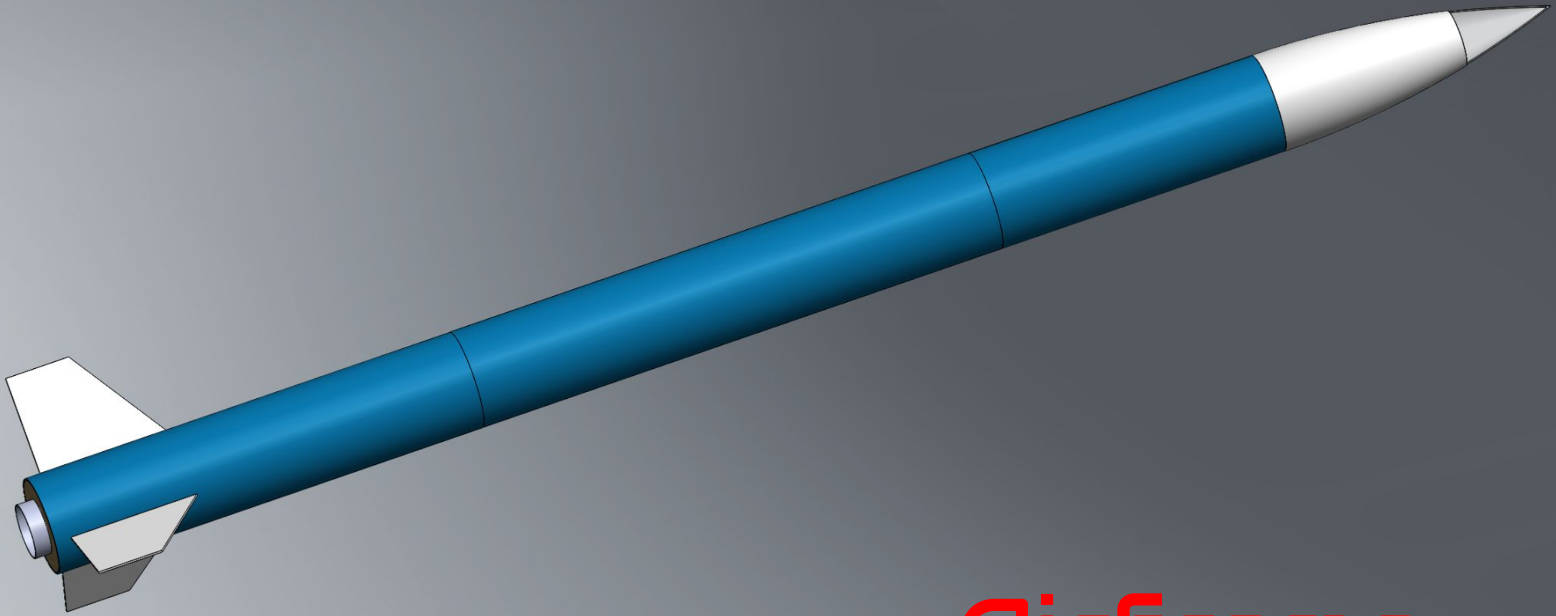
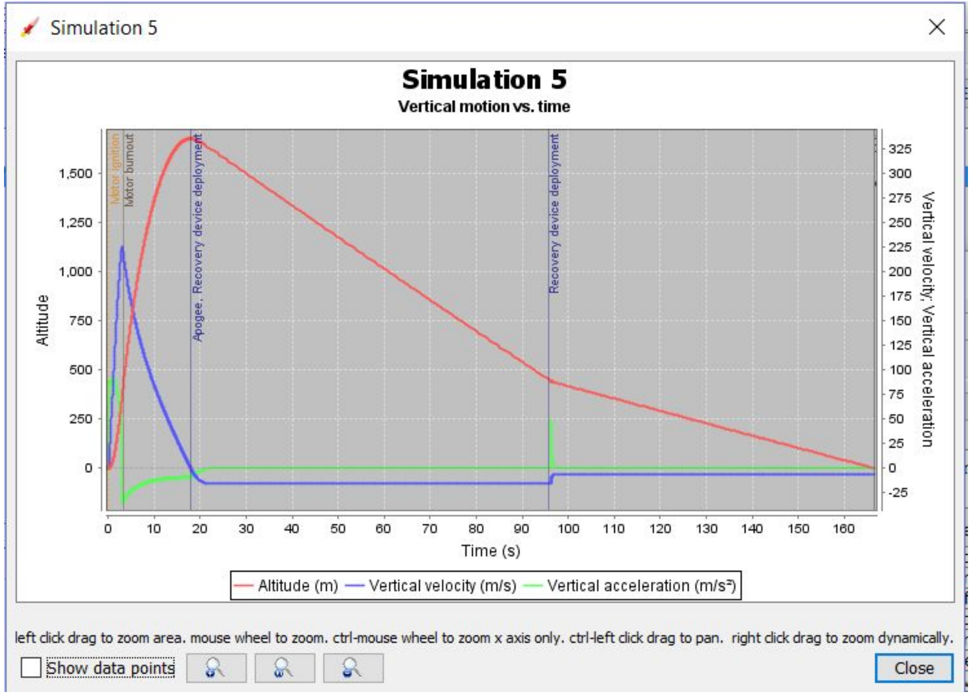
STAR



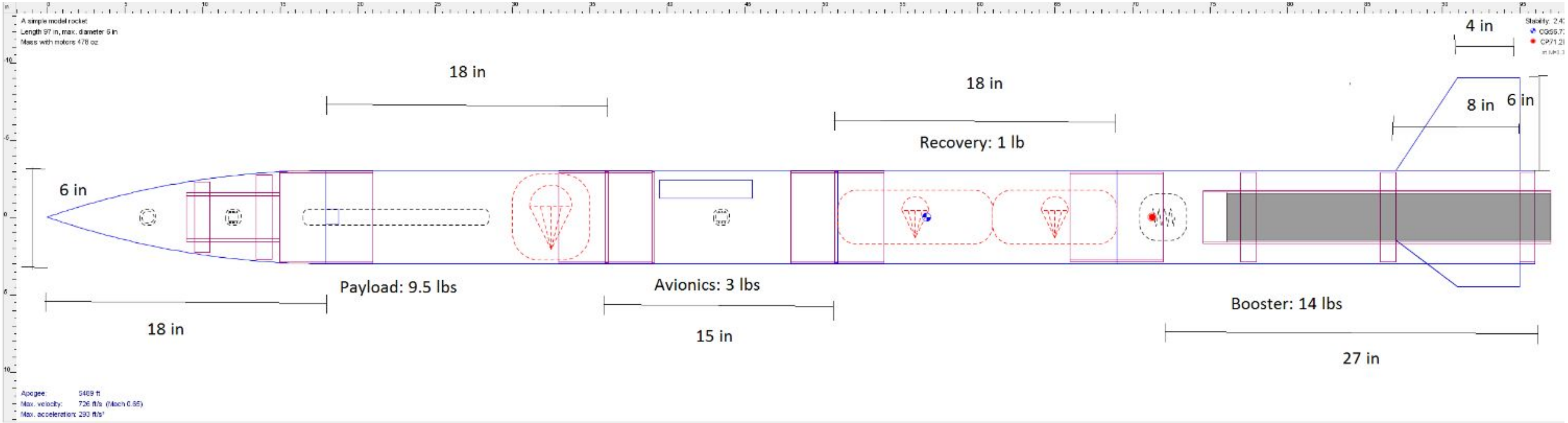
Airframe

Summary

- Overall length: 8’ 1”
- Nose cone base diameter: 6”
- Nose cone length (ogive): 18”
- Payload section diameter: 6”
- Payload section length: 18”
- Booster section diameter: 6”
- Booster section length: 2’3”
- Motor size and type: Aerotech L1150 motor
- CG: 39.7” from rear
- CP: 25.7” from rear
- Stability margin: 2.34 calibers
- Thrust to weight ratio: 8.839
- Rail exit velocity: 67.4 ft/s



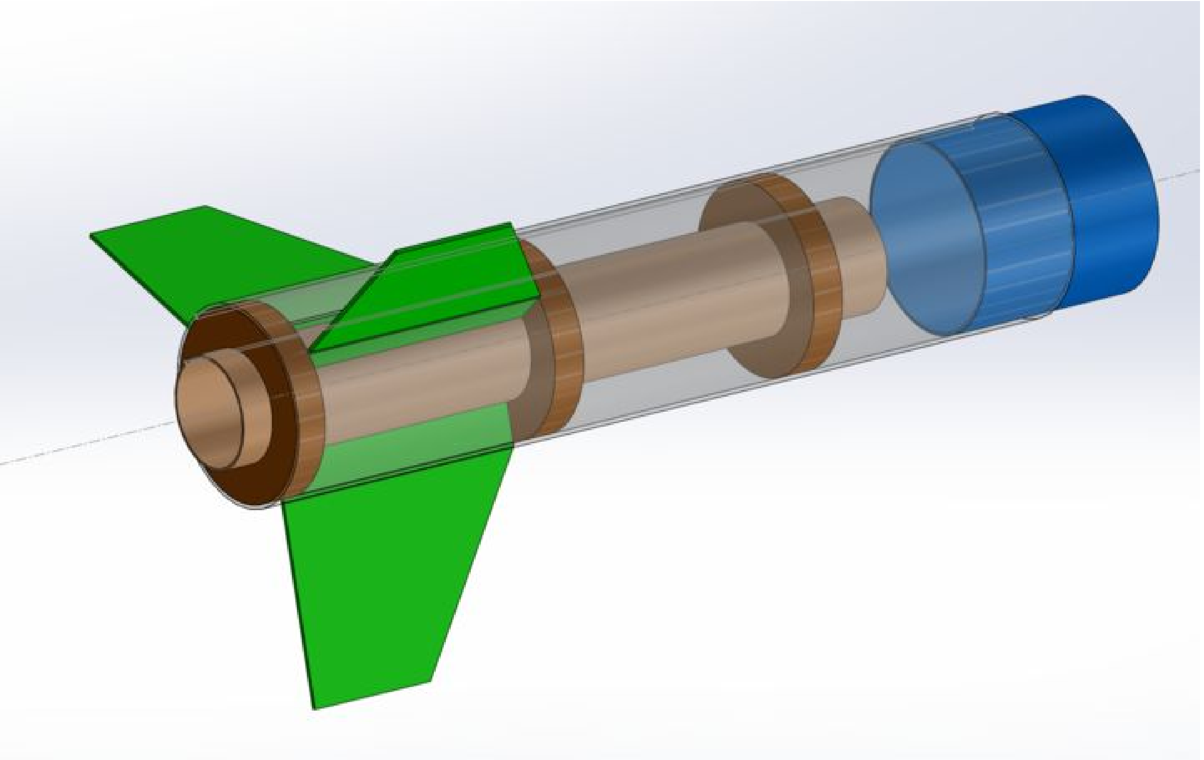
OpenRocket Diagram



Materials

- Main body
  - BlueTube
- Nose cone
  - Upper-half polycarbonate
    - To facilitate camera viewing through the nose cone, as required by our payload experiment.
  - Lower-half fiberglass
- Fins
  - Fiberglass with carbon fiber/glue reinforcement
- Motor Mount Tube
  - Phenolic
  - Wood centering rings
- Glue
  - Epoxy/ JB Weld

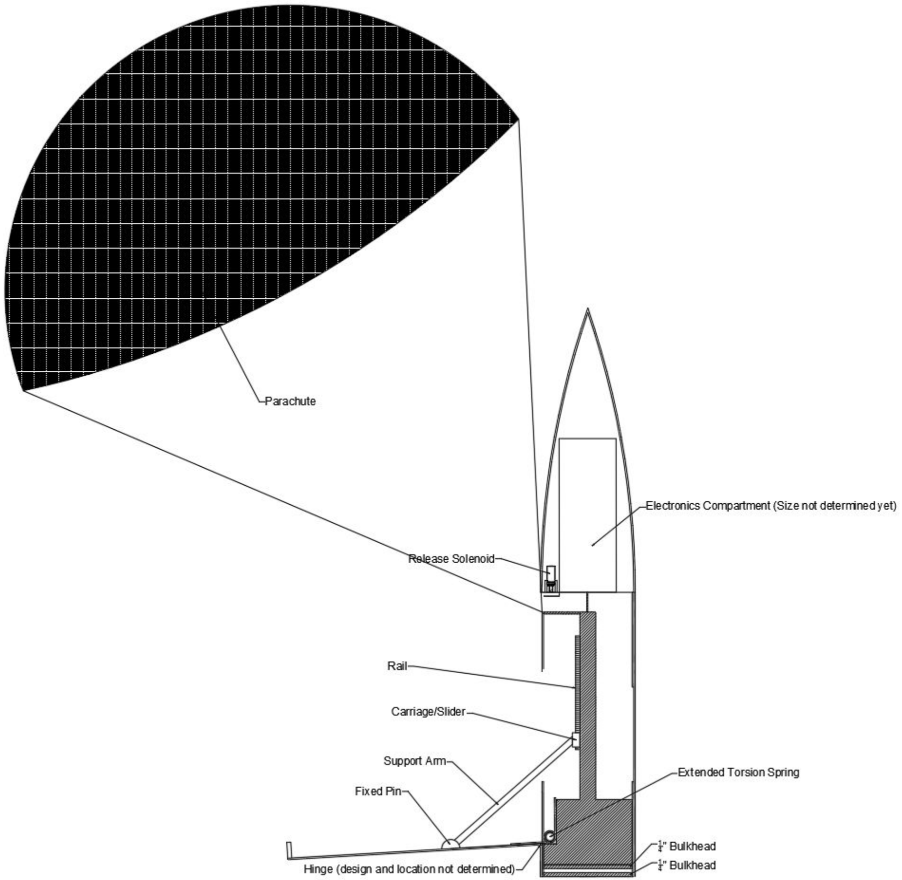
Booster Section



Payload

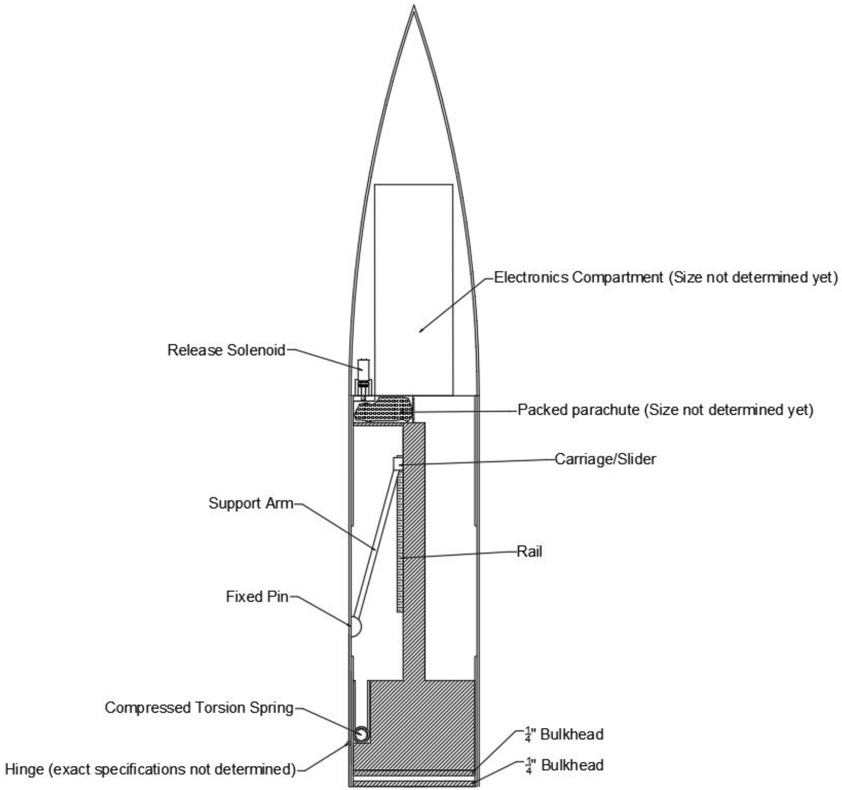
Target Detection and Upright Landing

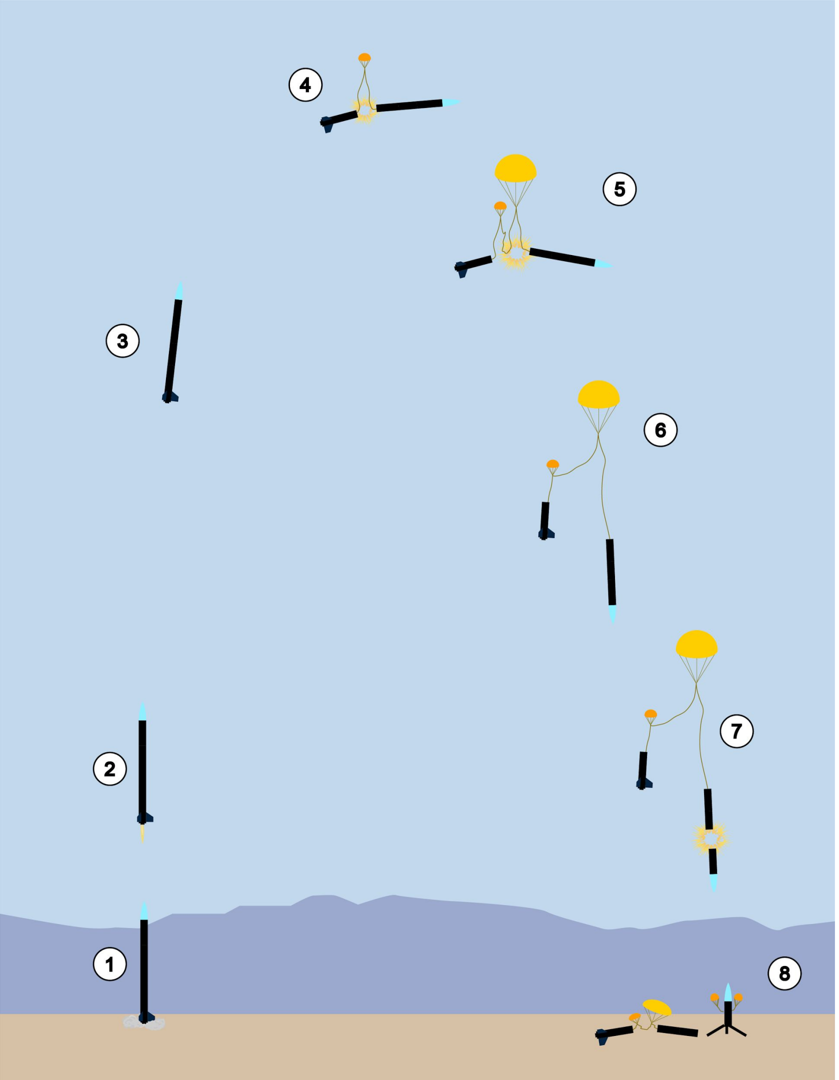
- Detect and differentiate ground targets with camera mounted in nose cone
- Deploy landing legs
    - Simultaneously deploy three parachutes



Target Detection and Upright Landing

- Legs mounted within airframe wall, pin-closure
  - Spring-loaded hinge
  - Alternative: gas-spring deployment





PHASE	EVENT
1	Ignition.
2	Powered flight.
3	Coasting.
4	Drogue parachute deployed at apogee (projected at 5,567 ft. AGL)
5	Main parachute deployed at an altitude of 1,000 ft. AGL.
6	Camera in the nosecone of the rocket begins target spotting.
7	Payload section deploys itself from rocket and deploys its legs and three parachutes.
8	All sections of the rocket land with a KE under 75 ft-lbf.

Recovery

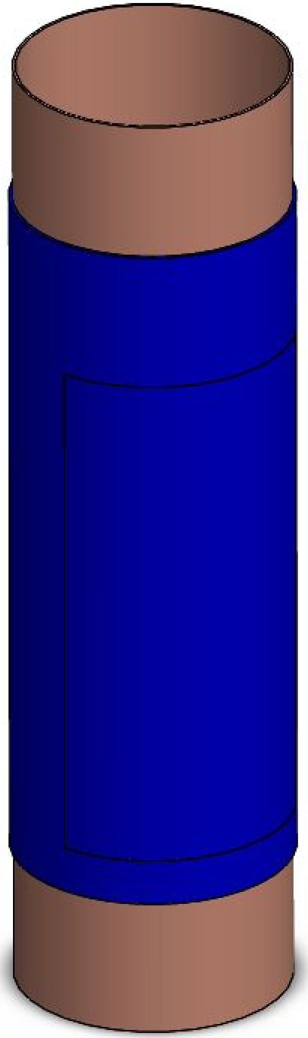
Avionics Bay

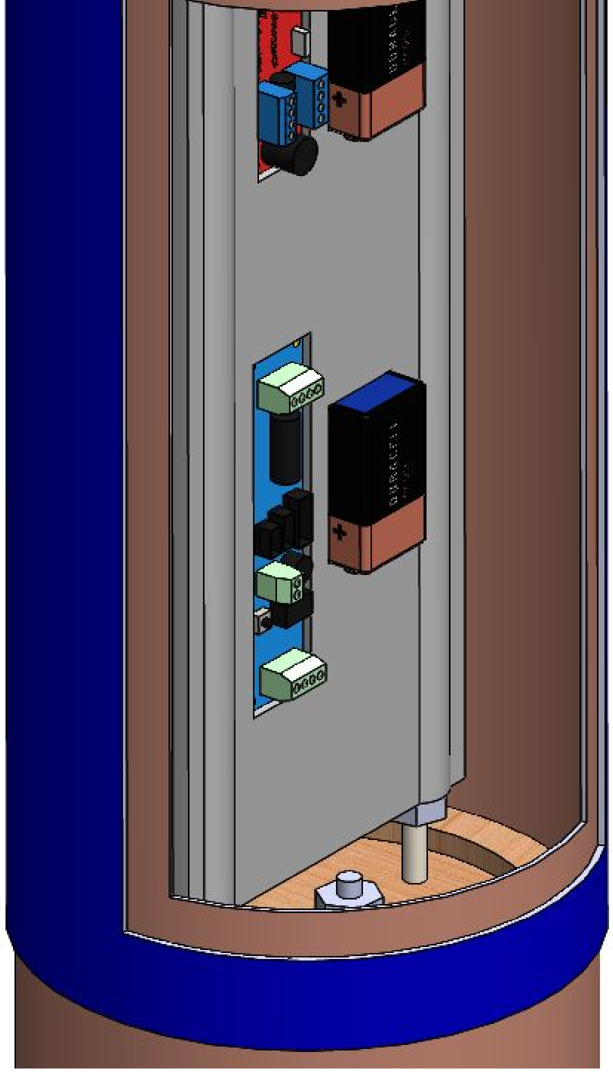
External Design

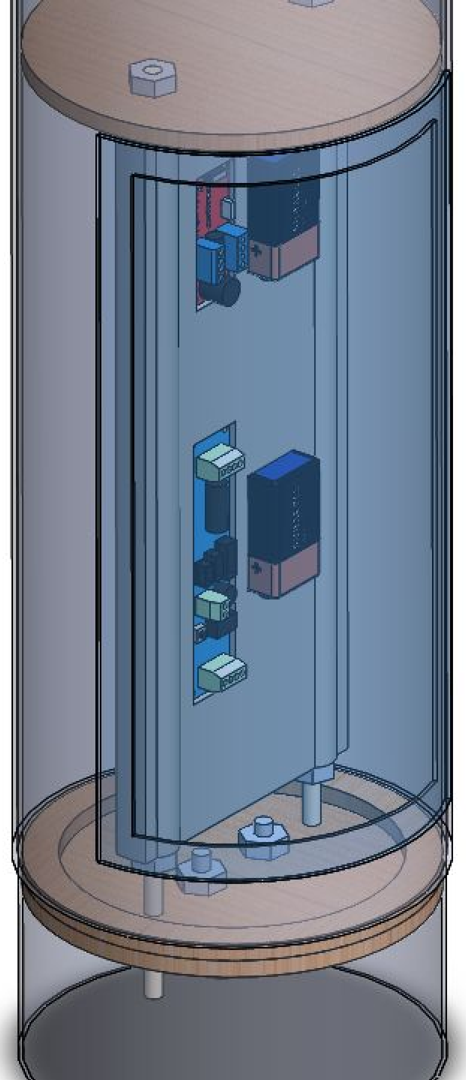
-removable door
-covered by an o ring

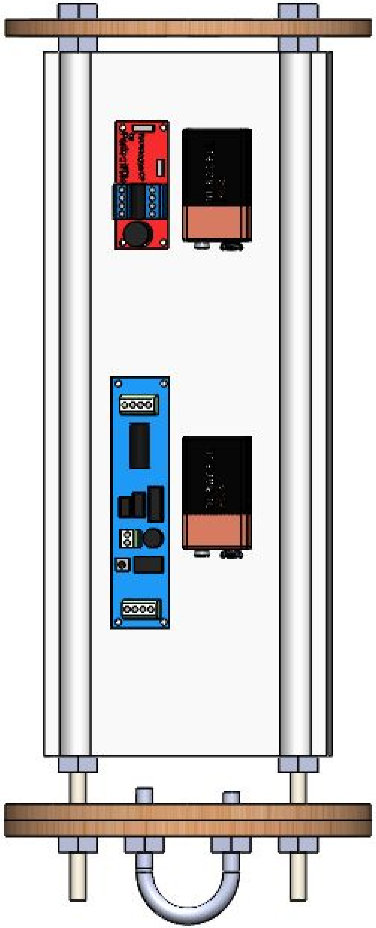
Internal Design

-3D printed









Calculating Parachute Sizes

- *Drogue Parachute*
  - Optimally main parachute opens when the vehicle is at 50mph or 73 ft/s
  - Equation for terminal velocity $$V_{Terminal} = \sqrt{\frac{(2m_{total}g)}{\rho C_1 A_1}}$$
  - **1x 24’’ diameter elliptical parachute with C_d = 1.5**
- *Main Parachute*
  - Payload will detach before rocket lands
  - $KE=(0.5)mv^2$ and heaviest component’s mass → must land slower than 20.501 ft/s
  - Increase safety margin → land with about 15 ft/s
  - Equate force of gravity to force of drag $m_{total(w/o\ payload)}g = \frac{1}{2}\rho v_{max}{}^2 C_1 A_1 + \frac{1}{2}\rho v_{max}{}^2 C_2 A_2$
  - **1x 72’’ diameter toroidal parachute with C_d = 2.2**
- *Payload Parachute*
  - 3 parachutes for stabilization
  - $KE=(0.5)mv^2$ and mass → must land slower than 22.552 ft/s → final speed 15 ft/s
  - **3x 42’’ diameter elliptical parachute with C_d = 1.5**

Calculating Final KE

- Avionics Bay and Booster
  - Terminal velocity equations → land at a velocity of 13.988 ft/s
  - Kinetic Energy equations
    - Avionics bay lands with 12.416 ft-lbf
    - Booster lands with 34.918 ft-lbf
- Payload
  - Lands at a velocity of 13.578 ft/s
  - Kinetic Energy equations
    - Payload lands with 27.1856 ft-lbf

Safety

Safety Officer: Grant Posner

We make sure the team follows codes and regulations and maintains safety, throughout construction, testing, assembly, and launch.

Responsibilities:

- Primary goals: mitigating risks and following laws
- Teaching/reinforcing proper safety protocols
- Maintaining MSDS, and explaining relevant information in them
- Maintaining and developing team procedures and hazard analyses

Team Mentor

Mentor: David Raimondi

- President of Livermore Unit of NAR (LUNAR)
- Level 3 High Power Rocket Certification

Mentor duties:

- Supporting the team throughout the project year
- Individual owner of the rocket for liability purposes
- Will travel with the team to launch week
- **Designated for purchase, store, transport, and use of rocket motors and energetic devices**

Personnel Hazards: Greatest Risks

- Construction injuries
    - University workshops require extensive training before access is given
    - Team members are always encouraged to ask other experienced members, or university staff, if there are any questions about machine protocols, instructions, or safety
- Launch safety: energetic devices
    - Subscale tests:
        - Proper procedures and checklists greatly minimize risk
        - Proper handling of motors and black powder charges
    - Full-scale tests/launches:
        - All members will understand and abide by the NAR High Power Rocket Safety Code
        - Mentor handles energetic devices
        - Mentor supervises assembly and launch activities

Environmental Risk Analysis

1. Minimize any environmental issues during the design phase.
2. Be aware of applicable laws and regulations.
3. Identify and rate all risks.
4. Have containment and remediation plans.

Environmental Ratings for Livermore

1.	Water Contamination	None
2.	Ground Contamination	Very Minimal
3.	Air Contamination	Very Minimal
4.	Ecosystem & Animal Risk	Very Minimal
5.	Human Risk	Very Minimal
6.	Noise	Very Minimal
7.	Community Risk	Minimal
8.	Rocket Engine	Minimal

Clean-Up and Disposal of Launch Waste

1. Identification of possible hazardous contaminants
2. Proper neutralization and disposal of hazardous contaminants
3. Post launch cleanup of launch site
4. Remediation of contamination, if necessary
5. Disposal of non-hazardous waste

Requirement Compliance Plan

- Have complied with all design requirements
- Delegation of responsibility for complying with requirements distributed among multiple team leads
- Redundancy: When possible, use both verification by test or analysis and by demonstration or inspection
- Track progress of verifications throughout year (Completed, In Progress, Planned, Not Started)
- Team Derived Requirements: Must meet/adhere to in order to declare project success

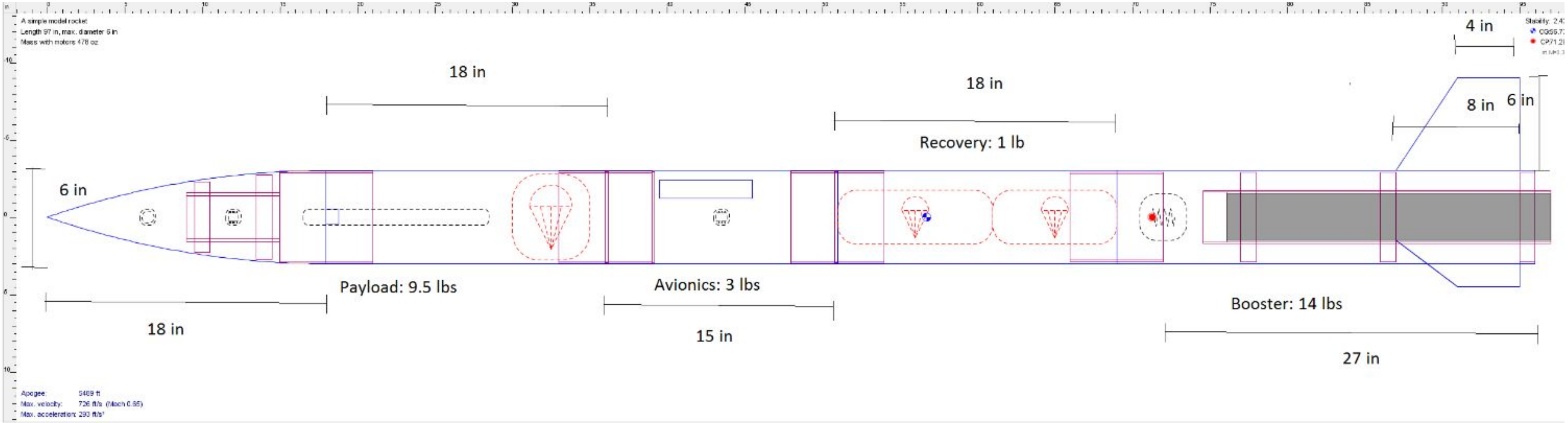
Outreach

Current Events:

- Habitat for Humanity School Trip: Local middle schoolers will be visiting the campus and participating in a bottle rocket launch. We will go over the physics behind the bottle rockets and rockets in general.
- KIPP Bay Area: We are communicating with a local school district to see if we can visit and hold STEM fairs and promote Aerospace studies.

Appendices

Dimensioned OpenRocket Flysheet


A simple model rocket
Length 97 in, max. diameter 6 in
Mass with motors 478 oz
18 in
18 in
Recovery: 1 lb
4 in
8 in
6 in
6 in
Payload: 9.5 lbs
18 in
Avionics: 3 lbs
15 in
Booster: 14 lbs
27 in
Apogee: 5409 ft
Max. velocity: 726 ft/s (Mach 0.65)
Max. acceleration: 293 ft/s²

Milestone Review Flysheet

Institution	University of California Berkeley

Milestone	PDR

Vehicle Properties	
Total Length (in)	96
Diameter (in)	6
Gross Lift Off Weigh (lb)	29.25
Airframe Material	Blue Tube
Fin Material	Fiberglass
Coupler Length (in)	6

Motor Properties	
Motor Designation	L
Max/Average Thrust (lb)	303/259
Total Impulse (lbf-s)	791
Mass Before/After Burn	8.1/3.9
Liftoff Thrust (lb)	1262
Motor Retention	Aft and fore closure screws

Stability Analysis	
Center of Pressure (in from nose)	71.293
Center of Gravity (in from nose)	57.236
Static Stability Margin	2.34
Static Stability Margin (off launch rail)	2.38
Thrust-to-Weight Ratio	8.839
Rail Size and Length (in)	96
Rail Exit Velocity (ft/s)	67.4

Ascent Analysis	
Maximum Velocity (ft/s)	747
Maximum Mach Number	0.66
Maximum Acceleration (ft/s^2)	300
Target Apogee (From Simulations)	5697
Stable Velocity (ft/s)	45.25
Distance to Stable Velocity (ft)	4

Recovery System Properties			
Drogue Parachute			
Manufacturer/Model	Fruity Chutes		
Size	24'' Elliptical		
Altitude at Deployment (ft)	5280		
Velocity at Deployment (ft/s)	0		
Terminal Velocity (ft/s)	66.891		
Recovery Harness Material	Tubular Kevlar		
Harness Size/Thickness (in)	1/2''		
Recovery Harness Length (ft)	20		
Harness/Airframe Interfaces	U-Bolt of Boosters, Top and Bottom Quicklinks of L2 Tender Descender		
Kinetic Energy of Each Section (Ft-lbf)	Section 1	Section 2	
	Booster	avionics and payload	
	798.463	943.72	

Recovery System Properties				
Main Parachute				
Manufacturer/Model	Fruity Chutes; Iris Ultra Compact			
Size	72'' Toroidal			
Altitude at Deployment (ft)	1000			
Velocity at Deployment (ft/s)	66.891			
Terminal Velocity (ft/s)	13.988			
Recovery Harness Material	Tubular Kevlar			
Harness Size/Thickness (in)	1/2''			
Recovery Harness Length (ft)	20 (2x)			
Harness/Airframe Interfaces	U-Bolt of Avionics Bay, Bottom Quicklink of L2 Tender Descender			
Kinetic Energy of Each Section (Ft-lbs)	Section 1	Section 2		
	booster	avionics		
	34.918	12.416		

Recovery Electronics	
Altimeter(s)/Timer(s) (Make/Model)	Perfectflite Stratologger CF Missileworks RRC3
Redundancy Plan	Having two different altimeters that can both launch the drogue and main chutes
Pad Stay Time (Launch Configuration)	2 hours

Recovery Electronics	
Rocket Locators (Make/Model)	Eggfinder GPS System
Transmitting Frequencies	***Required by CDR***
Black Powder Mass Drogue Chute (grams)	2.97 g
Black Powder Mass Main Chute (grams)	0.2 g

Institution	University of California Berkeley

Milestone	PDR

Payload	
Payload 1	Overview
	SAGITTA-VL is designed to execute a “Target Detection and Upright Landing” experiment using an onboard camera housed in the upper airframe and nose cone to identify and distinguish between three differently colored 40 ft. square tarps. The upper airframe section is then ejected, and landed under its own recovery system, deploying legs built into the airframe wall in order to land on the ground upright. The purpose of this experiment is to verify the capability to examine and differentiate features of the landing zone in order to verify safe landing sites or potential ground hazards, and perform an upright landing of a reusable payload.

Test Plans, Status, and Results	
Ejection Charge Tests	Have not yet been scheduled. Planning is in progress and first test will occur 1-2 weeks before first sub-scale test flight.
Sub-scale Test Flights	Scheduled for December 3rd at Livermore Unit NAR (LUNAR). Alternate/back-up launch date scheduled for December 17th at Fresno TRA.
Full-scale Test Flights	Scheduled for February 4th at Livermore Unit NAR (LUNAR). Alternate/back-up launch date scheduled for February 18th at Fresno TRA.