COMMON PROBE DESIGN STUDY AND FOLLOW-ON ACTIVITIES

Helen Hwang*[1]

[1]NASA Ames Research Center – United States

Abstract

Introduction: The Common Probe Study was funded by the NASA's Planetary Science Division (PSD) in the Science Mission Directorate in 2018 to investigate the feasibility of a common aeroshell design for atmospheric probe missions at Venus, Jupiter, Saturn, Uranus, and Neptune. The study involved 4 NASA Centers: Ames Research Center, Goddard Space Flight Center, Langley Research Center, and the Jet Propulsion Laboratory.
The common aeroshell baseline design was a 400 kg, 1.5 m diameter, 45-degree sphere cone shape with a high-density thermal protection system (TPS) material (Heatshield for Extreme Entry Environments Technology, HEEET) and a parachute system to extract the descent vehicle. The descent vehicle was 0.75 m diameter, which could encompass both Tier 1 and Tier 2 science instruments at each of the 5 destinations.

Study methodology: First, a notional instrument payload was defined for each destination [1] based on top priority measurements given by the Planetary Science Decadal Survey [2]. Steep and shallow entry flight path angles (EFPA) were defined for each planet based on qualification and operational g-load limits for current, state-of-the-art instruments. Interplanetary trajectories were then identified that bounded the EFPA range [3].

Next, entry trajectories were determined using 3-DoF simulations [4,5]. Conical ribbon parachutes were sized based on heatshield separation dynamics. Aeroheating correlations generated stagnation point convective and radiative heat flux profiles [6]. High fidelity thermal response models for TPS materials determined stagnation point thicknesses, with margins based on previous studies. Backshell TPS masses were calculated based on scaled heat fluxes from the heatshield and correlations to previous studies.

Based on these analyses, we have found that the common design is applicable for atmospheric probe missions for 4 out of the 5 destinations. Because of the unique gravity well for Jupiter, its severe entry environments prohibit using the common design.

The next step is to determine follow-on activities for NASA. A questionnaire for the atmospheric probe community has been developed, with a focus on what size of aeroshell should be further analyzed (smaller or same diameter), and what incentives would make using such an aeroshell, if assembled and available, desirable to mission proposers. The questionnaire will be available and distributed to workshop attendees. Participation is highly encouraged and helps to promote the ongoing ESA-NASA partnerships for outer planet exploration.

*Speaker

Preliminary results from this questionnaire will be presented at the workshop. A final summary of the questionnaire results, along with other recommendations, will be delivered to NASA PSD.

References:

Atkinson, D. H. *et al.* (2018) *15th IPPW*, Boulder, CO, June 11–15. [2] Squyres, S., et al., "Visions and Voyages for Planetary Science in the Decade 2013-2022," National Academies Press (2011). [3] Lobbia, M. A. *et al.* (2018) *15th IPPW*, Boulder, CO, June 11–15. [4] Dwyer-Cianciolo, A. *et al.* (2018) *15th IPPW*, Boulder, CO, June 11–15. [5] Allen, G. A., Jr., *et al.* (2018) *15th IPPW*, Boulder, CO, June 11–15.

Keywords: aeroshell design, atmospheric probes