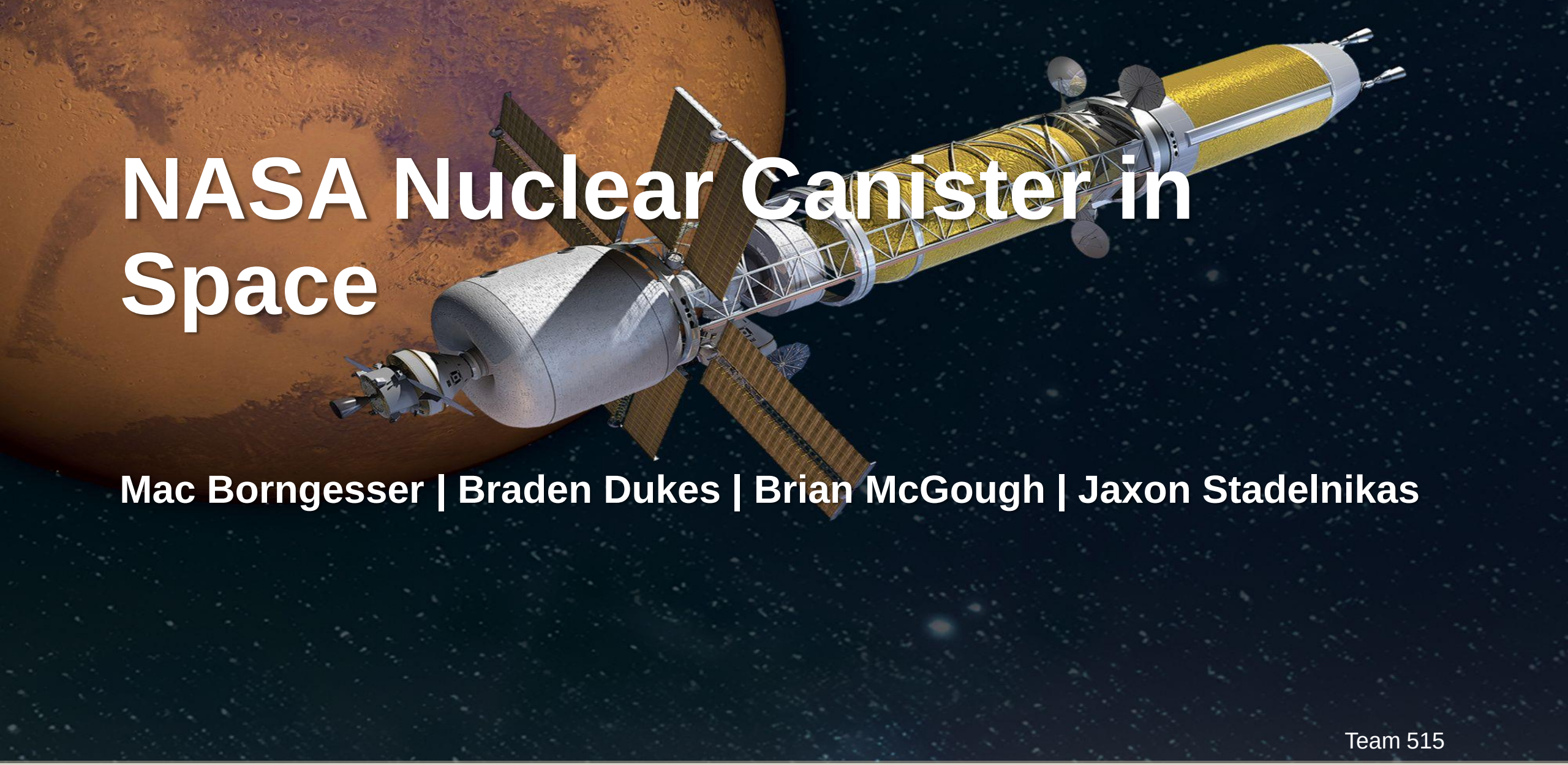


NASA Nuclear Canister in Space

Mac Borngesser | Braden Dukes | Brian McGough | Jaxon Stadelnikas

Team 515

Team Introductions

McAnarney Borngesser
Aeronautics Engineer

Braden Dukes
Materials Engineer

Brian McGough
Aeronautics Engineer

Jaxon Stadelnikas
Aeronautics Engineer

Jaxon Stadelnikas

Sponsor and Advisor

Engineering Sponsor
Marvin Barnes
NASA Marshall Space Flight Center

Academic Advisor
Eric Hellstrom, Ph.D.
FAMU-FSU College of Engineering

Jaxon Stadelnikas

Objective

The objective of the project is to develop and test a canister to go into Big BUSTER to test nuclear fuel compounds for thermal nuclear propulsion systems in the Transient Reactor (TREAT).

Jaxon Stadelnikas

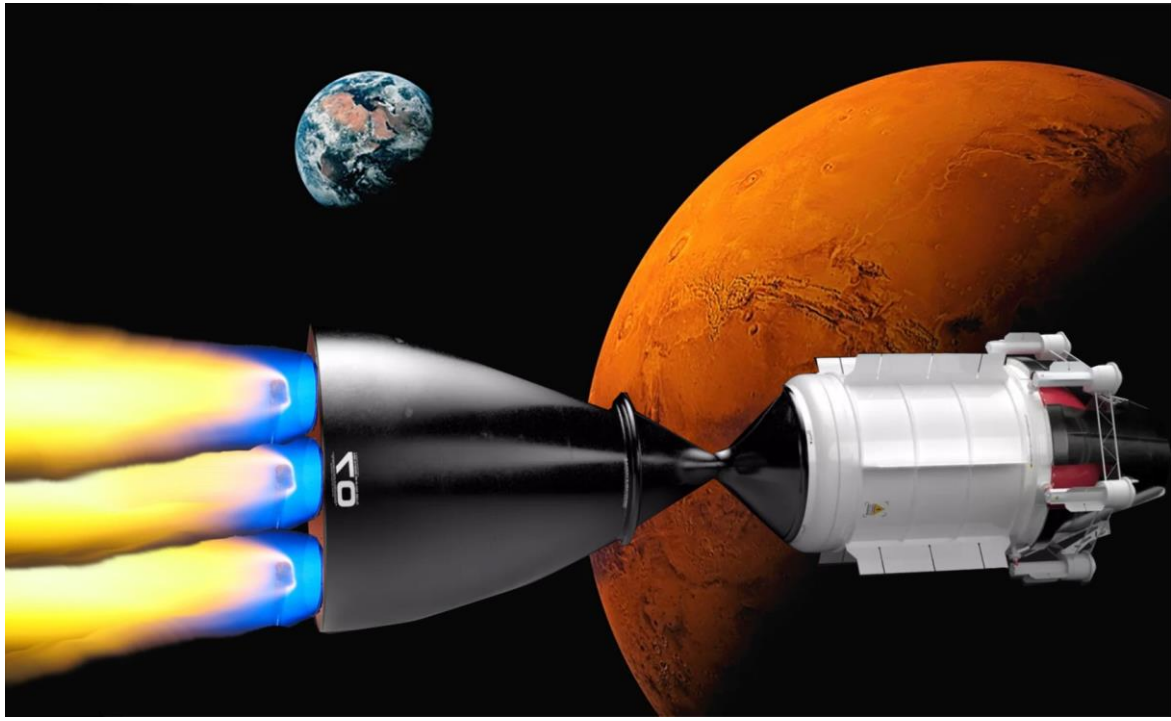
Project Background

NASA plans on going to Mars

Nuclear Thermal Propulsion engines are very efficient

Further research can improve efficiency of NTP engines

Develop a component for Big BUSTER to test different fuels for NTP engines.



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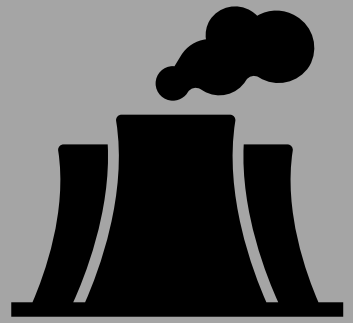
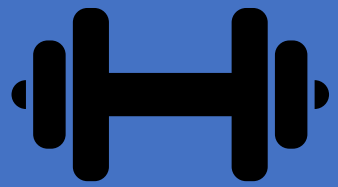
Assumptions

Big BUSTER will function according to the specifications given by NASA

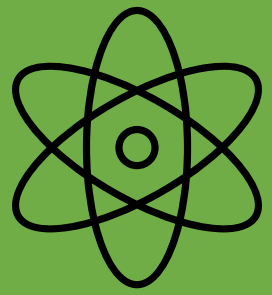


Weight will not be a constraining factor



Temperature range will not exceed 3000K

Radiation containment is done by Big BUSTER, not the canister



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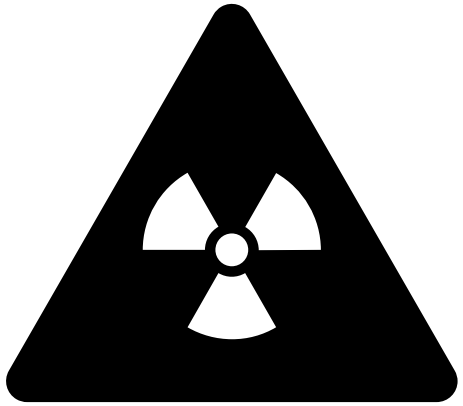
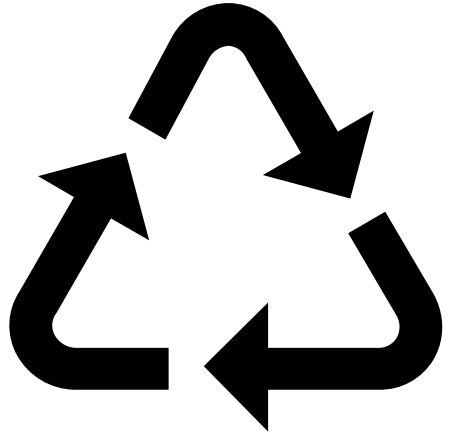
Key Goals

Temperature Resistant

Resist Effects of Radiation on the Canister



Reusability



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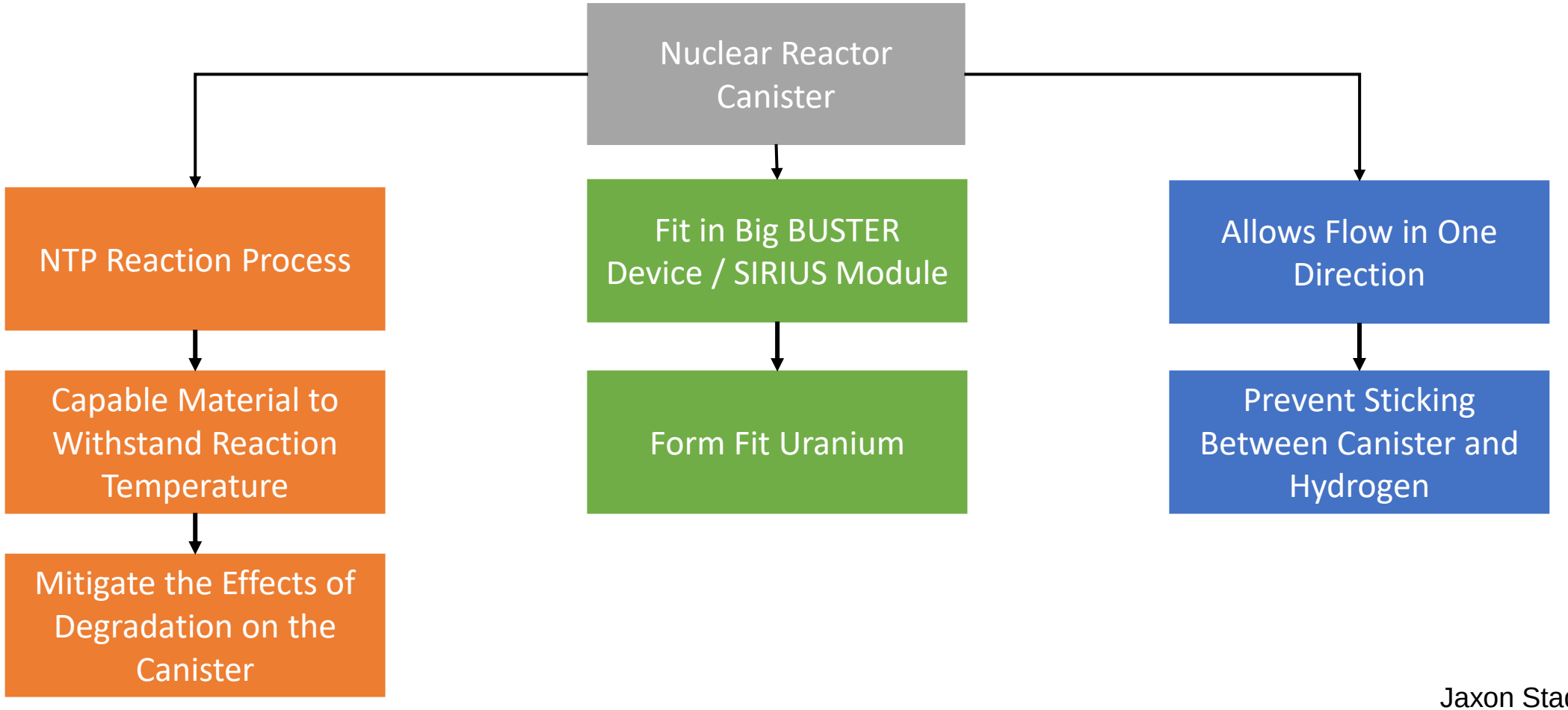
Functional Decomposition



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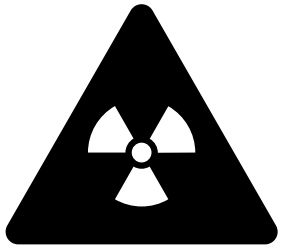
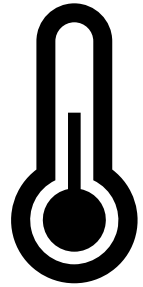
NTP Reaction Process





Capable Material to Withstand Reaction Temperature

- 3000 K

Mitigate the Effects of Degradation on the Canister

- Less than 8 GPa increase in hardness

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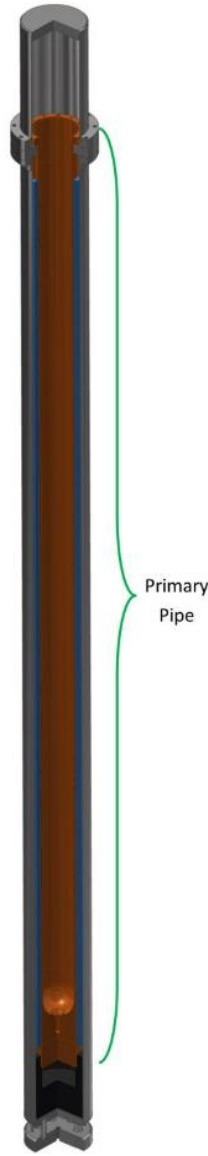
Fit in Big BUSTER Device / SIRIUS Module

Form Fit Uranium

- Marble size reference
  - Volume of 9.2cm^3
  - Mass of 179 g
- Maximum dimensions for the canister is 61 cm length and 8 cm diameter
- Less than $6 \times 10^{-6} \frac{m}{m°C}$ Thermal expansion rate



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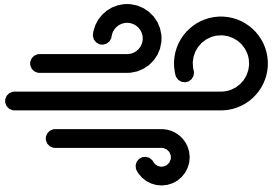
Allows Flow in One Direction



Prevents Hydrogen Propellant from Sticking to the Canister

- Less than $6 \times 10^{-6} \frac{m}{m°C}$ Thermal expansion rate
- Hydrogen flow rate of 20 $\frac{g}{sec}$

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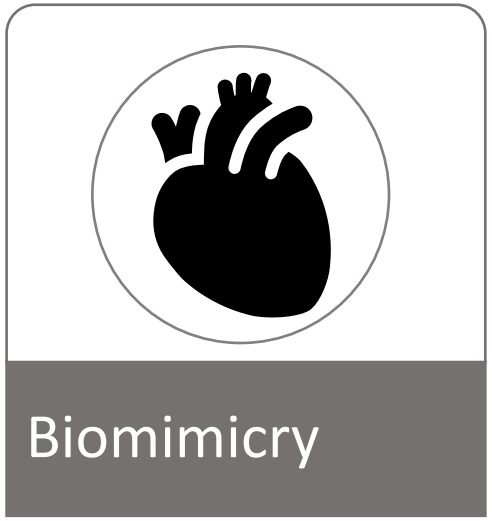
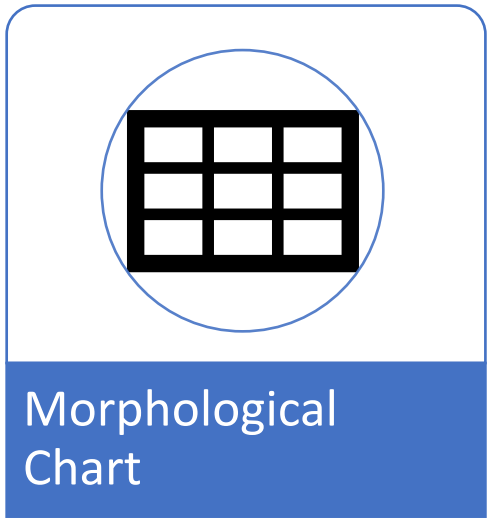
Concept Generation





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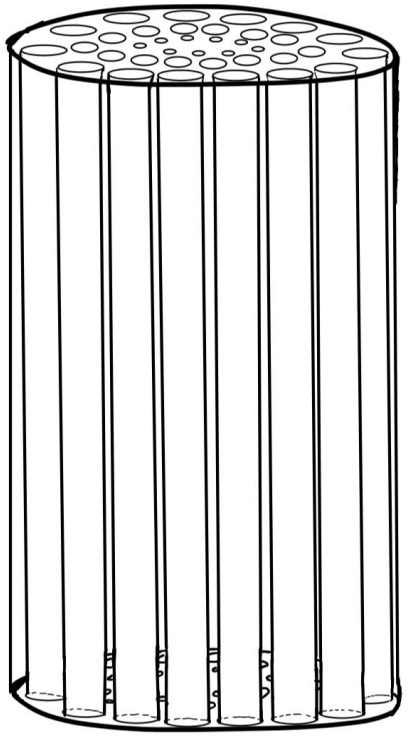
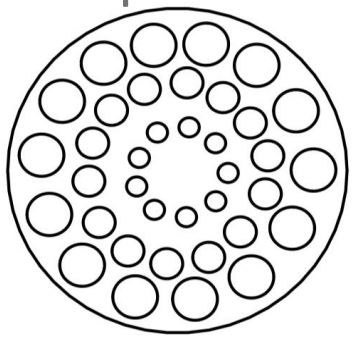
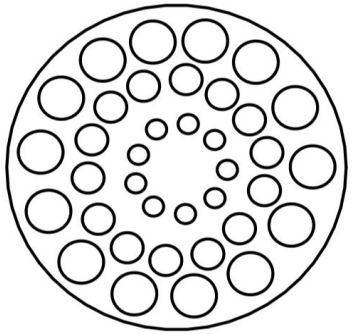
First High-Fidelity Design



Top View





Bottom View

Base metal of Tungsten

Straight path for hydrogen to flow

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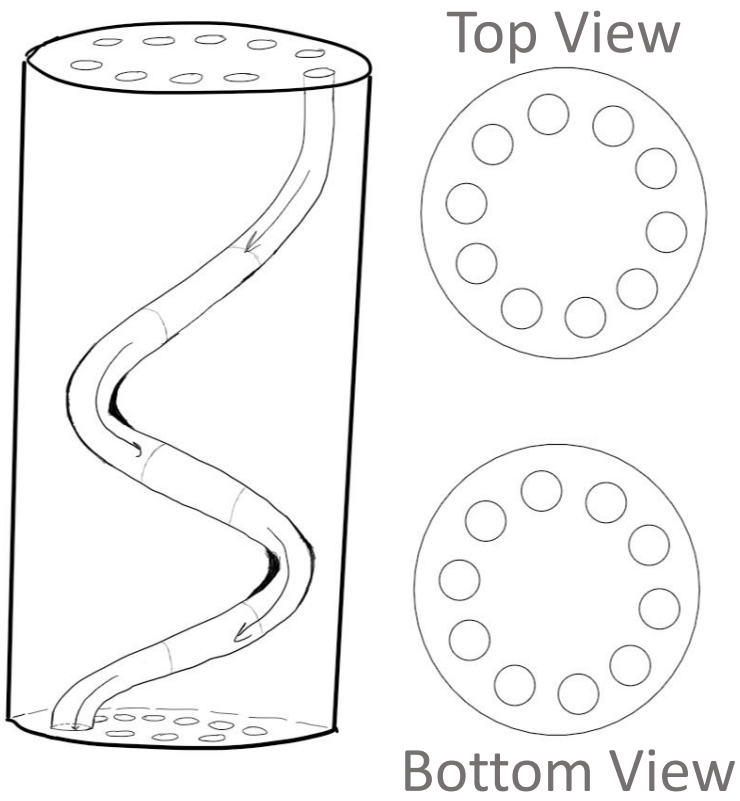
Second High-Fidelity Design



Base metal of Tungsten

Spiral path for hydrogen to flow

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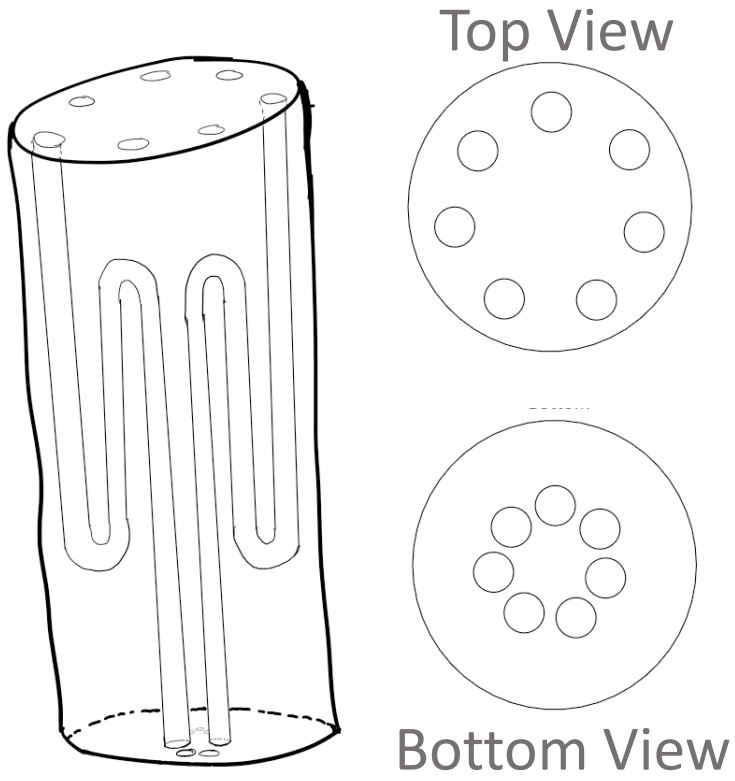
Third High-Fidelity Design



Base metal of Tungsten

Triple pass path for hydrogen to flow

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Concept Selection

Selected concept: High-fidelity concept #1

Tungsten Base Metal Straight Paths

- Highest ranking among Pugh charts
- Best suited for the project
- Integrates well with existing design

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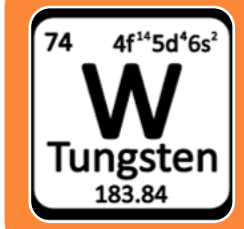
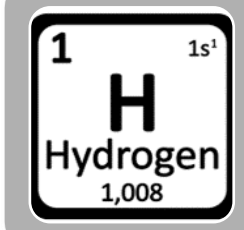
Proposed Design



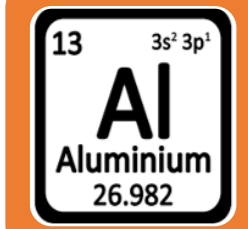
99.99% Pure Tungsten



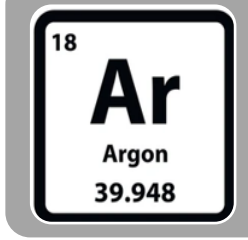
Hydrogen Propellant

Uranium Fueled

Experimental Design



Aluminum 6061



Argon "Propellant"

Heating Element "Fission Product"

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Prototype

7in tall 3-D printed "mock" canister

- 3.81cm (1.5in) diameter
- 28 flow channels
  - 0.316cm (0.125in) diameter flow channels

Aluminum 6061 14in machined canister

- 7.62cm (3in) diameter
- Heating element
- 28 flow channels
  - 0.635cm (0.25in) diameter flow channels
- Lundy Enterprise

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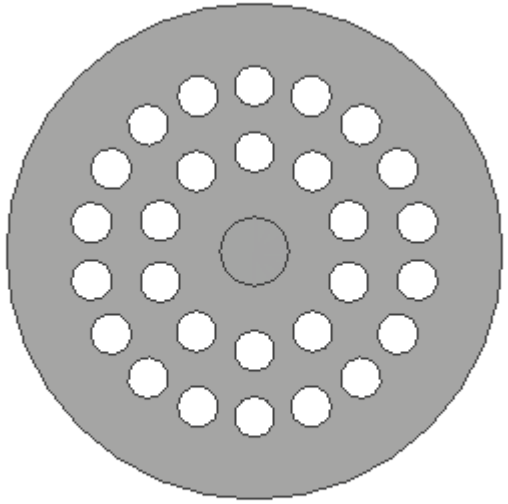
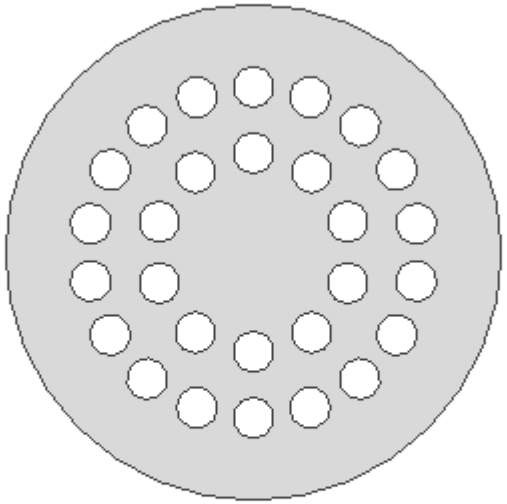
Prototype CAD Models





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Prototype CAD Assembly

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Canister Testing

Thermocouples

- Measure the heat on each end of canister
- Measure the heat transfer of the canister

Regulators

- Control the flow of argon
- Control the flow rate

Flexible Tubing

- Required to connect argon to canister

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Future Work

Finalized Design

- Communicating with manufacturers

Testing Procedure

- Finding the best way to test
- Safety Protocol

Validation

- Confirming and comparing with expected results

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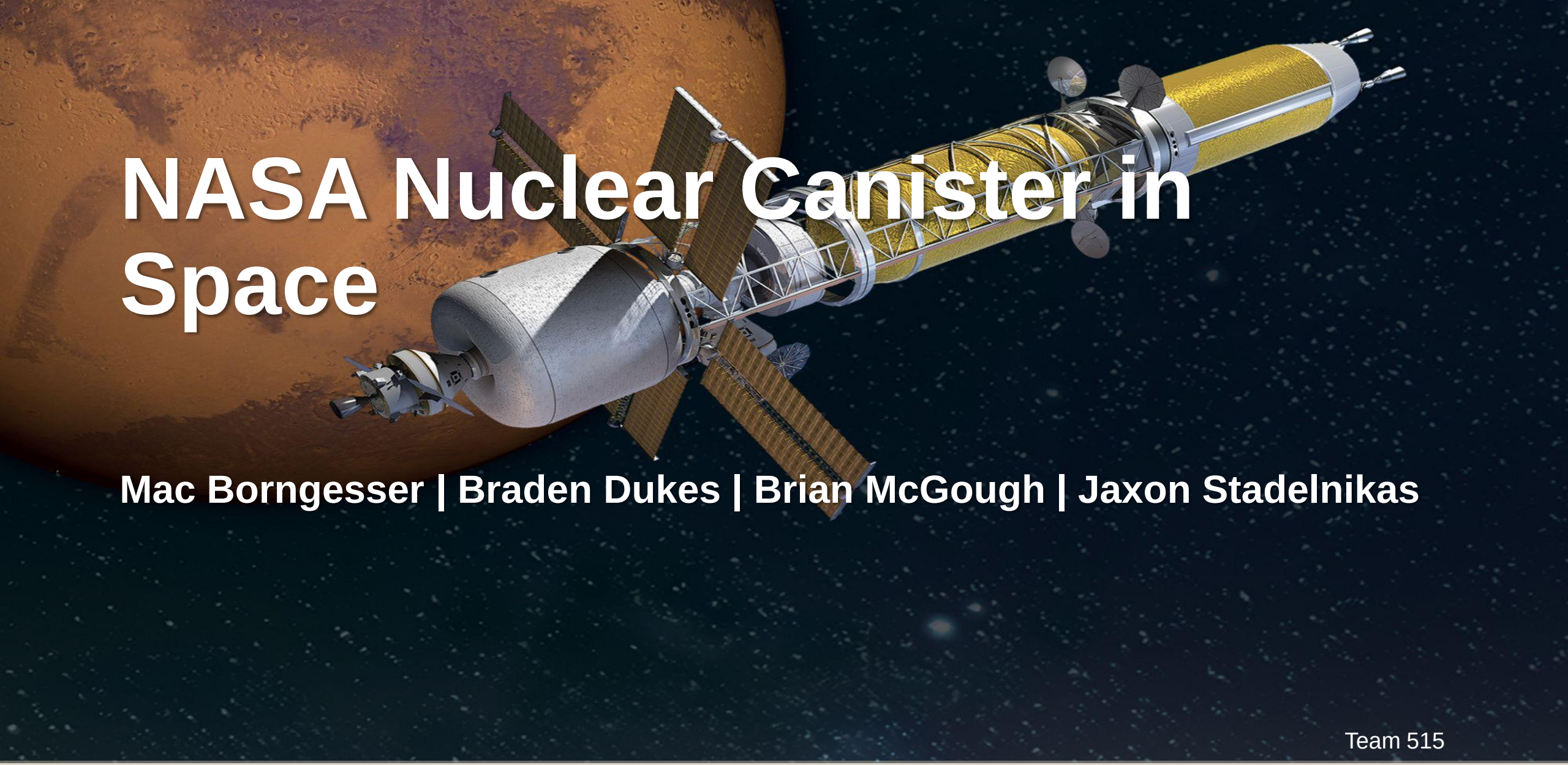

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Team 515