Comprehensive detector options for the measurement of small beams on the Nu Plasma 3 MC-ICP-MS

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In recent years, the demand for high precision measurements of small ion signals has increased significantly in Earth Sciences and Nuclear applications.

For the determination of small ion beams, several detector options are currently available on the Nu Plasma 3 MC-ICP-MS, each suited to a certain range of ion beam sizes. A high-gain resistor (10^12 ohm or 10^13 ohm) pre-amplifier equiped on a Faraday detector can be used for ion beam smaller than 1pA. Comparing to the 10^11 ohm resistor, the higher signal-to-noise ratio on the high-gain Faraday detector will yield better measurement precision. The other option for small ion beam measurement is the ion counting detector (SEM detector or Daly detetor). The faster response of these types of detector is an advantage in comparison with the Faraday cups particularly for transient signal measurements. The ion counting detectors also benefit from the lack of resistor noise (Johnson noise), the beam size may therefore go down to below 1aA. The ion counting detectors, however, display less gain stability and linearity in comparison with the Faraday detectors.

The performance of different types of detector vary widely in terms of dynamic range, gain stability, linearity, response time and life time. Choosing the optimal detector type for measurement of an ion beam is crucial to achieving the best precision possible. This study investigates the suitability of several types of detectors on the Nu Plasma 3 MC-ICP-MS for small ion beams and demonstrates their typical performance using several isotope systems. The aim of the study is to identify the ideal application range of each detector type in order to facilitate the selection of detectors to achieve optimal analytical performance.