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DEVELOPMENT AND FLIGHT TEST OF A SUBORBITAL RE-ENTRY DEMONSTRATOR

Abstract

The paper describes the activities of the IRENE (Italian Re-Entry NacellE) program, funded by the Italian Space Agency (ASI) and European Space Agency (ESA), which are aimed at realizing an innovative deployable (umbrella-like) heat shield concept developed by ALI, CIRA and University of Naples. IRENE is a capsule whose innovative characteristics are the heat-shield opening mechanism (umbrella-like configuration) and the (off-the-shelf) materials used for the thermal protection, both covered by international patents.

The "umbrella-like" deployable heat shield reduces the capsule ballistic coefficient, leading to acceptable heat fluxes, mechanical loads and final descent velocity. The feasibility study of the IRENE has been carried out in 2011. The Thermal Protection System (TPS) materials have been tested in the SPES

hypersonic wind tunnel at the University of Naples, and in the SCIROCCO Plasma Wind Tunnel at CIRA in 2011. Thanks to the promising results of the first activities, ASI and ESA decided to fund, in the frame of GSTP program, the current phase of the program called MIFE "MINI-IRENE Flight Experiment".

To test the functionality of the MINI IRENE deployable heat shield for the atmospheric re-entry, two different-scale demonstrators have been designed and manufactured, achieving an overall TRL 6. A Ground Demonstrator (GD), representative of the TPS materials (nose and flexible part) and of the mechanisms of the FD, has been successfully qualified in SCIROCCO (Plasma Wind Tunnel) in 2018. A Flight Demonstrator (FD), designed to sustain the dynamic pressure and mechanical loads encountered during launch and microgravity phases of the re-entry mission, has been subjected to a space qualification campaign between the end of 2019 to the beginning of 2020.

The Flight Demonstrator will be included as a secondary payload in the interstage adapter of a VSB-30 Sounding Rocket that will be launched in June 2022 from the ESRANGE, Sweden, launch base, then ejected during the ascent phase of the payload section, perform a 15-minutes ballistic flight, re-enter the atmosphere and hit the ground.

As a further application of "IRENE technology", ALI has proposed the "Small Mission to Mars" (SMS) project. SMS is a low-cost system suitable for the entrance in the atmosphere and the operations on the ground of Mars. The SMS feasibility study was funded by the European Space Agency (ESA) in 2016. In the paper are also illustrated the results of the feasibility study of SMS, including a description of the mission profile, launch and escape phases, interplanetary trajectory, Mars approach, entry, descent and landing (EDL), and payload deployment and operations.