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Long term behavior of ATONA-type charge-collection amplifiers on the Phoenix TIMS and NGX noble gas mass spectrometer

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We present data on the ATONA-branded charge-collection amplifiers from two Isotopx instruments, a TIMS with 9 moveable Faraday cups and an NGX noble gas mass spectrometer with two fixed cups. Both instruments have identical amplifiers.

On both instruments, ATONA noise has a linear relationship with inverse integration-time. Due to the differences between detectors, the 2σ amplifier noise for a 30 second integration on the NGX is ~51 cps, and 163 cps on the TIMS (compared to ~92 cps for a $10^{13}\Omega$ resistor). We present a physics-based parameterization that can be used to predict and characterize the noise behavior and demonstrate that combining our parameterization with shot noise accurately predicts real scatter in measured isotope ratios.

Over 4.5 years, the relative amplifier gains on the nine TIMS Faraday channels have changed by a median of 2.6 ppm and a maximum of 4.0 ppm. Gains are typically characterized by long periods of sub-ppm stability, and measurable shifts are only associated with venting the amplifier housing.

The repeatability of electronic baselines are typically ~20 cps (2SD) when sampled as repeated, 1-hour measurements. Longer duration measurements suggest that true electronic baseline stability may be better than 10 cps over a period of at least a week.

The amplifier and detector assembly response time is too fast to directly measure, but upon removing a 10 pA (e.g., 1 V) signal from a cup, the amplifier readback returns to baseline values in less than 0.1 seconds. From experience, it is possible to use the same detector to accurately measure 700 pA and 7 fA (e.g., 70 V and 4000 cps) ion beams in the same sequence by peak hopping.

Curiously, the control software seems to be able to record (at least) two data channels from the same ion beam using different integration times, and hence different amplifier noise. This suggests that these amplifiers are more sophisticated than a simple capacitor charge-discharge, and more importantly, that it may be possible for the manufacturer to allow users to inspect data at different integration times *after* an analysis and select the one that provides the best quality data.