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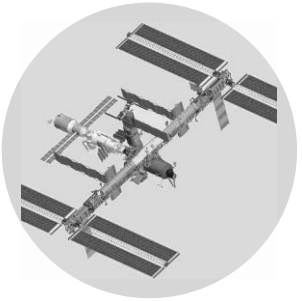
Pylon – Scalable Power for the Emerging Space Economy

04/26/2021

NETS 2021 Conference

The Problem: Human Settlement of Space Needs Power

SPACE SETTLEMENT IS LIMITED TO ROBOTIC PROBES, TEMPORARY SETTLEMENTS, AND EARTH ORBIT.

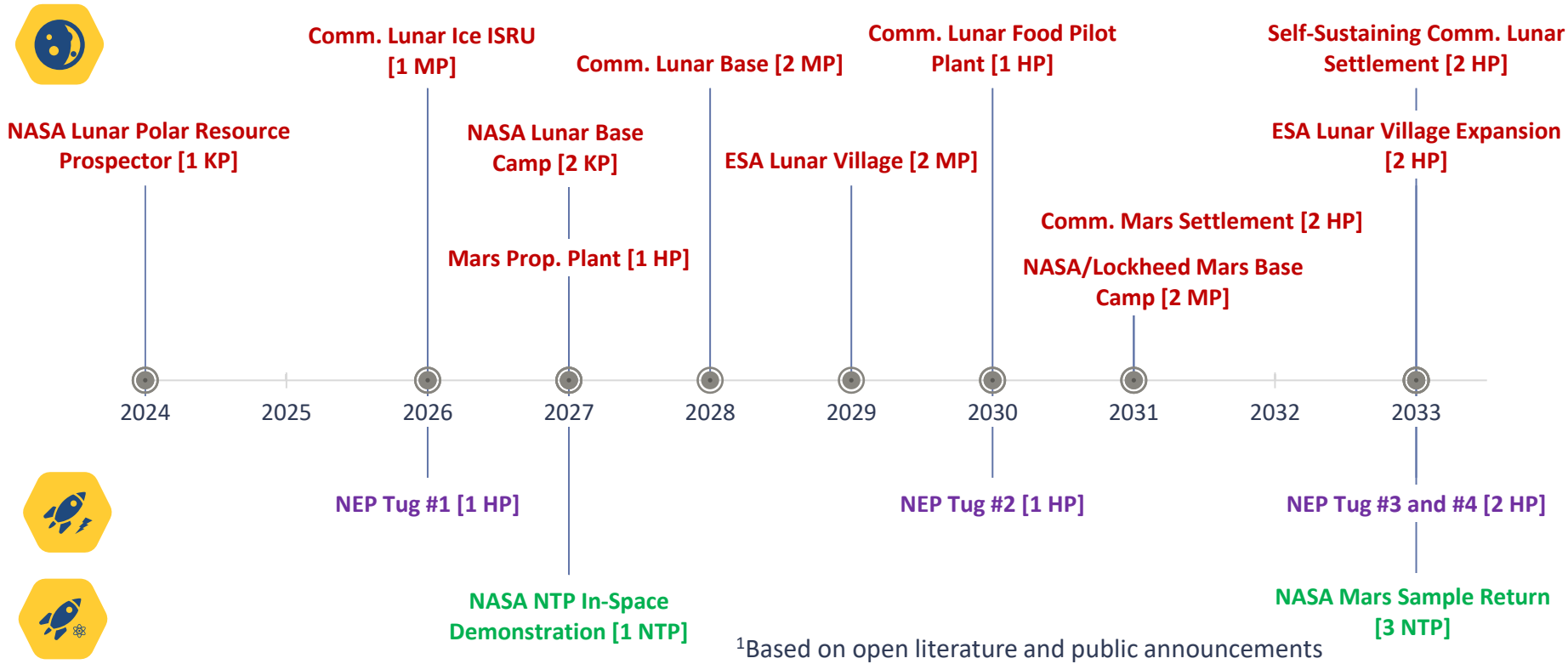


THE SINGLE LARGEST POWER SYSTEM IN THE HISTORY OF HUMAN SPACEFLIGHT IS THE INTERNATIONAL SPACE STATION: 120 KWE.

CURRENT POWER AND PROPULSION SOLUTIONS ARE INCAPABLE OF ENABLING THE SETTLEMENT OF THE SOLAR SYSTEM.

The Future Space Economy Requires Nuclear Power

Near-term space power market growth[1]



[1]Based on open literature and public announcements

The Pylon: Surface Fission Power for Commercial Space

Minimal Technology Development

- LEU fuel enables commercial product
- Operates at conservative operating temperatures
- Uses existing and well-known materials
- Maximizes ability to use off-the-shelf-components

Designed for Near-Term Space Markets and Applications

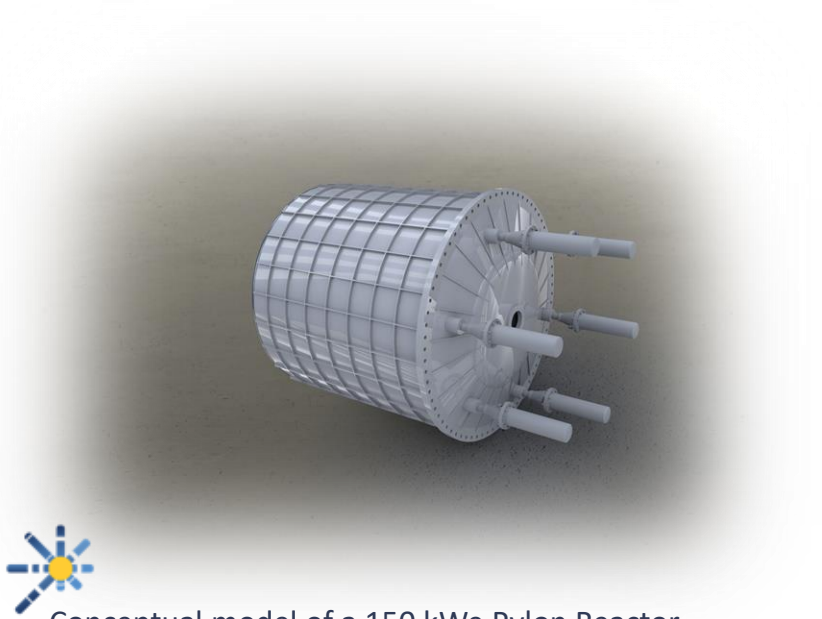
- Scalable design from kWe to MWe
- Reactor and system mass viable for near-term lunar landers
- Applicable to:
  - Life Support (ECLS)
  - Mining (ISRU)
  - Electrical power
  - Heat for Industrial processes

USNC's Pylon Reactor

Conceptual reactors with conservative performance and scalable power levels

Reactor	Reactor Mass (CBE) (kg)	Power Level (kWe)	Power per Reactor Mass (We/kg)
PYLON-10	950	10	10
PYLON-150	1,500	150	100
PYLON-1000	3,000	1,000	333

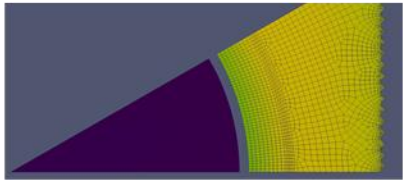
Parameter	Value
Turbine Inlet	1,150 K (875°C)
Lifetime	10 years
Uranium Enrichment	19.75 % (LEU)
Fuel Type	FCM™



Conceptual model of a 150 kWe Pylon Reactor

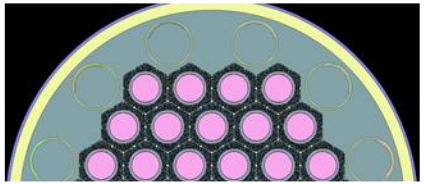
Pylon Analysis and Concept Development

In-Core Heat Transfer



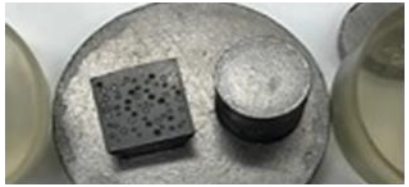
- Identify reactor outlet temperature
- Determine temperature across in-core components
- Determine informed reactor performance and limitations

Detailed Neutronics



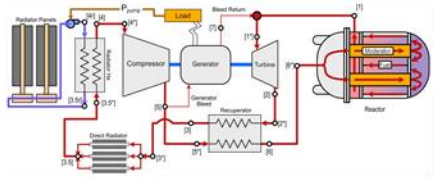
- Determine optimal core configuration
- Identify reactor lifetime
- Ensure minimum core mass
- Configure reactor control

Material Selection



- Material-informed design
- Fuel and moderator element suitability
- Reflector material optimization

System Analysis and Configuration



- Brayton and sterling power cycle options
- Optimize for minimal system mass

Space Power Design Philosophies

Different approaches yield different results.

Fast Spectrum Metal Fuel

- Metal Fuel
- Simple
- Irradiation induced swelling
- No Fission product retention
- High uranium loading
- HEU derived design

Thermal Spectrum Combined Fuel/Mod

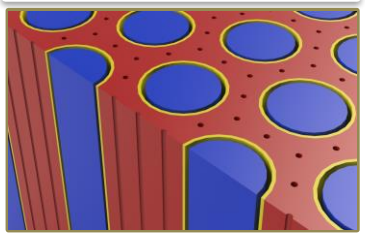
- UZrH fuel
- Lowest mass LEU system
- Poor life-time behaviour
- No Fission product retention
- Hydrogen retention issues
- Low mass low power systems

Thermal Spectrum Separate Fuel/Mod

- FCM™ Fuel
  - Fission product retention
  - High temperature fuel
- Highest performance LEU
- Scalable across multiple power levels
- Requires high performance moderators

U-Mod

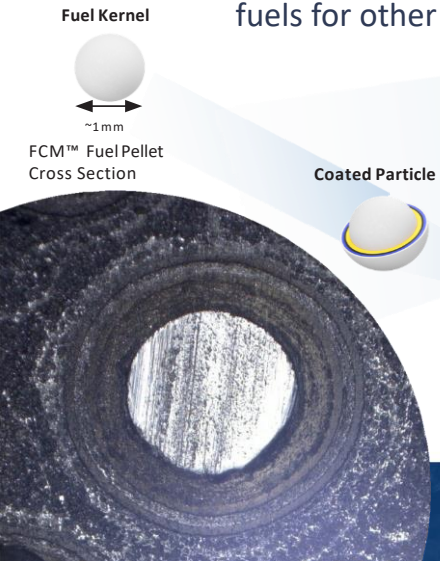
High Performance Moderator



- First engineered moderator
- Slows down neutrons to increase rate of fission
- Uses clad ZrH in an inert matrix
- Enables compact size and LEU implementation
- ARPA-E Funded – $3 mil

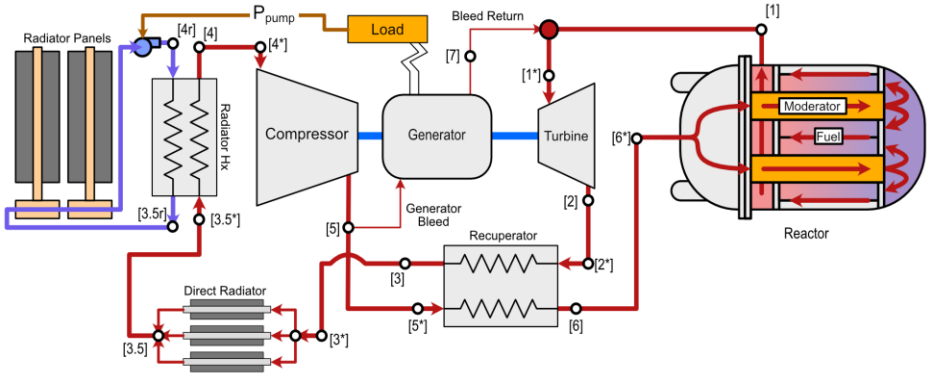
Why Use FCM™-Derived Technology for SFP?

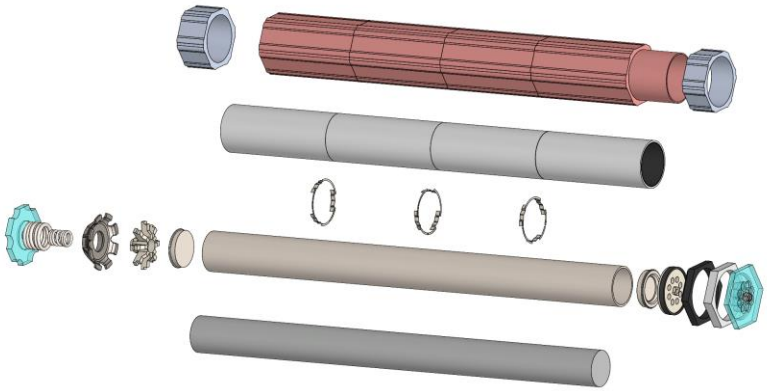
- Technical basis for fission product retention
  - Multiple fission product barriers
  - Assists in affordable development and testing
- Radiation Stability During operation
  - Enables forming of coolant channels with fuel
  - Maximizes fuel volume of the core
- Cross-Compatible Fuel Concept
  - NEP, DoD Mobile Reactors, and commercial terrestrial systems
  - Fuel integrity and fission product retention enable FCM™-Derived fuels for other applications



Brayton-cycle Selection

- Single-loop options for lower powers
  - Less components to fail
  - Mass reduction
  - High temperature capability
- Minimal neutronic impact at lower powers
  - Liquid metals introduce the possibility of positive void worths
- Use of a double-loop may enable higher power densities
  - Lithium 7 enriched primary coolant
  - HeXe secondary coolant
- Allows cooling of the moderator





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Thank you!