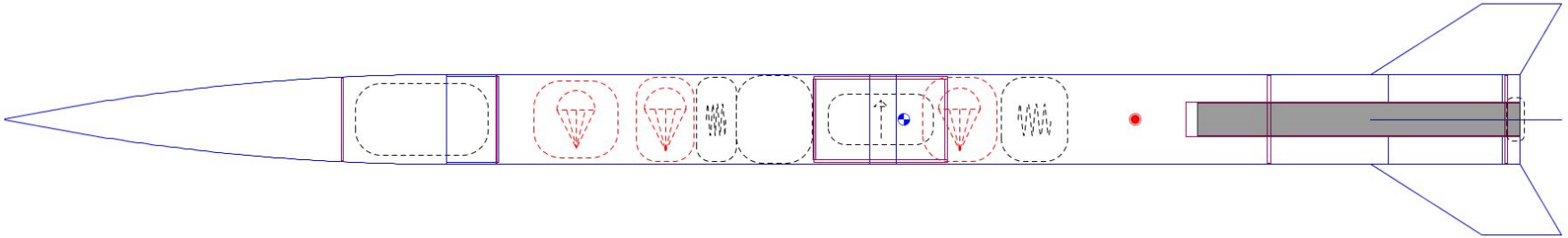
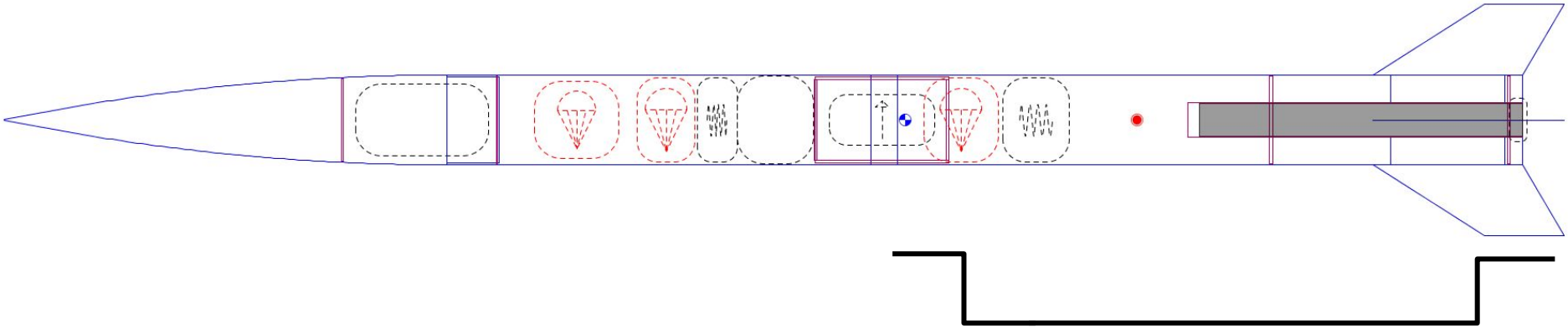
Explorer Post 1010
Student Launch Initiative 2021-2022
Flight Readiness Review

Vehicle Upper Section Design

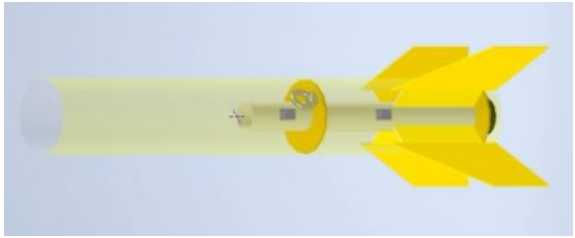


- Upper section recovered separately from rest of vehicle under parafoil
- 24 inches long, weighs 1.9 pounds

Vehicle Lower Section Design

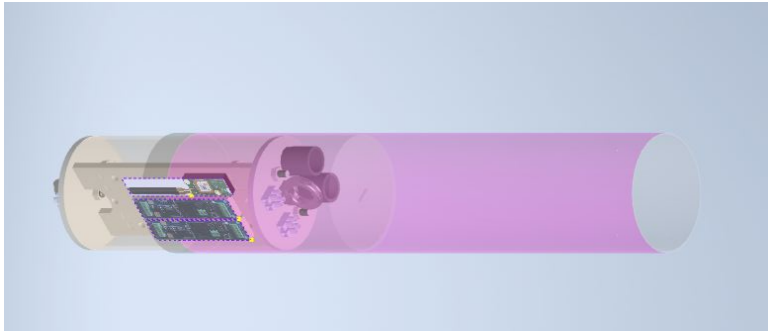


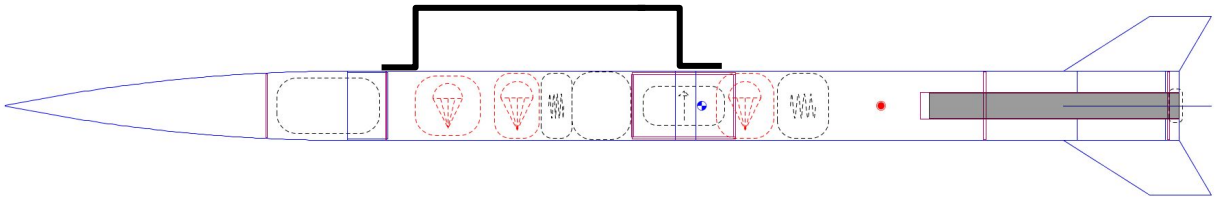
- Lower section recovered by conventional dual deploy
- 28 inches long, weighs 3.1 pounds with motor included
- Through the wall fin tabs, internal fillets

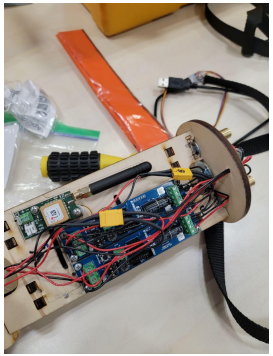


Electronics Bay/Middle Section Design

- Encompassing airframe 20 inches long
- Electronics Bay itself is 8 inches long
- Weight of 2.5 pounds





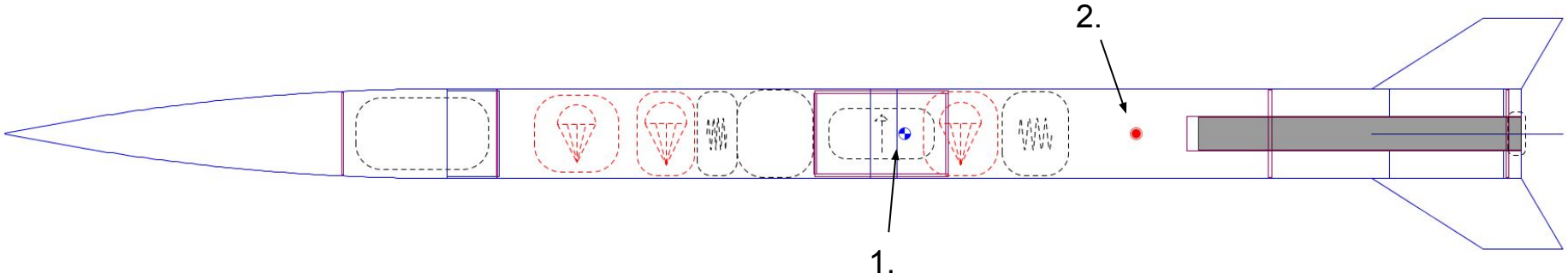


Front of subscale electronics sled, including two RRC3s and a Featherweight GPS

Key Design Features

- Threaded rod retention payload system
- Tubes made of thick-walled paper
- Ogive nose cone
- Swept Clipped Delta Fins with internal fillets
- Piston pushes drogue parachute out and defends parafoil during ejection charge activation
- ⅛ inch plywood fins
- ¼ inch plywood centering rings

Stability, Center of Mass, and Center of Pressure



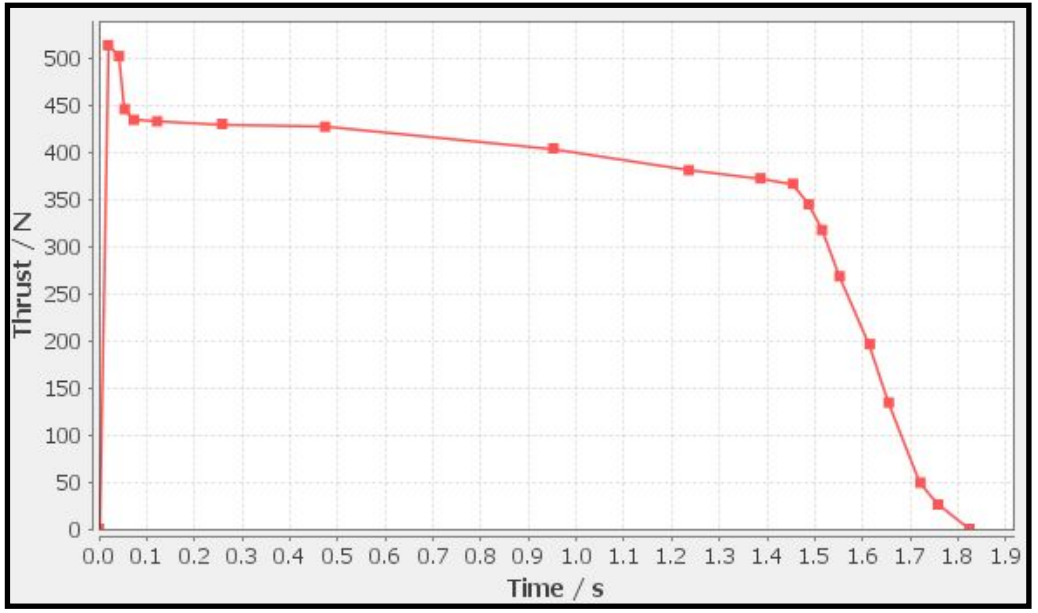
- Center of mass (1) located 40.16 inches from tip
- Center of pressure (2) located 50.79 inches from tip
- 2.58 calibers of stability at liftoff
- 2.69 calibers of stability in flight

Motor

Final Motor Choice: Cesaroni J357-14

Thrust-to-weight ratio: 12.75:1

Rail exit velocity: 81.06ft/s

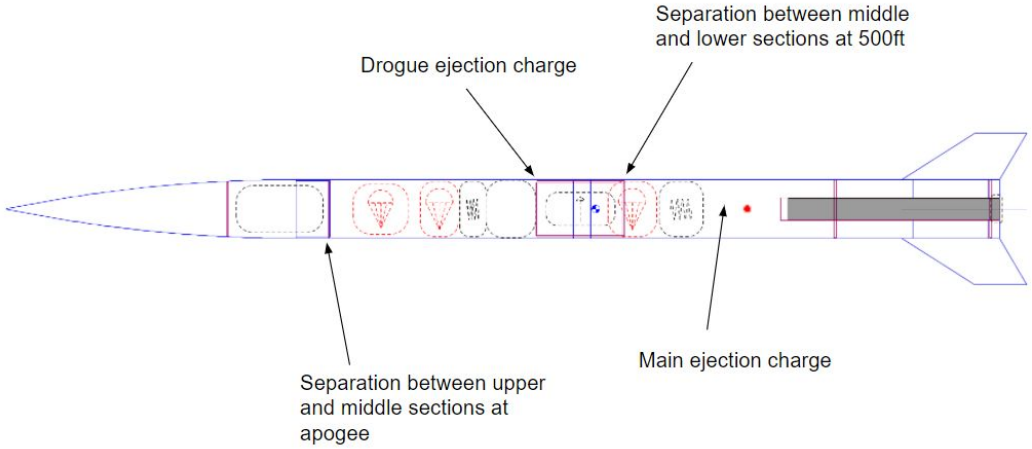


J357-14 Thrust Curve

Mass Statement

- The launch vehicle and payload currently weigh 7.5 lbs
- Current apogee altitude predictions are under the target altitude
- The vehicle demonstration flight with a 500g mass simulator reached an apogee of 3369 ft.
- We’re working on cutting as much mass as possible out of the payload and vehicle. The payload should be less weight than the mass simulator launched. Additionally, we are considering switching to a larger motor.

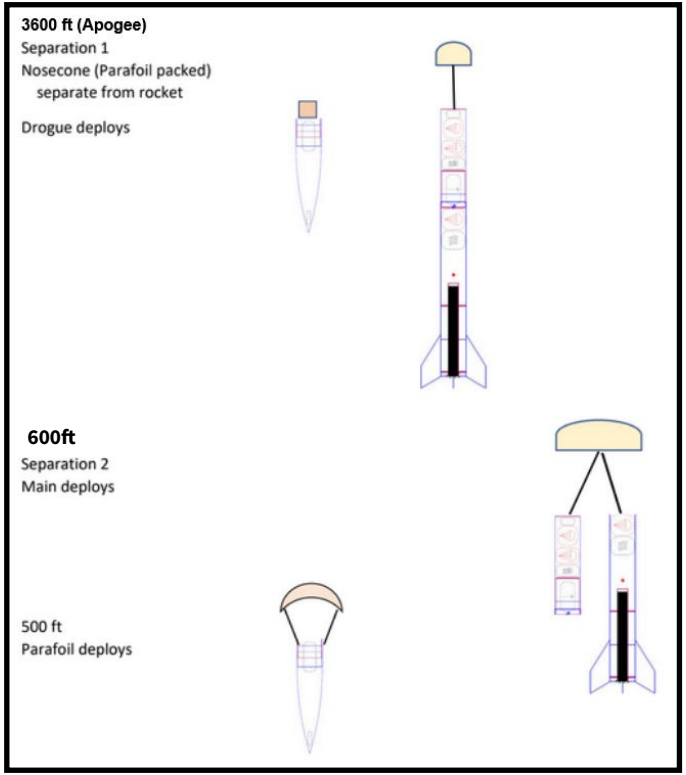
Energetics & Points of Separation



- Forward ejection charge uses 0.4g of black powder, with 0.5g for backup. Aft ejection charge uses 1g of black powder.

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 600 feet.
- At 500 feet, redundant Jolly Logic Chute Releases fully deploy parafoil. We do not make adjustments to the lines until 400 feet.



Recovery Diagram

Recovery Hardware

Piston: Pushes out drogue chute and defends parafoil, made by PML

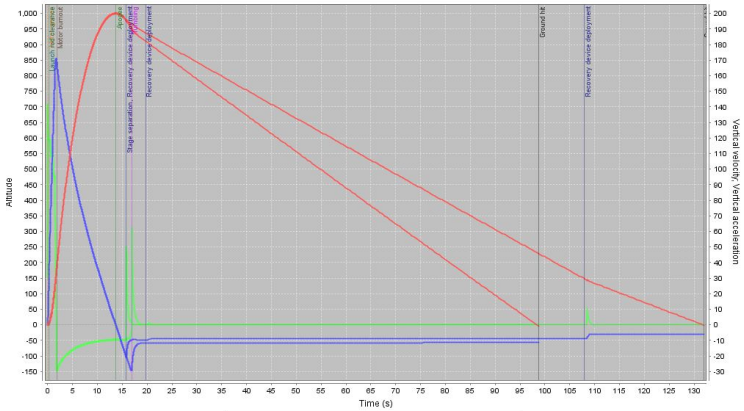
Shock Cord: 1000 lb rated kevlar line

Drogue Parachute: 12” nylon; retained on eye bolt forward of electronics bay on shock cord with length of 20 ft; descent rate of 48 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 18 ft/s

Parafoil: 0.6 meters squared nylon; retained on eye bolt aft of payload section with one line attached to eye bolt and the other a winch for control; descent rate of 23 ft/s

Flight Predictions



Simulated Apogee Altitude: 3293.9 feet
Simulated Descent Duration: 88 seconds

Wind speed (mph)	Manually Calculated Drift Distance (ft)	OpenRocket Drift Distance (ft)
0	0	0
5	645.3	517.4
10	1290.7	1000.7
15	1936	1480.9
20	2581.3	1974.25

Wind Drift Predictions

Wind Speed (mph)	Apogee (ft)
0	3293.90
5	3287.40
10	3267.72
15	3238.19
20	3202.1

Subsection	Kinetic Energy (Ft-lbs)
Lower Section	12.4
Middle Section/Electronics Bay	11.9
Upper Section (Payload)	20.11

Kinetic Energy on Impact

Vehicle Demonstration Flight

Full-scale Rocket Build

-Two successful ground tests of the ejection system, with 0.4 grams of black powder forward and 1.0 g aft.

-Launch conditions: 55 degrees Fahrenheit, low wind

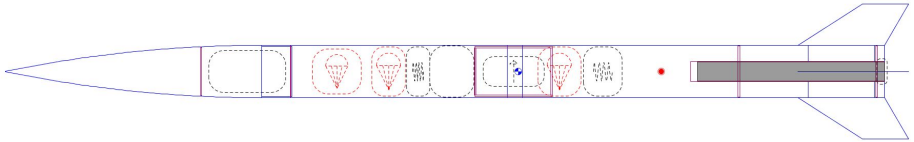
-Apogee:

Featherweight GPS - 3472ft

RRC3 Main - 3369ft

-Total flight time: 105 seconds

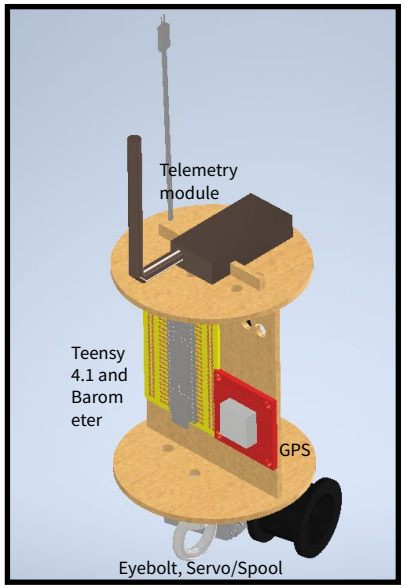
- Total descent time: 92 seconds



Full-scale Rocket Design

Payload

Our Payload is an Autonomous Guided Parafoil. Its electronics include a Teensy 4.1 Flight Computer, a GPS/compass for autonomous flight, a transmitter to receive manual commands and send back GPS data, and a servo to adjust the spool to control the parafoil. The electronics are retained by threaded rods in the nose cone. Pulling a parafoil line in/out using servo causes the payload to turn. The payload itself is 5 inches long and fits inside the nose cone.



Payload Electronics ISO View

Test Plan and Procedure

- Up to this point we have performed several ground tests (e.g. testing if black powder quantities suffice for separation) and a flight test on the vehicle
- We have performed radio override and drop tests on the payload
- We plan to launch our payload demonstration flight on March 12/13
    - We will update this slide with results and send an updated version of the presentation

Interfaces

Internal

- Payload avionics system: adjusts parafoil lines and sends GPS data back to ground station for recovery purposes
- Recovery system: activates black powder charges at specified altitudes

External

- Featherweight ground station receives data from the Featherweight GPS to locate the bottom and middle sections
- Custom-built ground station to receive GPS data from the parafoil for recovery and send overriding data to parafoil to manually control it

Requirements Verification

- Vehicle requirements
  - Deliver payload to an altitude of 3500 ft - 5500 ft; we are targeting 3750 ft.
  - Less than 4 separable sections
  - All parts of vehicle land in under 90 seconds
- Recovery requirements
  - All parts of vehicle recovered under parachute/parafoil
  - Safely recover both payload and launch vehicle
  - Redundant ejection charges and batteries; not using motor ejection charge as separation
  - Redundant Jolly-Logic Chute Releases on parafoil
- Payload requirements
  - No Parafoil adjustments until 400 feet
  - Autonomously guide itself to designated location within 20 meters
  - Override functionality from ground