IRMS based on 10kV Source and New Amplifier Technology

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INTRODUCTION

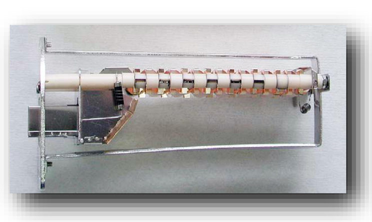
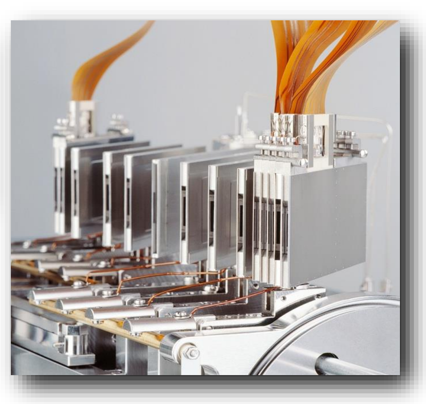
For measuring small ion beams in MC- MS we have two options

Multiple Ion Counting (SEM or CDD)

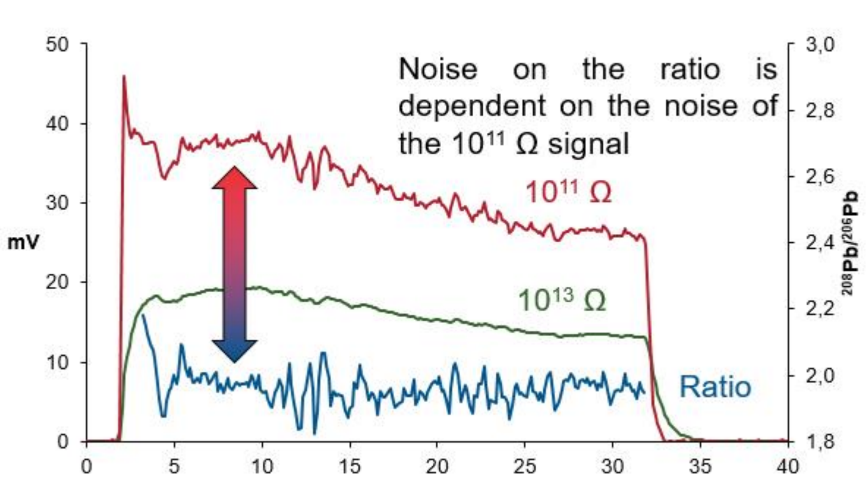
- Can measure from 0 ≈ 2,000,000 cps
- Low noise
- Problems with cross-calibration, linearity and stability

Faraday Detectors

- Stable
- High noise
- However the noise is ***amplifier dependent***
- 10^{13} Ω amplifiers theoretically improve
- signal-to-noise ratio by a factor of 10.
- Ideal for small ion beams.

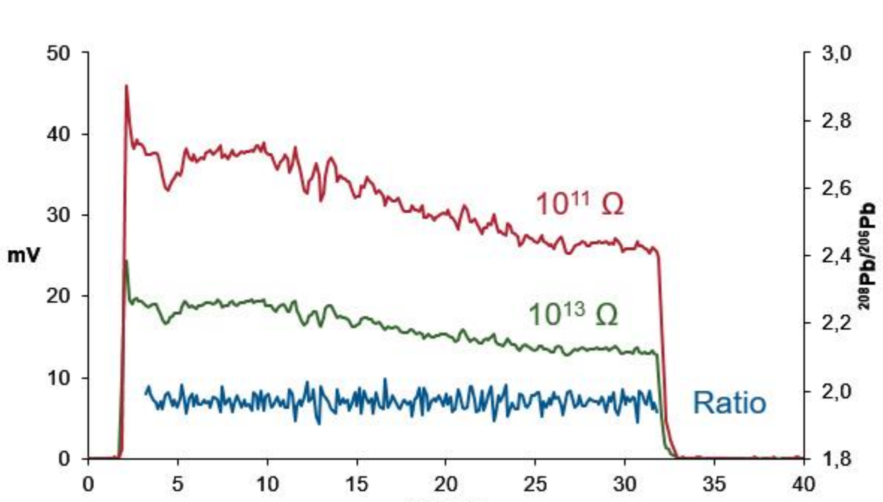



TAU correction for transient signal



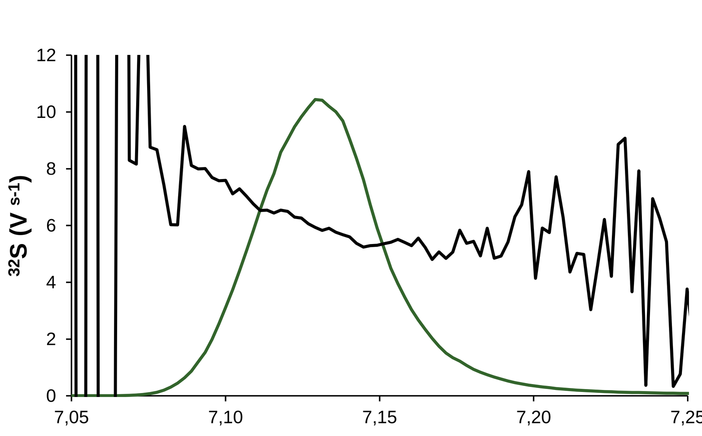
MPI-DING reference glasses by LA-MCICP-MS. 206Pb and 207Pb were measured on 10E13 ohm

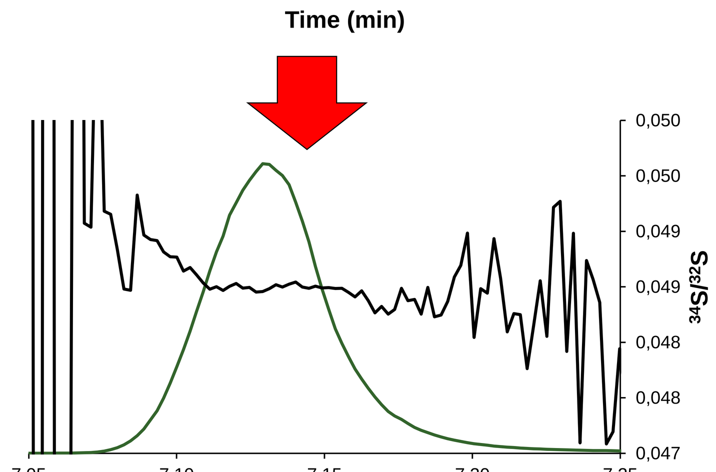
- By using a tau correction the 10^13 ohm signal is modified to resemble the 10^11 ohm output. As the response of each isotope is now outputted simultaneously, ratio precision is no longer dependent on the stability of the input signal. Drift is eliminated and hence accuracy and precision improve.



MPI-DING reference glasses by LA-MCICP-MS. 206Pb and 207Pb were measured on 10E13 ohm

- Problem: transient GC and Laser Ablation signals exhibit isotope ratio drift across the peak
- Like the 10^{13} Ω amplifiers, the source of the drift is related to the tau
- Approach described by Kimura *et al* (2016) can be used to correct for drift.





The benefits of Faraday cup detectors with the lowest noise amplifiers available.

- flexibility for use across MC Faraday cup arrays with different isotopic systems
- linearity with a dynamic range exceeding 30 Mcps
- stability of baselines within analytical sessions exceeding 12 hours
- technology improves response time compared with other high-gain amplifiers
- no need for inter-run cross calibration with long-term gain stability

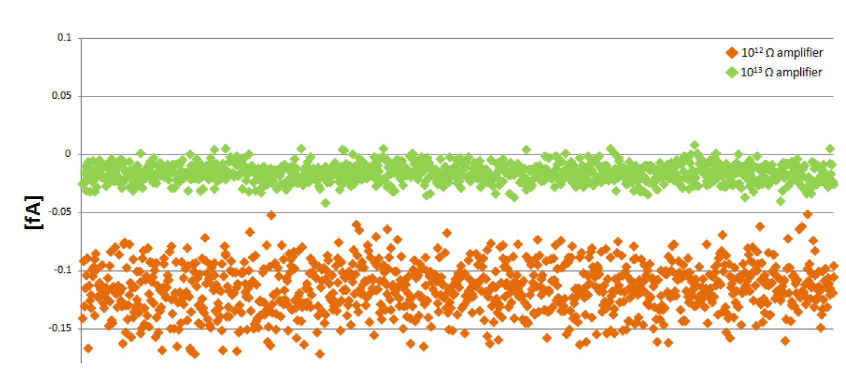
Baseline noise characteristics of 10^{13} Ω amplifier technology

The signal/noise ratio for Faraday cup amplifiers is proportional to the square root of the feedback resistor.

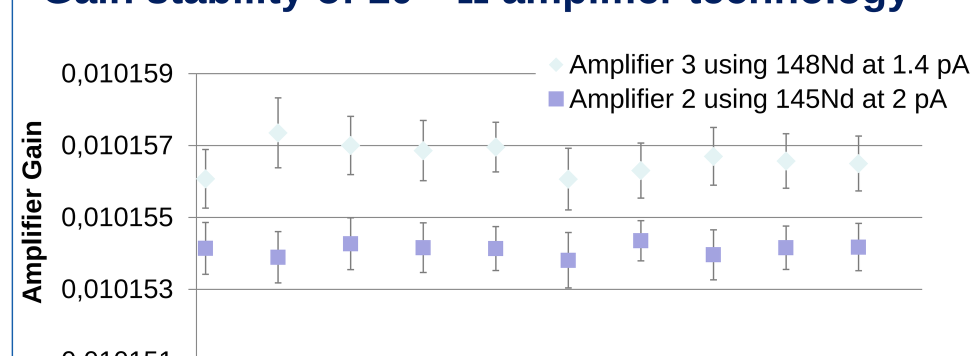
Thus a 10^{13} Ω resistor offers a significant advantage when compared to standard 10^{11} Ω resistors used in TIMS and MC-ICP-MS.

For 4.2 s integrations: ≤ 0.05 fA RSD (5 µV on 10^{11} Ω amp.)

- Baseline noise from the HELIX MC *Plus* with 10^{13} Ω amplifier technology is better than 0.03 fA (green dots). 10^{12} ohm amplifier data is shown for comparison (orange).



Gain stability of 10^{13} Ω amplifier technology



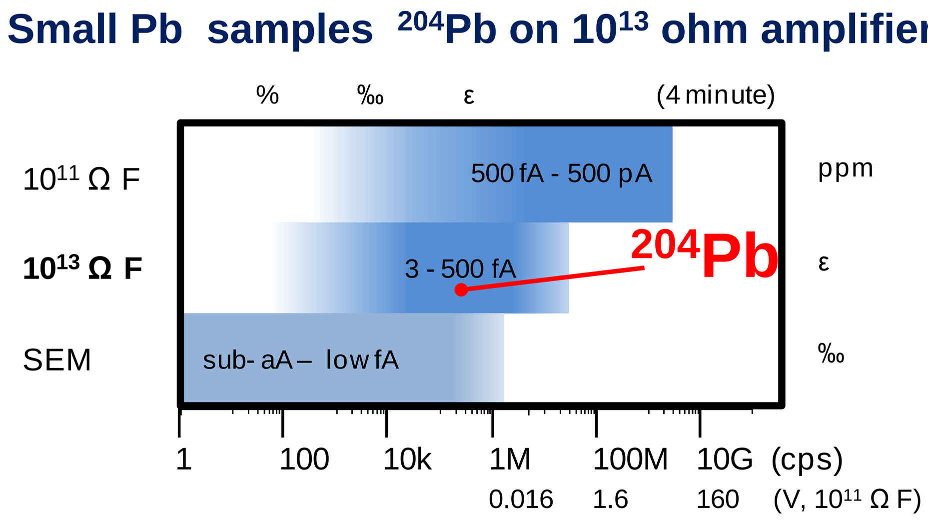
Amplifier gains were experimentally derived by comparing Nd isotope ratios measured with 10^{11} and then 10^{13} Ω amplifiers.

- 41 ppm (RSD) external reproducibility of 10 measurements spanning over 12 hours
- gains are readily measured at high-precision (sub-epsilon unit)

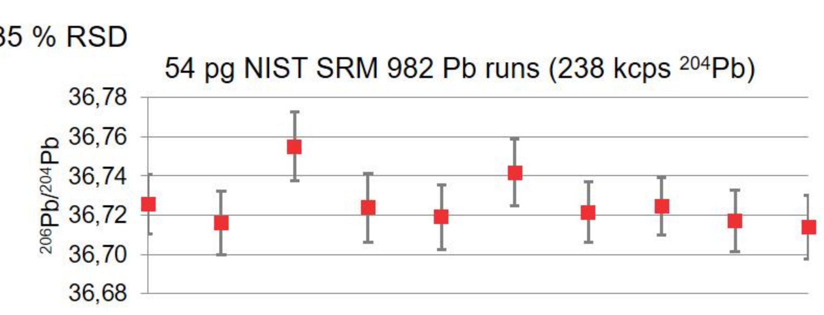
Amplifier gains are typically stable to within 50 ppm (RSD) over 3 – 6 months.

- von Quadt, et al., *J. Anal. At. Spectrom.*, 2016, **31**, 658–665
  - inter-run and inter-session cross-calibrations are not necessary
  - weekly cross calibration is recommended

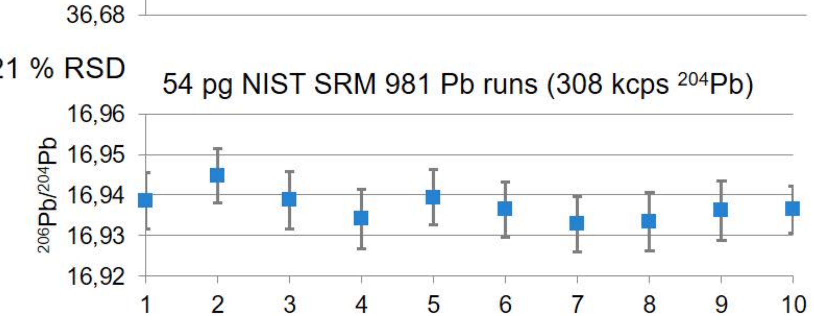
Small Pb samples ^{204}Pb on 10^{13} ohm amplifier



- 0.035 % RSD



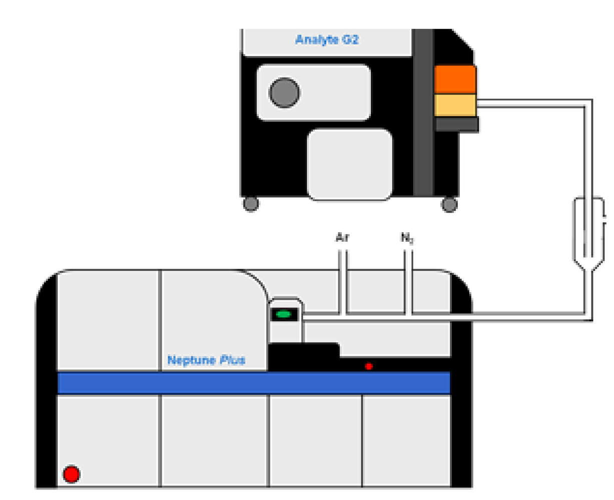
- 0.021 % RSD

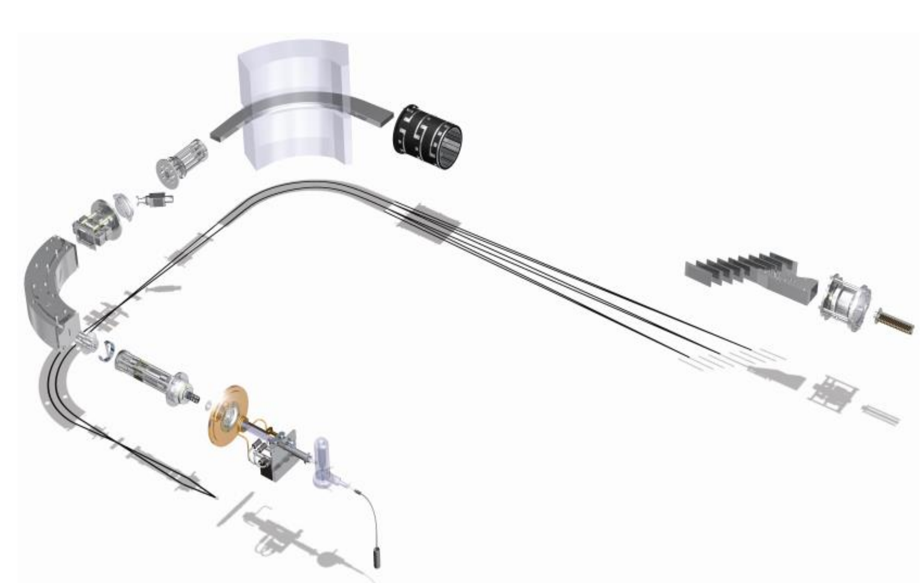


Achieve higher isotope ratio precision for limited sample amounts and minor isotopes using the portfolio of Thermo Scientific isotope ratio mass spectrometers with 10^{13} ohm amplifier technology.

- MC-ICP-MS & TIMS
- Noble gas mass spectrometry
- Gas isotope ratio mass spectrometry

Neptune Plus – High Resolution Multicollector ICP-MS

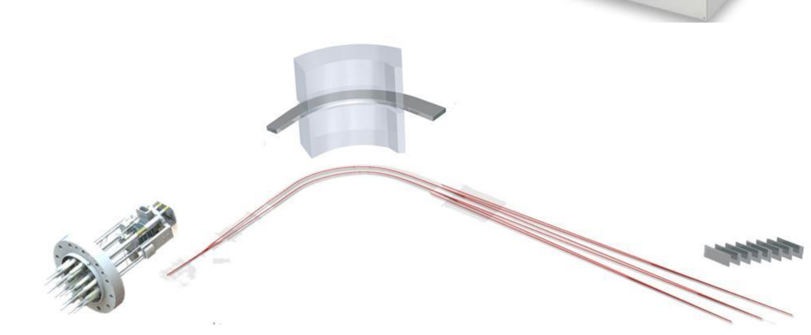




TRITON Plus – Thermal Ionization MS

Helix MC Static Noble Gas MS

MAT 235 Plus 10KV Isotope Ratio MS



MAT 235 ULTRA – High Resolution Isotope Ratio MS

CONCLUSIONS

10^{13} Ω amplifier technology improves the *s/n* ratio for

- improved precision for low ion beam intensities
- sub- per mille down to epsilon unit isotope ratio precision
- long-term stability
- highly linear response

10^{13} Ω amplifier technology for

- small samples
- minor isotopes
- interference monitoring
- baseline monitoring