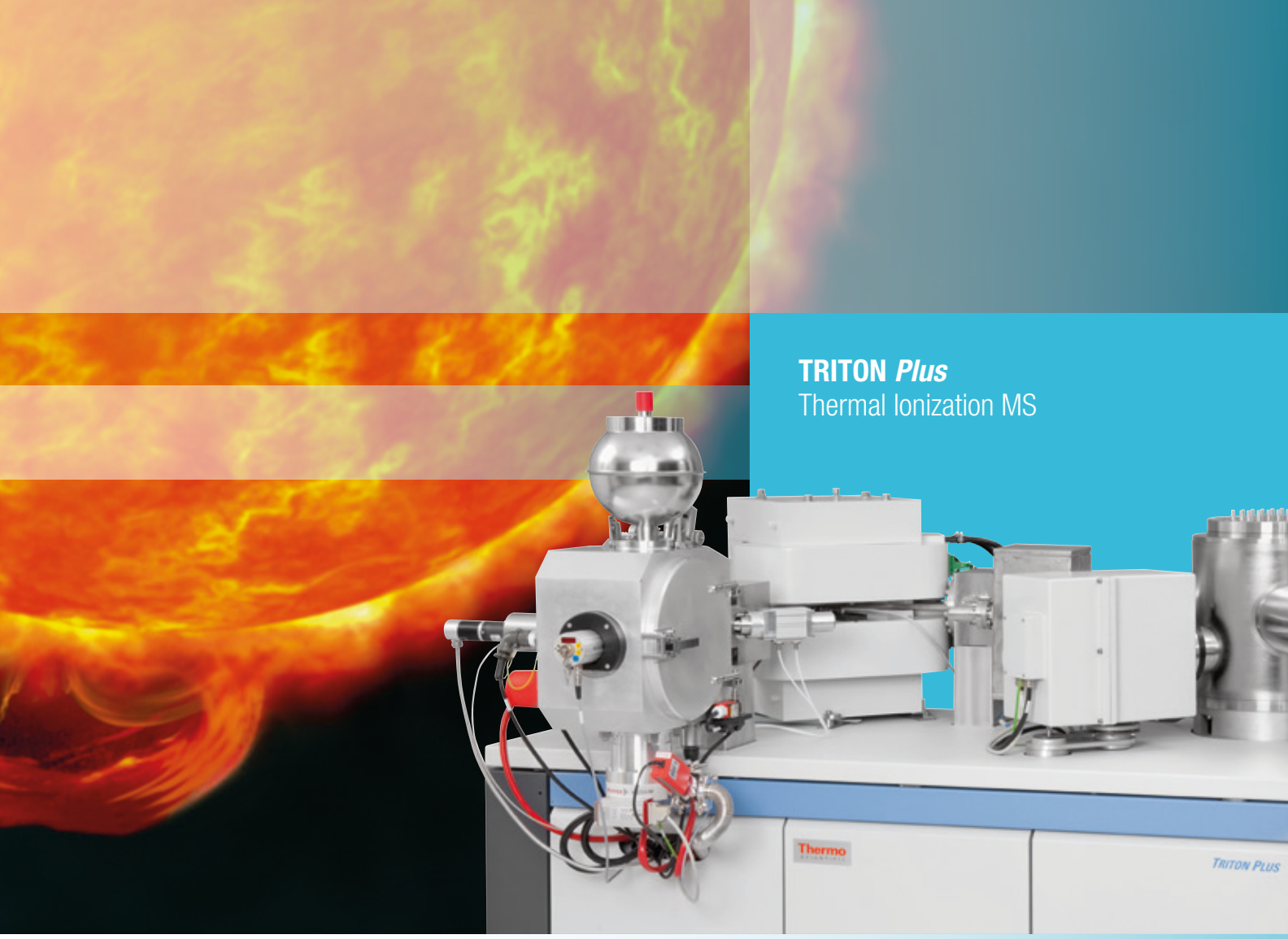


Another step ahead in TIMS

Earth and Planetary Sciences • Nuclear Sciences

Thermo SCIENTIFIC

Based on more than 35 years of experience in variable multicollector instrumentation, we have developed the Thermo Scientific TRITON *Plus*, our latest generation Thermal Ionization Mass Spectrometer (TIMS).

It combines new, innovative features, like dual RPQ and compact discrete dynode multi ion counting multipliers, with the field-proven technology of the Thermo Scientific TRITON instrument.

The TRITON™ *Plus* TIMS represents a major step forward in multicollector TIMS technology and opens the door to ever-expanding applications within Earth and Nuclear Sciences, as well as other disciplines.

TRITON *Plus*

Thermal Ionization MS

The TRITON *Plus* thermal ionization mass spectrometer sets another standard in high-precision TIMS isotope ratio measurements. It builds upon the strong field-proven reliability and cutting-edge technology from the TRITON instrument: high sample throughput, variable multicollector, zoom optics and multi ion counting. New features include a dual RPQ and multiple discrete dynode electron multipliers for high dynamic ranges, as well as unsurpassed linearity and stability.

Thermal Ionization Source

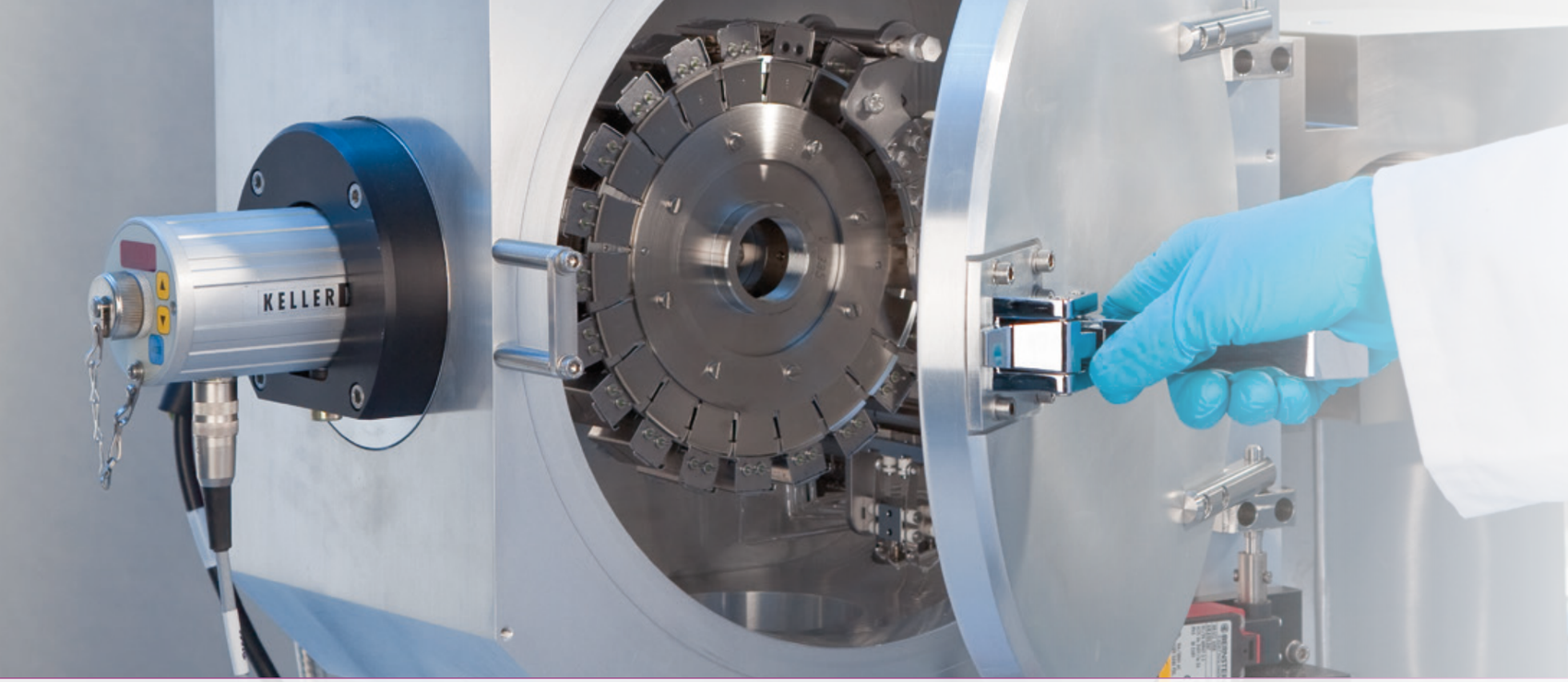
The thermal ionization source is characterized by a very small kinetic energy spread of the ions (~0.5 eV). A single focusing geometry that focuses for angular divergence only is therefore fully sufficient. Chromatic aberrations due to the initial energy spread of the ions can be neglected.

In this configuration, the magnetic sector lens focuses ions of different mass along an inclined focal plane with 45° angle. The magnet is laminated for high-speed peak jumping and low hysteresis. The inner width of the flight tube is 14 mm, ensuring minimal scattering. Baffles are present along the flight path to directly catch any diverging ions and to minimize scattering at the side walls.

The ion source optics of the TRITON *Plus* TIMS have been optimized for maximum ion transmission for both single and double filament techniques. The sample turret holds 21 single or double filaments. The filaments can be easily exchanged without using any tools.

The TRITON *Plus* system allows easy glove box adaptation for nuclear applications. It also offers an optional preheat device to heat up the next sample (max. 2) prior to analysis. A gas bleed system can be installed as well to bleed in gas into the ion source. The ion source is held at an acceleration potential of 10 kV to achieve optimum sensitivity.

Special care has been taken by shaping the ion source lens elements so that the build-up of contaminations and memory in the source are minimized. The lens stack is easily accessible by the user for inspection and maintenance.



Towards smaller samples

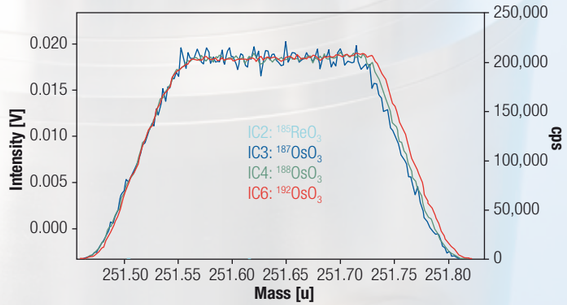
flexible and complete collector packages

Multi Ion Counting using a new technology

Small sample amounts require the use of ion counting detectors, where every single ion is detected and counted. The new TRITON *Plus* thermal ionization mass spectrometer features new Compact Discrete Dynode electron multipliers having high stability and linearity over a large dynamic range. They are only 6 to 7 mm wide and fit within the multicollector array. Performance is comparable to the established classical large-scale SEM.

In a Multi Ion Counting (MIC) setup, an array of ion counters is placed in the focal plane of the mass analyzer to allow parallel detection of all required ion beams. The MIC approach offers the ultimate detection efficiency, because of the simultaneous detection of the isotopes.

Up to eight discrete dynode electron multipliers can be installed at one time. The TRITON *Plus* TIMS offers dedicated collector packages for the analysis of Pb and Os isotopes in geochemistry. It also offers the most flexible and complete collector package for the analysis of U isotopes in nuclear sciences. This package consists of five discrete dynode multipliers at 1 amu spacing for actinides and independent RPQ filters for the analysis of ^{234}U and ^{236}U on high abundance sensitivity channels. Packages are made up of an application dependent combination multiple electron multipliers, dual detectors (Faraday/electron multiplier) and RPQs.



OsO_3 peak overlap using Compact Discrete Dynode SEMs on the TRITON *Plus* instrument. Mass scale is related to the center of the multicollector system. Counter intensities are normalized to IC6 (200 kcps).

Abundance sensitivity

The measurement of large isotope ratios is affected by scattered ions generated at slits and apertures, the flight tube walls and most importantly, the interaction of ions with residual gas particles. Ions which suffered one of these interactions have lost kinetic energy and/or have changed their direction of motion. As a result, these ions appear at incorrect mass positions along the focal plane, typically increasing background at neighboring masses.

The TRITON *Plus* TIMS can employ up to two Retarding Potential Quadrupole Lenses (RPQ) that act as high selectivity filters for ions with disturbed energy or angle. The use of an RPQ improves the abundance sensitivity of the TRITON *Plus* by two orders of magnitude from typical 2 ppm to <20 ppb at one amu (238 ± 1 u).

The nuclear package

	***Plus* Platform**					
	IC	**IC/RPQ**	**IC/ Faraday**	**IC/RPQ**	**Faraday**	**IC**
Config. 1	^{233}U	^{234}U	^{235}U	^{236}U	^{238}U	
Config. 2	^{233}U	^{234}U	^{235}U	^{236}U		^{238}U

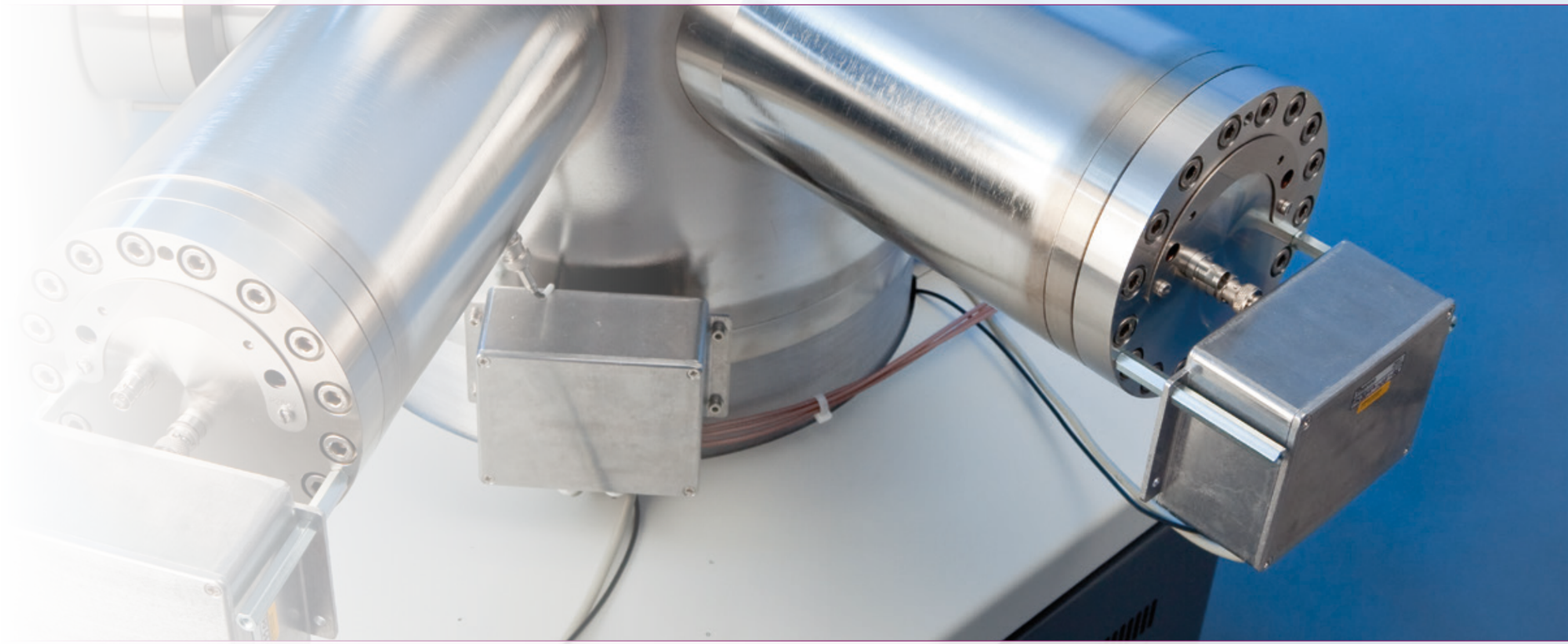
The Pb package

	***Plus* Platform**				
	IC	**IC**	**IC**	**IC**	**Faraday**
Config. 1	^{204}Pb	^{205}Pb	^{206}Pb	^{207}Pb	

The Os package

	***Plus* Platform**						
	IC	**IC**	**IC**	**IC**	**IC**	**IC**	**Faraday**
Config. 1	$^{184}OsO_3$ 232	$^{185}OsO_3$ 233	$^{186}OsO_3$ 234	$^{187}OsO_3$ 235	$^{188}OsO_3$ 236	$^{190}OsO_3$ 238	
Config. 2	$^{185}OsO_3$ 233	$^{186}OsO_3$ 234	$^{187}OsO_3$ 235	$^{188}OsO_3$ 236	$^{189}OsO_3$ 237		
Config. 3	$^{186}OsO_3$ 234	$^{187}OsO_3$ 235	$^{188}OsO_3$ 236	$^{189}OsO_3$ 237	$^{190}OsO_3$ 238	$^{192}OsO_3$ 240	

- Full dynamic range discrete dynode electron multipliers on all IC channels.
- High abundance sensitivity dual RPQ option for ^{234}U and ^{236}U detection.
- For other possible configurations, please contact your local sales specialist. Please also refer to the NEPTUNE *Plus* brochure.



Setting new standards
in Geosciences

High-performance Faraday cups

The Faraday cups used in the TRITON *Plus* TIMS are the largest ever produced for a commercial multicollector. They are laser machined from solid carbon to guarantee uniform response, high linearity, low noise and long lifetimes. The Faraday cups are designed to completely eliminate the need for cup factors. The effect of ion optical magnification on cup performance is depicted in the figure on page 9.

At increasing ion optical magnifications, the divergent angles of the ion beams are reduced and dispersion is increased. As a result, cups can be wider and deeper. Scattered particles released from the cup side walls by the incoming ion beams are less likely to escape and do not alter the “true” ion current measured.

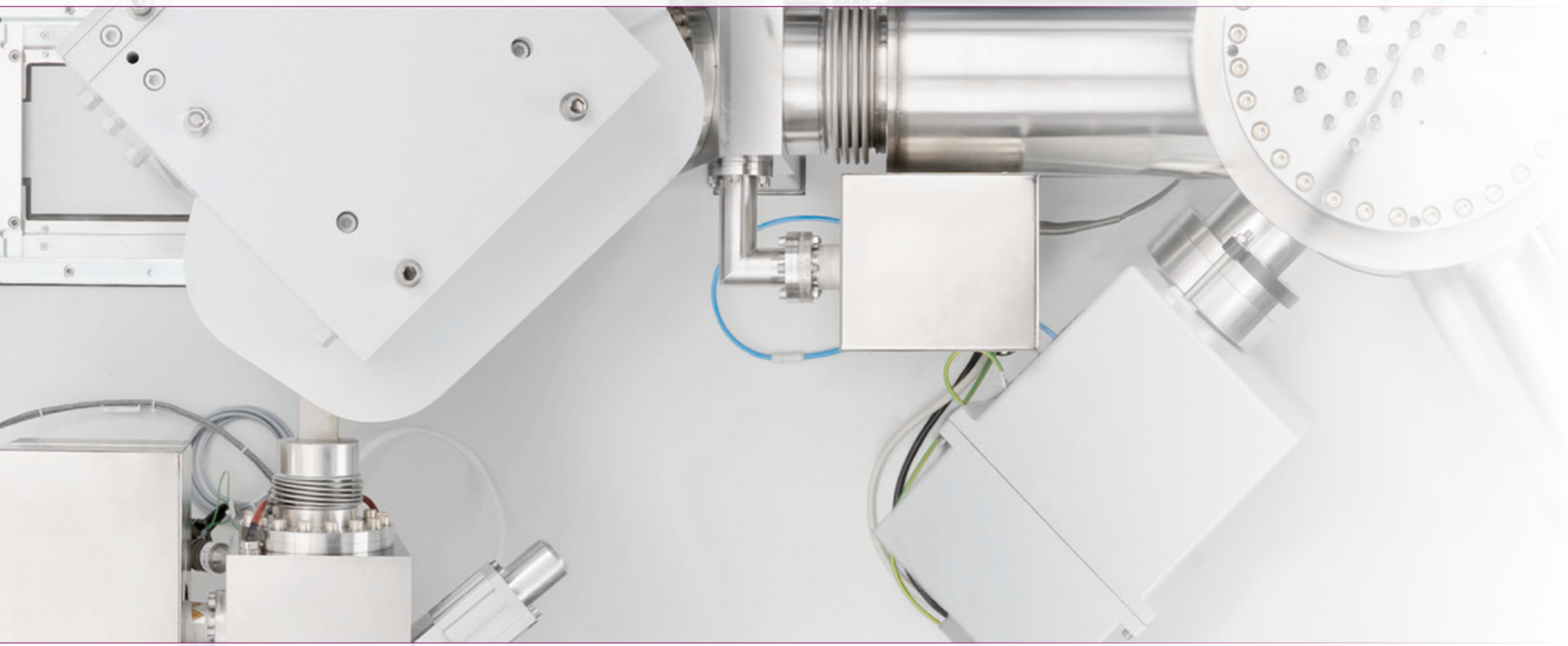
The Amplifier

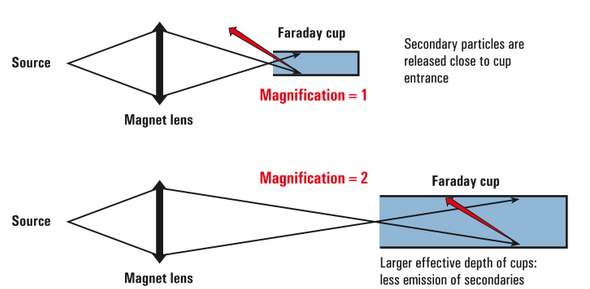
Each Faraday cup is connected to a current amplifier. The amplifier signal is digitized by a high linearity voltage to frequency converter with an equivalent digital resolution of 22 bits. This ensures sub ppm digital resolution of all measured signals independent of the actual signal intensity. The amplifiers are mounted in a double shielded, evacuated and thermostated housing with a temperature stability of ± 0.01°C / hour. The dynamic range of the current amplifiers (10^{11} Ω) is 50 V in positive ion detection mode. For negative ions, it is restricted to 15 V. For classical systems, the need for a precise cross calibration of the current amplifiers defines a precision barrier in static multicollection.

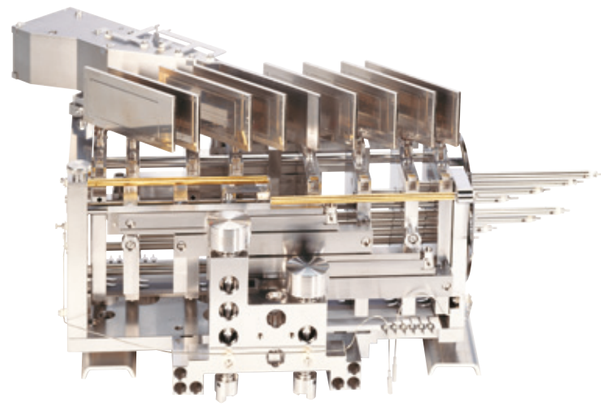
Even with perfect Faraday cups giving uniform response, results of static measurements are biased by the accuracy and reproducibility of the gain calibration. In the classical method of cross calibration, a high precision, constant current source is sequentially connected to all amplifiers. However, with this method, amplifiers cannot be calibrated to better than ~5 ppm per channel. For instance if one considers an isotope system consisting of three isotopes, the best external precision is estimated to be: 5 ppm x √3 = ~9 ppm.

The Virtual Amplifier

The TRITON *Plus* TIMS uses a proprietary measurement procedure, which completely eliminates gain calibration biases: the Virtual Amplifier concept. In all other multicollector systems, the relation (connection) between individual Faraday cups and amplifiers is fixed. In the Virtual Amplifier concept, all Faraday cups involved in a certain measurement are sequentially connected to all amplifiers. As a result, all signals are measured with the same set of amplifiers and for the calculation of the isotope ratios, all calibration biases of the amplifiers are cancelled out. This unique capability in combination with the very robust Faraday Cup detectors has given the TRITON *Plus* the reputation of being the natural choice in TIMS instrumentation. The TRITON *Plus* sets the standard in terms of high precision isotope ratio measurements. External reproducibility for Nd of <2ppm has been reported by various users around the world.



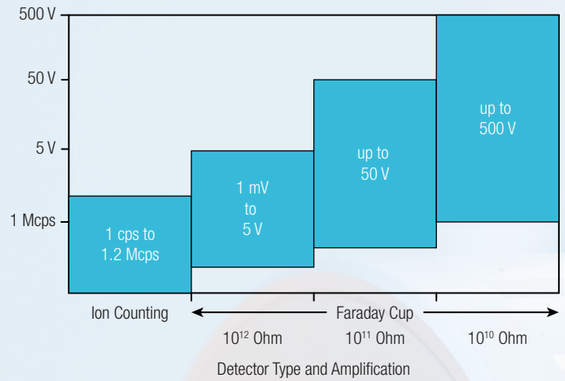


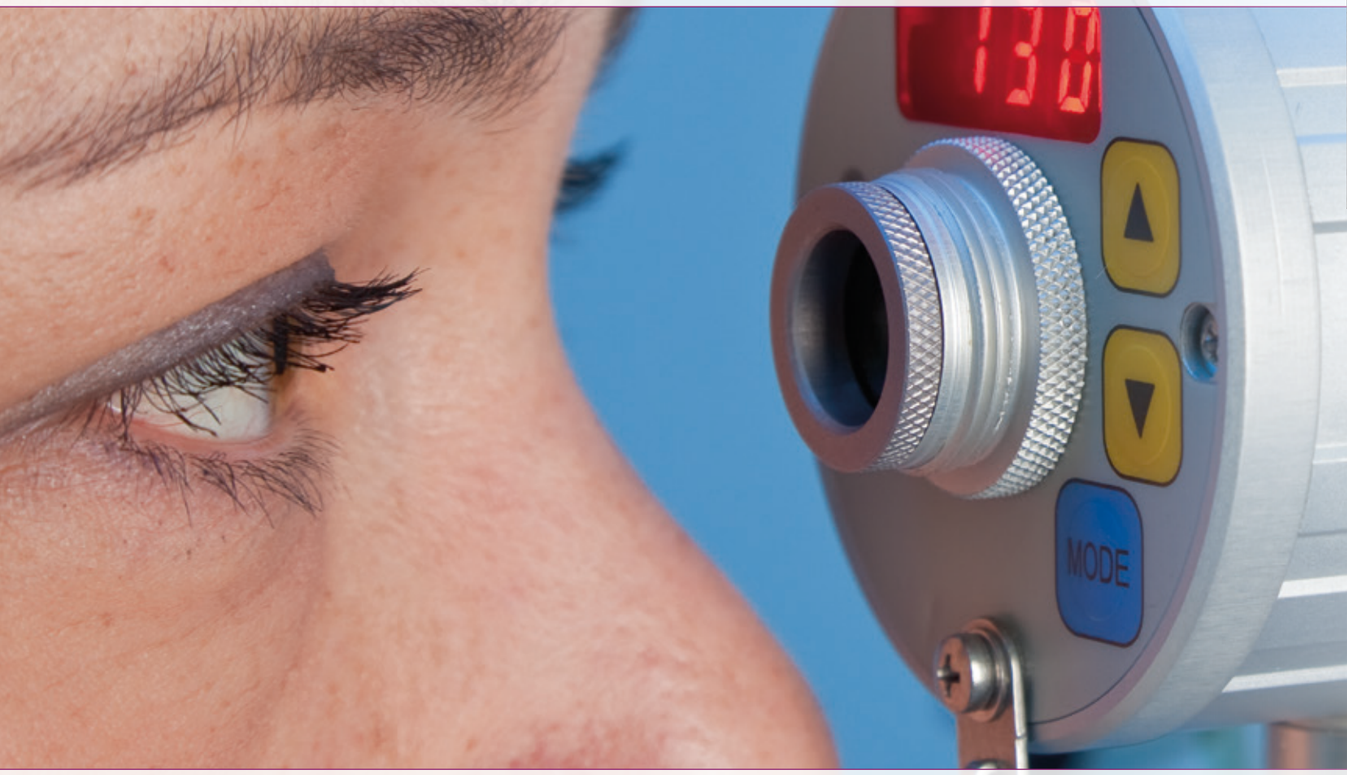


Switchable amplifiers
with different gains

To narrow gap between ion counting and Faraday cup measurements, we offer a set of current amplifiers with Tera-Ohm feedback resistors (10^{12} Ω). While the larger resistor results in a 10x higher gain of the amplifiers, the Johnson noise of the resistor only increases by √10. This promises a two to three-fold improvement in signal/noise. We also offer 10^{10} Ω amplifiers to increase the dynamic range up to 500 V.

Up to 10 current amplifiers with different gains can be installed simultaneously. Unique to the design of the TRITON *Plus* TIMS is the relay matrix that connects amplifier to Faraday cup. The connection scheme between amplifiers and Faraday cups is software controlled. This enables the user to tailor the amplifier configuration to the needs of current analytical task and its required precision. There is no need to open the amplifier housing and physically exchange the amplifiers, which is time-consuming and potentially harmful to the amplifiers.

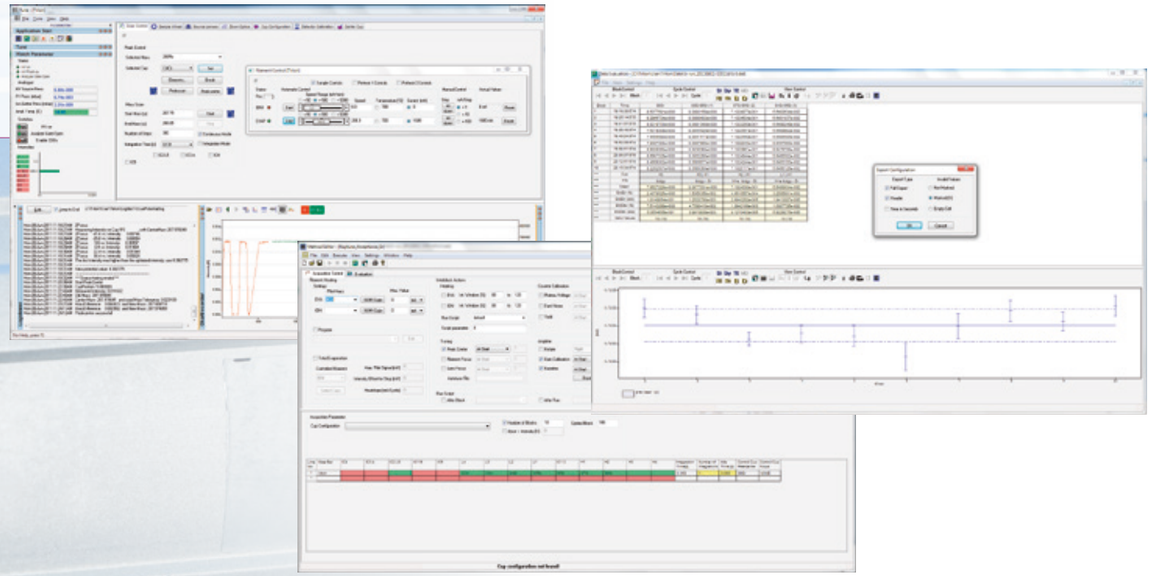




Triton *Plus*
software package

The software supports fully automated sample manipulation and configurable and automated filament heating procedures. It offers automated pyrometer readout of filament temperature. The cup configuration editor is used to define and select cup configurations. The method editor program enables the user to set up user-defined measurement procedures, including static, multidynamic and fast single collector peak jumping measurement strategies and sample heating programs.

On-line and off-line data evaluation packages are available, including statistical capabilities and display of the results in spreadsheet or graphical form. The user has access to all raw data and can monitor the results on-line during the analysis. The software allows a selection of the data to be evaluated and exported. The software also supports automated report generation of analytical results. The script language is based on C programming language, allowing modification of existing procedures.



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