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VEGA-C GUIDANCE IMPROVEMENT FOR OPTIMIZED SRM RE-ENTRY

Abstract

The VEGA-C is the European launcher for light payload which succeeds VEGA increasing performance, flexibility and competitiveness. It is a four stages launch vehicle with three Solid Rocket Motors (SRMs) and a liquid upper stage (AVUM). The use of SRM up to the 3rd stage (Z9) leads to reach uncertainties at separation conditions, mainly due to the inability to switch off the motor, control the thrust vector and provide an accurate evaluation of scatterings. High altitude and velocity at the end of Z9 burning phase spread these uncertainties, providing a large re-entry area in terms of probability ellipse. The result is the need to repeat the mission development loop to satisfy safety requirements and performances. The open-loop guidance algorithm that currently handles the last 3rd stage phase is Neutral Axis Maneuver (NAM) which consists of the orientation of the thrust along a predefined direction several seconds before the end of Z9 propulsion. The strategy is based on the phenomenon that at Z9 burnout there is some direction in the vertical plane such that delta velocity ΔV applied in this direction does not change impact point range. This paper presents a guidance algorithm improvement introducing a partially replacement of the NAM open loop with an on-board closed loop. The purpose is to exploit the new solid rocket motor performance knowledge after in flight tests. The concept concerns the use of the residual thrust after tail-off start, which consist in about 40 seconds of extra boost, by extending attitude control to rectify the pitch angle according to the impact point shift with respect to the nominal condition. Relative guidance algorithms design and tuning are described. Assessment of the advantages in term of re-entry area reduction, mission development time and performance improvements is provided.