Piedmont Student Launch Team

Preliminary Design Report

November 15, 2016

Overview

- Vehicle Information
- Flight Statistics
- Motor Choice
- Launch Statistics
- Subsystems
- Payload
- Requirements Compliance Plan
- Q&A

Vehicle Info - Summary

- Length: 98 in
- Diameter: 5.5 in (20.4 in at fins)
- Body material: Fiberglass
- Expected weight: 27.5 lbs

Flight Statistics

- Pre-burnout center of gravity: 54.4 in from nose
- Post-burnout center of gravity: 49.2 in from nose
- Center of pressure: 72.6 in from nose
- Static stability margin: 3.27 calibers

Motor Choice

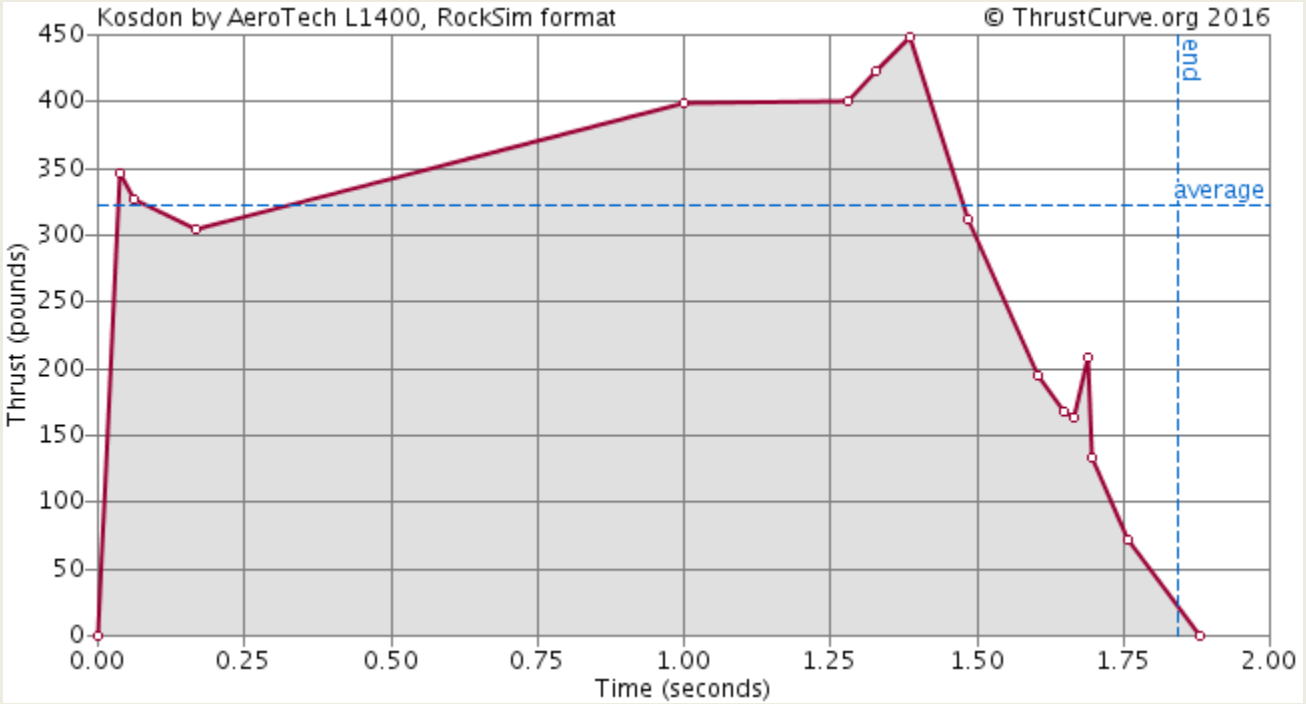
- Criteria:
  - Enough thrust to reach altitude of 5280 ft.
  - Not so much thrust that it requires excessive ballasting.

Motor Choice (cont.)

Motor	Altitude (ft)
Kosdon-by-AeroTech L1400F	5822.15
Cesaroni L1030RL	6379.89
Kosdon-by-AeroTech K750W	5363.68

- Kosdon-by-AeroTech L1400F

Motor Choice (cont.)



Launch Statistics

- Thrust to weight ratio: 16.25
- Rail exit velocity: 89.9 ft/s
- Maximum acceleration: 517 ft/s

Vehicle Info - Profile

Profile	Pros	Cons
Standard	Easy to Design. Easy to Model. Easy to Build. No unusual Aerodynamics	None.
Nonstandard	Unique Look. Potentially, more interior space	Unusual aerodynamic effects. Harder to design. Harder to model. Harder to build.

- Profile refers to the diameter of the rocket and its uniformity.
- Standard

Vehicle Info - Body Sections

Body Sections	Pros	Cons
Fewer than three	Fewer places for the rocket to separate accidentally	Not enough sections to be able to use a drogue & main parachute w/o more complex recovery.
Three	No more parts than needed for recovery system	More time & effort spent manufacturing the body
More than three	None	Even more time & effort spent manufacturing the body

- The body sections refers to the parts of the rocket that are separated by the ejection charges.
- Three sections

Vehicle Info - Bulkheads

Bulkhead Material	Pros	Cons
Plywood	Lighter weight. Easier to work with than aluminum.	Not as strong as alternatives.
Fiberglass	Easier to work with/lighter than aluminum.	Not as strong as aluminum, more expensive than plywood.
Aluminum	Stronger than alternatives.	Most expensive/ difficult to work with option.

- The bulkheads protect the subsystems and act as anchor points.
- Fiberglass

Vehicle Info - Nose Cone

Nose Cone Shape	Pros	Cons
Ogive	Commercially available in the same size as the body tubes being used	Somewhat higher drag
Parabolic	Somewhat lower drag	Not commercially available at team's body tube size
Cone	Lower drag at trans and supersonic speeds	Not commercially available at team's body tube size
Elliptical	Somewhat lower drag	Not commercially available at team's body tube size

- Ogive

Vehicle Info - Altitude Control

Altitude Control	Pros	Cons
Air Brakes	Precise control of the altitude of the launch Vehicle. Ability to account for variance in launch day conditions.	Need for control electronics. Additional points of mechanical/ program failure. Creates turbulent flow/instability.
Ballasting	Easy to Manufacture. Few extra points of failure. No exterior parts.	Less precise altitude control. Cannot account for launch day conditions.

- Necessary system for the altitude challenge. Allows for accurate arrival at specific altitudes.
- Ballasting

Vehicle Info - Fins

Fin shape	Pros	Cons
Trapezoidal	Easy design. Easy manufacture. Easier to attach	Higher drag than elliptical.
Elliptical	Less drag than trapezoidal.	Difficult to manufacture. Difficult to design.
Tube	Unique Look.	Little information to base decisions on.

Number of fins	Pros	Cons
Three	Less weight. Less drag. Less time/effort /resources. Less likely to be unstable.	None.
Four	None	More weight. More drag. More time/effort/ resources.

- Trapezoidal
- Three fins

Recovery System - Components

- Parachutes
  - Drogue Chute
  - Main Chute
- Harnesses
  - Kevlar
- Redundancy
  - Dual Ejection Charges/Altimeters

Recovery System - Strategy

- Deployment of rocket
  - Altimeters observe stalling height reached for the rocket
  - Drogue chute deployed to reach intended altitude
- Apogee reached
  - Drogue chute partially slows descent
- Recovery altitude reached
  - Altimeters observe recovery height has been reached on descent
  - Main parachute deploys, allowing easier recovery of rocket

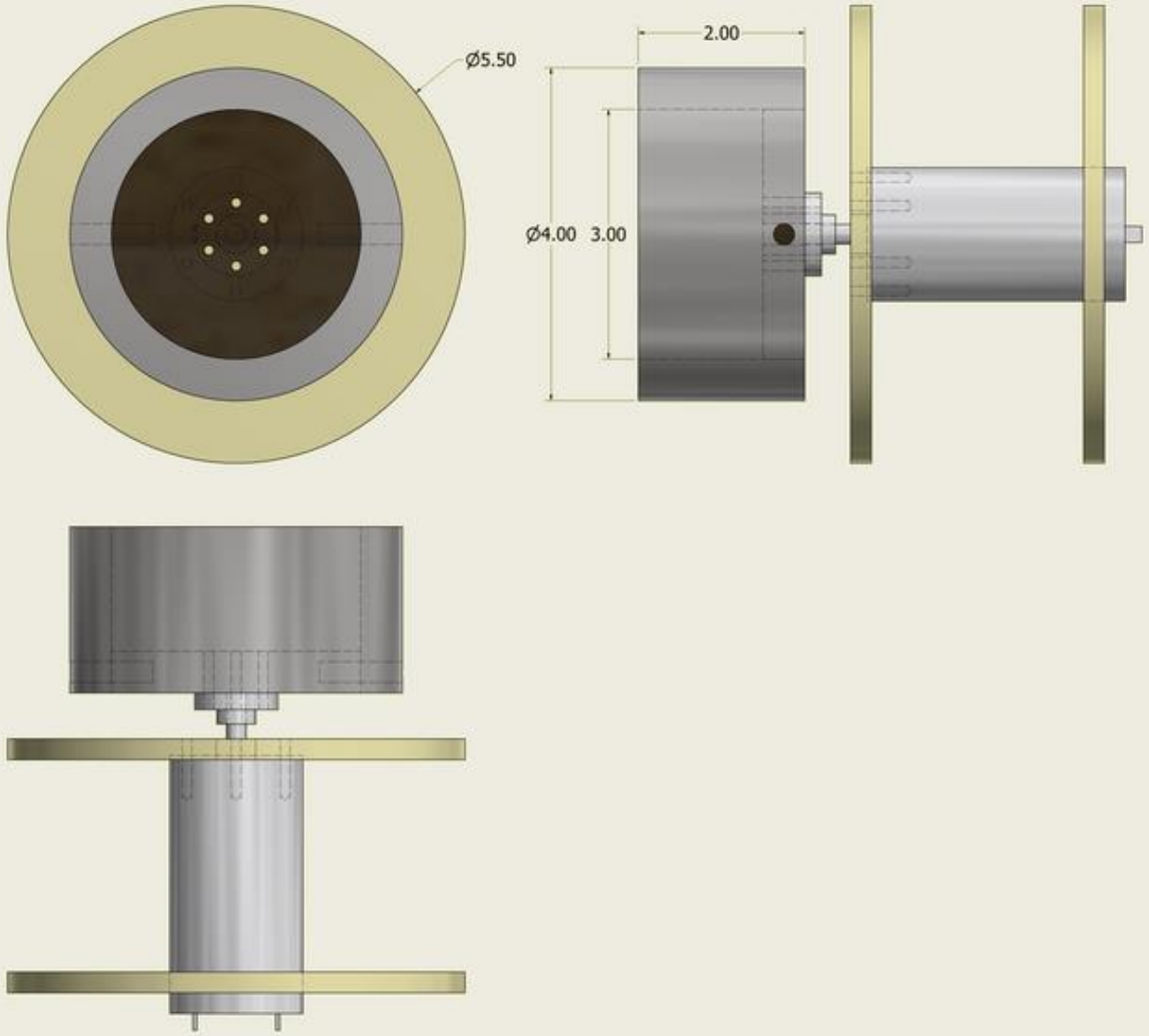
Payload Summary

- Roll and counter-roll
- Reaction wheel
  - Conservation of Angular Momentum
  - Precise control through ascent
- Team criteria
  - Identify ground targets
  - Aim camera
  - Transmit video

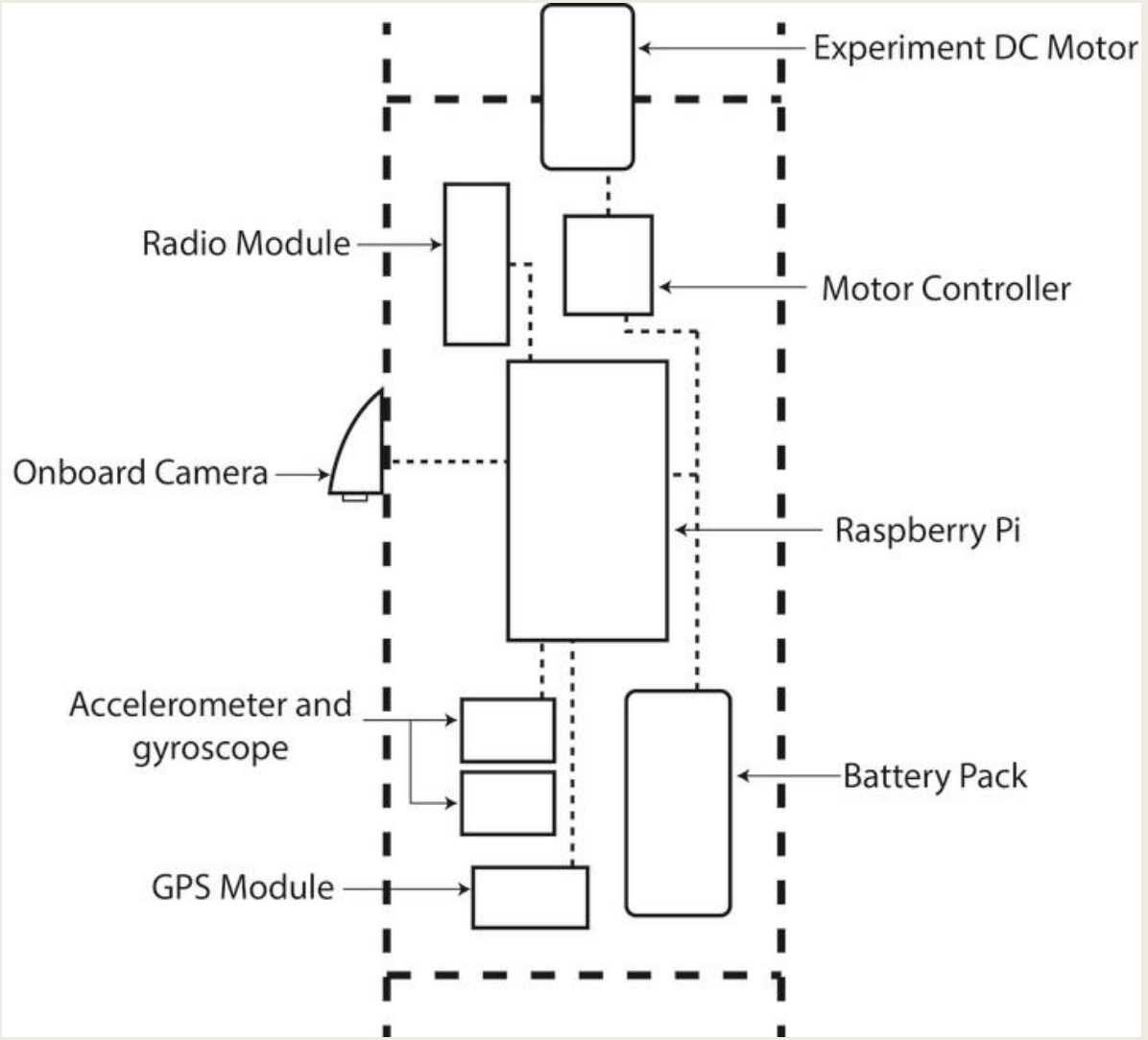
Payload Events

- Detect motor burnout
- Measure rotation
- Rotate twice
- Rotate to targets
- Return to burnout rotation
- Transmit data and video

Reaction Wheel

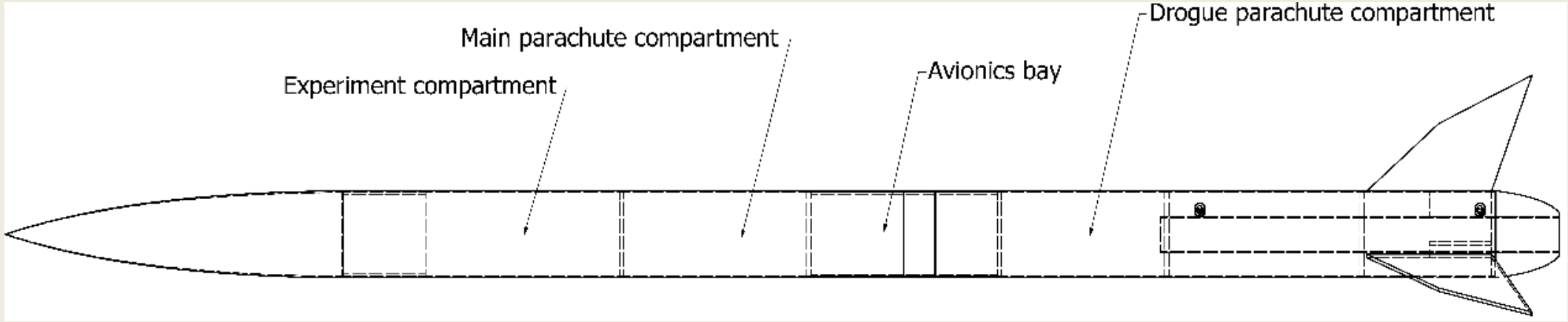


Payload Electronics



Payload Placement

- Toward nose
- Moves center of gravity forward
- Separated from recovery system



Data Transmission

- 900 MHz radio
- Data
  - GPS position
  - Velocity
  - Acceleration
  - Rotation
- Video

Requirements Compliance Plan – Launch Vehicle

- Altitude challenge
  - Two altimeters
  - Ballast
  - Testing
- Propulsion system
  - Single, ammonium perchlorate composite solid motor
- Subscale rocket
  - Design is happening
  - Construction will begin soon
  - Launch will happen around December 10th

Requirements Compliance Plan – Launch Vehicle (cont.)

- Full scale test flight
  - Final design is happening
  - Construction of the full scale rocket will begin after CDR
  - Launch will happen in mid to late February

Requirements Compliance Plan – Recovery System

- Parachutes
  - Drogue
  - Main
- Electronics
  - Same altimeters as altitude challenge
  - Avionics bay will be shielded
- Test fire
  - Will happen in early to mid February
- Ejection charges
  - Each altimeter will fire a separate ejection charge for the drogue and main parachutes

Requirements Compliance Plan – Recovery System (cont.)

- Tracking system
  - Will have a GPS
  - Will transmit the location of the rocket along with other flight data

Requirements Compliance Plan – Experiment

- Roll induction
  - Will use a reaction wheel
- Proof of success
  - Will use cameras, accelerometers, and gyroscopes
- Team requirements
  - Will be programmed to turn the rocket to aim a camera at one of the ground targets
  - Will transmit live video from a camera

Requirements Compliance Plan – Safety

- Safety officer
  - Nicolas
- Mentor
  - Review all designs to ensure they are safe
  - Instruct team members in safe and effective rocket design
- Safety plan
  - Come up with check lists for launches
  - Oversee all construction
  - Review all construction documents to ensure safety procedures and hazard warnings are in place

Requirements Compliance Plan – General

- Project plan
  - A project planning document is available to the entire team and is updated by the project manager
  - The project plan includes timeline, requirements, budget, and other information
- Educational engagement
  - PSLT is making a specific effort to do educational engagement
  - There are already several activities planned
  - PSLT has decide to engage a minimum of 200 women and girls in educational activities

Requirements Compliance Plan – General (cont.)

- Website
  - The team has a webmaster
  - There is a page on the website for documents

- Teleconference set up
  - Available for all future meetings
  - Provided by our sponsors

Requirements Compliance Plan – Other

- The project manager will ensure that all of the requirements of the project are met

- Sub-team leaders will ensure the requirements for their parts of the project are met

Questions?