

Isotope ratio measurements have many applications in geo and bio chemistry. In the past, these analyses have required large and expensive magnetic sector mass spectrometers, best suited to a dedicated research laboratory run by highly trained specialists. This has prevented widespread use of the technique. Monitor Instruments has developed a low cost, easy to use benchtop instrument, the IRMS 3000, which reduces the cost, size and complexity of earlier instrumentation.

The isotopic ratio analysis of CO₂, has many applications in medical diagnostics. Stable isotope (¹³C) labeled drugs are often administered to measure uptake or metabolism in order to characterize medical conditions. The most noninvasive indication of drug uptake is the ¹³C/¹²C ratio in exhaled CO₂, measured after taking the labeled drug or diagnostic cocktail. Cost effective, accurate measurement of this ratio can be made by the IRMS 3000 shown in Figure 1. The instrument is equipped with a heated direct capillary inlet system, an integrated computer with display, and internal application specific software to precisely measure and correct the isotope ratio data. The optional autosampler provides high throughput, unattended operation.

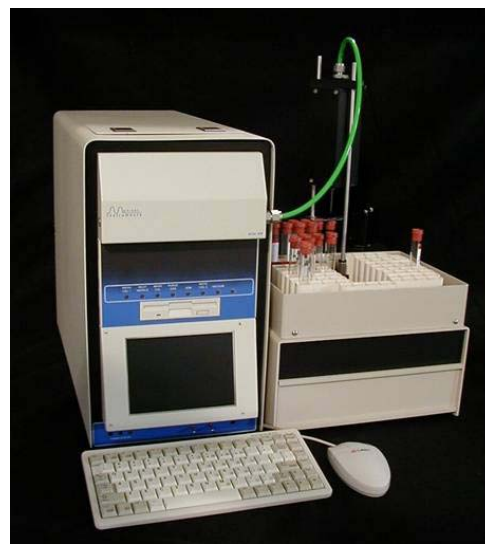


Figure 1 IRMS 3000

The instrument determines the ¹³C/¹²C ratio in exhaled CO₂ by measuring the ion current at 45 amu (¹³CO₂), correcting for the ¹⁷O contribution (¹²C¹⁶O¹⁷O), and dividing the result by the ion current at 44 amu (¹²C O₂). All calibration, data acquisition, calculation, and reporting are performed by the internal computer. Analytical results are expressed in terms of a delta or difference in parts per thousand (delta/mil) relative to Pee Dee Belemnite (PDB), a limestone mineral standard. This material produces CO₂ with a consistent isotope ratio (0.0112372) when heated. One delta/mil is equivalent to 10 ppm. The data shown in Figure 2 demonstrate excellent linearity observed when challenged with known samples having constant CO₂, but isotope ratios in the range from -39.8 ppt to 232 ppt relative to PDB.

These samples were run after calibration with a -22.4 ppt delta standard. The average deviation for all points compared to the reference values is 1.6% with no bias noted on either extreme.

The inlet system is virtually free of carryover: analysis of -42 delta/mil standards immediately after a series of +232 delta/mil standards produces correct data with no measurable positive bias.

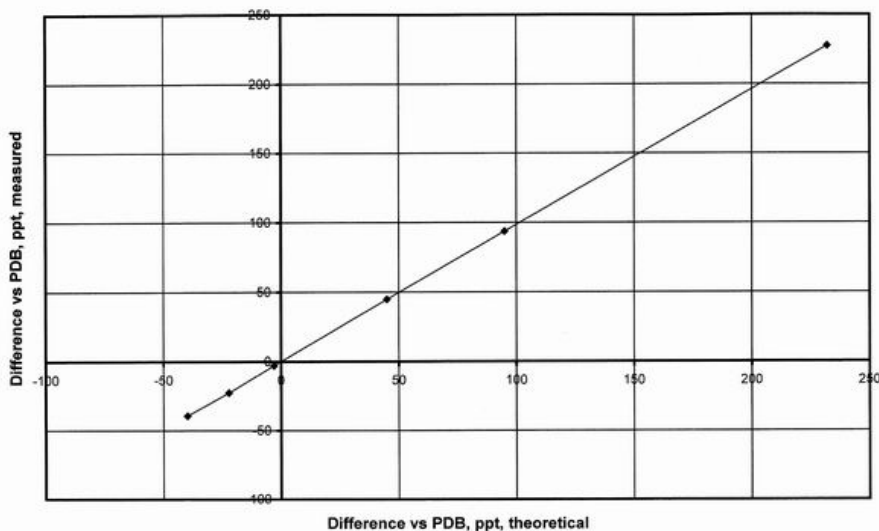
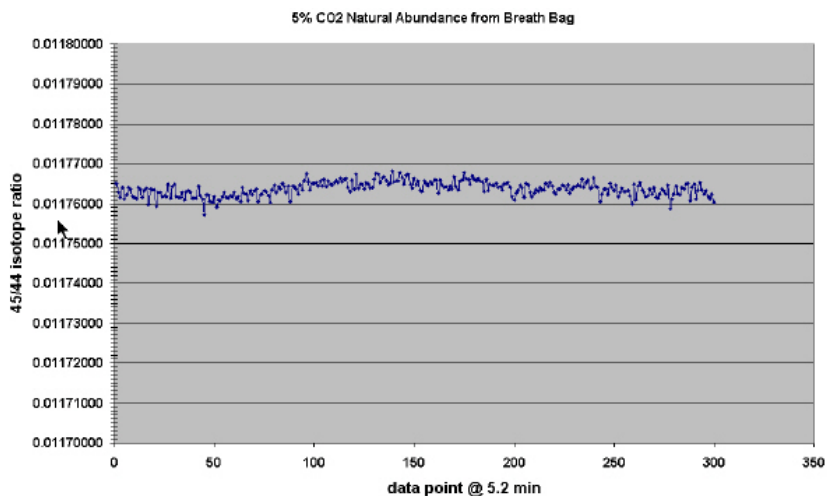


Figure 2 Isotope Ratio Linearity

IRMS 3000 stability and precision were demonstrated by sampling 5% natural abundance CO₂ in a 3 liter gas bag about every 5 minutes for 26 hours. These measurements—over 300 in total—are plotted and tabulated in Figure 3. Short term precision for 15 individual 1.7 hour periods of 20 measurements each shows a standard deviation less than 0.15 delta/mil. Long term precision, as characterized by the standard deviation for the full 26 hours, is 0.18 delta/mil with a range of 1.08 delta/mil.



	1st 1.7 hr	2nd	3rd	4th	5th	26th hr
Mean	0.011763	0.011762324	0.011761416	0.011762359	0.01176414	0.011763692
Standard Error	3.04E-07	3.03E-07	3.26E-07	2.77E-07	3.24E-07	1.04E-07
Standard Deviation	1.36E-06	1.36E-06	1.46E-06	1.24E-06	1.45E-06	1.80E-06
% RSD	0.01%	0.01%	0.01%	0.01%	0.01%	0.02%
Sample Variance	1.84E-12	1.84E-12	2.13E-12	1.53E-12	2.10E-12	3.23E-12
Range	5.35E-06	5.54E-06	7.18E-06	4.22E-06	6.99E-06	1.08E-05
Minimum	0.01176	0.01175937	0.01175733	0.01176037	0.0117605	0.01175733
Maximum	0.011765	0.01176491	0.01176451	0.01176459	0.01176749	0.0117681
Count	20	20	20	20	20	300

Figure 3 Summary of repetitive ¹³C/¹²C isotope ratio measurements of 5% natural abundance CO₂ in a 3 liter gas sample bag

Excellent stability and linearity is observed throughout the dynamic range important for breath testing. The system has been successfully tested using patient samples for the diagnosis of Helicobacter pylori gastrointestinal infection in a clinical environment. The ease of use of this system is a key component in this successful application.

Monitor Instruments' unique cycloidal mass spectrometers can monitor processes in a wide variety of industries. Our application specific inlet systems, versatile software, and stable analyzers assure cost effective, high quality process control information. We invite you to visit our website (www.monitorinstruments.com), to request information via e-mail at info@monitorinstruments.com, or post at 290 East Union Rd., Cheswick, PA 15024, USA, or to contact us by telephone at +1.724.265.1212 or fax at +1.274.265.1199. We will give your application the careful, confidential consideration it deserves.