



National Aeronautics and
Space Administration

Innovative Technology for Outer Planet Science Missions

Presentator Title
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Key Science Themes

PROTECT & IMPROVE
LIFE ON EARTH &
IN SPACE



SEARCH FOR LIFE
ELSEWHERE

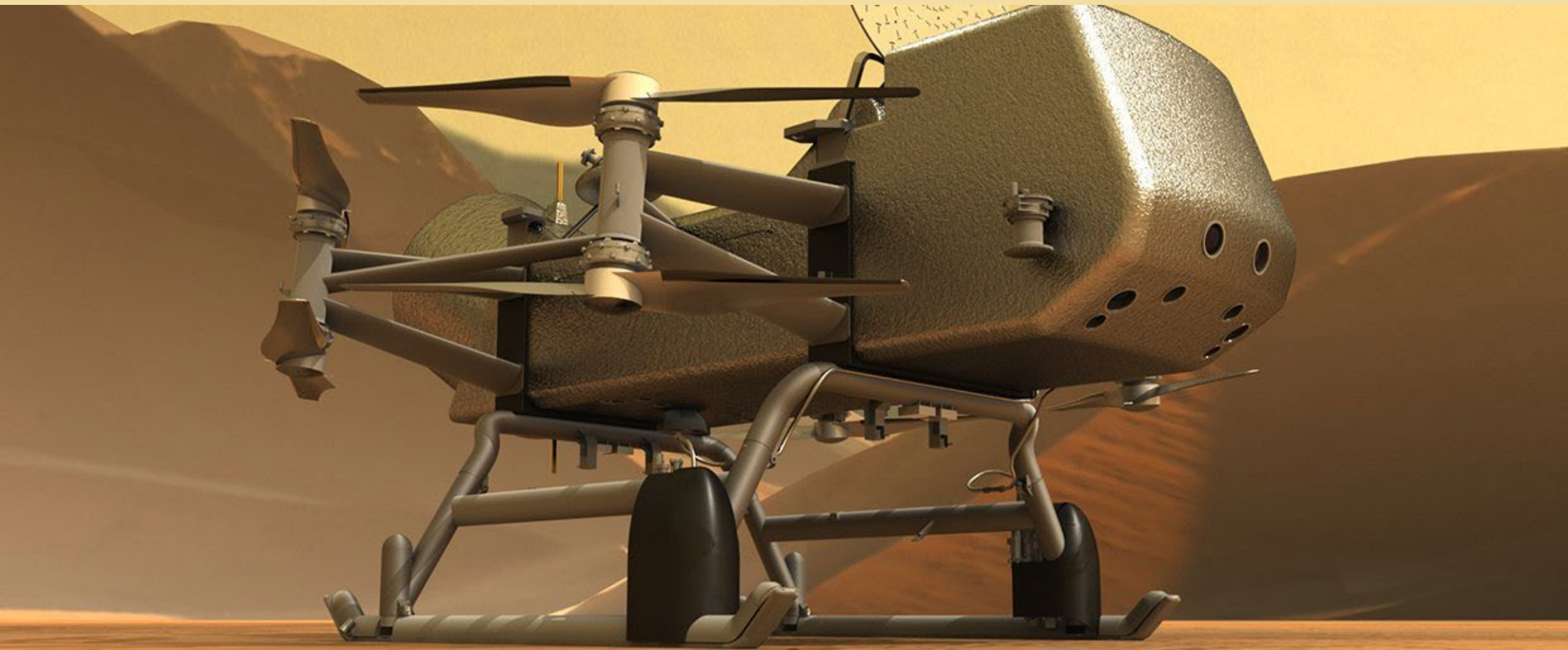


DISCOVER SECRETS
OF THE UNIVERSE





DART approaching Dimorphos (NASA/Illustration)



Dragonfly on Titan (NASA/Illustration)



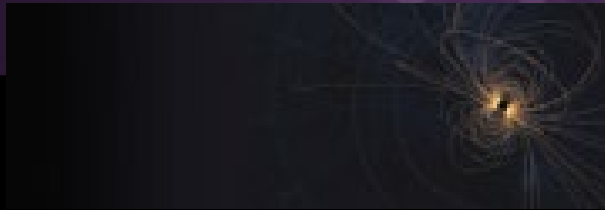
Europa (NASA/Juno)

Flagship Priorities for Planetary Science

Origins



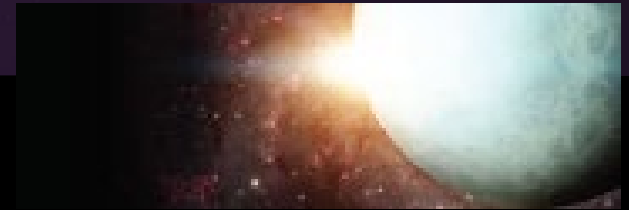
Processes



Habitability



Interconnections

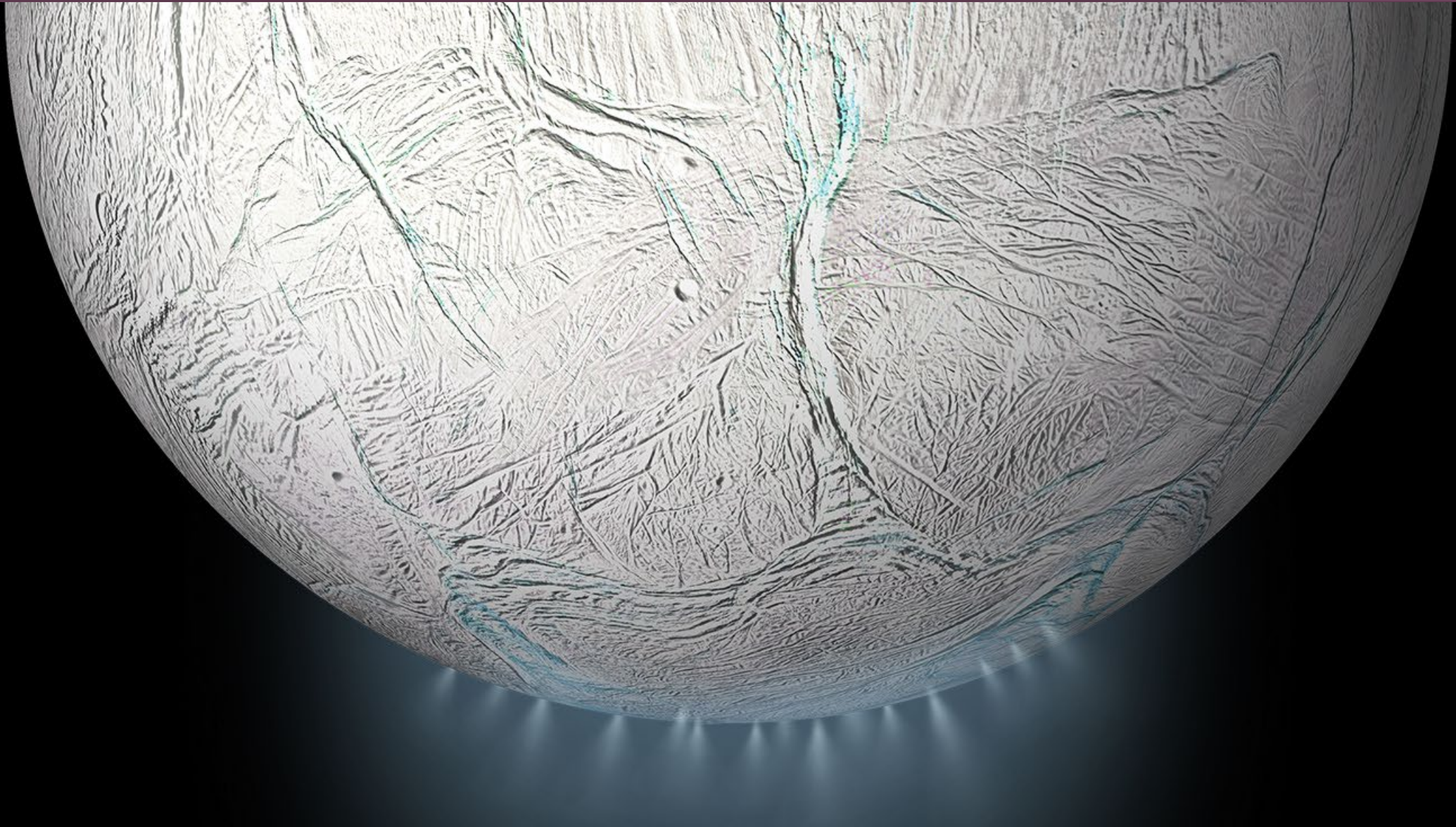


Uranus Orbiter and Probe

Enceladus Orbilander



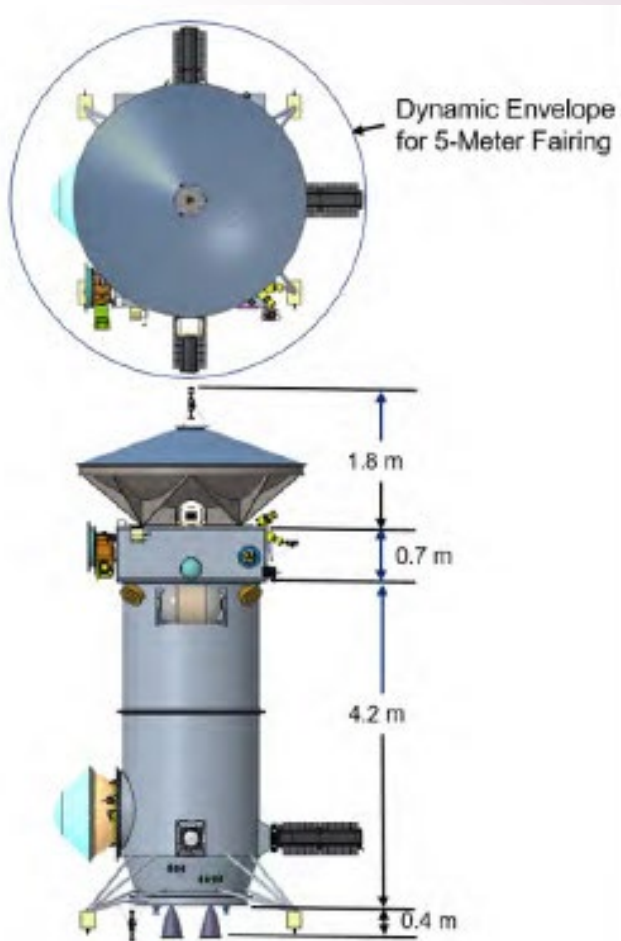
Uranus (NASA/JWST)



Enceladus Plumes (illustration)

Uranus Orbiter and Probe Nominal Configuration

A. Simon et al. (2021)



18.9 AU average heliocentric distance

June 2031 launch date: 13.4 years (12-15 yr range through 2038 launch)

2.8 t dry mass (includes probe)

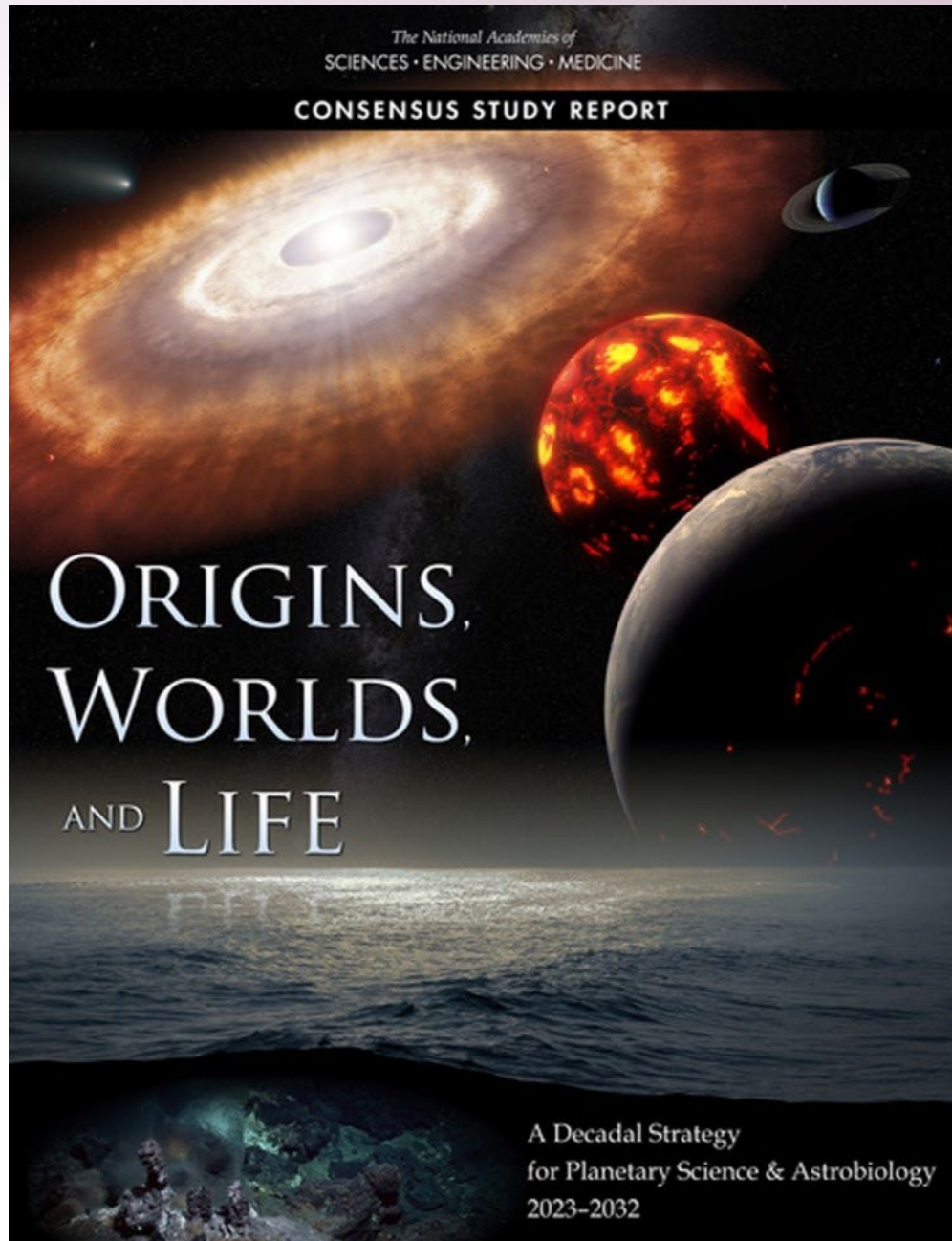
7.2 t wet mass (4.5 t propellant and oxidizer – 60%)

2.3 km/s total ΔV for Orbiter – 1.0 km/s of that for Uranus orbit insertion

Payload: 85.5 kg, 95 W (includes probe)

Aerocapture: Transit to Uranus in 7-9 years, save 1 t fuel for orbit insertion
– S. Dutta, “Aerocapture as an Enabling Technology for Ice Giants” Nov 2023

Nuclear Electric Propulsion: Transit to Uranus in ~10 years (50 kg payload) --
GRC, JPL, LANL: “Kilopower–Nuclear Electric Propulsion for Outer Solar System
Exploration,” JPL D-103385, April 24, 2019



Aerocapture

“Aerocapture is an orbital insertion technique which uses a single pass through a planetary atmosphere to dissipate enough orbital energy for planetary capture. It can deliver large orbit insertion ΔV s with minimum fuel, resulting in significant reductions in transit time and/or increases in science payload mass.”

Finding: “Aerocapture is a technology that is ready for infusion and that can enhance/enable a large set of missions, but that will require special incentives to be proposed and used in a science mission.”

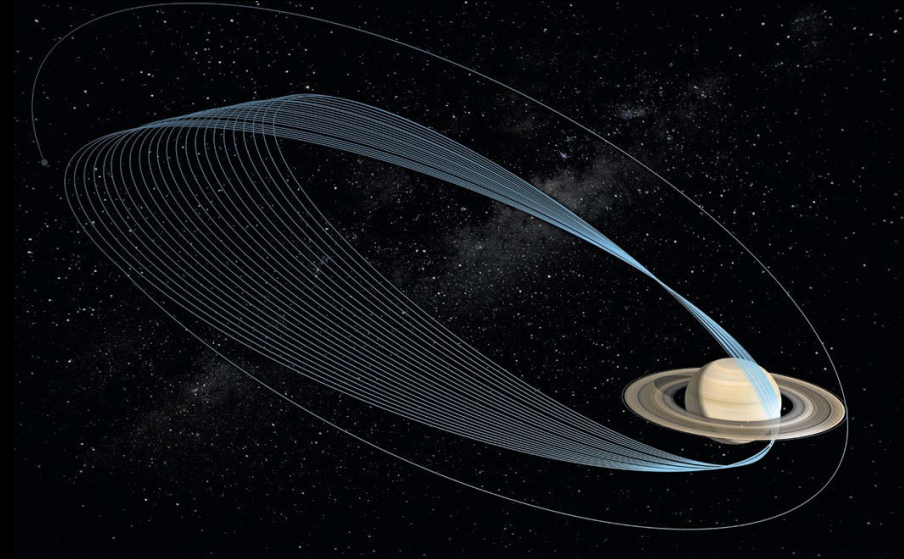
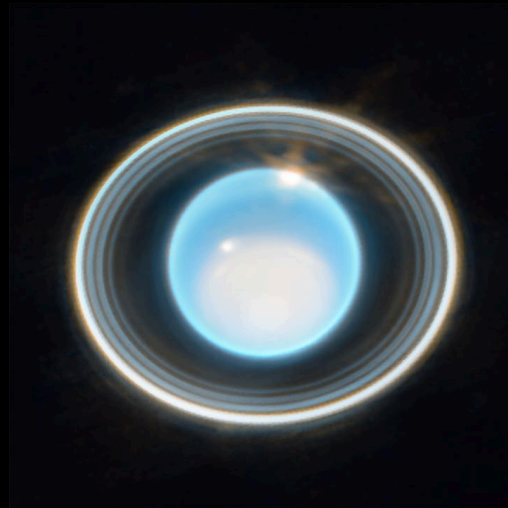
-- Origins, Worlds and Life: A Decadal Strategy for Planetary Science and Astrobiology (2022)

Aerocapture Demonstration Relevance Assessment Team

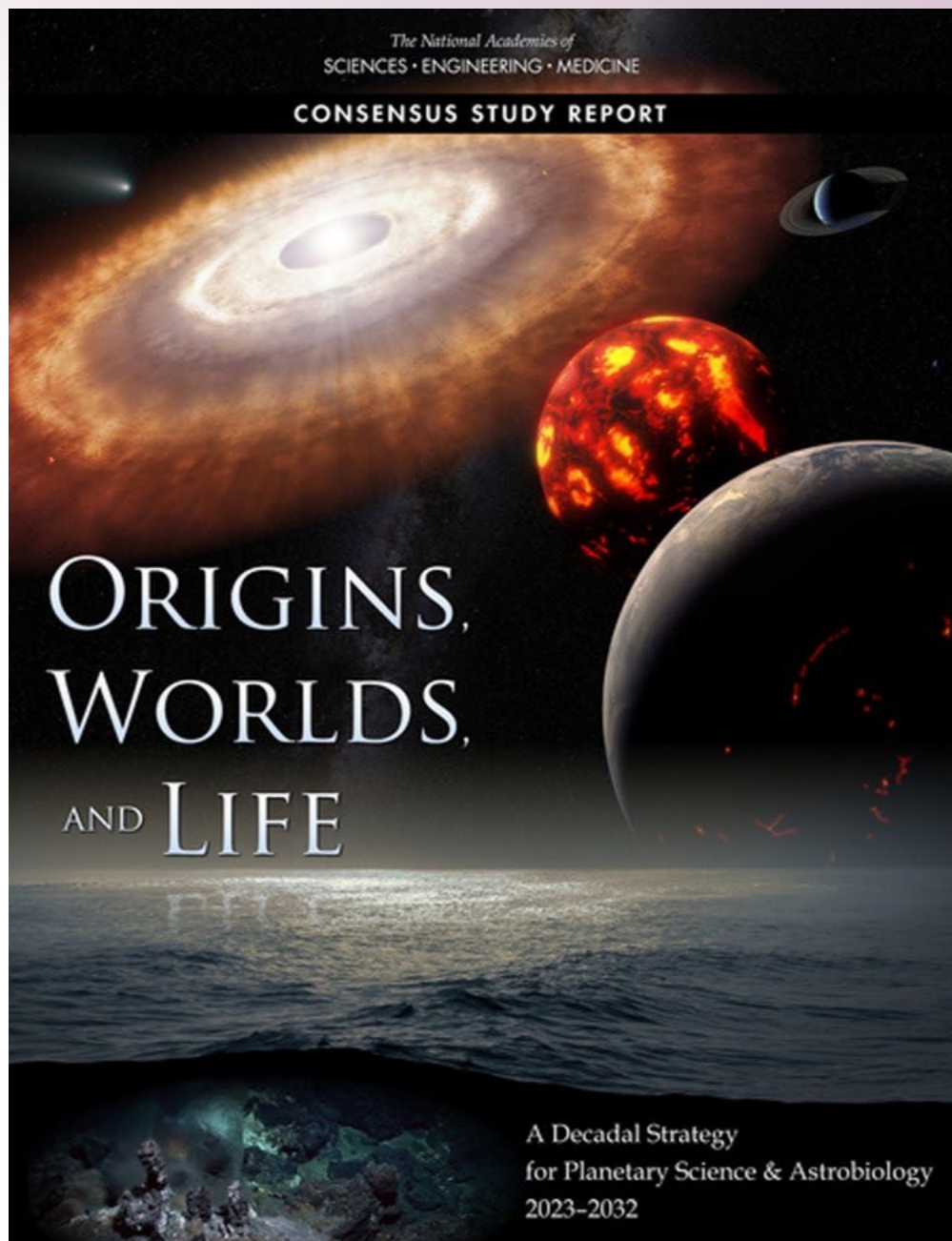
Final Briefing: November 29, 2022

Autonomous Navigation Demonstration Relevance Assessment Team

Final Briefing: July 25, 2024



SMD studies to assess scientific merit of
potential technology demonstrations,
and to provide objectives for demonstration if merited



Nuclear Propulsion

“Fission power systems can ...offer new possibilities for more capable missions and access to the farthest reaches of the solar system and beyond. NTP and NEP ...can significantly lower costs while enabling heavier science payloads and more frequent missions, and more importantly, open up exciting new science concepts.”

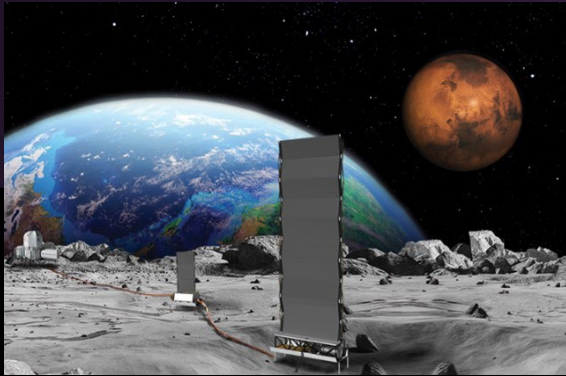
-- Origins, Worlds and Life: A Decadal Strategy for Planetary Science and Astrobiology (2022)

“Flight times to Saturn with 10 kW NEP can be as short as 5 years with 50 kg of science payload and 500 kbps of downlink data rate compared to 10 years with solar panels or RTGs”

“Outer solar system exploration missions having a Cassini-class science payload within short mission lifetimes (8 to 15 years)”

-- J.R. Casani et al: “Enabling a New Generation of Outer Solar System Missions: Engineering Design Studies for Nuclear Electric Propulsion” White Paper to Planetary Decadal Survey Report

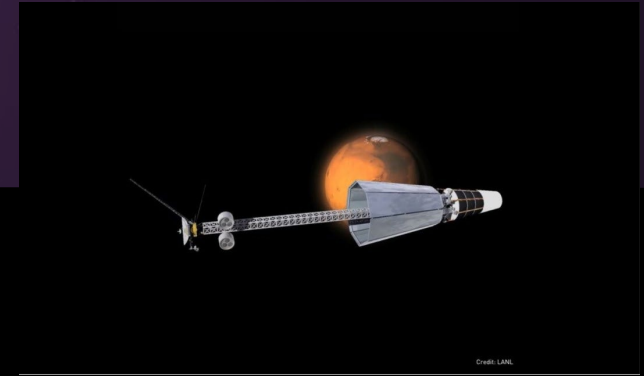
Nuclear Propulsion and Power



**Fission Surface
Power**



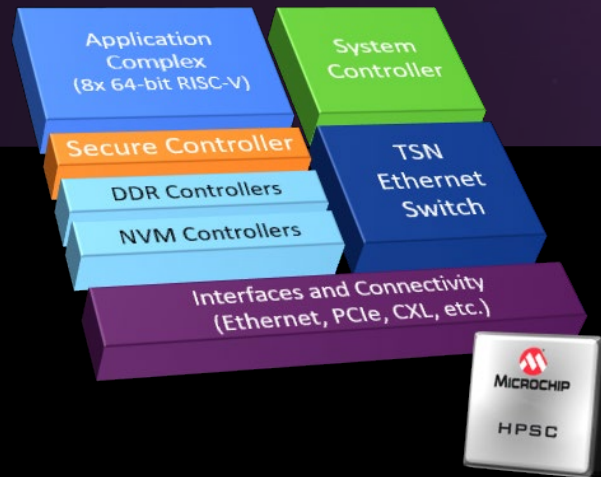
DRACO
Nuclear Thermal
Propulsion



JETSON
Nuclear Electric
Propulsion

Fast Transit and/or Large Payloads • High Data Rate Communications • Maneuverability

Advanced Data Processing



**High Performance
On-board
Computing**



**In-Space Data
Processing**



**High Data Rate
Communications**



Summary

- Landers and probes to outer planets are a high priority for future science exploration
- Both aerocapture and nuclear propulsion can substantially reduce trip times to the outer planets
- The amount of data returned is the true measure of science efficacy –
 - On-board data processing and high data rate communications are key to increasing science return