Paper ID: 27825
poster
student

EARTH OBSERVATION SYMPOSIUM (B1)
Interactive Presentations (IP)

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MINIATURIZED TIME-OF-FLIGHT MASS SPECTROMETER FOR THERMOSPHERE DENSITY AND COMPOSITION MEASUREMENTS

Abstract

Variations of gas density and composition in Earth's upper atmosphere create trajectory and orbit control problems for satellites of all sizes and significantly affect interactions between different layers of Earth's atmosphere. Mass Spectrometers are among an array of instruments used to explore Earth's upper atmosphere and other space environments. Normally, these instruments are substantial in size and deployed on larger satellites and space probes to perform studies of atmospheric properties while in orbit. Data from these studies generally provides information from a specific point in time at a single location. Studies of atmospheric density and composition with multiple locations for each time point could be performed by CubeSat swarms if proper instrumentation were available to fit CubeSat payload restrictions. The proposed miniaturized time-of-flight (TOF) mass spectrometer (MS) will have a mass resolution and range sufficient for measuring the free ion density of Earth's ionosphere while operating within the power and space constraints of a CubeSat. This capability can potentially dramatically reduce the cost of future missions while simultaneously enhancing the science return. Elements from existing TOF-MS designs, including the use of spatial focusing, an ion mirror and signal processing techniques, will be used to achieve the desired range and resolution. SIMION simulation of charged particle flight through the instrument has been used to evaluate electric field designs for the instrument and explore resolution refinement techniques. Electrical circuits for some TOF-MS components have been designed, built, and tested against component specific requirements.