



Optimizing the Design of Planetary Entry Probe and Lander Missions

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Program: FY22 R&TD Topics
Strategic Focus Area: GNC and Mission Design

Objectives

To aid science planning for future entry probe missions we have developed a tool for Visualization of the Impact of PProbe Entry (VIPRE) conditions on science, mission and spacecraft design.

- Provides mission formulation teams with a self contained and customizable visualization and tradespace exploration tool to enable rapid end-to-end probe mission prototyping
- Database generation can be accomplished with minimal user input, providing users with a wide toolset for mission design, entry targeting and data-uplink analysis
- Constraint-based interaction allows for direct, easy evaluation of scientific value and mission feasibility in real time.

Background

Atmospheric probes and landers provide a critical method for understanding the composition, structure, and dynamics of bodies throughout the solar system. The engineering and science for such a mission requires a delicate balance between science objectives, orbital mechanics, atmospheres, and signal processing.

VIPRE seeks to expand the capabilities of mission formulation teams to more effectively design such missions by providing a means to explore, filter, and visualize mission options and parameters in an intuitive GUI format.

Approach and Results



- 1 Overview displays selected trajectory summary
- 2 Customize filters and select filter values based on mission parameters and constraints
- 3 Create a variety of customizable visualizations: Scatterplots, 3D projections, and tables
- 4 Select from several data base sources: Trajectories, Entries, Data Uplink, Maneuvers, etc
- 5 Select the variables to be visualized or tabulated based on the selected source
- 6 Select a trajectory to view its entry options
- 7 Tooltips provide full details of a trajectory or entry when selecting
- 8 For each entry point a probe and carrier spacecraft trajectory are computed. Multiple entries can be selected to compare trajectory characteristics
- 9 Entry points are rejected if they are not reachable or require hazardous operation (ring flythroughs)
- 10 3D projections automatically show the Earth and Sun directions at the time of entry
- 11 Selecting an entry point allows the user to view its data uplink performance throughout descent
- 12 Tables allow the user to select and sort the data in each of the database sources
- 13 A dropdown allows the user to change mission target
- 14 The setting page allows the user to change the mission database
- 15 Users can load and save configuration files for sharing of figures and trajectory/entry selections
- 16 The launch vehicle dropdown allows users to better understand the delivered mass available
- 17 Data uplink scaling factor allows for simple change to evaluate telecom systems and needs

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Significance/Benefits to JPL and NASA

- VIPRE enables concurrent design of science, mission, and spacecraft parameters
- Versatile visualization options reveal data for trade space exploration
- Real-time filtering and data manipulation facilitate decision making
- The preliminary designs generated by VIPRE provide a foundation for refinement in higher-fidelity models

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