



Cross-Calibration of Secondary Electron Multiplier in Noble Gas Analysis

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The latest generation of multi-collector noble gas mass spectrometers has decisively improved the precision in isotopic ratio analysis [1, 2] and helped the scientific community to address new questions [3]. Measuring numerous isotopes simultaneously has two significant advantages: firstly, any fluctuations in signal intensity have no effect on the isotope ratio and secondly, the analysis time is reduced. This particular point becomes very important in static vacuum mass spectrometry where during the analysis, the signal intensity decays and at the same time the background increases. However, when multi-collector analysis is utilized, it is necessary to pay special attention to the cross calibration of the detectors. This is a key point in order to have accurate and reproducible isotopic ratios.

In isotope ratio mass spectrometry, with regard to the type of detector (i.e. Faraday or Secondary Electron Multiplier, SEM), analytical technique (TIMS, MC-ICP-MS or IRMS) and isotope system of interest, several techniques are currently applied to cross-calibrate the detectors. Specifically, the gain of the Faraday cups is generally stable and only the associated amplifier must be calibrated. For example, on the Thermo Scientific instrument control systems, the 10^{11} and 10^{12} ohm amplifiers can easily be calibrated through a fully software controlled procedure by inputting a constant electric signal to each amplifier sequentially [4]. On the other hand, the yield of the SEMs can drift up to 0.2% / hour and other techniques such as peak hopping, standard-sample bracketing and multi-dynamic measurement must be used.

Peak hopping allows the detectors to be calibrated by measuring an ion beam of constant intensity across the detectors whereas standard-sample bracketing corrects the drift of the detectors through the analysis of a reference standard of a known isotopic ratio. If at least one isotopic pair of the sample is known, multi-dynamic measurement can be used; in this case the known isotopic ratio is measured on different pairs of detectors and the true value of the isotopic ratio of interest can be determined by a specific equation.

In noble gas analysis, due to the decay of the ion beam during the measurement as well as the special isotopic systematic of the gases themselves, the cross-calibration of the SEM using these techniques becomes more complex and other methods should be investigated.

In this work we present a comparison between different approaches to cross-calibrate multiple SEM's in noble gas analysis in order to evaluate the most suitable and reliable method.

References: [1] Mark *et al.* (2009) *Geochem. Geophys. Geosyst.* **10**, 1-9. [2] Mark *et al.* (2011) *Geochim. Cosmochim.* **75**, 7494-7501. [3] Phillips and Matchan (2013) *Geochimica et Cosmochimica Acta* **121**, 229-239. [4] Koornneef *et al.* (2014) *Journal of Analytical Atomic Spectrometry* **28**, 749-754.