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DESIGN CONSIDERATIONS FOR DEEP SPACE CUBESAT DEPLOYMENT SYSTEMS

Abstract

Over the past decade, the number CubeSat launches has grown exponentially. As a result, CubeSat deployment mechanisms have become refined and reliable systems with a remarkable success rate. To date, most CubeSats have been deployed shortly after the launch vehicle reached orbit with spacecraft remaining in the deployer for a few hours at most. This is true even for proposed missions beyond Earth orbit. The few exceptions, such as FASTSAT/NanoSail-D, have deployed CubeSats a few days after reaching orbit. This timeline is very different from what would be expected of CubeSats operating as secondary spacecraft in future interplanetary missions. These mission architectures would incorporate a main spacecraft with a number of secondary vehicles to be deployed after arriving at the target planet. While this architecture is not new and has been employed by both Cassini and Galileo, advances in nano-satellite technology make it possible to incorporate small and highly capable secondary spacecraft that would significantly enhance the mission's scientific returns.

When compared to traditional CubeSat deployers, an interplanetary CubeSat carrier/deployer system must incorporate a number of unique design requirements. First, the system must ensure predictable and reliable deployment after an extended cruise period. Most CubeSat deployment systems utilize some sort of mechanical spring to provide the ejection force. A mechanical spring stowed for an extended duration can degrade, which can produce an uncertainty in deployment velocity. Additionally, being stowed for an extended period of time increases the risk of deployment anomalies. Second, a deployer used for a deep space long-duration mission must provide an electrical/data interface to the CubeSat to facilitate health checks and battery charging. Third, environmental conditions during the cruise phase, such as thermal and radiation environments, are very different from short term LEO conditions, and the deployer must be designed to support the spacecraft in such environments. Finally, in order to minimize impact on the primary spacecraft, a CubeSat deployer on an interplanetary mission would be mounted to the primary spacecraft and would appear to be simply an instrument that requires power, requiring the deployer to be mostly self-sufficient. Addressing these challenges is critical to the successful design of a deep space CubeSat deployer.

Cal Poly has developed a conceptual design and concept of operations for a CubeSat deployer for a hypothetical interplanetary mission, solving the concerns associated with CubeSat deployers on long term, deep space missions. This paper will present the results of this development effort.