ICP-MS

plasma 3

Multi-Collector ICP-MS

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Plasma 3 is a third generation Multi Collector ICP Mass Spectrometer (MC-ICP-MS), designed to provide the best possible precision and accuracy for simultaneous isotopic ion detection. The instrument retains the unique, variable dispersion Zoom lens enabling the simultaneous measurement of the isotopes of elements from lithium to the actinide series on its static collector array of sixteen Faraday detectors and up to six ion-counting detectors. Ground potential analyser operation provides ease of use and maintenance with excellent reliability.

While continuing to provide the highest precision, accuracy and flexibility that previous generations are renowned for, Plasma 3 adds new refinements and innovations to maintain its position as the instrument of choice for Earth Sciences, Environmental Science, Nuclear Research, Archaeology, Forensics, Biochemistry and Biomedical Science.

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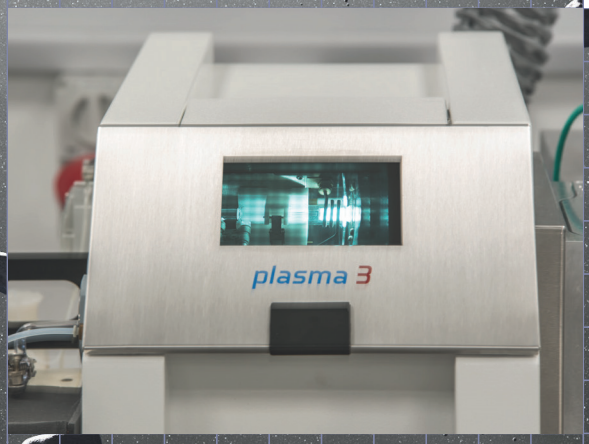
Key Features

- Double focussing high precision isotopic measurement mass spectrometer
- Enhanced Sensitivity Interface as standard
- All new, innovative torch box design allowing easy connection of a wide range of sample introduction devices
- EATO — Enhanced Abundance Transfer Optics (Patented)
- Robust third generation RF generator with “Frequency Tuning”
- Fully Dry Pumped configuration available
- Sixteen large dynamic range Faraday detectors, with optional software switchable resistor amplifiers
- Up to six ion-counting detectors (with SEM / Daly options)
- High abundance deceleration filters available for improved abundance sensitivity
- High resolution and pseudo high resolution capabilities
- Variable Zoom Optics allow for instantaneous switching between isotopic systems during analysis
- Fully compatible with third party accessories
- Low cost of ownership



Plasma 3

Overview

Plasma 3 incorporates a double focussing forward geometry Nier Johnson analyser with an Electrostatic Analyser followed by a laminated magnet. The forward geometry is essential for simultaneous detection of multiple ion beams. Ions are focussed in both energy and direction.

Variable Dispersion Zoom Optics

Plasma 3 utilises our unique field proven Zoom Optics system that removes the necessity for employing adjustable collectors. This provides a highly reliable collector array and allows instantaneous switching between collector configurations, and the use of full size discrete dynode SEMs or Daly detectors. The Zoom Optics system maintains double focussing conditions throughout the operational mass range.

Faraday Collector System

Sixteen Faraday detectors are fitted to the instrument as standard, giving the user the ultimate in flexibility for simultaneous measurement of all isotope systems.

The unique fixed Faraday collector array incorporates both electrostatic and magnet suppression devices to prevent the escape of ions and electrons from the Faraday detectors.

Plasma 3 comes with the option of switchable gain preamplifiers adding further flexibility to the collector.

Vacuum System

Plasma 3 utilises the latest generation of vacuum pumps for ultimate performance and reliability, ranging from the large $80m^3h^{-1}$ rotary vane pump for the plasma interface to the UHV turbo-molecular pumps on the analyser section. Failsafe mechanisms ensure vacuum integrity is preserved on power loss. Plasma 3 also comes with the option of a fully dry pumped configuration.

Analyser

To maintain the ultra-high vacuum specification required for many applications, Plasma 3 incorporates turbo molecular pumping of the analyser section. This results in the exceptional abundance sensitivity performance of the Plasma 3 of <2ppm at -1 amu spacing relative to ^{238}U. Only by utilising such efficient pumps is it possible to ensure the abundance sensitivity doesn't degrade as sensitivity increases. Plasma 3 is also available with the EATO (Enhanced Abundance Transfer Optics) option which further improves abundance sensitivity.

All New ICP Source

The ICP source has been designed and engineered to be robust while ensuring maximum stability and reliability during operation. This unique design of ICP source gives the user unrestricted access to the interface area to facilitate ease of use and maintenance.

The third generation frequency tuning RF generator delivers rapid response to changing matrix conditions resulting in greater stability for even the most challenging applications.

The source has been designed to simplify connection of the growing number of sample preparation systems required by the modern analyst with provision for Gas Chromatography (including heated transfer lines) Desolvation systems, Laser Ablation, and Cold Vapour generation among others.

Plasma 3

Setting a New Standard in Collector Flexibility

Plasma 3 is the most technically advanced detector system ever designed for a MC-ICP-MS.

Multiple ion counting devices, such as the full size SEM detectors that have been successfully deployed in Nu Instruments multi-collectors for two decades, can now be combined with multiple Daly Detectors and switchable resistor Faradays.

By allowing the user to specify a collector configuration to meet all of their analytical requirements, Plasma 3 now sets a new standard in flexibility.

SEM detectors

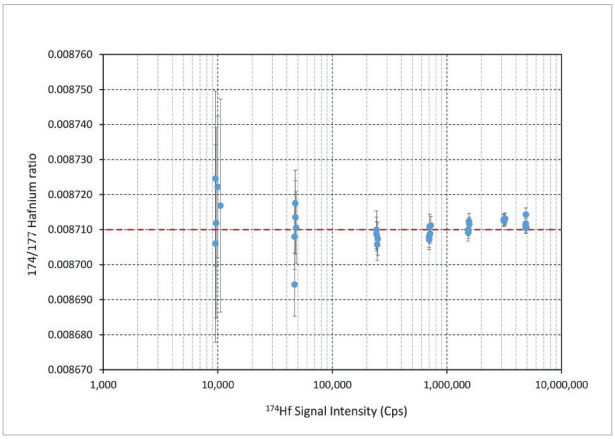
Up to six full size discrete dynode ion-counting multiplier channels can be interspersed within the plasma 3 collector array providing the flexibility and performance required for current and future applications. Simultaneous measurement of low level boron, U-Pb for geochronology studies and isotopic measurements of trace actinides for nuclear forensics are just a few applications. All of the multipliers used within the plasma 3 collector are of a full size, discrete dynode construction to ensure the best stability, linearity, lifetime and noise performance.

Software Switchable Resistor Faraday detectors

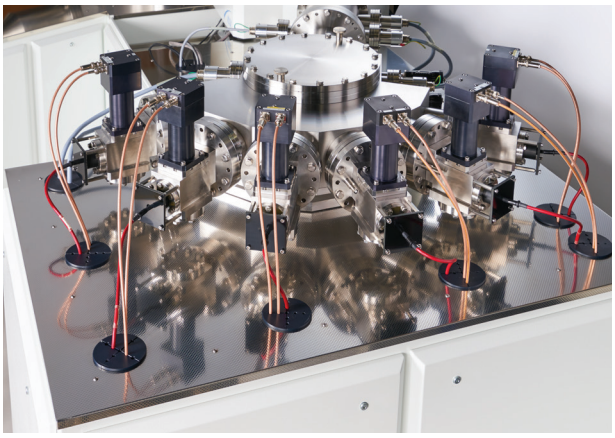
Any number of Faraday preamplifiers can be fitted with two resistors of various sizes ($10^{10}\Omega$, $10^{11}\Omega$, $10^{12}\Omega$, $10^{13}\Omega$), allowing adjustment of the signal amplification of a given Faraday, which increases the dynamic range of the detector. This coupled with the largest MC-ICP-MS digital voltmeter range on the market, and up to six ion counters, demonstrates the unrivalled capability of Plasma 3 for large dynamic range isotopic measurements.

Daly detectors

Daly detectors offer the highest performance of any ion counting device over the largest dynamic range.



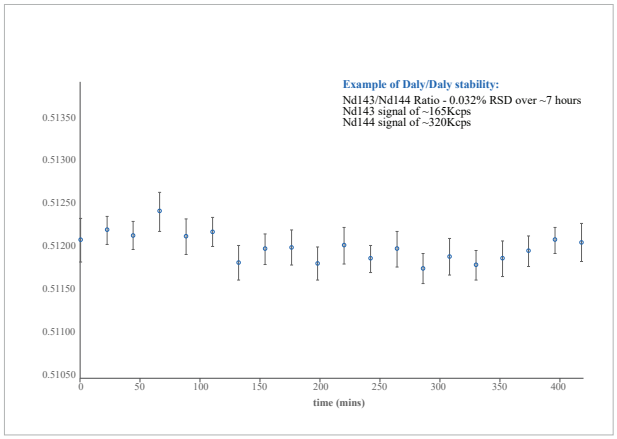
Example of Daly linearity up to >5Mcps



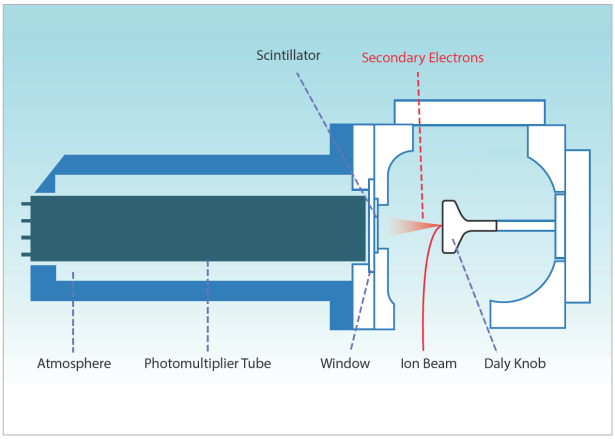
Multiple Daly detectors on a standard Plasma 3

Multiple Daly Detectors

Multiple Daly detectors can be substituted for SEM detectors on Plasma 3. A full Daly collector system is available as standard for outstanding ion counting performance. This Includes up to six Daly Detectors in addition to the sixteen Faraday cups.



Daly/Daly stability over several hours



Schematic of a Daly detector

Image of the Plasma 3

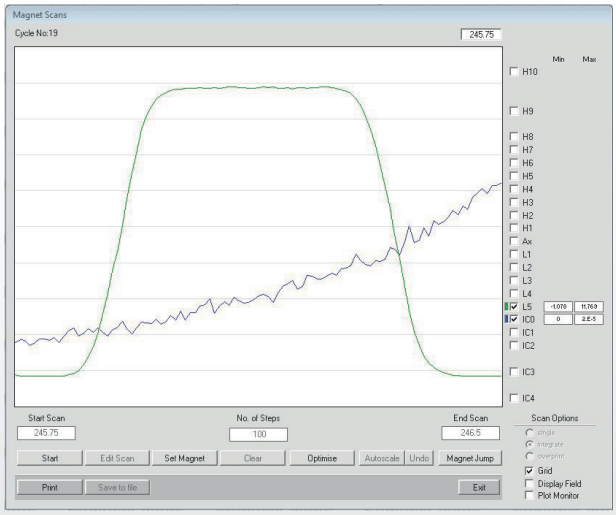
Plasma 3

Enhanced Abundance Transfer Optics (EATO)

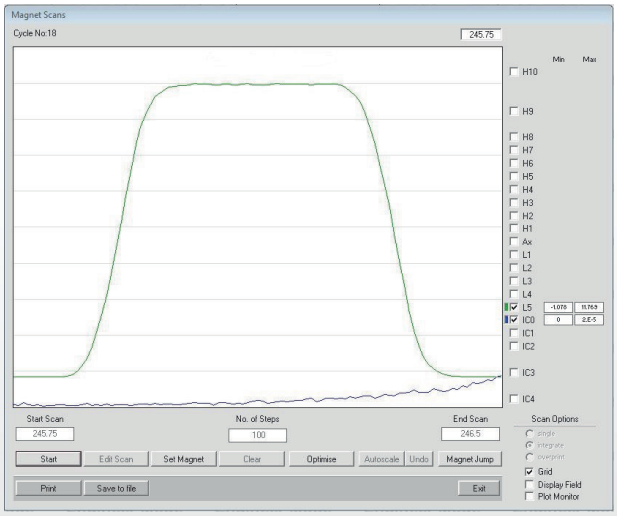
Due to the unique pumping system of Plasma 3, the analyser section routinely operates in the 10^{-9}mbar range which affords exceptional abundance sensitivity with standard optics, typically <2ppm pre-deceleration filter and <0.5ppm post-deceleration filter.

For the more demanding actinide applications an additional lens element EATO (UK Patent **GB 2545670**) has been designed which can be easily installed by users without the need to vent the analyser.
This device is inserted in to the transfer chamber and provides significant improvement to the abundance sensitivity, typically <1ppm pre-filter and <0.05ppm post-filter.

This improvement in abundance sensitivity performance is achieved without compromising transmission or mass bias stability.

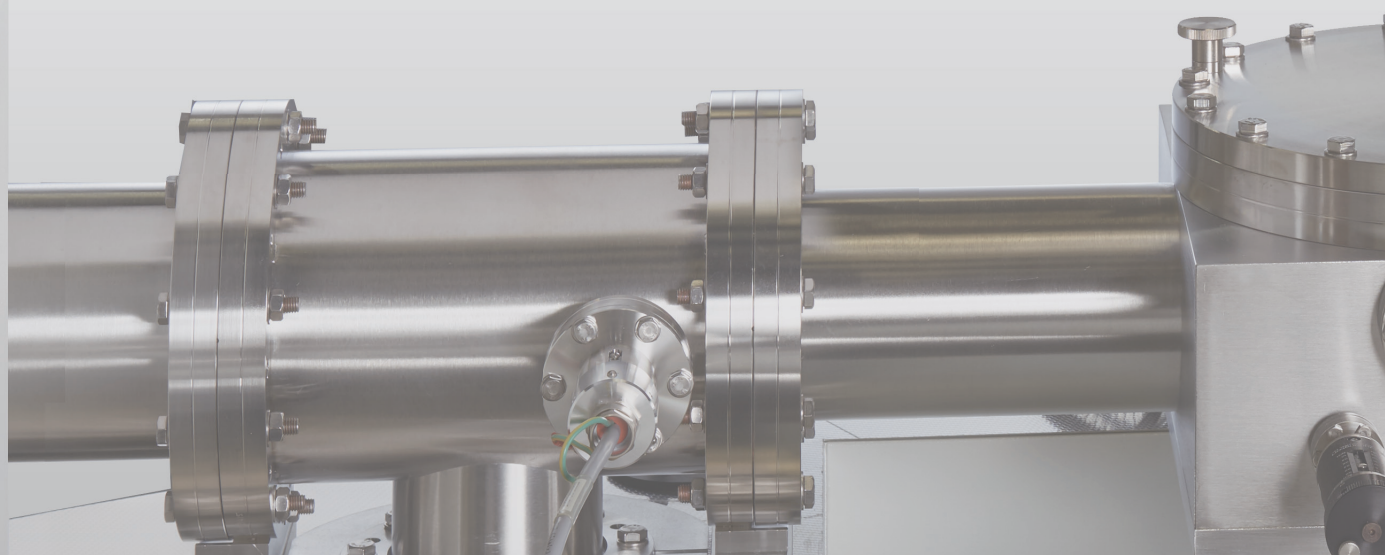


Deceleration Filter Off - 700ppb



Deceleration Filter On - 30ppb

Examples of abundance sensitivity measured at mass 237 in respect to ^{238}U using EATO with and without the use of a deceleration filter



High Mass Resolving Capability

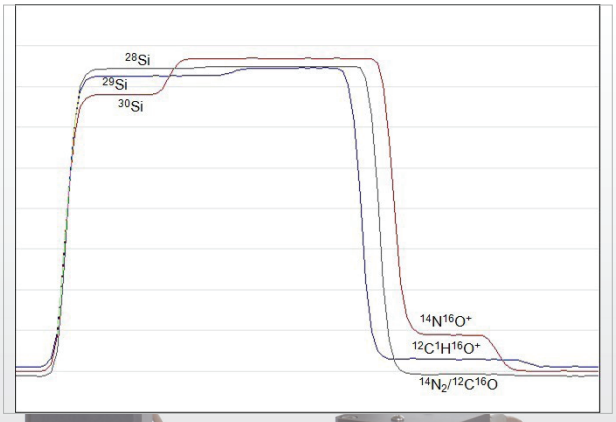
An interference free, flat-top peak is essential for precise and accurate isotopic measurements. The High Resolution features of Plasma 3 achieve high mass resolving power across the entire multi-collector array. Plasma 3 offers two types of high resolution capability: Pseudo High resolution and High resolution.

Pseudo High Resolution

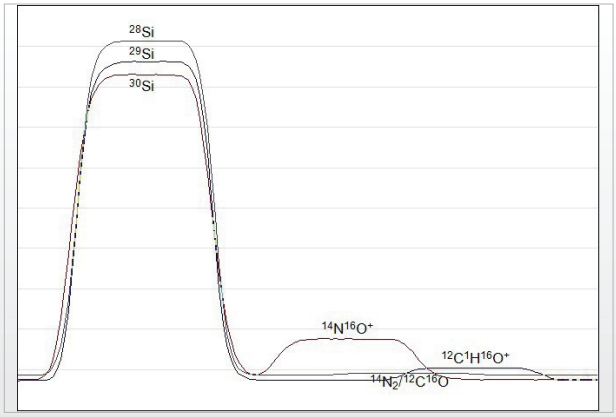
The Pseudo High resolution method partially resolves peaks, leaving a flat-topped section of resolved peak for isotopic ratio measurements. This technique works as long as the interferences are all on the same side of the peak.

High Resolution

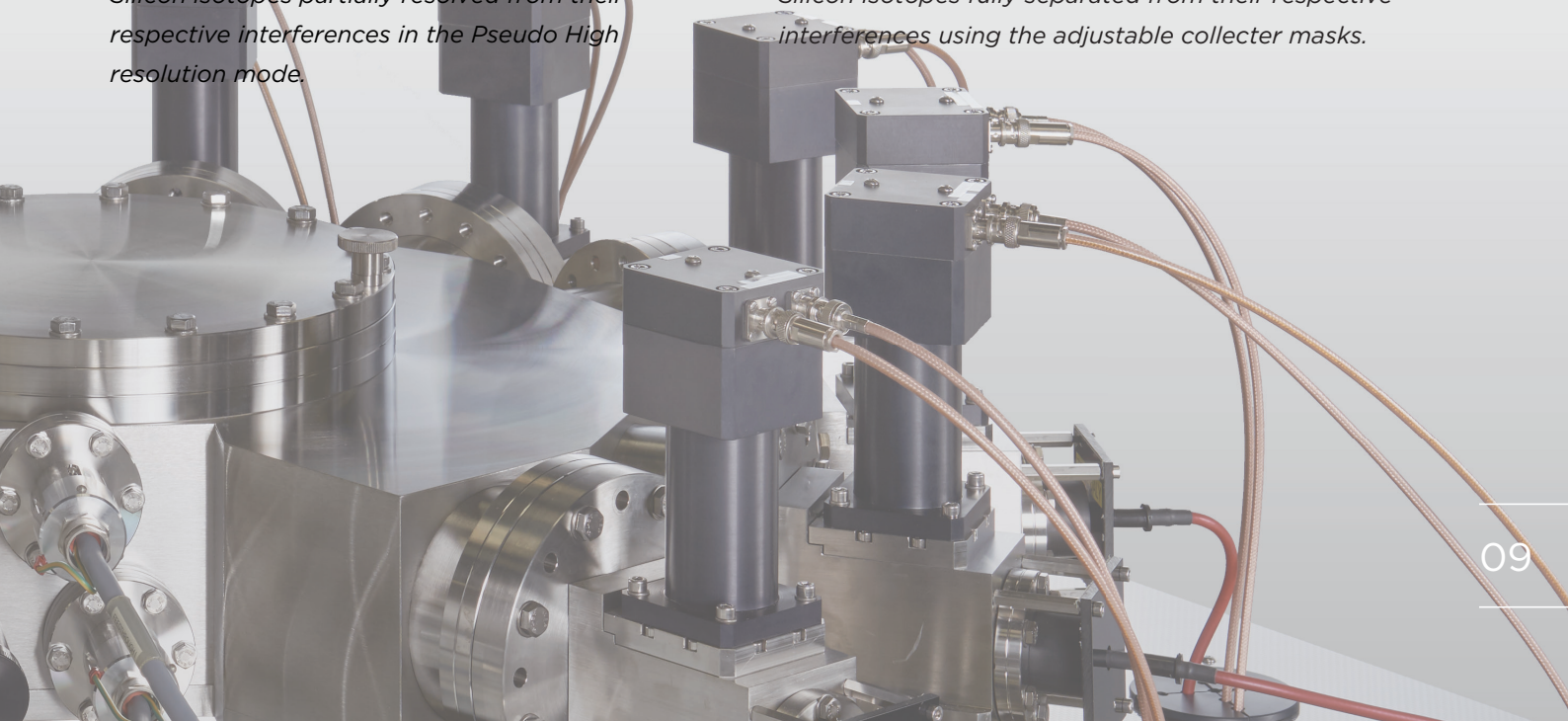
For applications where interferences appear on both low and high mass sides of the analyte, the high resolution method should be used. The unique design of the Plasma 3 fixed collector system makes it possible to obtain full resolution from interferences by changing the collector slit widths, without having to replace collectors. This method allows the user to observe the complete resolution of interfering peaks from analyte peaks without reducing the sensitivity any further compared to Pseudo High resolution.



Silicon isotopes partially resolved from their respective interferences in the Pseudo High resolution mode.



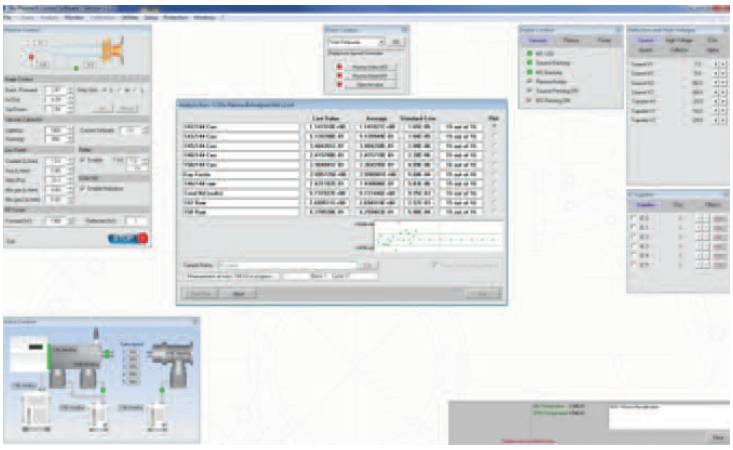
Silicon isotopes fully separated from their respective interferences using the adjustable collecter masks.



Plasma 3

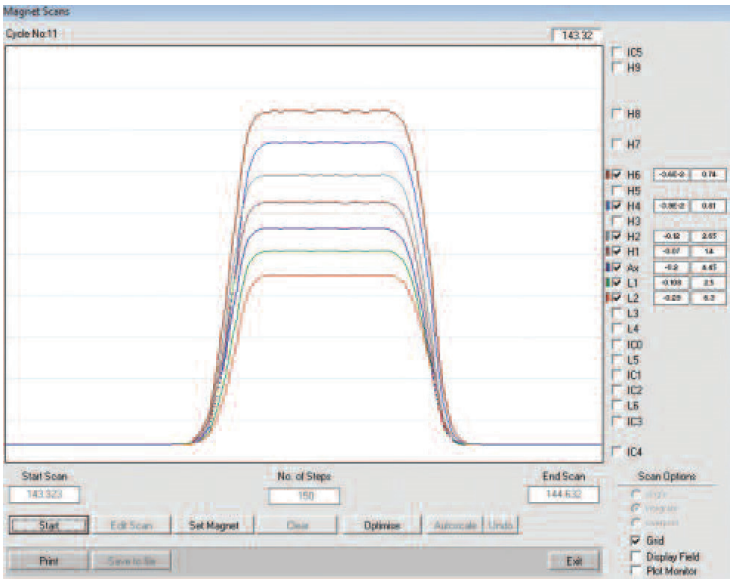
Bespoke and Intuitive Software Suite

Plasma 3 comes with a software suite, which gives the user full control of the operation and configuration of the various components of the instrument. It features fully automated instrument control including start up, plasma ignition sequence and shut down. The user friendly interface provides relevant controls for tuning, diagnostics, and instrument protection.



Plasma 3 software analysis window

Full integration with accessories such as auto samplers and laser ablation systems is also supported. The standard Nu Instruments Calculation Editor (NICE) software provides user-definable data reduction functions. Both raw and calculated data are available for each sample run along with full logging of instrument settings and operational parameters. Data can be analysed on-or off-line and can be easily exported for further analysis to third party software packages.

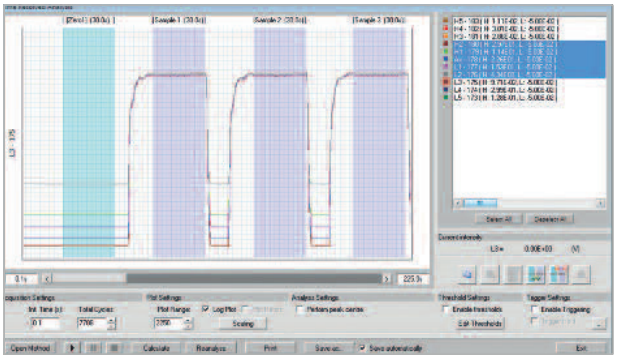


Magnet scan window showing peak shapes of Neodymium isotopes in coincidence

Time Resolved Analysis

The Time Resolved Analysis (TRA) feature was specifically developed for the analysis of transient signals resulting from coupled laser ablation systems, GC systems, hydride generators etc.

Within the TRA, data can be acquired at customisable integration times and the generation of calculated results is made easy by the simple and flexible data selection capabilities of the utility.



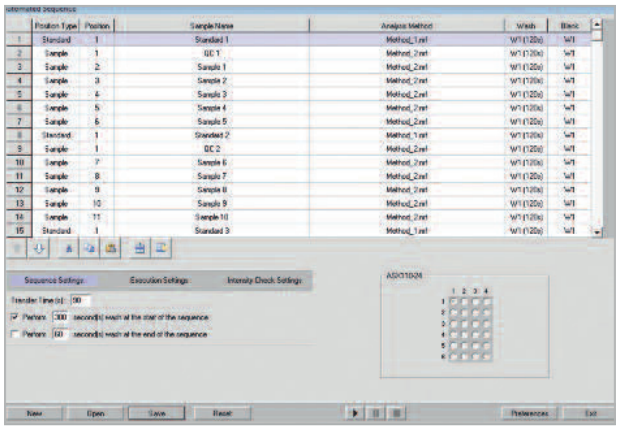
Time Resolved Analysis window

Data can be subsequently exported for further off-line analysis with popular third party data reduction software packages such as Glitter and Iolite or reanalysed in Plasma 3 software. External hardware triggering is also available allowing data acquisition initiation or pausing within the single or multiple TRAs.

Sequence Editor

Plasma 3 software incorporates a comprehensive and flexible integrated sequence editor enabling easy creation of automated sample analysis for unattended measurements in conjunction with an auto-sampler.

Creation of a new sequence is simple and rapid. Wash and blank measurement options can be fully customised for each sample and easily edited.



Automated Sequence Editor window

Sequences can be fully edited at any time, even whilst running, allowing the analyst to prioritise samples and providing maximum flexibility without disruption to the on-going measurement.

Furthermore, the automatic shutdown of the instrument on completion option is ideal for overnight runs.

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Innovators in Mass Spectrometry

Multi-Collector ICP-MS

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