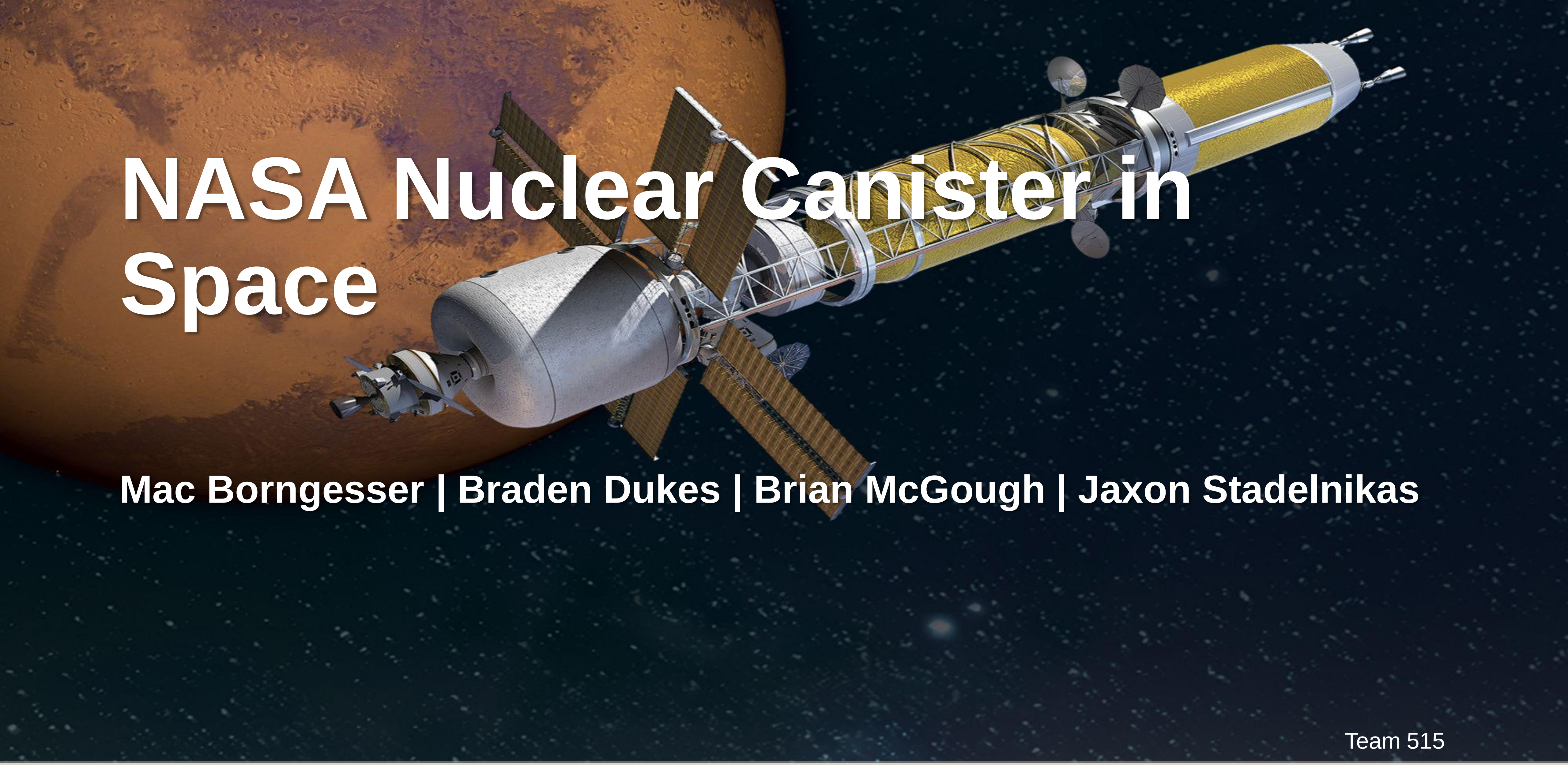


NASA Nuclear Canister in Space

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

+

<u>Engineering Sponsor</u>

Marvin Barnes

NASA Marshall Space Flight Center

<u>Academic Advisor</u>

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

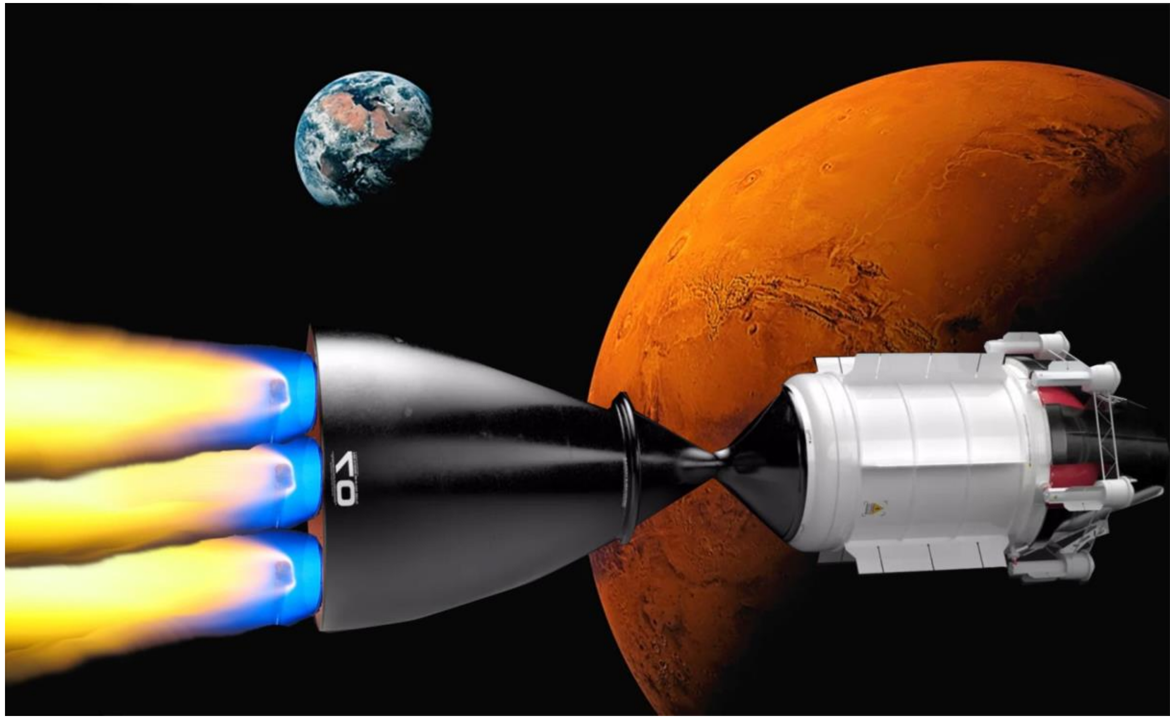
Project Background

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.



Jaxon Stadelnikas

Customer Needs

Where will this device be used?	Device will be used in TREAT inside of Big Buster
How to keep hydrogen from reacting with the canister?	Flow dynamics to keep the hydrogen away from the walls
How will the reactor work in the canister?	Device will withstand 3000K and radiation effects
What fuel will be used?	Device will hold and maintain uranium-235

Jaxon Stadelnikas

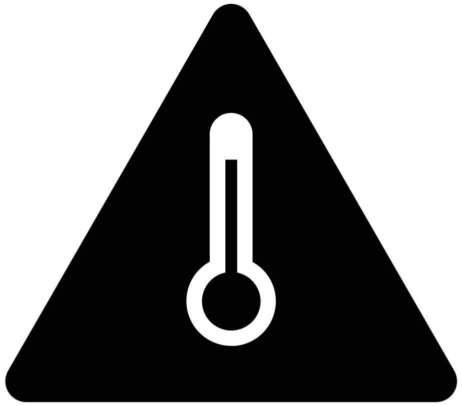
Assumptions

- Big Buster will function according to the specifications given by NASA
- Weight will not be a constraining factor
- Temperature range will be up to 3000 K
- Radiation containment is done by Big Buster, not the canister

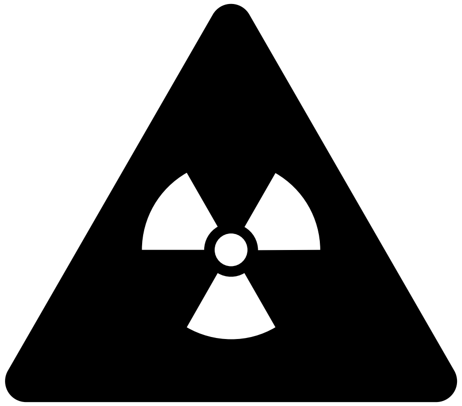
Jaxon Stadelnikas

Key Goals

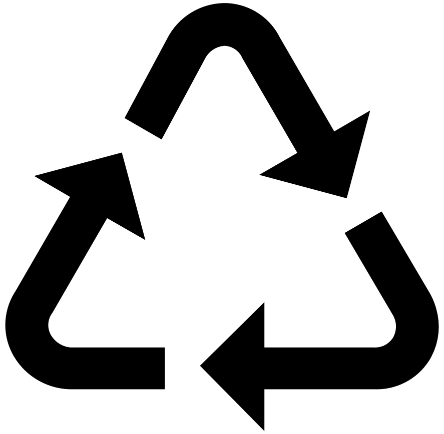
Temperature Resistant



Reduce Effects of Radiation on the Canister

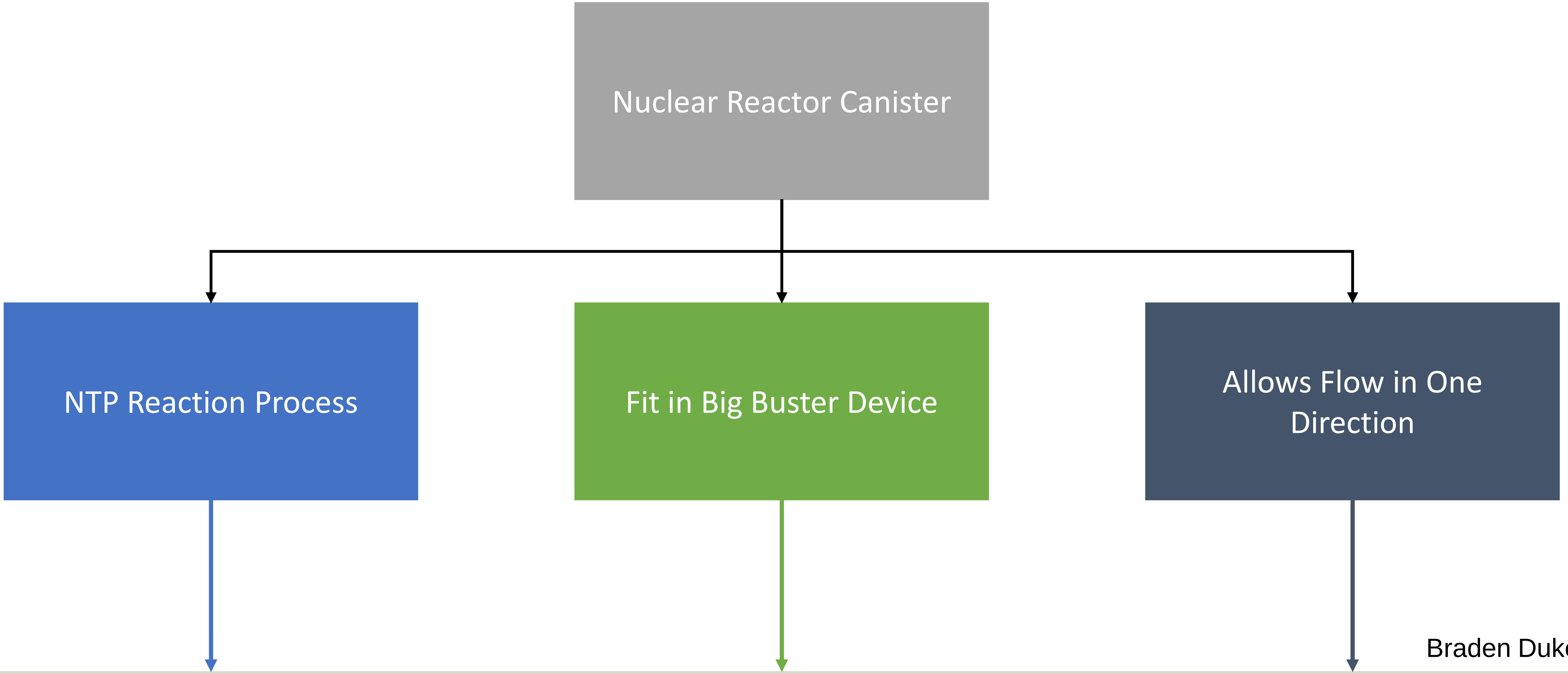


Reusability



Braden Dukes

Functional Decomposition



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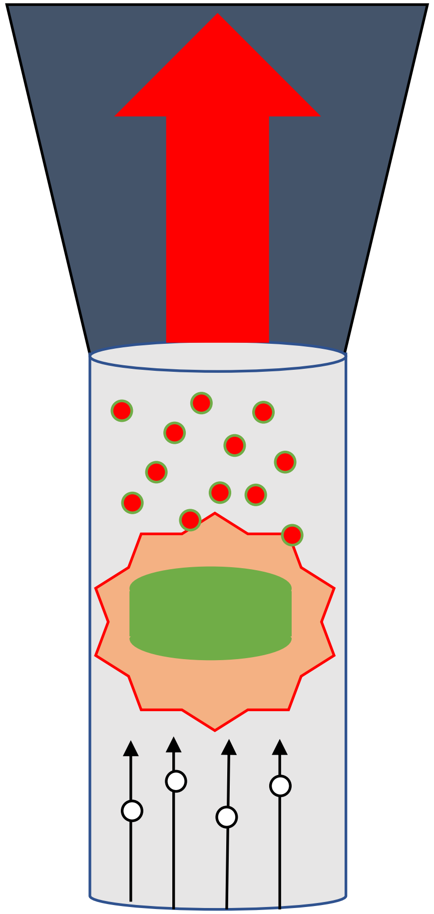
Functional Decomposition



NTP Reaction Process

Capable Material to Withstand Reaction Temperature

Resist Radiation Effect

NTP Reaction Process

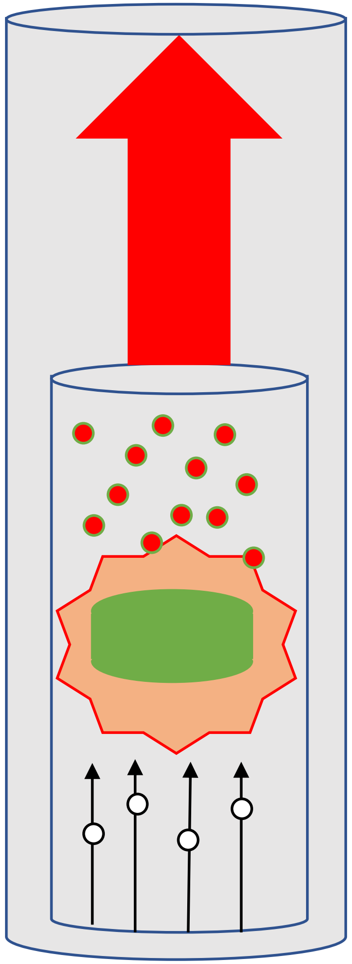
Nuclear Reactor Canister

Fit in Big Buster Device

Allows Flow in One Direction

Braden Dukes

Functional Decomposition



Fit in Big Buster Device

Form Fit Uranium

NTP Reaction Process

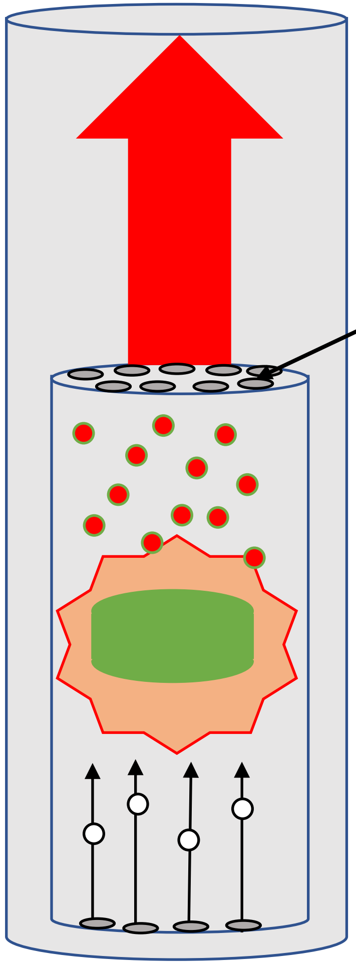
Fit in Big Buster Device

Nuclear Reactor Canister

Allows Flow in One Direction

Braden Dukes

Functional Decomposition



Allows Flow in One Direction

Allows Flow of Only Hydrogen

Prevent Sticking Between Canister and Hydrogen

NTP Reaction Process

Fit in Big Buster Device

Nuclear Reactor Canister

Allows Flow in One Direction

Braden Dukes

Future Work

Targets and Metrics

- Determine numerical goals for dimensions and materials

Concept Generation

- Research similar devices
- Use generation tools to ideate

Concept Evaluation

- Use multiple evaluation tools to rank our design according to the needs of NASA

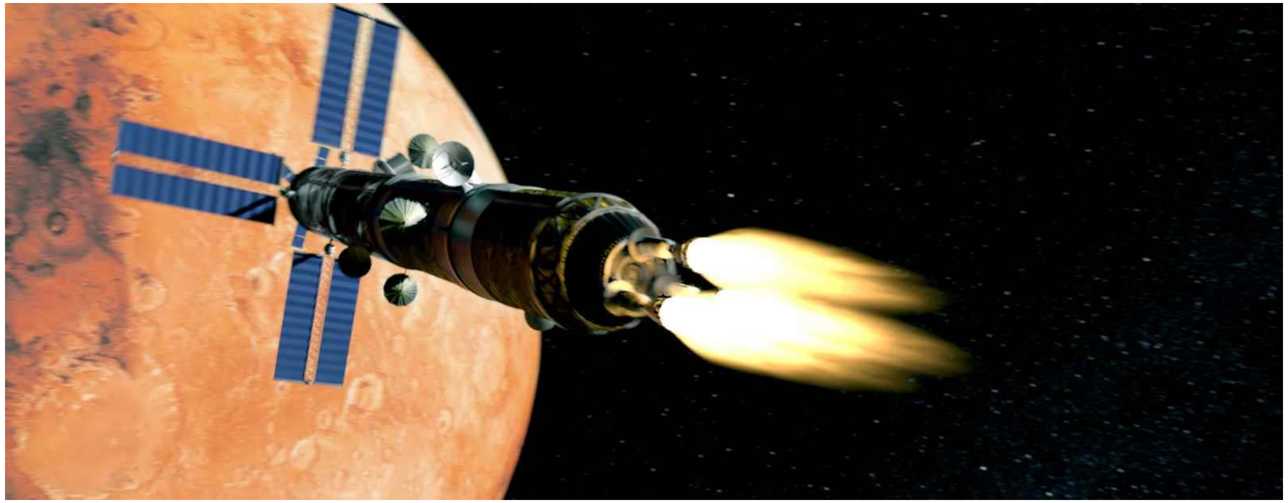
Concept Selection

- Evaluate the ranking of designs
- Decide the most important rankings

Braden Dukes

NASA Nuclear Canister in Space

- Background
- Customer Needs
- Assumptions
- Key Goals
- Functional Decomposition



Backup Slides

Project Scope

Description

- Develop a canister that will go around the nuclear reaction in NASA's "Big Buster" project

Key Goals

- Contain the nuclear radiation and withstand the reaction temperature

Market

- Canister will be designed specifically for NASA to be integrated in the "Big Buster" project

Assumption

- Ideal reaction temperature is 3000K and the weight of the canister is not a constraint

Stakeholder

- Including NASA, Harold Gerrish, Marvin Barnes, Dr. Eric Hellstrom, and all members of team 515

Key Goals Full

The main objective of this project is to design and develop a canister that will safely contain the nuclear reaction between the baseline fuel and the fluid it reacts with.

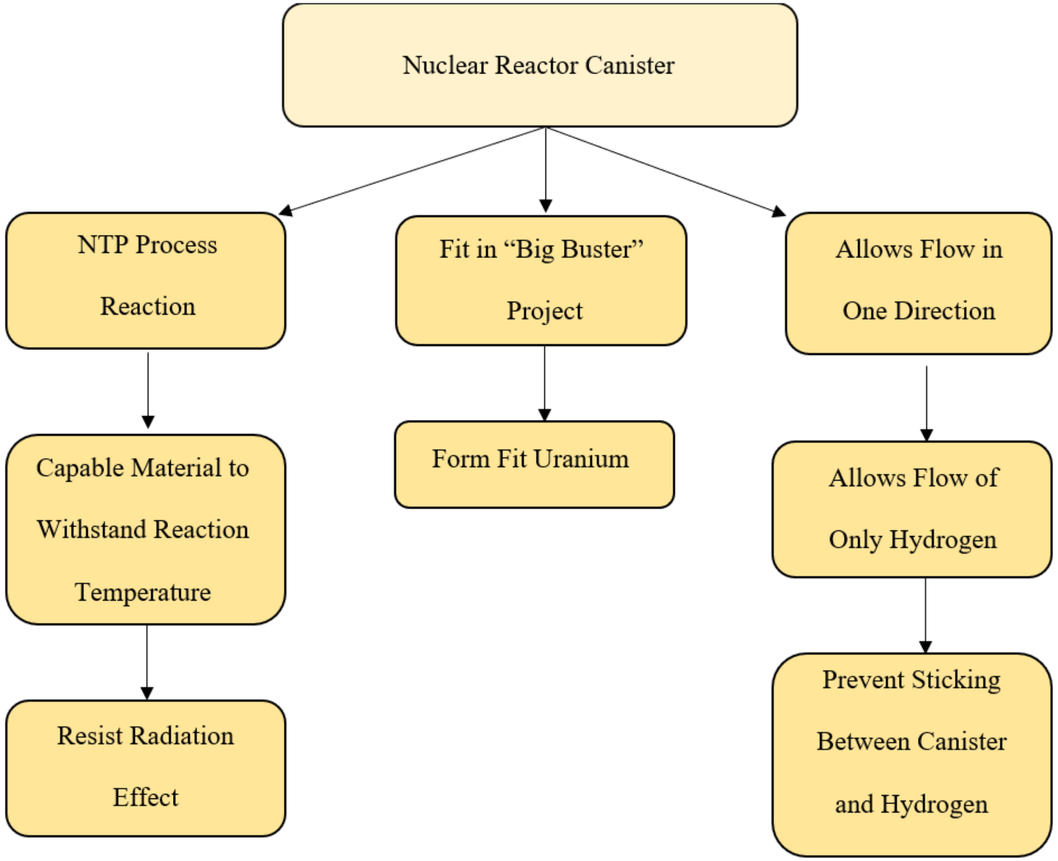
The baseline fuel will start out as uranium nitride if successful multiple other baseline fuels will be tested.

The biggest obstacle will be the reaction temperature of a fission reaction and the lack of a reaction between the walls of the canister and the fluid.

Customer Needs Full

Question	Response	Interpreted Need
What are the dimensions of the Canister we are designing?	You are designing a reactor canister to be used in project "Big Buster."	The canister will have to fit in the Big Buster project.
Where will this device be used?	Idaho Falls, Idaho at the TREAT Reactor in the Idaho National Laboratory.	Device will not be used in space and atmospheric gravity will be applied.
Do we need to be concerned with radioactivity?	The project is tested on the ground and for a short duration. You do not need to worry about radiation.	Radiation absorption does not need to be considered for this device.
What will be used as fuel for the nuclear reaction?	Uranium 235 will be used.	Our canister will need to be able to hold and maintain conditions for a reaction of U 235.
How will the reactor work in the canister?	The reactor will inject a stream of hydrogen into the canister and heat it to 3000K for around 30 seconds.	The canister will have to be able to withstand 3000K without failure for at least 30 seconds.
What will be the reactant flow?	Hydrogen will flow through the canister to react with the U 235.	The canister will need to be able to have a flow go through it in one direction.
What are our limiting factors for this project (weight, cost, etc.)?	Weight does not need to be a factor because the canister will not be in space. The budget is unknown so far.	When selecting a material, the weight or density does not need to be taken account for, and as for know a budget does not need to be a concern.
How will we keep the hydrogen from reacting with the material chosen for the canister?	Flow dynamics will be used to keep neutrons away from the walls and the walls can have a film to prevent sticking.	The canisters will need to be sticky resistant.

Functional Decomposition Full



Functional Decomposition (cont.)

- Action and Outcomes
  - This project consists of designing and building a canister for the Big Buster device.
  - It must withstand 3000K for over a period of 30 seconds, resist radiation effects, and resist hydrogen sticking to prevent hot spots.
- Smart Integrations
  - The material of the canister is the most vital component of the project.
  - Hydrogen will need to flow through the canister for the NTP system to operate successfully.

Functional Decomposition (cont.)

- Connection to System
  - The NTP Reaction Process requires all functions.
  - The canister fitting in Big Buster is the most important aspect of the project as it needs to fit in the device for the reaction to occur.
  - For the process of allowing flow in one direction, the canister will use hydrogen for the NTP reaction to without causing hot spot propagation.
- Functional Resolution
  - The form fitted canister should fit inside the Big Buster device, withstand 3000K, and allow hydrogen flow in one direction without sticking to the inner surface.

Cross Reference Table

Function	NTP Process Reaction	Fit in “Big Buster” project	Allow Flow in One Direction
Capable Material to Withstand Reaction Temperature	✖		
Capable Material to Resist Radiation Effect	✖		
Form Fit Uranium	✖	✖	
Allows Flow of Only Hydrogen	✖		✖
Non-Stick Between Canister and Hydrogen	✖		✖