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SMALL SATELLITE MISSIONS SYMPOSIUM (B4)
Hitchhiking to the Moon (8)

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OPTIMAL DESIGN OF LOW-ENERGY TRANSFERS TO HIGHLY ECCENTRIC FROZEN ORBITS AROUND THE MOON

Abstract

Scheduled for launch in 2013-2014, the European Student Moon Orbiter (ESMO) offers the opportunity for University students across Europe to design and build a microsatellite. Through the use of an all-day piggy-back launch opportunity, ESMO will exploit the benefits of a Weak Stability Boundary (WSB) transfer to reach a polar orbit around the Moon. Once in lunar orbit the primary mission objective is to acquire surface images of the South Pole, providing high resolution data over six months. This will be achieved through a Narrow Angle CCD Camera (NAC) at a resolution no more than 200 km at periselenium, above the South Pole. It is therefore critical that a stable polar orbit is achieved.

ESMO is therefore considered to be a highly ambitious mission design. The utilisation of a WSB transfer is used as a means to provide a high degree of flexibility in the selection of the launch opportunity. However, this flexibility, due to the sensitivity dynamics, is slated against the expense of having to use a far more complex navigation strategy. Therefore the transfer trajectory needs to include mitigation approaches and correction strategies.

This paper will present the optimal design of ESMO's WSB transfers to a highly elliptical frozen orbit(s) around the Moon. An optimal multi-burn strategy for both departure and arrival is also added to the transfer to minimise gravity losses, navigation budget and to accommodate injection errors at the Moon. Ultimately the analysis details the trade-off between the cumulative saving of delta-V and the mission lifetime of ESMO. High elliptical frozen orbits have the benefit of a low insertion delta-V with no or small long-term variations of eccentricity and argument of periapsis. This significantly reduces the requirement on orbit correction and station keeping. Coupled with the mission & scientific requirements, a highly elliptical frozen orbit is considered to be the optimal orbit design for ESMO.