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Pushing the Faraday Floor: Ultra-Low Uranium TE from Micrograms to 70 Femtograms on a Nu TIMS

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Recent advances in amplifier technology improve low-level precision, extend the usable Faraday operating window, and support stable, automated ion-beam control during ultra-low-level analyses. The Nu TIMS system integrates these developments through switchable, dual-mode amplifiers that combine extremely low noise at small signals with robust performance at higher intensities, allowing dynamic optimisation of noise characteristics across a broad range of beam currents.

Here we present a detailed assessment of uranium measured using a total-evaporation (TE) routine on a Nu TIMS Thermal Ionisation Mass Spectrometer. Measurements using dynamic amplifier configurations enabled stable Faraday detection down below ~400 cps, delivering <1% external precision at sub-picogram isotope amounts. These results demonstrate that the modern dual-mode amplifier system provides the stability required for significantly smaller sample sizes than previously possible.

This extensive dataset shows an order-of-magnitude reduction in required sample size, a substantial improvement in the Faraday limit of detection when operating in TE mode, and a clearly defined Faraday-to-ion-counter switchover point. Together, these developments expand analytical reproducibility within a fully automated routine while maintaining high sensitivity at low loads. Our results show that the modern Nu TIMS can reliably measure uranium isotope ratios at ultra-low sample sizes while maintaining high precision, accuracy, and ion-beam stability. Importantly, this defines a quantitative framework for selecting the appropriate detector: ion counters improve precision when isotope amounts fall below ~2 pg, while Faradays remain viable down to ~70 femtograms, still achieving ~10% external precision at these smallest quantities.