IRMS

perspective

Isotope Ratio Mass Spectrometry

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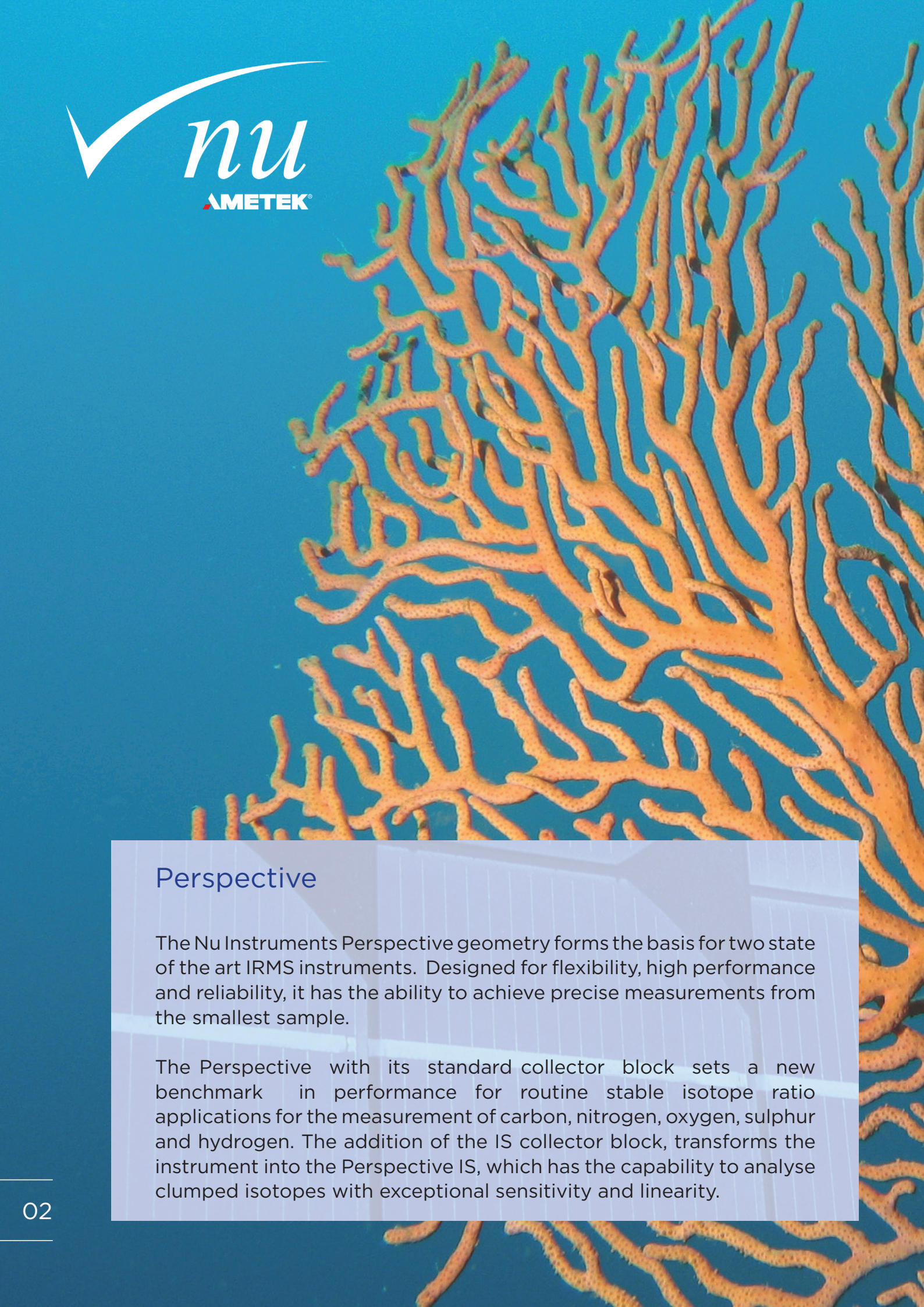


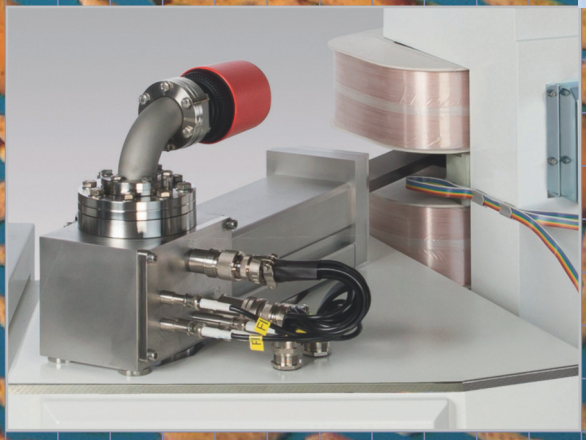
Perspective

The Nu Instruments Perspective geometry forms the basis for two state of the art IRMS instruments. Designed for flexibility, high performance and reliability, it has the ability to achieve precise measurements from the smallest sample.

The Perspective with its standard collector block sets a new benchmark in performance for routine stable isotope ratio applications for the measurement of carbon, nitrogen, oxygen, sulphur and hydrogen. The addition of the IS collector block, transforms the instrument into the Perspective IS, which has the capability to analyse clumped isotopes with exceptional sensitivity and linearity.

Perspective - key features

- High efficiency ion source with integral focussing lenses
- Fully differentially pumped as standard
- Hall probe stabilised electromagnet
- High efficiency, narrow entrance, deep Faraday collectors
- Amplifiers capable of measuring signals to 55V
- 100% analyser transmission
- State-of-the-art electronics with full self-diagnostics
- Unique SIRMS collector arrays using “Variable Zoom Optics” (with no moving parts)
- All masses, including H_2, are measured at the full deflection radius
- Integral ion source heater (temperature up to 200°C)
- Simultaneous ion beam collection using up to twelve Faraday collectors
- All masses measured at full 8kV accelerating potential
- Mass resolution CNOS and H ($m/\Delta m$) >200 (10% valley)
- Mini electrostatic filters for measurement of clumped isotopes and HD

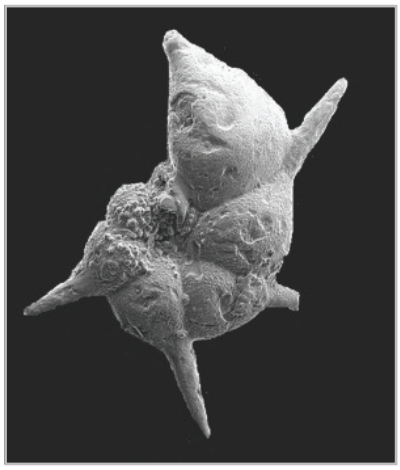


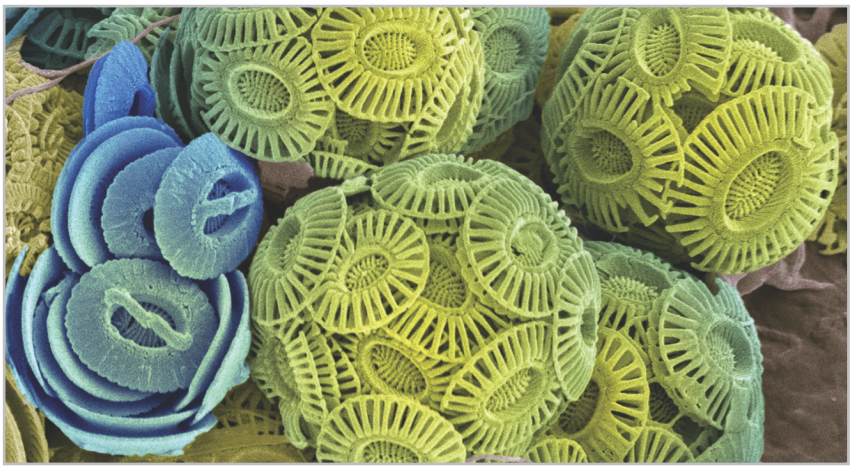
Perspective

Stable Isotope Ratio MS

Mass Spectrometer

The Perspective is an extended geometry magnetic sector isotope ratio mass spectrometer, incorporating a high efficiency electron impact ion source, unique Zoom Optics, and up to 12 fixed narrow collectors. The Perspective can be interfaced with the Nu Instruments Dual Inlet system and Nu Carb sample preparation systems for precise isotopic analysis of gases and carbonates. Running of samples is automated using flexible, user friendly software.





The Ion Source

The Perspective Ion source runs at 8kV acceleration potential for all masses. Integral bidirectional lenses, focussing in both the vertical and horizontal planes ensures 100% transmission of ions through the analyser.

The ion source is exceptionally linear over the full dynamic range of the instrument and also has a low (<10 ppm/nA) and stable (<0.03 ppm/nA/hour) H_3^+ formation, which is essential for precise D/H analysis. The integral source heater ensures that the lowest background is achieved. All ion source parameters are computer controlled, with the functionality to save and retrieve the tuning parameters for each sample gas and isotope ratio to be measured.

The Analyser

The Perspective has a large variable mass dispersion (up to 600mm) which creates excellent peak shapes, unparallelled mass resolution and high abundance sensitivity.

Exceptional stability is provided by a Hall probe controlled electromagnet which allows for peak jumping via magnetic field switching with accurate control of the magnetic field.

Perspective

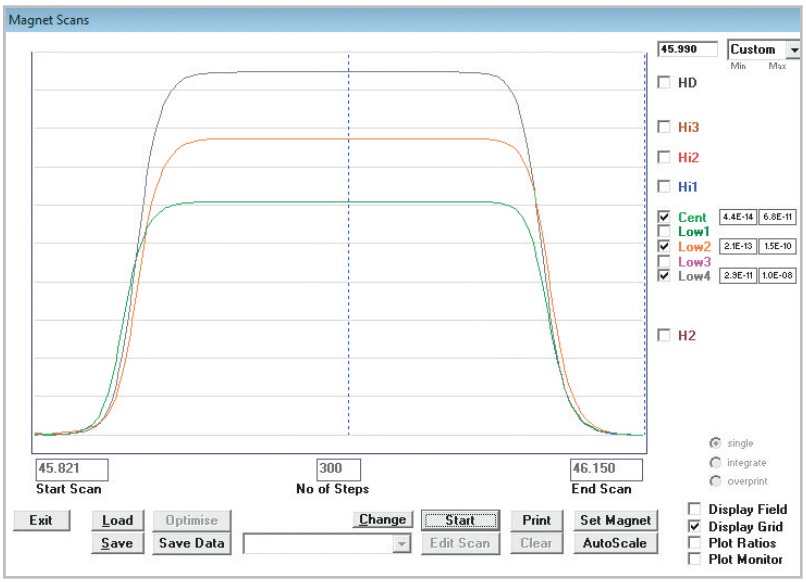
Optimised Collector Geometry

The Collectors

The Perspective has a unique optimised collector geometry. Instead of using a universal triple collector, the Perspective uses the variable zoom optics technology to alter the dispersion of the IRMS electronically so that the ion beams are aligned to image simultaneously on fixed and narrow detectors for all masses. All isotopes are measured on the same collector array. High efficiency, narrow entrance and deep Faraday collectors, provide high resolution on all collectors. Collectors are connected directly to individual preamplifiers in an evacuated, temperature controlled housing for the highest signal stability.

Dual Inlet System

The Dual Inlet system is located in a separate cabinet next to the Perspective, with the changeover block mounted close to the sample inlet valve on the ion source housing to minimise dead volume and gas path lengths. The dual inlet allows high precision measurements of a sample gas against a reference gas. Sample gas can be introduced into the dual inlet directly or via a sample preparation device such as the NuCarb.



Peak shape for CO_2 ion beams at 44, 45 and 46 amu

No Inter-sample Changeover Memory Effects

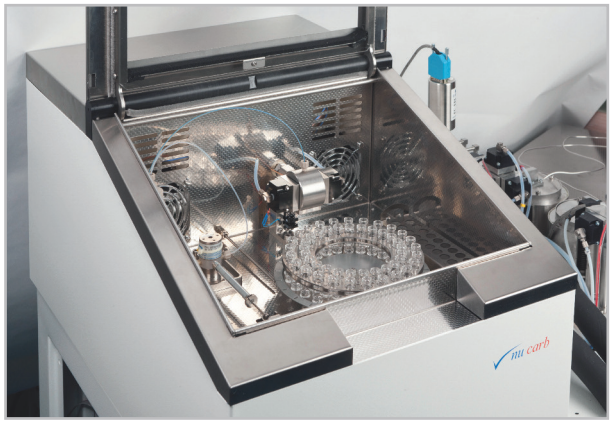
Any sample preparation system that is designed to sequentially analyse samples with variable isotopic composition has the potential to exhibit memory effects. However, the unique design of the Perspective's Dual Inlet changeover valve ensures that there are negligible source/changeover valve mixing effects when switching between samples, with sample switching times as low as 4 seconds.

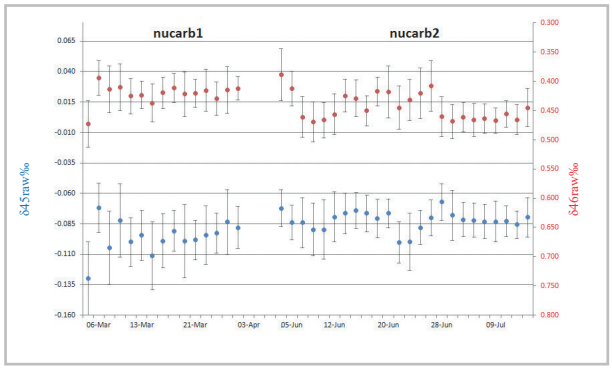
Nu Carb Carbonate Device

The Nu Carb is a compact bench-top dual inlet carbonate device that offers high precision $\delta^{13}C$ and $\delta^{18}O$ isotope ratio determinations on small carbonate samples. It can be interfaced with the high sensitivity high resolution Perspective isotope ratio mass spectrometer.

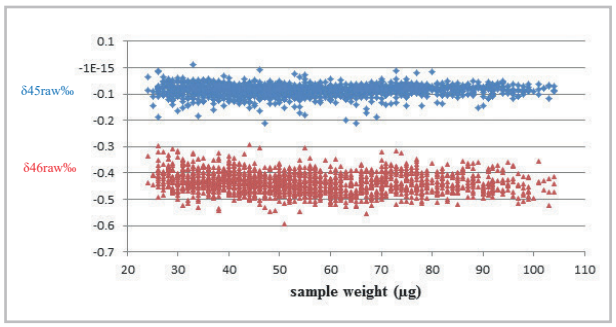
Features of the NuCarb include:

- 50 individual sample vials capacity
- Average sample analysis time of 32 minutes
- Motor driven syringe (1-250µl) for precise acid delivery to sample vials
- Slow pump mechanism that eliminates sample disturbance during pump out
- Optical vial detection system
- Optional automated reference gas refill system
- Reservoir capacity of 40ml H_3PO_4 (enough acid for 400 samples if 100µl of acid is used per sample)
- 250ml of LN_2 per sample
- All internal parts held at 70°C
- Bench top, located on dual inlet bench





Long term reproducibility of nucarb batch analysis



Routine analysis of 24-104µg carbonate samples

External Sample Stastistics

	No of analysis	δ45raw ‰	1σ ‰	δ46raw ‰	1σ ‰	rej.
nucarb -1	570	-0.10	0.03	-0.42	0.03	3
nucarb -2	1009	-0.08	0.02	-0.44	0.04	9
Total	1579					12

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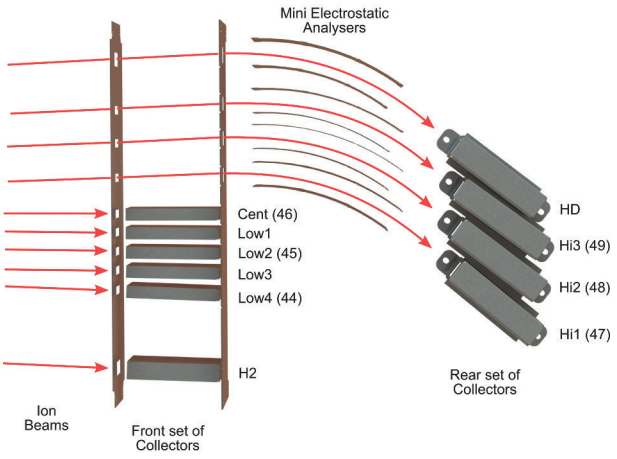
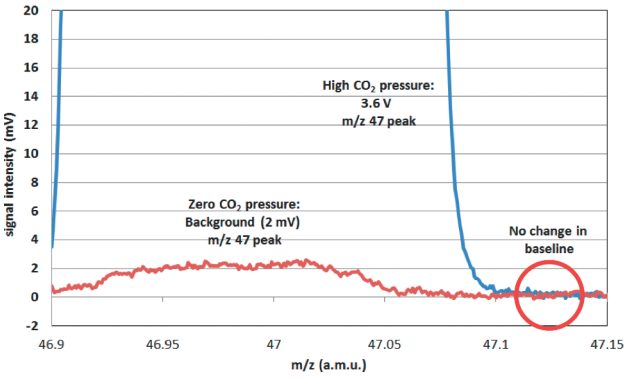
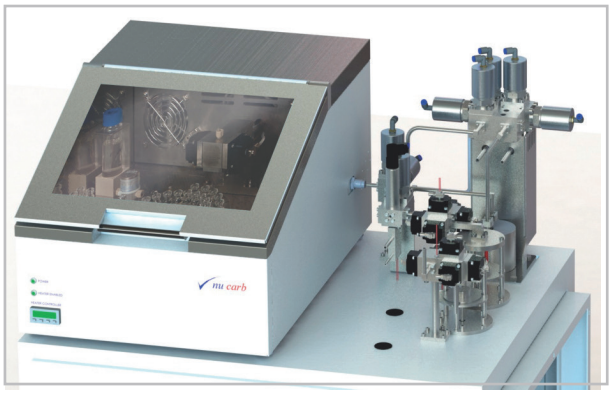
Clumped Isotope Analysis



IS – Faraday collector block. CO_2 collector configuration marked (mass 44 – 49)



Perspective IS mass 47 peak shapes with a high pressure of CO_2 (80 nA mass 44 signal) and without CO_2 (0.01 nA mass 44 signal).



Nu Carb with dual inlet and cryo-cooled adsorbent trap

For the study of clumped isotopes, the Perspective is available with an optional "IS" collector configuration. The IS collector block includes 3 small electrostatic analysers ("mini ESAs") placed in front of the 3 high mass collectors (masses 47, 48 and 49 for CO_2).

IS Collector Block

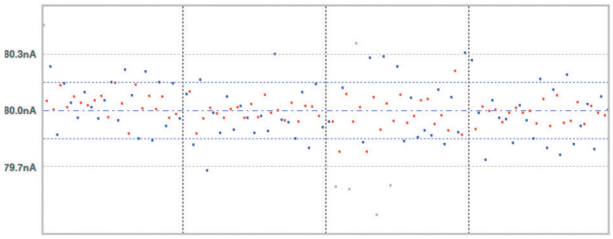
For accurate measurement of clumped isotopes the IS collector block has been designed to remove the well known pressure baseline effect. The pressure baseline effect is observed as a negative shift in the baseline value of the mass 47 peak that is dependent on sample gas pressure. Utilising the mini ESAs positioned on Hi1, Hi2, Hi3 and HD collectors the Perspective yields no pressure baseline effect and considerably simplifies the analysis method.

Nu Carb Adsorbent Trap

An automated solution for clumped isotope analysis is available with the Nu Carb carbonate device, allowing precise and accurate measurements of small carbonate samples. An automated cryo-cooled adsorbent trap has been developed to purify the CO_2 produced by the Nu Carb and eliminate any contaminants. This technique allows minimal wastage of sample gas and maximum statistical counting time.

Beam Balancing

The Perspective IS uses a patented (**GB 2520543, DE 102015000623**) beam balancing technique. Throughout the analysis routine, the sample and reference signals are monitored and adjusted so that a user-set major beam current is maintained. The benefits of the beam balancing technique combine to allow much shorter analysis times.



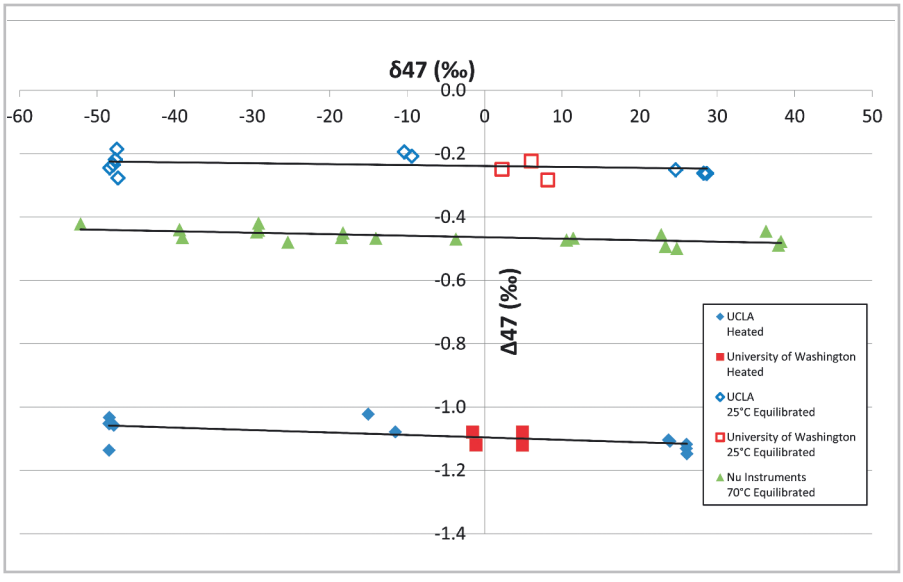
Sample (red) and reference (blue) signals during a clumped isotope analysis routine

Data for 1 block of 20 ref/sam cycles		
ISE	With balancing	Without balancing
δ45raw ‰	0.001	0.001
δ46raw ‰	0.002	0.003
δ47raw ‰	0.012	0.017
δ48raw ‰	0.047	0.062

Typical ISE for 4 blocks of 20 ref/sam cycles (with balancing)			
Mass 44 beam size	20nA	50nA	80nA
δ45raw ‰	0.001	0.001	0.001
δ46raw ‰	0.002	0.002	0.002
δ47raw ‰	0.012	0.009	0.007
δ48raw ‰	0.062	0.032	0.025

Clumped sample analysis

- Fast analysis time (circa 70 minutes for 4 blocks)
- High precision (typical SE for Δ47 < 0.010 ‰)
- No appreciable slopes for δ47 versus Δ47 for heated and unheated gases
- Measured values not dependant on filament used



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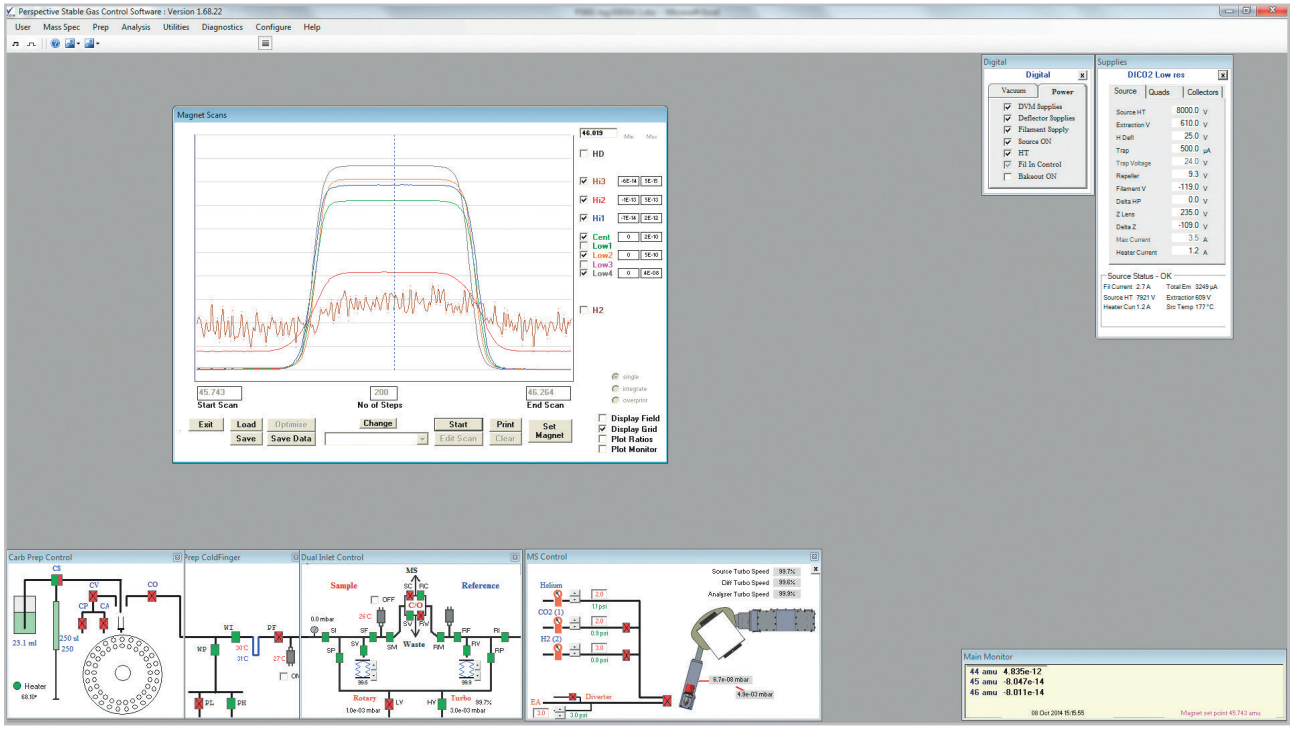
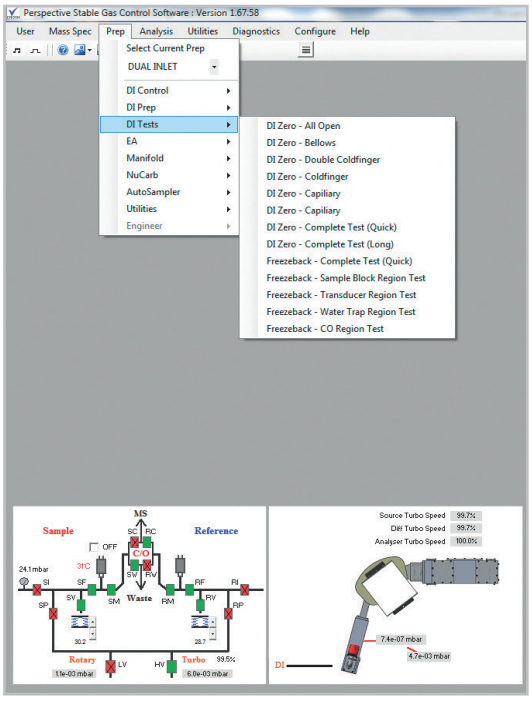
Nu Stable Software for Instrument Control

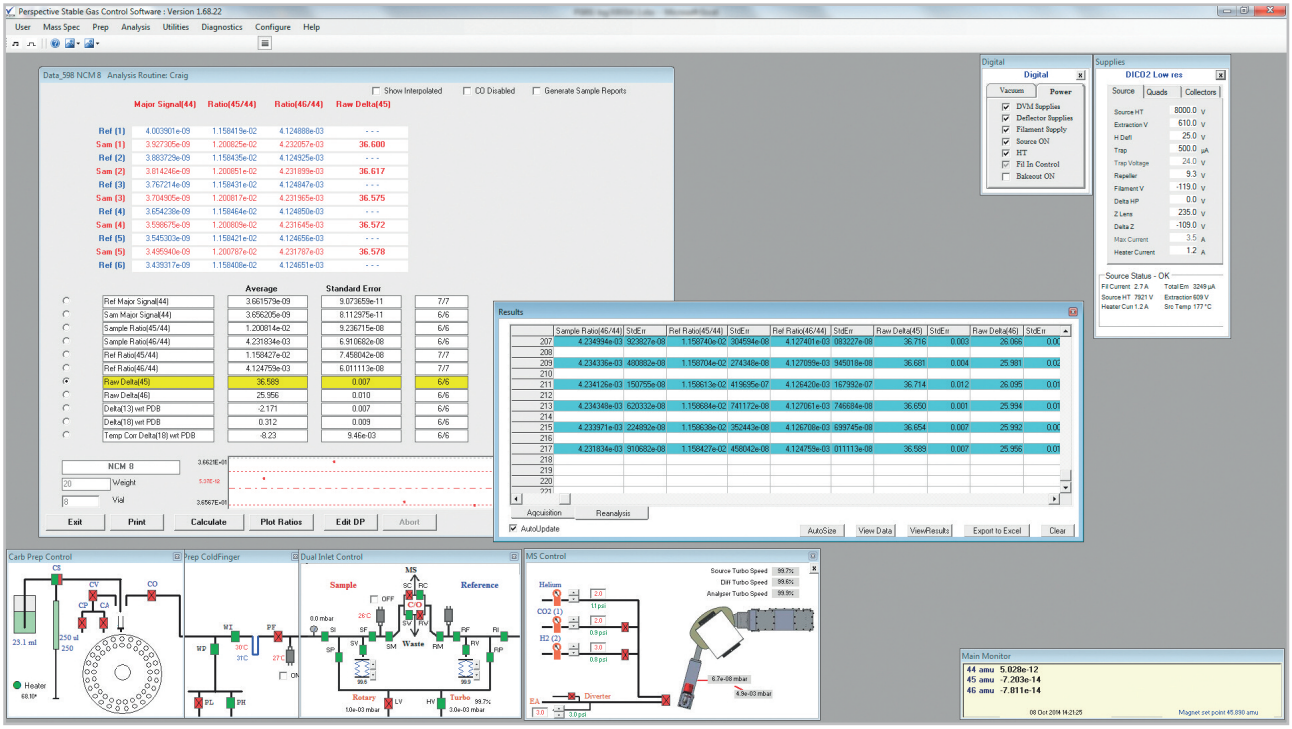


Quality control is provided with factory defined tests that indicate the system is ready for analysis.

The Nu Stable software provides a comprehensive integration of the functionality required to achieve results with the instrument, presented in a simple to use user interface.

The software provides intuitive control of all commonly used instrument parameters and libraries of settings allowing simple prep switching and configuration.

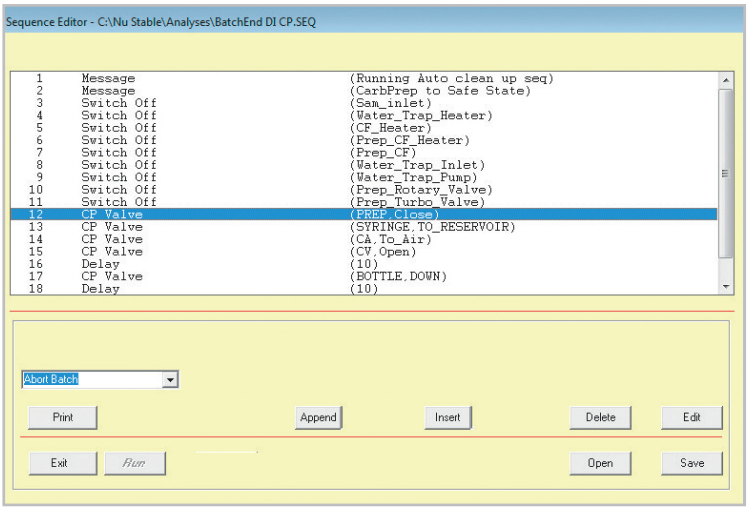




The software performs fully automated data acquisition with the capability of multitasking sample preparation and data acquisitions to achieve the maximum throughput from your instrument. Data Acquisitions are performed from methods created in the simple editor.

The Windows based software is fully compatible with the Windows 10 32 bit and 64 bit operating systems.

Remote support is available for the instrument and diagnostic log files can be enabled to help pinpoint any unusual instrumentation behaviour.



Methods can be extended to provide custom control of any instrument component by developing user editable sequences, defined using the simple, full featured sequence language.

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Innovators in Mass Spectrometry

Isotope Ratio Mass Spectrometry

environmental · planetary · life science · geochemistry

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