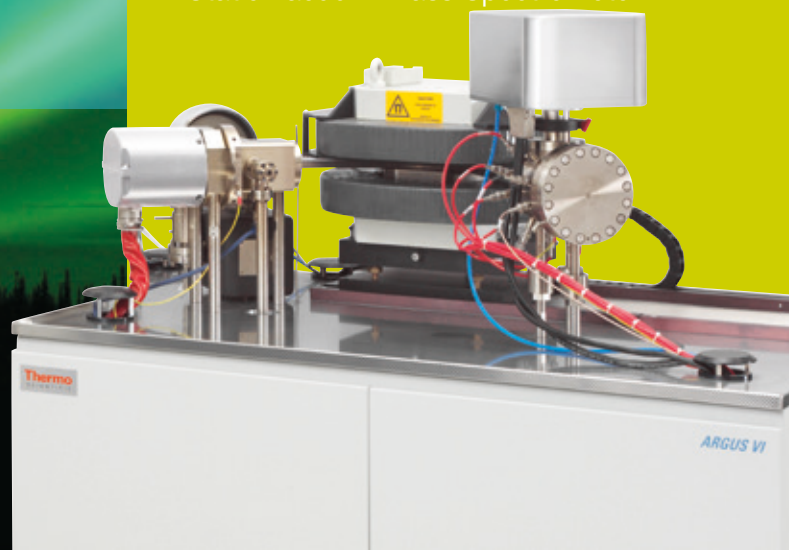


ARGUS VI
Static Vacuum Mass Spectrometer



Static Vacuum **ARGUS VI**

Multicollection • Low Volume • Precision

Thermo
SCIENTIFIC

Based on more than 20 years of experience in noble gas mass spectrometry instrumentation, we have developed the Thermo Scientific™ ARGUS VI™, our latest generation Static Vacuum Mass Spectrometer (SVMS).

It combines innovative new features with the field-proven technology taken from the Thermo Scientific isotope instruments. The ARGUS VI system is a major step forward in multicollector SVMS technology.

The ARGUS VI mass spectrometer is one member of a family of products designed to meet the requirements of the static vacuum community. The portfolio includes the HELIX SFT™ split flight tube mass spectrometer which is designed as a fast, high resolution peak jumping system that is also capable of measuring the isotopes of helium simultaneously and the HELIX MC™ mass spectrometer which is designed to be the ultimate high resolution variable multi collector system. This instrument is capable of measuring any five isotopes of neon, argon, krypton or xenon simultaneously at new levels of resolution.

Static Vacuum Mass Spectrometer

ARGUS VI

The ARGUS VI static vacuum mass spectrometer is a magnetic sector mass spectrometer designed for high precision isotopic analysis of small samples of the noble gases. It comprises a magnetic sector analyzer with 13 cm, 90° extended geometry ion optics. The geometry combines excellent ion optic performance with two-direction focusing and high dispersion in a compact footprint.

Sensitivity

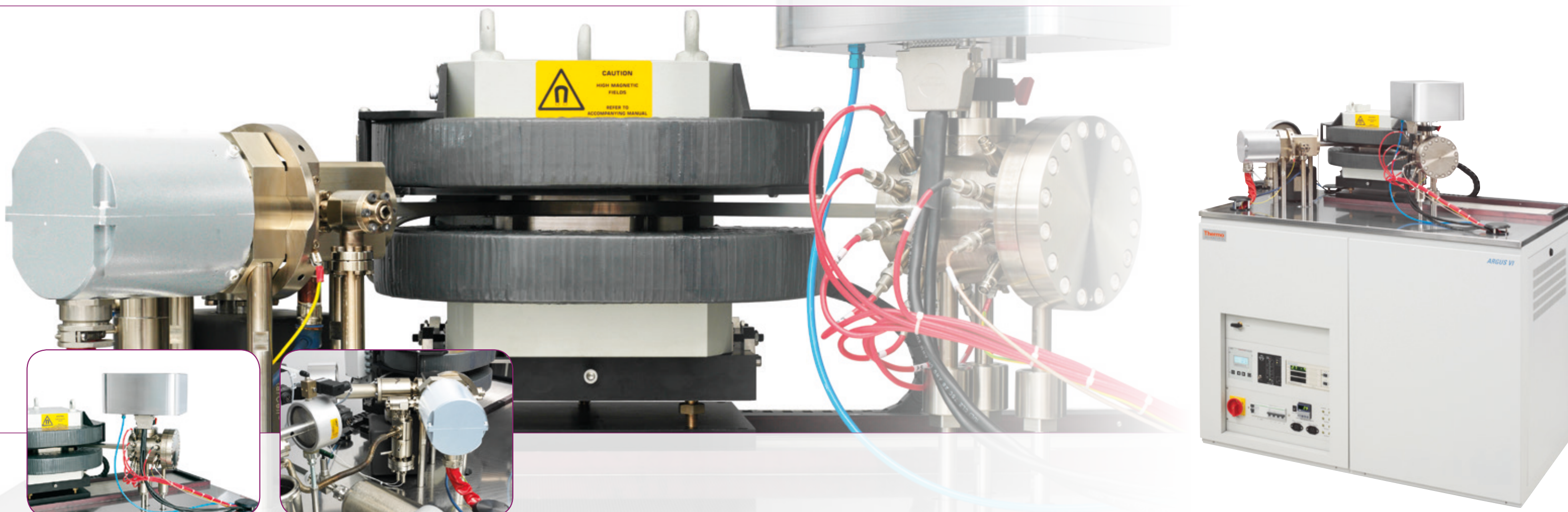
One of the key features of the ARGUS VI instrument is its very low internal volume of ~700 cc. Given that the sensitivity of a static vacuum mass spectrometer is inversely proportional to its internal volume, the instrument is the most sensitive commercial instrument available. Coupled to its low volume, the instrument utilizes a X & Z focused Nier type bright source giving sensitivities in excess of 1×10^{-3} Amps / Torr at a source current < 1mA for argon.

Detection

The collector array incorporates five Faraday detectors fitted to allow the true simultaneous collection of masses 36, 37, 38, 39 and 40. These Faraday cups incorporate new high gain amplifier circuits that allow for gains of 10^{10} , 10^{11} or 10^{12} Ohm measuring resistors to be used. These temperature controlled evacuated amplifiers have an extended measurement range of 50 V, rather than the historical 10 V, giving a much wider dynamic range.

The Faraday cup amplifiers have a built in electronic cross calibration that accurately calibrates the 5 channels. An optional ion counting electron multiplier can be fitted to the Low 3 mass position. This new compact discrete dynode (CDD) electron multiplier has an ion counting efficiency $\geq 80\%$ with inherent noise ≥ 10 CPM. and has been designed specifically for very low out gassing rates.

This CDD device can either be used for single collector peak jumping measurements or in conjunction with the low 1 Faraday for simultaneous 40 / 36. This collector array, coupled to the flexible user definable software suite, allows for not only multicollection analysis or single collector measurements, but also a mixture of both during the same run.



Analyzer

Beam Deflection Technology

The ARGUS VI collector includes a new electrostatic beam deflection technology which allows for the simultaneous measurement of multiple isotopes across its fixed array. The three diagrams below show the capability of the system.

Multiplier Performance Details

- Dynamic range: 1 CPS to ~1,400,000 CPS
- Dark noise: < 10 CPM (0.2 CPM typical)
- Stability: < 0.2% drift per hour at 100 KCPS

Electromagnet

The electromagnet is fabricated from high purity soft iron. It is mounted on roller bearings and has translational and rotational adjustment in all three planes to optimize peak shape and flatness.

- High stability achieved with a temperature controlled field probe
- Excellent results for peak jumping acquisitions
- Maximum sensitivity in all applications
- Fully controlled by the control software, allowing rapid peak jumping between masses while maintaining maximum sensitivity

Ion Source

The ARGUS VI system utilizes a flange mounted "Nier" type ion source that has evolved in design over the last 30 years. This source gives excellent sensitivity while maintaining a low trap / total emission ratio leading to long filament life and low source temperatures. The source is designed for easy de-mount, filament change and cleaning. The source is self-realigning on assembly.

- Self-aligning source filament
- Maximized ion production for high sensitivity
- Simple design, easy to maintain

Vacuum System

The vacuum system is designed for true UHV performance. The system, including the flight tube, is manufactured from a range of advanced materials. These new materials, in conjunction with limited welding and new high specification heat treating and cleaning processes, lead to ultra low background and rates of static rise.

The UHV pumping is achieved by utilizing a 20L/s ion pump designed specifically for pumping noble gases and a 80L/s turbo molecular pump backed by a two stage diaphragm pump. The pumping system isolation valve is an automated DN 40 all metal valve that is pneumatically controlled from the Qtegra software. The CF-16 inlet valve to the mass spectrometer is manually controlled. The mass spectrometer also includes one SAES NP10 non-evaporable getter pump located in its own water cooled jacket. The getter can be isolated from the system via a CF16 all metal valve.

- Vacuum ~ 10⁻¹⁰ mbar
- Dry-pumped backing line
- Ion gauge for vacuum monitoring
- Optional pneumatic / manual valves have helium leak rates for valve and body < 1 x 10⁻¹⁰ cc STP/sec
- Heaters and controls to bake mass spectrometer to > 300 °C included

Collector Options

CDD Low 3	Faraday Low 2	Faraday Low 1	Faraday Axial	Faraday High 1	Faraday High 2
	Argon 36	Argon 37	Argon 38	Argon 39	Argon 40
Argon 36	Argon 37	Argon 38	Argon 39	Argon 40	



Collectors (from left to right)
High 2, High 1, Axial, Low 1, Low 2, Low 3 CDD

Beams shown
Blue ⁴⁰Ar, Green ³⁹Ar, Pink ³⁸Ar, Red ³⁷Ar, Yellow ³⁶Ar

Control

Electronic Control Systems

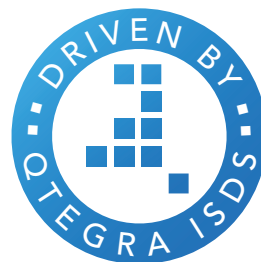
The ARGUS VI mass spectrometer is driven by a state-of-the-art suite of electronics derived from the industry standard Thermo Scientific TRITON™ and MAT 253™ systems. The source electronics are taken from the MAT 253 stable isotope mass spectrometer and the magnet, data acquisition and collector electronics come from the Thermo Scientific TRITON Plus thermal ionization mass spectrometer.

- Source electronics - All tuning parameters are computer controlled, interfacing to a suite of electronics that operate the HV, focus, electron volts, ion repeller, trap and steering
- Intelligent interface controls communication between the PC and the source, the magnet and all valve controls
- Optional I/O electronics for interfacing third party hardware
- High stability high gain amplifiers taken from the TRITON Plus TIMS system coupling 50 volt dynamic ranges to 1e10, 1e11 or 1e12 gain amplification

Qtegra Software

The Thermo Scientific Qtegra™ Intelligent Scientific Data Solution™ is the dedicated data acquisition and control software utilized to control the ARGUS VI system. Operating under Windows® 7 and in conjunction with the embedded interface, this provides comprehensive system control, acquisition and reporting.

- Full computer control and storage of all source parameters
- Full display, including a numeric and graphical display of ion beams and pressure gauges and a graphical valve status display
- Full access to valve control when automatic sequences not in operation
- Ion beams and isotope ratio display during data acquisition to allow operator assessment of data quality during analysis
- All raw data stored



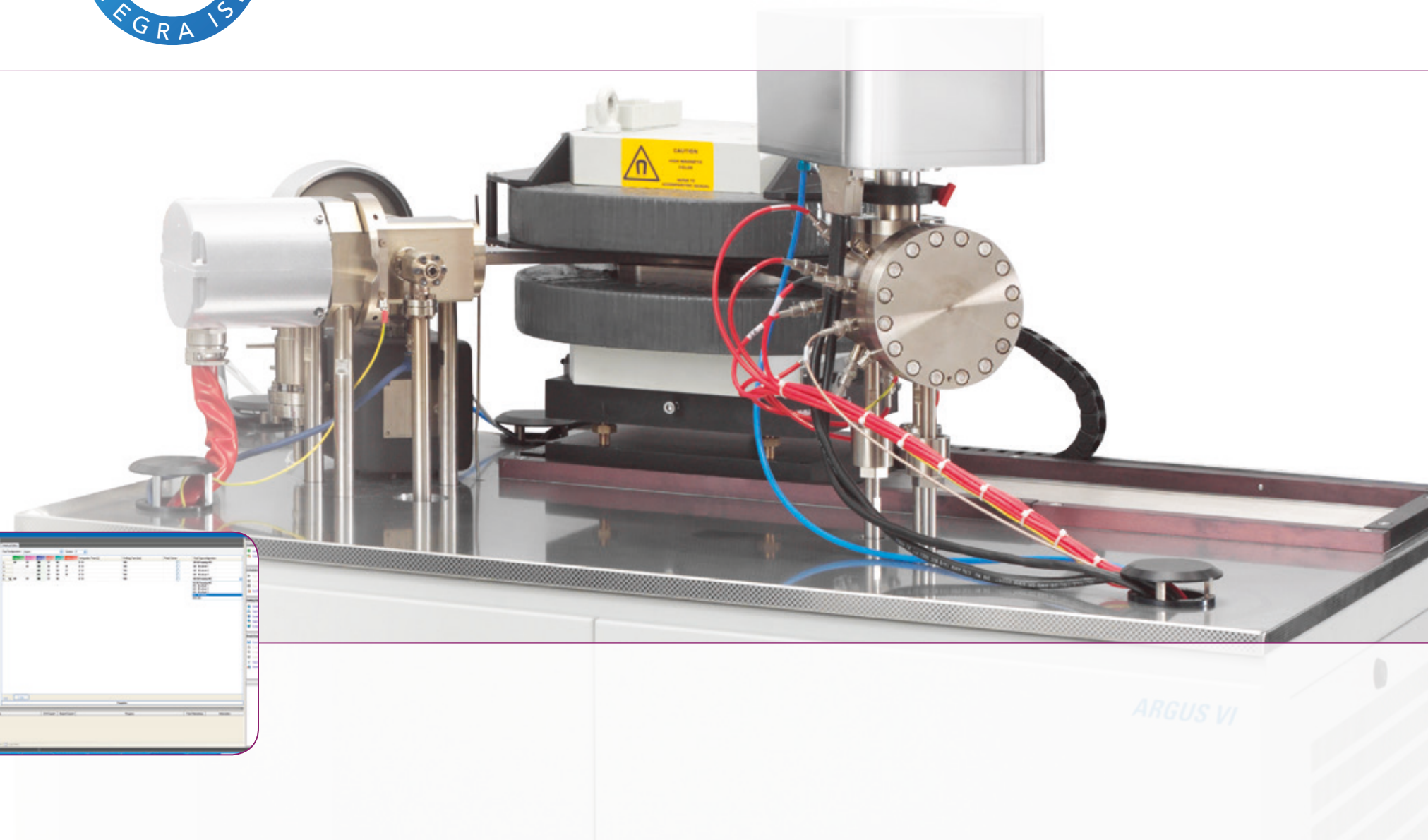
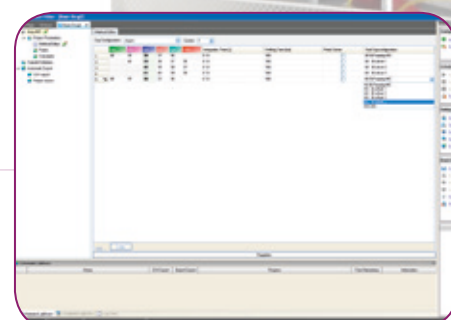
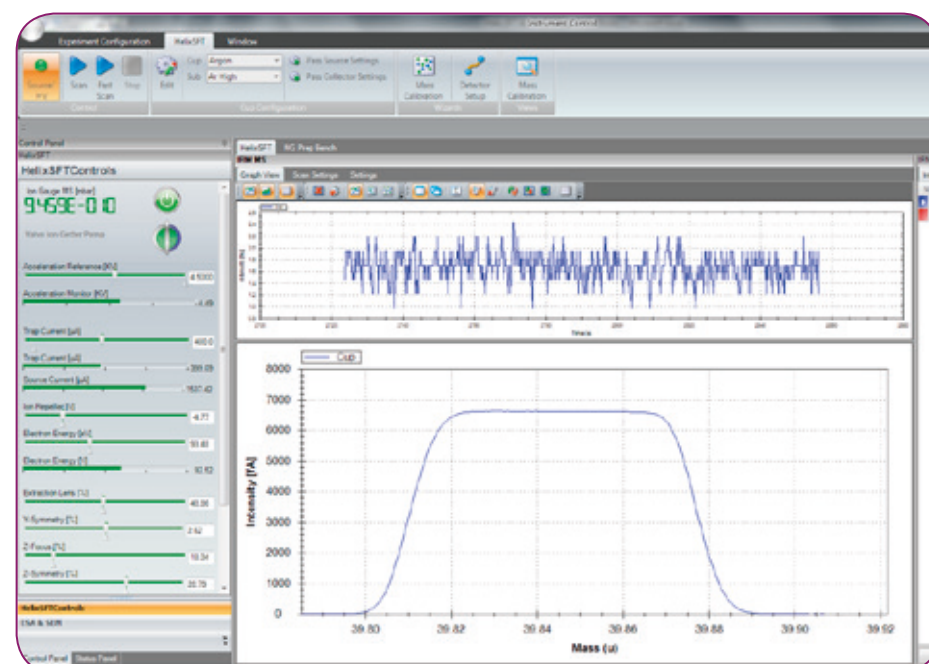
Performance

ARGUS VI Mass Spectrometer Summary

- Extremely efficient ion source capable of sensitivities in excess of 1×10^{-3} Amps / Torr at a source current $< 1 \text{ mA}$ coupled to an industry leading ~ 700 cc internal volume.
- The ability to measure all 5 argon isotopes simultaneously. No peak jumping required. This leads to reduced analysis time and greater productivity.
- An advanced collector array incorporating several new features including beam deflection technology allowing for multi dynamic measurements with a fixed collector array (proprietary technology). Electronically calibrated $1 \times 10^1 / 1 \times 10^{11} / 1 \times 10^{12}$ amplifiers with 50 volt ranges enable majority of analysis to be carried out on long life Faraday detectors. CDD multiplier technology allows for high counts rates coupled with extremely low noise.
- Footprint. The ARGUS VI mass spectrometer is the most compact noble gas system available.

Performance Specifications

Mass range	1 to 140 mass units (> 80 at reduced HV)
Background	$\geq 5 \times 10^{-14}$ cc STP at ^{36}Ar
Argon sensitivity	$> 1 \times 10^{-3}$ Amps / Torr with a source current $< 1 \text{ mA}$
Axial detector resolution	> 200 @ 10% peak valley
Peak side stability	Drift to be less than the equivalent of ± 50 ppm in mass over 30 minutes at ^{40}Ar
Rate of rise	$< 1 \times 10^{-12}$ cc STP/min of ^{40}Ar over 30 minutes
Abundance sensitivity	< 5 ppm for adjacent masses (^{39}Ar contribution from ^{40}Ar) at a pressure of 1×10^{-7} mbar
Axial Faraday peak flat	$\geq \pm 1$ in 1×10^3 over ± 150 ppm in mass



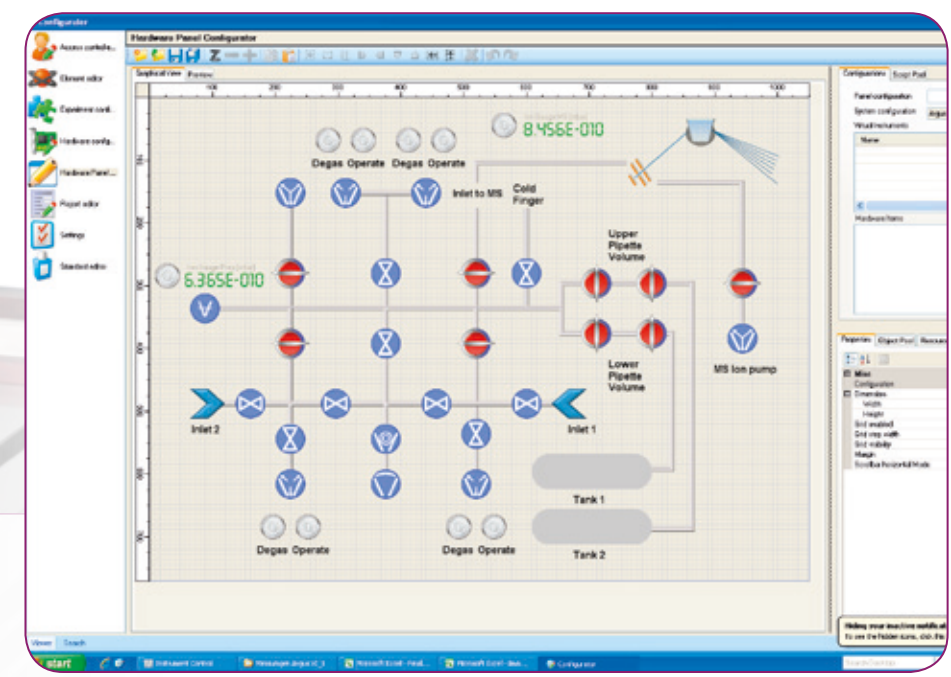
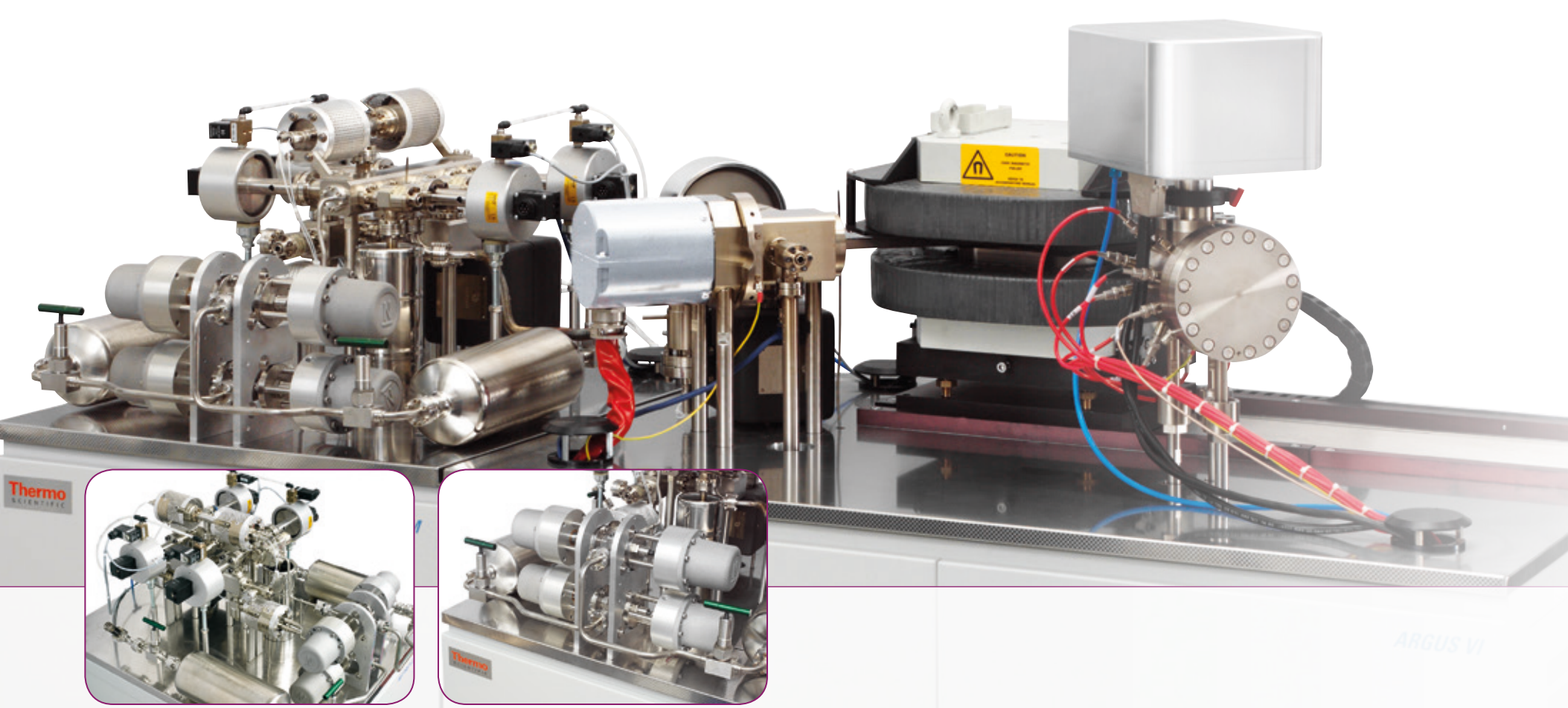
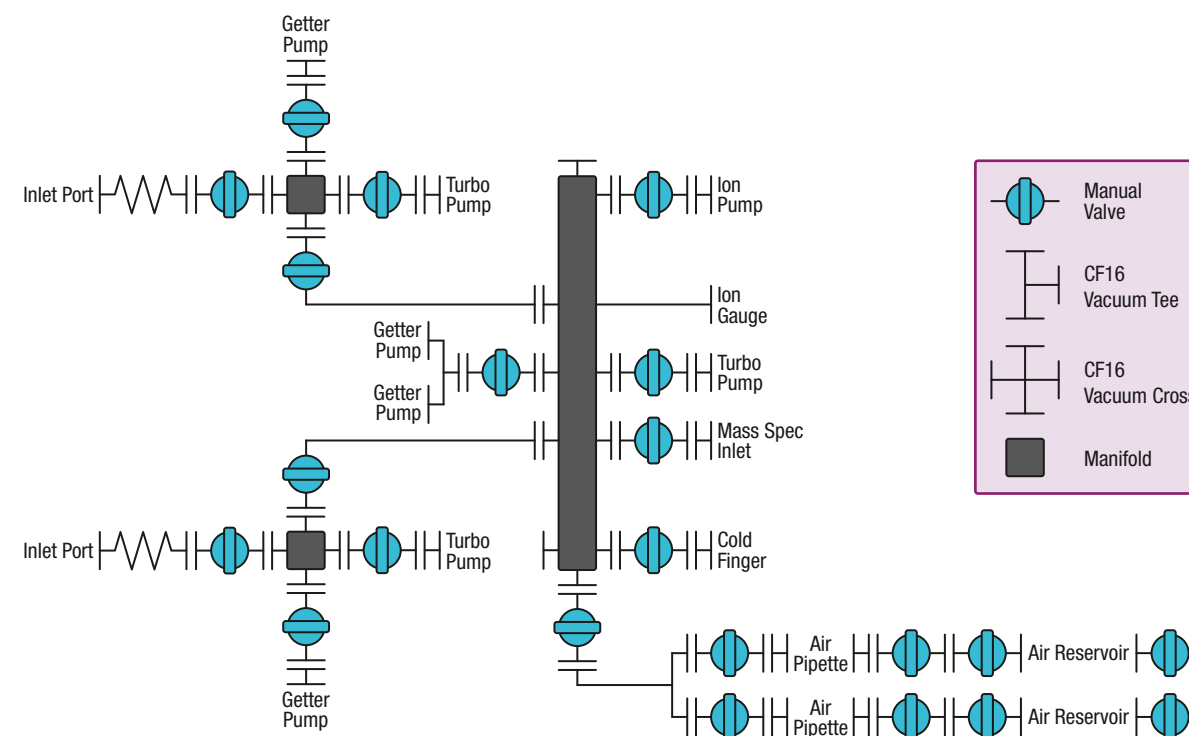
Automation

Rapid Sample Analysis

Preparation System

This prep line is used for all sample and reference gases prior to entry in the mass spectrometer. The line is equipped with two SAES NP10 getter pumps in jackets that can be water cooled, an ultra low volume micro ion gauge, 2 x spike / air reservoir and pipettes (pipette volumes are both 0.1 cc), liquid nitrogen cold trap, Agilent StarCell 20 L/s ion pump and a connection to the dry turbo molecular pumping system. Two spare ports, sealed by a CF16 vacuum blank flange, are provided to allow for future upgrades.

The two inlet lines enable sample gas to be cleaned prior to admission to the final clean up line. The two lines are pumped by a 80 L/s turbo molecular pump backed by a 2 stage diaphragm pump and are fitted with an NP10 getter pump in jackets that can be water cooled. The temperature of each getter can be controlled by its own electrical supply.



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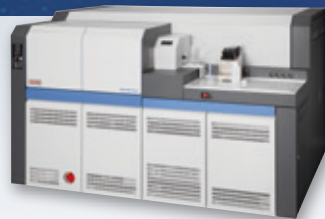
Noble Gas MS

Thermo Scientific ARGUS VI,
HELIX MC Plus and HELIX SFT



Thermal Ionization MS

Thermo Scientific TRITON Plus



Multicollector ICP-MS

Thermo Scientific NEPTUNE Plus



ICP-MS

Thermo Scientific ELEMENT 2, ELEMENT XR and iCAP Q



Gas Isotope Ratio MS

Thermo Scientific MAT 253



Gas Isotope Ratio MS

Thermo Scientific DELTA V

REE

$^7\text{Li}/^6\text{Li}$

$^{176}\text{Hf}/^{177}\text{Hf}$

$^{29}\text{Si}/^{28}\text{Si}$

D/H

$^{18}\text{O}/^{16}\text{O}$

$^{143}\text{Nd}/^{144}\text{Nd}$

$^{34}\text{S}/^{32}\text{S}$

$^{13}\text{C}/^{12}\text{C}$

U-Th-Pb

$^{187}\text{Os}/^{188}\text{Os}$

$^{87}\text{Sr}/^{86}\text{Sr}$

Noble Gases

www.thermoscientific.com/ARGUS

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