Paper ID: 14979
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SPACE TRANSPORTATION SOLUTIONS AND INNOVATIONS SYMPOSIUM (D2)
Upper Stages, Space Transfer, Entry and Landing Systems (3)

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LOW-THRUST TRANSFERS FOR THE VEGA ELECTRIC UPPER STAGE

Abstract

On December 2000 the Small-Launcher Development programme decided to embark on the full development of the Vega launcher and to start the P80 solid rocket motor advanced demonstrator programme. Almost twelve years later, the successful lift off of the Vega rocket from Kourou spaceport has represented a steppingstone in the European programme of small launchers. The Vega performance is limited to low Earth orbits; 300–2500 kg satellites can be released in polar and low Earth orbits. Such masses and these orbits are typical both for scientific and Earth observation missions. Vega, however, will enter a market with a harsh competition. The launch service market demand compatible with the Vega performance is fundamentally made up by institutional missions. Thus, in order to improve the launcher capabilities and to access this market securing a balanced exploitation, also the possibility of deploying payloads in higher orbits is under investigation. Assuming as reference an almost equatorial circular orbit of 1500 km altitude and 1500 kg spacecraft mass, the aim of this study is to investigate about the possibility to equip the launcher with an additional electric upper stage enhancing its performance. Indeed, because of the mass limits imposed by the baseline Vega design, virtually very small payload capability would be achieved considering a chemical propulsion transfer module. More in detail, the study aims at designing low thrust transfer solutions from the reference Vega target orbit up to a geostationary Earth orbit. Such a target, although quite challenging, has been identified as the one offering the widest option to broaden the launcher market. Such transfer orbits are typically composed by a huge number of spirals slowly rising the orbital energy up to the target. The more suitable thrust direction, thruster specific impulse and power can not be a-priory defined, thus detailed simulations are required to assess the feasibility of the electric upper stage option. With the aim of reducing the cpu load and providing a fast generation of feasible trajectories, averaging techniques and semi-analytic relations are exploited. The general criterion adopted is to minimize the transfer time to limit the payload inactivity and to guarantee fast passages through the van Allen belts. In general, it is showed that approximately 1100 kg can be delivered in the target geostationary orbit after 300 days, assuming the PPS-5000 thruster. The mission V is 4–4.5 km/s, with a typical propellant mass consumption of the order of 15