



plasma 1700

High Resolution Multi-Collector
ICP-MS



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Plasma 1700 & Sapphire 1700

Plasma 1700: Large Geometry Multi-Collector Inductively Coupled Plasma Mass Spectrometer



Introduction

The application of non-traditional stable isotope systems such as Mg, Si, S, K, Ca, Ti, V, Cr, Fe, Ni and Se in geochemistry, cosmochemistry and life sciences has been spurred by the advancement of the multi-collector ICP-MS (MC-ICP-MS) over the last two decades. This versatile technique, although widely considered as the standard method for the high precision isotopic analysis of such systems, is limited by the inevitable molecular species generated by the ICP source resulting from ions such as Ar^+ , N^+ , O^+ and H^+ . These species can often interfere directly with the atomic ions of the same nominal mass, leading to inaccurate isotope ratio determination. The ability to avoid unwanted interfering species in close proximity to the target ions on the mass focal plane is dependent on the mass resolution. Such interfering species are partially resolved by narrowing the source entrance slit to proportionally increase the mass resolution.

Narrowing the source entrance slit has the unavoidable consequence of decreasing the ion beam intensity. The natural size of the focussed ion beam entering the mass analyser is $\sim 0.3\text{mm}$, reducing this dimension proportionally reduces the ion beam intensity in a way that can not be recovered. A larger magnet and geometry results in a bigger mass dispersion which increases the base resolution of the instrument. Plasma 1700 has a mass dispersion of $\sim 1700\text{mm}$, giving a base resolution of >800 (10% valley definition), much higher than any standard MC-ICP-MS. This is sufficient to analyse nearly 40% of isotopes while operating at full sensitivity. Comparing to any standard MC-ICP-MS, the ion transmission is much higher on the Plasma 1700 for a given resolving power. The source entrance slit is continuously adjustable, allowing a suitable resolving power to be chosen to analyse a certain isotope system, without unnecessary sacrifice of transmission. The edge resolving power can go up to $>30,000$ (5, 95% edge definition) making most isotopes measurable.

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Key features:

- Double-focussing high-resolution MC-ICP-MS with large dispersion
- True high resolution and pseudo high resolution analysis capability
- Standard resolution >800 , Peak flat at >5000 resolution
- Variable independently adjustable high resolution collector slit for each collector
- Enhanced Sensitivity Interface as standard
- Sixteen large dynamic range Faraday detectors, with optional software switchable resistor pre-amplifiers
- Moveable Faraday detectors on the outer array providing extra flexibility for large dispersion isotope systems
- Up to five ion-counting detectors (with SEM/Daly options) and high abundance deceleration filters for improved abundance sensitivity
- Better abundance sensitivity than a standard MC-ICP-MS
- Variable Zoom Optics allow for instantaneous switching between isotopic systems during analysis
- Differential pumping configuration
- Fully Dry Pumped configuration available
- Ground potential analyser operation

Sapphire 1700: Large Geometry Dual-Path Multi-Collector Inductively Coupled Plasma Mass Spectrometer

Introduction

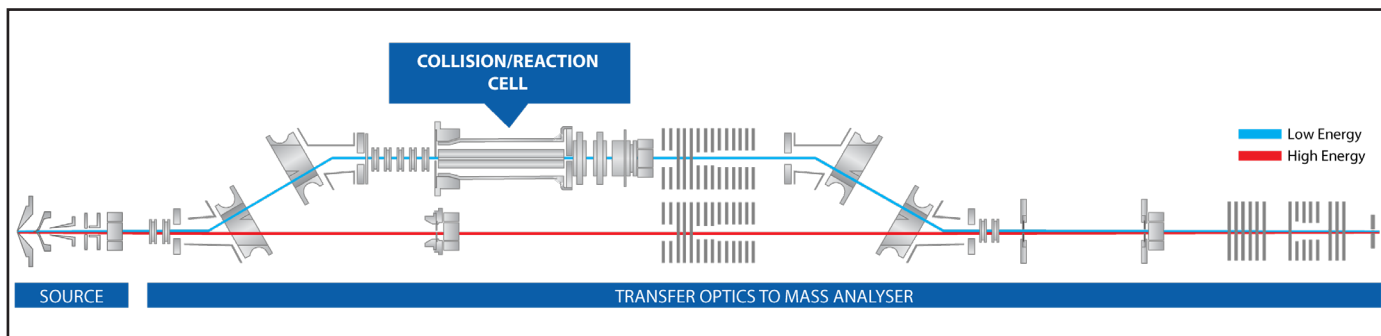
Sapphire 1700 combines the Plasma 1700 mass analyser with the dual transfer optics from the Sapphire, including a “high energy” ion path (traditional MC-ICP-MS) and a separate “low energy” ion path (collision/reaction cell), offering the benefits of collision/reaction cell without compromising performance on classical geological applications.

The ‘dual path’ design allows the cell to be used to remove isobaric interferences for special applications, and fully bypassed when analyzing classical isotope systems that do not require removal of interferences.

Dual Path Transfer Optics

The dual path transfer optics retain the high sensitivity of MC-ICP-MS by extracting the ions at high energy. The ion beam can then be directed along two distinct paths. The ‘High Energy Path’ retains the high ion energy throughout the transfer optics before focusing onto the defining slit of the double focusing mass spectrometer, retaining all the key performance of traditional MC-ICP-MS. The ‘Low Energy Path’ diverts the ion beam along a second route where the ions are decelerated before entering the collision / reaction cell. Gas is introduced into the RF cell to produce reactions with the low energy ions. On Exiting the cell, the ions are reaccelerated back to the high energy and focused into the defining slit of the double focusing mass spectrometer.

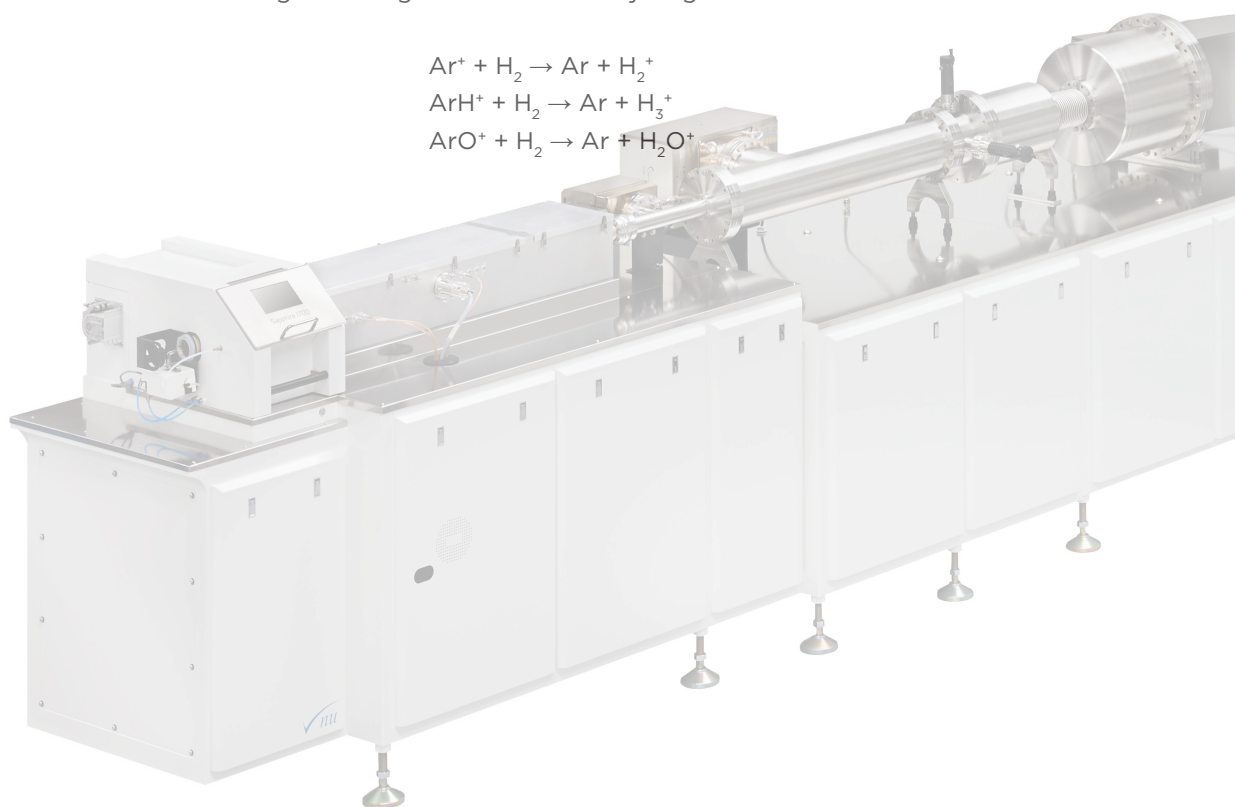
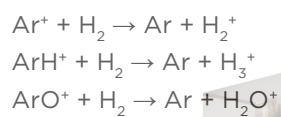
Dual Path transfer optics, incorporating: <ul style="list-style-type: none"> o Low Energy Path with Collision / Reaction cell for interference removal. o High energy Path for classical multi-collector performance.
Up to 4 independently controlled reaction gas inlets
Double-focussing high-resolution MC-ICP-MS with large dispersion
True high resolution and pseudo high resolution analysis capability
Standard resolution >800, Peak flat at >5000 resolution
Variable independently adjustable high resolution collector slit for each collector
Enhanced Sensitivity Interface as standard
Sixteen large dynamic range Faraday detectors, with optional software switchable resistor pre-amplifiers
Moveable Faraday detectors on the outer array providing extra flexibility for large dispersion isotope systems
Up to five ion-counting detectors (with SEM/Daly options) and high abundance deceleration filters for improved abundance sensitivity
Better abundance sensitivity than a standard MC-ICP-MS
Differential pumping configuration
Ground potential analyser operation



Interference Removal

The collision / reaction cell enables removal of isobaric interferences such as Ar^+ or polyatomic interferences such as ArH^+ , ArN^+ or ArO^+ which can interfere directly with the atomic ions of the same nominal mass for example K, Ca, Fe.

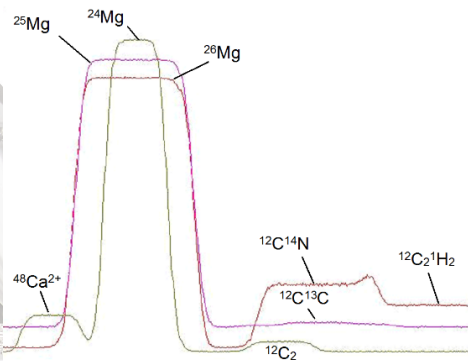
Such interferences can be removed via charge exchange reactions with Hydrogen such as:



Transmission (%)	Edge Resolving Power (5%, 95%)
100	5,000
32	12,900
25	16,700
19	20,260
15	25,800
7	28,400

True High Resolution

The Plasma 1700 has a unique true high resolution capability, utilizing independently adjustable collector slits fitted for each detector. Interfering peaks are completely resolved from analyte peaks, whilst maintaining a flat top profile. This is critical in cases when polyatomic interferences appear on the high mass side and doubly charged interferences on the low mass side of the analyte peaks, often observed in laser ablation mode.



Example Data

As a result of its higher transmission, sample-standard bracketing results of repeat measurements of a 100ppb Si standard solution and a 150ppb Fe standard solution yield precisions typically achieved on a standard MC-ICP-MS using solutions several times more concentrated. Plasma 1700 is thus particularly advantageous for isotopic analysis of samples of limited size.

Si (n = 10)	$\delta^{29}\text{Si}$		$\delta^{30}\text{Si}$	
	Mean (‰)	2σ (‰)	Mean (‰)	2σ (‰)
	0.023	0.052	0.070	0.104
Fe (n = 60)	$\delta^{56}\text{Fe}$		$\delta^{57}\text{Fe}$	
	Mean (‰)	2σ (‰)	Mean (‰)	2σ (‰)
	0.001	0.026	-0.003	0.078

δ denotes the ‰ deviation of the sample value from the average of two standard values measured before and after. Mean denotes the average δ of ten repeat brackets, 2σ the 2SD of the ten δ values.

plasma 1700

Innovators in
Mass Spectrometry



High Resolution Multi-Collector ICP-MS



environmental



planetary



life science



geochemistry



material science



nuclear

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