Bridging the gap between Faraday cup and ion counting measurements – A Faraday detector with the equivalent noise performance of a 10^{14} Ω resistor amplifier

SHAUN YARDLEY[1], VADIM VOLKOVOY[1], MATT HOCKLEY[1], DAMIAN TOOTELL[1], ZENON PLALACZ[1]

[1]Isotopx, Dalton House, Dalton Way, Middlewich , Cheshire, UK

Measurement of isotopic ratios with small ion beams has conventionally utilised low-noise ion counters or ion counter - Faraday detector combinations. The accuracy and precision of these measuements has often been limited by the gap between the noise floor of a Farday detector and the upper-detection limit of an ion counter.

Unlike ion counters, Faraday detectors have the advantage of well-characterised linearity, electronic gain calibration and a large dynamic range. Efforts to reduce the noise floor and lower the detection limit in traditional resistor-based amplification technology results in compromising dynamic range, response time and usability.

In response to this, a capacitor-based amplifier system, *A*TO*NA*®, was developed for Isotopx Phoenix Thermal Ionisation MS and NGX noble gas MS. This technology offers extremely low noise while significantly improving response time, stabilty and dynamic range. Here, we present a rear single-channel Faraday-detector system, *ZEP*TO*NA*, that fully exploits the limits of the *A*TO*NA*® technology.

At 2 second integrations, the detector noise is 2.8×10^{-17}A, equivalent to the theoretical performance of a $10^{13}\Omega$ resistor amplifier. At 30 second integrations, detector noise is 2.35×10^{-18}A (~15cps), equivalent to the theoretical performance of a $10^{14}\Omega$ resistor amplifier. Baseline stability of this detector has been measured at 8.15×10^{-20}A 2SD over 4 days at 10,000 second integrations. By positioning this Faraday at the back of the instrument, behind the WARP filter, it also beniefits from improved abundance sensistivty neccesary for small-signal analysis.