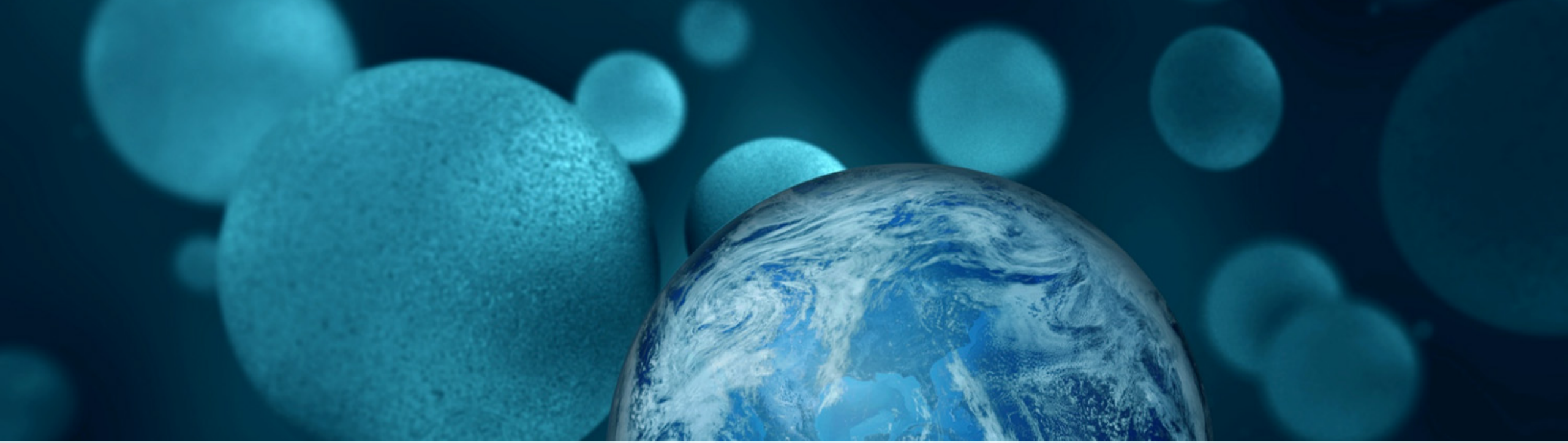


ThermoFisher SCIENTIFIC

Air Liquide and Thermo Fisher Scientific Collaboration

Stable isotope ratio certified N_2, H_2 and CO_2 gases for IRMS

Oliver Schlegel
Offer Deployment Manager
Air Liquide

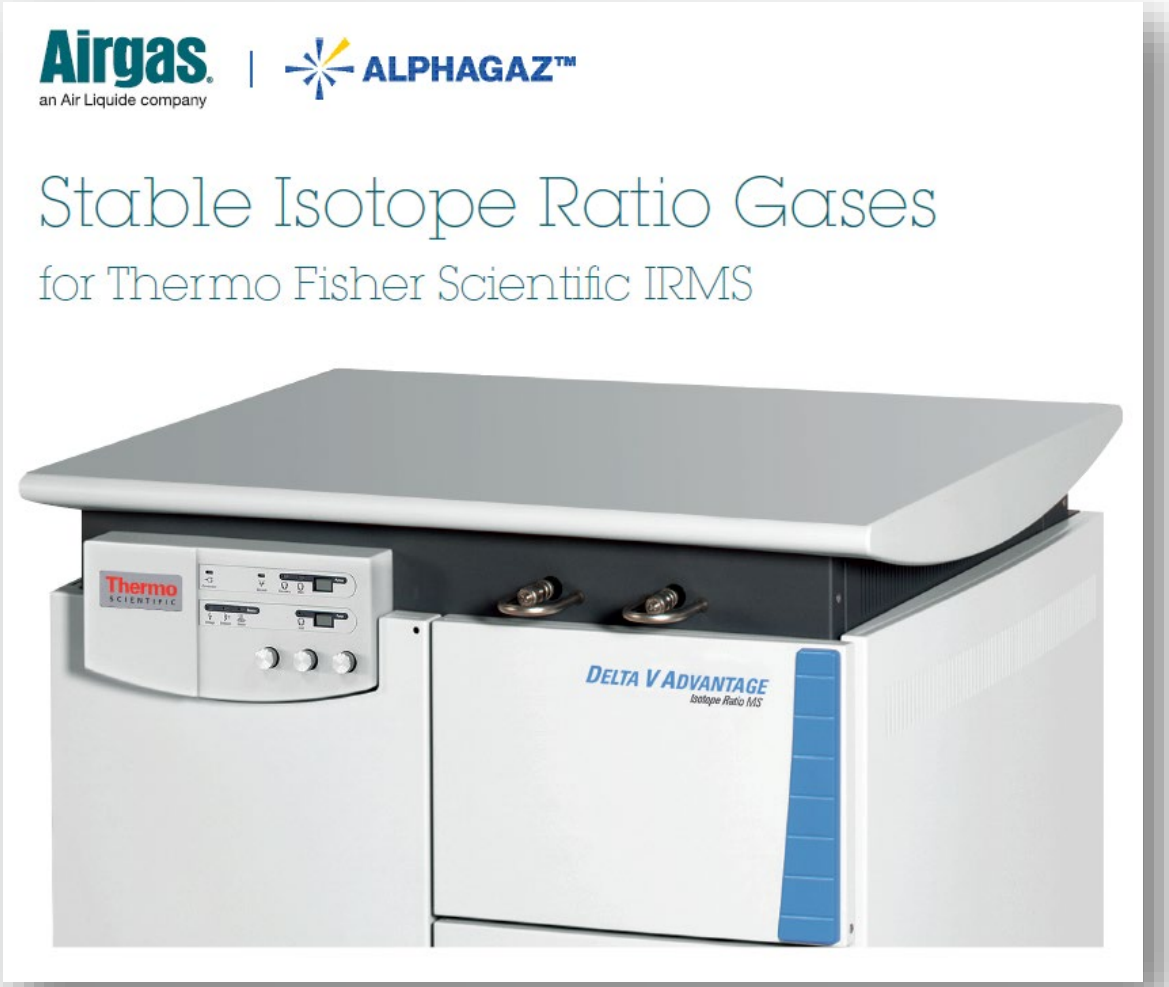
Air Liquide and Thermo Fisher Scientific Collaboration

- Air Liquide in partnership with Thermo Fisher Scientific has established stable isotope certified N_2, H_2 and CO_2 gases
- The aim of this collaboration is to bring to your lab:

✓ **Convenience**

✓ **Confidence**

✓ **Certainty**



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Product Description

Non refillable cylinders

- Gas volume CO_2: 55 liters
- Gas volumes N_2 and H_2: 60 liters
- Nominal pressure: 30-37 bar (420-550 psig)
- Water volume: 1.6 Liters
- Outlet Swagelok connection: C10-5/8"-18 UNF standard
- Weight: 0.4 kg (0.8 lbs)

Other cylinder sizes and packages are available upon request

Low internal volume regulator

- Model: 206BB.single-stage brass regulator
- Compact and light weight
- Low internal dead volumes minimizes purging time
- Delivery Pressure Range: 0.1 – 5 bar Regulator
- Regulator outlet: Swagelok connection: ¼" NPT Outlet to 1/16"
- Weight: 0.6 kg (1.3 lbs)

Airgas
an Air Liquide company

6141 EASTON ROAD, BLDG 1, PLUMSTEADVILLE, PA 18949-0310 Phone: 800-331-4953 Fax: 215-766-7226

CERTIFICATE OF ACCURACY:

Product Information

Part No.:	CD ISO20013CN3
Laboratory No.:	124-Plumsteadville - PA
Cylinder Size:	200
Cylinder No.:	A31964
Expiration Date:	016OCT2021
Cylinder Pressure:	835 psig
CGA Outlet:	320
Net Weight:	23 kg
Gross Weight:	85.80 kg
Fill Temperature:	20°C

CERTIFIED VALUE:

Component Name	Concentration	Isotopic Ratio (‰) $\delta^{13}C$ (vs. VPDB)*
Carbon Dioxide	99.99 %mol/mol	(-2.7 ± 0.5) ‰

*CO_2 isotopic characterization is traceable to the NBS18-NBS19 carbonate standards analyzed as CO_2 extracted by 100% orthophosphoric acid digestion.

APPROVED BY: James L. McHale DATE: 4/2/19

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Isotope Characterized Gases

- Available as Start Up Kits (gas bottle + regulator) or as individual gas bottles

- All δ-values are traceable to primary reference material
  δ ^{13}C in CO_2: Traceable to NBS-18 / NBS-19 - McCrea (1950) or Epstein, et al. (1964)
  δ ^{15}N in N_2: Traceable to NSVEC nitrogen gas standard
  δ ^{2}H in H_2: Traceable to VSMOW-SLAP scale - normalized to GISP - Coplen (1988)

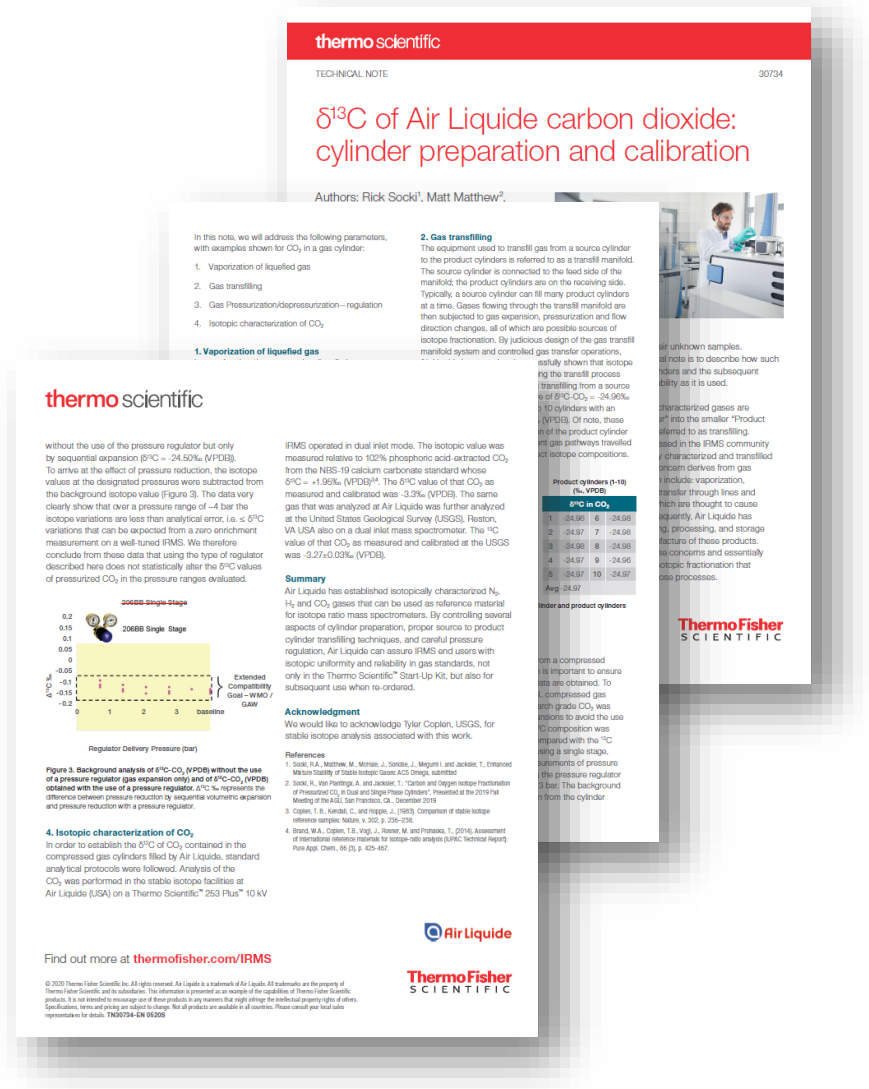
ALPHAGAZ™ Pure Gases		Element	Data value	Uncertainty (‰)	Source Variation (‰)
Carbon Dioxide	CO_2	$\delta^{13}C$ (‰ VPDB)	-25	±0,5	±3
	CO_2	$\delta^{13}C$ (‰ VPDB)	-3	±0,5	±3
Nitrogen	N_2	$\delta^{15}N$ (‰ Air)	0	±0,5	±15
Hydrogen	H_2	$\delta^{2}H$ (‰ VSMOW)	-250	±10	±30

Technical Note – Cylinder Preparation And Calibration

Air Liquide has rigorously validated gas filling, processing, and storage protocols used in the manufacture of these products to directly addresses and eliminate associated isotopic fractionation that commonly accompanies those processes.

Technical note reports:

- Vaporization of liquefied gas
- Gas transfilling
- Gas Pressurization/depressurization—regulation
- Isotopic characterization of CO_2



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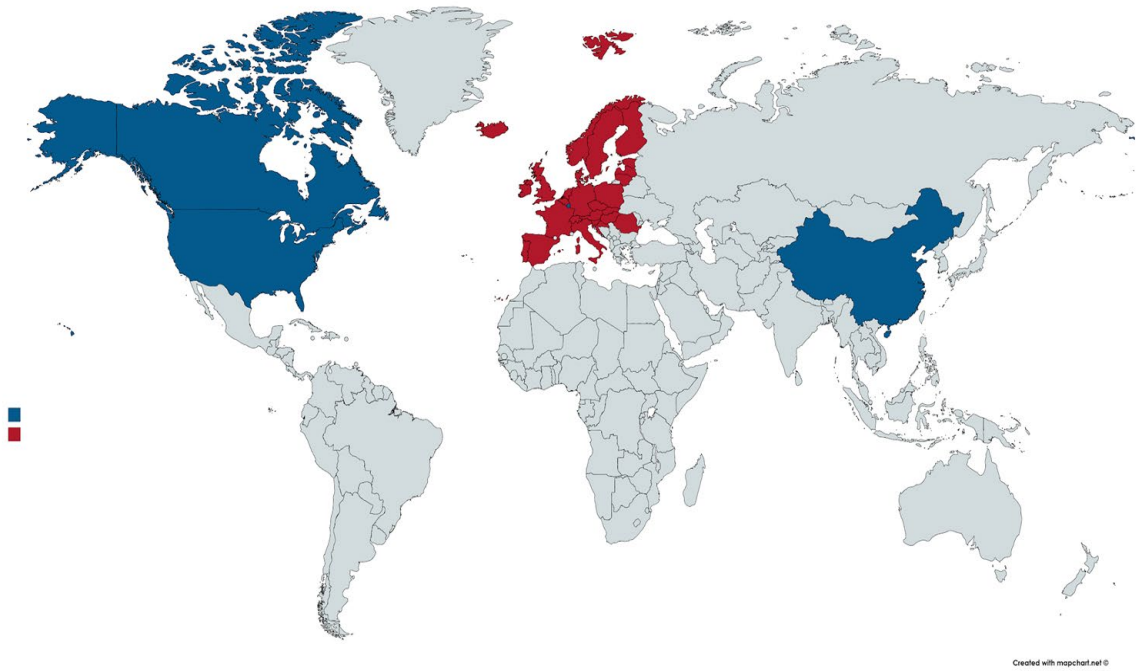
Evaluation - Ail Liquide / USGS Reston Lab, USA (Tyler Coplen)

- Proof-of-concept evaluation – the same gas that was analyzed at Air Liquide was further analyzed at the United States Geological Survey (USGS)

Component	Nominal value	Air Liquide - value on CoA	USGS Value
CO_2	-25 (VPDB)	$\delta^{13}C$ -24.9 ± 0.5‰ (VPDB)	–24.90 ± 0.05 ‰ (VPDB)
CO_2	-3 (VPDB)	$\delta^{13}C$ -3.3 ± 0.5‰ (VPDB)	-3.27 ± 0.03‰ (VPDB)
N_2	~0 (air)	$\delta^{15}N$ -1.9 ± 0.5‰ (air)	-1.90 ± 0.04‰ (air)
H_2	-250 (VSMOW)	$\delta^{2}H$ -253 ± 5‰ (VMSOW)	-250.0 ± 3.3‰ (VSMOW)

Supply Chain

- **Air Liquide Germany**
  27 European Union Members,
  UK, Norway, Switzerland
- **Airgas (Air Liquide Company)**
  USA, Canada, China
  (+ ROW through local Air Liquide affiliates)



Local Air Liquide personnel trained to support customers on site.
Reach out to your regional Thermo Fisher representative for more information on isotopically characterized gases.

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Q&A

Thank you for your attention.