

CO₂

CO₂



Discover more Research without boundaries

Thermo Scientific Delta Ray

CO₂ Isotope Ratio Infrared Spectrometer with URI Connect

Discover More using CO₂ Isotopes

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

Delta Ray with URI Connect represents a new and exciting solution that extends the continuous measurement of **isotope ratios** and **concentrations** of CO₂ in air to discrete samples such as head space analysis or direct injection of small amounts of CO₂.

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

- Water/Aquifer Research
- Paleoclimate Research
- Microbiology



The Power of Isotopes

The abundances of carbon and oxygen stable isotopes, which make up CO₂, 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 CO₂, you can discover more about the physical or biological processes that created it. In our environment the isotopic composition of CO₂ 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 trusted **Universal Referencing Interface (URI)** ensures **calibrated** and **verifiable** CO₂ measurements over a wide range of experimental time scales and **extends now to the analysis of discrete samples** such as headspace of vials in an autosampler or an aliquot introduced through the multi-function injection port.
- > Two custom calibration reference gases with isotopic target values near ambient and biological samples are included. Only power and CO₂ free air are required to operate.
- > 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.
- > Delta Ray IRIS provides **discrete sample analysis** as well as continuous, feature rich measurements in the field **every second**...

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

PERFORM



Discover More with a Versatile Sample Interface

The URI Connect system allows you to easily interface with samples available in amounts as little as 80 µg of CO₂, such as in vials, syringes or bags and then to be analyzed in the Delta Ray analyzer. The Delta Ray IRIS can reach precisions as low as 0.05‰ for δ¹³C and δ¹⁸O of CO₂. 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. To ensure reliable analytical results, the URI Connect interface intelligently balances the concentration of reference gases against that of the sample, ensuring superior accuracy. The URI brings classical dual inlet IRMS analysis concepts to bear on IRIS.

Autosampler

An autosampler with a tray holding 60 vials in conjunction with URI Connect accommodates repetitive sample analysis. The robust, compact autosampler facilitates field based head space analysis.

Sample injection port

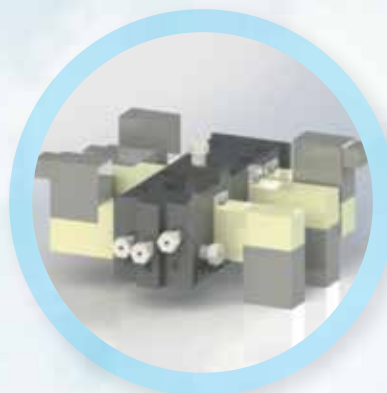
Samples in syringes, flasks or bags, are conveniently analyzed through the injection port on the URI Connect interface. The port is easy to assemble and clean if necessary, and the user can build their own accessories to perfectly match their sampling system. Even purge gas is available in the port for demanding applications.



Variable volume

...the connection to discrete sample analysis

At the core of the URI Connect system is a variable volume that collects the sample gas such as from a vial in an autosampler or injected through the front port. The system can automatically determine the concentration of the sample and adjust the dilution to perform the isotopic analysis in the Delta Ray IRIS at an optimal, constant concentration to achieve outstanding repeatability in a field deployable setup.



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



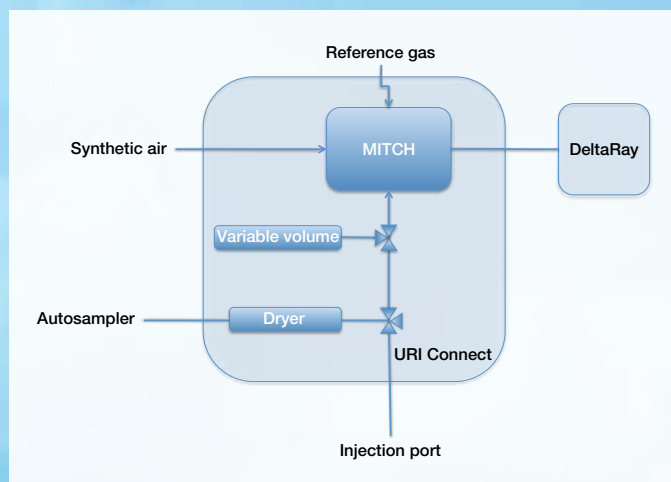
For easy maintenance the sample and the variable volume are accessed through a single cover door.

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.

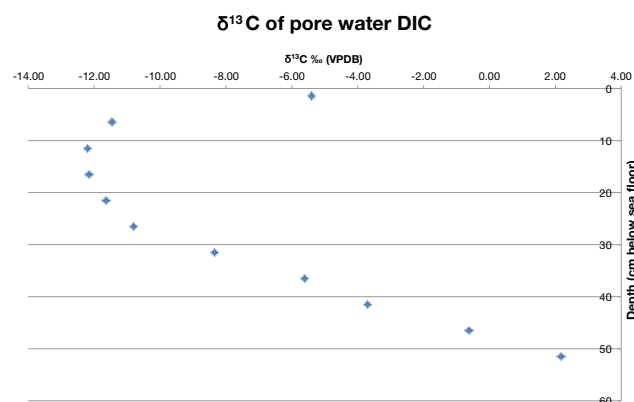
CONNECT

Discover More with a Mobile Isotope Lab



Carbon Isotope Ratios of Dissolved Inorganic Carbon (DIC)

Dominant microbial processes change with increasing depth below the sea floor and carbon isotope ratios of the pore water DIC are modified by these processes. Pore water of a sediment core collected at the floor of Eckernförde Bay, Baltic sea was analyzed using a Delta Ray with URI Connect. Deep in the seafloor, microbial reduction of CO_2 to CH_4 dominates. $^{12}\text{CO}_2$ is reduced preferentially over $^{13}\text{CO}_2$, leading to more positive $\delta^{13}\text{C}$ values; in layers closer to the surface, the oxidation of CH_4 to CO_2 becomes more prominent. Since $^{12}\text{CH}_4$ is again oxidized faster than $^{13}\text{CH}_4$, $\delta^{13}\text{C}$ decreases as we move closer to the seafloor. In the upper 15 cm, the pore water DIC mixes with the seawater DIC, increasing $\delta^{13}\text{C}$ again. Imagine analyzing up to 100 samples per day directly on board during a research cruise right after collecting the core eliminating the mandatory poisoning of the samples in the field.



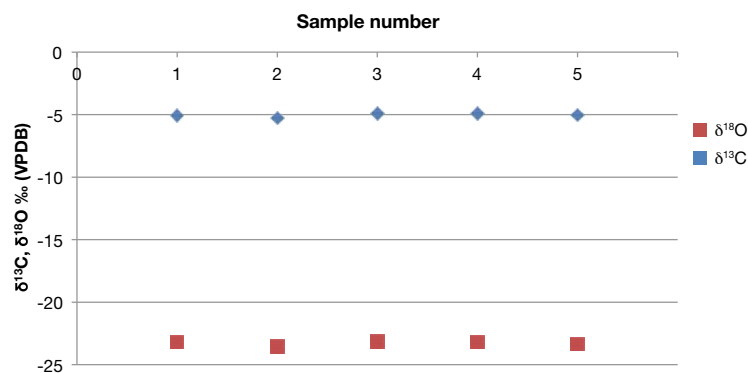
Extensive Sample Variety

A wide range of samples can be analyzed with the Delta Ray IRIS with URI Connect. The equivalent of 80 μg of CO_2 are required to perform reliable isotopic analysis. Examples include carbonates from speleothems or shells, isotopic DIC from sediment core pore waters or from surface waters; CO_2 emanating from sparkling drinks can yield information about the source of the CO_2 and the manufacturing process.



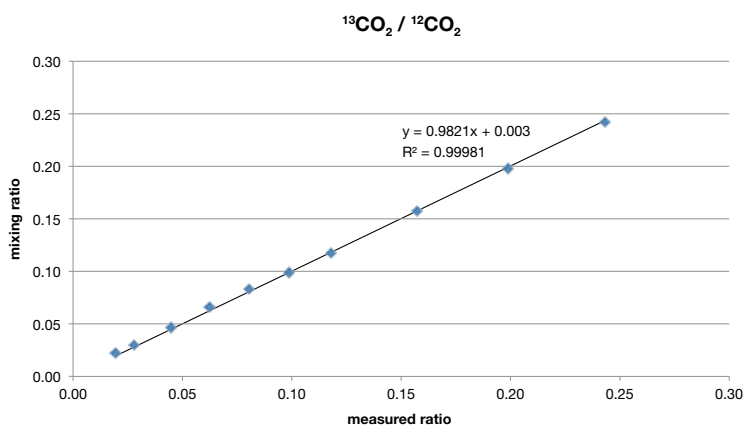
Carbonate Isotope Ratios

For many decades, $\delta^{13}\text{C}$ and $\delta^{18}\text{O}$ measurements of carbonates have been one of the major applications of stable isotopes analysis. Now it is possible to perform this analysis reliably with IRIS with sample amounts as low as 200 μg . Measurements of three reference materials (NBS 18, NBS 19 and LSVEC) were performed, and NBS 18 treated as an unknown. Five samples of NBS 18 of approximately 1 mg each were acidified using a few droplets of 100% H_3PO_4 and left for equilibration overnight at 25°C . NBS 19 and LSVEC samples were treated identically and used for linearity calibration and scale contraction of the measured $\delta^{13}\text{C}$ and $\delta^{18}\text{O}$ values. The obtained values for $\delta^{13}\text{C}$ and $\delta^{18}\text{O}$ were $-5.0(1)\text{‰}$ and $-23.3(1)\text{‰}$, respectively, in agreement with the values certified by IAEA of $-5.01(4)\text{‰}$ and $-23.2(1)\text{‰}$ within the analytical uncertainty.



Microbiology Labeling Experiments

Observing the decay or production of highly enriched substances by microorganisms gives insight into the efficiency of such processes. The Delta Ray IRIS demonstrates excellent linearity up to 25% $^{13}\text{CO}_2/^{12}\text{CO}_2$. CO_2 gas mixtures with different $^{13}\text{CO}_2/^{12}\text{CO}_2$ ratios were prepared from two gas standards. Using a one point calibration at a ratio of 9.9%, the unrivaled linearity of the Delta Ray between a $^{13}\text{CO}_2/^{12}\text{CO}_2$ ratio of 1.9% and 25% has been demonstrated. This confirms that the Delta Ray IRIS is the instrument of choice for high enrichment degrees in labeling experiments.



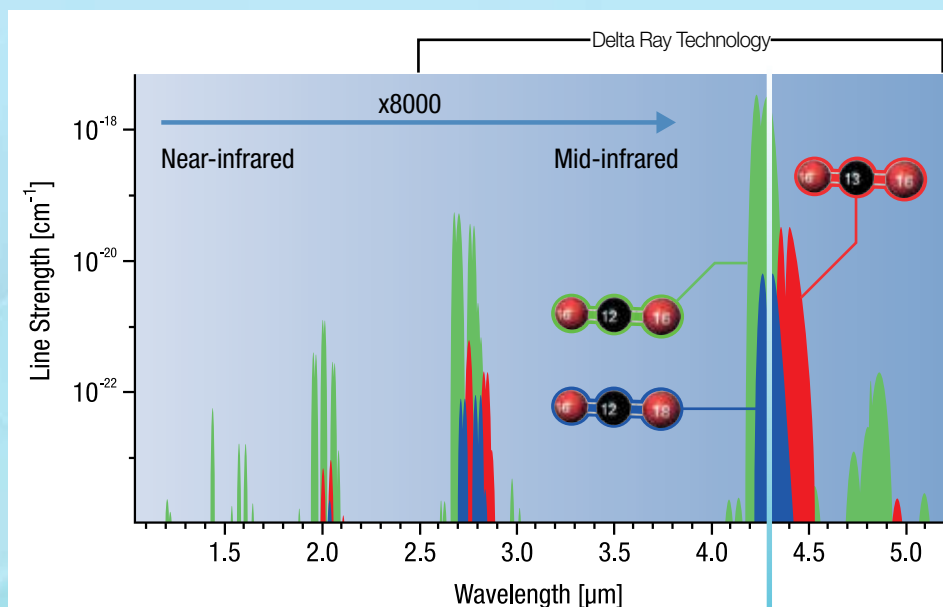
EXPLORE

Discover More using Isotope Ratio Infrared Spectroscopy

Laser-based Isotope Ratio Infrared Spectroscopy allows scientists to continuously monitor CO₂ 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.



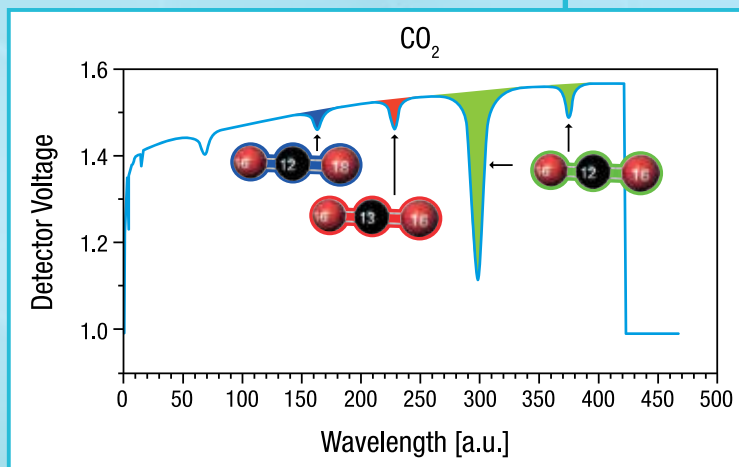
Line strengths of three isotopologues of CO₂ in the near and mid-infrared.

4.3 μm

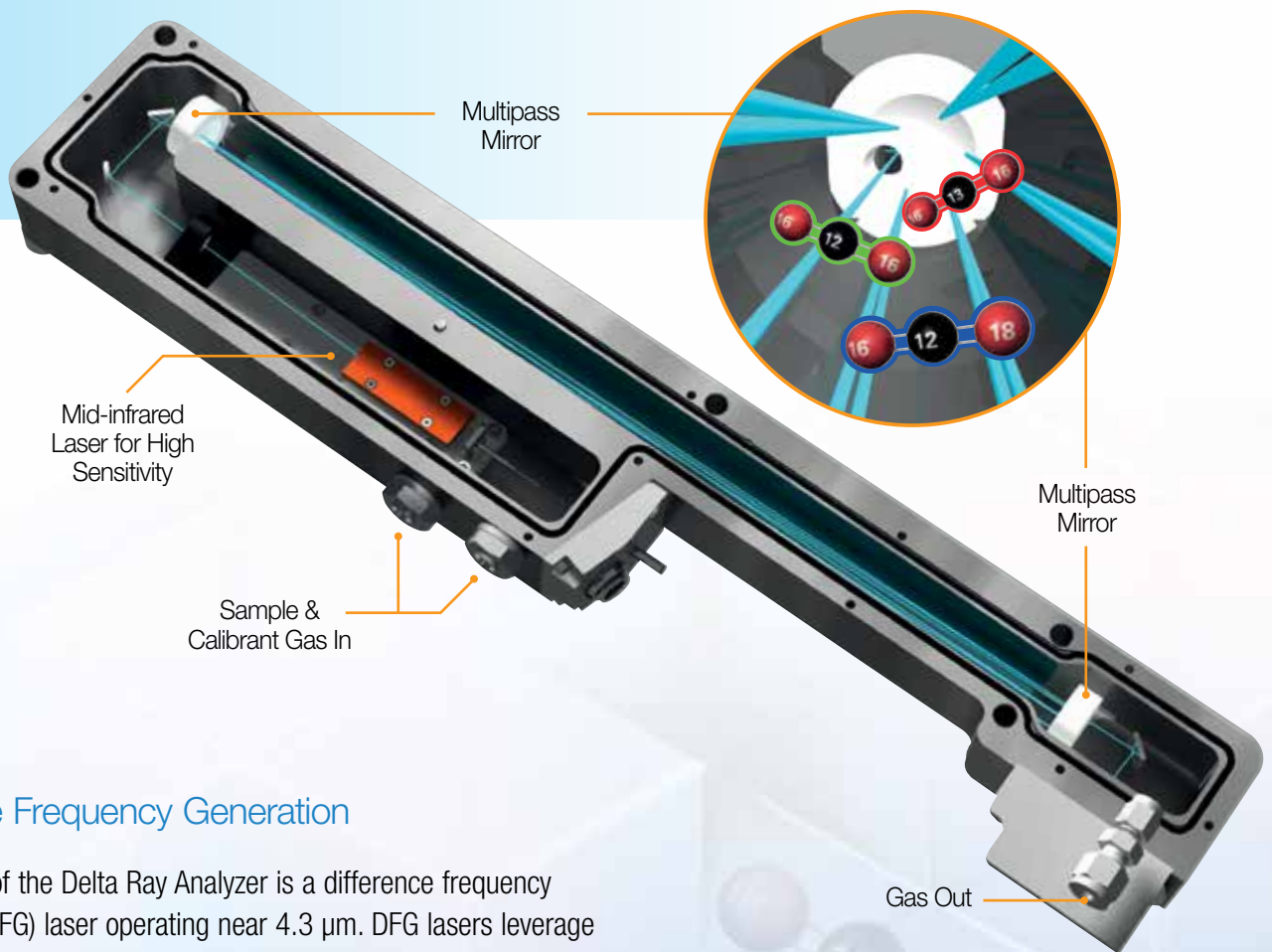
Why measure in the mid-infrared?

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.

The fundamental adsorption transition in the mid-infrared are less prone to spectral interferences with other gases, such as H₂S, than overtone transitions in the near-infrared.

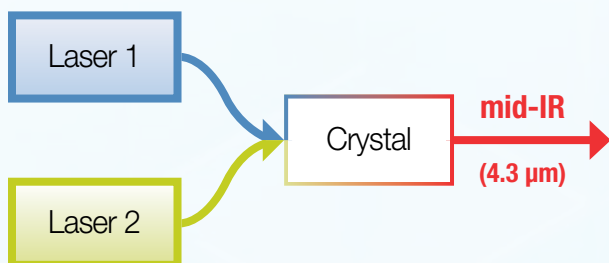


Spectral region in mid-infrared at 4.3 μm showing ¹⁸O, ¹²C and ¹³C isotopologues in one scan of the DFG laser. From calculations of respective peak areas the Isotope Ratios can be determined.



Difference Frequency Generation

At the heart of the Delta Ray Analyzer is a difference frequency generation (DFG) laser operating near $4.3\text{ }\mu\text{m}$. 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 Qtegra Software

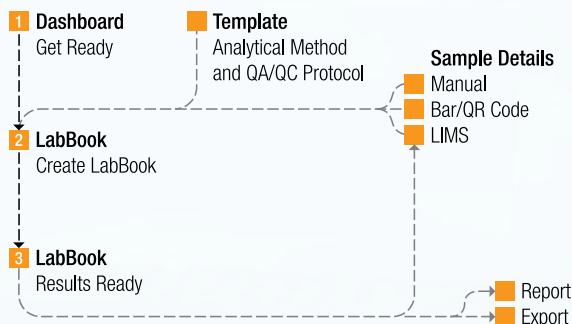
The power of Delta Ray IRIS is harnessed by the operational simplicity of Qtegra Intelligent Scientific Data Solution™ (ISDS). Qtegra ISDS is a new software platform dedicated to scientists tasked with the analysis of elements and isotopes. Qtegra ISDS is engineered for maximum simplicity, minimizing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

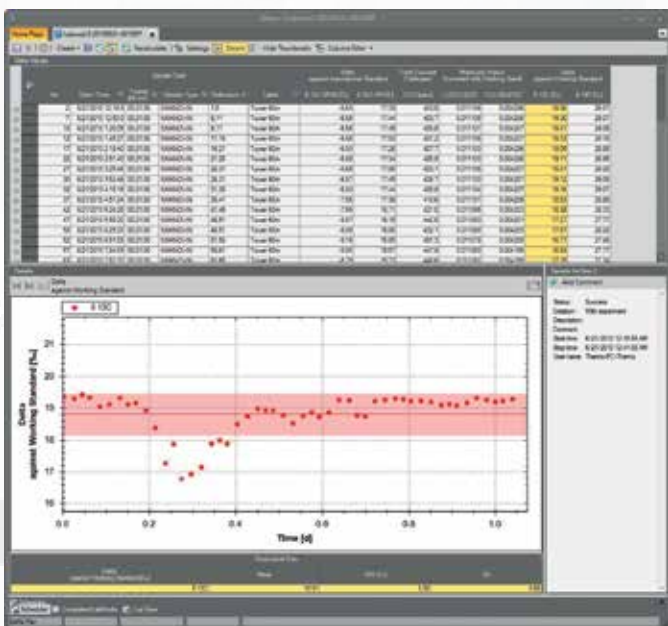
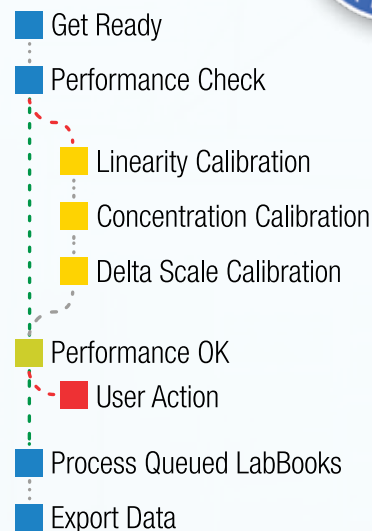
Every care is taken to ensure that wherever possible user actions are minimized and tasks are automated.



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.



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 earth's 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
CO₂ isotope ratio
infrared spectrometer



Delta Ray Connect
CO₂ isotope ratio infrared
spectrometer with URI Connect



Delta V
isotope ratio MS



253 Plus
10 kV isotope ratio MS

PROVEN

www.thermoscientific.com/DeltaRay

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