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FLYING QUALITIES AND MISSION ANALYSIS FOR THE RETURN LEG OF MESO'S LAUNCHER FIRST STAGE

Abstract

To perform a safe landing of a launch vehicle is mandatory for stage reusability but it is a major economic and technological challenge. The European Commission's Horizon 2020 RRTB research and innovation project (Recovery and Return-To-Base European Reusable Micro-Launcher) explores new concepts for the Earth re-entry and landing of a Vertical Take-Off and Landing (VTOL) micro-launcher first stage, with an entry mass around 3 tons. The analysis of the Concept of Operations (CONOPS) carried out in the early stage of the project identified clearly performance needs in terms of aerodynamic deceleration and longitudinal static stability of the RRTB's first stage during the passive phase of the entry. In order to fulfil the needs, DEIMOS Space, in collaboration with Pangea Aerospace, has designed a novel aerodynamic drag device for the hypersonic and supersonic re-entry phase. Computational Fluid Dynamics (CFD) was used to design and characterize the drag device, in an envelope that covers the hypersonic, supersonic, and subsonic regimes. The unique vehicle shape leads to some interesting design challenges and flow characteristics, which are currently being tested at the Von Karman Institute (VKI) premises.

This paper focuses on the Flying Qualities Analysis (FQA), and the Mission Analysis (MA) for the RRTB project, performed by DEIMOS Space, who are also responsible for the end-to-end GNC in the return flight. Using the aerodynamic database DEIMOS Space has done mission simulations, including a suborbital boostback maneuver and a passive re-entry assisted by the drag device, to explore the capabilities of the current design. The role of the boostback maneuver, in terms of timing and execution, is crucial to achieve the desired accuracy levels of the parachute triggering conditions; therefore, a dedicated boostback maneuver algorithm was developed and simulated against dispersions by means of Monte Carlo analyses. In a similar way, the performance of the Meso first stage in the passive, aerodynamic phase of the return leg were assessed by means of nominal and Monte Carlo flying qualities analyses. The results give an outlook on the opportunities and challenges related to reusable microlaunchers. This project

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