

Novel NDIR Sensors for Multi-Gas Sensing



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AVANTES

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LemnaTec

**SENSOR
SIHERM**

Image Engineering

MAG

nir

PHOTECTURE

art photonics

Thirteen Brands – One Product Portfolio

The whole spectrum of non-destructive optical measurement!



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Brief overview of m-u-t GmbH



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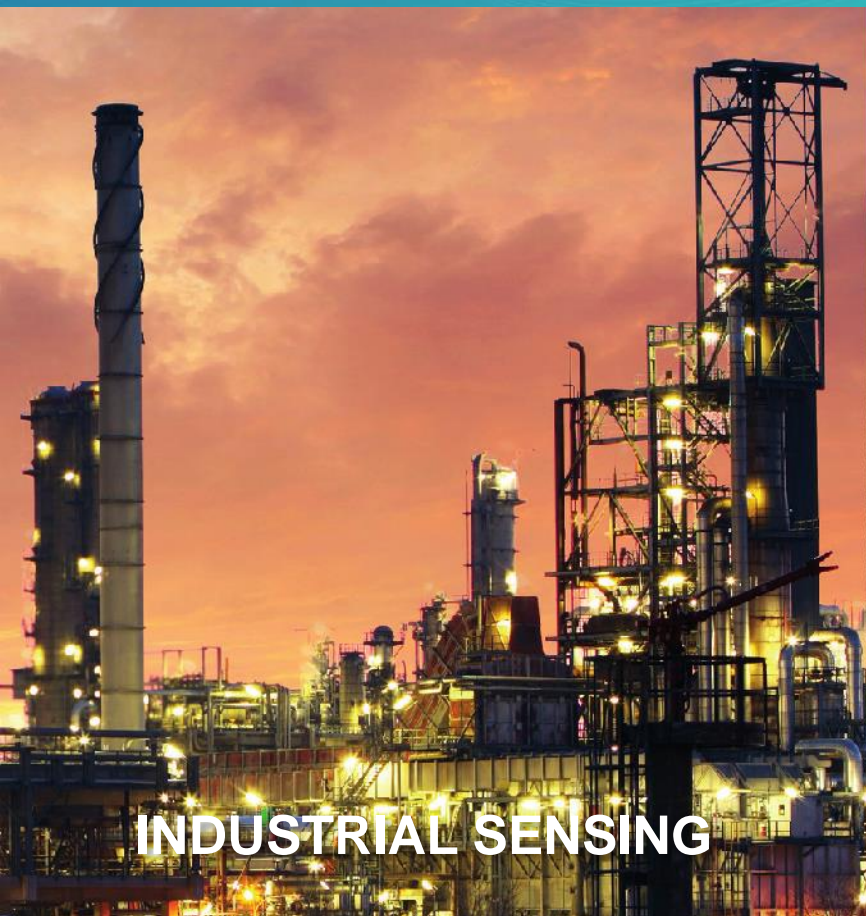
Management:	Axel Witte, Christian Felsch
Net Sales:	approx. 25 Mio. EUR
Employees:	approx. 110
Foundation:	1995
Location:	Wedel (bei Hamburg)
Further Information:	www.mut-group.com



Growing markets within the m-u-t GmbH: Spectrometric measurement and automation technology



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INDUSTRIAL SENSING

- Gas Sensing
- Fire Detection
- Transportation



GREEN TECH

- Agricultural Technology
- Environmental Technology



LIFE SCIENCE

- Medical Technology
- Lab Automation



Example 1: Early fire detection

- Patented integrated distance measurement to initiate extinguishing / cooling optimally and to enable maximum extinguishing agent output per m²
- Unique object recognition, detection of the smallest possible hot spots despite large, moving and permitted heat sources (e.g. wheel loader, truck exhaust, ...)
- Investment safe and expandable
- Proven continuous operation (24/7) under the most adverse environmental conditions
- Active cooling for continuous operation at up to 70 ° C
- VdS G 220008 approval

Example 2: Multi-gas sensor for hydrocarbons

- Infrared Multi-Gas Sensor using NDIR-Technology
- No chemical reaction in the Multi-Gas Sensor, no on-site test gases required, no moving parts, therefore durable and long-term stable
- 8 gases in one sensor – no cross-sensitivities
- CO, CO₂, CH₄, C₂H₂, C₂H₄, C₂H₆, C₃H₈, C₄H₁₀, gas humidity (water, H₂O) and many more are detected
- Up to 6 additional sensor modules possible, such as: H₂, O₂, temperature (T), relative humidity (RH), acceleration (a) and pressure (p)

Industrial
Sensing



Application example: Enhancing Transformer Safety... ... with Dissolved Gas Analysis (DGA)

- Insulation oil is used in high-power transformers
- Insulation oil breaks down over time, liberating gases
- Concentration of dissolved gases and their ratios indicate types of deterioration, such as pyrolysis or partial discharge
- Rate of gas generation indicates severity
- DGA is used for preventive maintenance
- DGA usually consists of sampling the oil and sending the sample to a laboratory for analysis
- Mobile DGA units can be transported and used on site as well; some units can be directly connected to a transformer
- Online monitoring of electrical equipment is an integral part of the smart grid
- Online monitoring is possible with m-u-t's multi-gas sensor
- Oxygen O₂, Hydrogen H₂, Methane CH₄, Ethane C₂H₆, Propane, C₂H₈, Ethylene C₂H₄, Acetylene C₂H₂, Carbon Monoxide CO, Carbon Dioxide CO₂ are detected simultaneously



OEM multi-gas sensor with NDIR technology

- Multi reflection White cell (named after J. U. White)
- Compact design with high absorption length
- Measuring range: a few ppm to several thousand ppm for many typical gases
- m-u-t proprietary 9-channel detector
- 1 reference channel
- 8 free channels: optimally adaptable to the measurement requirements of our OEM customers / OEM products by OEM filter equipment
- No chemical reaction in the multi-gas sensor
- No onsite test gases necessary
- No moving parts, therefore durable and long-term stable
- 8 channels/gases in one sensor – no/minimal cross sensitivities
- Filters for e.g. CO, CO₂, CH₄, C₂H₂, C₂H₄, C₂H₆, C₃H₈, C₄H₁₀, gas humidity (water, H₂O)



Up to 6 positions for conventional physical or chemical sensors

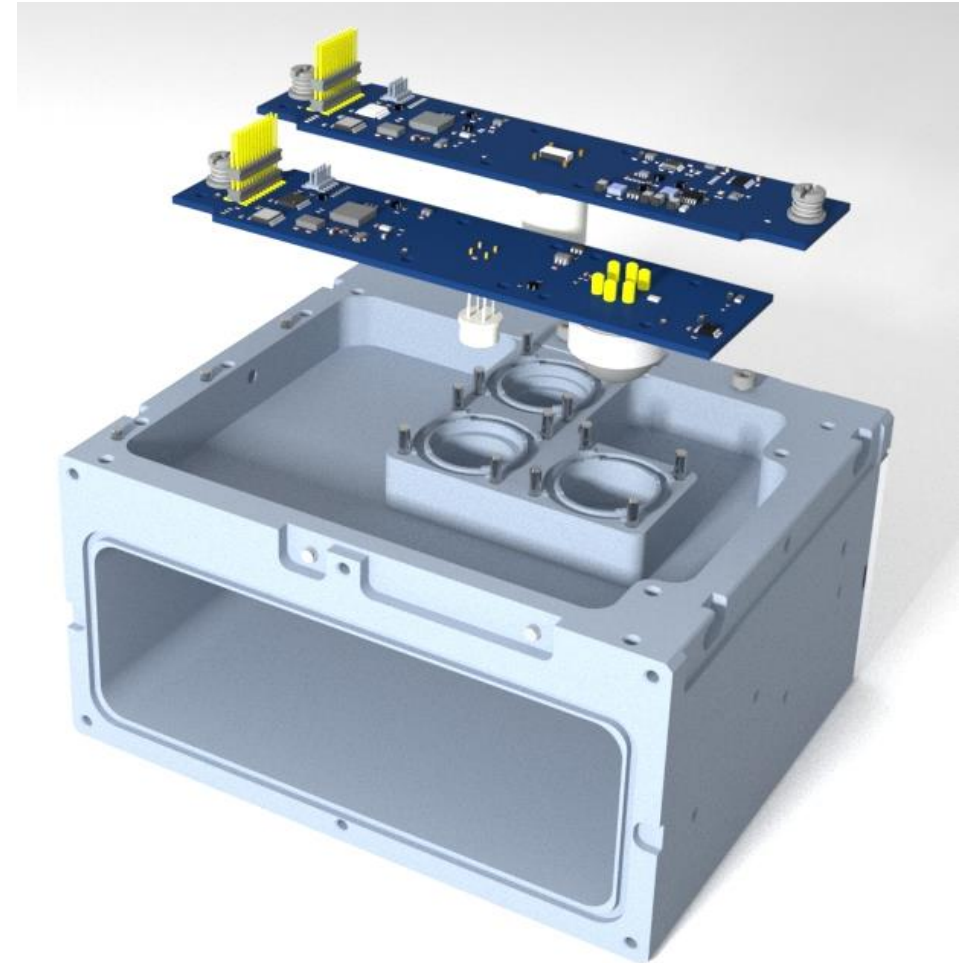
- H₂, O₂ or similar
- Temperature (T)
- Relative humidity (RH)
- Pressure (p)

Measurement outside of the gas chamber

- Acceleration (a)
- Pressure (p)
- Temperature (T)

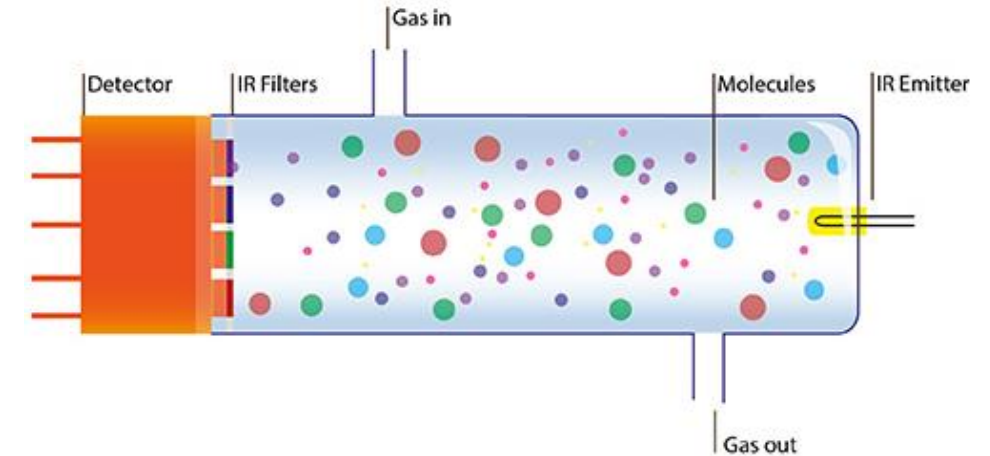
Interfaces

- Power supply 24 VDC
- Data RS422 (RS485 optional)
- Process interface:
 - Flexible or rigid pipe connection
 - Flange
 - Specific adaptations
- Interface for temperature control (option)



What is NDIR? And how does it work?

- Broadband IR-emitter
- Gas cuvette with suited absorption length
- Broadband IR-detector with dielectric bandpass filters
- White cell to keep the module compact



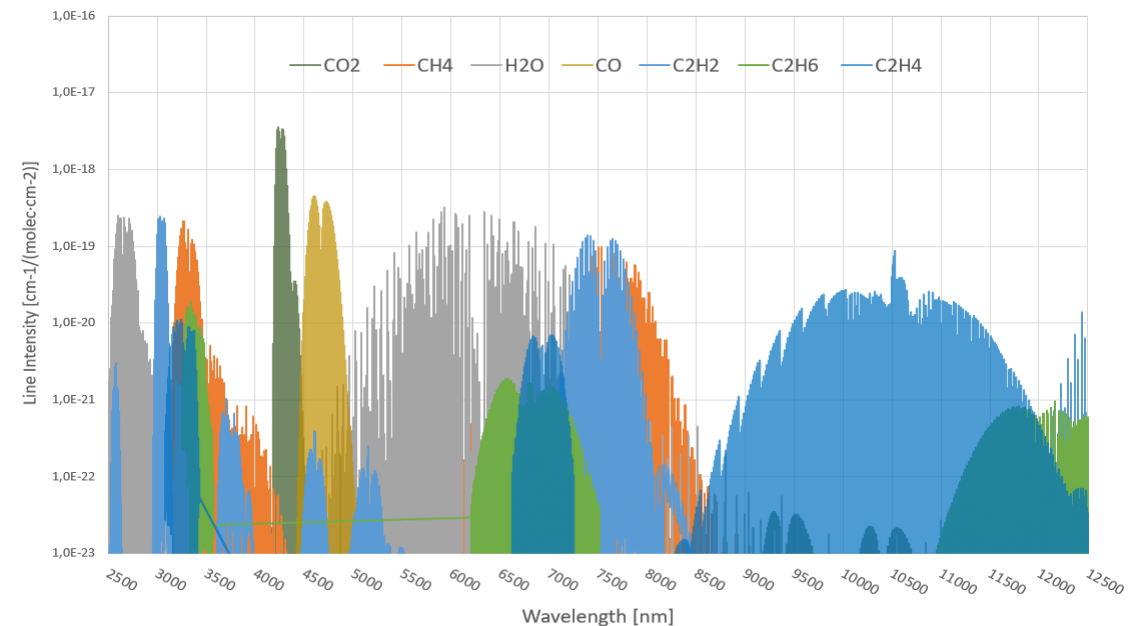
Absorption follows the Beer-Lambert law, depending mainly on gas concentration and absorption length

$$\log\left(\frac{I_0}{I}\right) = \epsilon_\lambda \times c \times l \quad (\text{Beer-Lambert law})$$

Internal compensation of cross-sensitivities

- Many NDIR channels have cross sensitivities with other gases
- Some are quite strong
- By measuring all interfering gas components simultaneously, cross-sensitivity compensation can be done within the multi-gas sensor
- NDIR channels can be compensated by other NDIR channels
- NDIR channels can be compensated by conventional sensors (e.g. humidity, temperature, pressure)
- Conventional sensors can be compensated by NDIR channels or other sensors.

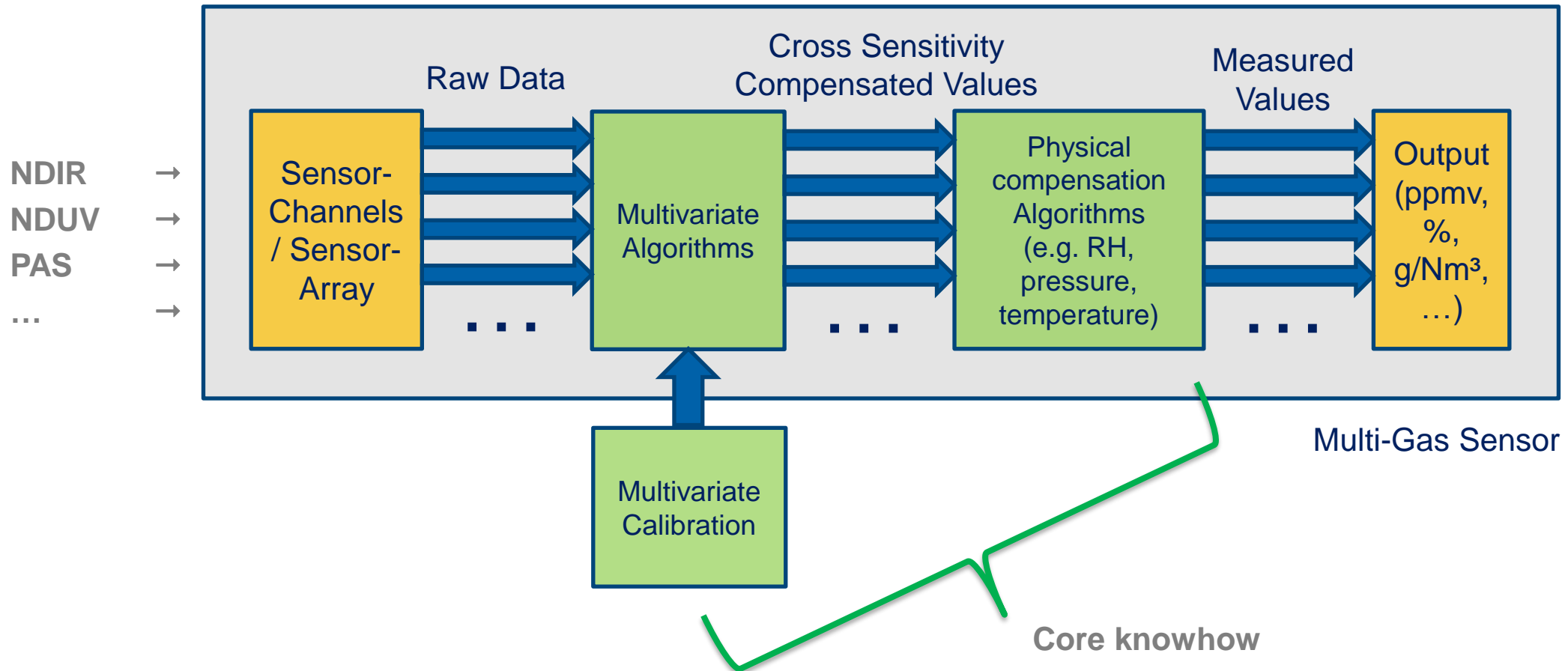
The algorithms of the compensation are created with a multi-parameter calibration procedure (multivariate calibration).



m-u-t OEM Multi-gas Platform

Multivariate software is at the core

Functional Multi-Gas Platform Block Diagram



- **Develop product ideas and bring them into series production as an OEM manufacturer**
- **Integrate IR detectors and IR emitters with other measurement principles to OEM sensor modules**
- **Support and spar with extensive knowledge of gas measurement technology**
- **Provide spectroscopy solutions from UV to MIR**

- **Approach m-u-t as a development and manufacturing partner for new projects**
- **Challenge m-u-t with ideas for applications of multi-gas sensors**

Contact

Your point of contact for Gas Sensing



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Thank you for your attention!



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