Italian National Agency for New Technologies, Energy and Sustainable Economic Development

European Photonics Industry Consortium

Is laser photoacoustic spectroscopy a good tool to detect warfare agents?

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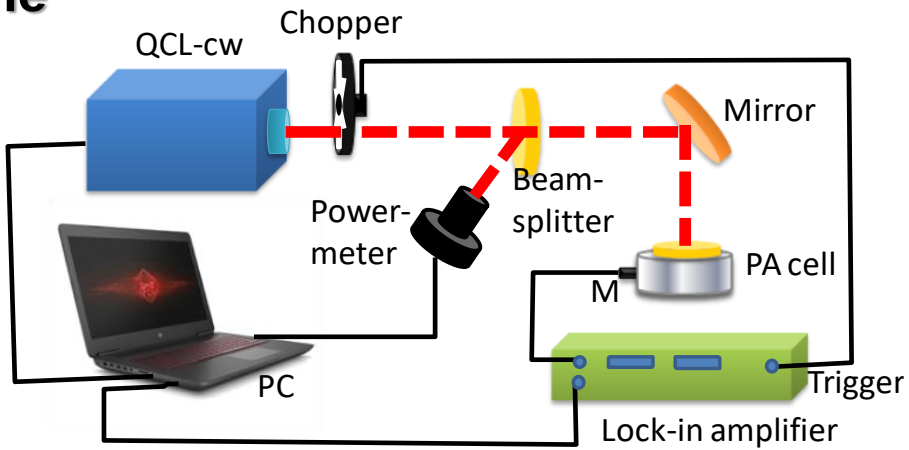
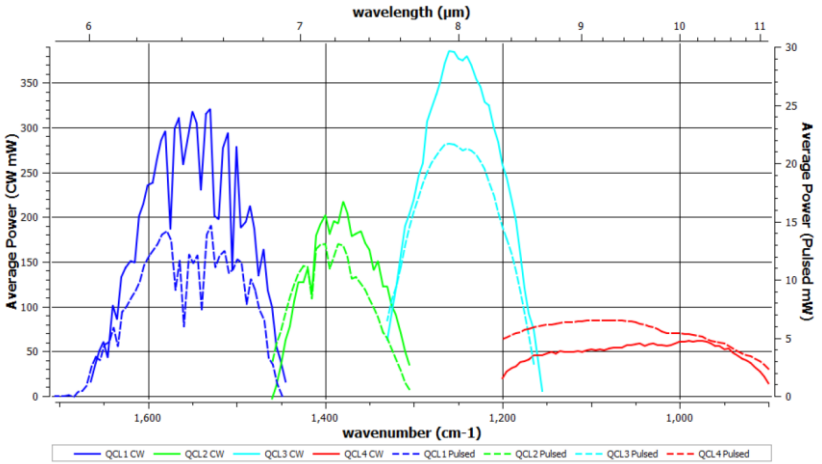
Laser photoacoustic spectroscopy (LPAS)

- The laser beam is chopped at an audio frequency and irradiates a sample inside a photoacoustic cell
- The radiation is absorbed by the sample → temperature increase → adiabatic expansion → pressure wave generation
- Acoustic resonance amplifies the signal that is detected by a microphone coupled with a lock-in amplifier
- Part of the laser beam is sent to a power meter by a beam splitter



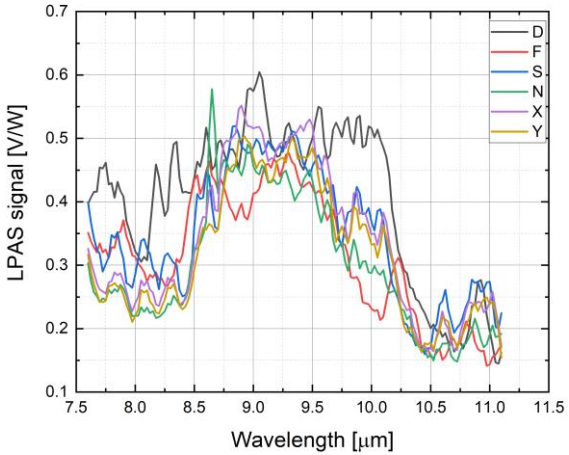
Typical experimental values

- Spectral range: **6.0 – 11.1 µm**
- Wavelength step: **0.025 – 0.1 µm** (about 30 points)
- Averaging: **10 measurements** per point
- Measurement time: **about 5’**
- Sample measured **as it is** once inserted in the cell

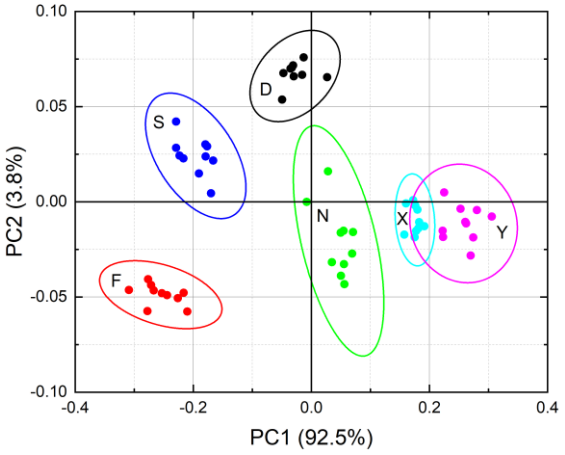


Example of result in food safety: sugars

- **3 sugars and 3 mixes simulating 1 natural and 2 adulterated apple juices:**
- **Dextrose (D)**
- **Fructose (F)**
- **Sucrose (S)**
- **Natural (N)**
- **Weakly adulterated (X)**
- **Strongly adulterated (Y)**

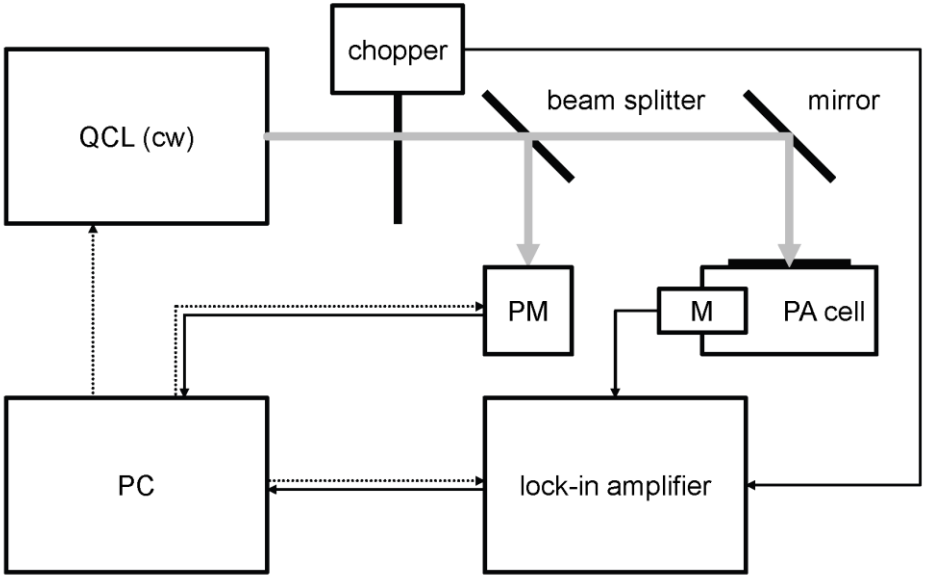


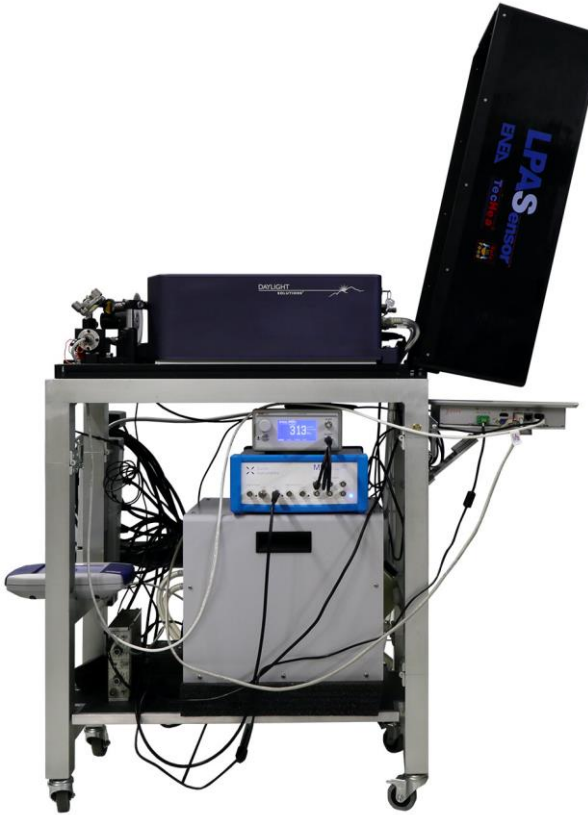
spectra



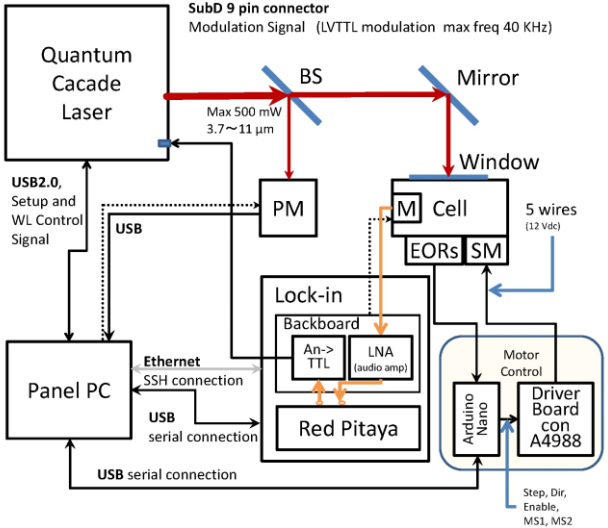
PCA

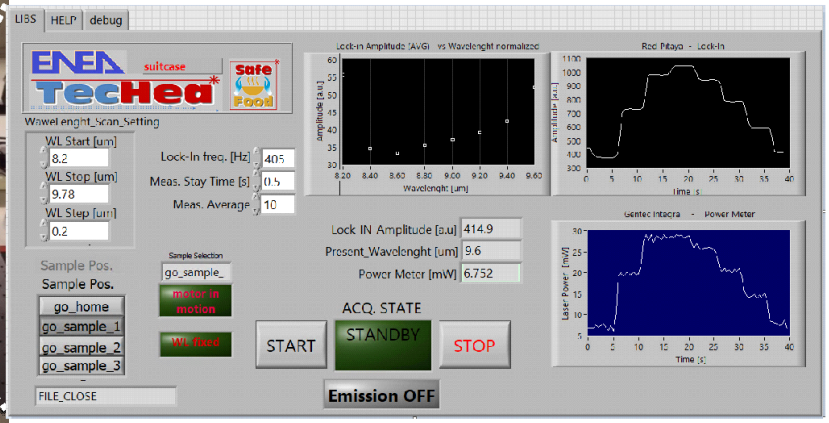
Cart system (field deployable)





Suitcase system (battery operated)





LPAS & warfare agents

- **LPAS detection of a decomposition product of sarin (vapor)**
- **Deposed aerosol and solid particles can be of interest (nerve agent attack of 21 August 2013 in Damascus, Syria)**

High sensitivity photoacosutic detection of chemical warfare agents

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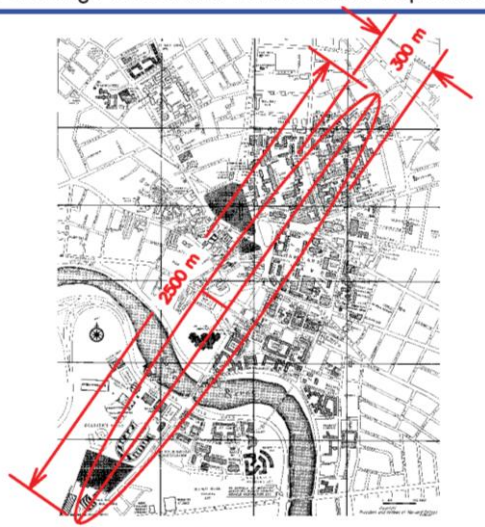
ABSTRACT

We report sensitive and selective detection of Diisopropyl methylphosphonate (DIMP)—a decomposition product of Sarin and a common surrogate for the nerve gases—in presence of several gases expected to be interferences in an urban setting. By employing photoacosutic spectroscopy with broadly tunable CO_2 laser as a radiation source we demonstrate detection sensitivity for DIMP in the presence of these interferences of better than 0.5 ppb in 60 second long measurement time, which satisfies most current homeland and military security requirements and validates the photoacoustic spectroscopy as a powerful technology for nerve gas sensing instrumentation.

Keywords: gas sensor, photoacosutic spectroscopy, PFP, CWA detection

Factors Affecting Aerosol and Solid-Particle Deposition Regions



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The Nerve Agent Attack of August 21, 2013 in Damascis, Syria

- **Collaborations we look for: sampling techniques, especially of vapors, and data analysys automation**
- **Challenges we face: our systems are user-friendly and fast but accuracy and limit of detection should be improved**

Thanks for your attention!

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