Nuclear Thermal Propulsion (NTP) In-Space Propulsion Demo Formulation

Les Johnson / MSFC

National Aeronautics and Space Administration

NASA

MARSHALL
SPACE FLIGHT CENTER

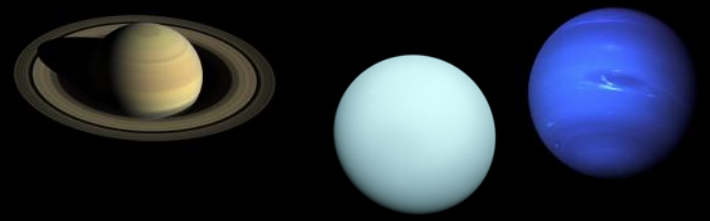
Exploring beyond the Moon requires new propulsion

- Minimal travel time
- Maximum flight flexibility
- Minimum complexity
- Nuclear Thermal Propulsion Option

Discover and Expand Knowledge for the Benefit of Humanity

NTP is the Next Logical Step Space Transportation System

Metric tonnes of useable payload to the outer planets



Spacecraft flying 4X faster than Voyager to explore nearby interstellar space

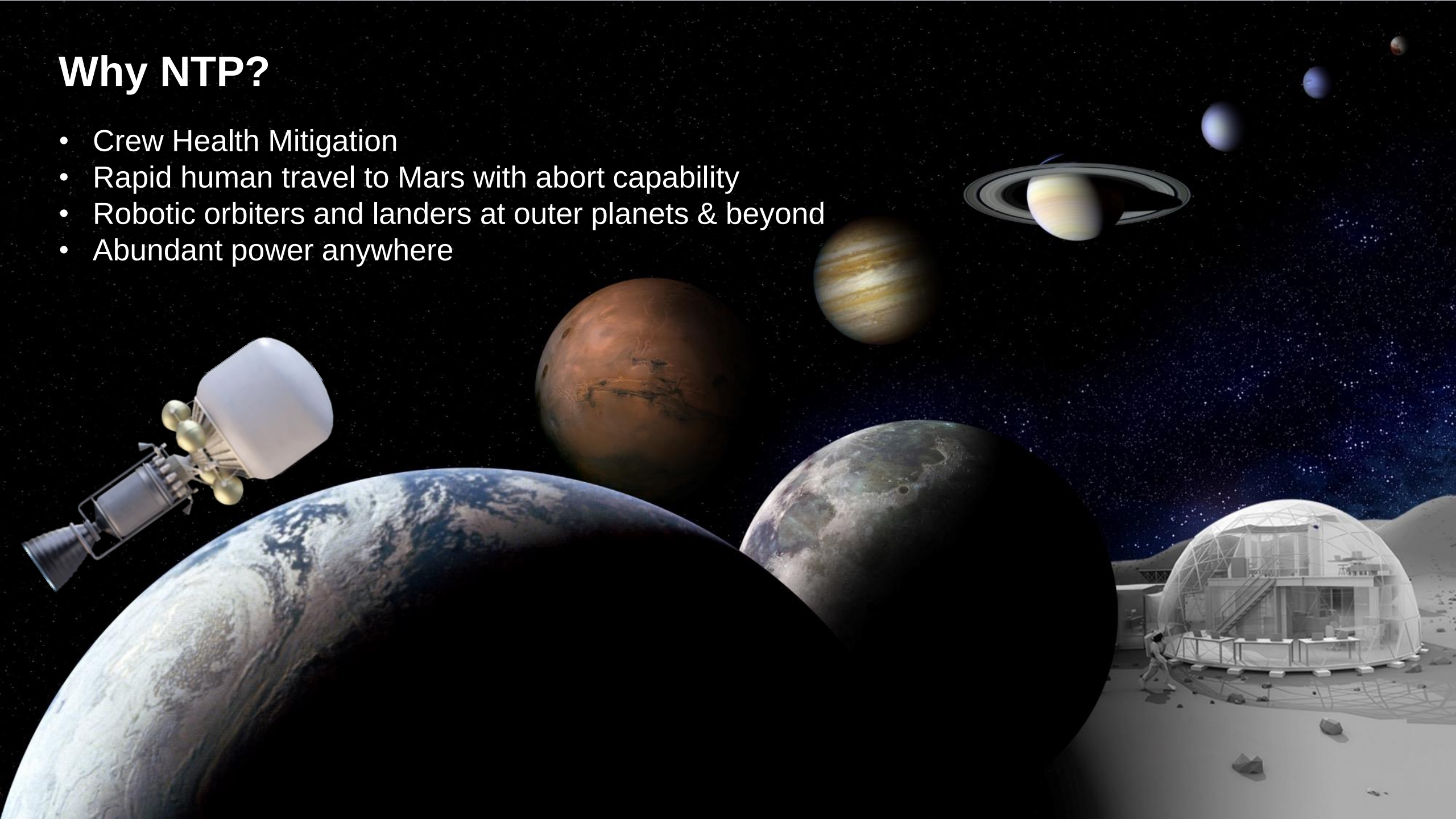
Using nuclear fuel comparable to what powers university class reactors across the USA

Sends people to Mars faster, with dramatically lower launch costs, than any other propulsion system

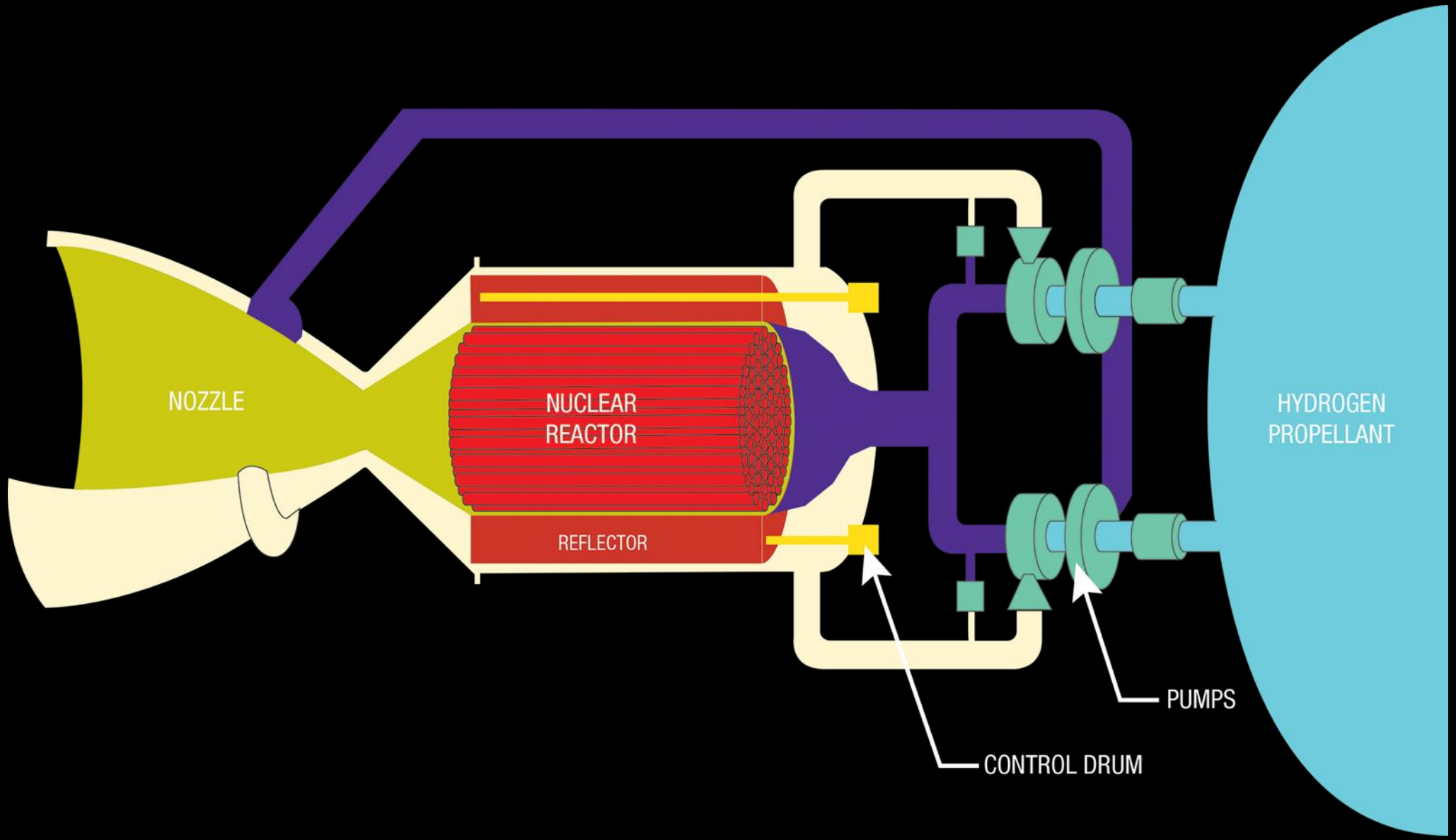
Spins off power systems to support bases on the Moon and Mars

Why NTP?

- Crew Health Mitigation
- Rapid human travel to Mars with abort capability
- Robotic orbiters and landers at outer planets & beyond
- Abundant power anywhere



Elements of an NTP Engine



Low Enriched Uranium vs Highly Enriched Uranium

Low-enriched uranium (LEU) has a lower than 20% concentration of ^{235}U. (Versus The fissile uranium in nuclear weapon primaries >85% ^{235}U)

NTP systems can be designed to use Low Enriched Uranium (LEU) with minimal (or no) impact on performance.

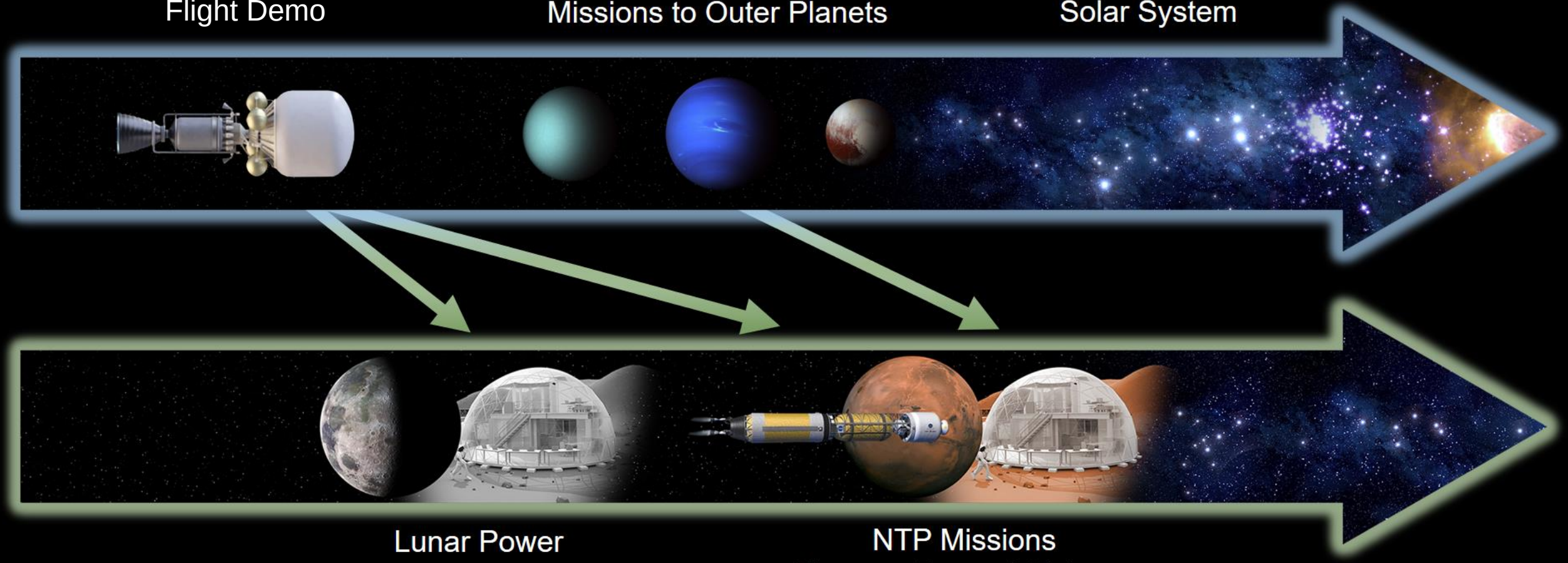
Previous NTP systems used HEU, dramatically increasing their real and estimated costs.

Fission products produced in one week at a university research reactor = 1 Mars mission

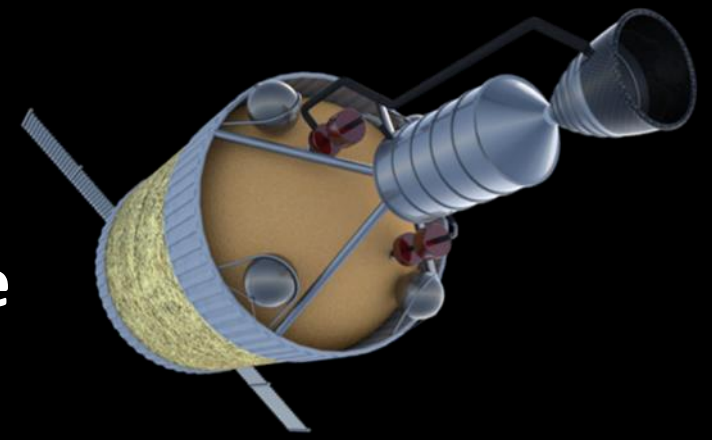
LEU nuclear reactors are used at a dozen universities across the United States.

The use of LEU reduces cost, lowers the risk and should dramatically decrease the regulatory burden.

NTP Demo: First Step



NTP Flight Demo (FD) Study Objectives



Peer-reviewed documentation and briefings on the potential for executing a NTP flight demo to make an informed response back to Congress.

- ❑ **Evaluate NTP concepts to execute a flight demonstration mission in the immediate timeframe and later options**
- ❑ **Invite similar concept studies from industry**
- ❑ **Assess potential users and missions that would utilize a NTP vehicle**
- ❑ **Assess additional fuel form options (traceability)**

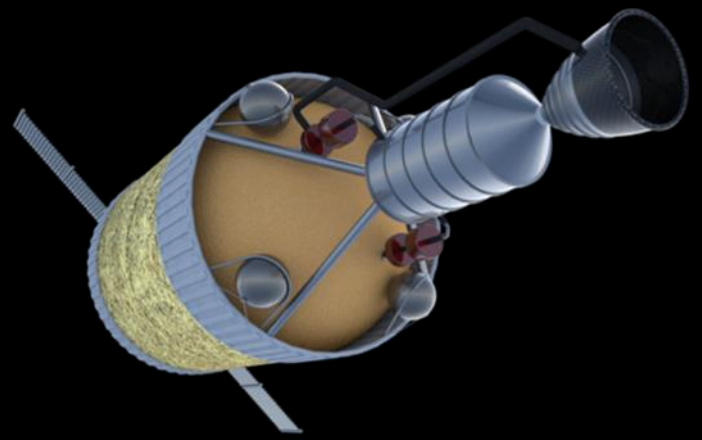
NTP Flight Demo Development

ASAP

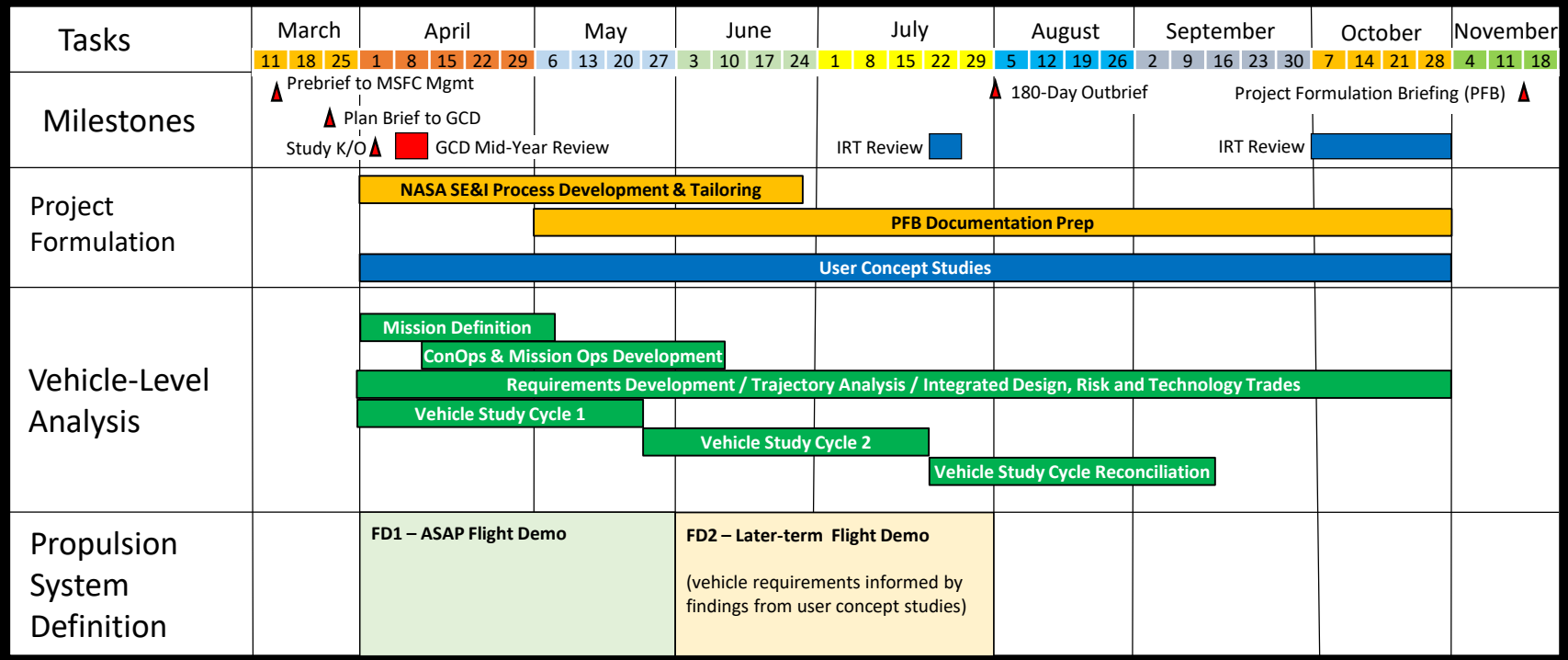
- Flight Demo (FD) Options to be Considered
  - FD1 - Nearest Term, Traceable, TRL Now (Target ASAP Flight Hardware Delivery)
  - FD2 - Near Term, Enabling Capability (TBD availability Date)
- Customer Utilization Studies
  - Science Mission Directorate
  - DoD (via DARPA)
- Industry Perspective (Industry Day followed by BAA release to award study contracts)
- Outbrief to STMD will provide “MCR-lite” products (including draft project plan, acquisition strategy, certification strategy, etc.)

NTP Demonstrator Notional Requirements (To Be Determined)

1) LV Insertion into Earth escape trajectory
2) System checkout
3) Engine startup
4) Steady-state operation
5) Engine shutdown / cool-down
6) Engine restart
7) Steady-state operation
8) Engine shutdown
9) Download telemetry data
10) End mission



NTP FD Formulation Study Schedule



- CE and LSE will insure alignment across all ongoing study activities
- Leverage previous design work as starting point for current design work
- The first vehicle study cycle will focus on the FD1 mission concept, which will be expanded in subsequent cycles to work the FD2 mission concept studies which will be informed by findings from the user concept studies.
- **BAA study deliverables are expected in early 2020; will work to enable earlier industry inputs via utilizing “Industry Day” approaches**

NTP Demo: First Step