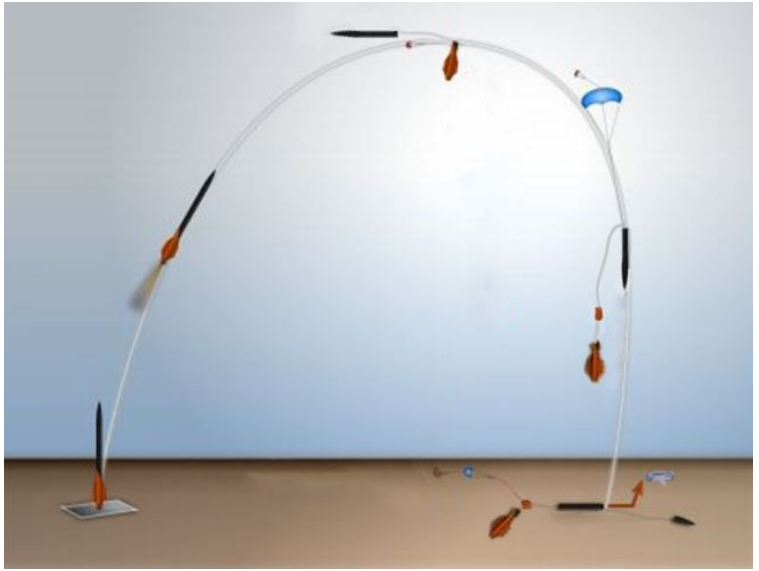
Oregon State University

Preliminary Design Review

11/12/2019

Mission Overview

1. Launch
2. Motor burnout
3. Separation at apogee
4. Drogue parachutes deploy
5. Main parachutes deploy
6. Landing
7. Rover deployment
8. Ice collection
9. Ice transportation

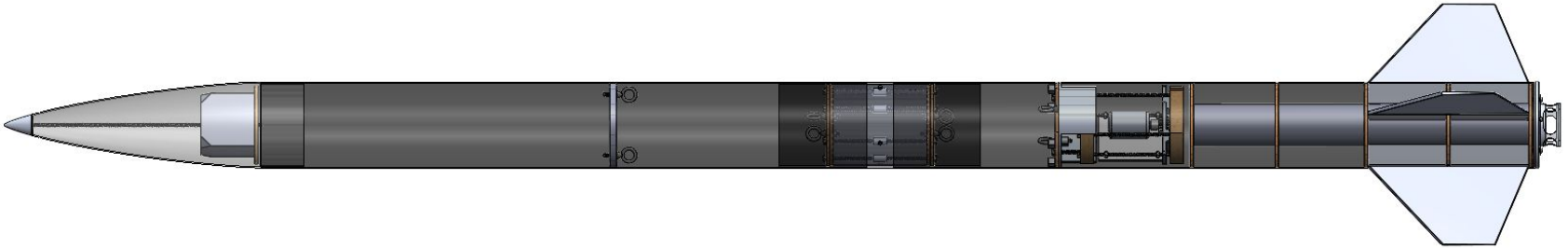


Launch Vehicle Overview

Length: 118 in.

Weight: 60 lbf

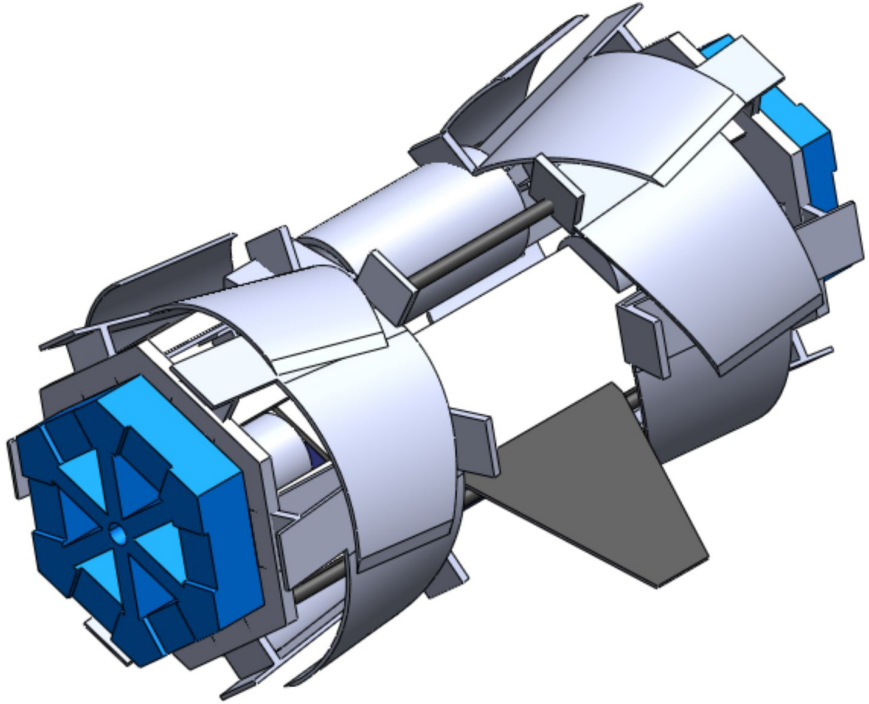
Inner Diameter: 6.25 in.



Payload Overview

Total Length: 17 in.

Total Weight: 13 lbf



Aerodynamics and Recovery

Stability Margin

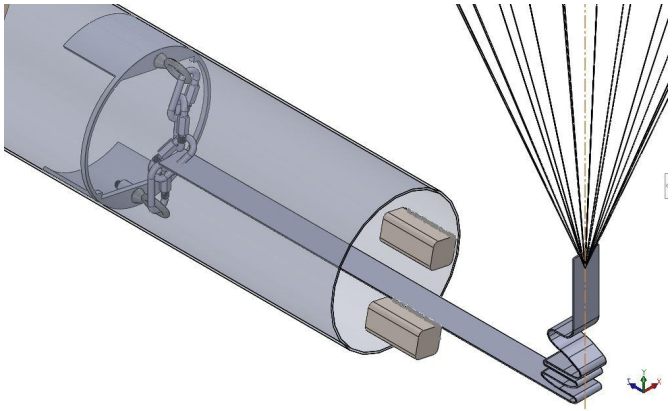
- CG: 68.51 in.
- CP: 87.81 in.
- Stability:
  - 3.01 on rail
  - 3.07 at rail exit
- Mass: 60 lb
- Rail Exit Velocity: 92.2 ft/s

Projected Altitude

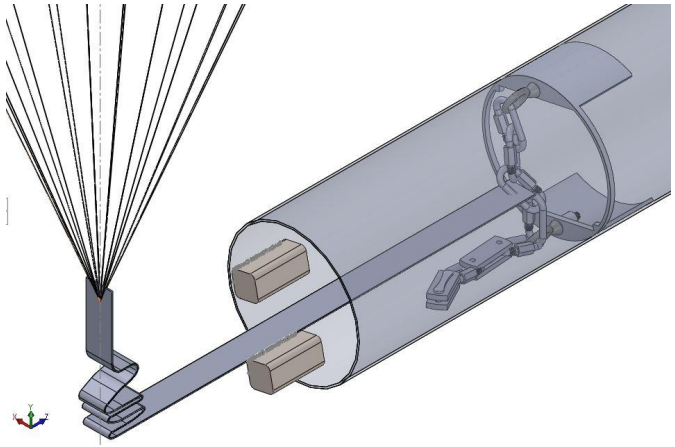
Wind Speeds	Projected Altitude	Descent Time	Ballast
0 mph	4120 ft	87.6 s	1 lb in nose 4 lbs in aft
5 mph	4112 ft	87.6 s	1 lb in nose 4 lbs in aft
10 mph	4095 ft	87.6 s	1 lb in nose 4 lbs in aft
15 mph	4067 ft	86.7 s	1 lb in nose 4 lbs in aft
20 mph	4030 ft	86.7 s	1 lb in nose 4 lbs in aft

Recovery

Layout - Dual deployment Dual compartment



Fore section Drogue parachute Housing



Aft Section Main Parachute Housing

Recovery

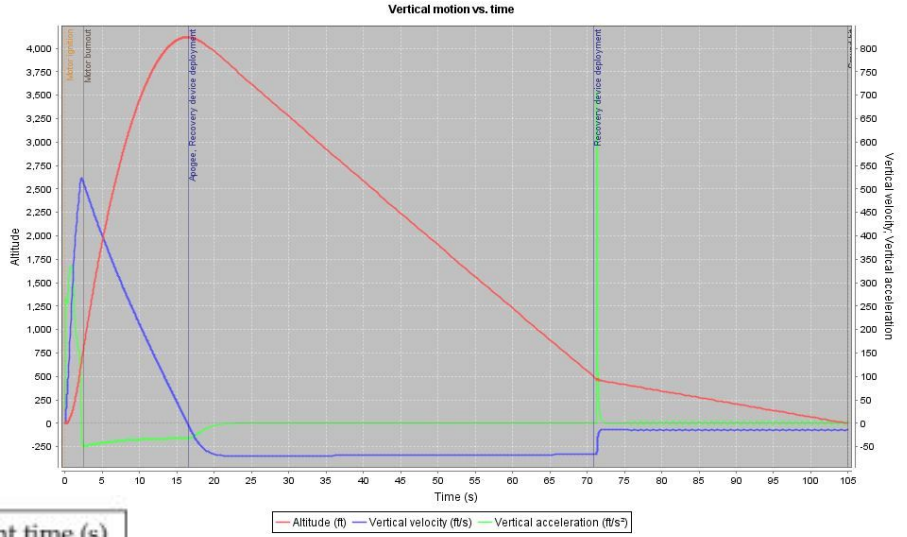
Parachutes stats

- Main Parachute- 12ft Toroidal Iris Ultra 2.2 cd
- Drogue Parachute- 4ft Elliptical 1.7 cd
- The given impact velocity will be 14.2 ft/s
- The given impact energy will be 63.1 ft-lbf
- The drogue chute will have a speed of 64.6 ft/s

Recovery

Descent Times

- Descent time is 88.8s
  - Under NASA Req <90s



Drift openrocket

Wind Speed (mph)	0	5	10	15	20	Descent time (s)
Drift OpenRocket (ft)	6.5	412.5	875	1250	1750	88.8

Recovery

Shock cord

Nylon 1” 200lb+ vehicle rating

Tape and artificial zipper

Drogue parachute-5x length of vehicle 45ft

Main Parachute-2x length of vehicle 18ft

Tether from coupling to vehicle 2x12ft sections

Parachute Packing

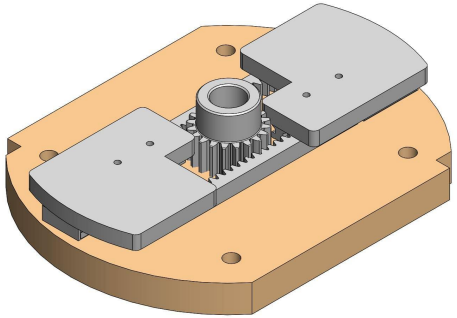
Drogue Parachute- Fold and wrap method in a nomex blanket

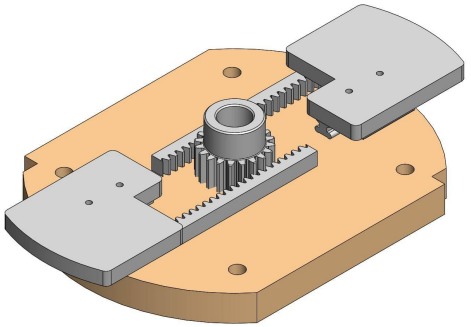
Main Parachute - Deployment bag

Blade Extending Apogee Variance System 2.0 (BEAVS 2.0)

- **B**lade **E**xtending **A**pogee **V**ariance **S**ystem 2.0

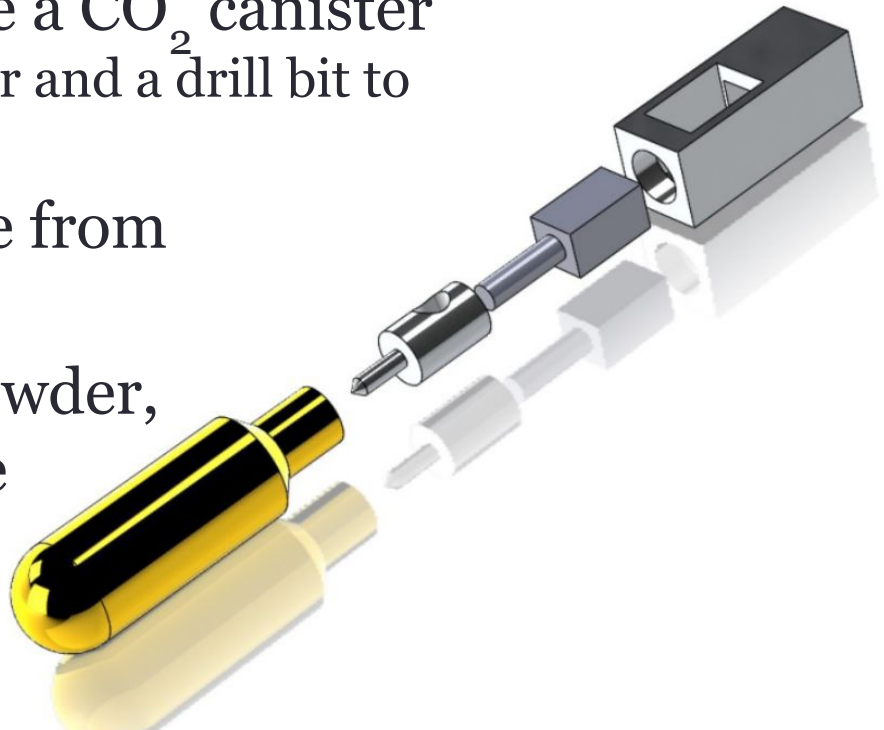
- Actively reduces the projected altitude of the launch vehicle by producing drag





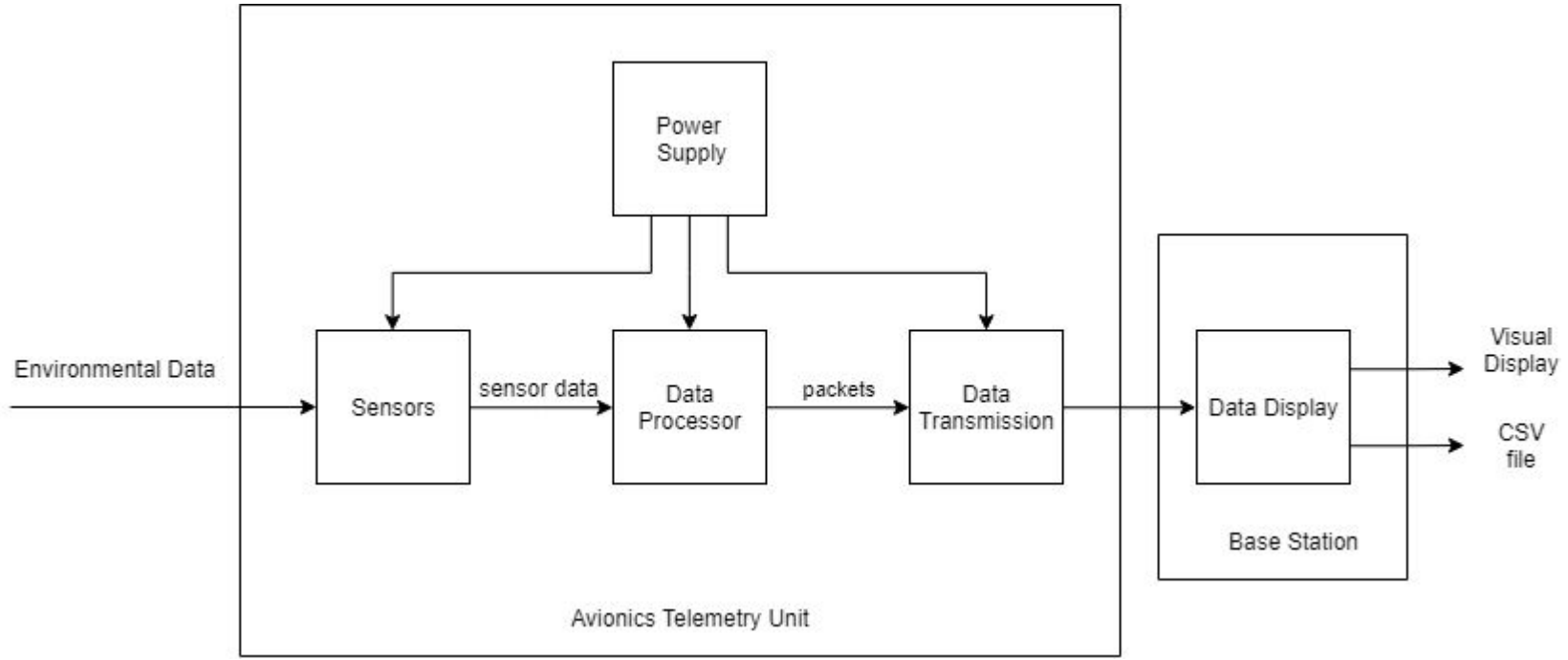
CO_2 Parachute Ejection System

- Use a solenoid to puncture a CO_2 canister
  - Back up design: use a motor and a drill bit to puncture the canister
- Calculate CO_2 canister size from Black Powder
- Back up charges: Black Powder, scaled to 1.5 the size of the main charges



Avionics and BEAVS Electronics

Avionics


Power Supply
Environmental Data
Sensors
sensor data
Data Processor
packets
Data Transmission
Avionics Telemetry Unit
Data Display
Base Station
Visual Display
CSV file

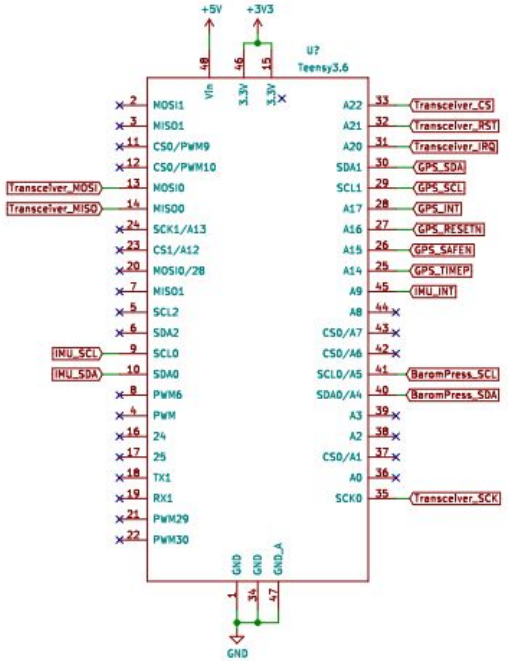
Avionics

Sensors:

- GNSS - tracks location
- IMU - acceleration
- Barometric pressure

Data processing:

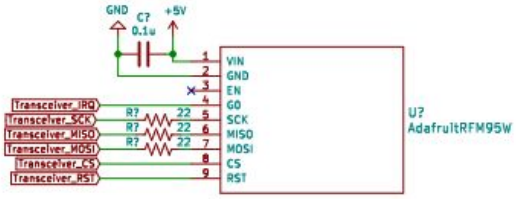
- Teensy
- TI M4 Cortex



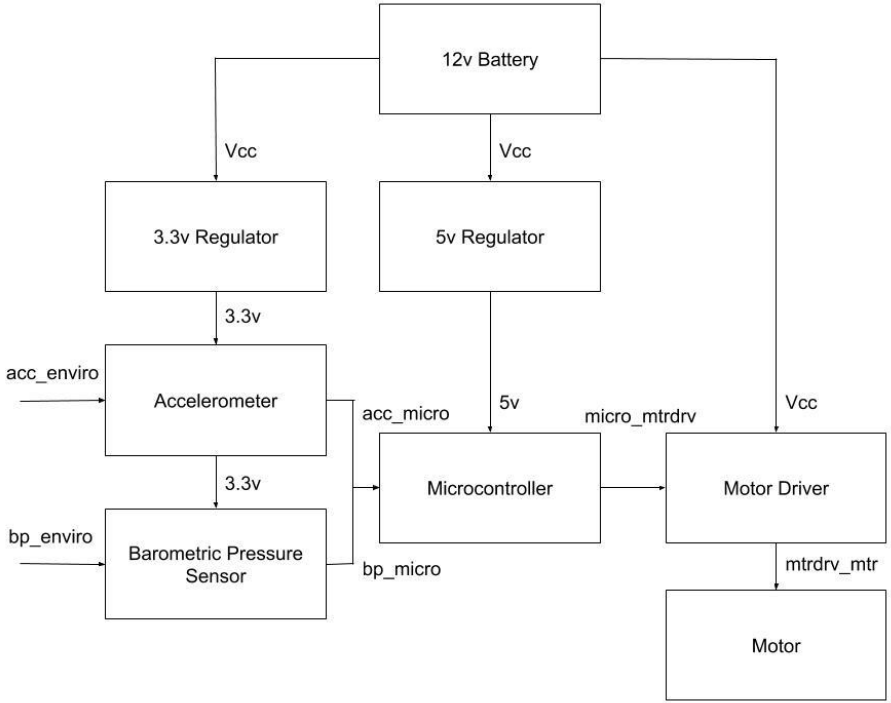
Avionics

Data Transmission:

- Based on LoRa
- Will use error detection
  - Header validation
  - Checksum
  - Parity



BEAVS 2.0


12v Battery
Vcc
Vcc
3.3v Regulator
5v Regulator
3.3v
acc_enviro
Accelerometer
acc_micro
5v
micro_mtrdrv
Vcc
3.3v
Microcontroller
Motor Driver
bp_enviro
Barometric Pressure Sensor
bp_micro
mtrdrv_mtr
Motor

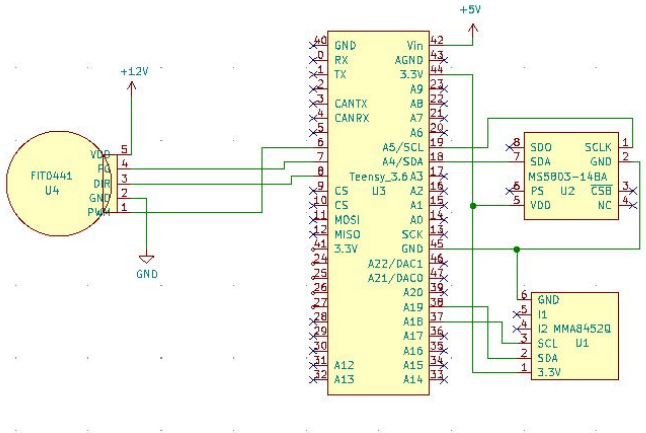
BEAVS 2.0

Sensor:

- Detects altitude
- Causes actuation of motors

Data Storage:

- microSD card storage record altitude
- Will record when BEAVS is deployed



Avionics and BEAVS Software

Avionics

- Display data via GUI
- Map to plot location
- Utilizing Python for GUI creation

- C will be used for avionics firmware
- Fast/ optimizable/ portable

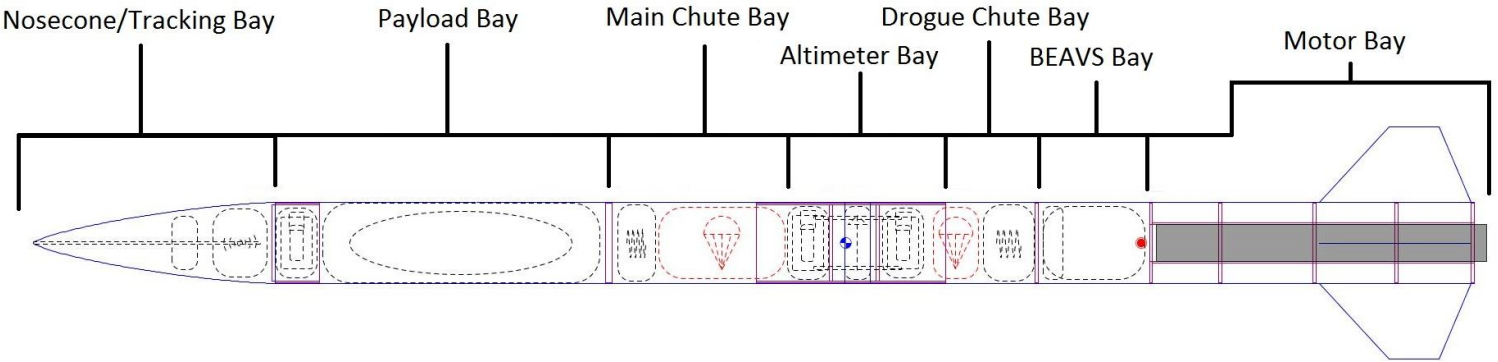
BEAVS 2.0

- Motor control scheme
- Sensor data acquisition and integration control scheme
- PID control loop with variable set point

Launch Vehicle Structures and Propulsion

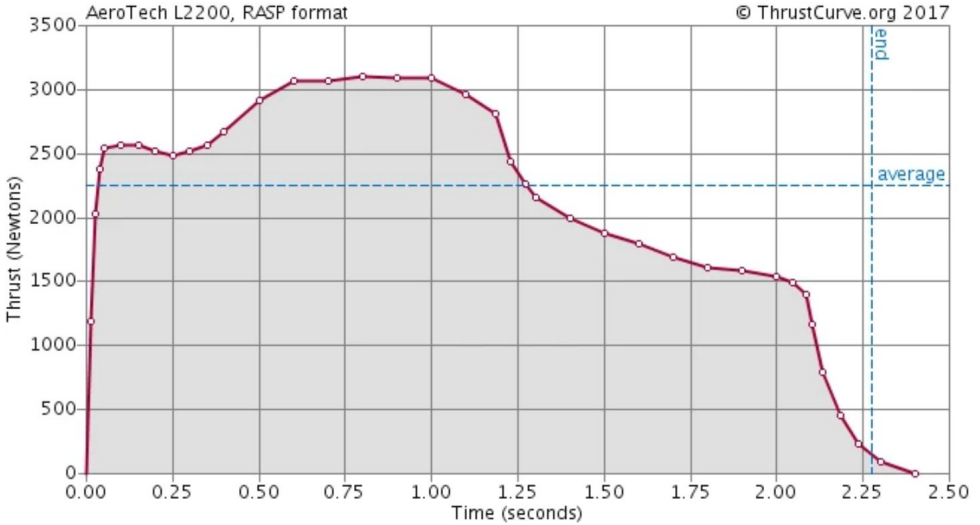
Airframe

Layout of launch vehicle



Motor Selection

- Motor selection as of PDR - AeroTech L2200G
- Estimated apogee: 4200 ft
- Burn Time: 2.32 seconds
- Average Thrust: 494.6 lb-s
- Total Impulse: 1147 lb-s
- Diameter: 2.95 in.
- Thrust to weight: 8.25:1



Nose Cone

Overview

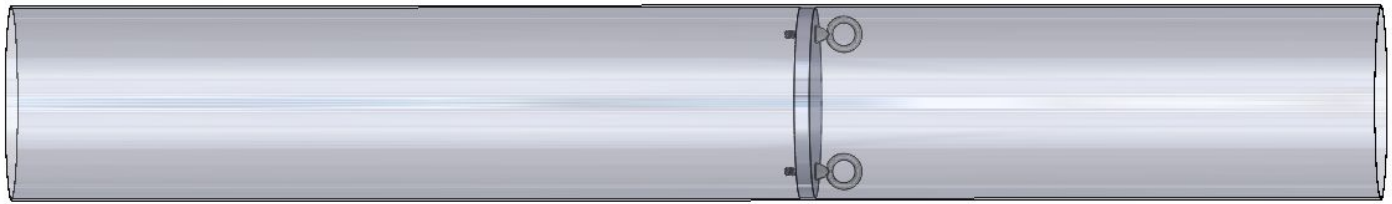
- Ogive nose cone roughly 3.5:1 ratio
- Deployed on the ground by rover deployment system
- Held in place by 4-inch coupler and shear pins
- Manufacturing and availability constraints

Manufacturing

- Modifying commercial 7-inch nose cone
- Fiberglass construction
- Aluminum tip

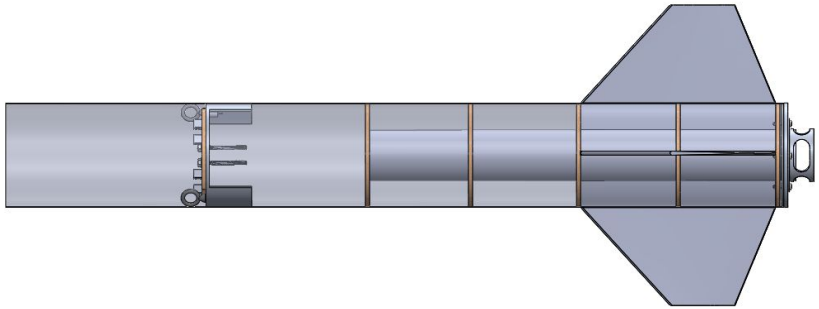
Fore Section

- Simple in over all design
- Houses payload and main parachute
- Filament wound carbon fiber
- Very important to protect payload
- Single bulkhead for both rover and parachute mounting



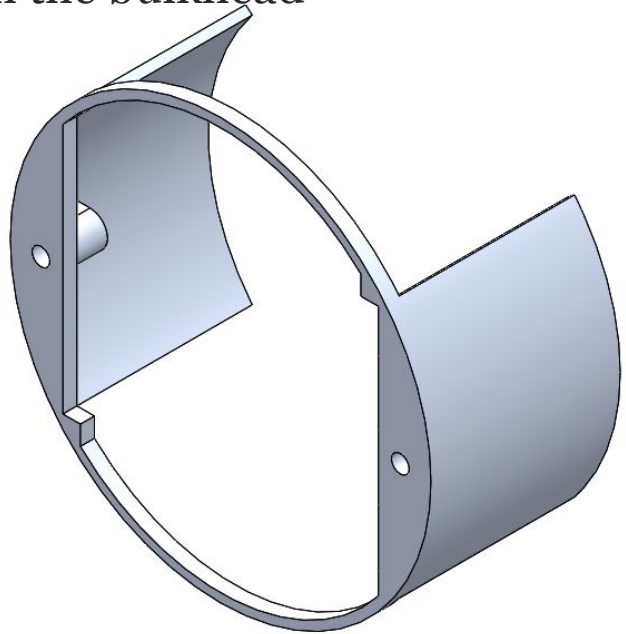
Aft Section

- Intricate construction
- Houses drogue parachute, motor bay, and BEAVS
- Filament wound carbon fiber
- Thrust plate to transfer thrust forces directly to airframe
- Through wall fin construction to increase rigidity for both fins and motor mounting



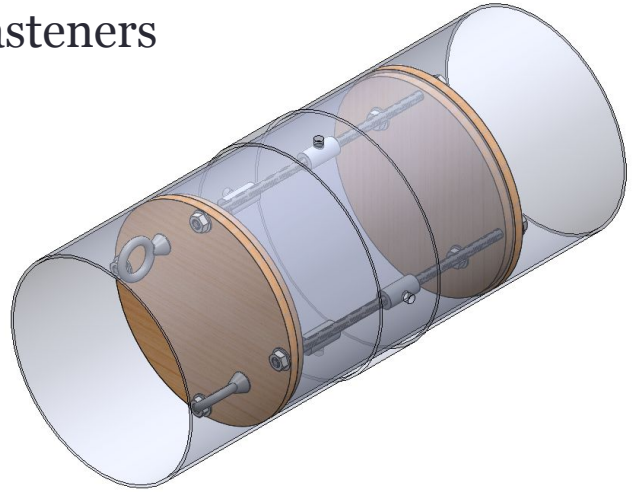
Aft BEAVS/Parachute Mounting

- Special consideration for the aft parachute mounts as BEAVS needs to mount, yet still be accessible through the bulkhead
- Allows strong airframe-to-coupler bond
- Allows BEAVS module through coupler
- Threaded parachute mounting points



Main Coupler

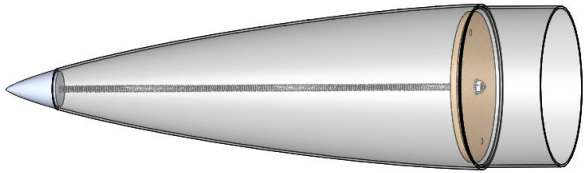
- Houses deployment altimeters, mounting for parachutes and CO2 ejection
- Removable altimeter bay
- 2-inch switch-band to enable external altimeter bay access
- Altimeter bay held in place by external fasteners
- Extends 6.5 inches into airframe



Avionics Bays

Nose Cone Bay

- Houses tracking for entire launch vehicle
- Single through threaded rod for mounting
- 3D-printed mounts for electronics



Coupler Bay

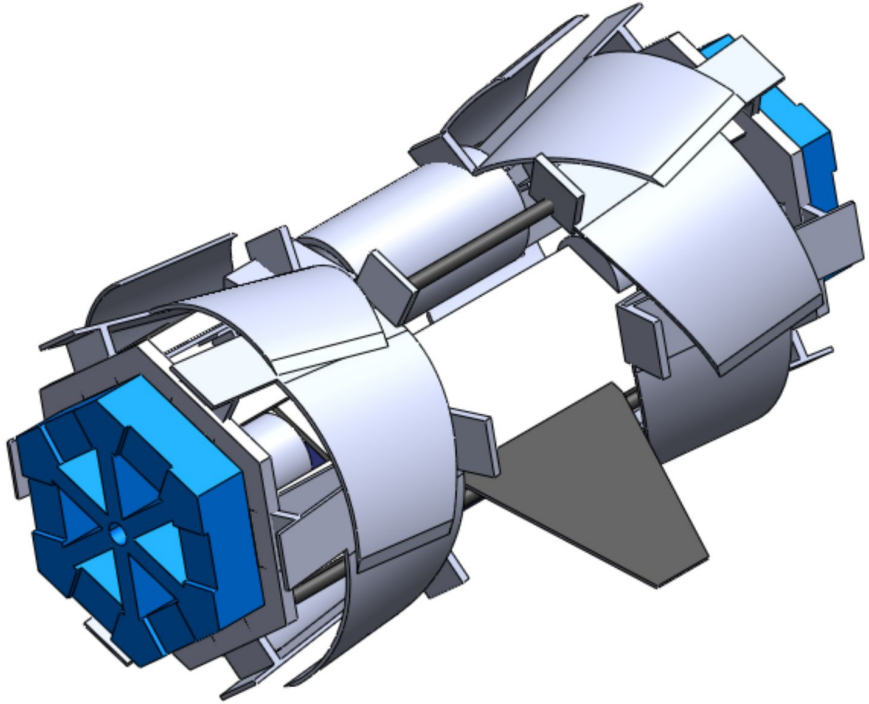
- Houses the altimeters for deployment
- 8 inches long
- 4 threaded rods that can be used for mounting
- 3D-printed mounts
- Easy access and removal for modifications

Payload

Payload

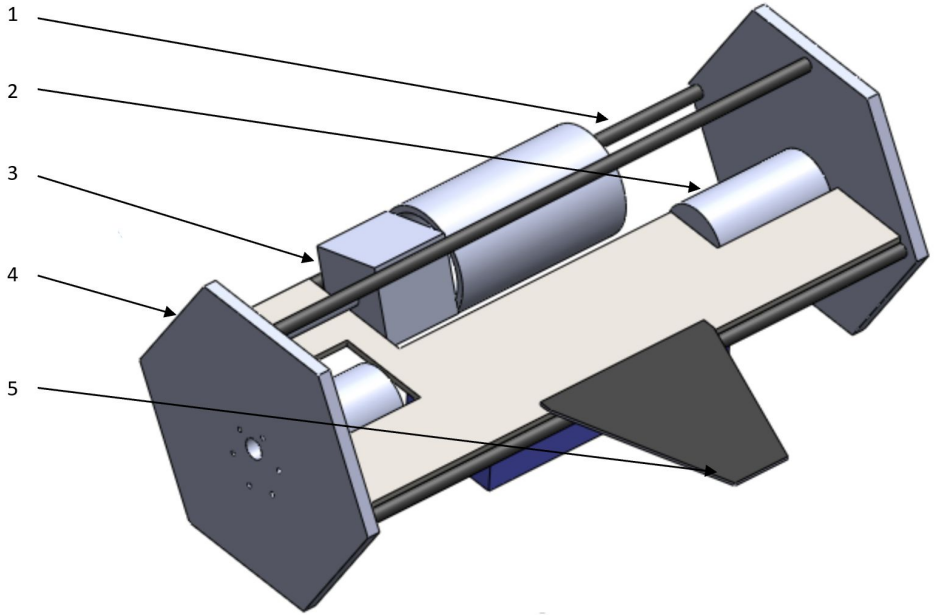
Features

1. Expandable wheels
2. Carbon fiber tail
3. Auger collection



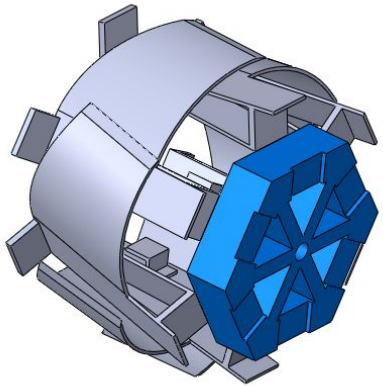
Chassis

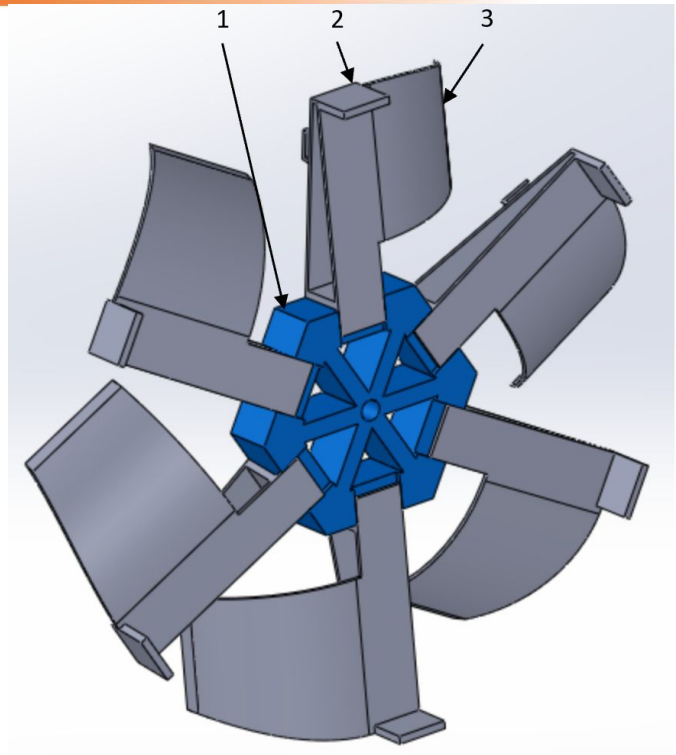
1. Carbon fiber strut
2. 12V DC motor
3. Collection system
4. HDPE motor mount
5. Carbon fiber tail



Drivetrain

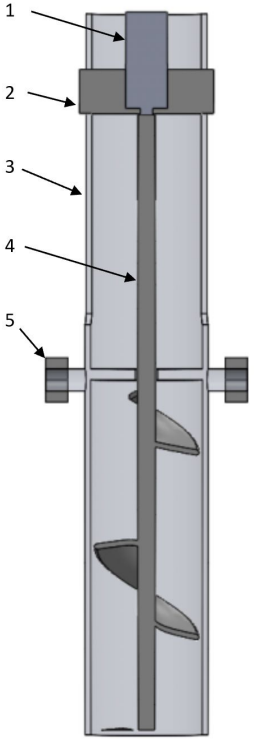
1. ABS hub
2. Steel bracket
3. Rubber fin

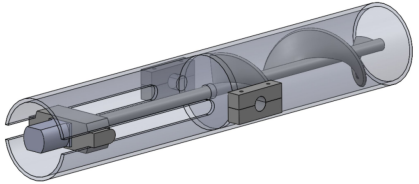


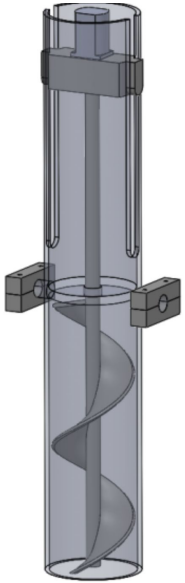


Collection System

1. Motor
2. Motor mount
3. Aluminum tube
4. Steel auger
5. Aluminum hinge mount

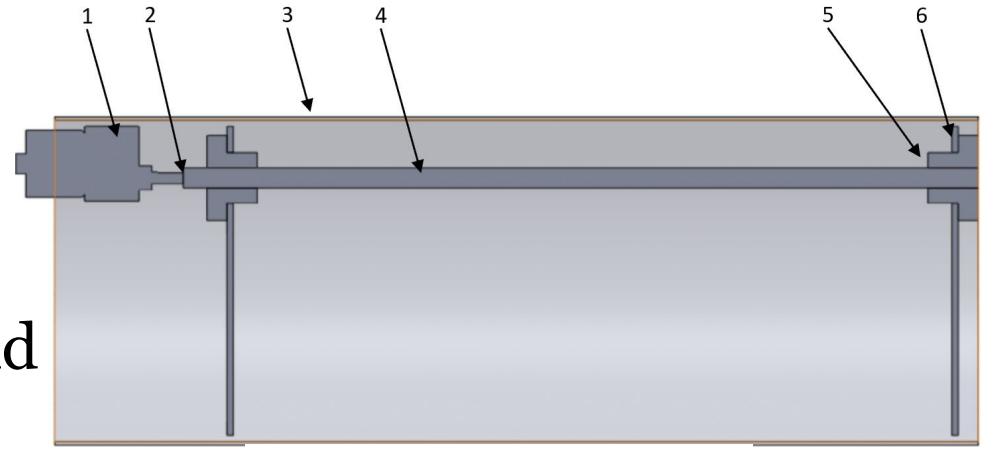


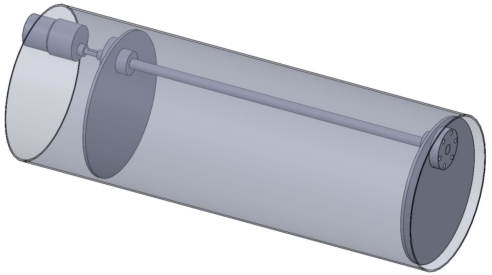




Retention and Ejection

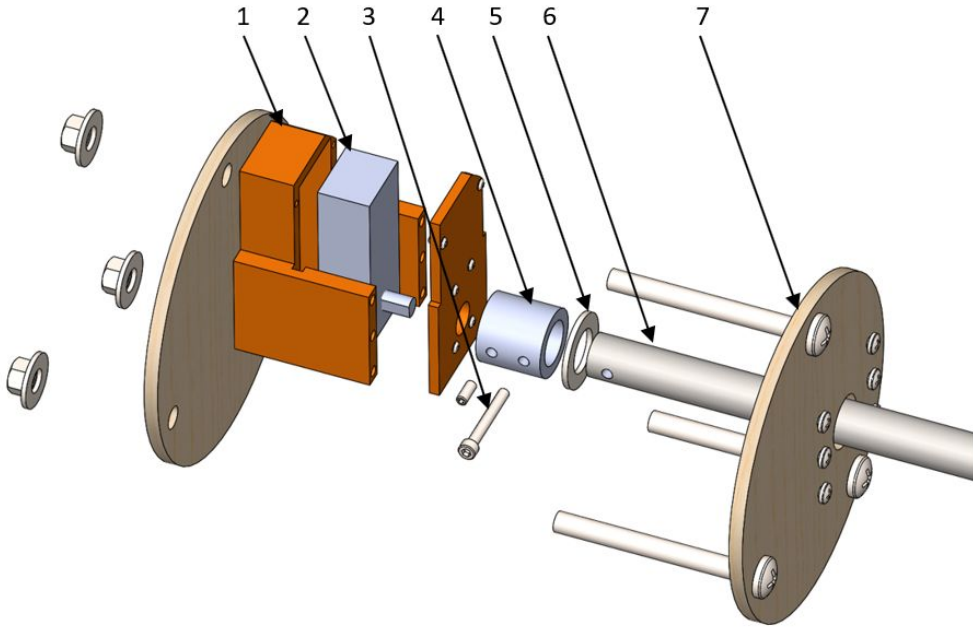
1. Motor
2. Motor to lead screw coupler
3. Airframe
4. 0.39 in. diameter lead screw
5. Lead screw nut
6. Wooden bulkhead





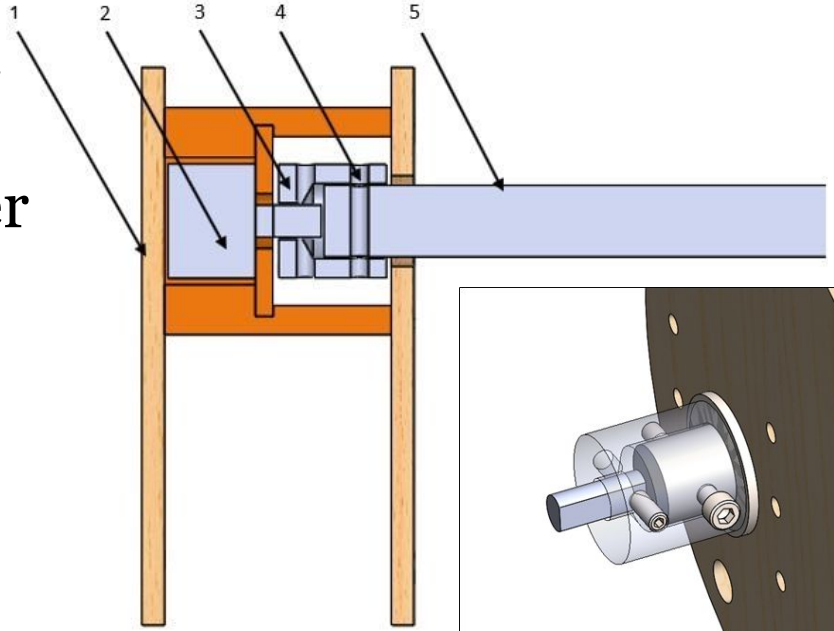
Retention

1. Motor retention
2. Worm gear motor
3. Lead screw pin
4. Coupler
5. Washer
6. Lead screw
7. Bulkhead



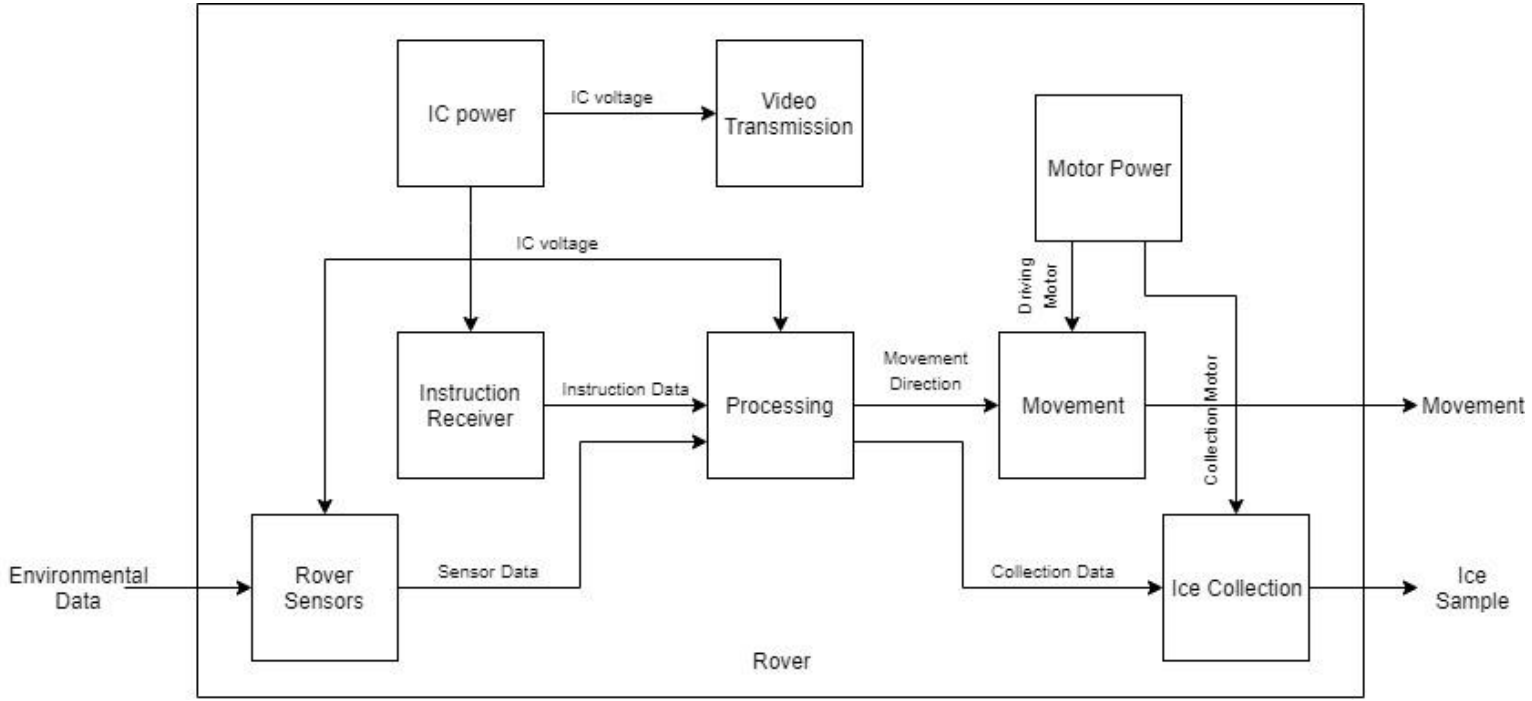
Retention

1. Wooden bulkhead
2. Worm gear motor
3. Lead screw coupler
4. Lead screw pin
5. Lead screw



Payload Electronics

Electronics



Electronics

Video Transmission:

- Range: 1 mile
- Displayed in GUI

Control:

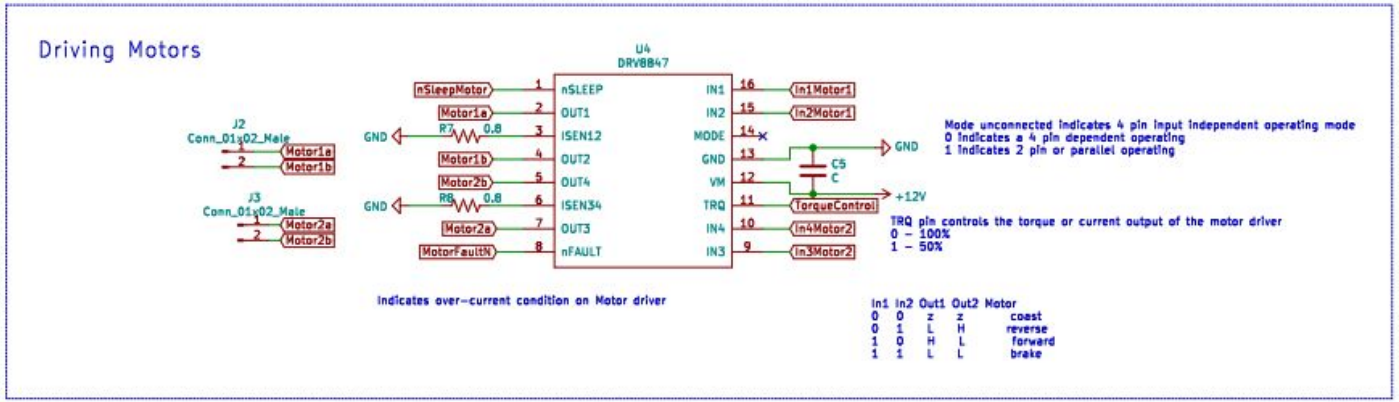
- RF wireless
- Human-controlled rover

Taken from https://www.amazon.com/Wolfwhoop-Adjustable-Transmitter-Cloverleaf-Aircraft/dp/B06XB2ZRBP/ref=pd_sbs_21_1/

Electronics

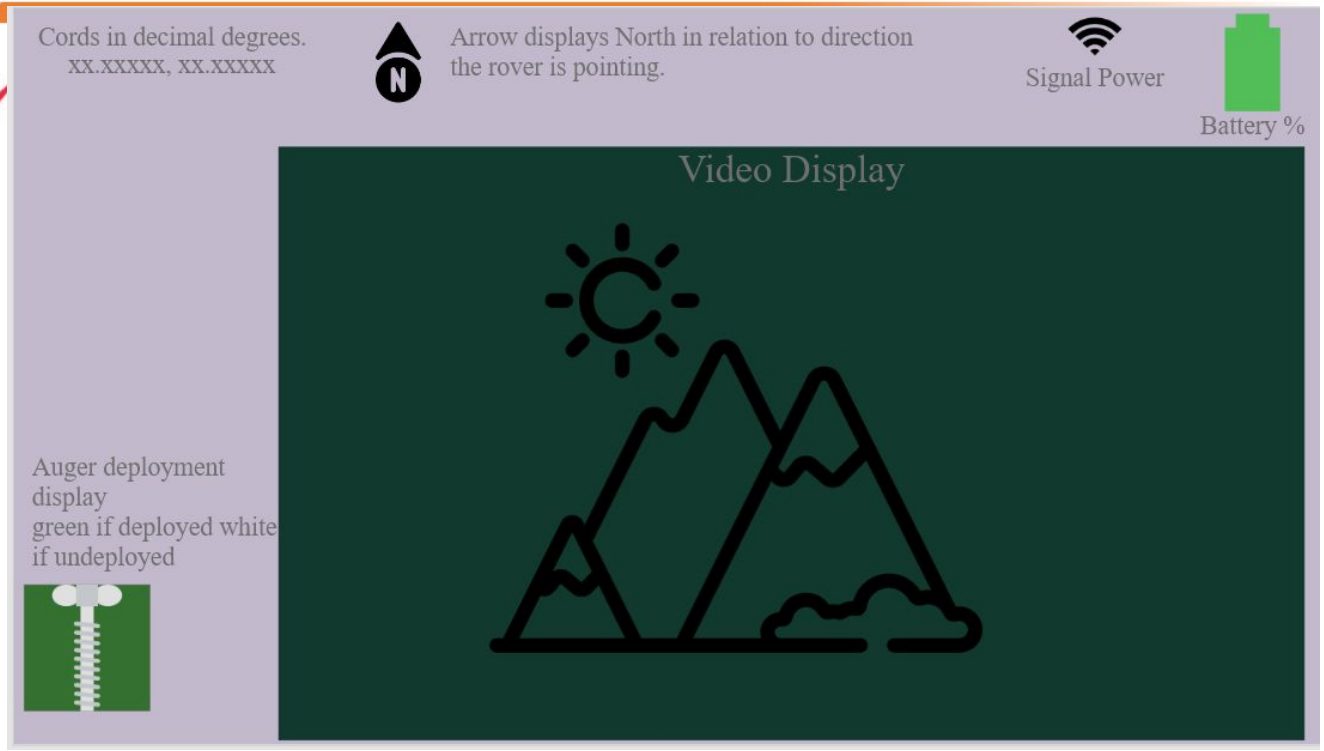
Motors and Drivers:

- Average Voltage: 12 V
- Maximum Current: 680 mA
- 100 RPM



Payload Software

Graphical User Interface V1



Icons from https://www.flaticon.com/:

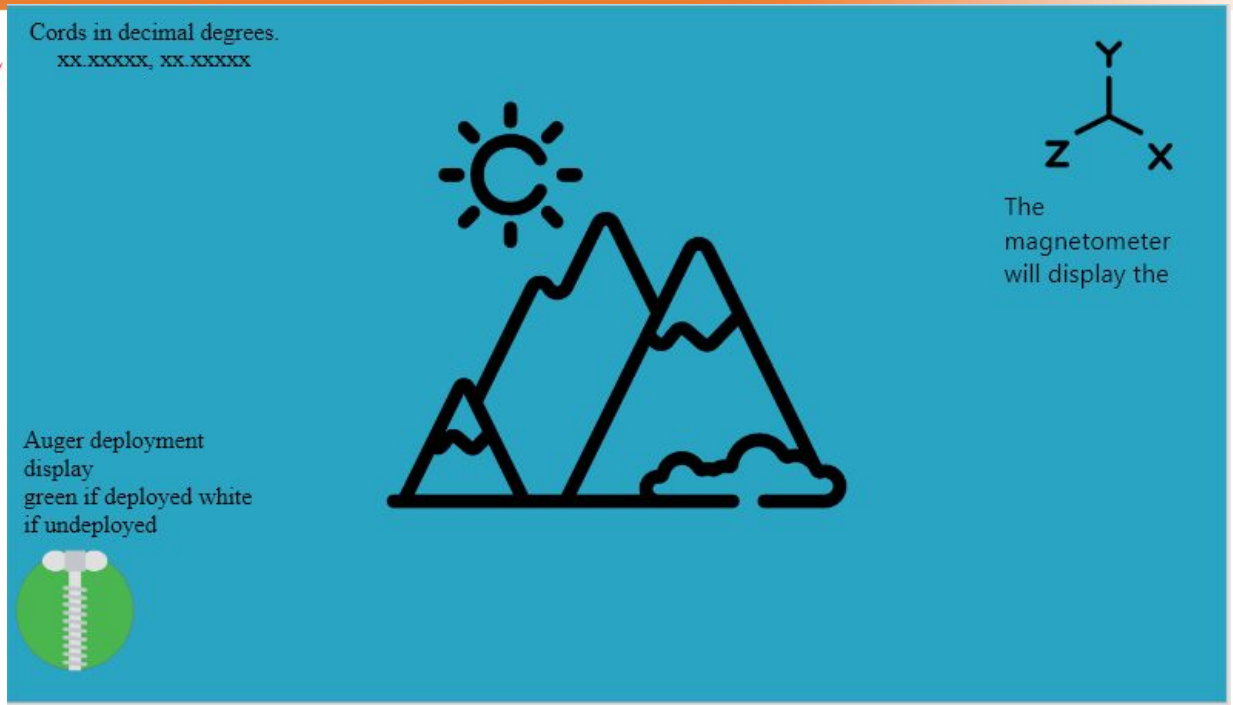
Mountains made by Freepik.

Screw made by Smashicons.

Direction Pointer made by Pixel Perfect.

Signal Strength made by Freepik.

Graphical User Interface V2



Icons from https://www.flaticon.com/:

Mountains made by Freepik.

Screw made by Smashicons.

XYZ Axis made by Cursor Creative.

STEM Engagement

STEM Engagement

- Past events
- STEM activities before football games
- SWARM Robotics Team presentation
- Science Saturday
- Discovery Days
- Future events
- Other events are planned out all the way through February

Safety

Safety

“Safety is something that happens between your ears, not something you hold in your hands.” Jeff Cooper

- Know Where to Go
- A Chain of Accountability
- Everybody is Safety Team

Know Where to Go

Centralized Information - MSDS, Contact Info

Pre Task Plans

Hazard Briefings

Warning Signs

A Chain of Accountability

Single Point of Contact (and a backup)

Timely Reporting, Post-Incident Revision

Ask Questions, Get Answers

Everybody is Safety Team

A Culture of Safety

Self-Regulating, Self-Improving

D.A.M. Forms, MSDS Submission

Requirement Compliance Plan

- Each requirement will be represented in the team's checklists
- All checklists must be completed in their entirety, and signed by the Safety Officer, the assembler, and the back-up assembler for the subsystem


1868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AIAA Student Chapter

Questions?