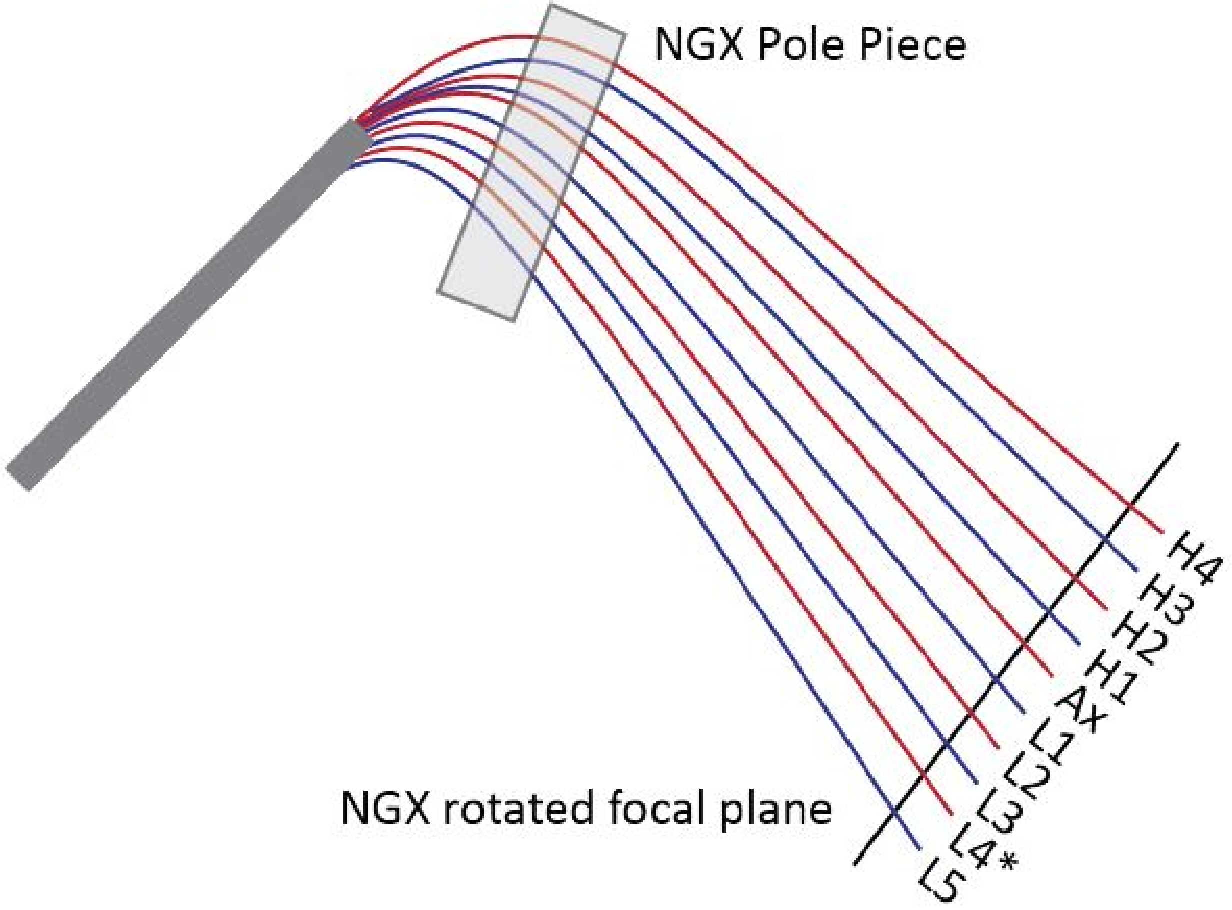
Optimizing $^{40}Ar/^{39}Ar$ analyses using an Isotopx NGX-600 mass spectrometer

INSTRUMENT FEATURES

- Customizable collector block which can consist of a combination of Faraday cup and ion counting electron multiplier detectors.
- ATONA technology performs similarly to 10^{13}-10^{14} Ω RTIA amplifiers (Cox et al., 2020).

PROJECT GOALS

- Quantify sensitivity of the ATONA backed Faradays.
- Determine optimal measurement and integration durations for various signal sizes.
- Develop and apply a mass discrimination correction.



L5	L4*	L3	L2	L1	Ax	H1	H2	H3	H4
^{36}Ar		^{37}Ar		^{38}Ar		^{39}Ar		^{40}Ar	
	^{36}Ar		^{37}Ar		^{38}Ar		^{39}Ar		^{40}Ar

*IC Multiplier in L4 position. Faradays in all other positions

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Sensitivity

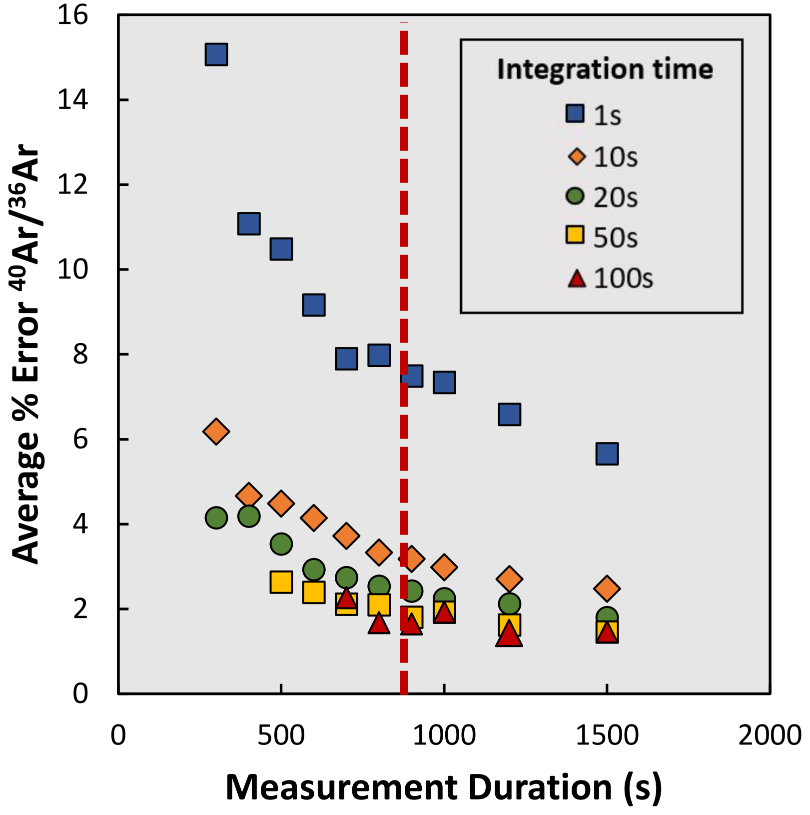
Instrument	Moles/fA $^{40}Ar^*$
ARGUS V	7.00E-18
ARGUS VI	4.00E-18
Nu Noblesse	6.45E-17
MAP215-50	1.13E-17
Helix MC Plus	3.50E-17
NGX-600	***1.21 ± 0.13 E-16***

Differences in sensitivity are dependent on resolution and trap current.

A new cathode source installed on Dec. 3rd can achieve a trap current of up to 1000 μA, which we expect will boost the sensitivity.

Optimization

Longer integration times are ideal (e.g. 100 s). As a result, longer durations are also necessary (e.g. > 800 s) for signal sizes < 0.1V.



Mass Discrimination Correction

Three corrections must be made:

1) ATONA gain quantifiable via Isotopx internal calibration.

2) Inter-Faraday bias shown to be negligible via peak hopping routine.

3) All-Faraday configuration allows for exponential correction using air.

$$\frac{^{40}Ar}{^{36}Ar}\,corrected = \left(\frac{^{40}Ar}{^{36}Ar}\right)_m \times \left(\frac{40}{36}\right)^{\beta}$$

$$where\ \beta = \left(\frac{\ln\left(\frac{(^{40}Ar/^{36}Ar)_a}{(^{40}Ar/^{36}Ar)_m}\right)}{\ln\left(\frac{40}{36}\right)}\right)$$

Key Takeaways

- ***Sensitivity*** on cathode source is expected to improve. Advantages of the NGX-600 include the high resolution, large dynamic range, and all-Faraday with ATONA configuration.
- ***Optimizing*** measurement conditions for signals of various sizes and carefully characterizing blanks and baselines is fundamentally important to making best practice measurements.
- ***Mass bias corrections*** are simplified with measurements on a single collector type.

Next Steps

- Define threshold for ^{36}Ar that can be accurately measured on an ATONA backed Faraday
- Measure a range of previously characterized geologic samples (single crystal fusions and groundmass, ranging from Permian to Pleistocene in age).
- Compare current source with Isotopx new cathode source.

Thank you!

Happy to take questions!

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