IAF SPACE EXPLORATION SYMPOSIUM (A3)
Small Bodies Missions and Technologies (Part 1) (4A)

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DOUBLE ASTEROID REDIRECTION TEST (DART) PHASE D MISSION DESIGN

Abstract

NASA's Double Asteroid Redirection Test (DART) mission is the first demonstration of kinetic deflection of an asteroid. DART uses terminal guidance to impact Didymos B, which orbits Didymos A, during its 2022 close-approach to Earth. The close range to Earth allows Earth-based observations to reconstruct the impact's effect. Light-curve data will be used to measure the resulting change in orbit period of the Didymos B due to the momentum change associated with the impact experiment.

Previous iterations of the mission design utilized NASA's Evolutionary Xenon Thruster (NEXT-C) as the primary propulsion system. Following the Mission Critical Design Review, the decision was made that the NEXT-C thruster demonstration should be completely independent from the asteroid deflection demonstration. As a result, DART's option to use NEXT-C for an opportunistic asteroid flyby was removed, and the spacecraft now uses a fully ballistic trajectory to Didymos with no deterministic maneuvers (either chemical or low-thrust). The ballistic outcome came from NASA's decision to give DART a dedicated launch vehicle, lowering mission risk by removing the dependency on the NEXT-C thruster and power unit. NEXT-C will be used for statistical trajectory correction maneuvers (TCMs) as well as a series of neutral burns, designed to allow it to be operated for a significant duration without altering the trajectory.

DART will launch on a dedicated SpaceX Falcon 9 launch vehicle, which will inject DART onto a hyperbolic Earth-escape trajectory to the Didymos system. The launch will depart from Vandenberg Air Force Base to provide the high magnitudes of declination of launch asymptote necessary to achieve the inclination change to reach Didymos.

DART's largest TCM is allocated for the cleanup of post-launch injection errors. In order to minimize this delta-V and save propellant, most missions perform the maneuver as soon as possible after launch. However, due to the geometry of DART's trajectory, a low delta-V maneuver opportunity exists several months after launch. This later TCM not only saves propellant, but also allows more time for post-launch checkout activities.

This paper will discuss the current DART trajectory and its recent trade studies and key decisions leading up to launch. The launch cleanup TCM placement analysis is presented, along with the design approach for the NEXT-C neutral burns.