

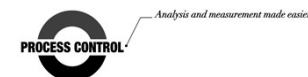


ABB ANALYTICAL MEASUREMENT

# ABB LGR-ICOS™ Product Line

Matthew Montague of ABB and Fredrik Pettersen of Process Control

2021  
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**ABB**

# ABB Quebec Factory

## Measurement products– Québec, Qc

### Our History

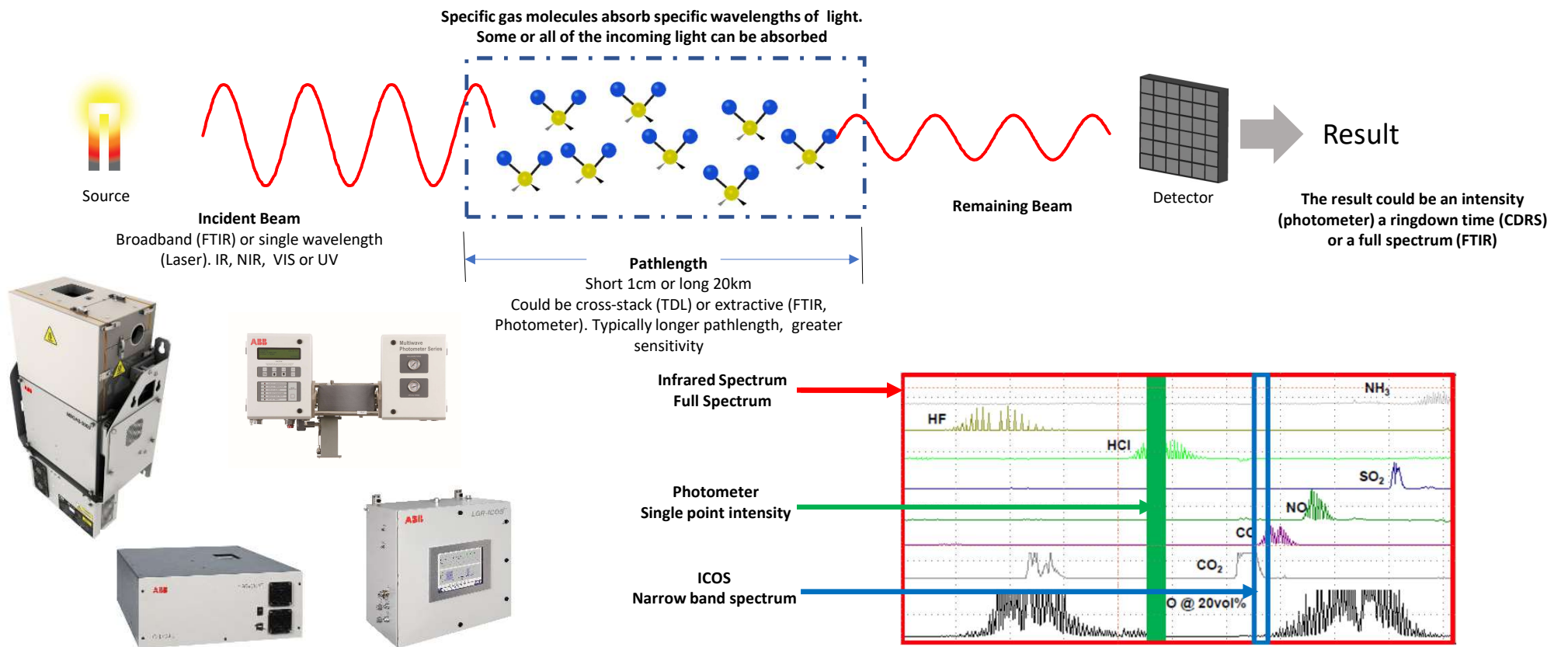
- Company started as Bomem in 1973 as the pioneer of FTIR technology
- Joined ABB group in 1999
- More than 250 employees in Quebec (>100 engineers & scientists)
- The largest R&D group in Measurement & Analytics Business Unit
- Reference site for best business practices
- **ISO 9001** since 1995, **ISO 14001** since 2016; certified **LEED Bronze**
- Operational excellence culture
- Recognized expertise in optics
- Global mandate for infrared applications
- Diversification of technology
- LIDAR: Level measurement added to our portfolio in 2012
- Transformer health monitoring instruments launched in 2015
- Guided Wave Radar: added to our level measurement line of products in 2017
- OA-ICOS technology: gas analyzers from LGR added to our portfolio in 2017
- Continuous Water Analyzers, Multiwave and RVP line of products transferred in 2019



March 8, 2021



# Basics of Optical Measurements



# OA-ICOS: Off-Axis Integrated Cavity Output Spectroscopy

The latest evolution in TDLAS

1<sup>st</sup>: TDLAS (tunable diode laser absorption spectroscopy)  
[First papers mentioning tunable diode laser for spectroscopy date from the 60's]



+Sensitivity

2<sup>nd</sup>: CRDS (cavity ringdown spectroscopy)  
[First paper mentioning CRDS using TDL date from the 1988 (Anthony O'keefe, LGR founder)]



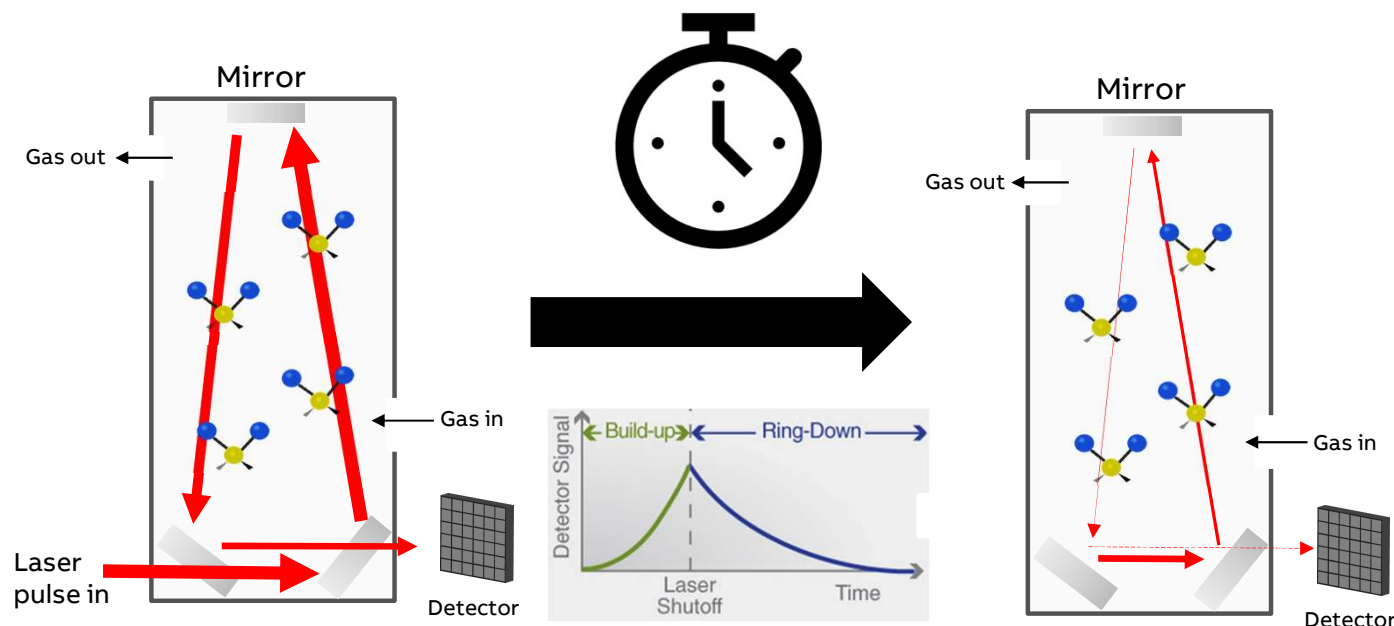
+ Accuracy and ruggedness/serviceability

3<sup>rd</sup>: OA-ICOS (off-axis integrated cavity output spectroscopy)  
[1<sup>st</sup> generation OA-ICOS patent filed in 2001, published in 2004 (Los Gatos Research)]

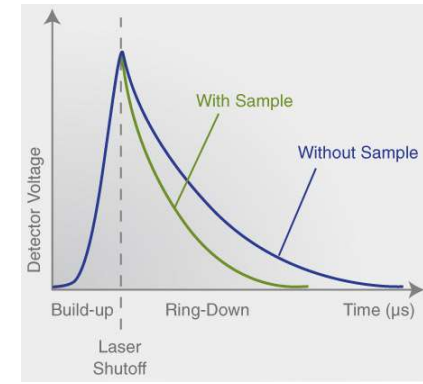
ABB now uses 4<sup>th</sup> generation OA-ICOS technology in the LGR-ICOS™ analyzers

# Conventional Cavity Ringdown Spectroscopy

## Sensitivity



Laser is pulsed into the cavity (cell) and time taken to decay is measured  
“Ring-down time” is simply the time for the laser intensity to decay to zero



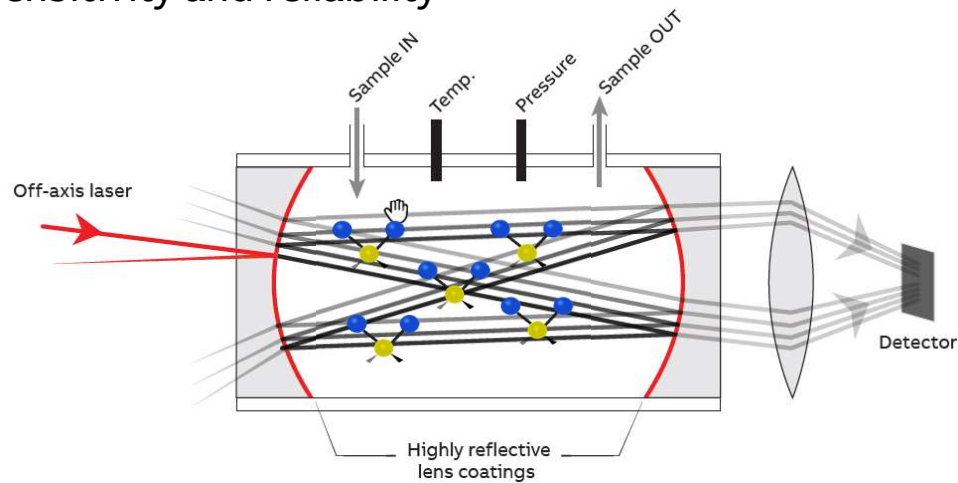
The higher the concentration of gas the quicker the light is absorbed thus the smaller the “ring-down” time. The ring-down time is used to determine the concentration of the gas

Advancements compared to TDL

- Lower limits of detection (LOD)
- Enhanced sensitivity (ppb)
- Challenges with, mirror alignment and contamination on mirrors

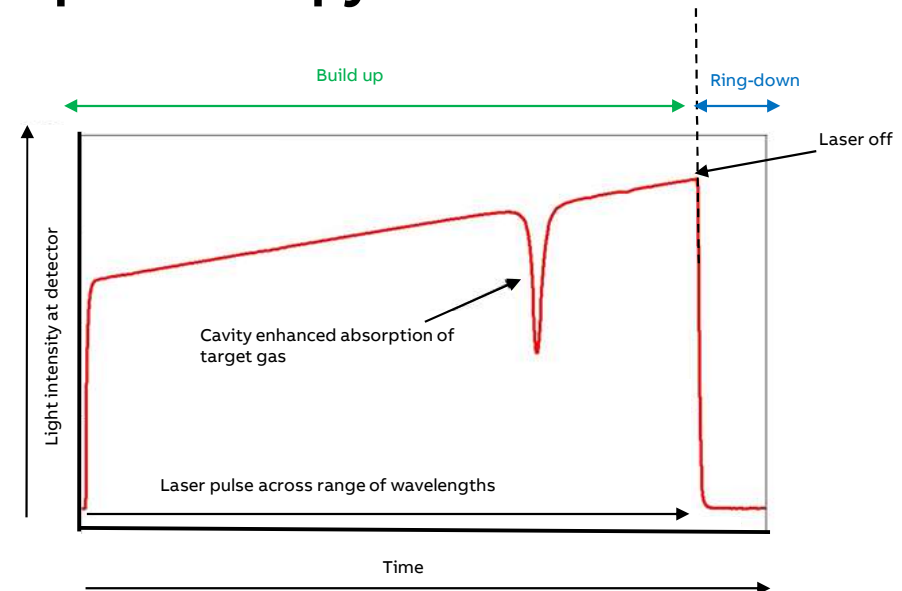
# OA-ICOS: Off-Axis Integrated Cavity Output Spectroscopy

Sensitivity and reliability



An improvement on Cavity Ringdown Spectroscopy

- Laser pulse wavelength sweeps enters the cell and “leaks” out through the mirror onto the detector
- Both a Narrow band (2cm<sup>-1</sup>) spectrum is measured as well a ringdown time for every scan.
- Same long pathlength and sensitivity as CRDS but with extra spectral information
- More robust optical design without the problems of mirror alignment or fouling

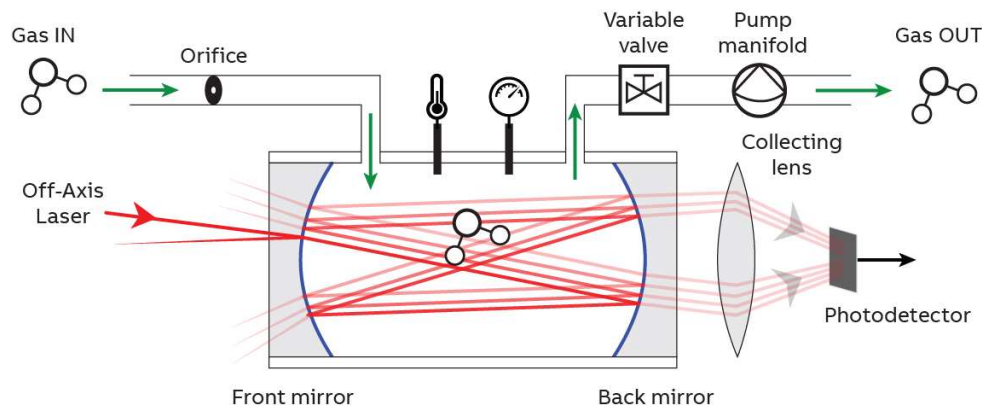


- Ring-down time measures the pathlength
- Spectrum used to determine gas concentration

# OA-ICOS: Off-Axis Integrated Cavity Output Spectroscopy

## Design basics

### OA-ICOS concept diagram

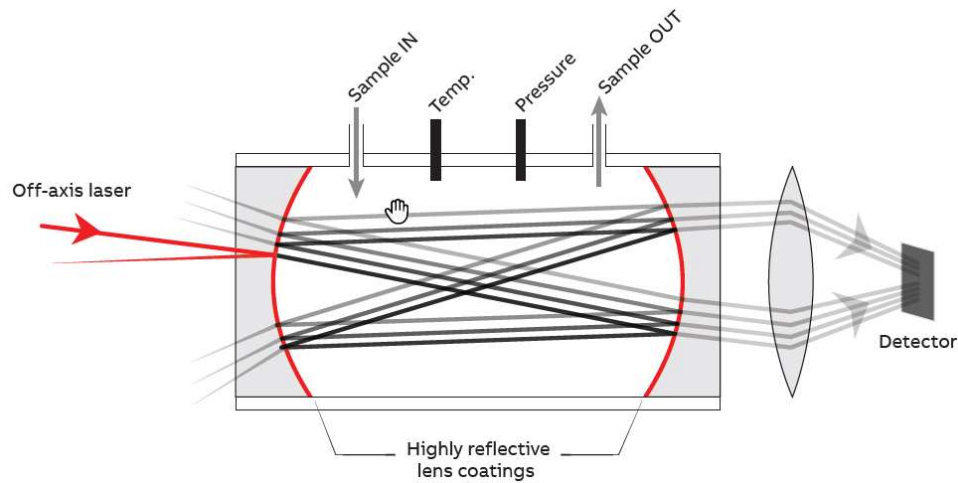


### Key points

- High intensity laser trapped in cavity by high reflective mirrors
  - Very long pathlengths (>20km). More chances of being absorbed by gas molecules, more sensitivity
- Off-axis laser and curved mirrors
  - 2 laser per cavity, more measurements with same analyser
  - More robust to alignment drift/shifts, more stable measurements, less maintenance
- Sub-atmospheric pressure inside the cavity/plumbing
  - Spectral features easier to resolve, more reliable measurements
- Wide dynamic range, can measure very low AND very high levels
- Not limited to infrared light, IR/ Near-UV/ Visible LED

# ABB OA-ICOS Technology Advantages

Focus on process hardware. Simple Low Maintenance



Optical design stable against vibrations and mechanical drifts

Long MTTF parts

Field-serviceable

- Infrequent
- Easy
- Fast
- Economical

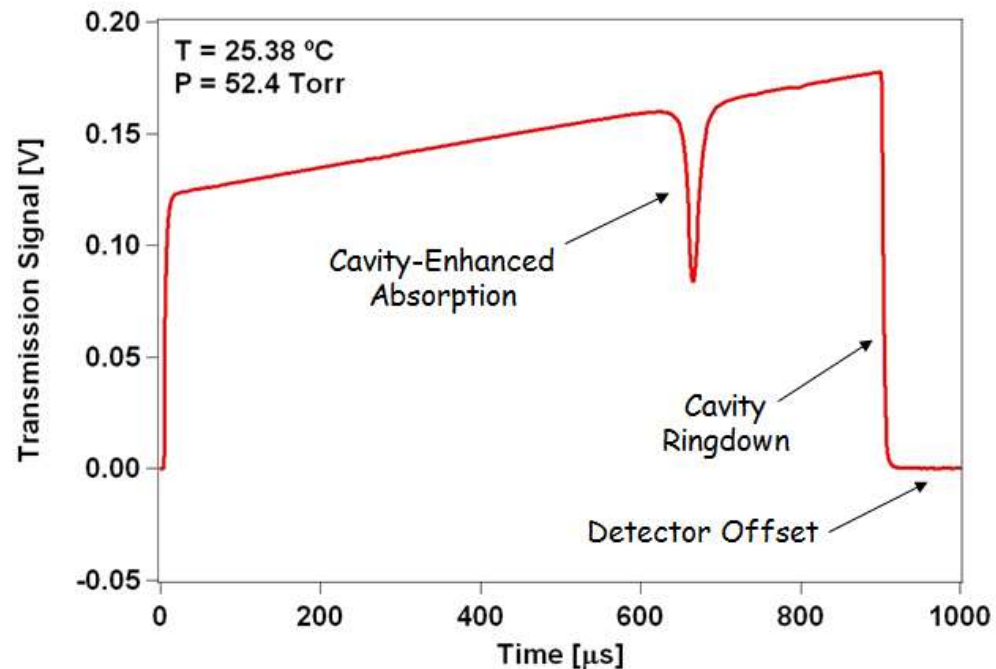




# Cavity Enhanced Absorption Spectroscopy

Measures high-resolution spectra, yields accurate data

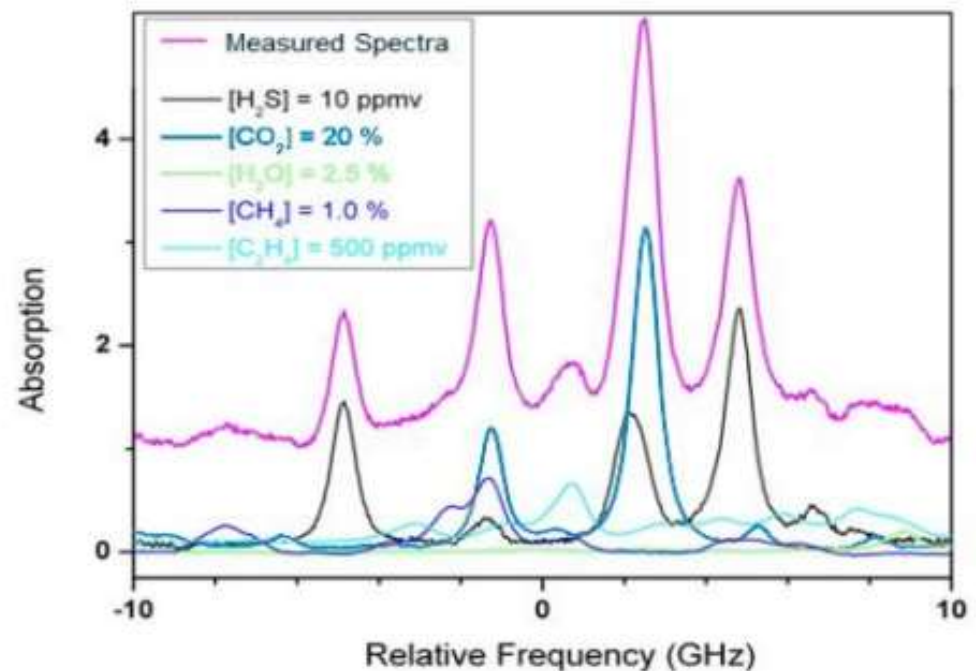
- Cavity pressure at 1/10 to 1/15 of 1.0 Atm Operating at lower than ambient pressure narrows spectral peaks and improves the spectral “fit”
- Baseline, absorption, detector offset and Ring down time are measured in every scan to confirm path length at every data point!
- Scan laser at 100-1000 Hz, measurements every 1-10 ms. Averaging ~ 1 sec of data (typical)



## Unique ability for multiple integration capability

Highly resolved Voigt fit integration plus Chemometrics fit

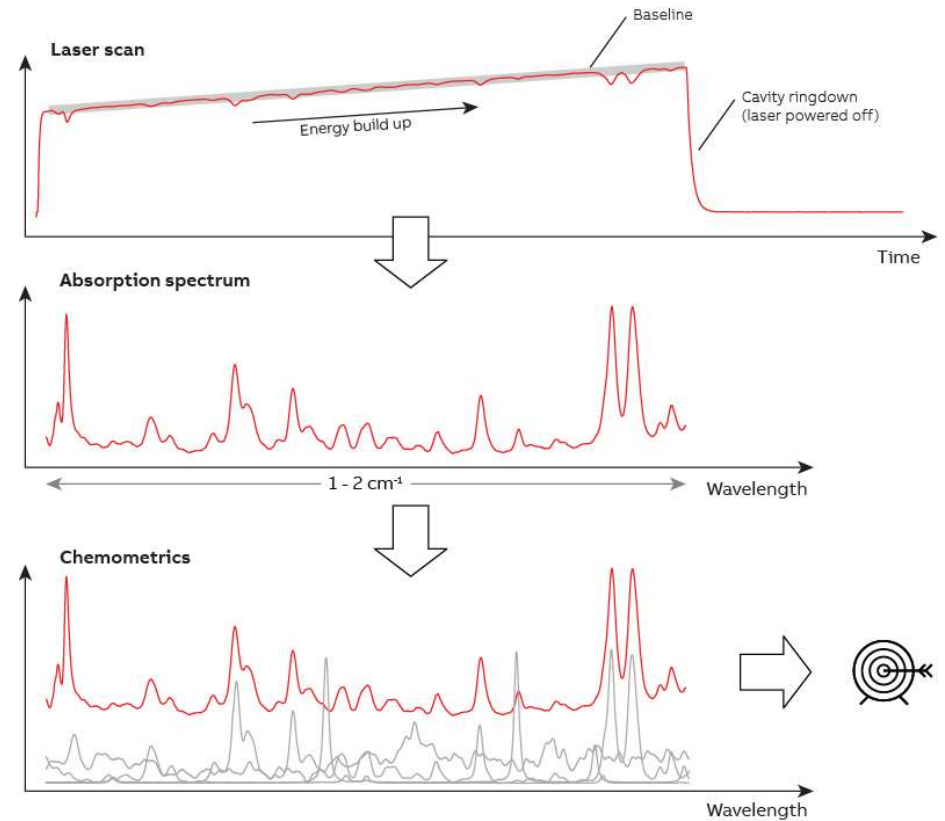
- ICOS provides a spectrum if the sample not just a single ring-down time.
- “Chemometrics fit” mode enables quantification of multiple gases in complex mixtures simultaneously with main component Voigt fit
- Enables single-laser instrument to accurately report multiple gas species
- Facilitates challenging process petrochem/chemical applications



# Off-Axis ICOS

## Summary

- 1) Scan laser → Transmission spectrum
  - 2) Turn off laser → Cavity ringdown (effective pathlength)
  - 3) Calculate absorption spectrum
  - 4) Run ICOS algorithms
- Proprietary algorithms enables quantification of multiple gases in complex mixtures
  - Allows a single laser instrument to report multiple species simultaneously
  - Analyze complex spectra by measuring basis set spectra and convoluting
  - Low pressure of ICOS analyzer provide sharper peaks
  - Unlike traditional CRDS ICOS generates an actual spectrum. In conventional CRDS the ring-down time provide the concentration in ICOS the ring-down time is used only for pathlength determination.



## ABB solution

Advantages improve speed and efficiency

Feature	Specification	Advantage
<b>Accurate, Calibration-Free</b>	Accurate to better than 1% without calibration and only infrequent verification.	1 <sup>st</sup> principles measurement technology
<b>High Sensitivity</b>	Detect contaminants at ppt/ppb-levels	Provides very long optical path length (> km)
<b>Fast</b>	T <sub>90</sub> < 15 seconds allows for process control and real-time monitoring	Low volume cell and fast flow rate
	Quick refresh rate for ultra-precise time measurement	Scan laser at 100 – 1000 Hz
<b>Highly Selective</b>	No cross-interferences between measured compounds or background matrices	High-resolution diode laser absorption technology
<b>Large Linear Dynamic Range</b>	Accurately quantify both trace and percent levels for measurements during routine operation and excursion events	Effective optical path length decreases with absorption
<b>No Consumables</b>	Reduces cost of ownership associated with maintenance and consumables	Sample is directly measured with little to no conditioning
<b>Remote Operation and Diagnostics</b>	Further reduces cost of ownership due to maintenance	Analyzer can be remotely accessed

# ABB offering for natural gas applications

## Natural Gas

### GLA531 series



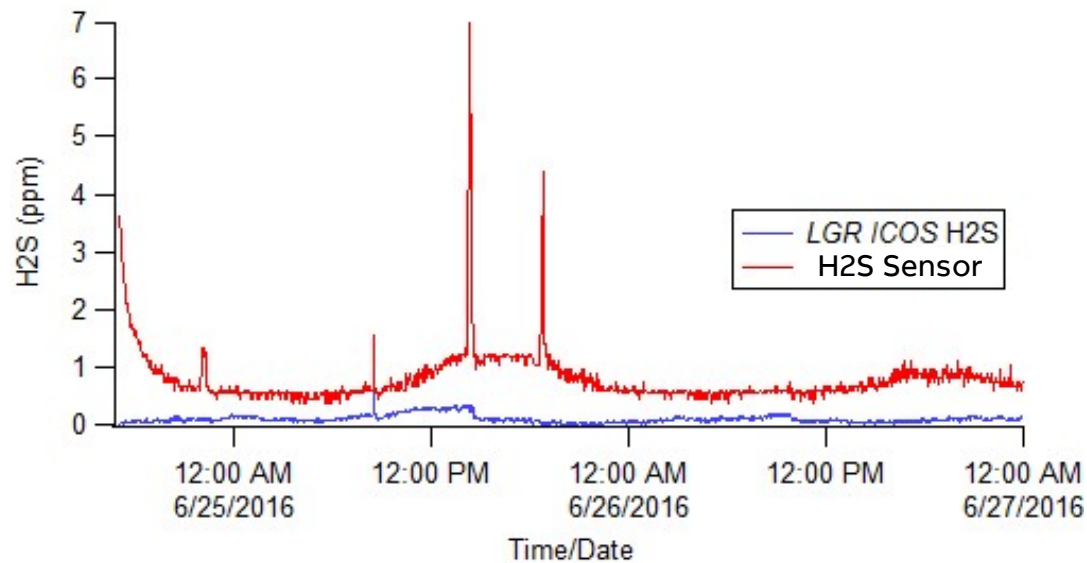
Contaminants	LOD	Upper Range
H <sub>2</sub> S	<u>0.02 ppm</u>	500 ppm
H <sub>2</sub> O	0.5 ppm	200 ppm
CO <sub>2</sub>	12 ppm	240000 ppm
O <sub>2</sub>	1 ppm	20000 ppm

### Natural Gas Transmission

- Fast
- Sensitive
- Simple direct measurement
- No complex SCS or pretreatment
- No scrubber no chromatography

## Natural gas

### Trace Measurements of H<sub>2</sub>S (Canada)



- LGR-ICOS H<sub>2</sub>S measurement is faster, more precise and accurate than current sensor
- Current H<sub>2</sub>S sensor exhibits drift and cross-interferences, giving false trend data
- Occasionally, current H<sub>2</sub>S sensor exceeds alarm levels, though the H<sub>2</sub>S is actually acceptable

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## Natural Gas

Installation in Norway - Alvheim – AkerBP

### H<sub>2</sub>S and O<sub>2</sub> in Natural Gas (along with NGC 8206)



### Testimonial transferred from Norway

*Two NGC 8206 to handle C1 to C6 and an LGR 950 to handle O<sub>2</sub> and H<sub>2</sub>S in very low concentrations with extreme accuracy and reliability.*

*Comment from customers installers:*

*The performance of the H<sub>2</sub>S measurement is amazing. Response of the unit is good, and analyzer is showing the same values as calibration bottle certificates (0, 0.6, 2.5ppm)*



# Natural Gas

Johan Sverdrup platform Norway

H<sub>2</sub>S Content in export gas

H<sub>2</sub>S concentration below 2ppm





## Natural Gas measurement performances

Typical analyzer configurations (<6% C2+ HC's)

Configurations	# Lasers	H <sub>2</sub> S (ppm)	H <sub>2</sub> O (ppm)	CO <sub>2</sub> (units)	O <sub>2</sub> (units)
H <sub>2</sub> S/CO <sub>2</sub>	1	0.02-500		12-240000 ppm	
H <sub>2</sub> S/CO <sub>2</sub> /Trace H <sub>2</sub> O	2	0.02-500	0.5-200	12-240000 ppm	
H <sub>2</sub> S/CO <sub>2</sub> /Trace O <sub>2</sub>	2	0.02-500		12-240000 ppm	1-20000 ppm

## ABB solution: ICOS

### Advantages

Performance feature	ICOS
Calibration-Free	✓
Fast	✓
Highly Selective	✓
High Sensitivity	✓
Minimal Maintenance	✓
No Consumables	✓
No Zero Point Drift	✓
Large Linear Dynamic Range	✓

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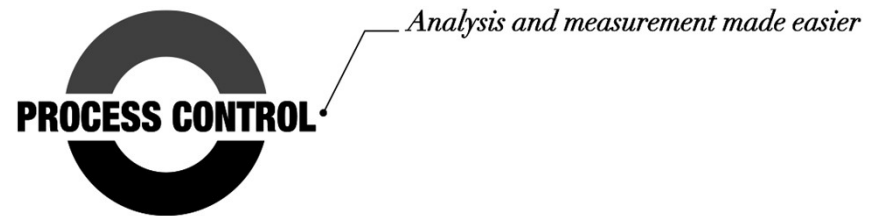
## Thanks for listening

Any questions?



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