

Thermo Scientific HELIX MC *Plus*
Static Vacuum Mass Spectrometer

Static Vacuum

HELIX MC *Plus*

Dynamic range • Multi collection • High mass resolution

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Based on more than 20 years of experience in noble gas mass spectrometry instrumentation, we have developed the Thermo Scientific™ HELIX MC *Plus*™, 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 HELIX MC *Plus* system is a major step forward in high resolution, multi collector SVMS technology. The HELIX MC *Plus* mass spectrometer is one member of a family of products designed to meet the requirements of the static vacuum community. The portfolio includes the Thermo Scientific ARGUS VI™ mass spectrometer, which is a high sensitivity, multi collector system designed predominantly as the ultimate tool for argon dating. The final product in the portfolio is the Thermo Scientific HELIX SFT™ mass spectrometer, which is designed as a high resolution multi collector system for both simultaneous helium analysis and high precision peak jumping.



Static Vacuum Mass Spectrometer

HELIX MC *Plus*

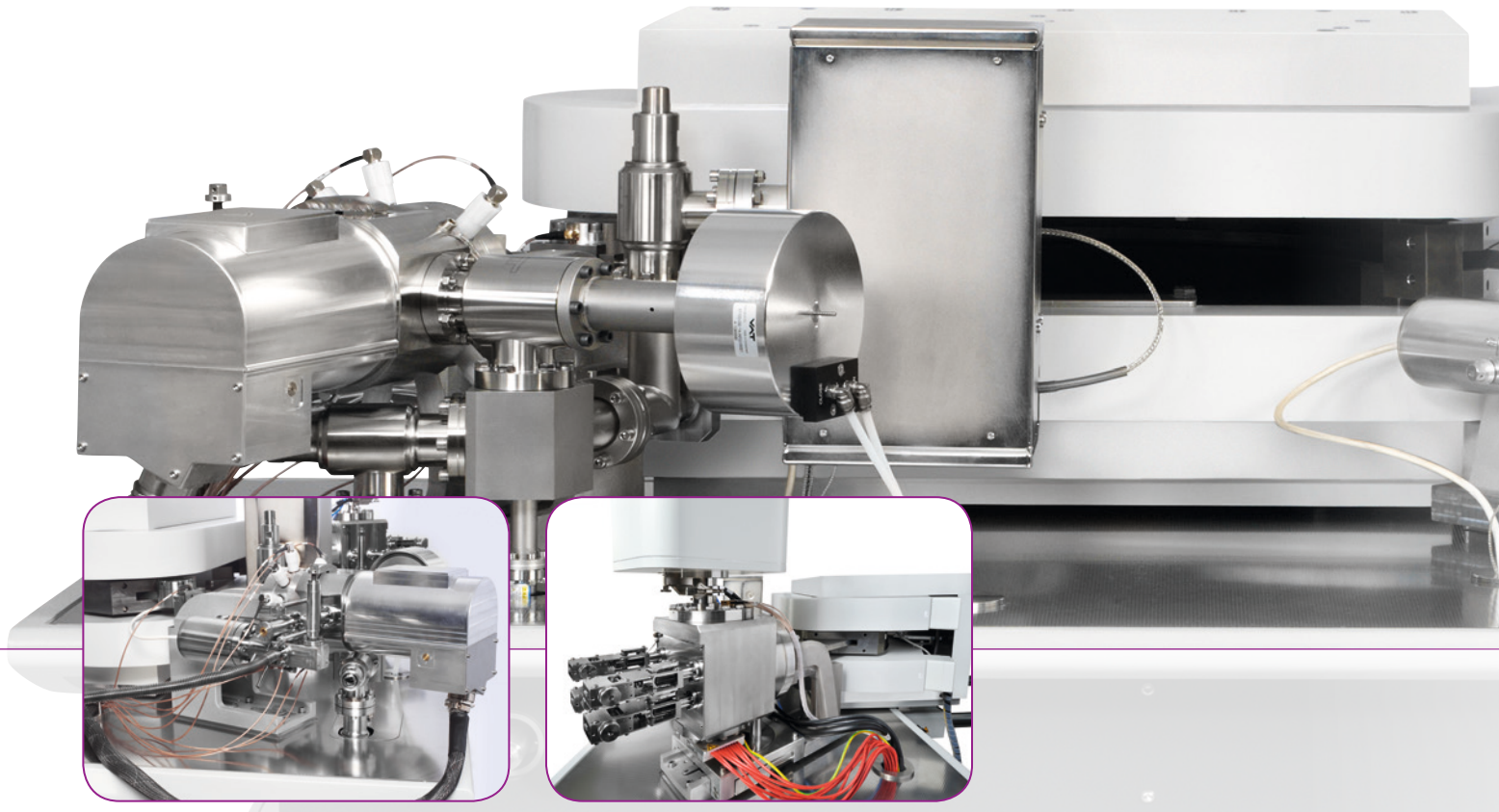
The HELIX MC *Plus* mass spectrometer is a high resolution magnetic sector mass spectrometer designed for high precision isotopic analysis of small samples of the noble gases. It comprises a magnetic sector analyzer with 35 cm 120° extended geometry ion optics. The geometry combines excellent ion optic performance with two-direction focusing and high dispersion in a compact footprint.

Resolution

One of the key features of the HELIX MC *Plus* instrument is its high resolution capability. The instrument utilizes a large radius geometry coupled to some novel ion optical elements never used on a SVMS system before. The instrument also utilizes a new 10 kV capable Nier type bright source, giving sensitivities in excess of 1 x 10^{-3} Amps / Torr at a source current of less than 1 mA.

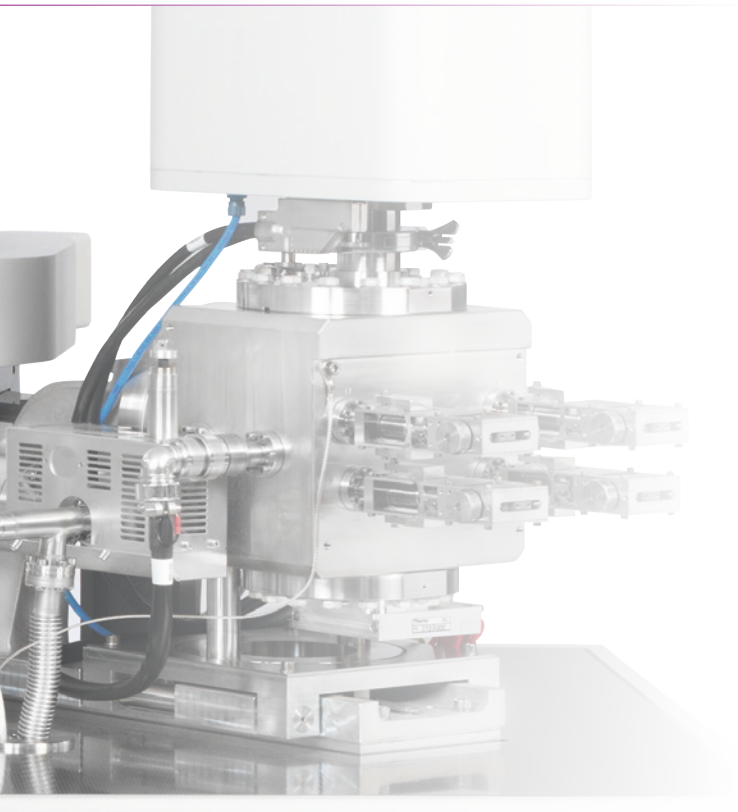
Detection

The variable collector array incorporates a number of new features. The detector array itself incorporates 5 new CFM modules. CFM stands for “Combined Faraday Multiplier” and contains an electrically suppressed Faraday detector and a CDD (compact discrete dynode) Copper Beryllium ion counting electron multiplier. The center CFM is fixed in the axial position whereas the two low mass and the two high mass CFMs can be adjusted by an external micrometer system and read back to the computer system.



Safety panel removed for illustration purposes only

The Faraday cup control system incorporates new high gain amplifier circuits that allow for gains of 10^{10}, 10^{11} or 10^{12} Ohm measuring resistors to be utilized. These temperature controlled evacuated amplifiers have an extended measurement range of 50 volt, rather than the historical 10 volt, giving the system an improved dynamic range. The CDD multiplier is a high performance extended lifetime device. This CDD electron multiplier has an ion counting efficiency >85% with inherent noise <10 CPM and has been designed specifically for very low out gassing rates.



The 5 CFMs can be used for single collector peak jumping measurements utilizing the Faraday or the CDD or used in a true multicollector mode where up to five isotopes can be measured simultaneously on either the Faraday or the CDD. This collector array, coupled to the flexible user definable software suite, allows for not only multi collection analysis or single collector measurements but also a mixture of both during the same run.

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



Analyzer

Ion Source

The HELIX MC *Plus* system utilizes a flange mounted 10 kV capable “Nier” type ion source that has evolved in design over the last 30 years. This latest version, specifically designed for the HELIX MC *Plus*, 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 demount and filament change. The source is self-realigning on assembly.

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

Electromagnet

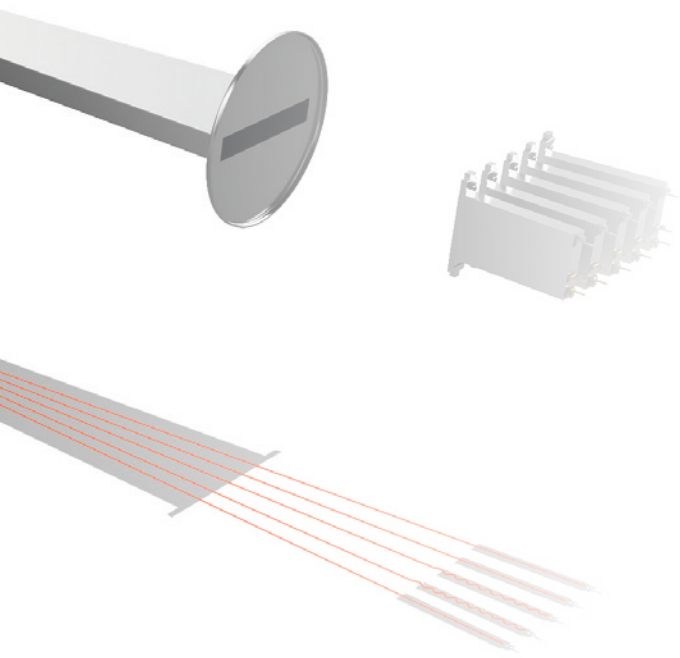
The electromagnet is fabricated from high purity soft iron. It is mounted on roller bearings so that it can be easily retracted for instrument bakeout.

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



Ion Optical Lens System

The HELIX MC *Plus* analyzer includes two new ion optical elements that ensure not only maximum transmission but also the best peak shape possible. The first element is an “multipole” lens located immediately after the ion source. This electrostatic system enables the user to tune the ion beam for sensitivity and shape ensuring best peak flat across the variable array. The second element is a “flatapole” lens located before the ion beam enters the main magnet. This lens allows the user to optimize the ion beam ensuring maximum resolution over the whole focal plane.



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 40 L/s ion pump designed specifically for pumping noble gases and a 80 L/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 CF16 inlet valve to the mass spectrometer is manually controlled. The mass spectrometer also includes two SAES NP10 non-evaporable getter pumps - the first located between source and inlet line and the second on the collector housing. Each of these getters is mounted in its own water cooled jacket (cooling water to be supplied by the end user). The getter can be isolated from the system via a CF16 all metal valve. One feature of the collector getter is that the pumping system is designed in such a way that the getter can be degassed through the turbo molecular pump and not through the analyzer itself.

- 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
- Computer controlled heaters to bakeout mass spectrometer upto 350°C included

Control

Electronic Control Systems

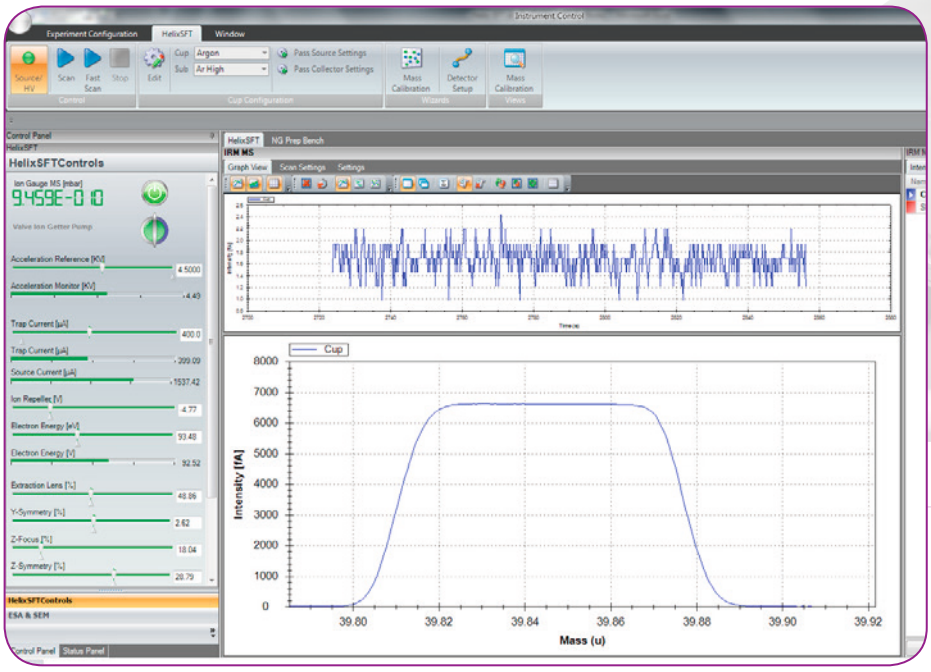
The HELIX MC *Plus* mass spectrometer is driven by a state-of-the-art suite of electronics derived from the industry standard Thermo Scientific TRITON *Plus*™ and MAT 253™ systems. The source electronics are taken from the MAT 253 stable isotope mass spectrometer and the magnet, data acquisition and collector electronics come from the 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, horizontal and vertical steering, multipole and flatapole lens
- Intelligent interface controls communication between the PC and the source, the magnet and all pneumatic 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 10^{10}, 10^{11} or 10^{12} gain amplification

Qtegra Software

The Thermo Scientific Qtegra™ Intelligent Scientific Data Solution™ (ISDS) is the dedicated data acquisition and control software utilized to control the HELIX MC *Plus* 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

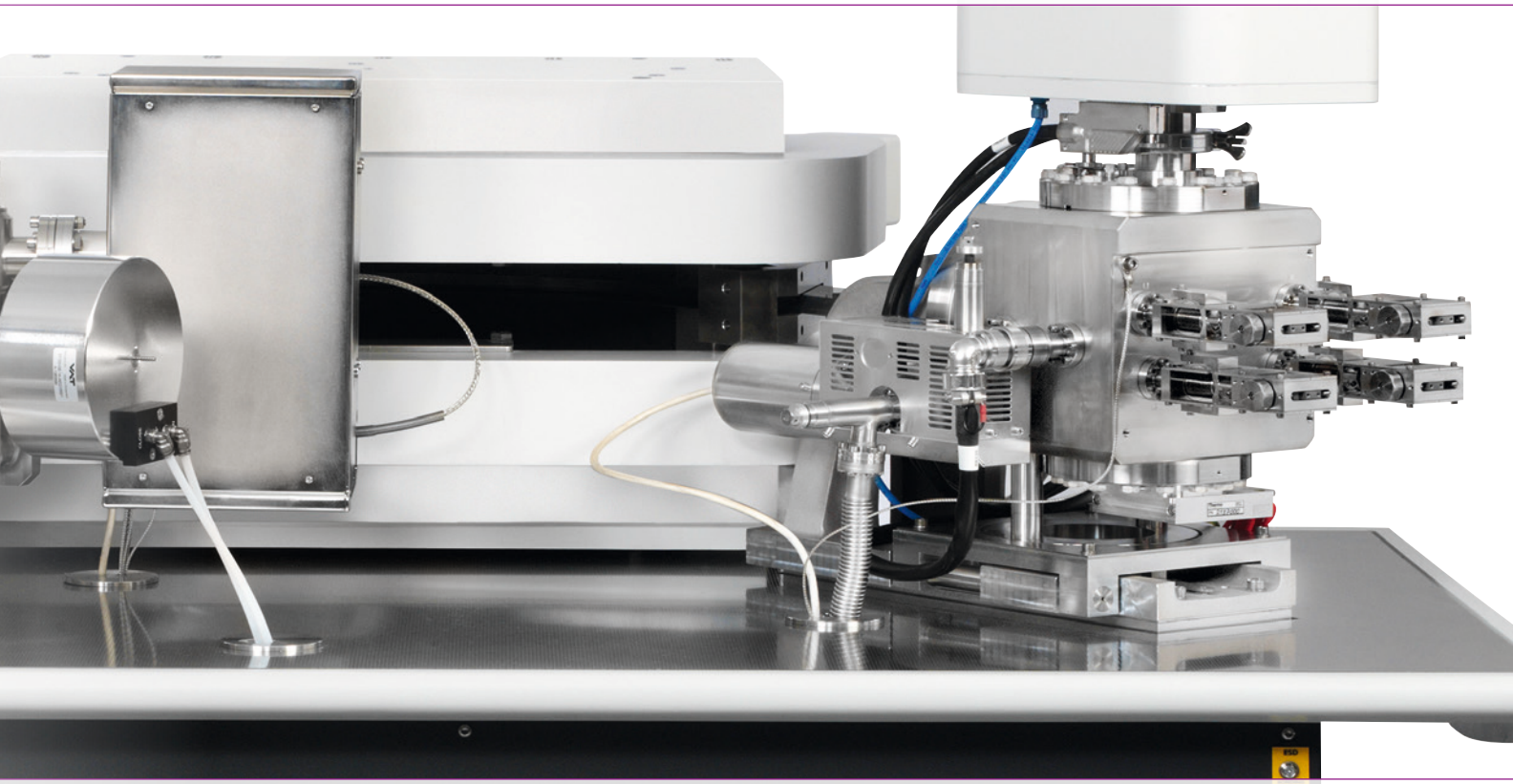
HELIX MC *Plus* Summary

- The system can measure the isotopes of neon, argon, krypton and xenon. No peak jumping is required for multicollector measurement of up to 5 isotopes simultaneously. This also leads to reduced analysis time, higher precision and greater productivity.
- Peak jump measurements are possible for e.g. helium isotopes.
- Detector dynamic range. Given the CFM detectors contain both a Faraday and a CDD, this enables a wide range of sample concentrations to be measured.
- Resolution: The standard resolution detector of > 750 @ 10% peak valley is capable of resolving many of the standard hydrocarbon interferences whereas the optional high resolution detector specified at > 1500 @ 10% peak valley enables a variety of scientific questions to be unraveled.
- 10^{10} / 10^{11} / 10^{12} amplifiers with 50 volt ranges enable majority of analysis to be carried out on long life Faraday detectors.

Performance Specifications

The HELIX MC *Plus* system is an extended geometry 35 cm radius 120° magnetic sector analyzer.

Mass range	He, Ne, Ar: 9.9 kV acceleration voltage Kr, Xe: ≥ 6 kV
Background	≤ 1×10^{-13} cc STP @ *m/z* ^{36}Ar
Sensitivity	Helium: ≥ 2×10^{-4} Amp/Torr @ ≤ 1.2 mA source, 9.9 kV, 0.25 mm source slit Argon: ≥ 1×10^{-3} Amp/Torr @ ≤ 1.0 mA source, 9.9 kV, 0.25 mm source slit
Resolution	For Faraday / ion counting CFM ≥ 750 @ 10% peak valley For Hi-Res Faraday / ion counting CFM ≥ 1,500 @ 10% peak valley
Res. power	> 5000 @ 0.05 mm source slit; typically achieved > 6500
Peak side stability	*m/z* ^{40}Ar: ≤ ± 50 ppm / 30 min.
Rate of rise	@ ^{40}Ar to be ≤ 2×10^{-12} cc STP/min of in 30 min
Abundance	≤ 1 ppm for adjacent masses sensitivity (^{39}Ar contribution from ^{40}Ar) at a pressure of 1×10^{-7} mbar

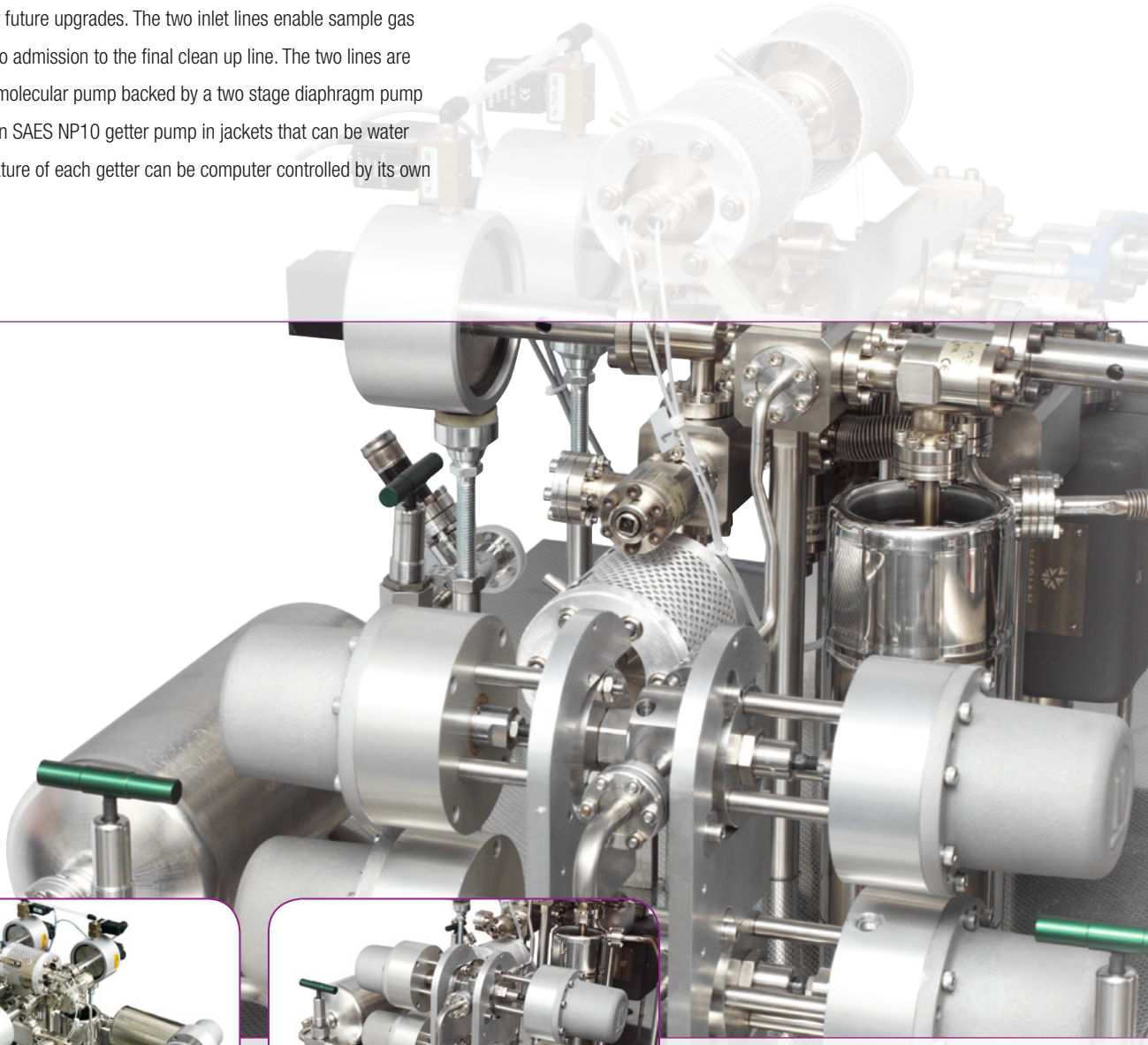


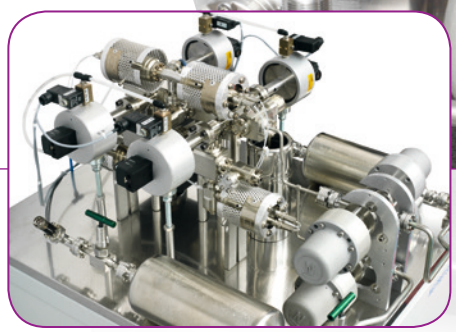
Automation

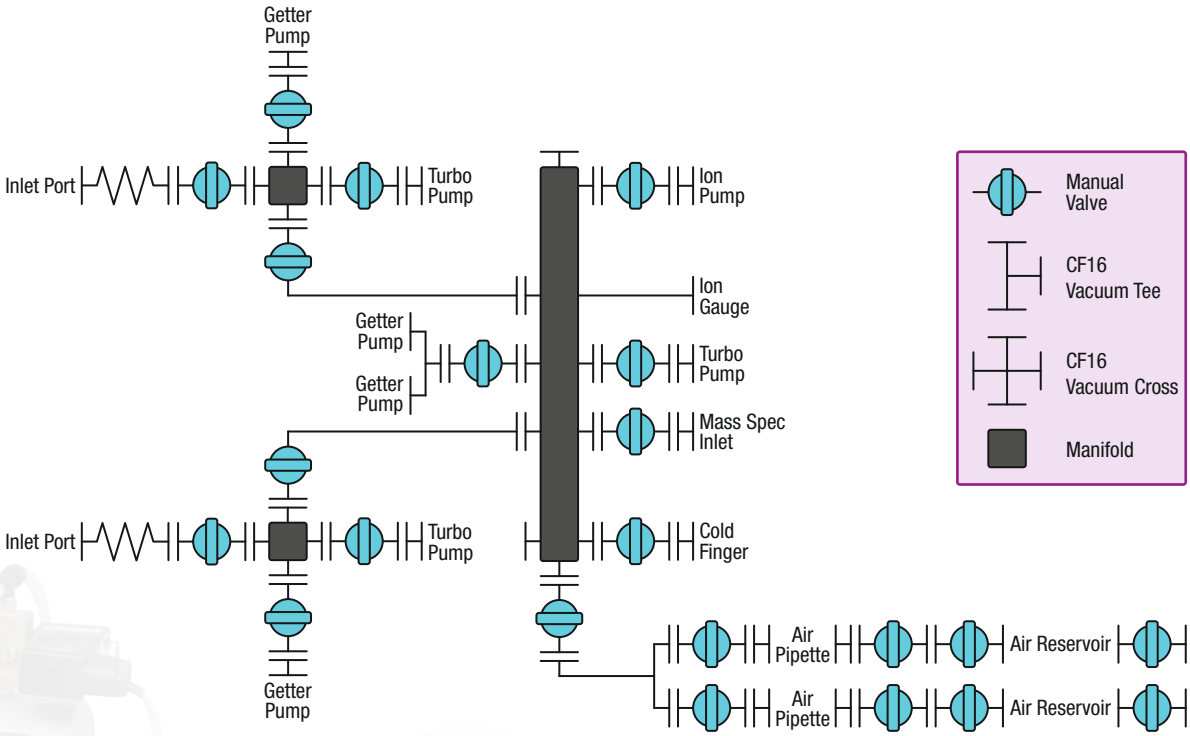
Rapid Sample Analysis

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, 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 turbo molecular pump backed by a two stage diaphragm pump and are fitted with an SAES NP10 getter pump in jackets that can be water cooled. The temperature of each getter can be computer controlled by its own electrical supply.






Getter Pump
Inlet Port
Turbo Pump
Ion Pump
Ion Gauge
Getter Pump
Getter Pump
Turbo Pump
Mass Spec Inlet
Inlet Port
Turbo Pump
Cold Finger
Getter Pump
Air Pipette
Air Reservoir
Air Pipette
Air Reservoir
Manual Valve
CF16 Vacuum Tee
CF16 Vacuum Cross
Manifold


Configurator
Hardware Panel Configurator
Degas Operate
Degas Operate
Inlet to MS
Cold Finger
Upper Pipette Volume
Lower Pipette Volume
MS Ion pump
Inlet 2
Inlet 1
Tank 1
Tank 2
Degas Operate
Degas Operate

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Noble Gas MS
Thermo Scientific ARGUS VI, HELIX MC *Plus* and HELIX SFT

Gas Isotope Ratio MS
Thermo Scientific MAT 253

Thermal Ionization MS
Thermo Scientific TRITON *Plus*

Gas Isotope Ratio MS
Thermo Scientific DELTA V



Multicollector ICP-MS
Thermo Scientific NEPTUNE *Plus*



ICP-MS
Thermo Scientific ELEMENT 2, ELEMENT XR and iCAP Q

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