LEISTER

Laser Diode Gas Sensors

Photonic Sensors
Swiss Laser Net Workshop Biel
17.09.09

Thomas Hessler

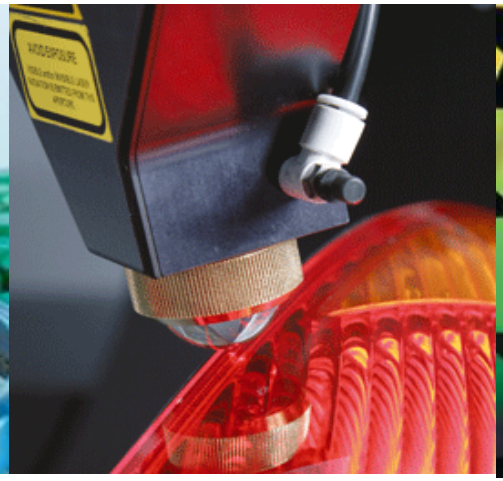
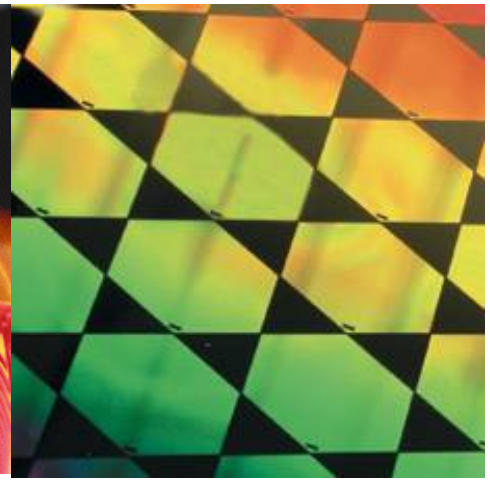
axetris
A Division of Leister

Overview

- Leister and ist photonic activities
- TDLS detection principle
- TDLS product plattform
- Applications

LEISTER Process Technologies



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PLASTIC WELDING

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PROCESS HEAT

NOVOLAS™

LASERSYSTEMS

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MICROSYSTEMS

Corporate Sites

Kägiswil, CH

Axetris,
Production

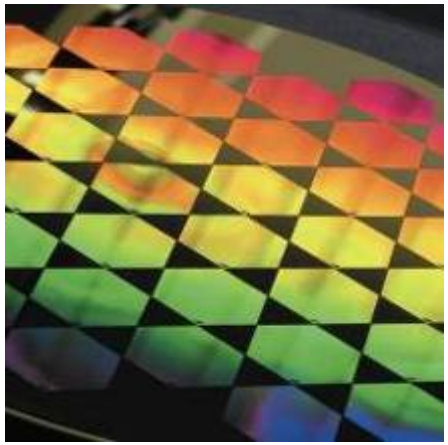
Kägiswil, CH

Corporate Headquarter
Marketing & Sales,
Administration,
Corporate R&D

Sarnen, CH

Production,
Logistics

Photonic Sensor Activities at Axetris



Micro-Optics

Refractives and diffractives for optical sensors

IR Sources

Broad band thermal IR emitters for NDIR gas sensors

Laser Gas Sensors

Tunable Diode Laser Gas Sensors

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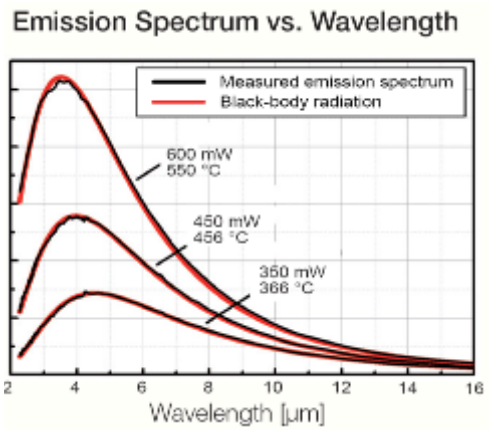
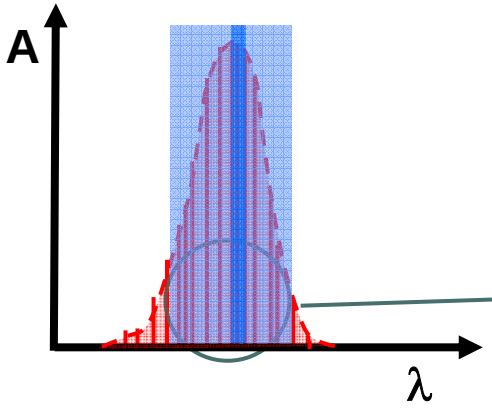
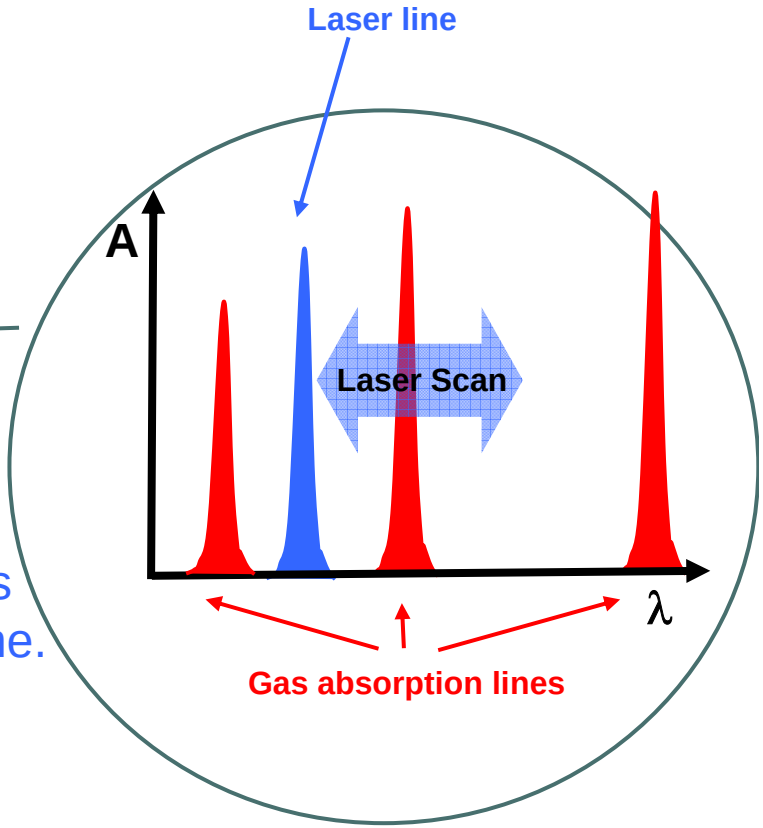
Technology - TDLS Measurement Principle







Laser diode scan across single gas absorption line.

IR Source

Detector

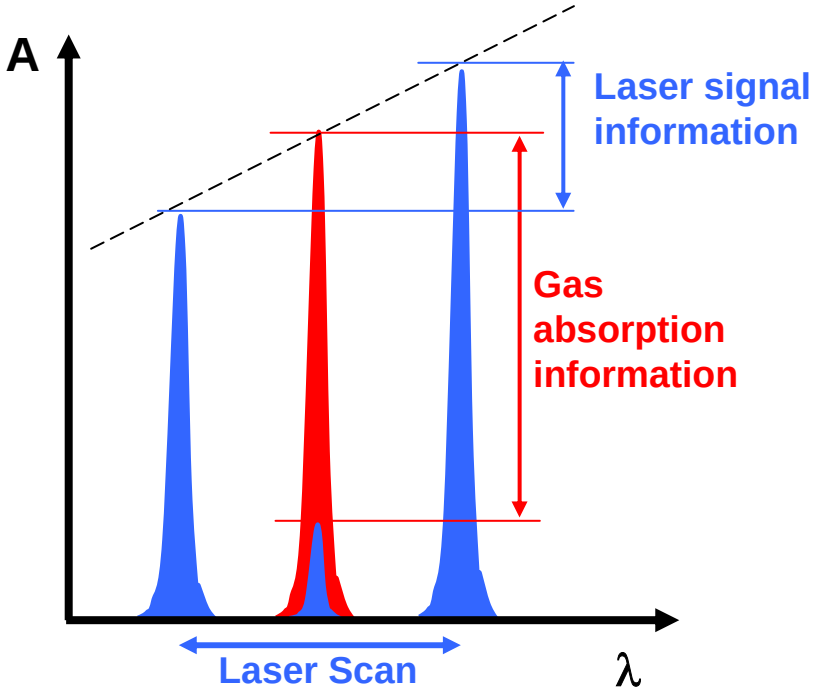
Reference

Laser

Technology - TDLS Measurement Principle

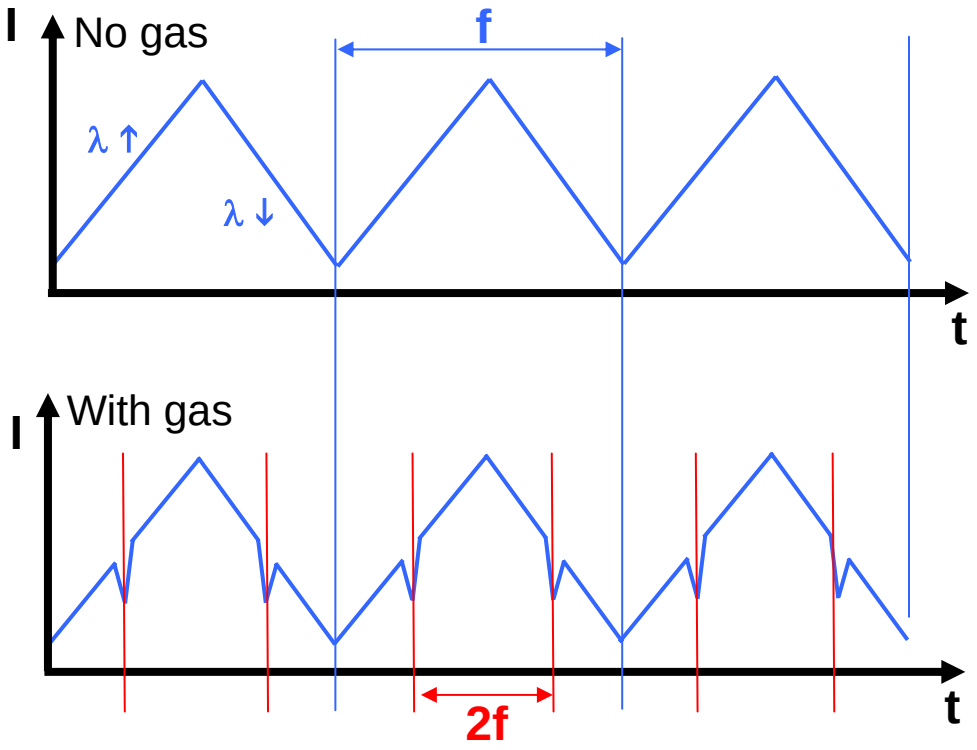
High linearity

- **Laser signal information:**
  Laser intensity & wavelength vary linearly with drive current
- **Gas absorption signal:**
  The detector sees less intensity as the laser hits the gas line

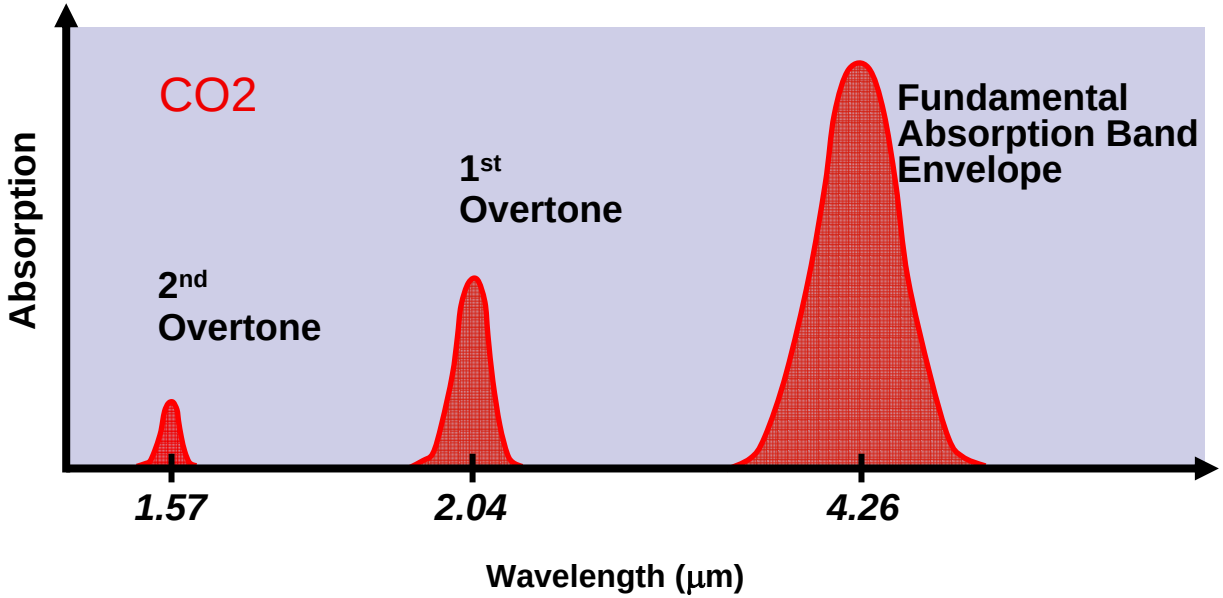


Intrinsic reference channel

- Optical system & reference information:
  On modulation frequency f
- Gas concentration signal:
  On modulation frequency 2f



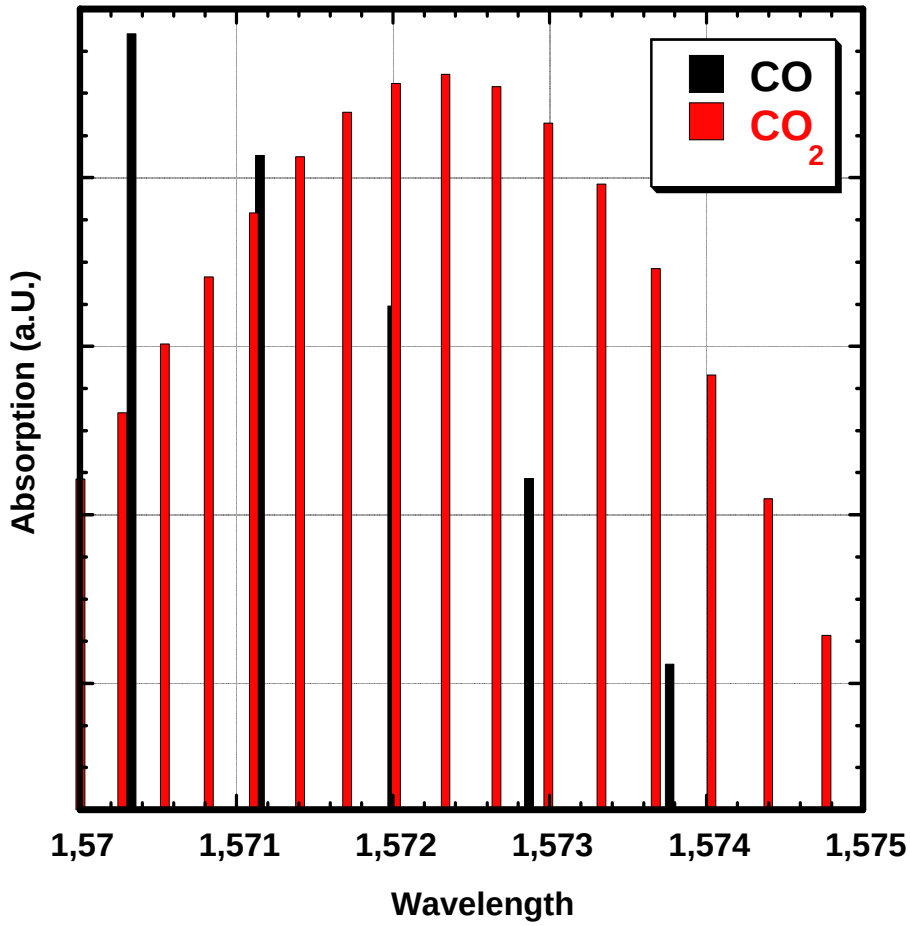
Technology – 1st or 2nd Order



- Optical and optoelectronic components (laser & detector) increase significantly in price with wavelength (if available)
- => work at 1st or 2nd overtone

TDLS - Selectivity

- TDLS is a high resolution measurement
- Superposed bands can be resolved for each gas: Results in high selectivity
- Example CO2/CO: Envelopes overlap, single absorption lines do not



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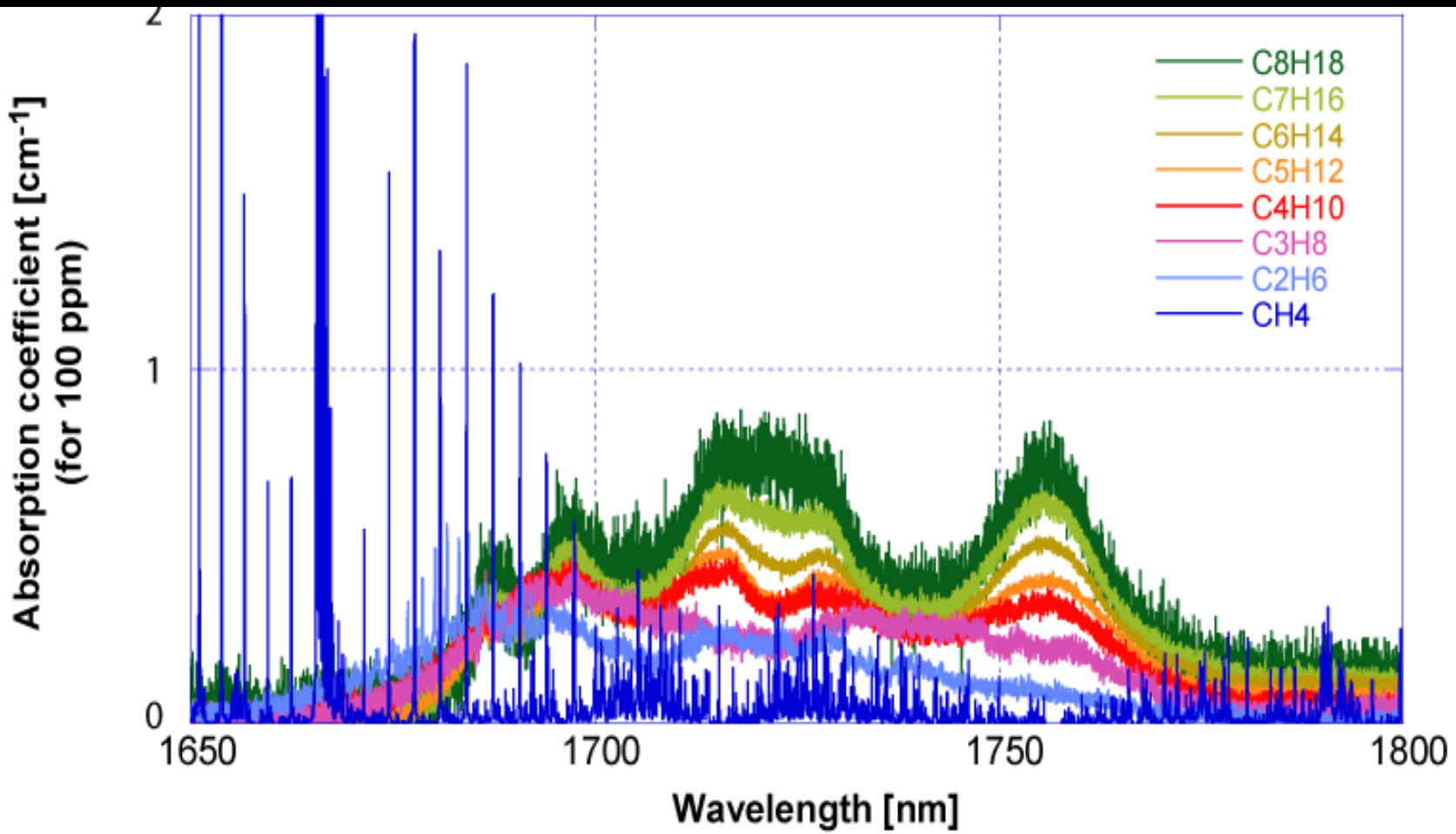
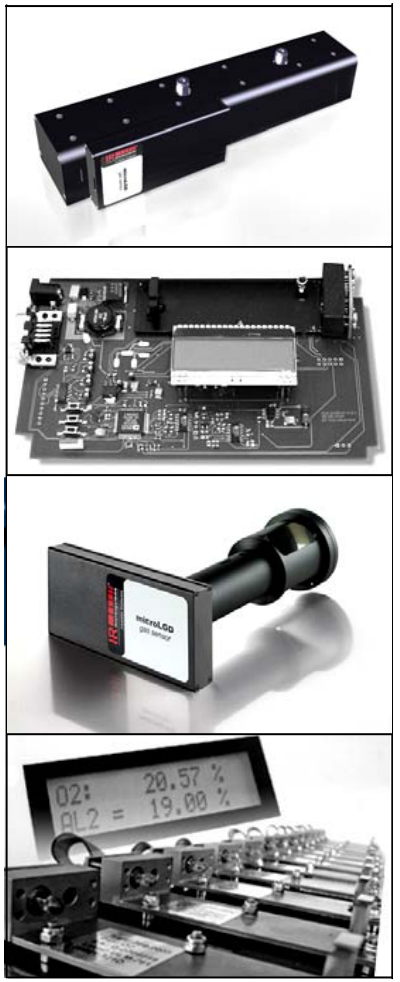
TDLS - Good for small molecules

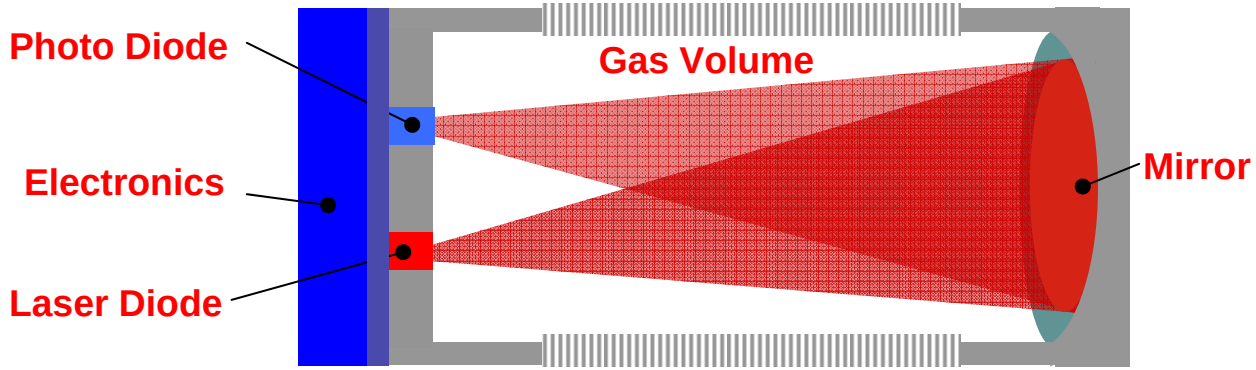


- TDLS can measure gases with resolved rotation & vibration bands, i.e. gases with small molecules.
- E.g. alkanes: Ok for CH4, C2H6, but not for longer chains

Technology - Laser Gas Monitor

- Sharp laser line
  - high selectivity
- Intrinsic reference channel
  - high, long term stability,
  - calibration-free
  - continuous status monitoring
- Optical technology
  - contactless & hot gas measurement





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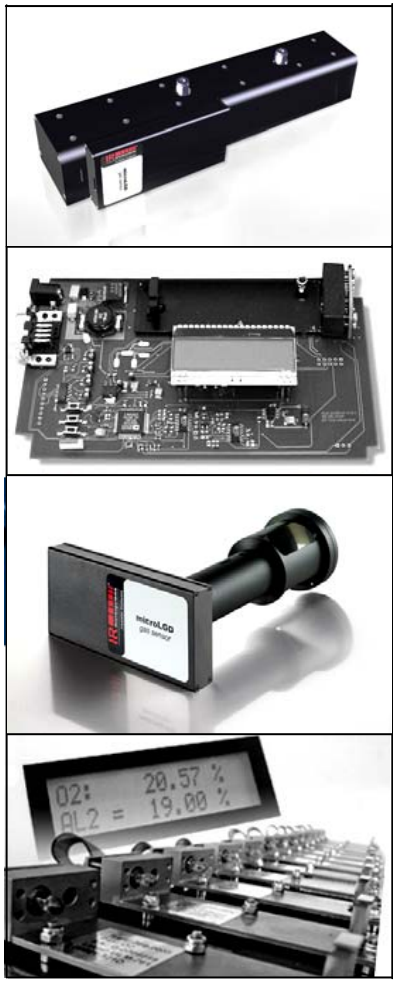
Business Focus

Laser gas detection

- Present Focus on NH3, CH4, CO2, O2
- Flow through and diffusive set-ups
- Self-contained OEM modules, sub-mounts

Applications in

- Process control & environmental monitoring
- Industrial safety
- Climate & air conditioning
- Medical technology



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TDLS Gas Monitor Set-up

Measurement interface to customer:

IR Microsystems provides:

- Self-contained measurement system with integrated optics (probe or flow-cell)
- Digital or analog data output

Customer provides:

- Input Power (10-30 V)
- Conditioned/filtered gas
- Purge gas (where necessary)

Flow: LGD F200 (H) Ambient / heated

Diffusive: LGD P50 Single point

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Technology (Flow) - LGD F 200 (H)

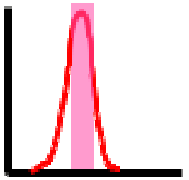
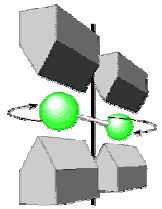
- Flow-through cell
- Optional heating up to 190°C
- Modular design

LGD F 200 (H) - Specifications

System Specifications		
LGD F200H layout	flow-through	
Meas. temp. flow-through	ambient, optional up to 190°C	
Measurement cell layout	modular, different path lengths	depending on gas & applic.
Measurement range	ppm- or %-ranges	depending on gas & applic.
Drift	below detection limit	

Main Target Gases		Precision at T constant	Peak-to-peak noise at T: -40°C to +65°C
NH_3	Ammonia	0.3 ppm	2 ppm
CH_4	Methane	0.5 ppm	3 ppm
CO_2	Carbon Dioxide	5 ppm	30 ppm
O_2	Oxygen	130 ppm	800 ppm

Gas Sensing Technologies

Characteristics	TDLS 	NDIR 	Paramag. 	E-Chem 
High Selectivity	✓	~	~	×
High Stability	✓	~	~	×
Calibration-free	✓	×	×	×
Cont. Sensor status monitoring	✓	✓	✓	×
Non-contact measurement	✓	✓	×	×
Acquisition cost	~	~	✓	✓
Low cost-over-time	✓	~	~	~
Rugged	✓	✓	×	✓
Overload damage or ageing	✓	✓	~	×
Compact multigas	~	✓	×	✓
Fast Recovery time	✓	✓	✓	×

Selected Applications

NH3

- SCR / Emission Control
- Safety / Refrigeration
- Livestock Climate Control

CH4

- Environmental Monitoring / Landfill

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Emission Control

Main application specific USP	Selectivity Non-contact
Precision at T = const.: Peak-Peak Noise -40°C – 65°C:	0.3 ppm 2 ppm

SCR Process Monitoring

- SCR system monitoring, combustion processes in power plants, powerstations, diesel engine development
- Need to measure NH_3 hot (190°C) to 1ppm (acid dew point, water)
- LGD F200 H offers real time emission control with non-contact measurement in heated sample cell

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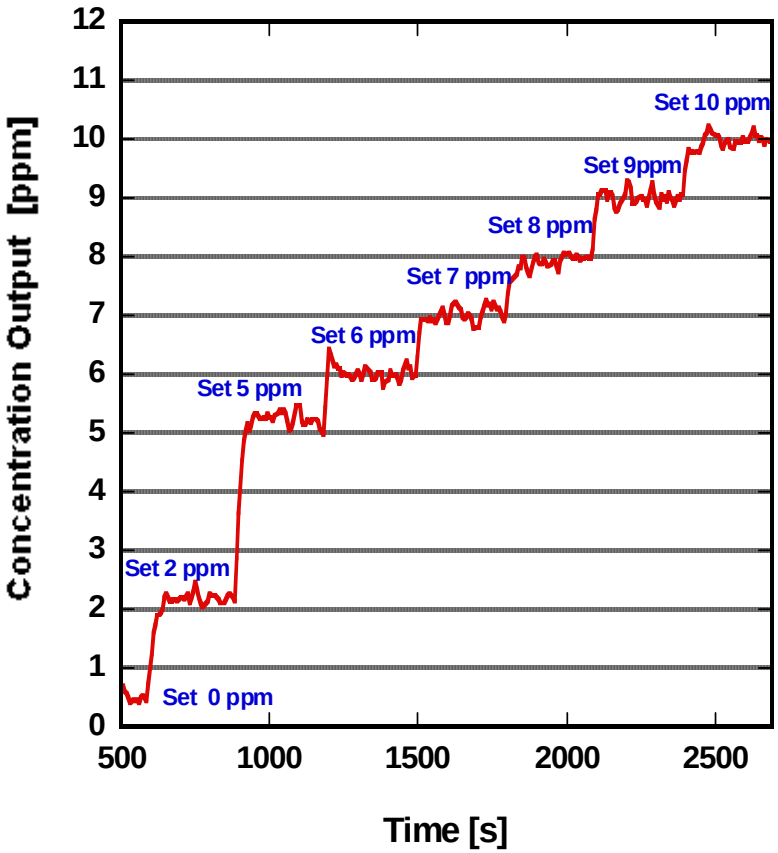
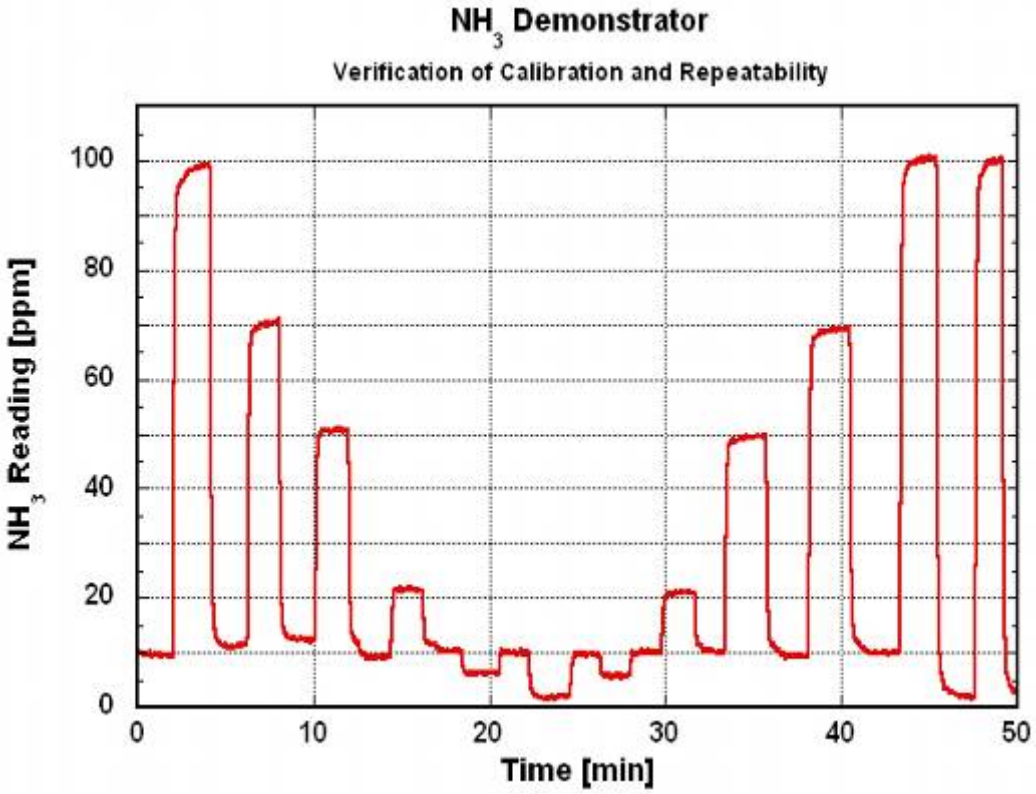
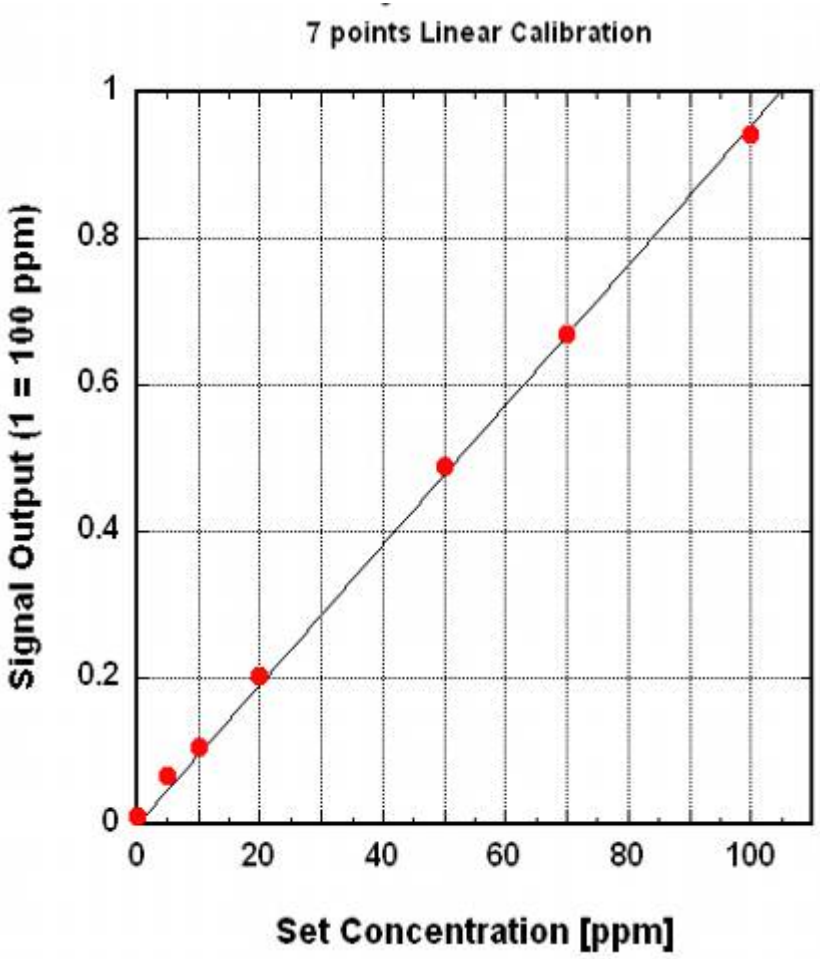
LGD F200 NH3 - measurements

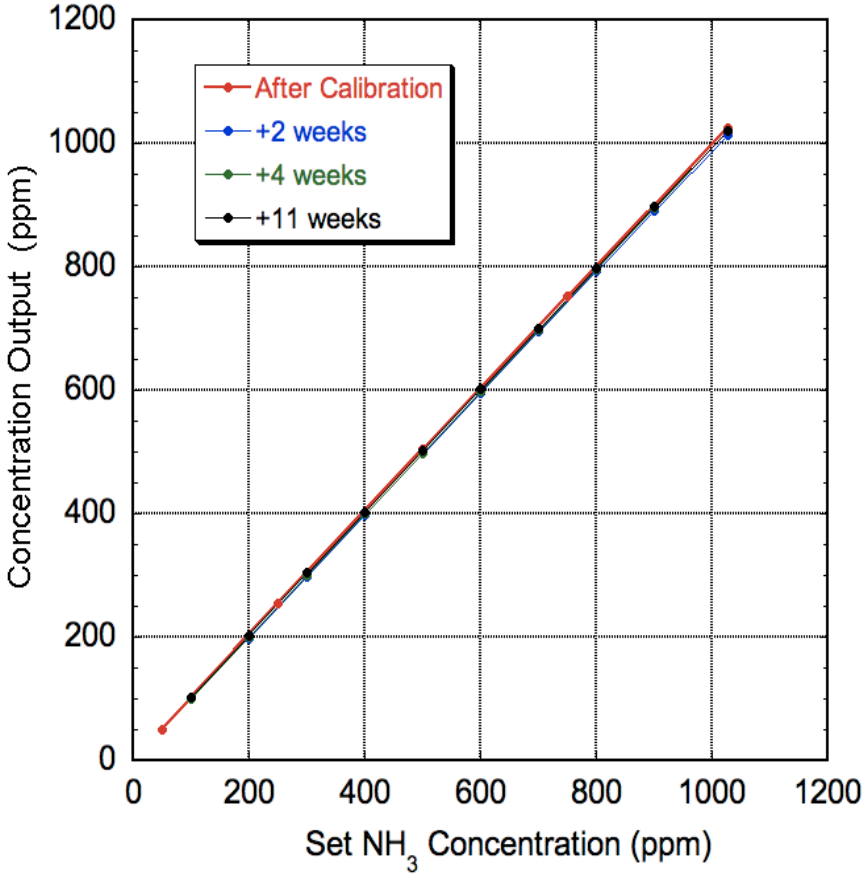




- resolution

LGD F200 NH3 - measurements





- linearity
- reproducibility

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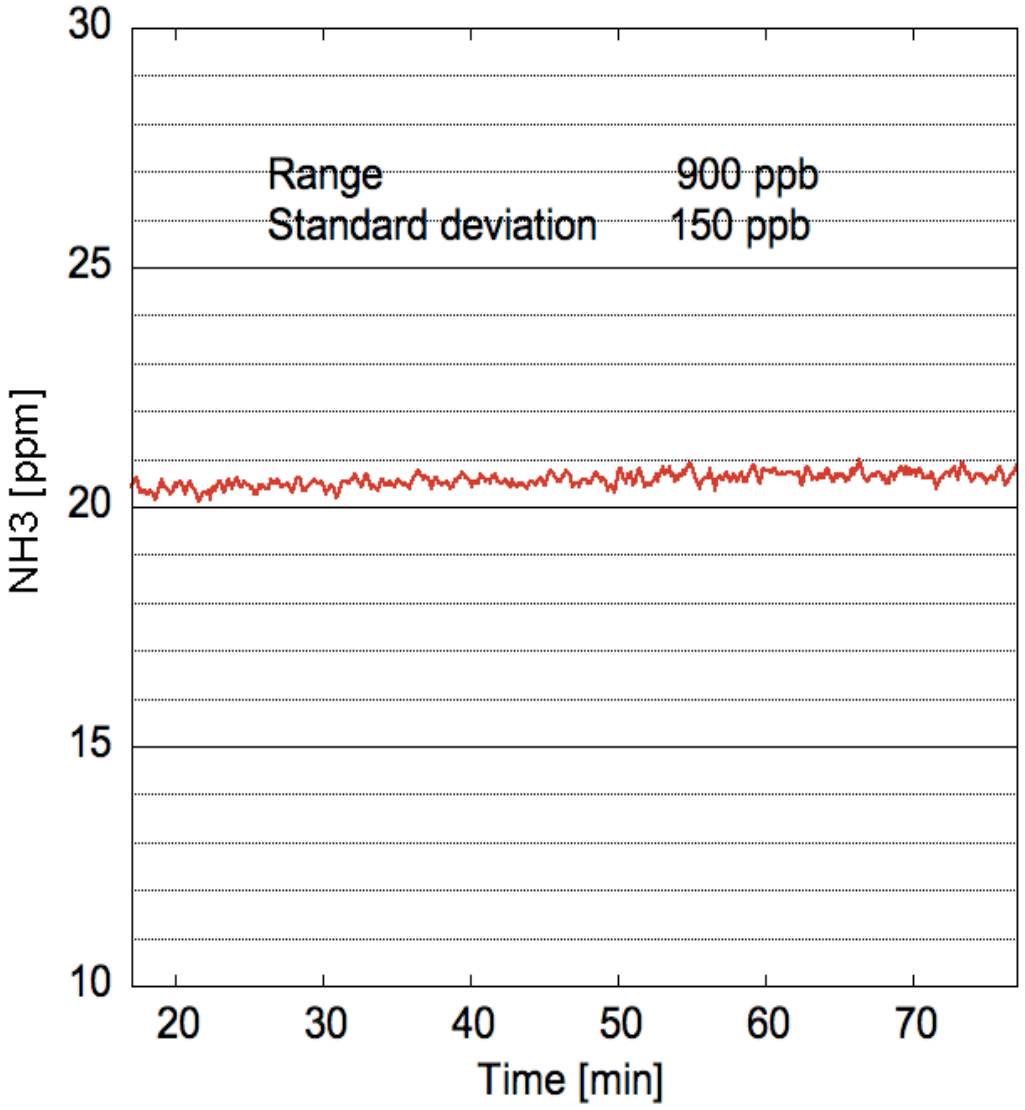
LGD F200 NH3 - measurements



Safety / Refrigeration

Main application specific USP	Selectivity Reliability Cost-over-time
Precision at T = const.: Peak-to-Peak Noise -40°C – 65°C:	0.3 ppm 2 ppm

Plant & personnel safety monitoring

- Workplace and site safety monitoring: 1-100 ppm
- Current sensors:
  - Life time ~ 12 months, 6-months calibration cycle
  - High cost for end-user
  - No sensor status monitoring
  - Cross sensitivities / false alarms
- microLGD offers better performance at lower cost-over-time

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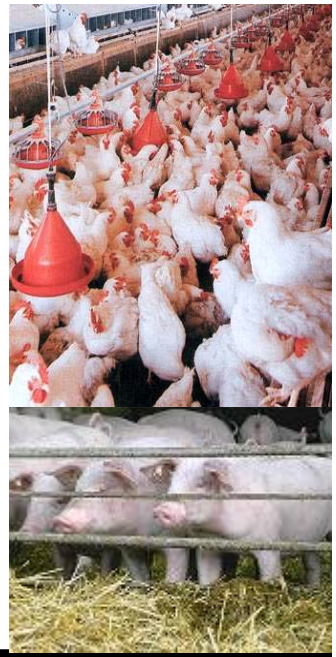
Livestock Climate Control

Main application specific USP	Life-time Cost-over-time
Precision at T = const.: Peak-to-Peak Noise -40°C – 65°C:	0.3 ppm 2 ppm

Ventilation Control & Ammonia Scrubbing

- Monitor NH_3 to improve health and growth of livestock
- Scrubb NH_3 out of exhaust air for environmental protection
- Well-suited sensors are not available today
- Current sensors:
  - Life time shortened to days by NH_3 background
  - Cross sensitivities
- microLGD enables livestock applications



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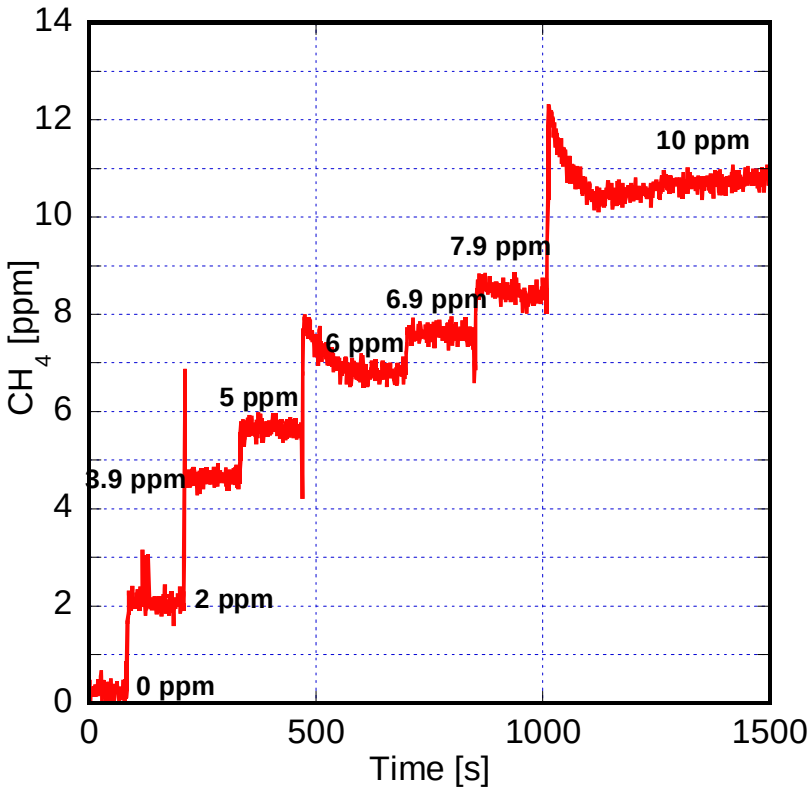
Environmental Monitoring

Main application specific USP	Selective High dynam. range
Precision at T = const.: Peak-to-Peak Noise -40°C – 65°C:	0.3 ppm 3 ppm

Landfill / waste water gas monitoring

- Monitoring of waste water for CH_4 emission; landfill de-gasing (safety)
- LGD F200 offers real time, monitoring with high dynamic range
- Selective measurement of methane



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Summary

- The optical, **non-contact** measurement principle and the intrinsic reference channel and the **high selectivity** offer significant benefit in a wide range of applications.
- TDLS moves from high end to upper medium end applications, component cost hinder further penetration into mainstream applications.
- Leister offers self-contained laser gas monitoring systems to OEMs to use the benefits of this technology in their field of activity.

Thank you for your attention!