laboratory on the other side of the world, then use global computer networks to design and run experiments that will yield analysis results within days instead of months or years.

This vision of 21st century laboratories already has been designed by researchers from Los Alamos, the University of California at Los

In this computer-generated image, a robot takes an infectious sample to a waiting helicopter, which will deliver it to a distant automated laboratory for analysis.

DATELINE: LOS ALAMOS

These images show an artist's conception of the virtual laboratory building and a worker in the lab's control room.

Angeles, and the San Francisco architectural firm of Kaplan McLaughlin Diaz. Such labs could let hundreds of researchers collaborate on the thousands of experiments needed to develop vaccines for infectious diseases such as AIDS before epidemics devastate huge populations.

"Most vaccine research is a painfully slow, trial-and-error process," explained Los Alamos robotics expert Tony Beugelsdijk. "It's notoriously difficult to find the common elements in various mutations, especially when dozens of new mutations of diseases like AIDS appear so rapidly."

The virtual lab concept combines computer and robotics technologies with the Internet and overnight shipping to speed research results by a hundred-, even a thousandfold.

The laboratory designed by the trio would appear as a collection of standardized robotic modules that researchers around the world could mix and match to customize sample preparation, analysis, and data interpretation. As experimental needs change, scientists could quickly reconfigure the modules to make new instruments. The lab would need a few humans to maintain the machines and watch and troubleshoot

DATELINE LOS ALAMOS

A MONTHLY PUBLICATION OF THE PUBLIC AFFAIRS OFFICE OF LOS ALAMOS NATIONAL LABORATORY

LOS ALAMOS NATIONAL LABORATORY, AN AFFIRMATIVE ACTION / EQUAL OPPORTUNITY EMPLOYER, IS OPERATED BY THE UNIVERSITY OF CALIFORNIA FOR THE U.S. DEPARTMENT OF ENERGY UNDER CONTRACT NO. W-7405-ENG-36

EDITOR
Diane Banegas

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

STAFF WRITER
Theresa Salazar

CONTRIBUTING WRITERS
Jim Danneskiold • Kathy DeLucas
John R. Gustafson • Gary Kliewer
James Rickman

CONTRIBUTING PHOTOGRAPHERS
Stephanie Mah • Fred Rick • Connie L. Witt

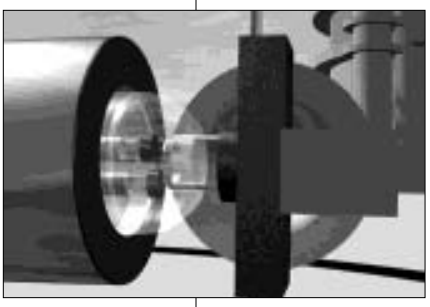
PRINTING COORDINATORS
G.D. Archuleta • Sandra Lopez

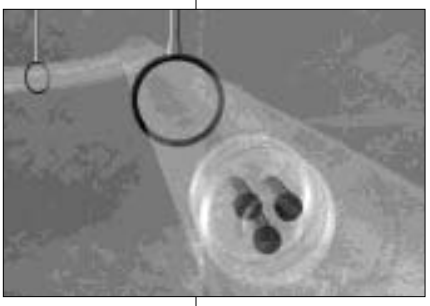
LOS ALAMOS NATIONAL LABORATORY
PUBLIC AFFAIRS OFFICE, MS P355
LOS ALAMOS, NM 87545

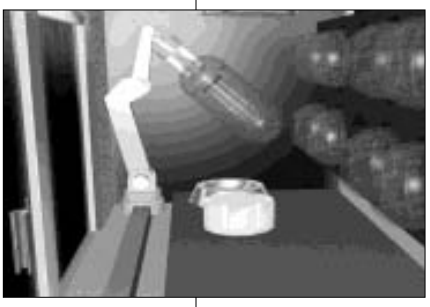
during experiments, but the handling of samples would be done by one-armed robots running on rails.

"The virtual laboratory would never grow obsolete," Beugelsdijk said. "The concept is so flexible that walls could be broken down, new technologies could be adapted, and the entire laboratory could be reconfigured quickly."

Over the past five years, researchers at Los Alamos and other Department of Energy laboratories have developed automated laboratory modules and the process-control software needed to run them. Now Beugelsdijk and his colleagues are working on a generalized laboratory interface: Internet-savvy software tools that give researchers at remote locations the ability to design and control specialized experiments at automated labs.







For example, an epidemiologist might find a new infectious agent. She could log onto a lab continents away through the Internet and get the codes needed to design an analysis, along with shipping labels and safe shipping instructions. When the sample arrives at the lab, the bar codes on the package tell the control software which modules need to do what, and the worker can log on to get the results of the analysis the next day, before the virus can spread. Similarly, other laboratories can be built that focus on drug discovery or environmental analysis.

Robotics systems have been used in laboratories for years but have lacked the flexibility needed for adaptable, modular experimental work. In addition, the widespread acceptance of the Internet as the primary medium of information exchange and recent developments in hardware and software engineering now make it possible to coordinate science over computer networks.

A patent on the virtual laboratory concept is pending.

CONTACT: TONY BEUGELSDIJK
ENERGY AND PROCESS ENGINEERING
(505) 667-3169 • E-MAIL: beugelsdijk@lanl.gov

←

Top: The sample is inserted into a transport tube, which transfers it into the laboratory. Center: A sample en route to a holding area. Bottom: A robotic arm on a rail selects a sample and sets it on the conveyor belt for transport to an analysis system.

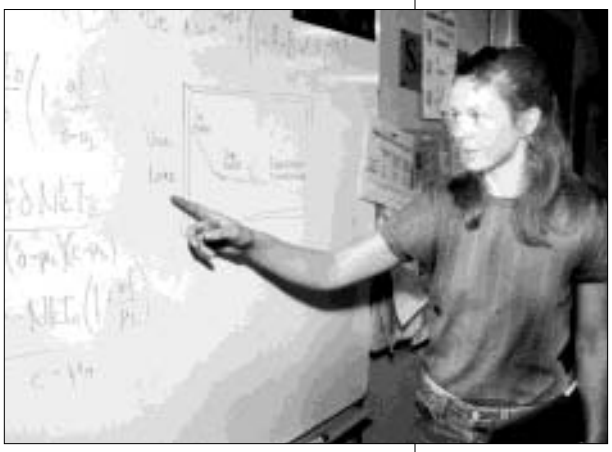
Illustrations courtesy of Kaplan McLaughlin Diaz

DATELINE: LOS ALAMOS

HIV HAS NOWHERE TO HIDE

COMBINATION DRUG TREATMENT IS A MAJOR WEAPON AGAINST THE AIDS-CAUSING VIRUS

Los Alamos researchers and their colleagues at the Aaron Diamond AIDS Research Center subjected new clinical data to a rigorous mathematical analysis and concluded that using combination drug therapy for a few years can eliminate HIV virus from the body's major sites of infection.



↑ Los Alamos researcher Paulina Essunger explains the response of HIV infection in patients receiving multi-drug treatment.

The researchers caution that their research results do not mean a cure for AIDS is near at hand. Viral "embers" could lurk in undetected sites in the body or in places where the drugs cannot reach and emerge to rekindle the infection years later.

The study is part of an ongoing collaboration between Los Alamos and Aaron Diamond. The researchers' strategy uses potent drugs to perturb the infectious process of HIV, then subjects the resulting clinical data to mathematical modeling to gain insights into the processes going on in the patients' bodies.

The study tracked eight patients given combinations of drugs designed to fight HIV infection. One drug the patients received (nelfinavir) blocked the action of the viral enzyme protease; if protease doesn't work properly, any new viral particles made as the HIV multiplies are unable to infect new cells. Two other drugs used in the study (zidovudine and lamivudine) inhibited the action of reverse transcriptase, another enzyme that plays a vital role in HIV's ability to replicate after it enters a cell.

The researchers tracked the amount of HIV, also called the "viral load," in each patient's blood plasma at the outset of the study and then at regular intervals during their multiple-drug treatment. Confirming

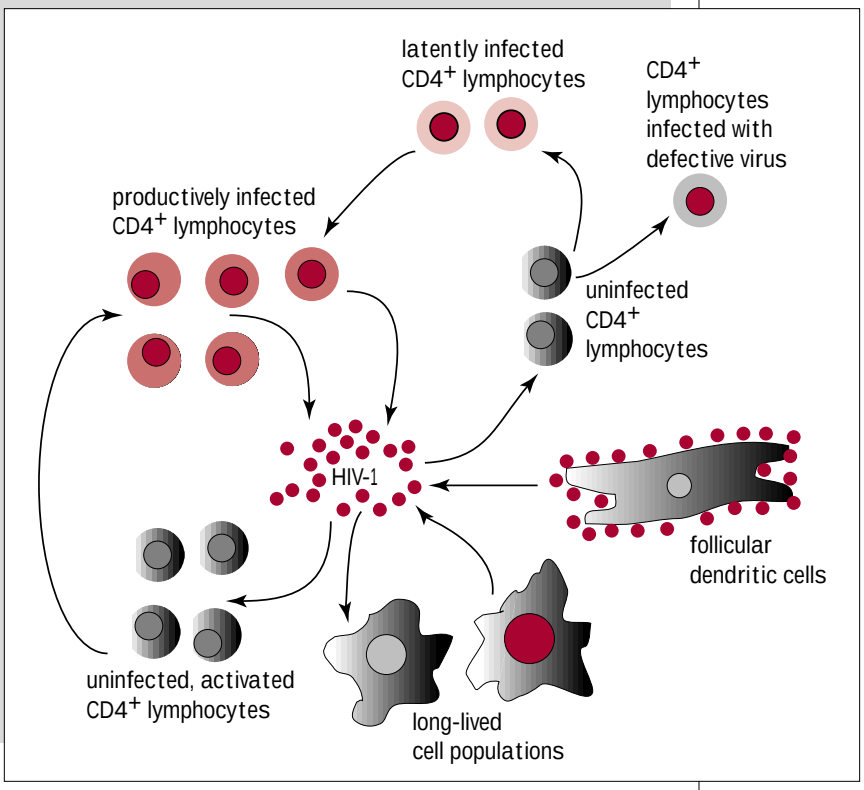
earlier results, they found that, in an initial phase, the level of HIV in each patient dropped by between 93 and 99 percent in the first two weeks of treatment as the body eliminated short-lived infected cells and viral particles.

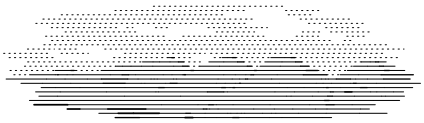
Thereafter, the residual load decreased at a much slower rate. The researchers believe this slow second phase, which had not been detected in previous studies, reflects the elimination of long-lived cells, such as macrophages, infected before therapy began and possibly viral particles trapped in lymphoid tissues.

The researchers concluded that continuing the combination drug therapy could in two or three years eliminate all HIV from the specific sites of infection they could analyze. New methods will be needed to detect possible lingering infection in other sites in the body to determine the complete effectiveness of such a treatment.

The researchers gained these insights into the behavior of HIV in the body by incorporating the clinical measurements into a detailed

Close to 99 percent of the HIV infection carried in a human body originates from previously infected lymphocytes (T-cells). HIV also infects other types of cells and these secondary sources, pictured on the right (follicular dendritic cells and long-lived cell populations), produce most or all the remaining infection. Viral "embers" can represent a tertiary source of infection by hiding in sites inaccessible to drugs and sparking a new round of infection years after treatment. Los Alamos researchers are using advanced mathematical models to quantify the HIV infection from each source. This knowledge will help the medical community devise the most effective drug treatments for AIDS patients.





mathematical model that tracks interactions between HIV and the various cells in an infected person. For this study, they incorporated new terms to account for the sources of infection during the disease's second phase of response to treatment.

The rapid decline in viral load, the researchers said, not only attests to the potency of combination drug treatment, but also indicates that a drug-resistant strain of the virus did not emerge during the study period. Medical researchers have long worried that HIV's ability to mutate rapidly would enable it to evolve and develop resistance to drug treatments.

Although the results of the new study are a positive development, the researchers noted that people taking part in the study had not previously used any of the drugs given for treatment and therefore the HIV they carried could not previously have had a chance to adapt to the drugs. Patients who had already used any of the three drugs could possess a more drug-resistant form of HIV that might respond differently to the combination drug treatment.

As a general rule, people in clinical trials respond better to treatment than people in the general population who receive identical treatment because of their lack of exposure to the drugs being studied, the rigor of the treatment protocol, and the higher level of overall care people in clinical trials receive.

Perelson credits the Santa Fe Institute, where he holds a position, with advancing the team's collaborative discussions.

CONTACT: ALAN PERELSON
THEORETICAL BIOLOGY AND BIOPHYSICS
(505) 667-6829 • E-MAIL: asp@lanl.gov

DATELINE: LOS ALAMOS

TEACHERS ARE TOPS

SCIENCE TEACHERS PARTICIPATE IN EDUCATION PROGRAM TO IMPROVE CURRICULA

After completing three years of study, 22 teachers from Northern New Mexico, Colorado, Oklahoma, and Wyoming graduated from Los Alamos' science education program designed to help teachers improve science curricula in their schools.

At a visit to the Very Large Array — 27 gigantic antenna — in Socorro, N.M., teachers learned how the system is used to scan the universe for radio waves.

The teachers — participants in Los Alamos' Teacher Opportunities to Promote Science (TOPS) Program — developed a storm-tracking curriculum to take back with them to their schools. "Meteorology gave the teachers an opportunity to teach a number of science concepts," said Connie Witt, TOPS coordinator in Los Alamos' Science Education Team.

During the three-year period, teachers set up weather stations at their schools and transmitted weather information to a statewide network. During a partial solar eclipse in May 1994, students observed the stations to learn how the eclipse affected weather on Earth. In addition, the weather data helped an educational and research consortium called LodeStar to locate a suitable astronomical viewing area in New Mexico.

Weather observations from participating schools indicated that the lava bed area near Grants, N.M., was a good area for astronomical observation. Members involved with the LodeStar project are proposing to set up an educational astronomical park on Horace Mesa near the lava beds. Teachers plan to continue using the weather stations as part of science curricula.

The next TOPS topic will be communication issues — from cellular communication to the cyber age. A new group of teachers will begin TOPS training this summer.

CONTACT: CONNIE L. WITT
SCIENCE AND TECHNOLOGY BASE PROGRAMS
(505) 665-5194 • E-MAIL: cwitt@lanl.gov

DATELINE: LOS ALAMOS

HOT NEW TREATMENT FOR "HOT" WASTE

PLASMA TECHNOLOGY CUTS NUCLEAR WASTE AND SAVES MONEY

Los Alamos researchers are developing a new technique that uses ionized gas to strip radioactive contamination from tools, gloveboxes, pipes, and other materials. The technique could significantly reduce the volume of nuclear waste destined for the WIPP site near Carlsbad, N.M.

↑

Researcher John Veilleux checks on an experiment that shows how plasma can remove uranium and other contaminants from crevices on metal test materials.

Since the development of the atomic bomb in the early 1940s, the U.S. weapons complex has accumulated about 256,000 cubic meters of transuranic waste — which cannot be disposed of in an ordinary landfill because of its radioactivity.

Transuranic waste refers to radioactive materials that are contaminated with uranium and certain forms of plutonium, and other nuclides whose atomic numbers are greater than uranium's. Transuranic waste results primarily from the chemical processing of spent nuclear fuel and the use of plutonium in the fabrication of nuclear weapons.

The cost of treatment, storage, and disposal of transuranic waste varies but can be as high as $71,000 per cubic meter and may create significant secondary waste streams. Until now, the waste could not be decontaminated but awaited disposal at a site such as the Waste Isolation Pilot Plant.

The Los Alamos decontamination technology, still in the research and development state, uses plasma, a hot gas-like substance, to remove uranium or other transuranic elements from contaminated items. The researchers then use liquid nitrogen to cool the plasma, and they chemically recover the uranium for recycling purposes.

A bench-top trifluoride gas plasma system produces fluorine ions that travel to contaminated surfaces where they break uranium's existing

chemical bonds and react with the element. Once a uranium atom fully bonds with six fluorine atoms, the now gaseous molecule can be pumped away. The process removes up to 99.9 percent of the uranium from metal surfaces.

The researchers trap and cool the contaminated gas with liquid nitrogen. A small amount of water or nitric acid in the trap reacts with the radioactive component, producing a solution or solid when the temperature rises.

After 15 minutes in the plasma chamber, a metal sample is 66 percent clean. After nearly two hours in the plasma chamber, the metal is almost completely clean, although the cleaning rates differ depending on conditions inside the chamber. This process also works on plutonium and neptunium, which both react with fluorine.

In this closeup of the photo on the previous page, you can clearly see the piece of aluminum undergoing decontamination inside the plasma chamber.

The plasma system has many advantages over other treatments, such as acid washes. Plasma systems can be operated remotely and do not require direct human contact with the waste. Also, the waste stream is fully recoverable: the uranium can be disassociated from the fluorine and used again for added savings.

If plasma decontamination treated just 10 percent of the transuranic waste slated for WIPP, American taxpayers would save more than $1 billion in disposal costs.

CONTACTS: PHIL CHAMBERLIN
NUCLEAR AND RADIOCHEMISTRY
(505) 667-4103 • E-MAIL: epchamberlin@lanl.gov
CARTER MUNSON
PLASMA PHYSICS
(505) 667-7509 • E-MAIL: cmunson@lanl.gov

DATELINE: LOS ALAMOS

SEMICONDUCTORS AND SUPERCOMPUTING

RESEARCH AGREEMENT SIGNED WITH MOTOROLA

Los Alamos recently signed a Cooperative Research and Development Agreement with Motorola Inc. that will lead to technical advances in computing power and semiconductor design. Future joint projects may lead to the development of new kinds of sensors and new computer processor architectures.

↑

Motorola and Los Alamos will combine expertise to design new methods of high-speed data acquisition, analysis, and interpretation.

Photo courtesy of Motorola Inc.

"This is the birth of a long-term partnership that will bring new and competitive technical business opportunities to Motorola and Northern New Mexico and will contribute to our national mission of reducing the global nuclear danger," Los Alamos Director Sig Hecker said of the agreement.

Los Alamos will benefit from Motorola's expertise and stature in electronics and communications technologies and Motorola will help the Laboratory incorporate specialized software into a variety of operating systems for its national security mission.

In return, the semiconductor giant wants to tap the unrivaled expertise of Los Alamos in the fields of computer simulations and modeling for the design of future-generation semiconductor chips. Motorola and Los Alamos expect the partnership to lead to new methods of acquiring, analyzing, and interpreting large amounts of data at extremely high rates.

Motorola Semiconductor Products Sector plans to assign 10 to 20 people to Los Alamos by the end of 1997. As the collaboration grows, additional Motorola personnel will relocate to Los Alamos, and the company expects to do some local hiring. The new agreement follows a previous agreement signed in late 1996 between the Laboratory and Motorola University.

CONTACT: ELMER SALAZAR
INDUSTRIAL PARTNERSHIP OFFICE
(505) 667-5720 • E-MAIL: elmers@lanl.gov

DATELINE: LOS ALAMOS

NEW COLLEGE PROGRAM

LAB SCIENTIST WILL HELP DEVELOP AN ENVIRONMENTAL SCIENCE CURRICULUM

Anthony Gallegos, a radioecologist at Los Alamos, will help Northern New Mexico Community College in Española develop a four-year environmental science undergraduate program. The academic program will train students for jobs at Los Alamos and other institutions or agencies in Northern New Mexico and prepare students to pursue advanced degrees.

Los Alamos wants to increase minority participation in the fields of environmental and earth sciences. The expansion of the college's program will assist local young people in obtaining the necessary skills to compete successfully at the entry technical and professional levels.

"We will focus on the work force needs of the region. We'll look hard at future employment needs in and around Northern New Mexico," Gallegos said. "And it will be designed so the students can keep going into graduate science or management programs that lead to higher salaries."

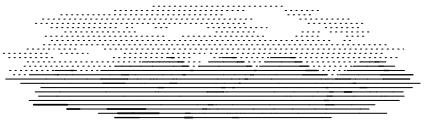
↑

Anthony Gallegos

The college course requirements will be linked to degree programs at New Mexico Highlands University in Las Vegas and New Mexico State University in Las Cruces, which award four-year bachelor of science degrees. The program will give students practical job skills and experience in environmental science as well as allow interactions with Los Alamos personnel and other professionals working in the field. Course work will range from air and water pollution studies and waste management to risk assessment, radiation safety, and health physics training.

Gallegos was dean of graduate studies and research at NMHU and was a senior performance assessment specialist for the New Mexico Environmental Evaluation Group. As a radioecologist, he specializes in computer simulation modeling of ecosystem dynamics and ecological risk assessment.

CONTACT: ANTHONY GALLEGOS
ENVIRONMENTAL SCIENCE
(505) 747-2214 • E-MAIL: agallegos@lanl.gov



BRIEFLY ...

LOS ALAMOS RESEARCHERS ARE PRODUCING URANIUM TARGETS FOR PRODUCTION OF MOLYBDENUM-99, A SHORT-LIVED RADIOACTIVE ISOTOPE THAT IS ESSENTIAL FOR MANY MEDICAL DIAGNOSTIC TESTS. Last fall, Los Alamos and Sandia national laboratories produced their first batch of the isotope for the Department of Energy's Office of Isotope Production and Distribution. Moly-99 decays into technetium-99, a short-lived isotope used more than 30,000 times each day to diagnose abnormalities of the heart, lungs, liver, and other major organs. Without the isotope, many of these maladies could only be detected by invasive surgery. This joint effort will provide the first domestic supply of moly-99 in the United States since 1989 and could supply part of the national demand for the isotope by 1998. Most of the moly-99 currently used in the United States comes from Canada. CONTACT: JIM LEDBETTER (505) 667-4653 • E-MAIL: jledbetter@lanl.gov

IN THIS ISSUE:

Dateline: Los Alamos is available on the World Wide Web: http://lib-www.lanl.gov/pubs/dateline.htm

DATELINE LOS ALAMOS

A MONTHLY PUBLICATION OF THE PUBLIC AFFAIRS OFFICE OF LOS ALAMOS NATIONAL LABORATORY

Nonprofit Organization
U.S. Postage Paid
Albuquerque, NM
Permit No. 532

LALP-97-1-7

Los Alamos NATIONAL LABORATORY