LOS ALAMOS NATIONAL LABORATORY
WHERE SCIENCE MAKES A DIFFERENCE

DATELINE
LOS ALAMOS

RADIATION AND CLOUD MONITORING STATIONS HELP SCIENTISTS IMPROVE GLOBAL CLIMATE MODELS

"I'VE LOOKED AT CLOUDS FROM BOTH SIDES NOW
FROM UP AND DOWN AND STILL SOMEHOW
IT'S CLOUDS ILLUSIONS I RECALL
I REALLY DON'T KNOW CLOUDS AT ALL."

— JONI MITCHELL, "BOTH SIDES NOW"

Los Alamos researcher Fairley Barnes explains why Manus Island was chosen as a site for the Atmospheric Radiation Measurement program to a group of Manus Island students.

Songwriter Joni Mitchell isn't the only one lamenting "I really don't know clouds at all." Clouds are one of the biggest question marks in scientists' models of global climate change. Understanding the role of clouds in Earth's atmosphere — particularly how they affect the energy balance between incoming solar radiation and heat re-radiated from Earth's surface back into space — is crucial to improving the general circulation models used for climate research.

To assist in the hunt for clues on cloud-climate interactions, Los Alamos scientists recently led a team of scientists, engineers, and technicians in the installation of an Atmospheric Radiation and Cloud Station, or ARCS, on Manus Island in Papua New Guinea.

The ARCS will measure cloud properties, including height, thickness, and moisture content; area cloud coverage; solar and terrestrial radiation; and standard meteorological parameters such as wind, temperature, humidity, and barometric pressure. The Manus Island ARCS is the first of five that will be operating in the tropical western Pacific by 2002. The Pacific stations will become part of a larger data-gathering network that includes stations in the U.S. Southern Great Plains region and the North Slope of Alaska.

ARCS sites are a component of the Department of Energy's Atmospheric Radiation Measurement, or ARM, program. Established in 1989, the program supports the U.S. Global Change Research Program to help resolve scientific uncertainties about potential global climate change.

The ARM program includes a team of scientists, a collection of measurement sites, a data-management system, and an instrument development program. ARM program members come from eight DOE laboratories, 23 universities, 13 federal laboratories, six private agencies, and eight foreign countries.

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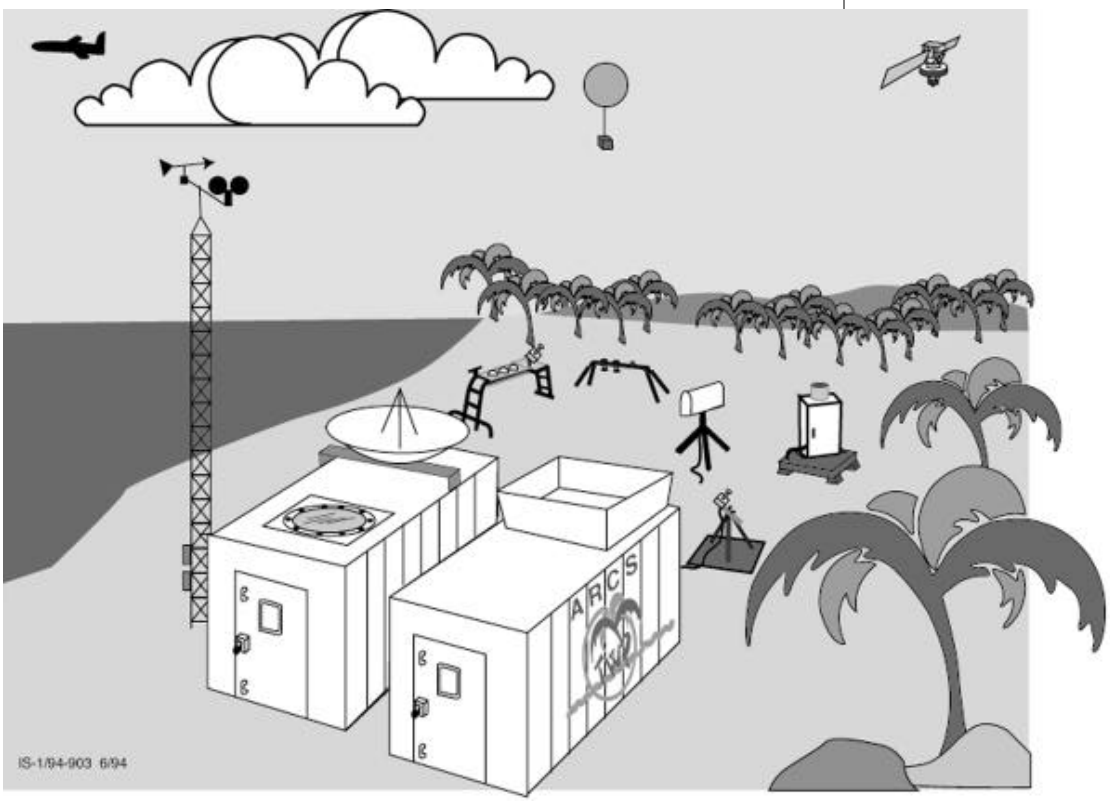
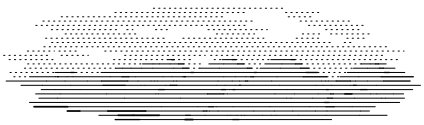


Modeling the impact of clouds on global climate is difficult because of their complex and differing effects on weather and climate. Clouds can reflect incoming sunlight and thereby contribute to cooling, but they also can absorb infrared radiation leaving Earth's surface and contribute to warming.

For example, high cirrus clouds may serve to warm the atmosphere while low-lying stratus clouds frequently found over oceans can contribute to cooling. To model and predict climate accurately, scientists must be able to describe the effect of clouds on the current climate and predict the complex change of events that might modify the distribution and properties of clouds in an altered climate.

The International Panel on Climate Change recently presented scientific evidence of global climate change. Since the industrial revolution 200 years ago, scientists have measured increasing levels of the so-called "greenhouse gases," principally methane and carbon dioxide, in the air. These gases may be warming the atmosphere by absorbing heat from Earth's surface that would otherwise escape into space.

↑ An artist's conception of ARCS. The stations will contain instruments, computer systems for data collection and storage, a satellite communications system, and support equipment.



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Los Alamos researchers Bill Clements (far left) and Fairley Barnes (second from right) confer with Chalapan Kaluwin (second from left), climate change officer of the South Pacific Regional Environmental Programme, and Peter Lunn, DOE ARM program manager. Behind them is the skystand under construction at the Manus Island monitoring site. The skystand holds upward-looking radiometers that measure downwelling solar and infrared radiation.

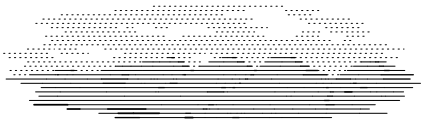
But greenhouse gases due to human activity are only part of any climate model. Water vapor is the most important greenhouse gas of all. Scientists suspect that if greenhouse gases warm the atmosphere and a warmer atmosphere holds more water vapor, then the extra water vapor will serve to amplify the warming effect from incremental increases of other greenhouse gases.

In addition to water vapor, water is present in clouds as both a solid and a liquid and the effects of clouds are a major factor in determining the potential for global climate change.

Data gathered by ARCS ultimately will help ARM team scientists predict how much Earth's climate might change, how fast the change could occur, and what the regional effects of that change might be. Over the next 10 years, ARCS data can be used by government leaders in making energy and economic policy decisions because they may show climate trends.

Scientists chose the ARCS sites based on their complex and globally significant weather patterns. The Tropical Western Pacific region includes the Pacific "warm pool," an area of water that consistently has the warmest sea surface temperatures on the planet.

The warm pool sends warm, moist air into the atmosphere, resulting in the formation of deep convective clouds. These may, in turn, produce high cirrus clouds that can spread out to cover large areas of the region.



These cloud systems regulate the amount of solar energy reaching Earth's surface and the amount of heat energy that escapes from Earth back into space.

Besides serving as a cloud factory for the region, the warm pool plays an important role in annual fluctuations in global climate. For example, El Niño, a weather phenomenon that every several years results in unusually warm ocean conditions along the west coast of South America, originates in the Pacific warm pool and has far-reaching implications over perhaps the entire planet.

Operation of the ARCS site on Manus Island is a cooperative effort between the United States and the Papua New Guinea National Weather Service. ARM's Tropical Western Pacific Program is managed at Los Alamos. The instruments are intended to withstand the marine tropical environment and require little day-to-day maintenance. Electrical power for the ARCS will be supplied by a local electric company and backed up by a 50-kilowatt generator located at the site.

In addition to the meteorological instrumentation, ARCS also includes computer systems for data collection and storage, two satellite communication systems, and support equipment. Information gathered from the ARCS will feed into a data-processing center at Pacific Northwest National Laboratories in Richland, Wash.

The ARM program includes an educational program to enrich the curricula at schools near ARCS sites. Scientists working in the Tropical Western Pacific region are collaborating with the South Pacific Regional Environmental Programme to develop a regional curriculum focused on climate, climate change, and its effects.

To communicate the scope and goals of the ARM program, the scientists will visit local schools to talk with students and teachers and lead field trips to ARCS sites. Los Alamos scientists will be offering in-service training for schoolteachers close to the ARCS sites, and they plan to sponsor participants to an annual regional education conference.

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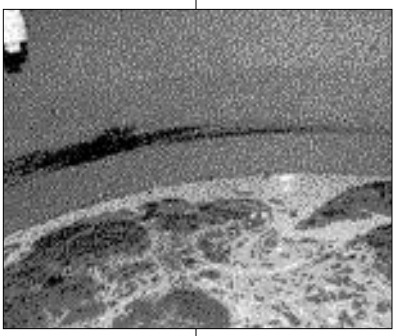
UV LIGHT ZAPS BACTERIA IN NEW WASTE TREATMENT PROCESS

BREAKTHROUGH PROCESS WILL REDUCE HEALTH RISKS FOR U.S. WORKERS EXPOSED TO CONTAMINATED FLUIDS

Pesky bacteria in machining fluids, waste water, and many other liquids could be zapped out of existence through a new process that uses ultraviolet light to treat opaque industrial fluids.



A new process uses intense ultraviolet light to kill bacteria in industrial fluids. This photo shows bacteria-contaminated opaque metalworking fluid.

The process has the potential to reduce health risks for millions of U.S. workers exposed to contaminated fluids in the auto, aerospace, and other metalworking industries. The technology may also be used to decontaminate drinking water, waste water, cooling towers, aqua-culture systems, and ballast water from commercial ships.

Triton Thalassic Technologies Inc., or T^{3}I, has invented an ultraviolet fluid treatment process that penetrates opaque fluids delivering germicidal-level ultraviolet dosage to large fluid volumes at high flow rates. Los Alamos and T^{3}I jointly developed the ultraviolet lamp technology that provides selected monochromatic ultraviolet light at a higher energy density and efficiency that greatly exceeds the performance of commercially available ultraviolet sources.

This breakthrough lamp technology, combined with T^{3}I's proprietary treatment process, controls and greatly reduces bacteria contamination in opaque industrial fluids, coolants, and turbid water without the use of chemical biocides — the present treatment method. The metalworking industry, aqua-culture farms, commercial shipping, and power plants are all prime target markets for this technology.

Machinists and metalworkers use a wide variety of industrial fluids for lubricating and cooling parts and tools and removing chips in grinding, milling, and other operations. Machining operations turn the fluids into aerosols to which workers are exposed. These aerosols are a complex mix of the fluids, bacteria, endotoxins that are byproducts of the bacteria, and the chemical biocides used to treat the fluids.

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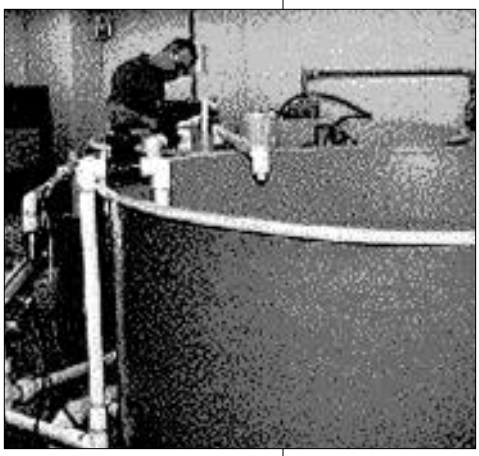
As reported in the December 1996 issue of American Machinist, metalworkers and machinists face elevated risks of gastrointestinal cancer, industrial asthma, other acute lung diseases, and dermatitis. The U.S. Occupational Safety and Health Administration this year is considering stringent new regulations governing exposure limits for workers in metalworking and machining fluids environments.

The T³I system has the potential to eliminate the chemical biocides used to control bacteria in metalworking and machining fluids; reduce and maintain the bacteria level up to one-millionth of the highest levels typically seen with biocide treatment; and, by reducing bacteria counts, reduce dramatically the threat from endotoxins, which can cause fever and shock when ingested.



↑ T³I senior research scientist Gary Morgan makes adjustments to the 500-gallon demonstration system at Triton Thalassic's Ship Point Laboratory in Maryland. Photos courtesy of Triton Thalassic Technologies Inc.

In addition to its cleanup role, the system may extend the life of metalworking fluids while reducing waste volumes requiring treatment and disposal.

T³I is also testing the ultraviolet fluid treatment system on ballast water from commercial cargo ships and tankers, hoping to stop the introduction of zebra mussels, toxic algae, and pathogenic microorganisms such as cholera into U.S. ports.

Contaminated ballast water is blamed for introducing the nonindigenous zebra mussel into the Great Lakes where it has flourished, clogging industrial and electric utility water systems and forcing industry and cities to spend hundreds of millions of dollars a year on maintenance and prevention. Recent research reports that one new nonindigenous species is introduced into San Francisco Bay every 12 weeks.

Sen. John Glenn, D-Ohio, last March introduced a bill to address the ballast problem, saying that vessels from foreign ports discharge into U.S. waters 21 billion gallons of ballast water a year, or 2.4 million gallons an hour.

Triton Thalassic Technologies Inc. is dedicated to the development of environmentally friendly advanced technology solutions for fluid, water, and airborne contamination problems. The value of the cost-shared agreement between Los Alamos and T³I is $131,000.

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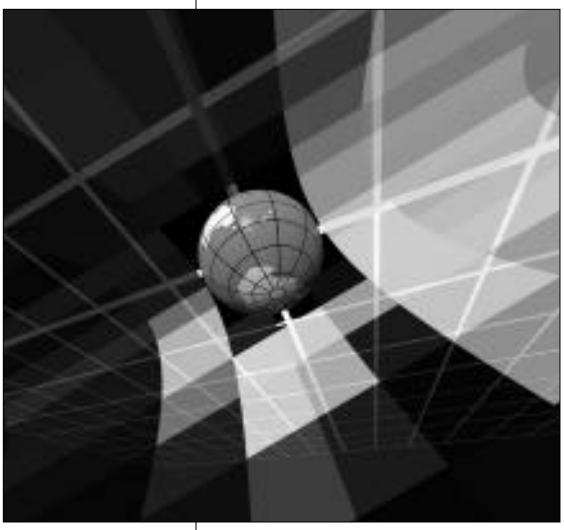
LOS ALAMOS TECHNOLOGY PROVIDES GLOBAL IMAGES OF EARTH'S MAGNETOSPHERE

MOVIES AND IMAGES HELP PREDICT MAGNETIC STORMS THAT KNOCK OUT SATELLITE COMMUNICATION

Scientists from Los Alamos and Boston University have generated the first-ever images of changes in the "radiation belts" that surround Earth.



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A single frame of the POLAR Satellite movies showing a buildup of electrically charged particles in Earth's radiation belts.

Radiation belts are regions in space where Earth's magnetic field traps energetic particles. Images of the belts were developed using data from the Imaging Proton Spectrometer, an instrument aboard NASA's POLAR Satellite.

When the images of radiation belts as viewed from above the poles are combined with measurements from satellites passing through the belts, it gives scientists an important new tool for studying and predicting changes in the "weather" in the magnetosphere, the space defined by Earth's magnetic field.

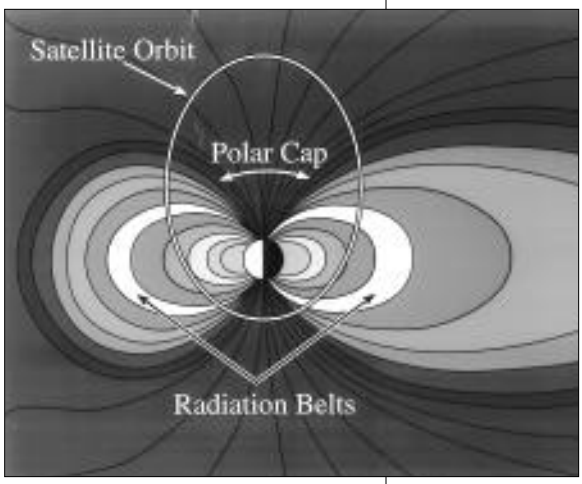
Magnetic storms in the magnetosphere can diminish a satellite's communication performance or even completely knock out a satellite.

The POLAR movies show a buildup of particles in the radiation belts when Earth is hit by a disturbance in the solar wind — a stream of magnetic fields and electrified subatomic particles pouring in from the sun — and the subsequent migration of those particles to other regions in the belts.

The radiation belts are created because electrically charged particles are constrained by magnetic fields in the magnetosphere. The particles travel a dizzying spiral along a field line, cycling from the north pole to the south pole, over and over again. The particles cannot be set free of their magnetic trap unless their electric charge is removed.

Atoms continually float spaceward from Earth's atmosphere. These uncharged atoms drift across magnetic field lines. However, when they

encounter an ionized atom in the radiation belts, they can lose an electron to the ionized atom. Now electrically neutral, the atom from the radiation belt shoots off into space at high speed, leaving the now charged atmospheric atom trapped in its place.



An illustration showing the POLAR Satellite's orbit in relation to Earth's radiation belts.

The energetic neutral atoms spray out from the radiation belts in all directions. When POLAR is above the poles, the background of charged particles is sufficiently small that the signature of the neutral atoms can be detected. By using the Imaging Proton Spectrometer to map the direction from which the energetically neutral atoms came, researchers can calculate the structure of the radiation belts.

Most previous measurements of the magnetosphere have been from satellites that take samples only at their location. Neutral atom imaging provides a way to take global measurements of the magnetosphere. The leap in technology is akin to putting your finger in the air to detect wind direction versus using a satellite image to see if a storm system is moving toward you.

The Comprehensive Energetic Particle and Pitch Angle Distribution experiment originated at Los Alamos. The principal investigator for the experiment is Bernard Blake of The Aerospace Corp. in Los Angeles. Geoff Reeves and Mike Henderson of Los Alamos and Harlan Spence of Boston University are co-investigators.

POLAR was launched into Earth's orbit in late February of 1996 and spends much of its orbit over the northern geographic pole. The mission is part of the International Solar-Terrestrial Physics program, a collaboration of NASA, the European Space Agency, the Russian Space Institute, and the Japanese Institute of Space and Aeronautical Science. Using ground observatories, satellites, spacecraft, and computer simulations and models, ISTP is building a comprehensive picture of Earth's magnetosphere and how it is influenced by changes on the sun.

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SUPERCONDUCTIVITY BOOSTS EFFECTIVENESS OF MAGNETIC SEPARATORS

LOS ALAMOS RESEARCHERS BUILD DEMONSTRATION SEPARATOR

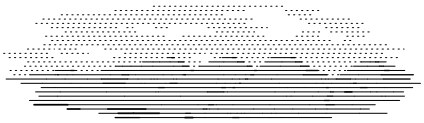
Los Alamos researchers are applying their expertise in high-temperature superconductivity to magnetic separators — an adaptation that could result in more cost-effective paper making, high-volume water purification systems, and powerful, portable units that could clean up contaminated soils on site.

Through a cooperative research and development agreement between the Superconductivity Technology Center at Los Alamos and Eriez Magnetics of Erie, Pa., Los Alamos researchers are integrating a powerful superconducting magnet and current leads, both manufactured by American Superconductor Corp. of Westborough, Mass., with Los Alamos cryogenics technology to cool the magnetic separation system.

By using high-temperature superconducting systems in devices that pull contaminants or other particles out of solids and liquids, companies can potentially make their separation processes more cost-effective. Since large superconducting magnets can operate at greater magnetic fields than conventional magnets, it is possible to move a much larger volume of material through the separator at a faster rate and still achieve the same degree of separation. This research also paves the way toward more rugged, portable magnetic separation systems because cooling systems for high-temperature superconductors are simple enough that a magnetic separator can be transported to sites where environmental clean up is needed.

High-temperature superconductors are ceramic-based materials that can carry electric current with little or no resistance when cooled to very low temperatures — several hundred degrees below zero Fahrenheit. At these temperatures, room-temperature gases such as neon or nitrogen turn into liquids. Electrical devices made of superconducting materials show much greater performance and efficiency than their conventional counterparts.

The magnet used in this research — one of the most powerful high-temperature superconducting magnets ever — is made of the ceramic bismuth-strontium-calcium-copper-oxide, known as BSCCO.



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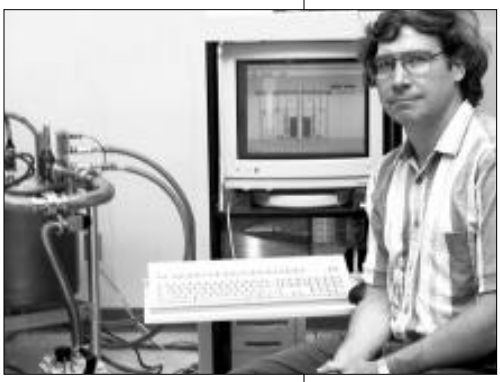
So far, the researchers have been able to get a magnetic field of 2 tesla out of the magnet at around minus 400 degrees Fahrenheit. Tesla is a measure of magnetic field strength. Earth's magnetic field is less than one ten-thousandth of a tesla. Two tesla is a significant field strength because it exceeds that of the conventional magnets currently found in magnetic separators.

For magnetic separation applications, a high-magnetic field means that more material can be passed through the separator faster, while still achieving maximum separation of materials.



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Los Alamos researcher Mark Daugherty and a demonstration model of the superconducting magnetic separator. The principles behind magnetic separation can be used to remove strongly and weakly magnetic materials from gases and liquids.

High-temperature superconducting magnetic separators could prove beneficial in a number of applications. Right now, magnetic separators are used to remove impurities from kaolin clay — a substance used to coat high-quality paper. But the principles behind magnetic separation can be used to remove strongly and weakly magnetic materials from gases and liquids.

Therefore, smaller, more powerful and portable separators show great promise for cleaning up contaminated soils and liquids throughout the Department of Energy defense complex.

A number of DOE sites are contaminated with actinides such as uranium or plutonium. Actinides are slightly magnetic, so powerful separators would prove useful in extracting these contaminants out of soil or water.

Researchers from Los Alamos have demonstrated a bench-top, high-temperature superconducting magnetic separation system.

The demonstration separator is about the size of an old-fashioned ice-cream maker. The superconducting magnet inside the system is a cylinder-shaped apparatus about 6 inches in diameter and about 6 inches tall. A high-temperature superconducting magnet for a full-size clay separator would be 8 to 12 feet in diameter and about 20 inches thick.

Another potentially large application for these separators is water purification. Since viruses and bacteria can be made to cling to iron compounds, it is possible to add ferrous materials to water, run the water through a separator and get rid of the metal and biological contaminants.

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BRIEFLY ...

LOS ALAMOS HELPS NORTHERN NEW MEXICO ECONOMY. Los Alamos accounted for nearly 5 percent of the total economic activity in New Mexico in fiscal year 1995 and for almost one-third of the economic activity in Los Alamos, Rio Arriba, and Santa Fe counties, according to a report prepared by analysts at New Mexico State University, the University of New Mexico, and the Department of Energy's Albuquerque Operations Office. The Laboratory's fiscal year 1995 funding level of about $1.2 million supported a total economic impact of $4.1 billion in New Mexico, or 4.8 percent of the state's total estimated economic activity. In the local three-county area, the Laboratory's economic impact was $3.4 billion, which was 30.1 percent of the region's estimated economic activity of $11.35 billion.

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