Aerocapture Technology for Enabling Ice Giant Exploration

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Abstract

In-situ exploration of the Ice Giant planets will require novel approaches for reducing trip time
and mass, to maximize scientific return for a reasonable cost. Although such a mission is

expected to be ten or more years in the future, there are some enabling, long-lead technologies

that should be demonstrated in the next four to six years to reduce risk in support of Ice Giants

exploration. One such technology is Aerocapture.

Aerocapture is the use of atmospheric drag, in lieu of propellant, to slow a vehicle from a

hyperbolic, heliocentric orbit to an elliptical orbit about a planet or moon in a single

atmospheric pass. The aerocapture maneuver has been studied for decades, and is deemed

enabling for missions where the spacecraft is approaching a body at high velocity, where the

spacecraft mass is high, or where both are true. Aerocapture is directly applicable to emplacing

a large, scientifically-capable orbiter, carrying at least one probe, in orbit about Uranus or

Neptune. According to the Fall 2018 Findings of the Outer Planet Assessment Group (OPAG),

Neptune is a preferred Ice Giants Flagship mission destination, with Triton being a priority

Ocean Worlds target. Optimal interplanetary trajectories to Neptune will occur in 2028-2030,

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and will not repeat for twelve years.

Although Aerocapture has never been fully demonstrated in flight, much related work has been

conducted and flight-proven, to raise its Technology Readiness Level (TRL) and reduce its risk.

This presentation will introduce the fundamentals of Aerocapture, and present some results

from a survey of past studies of Aerocapture at the Ice Giants. In particular, an in-depth study

of Neptune Aerocapture was conducted in 2003 and serves as the basis for more recent

studies. The presentation will also provide a history of Aerocapture technology development

efforts over the past two decades, in the United States. Finally, we will suggest methods by

which Aerocapture risk can be retired in the four-to-six-year timeframe necessary for 2028-

2030 mission infusion and make the case that Aerocapture should be included in the

architecture trade space for any future Ice Giant mission studies, including those recommended
by the Mid-Term Planetary Decadal (Visions and Voyages) Review.

Keywords: Aerocapture, arrival, orbiter, probe, Neptune, Triton, Uranus, Entry, Descent and Landing (EDL), technology maturation