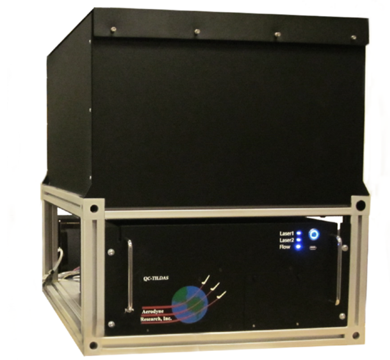
AerodyneResearch

Technology Enhancing Science

TILDAS Dual Laser CO_2 Isotope Analyzer for $\delta^{13}C$, $\delta^{18}O$ and $\Delta^{17}O$

Direct Spectroscopic Measurement of $\Delta^{17}O$ and $\delta^{13}C$ in CO_2 for Geochemistry and Atmospheric Chemistry



Rugged, field-ready instruments

Direct absorption spectroscopy allows for highly specific and accurate gas detection

Mid-IR detection enables maximum measurement sensitivity

Features

- Direct measurement of CO_2 isotopes in air with no chemical processing or separation
- Repeatability < 0.013 ‰ in $\Delta^{17}O$ and < 0.01 ‰ in $\delta^{13}C$ for a 30-minute measurement including a balanced working reference
- Small sample size (~0.25 μmol CO_2 or 15 mL of air) for discrete sample model
- Suitable for samples derived from carbonate via acid digestion
- Automated valve control capable of custom sample scheduling, backgrounds, and calibrations
- 10 Hz time response and 1-sec δ precisions < 0.2 ‰ enable eddy covariance studies for continuous flow model

TILDAS TECHNOLOGY

Aerodyne instruments use **tunable infrared laser direct absorption spectroscopy (TILDAS)** at mid-IR wavelengths to probe molecules at their strongest "fingerprint" transition frequencies. We further enhance sensitivity by employing a patented multi-pass broad-band absorption cell that provides optical path lengths up to 400 meters. Direct absorption spectroscopy allows for fast (<1 sec) absolute trace gas concentrations without need for elaborate calibration procedures. Moreover, TILDAS instruments are relatively free of measurement interference from other molecular species, enabling extremely specific detection.

Related Instruments

- Single laser isotope monitor for $\delta^{13}C$ and $\delta^{18}O$ of CO_2
- Single laser isotope monitor for $\Delta^{17}O$ of CO_2
- Dual laser isotope monitor for CO_2 ($\delta^{13}C$, $\delta^{18}O$) and H_2O ($\delta^{18}O$, δD)

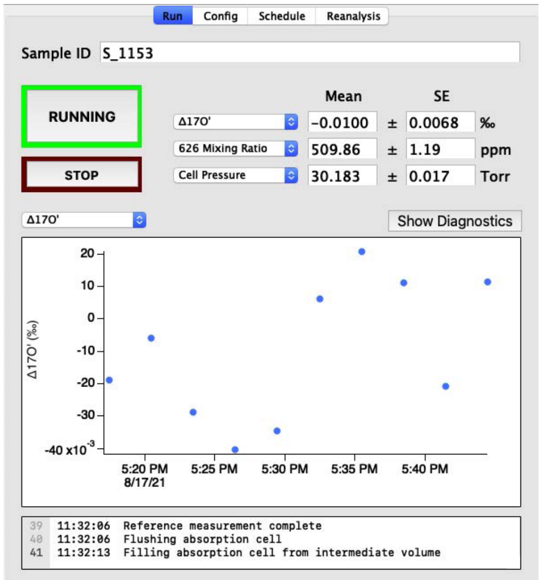
Applications

- Analysis of CO_2 samples derived from carbonate
- Determination of atmospheric sources, sinks, and transport through CO_2 isotopic ratios
- Carbon capture and sequestration monitoring
- Breath analysis

Advantages over IRMS

- Direct measurement of ^{17}O-CO_2, which is not possible by IRMS
- High precision (< 0.013 ‰ in $\Delta^{17}O$ and < 0.01 ‰ in $\delta^{13}C$)
- Lower cost
- Faster measurements (e.g. 30 min)

Powerful software provides easy, flexible instrument control, and real-time result.



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Specifications

Discrete Samples – High Precision

	CO_2	$\delta^{13}CO_2$	$\delta CO^{18}O$	$\delta CO^{17}O$	$\Delta^{17}O$
1 Sample (0.25 µmol CO_2, 3 min)	0.02 ppm	0.03 ‰	0.03 ‰	0.04 ‰	0.04 ‰
10 Samples (2.5 µmol CO_2, 30 min)	0.01 ppm	0.01 ‰	0.01 ‰	0.013 ‰	0.013 ‰

Note: These measurements alternate the sample gas with a working reference with a similar mixing ratio, and the time to do so is included in the quoted measurement time.

Continuous Air Measurement – High Precision

	CO_2	$\delta^{13}CO_2$	$\delta CO^{18}O$	$\delta CO^{17}O$
2 min	0.02 ppm	0.03 ‰	0.03 ‰	0.04 ‰
20 min	0.01 ppm	0.01 ‰	0.01 ‰	0.013 ‰

Note: These measurements are normalized to a working reference with a mixing ratio similar to the sample. The flow rate is 0.6 slpm.

Continuous Air Measurement – High Speed

	CO_2	$\delta^{13}CO_2$	$\delta CO^{18}O$	$\delta CO^{17}O$
0.1 second	0.15 ppm	0.3 ‰	0.3 ‰	0.4 ‰
1 second	0.05 ppm	0.1 ‰	0.1 ‰	0.13 ‰
60 second	0.015 ppm	0.03 ‰	0.03 ‰	0.04 ‰

Note: These measurements are not referenced to a working reference. This configuration supports 10 Hz eddy covariance measurements with a modest pump (120 lpm) and a flow rate of 6 slpm.

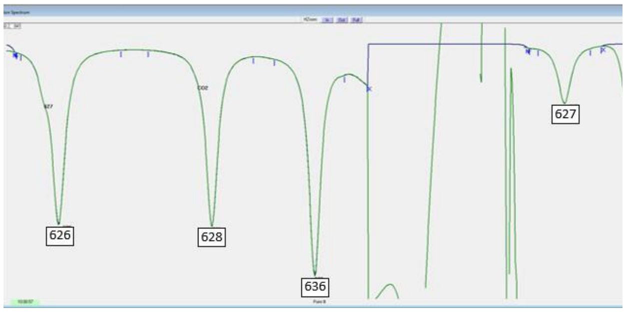
Dynamic Range

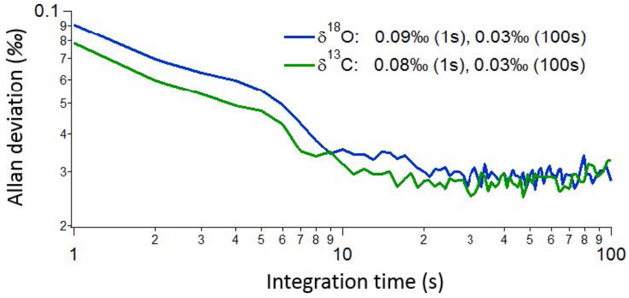
0 – 1000 ppm CO_2

Operating Conditions

-20 to +40 °C, 0 to 20 slpm

Experimental Spectrum Acquired at 1 Hz





Installation

Benchtop system

Flushing the optics with CO_2-free gas is recommended

Instrument Components

Core instrument, thermoelectric chiller, vacuum pump (customer specified), inlet sampling system (customizable), keyboard, mouse, monitor

Data Outputs

RS-232, USB drive, ethernet

Size, Weight, Power

Dimensions: 440 mm x 660 mm x 6U (267mm) (W x D x H)
Weight: 35 kg (core instrument) + 15 kg (chiller) + pump weight
Electrical Power: 250 W, 120/240 V, 50/60 Hz (without pump)

REFERENCES

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