Paper ID: 54598
oral
student

26th IAA SYMPOSIUM ON SMALL SATELLITE MISSIONS (B4)
Constellations and Distributed Systems (7)

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CUBESAT CONSTELLATION FOR SPACE RADIATION MEASUREMENTS (CCSRM)

Abstract

Space radiation is one of the key limiting factors in space exploration. Radiation hazard threatens satellite electronics, communications, health of astronauts, degrades sensitive instrumentations and solar panels. It is extremely important to have a precise radiation environment model for space mission planning. Knowledge about space radiation allows us to optimize spacecraft at the design stage and protect ongoing space missions from the solar energetic particles. Previous missions (Van Allen Probes, CLUSTER, PAMELA, GOES, CRRES, SAMPEX) focused on studying Van Allen belts at high altitudes. However, all these missions do not provide enough data about proton radiation environment on low-altitude (400 km) orbits. Current progress in small satellites building makes these orbits very perspective for cubesat missions for Earth observation. Our team at the Space Center of the Skolkovo Institute of Science and Technology (Skoltech) designed a cubesat constellation to make systematic spectral measurements of trapped radiation environment with high angular resolution and large spatial coverage. In this paper, we discuss the overall mission design as well as the design of the cubesats for the Cubesats Constellation for Space Radiation Measurements (CCSRM). The constellation consists of 12U identical

cubesats evenly spaced along a circular polar orbit (the number of cubesats in the constellation can vary depending on the selected launch option and overall budget for the mission). The altitude of the orbit is 550 km in the beginning of the mission; it then gradually decreases due to the natural orbit decay until it reaches 350 km in the end of the mission. Each cubesat is equipped with a block of proton spectrometers that measures proton flux in a 180-degree plane angle with a 20-degree step in the energy range from 1 MeV to 250 MeV. The rotation of each cubesat about its axis allows measuring the proton flux coming from all directions, with a 20-degree resolution. Additionally, a deposited dose detector is installed inside the spacecraft to study the net radiation dose and assess the effectiveness of the employed shielding. The cubesats could be launched as a secondary payload for a polar orbit primary mission. The spacecraft then use their own propulsion systems to finish the deployment of the constellation. The estimated mission duration is approximately 2 years. After the end of the mission, it will take the CubeSats about a month to reach the Earth's atmosphere and burn due to the continuing orbit decay.