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Saturn Probe Mission Concepts: US 2012 Decadal Survey Studies

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In the past decade the scientific motivation for a mission to conduct in situ atmospheric measurements at Saturn has been well documented and is summarized in the US 2012 Planetary Science Decadal Survey (PSDS) white paper, "Entry Probe Missions to the Giant Planets" (available at http://www.mrc.uidaho.edu/∼atkinson/Papers/Publ/OutrPlanPrbsWhiteppr_Final.pdf). The science rationale is discussed in an accompanying paper at this meeting, "A Shallow Probe Mission to Saturn," (A. Colaprete et al., Session PS3.0, EGU2011-9494).

In December 2009 the Giant Planets Panel of the PSDS requested a series of two studies to determine whether a mission to deliver one or more entry probes into Saturn's atmosphere might fit within the resource constraints of NASA's New Frontiers Program. The first study, a "Trade Study" conducted at JPL in January 2010, focused on major high-level trades, such as determining if there might be a significant cost difference between a mission concept based on solar electric power and one based on electric power from a radioisotope power source (RPS), and establishing the most promising, cost-effective mission architecture options. These were the basis used to determine if a more detailed design study would be warranted. This first study found that the design study was indeed warranted, and within the uncertainties of the high-level analyses there was no discernable difference between the estimated total mission costs of a solar-powered mission and an RPS-powered mission.

The second study was conducted in March 2010 by core members of the first study team working with JPL's "Team X" concurrent engineering design team, using a study plan based on the results of the first study. The Team X study's more detailed analyses verified many of the conclusions reached by the Trade Study, including the potential fit within New Frontiers Program resource constraints. It verified that for the great majority of Saturn approach trajectories, there are easily-implemented trajectory options for both probe delivery to scientifically interesting regions and effective Galileo-like relay of the probe data, at greater data rates. But it also found a discernable difference in the cost of solar-powered and RPS-powered implementations: surprisingly, for the same mission profile, the solar-powered option would be slightly more expensive than the RPS-powered option.

This paper gives the high-level results of those studies, discussing example mission profile options, the strawman payload assumed, the (relatively small) size of the data set, and methods for returning the data to Earth.