
# Journey to Spaceport

Charlie Nitschelm

UNH SEDS

University of New Hampshire
Students for the Exploration and Development of Space

# My Background

- Senior mechanical engineering major and physics minor at the University of New Hampshire
- Founded UNH SEDS at the end of my freshman year and am the current President and Lead Engineer
- Elected to the board of SEDS USA, the largest student-run space organization, as the Member at Large

**Job Experiences**

Summer 2018

*Researcher at NIST on the mechanical behavior of Inconel in extreme conditions*

2018-2019 School Year

*Manufacturing engineering intern at TURBOCAM international focused on the affect tool coatings have on the lifetime of a tool*

Summer 2019

*Propulsion manufacturing intern at Rocket Lab USA focused on process improvement within printing, machining and welding*



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# The 3-Year Plan

Year One
2017-2018

Rocket Building
*Simulating*
*Launching*
*Optimizing*

Year Two
2018-2019


Hybrid Engine
*Engine Design*
*Manufacture*
*Test*

Year Three
2019-2020

Hybrid Rocket
***Spaceport America Cup***
*Rocket Vehicle*
*Engine Optimization*

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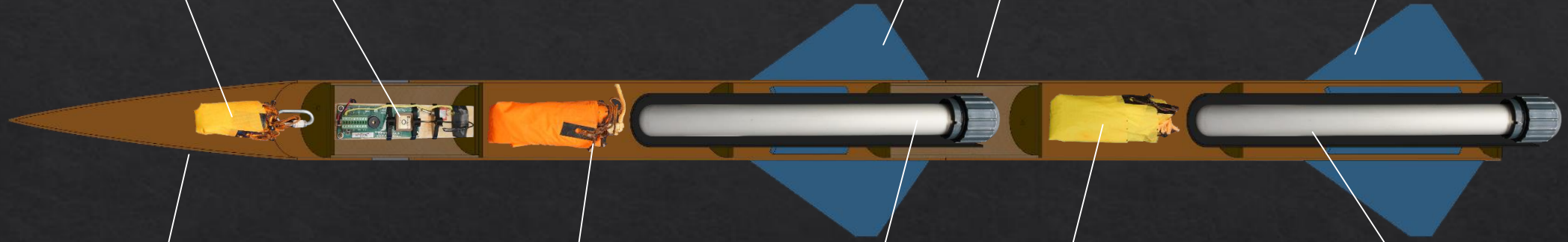
# Year 1 – Sophomore Year

**Organization Statistics**

Committed Members: 14
Majors: 3
Senior Projects: 4
Funding: $2,250

*SEDS Rocketry Competition, May 2018, Maine*

# Year 1 – Rocket Building



**Electronics Bay**
Houses the TeleMega GPS and controls both parachute deployment and sustainer ignition

**Staging Coupler**
Supports stage separation at sustainer ignition

**Drogue Parachute**
A small parachute deployed at sustainer apogee

**Forward Fins**
Provides stability to the sustainer after stage separation

**Aft Fins**
Provides stability to the rocket before stage separation

**Custom Nose Cone**
A 3D printed nose cone that houses the drogue parachute and connects directly to the electronics bay

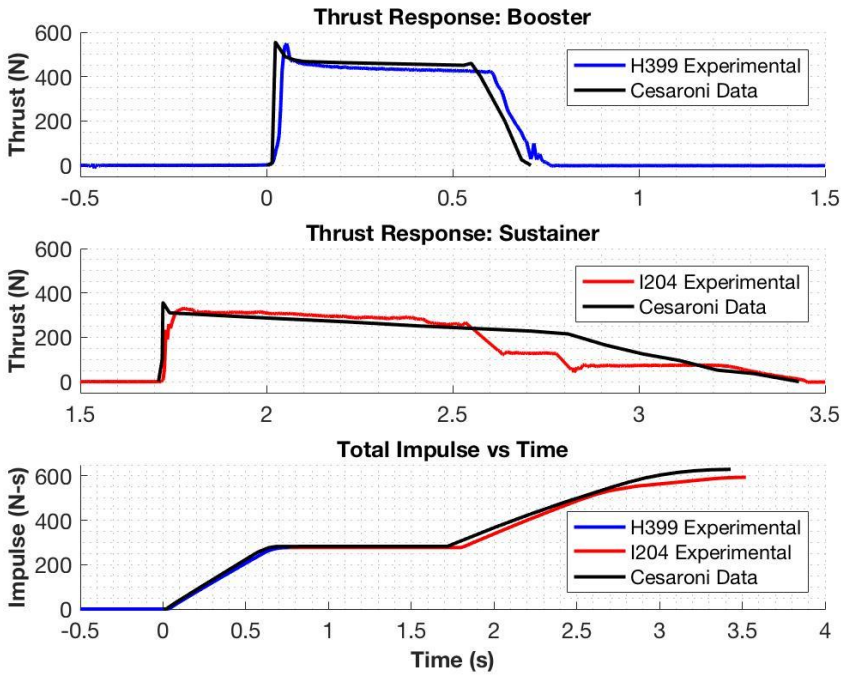
**Sustainer Engine**
Propels the rocket to max altitude after booster burnout; 1.7 second burn time

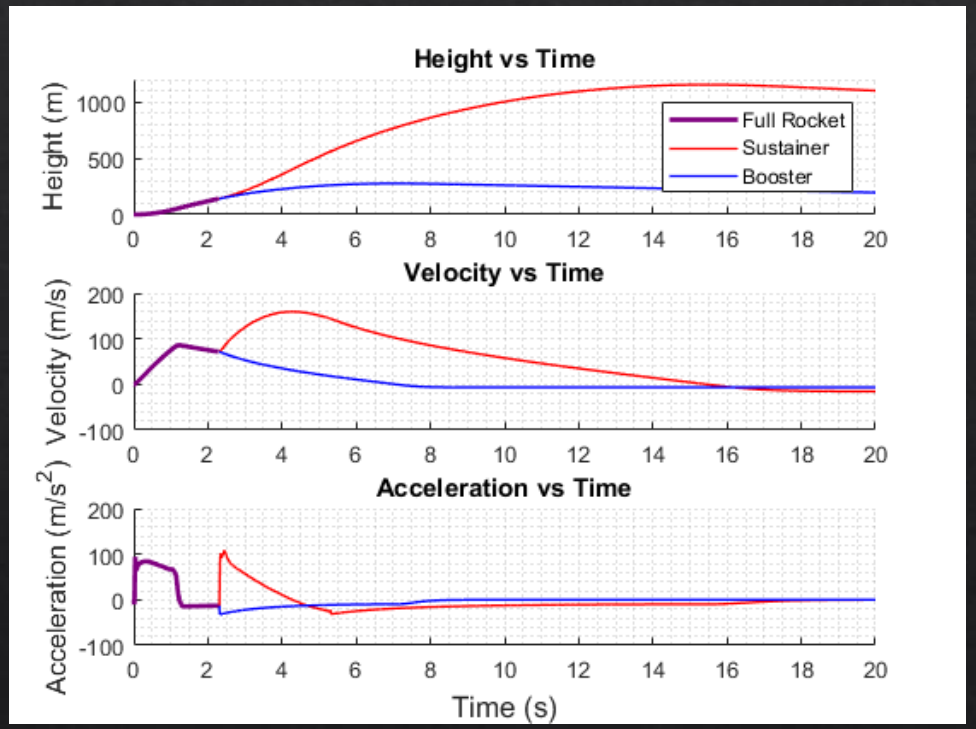
**Booster Engine**
Initiates flight with a 0.7 second burn time

**Sustainer Parachute**
A larger main parachute that slows the sustainer to a safe landing speed

**Booster Parachute**
A large parachute to slow the booster to a safe landing speed

# Year 1 – Simulating




| | Reported Max Thrust | Measured Max Thrust | Reported Total Impulse | Measured Total Impulse |
|---|---|---|---|---|
| **Booster Engine: Cesaroni H399** | 545.8 N | 549.6 N | 282.2 N-s | 277.1 N-s |
| **Sustainer Engine: Cesaroni I204** | 356.8 N | 329.7 N | 347.7 N-s | 322.7 N-s |

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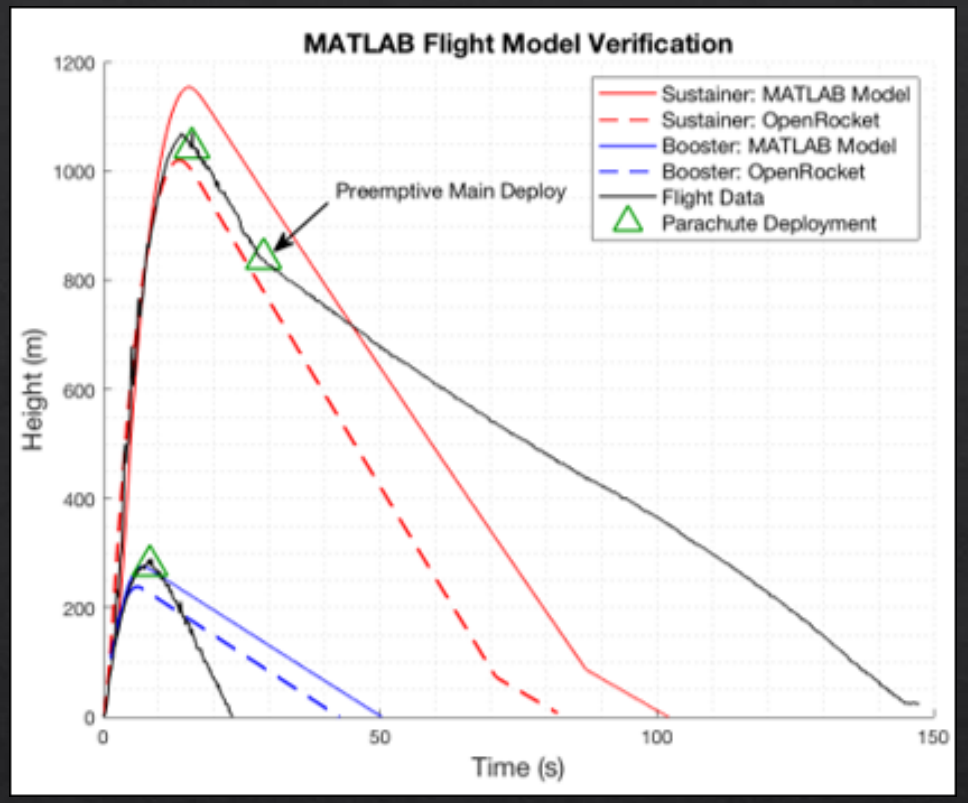
# Year 1 – Launching




| | Flight Data | OpenRocket Model | MATLAB Model |
|---|---|---|---|
| **Sustainer Apogee** | 1071.1 m | 1020.6 m | 1154.1 m |
| **Booster Apogee** | 290.0 m | 238.6 m | 276.3 m |

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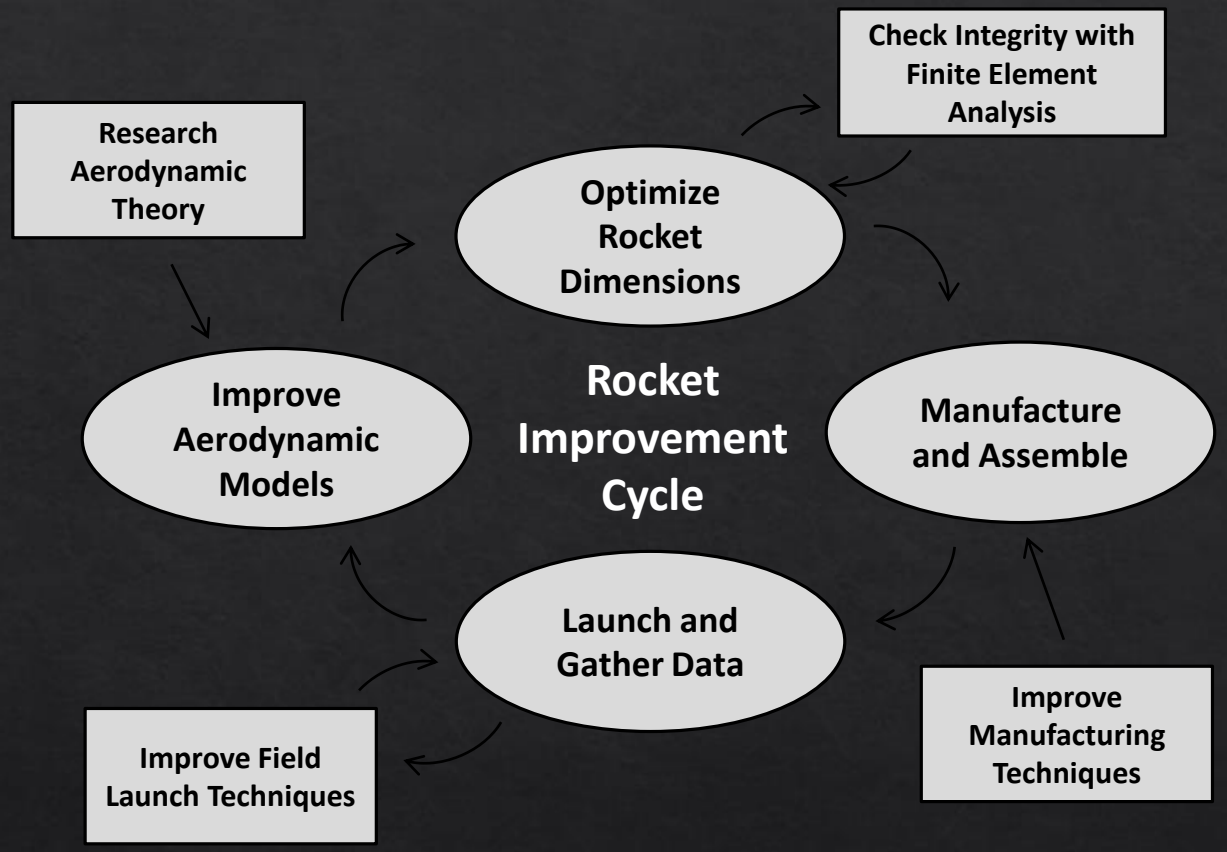
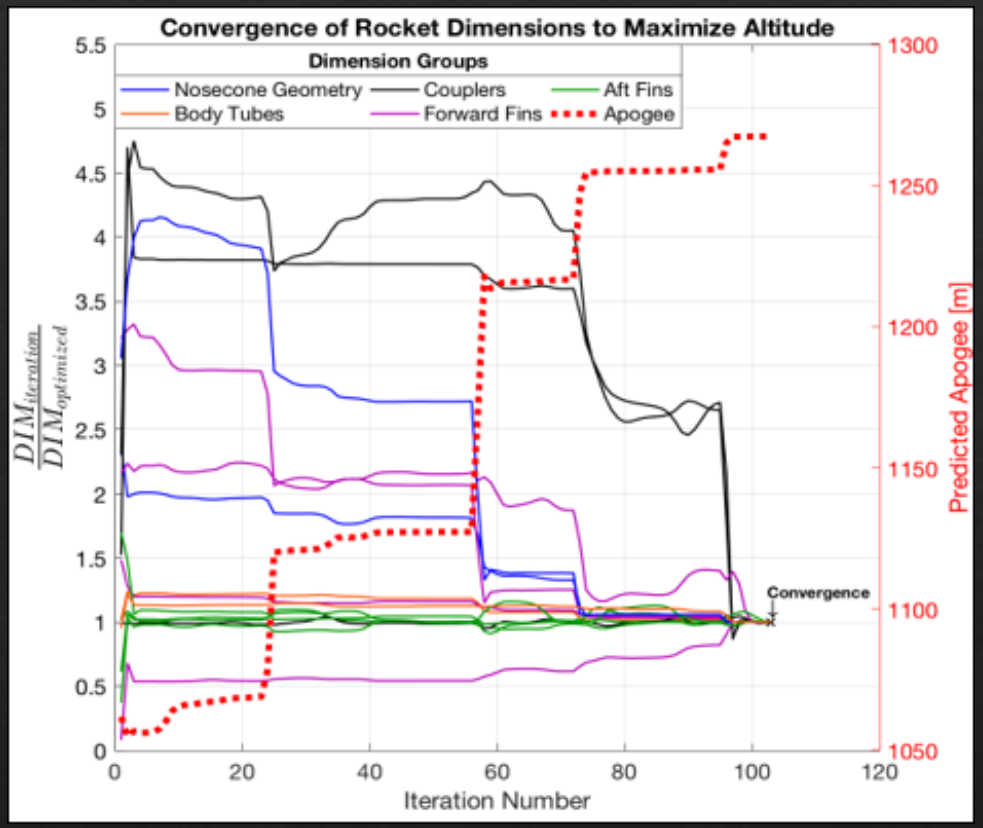
# Year 1 – Optimizing and Repeat



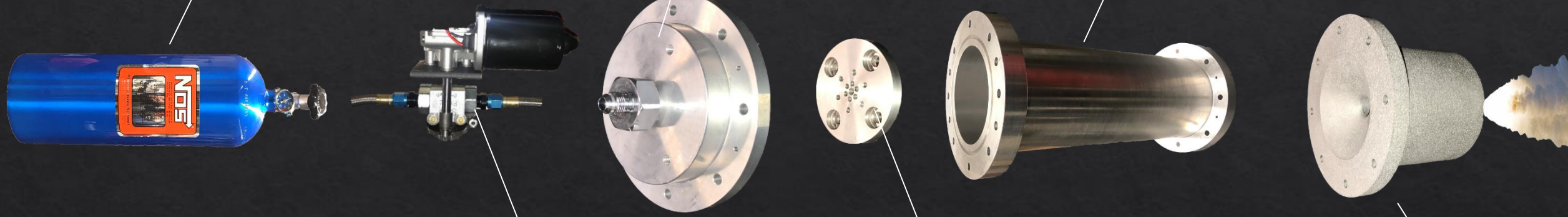
# Year 2 – Junior Year

**Organization Statistics**

Committed Members: 20
Majors: 5
Senior Projects: 9
Funding: $5,500


*Spacevision 2018, November 2018, San Diego*

# Year 2 – Hybrid Engine Development




**Oxidizer Tank**
A highly pressurized vessel that contains liquid Nitrous Oxide, acting as our oxidizer within the combustion chamber

**Flow Regulator**
A motorized valve that monitors flow regulation of the oxidizer into the injection plate controlled by an electric motor and an Arduino.

**Injection Plate**
Responsible for providing desired oxidizer flow into the combustion chamber with the assistance of the impinging plate

**Impinging Plate**
An interchangeable cylindrical plate responsible for the impingement and atomization of the oxidizer flow streams

**Combustion Chamber**
An enclosed volume where the solid reducer and liquid oxidizer react to produce a superheated, highly pressurized chamber of gas

**Nozzle**
Graphite was machined into a de Laval curve responsible for directing the flow of hot gases outside of the combustion chamber into the environment providing thrust

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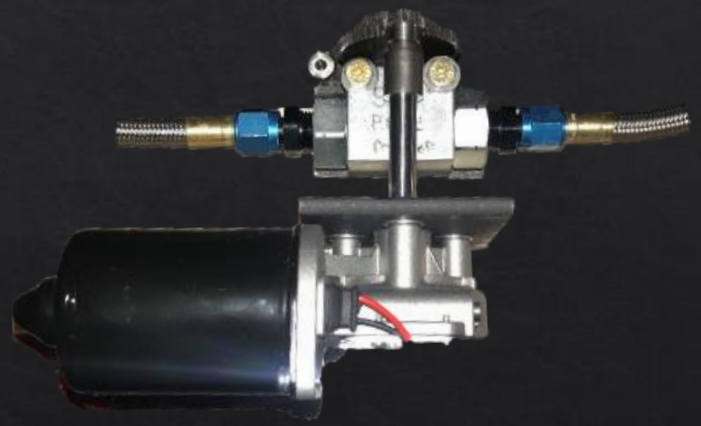
# Year 2 – Engine Design

## Oxidizer Selection and Flow Regulation

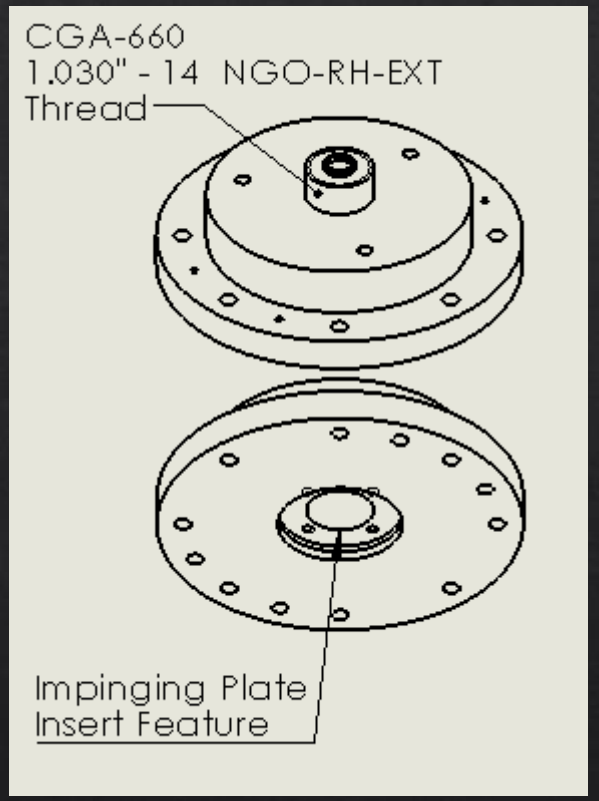
- Needs to be self pressurizing
- Needs to be safe to handle
- Can be refilled within a day

- Nitrous Oxide meets these requirements

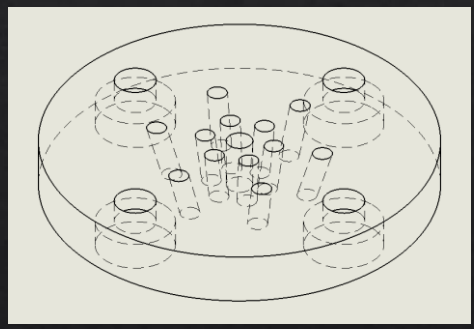
- Suitable for ground testing
- Ability to throttle
- Cheap



## Injector and Impinging Plate

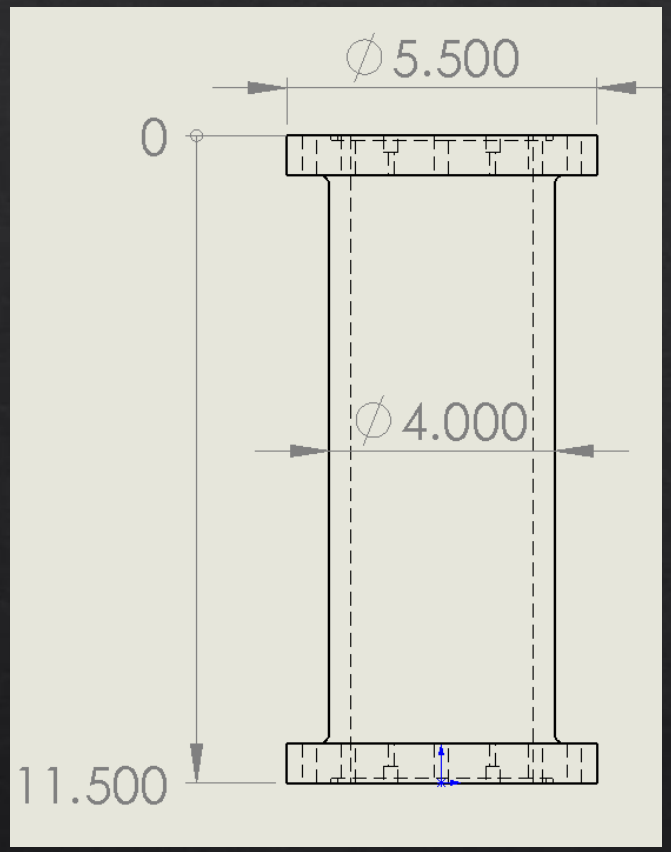


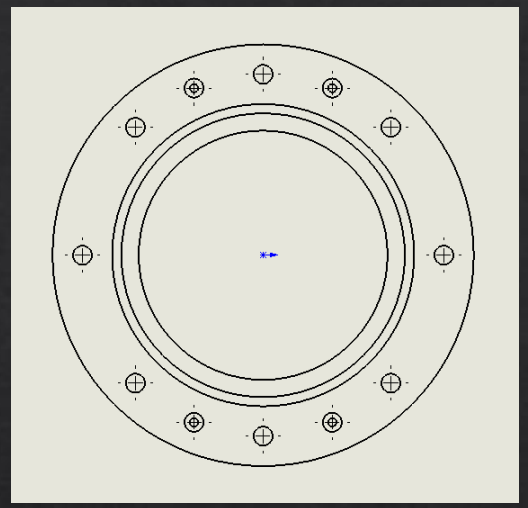

- Interface with COTS piping from flow regulator
- Quick testing of different impinging geometries
- Transitions the liquid oxidizer to a gas



# Year 2 – Engine Design

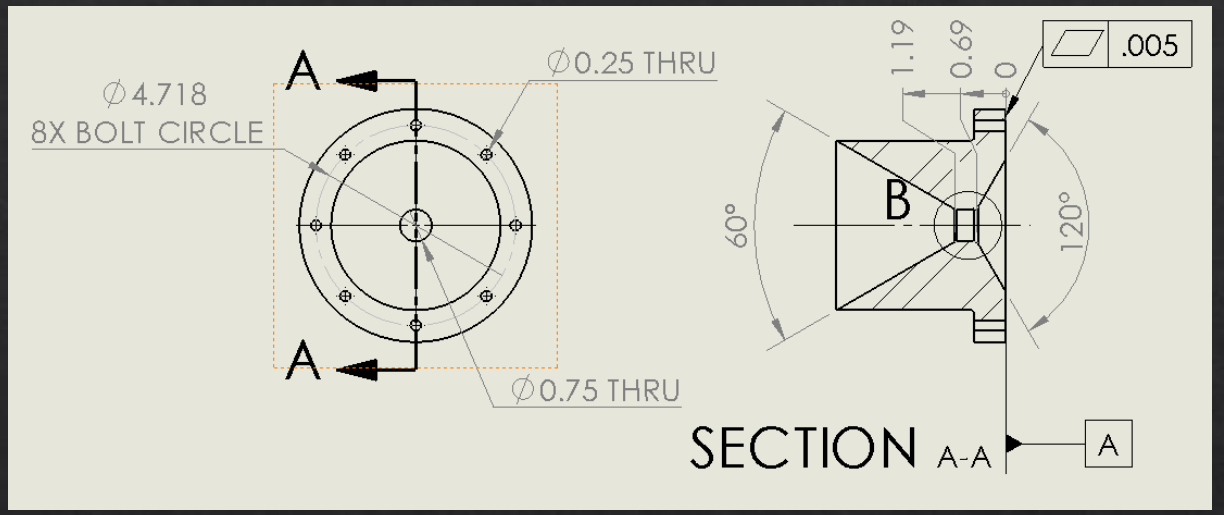
## Combustion Chamber



- Withstand 400 psi internal pressure
- Hold a volume of fuel to support the defined mixture ratio
- Seals with the nozzle and injector

## Nozzle



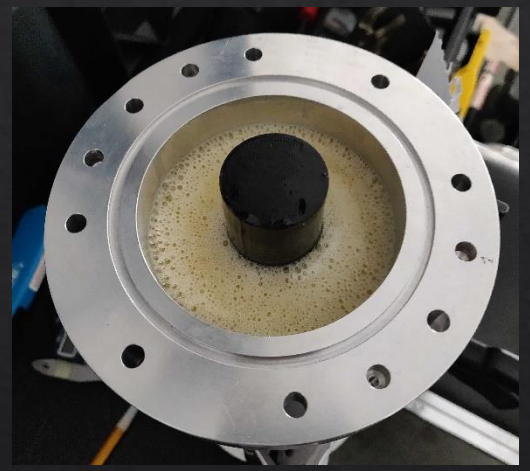

- Accelerate the hot gases within the combustion chamber using converging/diverging design
- Withstand a corrosive, high temperature environment

# Year 2 – Manufacture

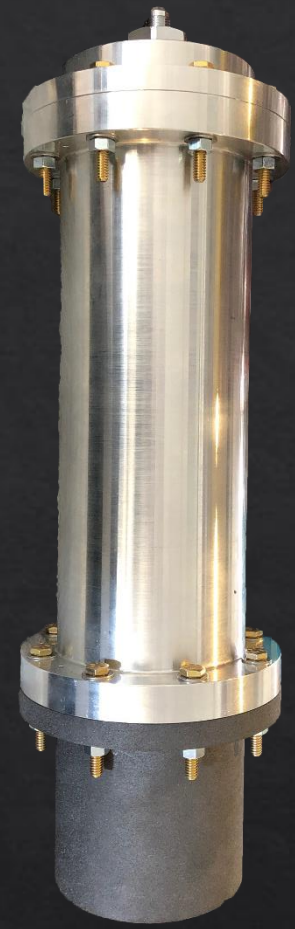
*Combustion chamber chucked on the lathe*

*Machining and assembly of impinging plate*

*Assembly of the flow regulator*



*Molding the rubber into the combustion chamber*



*Runaway fully assembled with the aluminum chamber, injector and graphite nozzle*

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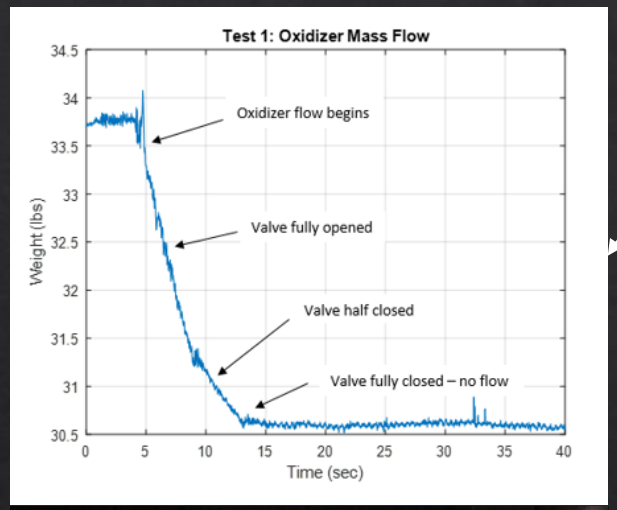
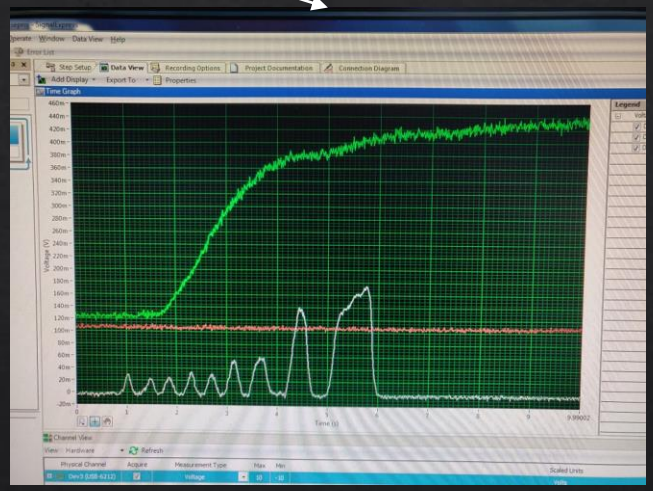
# Year 2 – Test




Rapid impinging plate designs tested for impingement and desired flow rate

Obtain thrust and temperature data during the hot-fire test



Electric spark and igniter assembly

Control bunker for hot-fire tests

Hot-fire test 1 – Ignition

# Year 3 – Senior Year

**Organization Statistics**

Committed Members: 42
Majors: 7
Senior Projects: 14
Funding: $9,000 and counting

# Year 3 – Spaceport Competition

SPACEPORT AMERICA®
CUP

- Rocket competition hosted in New Mexico from June 16th to June 20th
- Requires teams to launch a rocket using COTS or experimental rocket engines to as close to 10,000/30,000 feet with full recovery
- UNH SEDS will be competing in the 10,000-foot experimental hybrid engine category

# Year 3 – Rocket Vehicle

**Avionics**
An electronics module responsible for GPS tracking, engine ignition and flow control, real-time data collection, and recovery triggers

**Research Payload**
A payload built in-house to collect data throughout flight for use in the future

**Throttle Control**
A flow regulation system to insert oxidizer flow into the combustion chamber to provide thrust to the rocket


**Recovery System**
A recovery module that is deployed at apogee to land the rocket safely back on Earth

**Oxidizer Storage**
A pressurized vessel holding the liquid oxidizer to be pumped into the combustion chamber

**Runaway**
New Hampshire's first hybrid rocket engine that utilizes a liquid oxidizer and solid fuel to propel its rocket to 10,000 feet

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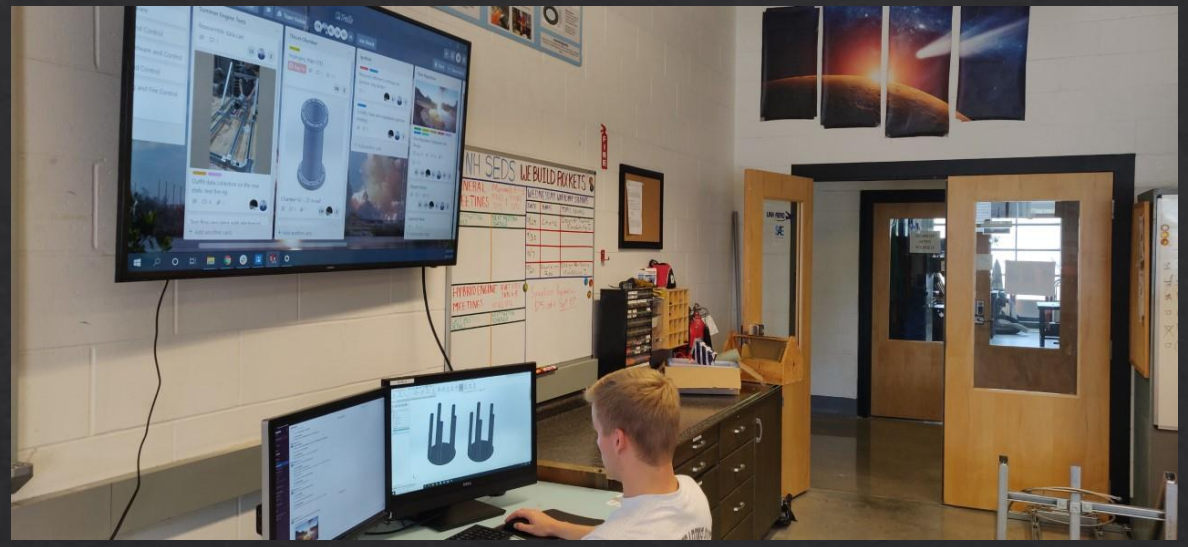
# Year 3 – Engine Optimization

Currently the propulsion lead working on optimizing Runaway for integration into the rocket

- Team of 9 students in propulsion

# Year 3 – Project Management




Chicken suit

| Companies | Responsible | Status | Notes |
|---|---|---|---|
| Advanced Machine Technology | Thomas Pham | Contacted | |
| Apex Plastics | Thomas Pham | Contacted | |
| Aviation Technology Inc | Lucas Simmonds | Contacted | contacted kboyer@aviationtec.com |
| Boston Welding & Design, INC. | Thomas Pham | Contacted | |
| Cannon Mountain | Silas Johnson | Needs Action | |
| Choice Metals | Lucas Simmonds | Needs Action | |
| Cirtronics | Grace Johnston | Needs Action | |
| Cohen Steel | Thomas Pham | Contacted | |
| ControlAir, Inc. | Thomas Pham | Contacted | |
| Dynomite Dynamometer | Grace Johnston | Needs Action | |
| Fibre Glast Developments Corporation | Thomas Collins | Rejected | No direct sponsorship, advice and some discount |
| G&A Machine | Thomas Pham | Contacted | |
| General Dynamics Electric Boat | Lucas Simmonds | Talking | Contact for EB in CT |
| Geokon | Grace Johnston | Needs Action | |
| GT Advanced Technologies | Carly Benik | Contacted | |
| Hitchiner | Silas Johnson | Accepted! | |
| Incite Innovation | Lucas Simmonds | Contacted | Contacted through LinkedIn |
| Kimball Physics | Megan Johnson | Contacted | |
| KMC Systems, Inc. | Ben Letourneau | Contacted | |
| L3 Warrior Systems | Zach Raboin | Talking | Doesn't look good for sponsorship :/ |
| Lewis and Saunders | Megan Johnson | Contacted | |

| Personal Companies | Responsible | Status | Notes |
|---|---|---|---|
| SpaceX | Charlie Nitschelm | Talking | Emailed my contact about it. Low chance. |
| GE Aviation | Zach Raboin | Talking | asked for final request to show to finance |
| Rocket Lab | Charlie Nitschelm | Talking | just followed up |
| Virgin Orbit | Charlie Nitschelm | Contacted | dont feel good to follow up yet, I will see her at IAC |
| Virgin Galactic | Charlie Nitschelm | Contacted | ditto from above, same company kinda |
| The Spaceship Company | Charlie Nitschelm | Rejected | |
| Pratt & Whitney | Charlie Nitschelm | Follow-Up | |
| Aerospace Corporation | Charlie Nitschelm | Talking | just followed up again to get it moving again |
| Additive Rocket Coorporation | Charlie Nitschelm | Accepted! | Very reduced cost printing and post-machining services! help with design for printing as well! |
| NH NASA Space Grant | Thomas Collins | Contacted | Follow up 10/3 |
| Seneca Machine | Charlie Nitschelm | Accepted! | they can do our nozzle!! will be of great help this year |
| Hydrocomp | Grace Johnston | Needs Action | |
| Turbocam International | Thomas Collins | Talking | Met 9/25. Waiting on Charitable giving department to get back |
| New England Wire Technologies | Trevor Blampied | Accepted! | |
| Revision Military | Lucas Simmonds | Talking | |
| Waldron Engineering | Ben Letourneau | Accepted! | 250 |
| Conected Office Technologies | Andrew Masters | Talking | Company that sells printers, but they would probably give 500-1000 if we put the word "toner" on the rocket somwhere |
| Hitchiner Manufacturing | Silas Johnson | Accepted! | Donated last year |
| Flight Coffee | Silas Johnson | Needs Action | Coffee shop in dover, likes flight |
| Mentis Sciences | Silas Johnson | Contacted | Possibly manufacturing services |
| Exothermics Inc | Silas Johnson | Contacted | |