New laser technique may help detect chemical warfare in atmosphere

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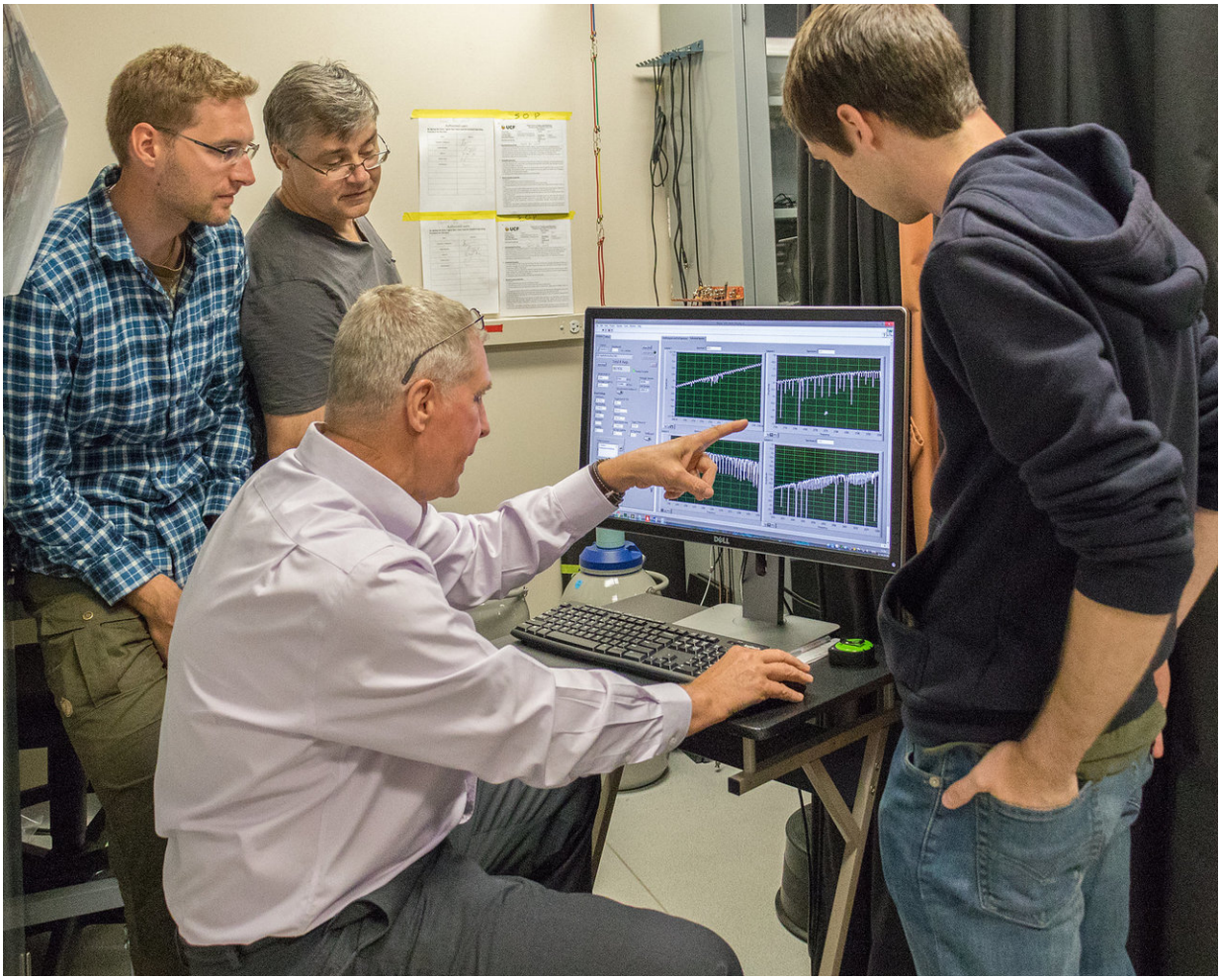

UCF optics and photonics Professor Konstantin Vodopyanov works with his team to broaden the range of the laser frequencies that can get the job done. If costs can be reduced and the tech made mobile, the applications could be endless, he said. Credit: UCF: Karen Norum

The Department of Homeland Security could benefit from a reliable, real-time instrument that could scan the atmosphere for toxic agents in order to alert communities to a biological or chemical attack. UCF optics and photonics Professor Konstantin Vodopyanov is developing just such a technology to accomplish that.

He has found a new way to use infrared lasers to detect even trace amounts of chemicals in the air. Every chemical is made up of individual molecules that vibrate at their own unique frequency. Vodopyanov has found a way to use lasers to detect these vibrations.

The technique is so accurate and sensitive that he can determine if there is a molecule of any chemical present even at concentrations as low as one part per billion. So even if someone tried to hide the toxic chemicals , his technique would be able to detect them.

His findings are published online this week in *Nature Photonics*.

"We still have much work ahead," he said. "We are now working on broadening the range of the laser frequencies that can get the job done. If costs can be reduced and the tech made mobile, the applications could be endless."

A similar principle is used in the medical field to detect biomarkers for different kinds of health conditions, including cancer, by taking breath samples.

It's possible, Vodopyanov said, because of the rules of physics.

"The frequencies of molecules are very distinct, but they are invariant - here, on a different continent, on a different planet, anywhere," Vodopyanov said. "It is universal. Think of it as a molecular fingerprint. So when we use the laser we can detect these fingerprints with great

precision."

The novel approach could open the door for developing non-invasive technology, including sensors, that could be used to detect:

- airborne agents that could be encountered in a biological or chemical attack at home or on the battlefield
- traces of life by space explorers on missions to other planets or asteroids

Other collaborators on the *Nature Photonics* paper include Andrey Muraviev at UCF's the College of Optics & Photonics, Viktor Smolski of IPG Photonics—Mid-Infrared Lasers in Birmingham, AL, and Zachary Loparo from UCF's Department of Mechanical and Aerospace Engineering.

More information: Massively parallel sensing of trace molecules and their isotopologues with broadband subharmonic mid-infrared frequency combs, *Nature Photonics* (2018). nature.com/articles/doi:10.1038/s41566-018-0135-2

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