Isotopic analysis of sub-nanogram Nd standards using new ATONA amplifiers

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Motivation

In the last several years new amplifier technologies have been released for thermal ionization mass spectrometers (TIMS) including the ATONA amplifiers produced by Isotopx. One of the Isotopx TIMS housed in the Nuclear and Radiochemistry (C-NR) group at Los Alamos National Laboratory (LANL) was upgraded with the new ATONA amplifiers; this study is our initial effort to identify how these amplifiers can be best utilized for the variety of work undertaken by the C-NR group at LANL; particularly for high precision analyses of very small samples. ATONA amplifiers utilize a capacitor in the feedback loop instead of a standard high-ohmage resistor, which results in a theoretical relationship between the effective signal to noise ratio and the integration time of the detectors. Here we examine how integration time affects analytical uncertainty in measured standards as a proxy for signal to noise. All standard analyses presented here were run as NdO, and loaded using the method described in Harvey and Baxter (2009)

Effect of integration time on analytical uncertainty

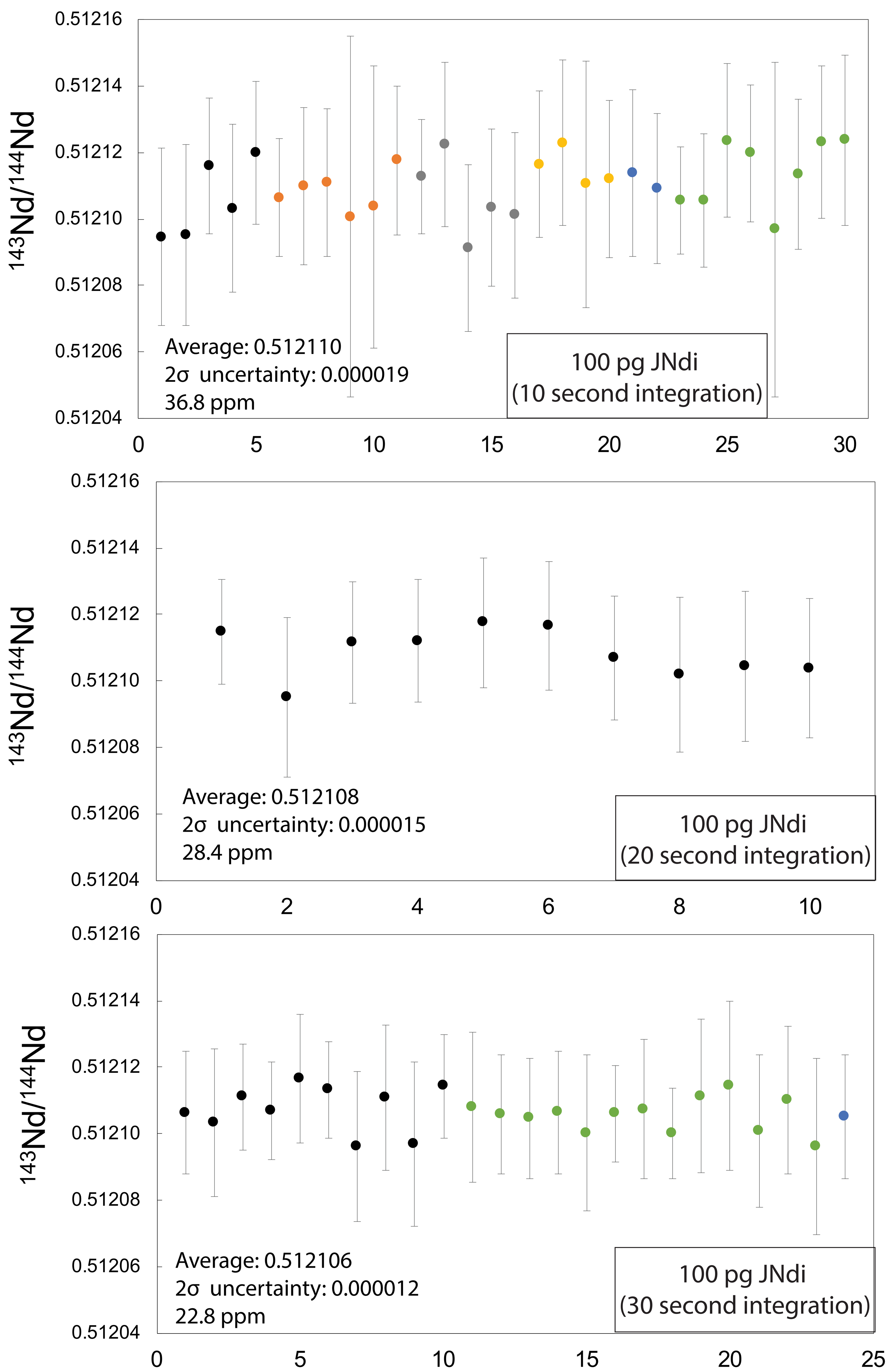

Figure 1. Plots of JNdi standards run with different integration times. In each plot a single color represents samples run within a single barrel

Signal stability and analytical uncertainty

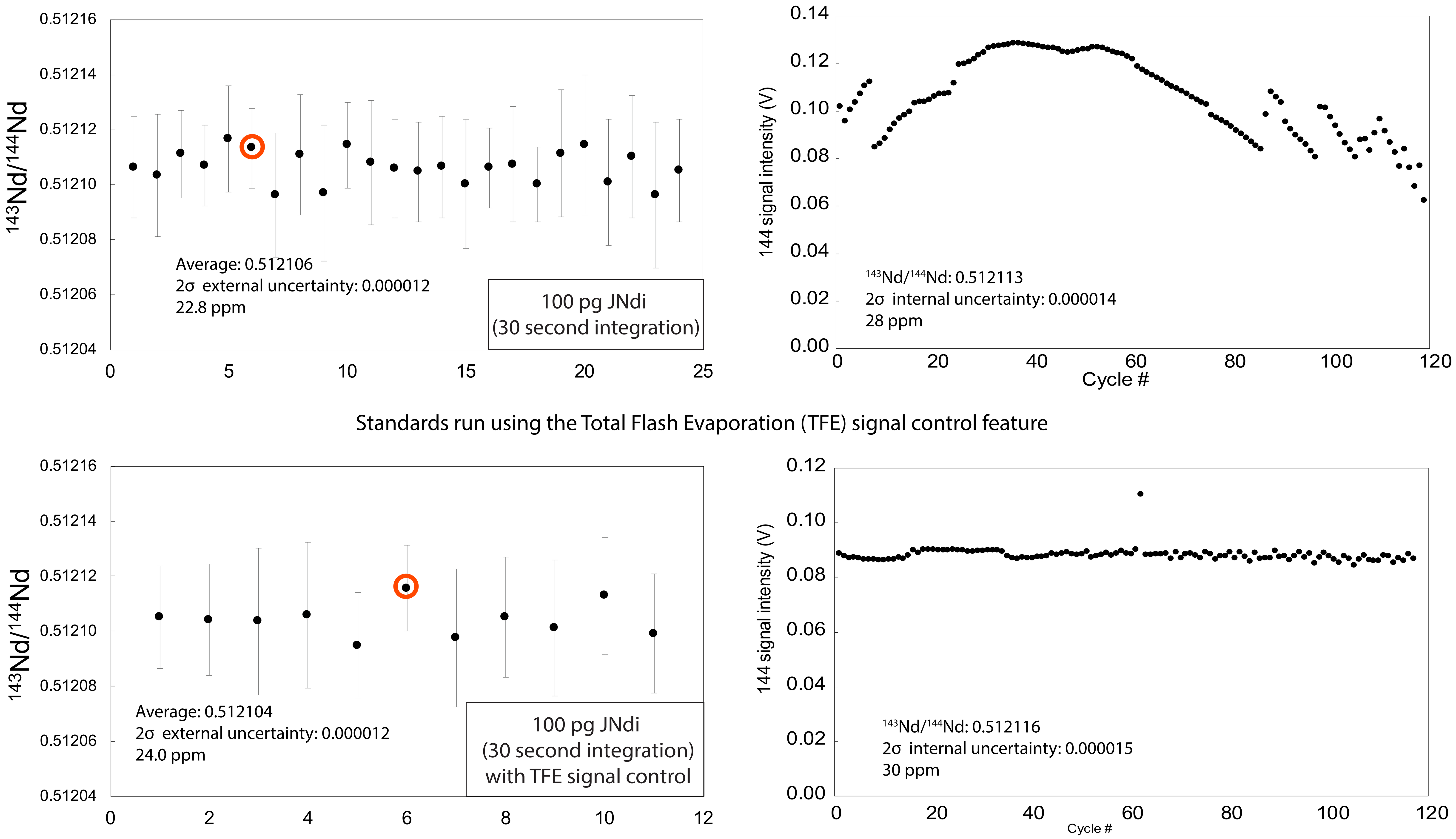

Figure 2. Plots of JNdi standards run with the 30 second times. The standards in the upper plots were run by leaving the filament at a given current and letting the sample run until signal began to decrease significantly and the additional ramping of the filament was employed to extend analysis time. The upper right plot displays the signal intensity of the analysis circled in red in the upper left plot over the course of the analysis as an example. The standards in the lower plots were run by utilizing the TFE set signal intensity feature in the ATONA ICONIA software, this feature allows you to set a desired signal intensity and the software ramps the filament up or down to achieve the desired intensity. The lower right plot displays the signal intensity of the analysis circled in red in the lower left plot over the course of the analysis as an example.

Multidynamic analysis of larger standards

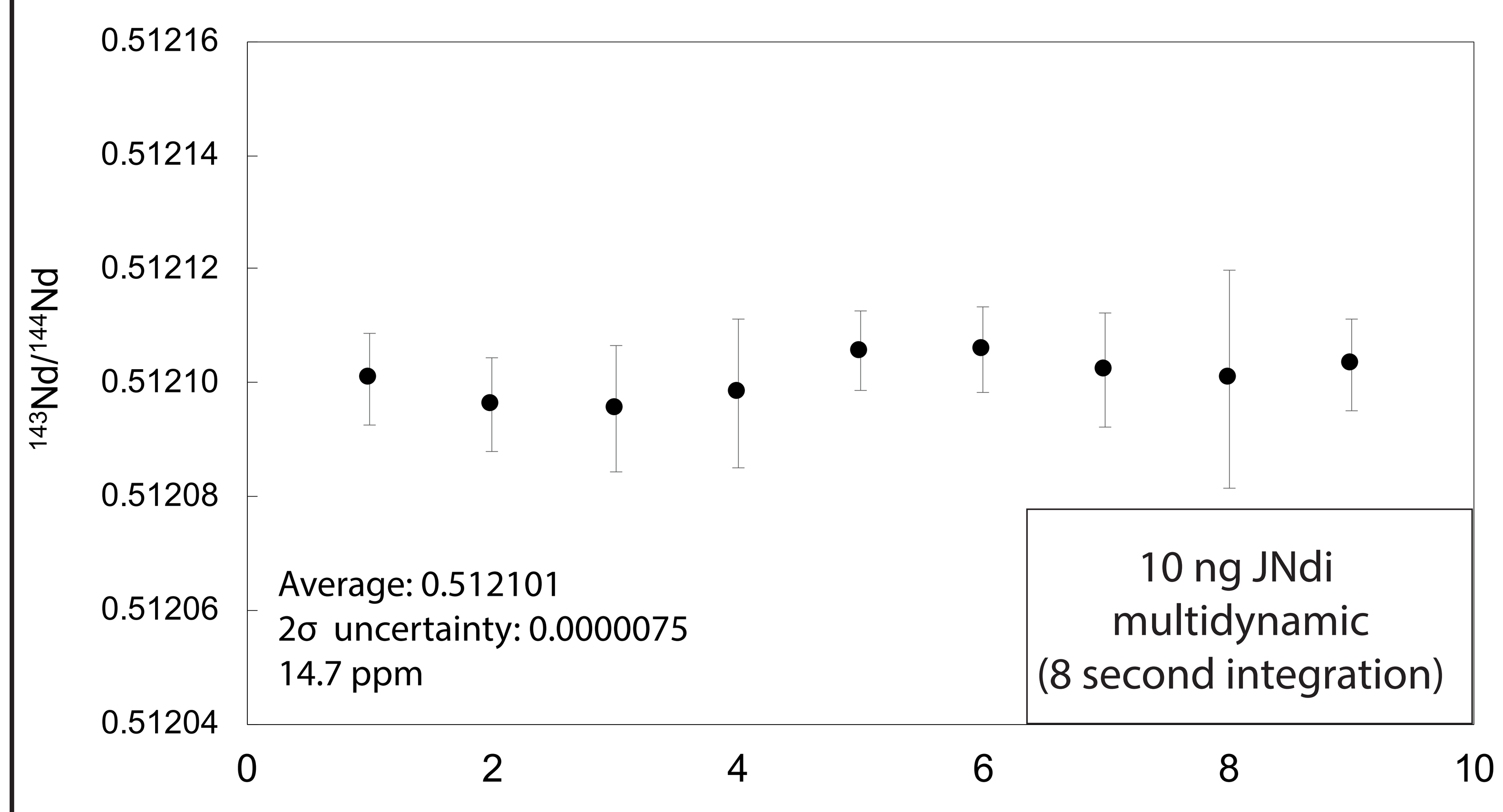

Figure 3. Plot of 10 ng JNdi standards run using a standard multidynamic routine.

Conclusions

This work demonstrates the ability of the ATONA amplifiers to precisely measure small ion beams. We find that selecting an appropriate integration time for each cycle has a considerable effect on the external and internal uncertainties of $^{143}Nd/^{144}Nd$ measurements. Increasing the integration time can significantly decrease the external uncertainty for measuring 100pg loads of JNdi; however, an excessively long integration time can negatively affect internal analytical uncertainty. Interestingly, the signal stability does not appear to significantly impact the internal or external analytical uncertainty associated with these measurements. This is a useful when running very small samples (<100 pg) where maintaining a stable ion beam can be particularly challenging. We also note that this amplifier technology is promising for larger loads and multi-dynamic analyses where we find we can achieve high precision measurements on JNdi loads of 10ng using the ATONA amplifiers.

References

Harvey, J., Baxter, E.F., 2009. An improved method for TIMS high precision neodymiumisotope analysis of very small aliquots (1–10 ng). Chemical Geology 258, 251–257.