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Ongoing and Upcoming Mission Highlights – DART Mission

Solar Electric Propulsion Options for Future Planetary Defense Missions based on DART Flight Experience

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Abstract

Solar electric propulsion (SEP) has been shown to offer mass efficient solutions to changing a spacecraft's trajectory. From basic orbit raising in near Earth applications to deep space maneuvers that move a spacecraft between multiple objects, SEP enables a spacecraft to have operational flexibility. In combination with a chemical, divert propulsion system, a spacecraft equipped with SEP has capability to meet new potentially hazardous asteroids and offer options such as a flyby observer to a kinetic deflector, similar to DART.

The NEXT-C Ion Propulsion System is one type of SEP system that offers a wide range of performance options that include high thrust to input power, or high I_{sp} to input power operating conditions. The system's operational flexibility means that it is responsive to multiple mission scenarios involving potentially hazardous asteroids. As an example, a spacecraft with this type of SEP could be parked in high Earth orbit with the goal of offering a quick response to these types of asteroids by escaping out with a high thrust maneuver before utilizing the high I_{sp} to cruise to intercept the asteroid.

For the DART mission, the NEXT-C Ion Propulsion System was demonstrated for the first time in flight on December 18, 2021 as part of the spacecraft's commissioning phase. The system was operated for just over two hours of total firing time before being manually commanded to shutdown. The spacecraft was able to provide sufficient input power for the thruster to achieve steady thrust and I_{sp} during its operating period. The spacecraft supplied xenon to the thruster at a higher than anticipated rate but was stable throughout operation. The higher flow rate was due to higher pressure at the inlet to the flow controllers, which is downstream of the pressure regulator. The thermal

control of the feed system and spacecraft was initiated several hours before the start of the thruster operation to ensure that the feed system temperatures were stable.

The spacecraft attitude control during NEXT-C operation was an open question prior to operation as there was a large analytical range of the amount of hydrazine required to maintain the spacecraft attitude control. The guidance and control system maintained the spacecraft in a stable orientation that did not consume excess amounts of hydrazine in the process. Compared to pre-launch analysis, the hydrazine consumption was on the lower end of the estimated range, only 38.6% of pre-launch nominal value. This hydrazine usage value was extrapolated out for steady state operation following the initial heating period for the ion optics.

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Comments:

Oral Presentation