



Oregon State University



Preliminary Design Review

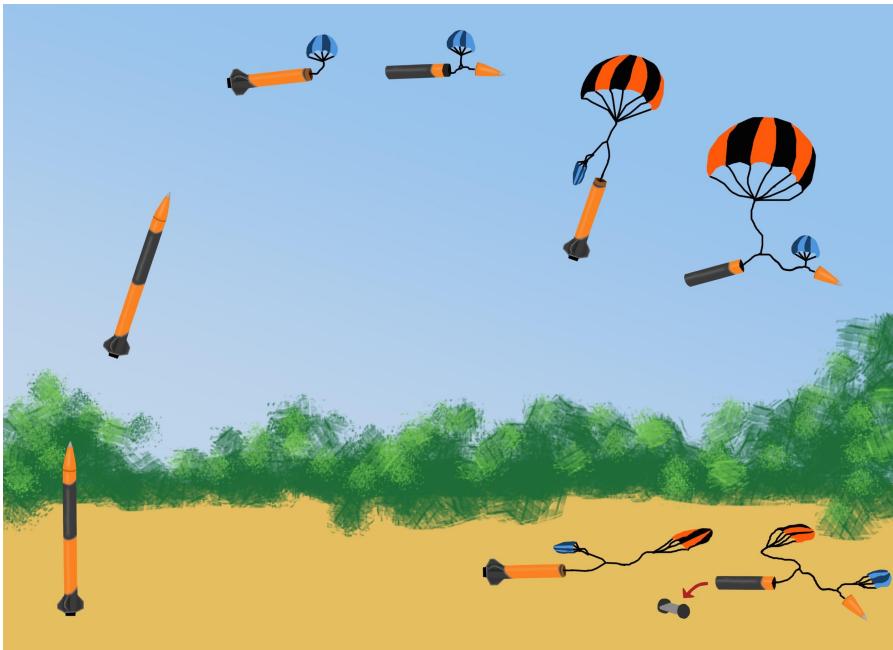
11/05/2018



Mission Overview



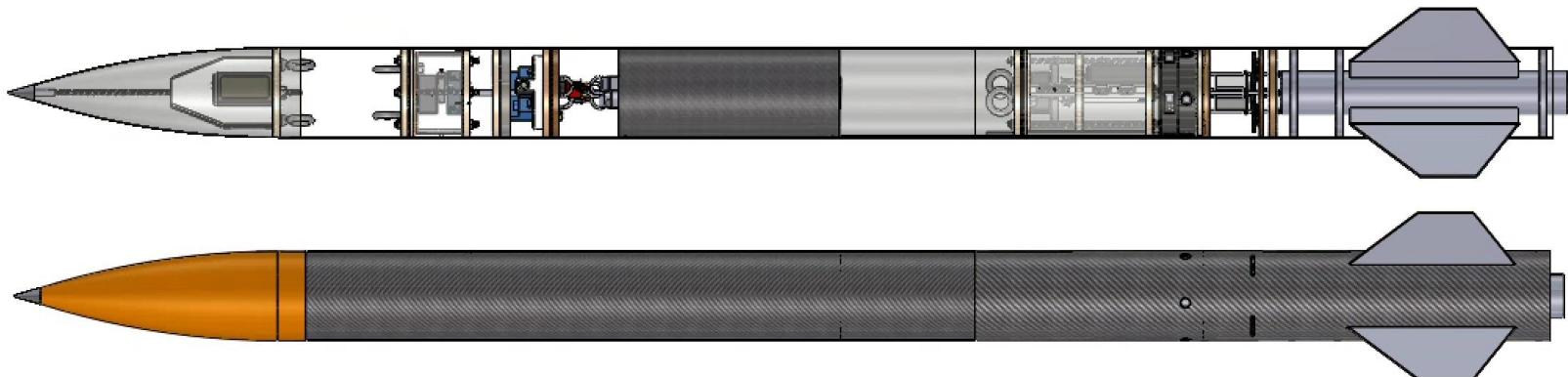
1. Launch
2. Motor Burnout
3. Separation at apogee
4. Drogue chutes
5. Main chute release
6. Landing
7. Rover deployment
8. Soil collection
9. Scientific Experiment





Launch Vehicle Overview

- 54.9 lbf at launch
- 6.25 in. Diameter
- 100 in. Overall Length





Aero and Recovery Sub-team

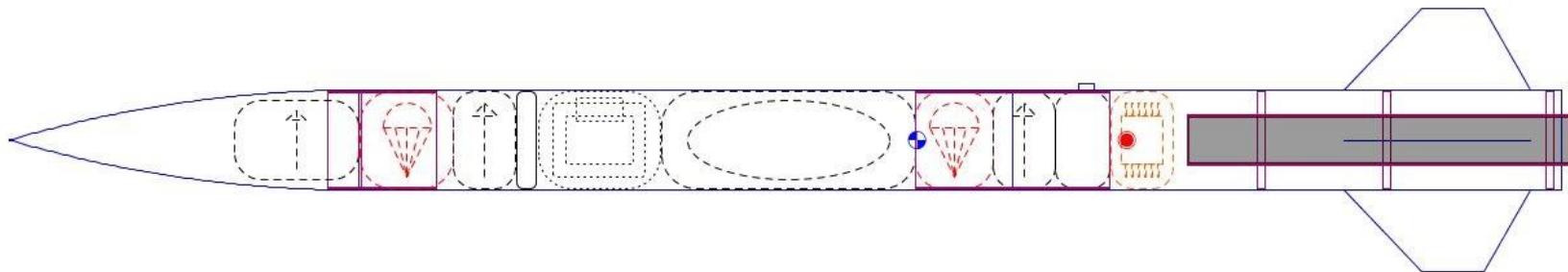




Aerodynamics

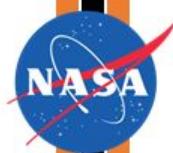


- CG from Nose Cone Tip: 58.353 in.
- CP from Nose Cone Tip: 71.83 in.
- Stability: 2.1 calibers
- Projected Altitude: 4797 ft



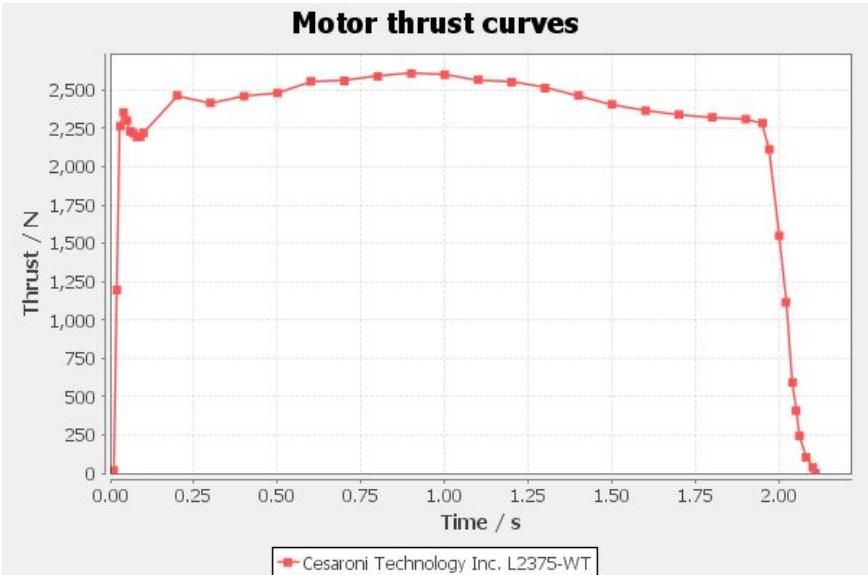


Motor Selection



Cesaroni L2375-WT

Diameter	75 mm
Total Weight	9.17 lbf
Empty Weight	4.06 lbf
Maximum Thrust	533.7 lbf
Thrust/Weight	9.77
Rail Exit Velocity	84.6 ft/s
Total Impulse	4905 N-s

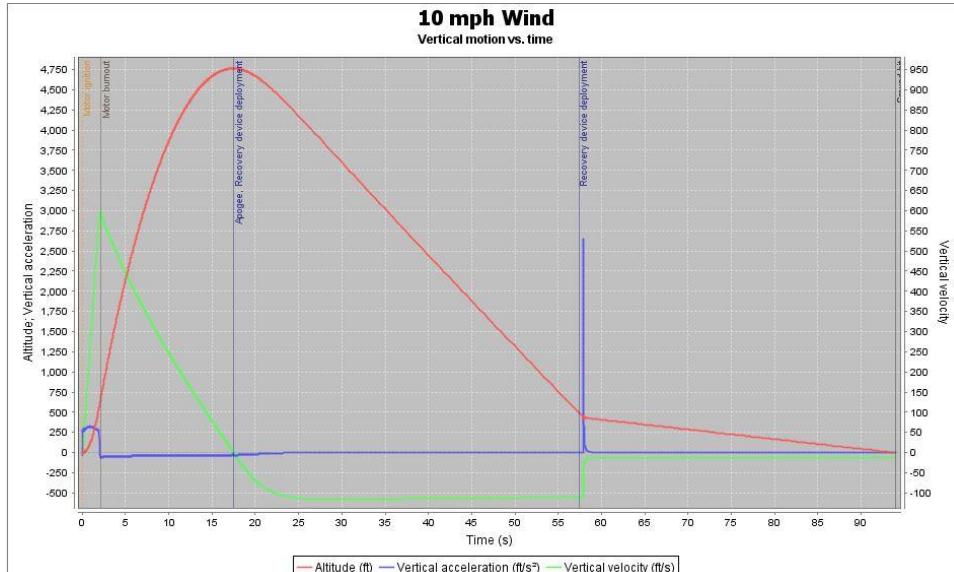




Altitude with Cross-Winds



Wind Speed (mph)	Predicted Apogee (ft)
0	4797
5	4791
10	4775
15	4748
20	4713

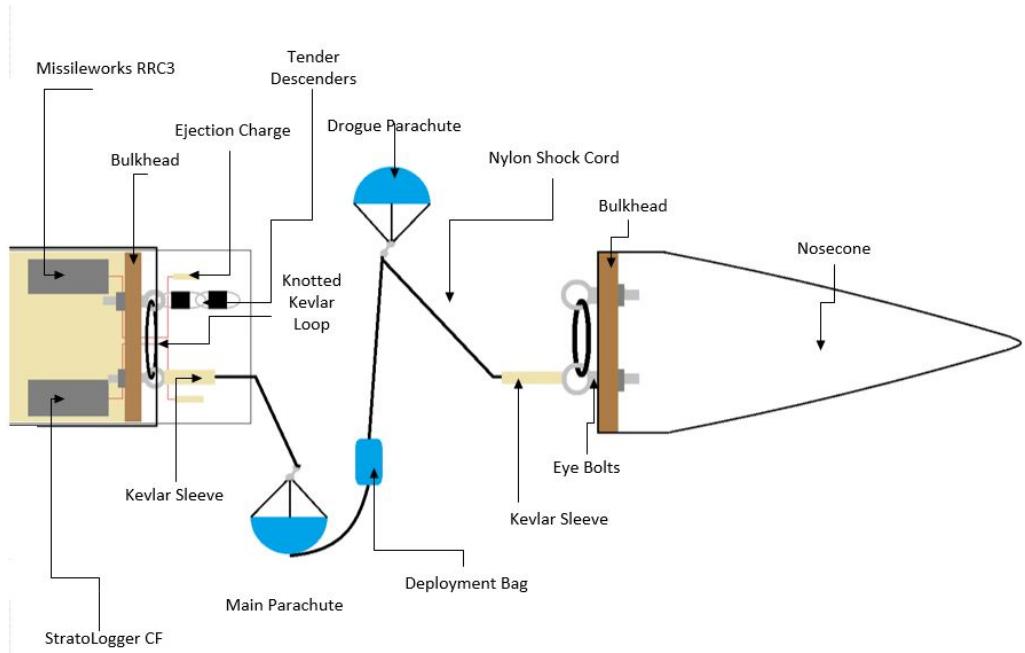




Recovery - Layout



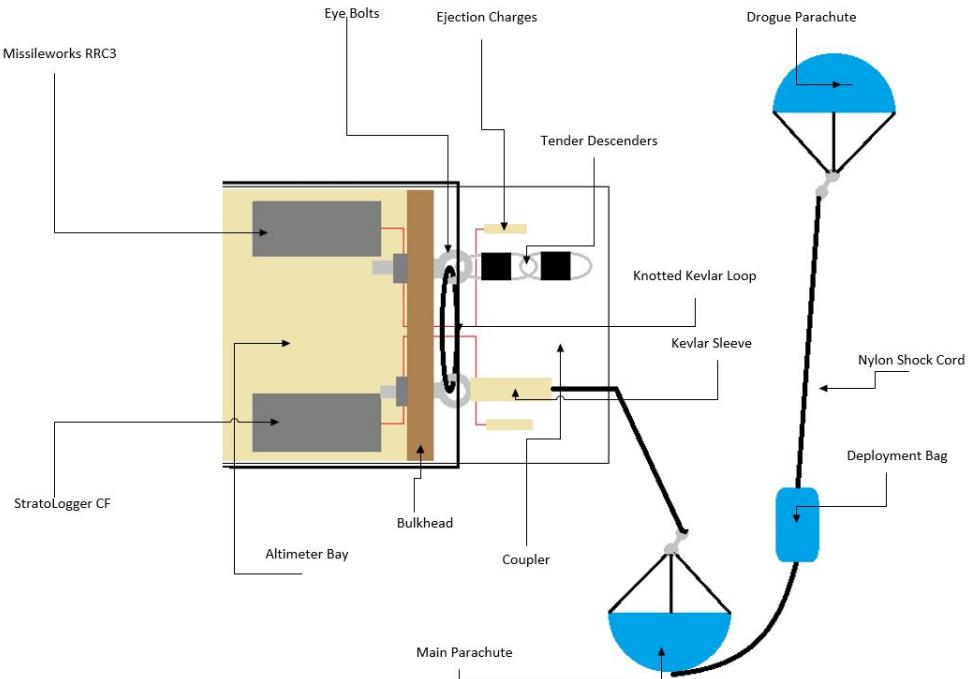
- Fore Recovery Layout
- Quick links at all attachment points
- Main parachute retention
- Parachute placement





- Aft Recovery Layout
- Quick links at all attachment points
- Main parachute retention
- Parachute placement

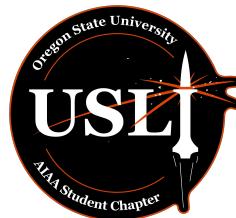
Recovery - Layout





Recovery - Parachute Information

- Toroidal parachutes will be used for their high coefficient of drag
- Cruciform parachutes will be used as the drogue

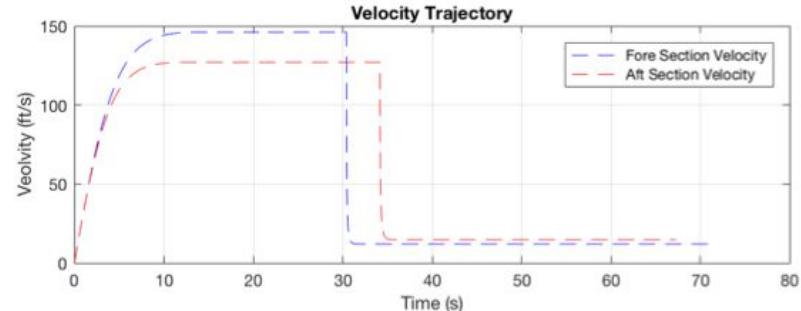
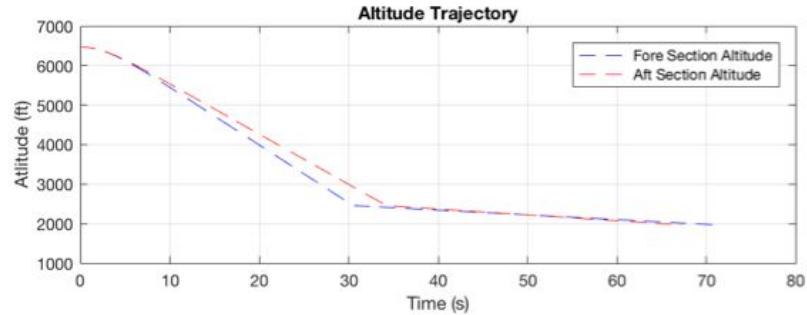




Recovery - Parachute Information



- MATLAB script that was used to determine:
 - Descent time
 - Landing kinetic energy
- Output used to determine:
 - 1.5 ft drogue for fore and aft
 - 10 ft parachute for the fore
 - 8 ft parachute for the aft





Recovery - Shock Cord



- Nylon 1" webbing shock cord
 - Kevlar protection
- The drogue shock cord will be 5 times the length of connected section
- The main shock cord will be 2 times the length of connected section





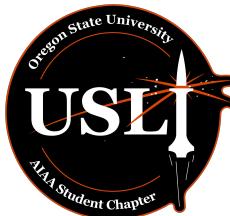
Recovery - Kinetic Energies



Measurement	Fore Section	Aft Section	Nosecone
Weight (lbf)	26.8	20.1	2.2
Velocity with Main and Drogue Deployed(ft/s)	12.0	13.0	12.0
Kinetic Energy with Main and Drogue Deployed (ft-lbf)	60.2	52.4	4.9
Velocity with Only Drogue Deployed (ft/s)	111.0	105.0	111.0
Kinetic Energy with Only Drogue Deployed (ft-lbf)	5,137.5	3,444.5	419.3
Velocity with no Parachutes Deployed (ft/s)	115.0	112.0	115.0
Kinetic Energy with no Parachutes Deployed (ft-lbf)	5,514.4	3,919.1	450.1



Recovery - Descent Times and Drift



Wind Speed (mph)	0	5	10	15	20	Descent Time (s)
Drift of the Fore Section (ft)	0	523	1,046	1,596	2,092	71
Drift of the Aft Section (ft)	0	524	1,056	1,585	2,113	72
OpenRocket Simulation (ft)	8	248	521	856	1,069	76

All sections stay within the maximum drift radius of 2,500 ft



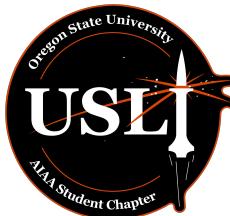
Recovery - Packing

- Main parachutes
 - Packed into a deployment bag
- Folding method recommended by FuryChutes
- Possible nomex blanket around deployment bags
 - Additional protection



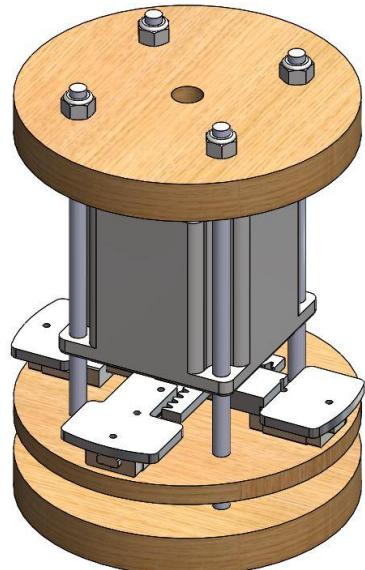


BEAVS



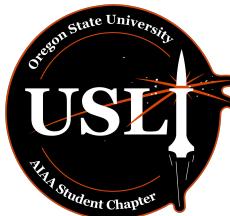
Blade Extending Apogee Variance System

- Passive System
 - Coupled ballast bays in fore and aft
- Active System
 - Four blades extend from within airframe





BEAVS



- With passive system implemented
 - Simulations performed in OpenRocket

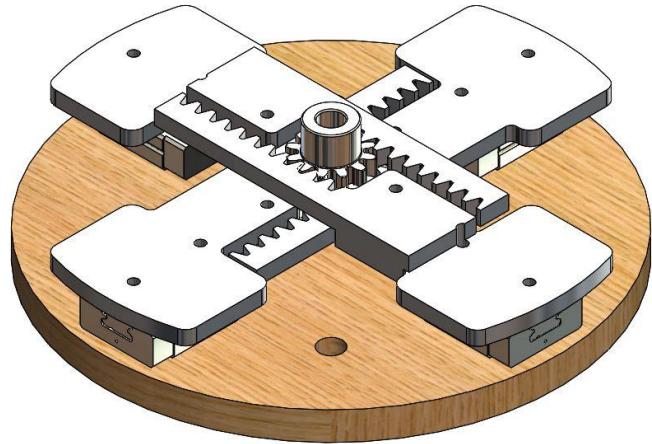
Wind Speed (mph)	Aft Ballast (lbf)	Fore Ballast (lbf)	Stability (calibers)	Predicted Apogee (ft)
0	1.45	0.70	2.10	4500
5	1.42	0.68	2.10	4500
10	1.32	0.64	2.10	4500
15	1.17	0.57	2.10	4500
20	0.99	0.47	2.10	4500



BEAVS



- Electronics
 - Driven by Stepper Motor
 - Barometric pressure sensor
 - 9 DOF IMU
 - Rotary Encoder
- Control scheme
 - Varying Set Point
 - Long Duty Cycle





Structures Sub-team

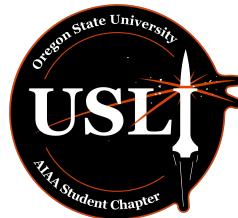
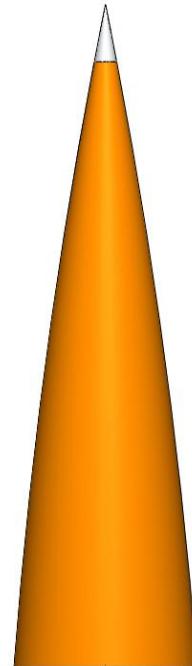




Nosecone



- Shape: 5:1 Fiberglass Tangent Ogive
 - Purchase 7.5 in.
 - Cut to 6.415 in. outer diameter
- Length: 23.5 in.
- Shear Pins
- Aluminum Tip





Fore Body Tube



- Material: Carbon Fiber & Fiberglass
 - Transition from CF-FG
- Length: 42 in.
- Inner Diameter: 6.25 in.
- Thickness: 0.0825 in.

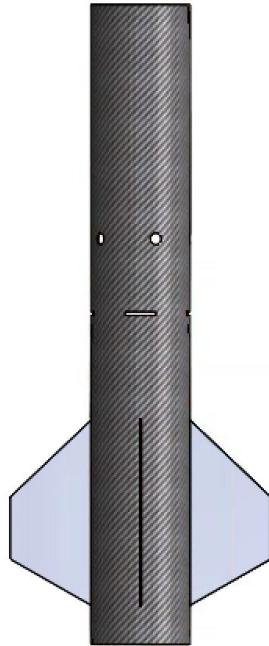




Aft Body Tube



- Material: Carbon Fiber & Fiberglass
 - Transition from CF-FG
- Length: 35.25 in.
- Inner Diameter: 6.25 in.
- Thickness: 0.0825 in.





Fore Coupler

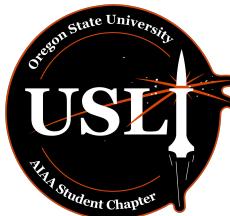


- Material: Fiberglass
- Length: 10 in.
- Outer Diameter: 6.25 in.
- Thickness: 0.0715 in.





Main Body Coupler Canister



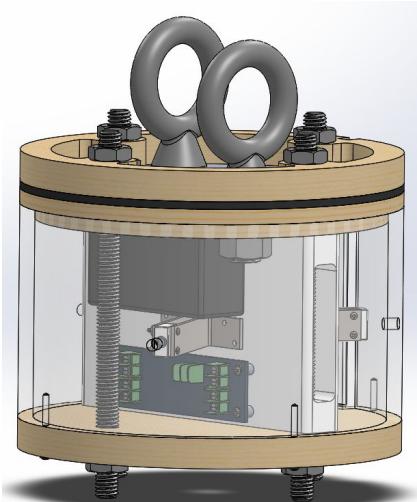
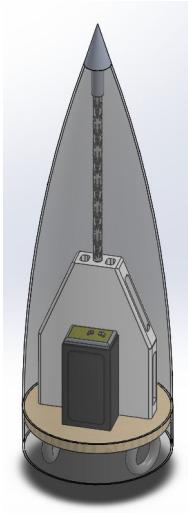
- Fiberglass Canister Contains:
 - 360° camera system
 - Aft avionics bay
 - Aft ejection bay and parachutes
- Length: 26 in.
- Outer Diameter: 6.25 in.
- Thickness: 0.0715 in.





Fore Electronic Bays

- Fore avionics
 - Within nosecone
- Fore altimeters
 - Above payload

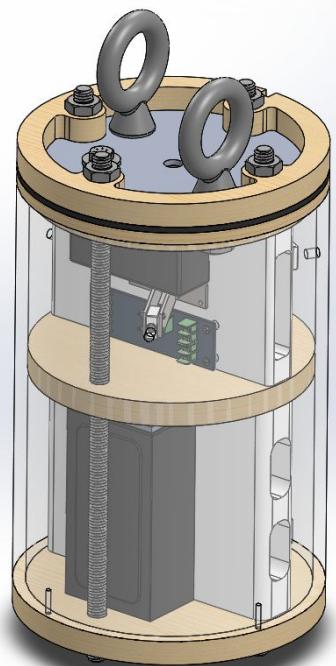




Aft Electronic Bays



- Aft Electronic Bays
 - Combines avionics and altimeters
 - Above 360° camera system
 - In main body coupler canister





360° Camera System



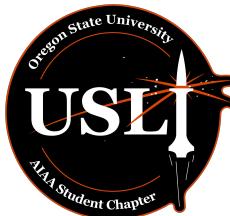
- Five GoPro cameras
 - 360° Panorama
- Material: ABS Plastic
- Manual trigger connected to five shutter cables to start and stop cameras





Payload Sub-team

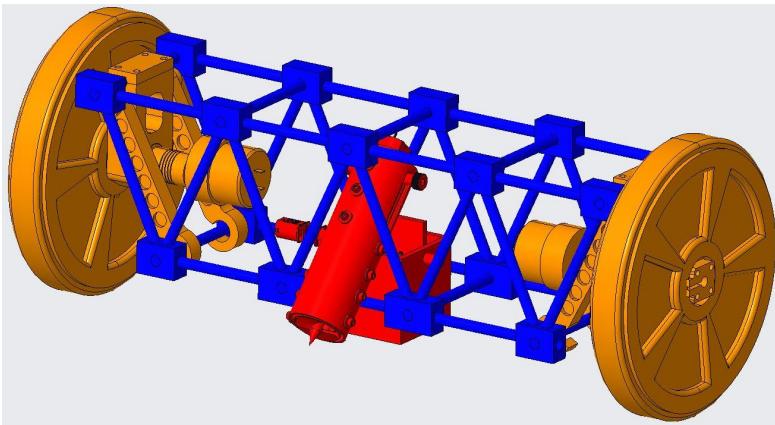




Rover Configuration



- Two wheel rover
 - Independent motors
- Auger mechanism mounted to the chassis
 - Drills into surface
 - Obtains sample
 - Deposits into container
- Spring-assisted flexible stabilizer

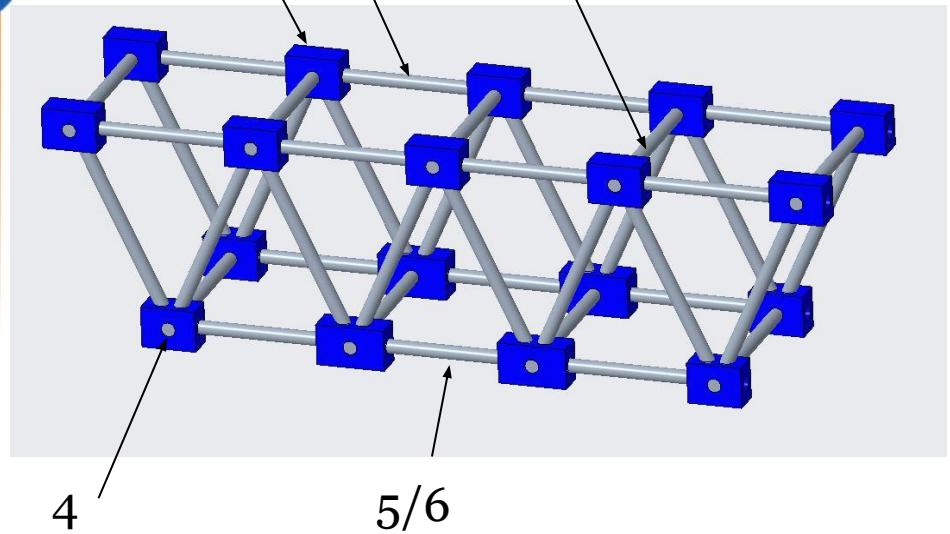


Orange:
Blue:
Red:

Drivetrain
Chassis
Soil Collection/Retention



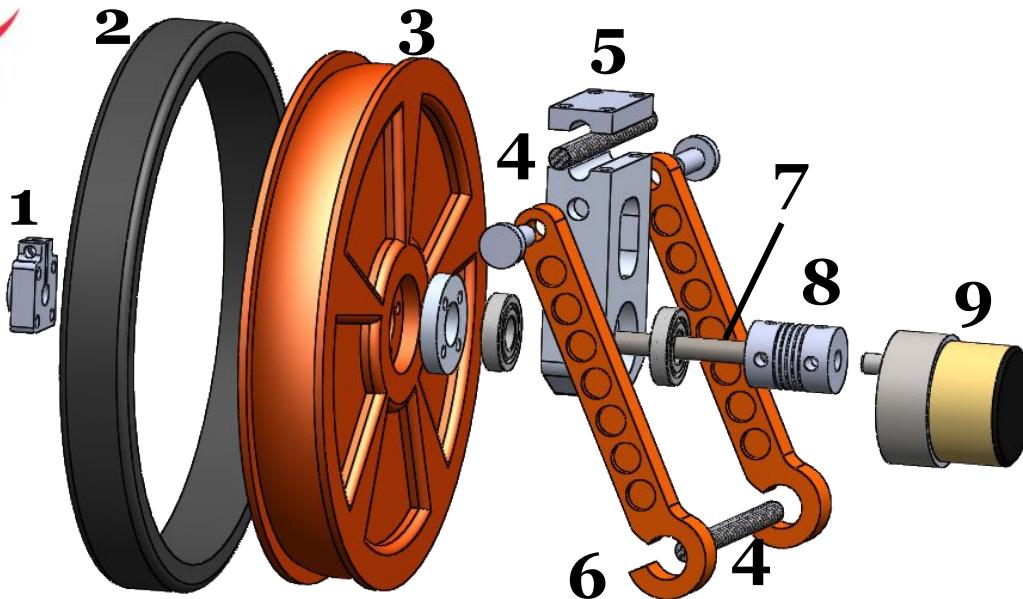
Chassis Materials



1. Aluminum connection blocks
2. Carbon fiber rods
3. Tapped aluminum cross bars
4. Screws and washers
5. Carbon fiber tail
6. Spring mechanism for tail



Drivetrain



1. Clamping hub
2. Urethane foam strip
3. Wheel
4. Truss member
5. Truss mounting assembly
6. Connecting rods
7. Drive shaft
8. Shaft coupling
9. DC motor

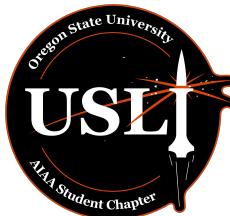
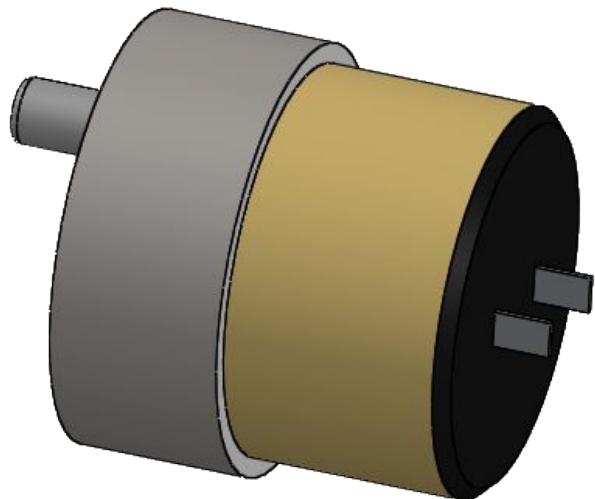
not pictured: fasteners, foam insert, motor mount



Drivetrain



- Two GHM-04 DC brushed motors
 - 4.30 oz, 13.9 oz-in rated torque
 - 1.65" in length
- Six in. diameter wheels
 - Required 3.8 oz-in torque per motor
 - 0.5 ft/s² acceleration on flat ground

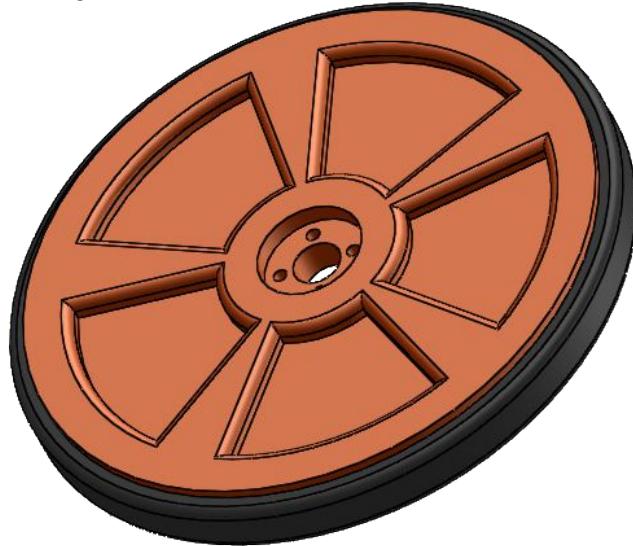
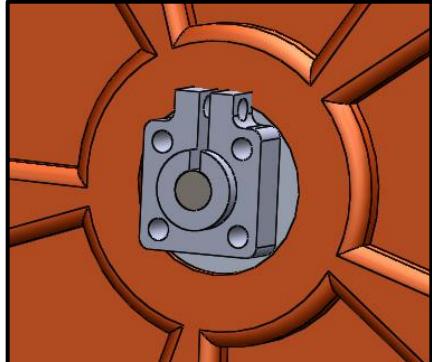




Drivetrain



- Expanding urethane foam tread applied to perimeter of wheels
 - Foam acts as a pressure seal for PEARS ejection
 - Effective increase in wheel diameter
 - Better traction
- ABS plastic
- Aluminum inserts

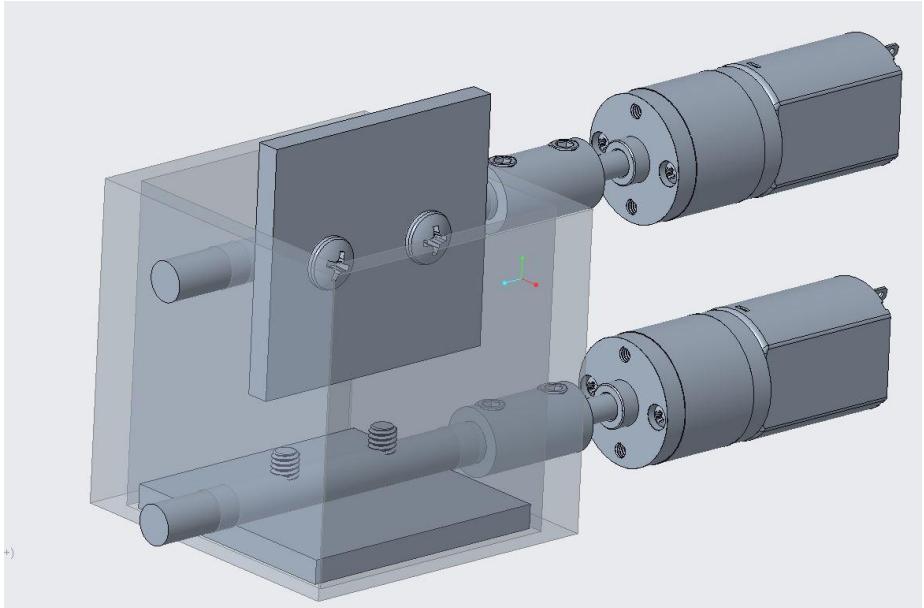




SCAR



Soil Collection and Retention

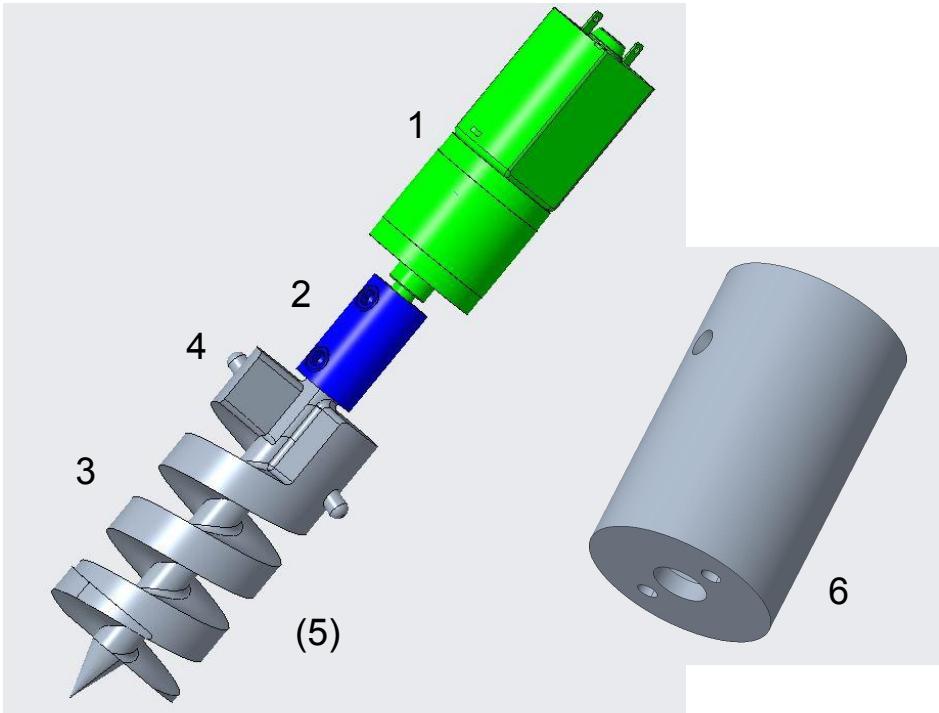




SCAR - Basic Components



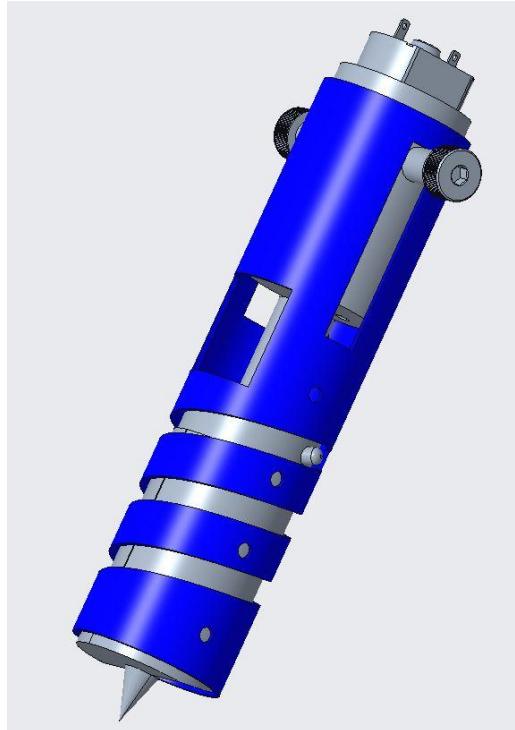
1. Motor
2. Coupler
3. Auger
4. Auger Bar
5. Auger Wrap (not pictured)
6. Motor Mount





SCAR - Inner Auger Tube

- Extend/Retract Basic Components
- Motor - Linear motion
- Auger - Helical motion
- Soil deposit slot





SCAR - Outer Auger Tube

- Structural support
- Frame for attaching to Chassis

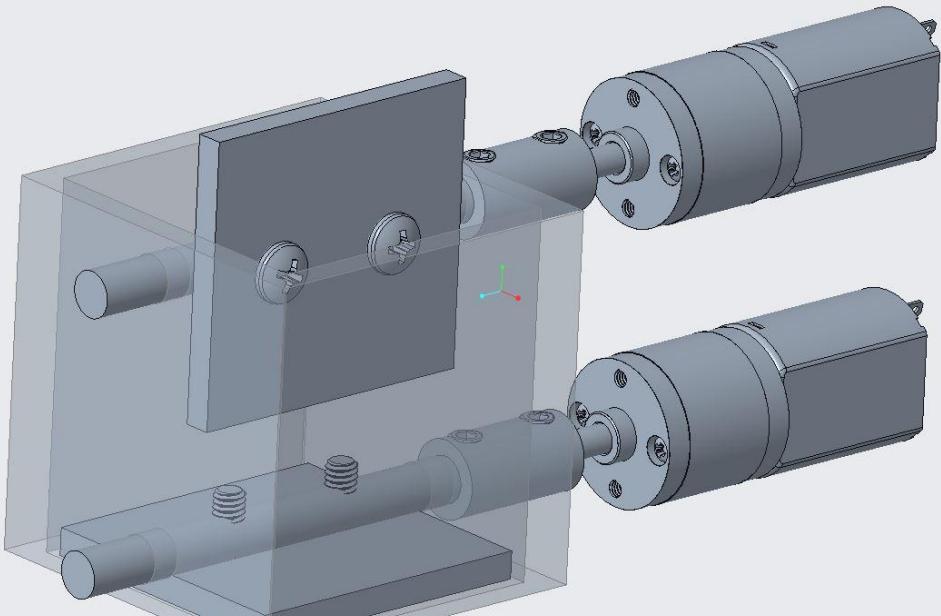




SCAR - Soil Container



- Center-pivot doors
- Two doors
 - Top: Sealing
 - Bottom: Deposit

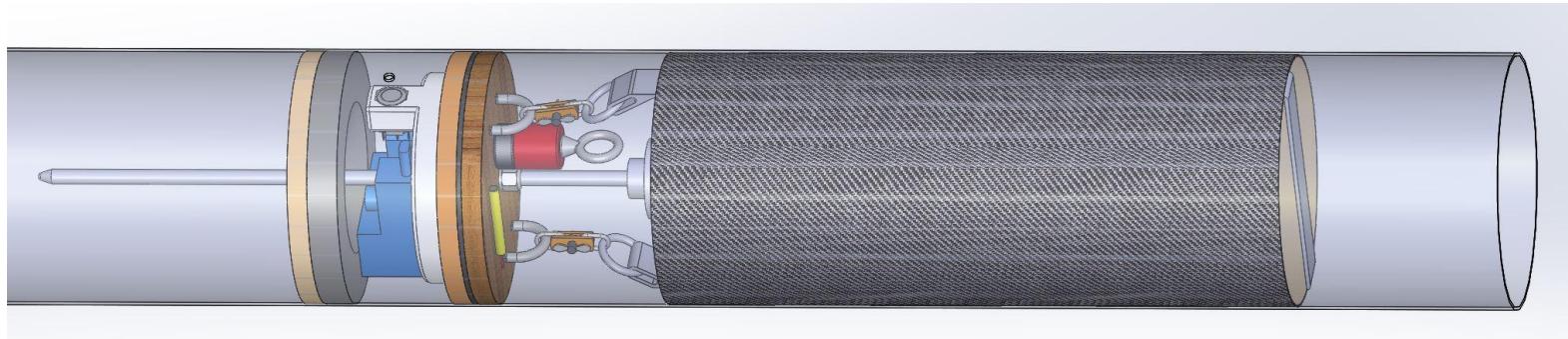




PEARS



Payload Ejection and Retention System

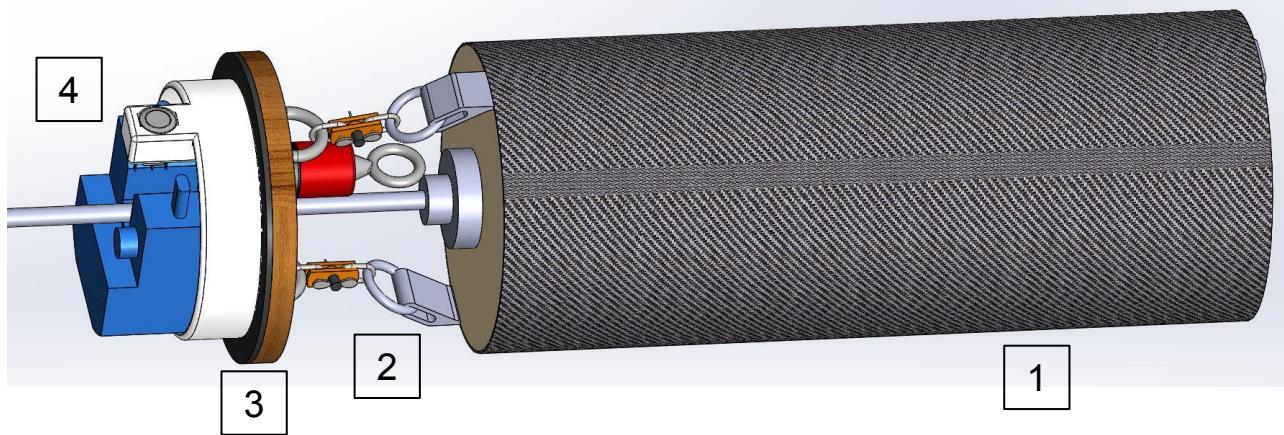




PEARS - Assembly

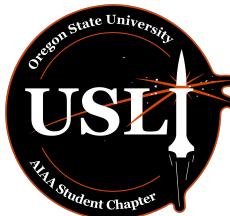


1. Carbon fiber payload wrap
2. Connected to Tender Descenders and ARRD with Kevlar harness
3. Rubber to create pressure seal
4. Single pole double throw switch on payload ejection controller

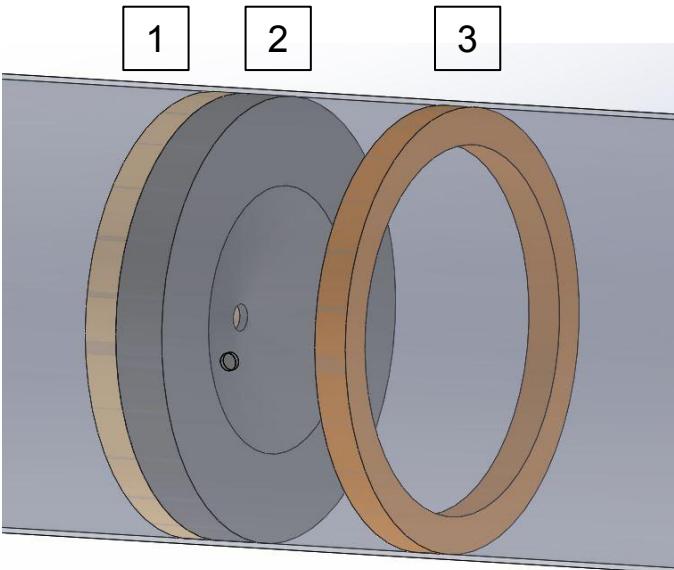




PEARS - Fore Hard Point



1. Fixed bulkhead with $\frac{3}{8}$ in. hole
2. Fixed funnel bulkhead to ease integration
3. Fixed pass through bulkhead to create pressure seal between switch and ejection charge





PEARS - Integration



1. Fore Ejection Bay mounted on rod
2. PEARS fixed to bulkhead
3. Access hole for SPDT switch
4. Pressure seal for payload ejection
5. Open airframe end after apogee separation



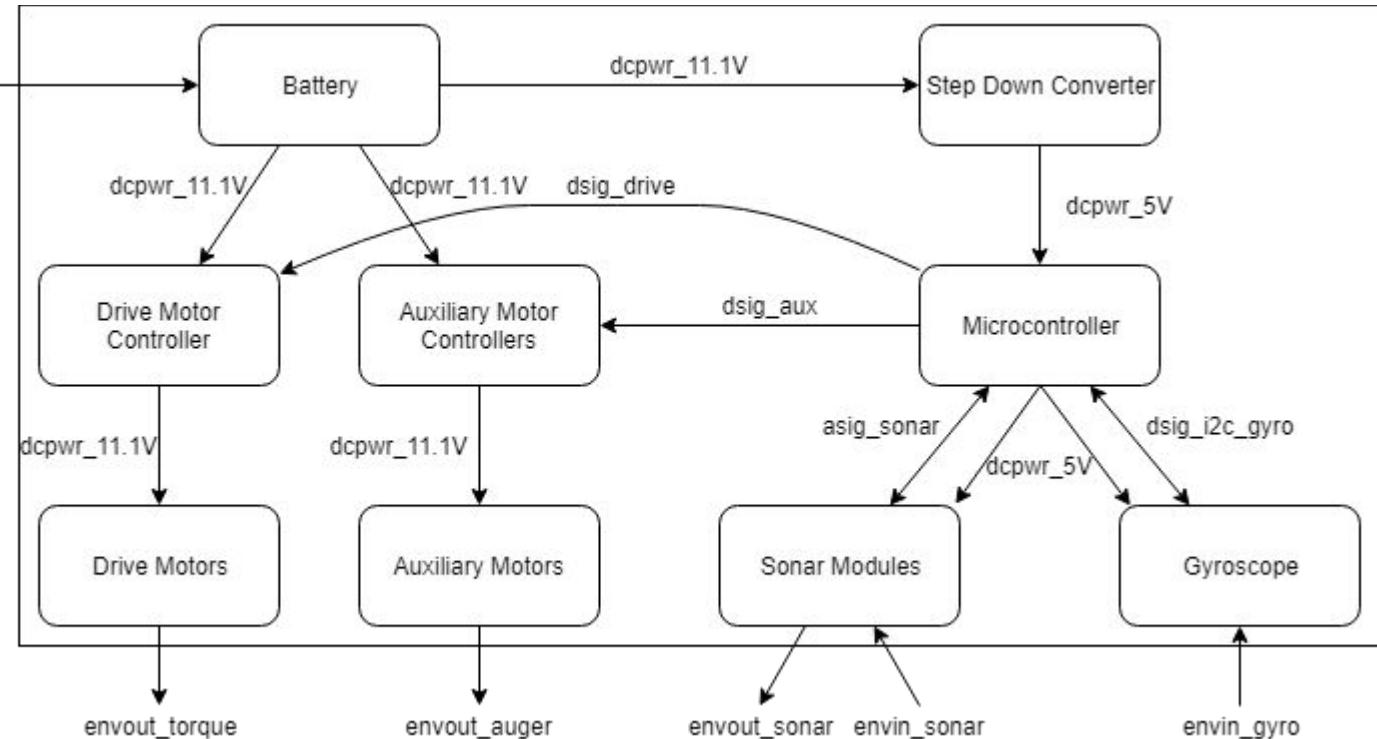


ECE Sub-team





High Level Block Diagram

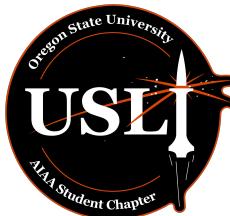




Interface Definitions (1/2)



Interface Name	Interface Type	Specifications
dcpwr_charging	DC Power	V_{min} : 10.5V V_{max} : 12V $I_{nominal}$: 2A I_{max} : 3A
dcpwr_5V	DC Power	V_{min} : 4.5 V_{max} : 5.5 $I_{nominal}$: 300mA I_{max} : 1A
dcpwr_11.1V	DC Power	V_{min} : 10.5V V_{max} : 12V $I_{nominal}$: 500mA I_{max} : 10A



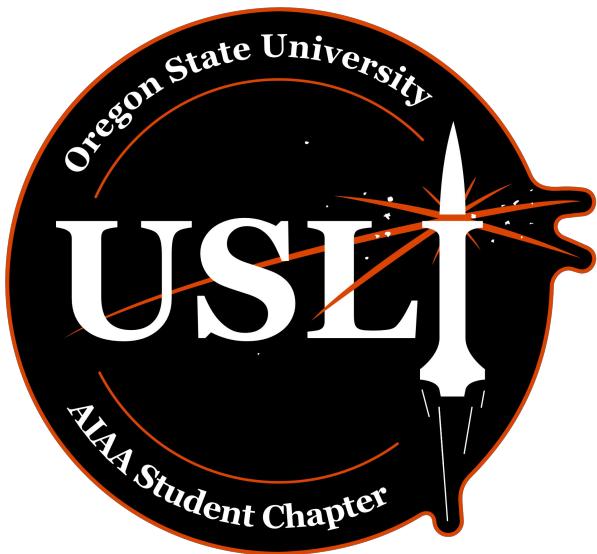
Interface Definitions (2/2)



dsig_drive	Digital Signal	Digital bus controlling drive motor direction and speed.
dsig_aux	Digital Signal	Digital bus controlling auger and container motor direction and speed.
asig_sonar	Analog Signal	V _{min} : 0V V _{max} : 5V Voltage level indicates how far away the closest object is, 0.98-16.4 feet.
dsig_i2c_gyro	Digital Signal; I ² C Bus	I ² C bus conveying gyroscope information back to the processor.



CS Sub-team

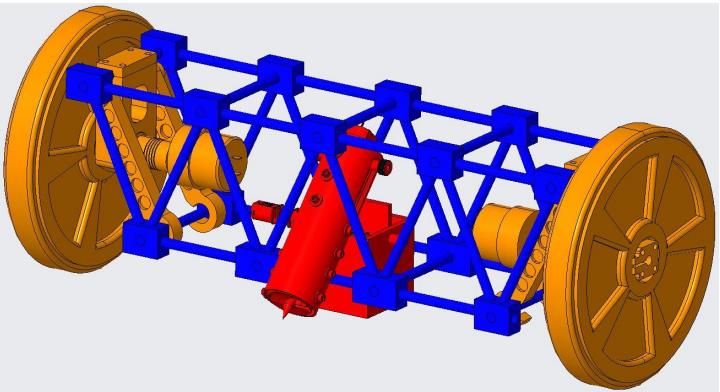




Payload Software

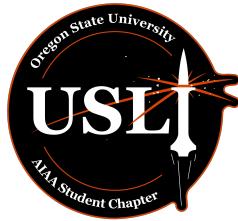


- Object Avoidance Sonar Configurations
 - Dual Horizontal Inline
 - Dual Vertical Inline
 - Tri-Mounted
- Navigation options
 - GPS + Infrared - max distance, low power, high range. Suffers from low accuracy.
 - Computer Vision - Powerful and flexible, but requires significant processor overhead.





Payload Navigation



- GPS and Infrared Navigation
 - Range: Maximum travel distance
 - Pros: Low power, high range
 - Cons: Inaccurate, Lock-on time
- Computer Vision Navigation
 - Range: Vision of object
 - Pros: A lot of power and flexibility
 - Cons: High Power consumption/High power microcontroller



Avionics

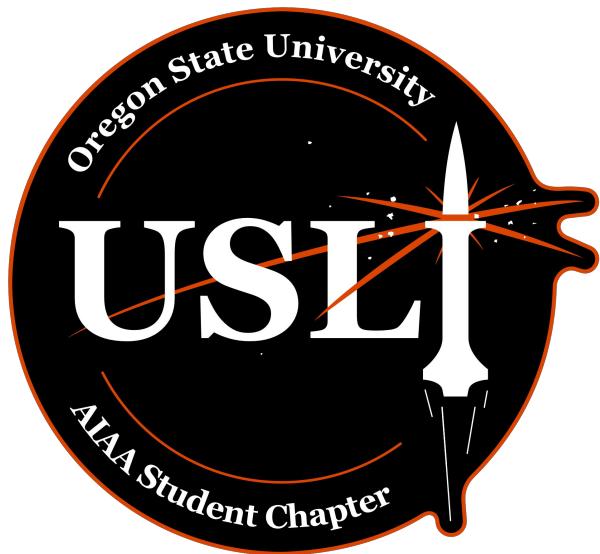
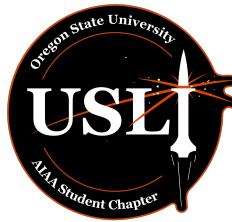


- Teensy 3.6 (ARM based microcontroller) - power efficient, high performance, runs C/C++
- 900 MHz + 433 MHz transceivers
 - 210 mW and 40 mW respectively, complies with 250 mW power requirement across all frequencies
 - High effective transmission range - line of sight
 - Cons: 433 MHz transceiver doesn't have pre-existing software, 900 MHz prone to interference





Administrative Roles





STEM Engagement



- Working with teachers from all over Oregon
 - Students from grades K-12
 - Topics: Rocketry, Physics, Engineering, Chemistry, Biology
- Completed: Yamhill-Carlton Design Review
 - October 26th
 - Engaged with 25 high school students
- Completed: Discovery Days
 - October 30th and 31st
 - Engaged with 950 elementary students



Questions?

