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ANALYSIS OF POSSIBLE EARLY ORBIT CONTINGENCIES AND RECOVERY STRATEGIES FOR HERSCHEL/PLANCK

Abstract

Herschel and Planck, the ESA astronomy cornerstone missions, will be launched in April 2009 on Ariane 5. Herschel, the largest ever infrared telescope, and Planck, to study the cosmic microwave background radiation, will be injected together into a nearly parabolic orbit. From there, they will be manoeuvred to their operational orbits around the libration point L_2 of the Sun-Earth system: a halo type orbit for Herschel and a small amplitude Lissajous orbit for Planck. Essential to nominal orbit insertion is a correction manoeuvre to be performed within two days from launch, to correct for the launcher dispersion and other systematic deviations from the required transfer conditions.

The present work focuses on preparing recovery strategies in case of an under-performance of the launcher or the failure to execute the first correction manoeuvre on time. It is shown that over a large range of launcher under-performances, it would still be possible to follow the nominal mission design, using the propellant margins. Similarly, for a nearly nominal launch orbit, a delay of the first orbit correction up to day 20 on Planck is possible. For Herschel, however, the margin is lower and the delay of the first orbit correction would only be feasible up to day 7.

However, the evaluation of how far the nominal scenario could be kept is not the main objective of the paper, but the development of other strategies implying substantial changes in the mission design. For instance, a recovery strategy consists in letting the two spacecraft perform one complete revolution in the initial eccentric orbit, and start manoeuvering them near the second perigee passage. This procedure appears simple from a trajectory design point of view, as the same optimization techniques used for the original mission design can be applied. However, it is not straightforward operationally, as the mounting and cycling of the thrusters, the constraints on the viewing direction of the star mapper with respect to Sun, Earth and Moon during maneuvers, as well as the necessary attitude changes between the two necessary thrust arcs around perigee have to be taken into account. These constraints are different between Herschel and Planck as built. Furthermore, the propellant margins are not enough to follow this recovery strategy for all the contingency cases included in the study. Therefore, more complicated designs, taking advantage of moon fly-bys or the Sun-Earth-Moon weak stability boundaries, must also be considered.