**Abstract**
A portable CLaDS instrument has been deployed for the environmental monitoring of nitrous oxide at Princeton University (invention partners). This proved the instrument’s enhanced properties over other traditional sensors, and shows outstanding performance in terms of sensitivity, robustness and reliability of results.

A tabletop instrument is currently being built at the STFC (Oxford) to demonstrate the technique’s capabilities with methane and ultimately to find partners to develop products at target applications. A custom spectrum analyser specified for CLaDS is in development that will aid the further miniaturisation of the instrument.

**Description**
CLaDS is a new spectroscopic technique that is capable of real-time, sensitive and selective trace gas analysis. It is based on a different principle to other optical gas sensing methods available today. Standard laser-based technologies determine concentration of the molecule by measuring how much light is absorbed by the gas sample at different wavelengths. CLaDS performs sensitive detection by measuring changes in refractive index of the sample generated by the target molecules.

Existing instruments on the market are fundamentally limited by the absorption technique, which has several drawbacks:

- It relies on a measurement of a small change of light intensity on top of a large background. The background intensity fluctuates as a result of the environment; turbulence, soot, water vapor, etc. This limits the instrument’s capabilities in terms of sensitivity, selectivity and reliability.

- There is a non-linear dependence of the absorption on sample concentration. Therefore over a certain range of concentration the instruments give null results.

To overcome these limitations, industries that require sensitive and flexible instrumentation use more expensive and bulky techniques, most notably Gas Chromatography (GC) that offers high sensitivity and a linear response over the full concentration range of gases. However these instruments are very expensive.
(~100k) and bulky, thus limiting their application in the field. Furthermore GCs require dedicated staff members and time consuming sampling procedures that prohibit real time analysis.

CLaDS overcomes the fundamental limitations of absorption techniques and thus offers users several advantages and a unique capability.

Left: optical arrangement of the developed CM-CLaDS setup (RF - radio frequency, M - mirror, PM - primary mirror, BS - beam splitter, RR - retroreflector);
Right panel: dispersion spectra recorded using CM-CLaDS (top) and the HITRAN simulation (bottom). Despite being recorded at different powers of the heterodyne beatnote, both measured signals and SNRs are almost identical.
Innovations and advantages of the offer
Sensitive detection is performed by measuring changes in refractive index of the sample generated by the target molecules, rather than measuring the amount of light absorbed by the sample.

- High sensitivity (parts per billion (ppb) / parts per trillion (ppt))
- Immunity to detected power fluctuations (thus high immunity to demanding environments (soot, water vapor, temperature)
- Linear response over the full concentration range (0 – 100%) of the target molecule.
- Fast response (frozen atmosphere) allowing reliable results in turbulent environments
- Small and robust - CLaDS is made up of relatively few components with no moving parts and low power consumption – allowing it to be portable and thus applied in field deployment.

Further Information
The improved performance is provided using only off-the-shelf components (not different from what is used in current systems) and very simple inexpensive electronics for signal processing. This is important for further commercialisation of CLaDS since the market is more likely to accept solutions that are well known and can be trusted in terms of hardware availability and reliability.

Video from inventor [https://www.youtube.com/watch?v=f8zoVsXU8QI](https://www.youtube.com/watch?v=f8zoVsXU8QI)

Application
Defence:
- Identification of hazardous materials
- Chemical weapons, explosives and their precursors.

Automotive:
- Analysis of car exhaust gases.

Manufacturing industry/ Power Generation:
- Continuous monitoring of greenhouse gas emission.
- Assessing process efficiency.
- Analysis of headspace gases in pipes and barrels.
- Semiconductor device manufacture exhaust gases.

Environmental Protection:
- Atmospheric monitoring.
- Crop monitoring

Medical Diagnostics:
• Breath test for various diseases.

Scientific:
• Monitoring of chemical reactions.

Description of Space Heritage
The technology has been developed in conjunction with the laser & molecular spectroscopy department of RAL Space for atmospheric monitoring from space.

This technology description was downloaded from www.esa-tec.eu