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ADVANCED EUROPEAN RE-ENTRY SYSTEM BASED ON INFLATABLE HEAT SHIELDS: TECHNOLOGY ROADMAP AND TECHNICAL CHALLENGES (EFESTO PROJECT)

Abstract

The payload capability and the landing sites for Mars exploration missions may be boosted using inflatable decelerators. Similarly, these may allow recovering launcher upper stages for Earth re-entry enabling reusability. The EFESTO project, funded by the European Union programme H2020, aims at raising the European TRL of Hypersonic Inflatable Aerodynamic Decelerators. It includes design, development, test and validation of tools for the design of the flexible TPS (F-TPS) and the inflatable structures of the heat shield for atmospheric entry missions. The project culminates with the design of an In-Orbit Demonstration (IOD) mission, setting the basis for a technology development programme. Within EFESTO, the technology roadmap, planning the necessary development activities, is generated to support the European strategic decisions in this field. A rational and logical methodology is proposed for the technology roadmap generation, considering the robustness of the result and the influence of the chosen parameters through sensitivity analysis. Multi-attribute theories are considered and implemented to include features of different nature and the preference among them. An ad hoc database of the past, present, and planned efforts in the field of atmospheric entry systems is developed and implemented in the process. The technology roadmap defined responds to the multiple technical challenges identified in the different disciplines involved: system aspects, addressing geometric and functional integration of critical uncommon sub-systems as the F-TPS and the inflatable structure in folded state, concerning the available volume and cross-section, and during re-entry conditions in consideration of the centre of gravity position and related impact on flight stability and control; aerothermodynamic aspects, strong fluid-structure interactions along the atmospheric entry which are critical for the TPS design; materials and structures aspects related with not yet matured technologies including the design of a flexible thermal protection sheet able to withstand the peak heat fluxes experienced during entry, as well as a suitable underlying inflatable structure that allows maintaining the optimal aerodynamic shape during the entirety of the mission; mission and GNC aspects, controlled entry on Earth combined with parafoil descent and

Mid-Air Retrieval and ballistic entry combined with supersonic retro propulsion for Mars. Purpose of this paper is to propose a methodology to define the technology roadmap for a hypersonic inflatable aerodynamic decelerator, addressing the main technical challenges and giving the incremental technology development to cope with them. This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 821801.