Eye *in the* Sky

by JANE M. SANDERS

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Ground-level ozone pollution in Atlanta has prompted a technology development to improve ozone forecasting.

Next generation ozone-monitoring technology expected to improve smog forecasting.

On a calm summer night, the air above Atlanta can be saturated with ozone and particulate matter while the pollutants at ground level plummet to near zero. It may appear, even to experts, that tomorrow's air quality will not merit a smog alert.

But the sun rises, and the heat begins to cook chemicals suspended in the air, forming more ozone. Soon, the winds mix pollutants into the air at ground level. By noon, haze mutes the Atlanta skyline, contaminating the air metro residents breathe.

By then, it's too late to issue a smog alert that might divert some motorists from the city's clogged highways and encourage mothers to limit the time their children play outdoors.

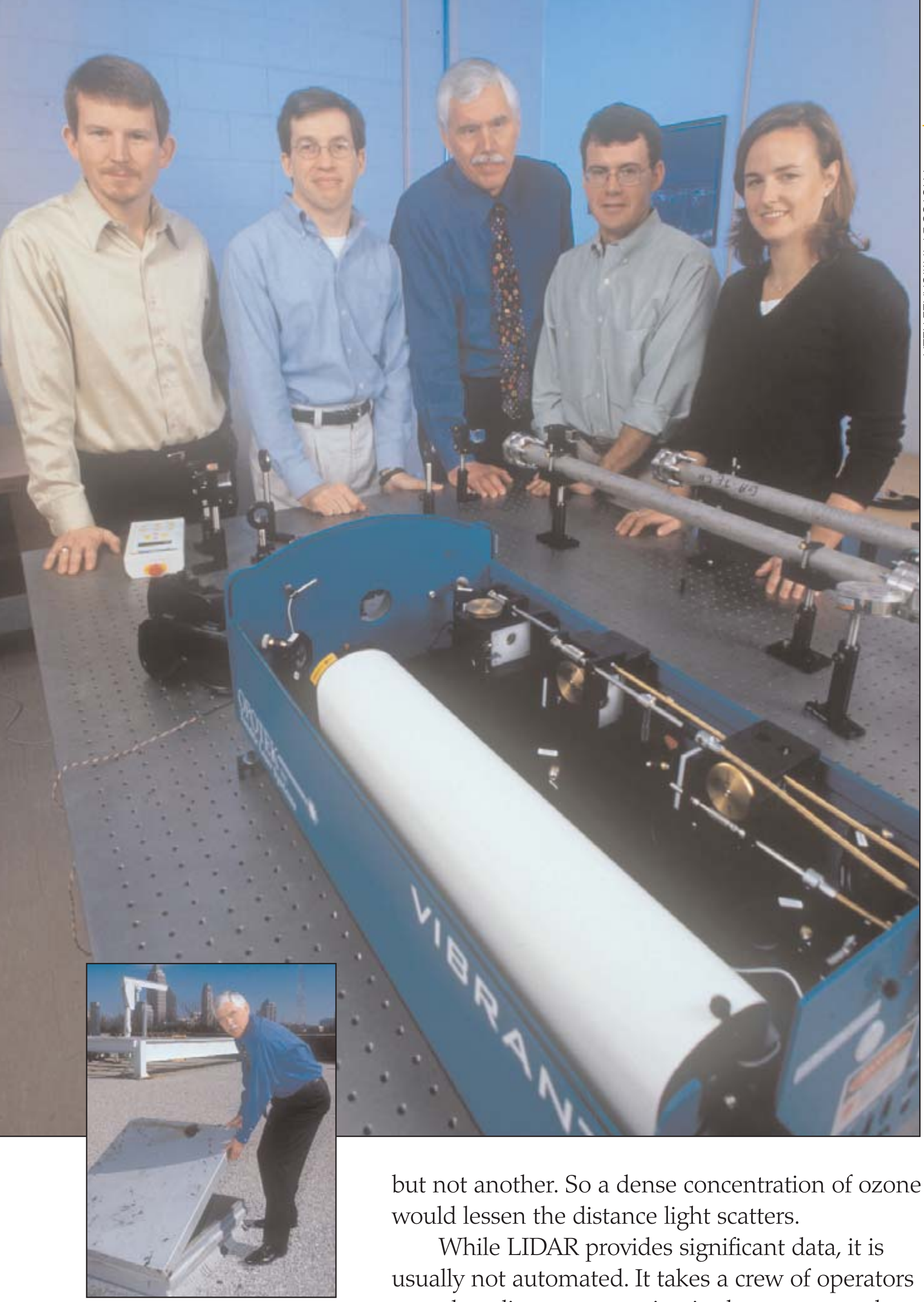
Had the experts known the concentration of ozone in the air above the city, they would have had a vital piece of information in making the next day's ozone forecast. And, over time, researchers could use this information to help determine the "sources and sinks" (i.e., where it is created and where it goes) of air pollutants. In turn, metro area planners could devise effective strategies to address air quality issues.

With these ultimate goals in mind, a team of engineers at the Georgia Tech Research Institute (GTRI) is designing the next generation of ozone-monitoring technology. Based on light detection and ranging (LIDAR) technology developed by the National Oceanic and Atmospheric Administration, the updated version will make ozone monitoring continuous and affordable, and results will be available via the Internet in real time. Funded by a Technology Development Partnership through the Georgia Research Alliance and LaserCraft Inc. of Norcross, Ga., the device has been dubbed NEXLASER for NEXt Generation Laser Air Sensor for the Southeastern Region (though the technology could be applied anywhere in the world, researchers explain).

"NEXLASER will be great for ozone forecasting, and it should enable people to do new kinds of research projects in city planning, environmental engineering and atmospheric chemistry," says GTRI project director Gary Gimmestad. "…. Right now, it's hard to correlate anything like traffic patterns with ozone. It's just not accurate yet because there's not enough information."

NEXLASER will adapt and automate the operation of LIDAR, which in the past has been suitable only for short-term pollution studies because it requires numerous personnel to operate it. LIDAR works like this: 1) A laser emits pulses of light that scatter into the atmosphere. 2) Then a telescope receives that scattered light. 3) A detector converts the light to electronic signals. 4) A data system digitizes and stores those signals. 5) Finally, researchers determine the distance the light scattered by multiplying the speed of light by the flight time it took the pulse to travel up and back.

This information reveals the ozone concentration at periodic measured distances because ozone absorbs one color of light emitted from the laser,



Above: Researcher Gary Gimmestad and his colleagues will field test the first NEXLASER ozone monitor through a hatch atop a Georgia Tech building later this summer.

PHOTOS BY T. MICHAEL KEZA

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but not another. So a dense concentration of ozone would lessen the distance light scatters.

While LIDAR provides significant data, it is usually not automated. It takes a crew of operators to make adjustments, maintain the system, and collect and analyze data. NEXLASER will automate this process, making data collection continuous and data analysis occur in real time.

"NEXLASER's three-dimensional data — altitude up to 3 kilometers, ozone concentration and geographic distribution from a network of units — will represent a significant technological improvement," Gimmestad says. "We hope that knowing the ozone concentration in all of these places can improve researchers' understanding of ozone sources and sinks."

Senior research scientist Michael Chang in the Georgia Tech School of Earth and Atmospheric Sciences is hopeful about the potential of NEXLASER. "If they can pull this off and get a unit that is affordable, it would be great," Chang says. "We can do this type of monitoring now, but it requires a $2 million investment. If they can get the cost down to about a quarter of a million, it's still costly, but we can handle that.

"Vertical profiles of air quality are the great unknown. All of the air quality monitoring we do now is essentially at the surface. But what's above the surface is extremely critical in terms of the air quality at the surface, particularly in the late afternoon. NEXLASER could be the single greatest improvement to our ozone forecasting at this time…. We're looking forward to it with great anticipation," Chang adds.

Researchers have completed a laboratory version of NEXLASER and a prototype of software to automate data analysis. They recently began operating, testing and evaluating the system in their lab. The next phase, which may begin this summer, will be field-testing. After that, researchers would work with LaserCraft engineers in developing a commercial version of NEXLASER, which would cost about $250,000 per unit. Gimmestad hopes a network of five to six NEXLASER units will be deployed within two years at Georgia Environmental Protection Division field sites around metro Atlanta.

"Atlanta is the perfect test case for a NEXLASER network," Gimmestad says. "It has the third-worst air quality in the nation after Los Angeles and Houston…. We hope the NEXLASER technology would be adopted by other cities within five years."

Meanwhile, much work must be done in the lab, the field and the commercial arena. Because LaserCraft is funding part of the NEXLASER research, it has the rights to license the technology. Georgia Tech would grant an actual license to LaserCraft after Gimmestad's team completes field-testing.

"LaserCraft is very pleased to sponsor this project for a number of reasons," says Glen P. Robinson Jr., CEO of LaserCraft and a Georgia Tech alumnus. "It fits into our long-range plans to develop new products around laser technology. The NEXLASER will help solve a serious air pollution problem, and it will provide many new, high-tech employment opportunities for Georgia citizens." LaserCraft engineers have experience in developing laser-based sensing and monitoring systems for military and commercial applications. The company's major products are laser speed guns used for traffic speed control, monitoring violations at traffic lights and stop signs, and identifying speeders in school zones and residential areas, and a line of laser-based surveying instruments.

The Georgia Research Alliance is also hopeful about the prospects for NEXLASER. "The NEXLASER system is an exemplary project for the Georgia Research Alliance Technology Development Partnership program," says Kathleen K. Robichaud, program manager for GRA. "It brings together Georgia Tech's research and development strengths with LaserCraft's success in marketing and selling laser-based technology. And it has real potential for helping to address very serious air quality problems."

In addition to Gimmestad, the GTRI researchers involved with the study are project lead engineer Dave Roberts, and engineers John Stewart, Leanne Little West and Jack Wood. RH

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Above: NEXLASER is expected to improve ozone forecasting and enable researchers to do new kinds of projects in city planning, environmental engineering and atmospheric chemistry.

Below: Leanne West and Jack Wood are part of the research team.

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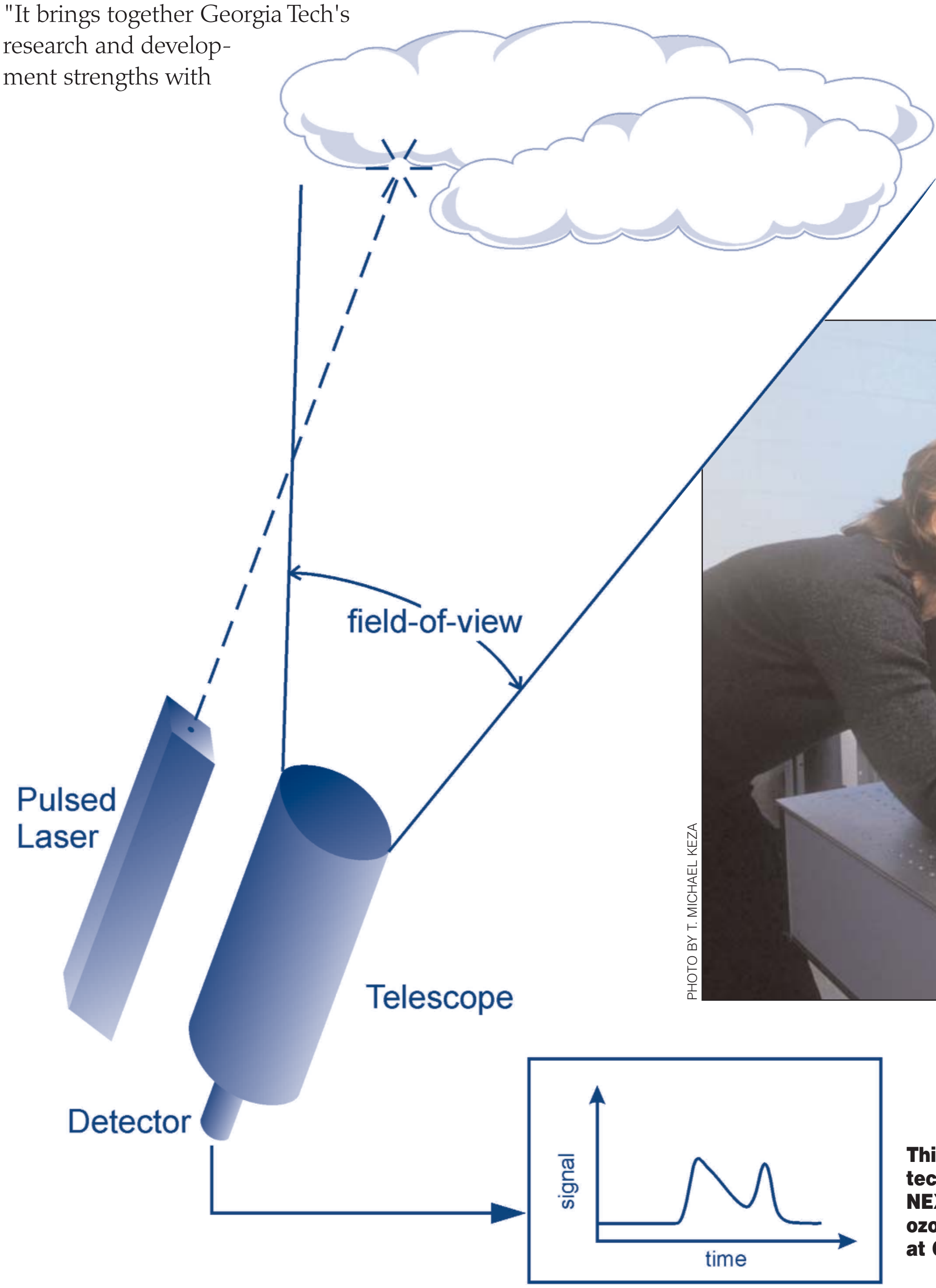

ILLUSTRATION COURTESY OF GARY GIMMESTAD

This graphic depicts the LIDAR technology that forms the basis for NEXLASER, the next-generation ozone monitor under development at GTRI.