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MISSION CONTINGENCY RECOVERY OPTIONS FOR THE DOUBLE ASTEROID REDIRECTION TEST (DART)

Abstract

Launching as early as July of 2021, NASA's Double Asteroid Redirection Test (DART) mission will be the first planetary defense mission to demonstrate and test a kinetic-impact asteroid mitigation approach. The mission's target is the secondary member of the 65803 Didymos binary asteroid system, with an impact date between 29 Sep and 01 Oct 2022 depending on the launch date. DART is also the first demonstration of NASA's Evolutionary Xenon Thruster (NEXT-C) ion propulsion system, which will be operated at roughly 3.5 kW. DART is currently in Phase C undergoing Integration and Test activities.

As a mission, DART has evolved substantially from its original concept to its current implementation. The primary variation has been DART's dependence on the ion propulsion system to reach Didymos or flyby targets. In its current and final flight implementation, DART traverses to Didymos on a ballistic trajectory. The ion propulsion system is used to perform trajectory correction maneuvers. It is also exercised using a series of "neutral burns", which provide an opportunity to operate the thruster without substantially changing the ballistic impact trajectory. However, in the unlikely event of a failed impact encounter, NEXT-C is an enabling technology to recover the mission. In this paper, we explore mission recovery options to provide a second impact experiment opportunity. All of the results consider the allocated propellant budget and key trajectory constraints, including: thruster pointing, target illumination at impact, and pre-impact communications geometries to Earth.

One option is to return to Didymos an orbit period later. These encounters occur in November and December of 2024. However, in these cases, DART cannot achieve the ideal operational constraints for the high gain antenna link with Earth, which allows the mission to downlink the final images just prior to impact. With these images, the investigation team can reconstruct the impact site and topography, which is an important input to the deflection experiment. Nevertheless, these trajectories comply with thrust pointing constraint and minimum solar-phase angle at impact. Alternatively, we have found solutions that allow the images to be downlinked, but offer very poor lighting conditions during the impact encounter.

We also are exploring options to impact single asteroids other than the binary Didymos system. In these cases, we could demonstrate the closed-loop guidance, but we would lose the opportunity to accurately measure the effects of the impact, which relies on a well characterized binary asteroid.