A COMMON PROBE DESIGN FOR MULTIPLE PLANETARY DESTINATIONS.

H. H. Hwang,[1] G. A. Allen, Jr.,[2] A. I. Alunni,[2] M. J. Amato,[3] D. H. Atkinson,[4] B. J. Bienstock,[4] J. R. Cruz,[5] R. A. Dillman,[5] A. D. Cianciolo,[5] J. O. Elliott,[4] J. D. Feldman,[6] M. D. Hofstadter,[4] K. M. Hughes,[3] M. A. Lobbia,[4] G. C. Marr,[3] F. S. Milos,[6] K. H. Peterson,[6] D. K. Prabhu,[2] and T. R. White.[6] [1]NASA Ames Research Center, M/S 230-3, Moffett Field, CA 94035, USA (helen.hwang@nasa.gov), [2*]AMA, Inc. at NASA ARC, [3]NASA Goddard Space Flight Center, [4]Jet Propulsion Laboratory, [5]NASA Langley Research Center, [6]NASA Ames Research Center.

Introduction: Atmospheric probes have been successfully flown to planets and moons in the solar system to conduct *in situ* measurements. They include the Pioneer Venus multi-probes, the Galileo Jupiter probe, and Huygens probe. Probe mission concepts to five destinations, including Venus, Jupiter, Saturn, Uranus, and Neptune, have all utilized similar-shaped aeroshells and concept of operations, namely a 45° sphere cone shape with high density heatshield material and parachute system for extracting the descent vehicle from the aeroshell. Each concept designed its probe to meet specific mission requirements and to optimize mass, volume, and cost. At the 2017 IPPW, NASA Headquarters postulated that a common aeroshell design could be used successfully for multiple destinations and missions [1]. This "common probe" design could even be assembled with multiple copies, properly stored, and made available for future NASA missions, potentially realizing savings in cost and schedule and reducing the risk of losing technologies and skills difficult to sustain over decades.

Thus the NASA Planetary Science Division funded a study to investigate whether a common probe design could meet most, if not all, mission needs to the five planetary destinations with extreme entry environments. The Common Probe study involved four NASA Centers and addressed these issues, including constraints and inefficiencies that occur in specifying a common design.

Study methodology: First, a notional payload of instruments for each destination was defined [2] based on priority measurements from the Planetary Science Decadal Survey [3]. 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 for a bounding range of EFPA [4].

Next, 3-DoF simulations for entry trajectories were run using the entry state vectors from the interplanetary trajectories [5,6]. Aeroheating correlations were used to generate stagnation point convective and radiative heat flux profiles [6] for several aeroshell shapes and entry masses. High fidelity thermal response models for various TPS materials were used to size stagnation point thicknesses, with margins based on previous studies. Backshell TPS masses were assumed based on scaled heat fluxes from the heatshield and also from previous mission concepts.

Presentation: We will present an overview of the study scope, highlights of the trade studies and design driver analyses, and the final recommendations of a common probe design and assembly. We will also indicate limitations that the common probe design may have for the different destinations. Finally, recommended qualification approaches for missions will be presented.

References:

[1] Session: Outer Planets (2017) *14th IPPW*, The Hague, Netherlands, June 14. [2] Atkinson, D. H. *et al*. (2018) *15th IPPW*, Boulder, CO, June 11–15. [3] Squyres, S., et al., "Visions and Voyages for Planetary Science in the Decade 2013-2022," National Academies Press (2011). [4] Lobbia, M. A. *et al*. (2018) *15th IPPW*, Boulder, CO, June 11–15. [5] Cianciolo, A. D. *et al*. (2018) *15th IPPW*, Boulder, CO, June 11–15. [6] Allen, G. A., Jr., *et al.* (2018) *15th IPPW*, Boulder, CO, June 11–15.

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