LOS ALAMOS NATIONAL LABORATORY
WHERE SCIENCE MAKES A DIFFERENCE

DATELINE LOS ALAMOS

U.S. DEPARTMENT OF ENERGY
UNIVERSITY OF CALIFORNIA

LEONID METEOR SPECTACLE OBSERVED BY LOS ALAMOS TELESCOPE

SEE PAGE 2

DATELINE: LOS ALAMOS

ABOUT THE COVER:

The illustration on the cover of this month's issue is a frame from a 30-frame movie of a Leonid meteor detonating above Earth. The explosion and resulting cloud were captured on film by a team of Los Alamos astronomers using the Robotic Optical Transient Search Experiment (ROTSE-I) telescope.

November's meteor shower was created by Earth's collision with dust left behind by Comet Temple-Tuttle. The explosion occurred just northeast of Las Vegas, N.M., at an altitude of approximately 83 kilometers.

ROTSE is a collaboration between Los Alamos and Lawrence Livermore national laboratories and the University of Michigan. The main focus of this effort is the search for the optical counterparts of gamma-ray bursts. The robotic telescope system actively maps the sky twice each night, searching for transient objects of all kinds.

The entire movie can be seen at the following site on the World Wide Web: http://rotsei.lanl.gov/leonid.html.

DATELINE LOS ALAMOS

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DATELINE: LOS ALAMOS

LOS ALAMOS HAS WORLD'S FASTEST SUPERCOMPUTER

RECORD-BREAKING BLUE MOUNTAIN UNVEILED

The Laboratory has claimed bragging rights for the world's fastest supercomputer.

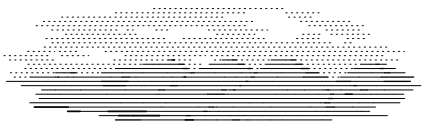
In November, the Blue Mountain computer ran one of the computer industry's standard speed tests for big computers, Linpack, at 1.608 trillion calculations per second (teraOps), giving it a claim to the coveted top spot on the TOP500 list, the supercomputer equivalent of the Indianapolis 500.

Blue Mountain, built by Silicon Graphics Inc., is the latest advancement in the Energy Department's stockpile stewardship program, which uses science-based methods to assess and certify the safety, security and reliability of nuclear weapons without underground nuclear testing. The Laboratory also has installed the most powerful visualization system to enable scientists to see and understand the unprecedented amounts of data from Blue Mountain.

"With Blue Mountain and SGI's visualization engines, we are beginning a new era in computing and in science, moving the stewardship of our nation's nuclear weapons from its 50-year foundation in nuclear testing to one based in science and simulation," said Steve Younger, associate Laboratory director for nuclear weapons.

"These computing tools are the first step toward what we need to maintain confidence in an aging stockpile and our commitment to the Comprehensive Test Ban Treaty. With Blue Mountain we can begin harnessing the computer's power to make accurate predictions about the future of the nuclear stockpile," Younger added.

The Laboratory bought Blue Mountain from SGI through the Accelerated Strategic Computing Initiative, or ASCI, a program funded through the Department of Energy's Office of Defense Programs. One of ASCI's goals is to build, over the next five



years, an even more powerful supercomputer that can execute 100 trillion calculations in a second.

At the heart of Blue Mountain are 48 Silicon Graphics/Cray Origin2000™ servers containing a total of 6,144 processors, with projected peak performance of 3.072 teraOps. The system is designed so the cluster of 48 shared memory multiprocessors, or SMPs — all commercially available servers — behave like a single computer. These 48 SMPs can communicate with each other at world-record sustained speeds in excess of 650 gigabits a second.

This high bandwidth is possible because HIPPI-800 switches interconnect Blue Mountain's SMPs. HIPPI, or high-performance parallel interface, is a supercomputer communications link conceived at Los Alamos that now is a global standard. Early this year, Blue Mountain will become the first computer to run the new HIPPI standard, called HIPPI-6400, which is eight times faster than standard interconnects.

Storage systems also will break records. Blue Mountain will have more than 76 trillion bytes of state-of-the-art fiber channel disk, making it one of the largest "disk farms" ever assembled for a single computer.

The Lab and SGI also have completed installation of the largest system in the world for visualization of computer output, comprised of 16 of Silicon Graphic's Infinite Reality graphics engines. This dedicated visualization system permits scientists to view and refine information sets as large as one billion cells in a single interactive picture. The visualization system is especially valuable because it is an intrinsic part of Blue Mountain, not a separate unit.

Blue Mountain represents a new era in supercomputing. Instead of ordering one-of-a-kind machines from a highly specialized market, the Laboratory is working with SGI to create the most powerful computer on the planet based on off-the-shelf technologies that are of direct value to the half-trillion-dollar-a-year commercial computing market.

Through ASCI, the DOE initially is providing 3-teraOps-scale supercomputers at two of its nuclear weapons laboratories: Los Alamos and Lawrence Livermore, and a 1.8 teraOps system at Sandia. Program plans include a 10-teraOps supercomputer by 2000, a 30-teraOps machine by 2001 and a 100-teraOps supercomputer by 2003-4. Next year, DOE plans to award a contract for the 30-TeraOps ASCI supercomputer at Los Alamos following competitive bidding.

In addition to its extraordinary speed, Blue Mountain is giving weapons scientists a much better computer picture of the weapons in their care. During 1999, Blue Mountain should execute 80 million trillion operations over the course of thousands of ASCI simulations focused on

key weapons issues. This is roughly 10 times more computing in one year than all the calculations executed in support of the U.S. stockpile from the Manhattan Project through 1992, the last year of underground testing.

The first supercomputer at the Laboratory, "MANIAC," was built in the early 1950s based on the ideas of computer genius John von Neumann. The nuclear weapons program at the Lab was the birthplace of high-performance computing. The first model of nearly every supercomputer was sold to the Laboratory, including the first Cray supercomputer ever manufactured, which was installed at the Laboratory in 1976.

Advances in supercomputing at Los Alamos and its sister laboratories have driven computing to the modern era in which personal computers have more power than the machines used in the 1950s to design the first thermonuclear weapons.

MANIAC was Los Alamos' first supercomputer.

Through the DOE's Office of Energy Research, the Laboratory and SGI are building a second supercomputer, Nirvana Blue, which will be capable of 1 teraOps of nonweapons computing. Academic and industrial supercomputer users are working with the Lab to develop and improve predictive simulations on Nirvana Blue. Because Nirvana Blue and Blue Mountain share an identical architecture, these unclassified advances will be invaluable in helping to improve the state of the art in weapons simulations.

Nirvana Blue, which was funded by DOE's Office of Energy Research, currently has 768 of its 2,048 Origin2000™ processors installed. Installation should be complete by March 1999.

The Laboratory is coupling its advances in nuclear weapons simulations with new predictive capabilities in such scientific areas as the modeling of global climate, wildfire, disease epidemics and other crises, and transportation, electric power and other infrastructure.

Los Alamos computer scientists are working with the oil industry to analyze seismic data to locate new wells and increase the amount of oil recovered from existing wells. The automobile industry uses computer codes invented at the Laboratory to model and improve the efficiency of internal combustion engines.

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ARIES DEMONSTRATION LINE BEGINS OPERATION

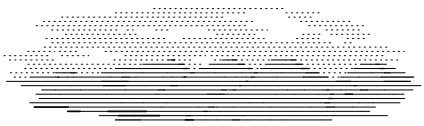
TECHNOLOGY REMOVES PLUTONIUM FROM WEAPONS' CORES AND CONVERTS IT INTO AN UNCLASSIFIED FORM

A technology demonstration for separating the plutonium components from surplus nuclear weapons recently received a green light from the Department of Energy and is now under way at Los Alamos. Two pits, the plutonium components at the heart of nuclear weapons, were taken apart during the first activity in the demonstration.

The ARIES Demonstration Line — Advanced Recovery and Integrated Extraction System — integrates the technologies needed to remove plutonium from the cores of surplus nuclear weapons and convert it into an unclassified form for international inspection. The plutonium is packaged for long-term storage and disposition.

"This demonstration is the culmination of several years of work by Los Alamos and Lawrence Livermore, our sister lab," said Randy Erickson,

Doug Wedman, project leader for electrolytic decontamination technology, readies a sealed container of plutonium for analysis inside a glovebox.



program manager for nuclear materials management. “We designed and installed the equipment, developed all the operating protocol and safety procedures and now are in a position to get the key data needed to design a full-scale facility.”

The ARIES demonstration, which involves dismantling pits over a two- to three-year period, will provide important information for designing and operating a full-scale Pit Disassembly and Conversion Facility.

In June, DOE announced that its Savannah River Site and Pantex Plant are equally preferred locations for this facility, which would be designed and constructed in the 1999-2004 time frame, with production operations beginning in 2005. Construction and operation of the facility is contingent on reaching agreement with Russia on plutonium disposition.

Key components of the ARIES prototype were proven in earlier experiments. The current demonstration uses an integrated system to perform all of the necessary tasks — cutting the pits apart, separating the plutonium from other components with gas, converting the plutonium to an oxide form, packaging it in sealed containers, and decontaminating and determining the characteristics of the resulting product.

ARIES uses hydrogen and/or oxygen gas to recover the plutonium from the pits that are at the heart of nuclear weapons. The plutonium pit falls apart in flakes, which are collected and formed into plutonium oxide.

The plutonium oxide will either be blended with other materials to make a mixed oxide, which will be burned in existing domestic reactors as fuel and disposed of as spent fuel, or it will be disposed of by being immobilized and surrounded by vitrified high-level waste.

Both of these technologies form the basis for the United States' hybrid plutonium disposition strategy aimed at making the plutonium no longer useable for nuclear weapons.

In addition to Los Alamos and Livermore, DOE's Sandia National Laboratories is developing some of the robotics for the system.

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LOS ALAMOS TO BUILD POWERFUL ACCELERATOR

FIVE NATIONAL LABORATORIES WILL COLLABORATE ON SPALLATION NEUTRON SOURCE

Los Alamos will build a linear accelerator for the Spallation Neutron Source, a $1.3 billion facility that will produce the most intense pulsed neutron beams in the world.

The facility, which will be located at Oak Ridge National Laboratory in Tennessee, is a collaborative project involving five Department of Energy national laboratories. When operational, the slightly less than one-half of a kilometer long accelerator will be used for a wide range of materials research and neutron scattering experiments.

Roger Pynn, director of the Los Alamos Neutron Scattering Center (LANSCE), said the Laboratory also would build control and diagnostic systems to handle the beam.

"This is an important project, and it fits very well with our role of being a national center for development of high-power accelerators for defense and civilian research," Pynn said. "It will allow us to continue to develop our competency and to continue to attract top-notch young scientists."

The Laboratory is expected to receive about $30 million in funding for the project during the current fiscal year and about $350 million over the seven-year life of the design and construction phases.

Spallation is a term used to describe the reaction that occurs when a high-energy particle bombards an atomic nucleus, ejecting some of its neutrons. When aimed at a sample, some of these neutrons will interact with the nuclei and bounce away at an angle.

This phenomenon, called neutron scattering, can provide detailed information that cannot be learned in any other way about the structure, motion and atomic interactions of a wide range of materials.

Neutron scattering research has already been valuable in the development of such products as small electric motors, plastics, lubricants, jet aircraft and high-temperature superconductors, and the DOE has made construction of a new neutron-scattering facility a high priority.

The SNS, which involves Lawrence Berkeley, Brookhaven and Argonne national laboratories as well as Los Alamos and Oak Ridge, will have an

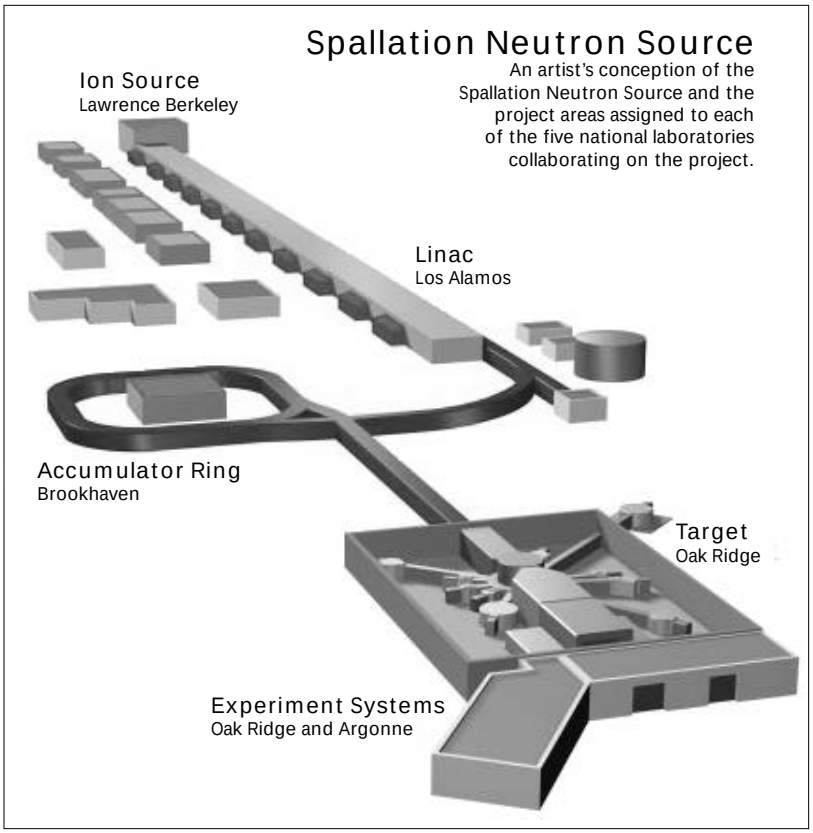
ion source that produces negative hydrogen ions, accelerates them to 2.5 million electron volts and delivers them to the linear accelerator, or linac.

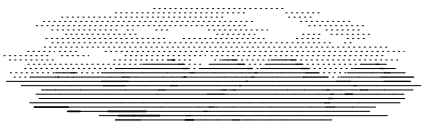
The linac will accelerate the hydrogen ions to one billion electron volts and transfer them to an accumulator ring, where they will be bunched and intensified for delivery onto a mercury target to produce the pulsed neutron beam, which is then aimed at the target samples.

Pynn said the accelerator for the new facility will look a lot like the existing half-mile-long linac that has been in operation at Los Alamos since the early 1970s.

"I like to show a picture of our facility and then point out that the difference between the two of them is that here, the sky is blue," he joked.

The main difference is that the number of neutrons produced by the SNS will be five times that of the existing facility at LANSCE, but Pynn expects the Laboratory's facility to continue to be attractive.





For one thing, the type of research instrumentation can easily make up for such a difference in source intensity. Pynn also said the geographical location would make the Los Alamos facility more attractive for some researchers in the western United States and said the Laboratory will continue to have a defense-related research role that the SNS will not have.

"There's plenty of room for more than one facility, given the importance and usefulness of neutrons in research and the demand for them in the research community," he said.

Pynn said the project participants recognize that sharing the responsibility for planning and building a large research facility among five laboratories will be challenging, but the challenge is exciting because such collaborations may become the model for major scientific projects in the future.

When completed in 2005, the SNS will provide users from federal laboratories, universities and private industry with a powerful new tool to study the properties of materials ranging from liquids to plastics to composites to metals.

More information about the facility is available on the World Wide Web at http://www.ornl.gov/sns. Information about work on the project at Los Alamos is available at http://sns.atdiv.lanl.gov.

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DATELINE: LOS ALAMOS

MODELING THE CITIES

LOS ALAMOS' HIGH-PERFORMANCE COMPUTING CAPABILITIES ARE HELPING CITIES COPE WITH DISASTER AND BETTER PLAN FOR THE FUTURE

An earthquake rocks a large modern city, injuring hundreds of people, producing major structural damage, knocking out electrical power, breaking gas mains and causing an industrial plant to leak toxic chemicals. Collapsed bridges and buildings prevent emergency vehicles from reaching the injured, attending to dozens of small fires before they become big ones and carrying supplies to hospitals and rescue workers.

How do emergency responders and city officials cope? How do they deploy resources where they are most needed? How can they prepare in advance for such disasters, and what can they do to recover from them?

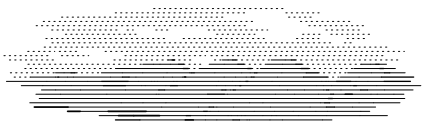
Los Alamos researchers are working on a project to give city officials, regional planners, police and other agencies a tool to help them plan for and respond to disasters such as earthquakes.

The project, called the Urban Security Initiative, links a wide range of urban subsystems — including transportation, energy distribution, weather, infrastructure damage, water distribution, ecosystems, economic activities, geology and demographics — into an integrated system that takes advantage of the Lab's high-performance computing capability.

"The tools being developed through this project can be used to help deal with natural disasters, environmental problems, the threat of chemical or

A collapsed portion of Interstate 5 and a geyser from a broken water pipe were just two of the problems residents of Northridge, Calif., faced in the aftermath of the 6.69 magnitude earthquake that shook the city Jan. 17, 1994. Los Alamos researchers are using the Laboratory's high-performance computing capability to develop a tool to help cities plan for and respond to natural disasters

Photos courtesy of the Northridge Collection, Earthquake Engineering Research Center, University of California, Berkeley



biological attacks, industrial accidents and other events," said geologist Grant Heiken, a member of the Urban Security Team. "The same tools can be used for long-range urban planning."

The project, now operating for a second year with internal Lab funding, involves many scientific disciplines, huge amounts of data, dozens of computer programs and tricky interfaces, and numerous collaborations. Heiken likens it to a big jigsaw puzzle being assembled by different groups, with various sections emerging and then needing to be connected properly to make a complete picture.

The Los Alamos team is now focusing on several major areas: air and water transportation pathways, earthquakes and infrastructure, recovery and re-growth, airborne toxic releases with traffic exposure, integrating the pieces of the project and geographic information systems to collect and organize data into common databases.

The plan is to link this information across all kinds of computer platforms, to allow those responsible for dealing with an emergency to click a button and find out just what is damaged and threatened, where the resources for responding are located and how to get them deployed.

One of the team's collaborations is with the Southern California Earthquake Center and other California agencies on a project to link computer models of seismic ground motion, earthquake-damage predictions and the infrastructure of the city of Los Angeles to enhance pre-event planning and emergency-response efforts.

Current activities as part of this collaboration include modeling the effects of a major earthquake on infrastructure in the Los Angeles area, using information about local geology, ground motion from shock waves, vulnerabilities of the infrastructure and other factors. All of these model components will be linked with models such as those for damage assessment, infrastructure operations during emergencies and longer-term recovery.

The project team has already reported useful findings. For instance, it found that a gas plume travels farther in the presence of buildings. The reason is that turbulence caused by the buildings lifts the plume higher in the air, allowing it to be carried by stronger winds aloft. This finding is important to the nonproliferation community, which is interested in modeling flow around buildings because of possible terrorist attacks.

In addition to collaborating on earthquake modeling in Southern California, the team is working with universities, federal agencies, other

cities and professional organizations. It initiated and is working with other organizations on a program to urge additional studies of urban systems, including seeking a declaration of the years 2001-2010 as the "Decade of Science in the Cities."

"Today, almost all the growth in the world is in the cities, and they are the most vulnerable places for natural or human-caused disasters," Heiken said. "Developing a science-based understanding of their vulnerabilities will help them survive."

More information on the Urban Security Initiative is available on the World Wide Web at http://geont1.lanl.gov/urbansecurity.htm .

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DATELINE: LOS ALAMOS

PEOPLE IN THE NEWS

ENGINEER SELECTED AS FELLOW

Joel Bennett

Joel Bennett has been selected to the prestigious honor of Fellow in the American Society of Mechanical Engineers. Bennett was honored for 24 years of seminal work in research areas such as reactor safety, superplastic forming and advanced modeling for composite materials. His most recent accomplishment is in predicting the ignition of high explosives that can occur because of mechanical insult.

During his 24 years at Los Alamos, Bennett has authored or co-authored about 80 technical papers. His most recent effort is developing the micromechanical ignition model used to analyze explosive accidents that could occur during the handling of weapons systems.

In additional to his technical duties, Bennett also participated extensively in education activities, including serving as an adjunct professor of mechanical engineering at Colorado State University, University of Illinois, West Virginia University and University of New Mexico.

PHYSICIST RECEIVES AWARD FROM AMERICAN PHYSICAL SOCIETY

Steve Lamoreaux

Physicist Steve Lamoreaux recently was selected to receive the American Physical Society's Francis M. Pipkin Award for outstanding work in the field of precision measurement and fundamental constants. The two-year Laboratory employee and Fellow of the APS will receive a plaque and a check for $2,000 during APS' centennial meeting in Atlanta in March.

The award, created in 1997 by APS' Topical Group on Precision Measurement and Fundamental Constants, is named after the late Francis Pipkin, who was an active member of the group. The award is given biennially to scientists who have made significant contributions in precision measurement and fundamental constants while having received their doctorates less than 15 years ago.

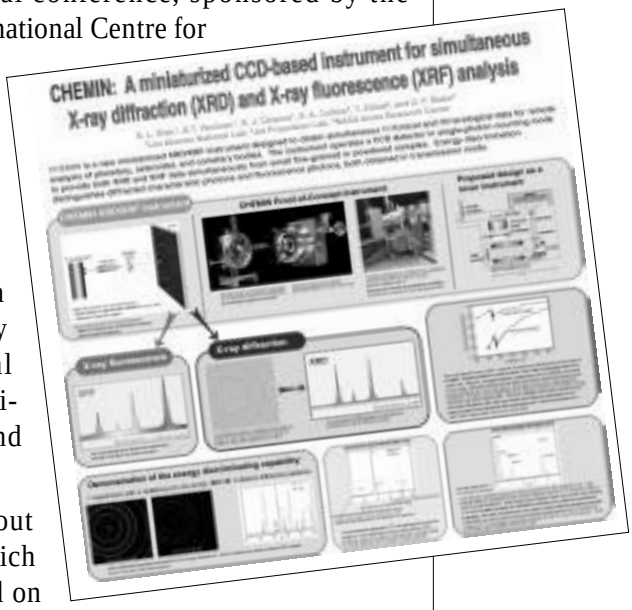
Lamoreaux specifically was recognized for "searches for a permanent electric dipole moment of the neutron and atoms, measurements of atomic parity violation and tests of spatial symmetries and quantum mechanics, including observation of the vacuum Casimir Effect."

GEOLOGISTS RECEIVE AWARD FOR BEST POSTER

Three Los Alamos geologists recently received the X-ray Fluorescence Poster Award for best poster during the 1998 Denver X-ray Conference held in Colorado Springs, Colo.

David Bish, Steve Chipera and David Vaniman, all of Los Alamos' Geology and Geochemistry Group, received certificates for their poster titled "CHEMIN: A Miniaturized CCD-based Instrument for Simultaneous X-ray Diffraction and X-ray Fluorescence Analysis." CHEMIN is an acronym for chemistry/mineralogy.

The geologists' poster beat out approximately 30 other posters presented during the five-day international conference, sponsored by the University of Denver and the International Centre for Diffraction Data.



The poster details the collaborative efforts of researchers at Los Alamos, the NASA Ames Research Center in California and NASA's Jet Propulsion Laboratory to develop a miniature instrument that uses a charge-coupled device and an X-ray source to determine the crystal structures and chemical compositions of soils, ice, rock powders and other samples.

Los Alamos has been working about four years on the instrument, which can be used on spacecraft that land on other planetary bodies as well as in a variety of terrestrial applications.

More information on CHEMIN is available at the following address on the World Wide Web: http://www-geo.lanl.gov/chemin/chemin.html.

BRIEFLY ...

LOS ALAMOS RECENTLY RECEIVED A "BEST OF WHAT'S NEW AWARD" FROM *POPULAR SCIENCE* MAGAZINE FOR ITS ROLE IN LUNAR PROSPECTOR, which the magazine chose as one of top 100 most important and innovative products introduced to the world this year. *Popular Science* is the world's largest science and technology magazine. The Laboratory built three of the five instruments on board Lunar Prospector (neutron, gamma-ray and alpha-particle spectrometers), part of NASA's Discovery Program of lower-cost, highly focused solar system exploration missions. Data from the Lab's neutron spectrometer revealed the presence of as much as six billion metric tons of water ice on the moon's north and south poles, a major prerequisite for possible colonization. The Lunar Research Institute in Gilroy, Calif., was principal investigator for Lunar Prospector; the Observatoire Midi-Pyrenees in Toulouse, France, also was involved in the project.

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