Georgia Tech NASA Preliminary Design Review Teleconference

Presented By:

Georgia Tech Team ARES

Agenda

1. Team Overview (1 Min)
2. Changes Since Proposal (1 Min)
3. Educational Outreach (1 Min)
4. Safety (2 Min)
5. Project Budget (2 Min)
6. Launch Vehicle (10 min)
7. AGSE & Flight Systems (13 Min)
8. Questions (15 Min)

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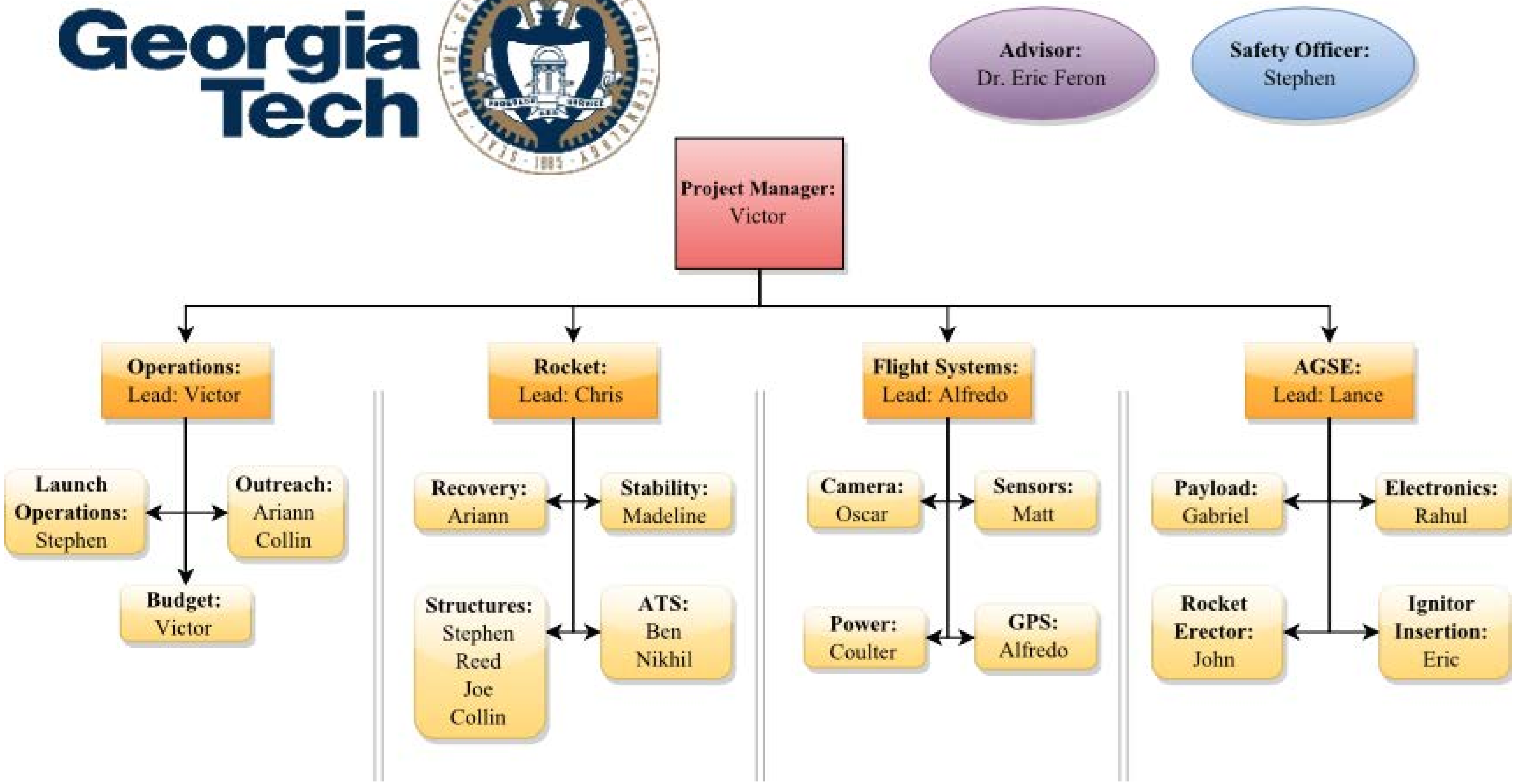
TEAM OVERVIEW

Georgia Tech Team Overview

- 19 person team composed of both undergraduate and graduate students
  - Graduate Students: 2
  - Undergraduates: 17
- Highly Integrated team across several disciplines

Work Breakdown Structure



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CHANGES SINCE PROPOSAL

Changes since Proposal

- Launch Vehicle
  - ATS Finalized Design, utilizing four push-pull solenoids to extend and retract the tabs
  - Drogue and main parachutes relocated
  - Opened possibility for a motor change from an L820 to an L990.
- Autonomous Ground Support Equipment
  - Switched from linear actuators to cable and spool system
  - New robotic arm claw design
  - Narrower base
- Flight Systems
  - No changes
- Project Plan
  - No changes

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EDUCATIONAL OUTREACH

Educational Outreach

- **Atlanta Maker’s Faire**
- **FIRST Lego League**
- **CEISMC GT**

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SAFETY

Risk Assessment & Launch Vehicle

- Hazard Identification
  - What has the potential to become a safety hazard?
- Risk and Hazard Assessment
  - What are the potential consequences of the hazard?
- Risk Control and Mitigation
  - What can be done to mitigate the risk?
- Reviewing Assessments
  - Are the mitigations working?

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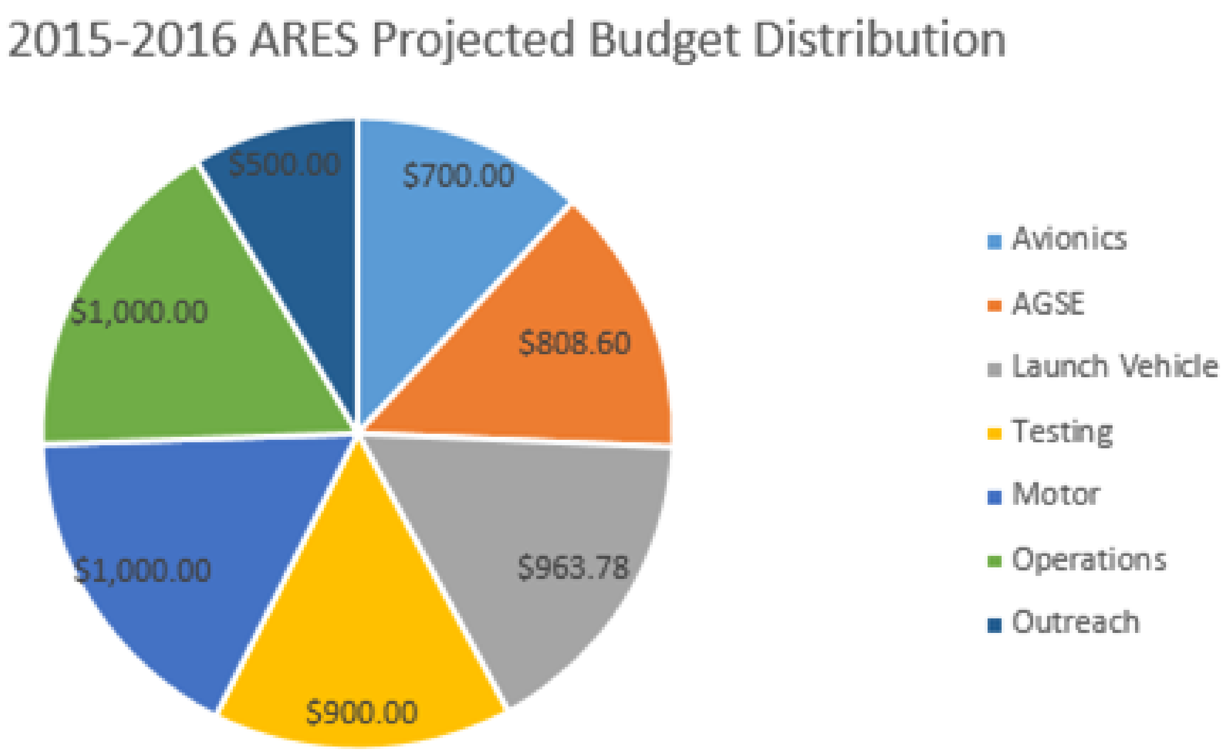
PROJECT BUDGET

Project Budget Summary

Section	*Cost*
Avionics	$700.00
AGSE	$808.60
Launch Vehicle	$963.78
Testing	$900.00
Motor	$1,000.00
Operations	$1,000.00
Outreach	$500.00
Total Budget	$5,872.38



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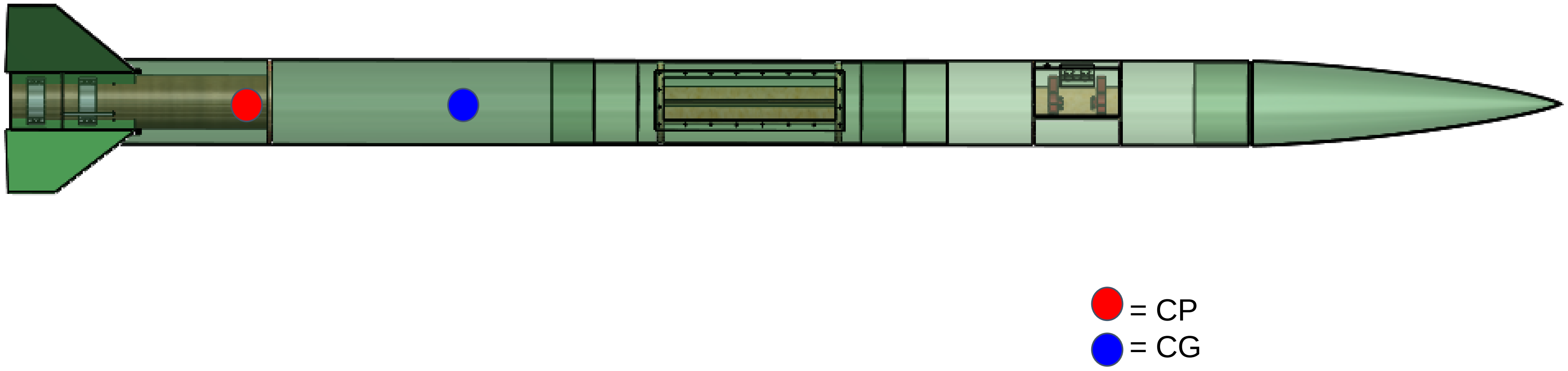
LAUNCH VEHICLE

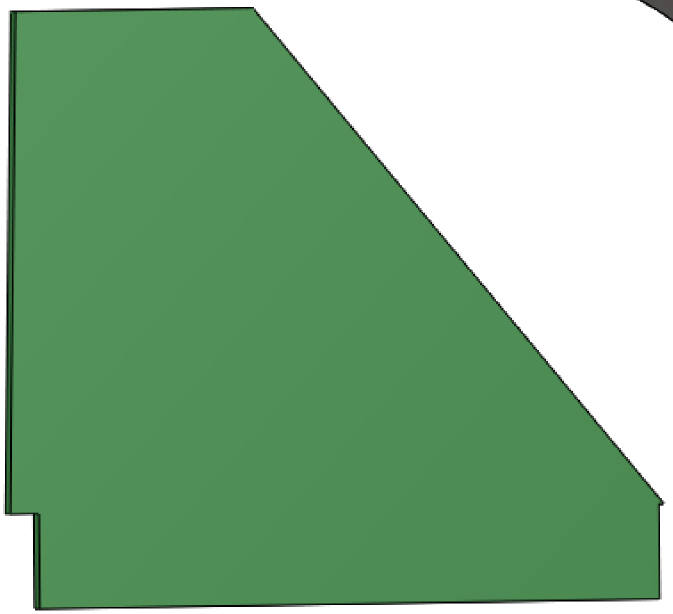
Launch Vehicle Summary

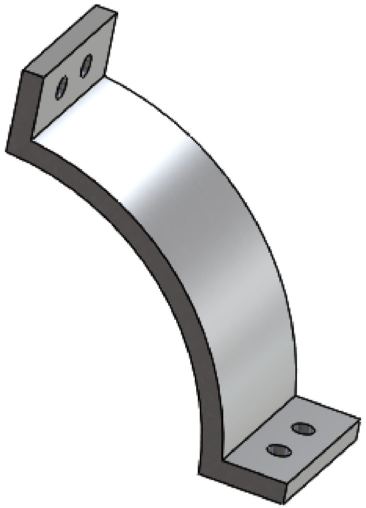
- Predicted apogee: 5280 ft
- Stability margin: 1.8 calibers
- Motor: Cesaroni L820
- CP = 184 cm

- Max Mach 0.72
- Total weight: 22.22
- Dual deployment
- CG = 160 cm



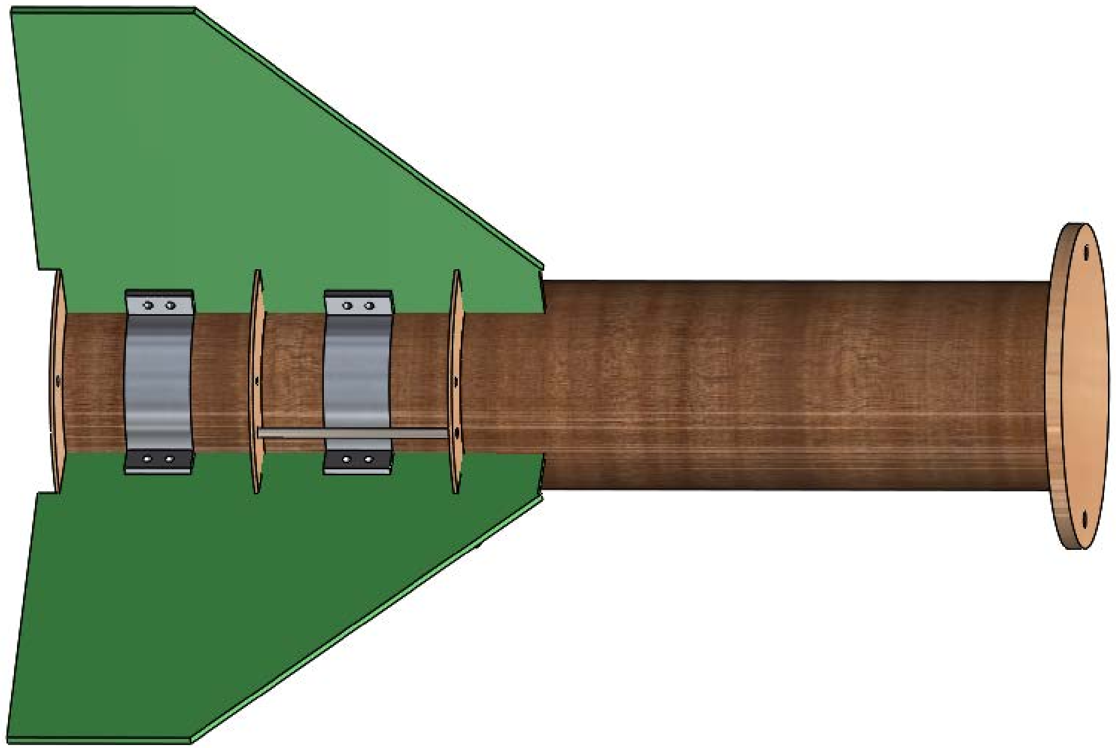
Fins





Variable	Unit
Speed of Sound, a	1105.26 ft/sec
Pressure, P	13.19 lb/in^2
Temperature, T	48.32 Fahrenheit
Shear Modulus, G	425,000 psi
Taper Ratio,	0.3627
Tip Chord	7 cm or 2.75591 in
Root Chord	19.3 cm or 7.598 in
Thickness	0.318 cm or 0.1252 in
Fin Area	55.23 in^2
Span	13.4 cm or 5.275591 in
Aspect Ratio	0.50392

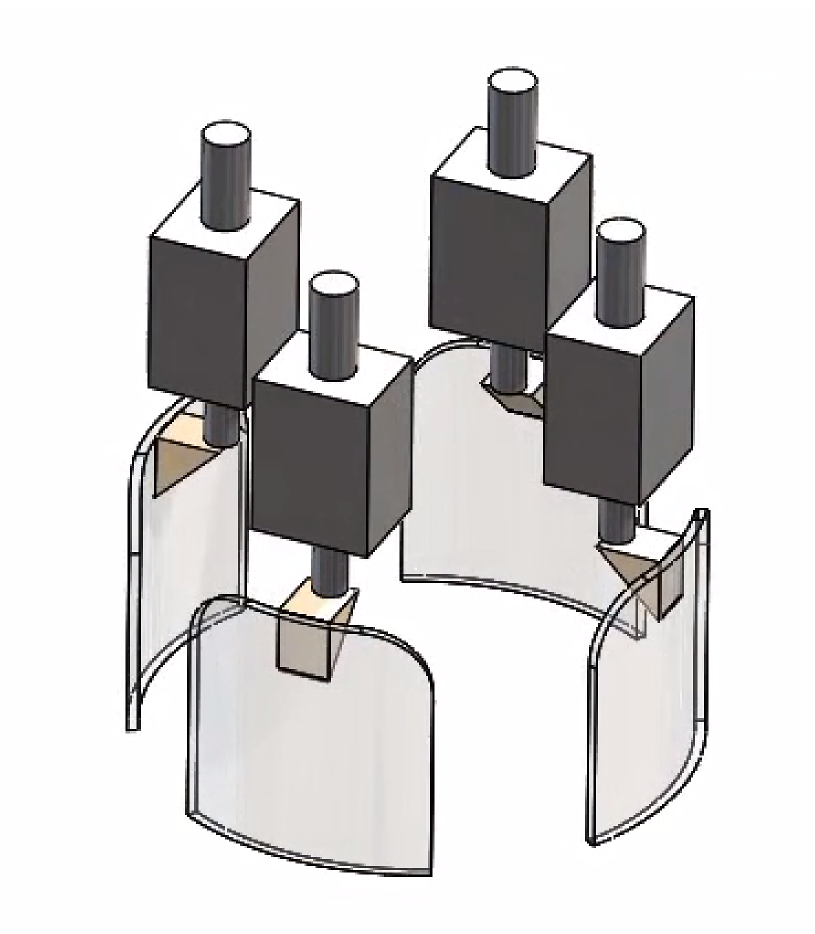
Booster Section



Materials:
Cardboard,
Plywood, Aluminum,
Fiberglass

Attachment: Nuts,
Bolts, Epoxy

Apogee Targeting System (ATS)



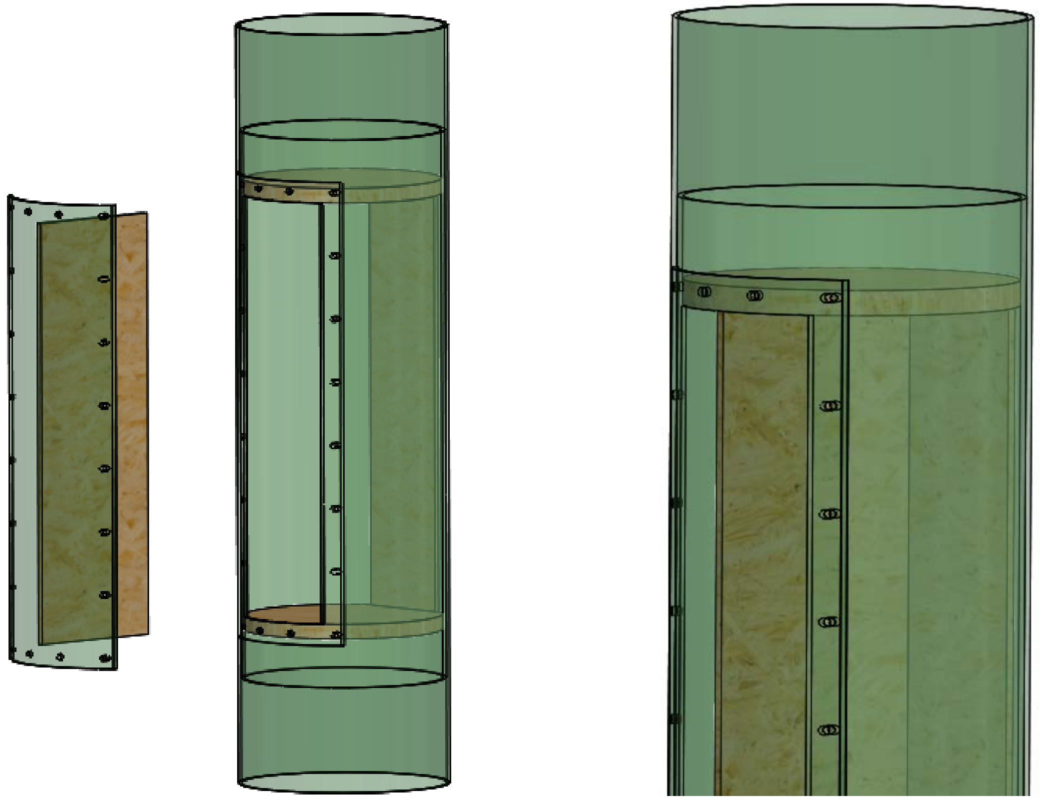
Materials:
Acrylic,
Aluminum,
Solenoids

Attachment:
Nuts, Bolts,
Brackets,
Hinges

Motor Selection

MOTOR NAME	Cesaroni L820	Cesaroni L990
DIAMETER	75mm	54mm
LENGTH	48.6cm	64.9cm
PROP WEIGHT	1.760kg	1.369kg
TOTAL WEIGHT	3.420kg	2.236kg
AVG THRUST	819.9N	991.0N
MAX THRUST	948.8N	1702.7N
TOTAL IMPULSE	2,945.6 N-s	2771.6
BURN TIME	3.6s	2.8s
PROPELLANT TYPE	Skidmark	Blue Streak

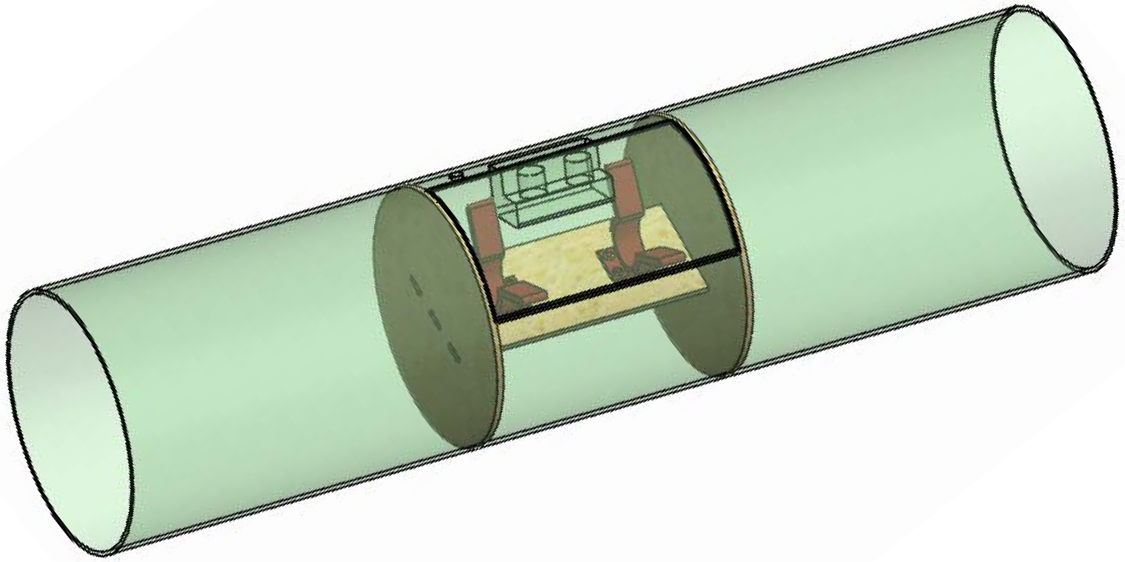
Avionics Bay



Materials:
Plywood,
Fiberglass

Attachment:
Screws, Nuts,
Epoxy

Payload Bay

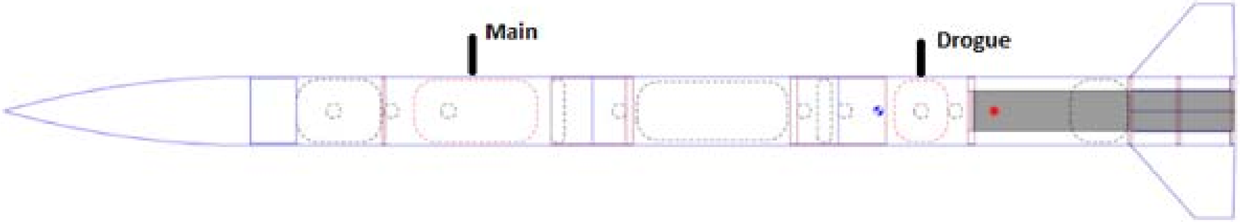


Materials:
Plywood,
Fiberglass,
Polycarbonate

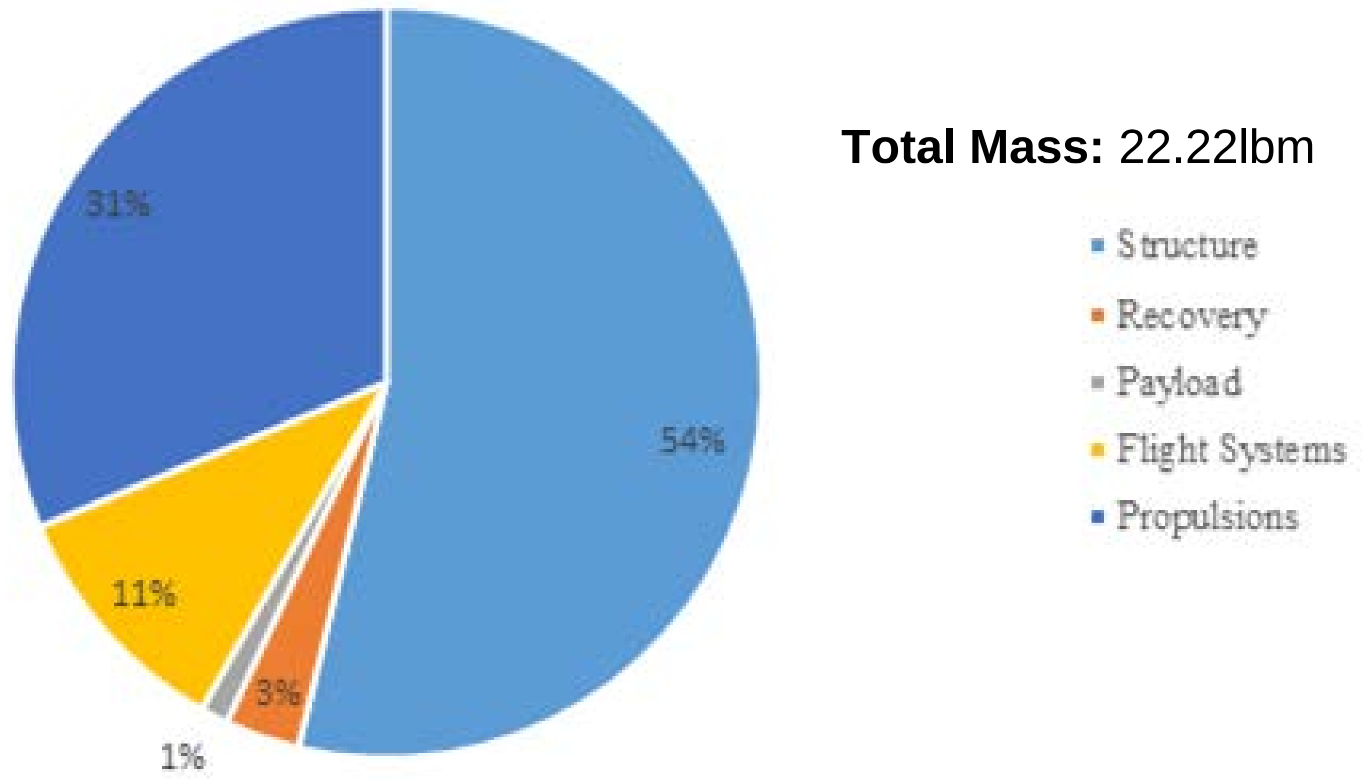
Attachment:
Epoxy, Nuts,
Screws

Recovery System

Requirement Number	Requirement Definition
2.1	The launch vehicle shall stage the deployment of its recovery devices in the following order, drogue parachute, main parachute
2.2	Teams must perform a successful ground ejection test for both the drogue and main parachute
2.3	At landing, each independent section's kinetic energy shall not exceed 75 ft-lbf
2.4	The recovery system electrical circuits shall be completely independent of any payload electrical circuits
2.5	The recovery system shall contain redundant, commercially available altimeters
2.6	A arming switch shall arm each altimeter, which is accessible from the exterior of the rocket airframe
2.7	Each altimeter shall have a dedicated power supply
2.8	Each arming switch shall be capable of being locked in the ON position for launch
2.9	Removable shear pins shall be used for both the main parachute compartment and the drogue parachute compartment
2.10	An electronic tracking device shall transmit the position of the rocket
2.11	The recovery system will by shielded from magnetic waves and all onboard devices, and placed in separate compartments within the vehicle



Mass Breakdown



Total Mass: 22.22lbm

Stability Calculation

Table 13: Terms and their Respective Values

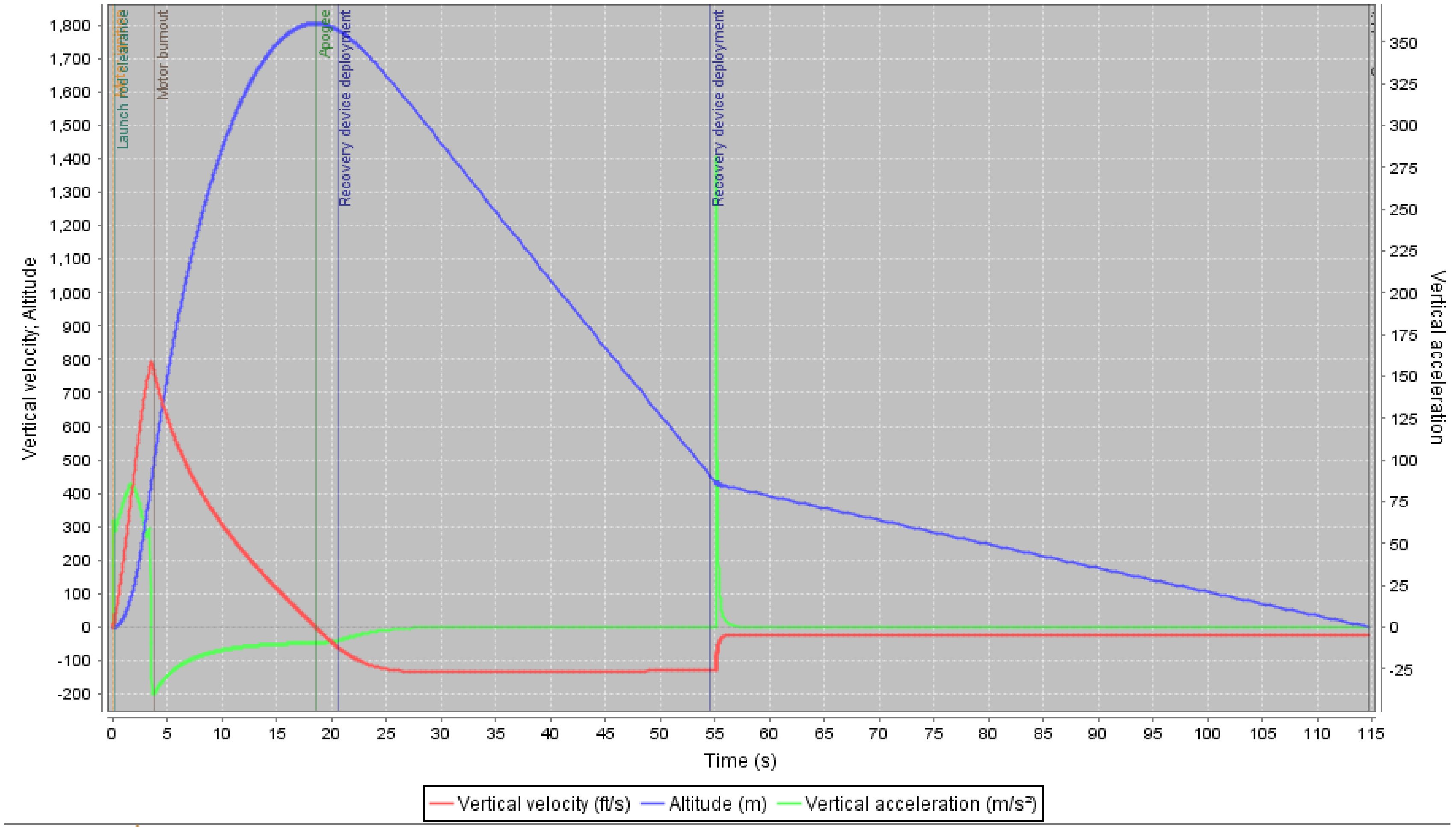
Term	Length (cm)
L_N	45.7
D	12.7
d_F	12.7
d_R	12.7
L_T	45.7
X_P	96.5
C_R	19.3

Term	Length (cm)
C_T	7.1
S	13.4
R	6.35
X_R	11.9
X_B	209.3
N	4 Fins

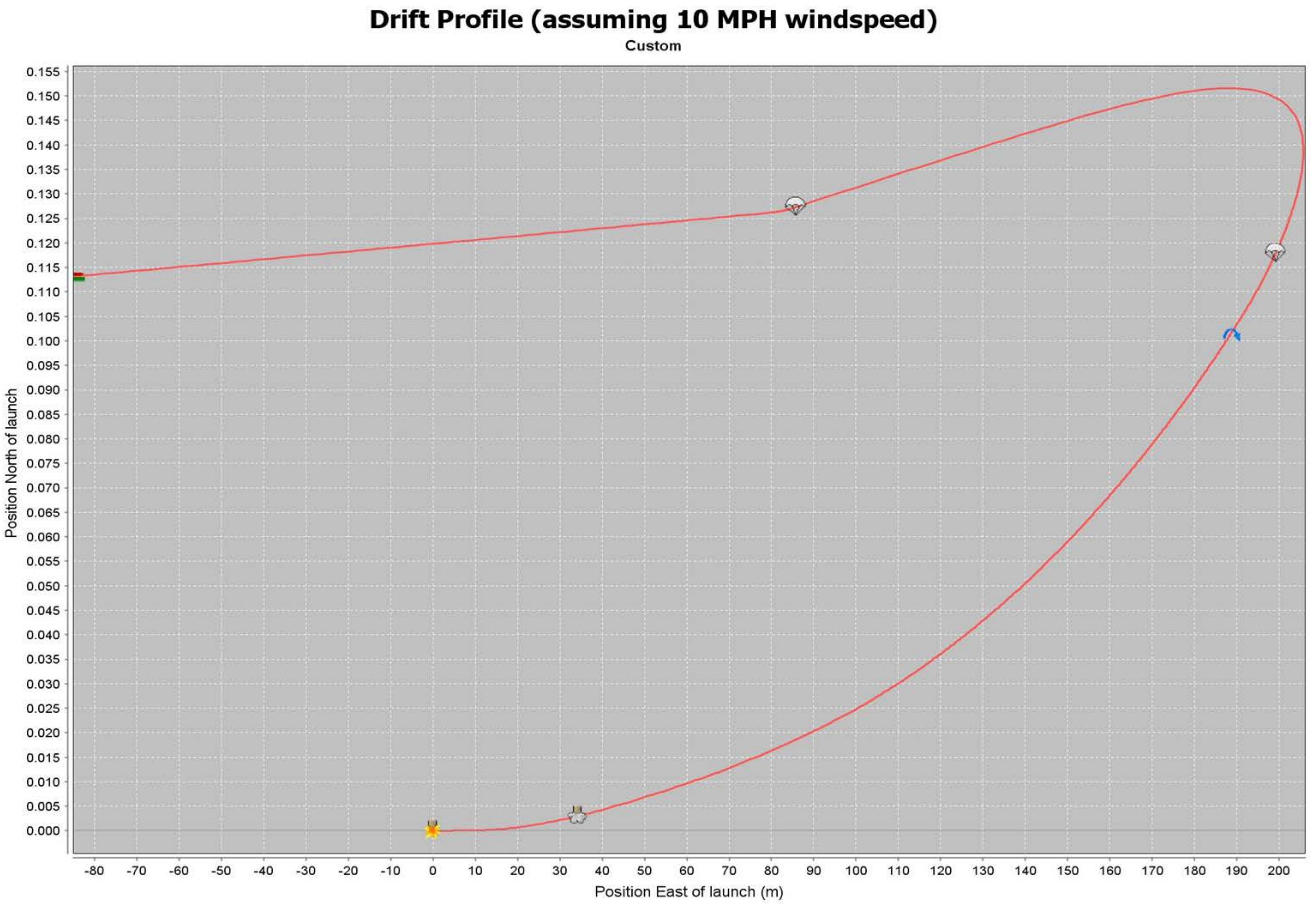
$$\bar{X} = \frac{(C_N)_N X_N + (C_N)_T X_T + (C_N)_F X_F}{(C_N)_R}$$

$$\bar{X} = 182.7957184 cm$$

Mission Performance – Flight Profile



Mission Performance - Drift Profile



Bird-eye view of Drift Profile

Test Plan Overview

- **Solenoids:** Extension force test
- **ATS:** Wind tunnel testing to confirm Cd simulations
- **Thrust Plate:** Bend test and pressure test to test rigidity
- **Payload Bay:** Payload retention force test
- **Avionics Bay:** Altimeter performance test
- **Recovery System:** Recovery system test fire
- **Fins:** Fin attachment robustness test

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FLIGHT SYSTEMS

Flight System Responsibilities

Outline of Success Criteria

Requirement	Design Feature to Satisfy Requirement	Requirement Verification	Success Criteria
The vehicle shall not exceed an apogee of 5,280 feet	Drag from the ATS system	Subscale flight test	Apogee within 1% of target
The vehicle will be tracked in real-time to locate and recover it	GPS module will be used in the vehicle and base station	Subscale flight test	The vehicle will be located on a map after it lands for recovery
The data of the vehicle's flight will be recorded	Sensors will save data into a memory card	Subscale flight test	The data will be recovered and readable after flight

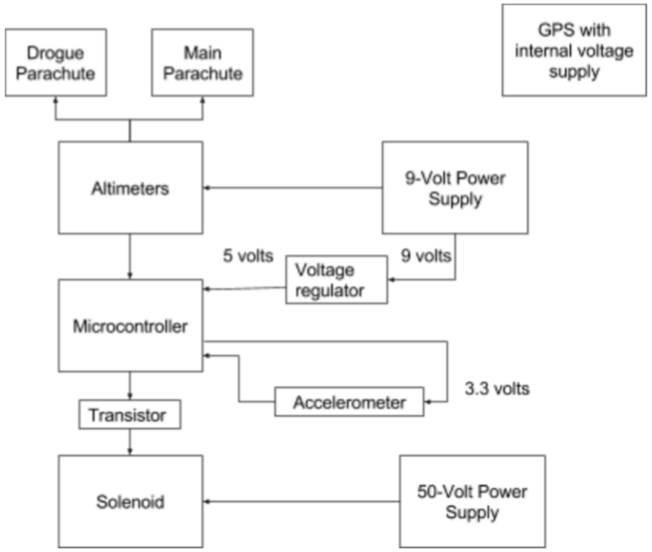
Flight Systems: Avionics

Avionics Components

Part	**Function**
Stratologger SL100	Altimeter - used to receive and record altitude
MMA8452Q	Accelerometer - used to receive and record acceleration
mbed LPC 1768	Microcontroller - used to receive sensor data to compute and control the ATS system
Eggfinder TX/RX Module	GPS module - used to track the rocket in real time
9V Alkaline Batteries	Used to power all Avionics components
3.7V Lithium-Polymer Batteries	High discharge batteries used for the solenoids

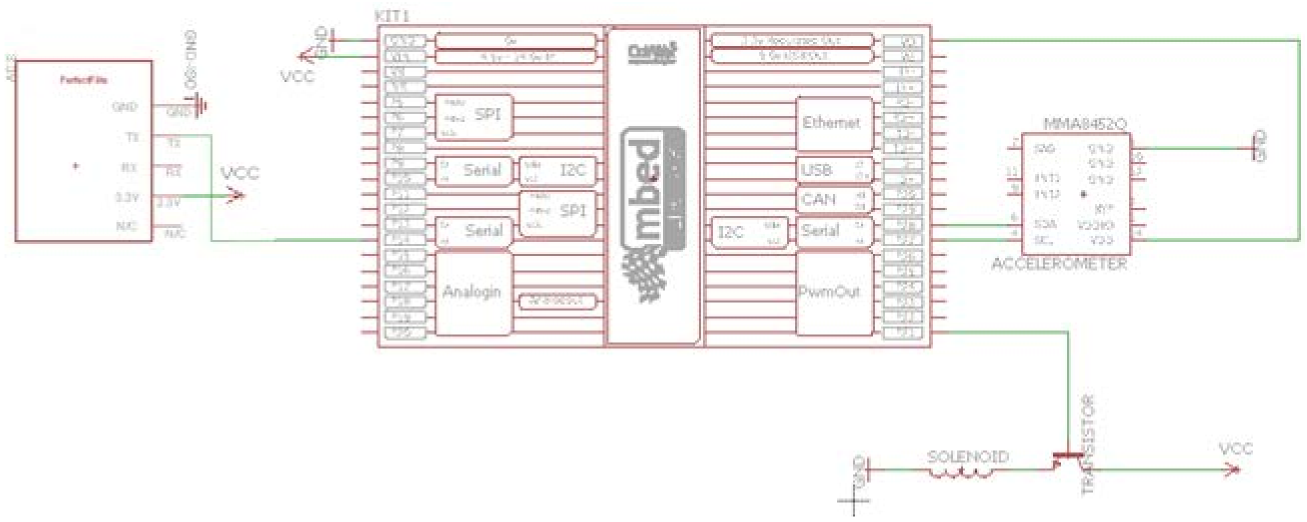
Flight Systems: Avionics

General connection of main components

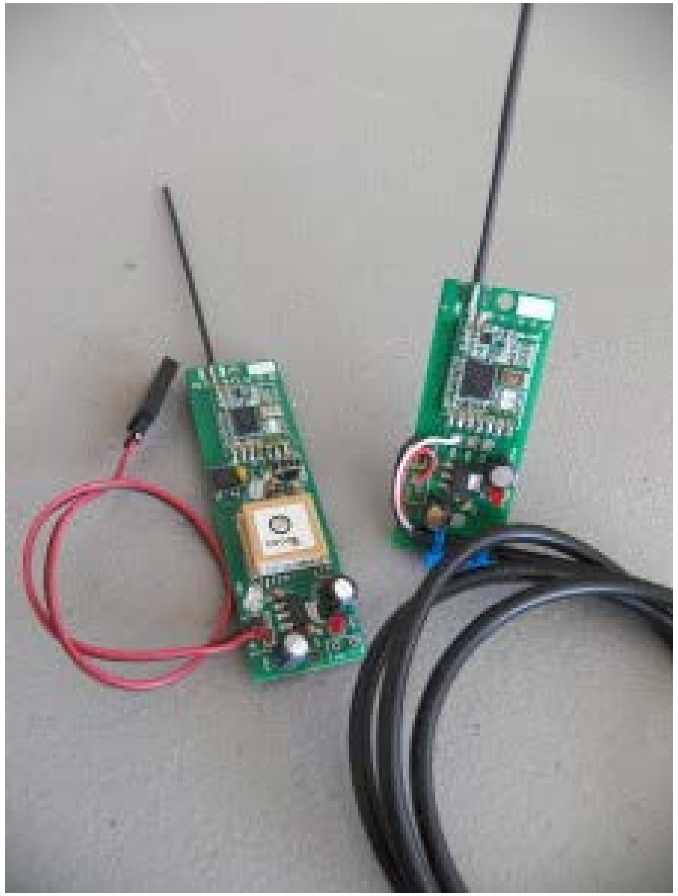


Flight Systems: Avionics

Eagle CAD schematic of main components



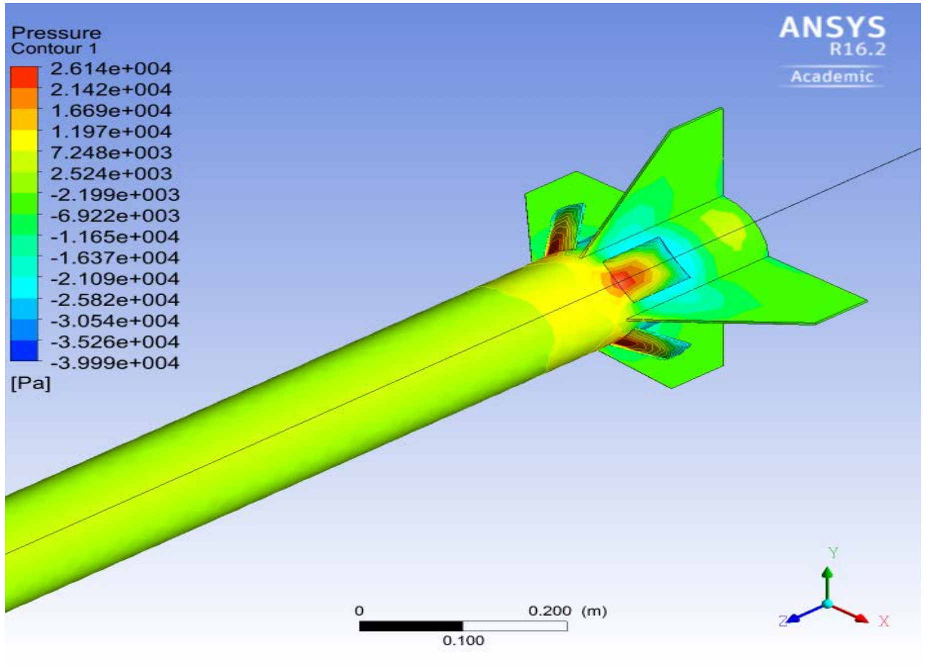
Flight Systems: Ground Station

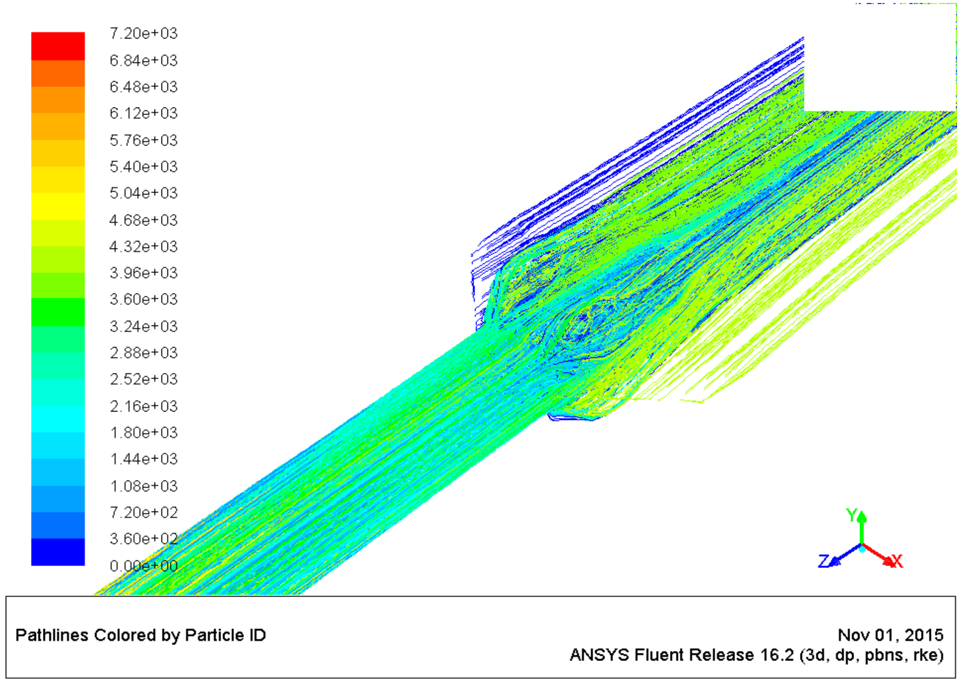


Equipment:

- ❖ Eggfinder TX (Transmitter)
- ❖ Eggfinder RX (Receiver)

Flight Systems: ATS Science





Dynamic drag adjustment by changing the geometry exposed to the flow to increase the vehicle’s aerodynamic properties.

Flight Systems: ATS Power

Flight Systems: Testing Overview

Wind Tunnel: Test Cd of flaps against simulation, and ability for solenoids to withstand the given pressures

Flight Simulation: Forged flight data will be fed to the sensors and the response efficacy will be analyzed.

Power Consumption: Full charged power supply will be connected to flight systems to see its maximum lifespan.

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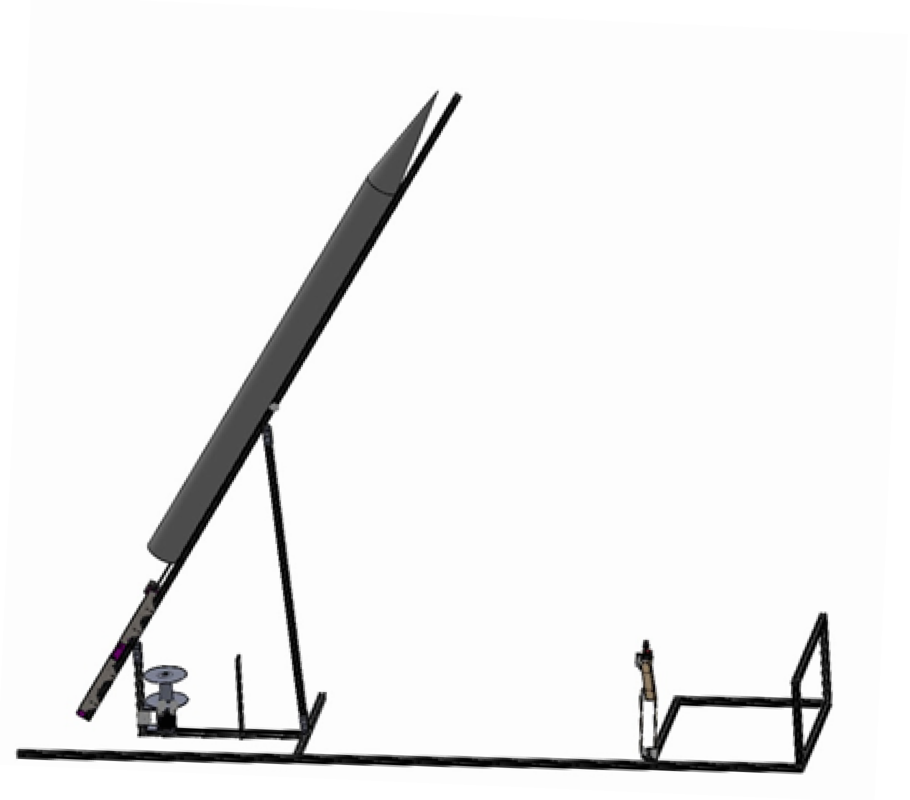
AUTONOMOUS GROUND SUPPORT EQUIPMENT

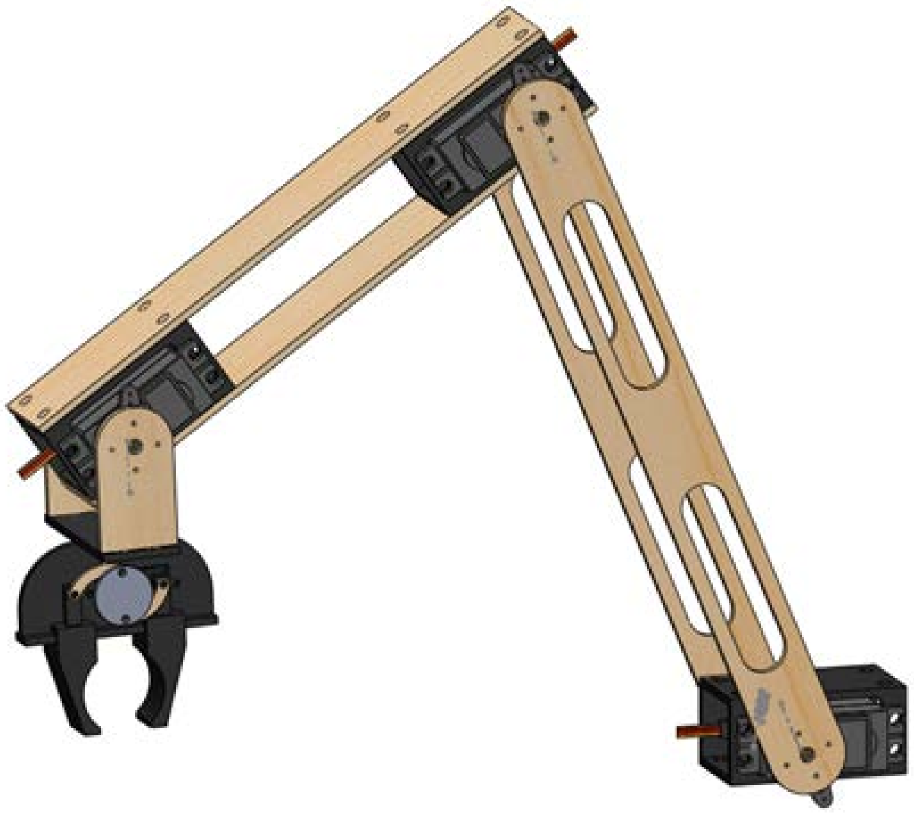
AGSE: Initial Design

- 10 ft. by 2 ft. base constructed from aluminum t-slotted rails
- 3 subsystems
  - Robotic Payload Delivery System (RPDS)
  - Rocket Erection System (RES)
  - Motor Ignition System (MIS)
- Weight: 60 lbs
- Estimated time for completion of all tasks: 8 minutes



AGSE: RPDS

- Will locate payload using IR sensors
- Grab payload using gripping claw
- Constructed of wood and plastic parts

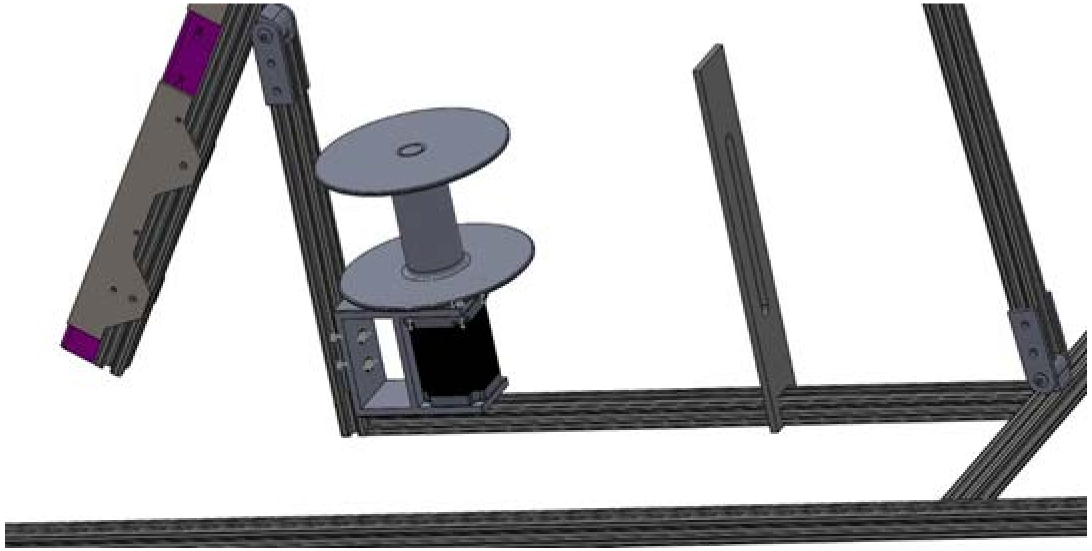


AGSE: RPDS

- Arm will move payload into payload bay
- Secure payload through plastic clips

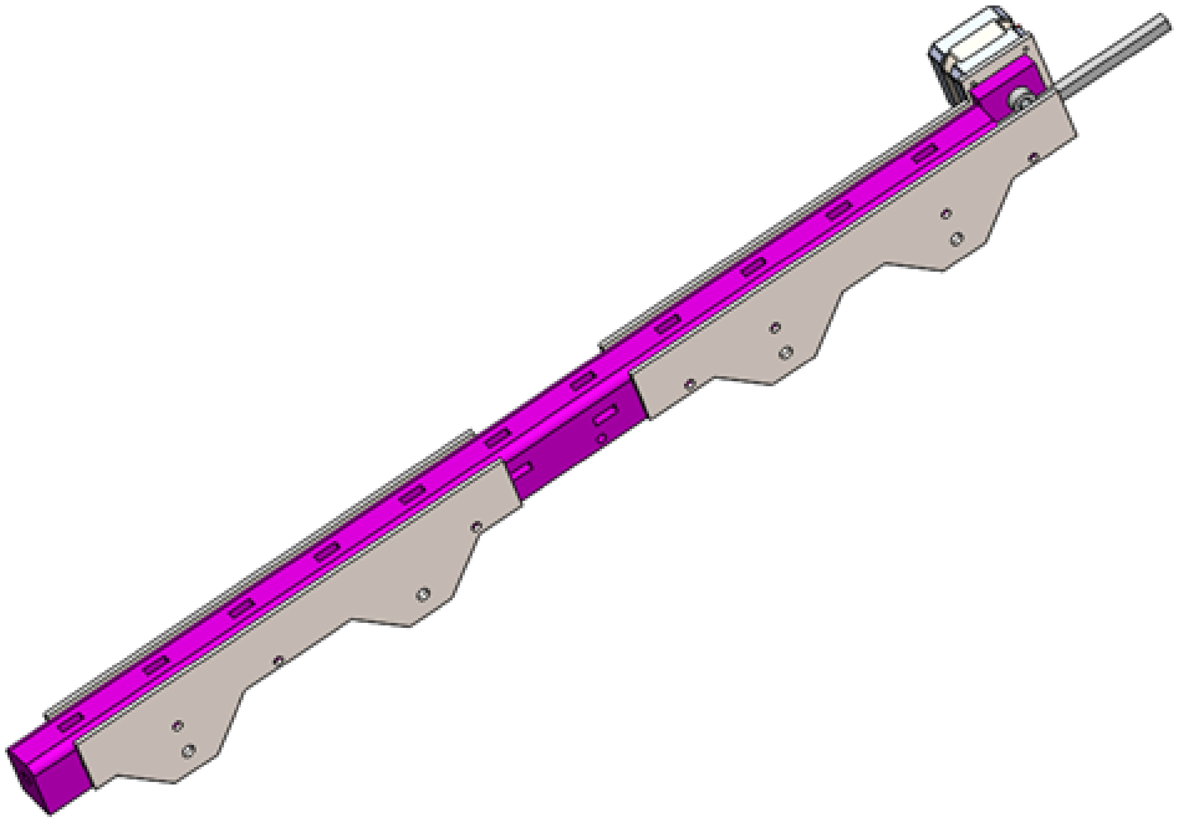
AGSE: RES

- Raise the rocket through a cable and spool system
- Spool will pull in steel cable that is attached to hinged rail
- Ratchet system will keep launch vehicle in place



AGSE: MIS

- Rack and pinion system will move the electronic match 12 inches into the motor cavity
- Will be fixed to bottom of guide rail



AGSE: Safety

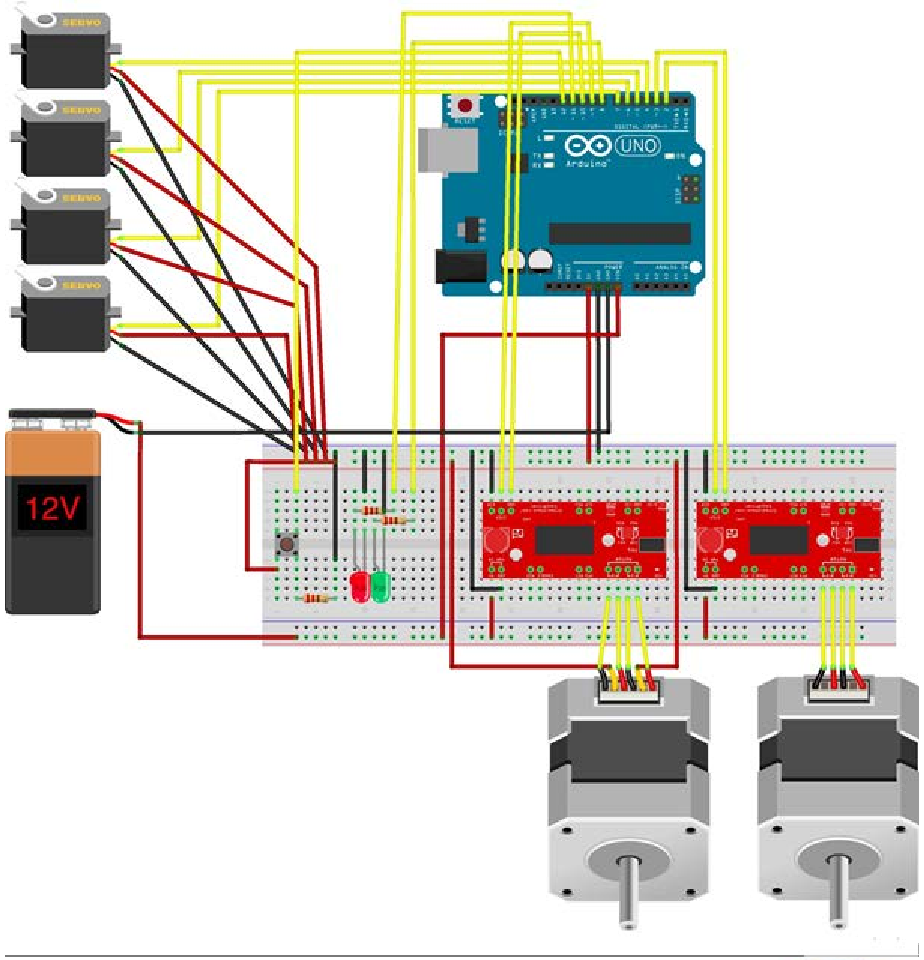
Potential Failure	Effects of Failure	Failure Prevention
Payload is not secured in bay	Payload will bounce inside payload bay, disrupting flight	Test various plastic clip dimensions to find best fit
RES is not stable while raising	Rocket will not be raised, and potentially the motors will be broken	Test subsystem, add counterweights to reduce necessary force from motor, and add more framing to increase stability
RES does not stay upright	Launch vehicle will fall unpredictably	Perfect ratchet system, ensure tension in steel cable
Electronics short circuit or are overloaded	System will lose control	Fuses

AGSE: Electronics

- 4 servo motors for RPDS
- 1 unipolar stepper motor for RES
- 1 bipolar stepper motor for MIS
- 2 LEDs as indicators
- 1 button to start and stop the program
- Controlled by Arduino Uno-R3

AGSE: Power

- System will be powered by 12V- 10.5Ah lead acid battery
- System can run for up to 45 minutes



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NASA

AGSE: Test Plan Overview

- RES: cable and spool stability test
- RPDS: Arm strength test
- MIS: Insertion speed test

Questions

Questions?