Critical Design Review (CDR) Presentation

AIAA OC Section 2018-2019
January 7, 2018

Contents

Launch Vehicle

Final Launch Vehicle and Payload Dimensions

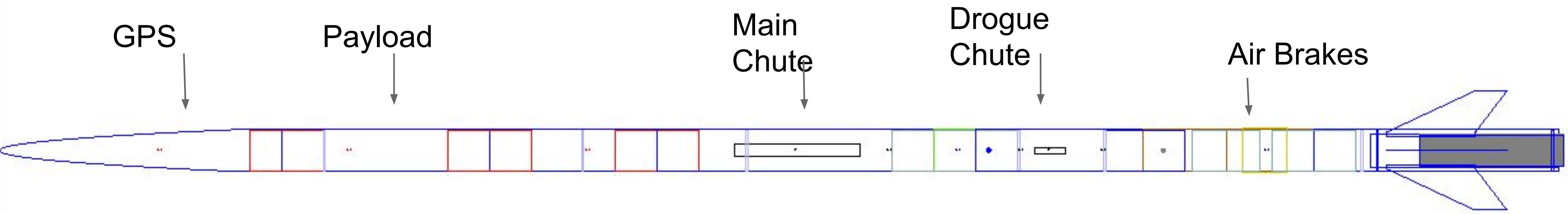
Length: 149.325 inches

Diameter: 4 inches

Semi-Span of Fins: 3.25 in

Total Mass: 11.074951 kg

Motor Choice: Cesaroni K1085WT



Key Features

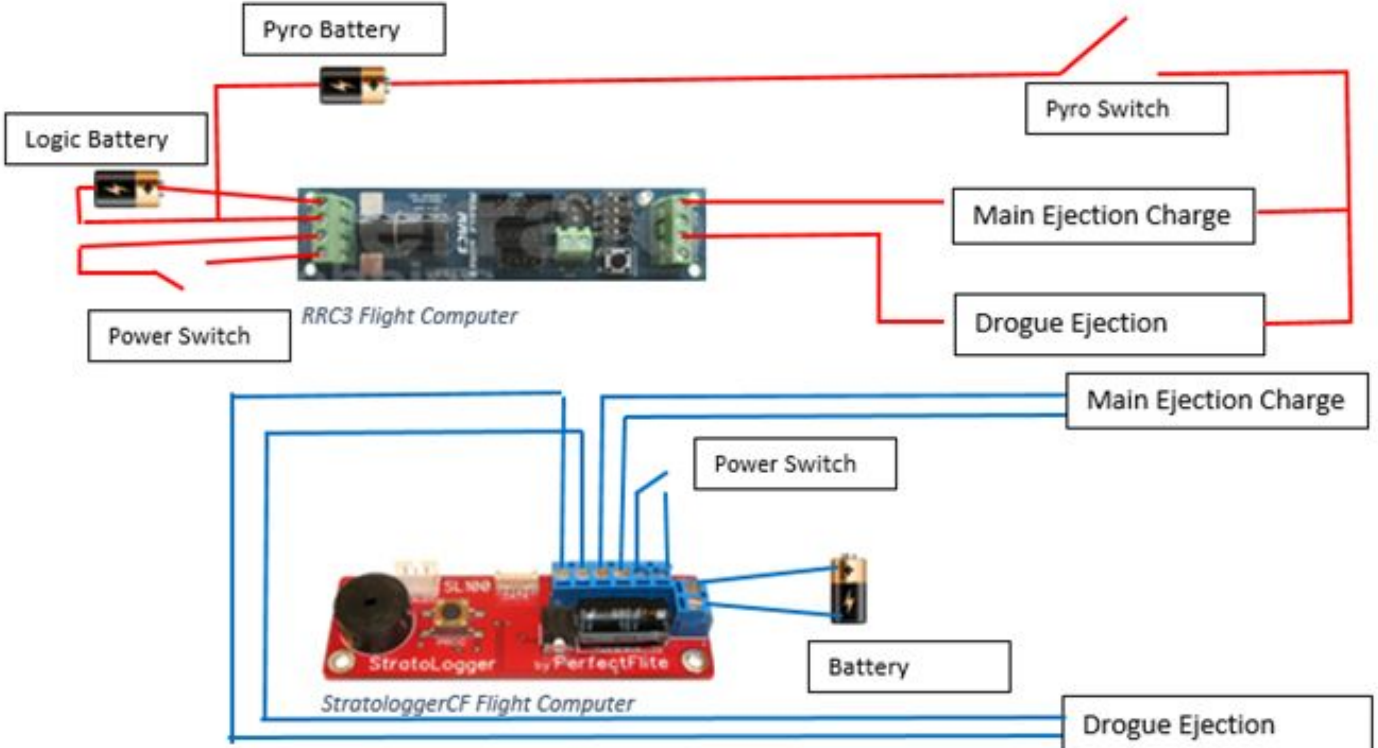
Key Design Features of Launch Vehicle

- Avionics
  - Redundant Dual Deploy System
- Payload
- Air Brakes

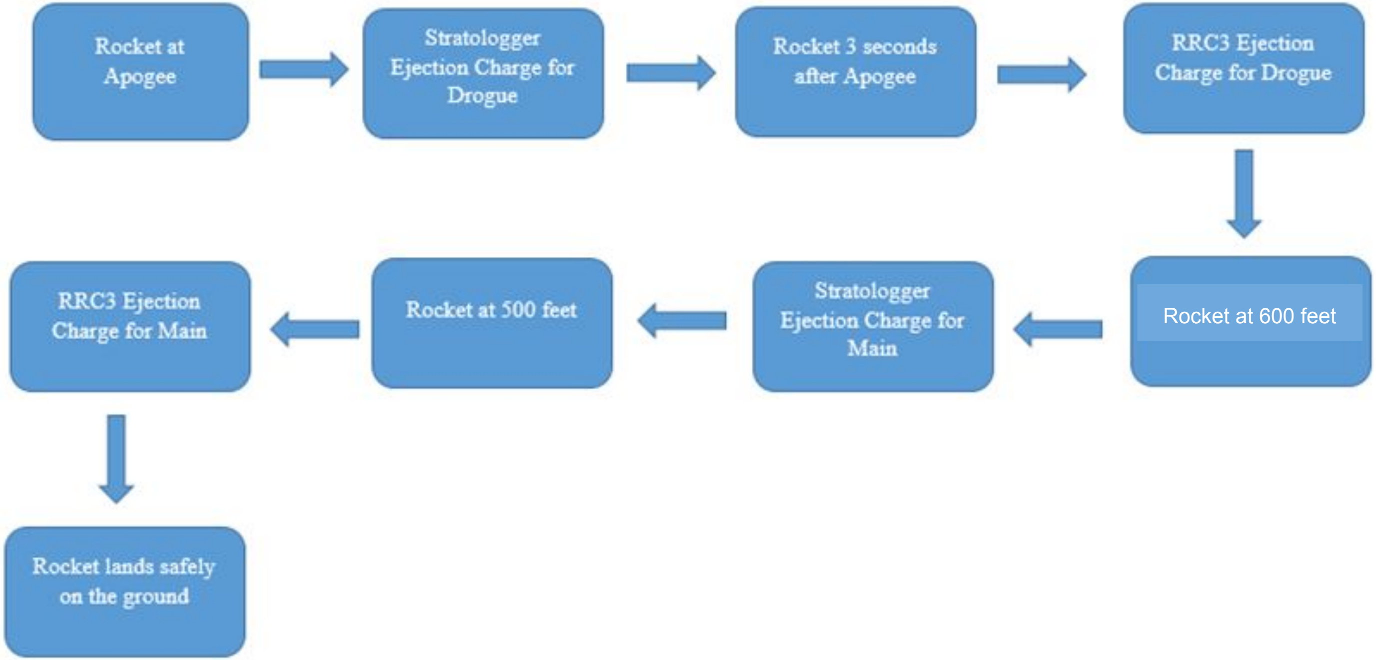
Key Design Features of Avionics

- Stratologger CF (primary)
- RRC3 (backup)
- 2 9V batteries
- 4 Terminals in the bulkheads
  - 2 for main Stratologger and main RRC3
  - 2 for drogue Stratologger and drogue RRC3

Proof of Redundancy



Recovery Algorithm Flowchart



Key Design Features of Payload

- Piston Release Mechanism (now released from the nose cone)
- Rover that will be manually released using RC control

Release Mechanism

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A track linear actuator that moves a piece along the track.
Pros:
- Small but still provides enough force.
Cons:
- Harder to implement and need modification.
Decision: Chosen because of its size and weight, and easier to modify.
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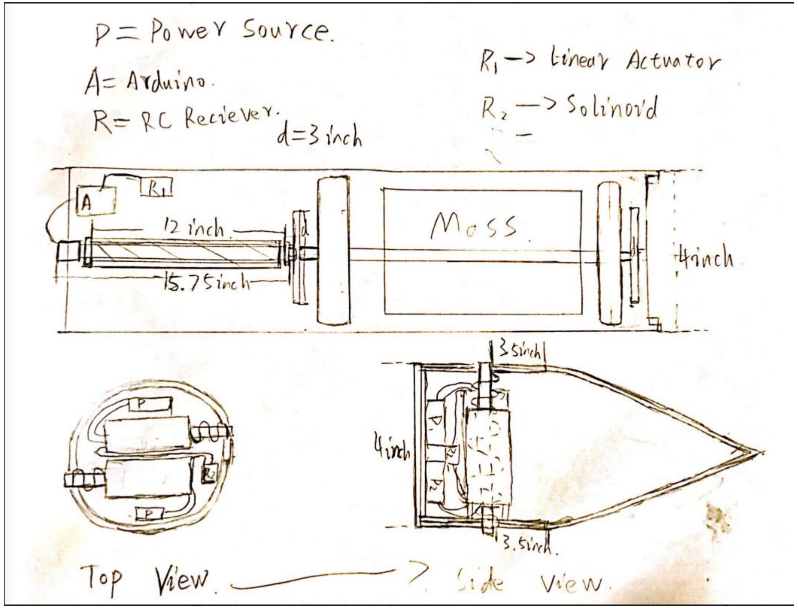
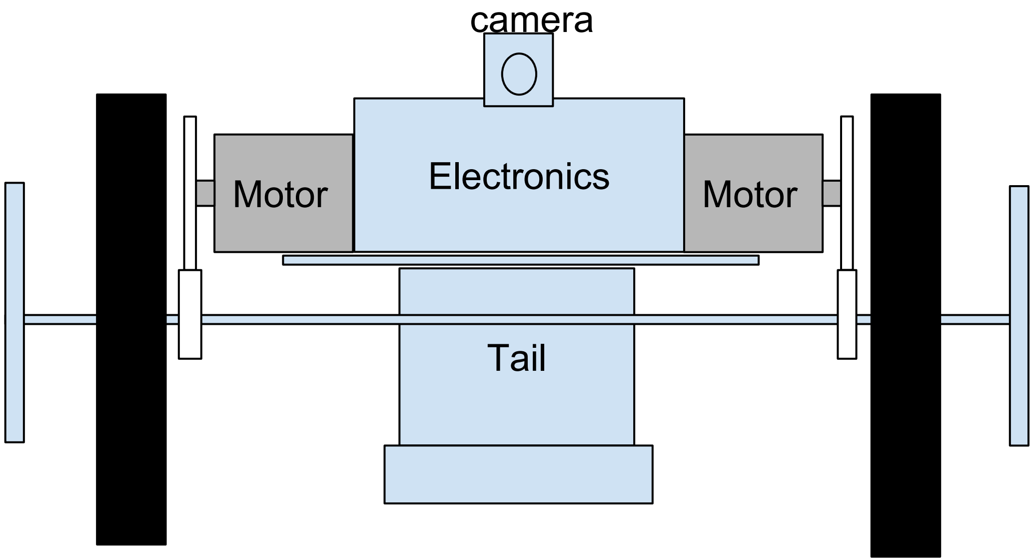


Payload Design

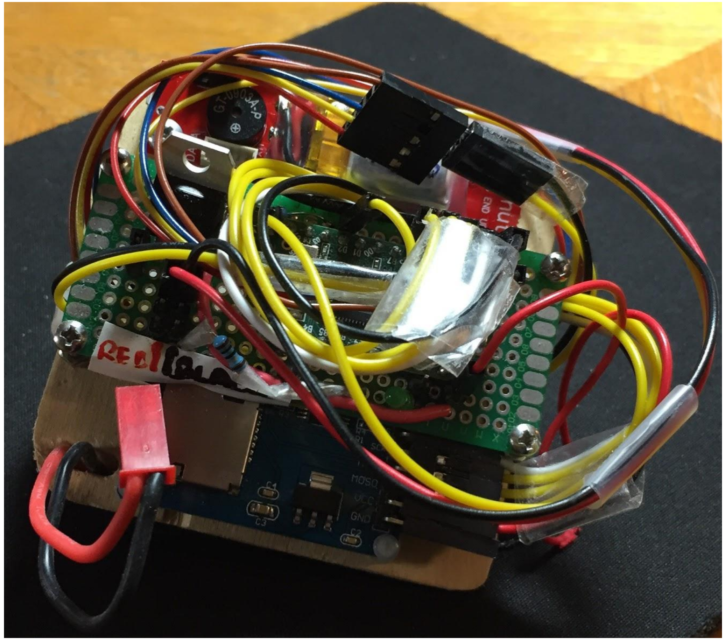
Longer rover body
Pros: more gaps between bottom and top of wheels and the body, allowing for overcoming obstacles
Cons: Requiring more space in the rocket for the payload section

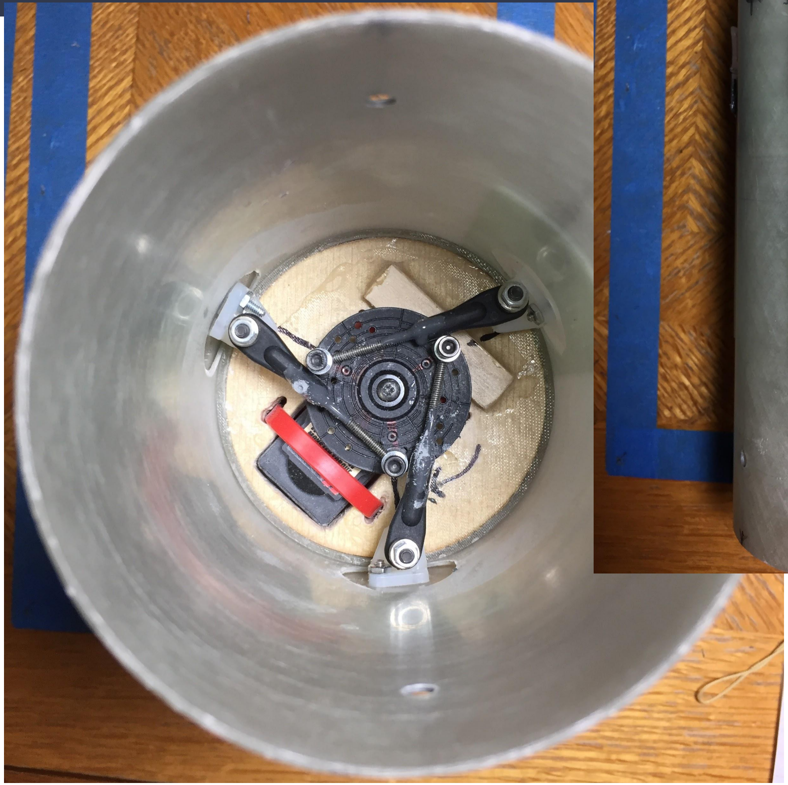


Key Design Features of Air Brakes

- Servo Design

Air Brakes

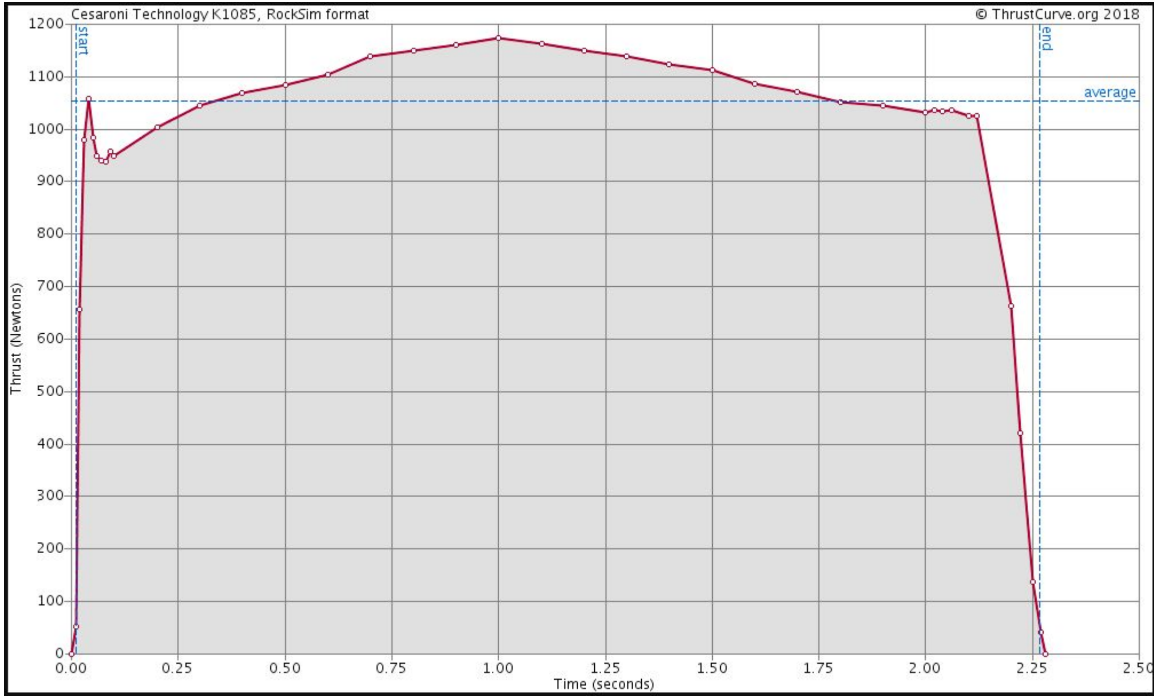




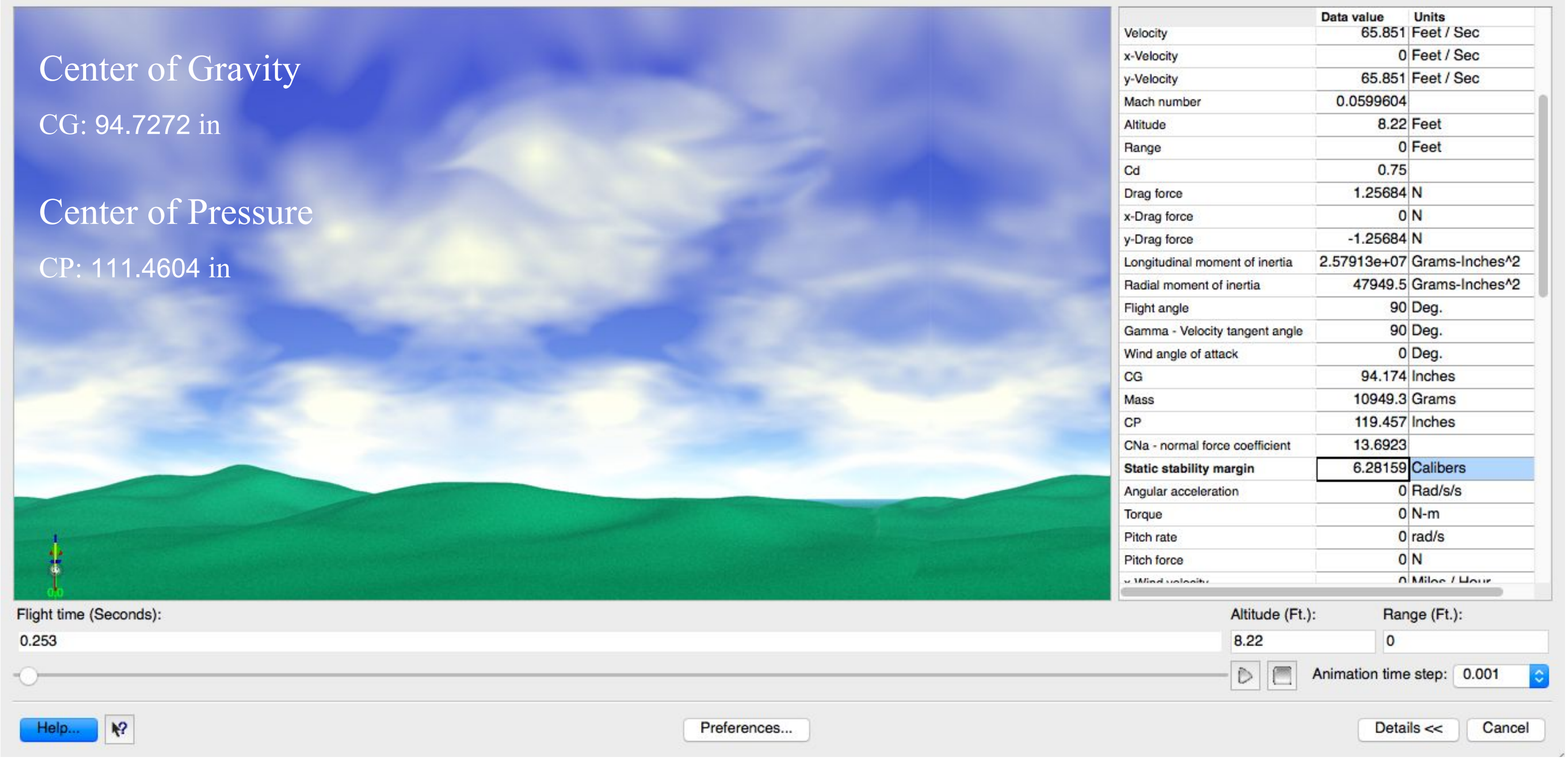
Motor and Stability

Final Motor Choice

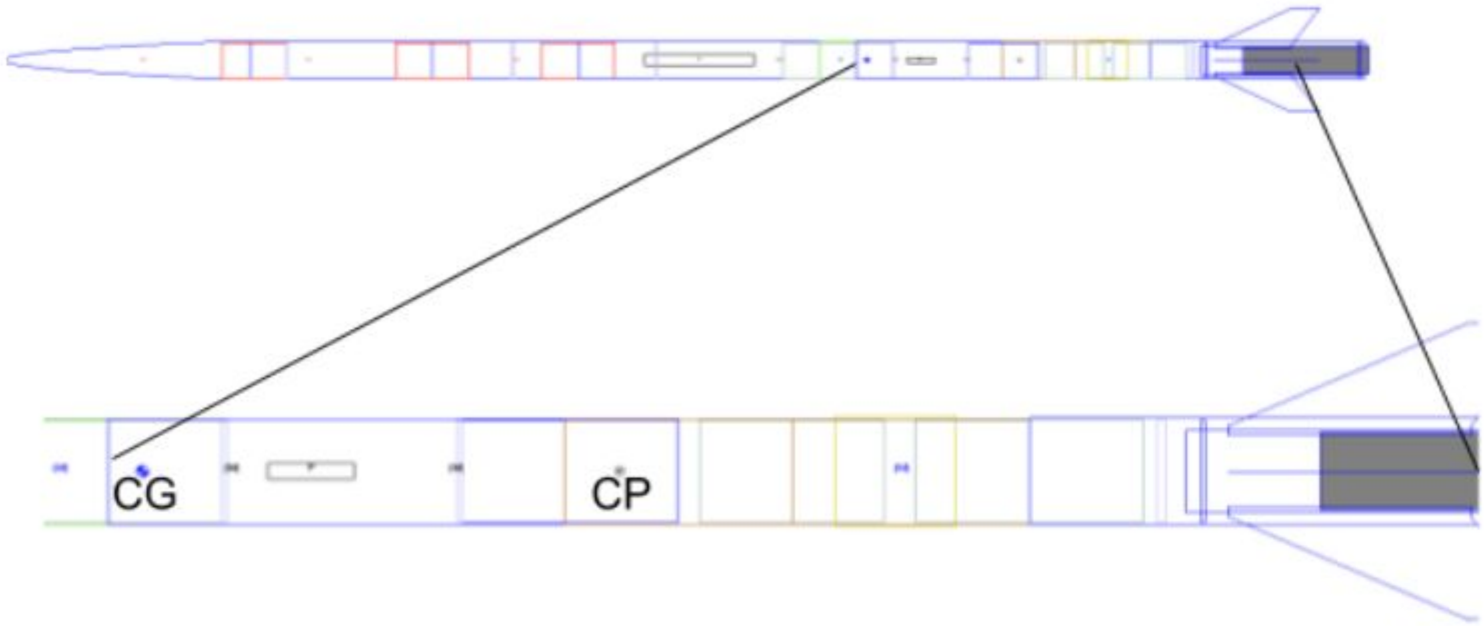
- Cesaroni K1085WT



Rocket Flight Stability in Static Margin Diagram



Rocket Flight Stability in Static Margin Diagram

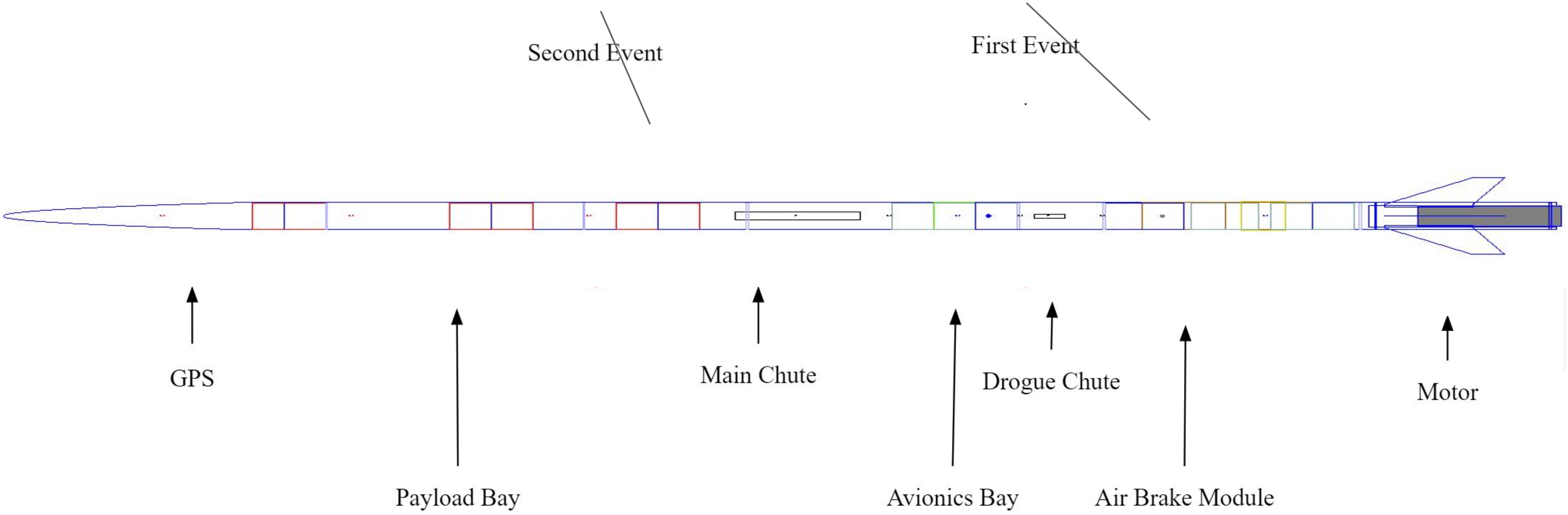


Thrust-to-Weight Ratio and Rail Exit Velocity

Thrust:Weight = 1:10.74

Rail Exit Velocity = 65.851 ft/s

Mass Objects and Separation Points



Recovery

Parachute Sizes, Recovery Harness Type, Size, Length, and Descent Rates

Recovery System Properties - Drogue Parachute	
Manufacturer/Model	Fruity Chutes
Size or Diameter (in or ft)	18"
Main Altimeter Deployment Setting	Apogee
Backup Altimeter Deployment Setting	1 seconds after Apogee
Velocity at Deployment (ft/s)	0 ft/s (main) 75.582 ft/s (Backup)
Terminal Velocity (ft/s)	95.244
Recovery Harness Material, Size, and Type (examples - 1/2 in. tubular Nylon or 1 in. flat Kevlar strap)	1" Tubular Nylon
Recovery Harness Length (ft)	25 ft
Harness/Airframe Interfaces	Machine-closed stainless steel eye bolts, tubular nylon shock cord

Recovery System Properties - Main Parachute	
Manufacturer/Model	Fruity Chutes
Size or Diameter (in or ft)	72"
Main Altimeter Deployment Setting (ft)	600
Backup Altimeter Deployment Setting (ft)	500
Velocity at Deployment (ft/s)	95.244
Terminal Velocity (ft/s)	21.388
Recovery Harness Material, Size, and Type (examples - 1/2 in. tubular Nylon or 1 in. flat Kevlar strap)	1" Tubular Nylon
Recovery Harness Length (ft)	25 ft
Harness/Airframe Interfaces	Machine-closed stainless steel eye bolts, tubular nylon shock cord

Calculations

Kinetic Energy

Kinetic Energy of Each Section (Ft-lbs) (**Drogue**)	Section 1	Section 2	Section 3
	819.86	323.57	1027.93

Kinetic Energy of Each Section (Ft-lbs) **(Main)**	Section 1	Section 2	Section 3
	34.63	13.67	43.4

Predicted Drift

3.4.8.1 0 MPH Wind

[(1 second82.43 feet)(4600-600 ft)+(1 second16.94 feet)(600 ft)] (0 miles1 hour)(5280 feet1 mile)(1hour3600 seconds) =**0 ft**

3.4.8.2 5 MPH Wind

[(1 second82.43 feet)(4600-600 ft)+(1 second16.94 feet)(600 ft)] (5 miles1 hour)(5280 feet1 mile)(1hour3600 seconds) =**615.597755 ft**

3.4.8.3 10 MPH Wind

[(1 second82.43 feet)(4600-600 ft)+(1 second16.94 feet)(600 ft)] (10 miles1 hour)(5280 feet1 mile)(1hour3600 seconds) =**1231.19551 ft**

3.4.8.3 15 MPH Wind

[(1 second82.43 feet)(4600-600 ft)+(1 second16.94 feet)(600 ft)] (15 miles1 hour)(5280 feet1 mile)(1hour3600 seconds) =**1846.793265 ft**

3.4.8.4 20 MPH Wind

[(1 second82.43 feet)(4600-600 ft)+(1 second16.94 feet)(600 ft)] (20 miles1 hour)(5280 feet1 mile)(1hour3600 seconds) = **2462.39102 ft**

Test Plans and Procedures

Recovery Preparation Checklist	
	Replace the battery, then ziptie them • **Risk**: Battery falls out
	Attach the wires according to color (green to green, white to white, etc) • **Risk**: Drogue or main is ejected at the wrong time • **Note**: Attach orange and green wires first, and have orange, green, blue, and yellow in the same side. • **Note**: The bulkhead with blue and yellow is at the bottom, and the bulkhead with white and purple is at the top.
	Unlock the keys for stratologger and check the beeps according to key card • **Risk**: What if something is wrong with the stratologger?
	Unlock the keys for RRC3 and check the beeps according to key card • **Risk**: What if something is wrong with the RRC3?
	Attach ejection charges • **Risk**: Parachutes don't eject • **PPE**: goggles

** Mr. Koepke (our mentor) will be building the K1085 Motor.

Motor

Setup on Launcher Checklist	
	Tilt the rail back ● **Risk**: Beware of not catching it before it falls too fast! Lower it slowly so the launchpad and people aren’t damaged. ● **Note:** If necessary, use hard hats.
	Mount the rocket and slide it all the way down. ● **Note:** Make sure the rail buttons align and are in the right place. Also check to make sure no screws conflict with the rail.
	Tilt the rail back up.
	Level the launch pad accordingly. ● **Note:** The rocket must not point toward people in the proximity of the launchpad.

Igniter Installation Checklist ****Mr. Koepke (mentor) will be inserting the igniter**	
	Twist the igniter leads. ● **Risk**: Accidental ignition can damage rocket during launch if the rocket is not fully set up and poses a risk to Student Launch members. Twist the leads! ● **Note:** Wear clothing that does not generate static electricity. An accidental discharge of static electricity may cause the igniter to ignite. This is much more dangerous around the black powder charges.
	Mark how far up the igniter should be prior to installation ● **Risk**: The rocket will not launch even if the igniter goes off. ● **Note**: The igniter must be as far up the motor as possible in order to have contact with the solid fuel.
	Install the rocket on the launch pad and arm the avionics before placing the igniter. ● **Risk**: accidental ignition when transporting the rocket, which can lead to injuries and rocket damage
	Coil the igniter after it is pushed in all the way. ● **Risk**: The igniter must be as far up the motor as possible in order to have contact with the solid fuel. ● **Note**: The coil will help maintain how far the igniter is inside the motor.
	Replace the plug ● **Risk**: The igniter will fall out and the rocket won’t launch
	Untwist igniter leads and attach the alligator clips. ● **Risk**: If skipped, the rocket will not launch.
	Check for continuity. ● **Risk**: If skipped, the rocket may not launch.

Igniter

Post-Flight Inspection Checklist	
	Once the rocket has landed, approach carefully and inspect any major issues, dangers, or damages done to the rocket.
	Each team member should grab a section of the rocket or the parachute and bring back to the team table where the rocket was constructed.
	Hear the altitude of the rocket with the beeps from the avionics bay.
	Open avionics bay, payload bay, and airbrake module and check for any visible issues.
	Cut the power source and retrieve data from the rover and air brakes.
	Wrap the parachutes and place them back into the their respective body tubes to avoid damage.

Post Flight

Energetics Testing

Successful Black Powder Testing on 12/09

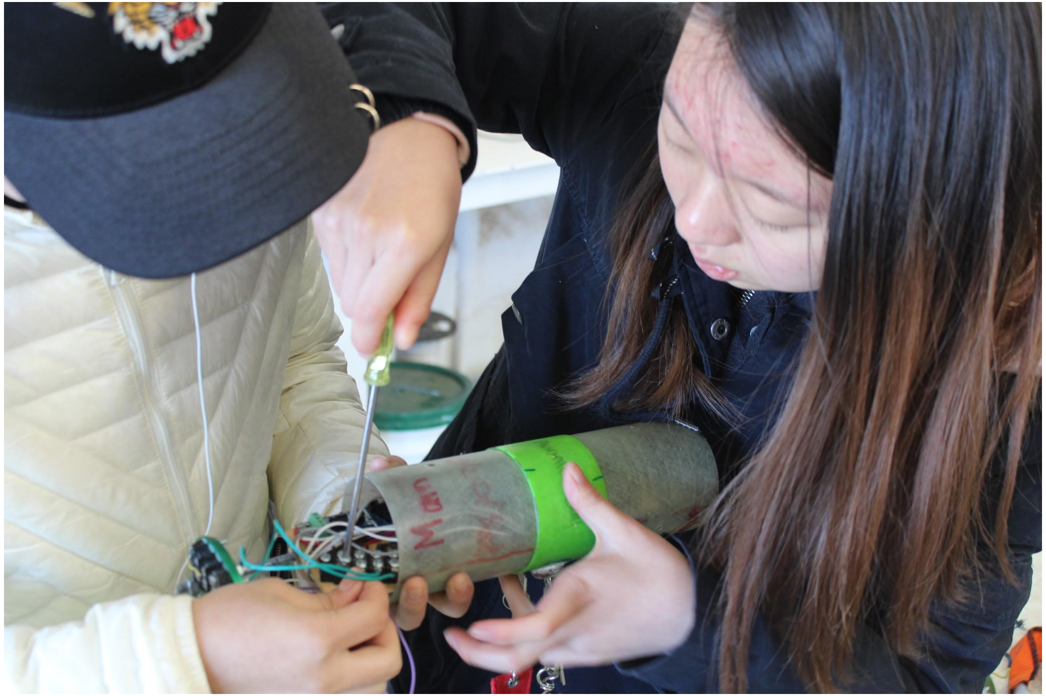
Scale Model Flight

Launch Results

Max Altitude: 3185 feet
Motor Used: CTI J295

The success of the subscale indicates that the omission of the aft fins will work well.

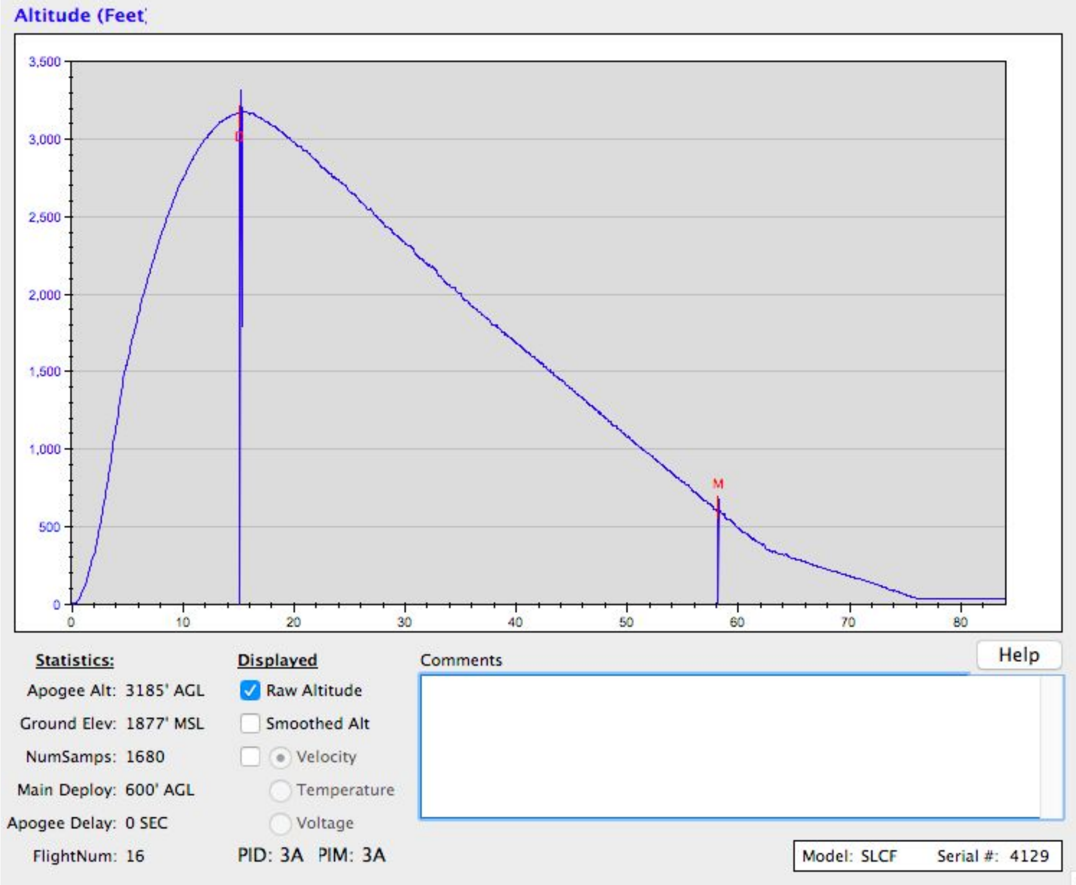
Due to safety concerns with the avionics, the launch was postponed to January 5th



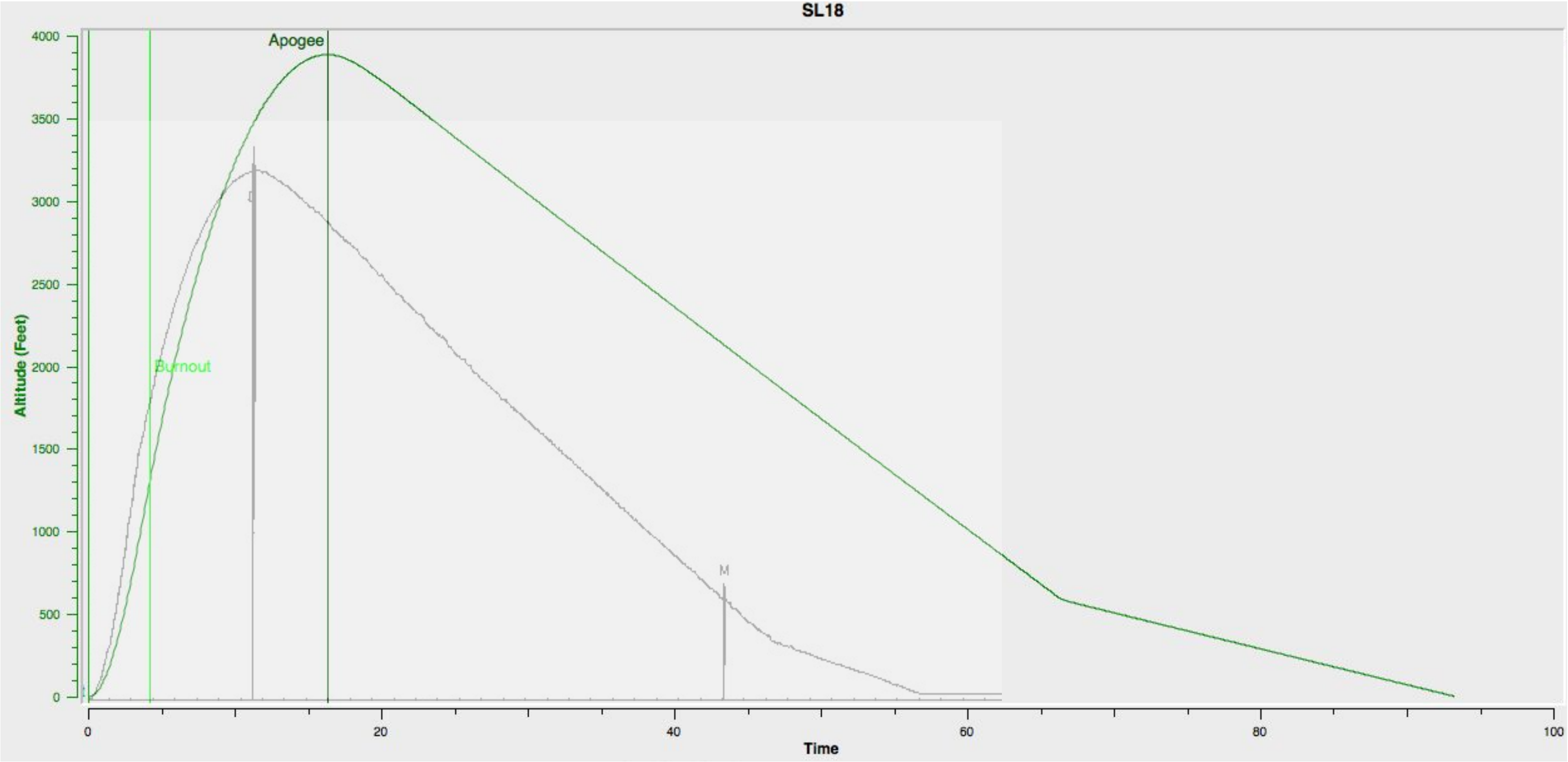
Launch Day Attempt 1




Launch Day Attempt 2


Altitude (Feet)
3,500
3,000
2,500
2,000
1,500
1,000
500
0
0
10
20
30
40
50
60
70
80
D
M
Statistics:
Apogee Alt: 3185' AGL
Ground Elev: 1877' MSL
NumSamps: 1680
Main Deploy: 600' AGL
Apogee Delay: 0 SEC
FlightNum: 16
Displayed
Raw Altitude
Smoothed Alt
Velocity
Temperature
Voltage
PID: 3A PIM: 3A
Comments
Help
Model: SLCF Serial #: 4129

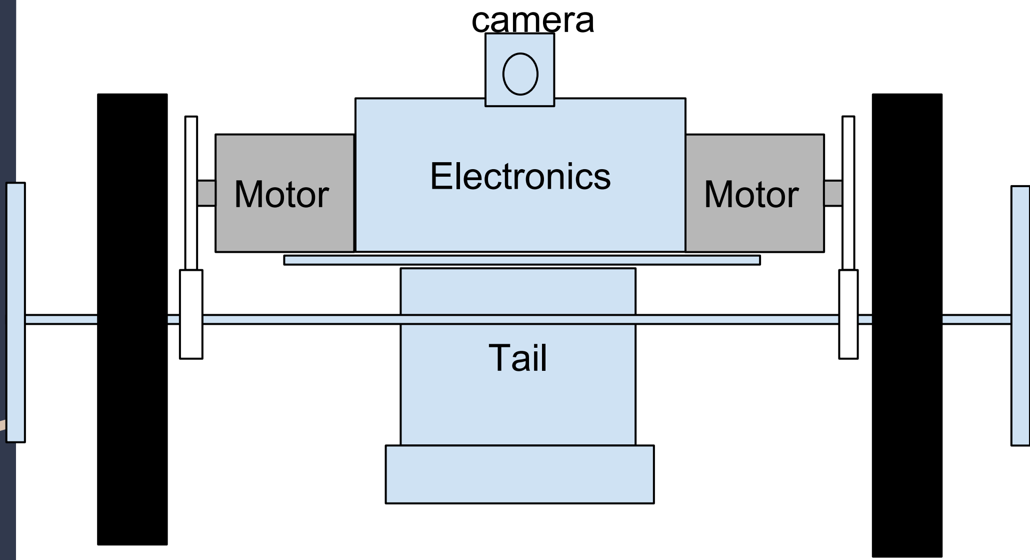
Flight Data



Comparison of Predicted and Actual Flight Models

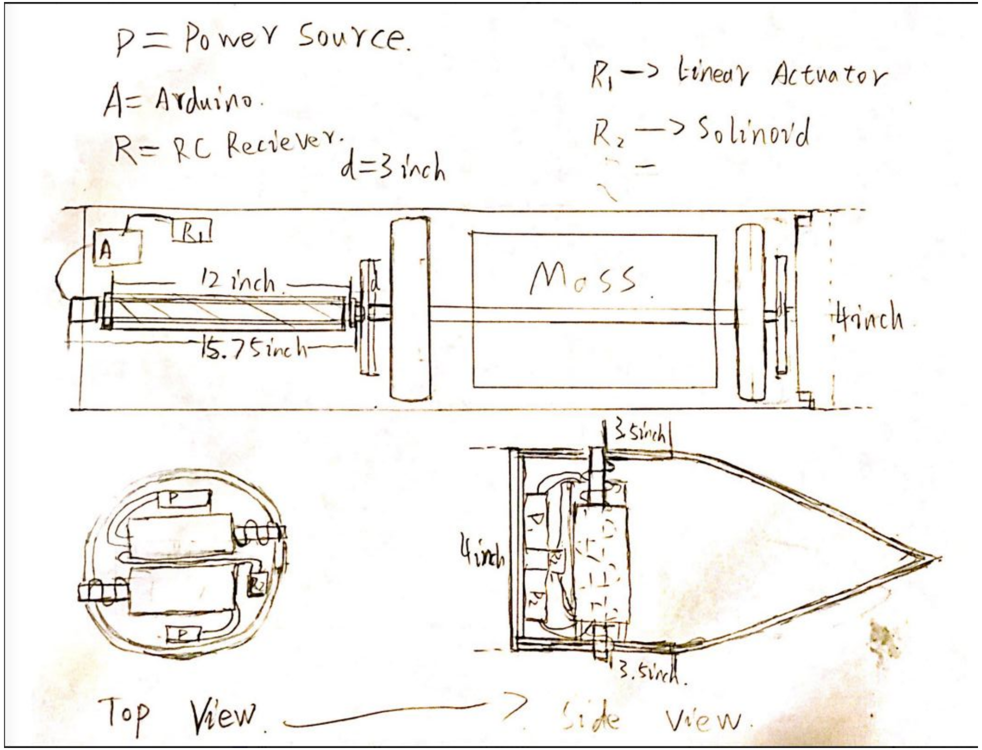
Final Payload Overview

Final Payload Design Overview



Payload Integration Plans

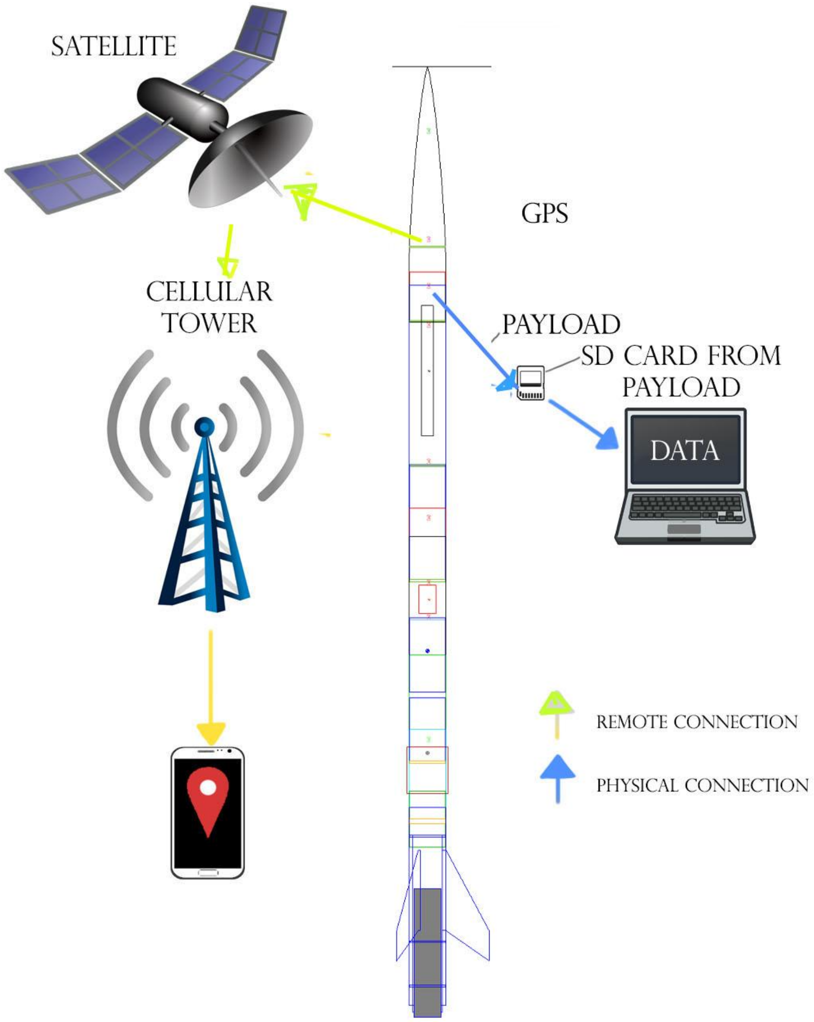
The rover will be secured with the solenoid acting as a pin to connect the nose cone and the payload body tube.



Interfaces

Interfaces

- Internal
  - Air Brakes
  - Avionics
  - Payload
- External
  - GPS and smartphone
  - Igniter



Requirement Verification

Vehicle Verification

To test the vehicle, we performed a series of analyses to ensure that it works properly. To make sure that the rocket is designed properly, we placed the design in RockSim 9 to predict the rocket's behavior, such as its velocity at rail exit. We also calculated the drift of the design, its kinetic energy at which it lands, and its stability margin.

If the rocket was unable to perform correctly in simulation or fails to meet the SL requirements for safe ascent and descent, we continued adjusting the rocket until it reached SL requirements.

Recovery Verification

Stratologger CF

Present number - 1 through 9

Main Deploy Altitude

Long beep if Apogee delay set

Altitude of last flight (Warble = Power lost)

Battery Voltage

Continuity beeps (repeats every 0.8 seconds)

- Zero beeps = no continuity
- One beep = Drogue OK
- Two beeps = Main OK
- Three beeps = Drogue + Main OK

RRC3

5 second long beep (init mode)

10 second baro history init time (silence)

Battery Voltage

10 second launch commit test time (silence)

Launch Detect mode (continuity beeps)

- A long beep indicates no continuity on any event terminal.
- One short beep indicates continuity on only the drogue terminal.
- Two short beeps indicate continuity on only the main terminal.
- Three short beeps indicate continuity on the main and drogue terminals.

Safety

Safety Standards

The AIAA OC Section team will abide by all safety standards set by NASA and by the team.

Safety requirements may be found on the report, Section 4

Thank You