



# Critical Design Review

NASA USLI

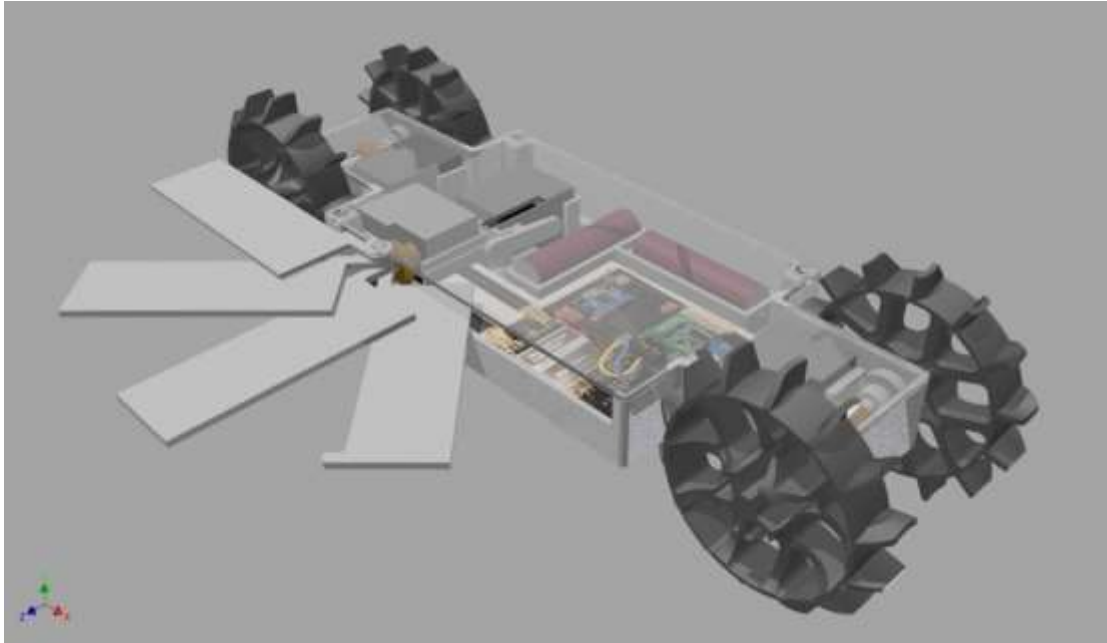
Tarleton Aeronautical Team

Tarleton State University

January 17, 2018

# Introduction

## The team proposes to complete Option 2: Deployable Rover

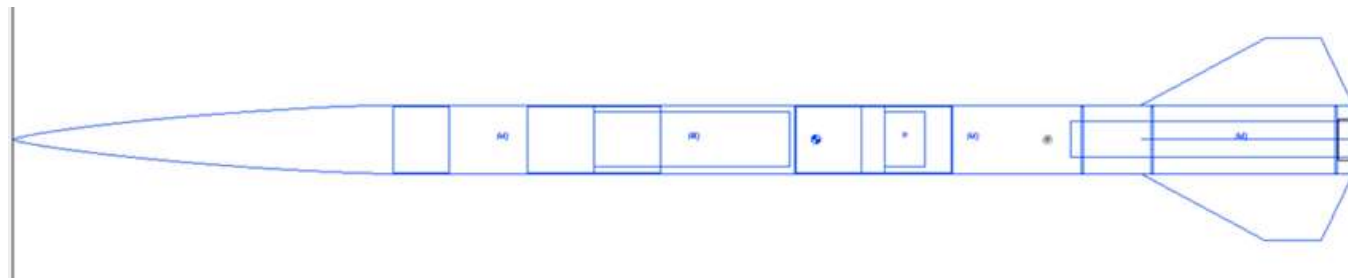
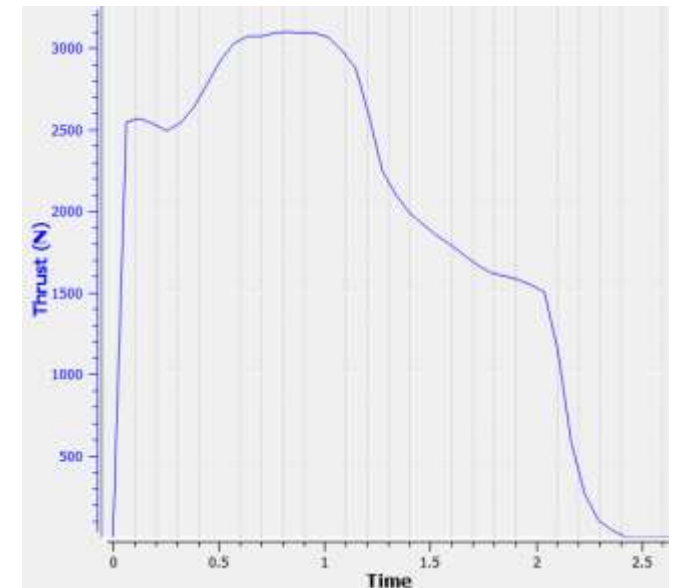


- The rover will deploy from an 18 inch long section that is directly behind the nose cone.
- The rover design is focused on modularity and simplicity.
- The same servos are used throughout the rover to control all of the mechanical aspects. The solar panels and the launch vehicle securing mechanism are incorporated into the rover.

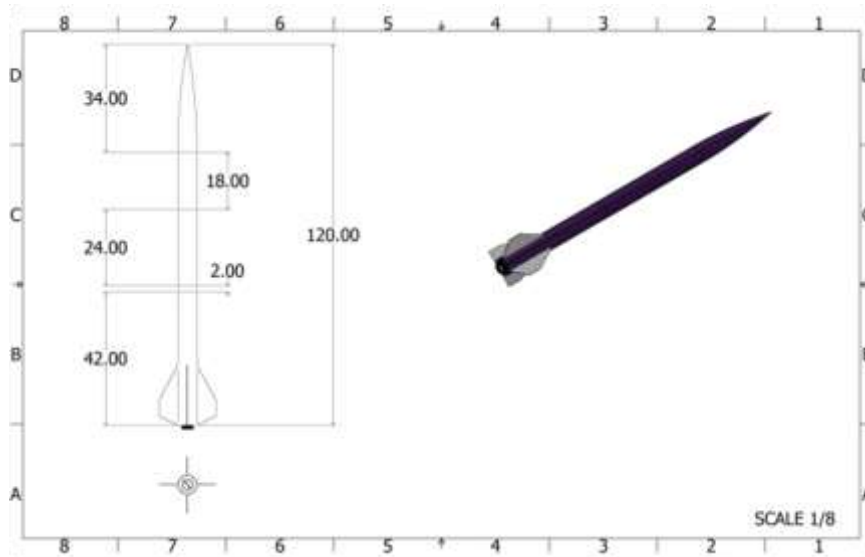


# Final Launch Vehicle

- 120 inches in length, 6 inches in diameter
- Mass: 824.203 ounces including motor
- 1515 Launch Rail 120 inches
- Static Stability Margin: 2.18
- Final Motor Selection: Aerotech L2200G
- Total Impulse: 5104N
- CP: 92.6292 inches
- CG: 71.4211 inches



# Final Launch Vehicle Dimensions

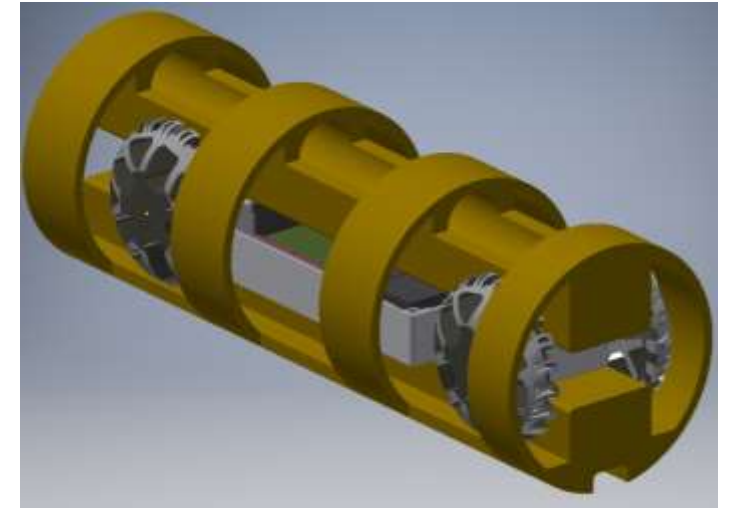
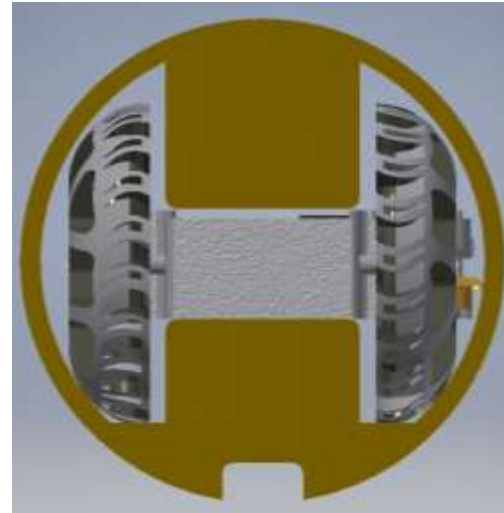
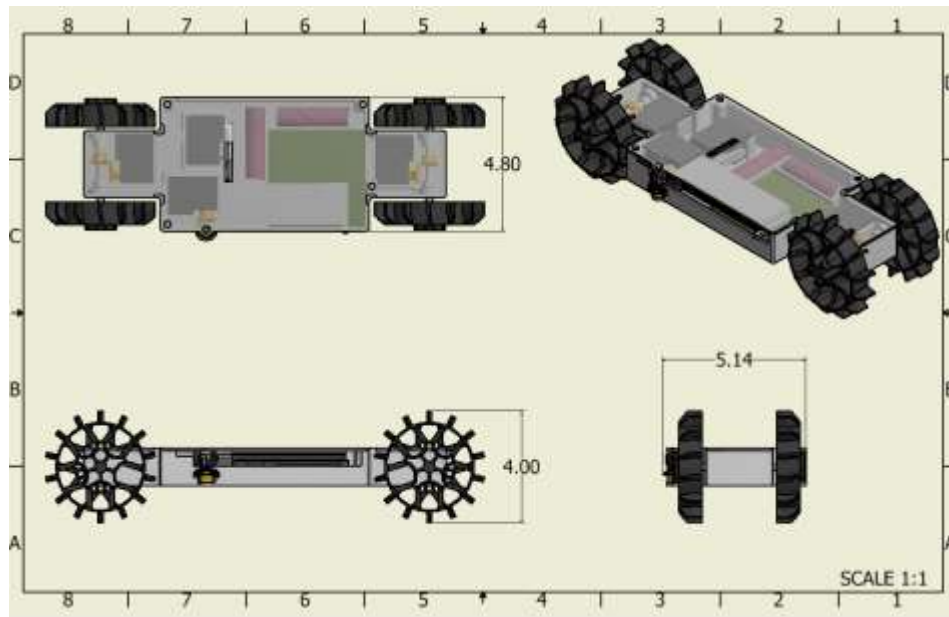


Component	Dimensions (length, inches)	Material
Nose Cone Section	34 inches	G12 Fiberglass with Aluminum Tip
Rover Housing	18 inches	G12 Fiberglass
Middle Section	24 inches	G12 Fiberglass
Avionics Bay	2 inches	G12 Fiberglass
Booster Section	42 inches	G12 Fiberglass

External Airframe Dimensions		
Fin	Dimensions	Material
Root Chord	20 inches	G10 Fiberglass
Tip Cord	5.6631 inches	G10 Fiberglass
Fin Tab Length	16 inches	G10 Fiberglass
Sweep Length	9.84 inches	G10 Fiberglass
Sweep Angle	63.025 degrees	G10 Fiberglass
Height	5.8 inches	G10 Fiberglass

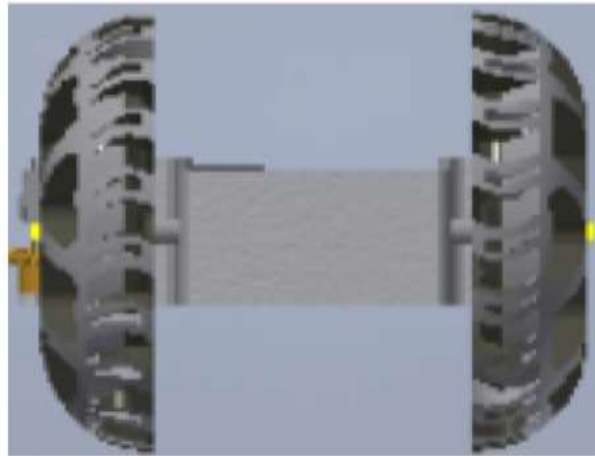
# Final Payload - Rover

The rover body will be 3D-printed from PLA plastic. The rover body completely houses the solar array and the mechanical locking mechanism that secures the rover in the launch vehicle.

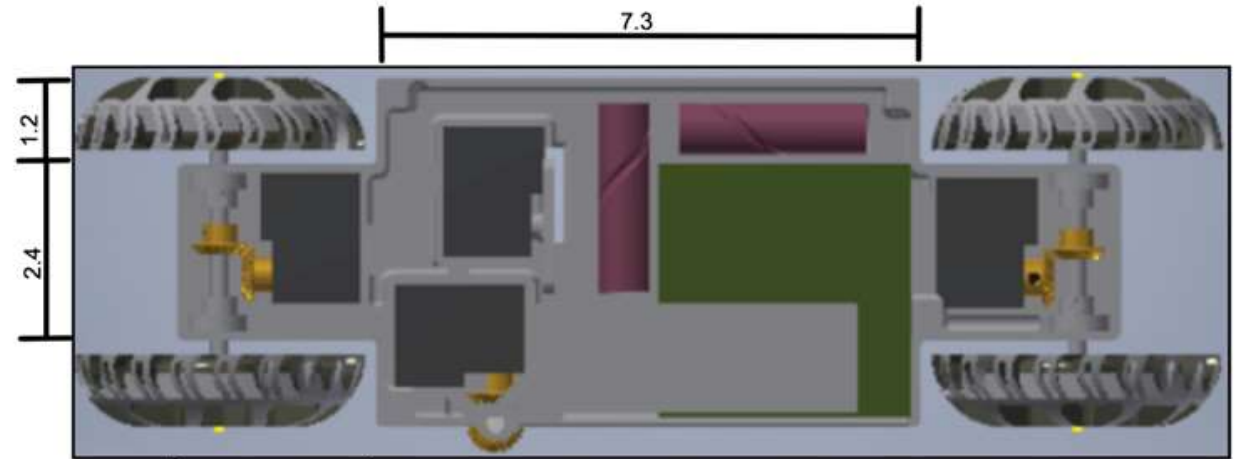


The rover is designed to fit inside of a 6 inch OD fiberglass launch vehicle body. The rover will drive out of the body section directly behind the nose cone.

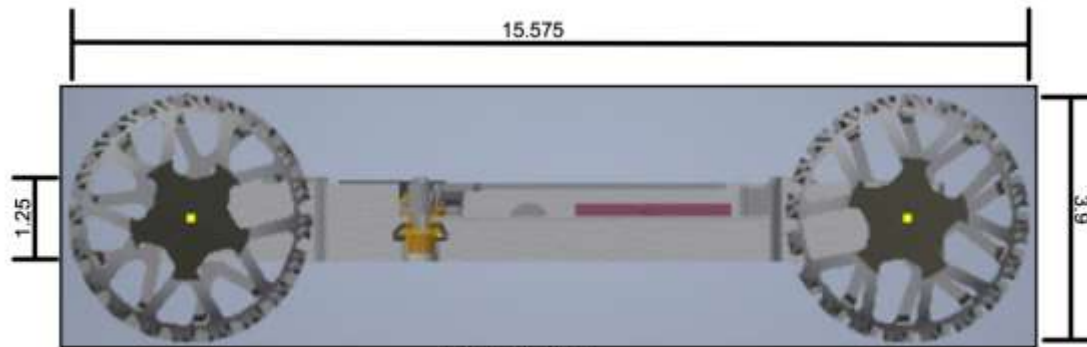
# Final Payload Dimensions



4.8 inches  
Rover Front View



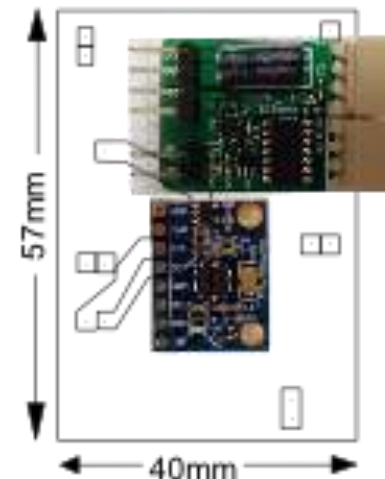
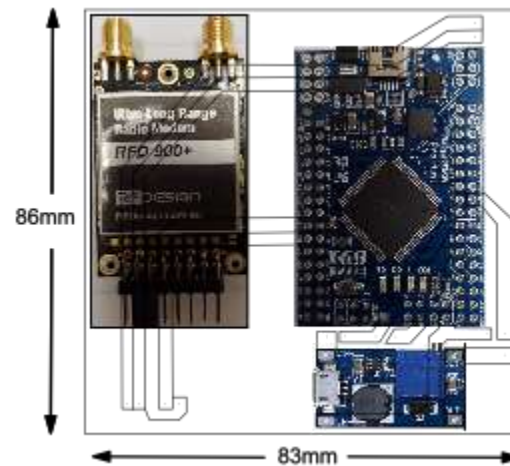
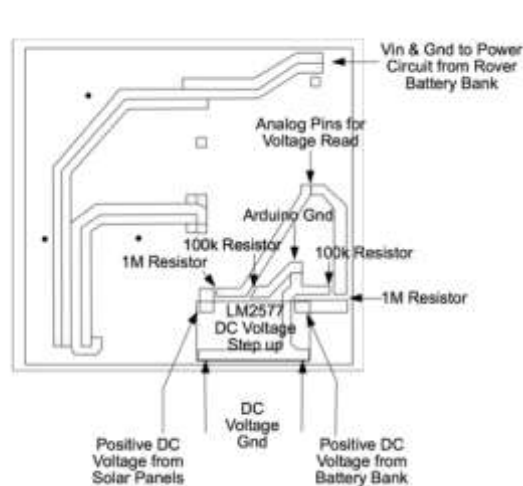
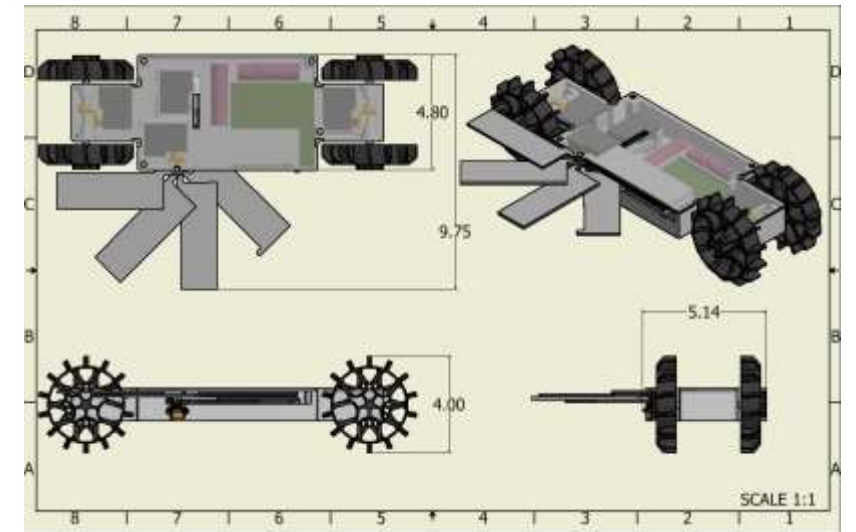
7.3  
2.6  
1.2  
2.4  
Wheel Diameter 3.9  
Dimensions are in inches



15.575  
1.25  
3.9  
Rover Sideview  
Dimensions are in inches

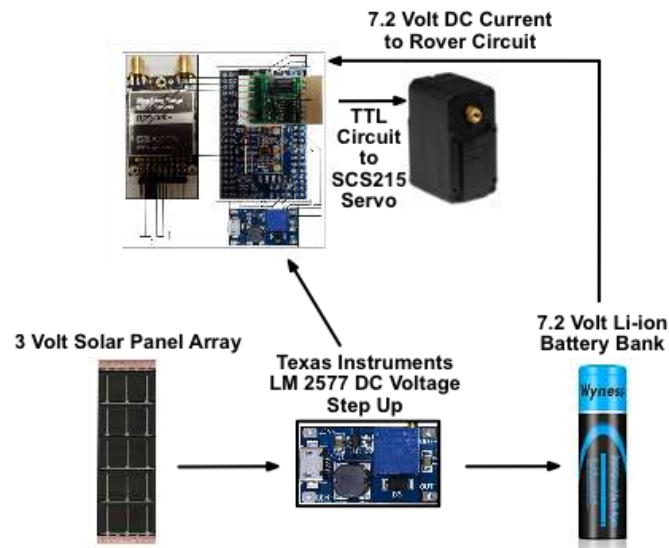
# Payload-Rover Key Features

- The rover will be remotely deployed by a RF Design radio
- FeeTech SCS215 servos employ all mechanical operations
- The solar array charges the rover's battery bank
- A MPU 6050 gyroscope determines the rover's orientation
- An Arduino mega controls the rover and monitors the battery bank



# Payload Power Budget

- The 3000 mAh battery bank is more than sufficient to handle the required actives of the rover.
- The RF Design radio and the SCS215 servos will be operated for a short time period.
- The deployed solar array will supply approximately 180mA to the battery bank which is more than enough to run the circuit without the radio transmitting or the servos running.

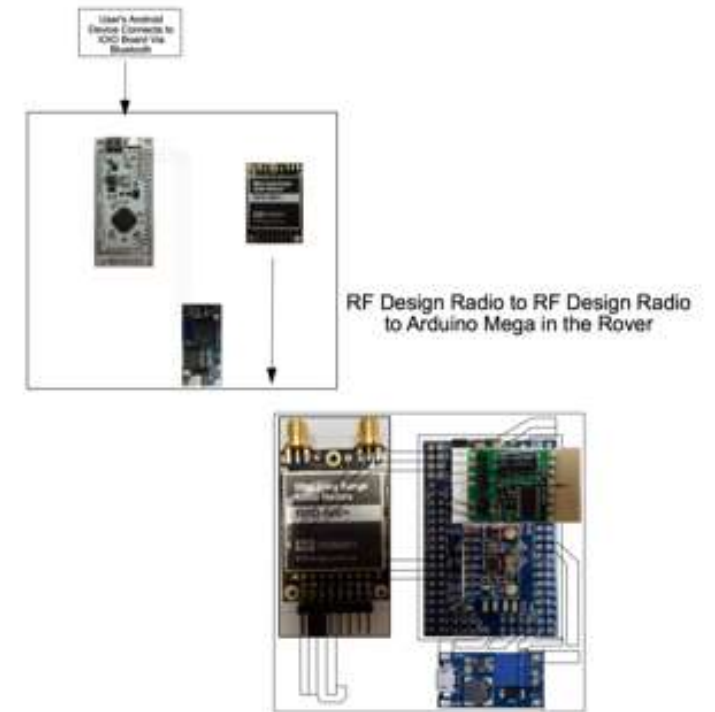


Rover Power Budget	
Arduino Mega	45mA
MPU 6050 Gyroscope	5mA
UART to TTL Circuit	5mA
RF Design Radio Transmit	800mA
RF Design Radio Standby	45mA
SCS215 Servo Engaged	1000mA
SCS215 Servo Standby	5mA
Solar Array	200mA
LM2577 Efficiency	90%
Battery Bank	3000mAh



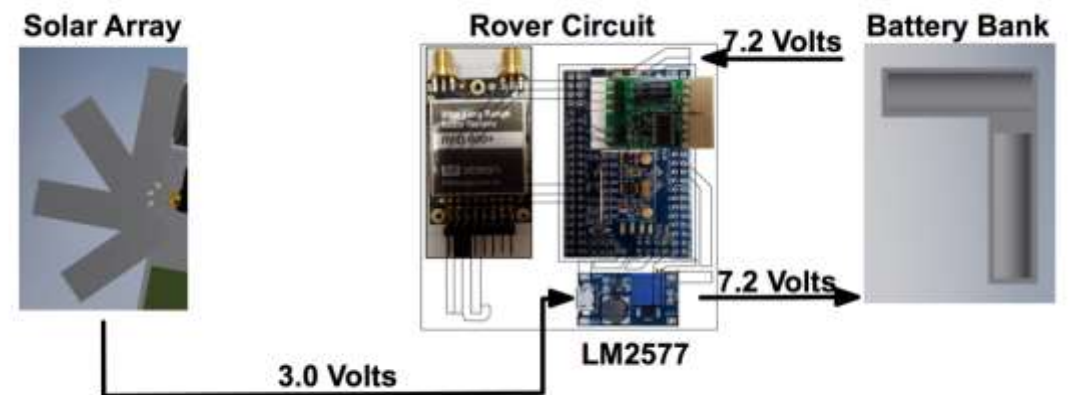
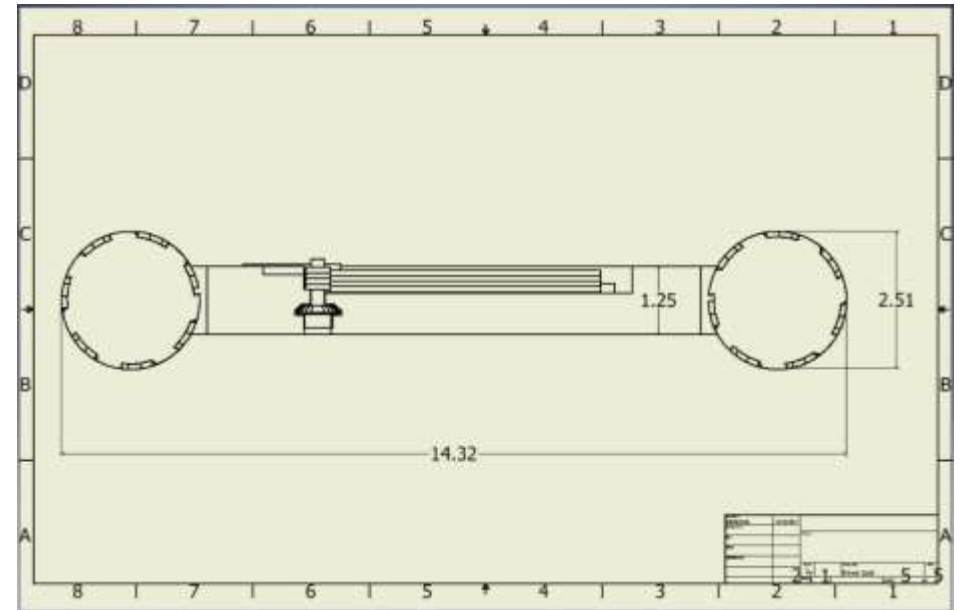
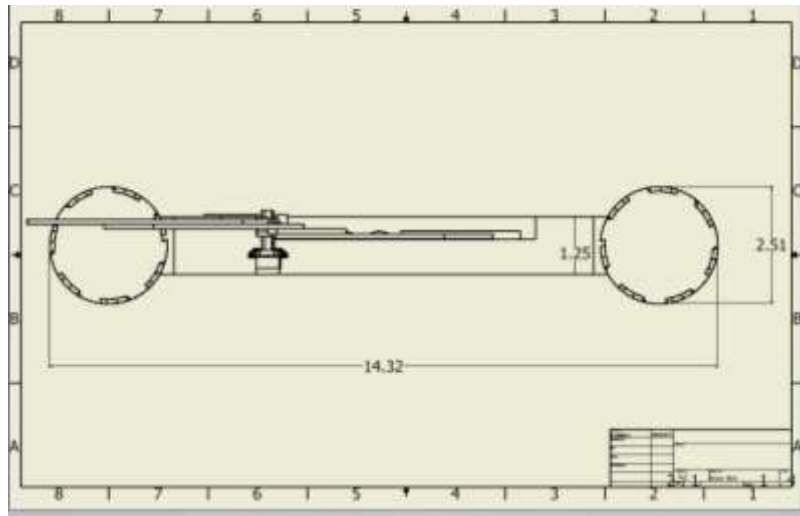
# Payload Remote Deployment

- The rover deployment system is using components of a rocket launch station system the TSU has developed.
- An Android application will be used to deploy the rover and receive data back such as rover battery bank voltage and solar array voltage.
- The user end relies on Bluetooth and the field deployment end relies on RF radio.



# Payload Solar Array

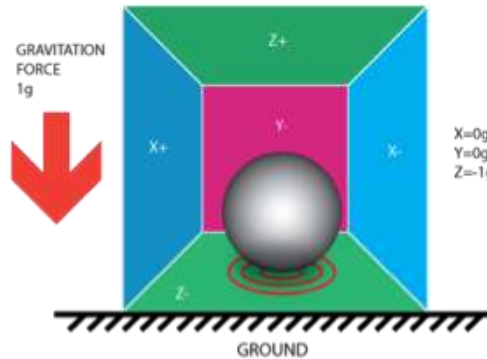
- Eight, 3 volt, 50mA solar panels wired in parallel will deploy from the side of the rover.
- Four panels will face down and four panels will face up so rover orientation is not an issue.



# Payload Software

The Arduino IDE and C++ will be used to build the rover software. A concern is determining the orientation of the rover after landing. The drive direction of the rover will be determined by output from an MPU 6050 gyroscope.

All of the mechanical requirements are handled by 1 UART connection and a common servo protocol.

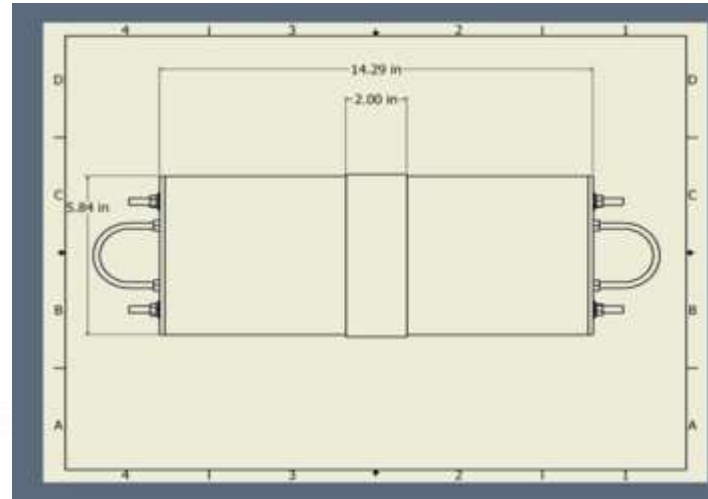
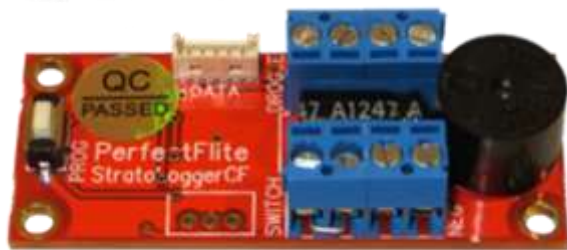


## Parachute Design

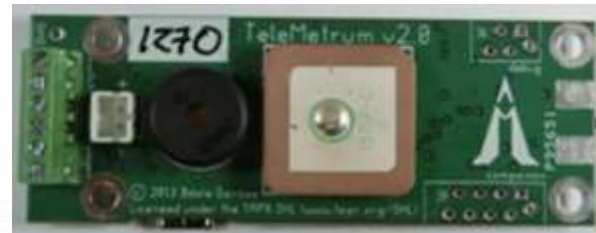
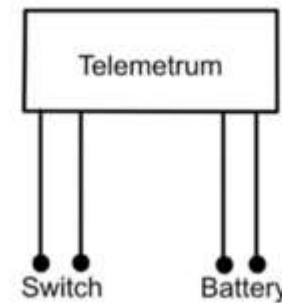
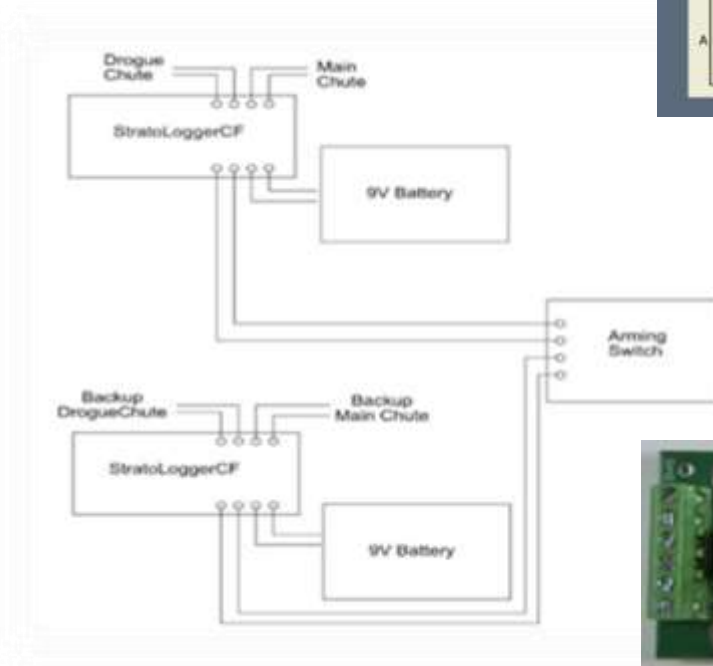
- Ejection of a drogue parachute occurs at apogee.
- Both chutes are protected from black powder ejection charge firing by Nomex cloth.
- The drogue parachute is the Sky Angle CERT-3 Drogue, with a surface area of 6.3 feet, weight of 6.0 oz., and a drag coefficient of 1.16.
- The main parachute is the Sky Angle CERT-3 XXLarge, with a surface area of 129 feet, weight of 64 oz., and a drag coefficient of 2.92.
- The shroud lines are made out of 5/8-inch mil-spec tubular nylon.
- The drogue parachute has three 24-inch shroud lines.
- The main parachute has four 120-inch shroud lines.
- A 1500 pound tested swivel is placed between the main parachute shroud lines and shock cord.
- In the midsection between the payload and avionics bay, 30 feet of z-folded 1/2 inch tubular Kevlar shock cord is attached to the main parachute.
- The main parachute is located 2/3 of the way down the shock cord towards the avionics bay bulkhead.
- In the booster section below the avionics bay, 30 feet of z-folded 1/2 inch tubular Kevlar shock cord is attached to the drogue parachute.
- The drogue parachute is located 2/3 of the way down the shock cord towards the booster section.



## Altimeter System



- Copper shielding lines all surfaces of the lower avionics bay compartment
- The Altimeter system houses the StratologgerCF deployment altimeters.
- The Telemetry v2.0 is not wired to any black powder ejection charges and must transmit data.
- It is not in a shielded compartment.



# Recovery

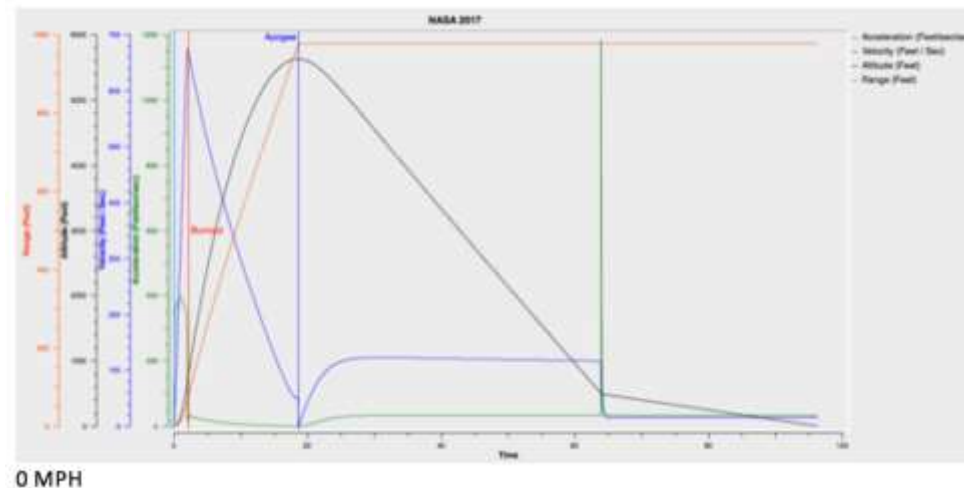
## Kinetic Energy

Vehicle Section	Kinetic Energy (foot-pounds)
Nose Cone Section	20.644
Payload Section	20.414
Middle Section & AV Bay	34.522
Booster Section	73.5949

## Drift Calculations

Wind Speed	Calculated Drift
0 MPH	0 ft
5 MPH	555.394 ft
10 MPH	1110.864 ft
15 MPH	1666.258 ft
20 MPH	2221.652 ft

## Predicted Drift Diagram



# Subscale Flight Test



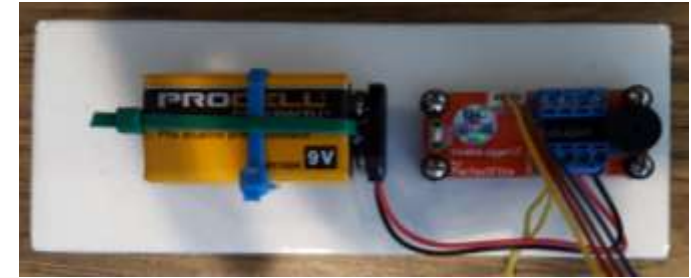
Drogue Parachute Ejection Test



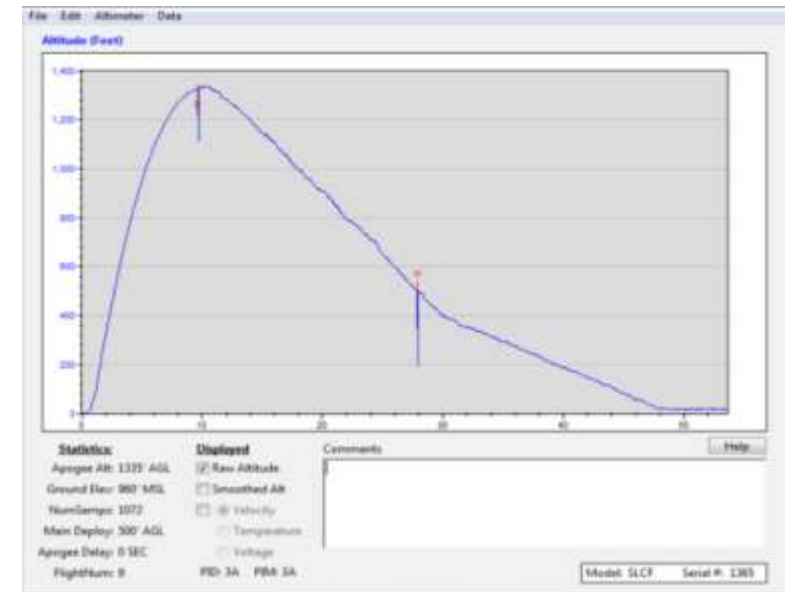
Main Parachute Ejection Test



Subscale Launch 1/5/18



Avionics Bay Sled



StrattoLogger Data



# Test Plans and Procedures

15-Jan	Complete Build of Payload: Rover
15-Jan	Payload Testing
15-Jan	Start Building Avionics Bay
18-Jan	Complete Avionics Bay
19-Jan	Start Building Payload Housing and Nose Cone
26-Jan	Complete payload housing and Nose Cone
27-Jan	Complete Midsection
29-Jan	Start Building Booster Section
31-Jan	CDR video teleconferences
2-Feb	Complete Booster Section
2-Feb	Complete Full-Scale Launch Vehicle
6-Feb	Launch Vehicle and Recovery Subsystem Sub-scale Testing: 2
7-Feb	Flight Readiness Review (FRR) Q&A
8-Feb	Ejection Testing
9-Feb	Full Scale Flight Testing
9-Feb	Recovery Subsystem Testing

## Tests to be Conducted

- Payload Testing
- Ejection Testing
- Sub-scale Testing
- Full-scale Flight Testing

## Procedures/Checklists

- Recovery Preparation
- Motor Preparation
- Setup on Launcher
- Igniter Installation
- Troubleshooting
- Post-flight Inspection
- Travel Checklists



# Educational Outreach



- National Association of Rocketry
  - Nar.org
  - <http://www.nar.org/educational-resources/>
- Safety Overview: [http://www.nar.org/wp-content/uploads/2014/08/hobby\\_overview.pdf](http://www.nar.org/wp-content/uploads/2014/08/hobby_overview.pdf)
- Rocketry Basics: <http://www.nar.org/wp-content/uploads/2014/03/NAR-Rocketry-Basics.pdf>

