

QIT-Mass Spectrometer for Lunar and Planetary Applications

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The Planetary Mass Spectrometer group at the Jet Propulsion Laboratory has developed a compact Quadrupole Ion Trap Mass Spectrometer (QIT-MS) with potential usage for multiple missions. One proposed implementation is to combine the QIT-MS with a JSC-built Linear Energy Transfer Spectrometer (LETS) for multi-day lunar surface exospheric and radiation investigations. Both subsystems primary science goals are to determine the density, composition, and time variation of the lunar volatiles and atmosphere, and correlate these with the local solar wind environment. Another application is to use the QIT-MS as a mass analyzer coupled to an electrospray ionization (ESI) source, in order to analyze ionizable species present in liquid samples.

The QIT-MS has the capacity of identifying and quantifying molecular species with abundances of ten (10) molecules/cm³, which has been verified for gaseous samples [1,2,3]. Currently, we are exploring the sensitivity of the QIT-MS with ESI inlet for molecular species that can be ionized in solution. In addition, the QIT-MS has an unprecedented combination of low mass (7 kg) and power (max 30 W with heater bulb on), with high sensitivity (0.003 counts/cm³/sec) as well as an ultra-high precision (0.5% for noble gas isotope ratios over 24 hours). These parameters yield 10× better than previously reported ion trap mass spectrometer, ex. [4].

The low mass, power, and data rate of the QIT-MS enable flexibility for the accommodation in different space missions with constrained resources. Moreover, the measured performance on breadboards and engineering demonstrators [3] show that high-value science return can be obtained without needing complex sample handling or mobility. The maturity (>TRL=7) and versatility of the QIT-MS enable tailoring for a wide range of flight opportunities of interest to NASA.

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