



Critical Design Review

NASA USLI

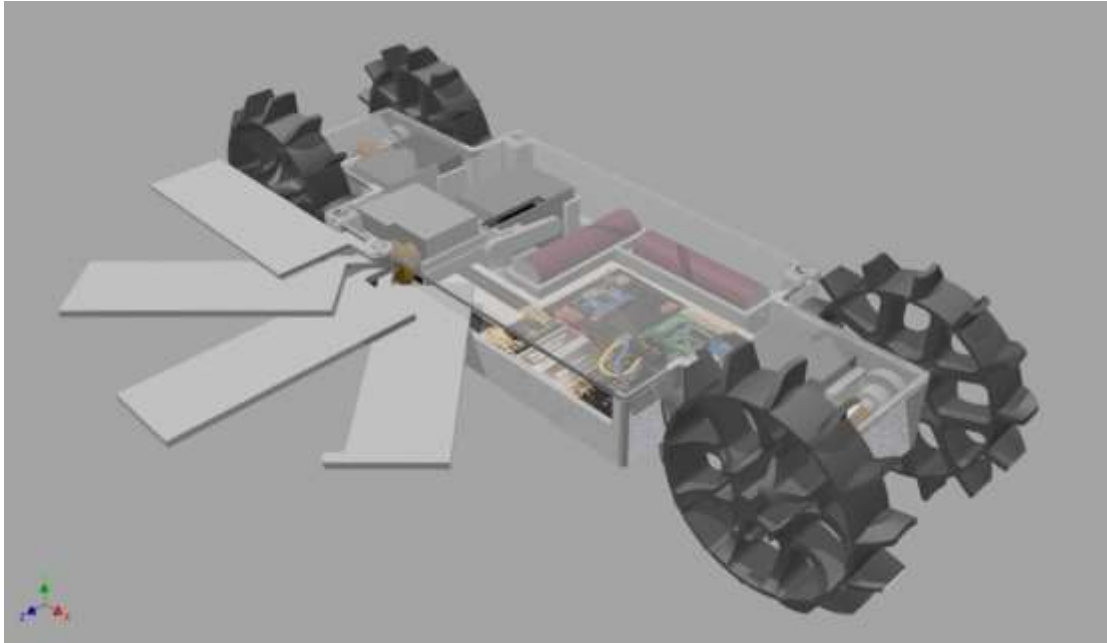
Tarleton Aeronautical Team

Tarleton State University

January 17, 2018

Introduction

The team proposes to complete Option 2: Deployable Rover

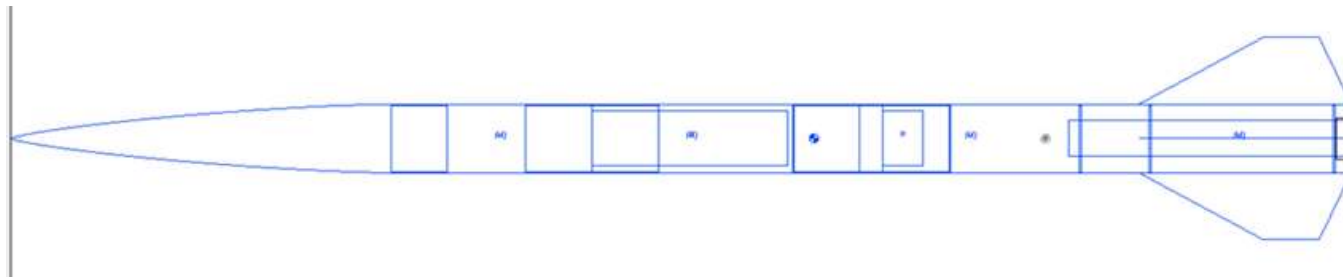
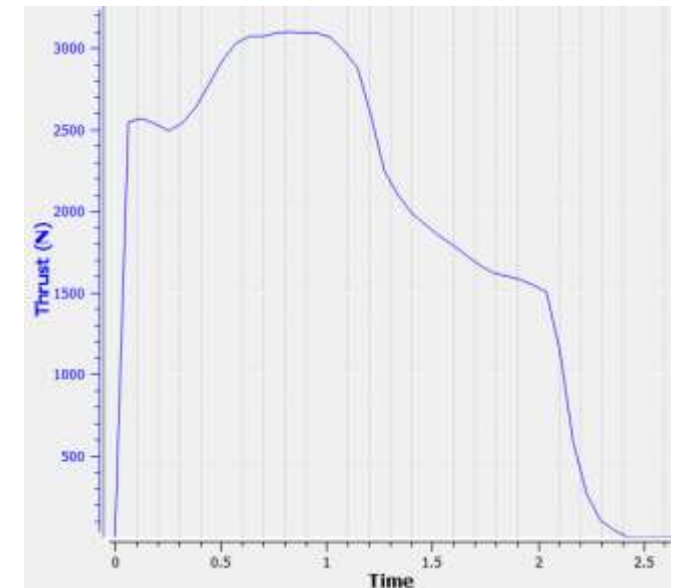


- The rover will deploy from an 18 inch long section that is directly behind the nose cone.
- The rover design is focused on modularity and simplicity.
- The same servos are used throughout the rover to control all of the mechanical aspects. The solar panels and the launch vehicle securing mechanism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

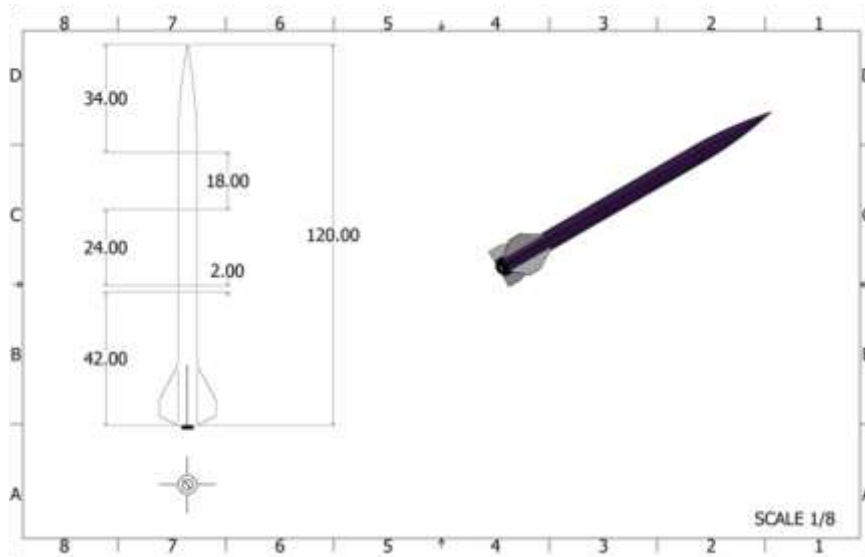


Final Launch Vehicle

- 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

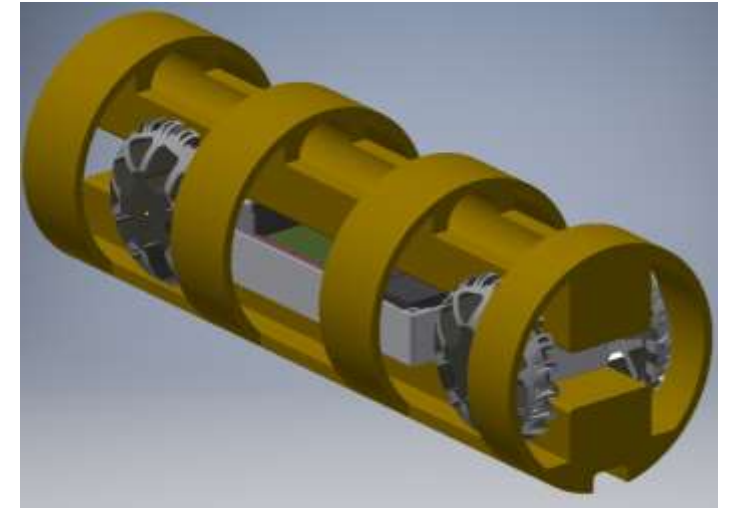
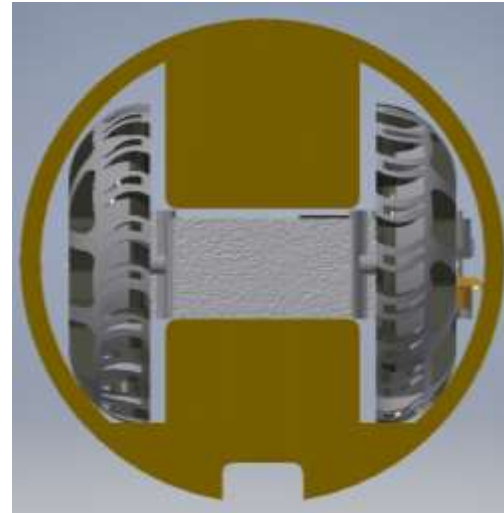
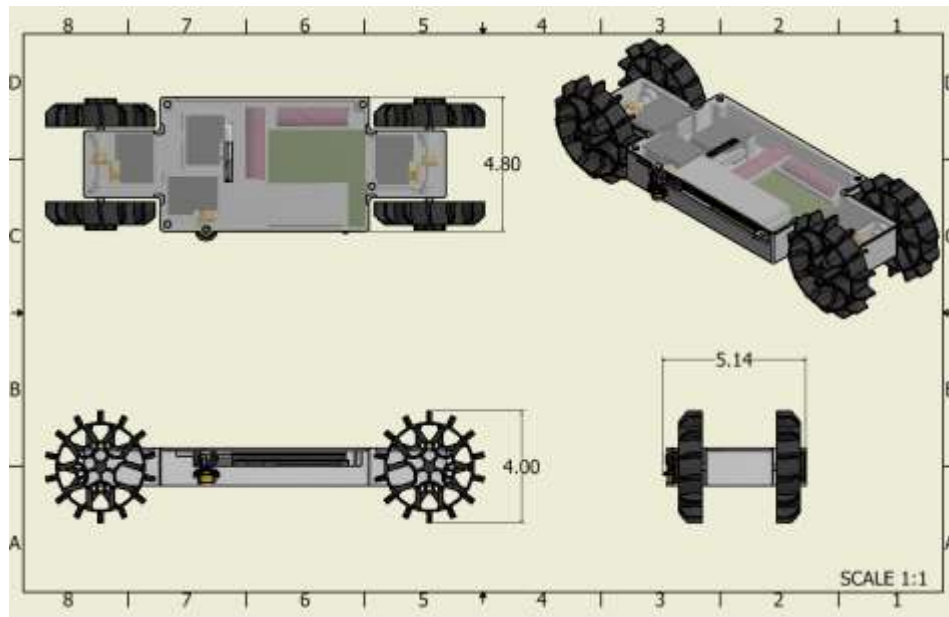


| Component | Dimensions (length, inches) | Material |
|-------------------|-----------------------------|----------------------------------|
| Nose Cone Section | 34 inches | G12 Fiberglass with Aluminum Tip |
| Rover Housing | 18 inches | G12 Fiberglass |
| Middle Section | 24 inches | G12 Fiberglass |
| 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 |

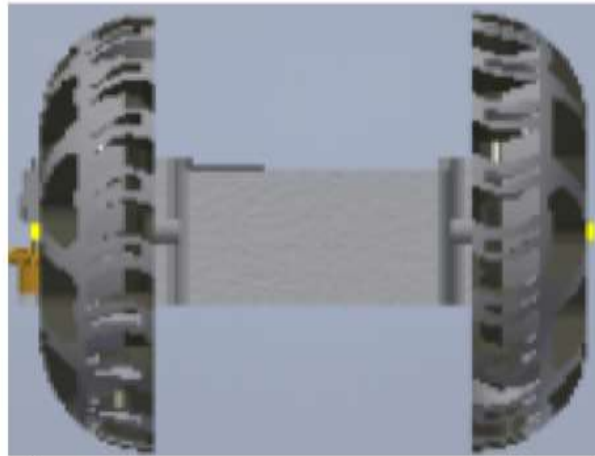
Final Payload - Rover

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.

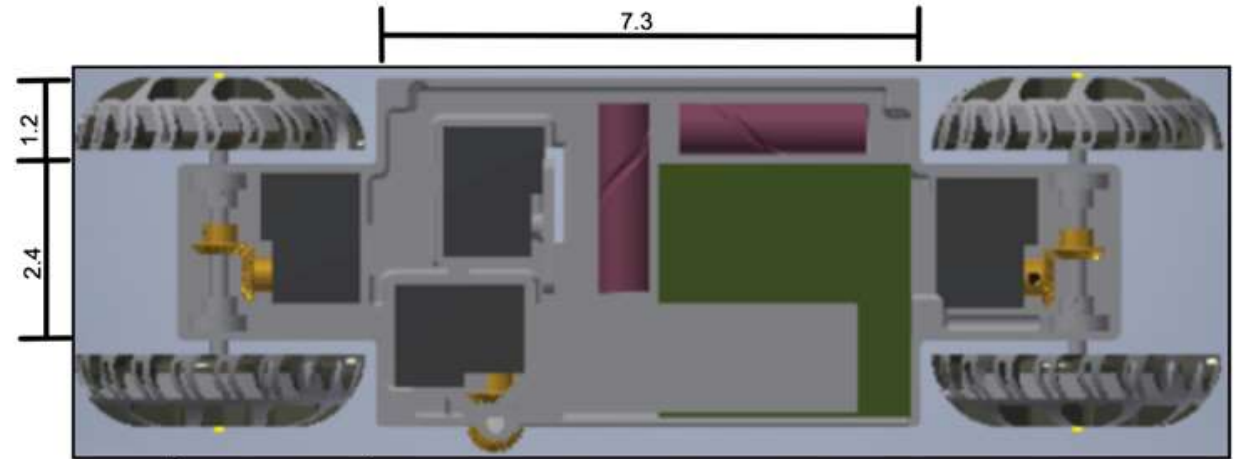


The rover is designed to fit inside of a 6 inch OD fiberglass launch vehicle body. The rover will drive out of the body section directly behind the nose cone.

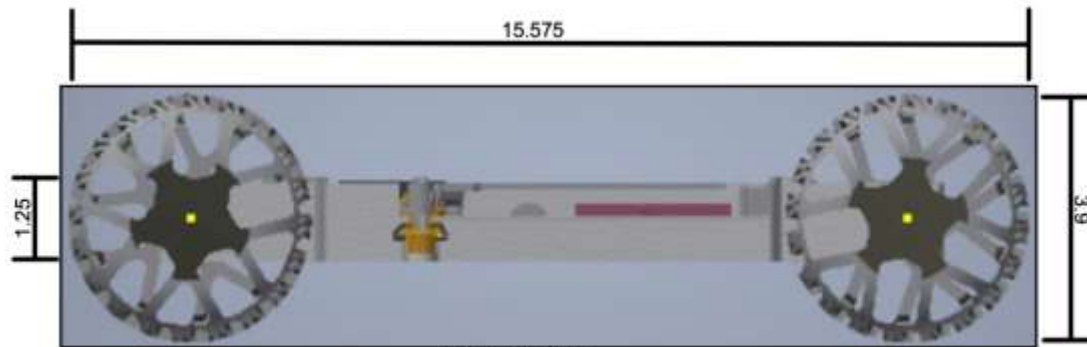
Final Payload Dimensions



4.8 inches
Rover Front View



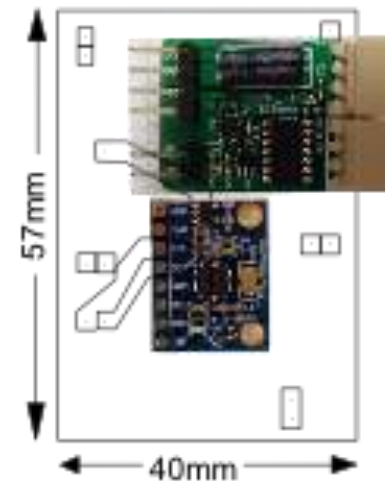
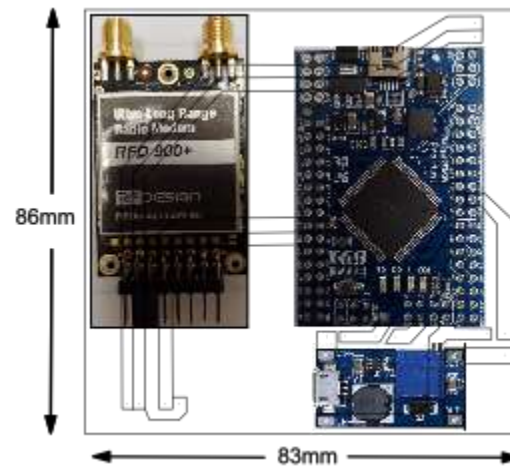
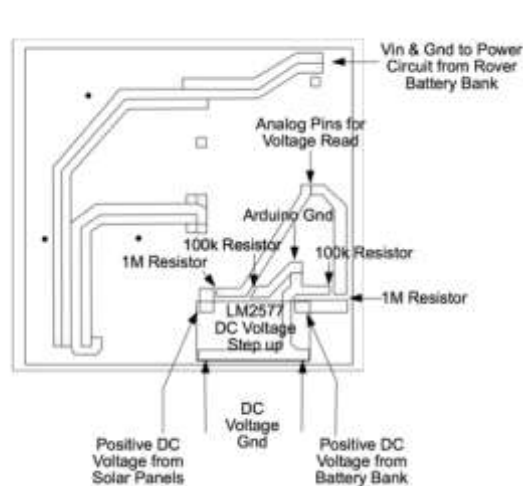
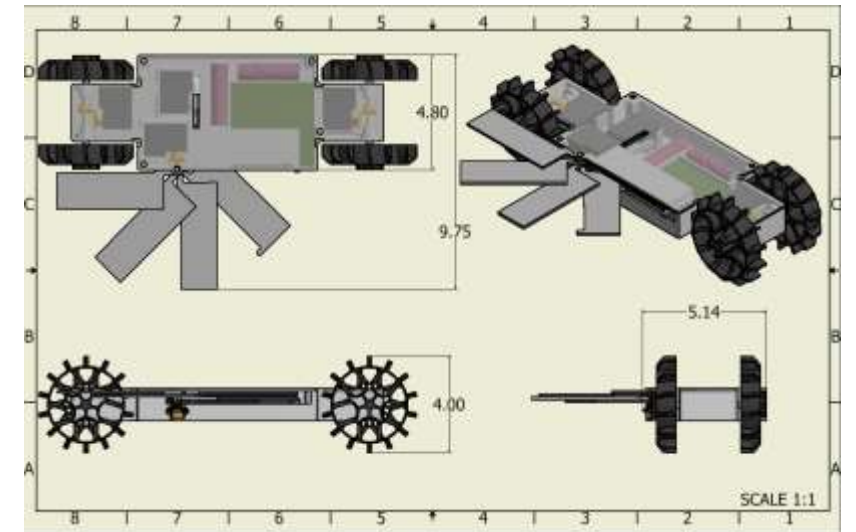
7.3
2.6
1.2
2.4
Wheel Diameter 3.9
Dimensions are in inches



15.575
1.25
3.9
Rover Sideview
Dimensions are in inches

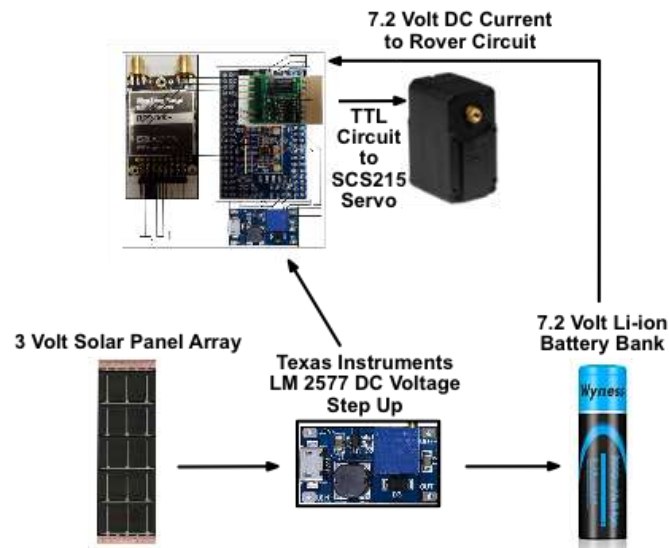
Payload-Rover Key Features

- 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 |

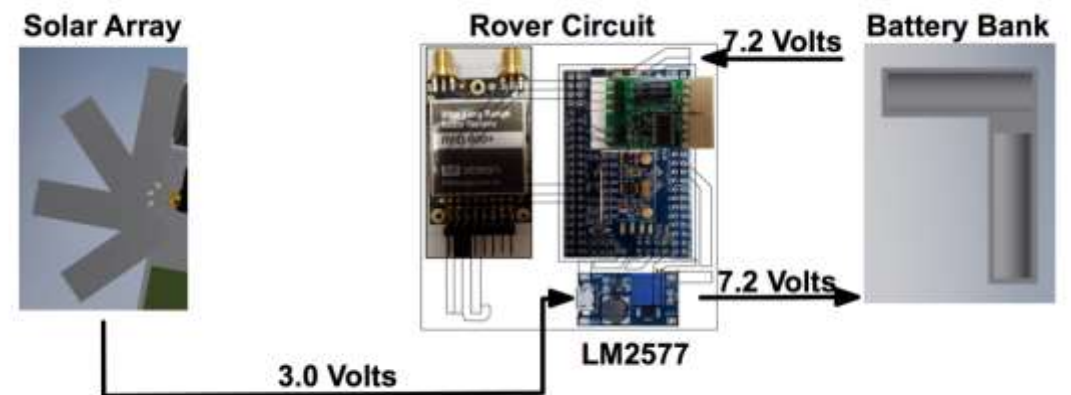
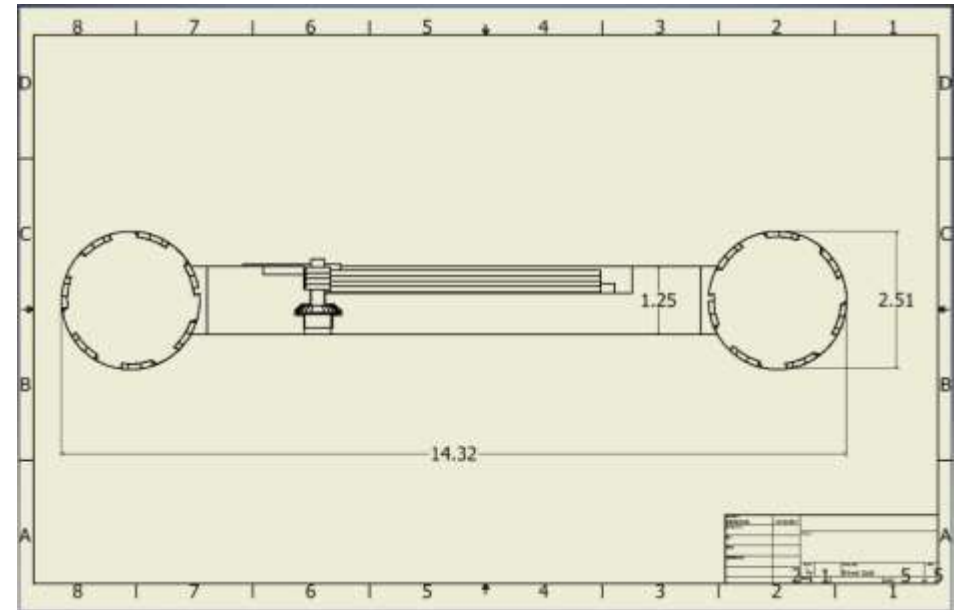
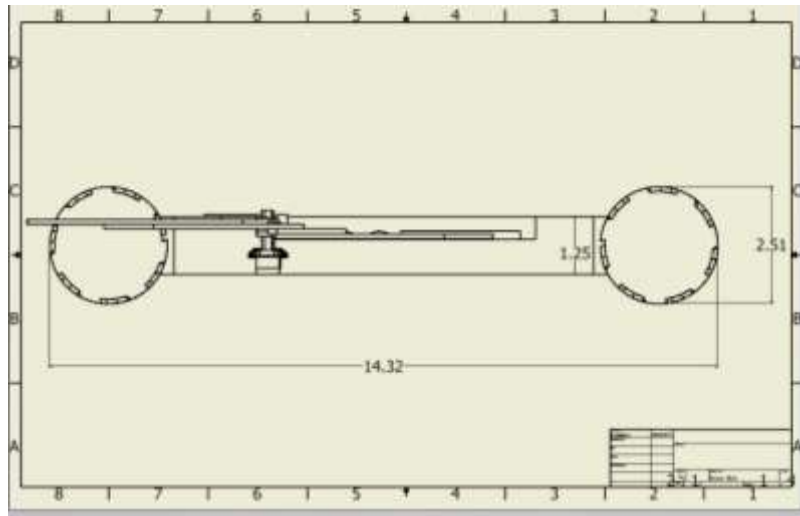
Payload Remote Deployment

- 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

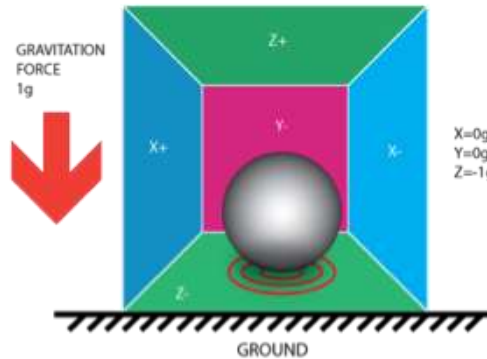
- Eight, 3 volt, 50mA solar panels wired in parallel will deploy from the side of the rover.
- Four panels will face down and four panels will face up so rover orientation is not an issue.



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.

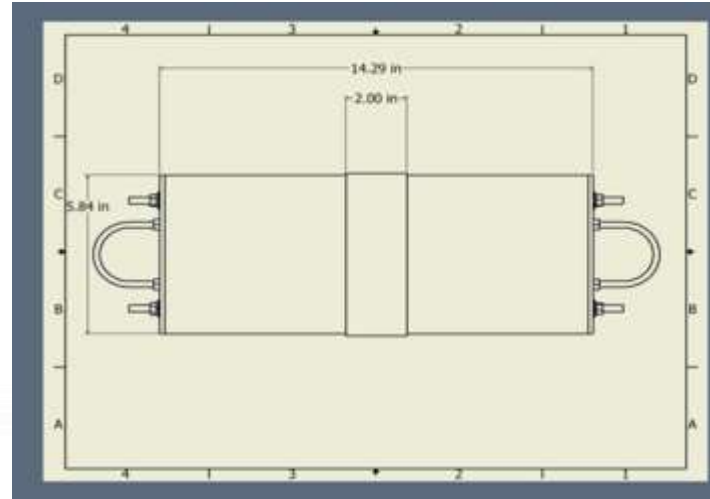


Parachute Design

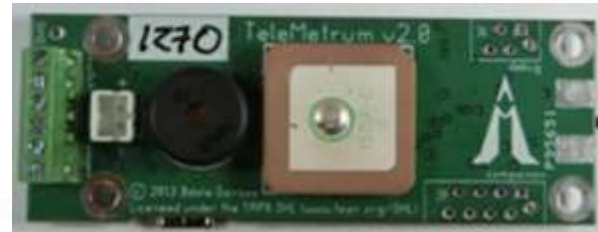
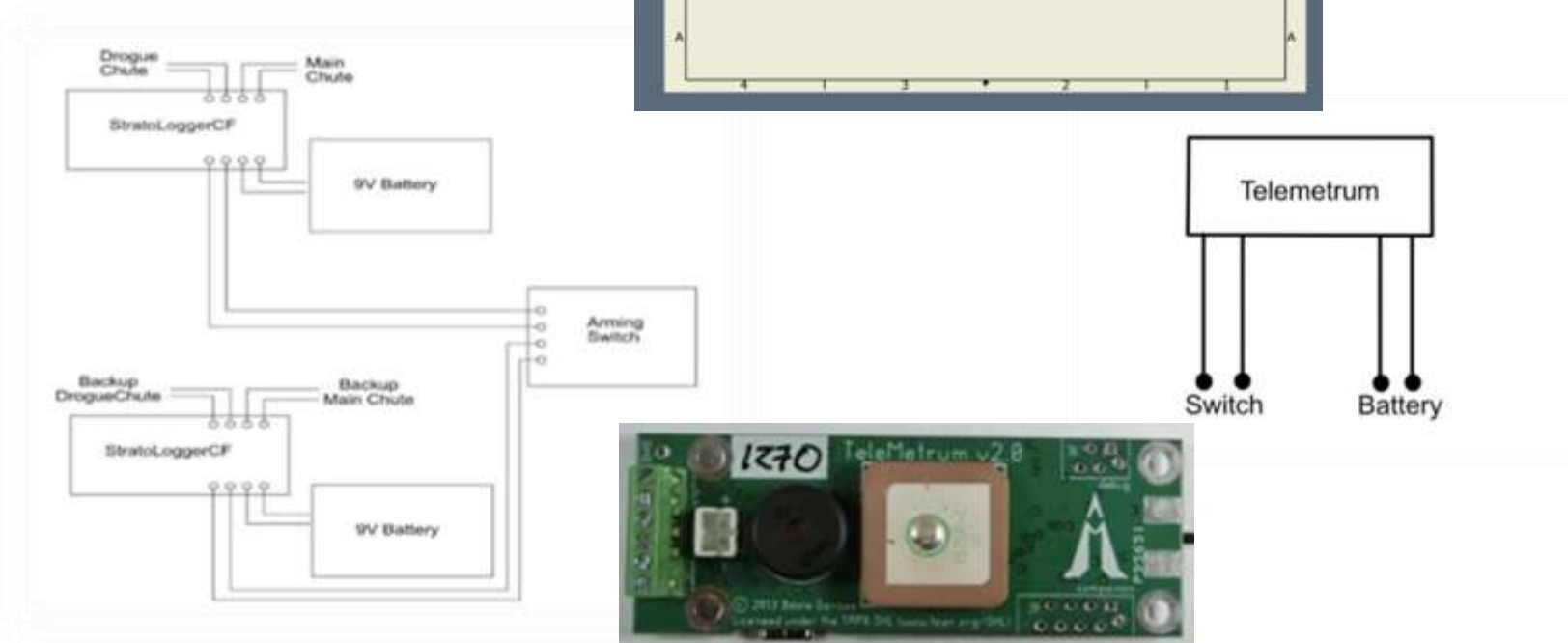
- Ejection of a drogue parachute occurs at apogee.
- Both chutes are protected from black powder ejection charge firing by Nomex cloth.
- The drogue parachute is the Sky Angle CERT-3 Drogue, with a surface area of 6.3 feet, weight of 6.0 oz., and a drag coefficient of 1.16.
- The main parachute is the 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

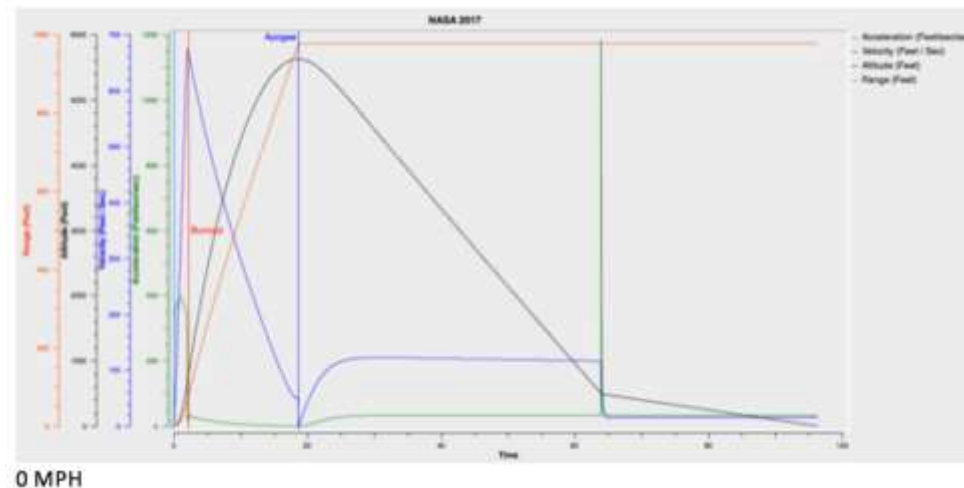
Kinetic Energy

| 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



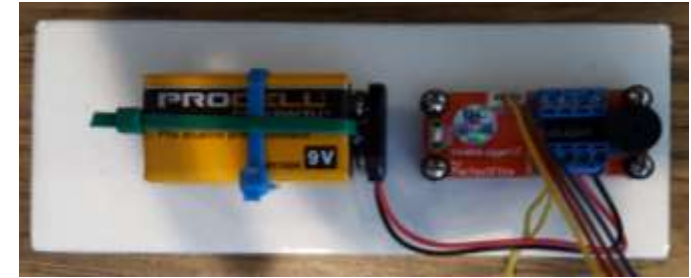
Drogue Parachute Ejection Test



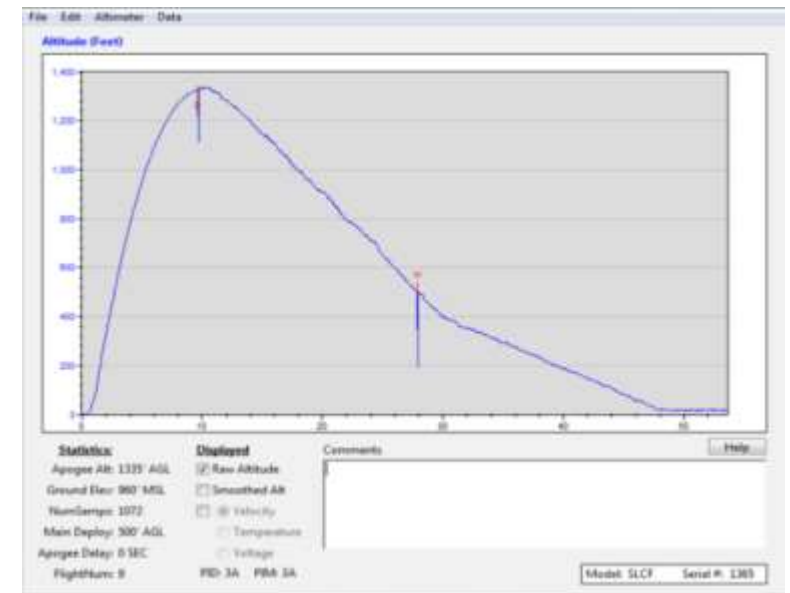
Main Parachute Ejection Test



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
- Rocketry Basics: <http://www.nar.org/wp-content/uploads/2014/03/NAR-Rocketry-Basics.pdf>

