# UNH SEDS | Europa Hybrid Rocket

University of New Hampshire

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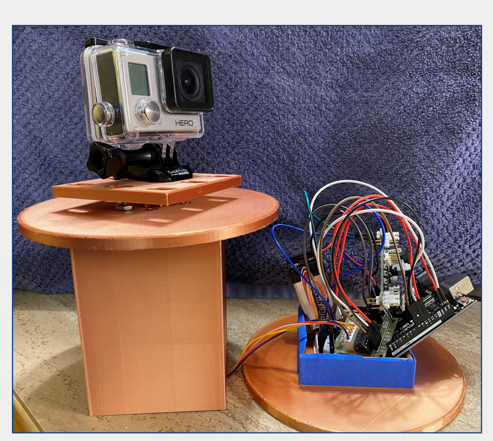
## Project Overview

- Goal: Design and build a rocket for the Spaceport America Cup
- Requirements
  - Build a rocket capable of climbing to 10,000 ft using a hybrid rocket engine
  - Carry an 8.8 lb payload
  - High safety and stability requirements
  - Redundant electronics

SPACEPORT AMERICA® CUP

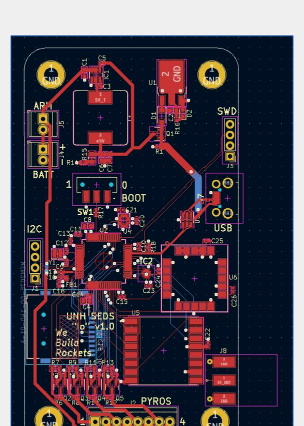
## Payload and Recovery

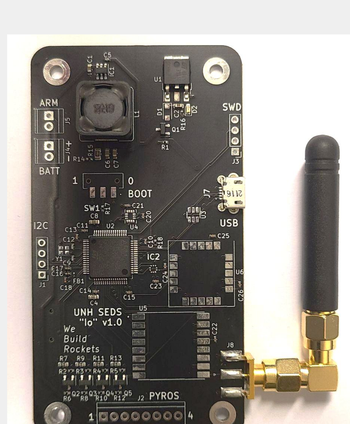
- A dual deployment recovery system is being utilized with a drogue chute stabilizing the rockets decent to 1000 ft, where the main chute will then deploy
- To deploy the parachutes the nose cone is ejected at apogee by a Raptor $CO_2$ ejection system
- An aluminum base plate holds two raptor $CO_2$ systems (one for redundancy) along with U-bolts that attach parachutes to the rocket
- The payload is a 1 DOF camera tracking system, utilizing an IMU gyroscope to measure the rockets rotational velocity.
- A stepper motor connected to the GoPro then rotates the camera in the opposite direction, keeping the system in-line of its original position.

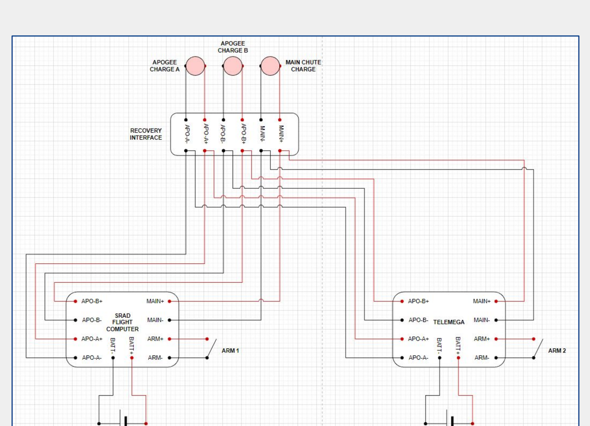


## Avionics

- In charge of all of the necessary electronics to run the rocket
- The primary and secondary systems both use altimeters to control recovery deployment through the ignition of e-matches
- COTS primary system sends telemetry over 70 cm HAM radio
- Custom-built secondary system sends telemetry over 915MHz LoRA

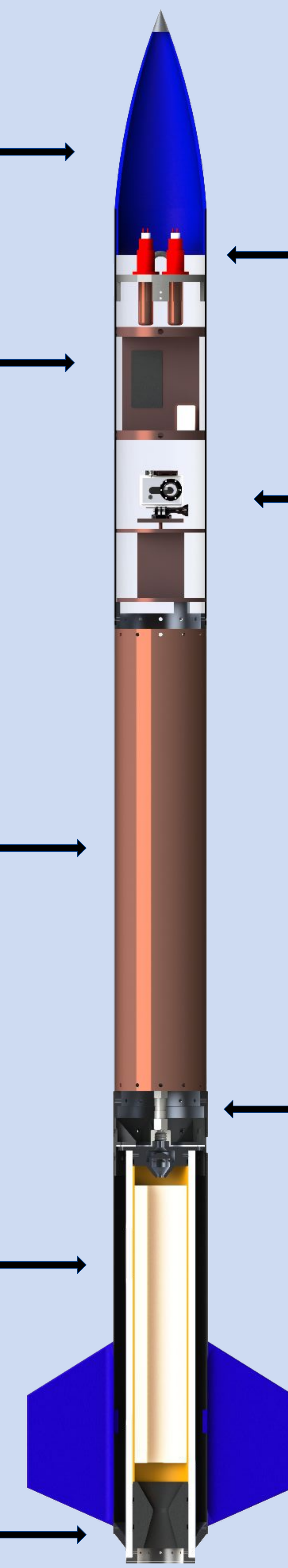






## Frame

- Consists of an Acrylic upper section and a Fiberglass lower section coupled to a central Aluminum oxidizer tank
  - Frame couplers were built into the tank bulkheads and 3D printed out of Onyx Carbon Fiber filament
- Prioritized high safety factor and weight optimization
- Fins and nose cone optimized for stability and drag reduction at high speeds



**Nose Cone**
The nose cone is a 3D printed Von Karman curve with an aluminum tip and a hook on the bottom to connect to the parachutes.

**Recovery**
The recovery system includes both parachutes along with two Raptor $CO_2$ ejection systems.

**Avionics**
Avionics accounts for all of the electronics in the rocket. It ignites e-matches to deploy recovery.

**Payload**
A 1-axis roll stabilizing gimbal with a camera that counteracts the rocket's spin during flight.

**Nitrous Oxide Tank**
Custom designed aluminum pressure vessel containing 15 lb of liquid/gaseous Nitrous Oxide used as oxidizer in the engine.

**Oxidizer Flow Regulation**
Urbanksi-Colburn valve is used to fill Nitrous tank on the launch pad, burns through hose to start ignition.

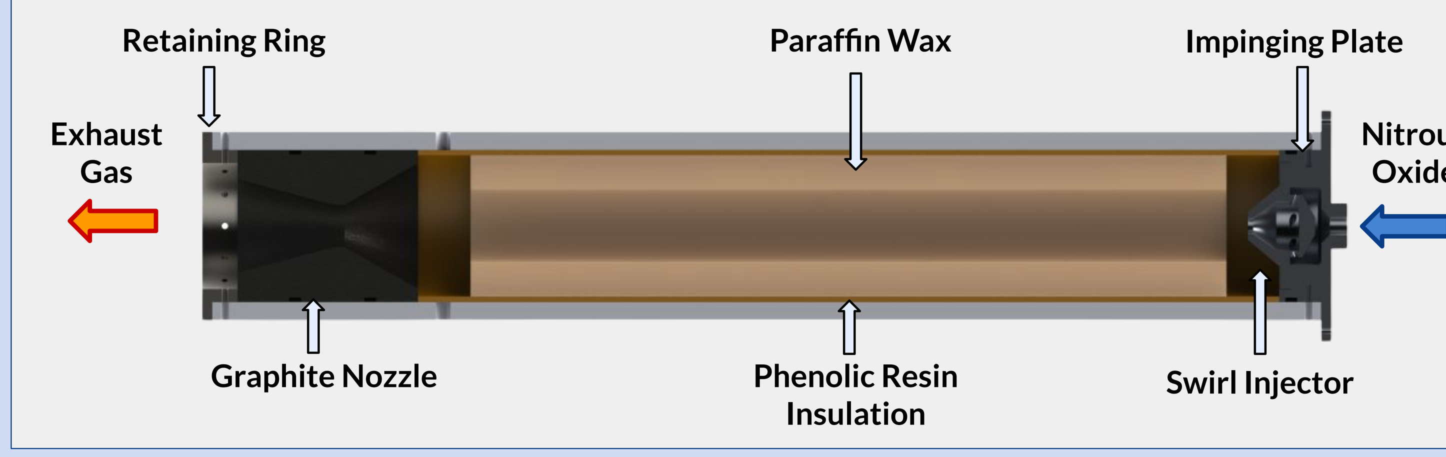
**"Deimos" Engine**
Hybrid engine uses a solid paraffin wax fuel and Nitrous Oxide to create combustion. The target thrust is 500 lbf.

**Stabilization Fins**
A set of 4 fins fixed to the frame using a seven layer bi-axal fiberglass molding technique shifts the center of pressure of the rocket.

**Graphite Nozzle**
Optimized geometry using ideal flow assumptions, CFD, and experimental data for high specific thrust.

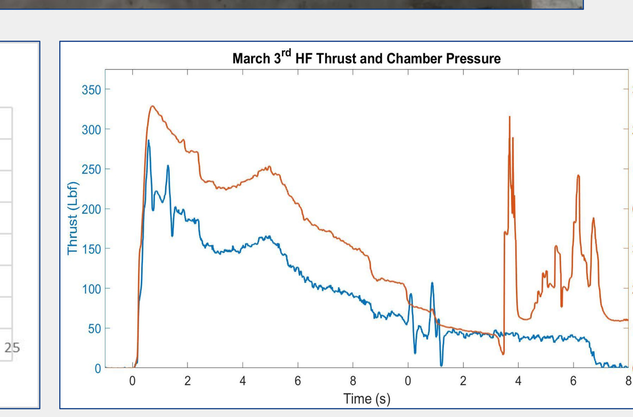
## Propulsion

- The Deimos Hybrid Engine provides the thrust needed to launch the rocket, which uses solid paraffin wax fuel and liquid nitrous oxide as the oxidizer
- The propulsion system consists of an oxidizer tank, flow injection system, Urbanski-Colburn injector, combustion chamber, and graphite nozzle
- The combustion chamber uses an ablative phenolic resin insulator to protect the walls of the engine from the heat of the combustion
- The graphite nozzle was initially designed using ideal fluid flow equations, then optimizing with CFD and experimental data to improve performance
- The swirl injector atomizes the nitrous oxide to reach the proper air-fuel ratio for combustion




## Design & Testing

- Sensors were used during engine static test fires to measure engine thrust, internal pressure, and internal temperature
- The area ratio of the nozzle was changed and flow optimized across three static test fires, with a smaller ratio proving to provide more thrust
  - Peak thrust was found to be ~360 lbf
- Simulations produced the following simulated flight with an apogee of ~3100 m (10,100 ft) from a decreasing thrust peaking at 1600 N (360 lbf)

## Acknowledgements

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