

## LGR-ICOS Advantage

### A technology of the future, now

All LGR-ICOS analyzers utilize a unique laser absorption technology called Off-Axis Integrated Cavity Output Spectroscopy (OA-ICOS). This ABB-patented technique **offers numerous advantages** compared to other laser-based techniques, but is also regarded as being **disruptive** in the industrial world as it displaces long-established measurement technologies such as lead acetate tapes, chilled mirrors, NDIR, FTIR, electrochemical sensors, gas chromatography, paramagnetic sensors or mass spectrometry in various applications.

Cavity enhanced absorption was first developed as an ultra-sensitive detection method by LGR (now ABB) founder Anthony O'Keefe in 1988<sup>1</sup> in the form of CRDS. While innovative, this first-generation technique requires sub-nanometer alignment of its internal optics, which

translates directly into limitations in terms of high cost, reliability, and vulnerability to vibrations and temperature/pressure changes.

To overcome these drawbacks, our scientists developed, and subsequently patented, a fourth-generation cavity enhanced laser absorption technology called OA-ICOS. This approach represents the **latest advance** in tunable diode laser absorption spectroscopy and delivers **superior performance and reliability**, yet is orders-of-magnitude less sensitive to internal alignment of components and to variations in local temperature and pressure. As a result, OA-ICOS is ideal for use in commercial instruments for even the most demanding applications in remote and/or hazardous locations.

#### Superior performance

Advantage	Benefit	Feature and explanation
Ultra-High Sensitivity	Detect contaminants at ppt/ppb-levels	<b>Provides very long optical pathlength (&gt;&gt; 1000 m)</b> – We use high reflectivity mirrors, high quality optics and high quality electronics.
Accurate / Highly Selective	High accuracy to optimize process monitoring and control	<b>Minimizes cross-interferences through the use of high-resolution diode laser absorption technology, low pressure and algorithms</b> – Our unique technology produces absorption spectra with very narrow bands that can be fitted to remove the remaining cross-interference effects of other compounds in the gas stream.
Fast	<b>T<sub>90</sub> &lt; 10-30 seconds allows for process control and real-time monitoring</b>	<b>Optimal volume-to-surface ratio, fast flow rate and coatings</b> – We optimize the volume-to-surface ratio and use special coatings to minimize memory effects for sticky contaminants like ammonia. When required, external pumps can provide an increased flow rate to optimize performances further.
	<b>Quick refresh rate for ultra-precise time measurement</b>	<b>Extremely fast electronics</b> – We collect a single scan at 100 – 1000 Hz. Even within 0.1 second, scans can be coadded to optimize SNR significantly. User can select up to 100 seconds for further improvements.
Wide Linear Dynamic Range	<b>Accurately quantify both trace and % levels for measurements during routine operation and excursion events</b>	<b>Effective optical pathlength decreases with absorption</b> – Each bounce on the rear mirror means a few photons escape. The final transmission intensity is then higher than for direct absorption which increases the range before saturation occurs. ICOS also measures the ringdown time i.e. the time for the photons inside the cavity to exit once the laser is reset. This ringdown time represents the rate at which photons exit the cavity at each bounce therefore compensating the higher transmission for the analyte.

<sup>1</sup>Review of Scientific Instruments (ISSN 0034-6748), vol. 59, Dec. 1988, p. 2544-2551

## Low cost of ownership

Advantage	Benefit	Feature and explanation
<b>Ruggedness</b>	Higher stability, minimal downtime (low maintenance)	<b>Overall sturdiness and tolerant optical design</b> – Our design inherently provides more stability towards vibrations, extreme temperatures and measurement drifts through the use of parabolic mirrors that keep light within the optical path even if mechanical parts drift. We also rely on state-of-the-art components and high quality engineering and manufacturing.
<b>Easier, faster and cheaper maintenance</b>	<b>Low cost of ownership, minimal downtime (field serviceable)</b>	<b>Smart design</b> – Parts that can be subject to long term contamination (filters) and normal aging (pump diaphragm) or that can be exposed to abnormal amounts of contamination during extraordinary events (mirrors) can all be replaced easily, even by untrained personnel when need be. Most other components can be diagnosed and replaced in the field by our service engineers.
<b>Remote Operation and Diagnostics</b>	<b>Further reduces cost of ownership due to maintenance</b>	<b>Analyzer can be remotely accessed</b> – All analyzers can be equipped with a wireless router to access the user interface, including with TeamViewer for distant internet connections by service team.
<b>Calibration free</b>	<b>No calibration efforts needed and only infrequent verifications</b>	<b>1<sup>st</sup> principles measurement technology</b> – Along with the collection of high-resolution absorption spectra, we use ultraprecise measurements of several parameters (including T°, P, ringdown time) and feed it to our in-house algorithm to resolve the Beer-Lambert law without the use of primary reference methods.
<b>No Consumables</b>	<b>Reduces cost of ownership associated with maintenance and consumables</b>	<b>Sample is directly measured with little to no conditioning</b> – Our design inherently eliminates the use of columns, carrier gas, tapes, solvents or scrubbers.
<b>No Zero Point Drift</b>	<b>No need to periodically calibrate using zero gas</b>	<b>Measured spectra includes baseline</b> – Each scan starts at a base current which is measured. If this base current shifts, the whole spectra (each scan) is compensated accordingly.

### Note

Analyzers based on conventional cavity ring down spectroscopy (CRDS) **require** high temperature and pressure stability to operate. Without such control, changes in cavity mirror position or laser wavelength preclude effective measurements. As a result, some CRDS companies tout their high pressure and temperature stability as a feature while in fact such as attributes are requirements that increase cost and complexity and decrease reliability.

Analyzers based on ABB-LGR's patented off-axis ICOS technology **do not require** such stability to provide exceptional performance. This allows us to provide remarkably simple, robust and easy to service gas and isotope analyzers for applications involving measurements almost anywhere without modification, including onboard planes, or even UAV.

For applications demanding long-term stability and utmost performance, we offer our Enhanced Performance series (with 0.005 Kelvin and 0.0001 atm stability). Thus, we can provide you a selection to best match both your requirements and budget.

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