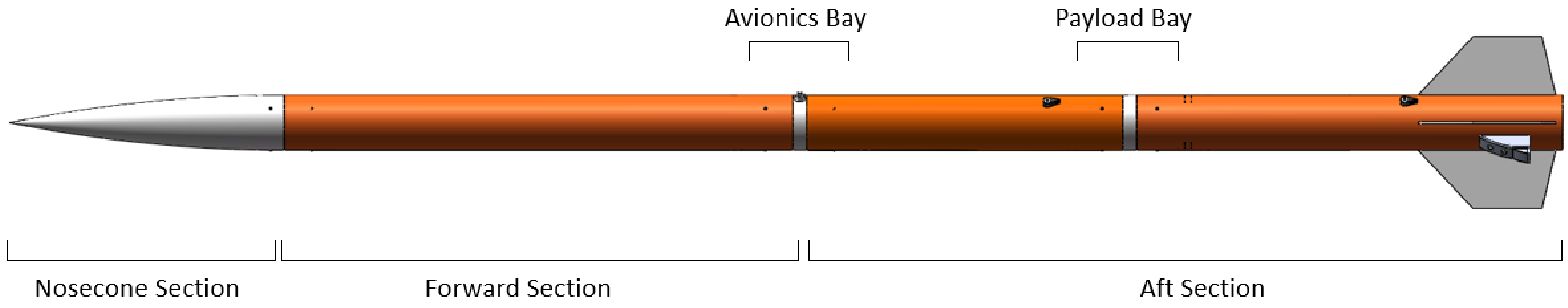
University of Florida

Swamp Launch Rocket Team

Preliminary Design Review Presentation

NASA University Student Launch 2022

Vehicle Dimensions

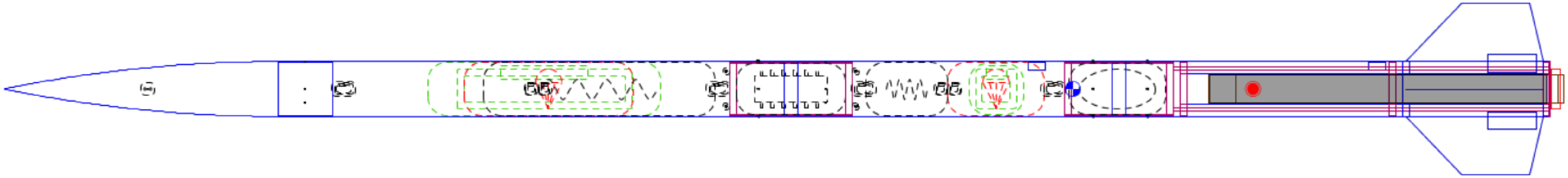


Section	Exterior Length (in.)	Overall Mass (oz.)
Nosecone Section	20	27
Forward Section	38	118
Aft Section	56	281
Overall Launch Vehicle	**114**	**426**

Leading Design

Sections

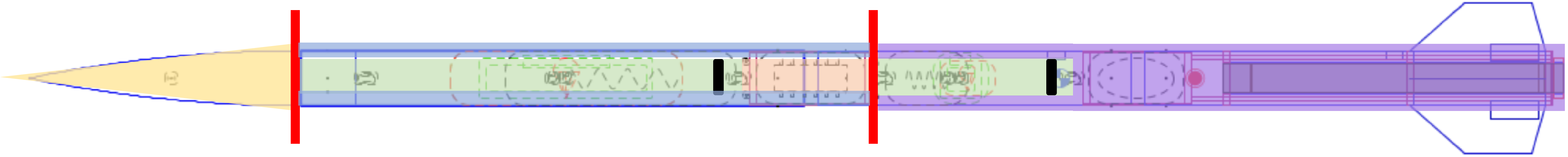
- Nosecone Section
- Forward Section
  - Avionics Bay
- Aft Section
  - Payload bay



Points of Separation

Specific energetics

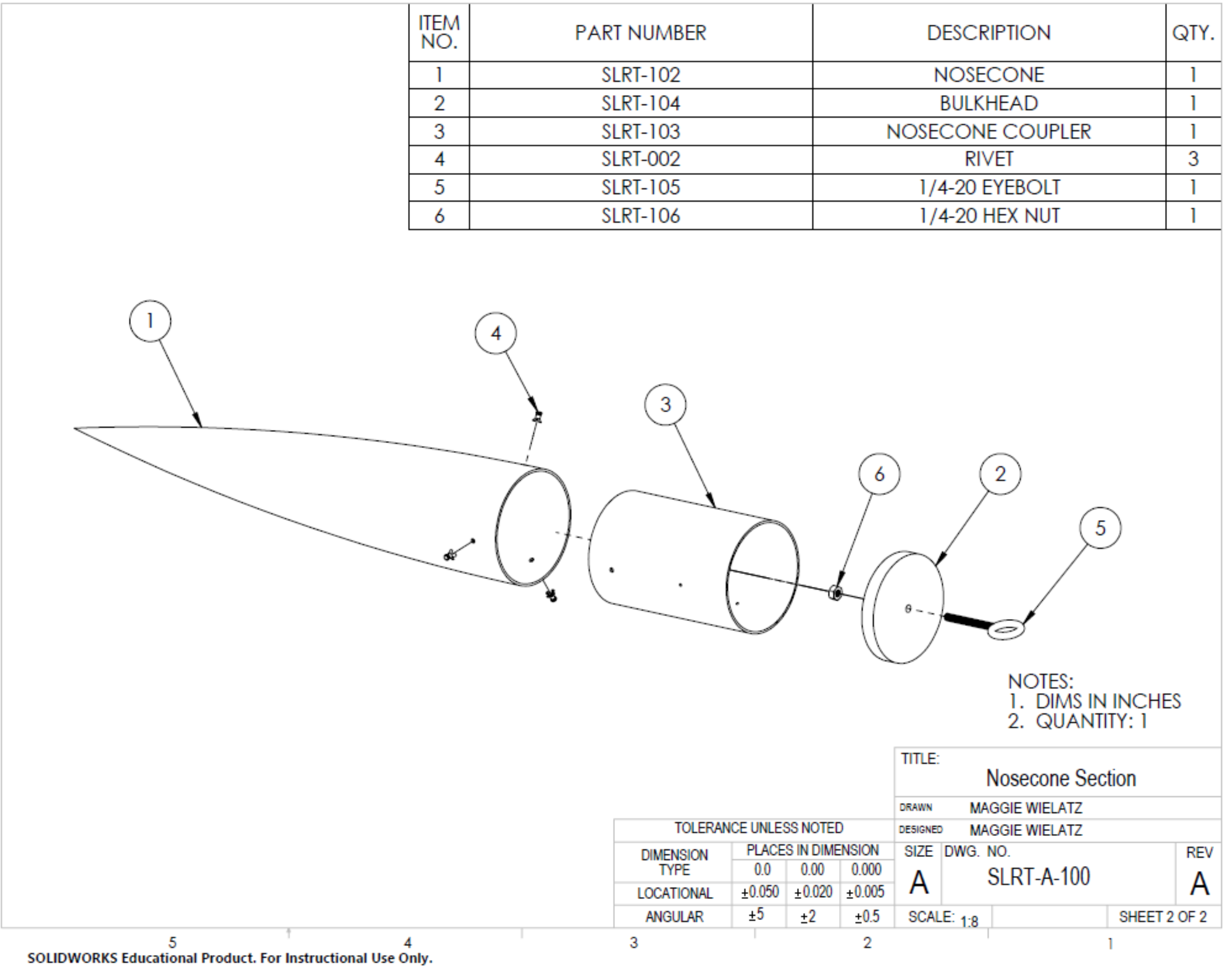
- Aft Section
- Forward Section
- Ejection Charge Location
- Parachute compartment
- Avionics bay
- Nosecone
- Separation Point



Object	Description
Primary aft ejection charge	2.5 g black powder at apogee
Secondary aft ejection charge	3.2 g black powder at 0.5 s after apogee
Primary forward ejection charge	1.5 g black powder at 600 ft AGL
Secondary forward ejection charge	2.0 g black powder 550 ft AGL

Nosecone Section

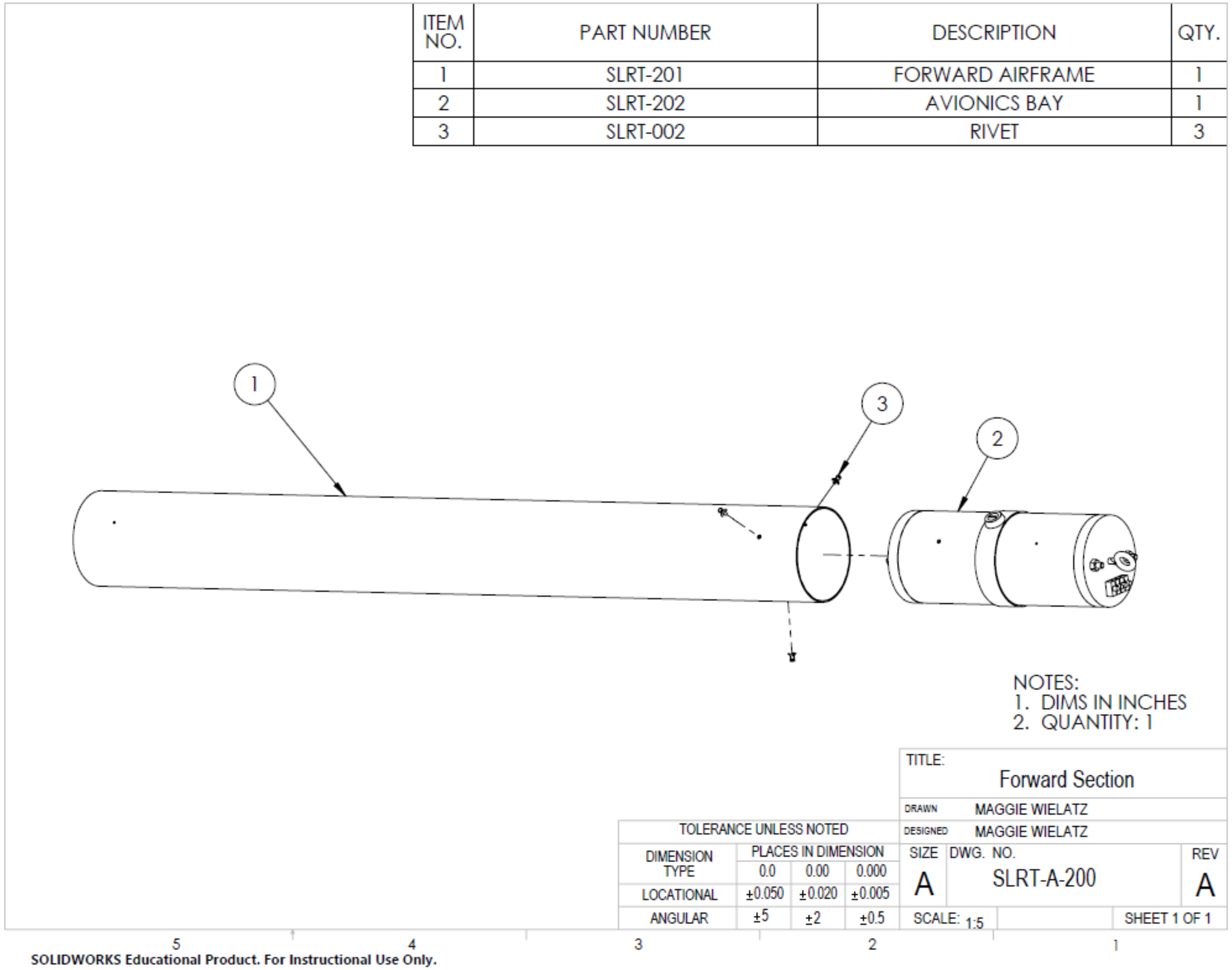
- Components
  - 5:1 Ogive nosecone
  - Nosecone bulkhead
  - GPS



ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	SLRT-102	NOSECONE	1
2	SLRT-104	BULKHEAD	1
3	SLRT-103	NOSECONE COUPLER	1
4	SLRT-002	RIVET	3
5	SLRT-105	1/4-20 EYEBOLT	1
6	SLRT-106	1/4-20 HEX NUT	1

Forward Section

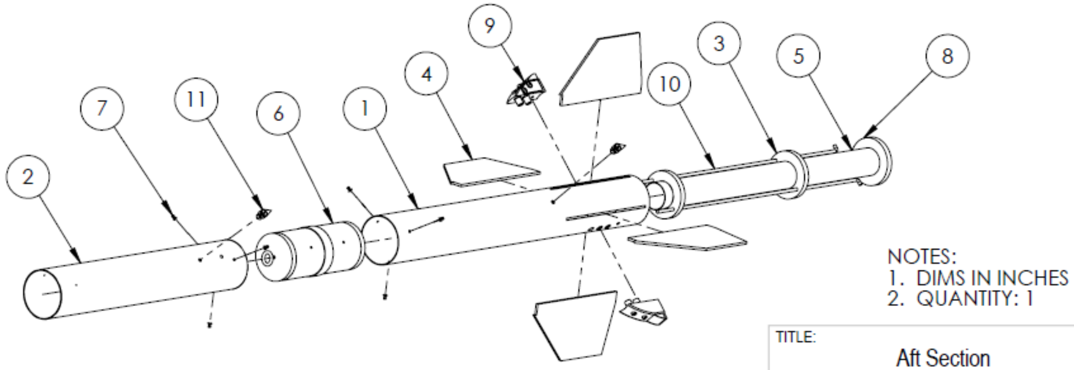
- Components
  - Forward Airframe
  - Avionics Bay



Aft Section

- Components
  - Upper aft airframe
  - Lower aft airframe
  - Payload bay
  - Motor tube
  - Centering rings
  - Fins

ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	SLRT-302	UPPER AFT AIRFRAME	1
2	SLRT-301	LOWER AFT AIRFRAME	1
3	SLRT-304	ELECTRONIC TUBE CENTERING RINGS	2
4	SLRT-307	FINS	4
5	SLRT-303	MOTOR TUBE	1
6	SLRT-314	PAYLOAD BAY	1
7	SLRT-002	RIVET	6
8	SLRT-305	AFT CENTERING RING	1
9	SLRT-312	CAMERA HOUSING	2
10	SLRT-306	ELECTRONICS TUBE	2
11	SLRT-318	RAIL BUTTON	2



NOTES:
1. DIMS IN INCHES
2. QUANTITY: 1

TOLERANCE UNLESS NOTED			
DIMENSION TYPE	PLACES IN DIMENSION 0.0	0.00	0.000
LOCATIONAL	±0.050	±0.020	±0.005
ANGULAR	±5	±2	±0.5

TITLE: Aft Section

DRAWN MAGGIE WIELATZ

DESIGNED MAGGIE WIELATZ

SIZE A | DWG. NO. SLRT-A-300 | REV A

SCALE: 1:10 | SHEET 1 OF 2

5 4 3 2 1

Vehicle Materials: Nosecone

Nosecone			Plastic			G12 Fiberglass		
Objective	Weighting Factor	Parameter	Mag.	Score	Value	Mag.	Score	Value
Cost	0.20	USD/lb	48.35	10.0	2.00	79.95	6.05	1.21
Density	0.35	lb/in^3	0.033	4.93	1.72	0.067	10.0	3.50
Tensile strength	0.45	ksi	6.50	0.57	0.25	115.0	10.0	4.50
Overall value					3.98			**9.21**

Vehicle Materials: Airframe and Couplers

Airframe/couplers			**G12 Fiberglass**			**Blue tube**			**Quantum tube**			**Phenolic**		
Objective	Weighting Factor	Parameter	Mag.	Score	Value	Mag.	Score	Value	Mag.	Score	Value	Mag.	Score	Value
Cost	0.20	USD/in	1.95	3.54	0.71	0.83	8.31	1.66	0.81	8.52	1.70	0.69	10.0	2.00
Density	0.25	lb/in^3	0.067	6.87	1.72	0.059	7.80	1.95	0.048	9.65	2.41	0.046	10.0	2.50
Compressive strength	0.40	ksi	37.1	10.0	4.00	5.08	1.37	0.55	18.2	4.92	1.97	13.5	3.63	1.45
Machinability	0.15	experience	Okay	6.00	0.90	Good	8.00	1.20	Good	8.00	1.20	Good	8.00	1.20
Overall value					**7.33**			5.36			7.28			7.15

Vehicle Materials: Motor Tube

Motor tube			**G12 Fiberglass**			**Blue tube**			**Quantum tube**			**Phenolic**		
Objective	Weighting Factor	Parameter	Mag.	Score	Value	Mag.	Score	Value	Mag.	Score	Value	Mag.	Score	Value
Cost	0.20	USD/in	1.20	3.33	0.67	0.40	10.0	2.00	0.96	4.17	0.830	0.71	5.63	1.13
Density	0.25	lb/in^3	0.067	6.87	1.72	0.059	7.80	1.95	0.048	9.58	2.40	0.046	10.0	2.50
Compressive Strength	0.40	ksi	37.1	10.0	4.00	5.08	1.37	0.55	18.2	4.92	1.97	13.5	3.63	1.45
Machinability	0.15	experience	Okay	6.00	0.90	Good	8.00	1.20	Good	8.00	1.20	Good	8.00	1.20
Overall value					**6.62**			3.70			5.57			5.15

Vehicle Materials: Bulkheads

Bulkheads			Structural FRP Fiberglass			Plywood			Type II PVC		
Objective	Weighting Factor	Parameter	Mag.	Score	Value	Mag.	Score	Value	Mag.	Score	Value
Density	0.10	lb/in^3	0.065	3.23	0.32	0.021	10.0	1.00	0.049	4.29	0.43
Tensile Strength	0.40	ksi	13.5	10.0	4.00	4.50	3.33	1.33	7.54	5.59	2.23
Manufacturing time	0.15	min	16.0	4.38	0.66	7.00	10.0	1.50	40.0	1.75	0.26
Assembly	0.35	experience	fair	4.00	1.40	Fair	4.00	1.40	Great	10.0	3.50
Overall value					6.38			5.23			**6.43**

Vehicle Materials: Centering Rings

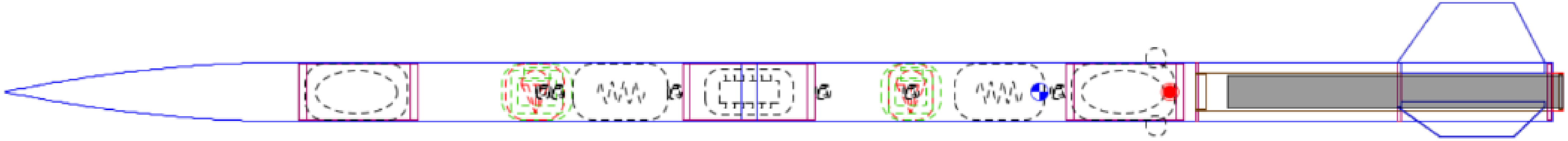
Centering rings			Structural FRP Fiberglass			Plywood			Type II PVC		
Objective	Weighting Factor	Parameter	Mag.	Score	Value	Mag.	Score	Value	Mag.	Score	Value
Density	0.25	lb/in^3	0.065	3.23	0.81	0.021	10.0	2.50	0.049	4.29	1.07
Shear strength	0.45	ksi	21.5	10.0	4.50	5.00	2.33	1.05	1.50	0.70	0.31
Manufacturing time	0.30	min	13.00	3.85	1.15	5	10.0	3.00	25.0	2.00	0.60
Overall value					6.46			**6.55**			1.98

Vehicle Materials: Fins

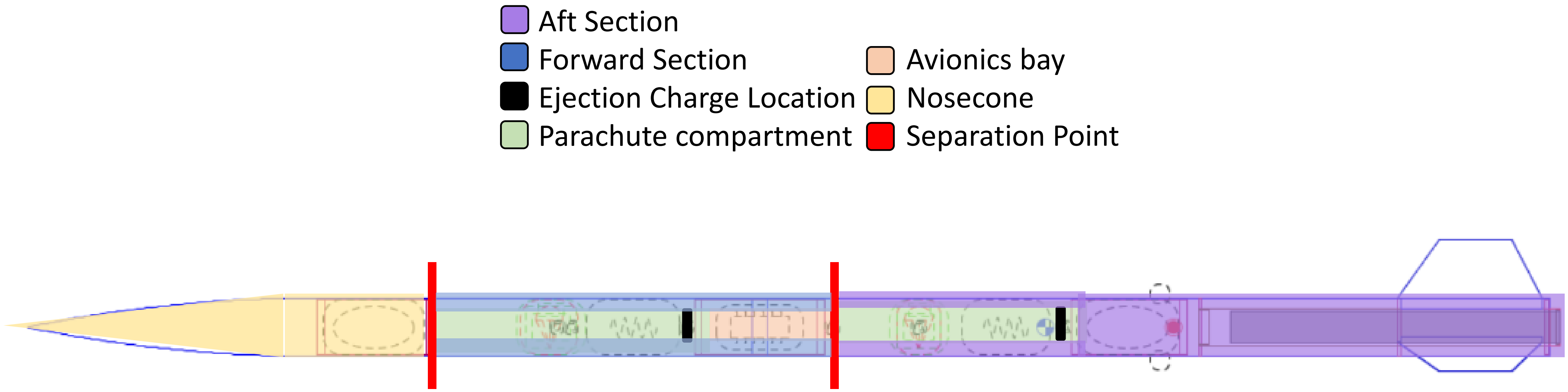
Fins			Structural FRP Fiberglass			Plywood		
Objective	Weighting Factor	Parameter	Mag.	Score	Value	Mag.	Score	Value
Cost	0.15	USD/ft^2	14.39	2.85	0.43	4.10	10.0	1.50
Density	0.20	lb/in^3	0.065	3.23	0.65	0.021	10.0	2.00
Shear strength	0.45	ksi	21.5	10.0	4.50	5.00	2.33	1.05
Manufacturing time	0.10	min	8.20	7.34	0.73	6.02	10.0	1.00
Overall value					**6.31**			5.55

Alternative Designs

- Mounted cameras on both forward and aft section
- Two payload bays located in the:
  - Nosecone coupler
  - Aft section

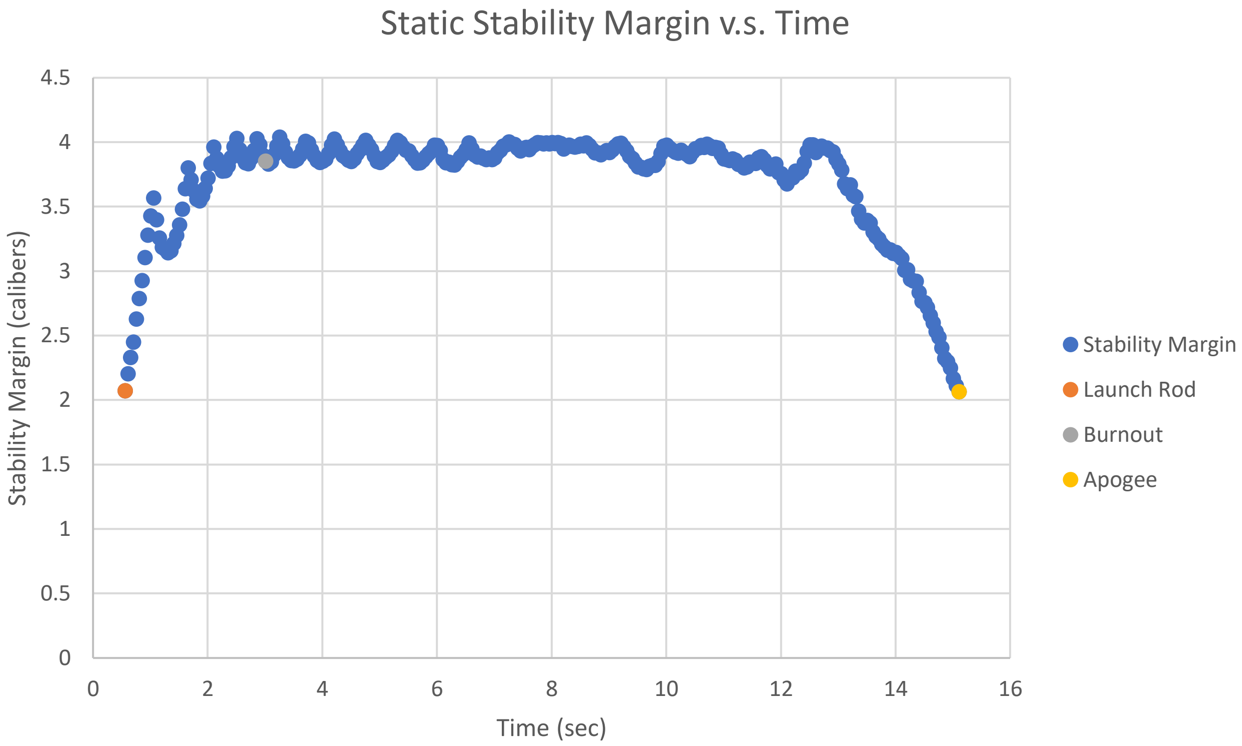


Alternative Separation Points



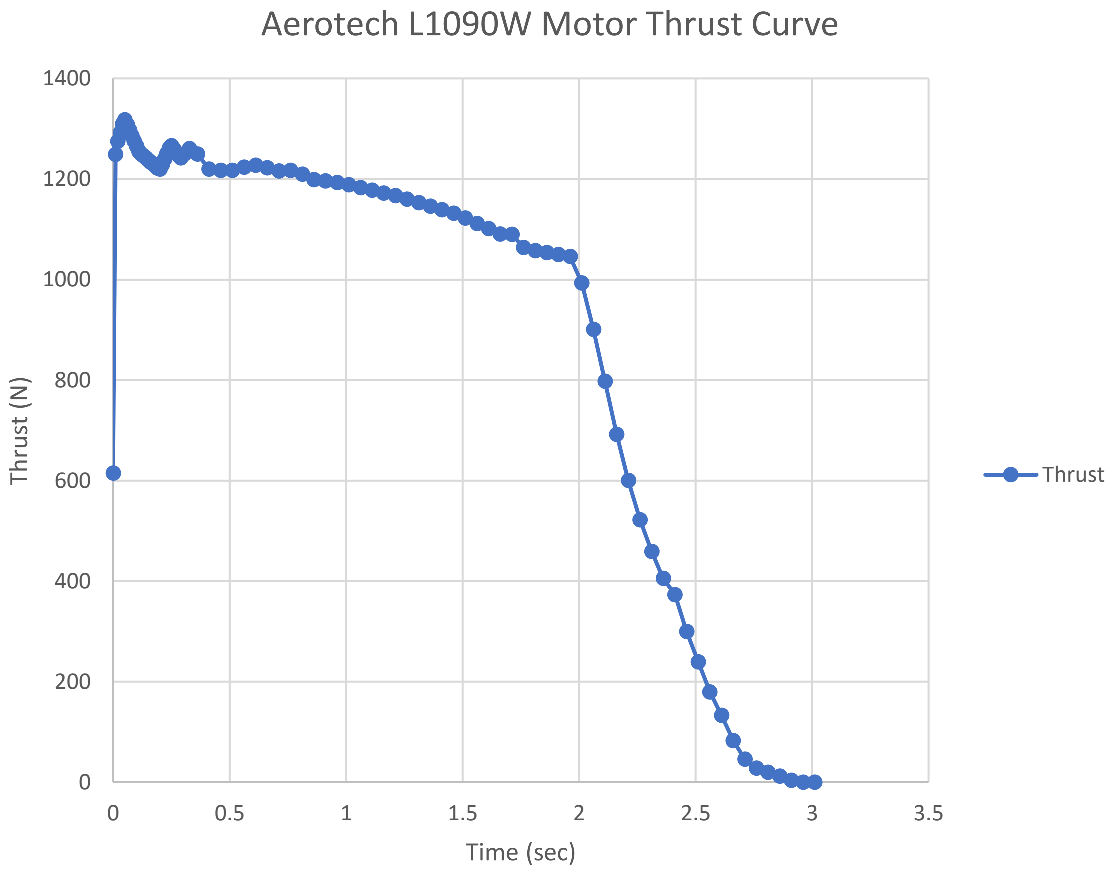
Stability

-Center of Gravity: 78.1 inches
-Center of Pressure: 91.3 inches
-Stability Margin at Launch Rod Clearance: 2.14

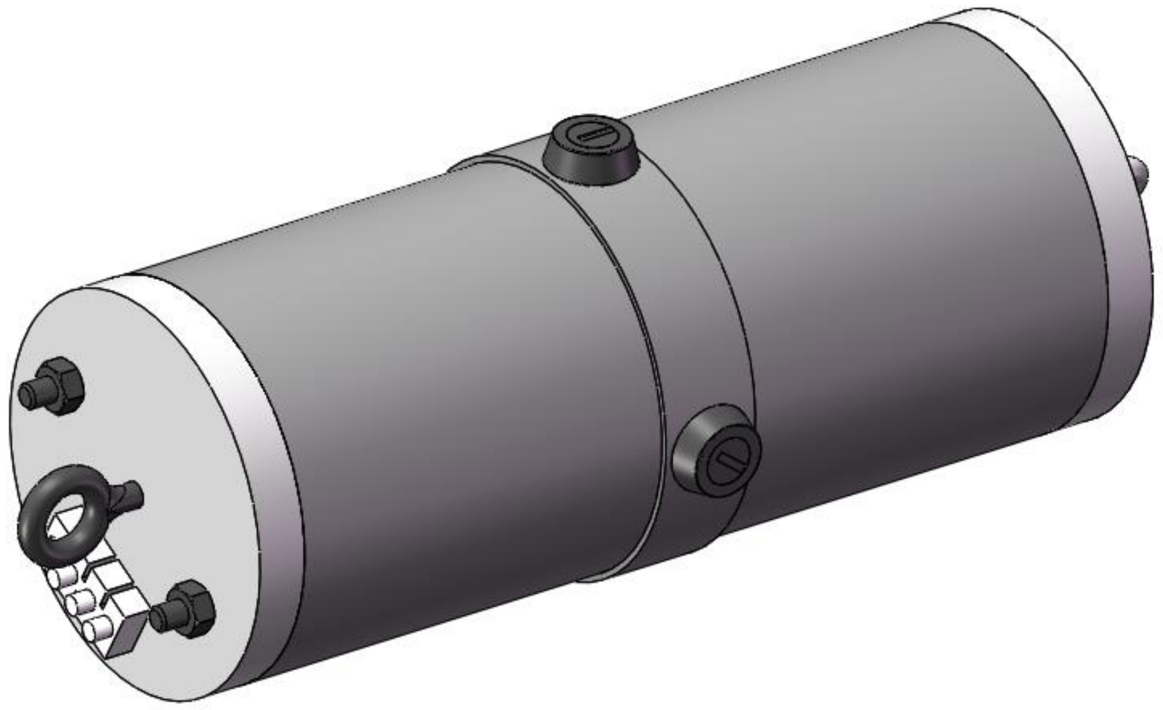


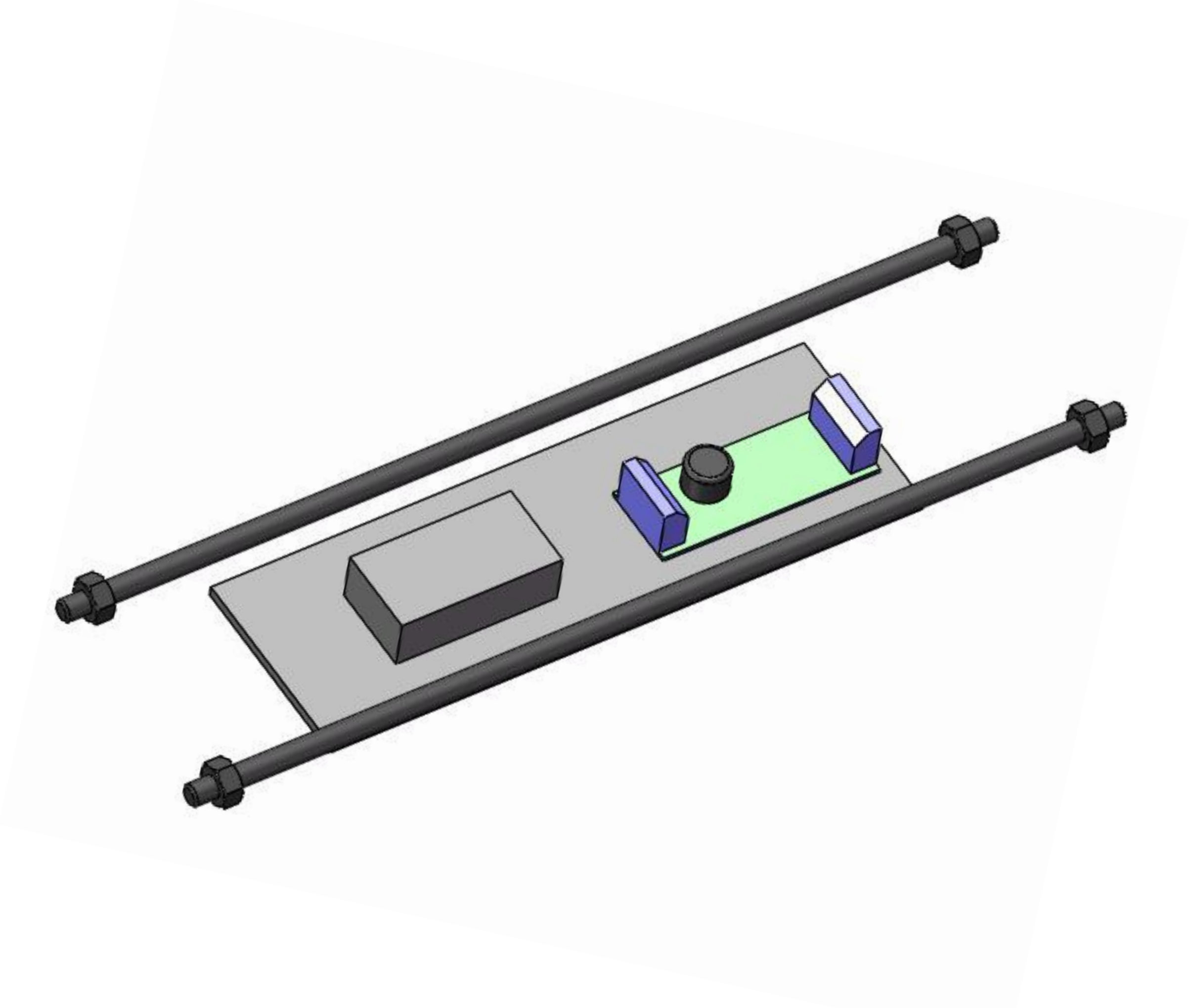
Motor Selection

Motor: Aerotech L1090W
Total Impulse: 2736 N-s
Maximum Thrust: 1334 N
Propellant Mass: 1400 grams
Burn Time: 3 sec
Thrust to Weight: 9.17:1

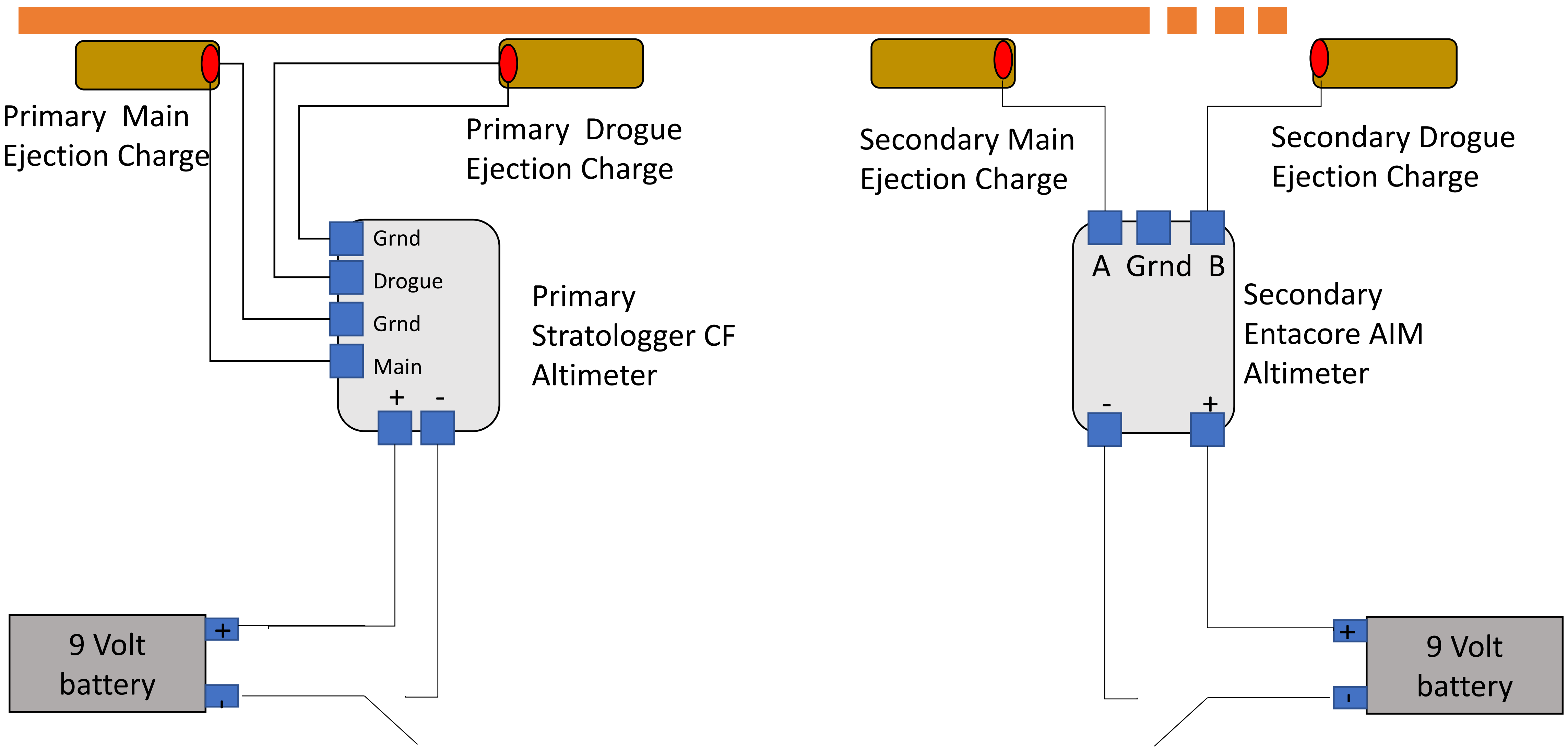


Avionics Bay



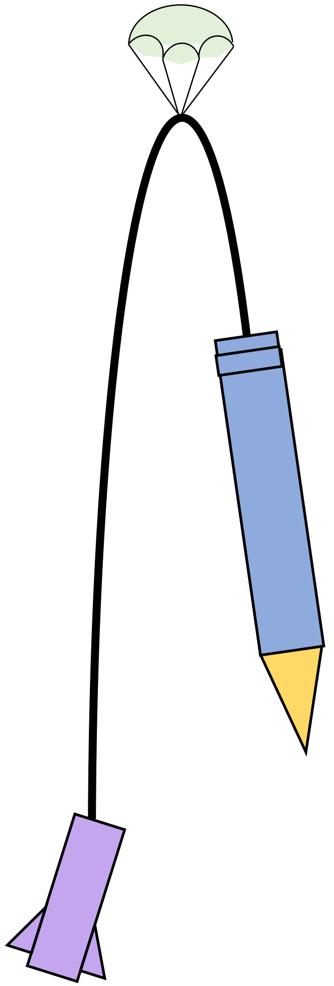


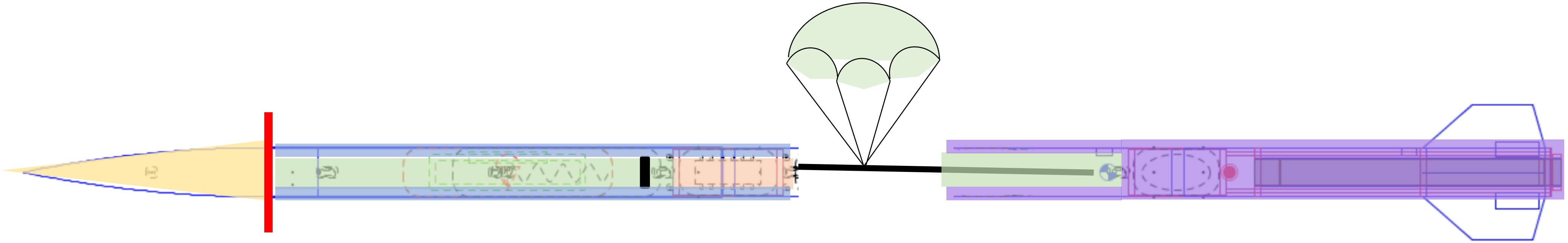
Redundancy



Primary Main
Ejection Charge
Primary Drogue
Ejection Charge
Secondary Main
Ejection Charge
Secondary Drogue
Ejection Charge
Grnd
Drogue
Grnd
Main
+
-
Primary
Stratologger CF
Altimeter
A Grnd B
-
+
Secondary
Entacore AIM
Altimeter
9 Volt
battery
+
-
9 Volt
battery
+
-

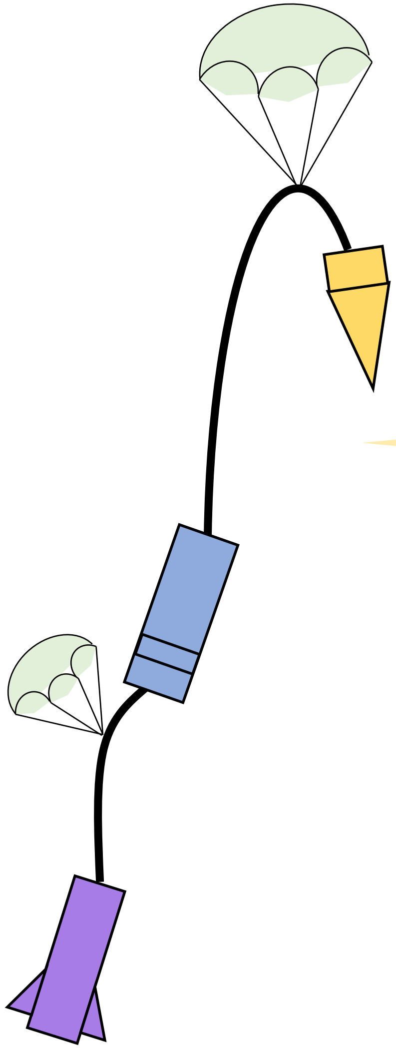
First Separation

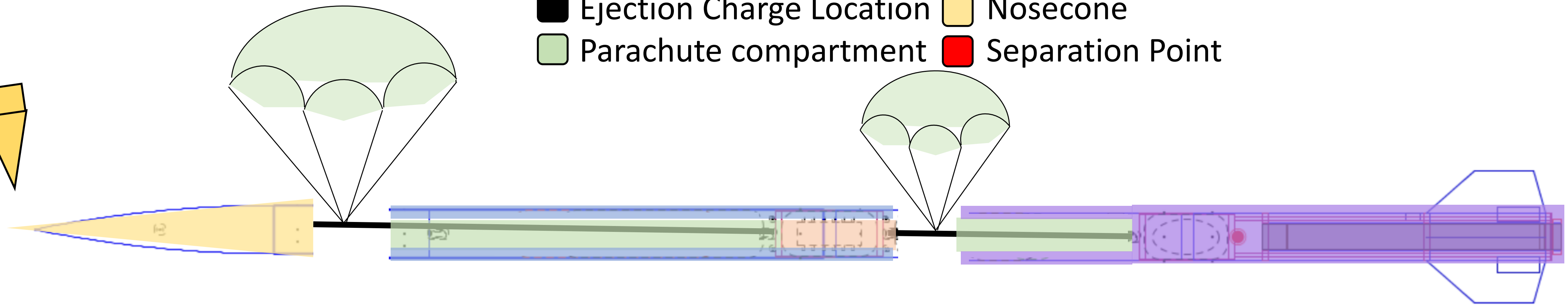




Object	Description
Recovery harness	Wildman Rocketry 7/16” Kevlar 25 ft long
Drogue Parachute	24” Skyangle C3 Drogue

Second Separation

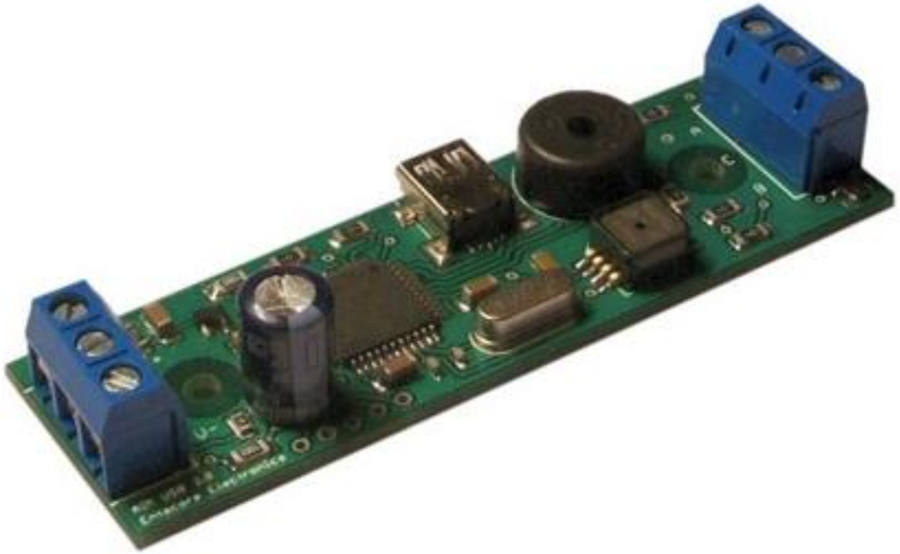


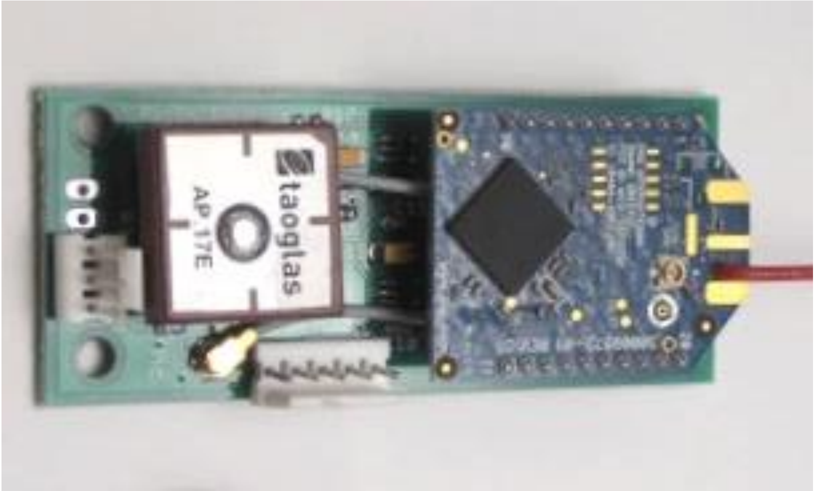


Object	Description
Recovery harness	Wildman Rocketry 7/16” Kevlar 25 ft long
Main Parachute	72” Fruity Chutes Irus Ultra

Selected Altimeters and GPS

Object	Description	Location
Primary altimeter	Perfectflite Stratologger CF	Avionics bay
Secondary altimeter	Entacore AIM	Avionics bay
GPS	Big Red Bee 900	Nosecone

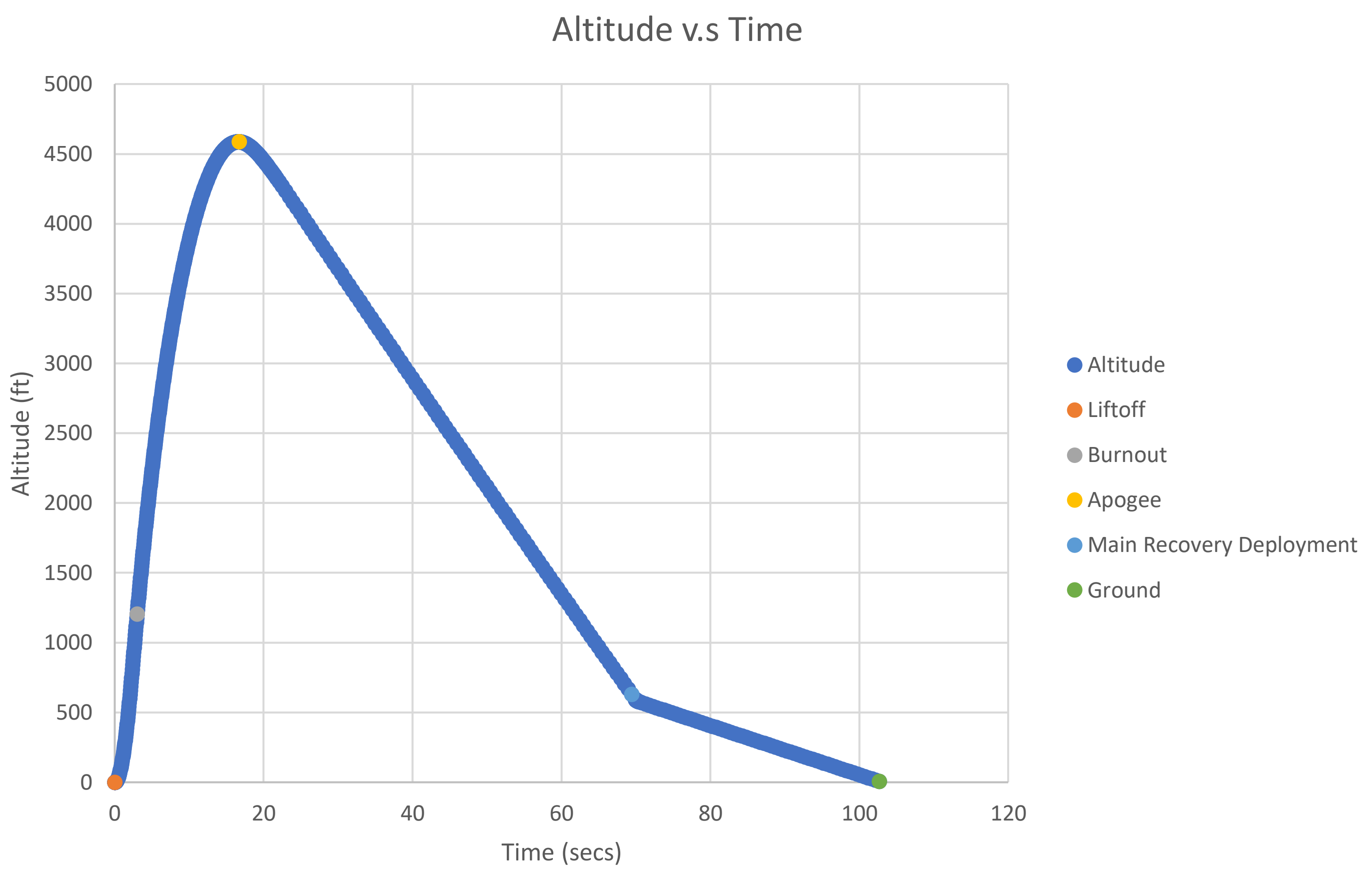




Mission Performance Predictions

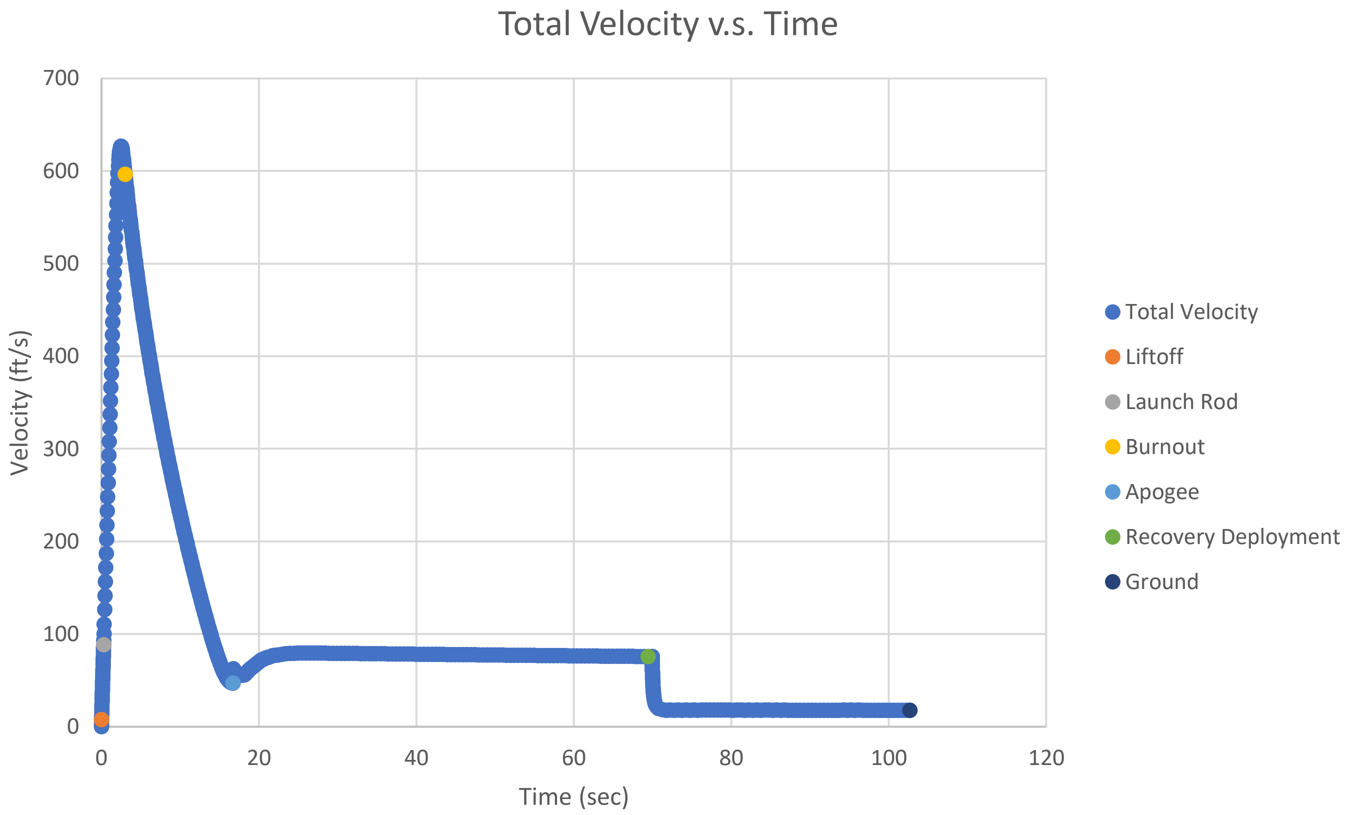
Target Altitude: 4578 ft

Predicted Altitude: 4588 ft



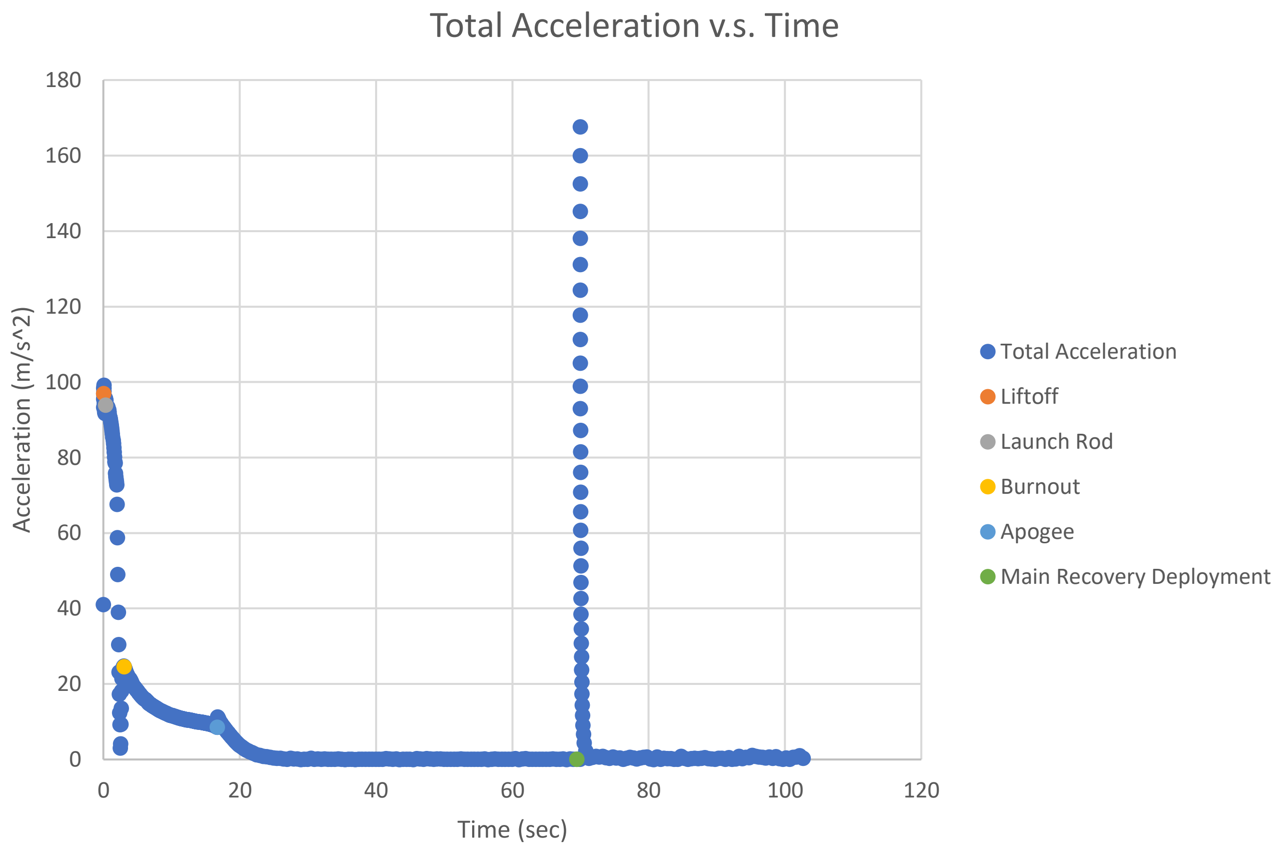
Mission Performance Predictions

Rail- Exit Velocity: 88.4 ft/s
Maximum Velocity: 626 ft/s



Mission Performance Predictions

Maximum Acceleration:
98.7 m/s^2



Mission Performance Predictions

Descent Time Calculated with Spreadsheet	
Drogue Descent Time (s)	52.6
Main Descent Time (s)	34.1
Total Descent Time (s)	**86.7**

Descent Time Calculated with Open Rocket	
Time to Apogee (s)	16.6
Total Flight Time (s)	103
Total Descent Time (s)	**86.4**

Mission Performance Predictions

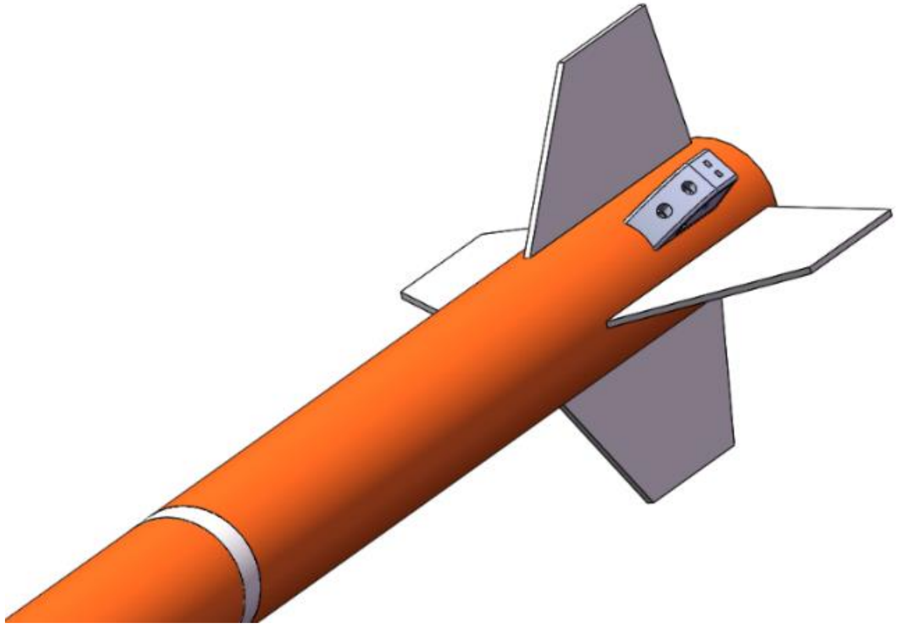
Drift Calculations Calculated with Spreadsheet				
Wind Speed	5 mph	10 mph	15 mph	20 mph
Drogue Drift	386	772	1158	1543
Main Drift	250	500	750	1000
Total Drift	**636**	**1272**	**1908**	**2543**

Drift Calculations Calculatedwith Open Rocket				
Wind Speed	5 mph	10 mph	15 mph	20 mph
Total Drift	**605**	**1215**	**1825**	**2350**

Kinetic Energy at Ground Hit Calculated with Spreadsheet	
Nosecone (ft-lbs)	6.9
Forward Section (ft-lbs)	39.5
Aft Section (ft-lbs)	61.7

Payload System Overview

- Computer Vision and Inertial Navigation Approach
- Images and IMU data is captured continuously during flight
- Image used to find location of rocket
- IMU data from landing and IMU data from image location used to find landing location
- IMU and Image compared by timestamp



Payload Software Design

Image Capture State

Best:

2500 ft – 4000 ft (During ascent)

Good:

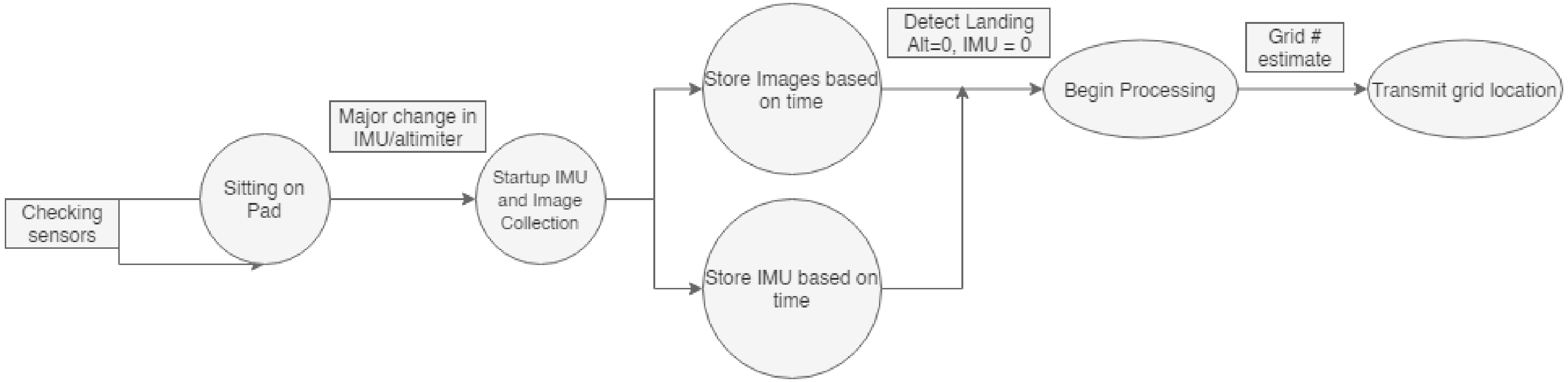
1000ft – 2500ft (During ascent)

Fair:

Under 1000ft

Poor:

Over cloud cover



Payload Software Design

IMAGE COMPARISON

- The image taken by the rocket is compared against the pre-uploaded image
- The comparison is done using the SIFT algorithm which identifies keypoints in images and compares them
- This helps us identify the location of the rocket at the time of the image taken.

IMU USAGE

- Once a location is aquired, the IMU data for that location is retrieved (by comparing the timestamp)

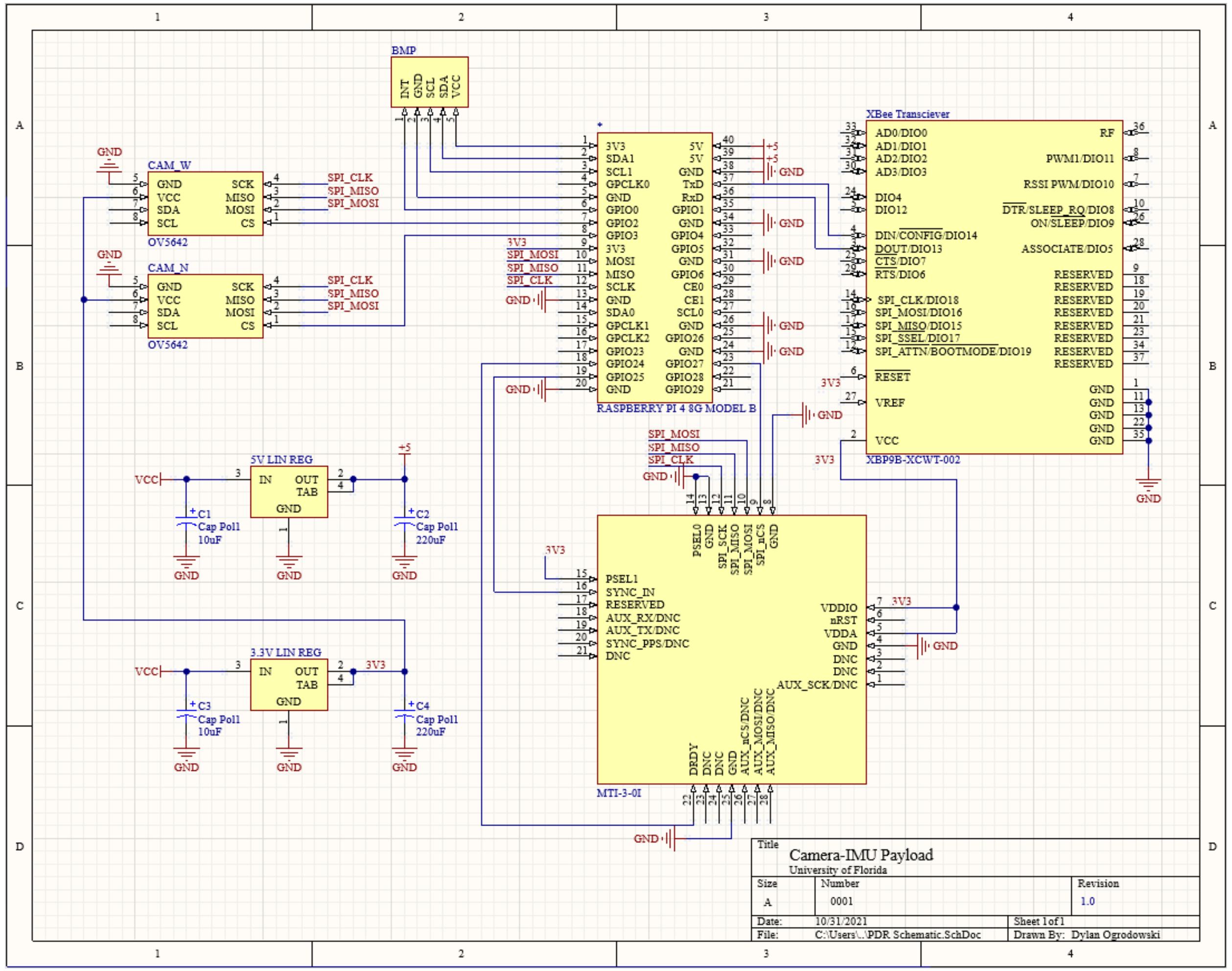
- This IMU data is used with the IMU data from after landing to get the final location

Payload Electronics

Raspberry Pi 4
- 8 GB RAM

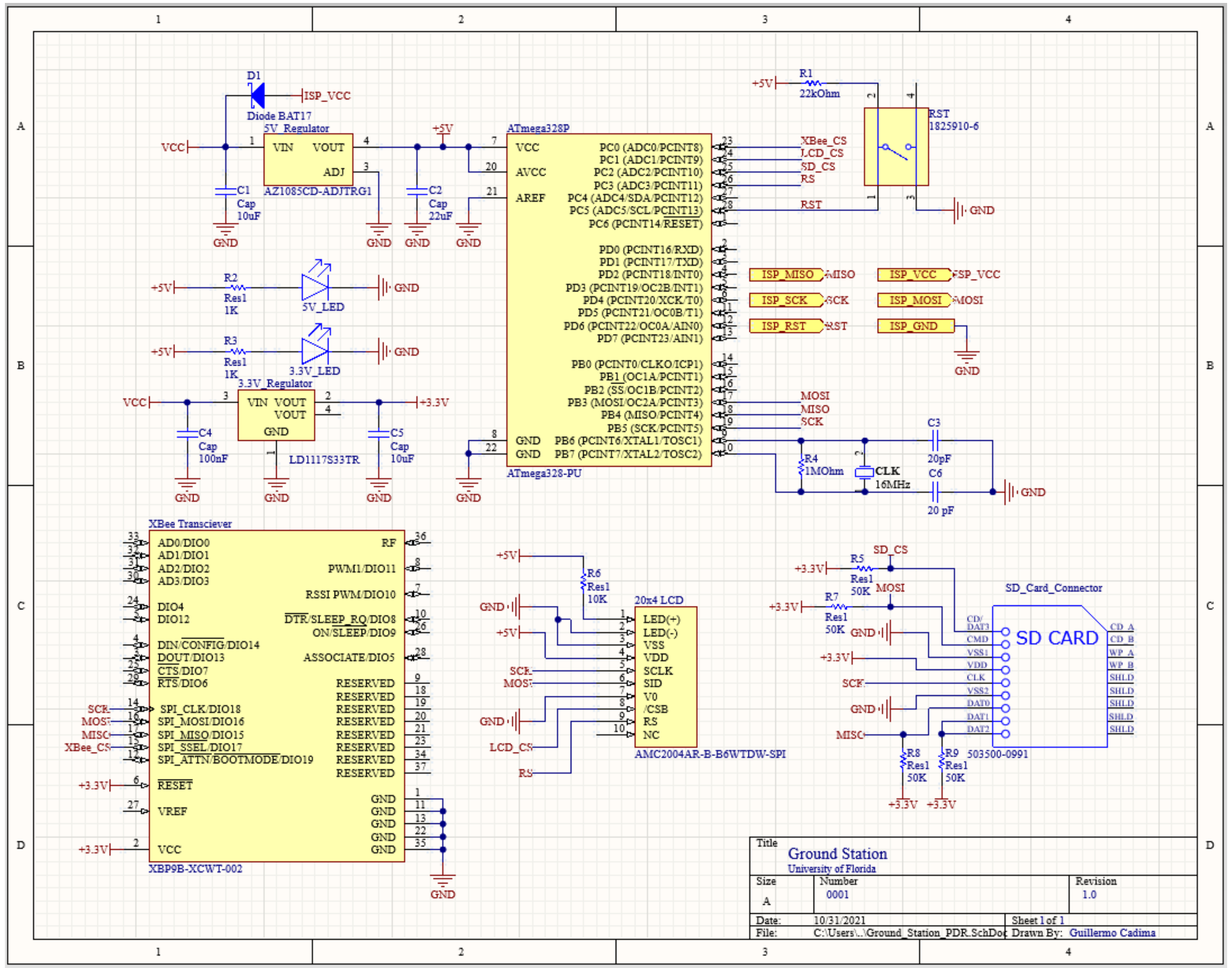
Inertial Measurement Unit (IMU):
- MTI-3-0I
- 2.5mg sensitivity

OV5642 Cameras:
- 65° FoV
- 90° FoV



Ground Station Electronics

Object	Description
Microcontroller	ATmega328P
Radio	Xbee 900 MHz Transceiver
Display	20x4 LCD
Storage	SD Card

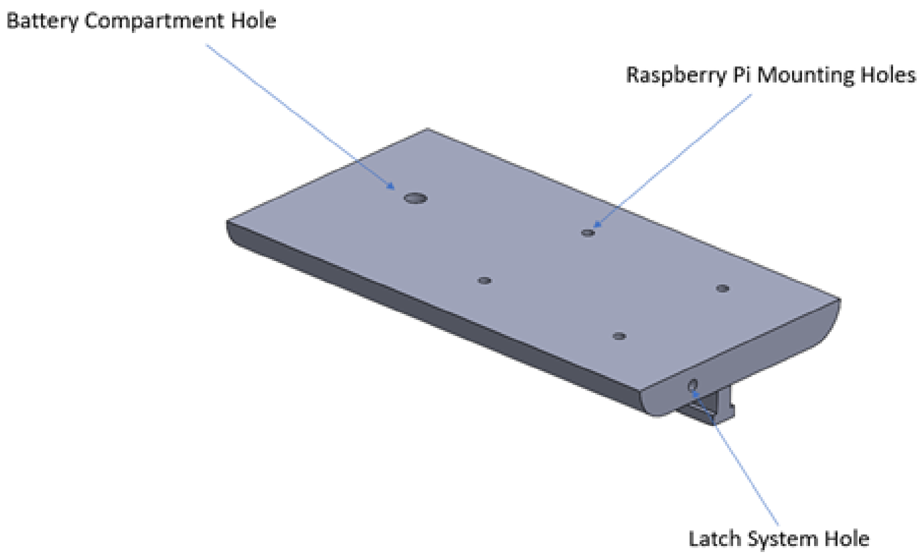


Payload Sled

- 3D Printed PETG
- Houses Raspberry Pi, batteries, and electronics
- Connects to Rail System
- PCB attachment methods compared

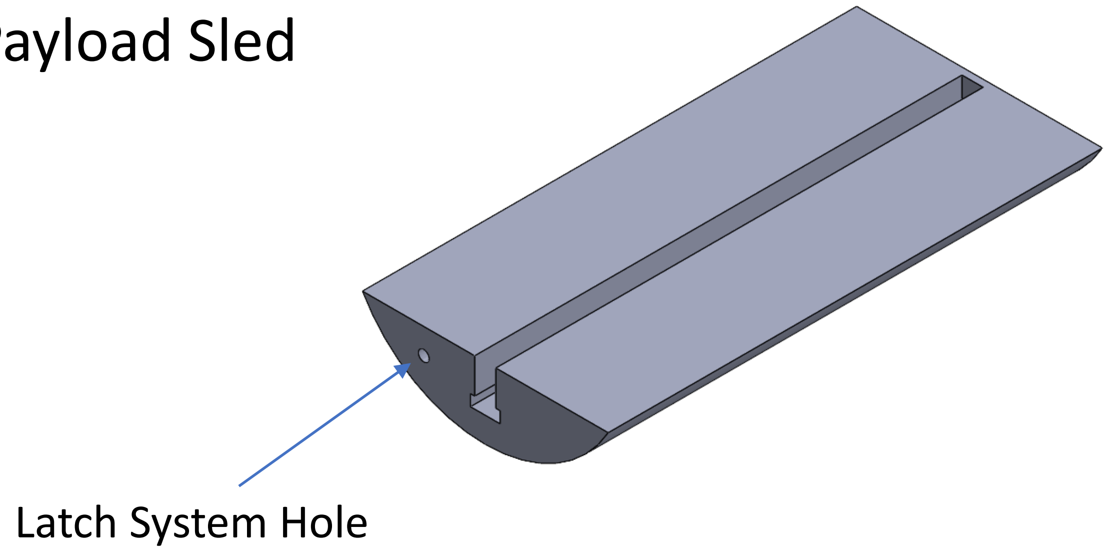
Sled PCB Attachment			Embedded Nuts			Threaded Inserts (Heat-Staking)		
Objective	Weighting Factor	Parameter	Mag.	Score	Value	Mag.	Score	Value
Material Cost	0.15	USD	7.5	10.0	1.5	9.0	8.3	1.2
Reliability	0.40	N	Good	8.0	3.2	Great	10.0	4.0
Manufacturability	0.15	hours	4.0	5.0	0.8	2.0	10.0	1.5
Modularity	0.30	fasteners	4.0	5.0	1.5	4.0	5.0	1.5
Overall Value					7.0			8.2

Sled PCB Attachment			Rail Slide		
Objective	Weighting Factor	Parameter	Mag.	Score	Value
Material Cost	0.15	USD	12.0	6.3	0.9
Reliability	0.40	N	Poor	2.0	0.8
Manufacturability	0.15	hours	4.0	5.0	0.8
Modularity	0.30	fasteners	2.0	10.0	3.0
Overall Value					5.5



Rail System

- 3D Printed PETG
- Epoxied to inside of airframe
- Provides support for Payload Sled

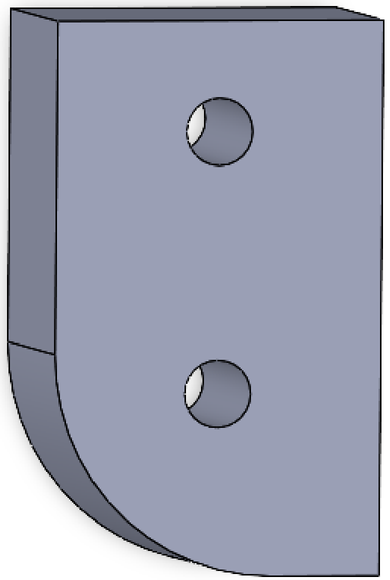


Latch System

- 3D Printed PETG
- Connects the Payload Sled to the Rail System
- Prevents Payload Sled from sliding out of Rail System
- Two M2.5 clearance holes
- Latch system methods compared

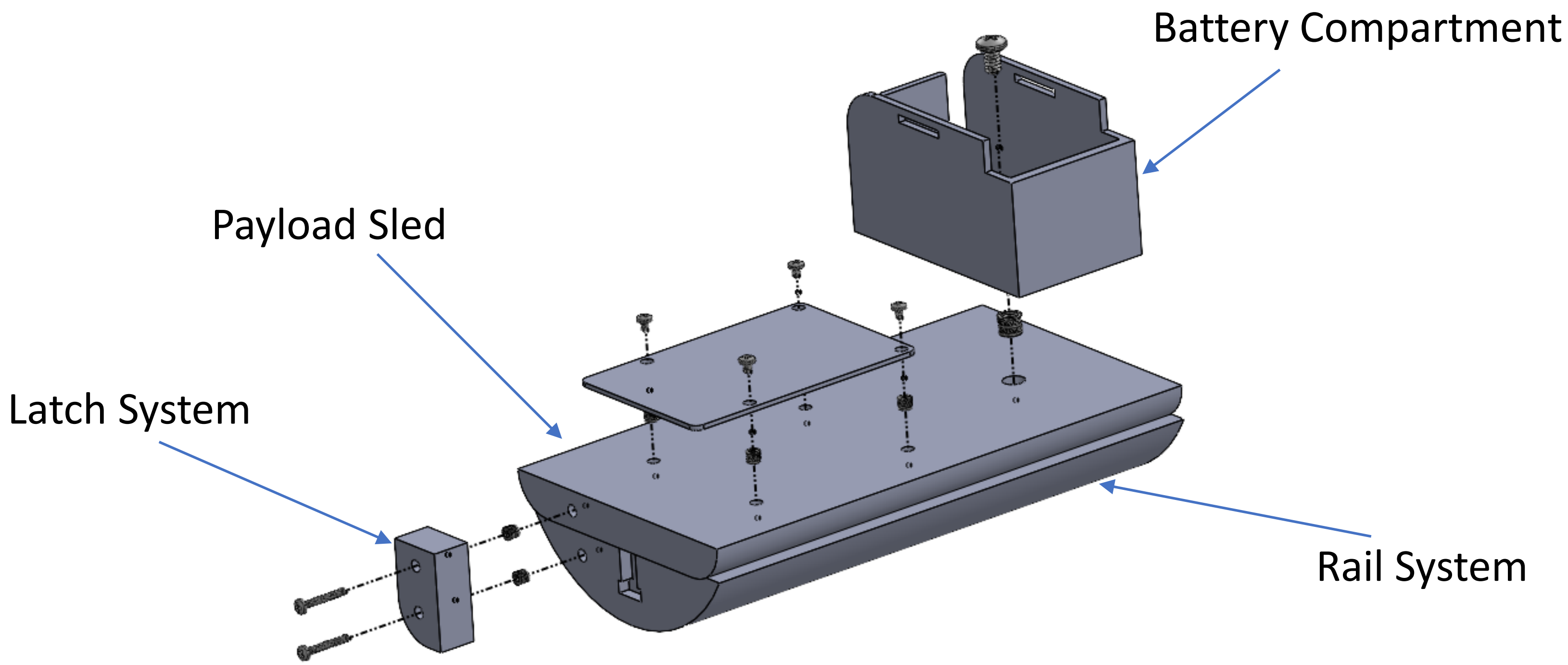
Latch/Retainment Method			Flat Face Door			Sliding Lock		
Objective	Weighting Factor	Parameter	Mag.	Score	Value	Mag.	Score	Value
Material Cost	0.20	USD	10.0	10.0	2.0	15.0	6.6	1.3
Surface Stress	0.40	in^2	Great	10.0	4.0	Great	10.0	4.0
Manufacturability	0.20	hours	2.0	10.0	2.0	4.0	5.0	1.0
Modularity	0.20	fasteners	2.0	5.0	1.0	1.0	10.0	2.0
Overall Value					9.0			8.3

Latch/Retainment Method			Pin Lock		
Objective	Weighting Factor	Parameter	Mag.	Score	Value
Material Cost	0.20	USD	19.0	5.0	1.0
Surface Stress	0.40	in^2	Fair	4.0	1.6
Manufacturability	0.20	hours	6.0	3.3	0.7
Modularity	0.20	fasteners	3.0	3.3	0.7
Overall Value					4.0



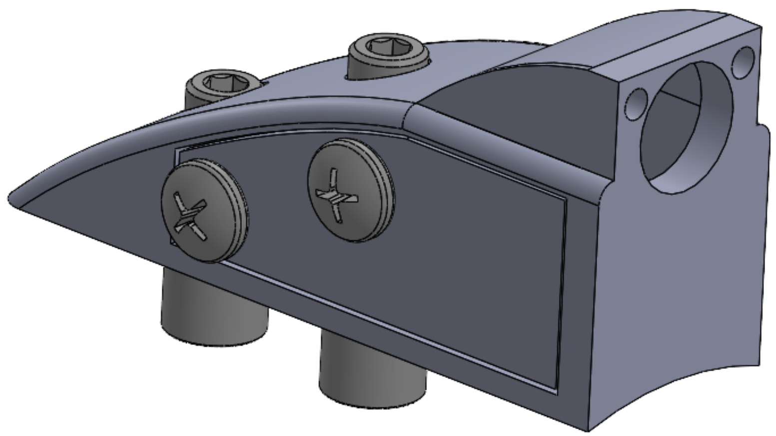
Full Payload Assembly

- Full Payload assembly exploded
- Mated using threaded inserts and fasteners



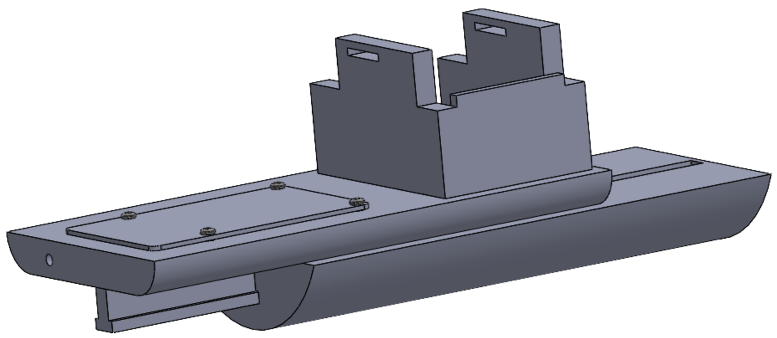
Camera Mount Assembly

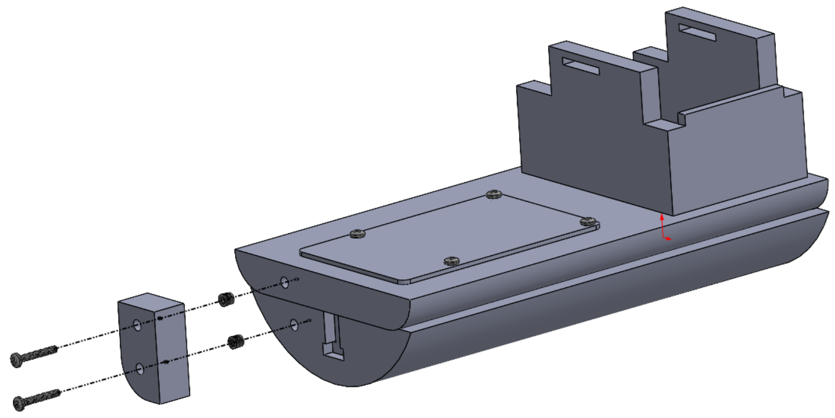
- Mates the camera housing to the camera cover
- Protects the camera from aerodynamic drag forces
- Streamline design to maximize aerodynamic efficiency
- Aligns camera along airframe for best image quality



Preliminary Payload Retention System

- Rail System epoxied to payload coupler
- Payload Sled slides into Rail System
- Latch System locks Payload Sled to Rail System





Requirements Compliance

A complete testing plan was designed to verify the competition requirements as well as the team-derived requirements. Team-derived requirements were created for the vehicle, recovery system, and payload.

Vehicle Requirements

Requirement	Justification	Verification Method
1.1 The apogee of the launch vehicle must reach between 4100 and 4700 ft.	The final apogee of the launch vehicle must be within this apogee range to ensure that it does not fall below the absolute minimum set forth.	The Flight Dynamics Lead will perform various simulations using the subscale design to ensure that the launch vehicle will meet this requirement through all external conditions.
1.2 The motor centering rings' holes must be aligned sufficiently in order for electronics tubes to fit through the holes properly.	The electronics tubes cannot bend as this may compromise the wiring within and cause the payload to fail.	Marks will be made by the Structures Lead during manufacturing that indicate where the centering rings must align.

Requirements Compliance

Recovery Requirements

Requirement	Justification	Verification Method
2.1 The drogue parachute will have a descent rate of 80 ft/s.	This descent rate ensures the vehicle is at a slow enough velocity once the main parachute must be deployed.	Test #7, Parachute Drag Test, will ensure the drag induced by the parachute is sufficient.
2.2 The main parachute will have a descent rate of 18 ft/s.	This descent rate ensures the launch vehicle will not be harmed during landing by landing at an appropriate velocity.	Test #7, Parachute Drag Test, will ensure the drag induced by the parachute is sufficient.
2.3 Each recovery harness will have a length of 2.5 times the total length of the vehicle.	This length is required to ensure the separate sections of the launch vehicle do not collide during descent. This length also prevents breakage of the recovery harness during separation, as a longer harness provides more slack.	Visual verification of the length of the recovery harness will be performed by the Avionics and Recovery Lead and the Project Manager.
2.4 There will be a delay of the secondary aft ejection charge of 0.5 seconds after the ejection of the primary charge.	The delay ensures that the launch vehicle does not over-pressurize, a possible occurrence during ejection that may occur if multiple charges ignite at once.	Test#10, Barometer Functionality Test, will ensure that the barometer functions correctly and thus ignites the ejection charge at the appropriate time.
2.5 There will be a delay of the secondary forward ejection charge to eject at an altitude of 50 ft below the altitude of primary charge, thus ejecting at an altitude of about 550 ft.	The delay ensures that the launch vehicle does not over-pressurize, a possible occurrence during ejection that may occur if multiple charges ignite at once.	Test #10, Barometer Functionality Test, will ensure that the barometer functions correctly and thus ignites the ejection charge at the appropriate time.
2.6 The secondary ejection charges will be 25% larger in black powder weight than the primary charges.	The secondary charge must be larger than the primary in the event that the primary fails to separate the vehicle and thus the larger secondary charge can provide a greater force and result in successful separation.	The weight of the black powder will be verified by the Avionics and Recovery Lead and the Project Manager prior to launch.

Requirements Compliance

Payload Requirements

Requirement	Justification	Verification Method
3.1 The payload will be able to resume operation after a momentary power loss.	The payload must be able to continue operation without losing previously captured images or data.	Test #34, Power Loss Test, ensures that the payload will continue operation correctly in a circumstance of loss of power.
3.2 The payload IMU expected positional drift must not exceed 100 ft over 90 sec.	The payload must be able detect the correct grid space the launch vehicle is located in.	Test #50, IMU Drift Test, determines the expected drift and ensures it does not exceed 100 ft.
3.3 The payload must be able to detect launch.	Launch detection allows the payload to idle in a low-power state while on the launch pad, preserving battery life.	Test #47, Payload Launch Detection Test, ensures that the payload can detect the sudden acceleration that will occur during launch.
3.4 The payload transmitter must have a range of at least one mile.	The payload must be able to communicate its results successfully even in the event of maximum drift as well as possible obstructions.	Test #49, Payload Transmission Range Test, ensures that the payload can transmit data over at least one mile.
3.5 The payload must be able to process at least 100 images within five minutes of landing.	The payload must be able to compile the data in the allowed amount of time in order to determine its grid location.	Test #48, Payload Data Compilation Test, ensures that the data can be compiled in the appropriate amount of time.

Safety

Safety Officers

- Primary: Jason Rosenblum
- Secondary: Raymond Pace

Implement mitigations to limit the risk of hazards

- Examine potential hazards to
    - Personnel
    - The environment
    - The project
- Identify priorities for mitigation using hazard score
- Conducted failure mode and effects analyses
- Oversee all manufacturing

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