National Aeronautics and Space Administration

RADIOISOTOPE POWER SYSTEMS PROGRAM

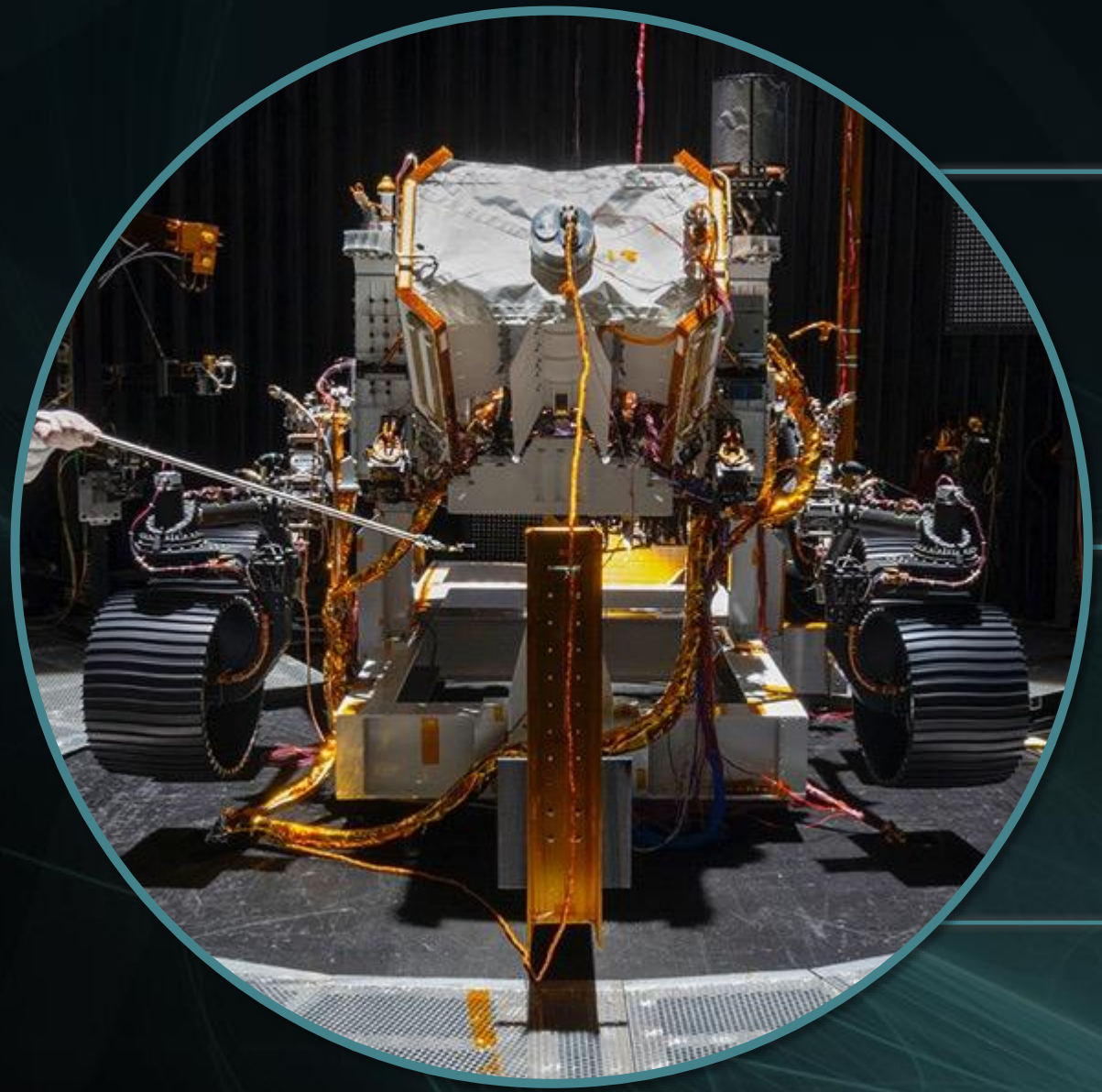
7th Isotope Federal Supply and Demand Workshop

Powering Exploration

June Zakrasjek

RPS Program Manager

Power to…



EXPLORE

DISCOVER

UNDERSTAND

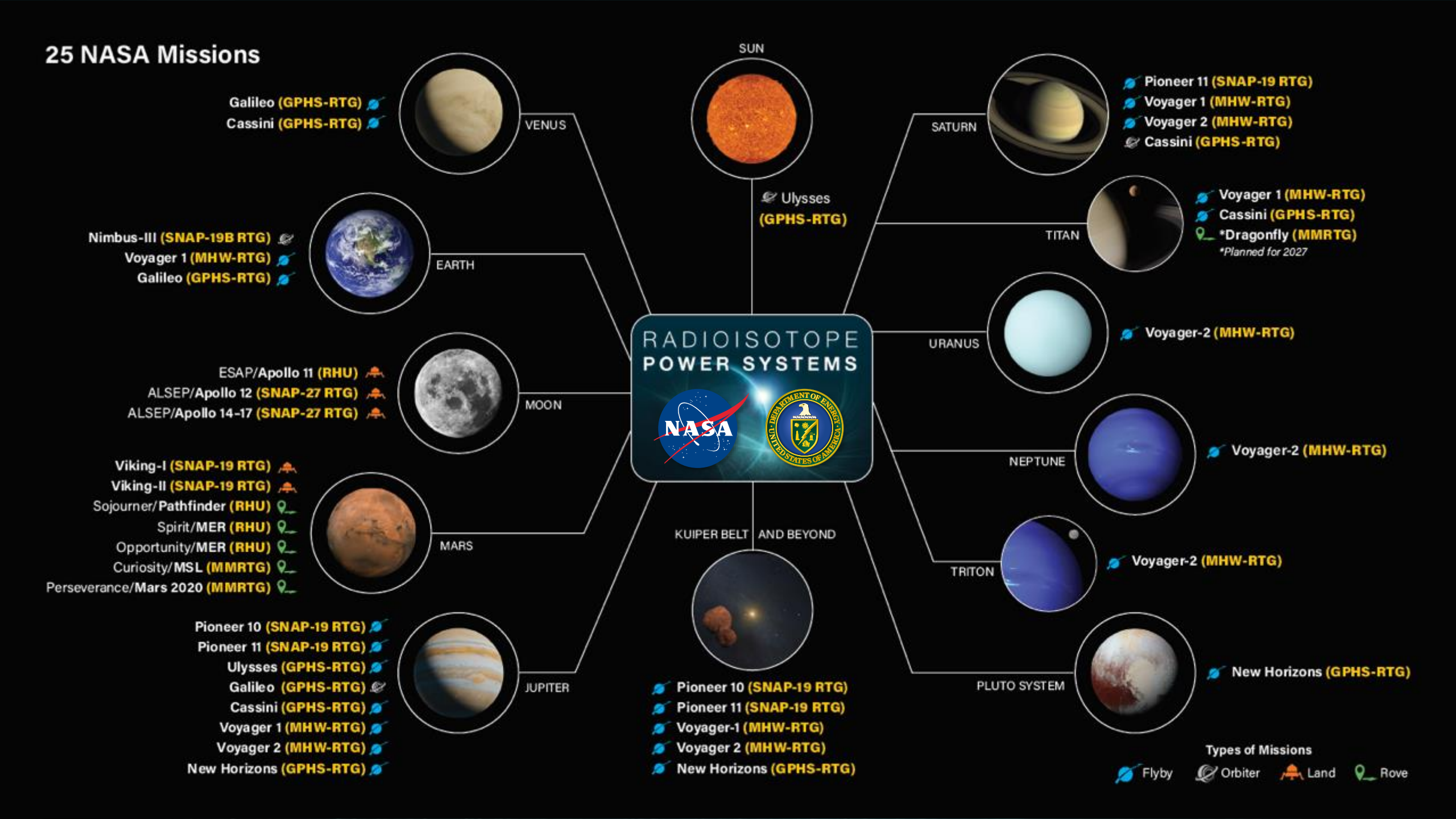
PEOPLE

POWER

PRODUCTION

PROGRESS

25 NASA Missions



Non-NASA Missions

5 Navy

2 Air Force

- Transit 4A **(SNAP-3B, 7)** 1961
- Transit 4B **(SNAP-3B ,8)** 1961
- Transit 5BN-1 **(SNAP-9A)** 1963
- Transit-5BN-2 **(SNAP-9A)** 1963
- Triad-01-1X **(Transit-RTG)** 1972
- LES 8 **(MHW-RTG)** 1976
- LES 9 **(MHW-RTG)** 1976

Types of Missions

- Orbiter
- Navigational
- Communications

Testament to the **Reliability of RPS Systems**

LES 8*
Mar. 14, 1976–2004
MHW RTG: 158 W_e BOL

LES 9*
Mar. 14, 1976–May 20, 2020
MHW RTG: 158 W_e BOL

Cassini
Oct. 15, 1997–Sept. 15, 2017
GPHS RTG: 292 W_e BOL

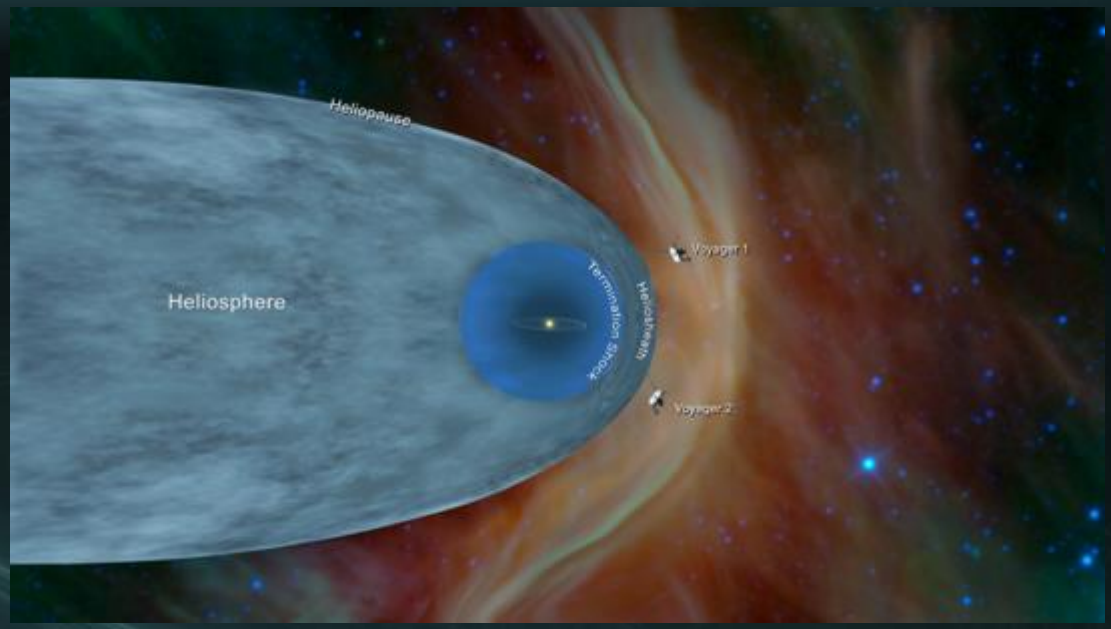
New Horizons
Launched Jan. 19, 2006
GPHS RTG: 292 W_e BOL

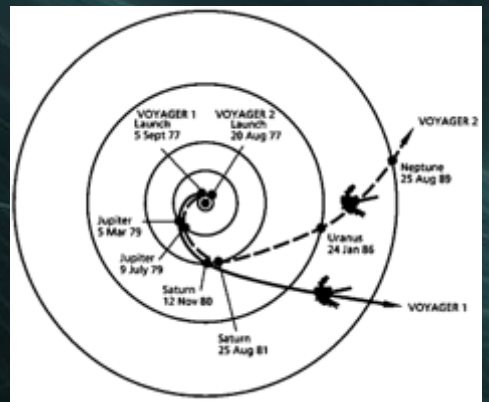
Voyager 1
Launched Sept. 5, 1977
MHW RTG: 158 W_e BOL

Voyager 2
Launched Aug. 20, 1977
MHW RTG: 158 W_e BOL

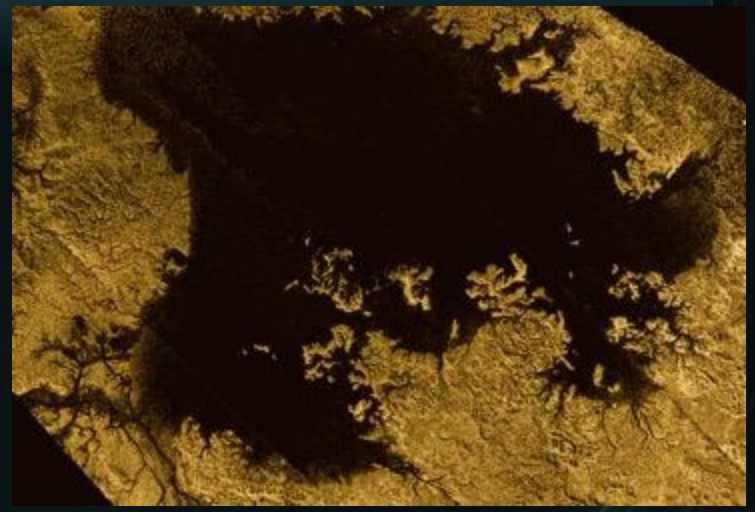
* U.S. Air Force Mission

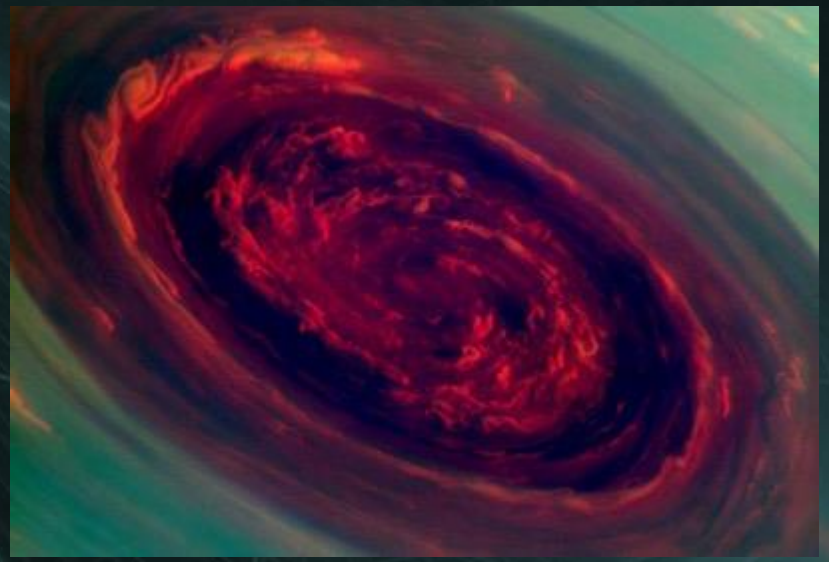
Voyagers 1 & 2


Heliopause
Heliosphere
Termination Shock
Heliosheath
Voyager 1
Voyager 2


VOYAGER 1
Launch
5 Sept 77
VOYAGER 2
Launch
20 Aug 77
VOYAGER 2
Neptune
25 Aug 89
Jupiter
5 Mar 79
Jupiter
9 July 79
Uranus
24 Jan 86
Saturn
12 Nov 80
Saturn
25 Aug 81
VOYAGER 1

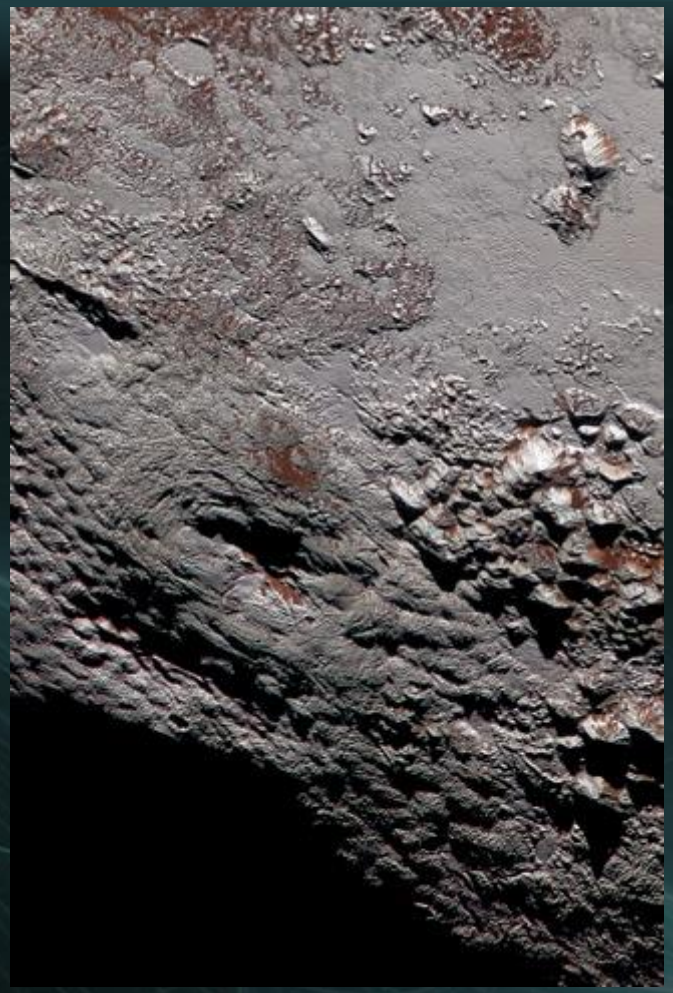
Cassini

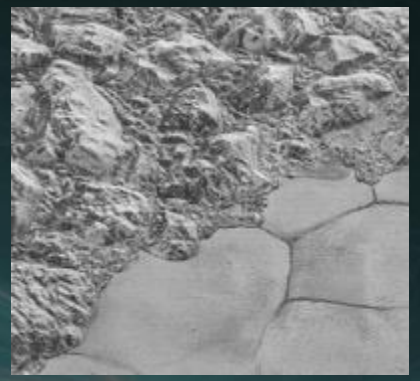


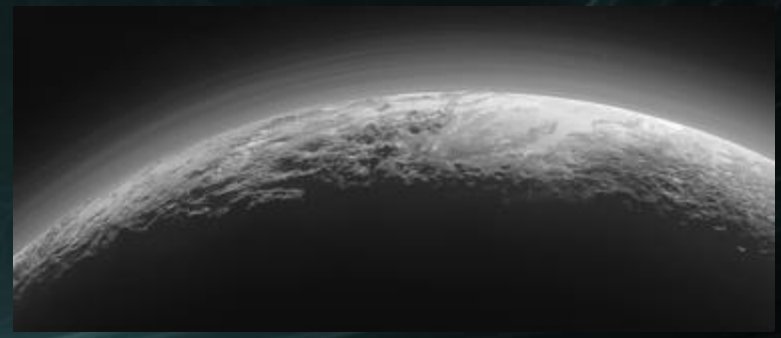


Mars Science Lab | Curiosity

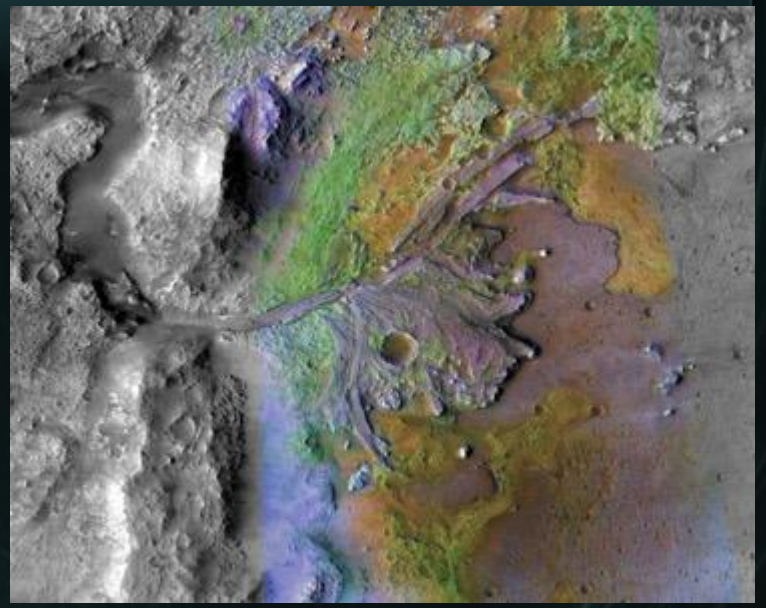
New Horizons

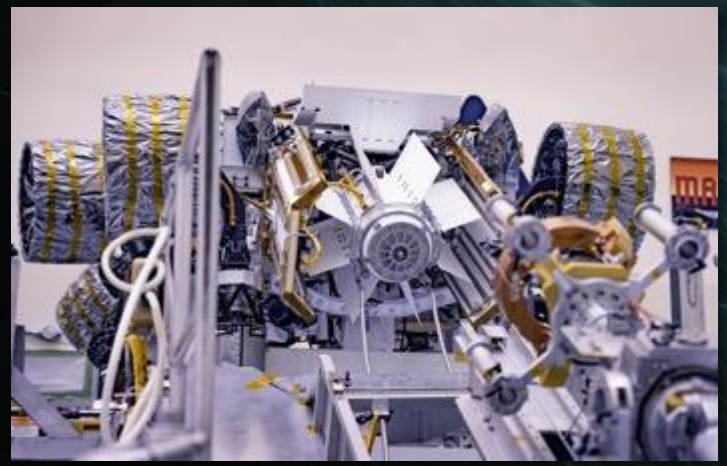




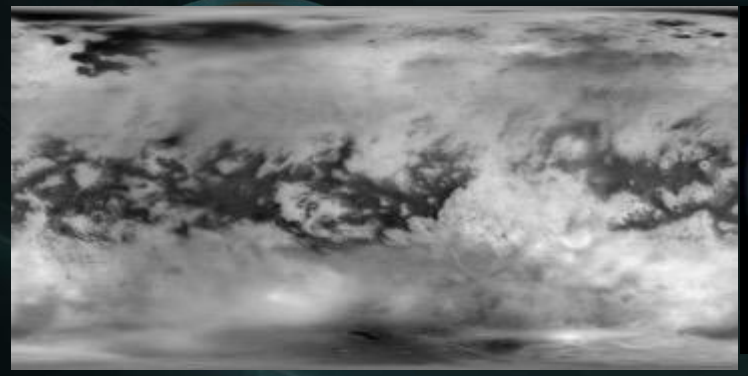


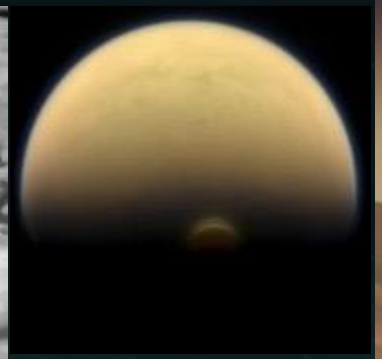
Mars 2020 | Perseverance Rover

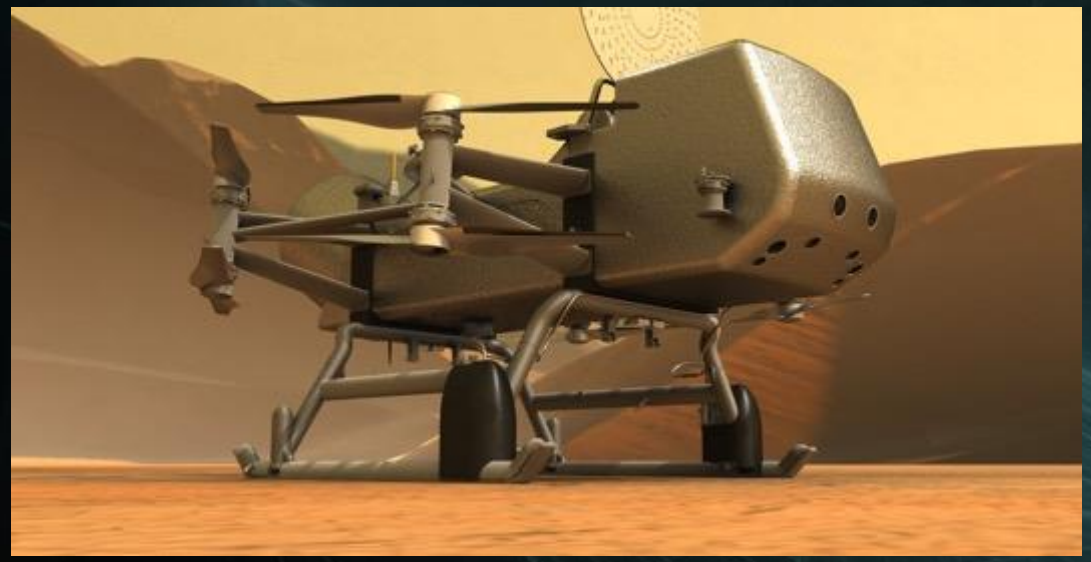




Dragonfly



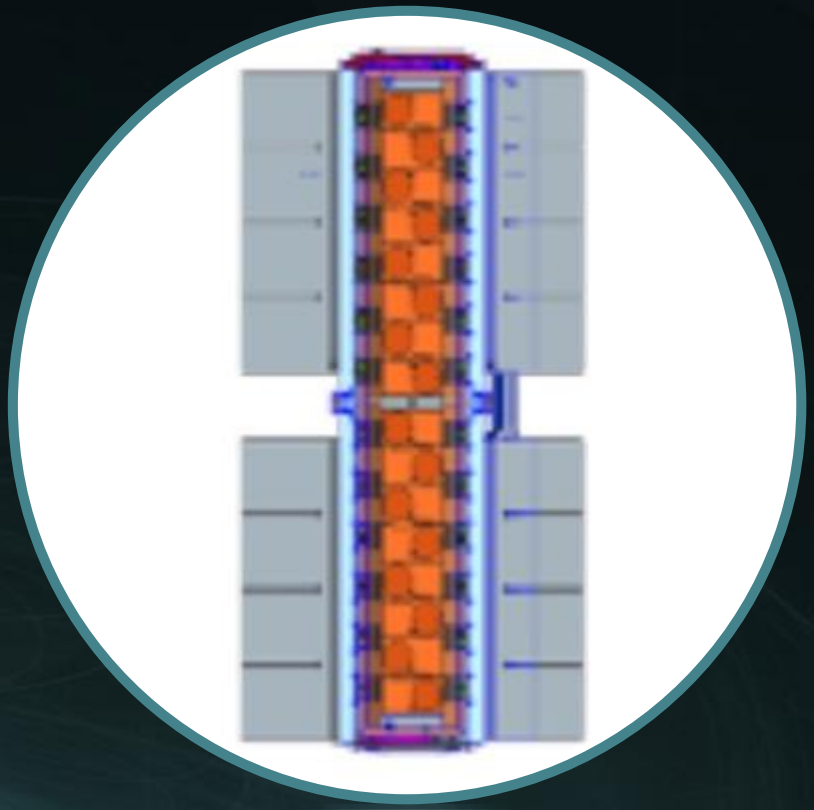




Technology Investments
Enable New Radioisotope Generators

MMRTG

Multi-Mission
Radioisotope Power
System



Next Gen RTG

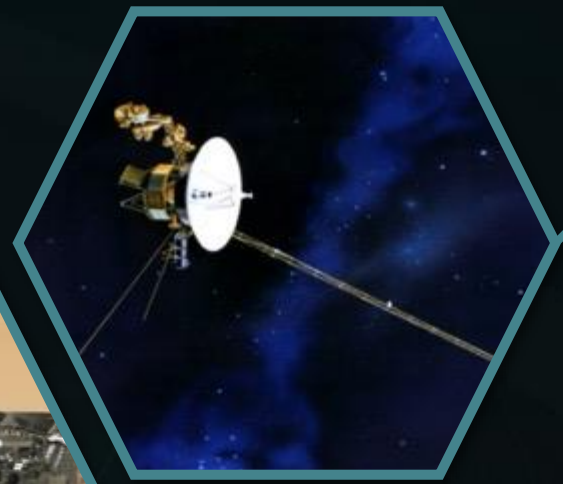
Deep Space
Radioisotope Power
System

DRPS

Mulit-Mission
Dynamic Radioisotope
Power System

PERSEVERANCE

Voyager 1 & 2

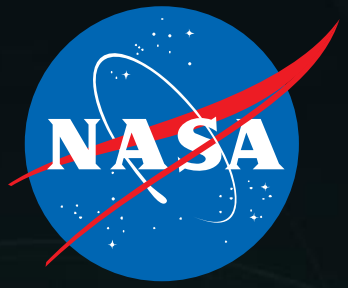


UNKNOWN POSSIBILITIES

DRAGONFLY

(PROPOSED) TRIDENT

New Horizons




NASA


NASA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NASA

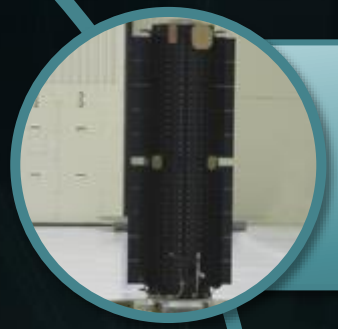
POWER TO EXPLORE

https://rps.nasa.gov

nasa-rps@mail.nasa.gov

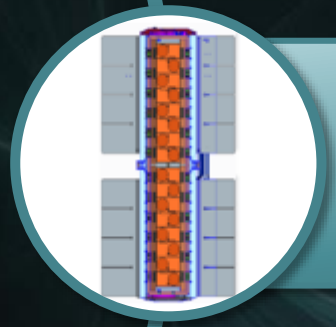
BACK UPS

Power Progression: Deep Space Exploration



MOD 0

Utilize proven GPHS-RTG design, QU at INL refurbished, re-qualified; same couples as the multi-hundred watts used on Voyager; EODL ~ 210W_e



MOD 1

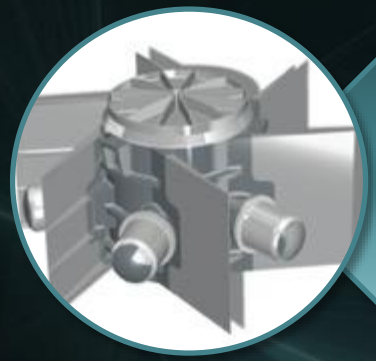
90% heritage design, but lower heat; lower power; 2 trades going on to consider change to stretch the housing; more efficiency of the couples; EODL~177-210 W_e

*Reestablishment of the GPHS RTG production line

MOD 2

"New" Next Gen RTG; which should have a EODL ~290 W_e

Innovative energy conversion investments to provide power in the deep craters of the moon to **enable spacecraft to survive** the long, dark, and cold lunar night.

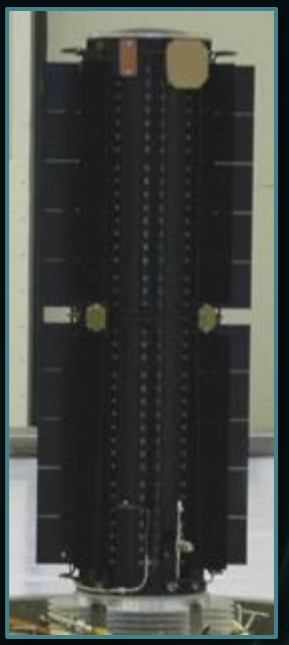


Dynamic Radioisotope Power System (DRPS) could achieve **efficiencies on the order of 3-4 times greater** than the current state of the art, Radioisotope Thermoelectric Generator (RTG).

A **demonstration unit on the moon** could prove the use of dynamic power in space, making DRPS an excellent candidate to enable specific missions that could not be achieve any other way.

Next Gen RTG Project Status

- Phase 1 design efforts by Lockheed Martin and Aerojet Rocketdyne ended with *both contractors* choosing SiGe conversion technology instead of advanced thermoelectrics
  - Integration of the new technology is a high-risk onramp
  - Additionally, Contractors input indicated an additional cost threat
  - *Both contractors* proposed a Mod 2 technology upgrade post 2028
- 2028 Next Gen RTG performance only slightly better than GPHS-RTG performance
  - **~10 % gain in power, for approximately 2x the funding***



* Based on DOE/NASA cost estimates