



# ENTRY PROBE STUDIES FOR ICE-GIANTS

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The Ice Giants Pre-Decadal Study was requested by NASA HQ as a new look at potential missions to the Ice-Giants. The present study is part of the above study focusing on atmospheric entry analysis of the probes.

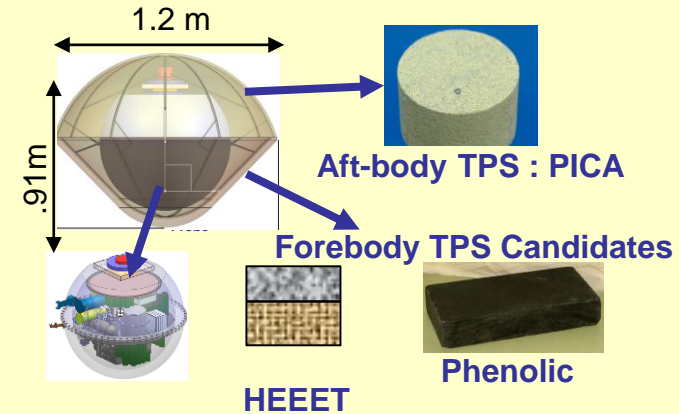
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## OBJECTIVES

- Establish atmosphere definitions for probe entry analysis.
- Investigate viable trajectory options for direct ballistic entry.
- Recommend feasible mission options including entry parameters and technologies and identify gaps

## PROBE WITH AEROSHELL

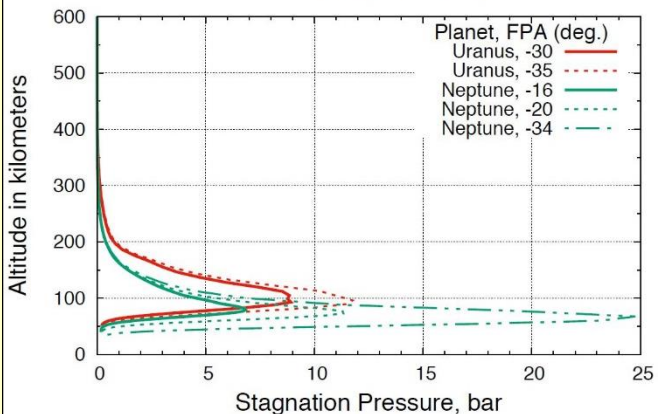


- 1.2 m diameter, 45 deg. sphere-cone
- Total entry mass : ~325kg
- Probe mass of ~200kg

## POINT DESIGNS FOR ENTRY TRAJECTORIES

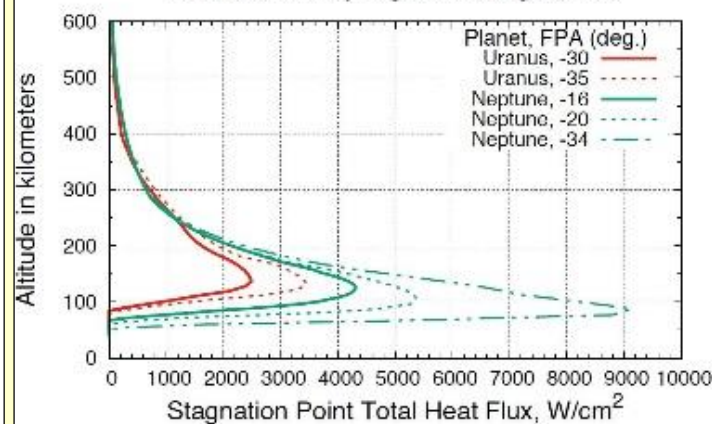
### STAGNATION PRESSURE

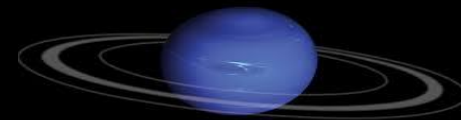
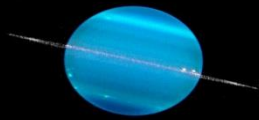
Stagnation Pressure versus Altitude for Uranus and Neptune At Different Entry Flight Path Angle (FPA)



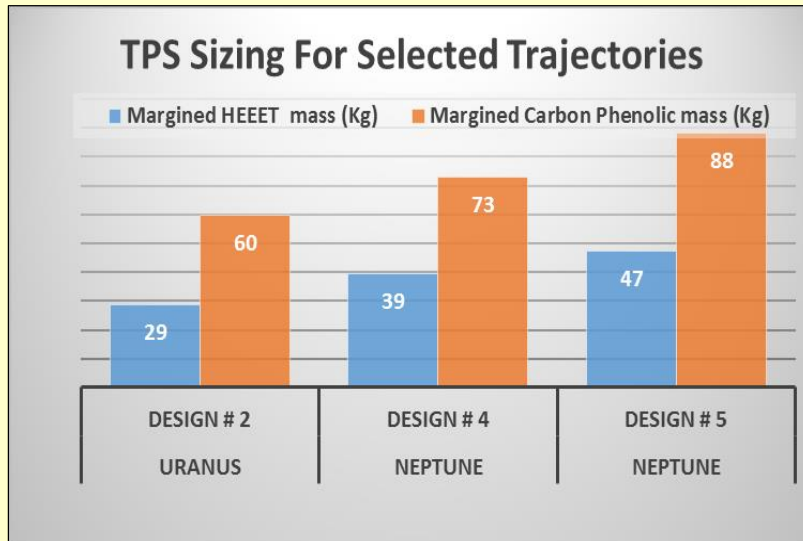
### ENTRY HEATING

Heat Flux versus Altitude for Uranus and Neptune At Different Entry Flight Path Angle (FPA)





## TPS MASS Estimates



## CONCLUSIONS AND RECOMMENDATIONS

- Mission concepts represent “first round” of design iteration between entry systems and communications
- Early engagement of EDL is recommended in future mission studies
- Uranus entry has a feasible design
- Neptune studies are incomplete and require further work for a closed design
- Based on stagnation point heating, a Carbon Phenolic (CP) heatshield is twice as heavy compared to HEEET.
  - Heritage CP is no longer available.
  - HEEET, a more efficient TPS, is under development.
- More detailed study including higher fidelity CFD analysis is recommended.

