Maneuver Analysis for the Stardust Mission

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The Stardust spacecraft will launch in February of 1999, and begin a seven year mission as part of NASA's low-cost Discovery Program. The primary purpose of this mission is to return a sample of a comet's coma to Earth. Stardust will encounter the comet Wild 2 in January, 2004. Coma particles will be collected as the spacecraft flies in proximity to the comet. These particles will then be returned to Earth in January of 2006.

The nature of the Stardust trajectory, which includes an Earth gravity assist, a close flyby of a comet, and very accurate delivery of the sample capsule back to Earth, provides several interesting challenges for the Stardust Navigation Team. The constraints on the spacecraft mass require that the total AV for this mission be optimized to reduce propellant. Also, the high accuracy necessary for the sample capsule return places added importance on maneuver placement and minimizing delivery errors. This paper describes the maneuver analysis for Stardust, and how this analysis minimized the A V and delivery errors throughout the mission.

The paper begins by describing the spacecraft's propulsion system. The paper continues by explaining the process for evaluating the launch injection errors. The maneuver strategy and placement throughout the mission are then discussed. Maneuver execution errors play an important role in the mission, and are discussed as well. The process to achieve the extremely tight tolerance on the flight path angle for the sample capsule return are also presented.

Orbit determination plays an important role in determining the size and placement of maneuvers. These uncertainties are presented and discussed, as well as the tracking and non-gravitational acceleration assumptions which led to these uncertaint ies.