



sercon
innovators in isotopes

HS2022 Isotope Ratio Mass Spectrometer



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HS2022 ISOTOPE RATIO MASS SPECTROMETER

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

The HS2022 is the most sensitive small radius IRMS in the world, and incorporates many high level design features.

- 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.
- 120° extended geometry with an 11cm radius magnetic sector giving an effective 21cm radius dispersion and double direction focusing. Additional high dispersion long spur with 98.8° sector which creates a distance of 24cm 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 via the software. Software switchable variable gain amplifiers and 50V amplifier outputs are available as options.
- Asymmetric extended geometry to give true stigmatic focusing 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 in continuous flow mode <850 molecules/ion for CO_2 .
- True differential pumping by turbo-molecular pumps with a high compression ratio for both He and 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; H_2 , N_2 , NO, N_2O , O_2 , CO, CO_2 , SO and 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. A greater number is available as an option.
- 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.





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 an all metal analyser permits bake out of the analyser and negligible water background. True UHV using 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, permanent magnet option
Resolution	m/Δm= 110 (N2) 10% valley definition. m/Δm= 40 (H2) 10% valley definition.
Sensitivity	< 850 molecules per m/z 44 ion in CF. < 650 molecules per m/z 44 ion in DI.
Abundance Sensitivity	< 5 ppm for N ₂ , < 30 ppm for CO ₂ , < 1 ppm for H ₂ at 4 x 10 ⁻⁶ mbar He in continuous-flow mode. < 3 ppm for CO ₂ - dual-inlet mode.
Linearity	< 0.02% / nA at beam intensity of 2 x 10 ⁻⁸ A for CO ₂
H ₃ ⁺	<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 a two-stage rotary pump. Ultimate vacuum of 1 x 10 ⁻⁹ 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.
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.
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.
Reference Gas	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.

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- 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.
- 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.

Gas	Reference Gas (‰ vs Ref)
CO ₂ (¹³ C)	0.06
CO ₂ (¹⁸ O)	0.06
N ₂	0.06
SO ₂ (³⁴ S)	0.1
H ₂	0.4

The HS2022 is the most sensitive small radius IRMS in the world. The HS2022 is the continuous flow version whereas the GEO-HS2022 is the dual-inlet version. The GEO-HS2022 has all the features and performance of the HS2022 with the extended capabilities that dual-inlet provides.

The GEO-HS2022'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.

External Precision (σ (n-1)) for n=10 from sample manifold		
Gas	Sample Size (bar µL)	Standard Inlet (‰)
CO ₂ (¹³ C)	100	0.02
CO ₂ (¹⁸ O)	100	0.03
H ₂	200	0.5

Internal Precision (2 σ 10 for 10 changeovers on gases at natural abundance)			
Gas	Sample Size (bar µL)	Standard Inlet (‰)	Cold Finger (‰)
CO ₂ (¹³ C)	100 10	0.01	0.01
CO ₂ (¹⁸ O)	100 10	0.015	0.015
N ₂	100	0.01	
H ₂	200	0.15	
SO ₂	100	0.015	

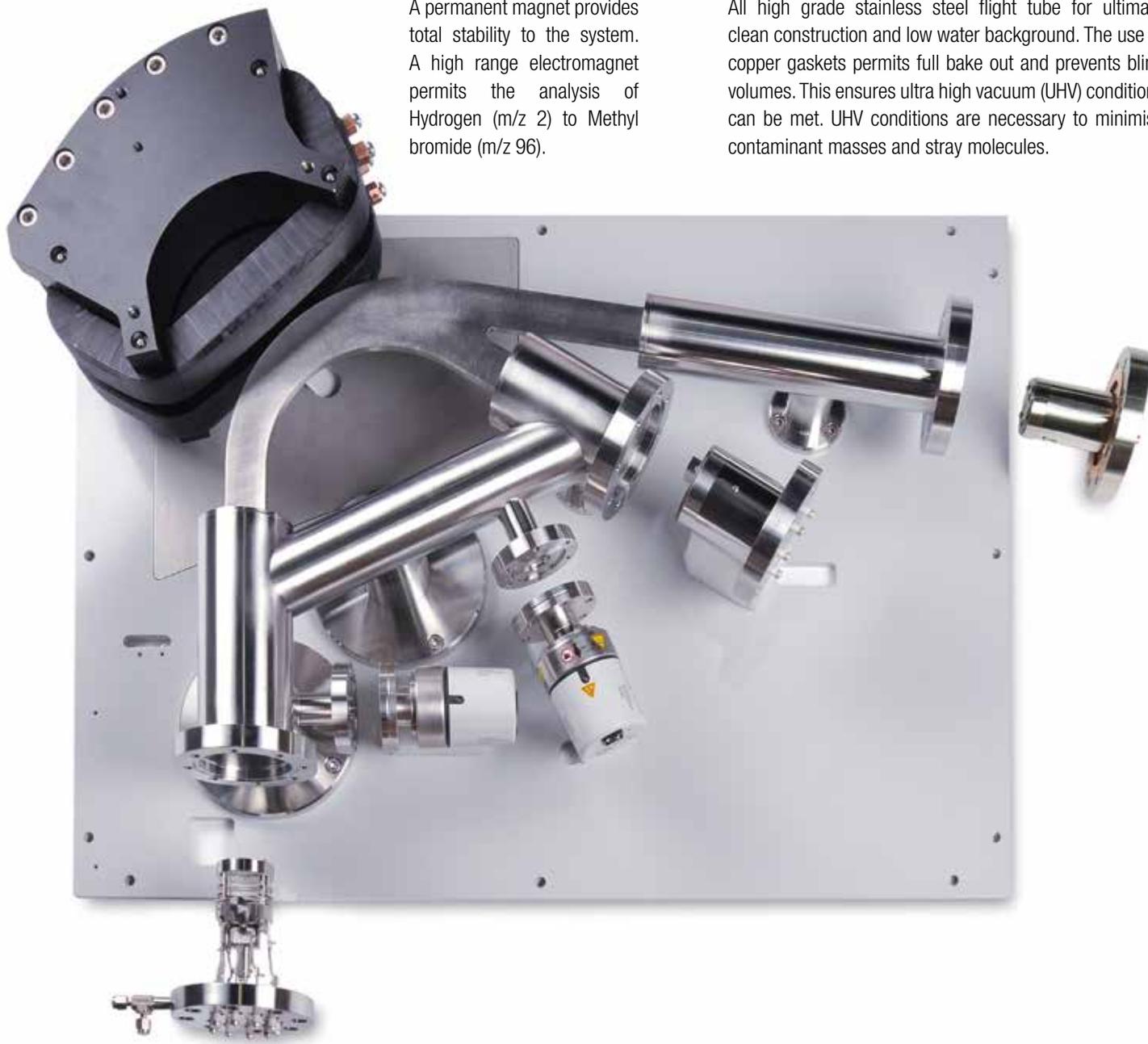
ANATOMY OF A HS2022 ION OPTICS

MAGNET

A permanent magnet provides total stability to the system. A high range electromagnet permits the analysis of Hydrogen (m/z 2) to Methyl bromide (m/z 96).

FLIGHT TUBE

All high grade stainless steel flight tube for ultimate clean construction and low water background. The use of copper gaskets permits full bake out and prevents blind volumes. This ensures ultra high vacuum (UHV) conditions can be met. UHV conditions are necessary to minimise contaminant masses and stray molecules.



ION SOURCE

High sensitivity Nier type electron impact design ensures high ionisation efficiency. Thoriated filament is highly stable and permits analysis of O_2 . Modern design concept ensures zero memory effect and permits analysis of SO_2 gas as standard. Self-alignment ensures perfect ion optics.

PUMPING

True differential pumping ensures the best possible vacuum conditions. Higher pressure in the source for sample ionisation with reduced analyser pressure ensures 100% beam transmission through the magnetic sector to the collector.

COLLECTORS

Universal triple collector of a fully enclosed design eliminates noise and scatter of ions. Dedicated HD (m/z 3) detector does not require electrostatic filter or retardation grid due to full spatial separation of He (m/z 4)



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	

ISO 9001:2015 Certified

ISO 13485:2016 Certified

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