Improvements in high precision multicollector isotope ratio measurements for small sample sizes using 10^{12} Ohm current amplifiers and Faraday cup detectors

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The multicollector measuerment of small sample sizes as small as a few pico grams or below is limited by the analytical blank, possible molecular interferences and finally by the noise of the analogue Faraday detectors. Improvements in sample preparation can help to reduce the blank and the interference problem whereas the reduction of the detector noise needs instrumental improvements.Ultimately multi-ion-counting resolves the noise problem, but here we see other limitations like cross calibration uncertainty, linearity, stability and dynamic range of the ion counters. There certainly is a gap in the dynamic range where the ion counting detectors are not good enough because of the limitations mentioned before and the Faraday cup detectors are limited because of the noise problem.

In this study, we aim to narrow the gap between ion counting and Faraday cup measurements by using a set of current amplifiers with a tera-Ohm feedback resistor (10^{12} ohm) instead of the standard 10^{11} Ohm feedback resistors. The larger resistor value results into 10 times increased gain of the amplifiers and at the same time the Johnson noise of the resistors only scales by a factor of square root of 10. This gives promise to an improvement in signal/noise of 3 by using tera Ohm amplifiers. This assumption is tested by a series of osmium and neodymium measurements on the Finnigan TRITON (TIMS) and by some heavy stable isotope systems measured on the Finnigan NEPTUNE (MC-ICPMS) with signal intensities ranging from about 50 mV (3000.000 cps) down to about 0.5 mV (30.000 cps) for the minor isotopes.