DART – The Double Asteroid Redirection Test Mission.

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Overview and Motivation: DART, the Double Asteroid Redirection Test, is NASA's first planetary defense test mission, intentionally executing a kinetic impact into an asteroid to slightly change its motion in space. The target of the DART mission is the Didymos binary asteroid system, which is not a threat to the Earth but rather provides an ideal target for this first test. The DART spacecraft will impact the smaller 160-meter-diameter secondary member of the asteroid system, Dimorphos, changing its roughly 12-hour period about the larger primary asteroid by several minutes. While there are no known asteroids that currently pose a threat to the Earth, if such an asteroid were discovered in the future, the kinetic impactor technique is one approach that could potentially be used to deflect such an asteroid and prevent its impact with Earth. In particular, an experimental test of a kinetic impactor was identified as the highest priority for a space mission in the mitigation area for planetary defense by the *Defending Planet Earth* report of the National Research Council [1]. DART launched in November 2021 and is on course to intercept Dimorphos on September 26, 2022. This presentation will discuss DART's planetary defense objectives and provide the latest status of the mission, with roughly one month to go before DART's kinetic impact event.

Mission Status and Plans: The DART spacecraft launched aboard a SpaceX Falcon 9 rocket from Vandenberg Space Force Base, California, on November 24, 2021. A few hours after launch, the spacecraft's two Roll-Out Solar Arrays (ROSA) successfully deployed, each extending 8.5 meters in length from the roughly 2-meter cubed main spacecraft body. Two weeks later, DART's only instrument, the Didymos Reconnaissance and Asteroid Camera for Optical navigation (DRACO), acquired its first images of a star field and demonstrated the imager's in-flight performance is achieving its requirements. To date, DRACO has acquired over 70,000 images in support of calibration and testing activities in preparation for DART's encounter with Dimorphos.

A key technology developed for DART is the capability to autonomously identify and navigate to a small asteroid that has not been previously seen. To accomplish this task, DRACO images are analyzed onboard the DART spacecraft using a set of algorithms named SMART Nav, Small-body Maneuvering Autonomous Real Time Navigation. The smaller asteroid Dimorphos can not be resolved from the larger asteroid Didymos (780-meter diameter) in the DRACO images until within the last hour of the spacecraft's operations. During this time, DRACO images are acquired every second and utilized by the SMART Nav algorithms to autonomously control the firing of DART's thrusters to adjust the course of the spacecraft to ensure an intercept with Dimorphos. These same DRACO images are also streamed back to Earth and will be used to determine the shape of Dimorphos and to characterize the impact site.

The DART spacecraft carries a CubeSat contributed by Agenzia Spaziale Italiana, named the Light Italian Cubesat for Imaging of Asteroids (LICIACube) [2]. LICIACube will be released from the DART spacecraft on September 16, 2022, and will have its closest approach to Dimorphos about three minutes after DART's kinetic impact. LICIACube is equipped with two cameras, which will obtain images of DART's kinetic impact event and further characterize Dimorphos' shape.

The key measurement of how much deflection is produced to Dimorphos' orbital path about Didymos by DART's kinetic impact will be made by telescopes on the Earth. The timing of DART's kinetic impact was purposely selected to occur in the fall of 2022 because the distance between Didymos and the Earth will be at a 40-year minimum, roughly 11 million km. This timing allows high-quality measurements of the Didymos system to occur from Earth-based telescopes for months following DART's kinetic impact event [3]. The combination of a kinetic impactor spacecraft mission with key measurements obtained from existing Earth-based telescopes enables the DART mission to be a highly focused, cost-effective approach for the first demonstration of planetary defense mitigation technologies. DART is developed, operated, and managed by the Johns Hopkins University Applied Physics Laboratory for NASA's Planetary Defense Coordination Office.

International Planetary Defense Collaboration: DART is just one component of NASA's larger planetary defense program, and international cooperation and collaboration in planetary defense efforts are priorities of that strategy. ESA's Hera mission [4] is scheduled to rendezvous with the Didymos system in 2026, observing the crater produced by DART, measuring the mass of Dimorphos, and further advancing our knowledge of kinetic impactor technology to potentially one day avert an asteroid collision with the Earth.

References: [1] National Research Council (2010) The National Academies Press, https://doi.org/10.17226/12842 [2] Dotto E. et al. (2021) *Planetary and Space Science*, 1999, https://doi.org/10.1016/j.pss.2021.105185 [3] Rivkin A. S. et al. (2021) *Planetary Science Journal,* 2, 173, https://doi.org/10.3847/PSJ/ac063e [4] Michel P. et al. (2022) *Planetary Science Journal*, in press.