SPACE NUCLEAR TECHNOLOGY GAPS

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ACTIONS TO ADDRESS TECHNOLOGY GAPS?

Build reactor engineering test models and prototypes for environmental testing

- Drive TRL improvements through ground testing of space nuclear HALEU reactor and subsystems
- Verify operability of reactor, system, and space vehicle thru modelling & test (***"Test as you fly, fly as you test"***)
- Use non-nuclear ground testing to demo autonomous operations – HWIL, SWIL, Digital Twin technology

Testing of fuels and reactor materials

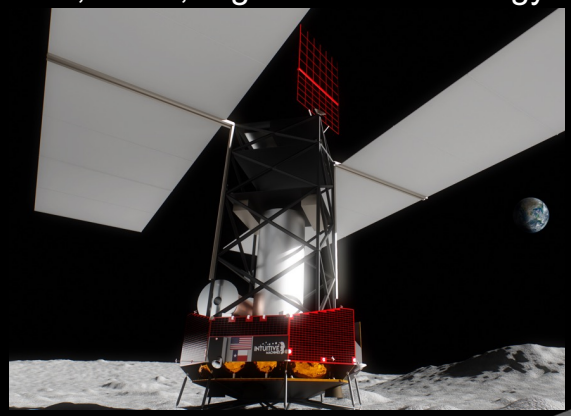
- High temperature materials testing
- Thermal vacuum & launch/landing loads effects on fuel and reactor
- Criticality testing of fuel and core design / construction

Avionics and EEE Parts - Gamma and Neutron radiation, flux rates

- We need to test reactor hardware in space environments
- We need to test space avionics in relevant radiation environments
- Highly efficient (e.g., high attenuation/kg & cm) shielding materials

Power conversion subsystem Development - Brayton, Stirling

- Improvements that increase efficiency and life, while low mass



Artist concepts for Surface Power and Nuclear Electric Propulsion

FUEL/MODERATOR DEVELOPMENT

HALEU - How do you get the most output from 19.75% U_{235} HALEU?

- R&D into new and advanced moderators
- Increase moderator manufacturing readiness level (MRL) – industry has only demonstrated lab-scale production

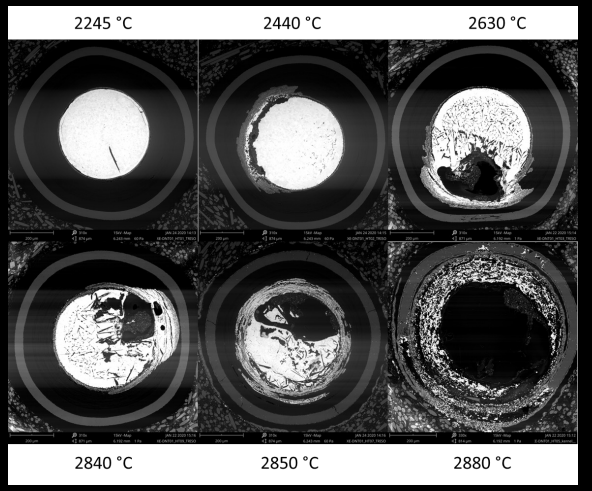
Fuel Form Development – ceramic coated fuel vs uranium metal

- Ceramic coatings provide fission product (FP) containment – makes ground testing more feasible
- Uranium alloys provide lower mass, near net shape production

Temperature/environmental conditions vs. the fuel options

- New Moderators – stable, high-temp, air/moisture compatible
- If ceramic-coated, what ceramic materials will maintain integrity and retain uranium over the expected temperature range?

TRISO-X performed a study exposing a TRISO kernel to temperatures typical for an NTP application. Results clearly identify need for advanced encapsulation of uranium at higher temperatures.



TRISO-X Particle vs Temperature Test

BACKUP - ENABLING NEW SNP MISSIONS

- *How to improve the probability of achieving a successful space nuclear power demonstration?*
  - Execute near-term projects that are smaller in size and less complex for technology demonstration
    - Don’t aim too high; should be less expensive
    - Should increase the probability of successful execution
  - Perform ground demonstrations to inform future system designs and show early achievements
  - Prototypes (ground and flight) are required to increase subsystem Technology Readiness Level (TRL)
  - For surface power, consider low power demo (10 kWe or less)
    - Follow a model similar to DOD/Pele - a demonstration system that shows what can be done
  - Define a Space Nuclear Power (SNP) plant that can be flown TODAY
    - Compatibility with current lunar landers (e.g., use CLPS vehicles for a short duration lunar demonstration)
    - Compatibility with current launch vehicles (do not depend on new SLS developments)
    - Employ high TRL space-qualified spacecraft buses