JPL EP Development and Plans

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Current EP Activities

Flight Applications

- Dawn operations
- ST7 post-operations (just completed)
- Psyche planned development

Pre-Phase A Studies

- Power and Propulsion Element / Deep Space Gateway
- Next Mars Orbiter (NeMO)
- Mission concepts for New Frontiers and Discovery missions

Technology Development / Plasma Modeling

- HERMeS (AEPS contract support) / Plume modeling
- Micropropulsion (MEP, LISA)
- XR-100 (100-kW nested Hall thruster)
- NEXT LDT evaluation
- MaSMi (500-W Hall thruster)
- Li-ion (60,000-s specific impulse ion thruster)
- NIAC Phase I—A Breakthrough Propulsion Architecture for Interstellar Precursor Missions

Dawn

ΔV Provided by the IPS: **11 km/s**

IPS Operating Time: **> 48,000 hrs**

ST-7

- The Space Technology 7 (ST-7) Disturbance Reduction System (DRS) is flying aboard the European Space Agency's (ESA) LISA Pathfinder spacecraft, launched on December 3, 2015.
- The ST-7 DRS consists of clusters of micronewton thrusters

"We were trying to hold it as stable as the width of a DNA helix," said John Ziemer, systems lead for the U.S. thruster system at NASA's Jet Propulsion Laboratory. "And we went down from there to the width of part of a DNA helix."

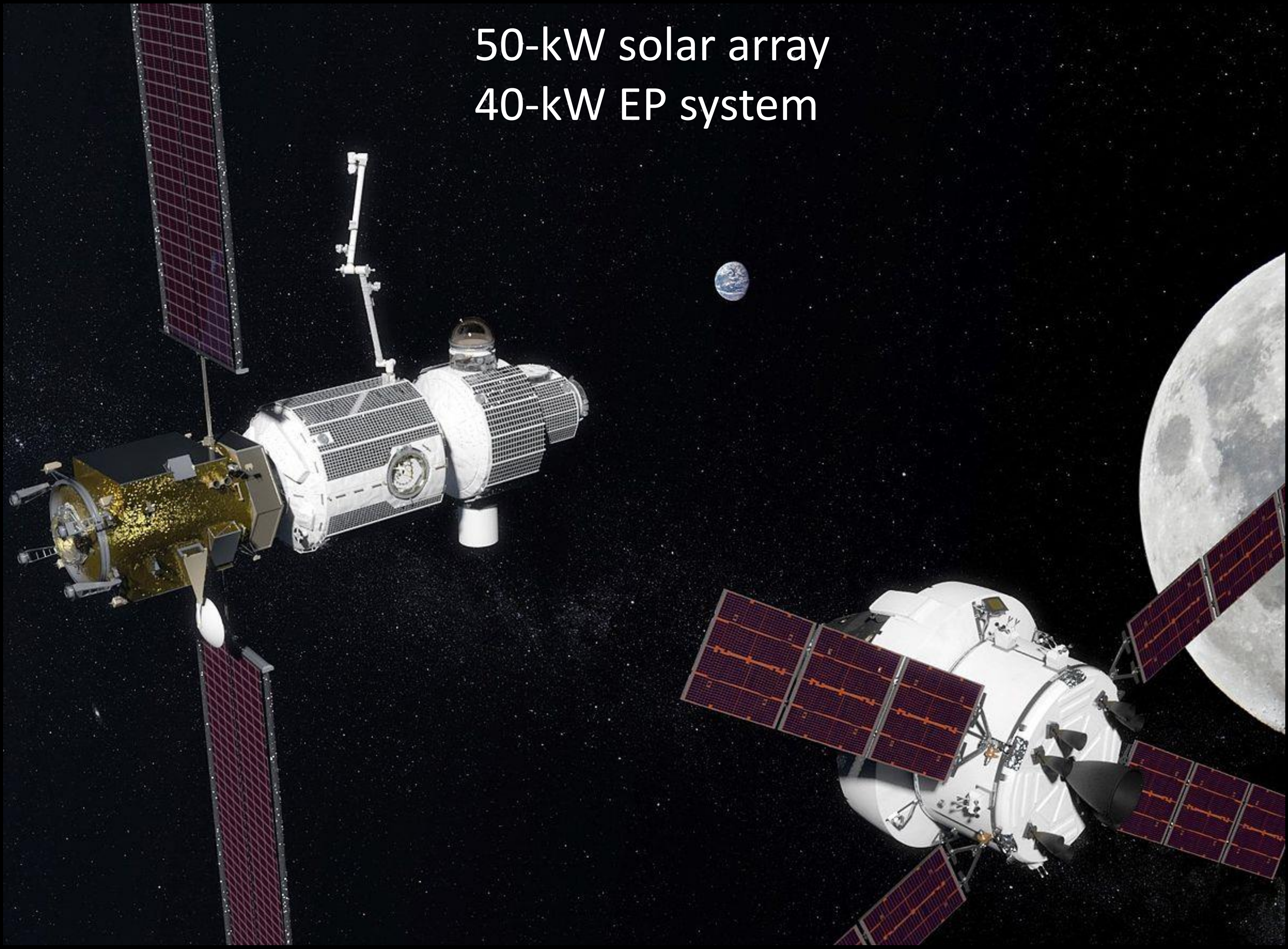
Psyche: Journey to a Metal World

NASA Discovery Mission
- Awarded 2017 for a planned launch in 2023

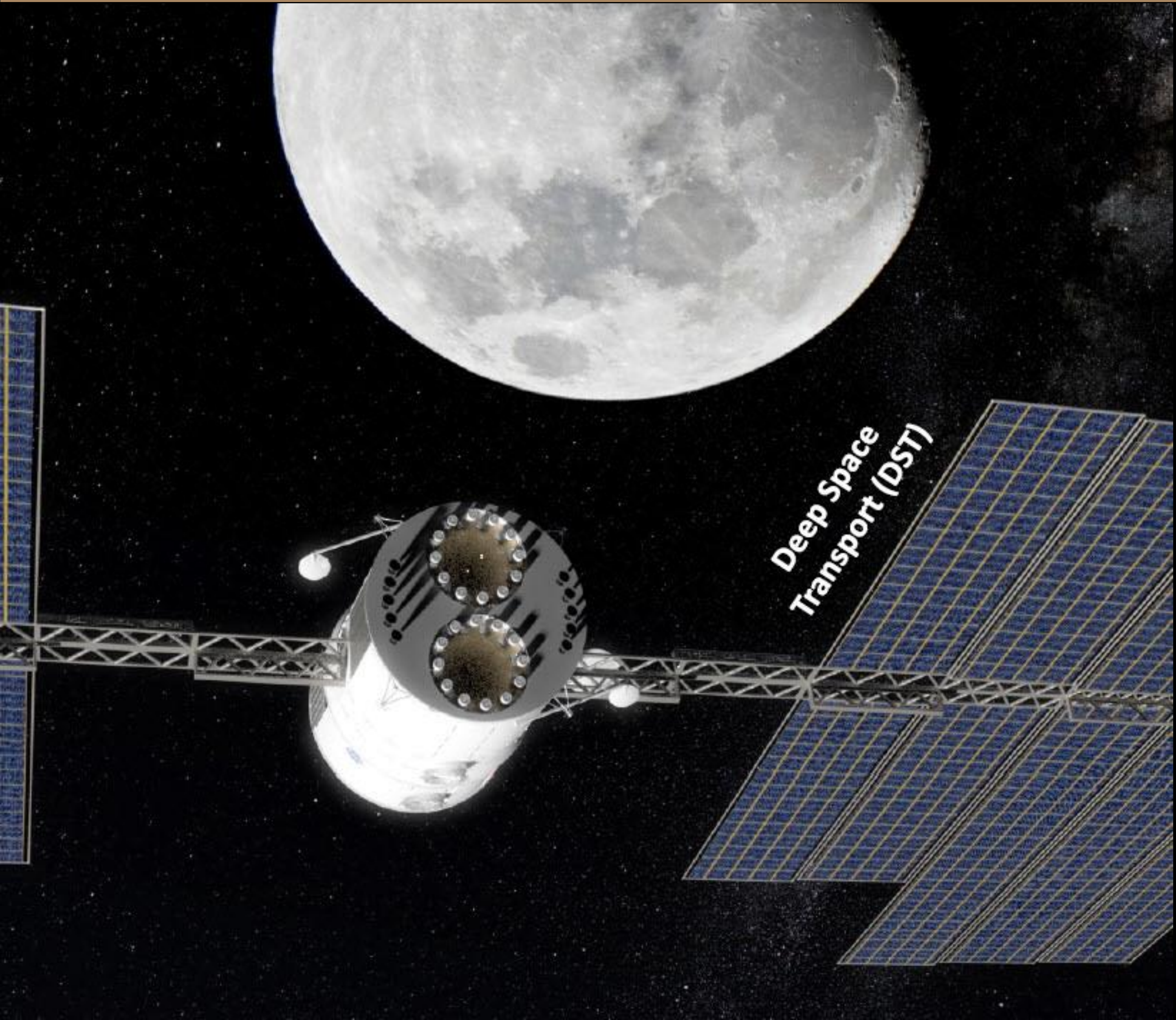
Psyche is the largest metal asteroid
- Diameter ~200 km, high density
- Almost entirely made of Fe-Ni metal

Science
- Is Psyche the exposed core of a larger differentiated body? Or, created by a slow accretion of metal rich material?

Deep Space Gateway Concept / Power & Propulsion Element Concept



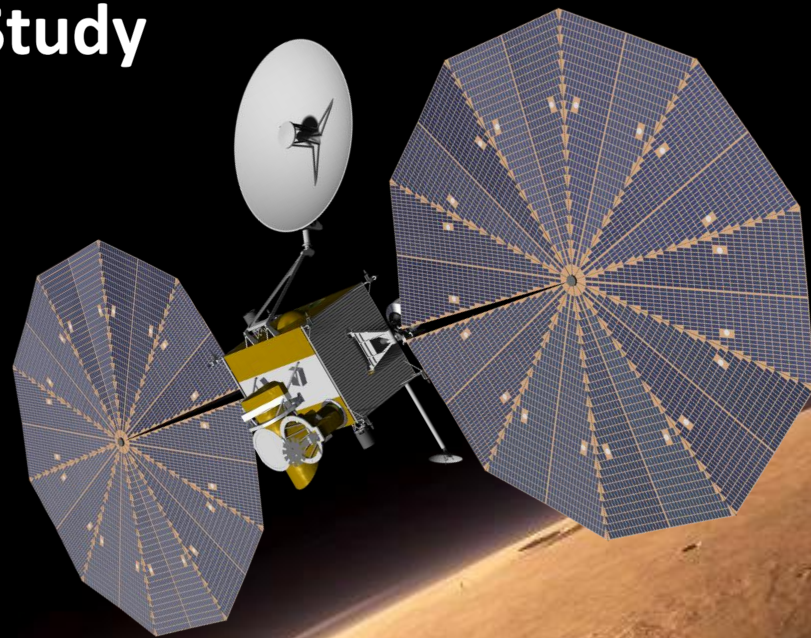
Deep Space Transport Vehicle Concept



Notional Requirements:
400-kW solar array
200-kW EP system

Next Mars Orbiter --Concept

Pre-Phase A Study

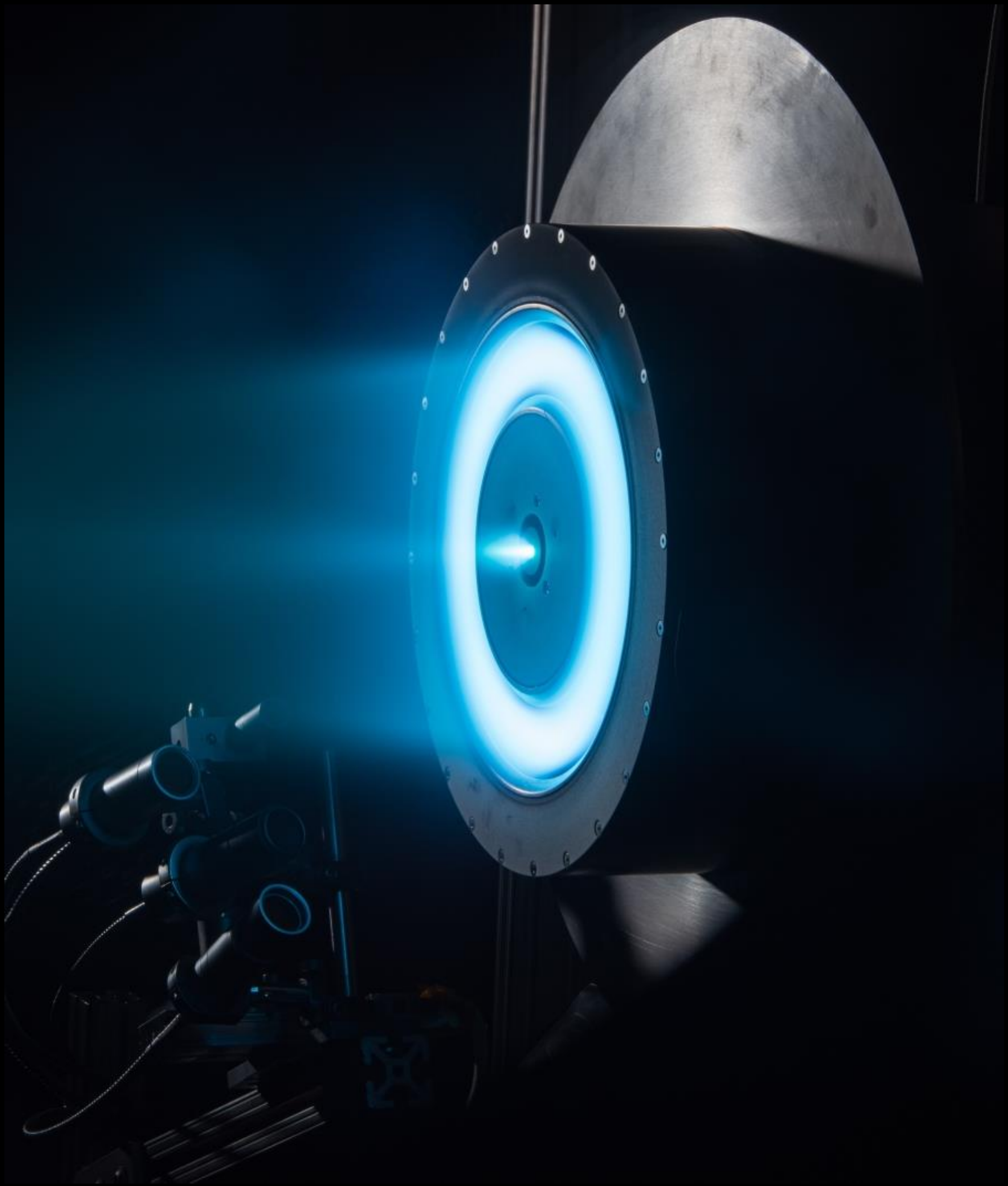


Objectives under consideration by NASA

- High Bandwidth Comm and Relay Support
- High-Resolution Surface Reconnaissance
- Orbital Flexibility to Support Future Missions
- Support for Sample Capture and Return
- Accommodate Contributed Payloads

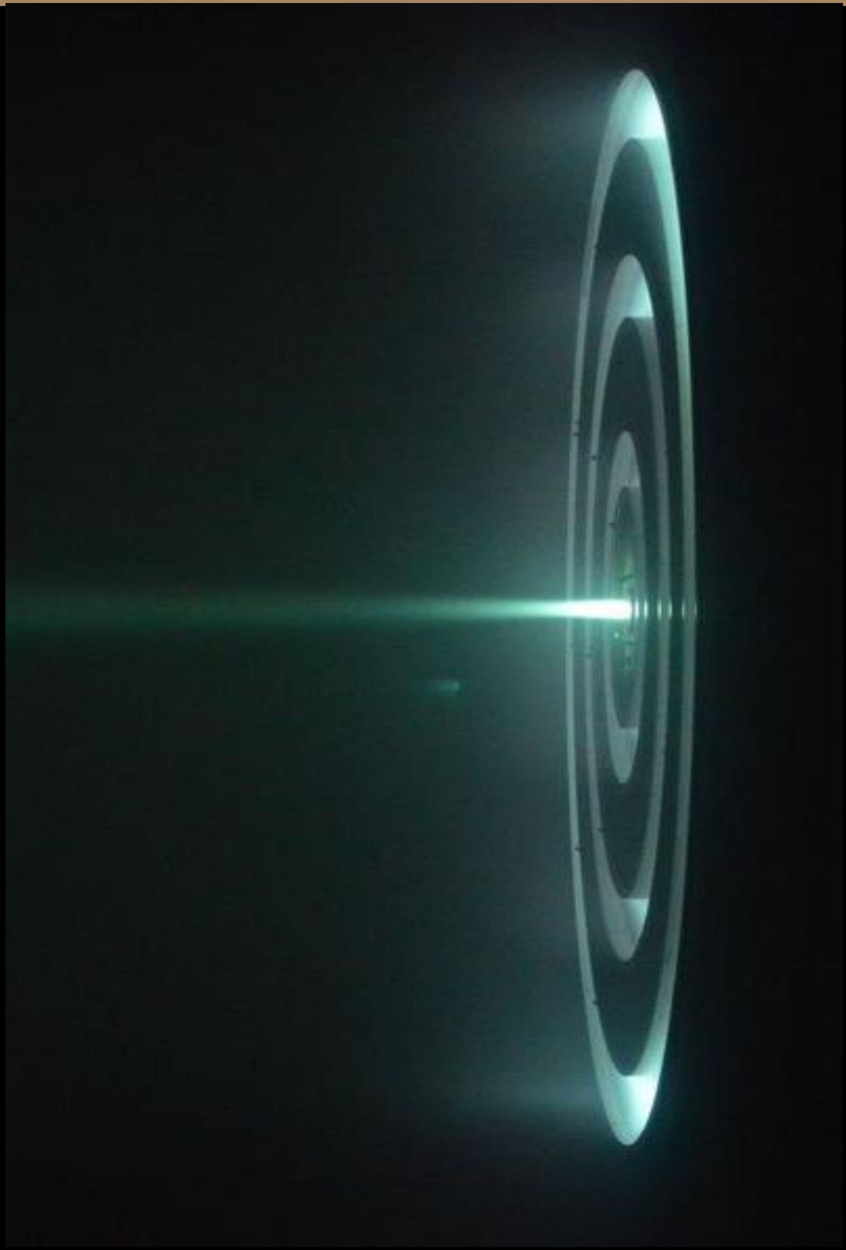
HERMeS Hall Thruster

Power: 12.5 kW
Isp: 2800 s
Xe Throughput: 2000 kg



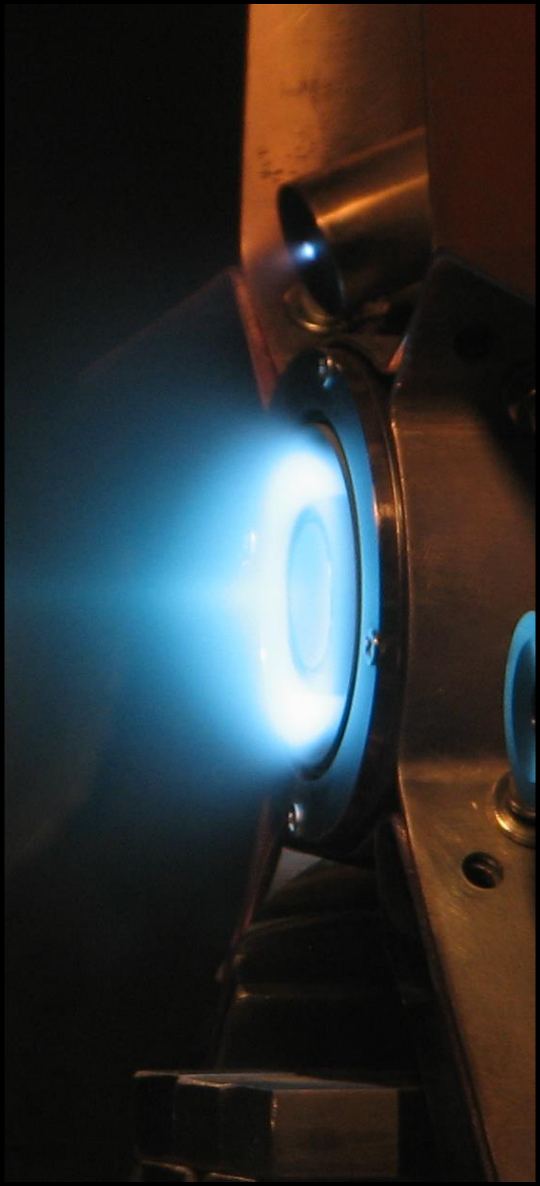
NASA NextStep: XR-100

- 100-kW nested Hall thruster
- Xenon fueled
- Objective:
  - 100 hrs of continuous operation at 100 kW



MaSMi Hall Thruster

- Magnetically-Sheided Miniature (MaSMi) Hall Thruster
- 350 W Hall thruster



Lithium-Ion Thruster

Parameter	State-of-the-Art	Li-ion
Specific Impulse	3,000 to 4,000 s	60,000 s
Input power	7 kW	100 kW
Propellant	Xenon	lithium

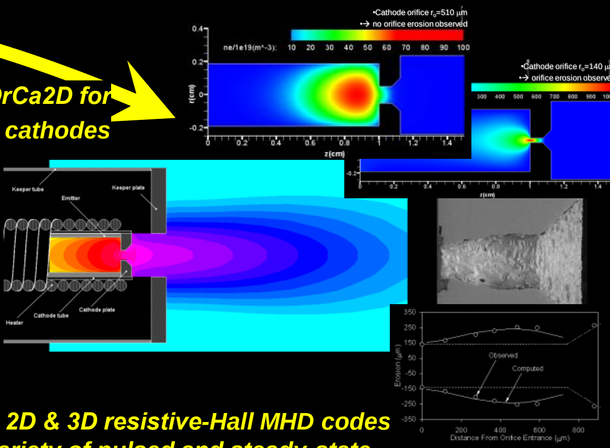
Initiate the development of a capability that would enable missions with ΔV’s of 100 to 200 km/s.

Physics-based modeling & simulation (M&S) capabilities at JPL support a wide range of electric propulsion technologies for NASA science missions.

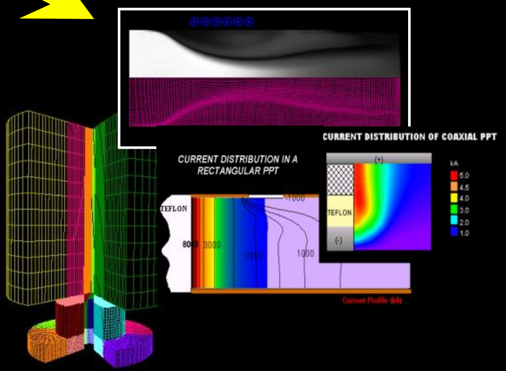
<u>THE MISSION OF THE M&S PROGRAM AT JPL HAS BOTH A NEAR-TERM AND A LONG-TERM IMPACT FOR EP:</u>

- **To Understand Critical Physics**
  that cannot be resolved or accessed by conventional diagnostics, leading to better-performing, longer-life engines
- **To Discover or Identify Unknown Physics**
  that may lead to breakthrough capabilities, enabling new science missions for NASA
- **To Guide Designs**
  of new engines (or refine past designs), reducing costly "trial-and-error" tests
- **To Diminish Risk**
  - both real and perceived - by elucidating test and/or flight observations that are not well understood and publishing findings in peer-reviewed journals
- **To Reduce Qualification Costs**
  by verifying performance and/or life capability that is otherwis[e] too costly to demonstrate by qualification tests
- **To Shorten Time To Flight**
  by reducing time to qualify

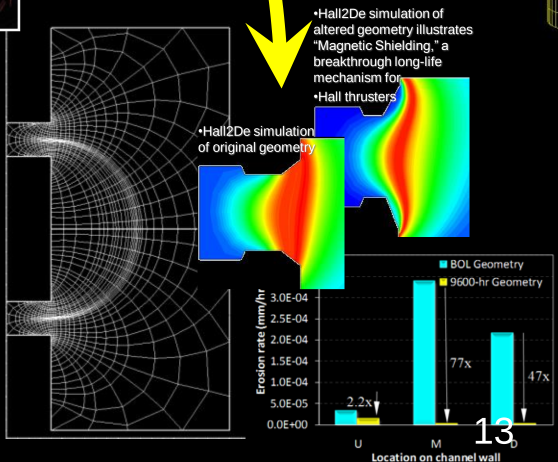
JPL's OrCa2D for M&S of EP hollow cathodes



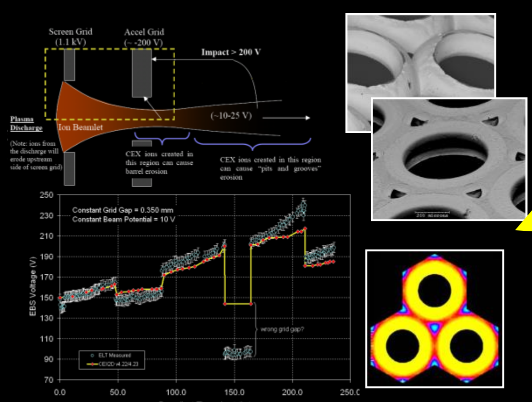
AFRL's MACH 2D & 3D resistive-Hall MHD codes for M&S of a variety of pulsed and steady-state electromagnetic thrusters



JPL's Hall2De & MIT/AFRL's HPHall for M&S of Hall-effect thrusters



JPL's CEX 2D & 3D for M&S of ion engine optics



Strong university partnerships strengthen and expand JPL's in-house M&S capabilities.