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ASTRODYNAMICS SYMPOSIUM (C1)
Mission Design, Operations and Optimization - Part 1 (1)

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MISSION ANALYSIS OF ROBOTIC, LOW-THRUST MISSIONS TO THE MARTIAN MOONS DEIMOS AND PHOBOS

Abstract

Within the frame of possible space exploration activities beyond Low Earth Orbit, human missions to Near Earth Objects and later to the Martian moons are investigated by several space agencies. To prepare for such an endeavor, robotic missions should be sent in advance of crewed missions to interesting targets. These precursor missions shall address scientific objectives, identify potential hazards to human spaceflight missions and search for in situ. Astrium analyzed conceptual system designs on phase 0 level for those precursor missions with special emphasis on missions to the Martian moons Deimos and Phobos. A mission analysis has been conducted to assess the potential benefit of using low thrust propulsion for such missions. Based on this, a brief mass estimation is given to determine feasible payload masses.

The mission analysis assumes a launch by a Soyuz Fregat and a direct injection into an escape trajectory with a v_∞ of 0 km/s. After successful check out, the spacecraft uses its electrical engines for the interplanetary transfer to Mars, the capture into a high circular Mars orbit and for the low thrust transfer to its destination. The mission analysis comprises of dedicated missions to Deimos or Phobos and combined missions with Deimos as the primary target and Phobos as secondary target during a possible mission extension.

The mission analysis assumes a launch in the 2018 and considers two different types of electrical engines, representing a wide range with respect to the specific impulse. The SNCEMA PPS1350 offers a specific impulse of 1,650 s and has been flight proven in the SMART 1 mission. The second engine type, the Astrium RIT 22 engine, is based on the flight proven RIT 10 (EURECA, ARTEMIS). Two designs of the RIT 22 are available with specific impulses of 3,704 s and 4,763 s. Within the analysis, the number of engines and the available electrical power is varied, followed by a down selection of a system design.

The effect of propulsion and power subsystem degradations on the transfer trajectory and thereby on the mission profile is analysed in the second part of the mission analysis. This is achieved by obtaining 60 position and velocity vectors from the nominal interplanetary transfer trajectory of the chosen system configuration. For each data point, a minimal time and minimal propellant demanding trans Mars trajectory is optimized for permanent engine cut offs and certain levels of solar cell degradation.