thermoscientific

Discover more
Research without boundaries

Thermo Scientific Delta Ray
CO_2 Isotope Ratio Infrared Spectrometer with URI Connect

ThermoFisher
SCIENTIFIC

Discover More …
… using CO_2 Isotopes

Thermo Scientific™ Delta Ray™ Isotope Ratio Infrared Spectrometer (IRIS)

Delta Ray represents a new and exciting solution for the continuous measurement of **isotope ratio** and **concentration** of CO_2 in air.

Utilizing state of the art mid-infrared spectroscopy, simultaneous determination of $\delta^{13}C$ and $\delta^{18}O$ empowers scientists to make profound scientific discoveries in a wide variety of research fields like

- Greenhouse gas monitoring
- Ecology and plant science
- Volcano monitoring
- Carbon storage and sequestration (CCS)

The Power of Isotopes

The abundances of carbon and oxygen stable isotopes, which make up CO_2, vary in nature. The specific ratio of these molecules, which differ only in isotopic composition (isotopologues) is determined by the conditions associated with the molecules formation. By studying the isotope ratio of CO_2, you can discover more about the physical or biological processes that created it. In our environment the isotopic composition of CO_2 also provides us with a unique fingerprint of its sources and sinks.

Results, right at the point of research.

> Delta Ray IRIS was designed with **field portability** and **operational simplicity** in mind. Its modular design, low weight and small footprint enable it to be placed right at the point of research interest
…a paradigm shift in isotope ratio analysis.

> The **Universal Referencing Interface (URI)** ensures **calibrated** and **verifiable** CO_2 measurements of both large and small scale atmospheric changes over a wide range of experimental time scales.

> A **Quick Start** guide takes the user from un-boxing to first results. Guided by application workflow templates within the Thermo Scientific™ Qtegra™ software platform, generation of results is seamless and uncomplicated.

> No need for sampling vials and the cost incurred from sample transportation. Delta Ray IRIS provides continuous, feature rich measurements **every second...**

...24 hours a day,
7 days a week

LEAD

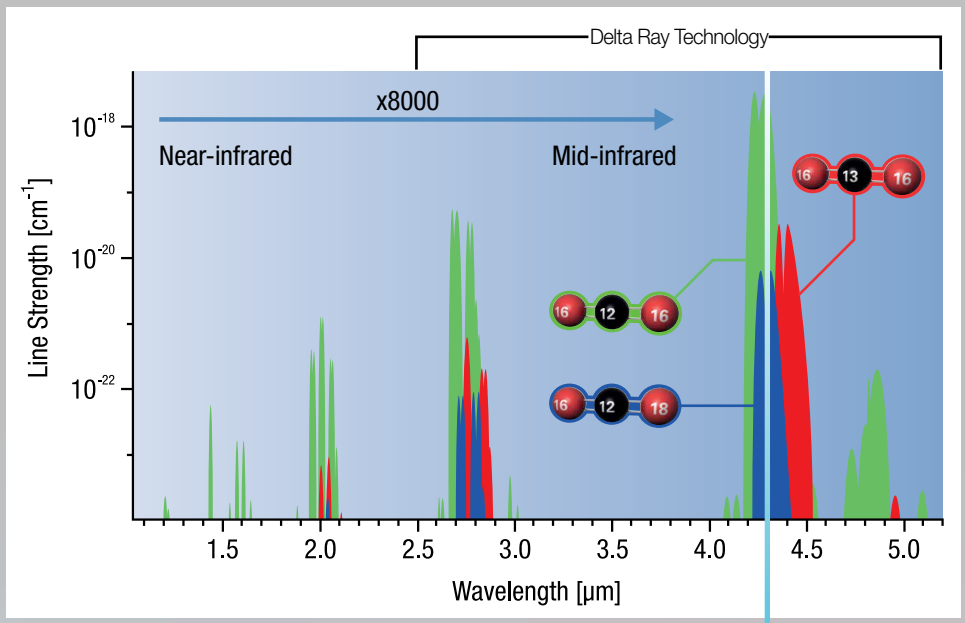
Discover More …

… using Isotope Ratio Infrared Spectroscopy

Laser-based Isotope Ratio Infrared Spectroscopy allows scientists to continuously monitor CO_2 isotope ratios directly at ambient concentrations in air with exceptional precision and high temporal resolution. Sampling occurs in seconds allowing feature rich data to be immediately generated. Robust and simple by design, isotope ratio infrared spectrometers are readily field deployable.

How do you measure isotope ratios optically?

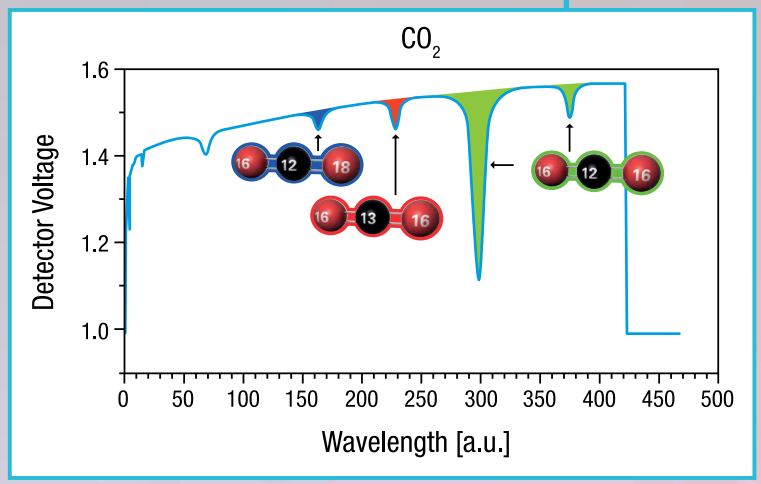
Molecules have absorption lines at specific wavelengths due to the quantum mechanical rotational and vibrational states. The spectrum of the different isotopologues are shifted relative to each other and allow their respective abundances to be easily determined and hence the isotope ratios.



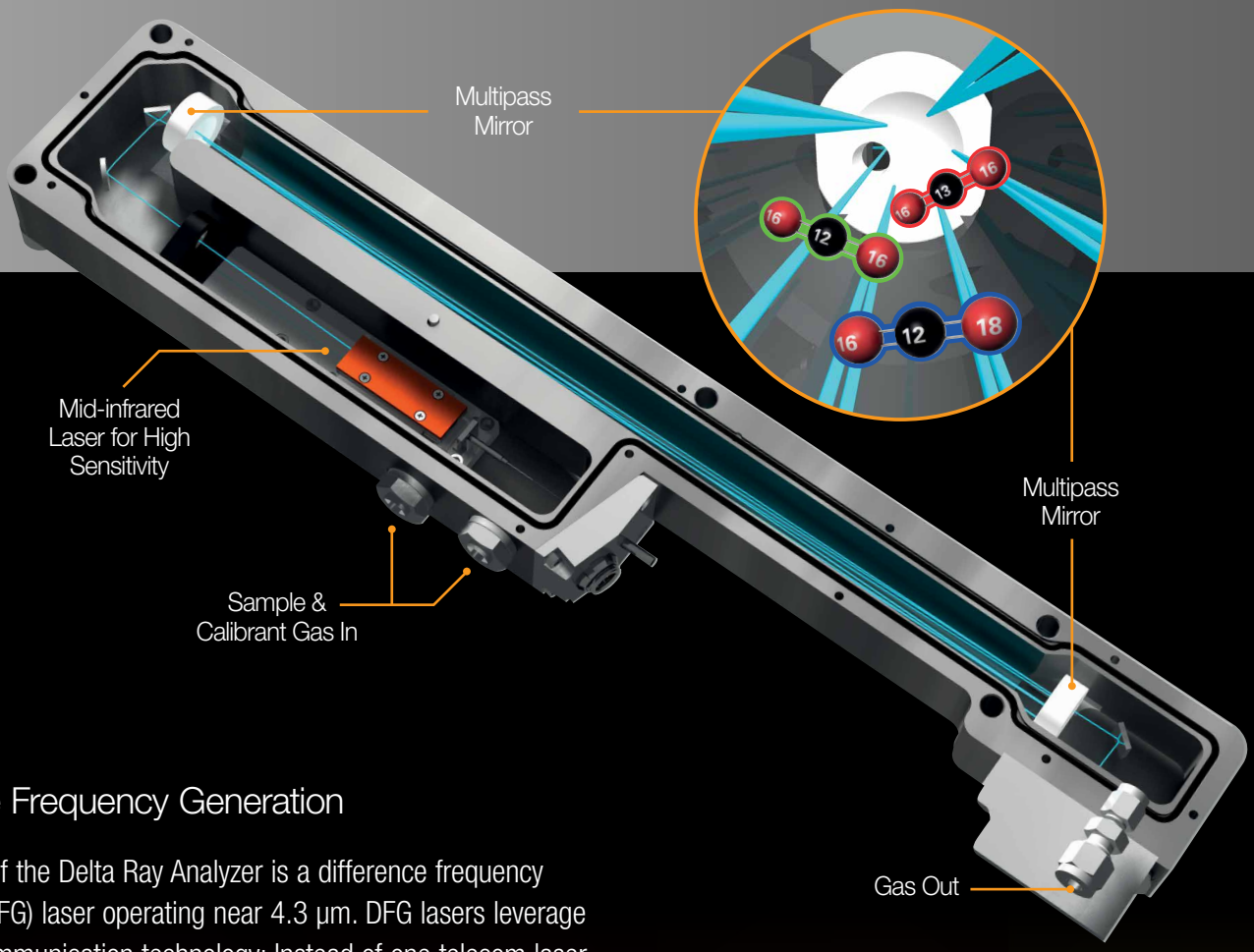
Line strengths of three isotopologues of CO_2 in the near and mid-infrared.

Why measure in the mid-infrared?

In the mid-infrared range absorption lines are about 8000 times stronger than in the near-infrared. This enables a simple direct absorption approach requiring laser path length of only 5 m. This robust setup offers superior ruggedness, higher data acquisition rates and simplicity over the long path length cavity-based methods precluding the requirement for ultra clean mirrors in order to be effective.

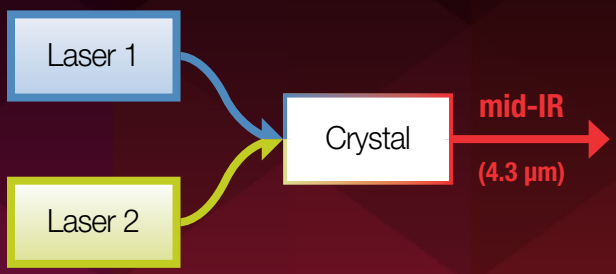


Spectral region in mid-infrared at 4.3 µm showing ^{18}O, ^{12}C and ^{13}C isotopologues in one scan of the DFG laser. From calculations of respective peak areas the Isotope Ratios can be determined.



Difference Frequency Generation

At the heart of the Delta Ray Analyzer is a difference frequency generation (DFG) laser operating near 4.3 µm. DFG lasers leverage robust telecommunication technology: Instead of one telecom laser, two are used and interact in a non-linear crystal (Periodically Poled Lithium Niobate). The generated mid-infrared beam retains the desirable characteristics of telecom lasers, such as scan frequency, spatial and frequency modes.



Difference frequency generation: Two telecom lasers are interacting in a non-linear crystal generating mid-infrared radiation while maintaining desirable characteristics of telecom lasers.

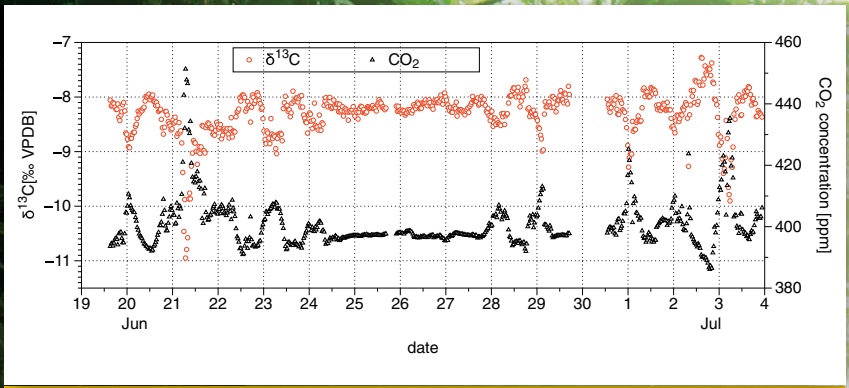
INNOVATE

Discover More …

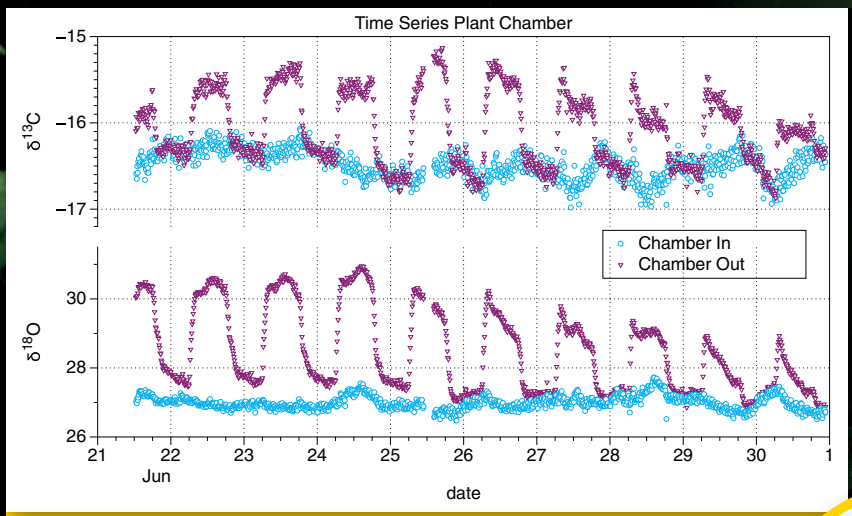
… with a Field Deployable Isotope

Greenhouse Gas Monitoring

By determining the isotopic composition crucial information can be derived about the sources of the observed increase in atmospheric CO_2. Delta Ray IRIS allows you to perform continuous, unattended measurements at remote observation stations. Greenhouse gas monitoring requires rigorous quality control to ensure the long term traceability. Delta Ray with its excellent precision, built in referencing system and workflows provides a perfect match to these challenges. Discover unexpected short term synoptic events with high sampling rates.



CO_2 concentration and $\delta^{13}C$ at Lutjewad Station, NL, from summer 2013. Values are reported for every 30 minutes, but can be expanded to up to 1 s if desired.

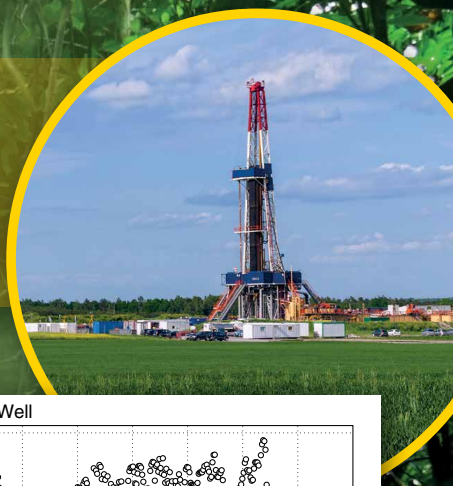


Plot showing the impact of drought conditions.

Plant Research and Ecology

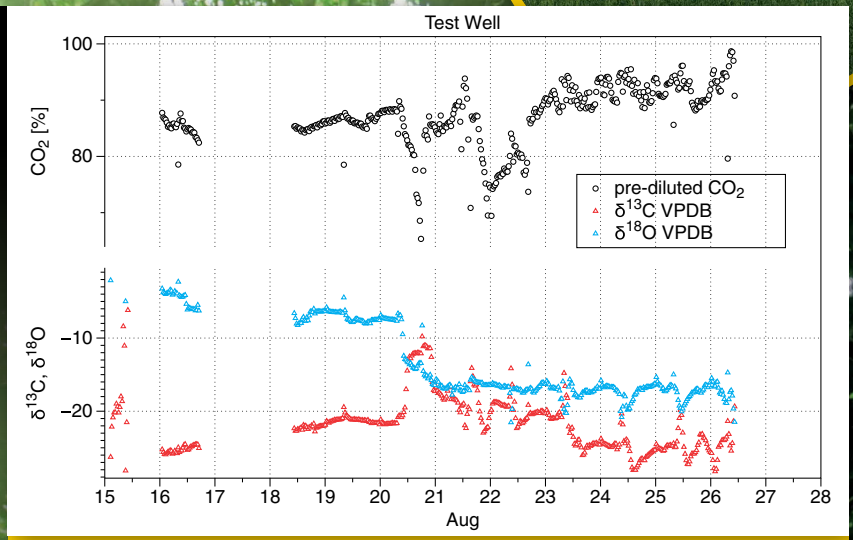
Elucidating metabolic processes within plants is possible by quantifying the imposed isotopic signature. Under controlled conditions in a laboratory plant chamber, environmental parameters such as temperature, air humidity, soil moisture and light intensity are varied, and the isotopic signature quantified. Studying these processes allows to partition CO_2 fluxes in and out of ecosystems and ultimately leads to a better understanding of the carbon cycle in the terrestrial biosphere.

Analyzer



Carbon Storage and Sequestration

Research to investigate whether carbon can be stored reliably and without endangering the environment around a storage site is increasingly important in order to gain public acceptance of CSS technology. Isotopologues of CO_2 also carry information about diffusion processes in the ground and interaction with aquifer.



Feature rich data sets over 10 days at an observation well after a period of injecting isotopically different CO_2 into a geological formation.

Delta Ray being set-up on Mount Etna.

Volcano Monitoring

Changes in $\delta^{13}C$ of magmatic CO_2 are correlated with the depth of the origin of CO_2. Gas from lower depth appears usually several weeks before seismic activity or eruptions occurs. Additionally, continuous, high frequency monitoring of $\delta^{13}C$ opens new fields of research in volcanology.

EXPLORE

Discover More …

… with Highest Precision and

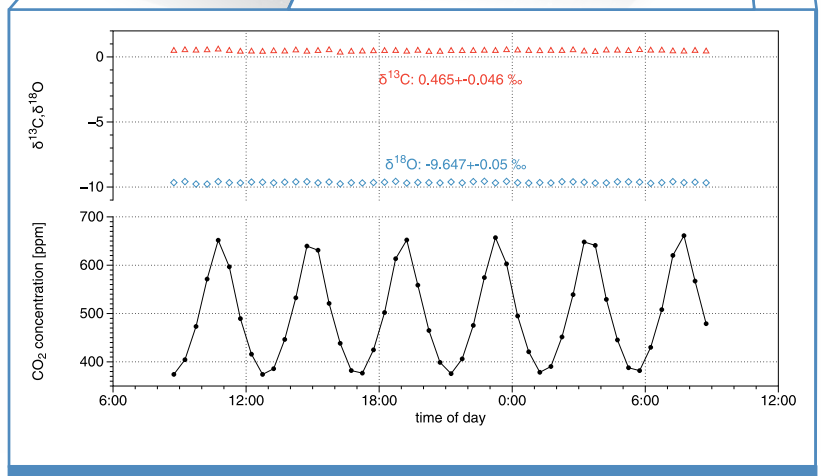
Precise by design

Delta Ray IRIS can reach precisions as low as 0.05‰ for $\delta^{13}C$ and $\delta^{18}O$ of CO_2. This is achieved by a combination of the benefits of the mid-infrared and precisely controlled pressure and temperature feedback loops within the optical core.

Verifiable, accurate results

To ensure reliable analytical results, the Delta Ray system incorporates the Universal Reference Interface (URI). **This provides the scientist with fully automated referencing and calibration for verifiable measurements.** The concentration of the reference gas is intelligently balanced against that of the sample, ensuring superior accuracy. URI is optionally configurable with Delta Ray Xpand dilution box, extending the concentration range up to 100% CO_2.

Delta Ray IRIS shows unprecedented accuracy and precision compared to any infrared spectroscopy device in its class. In a direct comparison to the gold standard Delta V isotope ratio mass spectrometer, Delta Ray system shows excellent agreement.

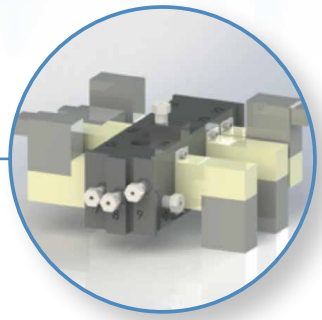


In a challenging simulation of highly variable CO_2 concentrations, Delta Ray shows impressive accurate and precise comparisons with mass spectrometry. Observed differences are as small as ^{13}C=0.047‰ and ^{18}O=0.046‰.

Accuracy

Seamless integration within your experiments

Delta Ray IRIS was designed to control and to be synchronized to extended experimental workflows. External valves can be driven, or signal triggers received to initiate sample acquisition. Auxiliary signals from third party devices can be recorded and stored within the host PC.

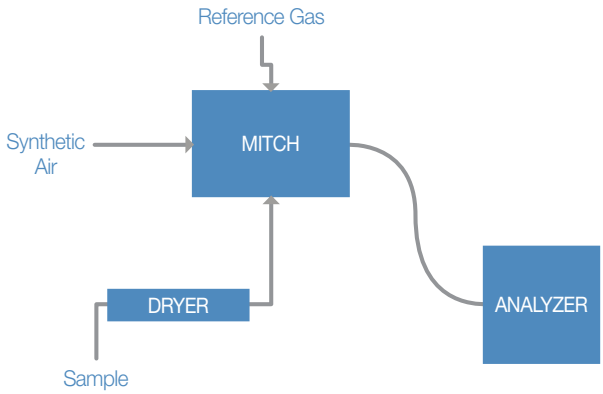


MITCH™ enabling mixing and selection of multiple reference gases and sample lines.

Thermo Scientific MITCH™ ...the key to stable isotope analysis

At the center of the URI is MITCH, a proprietary* precision engineered **Mi**x and swi**TCH** device to support advanced referencing schemes. It is designed to dilute and switch multiple calibration and sample gases, a key requirement for reliable isotope analysis. Before the sample gas enters the laser analyzer it is dried through a maintenance free membrane drying system to prevent oxygen isotope exchange and any matrix effects of water, with the added benefit of providing dry mole fraction concentration data.

** selected patent applications in selected countries*



Schematic showing functionality of URI. Reference gas and synthetic air are combined to match the sample concentration.

PERFORM

Discover More …
… with Qtegra Software

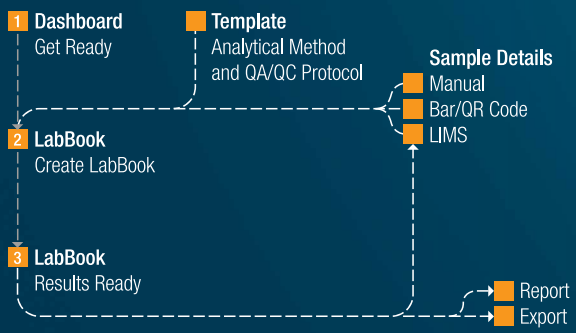
The power of Delta Ray IRIS is harnessed by the operational simplicity of Qtegra Intelligent Scientific Data Solution™ (ISDS). Qtegra ISDS is a new software platform dedicated to scientists tasked with the analysis of elements and isotopes. Qtegra ISDS is engineered for maximum simplicity, minimizing workflow steps to save time, reducing training and boost productivity.

Intuitive enabling features of Qtegra software deliver maximum productivity:

Dashboard

The Qtegra Dashboard displays your system and peripheral status in a transparent layout. The Dashboard is designed to contain all necessary information whilst remaining familiar and uncomplicated.

Qtegra Dashboard - simple system overview.



Qtegra Workflow - Three steps to productivity.

Workflow

The Qtegra Workflow is simple;

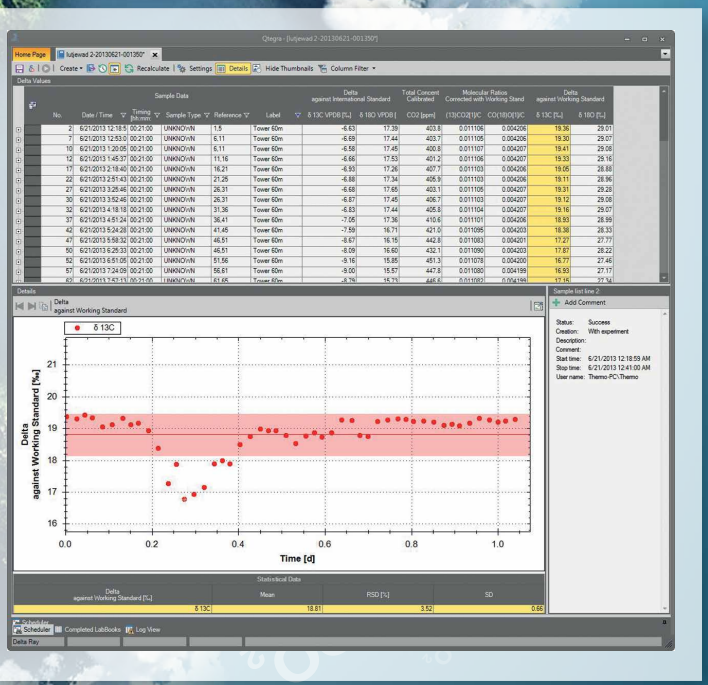
[1] Set up your system, with Get Ready
[2] Create a LabBook
[3] Work with your data.

Every care is taken to ensure that wherever possible user actions are minimized and tasks are automated.

Get Ready

Qtegra 'Get Ready' is a **single click setup** button that initiates an intelligent automated setup routine to take the system from standby to analysis. Get Ready saves you time and increases the quality and reproducibility of results.

Get Ready takes you from standby to analysis in a single click.



- Get Ready
- Performance Check
  - Linearity Calibration
  - Concentration Calibration
  - Delta Scale Calibration
- Performance OK
  - User Action
- Process Queued LabBooks
- Export Data

LabBook

Prepared in just 5 clicks, the LabBook is home to both method and results. The LabBook starts the analysis sequence and data are processed on the fly and are immediately ready for inspection. Results can be automatically exported directly to a PDF report, spreadsheet, text file or to your favorite statistical analysis package.

LabBook review is quick and simple.

Connectivity

Qtegra ISDS runs on the on-board Windows computer inside the Delta Ray IRIS. It is networkable and an internet connection allows the operator to remotely connect to the instrument and control it from anywhere in the world.

DELIVER

Discover More …

… with the Leader in Isotope Analysis

For over 60 years Thermo Fisher Scientific has been the leading supplier of isotope ratio instrumentation to scientists throughout the world.

The Delta Ray solution complements the broadest portfolio of isotope ratio technologies in the market today.

Our products have enabled some of the most exciting pioneering discoveries in the study of the earths geochemical cycles. Delta Ray is built on our heritage and keen understanding of the science of isotope analysis. Created to the most exacting standards in German engineering, Delta Ray IRIS performance and reliability are assured.

Thermo Fisher Scientific offers a proven global distribution, support and service network with thousands of satisfied customers in the field of isotope analysis.

Thermo Scientific Isotope Ratio Analyzers

Delta Ray Isotope Ratio Infrared Spectrometer

Delta V Isotope Ratio MS with Elemental Analyzer

Delta V Isotope Ratio MS with Gas Chromatograph

253 Plus 10kV Isotope Ratio MS

PROVEN

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