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LESSONS LEARNED FROM THE GREENCUBE 3U CUBESAT OPERATIONS IN MEDIUM EARTH ORBIT

Abstract

With the broadening of the space business stakeholders, in the framework of the so-called New Space Economy, novel mission profiles for small satellite missions are being evaluated for future Programmes. In this perspective, an extension of small satellite missions to higher orbits, including Medium Earth Orbit (MEO), can be extremely impactful for future mission envelopes, such as optical communication, inter-satellite links and data relay for Lunar and Deep Space exploration. Feasibility studies and mission design for such profiles need to consider the weaker received power levels at ground due to the greater slant distance, the slower data rates, and operators access times that are unusual for typical Low Earth Orbit (LEO) missions. Additional challenges arise from the harsher environmental conditions, with focus on prohibitive radiation levels and the sunlight and darkness cycles. Launch opportunities in higher orbits and MEO are not common and technologies for future MEO missions are often characterized by lower Technology Readiness Levels (TRL). In this framework, Sapienza Space Systems and Space Surveillance Laboratory (S5Lab) has developed a 3U CubeSat that was launched on-board the VEGA-C maiden flight to MEO, on a 6000-km-high highly-inclined circular orbit, on the July 13, 2022. The CubeSat,

named GreenCube, was jointly developed thanks to a cooperation agreement between Sapienza and the Italian Space Agency, with the collaboration of ENEA and University of Naples "Federico II". The main mission aim was demonstrating the functionality of a CubeSat-size plant cultivation facility and at studying for the automated production of microgreens in MEO. The satellite also hosted secondary payloads such as a propulsion system for back-up attitude control, developed by the Institute of Space Systems at University of Stuttgart, and a radio-amateur digipeater, developed together with the AMSAT Community and currently operating in-orbit. These nano-satellite operations required changes in the TTC operations typical of CubeSats. In particular, the mission used a S-Band telemetry station (thanks to the collaboration with the ASI Broglio Space Center team in Malindi, Kenya), data-rate was reduced to 300bps, tracking and management strategies involved passes of around one hour each and observability times of several hours per day. This paper will focus on the lessons learned for space operations in MEO acquired thanks to the GreenCube mission. After a brief introduction of the satellite features, the main characteristics of the performed operations, including the description of the amateur MEO digipeater performed tasks, will be given.