National Aeronautics and Space Administration

Advanced Propulsion Technologies

October 29, 2014






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In-Space and Advanced Propulsion

TODAY | **CREW FLY-BY** | **CREW STAY** | **BASES & SETTLEMENTS**

IN-SPACE PROPULSION

R&D INVESTMENTS IN KEY AREAS ENABLE EVOLVED CAPABILITY AND OFFER MODEST GAINS IN CAPABILITY – *PROGRESS IS PREDICTIBLE.*

ARM Mission  **Electric / Plasma Propulsion**

AES / NCPS  **Nuclear Thermal Propulsion**

E-Cryo Lander  **Chemical Propulsion**

Emerging High-Capability Propulsion Concepts

Sustained, Low-Level Funding

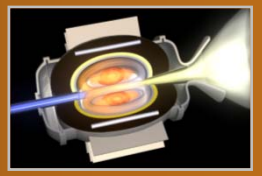
Research in Advanced Energetic Processes and Concepts

ADVANCED PROPULSION

SUSTAINED FUNDAMENTAL RESEARCH ENABLES POSSIBILITY FOR NEW, REVOLUTIONARY TECHNOLOGIES - *PROGRESS CANNOT BE PREDICTED.*


Antimatter


Pulsed Fission/ Fusion


Gas Core NTR


Advanced Energy Physics


Pulsed Fusion

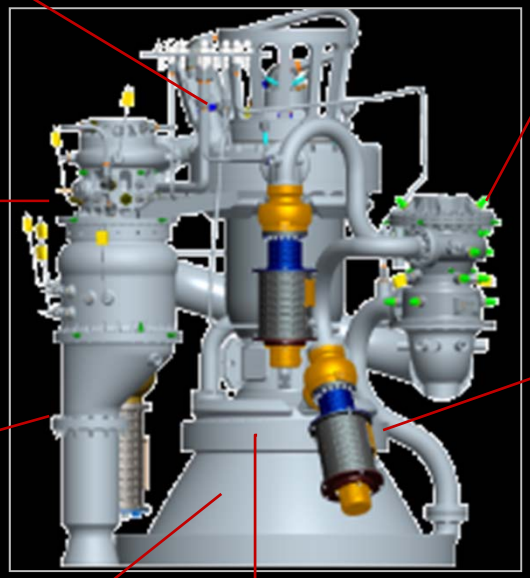

Pulsed Fission

A Prototype Engine for Additive Manufacturing TRL Advancement

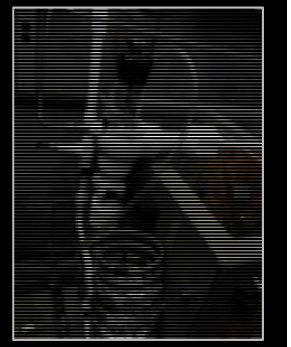
Injector Water Flow Testing

Injector Body with Lox Dome

Fuel Pump Components



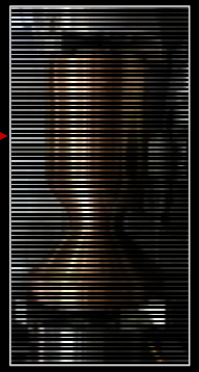
Assembled Valve and Actuator



Lox Pump Components

AM Turbine Bowl, with Bypass and Turbine Exhaust Nozzle

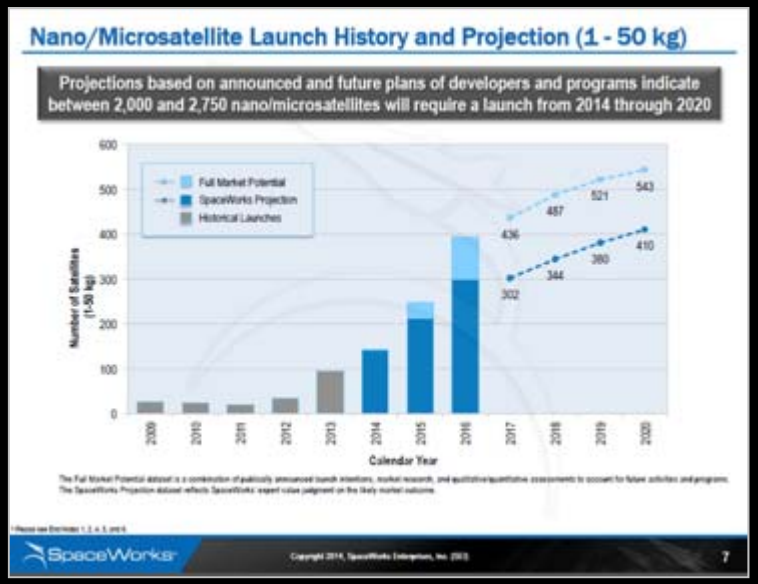
Development for nozzle and MCC liners

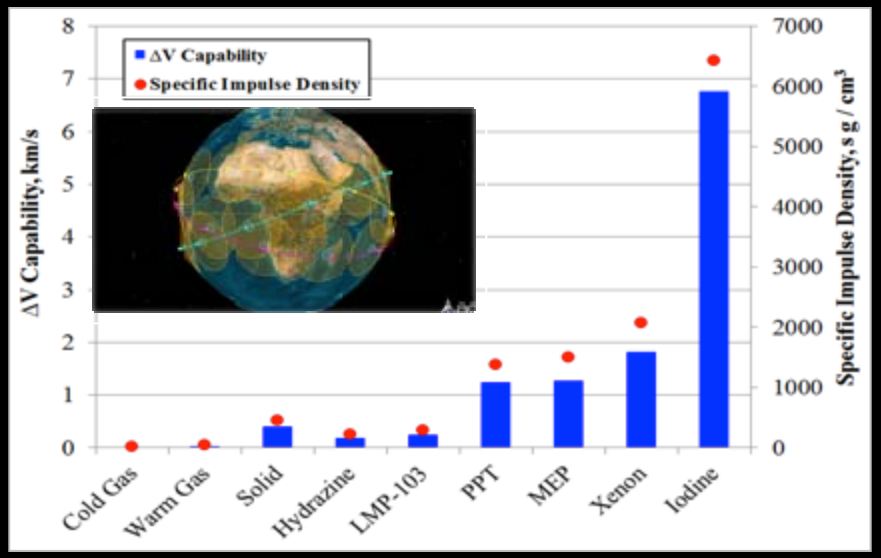


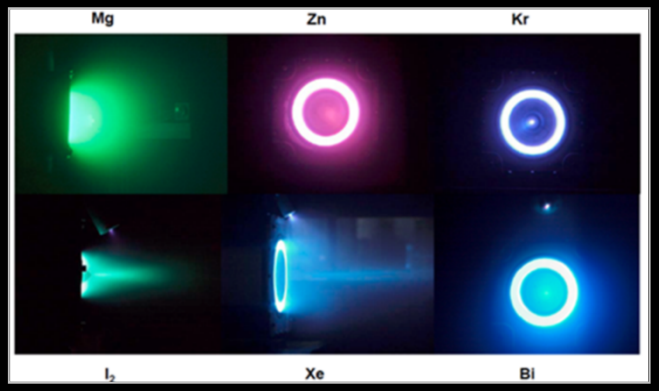
Main Chamber Liner

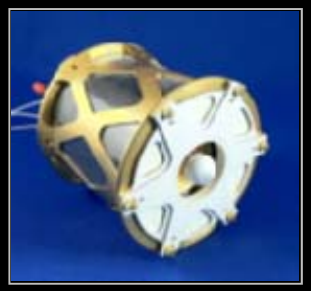
Main Chamber Manufacturing

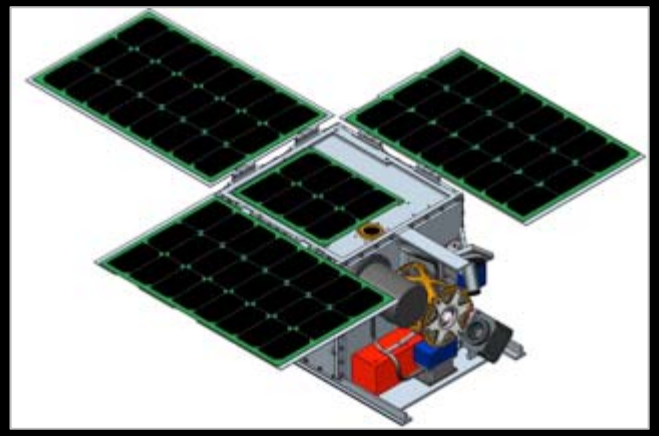
Iodine Satellite (iSAT) Project





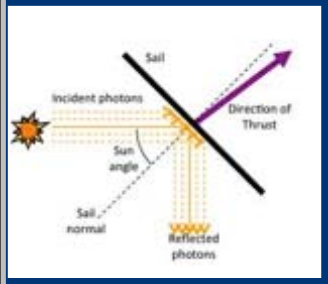




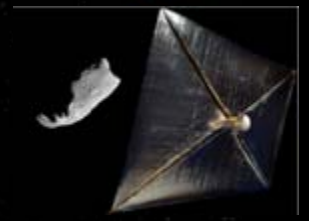


iSAT is the maturation of iodine Hall technology to enable high ΔV primary propulsion for small satellites culminating in a technology flight demonstration targeted for 2017.

Marshall is developing the solar sail propulsion system for NEA Scout and Lunar Flashlight, drawing from our extensive history in solar sail technology development.



Solar sails derive thrust by reflecting sunlight and therefore never run out of fuel, enabling many heretofore impossible robotic missions.



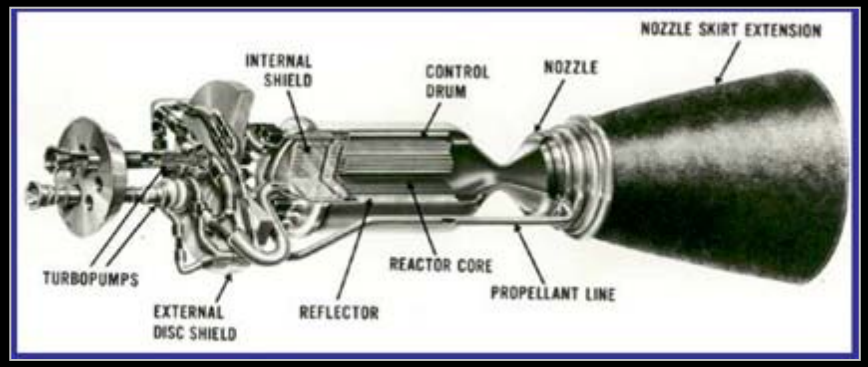
~9-m NEA Scout
(MSFC / JPL 2017)

20-m ground demos
(MSFC Program
Management 2005)

~9-m Lunar Flashlight
(JPL / MSFC 2017)

3.5-m NanoSail-D
(MSFC 2010)

Nuclear Thermal Propulsion (NTP)



Nuclear thermal propulsion (NTP) is a fundamentally new capability enhancing mission opportunities to Mars and beyond

- Energy from fission, not chemical reactions-virtually unlimited energy density

Enables shortest trip times with less launches

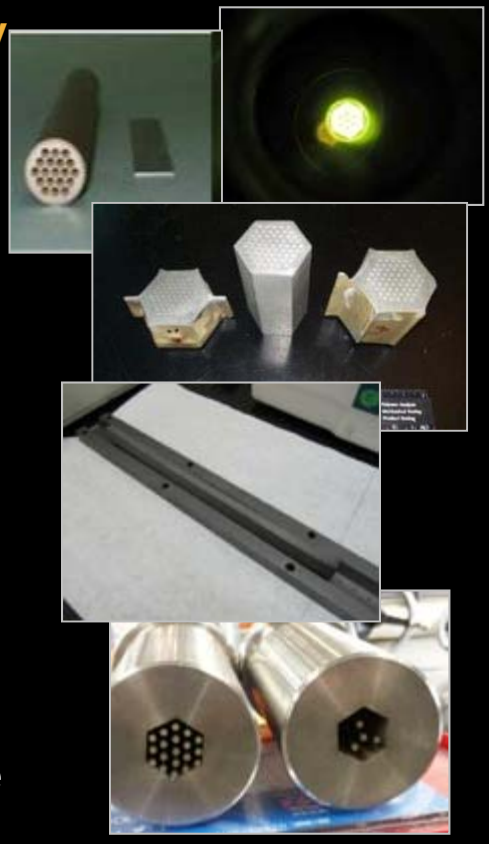
- Exposes astronauts to less galactic cosmic radiation and zero-g time

Higher Technology Readiness Level (TRL)

- Current TRL 4 for fuel and TRL 5-6 for non-nuclear “rocket” engine components (due to materials/environment)
- Flight demo mission in 2020s and human mission to Mars by 2030s

Affordable Development Strategy

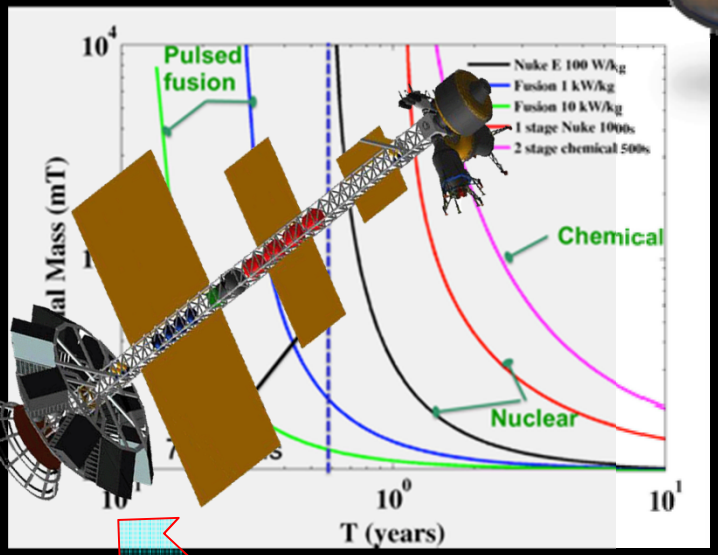
- Currently working fuel element development at Oak Ridge National Laboratory and Marshall Space Flight Center
- Affordable non-nuclear testing to help resolve significant issues (including fuel endurance at temperature) using Marshall Nuclear Thermal Rocket Element Environmental Simulator (NTREES), Compact Fuel Element Environmental Test (CFEET) System, and other capabilities
- Possible use of low enriched uranium to reduce cost and schedule and increase programmatic flexibility



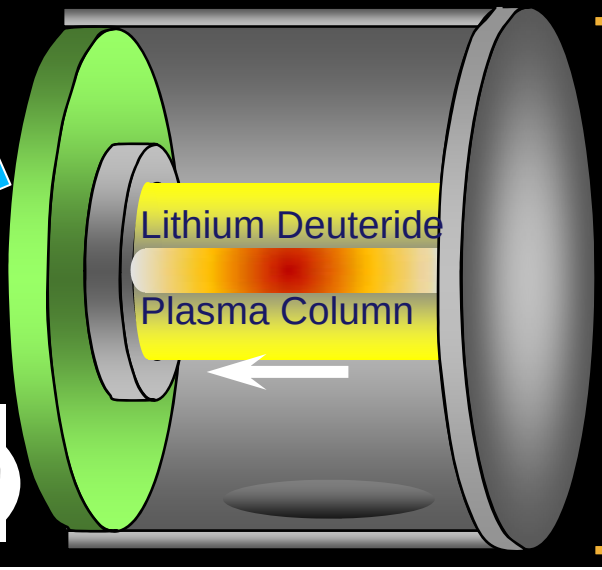
Fusion Propulsion Research

Experimental and Theoretical Fusion

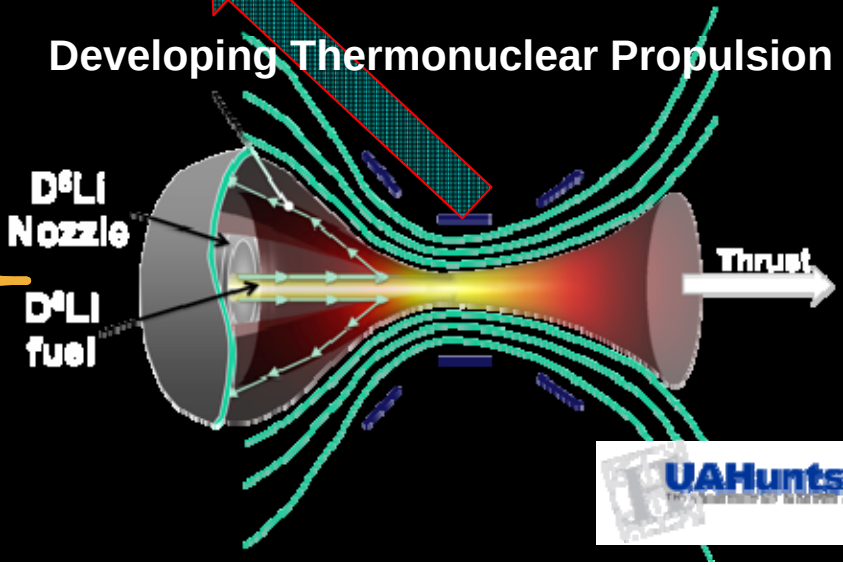
Round trip to Mars in 7 months (20 year development time)

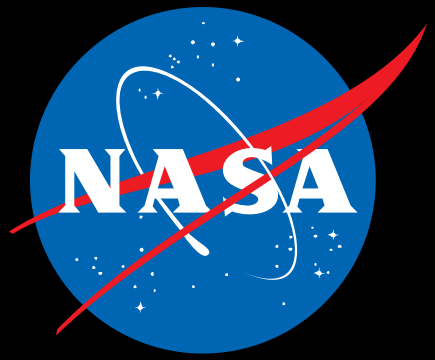


Z-Pinch



Developing Thermonuclear Propulsion





www.nasa.gov/marshall