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Hitchhiking to the Moon (8)

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CONTINGENCY AND RECOVERY OPTIONS FOR THE EUROPEAN STUDENT MOON ORBITER

Abstract

The European Student Moon Orbiter (ESMO) is scheduled for launch in 2014 – 2015, making it the first lunar micro-satellite designed entirely by students, and the only currently planned ESA mission to the Moon. The limited v budget available to ESMO and the requirement to be a piggy-back payload on any commercial launch in 2014-2015 made the design of a feasible transfer to the Moon a real challenge. To reduce propellant, a weak stability boundary transfer was proposed. The entire period from 2014 to 2015 was systematically scanned, by an automatic transfer generation algorithm, to compile a large database (over 300,000 solutions) of nominal transfer options. ESMO will be inserted into a highly eccentric frozen orbit at the Moon, in order to minimise propellant use to insert into, and maintain, its lunar orbit. At departure from the Earth, ESMO will perform a series of manoeuvres that, by optimally exploiting the natural perturbations of the orbit, will inject the spacecraft into a translunar transfer within the limits of the current propulsion system. This departure strategy offers an increased flexibility in the choice of the launch date and time. Although the current transfer solution for ESMO minimizes the v budget and fulfills all the requirements, it introduces an element of risk due to the high sensitivity of the orbital dynamics. Thus, this paper analyses the consequence of possible contingencies occurring during the transfer, in particular the incorrect firing of the engines, time and thrust vector direction and the delay or failure of execution of the manoeuvres. For the most critical contingency scenarios, some potential recovery options are proposed to safely reach the Moon and achieve the main objective of the mission. In particular, the paper will present an analysis of a delayed orbit insertion at the Moon. This case is of particular interest because the current transfer solution provides weak stability capture at the Moon, i.e. a temporary capture that allows the spacecraft to be in the vicinity of the Moon for a relatively long period of time when compared to the expected lifetime of the mission.