GASERA

MADE TO MEASURE.

GASERA ONE GHG & PULSE gas analyzers for greenhouse gas detection

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GASERA FACTS

Founded in Dec. 2004

Based in Turku Finland (HQ)

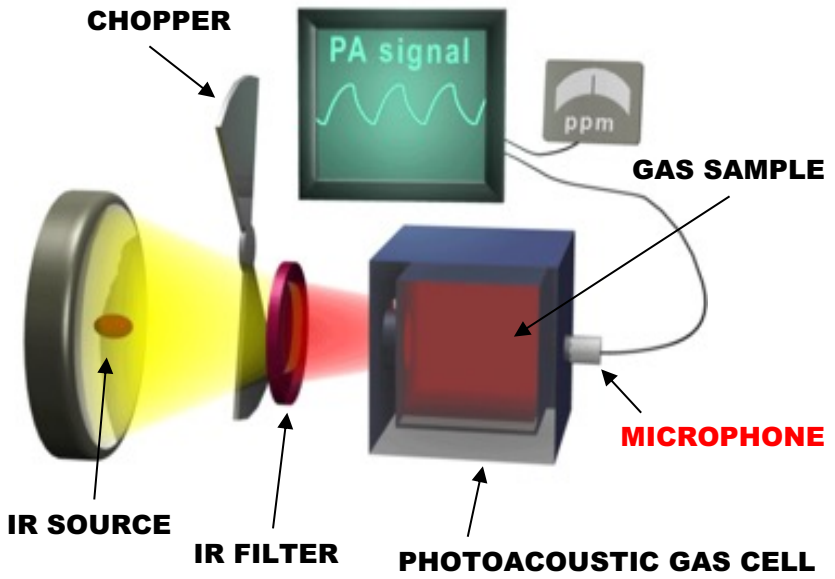
University spin-off

Own patented technology

Consortium member in 10 EU-projects over the time

PHOTOACOUSTIC SPECTROSCOPY (PAS)

- Photoacoustic effect was discovered in 1880 by Alexander Graham Bell
- Extremely powerful technique for gas analysis offering outstanding sensitivity, linearity, repeatability and low drift
- Full theoretical potential has not been achieved due to the limitations of conventional microphone used as pressure sensor



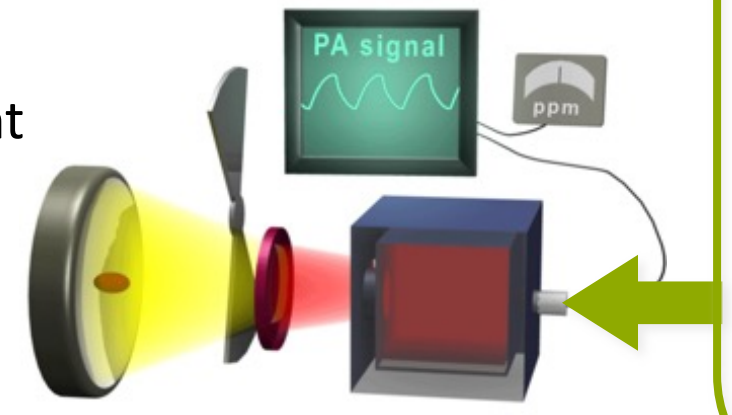
A typical setup of a conventional PAS system

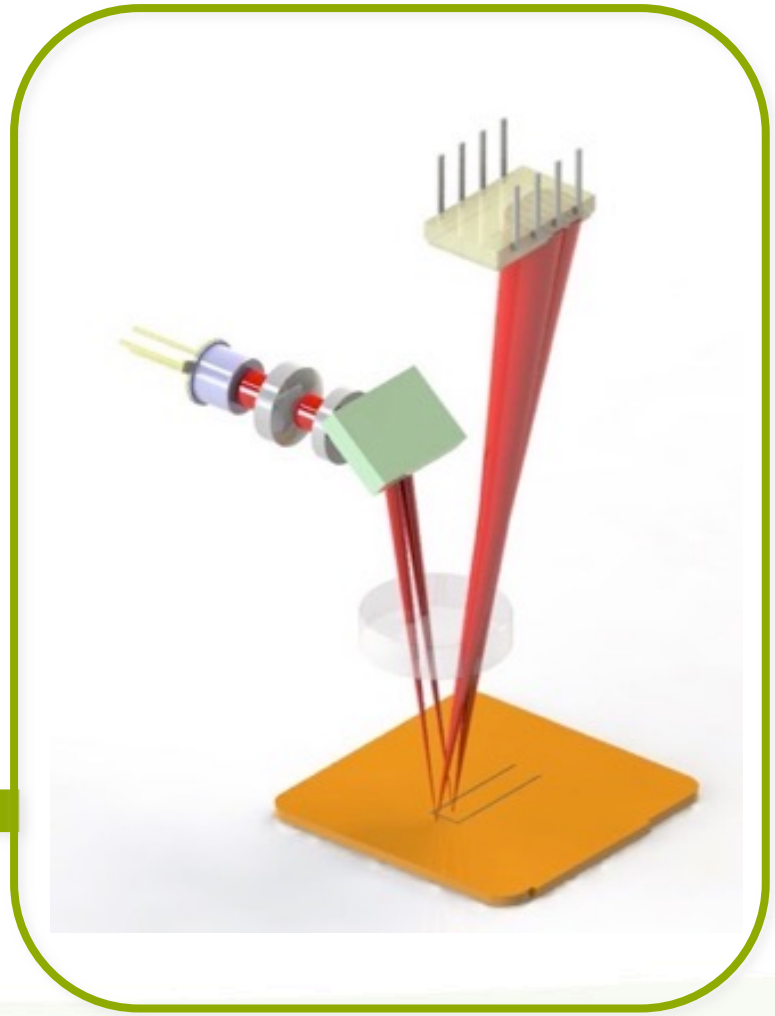
PAS is based on the **absorption of light** leading to the **local warming** of the absorbing volume element. The subsequent expansion of the volume element generates a **pressure wave** proportional to the absorbed energy, which can be detected using a pressure detector.

GASERA'S KEY INVENTIONS

Cantilever sensor with optical readout system

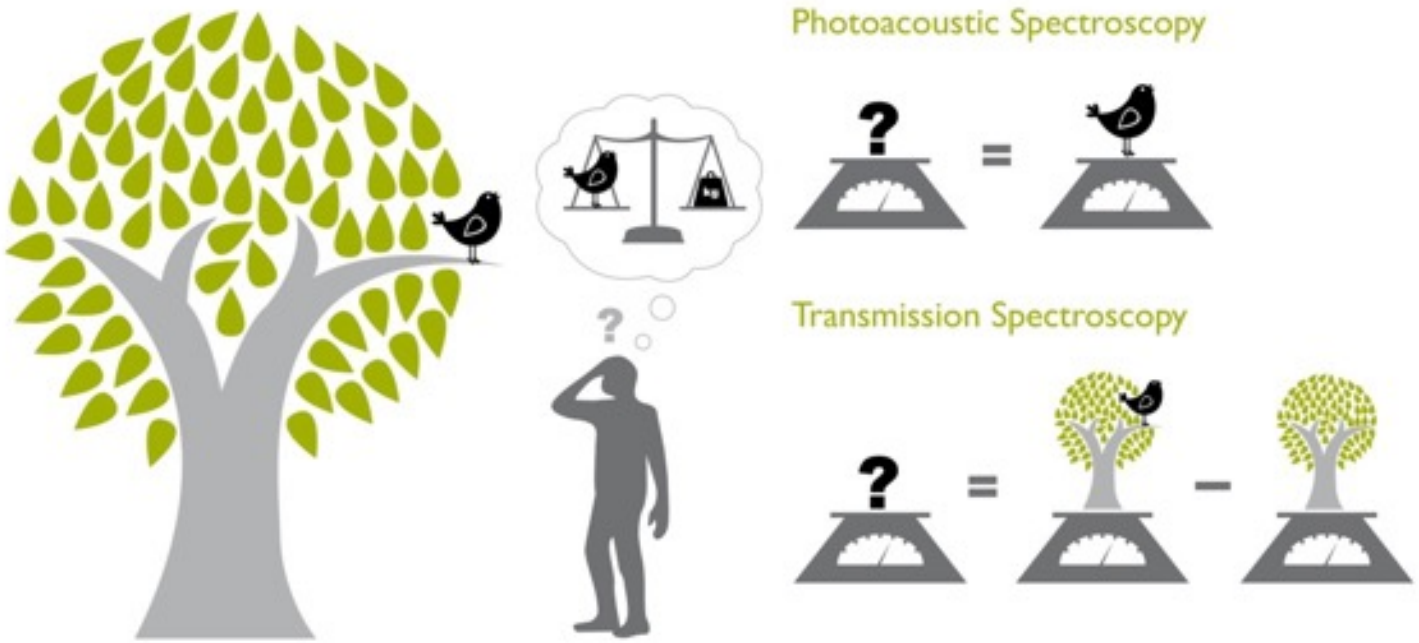
- More than 100 times greater physical movement compared to conventional microphone membrane provides unmatched sensitivity*
- Contactless optical measurement based on laser interferometry
- Extremely wide linear measurement range





*A sensitivity comparison of three photoacoustic cells containing a single microphone, a differential dual microphone or a cantilever pressure sensor; Lindley et. Al.; **Appl. Phys. B (2006)**

BENEFITS OF CANTILEVER ENHANCED PAS



stability, reliability, easy to use	Absorption is measured directly in PAS, which makes the measurement very accurate and free of drift and provides long re-calibration interval
parts per trillion -level detection limits	Cantilever sensor provides high sensitivity
wide linear dynamic range, miniaturization, low sample volume	Sensitivity is not dependent on the optical path length
multi-gas capability	Many different sources can be connected to one cell
suitable to wide range of process applications	Possibility to heat the sample cell for hot wet analysis

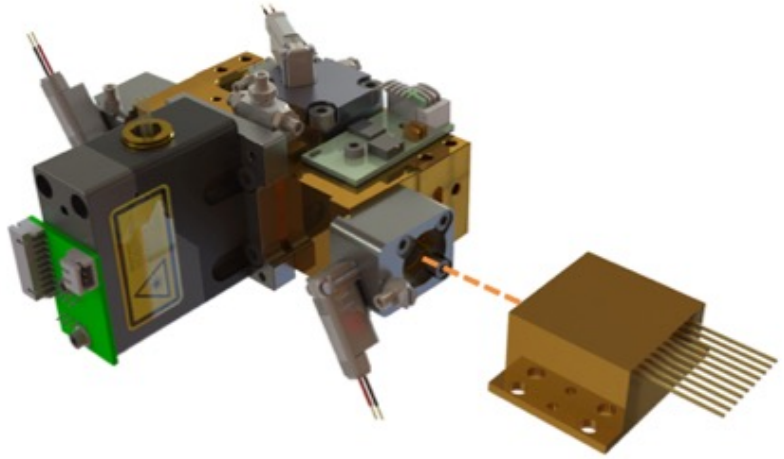
MEASUREMENT PLATFORMS

1

GASERA ONE GHG

LASER PAS – Tunable Laser Photoacoustic spectroscopy

Reliable and cost-effective gas analyzer products with down to remarkable parts per trillion -level (ppt) sensitivity in industrial, safety and environmental applications. Widely tunable lasers in MIR range enable multi-gas monitoring capability.

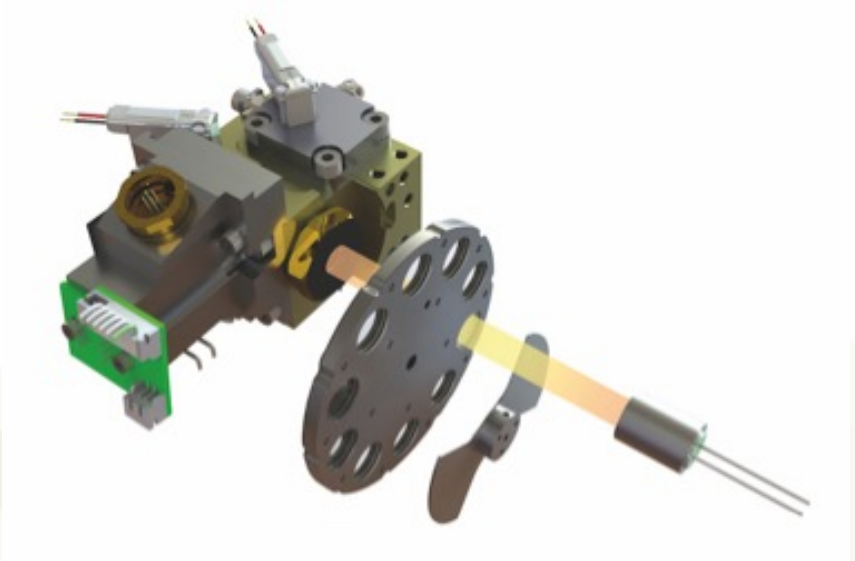


2

GASERA ONE PULSE

NDIR PAS – Non-Dispersive Infrared Photoacoustic Spectroscopy

Enables sensitive gas analyzer for multi-gas monitoring in industrial applications such as transformer condition monitoring, waste anesthetic gases, catalytic research and agriculture research. Can be configured to different applications with the selection of an appropriate set of optical filters.

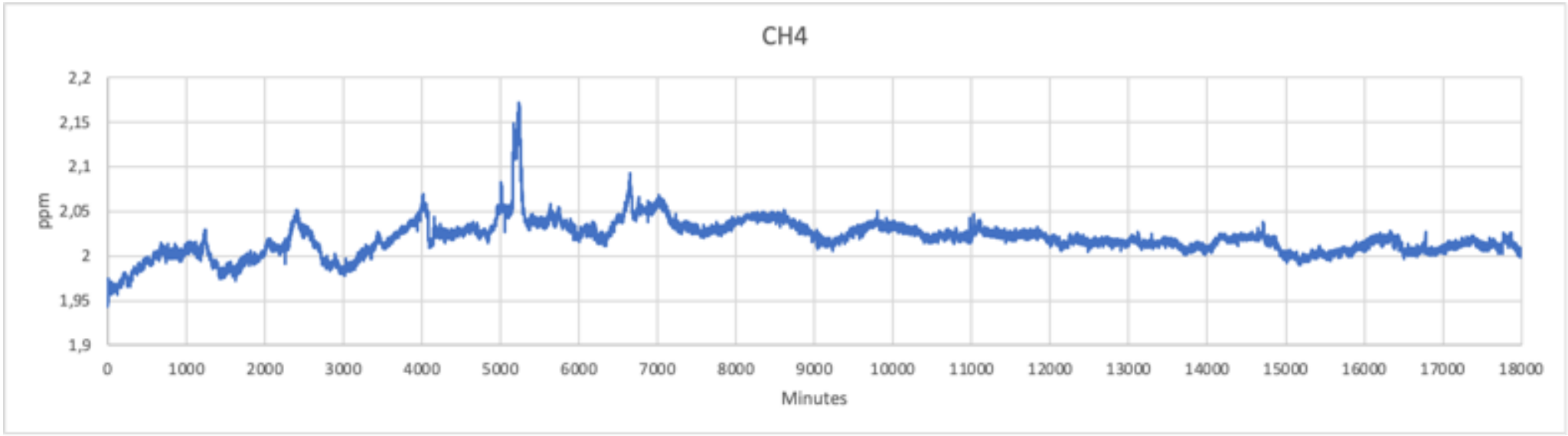


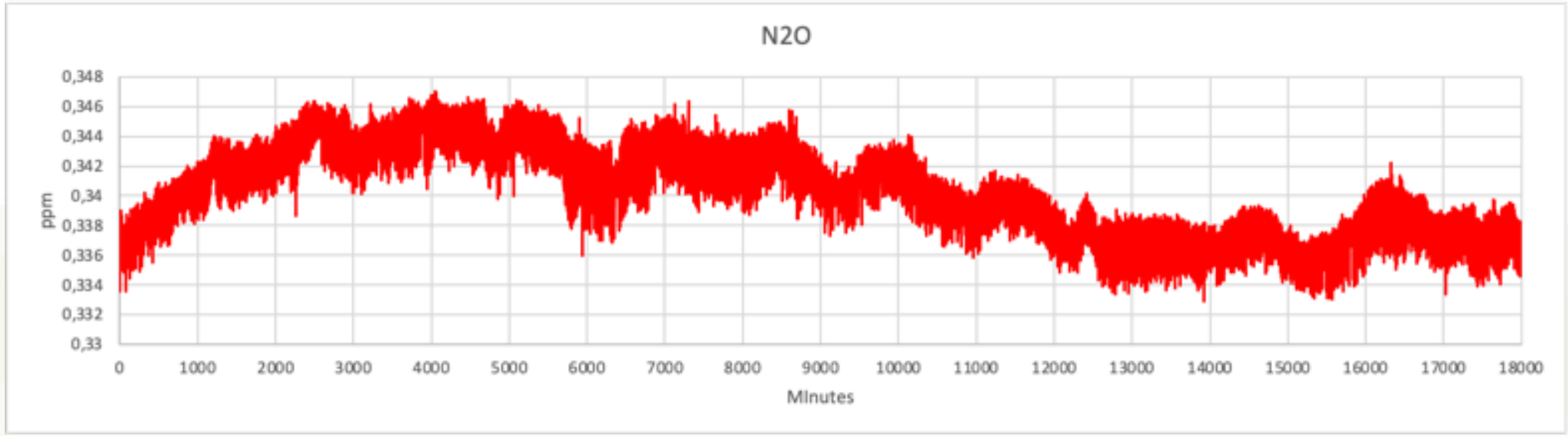
GASERA ONE GHG

- Applications: **ambient air monitoring, greenhouse gas research**
- Selective and simultaneous monitoring of CH4, N2O and H2O in ambient air
- Detection limits less than 10 ppb for CH4, and 2 ppb for N2O @ 60 seconds
- Re-calibration interval: 12 months
- Standalone system with built-in gas exchange unit
- No consumables or reagents

Brochure: https://gasera.fi/wp-content/uploads/2023/01/gasera_brochure_GHG_12042022_LR.pdf

GASERA ONE GHG 14-day ambient measurement





GASERA ONE PULSE

- Applications: **transformer condition monitoring, catalyst reaction, greenhouse gas research, SF6 leak monitoring, fence-line monitoring, coal mine safety, animal husbandry**
- Configurable multi-gas analyzer via selection of optical filters (max. 10 filters)
- Detection limits: CO2 <1ppm, CH4 0.3 ppm, N2O 0.03 ppm, NH3 0.2 ppm
- Re-calibration interval: 12 months
- Standalone system with built-in gas exchange unit
- No consumables or reagents

Brochure: https://gasera.fi/wp-content/uploads/2021/11/Gasera_brochure_OnePulse_11112021_web.pdf

GASERA ONE PULSE: actual performance

Detection limits and repeatability

Gas	Channel	Detection limit* [ppm]	Repeatability**
CO2	IR1_2272_22	0.11	0.06%
NH3	IR1_943_62	0.032	0.17%
N2O	IR1_2215_44	0.02	0.02%
CH4	IR1_3008_63	0.0074	0.04%
H2O	IR1_1976_39	21	0.11%

Linearity test

Gas	Sample concentration [ppm]	Measured concentration* [ppm]	Error (ppm)	Error (relative)
CH4	5000	4991.2	-8.8	-0.2 %
	2500	2513.3	13.3	0.5 %
	1010	1008.2	-1.8	-0.2 %
	505	503.3	-1.7	-0.3 %
	100	98.8	-1.2	-1.2 %
	50	49.5	-0.5	-1.0 %

*Method: Average of 10 consecutive measurements

MULTIPOINT GAS SAMPLING

- **Two sample inputs** in the GASERA ONE unit.
- **Multipoint sampling unit** with up to 12 channels
- Discrete sampling with **low volume** gas cell (few milliliters)
- Sealed gas cell allows low pressure (e.g., 250 mbar) sampling, which improves selectivity

ADVANTAGES OF LASER-BASED PHOTOACOUSTIC SPECTROSCOPY IN GHG APPLICATION

- Simultaneous ppb-level measurement of CH4, N2O and H2O
- Virtually no cross-interference
- No optics requiring precision alignment
- Low total gas volume
- Affordable price point

CONTACT AND FOLLOW

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