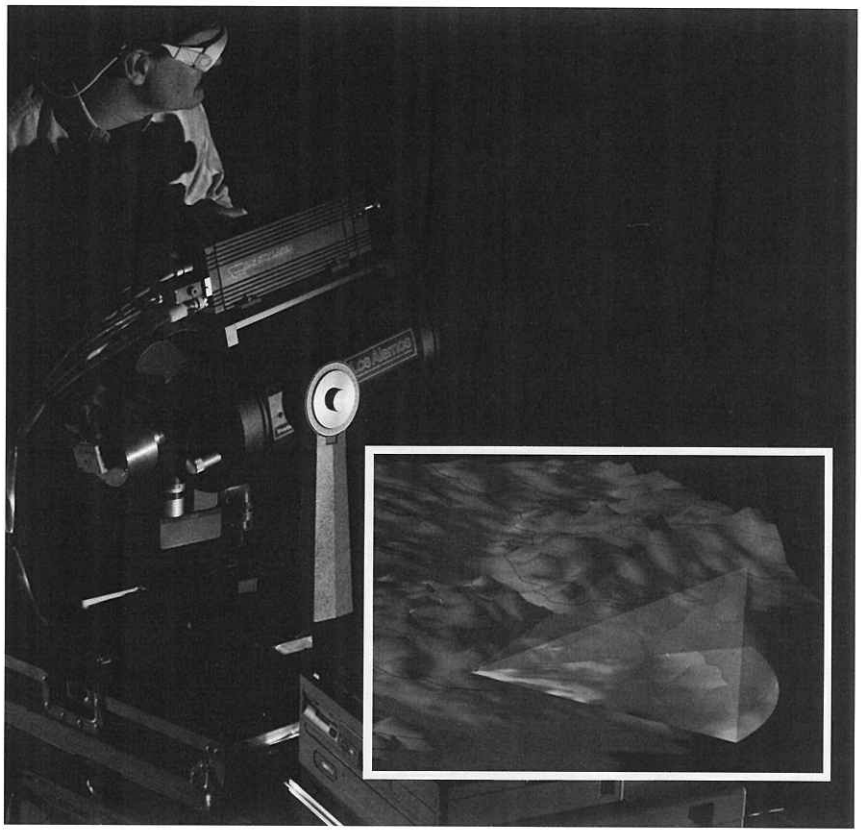
LOS ALAMOS NATIONAL LABORATORY 1993 R&D 100 AWARD WINNER
LOS ALAMOS NATIONAL LABORATORY 1993 R&D 100 AWARD WINNER
LOS ALAMOS NATIONAL LABORATORY 1993 R&D 100 AWARD WINNER



CN93-193

Our miniature elastic backscatter lidar system analyzes information on particulates in the atmosphere. This portable system has been used to help cities characterize their pollution-trapping problems. (inset) John M. Mcdonald of IBM overlaid aerosol lidar data onto a topographical map of Barcelona, Spain, to show how geographic features affect the movement of pollutants.

Miniature Elastic Backscatter Lidar

William E. Eichinger and Larry L. Tellier, Jr., Physics Division; David B. Holtkamp, Lidar Project Office, Los Alamos National Laboratory; Dale A. Richter, NASA Langley Research Center

Urban air pollution is becoming an increasing problem for the world's major metropolitan cities. To combat this problem, civil authorities worldwide are developing control strategies for managing urban air quality. Before these strategies can be developed, scientists must first collect measurements on the movement and concentrations of airborne pollutants. This information can then be used by authorities to determine effective actions to alleviate their pollution problems. At Los Alamos National Laboratory, we developed the miniature elastic backscatter lidar to help scientists detect, measure, and analyze airborne pollutants over the world's cities.

All lidar—short for light detection and ranging—systems operate in a manner similar to radar; however, lidar uses laser light rather than radio waves to scan a distant object. Lidar operates by sending a pulsed laser beam into the atmosphere. Gases, aerosols, and particles in the atmosphere reflect the laser light, and this return signal is collected by a telescope and focused onto a detector. By scanning the atmosphere with the lidar system, scientists can make a map of the concentrations of airborne pollutants.

Lidar technology has been around for years, but the miniature lidar is portable and improves the usefulness of lidar data. The return light that is collected by the telescope and detector is digitized and stored by a data acquisition computer. The data that the miniature lidar collects can help scientists develop a picture of atmospheric motion and turbulence, wind and weather behavior, and chemical reactions involving pollutants.

The miniature lidar provides an understanding of the sequence of events leading to severe pollution. By scanning quickly to avoid structural shifts in the aerosol positions and by making repeated scans, scientists can produce a moving record of aerosol transport.

Our miniature elastic backscattering lidar won a 1993 R&D 100 Award. These awards are presented annually by *R&D Magazine* to the one hundred most significant technical innovations of the year.

The Invention—Characteristics and Advantages

The miniature elastic backscatter lidar is the only portable, compact system capable of doing rapid-volume aerosol density scans of 30 degrees azimuth by 30 degrees elevation, using one-half degree steps, in approximately 70 seconds. This system has a range of 10 kilometers and will run off of a 3-kilowatt generator. Although the system is small, it contains a number of complex systems—laser, positioning system, receiver hardware, data acquisition computer, and computer control and analysis software.

Although other lidar systems exist that can be deployed in the field, their range is limited, they do not scan quickly, or they are configured for a limited application such as tracking sulfur dioxide from factory stacks. Our lidar can scan ten to twenty times faster than most systems, allowing us to track rapid movement of aerosols more efficiently. On a smaller scale, the system can locate and quantify separate pollution sources and can follow plume direction as well as dispersal characteristics. Systems that have ranges comparable to ours are typically much larger and are far from fully portable. Our system fits in three cases that meet airline cargo requirements and can be set up and operated by two people.

In addition, no other commercial lidars have data-processing software equivalent to our system's software. The miniature lidar is a totally integrated program package that not only controls all functions

LOS ALAMOS NATIONAL LABORATORY 1993 R&D 100 AWARD WINNER
LOS ALAMOS NATIONAL LABORATORY 1993 R&D 100 AWARD WINNER
LOS ALAMOS NATIONAL LABORATORY 1993 R&D 100 AWARD WINNER

of the data acquisition process but also provides several data analysis routines. Although it is difficult to represent three-dimensional data in a two-dimensional picture, our aerosol data has been overlaid onto topographical maps to show how geographical features such as mountains and human-created characteristics such as traffic jams affect aerosol movement.

Applications

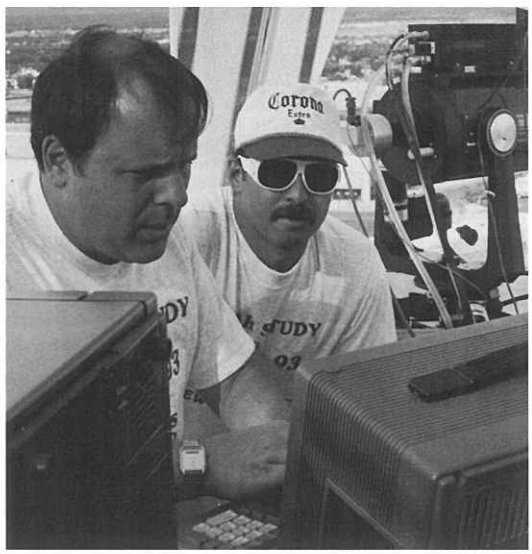
Although the primary application of the miniature lidar is atmospheric modeling, the system shows promise for other applications. The miniature lidar also could be used to detect forest fires; track hazardous smoke from chemical fires; monitor illegal drug manufacturing operations; and aid nuclear nonproliferation by looking for telltale emissions of weapons production.

The miniature lidar is the first system capable of taking data anywhere in the world on a moment's notice. It has traveled to Mexico City to assist in a three-year pollution study; to Barcelona, Spain, to quantify the effects on air quality of ground-transportation restrictions imposed during the Olympics; and to Albuquerque and Las Cruces, New Mexico, to identify sources of the city's pollution. Just as the information has been used to help the people in these cities, the data collected by the miniature lidar can be used to help other cities with similar air-quality problems.

William Eichinger's research interest is in atmospheric physics. In 1991 he became a regular staff member in the Subatomic Research and Applications Group at the Laboratory. Before coming to the Laboratory, he had been with the Army Corps of Engineers since 1976. In 1985 he earned an M.S. in nuclear engineering from the Air Force Institute of Technology. He began developing the miniature lidar in 1991.

David Holtkamp's research interest is in using lidar for applications in basic and applied research in the environmental and defense arenas. After earning a Ph.D. in physics from the University of Texas, he joined the Laboratory in 1980 as a postdoctoral staff member at the Meson Physics Facility. In 1982 he became a regular staff member and joined the Subatomic Research and Applications Group in 1986. After spending a year with the Strategic Defense Initiative Organization, he became the Lidar Project Office Leader in 1993.

Dale Richter's research interest is in lidar applications and technology development. In 1984 he became a technician at the Laboratory. In 1988 he left for the University of Arizona to pursue both a B.S. and an M.S. in electrical engineering. He joined the Laboratory's Subatomic Research and Applications Group in 1991 as a Graduate Research Assistant to work on his master's thesis. For the next two years, he worked on the miniature lidar. In 1993 he became a contractor to the NASA Langley Research Center specializing in lidar application work.



RN93-166-057

William Eichinger (left) and Larry Tellier, Jr., two developers of the miniature elastic backscatter lidar, perform measurements with the system. David Holtkamp and Dale Richter are the other developers.

Larry Tellier, Jr.'s research interest is in developing technologies for atmospheric research. In 1982 he became a materials technician at the Laboratory. In 1984 he joined the US Navy and served four years working on weapons systems. He returned to the Laboratory in 1988 as an electromechanical technician with the Subatomic Research and Applications Group. He began working on the miniature lidar in 1991.

For more information about Miniature Elastic Backscatter Lidar, please contact Kay Adams, Industrial Partnership Center, Los Alamos National Laboratory, P.O. Box 1663, Mail Stop M899, Los Alamos, NM 87545.
Telephone (505) 665-9090, Fax (505) 665-0154.

A US DEPARTMENT OF ENERGY LABORATORY
Los Alamos National Laboratory, an affirmative action/equal opportunity employer, is operated by the University of California for the US Department of Energy under contract W-7405-ENG-36.

LALP-93-76 August 1993