

# Bug-zapping lasers could add new weapon to our insect-fighting arsenal

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Control and monitoring of disease-vector insects are critical to global health, as insect vectors spread pathogens among humans, animals and agricultural products, creating worldwide strain on health care and food resources. Mosquito-borne malaria, for example, caused over 200 million infections and over 400,000 deaths in 2015, according to the World Health Organization. A small insect is also to blame for the jump in the price of orange juice in recent years. The Asian citrus psyllid, a vector of citrus greening disease, has devastated orange groves in Florida and threatened citrus production around the world.

Traditional insect control methods broadly rely on chemical insecticides, which may harm humans and [beneficial insects](#) and cause insecticide resistance in the target pests. A research team from Intellectual Ventures Laboratory, Washington State, USA, have developed a novel laser system called the "Photonic Fence," which can effectively identify, track and kill flying insects in real-time, shooting down insects with a low-energy laser without harming other organisms, animals or humans.

Originally invented for controlling certain types of mosquitoes that carry malaria, the 'Photonic Fence' system has been adapted for more general applications in pest control for agriculture. It has now reached a stage where field deployment is practical. This week in the journal *Optics Express*, from The Optical Society (OSA), the researchers describe the work.

In the study, conducted in collaboration with United States Department

of Agriculture (USDA) personnel, the researchers selected two important [insect vectors](#) as experimental subjects: *Diaphorina citri* psyllids, a vector of [citrus greening disease](#) and *Anopheles stephensi* mosquitoes, a vector of malaria.

"Our study showed that the 'Photonic Fence' is able to effectively track and distinguish between different insects by measuring insects' wing beat frequency," said Eric Johanson, primary investigator and a project scientist, Intellectual Ventures Laboratory. "We also confirmed that low-power lasers can indeed lethally disable the Asian citrus psyllid. These findings position the 'Photonic Fence' as an excellent tool to help citrus growers contain and eventually eliminate citrus greening disease."

According to Johanson, the 'Photonic Fence' is an electro-optical system that employs lasers, detectors and sophisticated computer software to search, detect, identify and shoot down insects in flight in real-time.

First, the optical tracking subsystem identifies targets from an insect database based on the characteristic data from insects, including flight behavior, insect size, insect shape and wing beat frequency (the measure of how fast the insect is flapping its wings). With this data the system decides whether a specific insect should be eliminated or not. Second, the safety interlock subsystem confirms there are no other organisms nearby that could be subjected to collateral damage. Finally, the lethal laser is employed to disable the insect target. The entire process, spanning from initial target acquisition through the application of the lethal dose, takes less than 100 milliseconds, Johanson said.

"Used as a virtual fence, the 'Photonic Fence' can be deployed as a perimeter defense around villages, hospitals, crop fields, etc. Over time, the population of target insects inside the protected region would be decreased to the point of collapse," he explained.

The researchers believe the 'Photonic Fence' presents a potential new way to monitor and control insects. A particularly useful case would involve a small number of insects moving into a sensitive area in which current abatement techniques are not effective.

"A few good examples are organic farms and greenhouses," Johanson said. "These areas are difficult to control for pests using organic means. A 'Photonic Fence' installation, which is inherently organic, could not only reduce the population of yield-reducing pests, but also inform the grower what kind of pests are present and when. Armed with this information, the grower could choose to use traditional insecticides in a precise, pin-pointed manner to stop the flying pests."

The researchers have established a database of insects that they have experimented on so far, and the database will continue to grow as the researchers test the system in new environments.

"Wherever a 'Photonic Fence' installation is deployed, we have situational awareness about the types of insects that are present, the insect density, and the time of day when [insects](#) are more prevalent, all on an up-to-the-second basis," Johanson explained. "Now imagine hundreds of thousands of 'Photonic Fence' units reporting back to a central data aggregation system. Using this information on a regional, state or national level, we can make decisions about where and when to concentrate our pest-control efforts, whether they should be photonic or traditional. We will now be able to understand, for the first time on this resolution, the trends in insect behavior and the impact that our pest control efforts are having."

The researchers said the study is part of a larger project supported by the "Global Good Fund" to assess the impact on a number of disease-carrying mosquitoes and agricultural pests. As the Global Good Fund is primarily focused on using technology to improve people's lives in the

developing world, the researchers' goal is to eventually make the new system deployable to the developing world for malaria eradication. In order to make the technology economically viable for the developing world, they are also exploring developed world applications such as those in agriculture and hospitality markets. Lead by Arty Makagon, the commercialization team aims to deploy in one or more of these markets in the coming years, scale up production and collect product robustness and effectiveness data prior to unleashing the technology in Africa and beyond.

**More information:** Emma R. Mullen et al. Laser system for identification, tracking, and control of flying insects, *Optics Express* (2016). [DOI: 10.1364/OE.24.011828](https://doi.org/10.1364/OE.24.011828)

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