

Preliminary Statistical ΔV Analysis for a Representative Europa Orbiter Mission

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The Europa Orbiter Mission will put a spacecraft in low altitude orbit around Europa to confirm the existence of a liquid ocean under the frozen surface. The trajectory consists of the interplanetary cruise phase, the Jovian tour and endgame phase, and the Europa orbital phase. The deterministic ΔV estimate for a representative trajectory to Europa is approximately 2000 m/s [Johanneson and D'Amario, 1999]. This paper describes the methods used to estimate the additional ΔV capability required to account for launch vehicle injection, orbit determination (OD), and maneuver execution errors. The estimated statistical ΔV through Europa Orbit Insertion (EOI) maneuver has a mean value of ~125 m/s with a 22 m/s standard deviation. The corresponding estimated 99 percent confidence interval is about 200 m/s, approximately 10% of the deterministic ΔV value. An injection covariance (provided by Lockheed Martin Astronautics) and simulated OD covariances are used to model injection and OD errors. Moreover, Gates' [1963] maneuver execution error model is used to model the effect of spacecraft attitude and propulsive uncertainties. A multiple maneuver optimization strategy in conjunction with a Monte Carlo method is used in order to assess the statistical ΔV requirements for the mission. Ongoing work includes the assessment of Europa orbital phase as well as new (and shorter) Jovian tour/endgame phases.