

▶ photonics.com ▶ 2010 ▶ December ▶ Research & Technology

## ▶ Invisible Border Patrol Employs Lasers, Optics

TUCSON, Ariz., Dec. 17, 2010 — A unique underground surveillance system that includes lasers, detectors and fiber optics could be used to watch the entire US-Mexico border continuously, and can determine whether a person or animal is crossing over it.

At the Helios system test site outside of Tucson, Brad Cowan of Cowan Horse Adventures takes his 1,300-pound mare at a trot across the buried fiber optic cable, which is connected to a Helios detection unit in the RV in the background. (Images: University of Arizona College of Engineering)



The border-monitoring system, known as Helios, is being tested by University of Arizona researchers. It consists of laser pulses transmitted through fiber optic cables buried in the ground that respond to movements on the surface above. A detector at one or both ends of the cable analyzes these responses. Helios is sensitive enough to detect a dog and can discriminate between people, horses and trucks. The system can be set to avoid being triggered by small animals, and it can also tell whether people are digging, running or walking, and in which direction.

Zonge, a geophysical engineering company based in Tucson, recently installed a Helios test system in the desert near Tucson. The University of Arizona's Lowell Institute for Mineral Resources is leading the project to evaluate Helios as a tool for border surveillance, assisted by the university's National Center for Border Security and Immigration.



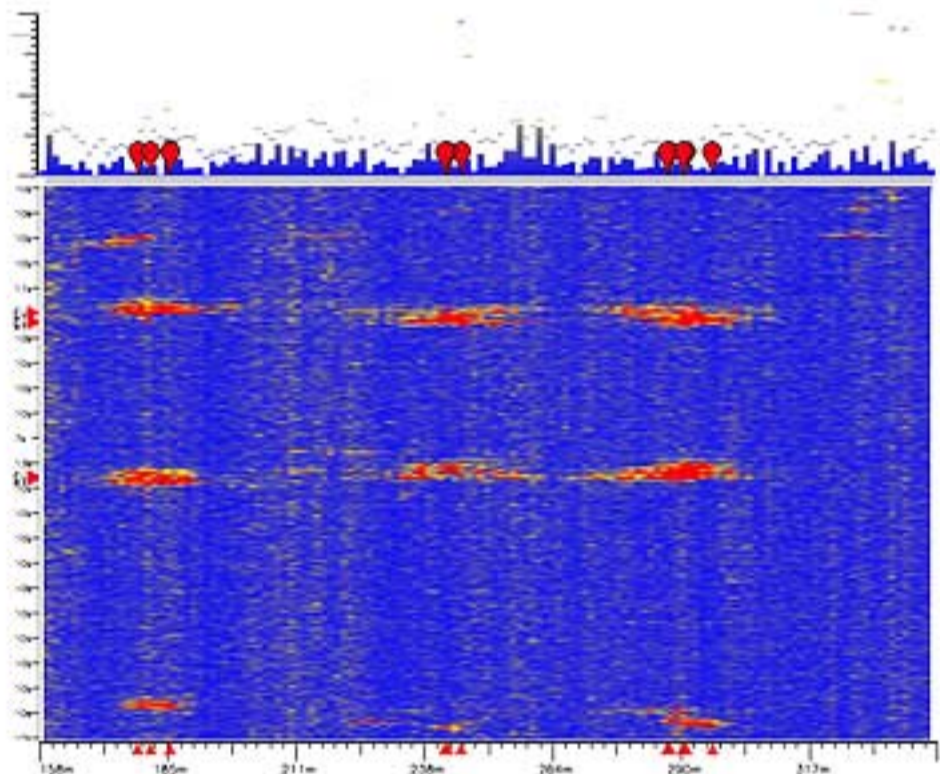
At the Helios system test site outside of Tucson, Moe Momayez, associate professor of mining and geological engineering at the university's Lowell Institute for Mineral Resources, prepares to unleash Blue, the test dog, while a Zonge engineer monitors how the dog's movement shows up on the Helios system.

unseen strain forces at work deep within structures.

The Helios system consists of fiber optic cables, lasers and detectors, and is more accurately described as a "distributed acoustic sensor." It relies on the physics phenomenon of "optical backscattering" for its operation, and it is made by British company Fotech Solutions.

"It's all a matter of scale," said Scott Urquhart, Zonge president and senior geophysicist, talking about the shift from detecting seismic events to measuring tiny subsurface vibrations caused by desert wildlife, both two- and four-legged.

This screen shot of the Helios system output was captured while two horses ran across the buried fiber optic cables. The red traces are clearly visible, unlike those made by a small dog, and are also quite distinct from the traces created by humans, cattle or trucks.



"When very small vibrations hit the fiber optic cables, the cables are slightly distorted," Urquhart said. "This distortion creates a unique signature change in the laser pulses, which can be detected by the Helios unit."

Urquhart said the Zonge team buried several types of cable at the desert test location.

"Each had different properties in terms of flexibility or type of shielding," he said. "The advantage of a Kevlar cable, of course, versus a steel cable, is that the Kevlar cable cannot be found with a metal detector."

Nor does digging up the cable and cutting it clean through stop the system working, provided a Helios unit is connected to both ends of the cable, Urquhart said. "We can detect people digging up the cable, and even if they cut it, the signal doesn't stop flowing from the cut back to the Helios unit," he said.

The resolution of the cable can be set to one-meter intervals, which means that the location of a cut cable, or people or vehicles can be pinpointed instantly to within one meter along a section of cable up to 50 kilometers long.

Moe Momayez, associate professor of mining and geological engineering at the University of Arizona's Lowell Institute for Mineral Resources, is co-author of a report detailing the recent Helios tests. "We can install cables up to 50 kilometers in length with only one Helios detector," he said. "Because the 50-nanosecond laser pulses travel at the speed of light, we can detect any event virtually instantaneously and deploy the appropriate resources to that location."

These 50-km cable lengths, each with a Helios detector, can be strung together indefinitely to cover vast distances. For example, the border between the United States and Mexico is 1969 miles, or 3169 km. Although the extreme topography of some border areas would make cable deployment difficult, dividing the border length into 50-kilometer segments equates to approximately 64 cable sections and detector units.

It is envisaged that Helios might be integrated into a larger system that includes mobile surveillance vehicles, such as those currently used by border patrol agents. For this and many other reasons, it is too soon to name the cost of monitoring the US-Mexico border, but all on the project agree it would be significantly lower than the ineffective barriers deployed to date, such as steel fences, disconnected grids of sensors or hi-tech virtual fences.

Momayez's report co-author is Kevin Moffitt, a research scientist at the National Center for Border Security and Immigration at the university. They conclude in the report that "with sufficient training, an observer could reasonably differentiate between events triggered by a group of people, cattle, horses, digging tunnels, cars or even 'stealthy' border crossers."

Fotech is already working on automating Helios operation. Once a database of signals has been built up over an extended period of time, advanced pattern-recognition software could be employed to automatically identify events detected by the Helios system. The system would generate an alert if the software determined that a border crosser was being detected.

Zonge and Fotech have signed a two-year agreement to develop a border security application. The next step, according to the report, is a limited deployment along a stretch of border with a known high volume of border-crossing traffic. Zonge is seeking funding for this extended field trial, results from which would most likely be released at the discretion of the funding agency. Zonge is considering working with a technical partner that could provide large-scale analysis and storage of the volumes of data that the test system will gather.

Because Helios can detect whether people are digging in or moving through underground tunnels, the system has great potential for perimeter security — prisons, for example — and mine safety. If such a system were installed in a network of mine shafts and tunnels, a trapped miner could just tap on the rock wall, and the system could pinpoint his location to within a couple of feet.

For more information, visit: [www.engr.arizona.edu](http://www.engr.arizona.edu)