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LASERS, INNOVATION, SENSORS

San Diego Startup's Breakthrough Is Making Lasers "the Color of Heat"

Bruce V. Bigelow 5/12/09

One understandable reaction to [Daylight Solutions](#), a 23-employee startup that has developed a breakthrough in semiconductor-based, mid-infrared laser technology, might be to ask, "Where did this company come from?"

The suburban San Diego company says its high-power lasers, about the size of a small box of matches, can be used in medical diagnostics, in environmental and industrial monitoring, and even to thwart anti-aircraft missiles targeting a commercial jetliner or military aircraft. Its technology was impressive enough to garner a [Prism Award for innovation](#) earlier this year from SPIE, the international society for optics and photonics.

One clue to the company's genealogy is hanging on the wall behind the receptionist's counter at Daylight Solutions' modest headquarters in Poway, CA. It is a lithograph of the San Diego State University campus, where founding CEO Timothy Day received his B.S. and M.S. degrees in physics—and where his father, Tom Day, was university president from 1978 to 1996. Tim Day completed his academic studies at Stanford University, where he got a Ph.D in Electrical Engineering, before joining a San Jose, CA-based startup called New Focus in 1990.

New Focus represents the other half of Daylight Solutions' origins. In addition to Day, New Focus was founded by Milton Chang, a renowned Silicon Valley entrepreneur, Robert Marsland, and Frank Luecke to provide "simply better" photonic tools. [New Focus](#) introduced its first tunable laser in 1992, and became a leading supplier of lasers used in fiber optics test-and-measurement work for the telecom industry and in non-telecom research. After New Focus raised about \$555 million through two stock offerings in 2000, Chang, the founding CEO, left to start [Incubic](#), the Menlo Park, CA, venture capital firm.



Tim Day

Day told me he decided to return to San Diego after San Jose, CA-based Bookham, now known as Oclaro, acquired New Focus in 2004 for \$338 million. He joined forces with Paul Larson, who had directed ASIC programs for Qualcomm, to develop a new type of laser, based on semiconductor-based lasers that had been developed for fiber optic networks in the telecom industry. "We pulled together our own investors among friends and family and started operations in January 2005," Day said.

The opportunity they saw was in developing a laser that operates at mid-infrared wavelengths, from 3 um to 12 um—a part of the spectrum previously untapped by laser technology. In lay terms, Day says Daylight Solutions' lasers operate at wavelengths beyond visible light that are "the color of heat. It's the color that snakes can see." It became clear to them within months that the technology was technically feasible. And by mid-2006, using a semiconductor composed of hundreds of layers of Indium gallium arsenide—with each layer only about 10 atoms thick—they created ECqCL, the company's patented "External Cavity quantum cascade Laser."

Daylight Solutions can manufacture the laser to emit [...NEXT PAGE >](#)

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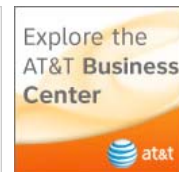
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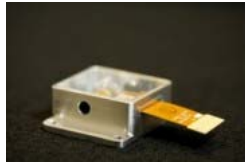
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mid-IR energy at a specific wavelength or make lasers tunable for a range of mid-IR wavelengths. "It's an exciting platform," Larson said. "It can be modular or tailored to different applications very quickly."



Mid-IR Laser

So how are these lasers used? The applications for mid-IR lasers are particularly compelling for detection, environmental monitoring, and medical diagnostics because nearly all molecules absorb energy at specific wavelengths of the mid-IR spectrum, Day said. The most exciting application, however, may be in defense—where Daylight

Solutions' lasers offer promise in thwarting heat-seeking anti-aircraft missiles.

As Day explained it, such missiles track the distinctive heat signature of the aircraft engines, regardless of whether the aircraft is a fighter jet, a lumbering helicopter, or a jetliner loaded with civilian passengers. By mounting a mid-IR laser aboard the targeted aircraft, Day said, "We send back a beam that confuses the missile, if you will, so it goes off course."

Beyond its use in infrared countermeasures, though, most applications call for using the company's laser technology to detect specific molecules. "It's a classic, multi-use technology that has applications in defense and national security as well as medical and industrial applications," Day said.

Yet the uses he listed sounded like the stuff of science fiction. In medical diagnostics, for example, a mid-IR laser would be used primarily to scan a patient's breath. Day said it is sensitive enough to detect:

—Certain types of ulcers and stomach cancers from the telltale molecular signature of *H. pylori*, the bacteria strongly associated with such ailments.

—Glucose in the breath of diabetic patients, a diagnostic test that could offer an alternative to continual finger pricks for conventional blood sugar measurements.

—Carbonyl sulfide in patients' breath as a potential indicator of liver disease.

In industrial and environmental applications, Day said mid-IR lasers can be used to detect a variety of toxic molecules, including benzene, toluene, xylene and nickel carbonyl, a liquid so poisonous at room temperature that it's also known as "liquid death."



Paul Larson

The co-founders told me the company has received five patents for its technology so far, with another dozen or so pending. The company has been selling its lasers since mid-2006. Since its start, Larson said Daylight Solutions has raised a total of \$13 million in venture founding through two rounds from Jade Invest SA, a Swiss venture capital firm; Innotech, a technology company based in Singapore; Masters Capital, a Chicago private equity firm; and individual investors. "The company has been doing well," Larson said, and is expanding beyond its 23 employees.

Day said his goal is to create separate divisions of Daylight Solutions to focus on the markets it has targeted in defense, medical diagnostics, and industrial and environmental monitoring. "Our strategy is to build the strongest, best company we can," Day said. "Our philosophy is that good companies are bought, not sold."

While there are laboratory instruments capable of identifying specific molecules by detecting their specific mid-IR absorption, Daylight Solutions says such equipment is bulky and expensive, and often requires cryogenic cooling or high power to operate. In contrast, the latest version of Daylight Solutions' laser is about the size of a quarter, and can operate in nearly any environment, from hospital operating rooms to military battlefields.

Day said the company has even developed a version of its laser that could be mounted in the ceiling or dashboard of a car for use as a breathalyzer. If the laser detects a sufficient number of alcohol molecules in the air, the driver would not be able to start the car.



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