LEADING SUSTAINABLE SHIPPING TECHNOLOGIES FORUM · HAMBURG · 25 JUNE 2026

From Estimation to Measurement

Calibration-free laser spectroscopy with dilution sampling — focused on accurate methane-slip measurement from LNG engines, reported as CO_2e for compliance.

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Combining the OXYDAN® DP7900 dilution probe

with ABB OA-ICOS calibration-free laser spectroscopy

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A bridge toward low-GHG methane — not the destination

DNV frames LNG as a possible bridging fuel — fuel oil → LNG → low-GHG methane (bio-methane and e-methane) — resting on three pillars: ship technology, low-GHG methane availability and bunkering infrastructure. The climate case is conditional, which is precisely why measuring methane slip matters.

A mature bridge today

Over 800 LNG-capable ships are in service, plus around 700 LNG carriers running on boil-off gas — with 600+ more ships and roughly 300 carriers on order. Proven engines and bunkering make LNG a practical near-term step.

Real but conditional gains

Up to ~90% lower NOx, near-elimination of SOx and a marked reduction in particulates. The GHG benefit versus fuel oil is genuine but varies with engine type and methane slip — fossil LNG may keep ships FuelEU-compliant into the mid-2030s.

Measurement extends it

DNV notes measurement-based slip factors can beat defaults — an advantage for modern dual-fuel engines. Ship-specific CH_4 data can extend compliance horizons, reinforcing the case for more continuous, methane-specific monitoring systems.

DNV's view: the LNG bridge appears promising, but uptake depends on the availability, cost and regulation of low-GHG methane — and on the sector's willingness to pay for it.

THE METHANE-SLIP DATA GAP

From fixed default factors and snapshots to continuous methane data

As dual-fuel LNG engines — widely viewed as a bridging fuel toward lower-GHG methane — are ordered in growing numbers, methane slip matters more. It is real and variable, yet still counted with fixed default factors, with most public data from short campaigns.

The gap

Few long-term shipboard datasets pair a methane-specific cavity laser (OA-ICOS) with a robust marine exhaust gas dilution sampling system — the combination needed for continuous, selective slip data.

The step needed

Longer-duration, ship-relevant datasets from a selective methane method under stable, well-controlled sampling conditions.

Our approach

DP7900 dilution with OA-ICOS measurement — continuous, time-resolved slip data that quantifies load-dependent slip and supports EU ETS and FuelEU verification.

Not to replace other methods — to add a continuous, reference-quality methane dataset that can help harmonise future measurement.

A REAL-WORLD EXAMPLE

Methane slip is not a fixed number

1.57%

annual methane slip — Salamanca

vs FuelEU 3.1% · IMO LCA 3.5% defaults

6.4%

ICCT FUMES avg — 18 LPDF 4-stroke ships

77% of measurements above default

Two ends of the same range

Salamanca's low figure reflects her operating profile — long crossings at high, stable engine load, where methane slip is lower (Sagot et al., 2025). ICCT's FUMES plume study of the broader LPDF four-stroke fleet found the opposite: an average well above default, with slip highest at low engine loads.

Detection method shapes the number. Lehtoranta et al. showed that well-maintained FTIR and NDIR can agree closely for methane slip measurements. In the ICCT/FUMES land-based cross-instrument comparison, HORIBA HFID and ABB LGR-ICOS GLA131-GGA were both included; based on our corrected internal comparison, the methane-specific OA-ICOS result was approximately 20% lower than the co-located Horiba HFID in part of the land test.

Some vessels beat the default factors, others exceed them — which is why reliable regulation is best supported by robust, ship-specific measurement, not generic assumptions alone.

THE DP7900 DILUTION PROBE · 1993

Designed for ships

Building on earlier company dilution probes, the DP7900 was engineered to be more reliable and dramatically simpler to maintain.

That low-maintenance design is not a convenience — at sea it is a necessity. There are no fixed service intervals — the Smart sampler tells you when service is due — and in practice we see required intervals stretch to two sometimes to three years.

Reliable by design

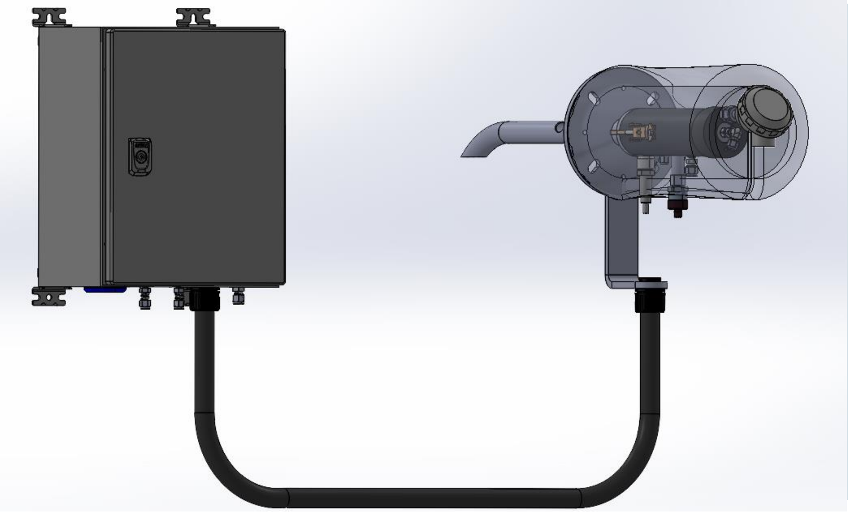
Fewer failure points and robust dilution geometry for continuous unattended operation.

Simple to maintain

Crew can normally carry out the required maintenance on-board — no specialist needed.

Built for the marine reality

Monitored from land — the Smart sampler self-monitors, reporting status locally or via IIoT (HiveMQ, MQTT).



No fixed service intervals – tells when

OXYDAN® DP7900

Smart Exhaust Gas Sampler — dilution sampling delivered at the probe, proven in marine service for around two decades.

The DP7900 ran on two Silja Line ferries (Stockholm–Helsinki) from 1994 to 2014 — two decades in continuous service.

WHY SAMPLING COMES FIRST

Accuracy starts at the probe

Even the best analyser struggles to recover a number from a poorly conditioned sample. Controlled dilution fixes the conditions before measurement begins.

Stable, repeatable sample conditions

Dilution drops the dew point below ambient (−10 to −20 °C), so no heated sample lines are needed. A clean, dry, conditioned sample keeps the optics and cells stable.

A tamed exhaust matrix

Water, particulates and reactive species are reduced, removing the very things that distort optical and detector readings. With water and CO_2 reduced, the absorption lines of the gases of interest stand out clearly.

Dilution ratio check without bottled span gas

Dilution is controlled and verified against the ambient CO_2 — outside air is measured directly, then fed to the DP7900 probe tip. This verifies the dilution/sampling chain without requiring bottled span gas.

Get the sample right, and the spectroscopy can do what it does best.

ABB OA-ICOS: measuring the molecule itself

Off-Axis Integrated Cavity Output Spectroscopy locks onto specific molecular transitions over an effective path of around 3 km — a first-principles optical reading, without the routine span-gas recalibration conventional analysers typically require.

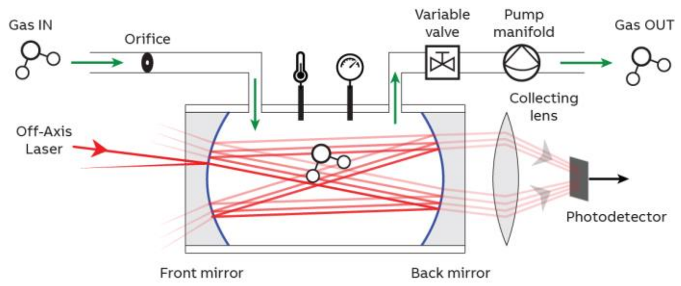


ABB GLA131-GGA

OA-ICOS cavity — off-axis laser, high-reflectivity mirrors, and sub-atmospheric pressure for sharp, well-resolved lines.

KEY ADVANTAGES

- **High accuracy —** absolute, first-principles readings
- **High selectivity —** one molecular transition per gas
- **Low detection limits —** trace CH_4 and N_2O
- **Low drift —** stable across long campaigns
- **Calibration-free operation —** no routine span gases; periodic verification still applies
- **Low maintenance —** field-serviceable, unattended-ready

OA-ICOS — trusted across global GHG science, including Europe's Integrated Carbon Observation System (ICOS) reference network.

Source: ABB LGR-ICOS

ABB

Broad-band absorption vs. a single targeted line

Conventional methods

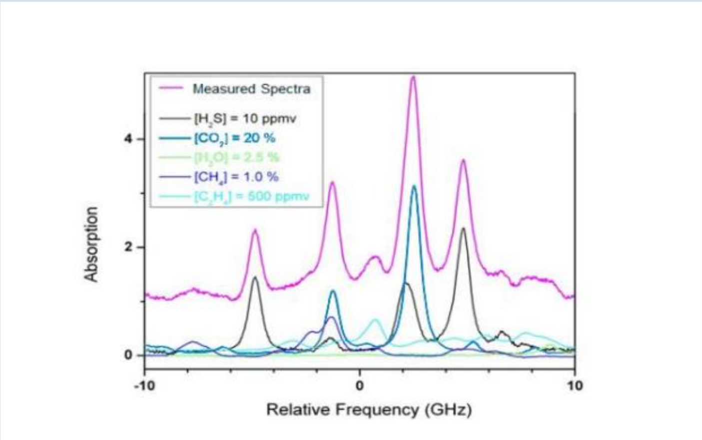
NDIR · IR-GFC · FTIR · HFID

- NDIR, IR-GFC and FTIR rely on spectral bands where overlapping species can interfere.
- HFID measures ionization, not absorption — not methane-specific. Methane estimation based on correction factors.

Narrow-line laser spectroscopy

OA-ICOS

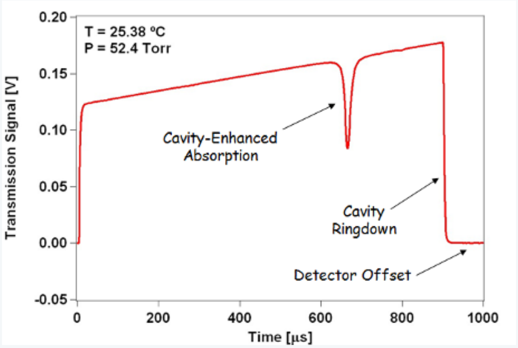
- Tunes to one molecular transition belonging to the target gas alone.
- Interference is designed out, not corrected after the fact.



Selectivity in practice

- CO_2 and CH_4 sit on separate, well-resolved transitions.
- Water and other species fall off the target line.
- Selectivity holds across complex GHG exhaust matrices.

Multi-gas OA-ICOS spectrum · Source: ABB LGR-ICOS



SIDE BY SIDE IN A COMPLEX EXHAUST MATRIX

DP7900 + OA-ICOS vs. conventional analysers

Criterion	DP7900 + OA-ICOS	NDIR	IR-GFC	FTIR	HFID
Selectivity in wet/sooty exhaust	Very high — single line	Moderate — band overlap	Moderate	High but model-dependent	N/A (FID, total HC)
Interference vulnerability	Low by design	High (H_2O, CO_2)	Moderate	Model- and matrix-dependent	Sensitive to O_2 / matrix
Calibration burden	Calibration-free	Regular calibration / verification	Regular	Frequent + modelling	Fuel gas + frequent cal
Drift over long campaigns	Low	Notable	Moderate	Moderate	Notable
Detection limits (trace GHG)	Low (CH_4, N_2O)	Limited	Limited	Variable	CH_4 only with methane-specific correction; not for N_2O
Unattended marine suitability	Strong	Service-dependent	Service-dependent	Complex upkeep	Consumables at sea

Across the criteria that matter at sea, the conditioned-sample and narrow-line pairing performs strongly — and reduces the routine calibration that other approaches typically require.

THE THREE GASES THAT NOW CARRY A PRICE

Purpose-built for CO_2, CH_4 and N_2O

These are exactly the species where selectivity and low detection limits decide whether a reading is defensible — and the DP7900 + OA-ICOS pairing is especially well-suited here.

CO_2

CARBON DIOXIDE

The dominant term in any CO_2e figure. Stable, low-drift readings support defensible EU ETS reporting.

CH_4

METHANE

High global-warming potential at low concentration — where narrow-line detection limits truly count, e.g. methane slip.

N_2O

NITROUS OXIDE

Trace but potent. Easily lost in broad-band noise; cleanly resolved on its own transition.

Reported together as CO_2-equivalent — in line with what regulators increasingly expect.

WHAT INDEPENDENT DEVICE COMPARISONS SHOW

Where CH_4 readings drift high or low

Recent on-engine and onboard studies show that much of the bias can come from sampling, conditioning, selectivity, maintenance and low-ppm performance — not simply from the methane molecule being difficult to measure.

OVERESTIMATE

FID / HFID — total-HC bias

In a six-device test, a heated FID read ~9–12% higher CH_4 than all others; it also needs a non-methane cutter and onboard hydrogen. ***Lehtoranta et al., 2025***

MATRIX INTERFERENCE

GC — water in the column

MicroGC read 8–18% higher than NDIR until residual water was conditioned out; conditioning of the sample decided accuracy. ***Lehtoranta et al., 2025***

SAMPLING SCATTER

Short, unstable sampling

Sea-trial runs as short as ~3 min gave widespread (e.g. 9.1 vs 7.8 g/kWh at ~25% load), where slip rises steeply with falling load. ***Sagot et al., 2025***

LOW-PPM LIMIT

Accuracy fades at low ppm

Past a CH_4 catalyst, devices agreed near 27–29 ppm but diverged at 9–15 ppm — low detection limits matter most post-abatement. ***Lehtoranta et al., 2025***

Most CH_4 error is not the spectroscopy — it is the sample and the method's selectivity. Controlled dilution and calibration-free narrow-line spectroscopy address both.

WHY THIS MATTERS NOW

EU ETS and FuelEU Maritime change the stakes

Shipping is now inside the EU ETS

CO_2 emissions translate directly into surrendered allowances — a real, recurring cost tied to every measured tonne of CO_2e.

FuelEU Maritime widens the scope

A well-to-wake greenhouse-gas intensity limit pulls CH_4 and N_2O into scope, all expressed as CO_2-equivalent.

Reporting must be verifiable

Default factors are widely accepted today — but as the numbers carry real cost, measurement, not estimates, is what withstands closer scrutiny.

Accurate CO_2e reporting now underpins compliance — and a more precise number might help reduce the allowances to surrender.

FROM GOOD-ENOUGH TO AUDIT-READY

From estimation to measurement

YESTERDAY

Estimation

- Default factors and fuel-based assumptions
- Good enough when no money rode on the figure
- Wide tolerances no one had to defend

TODAY

Measurement

- Direct, selective, calibration-free readings
- Defensible to verifiers and tied to real cost
- A truer CO_2e number — and, where measured emissions are lower than defaults, fewer allowances to surrender

Not a new requirement — just the point where a maritime GHG estimate becomes evidence: measured, defensible, and paid for at its true weight.

THE CORE MESSAGE

Accurate GHG measurement needs both halves

Controlled sampling

The DP7900 dilution probe delivers a stable, conditioned, low-maintenance sample — accuracy starts here.

Selective spectroscopy

OA-ICOS targets each molecule on its own line, calibration-free, even in a complex marine matrix.

Neither alone is enough. Together they turn maritime GHG reporting from estimate to evidence — and the EU ETS bill to the real number.

Thank you

I'd be glad to take any questions.

"In more than 35 years as a CEMS service engineer — working with in-situ, heated direct sampling, heated sampling with a gas cooler, Perma-Pure Nafion tube drying, and dilution extractive sampling — my experience points consistently to one conclusion: dilution sampling has been the easiest to work with and the lowest-maintenance of these systems, and the one that delivered the most consistent data capture over time."

Carsten Hansen · Instrumatic Marine A/S

instrumatic.com

References & further reading

On methane-slip measurement methods and CH_4 over/under-estimation

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