

THE SERCON GROUP

# 20-22 ISOTOPE RATIO MASS SPECTROMETER



**sercon**  
The *Stable* Isotope Company



## 20-22 ISOTOPE RATIO MASS SPECTROMETER

Sercon are dedicated to the design, manufacture and support of **Isotope Ratio Mass Spectrometers** and their associated **sample preparation systems**.

Backed by a wealth of experience in Isotope Ratio Instrumentation, we provide a full range of services specific to isotope ratio scientists and their applications.

Sercon continues the pioneering efforts of Europa Scientific. We are committed to the continuous development of our instrumentation and support services to ensure that ground breaking research needs are met.

To ensure that all Europa and Sercon instruments remain fully operational and productive, we offer a range of upgrades and system refurbishments from the Tracermass of the 1980s. All systems can benefit from electronics upgrades, pumping system renewal and ion optics refurbishments. All systems can be brought up to the latest technology.

In order to ensure the best possible performance at all times Sercon recommend an annual service of your instrument. Sercon are able to provide rapid on-site response from our team of specialist, experienced engineers. We can provide remote support via telephone and email. All of our users receive training as part of an installation programme. We can also provide further training on specific applications or tailor your course to your analytical needs.

As well as IRMS, Sercon supply consumables and spares of the highest quality for all isotope ratio monitoring mass spectrometers and elemental analysers. Our unique approach of providing the highest possible quality at the most competitive prices means that now all users can benefit from our products.

Sercon are the UK distributor for the complete range of isotopically labelled compounds. All products are of the highest possible chemical



purity and are always supplied with the MSDS and Certificate of Analysis. We can supply products of a full range of enrichments and of a large variety of label positions in any quantity you would require.

Sercon are global representatives  $^{18}\text{O}$  labelled water, both 10 atom % and 98 atom % used for energy expenditure and PET studies. We ensure that we supply water of the highest quality at a competitive price for your requirements.

## 20-22 AND 20-22 GEO STABLE ISOTOPE RATIO MASS SPECTROMETER

Combining superior analytical performance with class leading reliability, the 20-22 ensures that all your scientific needs are met. Backed by over 20 years of development with a no compromise approach to its engineering integrity, Sercon provides the ultimate isotope ratio mass spectrometer. This technology is available in both continuous flow 20-22 and dual inlet GEO 20-22 forms to be interfaced with our range of automated preparation units and peripherals.

The 20-22 incorporates many high level design features. These include an all stainless steel and metal gasket construction flight tube for ultra-high vacuum purity to ensure minimal backgrounds and zero water contamination. True differential pumping for superior ion transfer through the flight tube from the high sensitivity source to the large dynamic range collectors. The benchtop design with Windows 7 based software ensures a user friendly interface for the most productive IRMS system available.





## GEO 20-22

The Geo 20-22 dual-inlet gas isotope ratio mass spectrometer provides the ultimate precision and sensitivity in stable isotope measurement of a wide range of gases. High precision analysis combined with a wide range of sample preparation modules gives the Geo 20-22 the flexibility to adapt to a wide range of applications. These include geochemistry, hydrology, environmental research, marine and biological sciences.

Using all the superior features of the 20-22, combined with an ultra low dead volume dual inlet, the Geo 20-22 is capable of analysing all light gas species from  $m/z$  2 to  $m/z$  96. Provided as a modular benchtop unit, this system can be interfaced with all SerCon peripherals and preparation units including the microCAPS for carbonate analysis and WES for water equilibration through the dual inlet. For pure gases the system can be provided with a 10 or 20 port manifold and tube crackers.

An extensive range of automated sample preparation units gives the researcher the flexibility to measure  $^{15}\text{N}$ ,  $^{13}\text{C}$ ,  $^{18}\text{O}$  and  $^3\text{H}$  and other species in a host of applications. It is based on the 20-20, the first analyser that was purposely designed to measure  $^2\text{H}$  by continuous flow methodology.

The novel **120° ion optics** came out of a design study to find the best geometry for both dual-inlet and continuous flow use and to improve sensitivity for new applications.

True stigmatic focusing results in high sensitivity. Novel ion optical design results in an instrument having high dispersion with a **short ion path length**. This gives **exceptionally high stability** and has the distinct advantage of having very low abundance sensitivity when being used for continuous-flow.

The high dispersion hydrogen spur gives complete separation of HD  $m/z$  3 from He  $m/z$  4 without the need for shields or voltage driven retardation grids (to prevent He from entering the HD collector).





## FEATURES OF 20-22 AND GEO 20-22

- 120° extended geometry with an 11 cm radius magnetic sector giving an effective 21 cm radius dispersion and double direction focusing. Additional high dispersion long spur with 98.8° sector which creates a distance of 24 cm between the focal points for  $m/z$  2 and 3. This leads to an abundance sensitivity at  $m/z$  3 of <1 ppm which eliminates helium 'tailing' in to the D/H collector.
- Truly universal Faraday triple collectors for simultaneous collection of adjacent masses in the range 28,29,30 - 64,65,66 with no adjustment of collectors or amplifiers. Additional single Faraday collector and high gain amplifier for  $m/z$  3 on the hydrogen spur.
- The desired combination of the 4 collectors is selected through the software. Software switchable variable gain amplifiers and 50v amplifier outputs are available as options.
- Optional extended geometry system to incorporate up to 12 collectors for custom applications.
- Asymmetric extended geometry to give true stigmatic focussing with twice the dispersion of normal geometry with the same radius sector.
- Shorter path length than traditional extended geometry to decrease ion/molecule interactions and so ensure 100% transmission through the analyser and a sensitivity which is higher than any other commercial IRMS (<1000 molecules/ion for  $\text{CO}_2$ ).
- Small analyser footprint and wide flat peak shape reduce the effect of temperature drift therefore removing the need for peak centring during analysis.
- Design allows greater tolerance of the known variables of ion optics making the manufacture of the analyser more reproducible and less sensitive to magnet positioning.
- True differential pumping by turbo-molecular pumps with a high compression ratio for both He and  $\text{H}_2$ , to remove the detrimental effect of abundance sensitivity during continuous flow applications and eliminate memory.
- With a mass range covering 2 to 96 AMU it is suitable for the analysis of light stable isotopes in all the commonly measured gases;  $\text{H}_2$ ,  $\text{N}_2$ , NO,  $\text{N}_2\text{O}$ ,  $\text{O}_2$ , CO,  $\text{CO}_2$ , SO and  $\text{SO}_2$ .
- Triple port reference gas injection system. Suitable for calibrating each sample, using a reference gas instead of an internal standard and for easy tuning of the mass spectrometer. Size, type and positioning of reference gas pulses are under software control.
- Data acquisition system uses state of the art highly stable and linear high frequency converters which produce integral slices with zero dead time and quantisation below the beam statistical noise floor at all signal levels.

The 20-22 is a bench-top mass spectrometer with built-in continuous flow interface ready to be connected to our automated continuous flow sample preparation modules.





## Specification

Geometry	120° extended geometry with an 11 cm radius magnetic sector giving an effective 21 cm radius dispersion and double direction focusing. Truly universal Faraday triple collectors for simultaneous collection of adjacent masses in range 28, 29, 30 - 64, 65, 66 with no adjustment of collectors or amplifiers. Additional long spur with 98.8° sector which creates a distance of 24 cm between the focal points for m/z 2 and 3. Additional single Faraday collector for m/z 3.
Materials	All stainless steel construction with metal gasket seals to ensure ultra clean internal environment. The use of all metal permits bake out of the analyser and negligible water background. Industrial sealing technology (conflat flanges) means no dead volumes within ion optics so eliminating contamination and memory effects.
Ion source	High sensitivity, electron impact, plug-in design.
Magnet	Programmable electromagnet.
Resolution	m $\Delta$ m= 90 (N <sub>2</sub> ) 10% valley definition. m $\Delta$ m= 40 (H <sub>2</sub> ) 10% valley definition.
Sensitivity	< 1000 molecules per m/z 44 ion. < 10000 molecules per m/z 2 ion.
Abundance Sensitivity	< 5 ppm for N <sub>2</sub> , < 30 ppm for CO <sub>2</sub> < 1 ppm for H <sub>2</sub> at 4 x10 <sup>-6</sup> mbar He in continuous-flow mode. < 10 ppm for CO <sub>2</sub> - dual-inlet mode.
Linearity	< 0.03% / nA at beam intensity of 2 x10 <sup>-8</sup> A for CO <sub>2</sub>
H3+	<5 ppm / nA. Stability < 0.03 ppm/nA/hour.
Sample Decay	Time for a signal of 2E-8 Amps for m/z 44 to decay below 2E-10 Amps when inlet is isolated. Continuous flow mode = 30 seconds
Vacuum	Mass analyser - truly differentially pumped by 2 x drag stage turbomolecular pumps (70 L/s) backed by two-stage rotary pumps. Ultimate vacuum of 1 x 10 <sup>-9</sup> mbar. Source pressure monitored by inverted magnetron gauge. (Nb. this configuration is essential for GC-C-IRMS applications).
Inlet	Zero dead volume capillary interface to allow the use of continuous flow methods e.g. ANCA-MS and GC-C-IRMS.
Data acquisition system	Data acquisition system uses state of the art highly stable and linear high frequency converters which produce integral slices with zero dead time and quantisation below the beam statistical noise floor at all signal levels.
Software	Sercon Callisto software. Proprietary operational software for system control and data handling. Fully compatible with all versions of Windows, currently systems are installed with Windows 7.
Electronics	Sercon System Controller. Flashover-resistant electronics with semiconductors close to ground and isolated from high voltages. Full control of ion source parameters through software and on-board microprocessors. Communication is via USB with PC system. Valve control outputs for 32 valves as standard, can be extended to 64. Four VFC channels for ion beam and other detector readbacks are installed, extendable to eight or twelve depending on system configuration.
Refgas	Triple-port reference gas injection system to calibrate sample peaks produced by attached continuous flow modules. Fitted with dedicated pneumatic valves and inlet manifold for 3 reference gas bottles. Reference valve array can be expanded to six or more reference gases if required.
Basic unit comprises	20-22 mass spectrometer. Fitted with a triple and single collector for <sup>13</sup> C, <sup>15</sup> N, <sup>18</sup> O and <sup>2</sup> H, and electromagnet.
Precision	Precision analysis will always yield an SD better than presented below for 5 injections of gases at natural abundance. Major beam of 10 nano amps.



Gas	Reference Gas (‰ vs Ref)	Typical Data (from test records)
CO <sub>2</sub> ( <sup>13</sup> C)	0.1	0.06
CO <sub>2</sub> ( <sup>18</sup> O)	0.1	0.06
N <sub>2</sub>	0.1	0.05
SO <sub>2</sub> ( <sup>34</sup> S)	0.1	0.08
H <sub>2</sub>	1.0	0.46

The Geo 20-22 has all the features and performance of the 20-22 with extended capabilities that dual inlet provides.

The GEO20-22's low dead-volume dual micro inlet has been designed for high performance, sensitivity, reliability and ease of maintenance by using the most up to date materials and modern precision engineering. A micro cold finger and continuous flow interface are built in as standard features to meet the demands of modern day dual-inlet isotope ratio mass spectrometry. The whole instrument system is driven by Windows compatible software for ease of operation and networking capability

- Dual micro inlet consisting of twin ultra-low dead-volume, precision machined, five-sided stainless steel blocks (Pentabloc) interfaced to a common changeover valve (COV). Valves are of fail-safe, normally-closed design. Seals are manufactured from Kel-F making them more economical to service than the outdated gold seal design. The COV is a single ultra-low dead-volume fourway valve block which uses the same valve design as the dual-inlet blocks. An additional manual valve is provided to isolate the COV from the bleed pump to facilitate leak checking and allow maintenance without shutting off the vacuum pumps. The PentaBloc dual micro inlet and COV are pumped by a

turbomolecular pump (70 L/s). Standard cold finger has a total dead-volume when the sample is isolated of 90 µL. Liquid nitrogen usage is <100 ml per sample. Cold finger takes <2 min to reach minimum temperature from ambient and is easily interchangeable via screw fittings.

- Bench arrangement allows easy access to the analyser and dual-inlet for easy maintenance, removing the need to disassemble parts of the system while servicing others.

External Precision ( $\sigma$ (n-1)) for n=10 from sample manifold		
CO <sub>2</sub> (C)	100	0.01
CO <sub>2</sub> (O)	100	0.03
H <sub>2</sub>	200	0.5

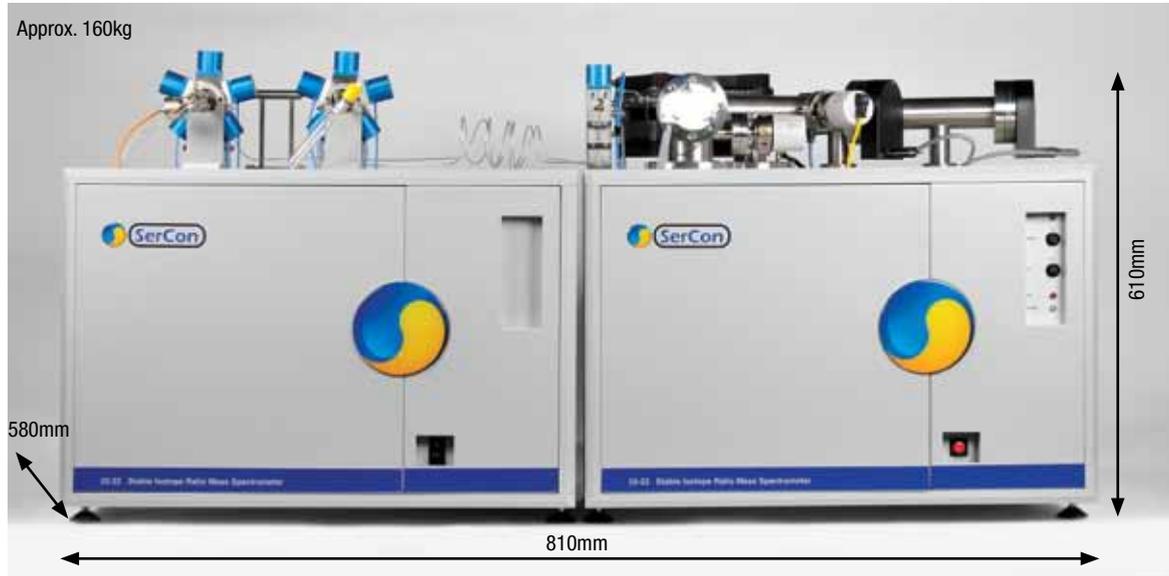
Internal Precision 2 $\sigma$ 10 for 10 changeovers on gases at natural abundance.			
Gas	Sample Size (bar µL)	Standard Inlet (‰)	Cold Finger (‰)
CO <sub>2</sub> (C)	100	0.01	0.01
	10		0.02
	3		
CO <sub>2</sub> (O)	100	0.015	0.015
	10		0.03
	3		
N <sub>2</sub>	100	0.01	0.01
N <sub>2</sub>	20		
H <sub>2</sub>	200	0.15	
SO <sub>2</sub>	100	0.015	0.015
	20		



## ANATOMY OF A 20-22 ION OPTICS



## GEO 20-22 DUAL INLET IRMS



## 20-22 IRMS



### Power and Gas Requirements

Power	100-240 VAC
Helium	99.998%
Compressed Air*	100psi
Nitrogen	99.999%
Carbon Dioxide	99.999%
Hydrogen	99.999%
Liquid Nitrogen*	

\* For GEO 20-22 only.

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