Miniaturized Inductively Coupled Plasma Mass Spectrometer (ICPMS) for Trace Element Analysis

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Targets: Primarily low-pressure (≤ 10^3 Pa) or airless planetary bodies, such as comets, the Moon, Phobos/Deimos, and many ocean world destinations

Science:

- Quantify planetary depletions in volatile element inventories (e.g., Na, K, Zn, and Pb)
- Analyze redox-sensitive agents (e.g., $V^{3+,4+,5+}$) to track the evolution in fO_2 through space & time
- Measure concentrations of fluid-mobile elements (e.g., Li and U) and identify alteration signatures
- Investigate potential biomineralization via chemical proxies (e.g., Sr/Ca and Se/S ratios)
- Identify signatures of deep mantle processes (e.g., local temperatures via Ni behavior)

Objectives:

1) Develop a self-sustaining Ar plasma source capable of atomization/ionization of laser ablation aerosols in low pressure environments
2) Refurbish a legacy Nozomi/ARES mass analyzer and retrofit with ion optics for ICPMS ops
3) Demonstrate an interface region that unites the low pressure plasma and heritage analyzer

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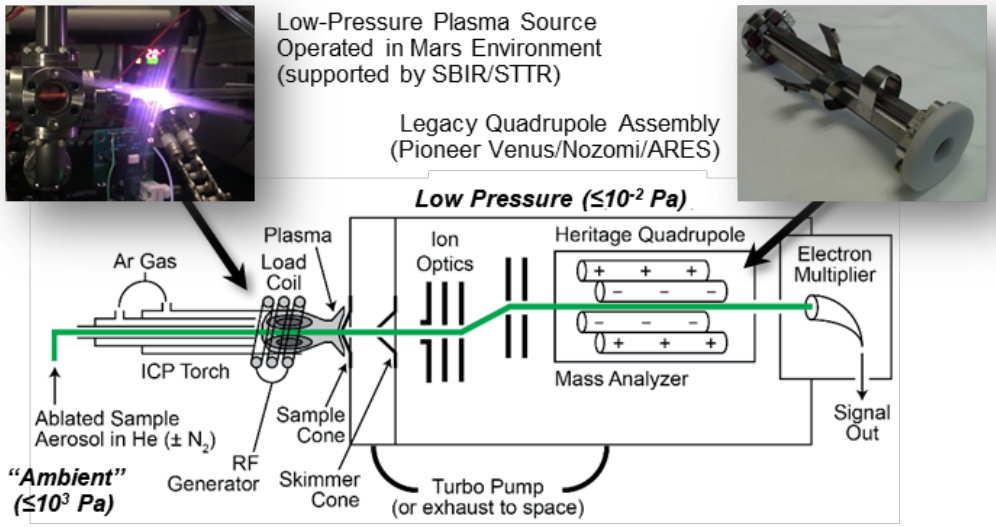

The miniaturized ICPMS proposed here will unite a low-power Ar plasma source capable of operation in low pressure environments (≤ 10^3 Pa), and a legacy Nozomi/ARES quadrupole mass analyzer to enable efficient atomization/ionization of solid planetary samples, and the quantitative measurement of trace elements down to ppmw level concentrations.

Key Milestones by Program Year (PY):

- (PY1) Development of RF tuning circuit for plasma source
- (PY1) Definition of mechanical/ion optical interface region
- (PY2) Refurbishment of Nozomi/ARES flight hardware
- (PY2) Validation of low-pressure plasma source performance
- (PY3) End-to-end demonstration of integrated ICPMS instrument
- (PY3) Verification of science objectives / functional requirements

Entry TRL 1 (basic principles); Exit TRL 4 (lab demo)