

Precise and Accurate Determination of Iron Isotope Ratios

Introduction

We present results of iron isotope ratio measurements performed on the Nu Plasma II instrument, illustrating the ability of the instrument to determine iron isotope ratios with good accuracy.

Instrumentation

In the experiment, a 1 ppm solution of the internal hematite standard originating from the ETH-Zürich laboratories and a 1 ppm solution of the iron reference material IRMM-014 have been used. Solution was introduced into the mass spectrometer under 'dry plasma' conditions, using a DSN-100 Desolvating Nebuliser System with a 100 µL/min glass concentric nebuliser and standard cones.

Data was collected using static analysis. Each analysis consisted of one block of 50 integrations of 5 s on-peak measurements of iron, following an 'on peak' blank measurement of a 2% HNO₃ solution with an integration time of 60 s. The analysis duration was approximately 6 minutes. Washes were performed between each analysis. 10 repeated analyses of the IRMM-014 standard were bracketed with the ETH standard, equating to ca. 4 hours of data collection. No tuning of the instrument or nebuliser was made once the measurements had started. Measurements were carried out on the interference-free shoulders of the ⁵⁴Fe, ⁵⁶Fe, ⁵⁷Fe and ⁵⁸Fe peaks, in the Pseudo-High Resolution mode (50 µm source defining slit, medium resolution) with a resolving power of approximately 8,000 (5, 95% Edge Resolving Power, for definition please refer to AN22). Measurements were performed using the collector configuration shown in Table 1.



Nu Plasma II

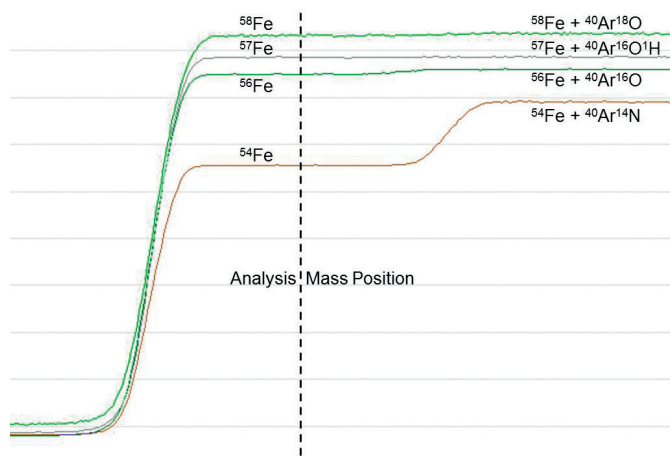


Figure 1: Iron isotopes ⁵⁴Fe, ⁵⁶Fe, ⁵⁷Fe and ⁵⁸Fe partially resolved from their respective interferences in the Pseudo-High Resolution mode using the 50 µm source defining slit.

Discussion

Iron isotopes partially resolved from their respective interferences in the Pseudo-High Resolution mode are shown in Figure 1. Bracketing results are shown in Table 2, where δ denotes the per mil deviation of the measured ratio of the IRMM-014 standard relative to the average of the two ratios of ETH standard measured before and after.

	⁵⁶ Fe/ ⁵⁴ Fe	⁵⁷ Fe/ ⁵⁴ Fe	⁵⁸ Fe/ ⁵⁴ Fe
Average δ (‰)	0.702	1.037	-4.825
SD (‰)	0.026	0.037	0.212

Table 2: Results of 10 repeated analyses of a 1 ppm IRMM-014 standard solution bracketed with a 1 ppm ETH Fe standard solution.

The measured $\delta^{56/54}\text{Fe} = 0.70 \pm 0.05\%$ (2σ) agree very well with the values of $0.72 \pm 0.13\%$ (2σ) reported in Mikutta et al⁽¹⁾.

The total iron sensitivity achieved in the Pseudo-High Resolution mode was approx. 18 volts/ppm. No mass fractionation correction or ⁵⁴Cr/⁵⁸Ni interference correction has been applied to the measured iron isotopic data. The measured ⁵⁶Fe/⁵⁴Fe, ⁵⁷Fe/⁵⁴Fe and ⁵⁸Fe/⁵⁴Fe ratios are plotted in Figure 2.

Collector	HMIC	H9	X	X	H8	X	H7	X	H6	H5	H4	H3	H2	H1	Ax	L1	L2	L3	L4	IC0	L5	IC1	IC2	L6	IC3	X	IC4
Position	-14	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12
Fe												58			57			56						54			

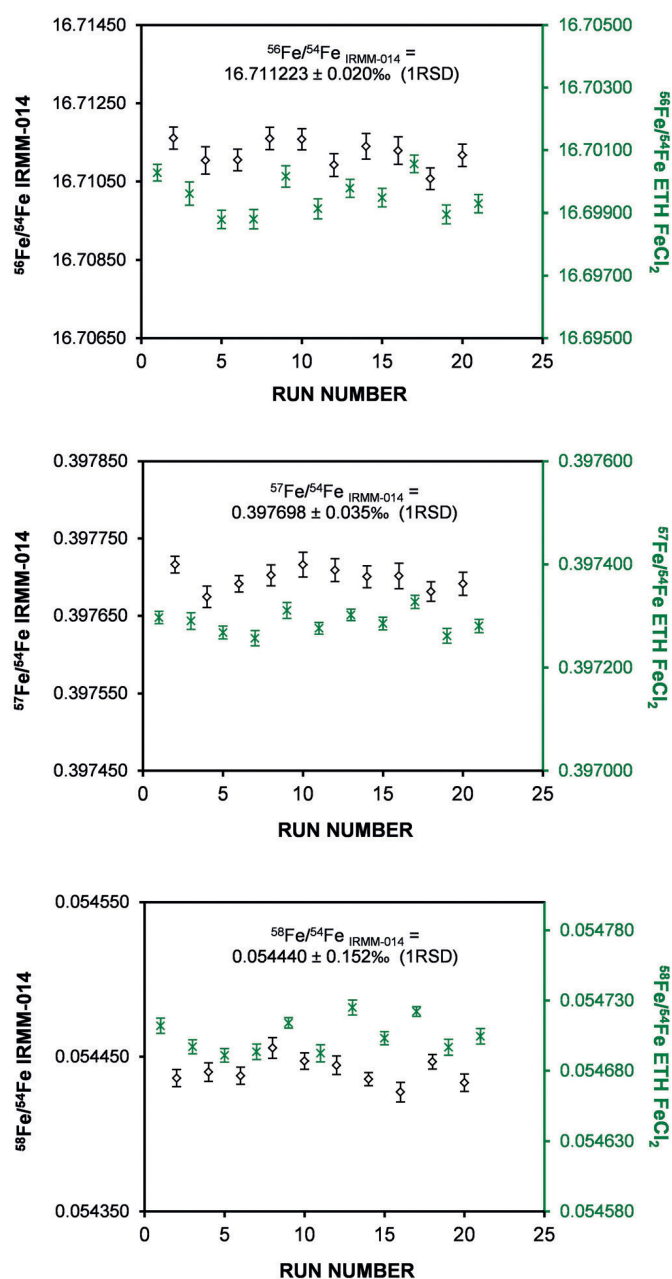


Figure 2: Measured $^{56}\text{Fe}/^{54}\text{Fe}$, $^{57}\text{Fe}/^{54}\text{Fe}$ and $^{58}\text{Fe}/^{54}\text{Fe}$ ratios of the 1 ppm IRMM-014 standard solution and 1 ppm ETH standard solution obtained over the course of 4 hours. Error bars are 2 SE. Black open diamond represents the IRMM-014 data and green cross the ETH data.

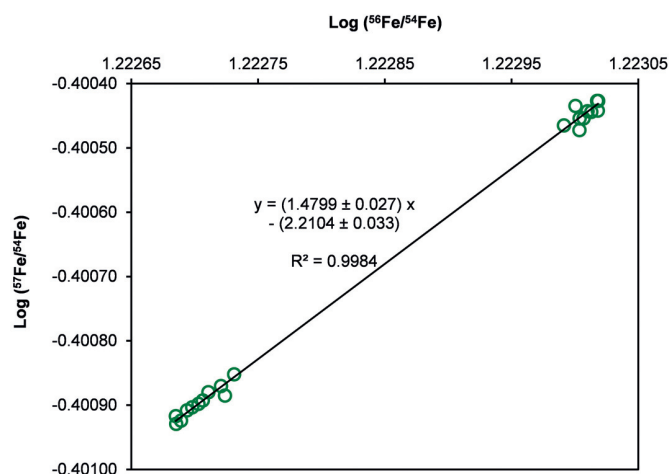


Figure 3: $\text{Log}(^{56}\text{Fe}/^{54}\text{Fe})$ and $\text{log}(^{57}\text{Fe}/^{54}\text{Fe})$ of all analyzed samples display a linear correlation. The slope of the fractionation line is within error of the theoretical 1.5.

In Figure 3, $\text{log}(^{57}\text{Fe}/^{54}\text{Fe})$ is plotted against $\text{log}(^{56}\text{Fe}/^{54}\text{Fe})$ for all analyzed samples. The two display a linear correlation ($R^2=0.9984$) and the slope of the fractionation line is within error of the theoretical value of 1.5, showing no evidence of mass-independent fractionation throughout the course of measurement.

Conclusions

The Nu Plasma II Multi Collector ICP-MS instrument exhibits very good accuracy and high precision in determining iron isotope ratios.

References

[1] Mikutta, C., Wiederhold, J. G., Cirpka, O. A., Hofstetter, T. B., Bourdon, B., Gunten, U. V., 2009. Iron isotope fractionation and atom exchange during sorption of ferrous iron to mineral surfaces. *Geochim. Cosmochim. Acta* 73:1795-1812.