A LINEAR ANALYSIS FOR THE FLIGHT PATH CONTROL OF THE CASSINI GRAND FINALE ORBITS

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The Cassini Mission is proposed to end with a series of 22 highly inclined (62 degrees), short period (6.5 days), ballistic orbits each passing within a few thousand kilometers of the cloud tops of Saturn, ultimately impacting the planet on September 15, 2017. The end of mission trajectory depicted in Figure 1 was incorporated in the final phase of the Solstice Mission. Despite the ballistic nature of the trajectory, the absence of targeted maneuvers throughout the 22 final orbits causes position uncertainties to grow exponentially with time, posing a significant difficulty for the science sequence planning team. Thus, it was of great interest to develop a strategy that incorporates trajectory correction maneuvers to significantly reduce dispersions from the reference path, eliminating late sequence updates and facilitating sequence planning tasks. Determining the optimal number and location of the maneuvers to control the trajectory, along with the corresponding targets, was a nontrivial task. Several strategies were attempted until a feasible solution was found via two different approaches: a linear analysis to strategize maneuver and target placement and a non-linear analysis to produce trajectory dispersions. Both methods were based on orbit determination covariance sampling with Monte Carlo simulations. The linear method mapped uncertainties from a given state to a future time while the non-linear approach was based on numerical state integration. After cautious initial testing, it was determined that the results from both methods were in agreement with insignificant differences, allowing the maneuver analysts to confidently run thousands of maneuver combinations in little time.

The control strategy ultimately adopted by the Cassini Project and the trajectory dispersion results from the non-linear approach were detailed in [1]. In this paper, the results from the linear Monte Carlo approach will be detailed along with the different strategies that led to a DV-optimal solution to control the position uncertainties along the proximal orbits. The benefits of adopting a linear technique for preliminary studies will be highlighted.

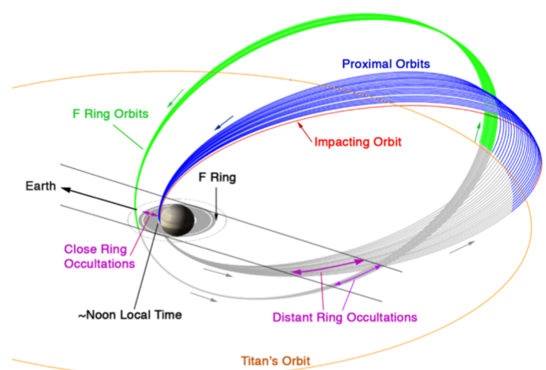

Figure 1. Cassini's Grand Finale Trajectory

1. References

[1] Wong, M., Hahn, Y., Roth, D., and Vaquero, M. "Trajectory Dispersion Control for the Cassini Grand Finale." "25th International Symposium on Space Flight Dynamics," Munich, Germany, October 19–23, 2015.