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CHALLENGES IN LICIA CUBESAT TRAJECTORY DESIGN TO SUPPORT DART MISSION SCIENCE

Abstract

In 2021, the DART spacecraft will be launched by NASA to intercept the binary system Didymos and impact the moonlet (Didymoon), to test the effectiveness of kinetic impactors for the deviation of hazardous asteroids' trajectories. The impact is expected to generate a cloud of particles, whose study could provide valuable data about asteroid's properties and impact models. Observations from ground to characterize ejecta and plume evolution after impact would be possible, but the resulting quality would be significantly lower than a short-range imaging. In this framework, ASI (Italian Space Agency) and NASA started a collaboration to embark on the US DART vehicle the LICIA (Light Italian CubeSat for Imaging Asteroid) 6U CubeSat as a piggyback payload. LICIA is devoted to grasp science data by imaging the ejecta plume just after the impact, while flying by Didymoon. To this end, our analyses underlined that the small vehicle shall be detached from DART several hours before the impact to gain the needed separation from the US spacecraft, and to be on time for impact and ejecta plume imaging, a few minutes after occurrence. Moreover, LICIA scientific goals include imaging the back side of Didymoon, while keeping flying along the binary on its escape leg. The Italian consortium involved in the mission sees ARGOTEC for the platform development, and INAF, Politecnico di Milano and Università di Bologna to cover the mission science, trajectory design and orbit determination tasks, respectively. The paper focuses on the mission analysis and maneuvers design strongly driven by the science return in plume tracking and imaging, under the tight constraints the small platform imposes in terms of agility and control authority. Occurred trade-offs, related to the trajectory design, and navigation and guidance baseline settings to balance the science objectives and the risk mitigation constraints, are discussed in deep.

Detailed robustness analysis will show criticalities related to the uncertainties in the flyby trajectory, associated with the cubesat subsystems accuracy. An optimization of correction maneuvers and time windows for Deep Space Networks contacts is finally presented, to show how the deviation of the nominal trajectory can be mitigated to ensure the mission being compliant with the science goals.