

## **A Faraday amplifier with sub attoamp noise floor and a headroom of 100 volts**

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The precision of isotope ratio mass spectrometry has always been limited by the ability to precisely measure ion beam currents, especially in the applications of static vacuum noble gas MS and Thermal Ionisation MS where there is an increasing trend to analyse smaller amounts of sample. The limit of precision becomes defined as the ion beam signal approaches the noise floor of the system where the signal/noise ratio falls and precision suffers.

Pulse counting techniques can be used with electron multiplier devices but are severely limited by dynamic range and can be susceptible to gain instabilities and non-linearities.

In contrast, the traditional Faraday cup detector has well characterised linearity, can be gain calibrated electronically and offers the ultimate dynamic range. Efforts to reduce noise have focussed on higher ohmic resistors, but this results in a compromise in dynamic range and time response.

In response to these limitations, we have developed a new Faraday amplifier which offers unique performance displaying an extended dynamic range with an extremely low noise floor.

At 100sec integration time we can achieve  $1.5 \times 10^{-18}$ A (<10 cps) amplifier noise which exhibits the equivalent performance of a  $10^{14}\Omega$  (100T $\Omega$ ) resistor amplifier. Ion beams in excess of 1pA can be measured which is equivalent to 100 volts on a 100T resistor amplifier.

Data loss due to tau delays are reduced by two orders of magnitude compared to conventional amplifiers, the signal settles to 10ppm within 100ms.