noblesse

Ne Isotope Ratios Measured with Noblesse

- **Routine removal of $^{40}Ar^{++}$ from $^{20}Ne^{+}$**
- **Adjustable sensitivity/resolving power**
- **$^{20}Ne/^{22}Ne$ by peak jumping: precision data without need for IC gain calibration**
- **$^{21}Ne/^{22}Ne$ by multicollection for most efficient use of measurement time**
- **Removal of ^{20}NeH from ^{21}Ne**

Introduction

Of all the noble gases, Ne is perhaps the most challenging for accurate isotopic measurement, owing to isobaric interferences at all masses combined with generally low isotope abundance.

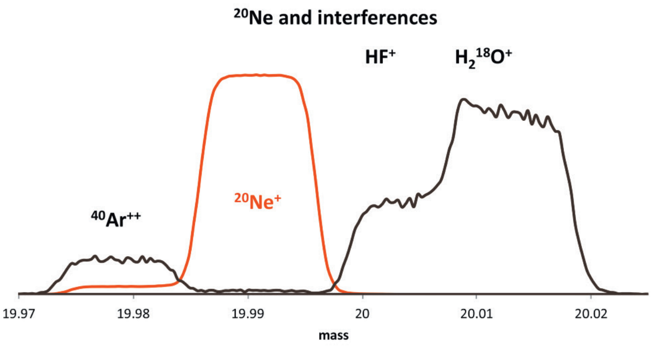


Figure 1: $^{20}Ne^{+}$ and its interferences.
Red trace shows $^{20}Ne^{+}$ (with a small amount of $^{40}Ar^{++}$); the brown trace shows $^{40}Ar^{++}$, HF^{+} and $H_2{}^{18}O^{+}$ at enhanced scale and with no Ne in the instrument. A narrow collector slit, requiring high mass resolving power (MRP), is necessary to resolve the peaks in this way. MRP (m/Δm for 5-95% on side of peak)= 6400 in this Figure.

Extensive development of Noblesse has resulted in a much higher mass resolving power and improved ability to deal with isobaric interferences. The performance of the Noblesse is assessed with Ne, taking full advantage of these improvements.

The instrument configuration used is the popular 1 Faraday and 3 ion counting multipliers. The multipliers are positioned with ~ 5% mass separation.

Analyses were performed using commercial Ne, and sample size was varied over a factor of 10. In some cases a small amount of Ar was added to test the performance in the presence of increased $^{40}Ar^{++}$ interference. The use of different sized samples provides a more rigorous test of instrument performance than the analysis of replicate fixed sized samples.

Measurements

Measurements were made using a wide collector slit and MRP 5200, as shown in Figure 2 and 3 (below). $^{20}Ne^{+}$ was measured free of $^{40}Ar^{++}$, and ^{21}Ne free of ^{20}NeH interferences.

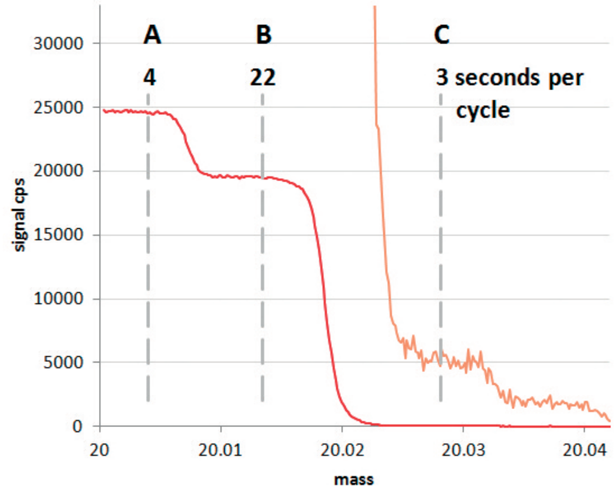


Figure 2: $^{20}Ne^{+}$ at MRP 5200, showing a preferred method of measurement, using a wide collector slit.
At position A $^{20}Ne^{+}$ and all interferences pass into the detector, at position B the $^{40}Ar^{++}$ is blocked, transmitting $^{20}Ne^{+}$ along with $HF^{+}H_2{}^{18}O$. Absence of $^{40}Ar^{++}$ at the $^{20}Ne^{+}$ measurement position is indicated by the flat shoulder at position B (and also Figure 5 overleaf). The $HF^{+}H_2{}^{18}O$ tail is measured in a separate mass step C and subtracted to give the ^{20}Ne signal.This tail was found to be stable and made, at most, a 2 ‰ correction. Use of a wide collector slit not only allows analysis of Ne, as shown here, but also permits the instrument to be used at higher sensitivity (lower MRP) for other applications e.g. Xe, if required.

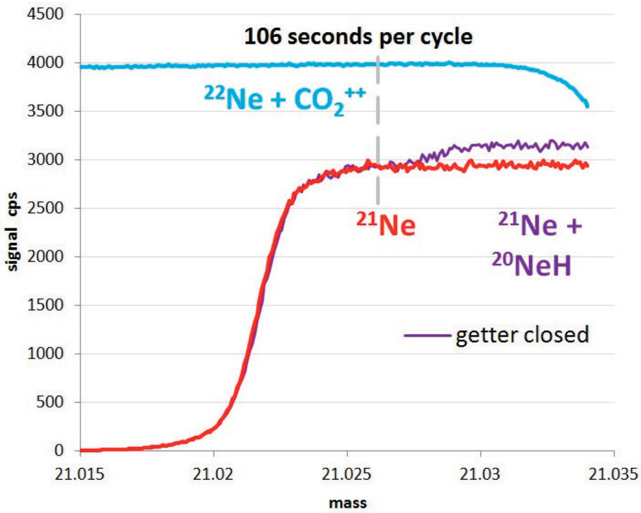


Figure 3: Simultaneous measurement of Masses 21 and 22. The MRP (5200) is sufficient to measure ^{21}Ne without ^{20}NeH interference. However, ^{20}NeH was only detectable with the source getter isolated, and was an order of magnitude lower (or less) during normal measurement conditions.

$^{20}Ne/^{22}Ne$ ratios were obtained by peak jumping on one detector. As shown below, this results in precise data close to ion counting statistical limits. The measurement time at mass 20, for the major ^{20}Ne isotope, can be minimised, with most of the measurement time used for simultaneous measurement of the minor isotopes ^{21}Ne and ^{22}Ne, using IC1 and IC0, respectively.

CO_2^{++}/CO_2^{+} was determined separately. A correction is applied to the mass 22 signal, based upon CO_2^{+} at mass 44, which is measured during the analysis.

Results

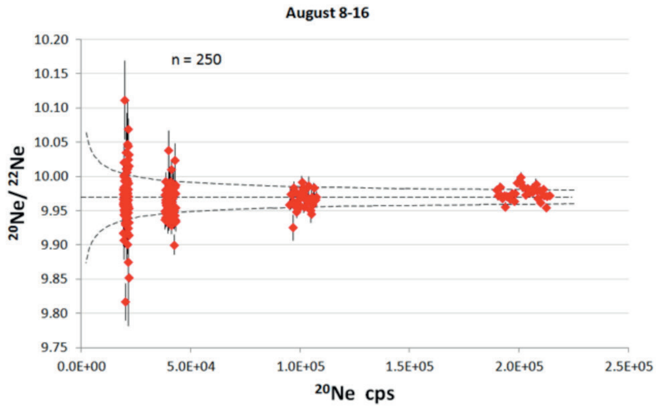
Results are shown in Figures 4 and 5. Figure 4 shows that the $^{20}Ne/^{22}Ne$ and $^{21}Ne/^{22}Ne$ ratios are constant over a factor of 10 in sample size, and that the dispersion is equal to — or only slightly in excess of — that expected from counting statistics.

Comparison with three isotope multicollection

Our measurement method offers an advantage over single collector peak jumping, in that ^{21}Ne and ^{22}Ne can be measured together – roughly doubling the number of ions counted. Based on counting statistics only, we calculate that 3 isotope multicollection would improve the precisions for $^{20}Ne/^{22}Ne$ and $^{21}Ne/^{22}Ne$ by 1.4 and 1.2 respectively. This of course ignores any other sources of error – in particular the problem of calibrating two ion counters to <2 ‰, which may require significant effort. It is unlikely that the $^{20}Ne/^{22}Ne$ precision would be improved much in practice.

Summary

The method described here is simple, deals with the interferences and yields precision close to the theoretical limit for the ion beams measured. For further information please contact us at nu.sales@ametek.com



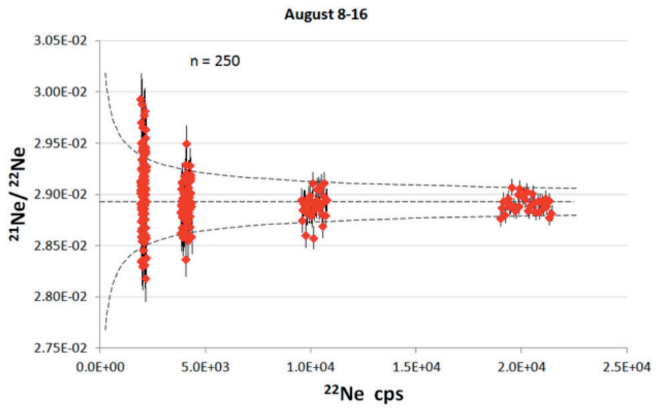


Figure 4: Ne isotope ratios obtained from samples varying in size by a factor of 10. Dotted lines indicate the weighted mean and theoretical 2 σ uncertainties, based upon counting statistics. No correction has been applied for instrument fractionation or ion counter efficiency.

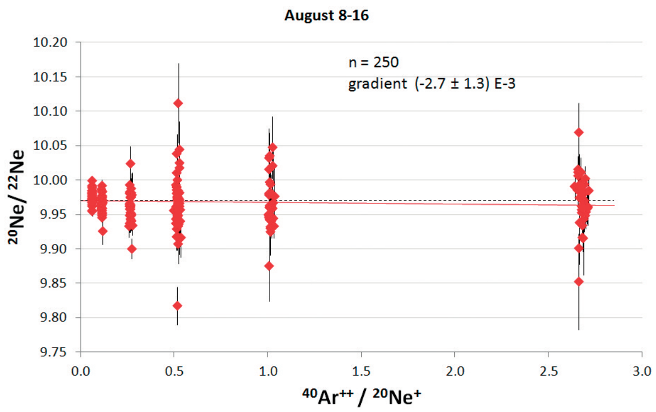


Figure 5: $^{20}Ne/^{22}Ne$ ratios as a function of added Ar, $^{40}Ar^{++}/^{20}Ne^{+}$. There is no significant deviation of $^{20}Ne/^{22}Ne$ with increasing $^{40}Ar^{++}$ demonstrating the resolution of this interference from $^{20}Ne^{+}$.