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Author: Mr. Brent Buffington
National Aeronautics and Space Administration (NASA), Jet Propulsion Laboratory, United States, Brent.Buffington@jpl.nasa.gov

Mr. John Smith
National Aeronautics and Space Administration (NASA), Jet Propulsion Laboratory, United States, john.C.Smith@jpl.nasa.gov
Dr. Anastassios Petropoulos
National Aeronautics and Space Administration (NASA), Jet Propulsion Laboratory, United States, stas@jpl.nasa.gov
Mr. Fred Pelletier
National Aeronautics and Space Administration (NASA), Jet Propulsion Laboratory, United States, fred.pelletier@jpl.nasa.gov
Dr. Jeremy Jones
National Aeronautics and Space Administration (NASA), Jet Propulsion Laboratory, United States, Jeremy.B.Jones@jpl.nasa.gov

PROPOSED END-OF-MISSION FOR THE CASSINI SPACECRAFT: INNER D RING BALLISTIC SATURN IMPACT

Abstract

Due to the success of the Cassini-Huygens Prime and Equinox missions, and the excellent state of the spacecraft (both the estimated remaining propellant and spacecraft health), focus shifted to the design of a second extended mission in early 2008. The resultant design spans from 1-Oct-2010 to 15-Sep-2017, and is referred to as the Solstice Mission since it will extend the mission lifetime past Saturn's northern summer solstice (25-May-2017) in order to increase the temporal baseline observable by Cassini to span nearly two Saturnian seasons. The Solstice Mission is planned to be the final installment of the Cassini spacecraft orbiting in the Saturnian system, hence the majority of the estimated propellant could be fully utilized, and a spacecraft disposal (i.e., end-of-mission) scenario needed to be considered and implemented. Previous end-of-mission studies were conducted in conjunction with Purdue University to determine what could potentially be done given the Cassini spacecraft's capability, and to discern the feasibility and level of difficulty associated with each of the derived options. These options included impact trajectories, long term stable orbits within the Saturn system, and Saturn system escape trajectories. Armed with the knowledge that a single Titan flyby could be used to hop the entire main ring system and render the s/c on a Saturn impact trajectory, an additional option, referred to as the "inner D ring option" has been developed. This option places the spacecraft's descending node crossings between the inner D ring and Saturn's upper atmosphere, and ballistically decays into Saturn after 22 orbits by utilizing distant non-targeted Titan flybys and Saturn oblateness perturbations. It must be noted that at the time of this writing, this end-of-mission scenario is only proposed, and has not been formally approved by NASA Headquarters.

This paper will develop the theory behind the aforementioned inner D ring end-of-mission option, characterize the stability of these transfers given orbit determination (OD) uncertainties associated with a number of estimated quantities, describe how specific scientific requests reduced the number of possible

orbital geometries to consider, explore alternate routes (i.e. earlier than anticipated disposal options) and potential extensions, and finally, describe in detail the current design in the baseline Solstice Mission trajectory.