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Perspective Note **PS02**

Clumped Isotope Analysis

Introduction

The study of small stable compounds containing more than one rare isotope places severe requirements on the mass spectrometers used to analyse them. The intensity of the species of interest may only be a few 100's of ppm of the major ion beam. This results in studies over extreme dynamic ranges, whilst isobaric interferences, which might be negligible in more conventional studies, can also dominate here.

Up to now, these studies have had to be undertaken using mass spectrometers designed for more conventional work, or by using analytical instruments made available by bolting together parts from a number of different instruments from the manufacturer's stable. These solutions tend to be far from ideal, and can suffer from the limitations normally found when "designing by committee". At Nu Instruments, such an approach is frowned upon, and we only offer instruments designed and optimised for the problem in hand.

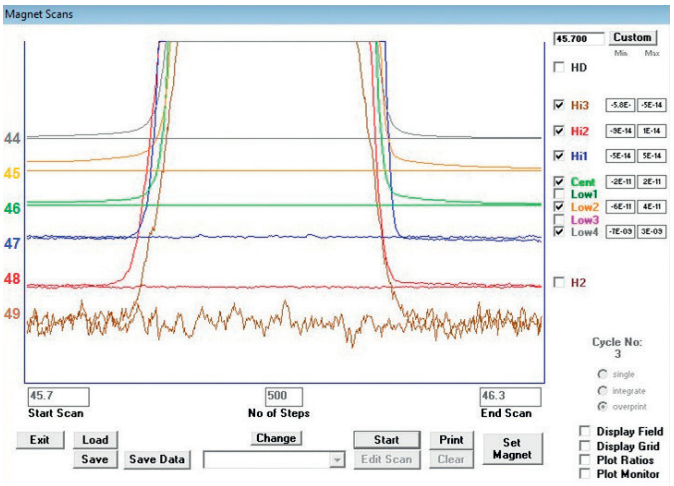

Figure 1: Background recorded on Perspective IS with large beam. The horizontal lines are the DVM responses with no HT.

Conventional Studies

Previous studies using the older generation instruments recognised problems on the baselines around the minor peaks, which tended to be negative and non-uniform. We recognised this is due to electrons produced by the major ion beam "scraping" the flight tube, and scattering into the collectors. This is a problem of convention geometry instruments, where the beam in the flight tube can be quite tall, especially when the source of ions is a tall pencil produced by a Nier type geometry. To avoid this problem, we have introduced a series of small electrostatic analysers situated after the collector defining slit, through which the isotopologue beams pass, but which reject

Figure 2: Perspective IS

this scattered background (Patent applied for). They are fitted as standard to the Perspective IS (Figure 2) instrument, and their effectiveness is illustrated in Figure 1.

High Resolution Studies

Separating the ions of interest from overlapping interferences often requires high resolution capability of 10,000 or more. It is well known that the conventional Johnson - Nier geometry is far from ideal for this work, since it tends to be limited in the ultimate resolution possible, and has poor transmission (sensitivity) when used in this mode.

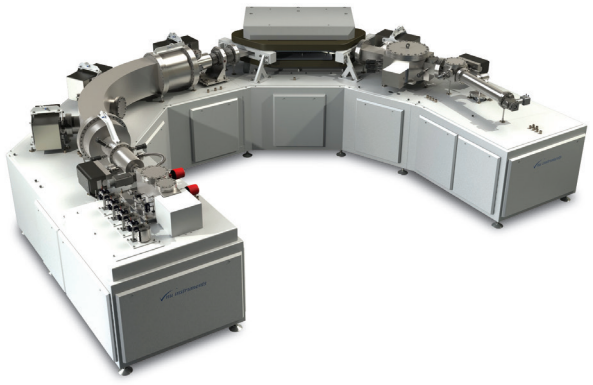

Figure 3: Panorama

To overcome these problems, Nu Instruments offers its Panorama mass spectrometer (Figure 3), which utilises the Matsuda ESA - Quadrupole Magnet geometry. This provides much higher resolution (to 40k and beyond) and higher transmission than other designs. As an added advantage, the beam is focussed down through the magnet, nicely eliminating

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the source of the baseline problems mentioned previously. A new source, working at up to 20 kV to maximise sensitivity, is provided, together with four sample bellows in the double inlet arrangement, so as to permit the greatest possible flexibility in sample analysis. All slits are fully adjustable, again to provide an instrument with no compromises.

For those who do not require the ultimate performance of the Panorama, Nu Instruments have developed the Aspect mass spectrometer (Figure 4). Incorporating our patented Zoom technology, Aspect combines the front end of the Panorama with a modified ion optical envelope developed from (but larger than) the Nu Plasma II MC-ICP-MS geometry. To remove the baseline scattering problem which will be present on such an instrument, the ESA arrays after the collector slit are utilised as standard. We also use the full 20 kV acceleration to maximise sensitivity, and employ a full size Electrostatic analyser rather than the smaller floating design used by other manufacturers (see US patent 5166518, Philip A Freedman). This limits both the ultimate resolution of the design, and the extraction voltage available for the source.

Figure 4: Aspect