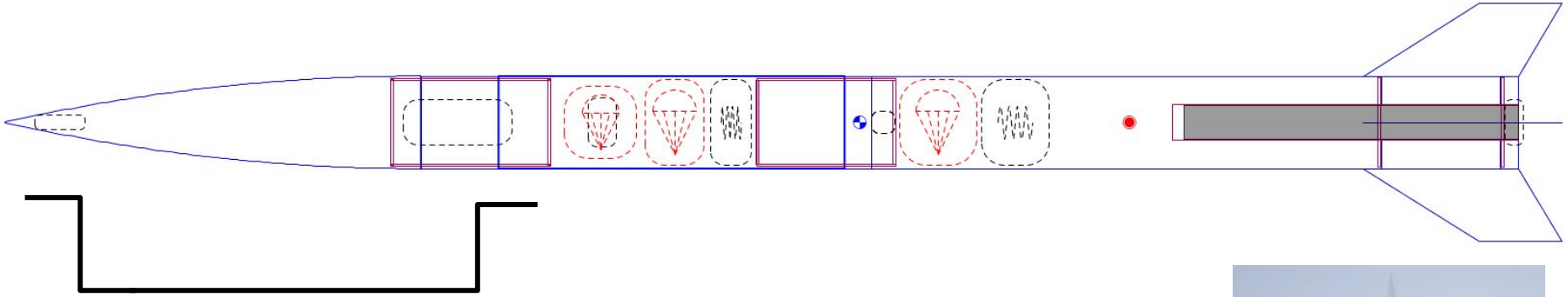
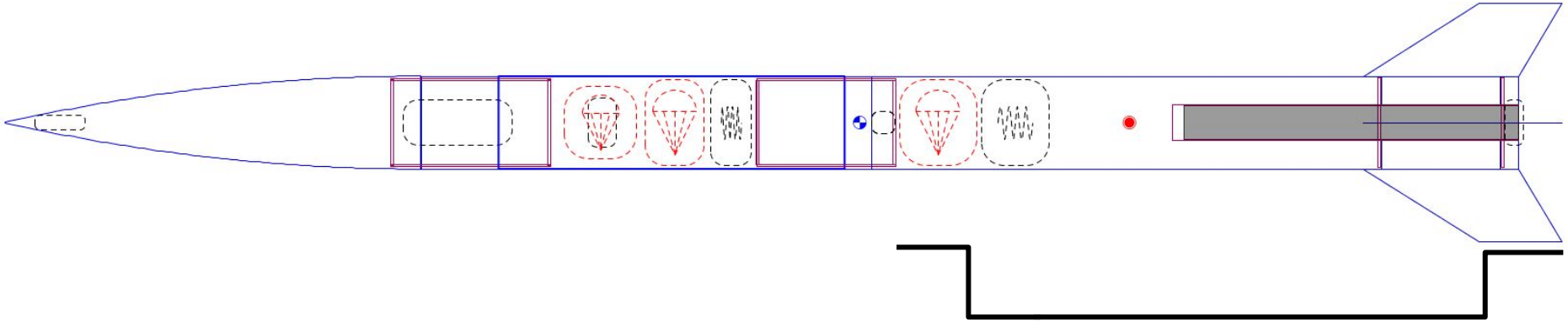
Explorer Post 1010
Student Launch Initiative 2021-2022
Critical Design Review

Vehicle Upper Section Design

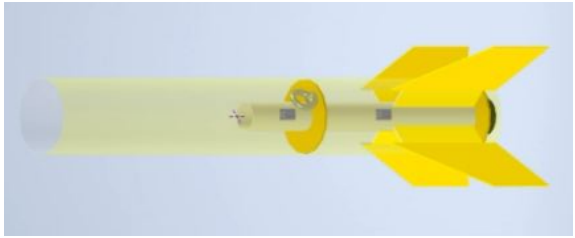


- Upper section recovered separately from rest of vehicle under parafoil
- 23.62 inches long, weighs 2.2 pounds

Vehicle Lower Section Design

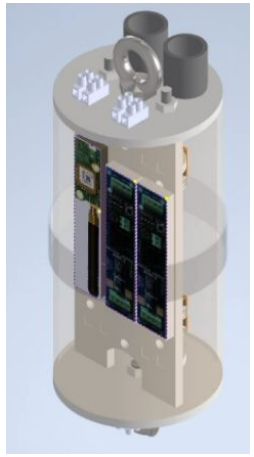


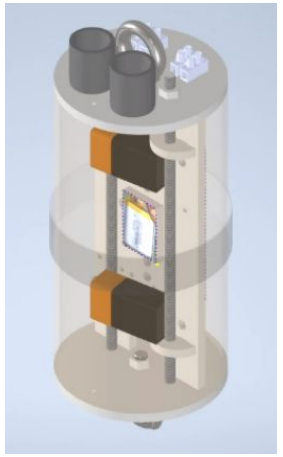
- Lower section recovered by conventional dual deploy
- 27.95 inches long, weighs 1.46 pounds not including the motor
- Through the wall fin tabs, internal fillets

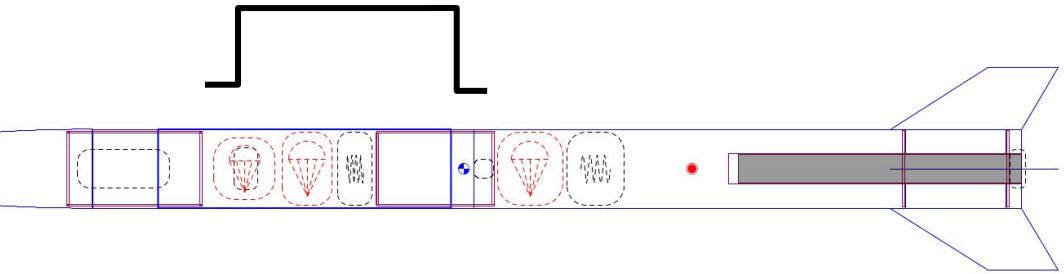


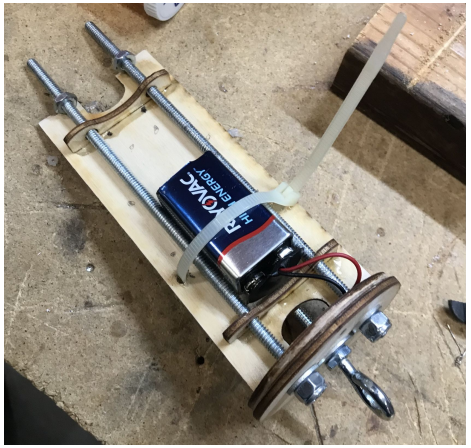
Electronics Bay Design

- Encompassing airframe 16.14 inches long
- Electronics Bay itself is 6 inches long
- Weight of 1.77 pounds







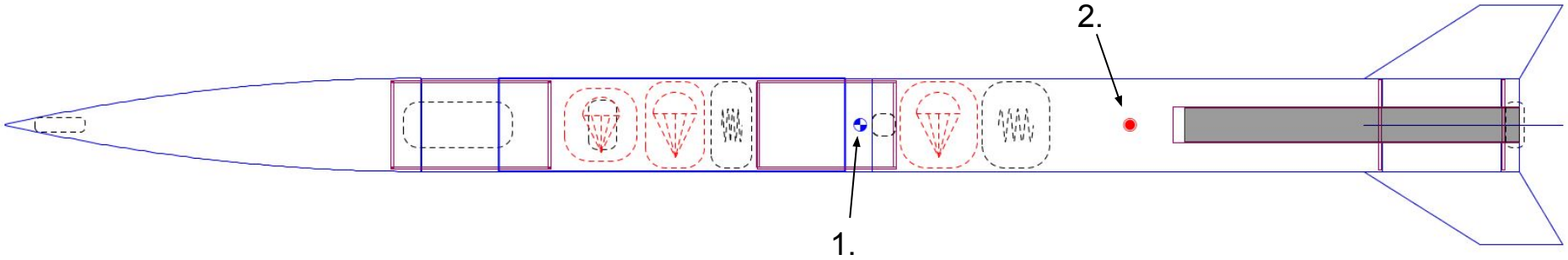


Subscale electronics sled; one battery and one altimeter

Key Design Features

- Tubes made of thick-walled paper
- Ogive nose cone
- Swept Clipped Delta Fins with internal fillets
- Fins & Bulkheads made from ⅛” plywood
- Upper/Payload section has no “empty” body tube space below it; therefore, the parafoil cannot get stuck
- To ensure main parachute deploys, aft ejection charge occurs toward back of booster section

Stability, Center of Mass, and Center of Pressure



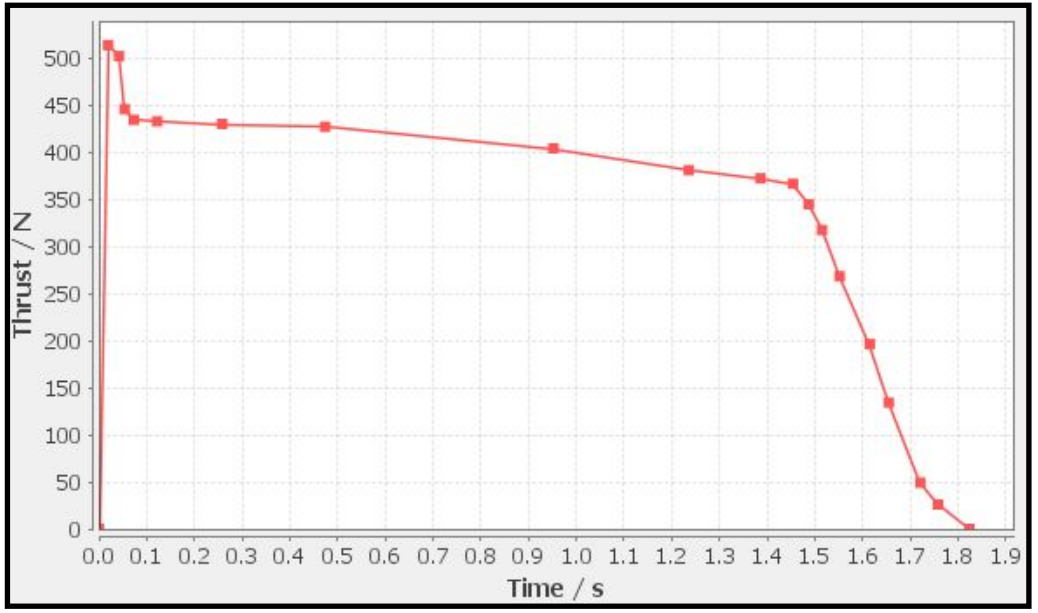
- Center of mass (1) located 36.8 inches from tip
- Center of pressure (2) located 48.43 inches from tip
- 2.94 calibers of stability at liftoff
- 3.00 calibers of stability in flight

Motor

Final Motor Choice: Cesaroni J357-14

Thrust-to-weight ratio: 15.4:1

Rail exit velocity: 89.48 ft/s

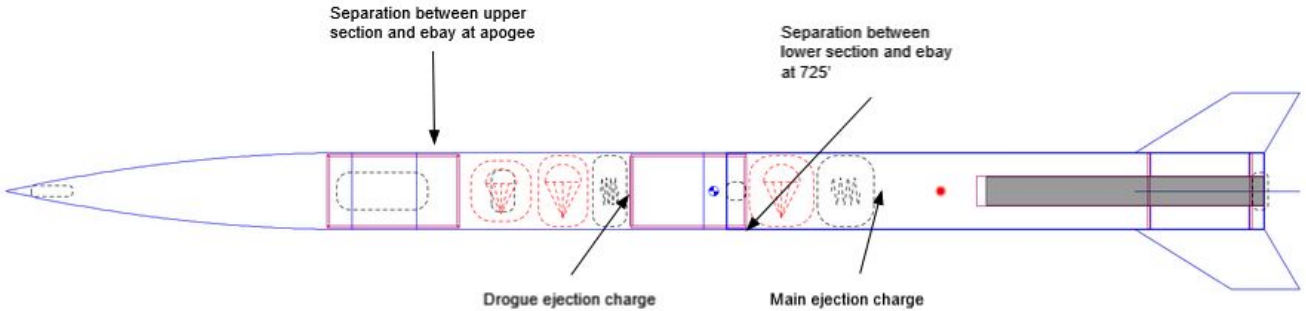


J357-14 Thrust Curve

Mass Statement

- The launch vehicle and payload are expected to weigh 6.17 lbs
- Current apogee altitude predictions are overshooting the target altitude, which leaves ~2 oz of margin to hit the target
- ~ 10 oz of margin to make 3500 altitude window

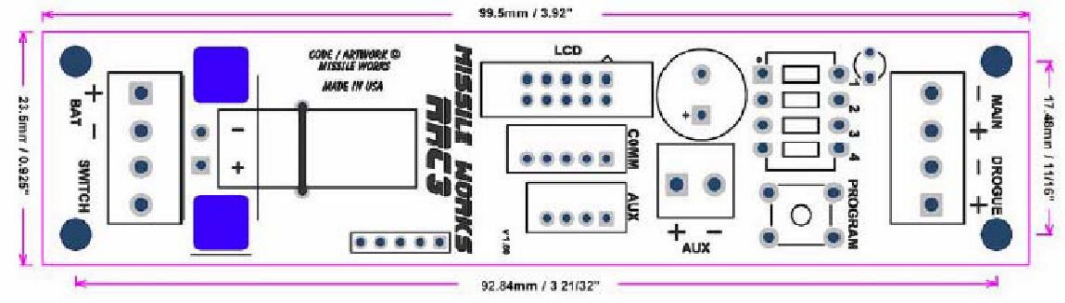
Energetics & Points of Separation



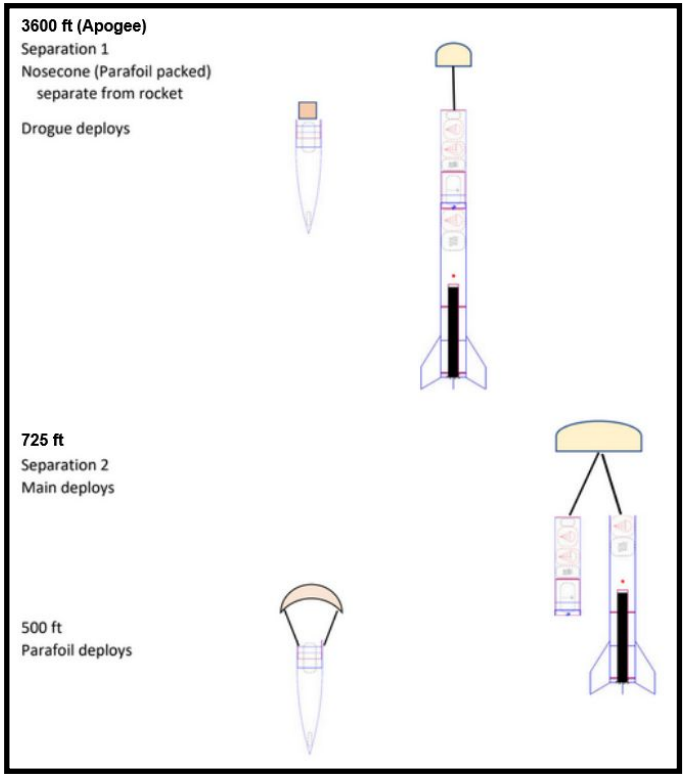
- Both the forward and the aft deployment charges use 1.5 grams of black powder, with the backup charges using 2.1 grams

Recovery System Overview

- Redundant RRC3-“Sport” Altimeters with separate batteries
- Forward separation point separates at apogee
  - Backup altimeter activates charge 1 second after apogee
- Aft separation point separates at 725 feet.
- At 500 feet, redundant Jolly Logic Chute Releases fully deploy parafoil



RRC3 Pinout Diagram



Recovery Diagram

Recovery Hardware

Shock Cord

1000 lb rated kevlar line

Drogue Parachute:

12” nylon; retained on eye bolt forward of electronics bay on shock cord with length of 20 ft; descent rate of 66.51 ft/s

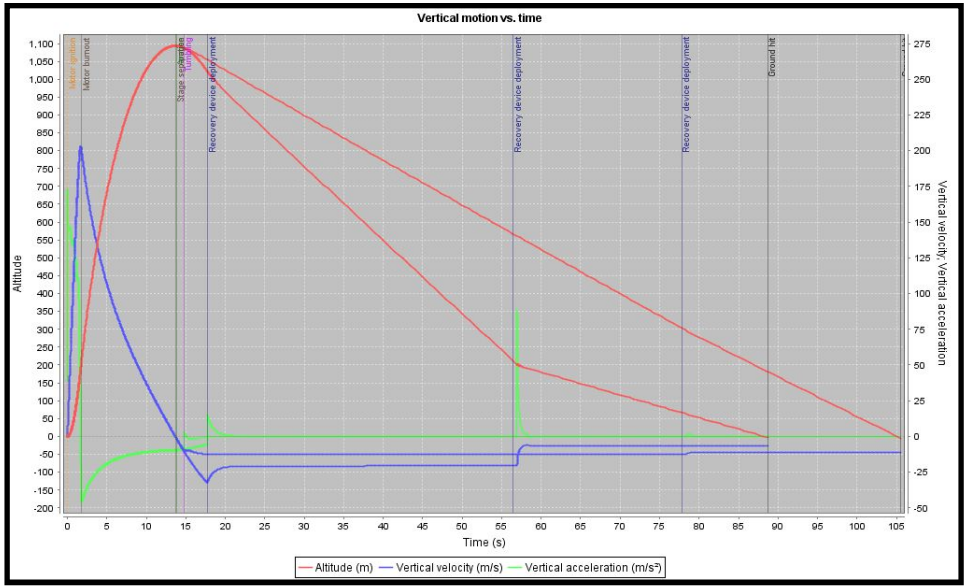
Main Parachute:

36” nylon; retained on eye bolts aft of electronics bay and on forward centering ring on shock cord with length of 15 ft; descent rate of 21.16 ft/s

Parafoil:

55x22” nylon; retained on eye bolt aft of payload section with one line attached to eye bolt and the other a winch for control

Flight Predictions



Simulated Apogee Altitude: 3620 feet
Simulated Flight Duration: 88.68 seconds

Wind speed (mph)	Drift distance (ft)
0	0
5	286.52
10	586.15
15	886.15
20	1181.1

Wind Drift Predictions

Subsection	Kinetic Energy (Ft-lbs)
Electronics Bay	16.21
Lower Section	9.87
Upper Section (Payload)	23.48

Kinetic Energy on Impact

Subscale Model

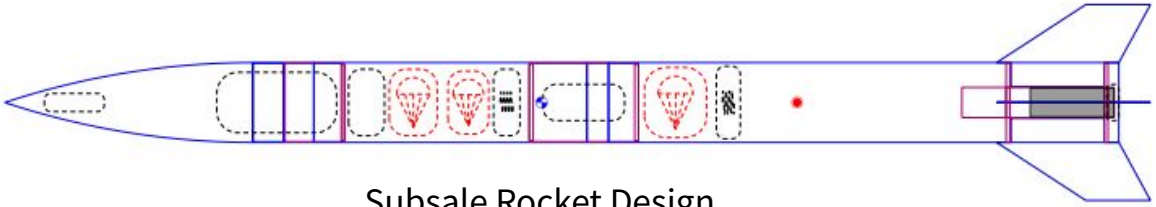
Subsale Rocket Build

-Two ground tests of the ejection system, with 0.36 grams of black powder forward and 0.45 g aft. Both separations were successful

-Launch conditions: Negligible wind (approx 2mph), 30 degrees Fahrenheit, 1.02 atm (1036 mb) pressure

-Apogee: 600 ft

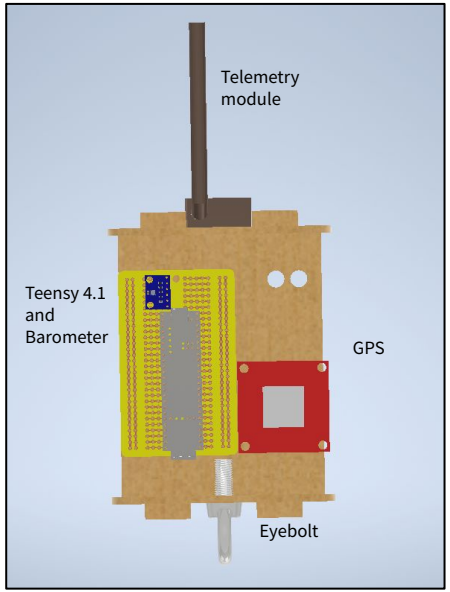
-Flight time: 46 seconds



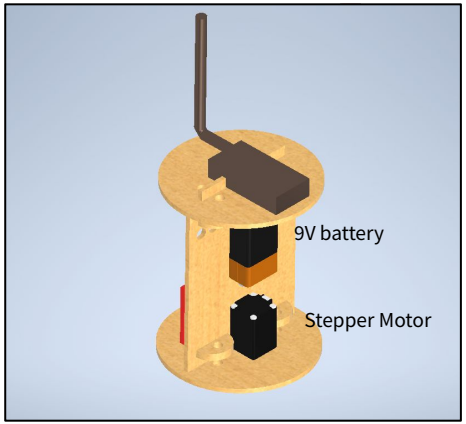
Subsale Rocket Design

Payload

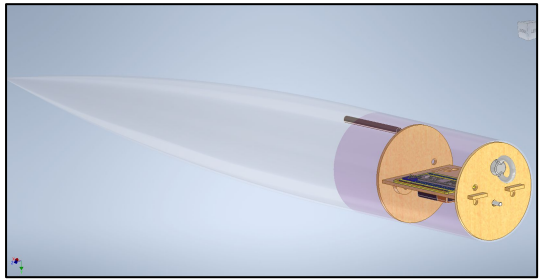
Our Payload is an Autonomous Guided Parafoil. At 400 feet, a winch will adjust the parafoil lines to turn toward its target location. In the avionics bay, we have a Teensy 4.1 Flight Computer, GPS, Altimeter, and Stepper Motor. The Stepper motor drives a winch outside of (but still attached to) the avionics bay which adjusts the parafoil lines. The other line of the parafoil is retained by an eyebolt. The entire avionics bay is screwed into the nose cone and is 7” long.



Payload Front View



Payload ISO View



Commercial parafoil

Interfaces

Internal

- Payload avionics system: adjusts parafoil lines (see previous slide) and sends data to parafoil ground station (see below).
- Recovery system: activates black powder charges

External

- Featherweight ground station receives data from the Featherweight GPS to locate the bottom section.
- Custom-built ground station to receive data from the parafoil and override if necessary.

Requirements Verification

- Vehicle requirements
  - Deliver payload to an altitude of 3500 ft - 5500 ft; we are targeting 3600 ft.
  - Less than 4 separable sections
  - All parts of vehicle land in under 90 seconds
- Recovery requirements
  - Safely recover both payload and launch vehicle
  - Redundant ejection charges and batteries; not using motor ejection charge as separation
- Payload requirements
  - No Parafoil adjustments until 400 feet
  - Autonomously guide itself to designated location