NASA Student Launch 2018

Preliminary Design Review Presentation

UNIVERSITY OF SOUTH FLORIDA

SOCIETY OF AERONAUTICS AND ROCKETRY

November 8th, 2017

Objectives

- Design and build a rocket and payload, guided by the criteria set forth in the 2018 NASA Student Launch Handbook, that will win one or more categories of award for the 2018 NASA Student Launch Competition
- Chosen payload is a rover, which will be designed to deploy from a section of the rocket, autonomously move at least five feet, and deploy solar panels

Vehicle Dimensions

Property	Quantity
Diameter (in)	5.148
Length (in)	94
Projected unloaded weight (lb)	22.2
Projected loaded weight (lb)	30.2

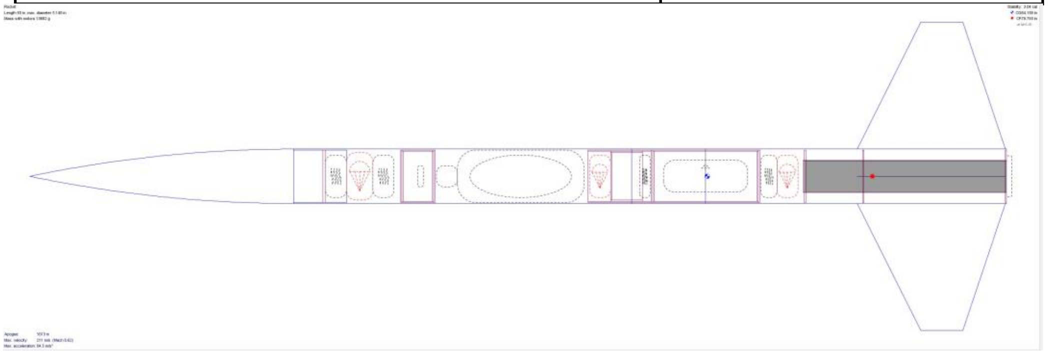


Figure 1: Overview drawing of launch vehicle assembly

Vehicle Materials. Part I

Part of Rocket	Brand (Supplier)	Model	Material
Nose Cone	Wildman Rocketry	FNC5.0-5-1 FW-VK-MT	Fiberglass
Shock Cord	Top Flight Recovery	TUK-½”	½” Tubular Kevlar
Rover Compartment	Custom (Wildman Rocketry)	G12-5.0	G12 Fiberglass
Nose Cone Parachute	SkyAngle	CERT-3 XL	1.9 oz Ripstop Nylon
Rover Compartment Parachute	b2 Rocketry	CERT-3 XL	1.9 oz Ripstop Nylon
Rover	Custom	--	ABS/PLA, Fiberglass

Vehicle Materials. Part II

Part of Rocket	Brand (Supplier)	Model	Material
Payload Altimeter Bay	Custom (Wildman Rocketry)	G12CT-5.0	5” G12 Fiberglass Coupler
Altimeter Bay	Custom (Wildman Rocketry)	G12CT-5.0	5” G12 Fiberglass Coupler
Internal Coupling Stage	Custom (Wildman Rocketry)	G12CT-5.0	5” G12 Fiberglass Coupler
Piston System	Custom	CERT-3 XLarge - SkyAngle	ABS/PLA
Altimeter Bay Bulkheads	Custom (McMaster-Carr)	--	1/8” Fiberglass Sheets
Altimeter, Sled, and Batteries	Public Missiles	--	3/8” Tubular Nylon (SkyAngle)
Booster Section	Custom (Wildman Rocketry)	G12-5.0	G12 Fiberglass

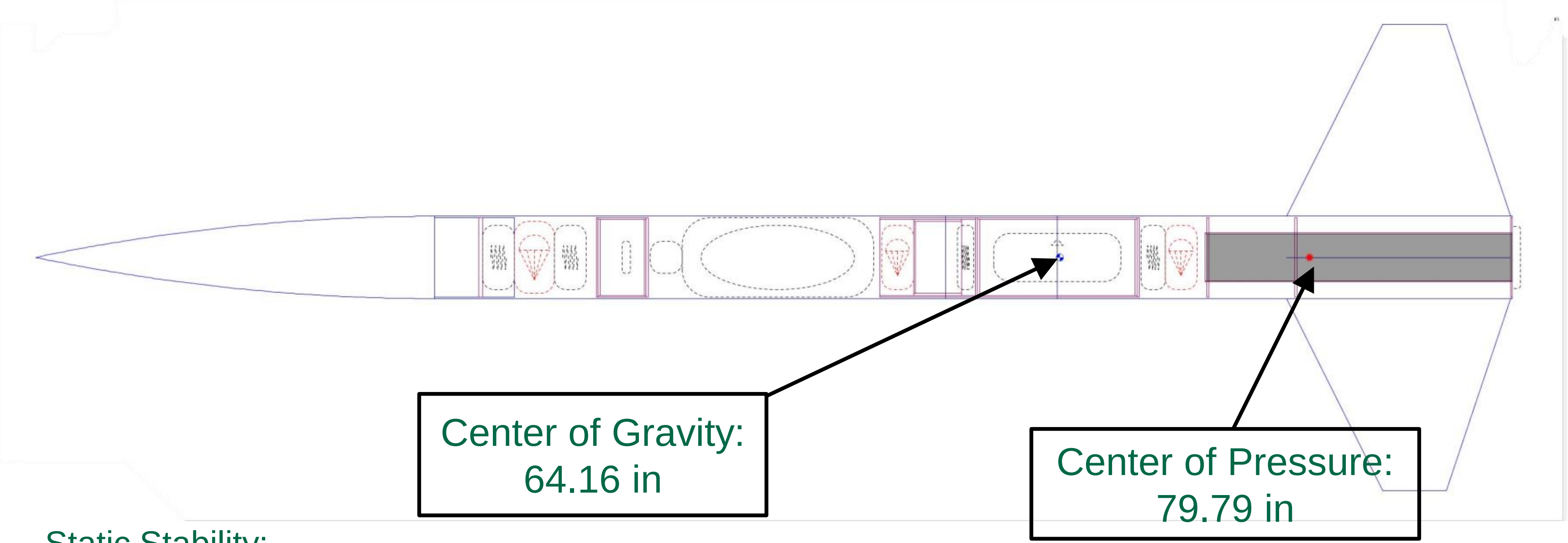
Vehicle Materials. Part III

Part of Rocket	Brand (supplier)	Model	Material
Fin Set	Custom (McMaster-Carr)	--	Carbon Fiber
Motor Mount	Wildman Rocketry	G12-3.0	Kraft Phenolic
Centering Ring(s)	Custom (McMaster-Carr)	--	1/8” Fiberglass Sheets
Main Parachute	b2 Rocketry	CERT-3 XLarge - SkyAngle	1.9 oz Ripstop Nylon
75mm Motor Mount	Wildman Rocketry	G12-3.0	G12 Fiberglass
75mm Flanged Motor Retainer	AeroPack (Apogee Components)	--	6061-T6 Alloy

Vehicle Justifications

- Launch vehicle designed with 5 inch diameter tubing for optimal spacing and flight.
- The Booster section is separated at apogee with drogue.
- At 1000 ft, the altimeters will deploy the Main and Rover Compartment parachute.
- The rover will deploy from the Rover Compartment after touchdown

CP/CG Locations



Static Stability:
3.04

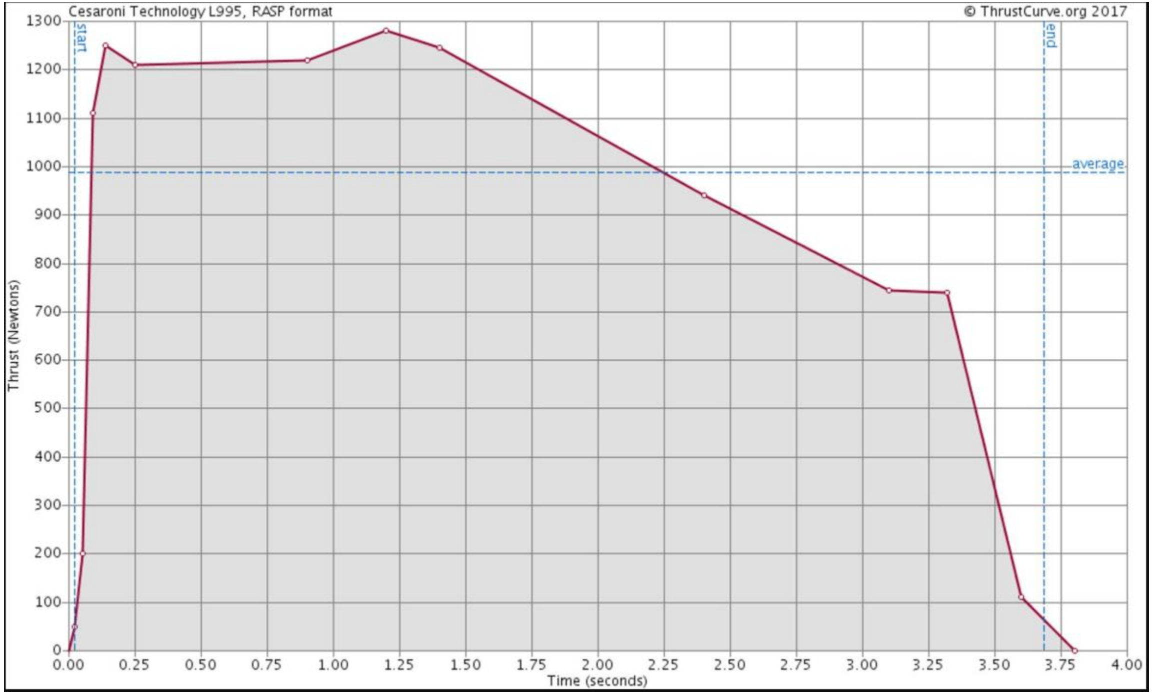
Preliminary Motor Selection & Justification

- The motor we have selected at this time is the L995 from Cesaroni.
- This motor was selected for reaching the altitude closest to the 5,280 feet goal.

Characteristic	Value
Total Impulse (Ns)	3618.0
Burn Time (s)	3.6
Diameter (mm)	75
Length (cm)	48.6
Propellant Weight (g)	1913

Characteristic	Value
Thrust-to-Weight Ratio	8.37
Exit Velocity (ft/s)	65

Cesaroni L995 Thrust Curve



Cesaroni L995 Pros and Cons

Pros	Cons
Fin design can be manipulated to achieve higher apogee.	Motor only reaches 5280 feet in ideal (zero) wind conditions.
Motor has clean, consistent thrust curve with higher average thrust.	Very unlikely to reach 5280 feet in worst wind conditions.
	Will not account for unexpected weight added during construction.

Recovery System

- SkyAngle Cert-3 XL parachute
- Extremely reliable, easy to fold and pack, and has been extensively tested and reviewed
- 5/8” mil-spec tubular nylon that has a 2,250 lb shock capacity

SkyAngle Cert-3 XL Parachute Characteristics

Material	Zero-porosity 1.9 oz balloon cloth
Surface Area	89 sq. ft.
Drag Coefficient	2.59
Number of Lines	4
Line Length	100 in.
Line Material	5/8” Tubular Nylon

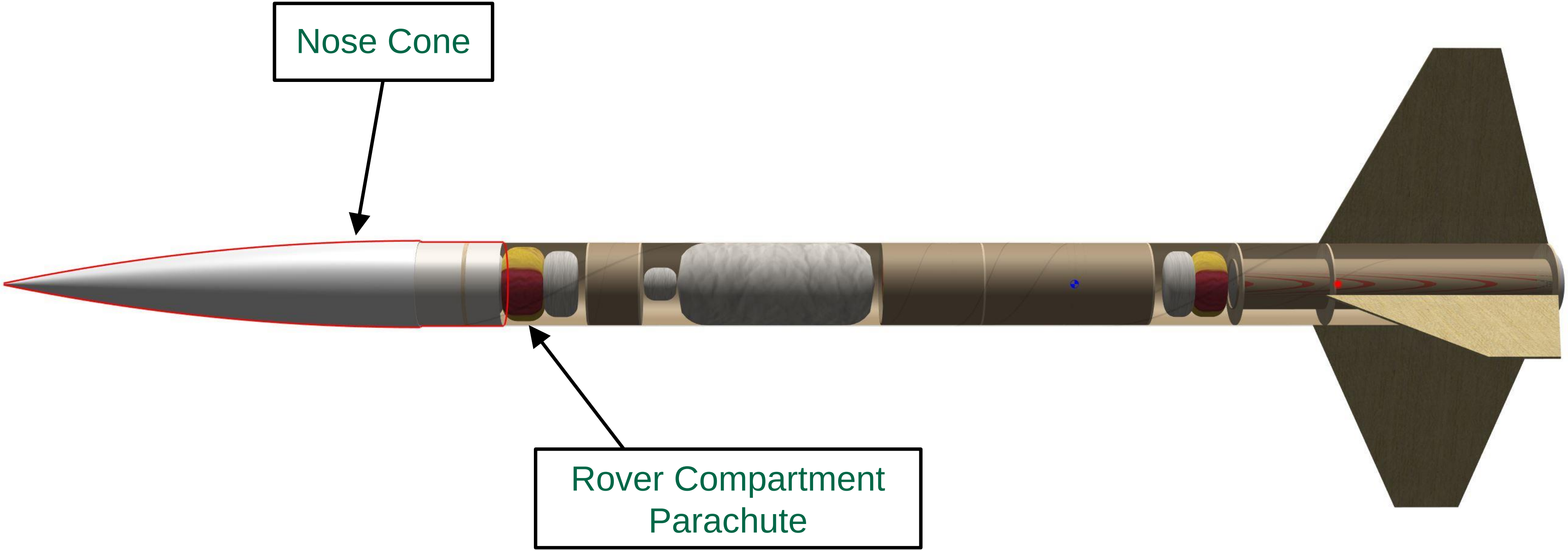
SkyAngle Cert-3 Parachute Flight Data

Velocity at Deployment	-78.34 f/s
Terminal Velocity	-10.22 f/s
Kinetic Energy of Nosecone and Rover Compartment at Impact	17.58 ft-lbs
Kinetic Energy of Booster and Altimeter Bay at Impact	18.49 ft-lbs
Kinetic Energy of Entire Launch Vehicle at Impact	42.13 ft-lbs

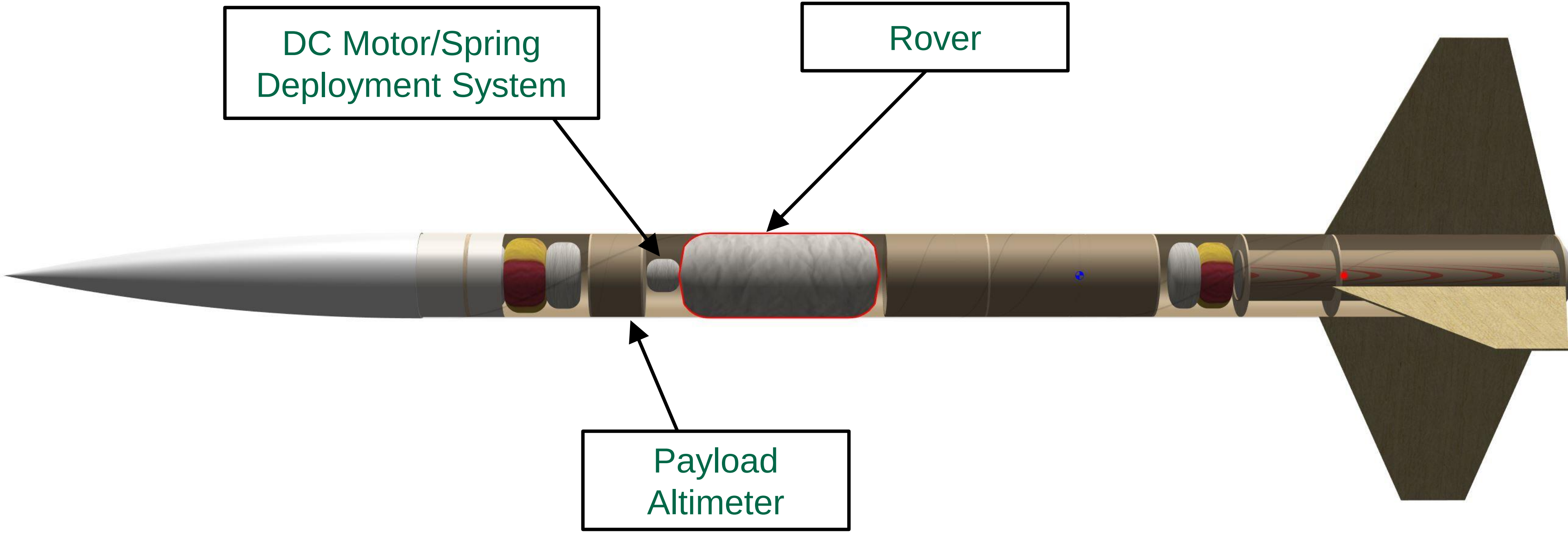
Other Recovery System Components

- Missile Works RRC3 “Sport” altimeter
- ½” tubular Kevlar
- 5/16” zinc-plated U-bolts and locking D-rings

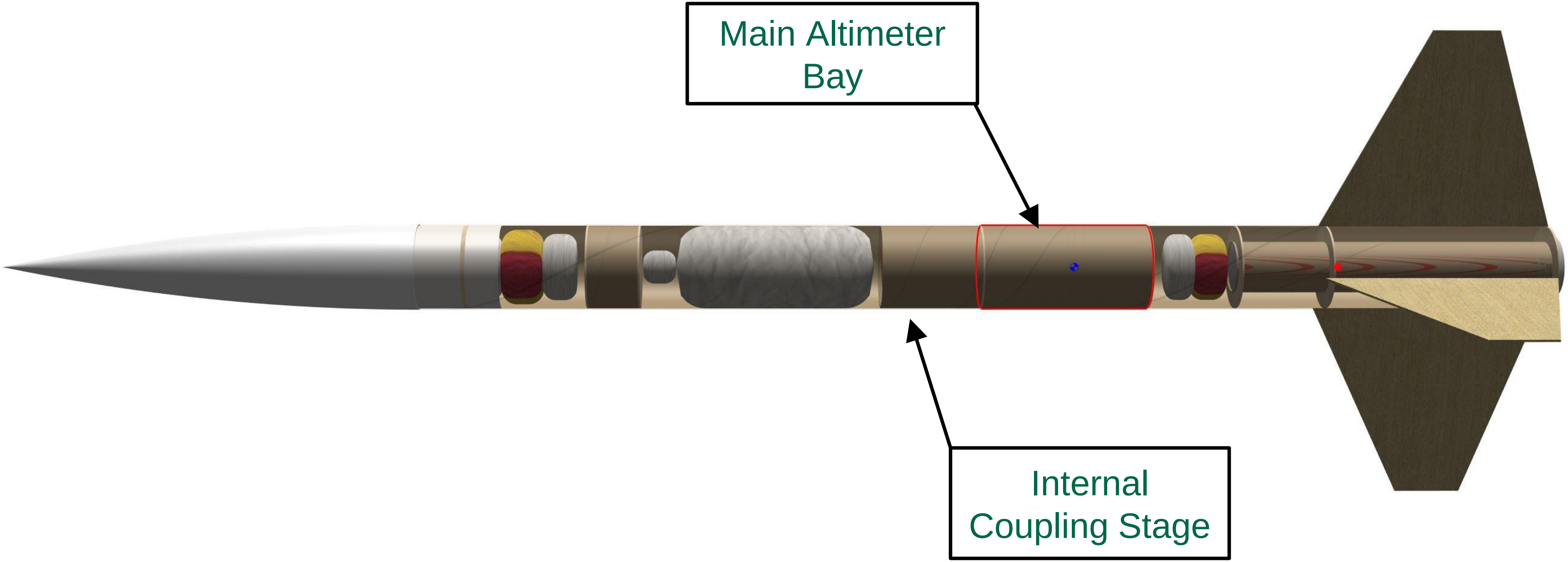
Launch Vehicle Section I: Nose Cone



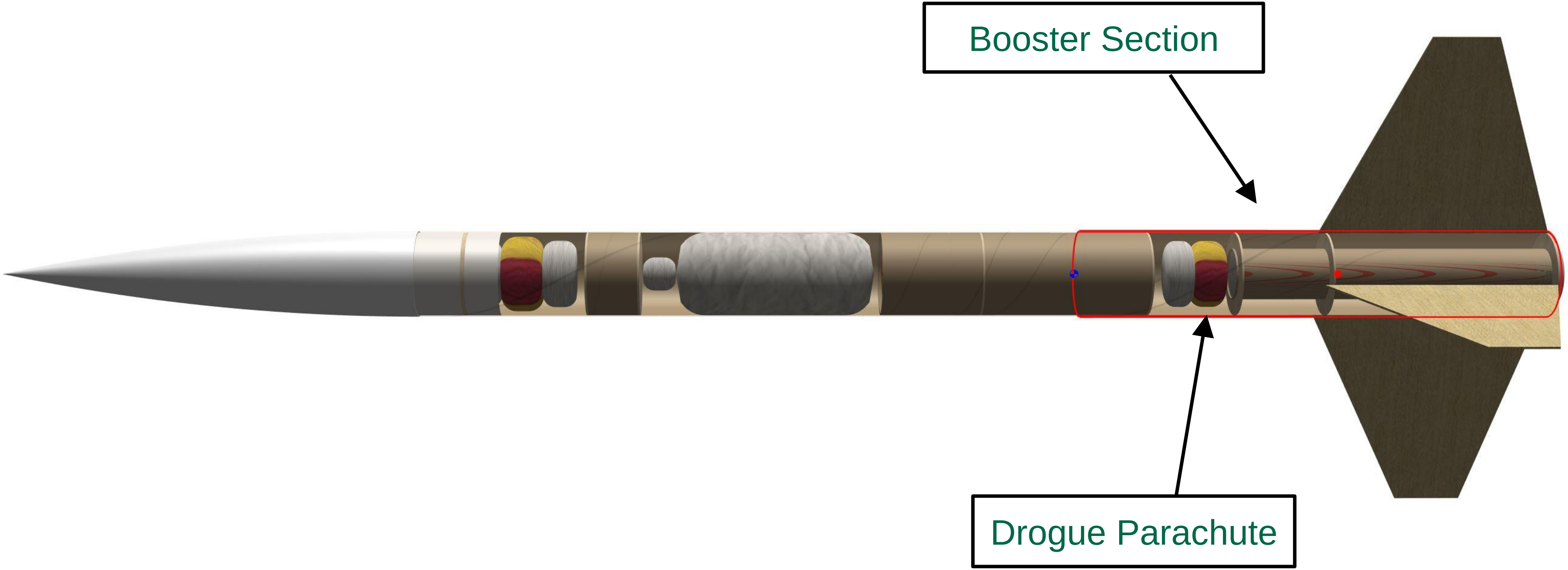
Launch Vehicle Section II: Landing Module



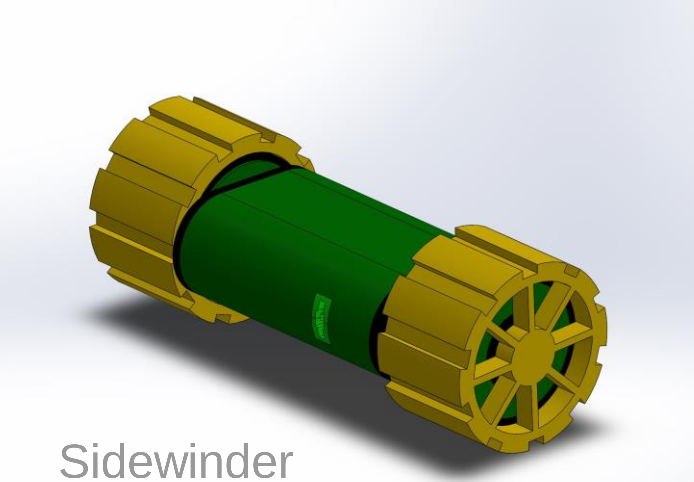
Launch Vehicle Section III: Electronics Bay



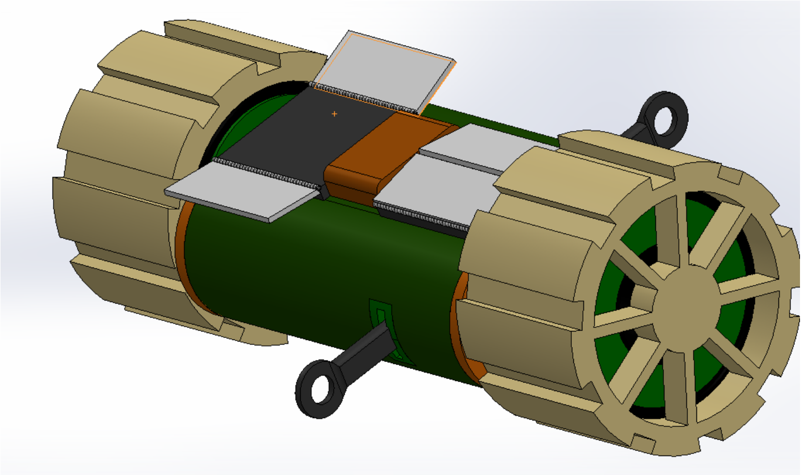
Launch Vehicle Section IV: Booster



Overview of Preliminary Designs



Sidewinder



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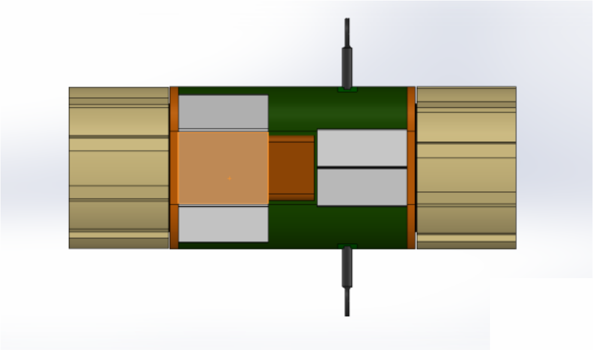
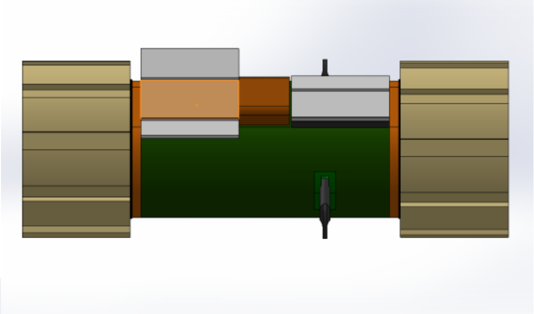
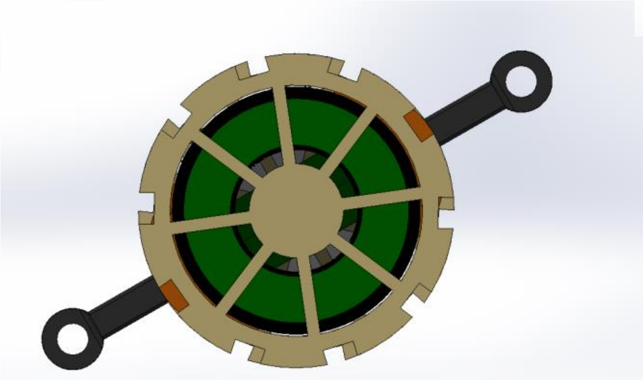
Preliminary Payload Design Cross Sections







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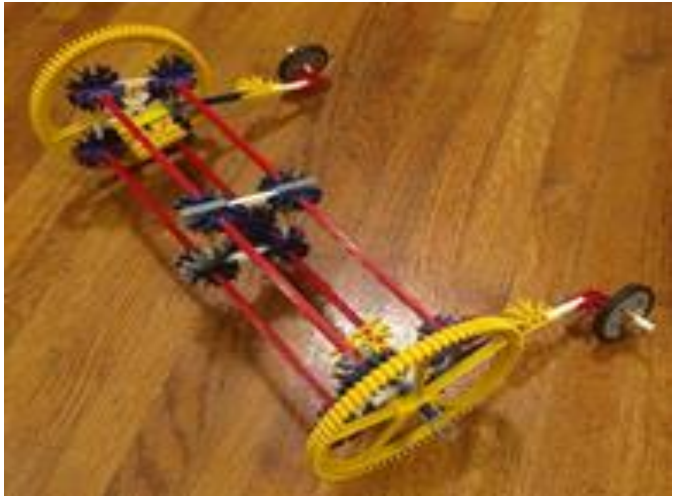
Sidewinder Payload Pros and Cons

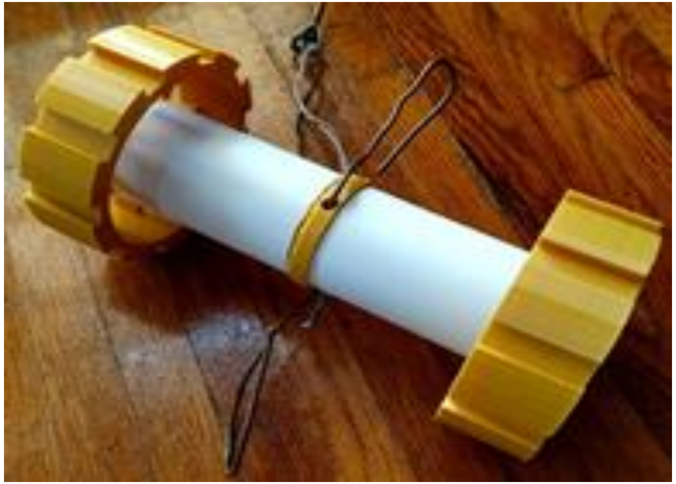
Pros	Cons
Takes up the most volume for the payload section, and allows for the largest diameter wheels.	Heavier than some designs
Design is modular. Parts or assemblies can be change quickly. This allow for fast repairs and efficient research and design.	Has the potential to get more easily "'stuck" than other designs
Large relative body size makes for easy incorporation of a wide variety of sensor and other electronics.	Will have difficulty going over obstacles than a tank or other wheeled design.
Rover will be able to hold up to 16 AA size batteries plus a 5V battery for the nav system. This allows it to have massive power reserves to accomplish the mission.	

Preliminary Payload Design Key Features

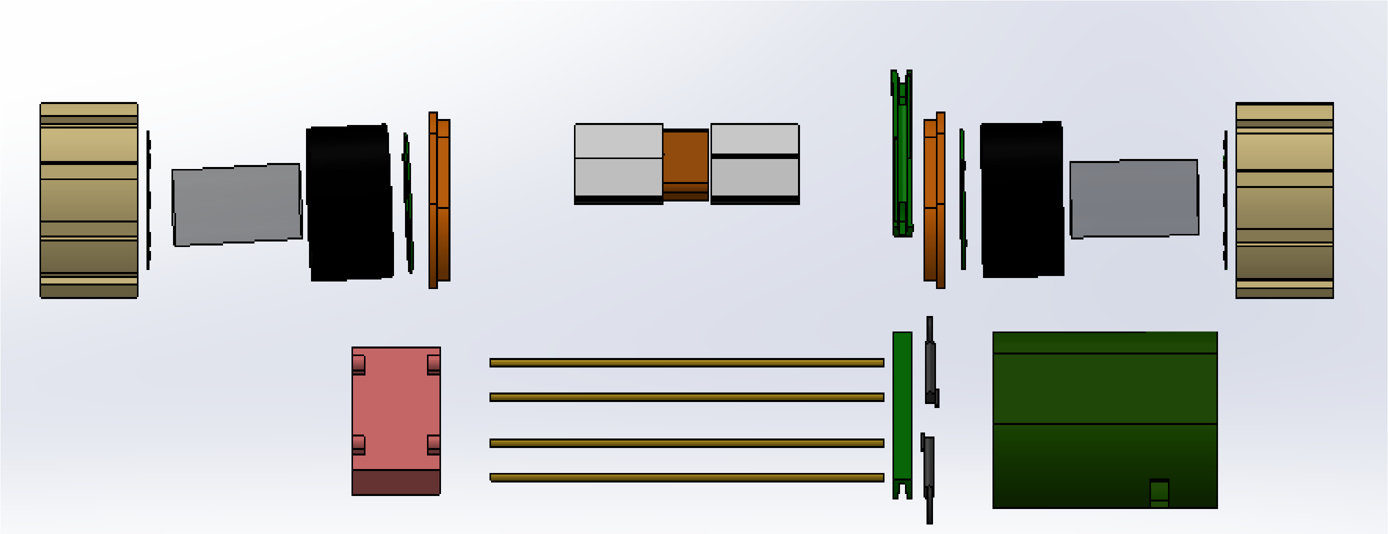
- Five inch diameter wheels
- Weight limit of ten pounds
- Overall length of rover and extraction mechanism needed to be no more than 12 inches
- Need for lever legs to push off from
- Primarily 3D printed parts and structure
- Rotating folding solar cell assembly

Sidewinder Rover Prototypes





Sidewinder Rover Components



Requirement Compliance Plan. Part I

Requirement	Method of Meeting Requirement	Verification
Vehicle criteria, including altitude, redundancy of altimeters, recoverability, reusability, and other safety and performance requirements.	Design simulations will be conducted, as well as full and subscale testing. All rules of the competition will be followed. Launch vehicle will contain no prohibited items.	Design simulations, NSL inspections, full and subscale launches, payload testing, safety officer evaluations.
Recovery system criteria, including staged recovery, ground tests, kinetic energy requirements, redundancy, and drift limits.	Design simulations will be conducted, as well as full and subscale testing. All rules of the competition will be followed. Launch vehicle will contain no prohibited items.	Design simulations, NSL inspections, full and subscale launches, payload testing, safety officer evaluations.

Requirement Compliance Plan. Part II

Requirement	Method of Meeting Requirement	Verification
Teams will design a custom rover that will deploy from the internal structure of the launch vehicle.	Custom rover will be designed that will deploy from the internal structure of the launch vehicle.	Current designs include air ejection, rack and piston, and spring loaded ejection methods.
At landing, the team will remotely activate a trigger to deploy the rover from the rocket.	Rover will utilize a receiver and team will operate a transmitter that will remotely trigger the rover to deploy from the rocket.	Current design criteria include this requirement. Team leads will continue to monitor to ensure continued enforcement of standard.

Requirement Compliance Plan. Part III

Requirement	Method of Meeting Requirement	Verification
After deployment, the rover will autonomously move at least 5 ft. (in any direction) from the launch vehicle.	Rover will be designed to move at least 5 ft. from launch vehicle.	Current design criteria include this requirement. Team leads will continue to monitor to ensure continued enforcement of standard.
Once the rover has reached its final destination, it will deploy a set of foldable solar cell panels.	Rover will be designed to deploy solar panels once it has reached its destination.	Current design criteria include this requirement. Team leads will continue to monitor to ensure continued enforcement of standard.

Questions?