ThermoFisher SCIENTIFIC

Mass spectrometry

See the world in technicolor

Ultimate precision for your noble gas IRMS analysis

Argus VI SVMS

thermo scientific

See the world in technicolor

The Thermo Scientific™ Argus™ VI SVMS takes high sensitivity, low volume Static Vacuum Mass Spectrometry (SVMS) to a whole new level.

Built on a platform of field-proven technology based on more than 30 years of experience in noble gas mass spectrometry, the Argus VI SVMS is the go-to workhorse of noble gas isotope ratio mass spectrometry. With exciting new technological innovations such as Emission Suppression Technology (EST), the Argus VI SVMS will revolutionize your science.

Emission Suppression Technology

Revolutionizing sample introduction

Smallest Volume

Highest sensitivity NG-MS on the market

Qtegra ISDS Software

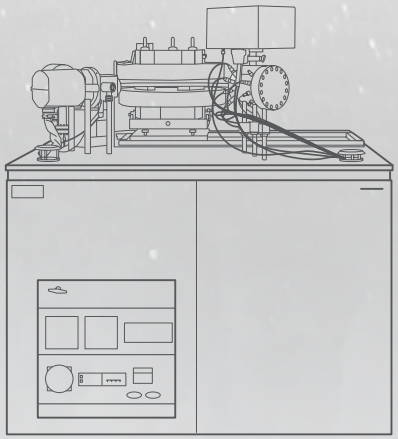
Ultimate control of your analysis

10^{13} Ω Amplifer Technology

Achieving the best precision for small samples

Beam Deflection Technology

Simultaneous measurement of multiple isotopes



Achieve ultimate precision for your noble gas IRMS analysis

The Argus VI SVMS represents the pinnacle of high sensitivity, high precision noble gas isotope ratio mass spectrometry. With the smallest internal volume of any SVMS and Emission Suppression Technology (EST), the Argus VI SVMS is uniquely suited for the isotopic analysis of small samples.

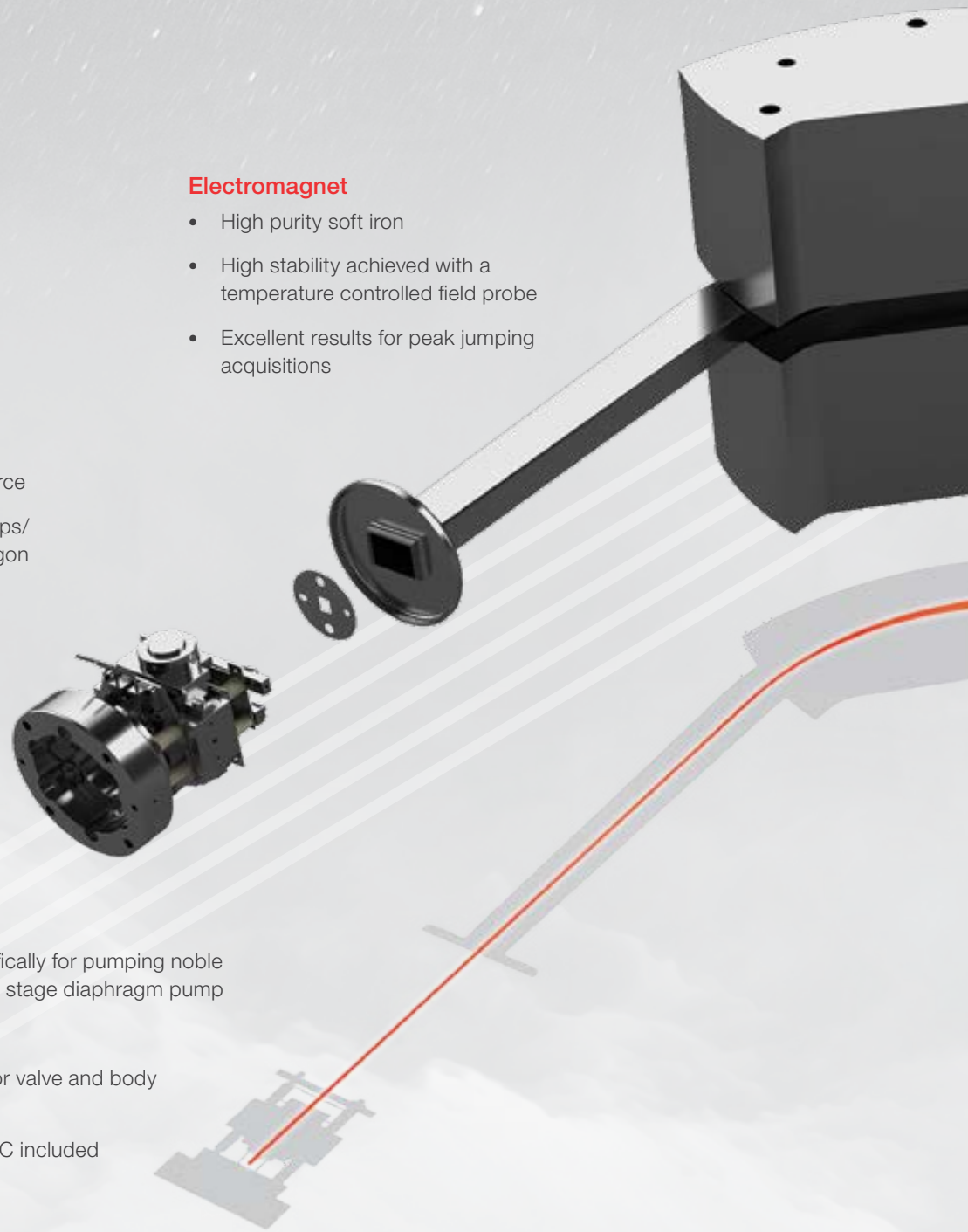
Inside the Argus VI SVMS

Electromagnet

- High purity soft iron
- High stability achieved with a temperature controlled field probe
- Excellent results for peak jumping acquisitions

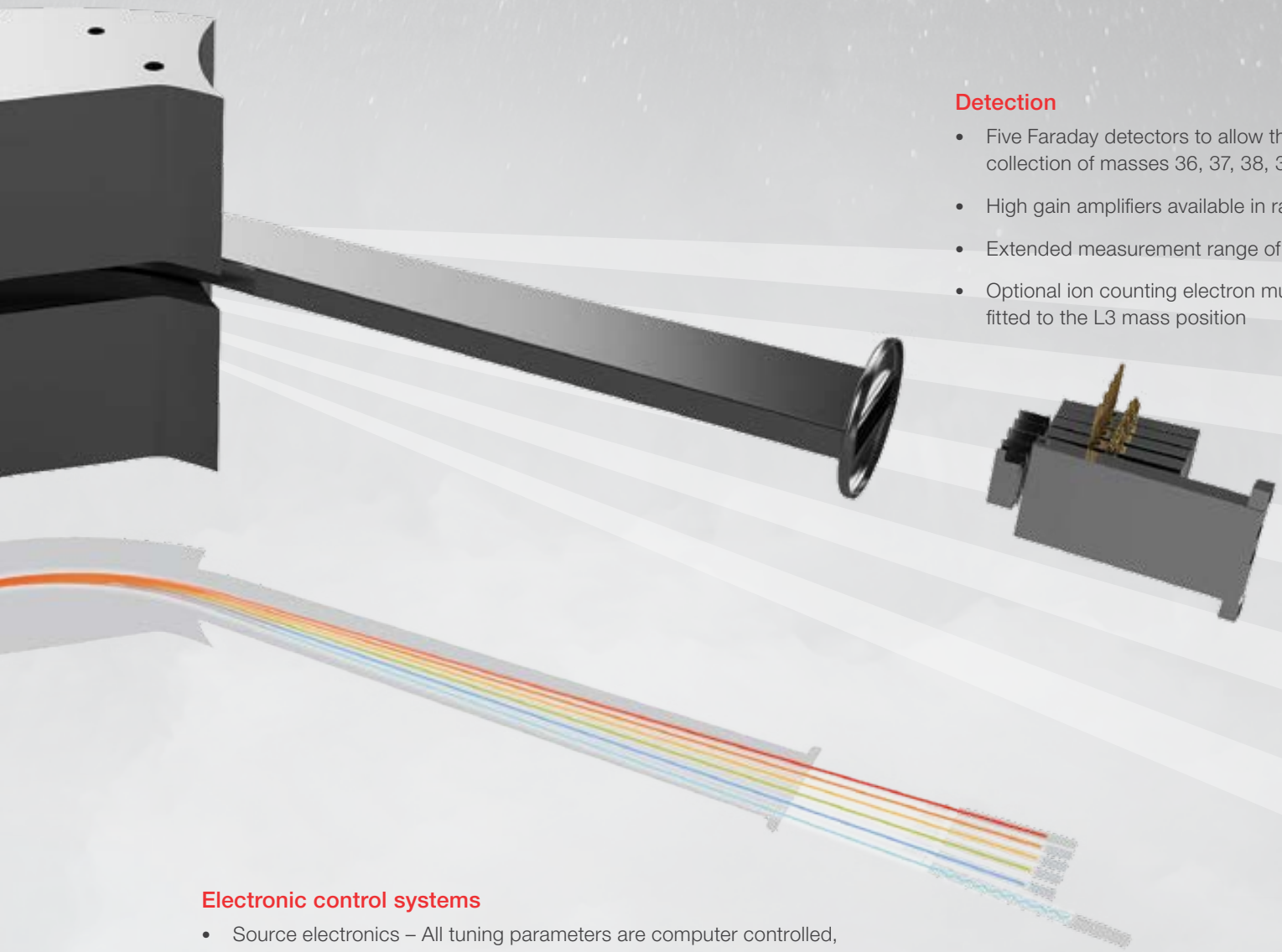
Ion source

- X and Z focused Nier type bright source
- Sensitivities in excess of 1 x 10-3 Amps/ Torr at a source current < 1mA for argon
- Simple design, easy to maintain
- Self-realigning on assembly



Vacuum system

- Designed for true UHV performance (~ 10^{-10} mbar)
- Ultra low background and rates of static rise
- Dry-pumped backing line: 20 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
- 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



Detection

- Five Faraday detectors to allow the simultaneous collection of masses 36, 37, 38, 39 and 40
- High gain amplifiers available in range 10^{10}-10^{13} Ω
- Extended measurement range of 50 V
- Optional ion counting electron multiplier can be fitted to the L3 mass position

Electronic control systems

- 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

Small but mighty

The Argus VI SVMS is the smallest volume NG-MS available on the market. With an internal volume of 700 cm³, the Argus VI SVMS is 3 times more sensitive than any other NG-MS.

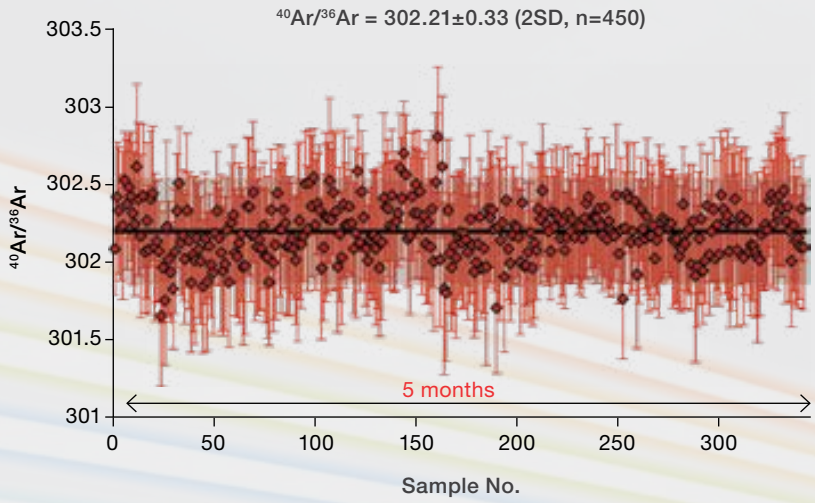
- 5 fixed faraday detectors plus optional CDD minimizes internal volume
- Patented Beam Deflection Technology caters for a wide range of applications whilst maintaining small sample volume
- Narrow flight tube to minimize internal volume

Exceptionally linear

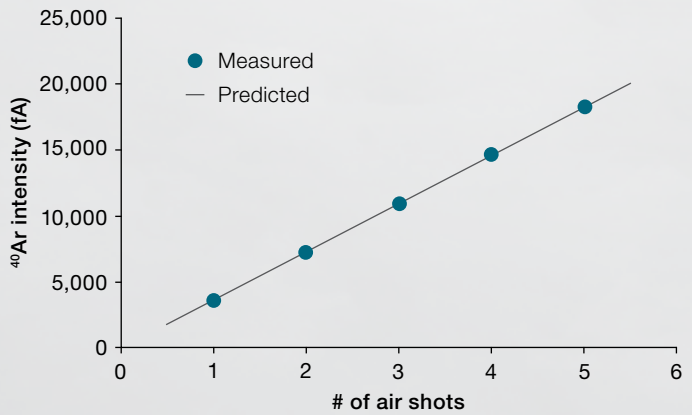
The system is exceptionally linear with increases in signal intensity.

Predicted intensities based off a single air shot perfectly match the measured intensity.

Highly stable over long periods of time



Linear over a large dynamic range



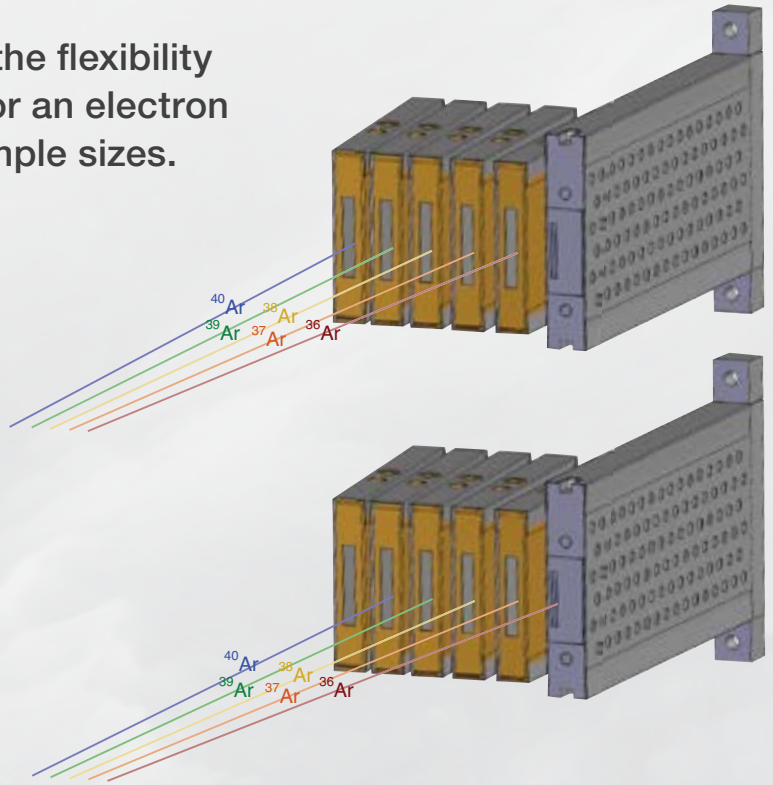
Data from Matt Heizler (New Mexico Tech, US)

Flexibility for all applications

The patented Beam Deflection Technology (BDT) provides the flexibility to measure the minor ^{36}Ar beam with either a Faraday cup or an electron multiplier, catering for a wide range of applications and sample sizes.

Table 1. Example collector configurations for different NG isotope systems

CDD/L3	L2	L1	C	H1	H2
^{36}Ar	^{37}Ar	^{38}Ar	^{39}Ar	^{40}Ar	-
-	^{36}Ar	^{37}Ar	^{38}Ar	^{39}Ar	^{40}Ar
-	-	^{80}Kr	^{82}Kr	^{84}Kr	^{86}Kr
-	^{20}Ne	-	^{21}Ne	-	^{22}Ne
-	-	^{129}Xe	^{132}Xe	^{136}Xe	-
-	-	-	^{131}Xe	^{134}Xe	-

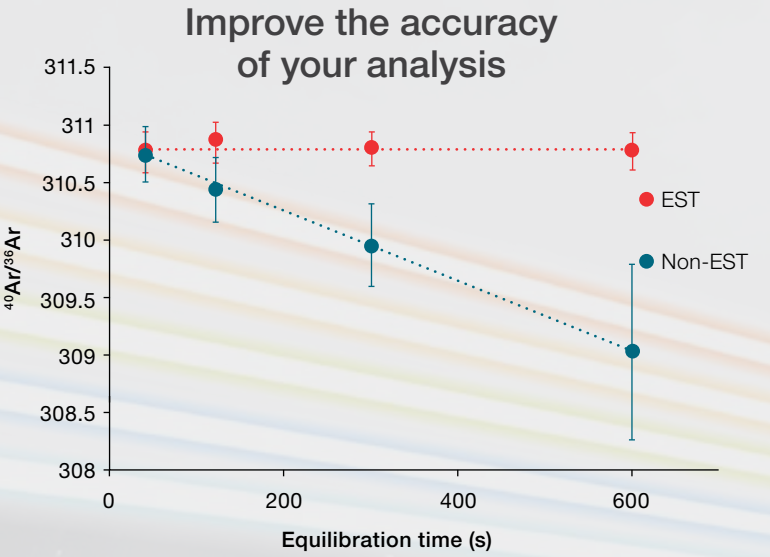


The Argus VI BDT allows for the simultaneous measurement of multiple isotopes across its fixed array (Table 1) rather than by dynamic peak hopping, providing maximum precision for your analysis. The BDT also reduced the necessity for additional Faraday collectors, minimizing internal volume and maximizing sensitivity.

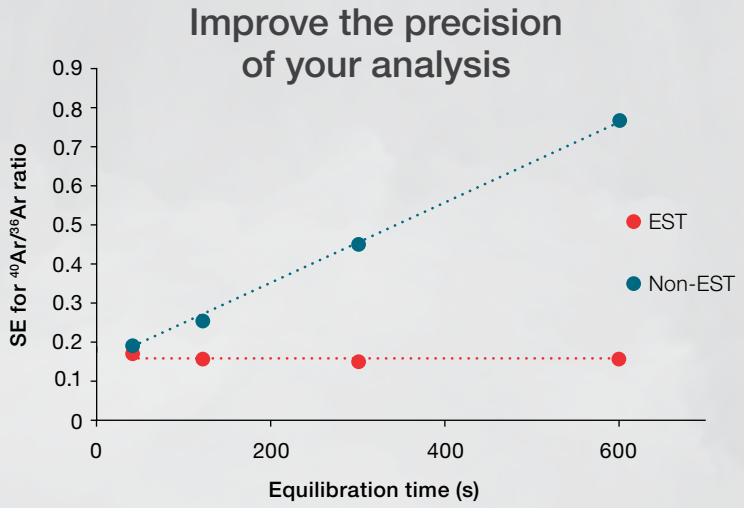
Analysis without compromise

The patented Emission Suppression Technology (EST) included in the Argus VI SVMS revolutionises noble gas isotope ratio mass spectrometry.

- Switch off ionization whilst your sample is equilibrating
- No trade-off between precision and equilibration time
- Start measuring at T0: measure the unfractionated isotopic composition of your sample
- < 0.1% signal stability either side of the dark mode
- < 1s switching time between dark mode and measurement mode



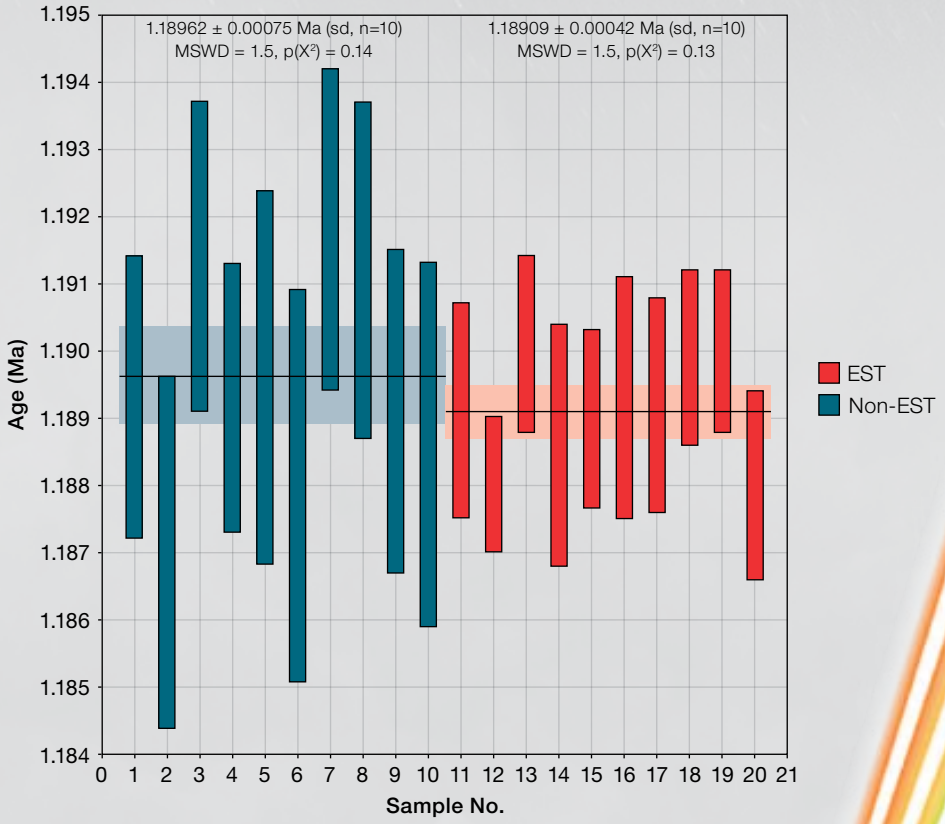
Comparison between EST NG-MS and traditional NG-MS showing the variation in $^{40}Ar/^{36}Ar$ ratio at different equilibration times.



Comparison between EST NG-MS and traditional NG-MS showing the precision achievable on the $^{40}Ar/^{36}Ar$ ratio at different equilibration times.

Achieve the best precision on your Ar-Ar dates

> 40% improvement in precision of Ar-Ar dates with EST.



Comparison between EST NG-MS and traditional NG-MS showing the precision achievable on the Ar-Ar ages of Alder Creek samples.

Push the limits of NG-MS with EST

EST allows a greater degree of flexibility of analytical methods and prep designs.

Boost your precision

Dramatically increase signal sensitivity by decreasing the volume of the prep system. Equilibration times can be extended as long as necessary.

Kr and Xe without trade-offs

The long equilibration times of Kr and Xe are now no longer a problem as they can be extended as long as necessary with no impact on analytical precision.

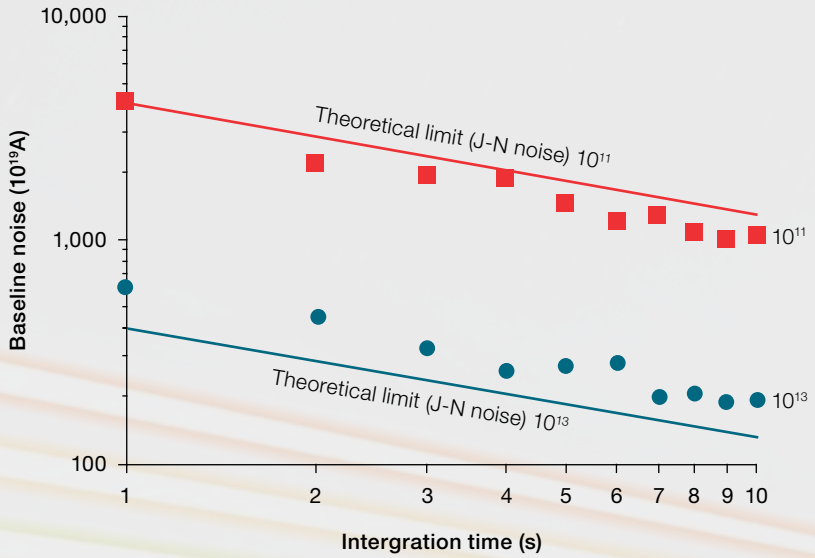
Method flexibility

Get a quick snapshot of the ion beam by switching between ion counters or Faraday detectors depending on the size of the ion beam. Perform on-peak baselines during sample analysis with no sacrifice to analytical precision.

Access the inaccessible

Thermo Scientific™ 10^{13} Ω Amplifier Technology™ has revolutionized the measurement of isotope ratios from low intensity ion beams.

- Measure low abundance isotopes at high precision
- Avoid single SEM peak hopping and maximize your sample



Baseline noise for 10^{13} Ω Amplifier Technology follows theoretical limit defined by Johnson-Niquist noise.

The benefits of Faraday cups can be realized at low signal intensities (30 Kcps – 3 Mcps), delivering external precisions that approach the ultimate limits of counting statistics.

With the new 3.3 pA current calibration board, the gain calibration procedures are fully integrated into the electronic calibration network. Therefore, the gain factors and electronic baselines of all amplifiers available, i.e. 10^{10} Ω, 10^{11} Ω, 10^{12} Ω and 10^{13} Ω, can be calibrated conveniently by an automated software routine.

The in-built tau correction ensures accuracy on transient signals.

10^{13} AMPLIFIER TECHNOLOGY

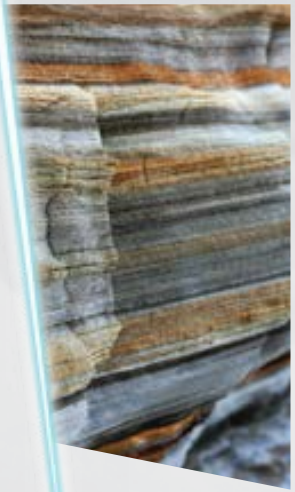
Unprecented control

Thermo Scientific™ Qtegra™ Intelligent Scientific Data Solution (ISDS) Software gives you total control over your analysis whilst using dedicated workflows to optimize the user experience.

Qtegra ISDS Software is the dedicated data acquisition and control software utilized to control the Argus VI system. Operating under Microsoft Windows® 10 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
- Ion beams and isotope ratio display during data acquisition to allow operator assessment of data quality during analysis
- All raw data stored
- Third party plug-in integration:
  - Lasers
  - Cryogenic traps
  - Self-made peripherals
- Simple integration to third party software

Field-proven technology



Geochronology

The Argus VI SVMS is the workhorse for Ar-Ar dating of rocks and minerals. Ar-Ar dating is a valuable tool for placing fixed timestamps within geological sequences, allowing us to develop a greater understanding of the cause-effect relationship of key events in the geological record.

- Di Vincenzo 2022, doi: **10.1016/j.chemgeo.2022.121026**
- Phillips et al. 2022 doi: **10.1016/j.chemgeo.2022.120815**

Cosmochemistry

Understand the formation of the solar system and beyond through noble gas IRMS. From reconstructing the age of meteorites to dating impact structures on Earth, the Argus VI SVMS provides unique insights into our place in the cosmos.

- Jourdan et al. 2023, doi: **10.1073/pnas.2214353120**
- King et al. 2022, doi: **10.1126/sciadv.abq3925**
- Clay et al. 2017 doi: **10.1038/nature24625**

Ore deposits

Being able to accurately reconstruct the formation and evolution of ore deposits is key to the development of future ore prospects. Noble gas IRMS allows us to understand temporal relationship between ore deposits and their surroundings.

- Muston et al. 2023, doi: **10.5194/gchron-5-153-2023**
- Bai et al. 2022, doi: **10.5382/econgeo.4889**

Oil and gas

Understand the origin of gas and petroleum using radiogenic isotopes (^{4}He, ^{40}Ar) to constrain residence time and non-radiogenic isotopes (^{3}He, ^{22}Ne) to constrain source.

- Karolytė et al. 2022, doi: **10.1016/j.chemgeo.2021.120491**
- Tyne et al. 2021, doi: **10.1016/j.chemgeo.2021.120540**
- Mtili, et al. 2021, doi: **10.1016/j.chemgeo.2021.120542**

Hydrology

Noble gases are ideal probes to study surface and groundwater dynamics by providing indications of flow paths, connectivity between aquifers, and water residence times.

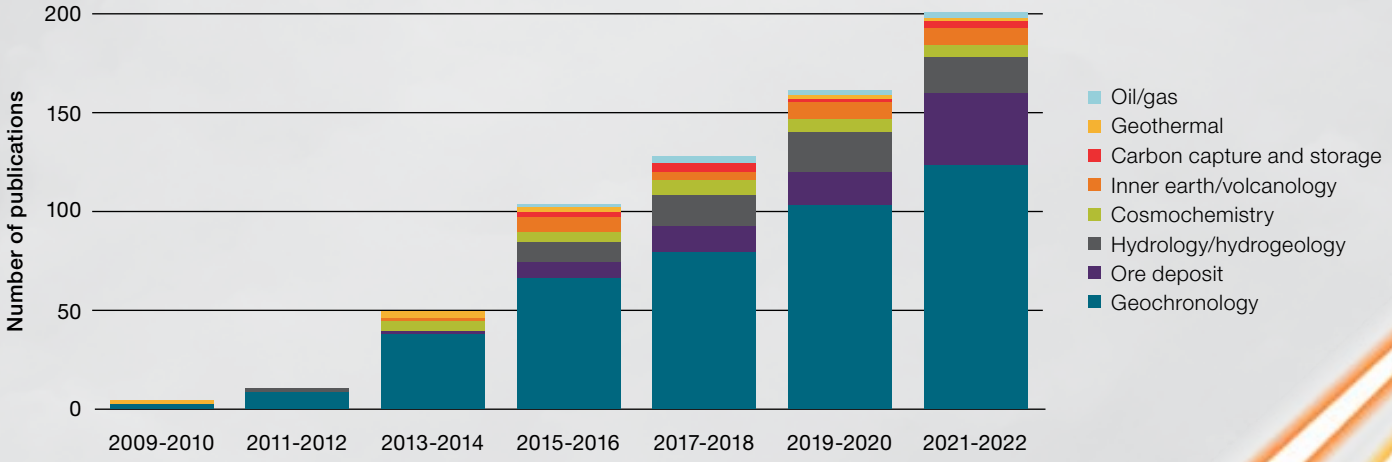
- Warr et al. 2022 doi: **10.1038/s41467-022-31412-2**
- Amalberti et al. 2018, doi: **10.1016/j.chemgeo.2018.02.022**

Inner earth/volcanology

Noble gas IRMS is a useful tool for reconstructing volcanic plumbing systems, understanding mantle heterogeneity and monitoring volcanic gases for predictive purposes.

Carter et al. 2022, doi: **10.1029/2021JB022669**

Barry et al. 2019, doi: **10.1038/s41586-019-1131-5**



Rapid sample analysis

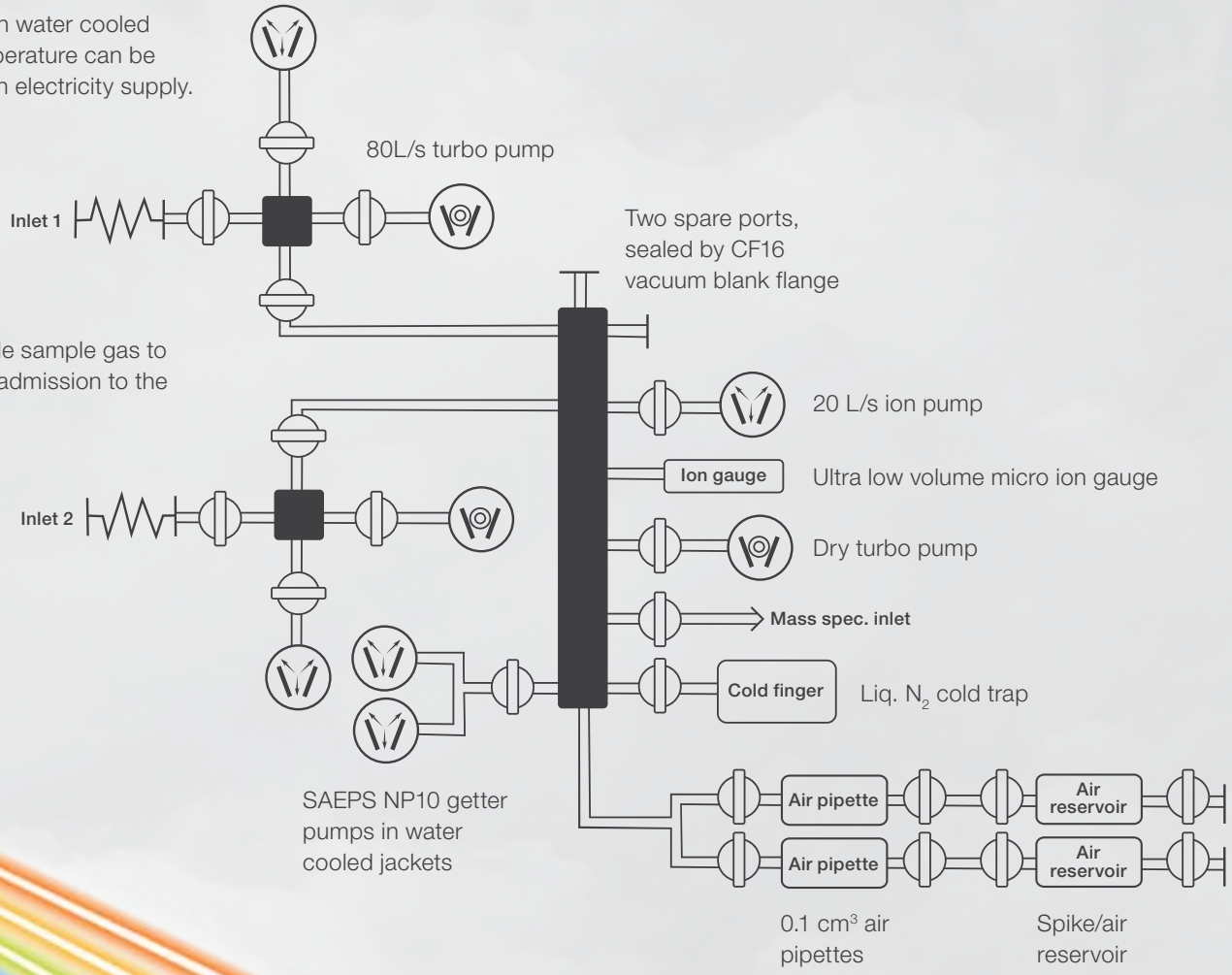
The Thermo Scientific NG Prep System is can be used to automate your sample and reference gas preparation prior to entry in the mass spectrometer, maximising your productivity.

- Pre-built – no need to reinvent the wheel
- Readily modifiable – with third party peripherals e.g. lasers
- Fully automated – guarantee reproducibility of measurement

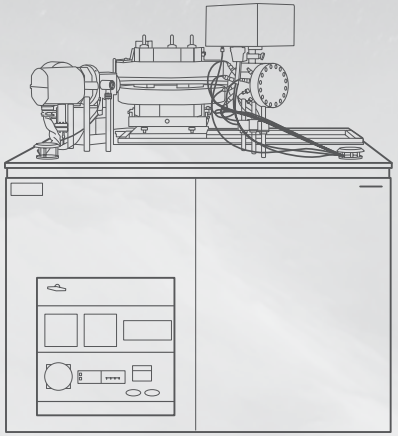
Inside the NG prep system

NP10 getter pump in water cooled jackets. Getter temperature can be controlled by its own electricity supply.

Two inlet lines enable sample gas to be cleaned prior to admission to the final clean up line.

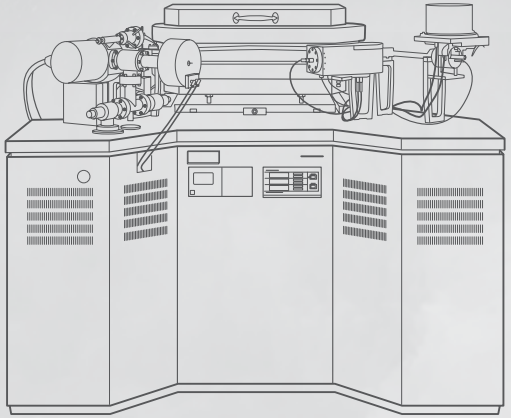


Catering for all your noble gas needs



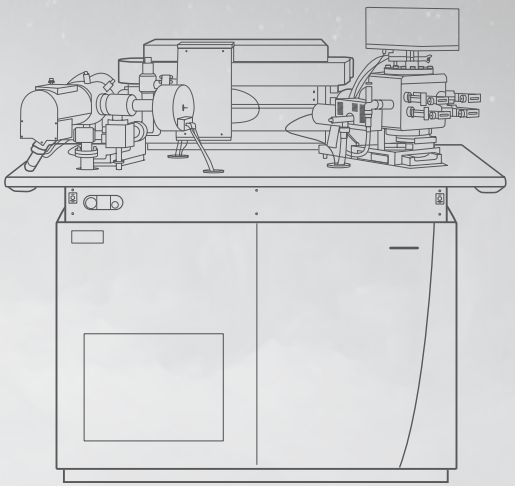
High sensitivity. Ultimate precision.

The Argus™ VI SVMS has the smallest internal volume of our noble gas mass spectrometer portfolio. Perfect for measuring small samples.



High sensitivity. Excellent versatility.

The Thermo Scientific™ 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.



Ultimate resolution. Total flexibility.

The Thermo Scientific™ HELIX MC Plus™ mass spectrometer 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.

Learn more at **thermofisher.com/argus**