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HYPER VELOCITY DEMONSTRATION MISSION TO PREPARE EUROPE FOR SAMPLE RETURN AND FUTURE EXPLORATIONS (HEARTED)

Abstract

Worldwide experience on Earth high-speed re-entry (>10km/s) is available in USA, Japan and Russia whereas the European background is limited to velocities not exceeding the 8km/s typical of a Low Earth Orbit (LEO) re-entry. ESA has considered various missions requiring Earth re-entries at speeds up to 13km/s. Very often the lack of the necessary background related to high-speed Earth re-entry was a highly influent factor on the decision not to implement those missions.

The main objective of Hyper-velocity EArth Re-entry TEchnology Demonstrator (HEARTED) as a demonstration mission is thus to fill such a knowledge gap by demonstrating Europe's capability of safely and successfully flying a hyper-velocity Earth Re-entry Capsule (ERC) with an entry velocity 11km/s and to prepare for future science/exploration missions.

Such a mission aims at speeding-up the maturation of several Identified Critical Technologies (ICT) to be implemented on the ERC. They are the technologies which lack of knowledge/experience and prevents Europe to participate to future high velocity Sample Return (SR) mission.

- ICT#1: The ERC aero-shape and more particularly its Aerothermal Data Base (AEDB), that must guarantee the ERC drag and stability performances along the entry, descent and landing trajectory phases,

- ICT#2: The ERC Thermal Protection System (TPS) technologies that aim at isolating the payload from a very harsh environment related to high-speed re-entry (temperature, pressure and gas penetration), and that guarantee geometrical stability of the aero-shape through all oxidation regimes.

- ICT#3: The high-speed re-entry aerothermodynamics environment and thermo-ablative response prediction tools that are attached to large uncertainties in particular in the field of radiative heating and

the role of ablation/pyrolysis products on the surrounding aerothermal environment.

- ICT#4: The descent and landing systems that provide the ERC with final deceleration and stabilisation through the transonic and subsonic descent down to ground impact.

- ICT#5: The recovery system and associated ground logistic that allow a fast and robust recovery of the capsule and payload.

Mandatory flight measurements concern the monitoring of ICT#1 and ICT#2 to retrieve trajectory and aerodynamic behavior during Entry, Descent, and Landing (EDL), as well as TPS performances. High-Priority Nice-to-have are the flight measurements that intend to increase our scientific knowledge in the field of radiative heat flux, surface static pressure, TPS behavior, and dynamic mechanical environment (ICT#3).

A shared launch on Ariane 62 is the proposed baseline with Vega-C as an option. A Carrier (ASTRIS Kick Stage) that will accelerate the ERC to the required high-velocity conditions at Entry Interface Point (EIP). The ERC will enter the Earth atmosphere, carry and operate the flight instrumentation suite, and finally land in Woomera (Australia) where it will be recovered.

The preliminary design of the ERC is defined with the willingness to retrieve as much experimental data as possible. ASTERM® ablator and NAXECO® based high-density Carbon/Phenolic on the front-shield, with Norcoat® Liège or conformal ASTERM® ablator on the back are two interesting TPS architectures.

The preliminary development logic aims at minimizing costs and programmatic risks, and ensuring proper development and qualification of all HEARTED systems and subsystems, including ground operation activities and interfaces with the Launcher. A "Proto Flight Model" approach is set up.

The paper presents the Phase 0 and Phase A studies that ended by successful Mission Definition Review (MDR) and Preliminary Requirement Review (PRR). A mission architecture and a system conceptual design have been determined. Critical points have been identified and the next phase is being prepared.