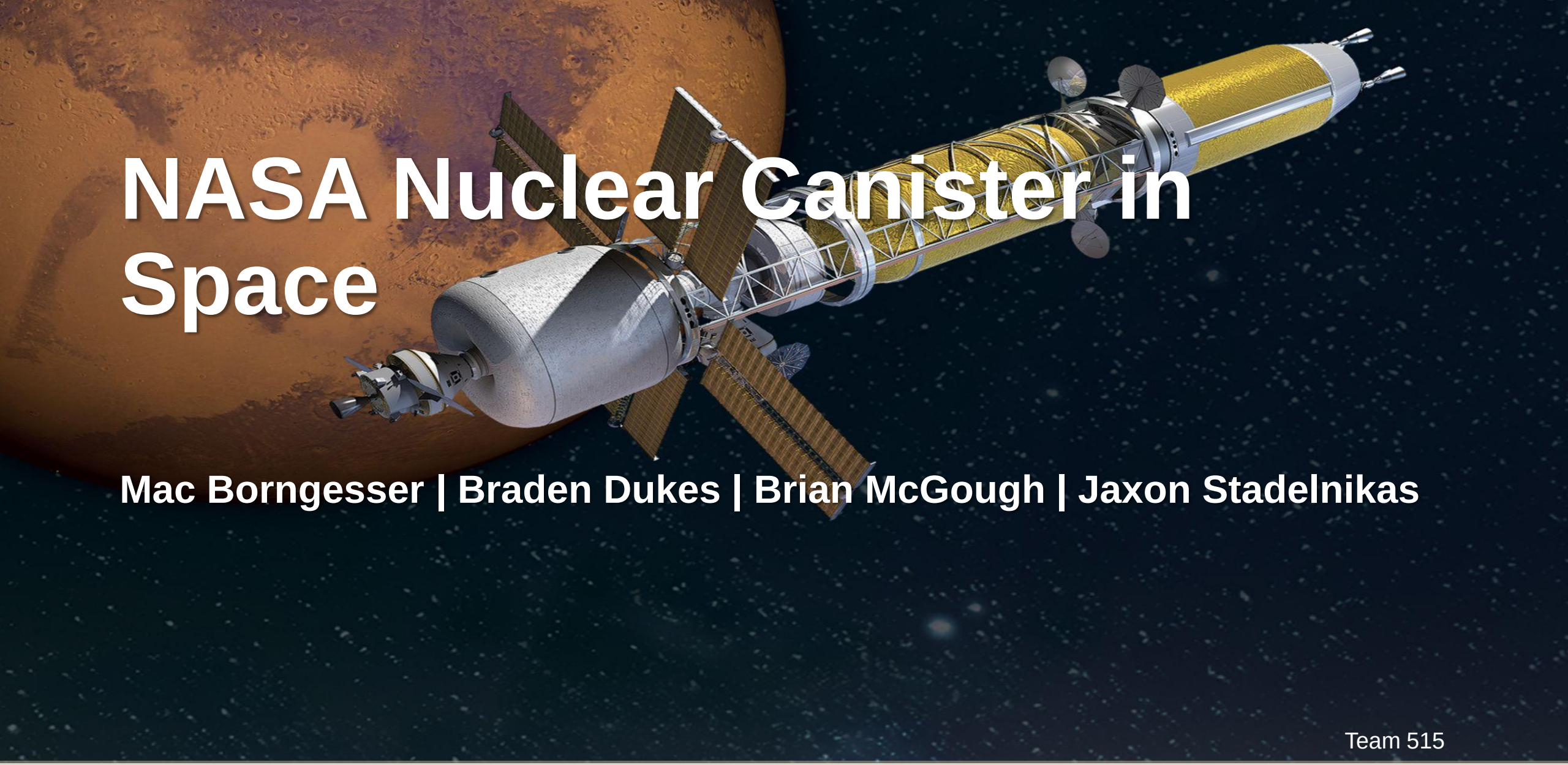


NASA Nuclear Canister in Space

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

Brian McGough

Sponsor and Advisor

Engineering Sponsor
Marvin Barnes
NASA Marshall Space Flight Center

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

Brian McGough

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).

Brian McGough

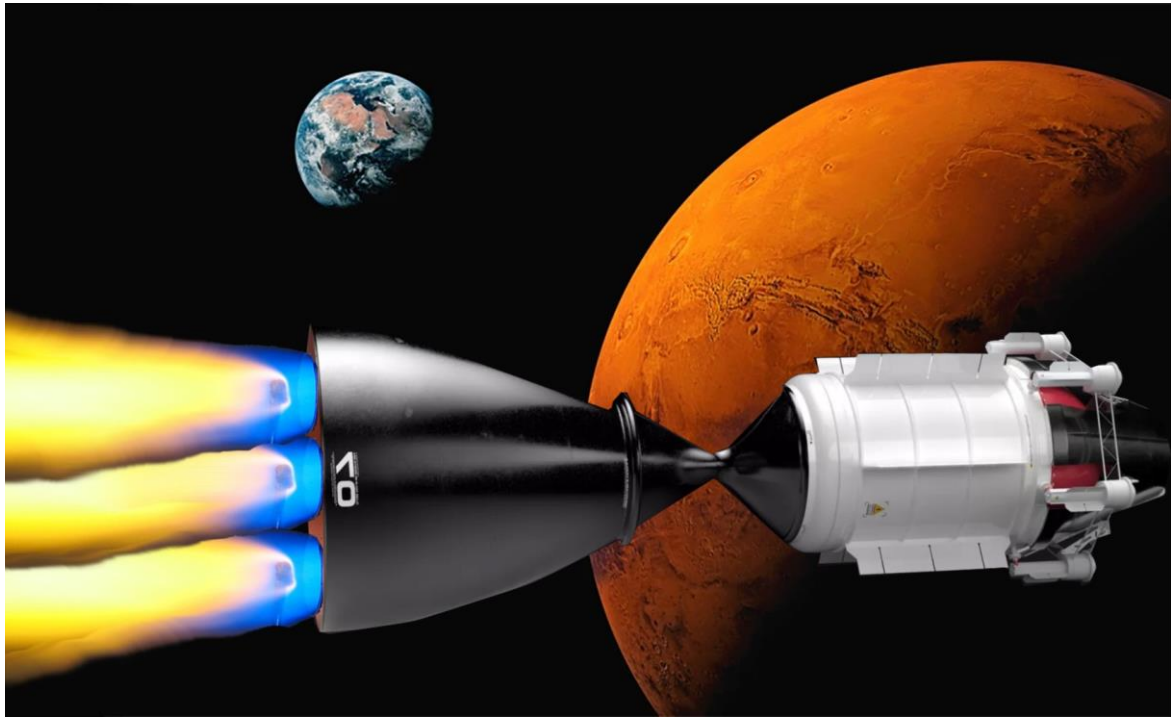
Project Background

NASA plans on going to Mars

Nuclear Thermal Propulsion engines are very efficient

Further research can improve efficiency of NTP engines

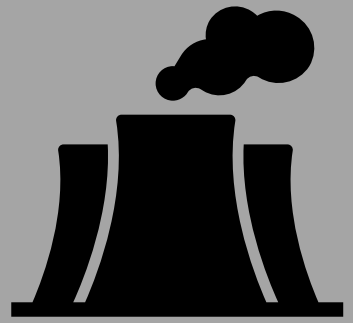
Develop a component for Big BUSTER to test different fuels for NTP engines.



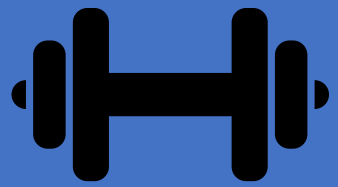
Brian McGough

Assumptions

Big BUSTER will function according to the specifications given by NASA

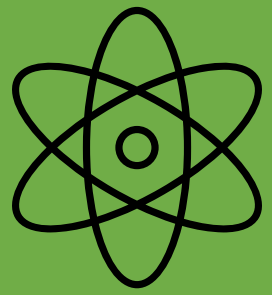


Weight will not be a constraining factor



Temperature range will not exceed 3000K

Radiation containment is done by Big BUSTER, not the canister

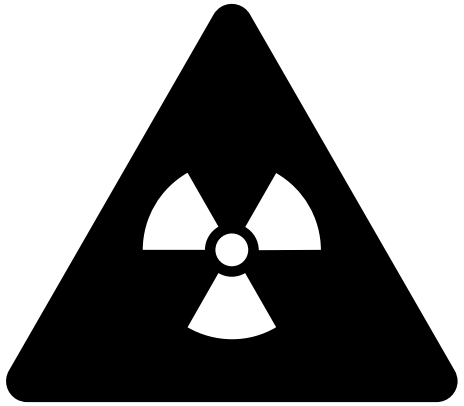


Brian McGough

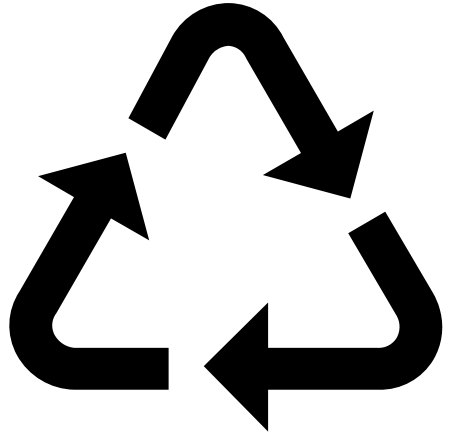
Key Goals

Temperature Resistant

Resist Effects of Radiation on the Canister

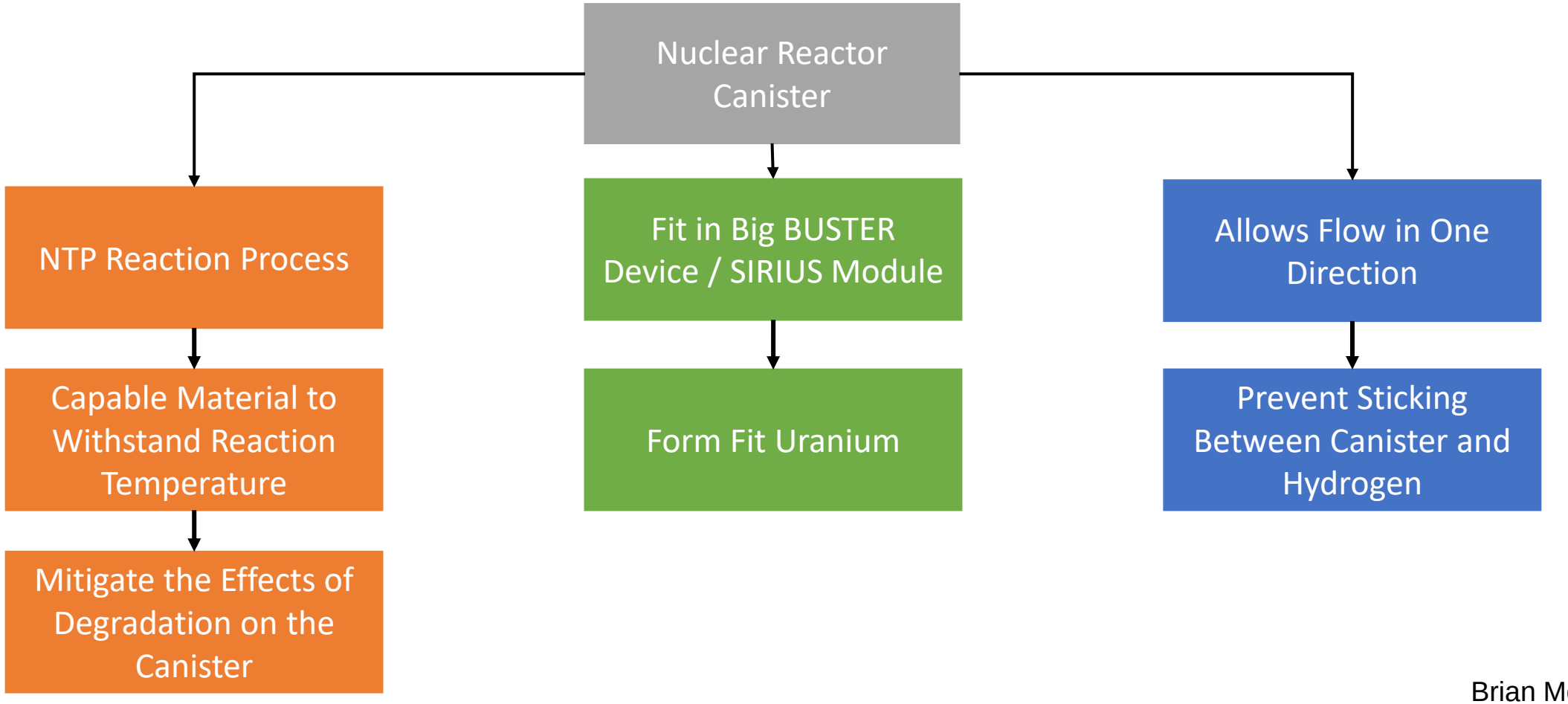


Reusability



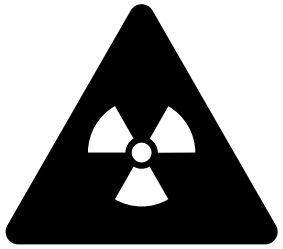
Brian McGough

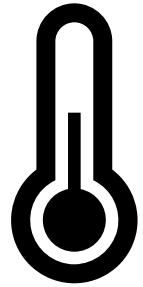
Functional Decomposition



Brian McGough

NTP Reaction Process





Capable Material to Withstand Reaction Temperature

- 3000 K

Mitigate the Effects of Degradation on the Canister

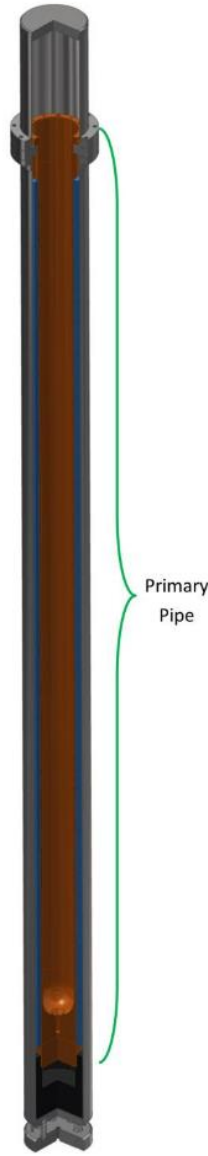
- Less than 8 GPa increase in hardness

Brian McGough

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



Brian McGough

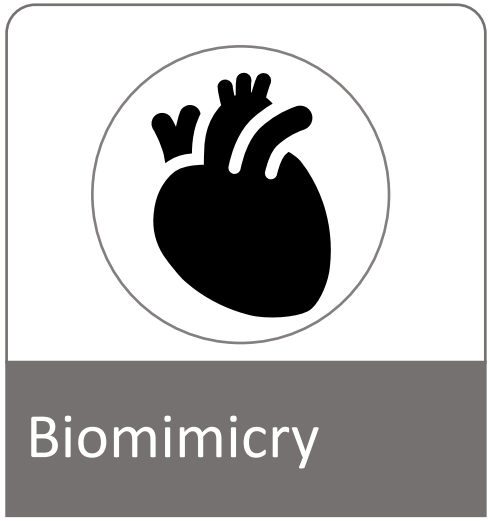
Allows Flow in One Direction

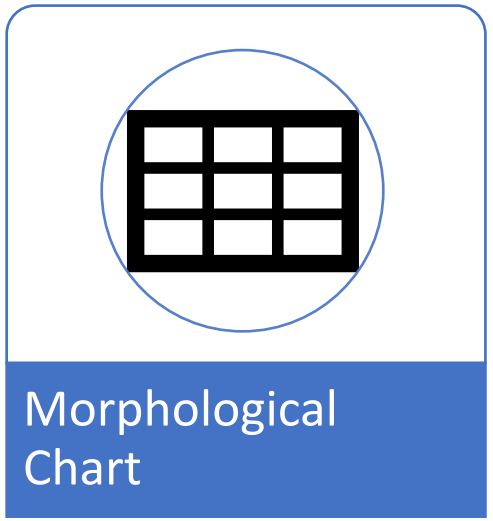
Prevents Hydrogen Propellant from Sticking to the Canister

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

Brian McGough

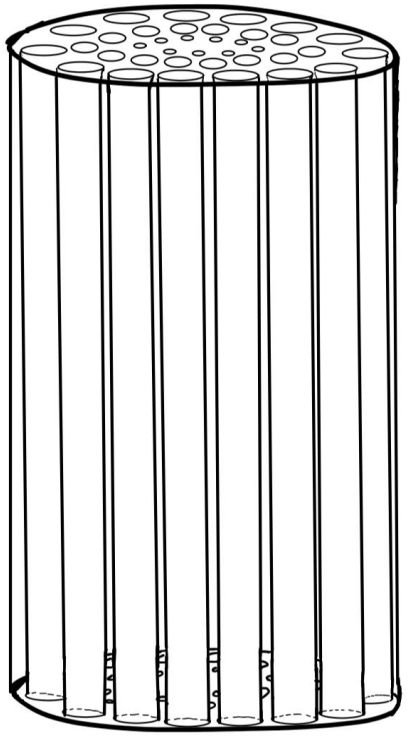
Concept Generation



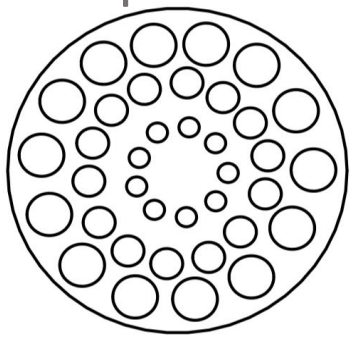


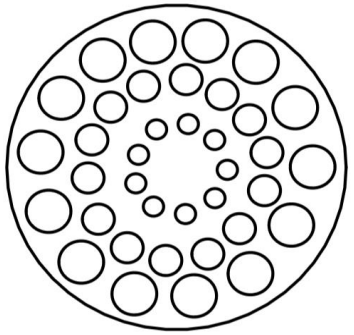
Braden Dukes

First High-Fidelity Design



Top View





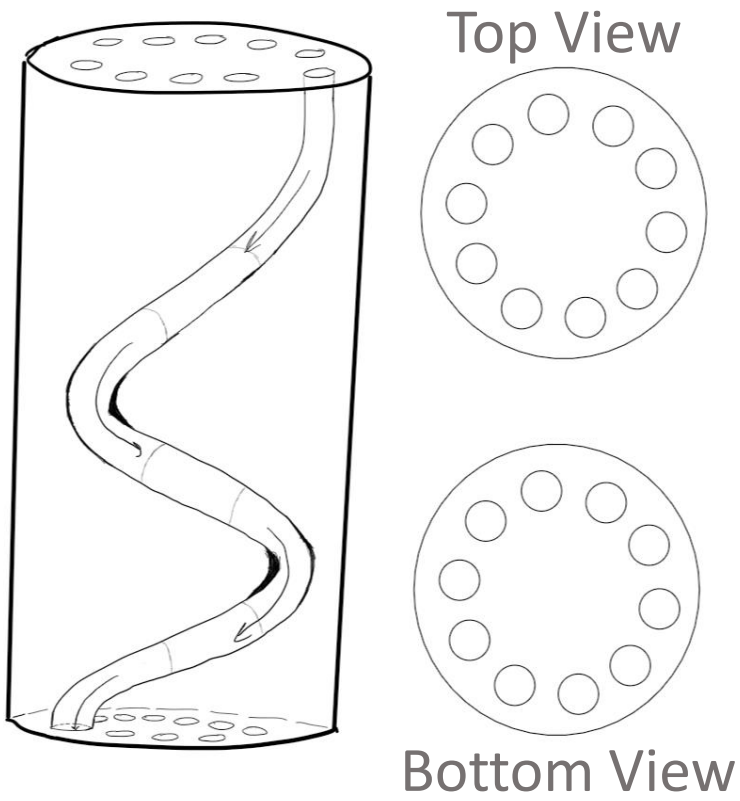
Bottom View

Base metal of Tungsten

Straight path for hydrogen to flow

Braden Dukes

Second High-Fidelity Design

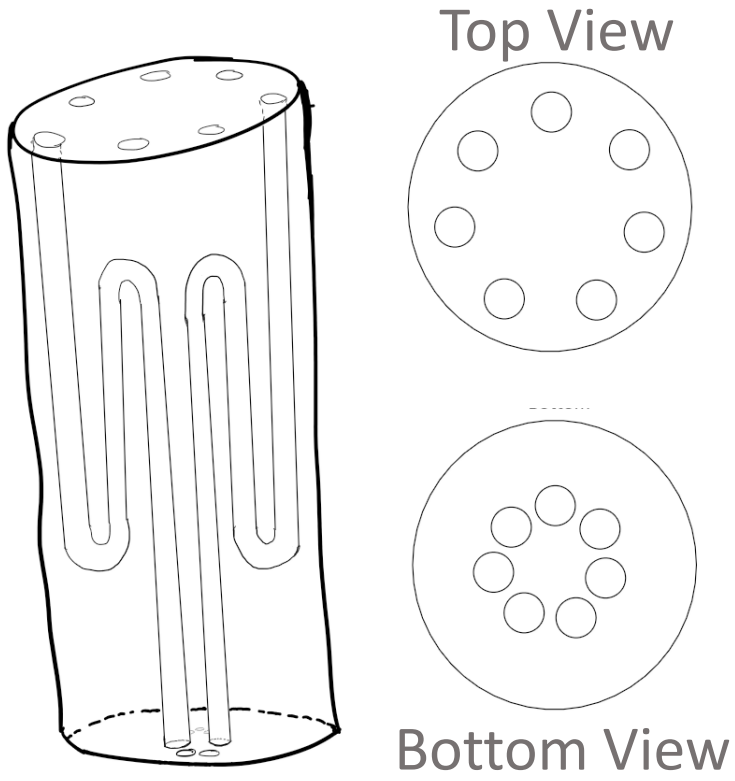


Base metal of Tungsten

Spiral path for hydrogen to flow

Braden Dukes

Third High-Fidelity Design



Base metal of Tungsten

Triple pass path for hydrogen to flow

Braden Dukes

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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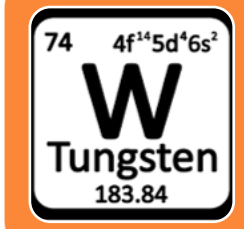
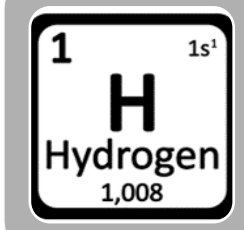
Proposed Design



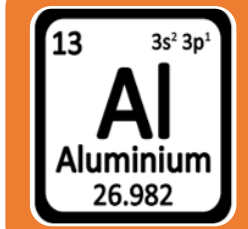
99.99% Pure Tungsten



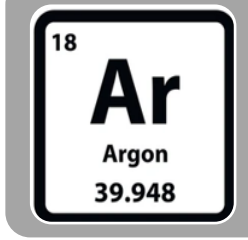
Hydrogen Propellant

Uranium Fueled

Experimental Design



Aluminum 6061



Argon "Propellant"

Heating Element "Fission Product"

Braden Dukes

Proposed Design

- Zirconium Carbide coated Tungsten
- 7.62cm (3in) diameter
- 0.635cm (0.25in) diameter flow channels [x28]
- 35.56cm (14in) length
- Pressure fitted variable size center whole adaptable to different uranium configurations

Braden Dukes

Prototype CAD Assembly

Braden Dukes

Prototype

7in tall 3-D printed "mock" canister

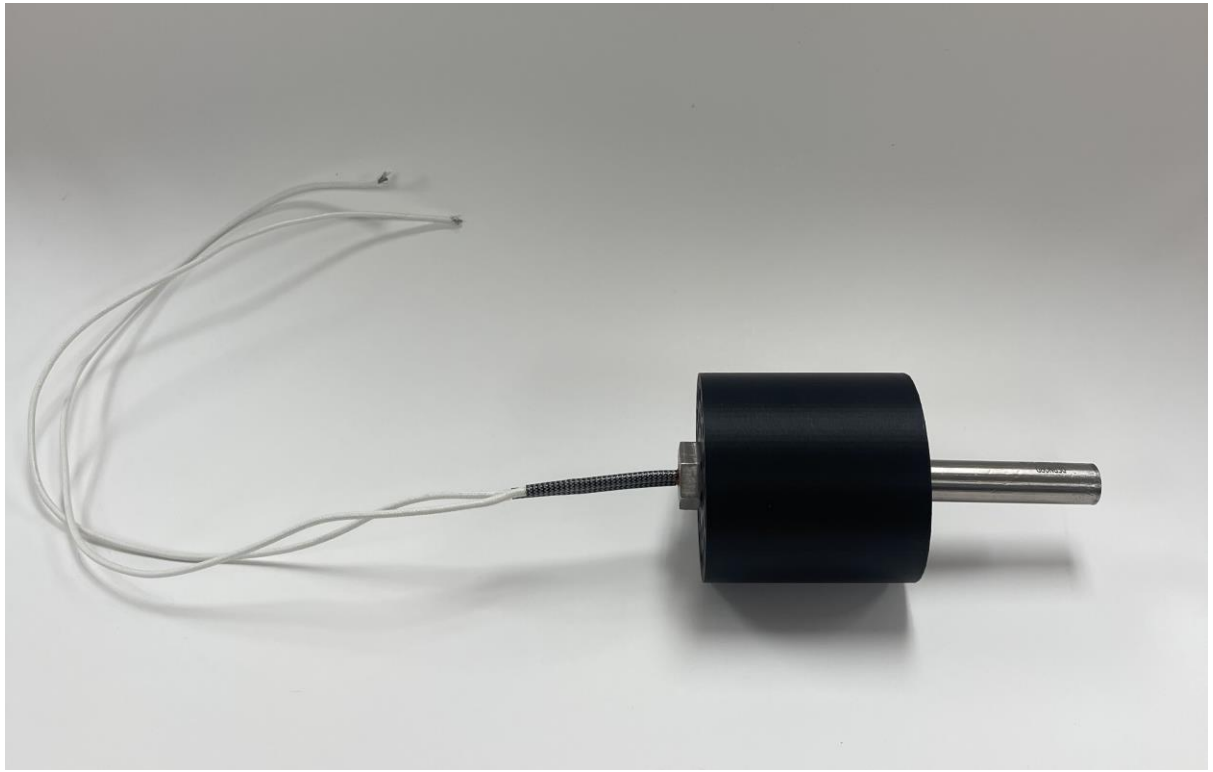
- 3.81cm (1.5in) diameter
- 28 flow channels
  - 0.316cm (0.125in) diameter flow channels

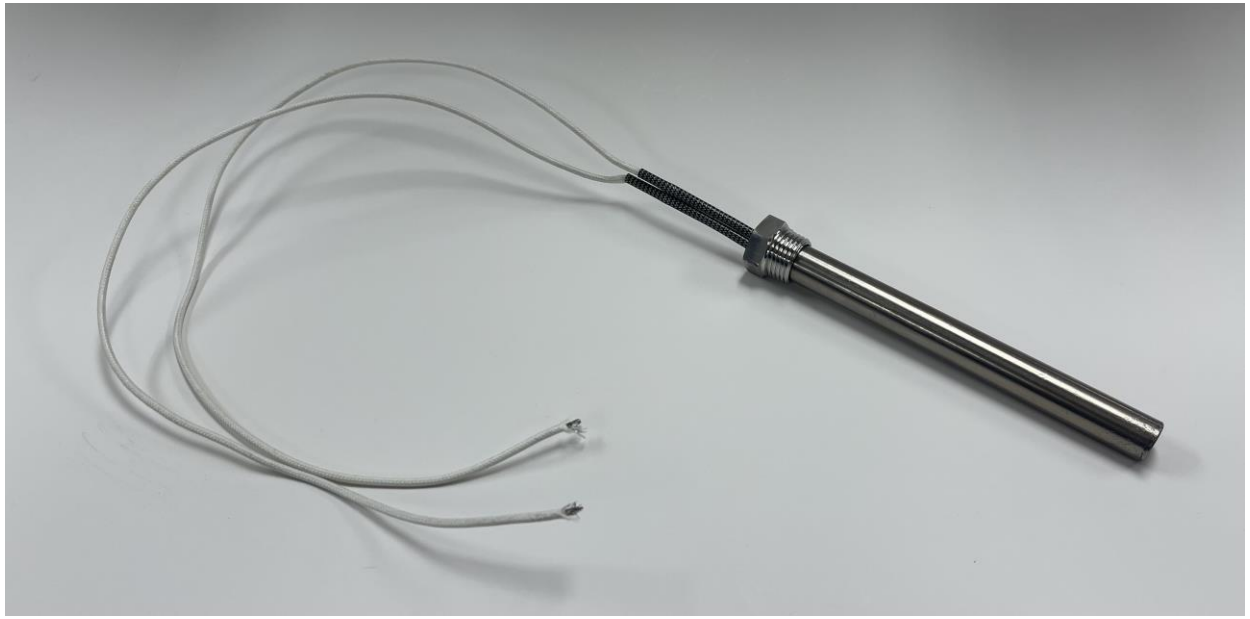
Aluminum 6061 14in machined canister

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

Braden Dukes

Parts Testing





Braden Dukes

Future Work

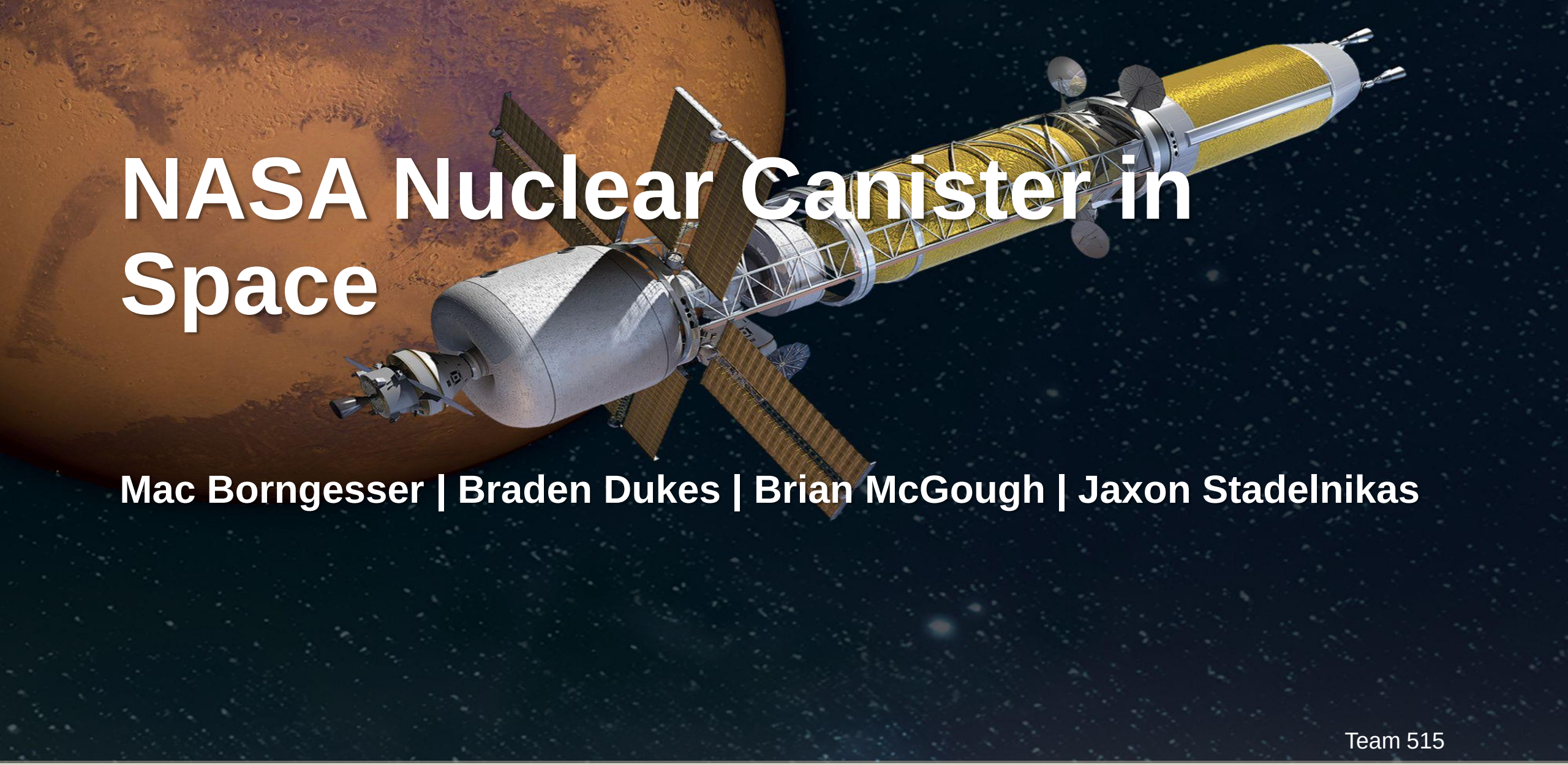
Testing Procedure

- Assemble Experiment
- Safety Protocol

Validation

- Confirming and comparing with expected results

Braden Dukes



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Team 515