CubeSat QIT-MS: Rad Hard Miniature Instrument for Solar System Exploration

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We present a new miniaturized mass spectrometer prime rely designed for sampling the atmospheres of the planetary bodies of the Solar System. The sensor is based on our previous 10mm Quadruple Ion Trap (QIT) design [1, 2] but with many improvements such as smaller sensor size, less power consumption, new electronics design etc. However, the new sensor has the same measuring capabilities. This is a cube-sat compatible instrument consisting of multiple 4"x4"x4" (U) units. The electronics for this instrument is designed from scratch in collaboration with Caltech and Space Physics Research Lab. The electronics is fully vacuum compatible and designed with rad-hard flight-like parts with utilizing technology and experience of preceding NASA missions. The size of electronics is 3U with components nominally rated for up to 100 krad. The electronics is made out of 5 main boards: digital control board (which is not rad hardened at the moment), power distribution unit (100 – 300krad), analog control and telemetry board (100krad), mass spectrometer control board (100-300krad) and RF power amplifiers (300krad). The sensor is based on the low capacitance (30pF) 8 mm QIT. The electron optics, detector and the sensor are housed within custom 3D printed titanium vacuum chamber and have been tested for vibration loads up to 60G. Sensor with pumping system occupies another 5U. Heat sink and radiation shielding is implemented for sensitive components and may be additionally reinforced to ensure stable operation during various planetary missions. The instrument mass is estimated at 6 kg and it requires 30W of power for nominal operation.

[1] Madzunkov et al., Accurate Xe Isotope Measurement Using JPL Ion Trap, J. Am. Soc. Mass Spectrom. (2014) 25:1841Y1852

[2] Madzunkov et al., Progress Report on the Spacecraft Atmosphere Monitor, 46th International Conference on Environmental Systems, 10-14 July 2016, Vienna, Austria