



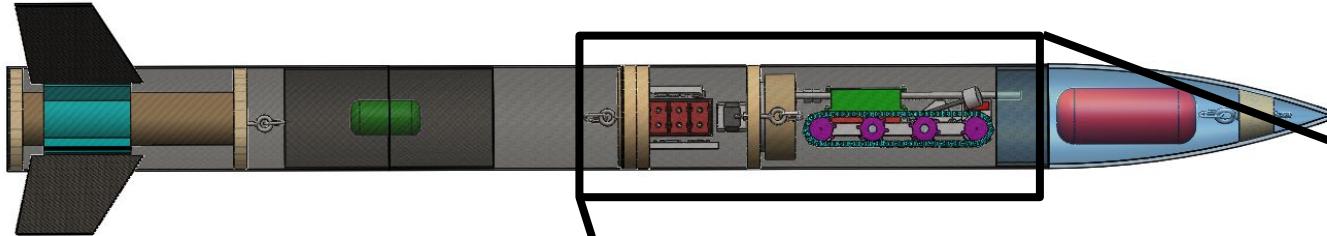
(LEXS)

Lunar Environment eXcavation Simulation



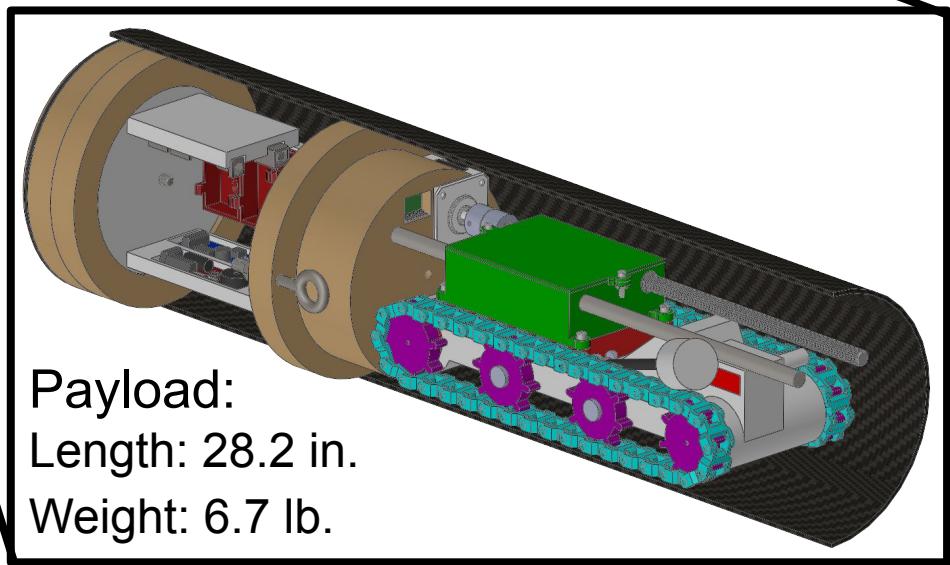
**UCLA**  
Bearospace

# CDR Overview



Launch Vehicle:  
Length: 77.9 in.  
Weight: 28.0 lb.

Motor Selection:  
2856-L910-CS-0



Payload:  
Length: 28.2 in.  
Weight: 6.7 lb.



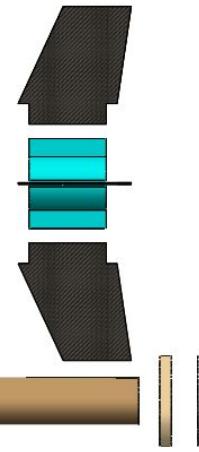
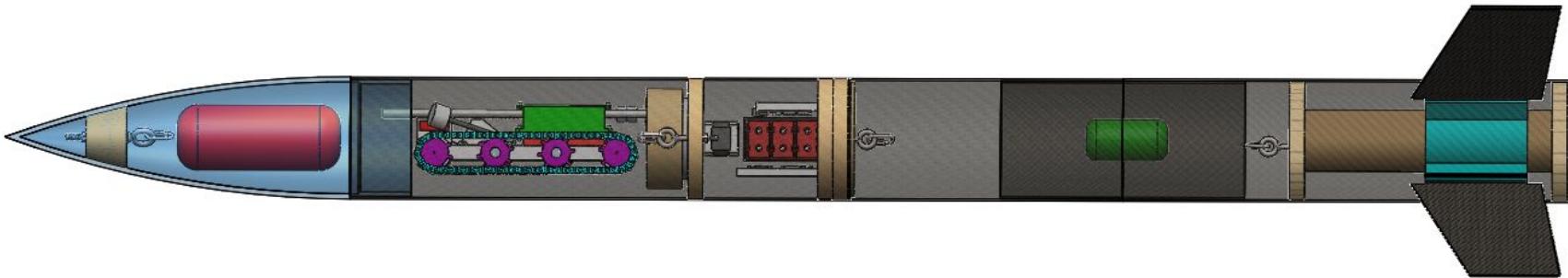
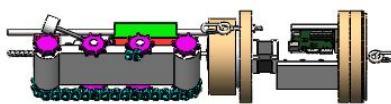
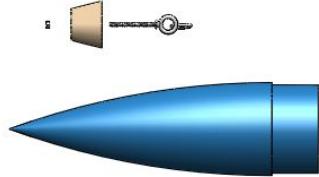
**UCLA**  
Bearospace

# Launch Vehicle



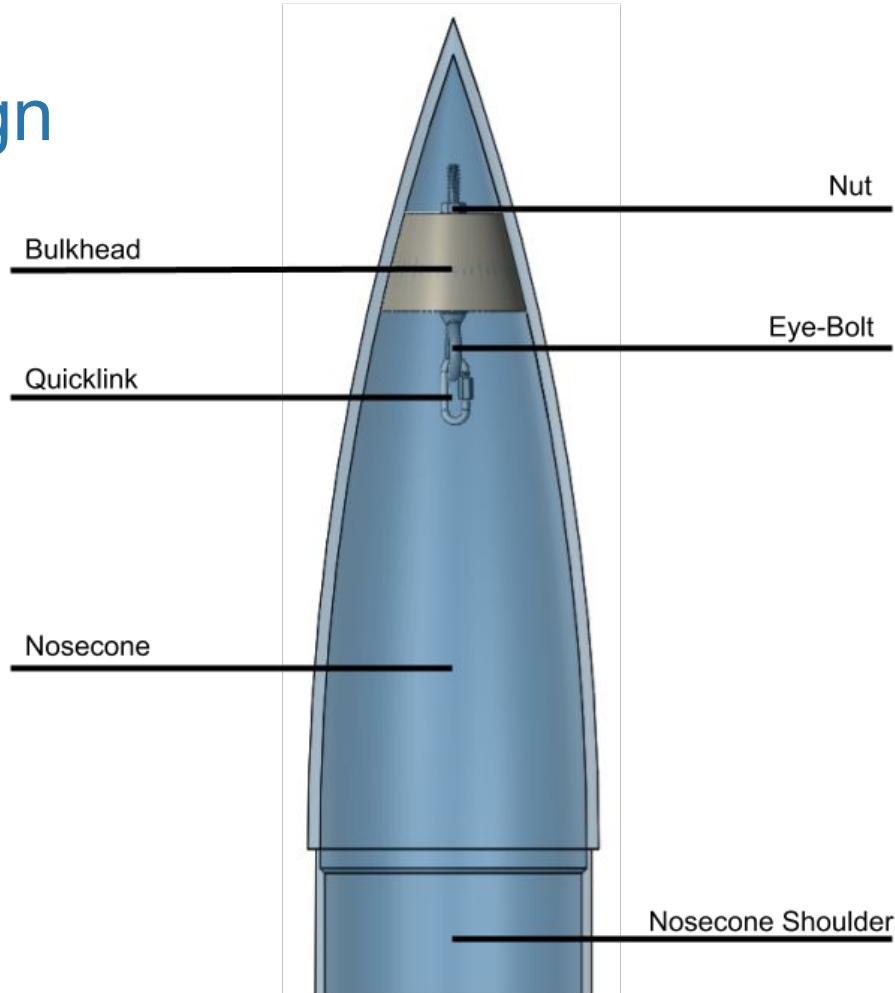
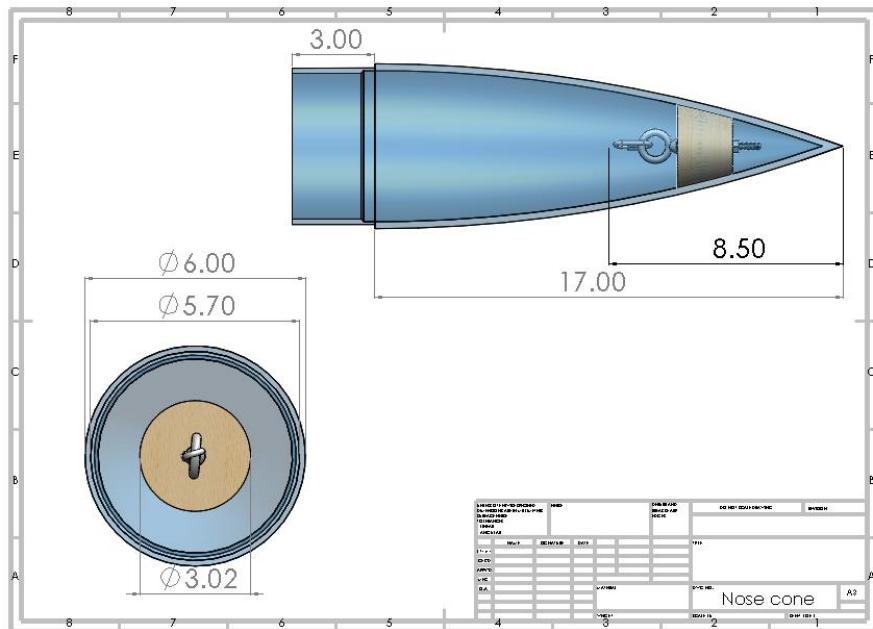
**UCLA**  
Bearospace

# Overview



UCLA  
Bearospace

# Nose Cone Section - Design

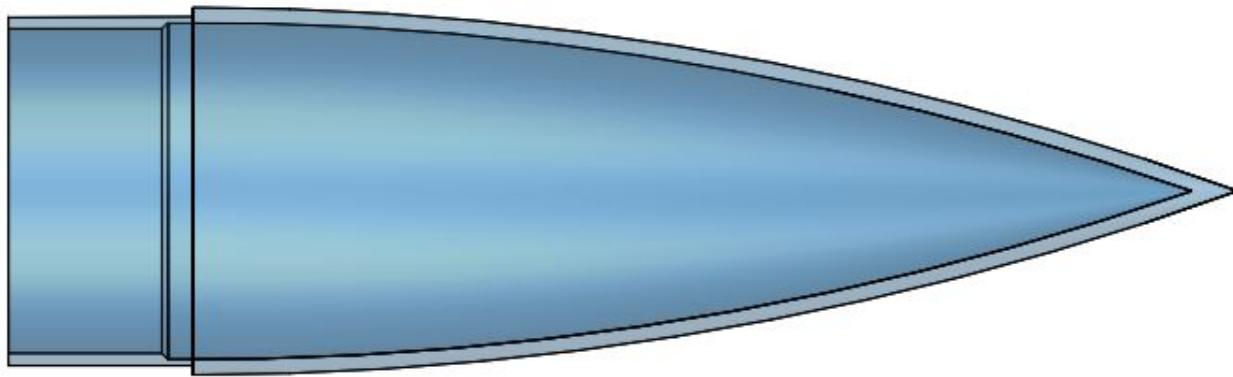


Section Mass:  
1.8 lb.



**UCLA**  
Bearospace

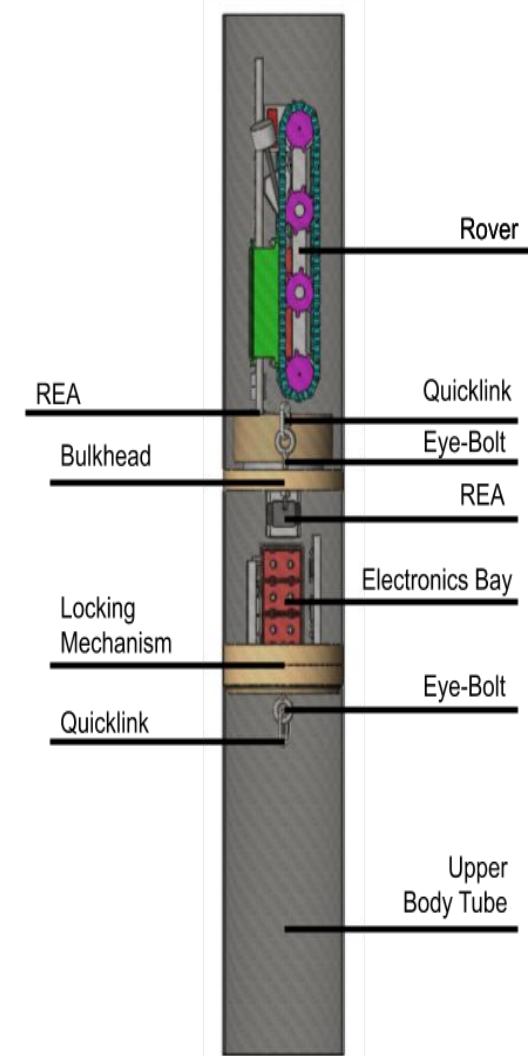
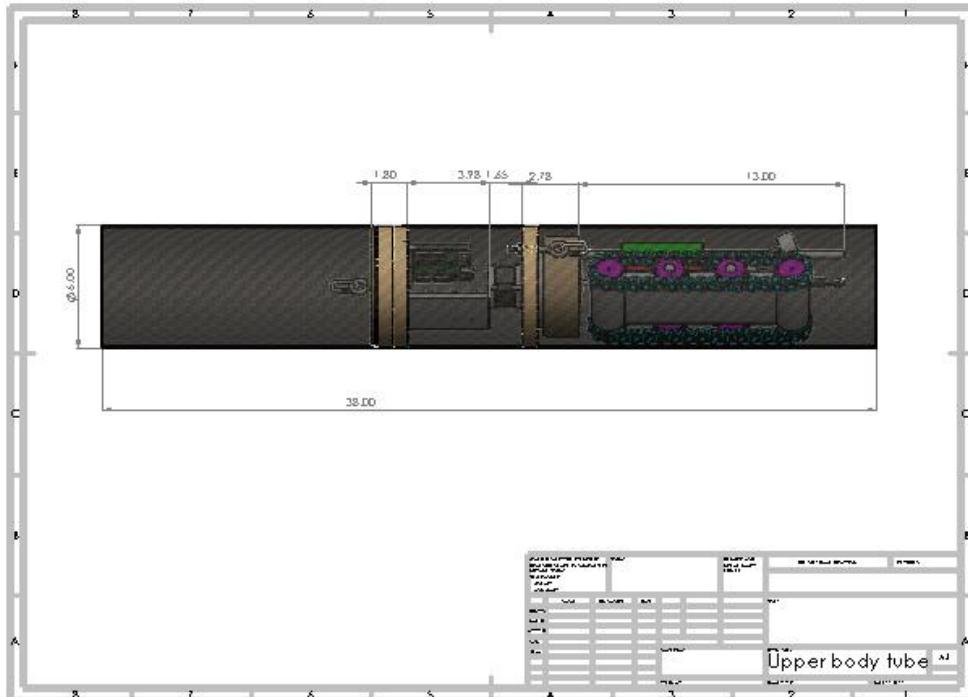
# Nose Cone Section - Assembly



**UCLA**  
Bearospace

# Upper Body Tube Section - Design

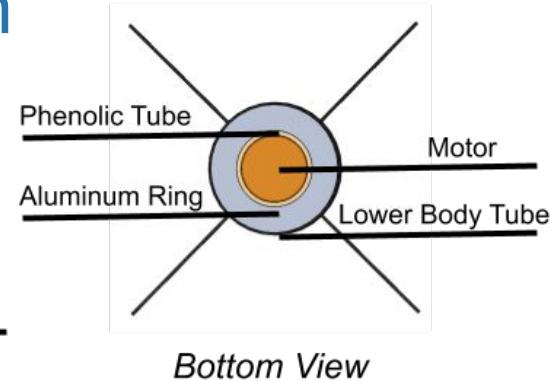
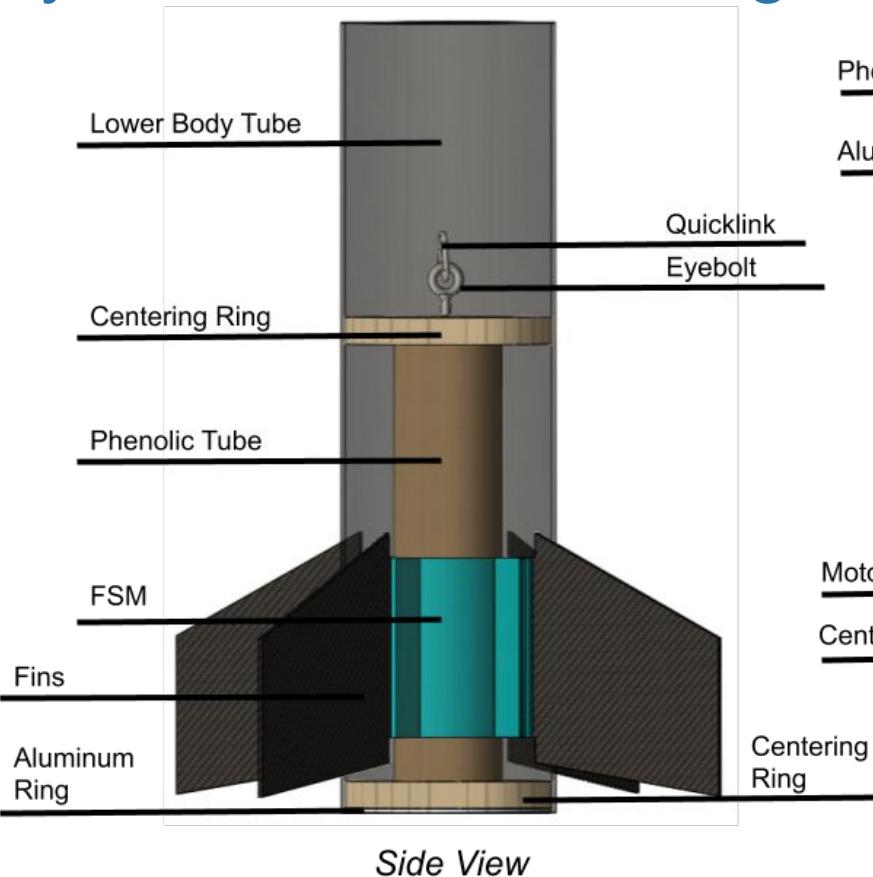
Section Mass:  
12.65 lb



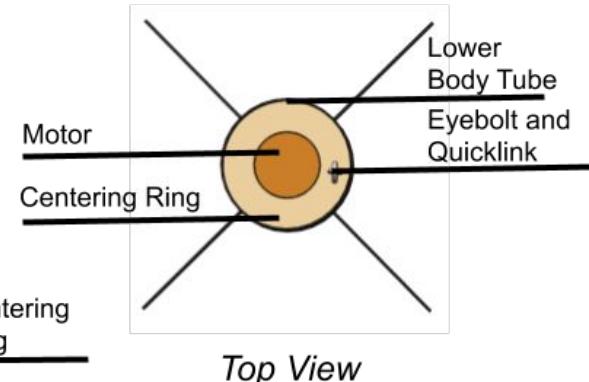
**UCLA**  
Bearospace

# Lower Body Tube Section - Design

Section Mass:  
13.2 lb



*Bottom View*

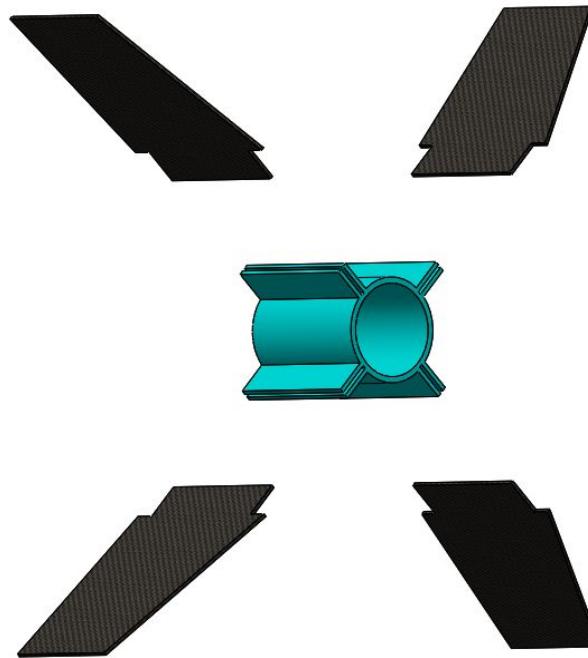
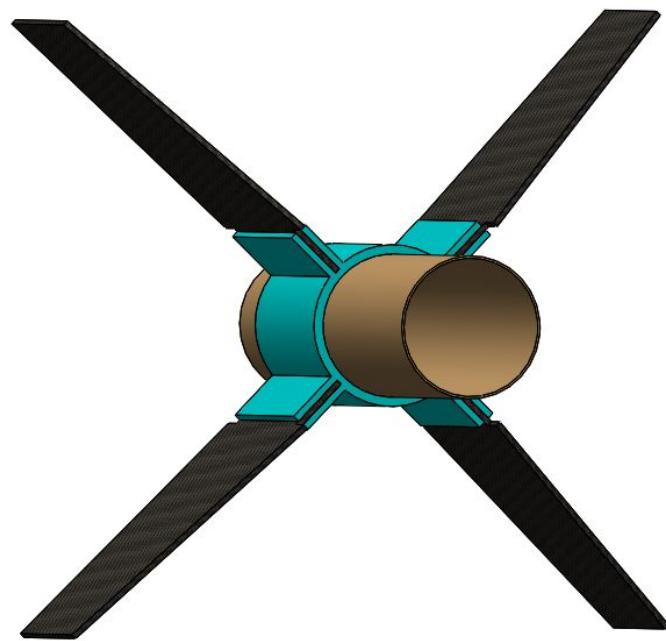


*Top View*



**UCLA**  
Bearospace

# FSM



**UCLA**  
Bearospace

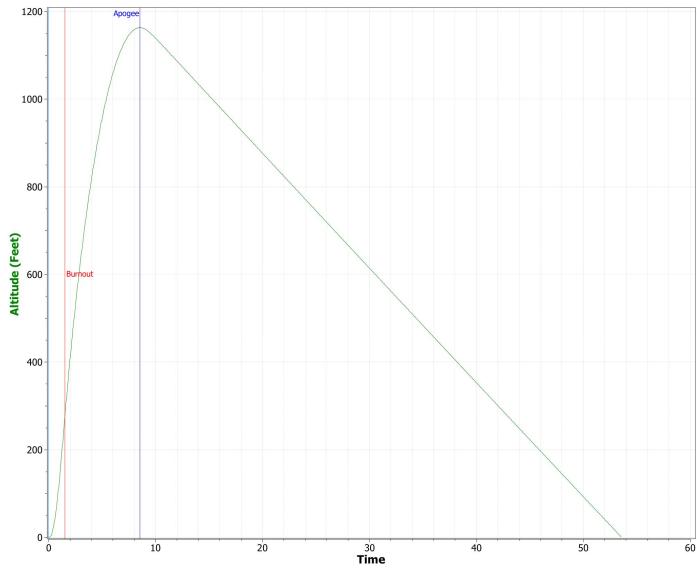
# Subscale Flight Data



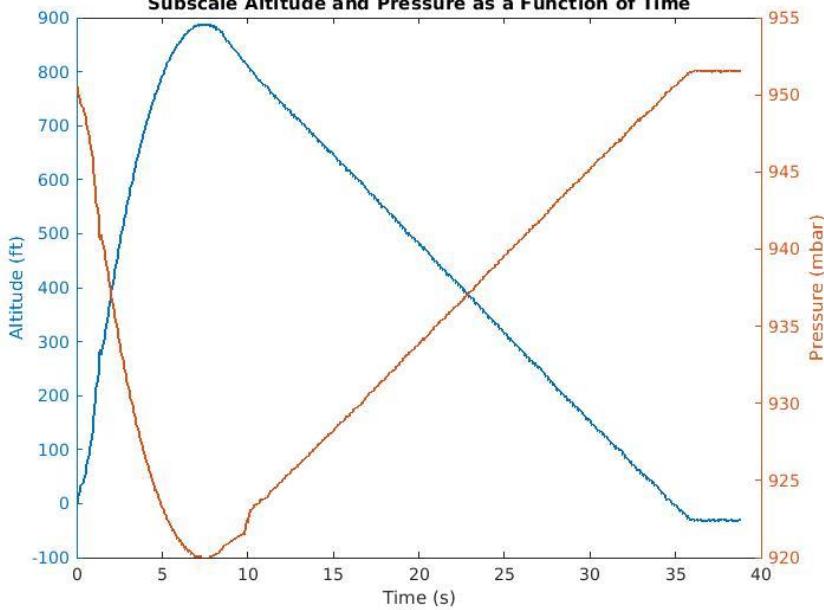
**UCLA**  
Bearospace

# Subscale Flight Data

Subscale Altitude Profile



Subscale Altitude and Pressure as a Function of Time



Scaling Factor: 0.4353  
Coefficient of Drag: 0.63



UCLA  
Bearospace

# Mission Performance Predictions



**UCLA**  
Bearospace

# Mission Performance (Ascent)

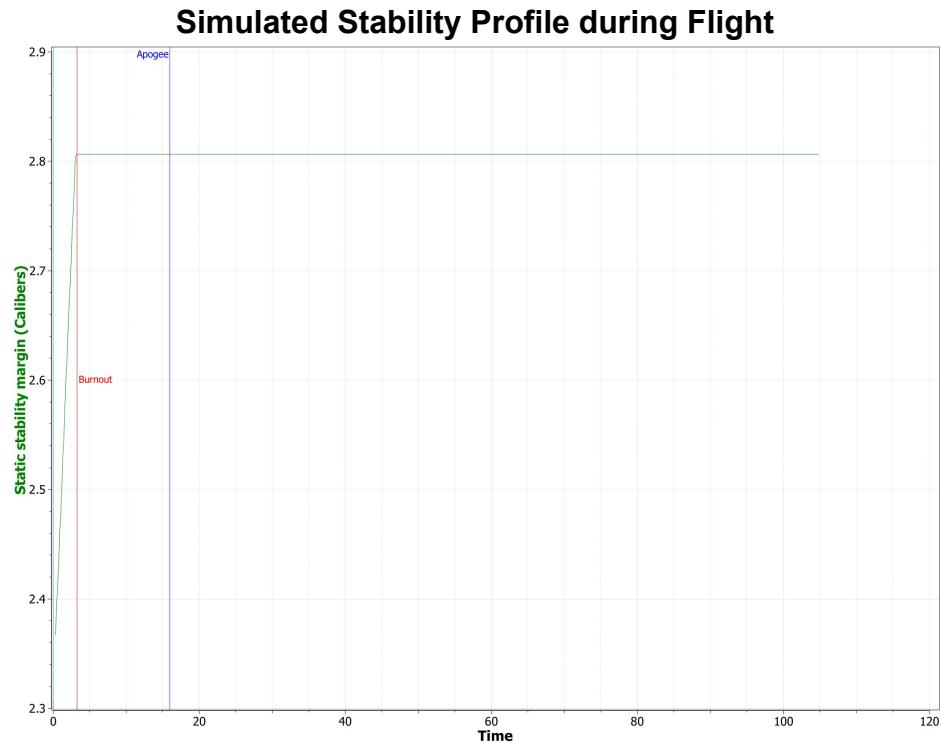
Motor Selection: 2856-L910-CS-0

Thrust-to-Weight Ratio: 7.28

Rail Exit Velocity: 58.72 ft/s

Static Stability: 2.33 cal

Static Stability at Rail Exit: 2.37 cal



**UCLA**  
Bearospace

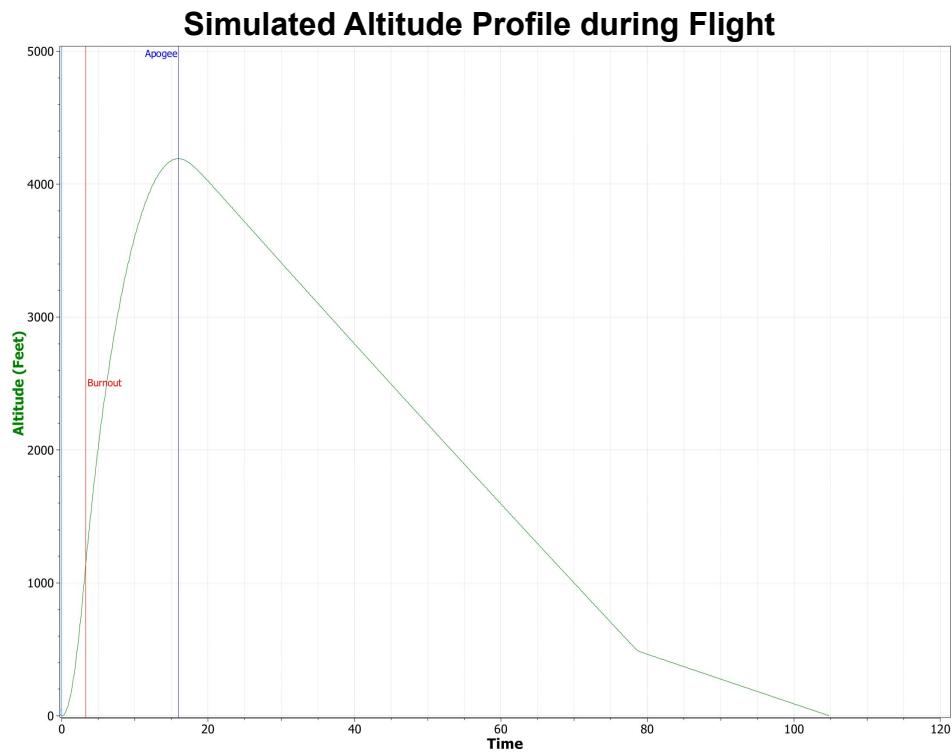
# Mission Performance (Descent)

Descent Time: 88.9 s

Descent Rate (drogue): 60.05 ft/s

Descent Rate (main): 21.37 ft/s

Landing Speed: 18.55 ft/s



# Mission Performance (Landing)

@ Main Parachute Deployment:

Vehicle Section:	Nose Cone	Upper Body Tube	Lower Body Tube
Kinetic Energy:	101.5	709.5	572.1

@ Landing:

Vehicle Section:	Nose Cone	Upper Body Tube	Lower Body Tube
Kinetic Energy	9.67	67.6	54.29



# Mission Performance (Landing) (cont'd)

Assuming apogee is reached directly above launch pad,  
and launch rail is inclined 5 degrees:

Wind Speed	0 mph	5 mph	10 mph	15 mph	20 mph
Horizontal Drift	0	362	543	855	1333

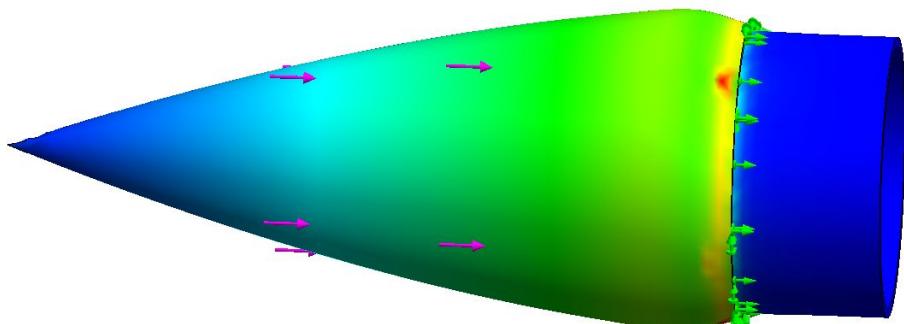


# Staged Recovery System Testing



**UCLA**  
Bearospace

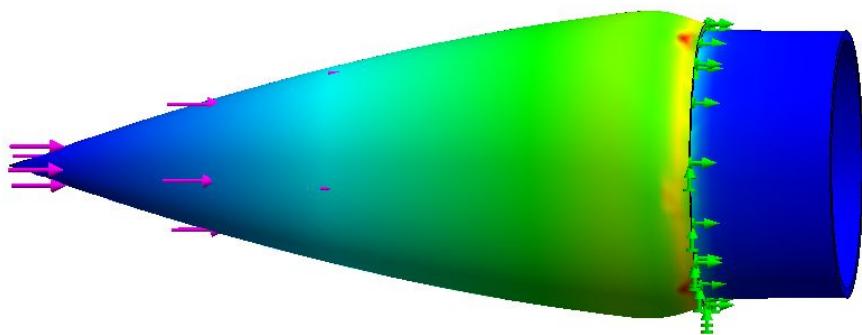
# Nose Cone - Testing



## Normal Stress:

Force Imposed: 208.5 lbf  
Max Stress Felt: 61.47 psi  
Yield Stress: 10800 psi

**Passed**



## Shear Stress:

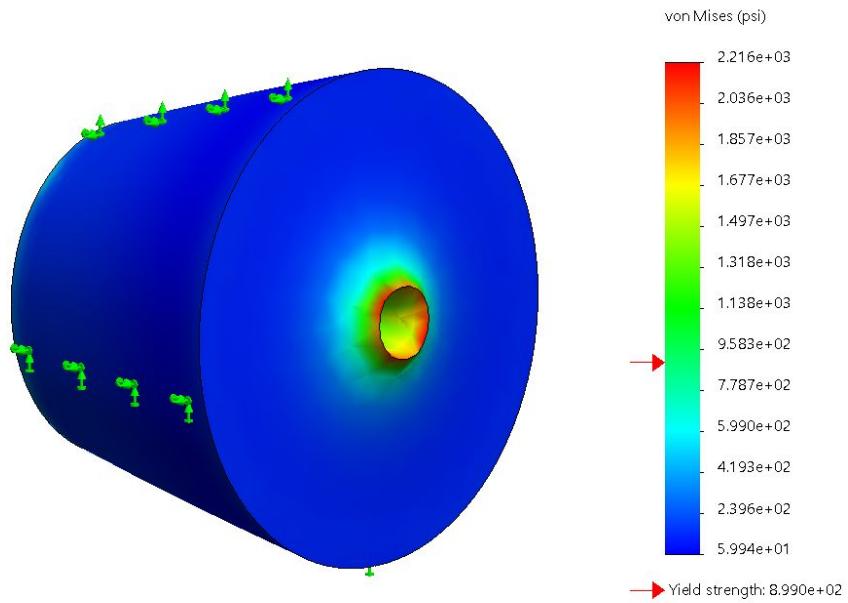
Force Imposed: 1247 lbf  
Max Stress Felt: 353 psi  
Yield Stress: 10800 psi

**Passed**



**UCLA**  
Bearospace

# Nose Cone - Testing (Cont.)



## Shear Stress:

Force Imposse: 1247 lbf

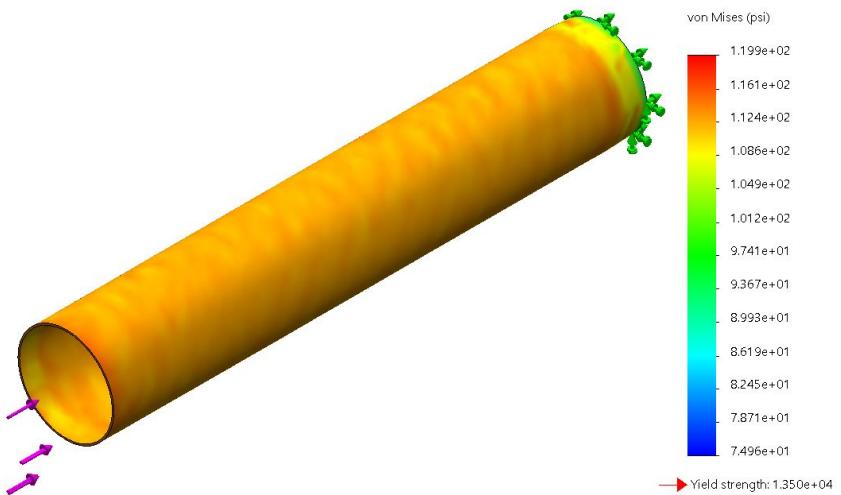
Max Stress Felt: 2216

Yeild Stress:~899 psi

**Fail - Physical Testing Needed**



# Upper Body Tube - Testing



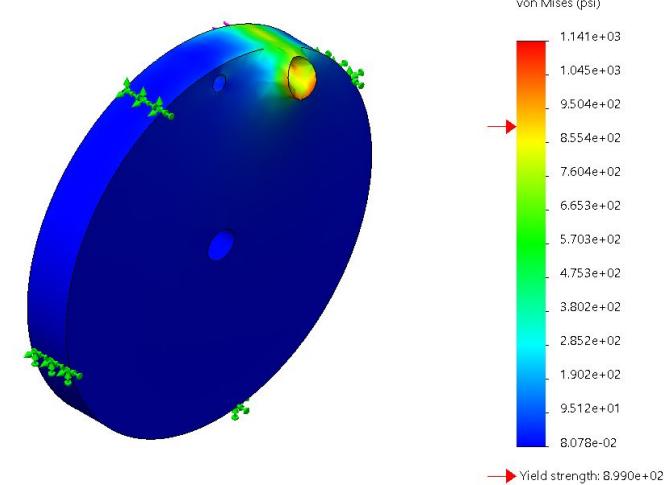
## Normal Stress:

Force Impossed: 208.5 lbf

Max Stress Felt: 120

Yeild Stress:13500 psi

**Passed**



## Shear Stress:

Force Impossed: 1247 lbf

Max Stress Felt: 1141

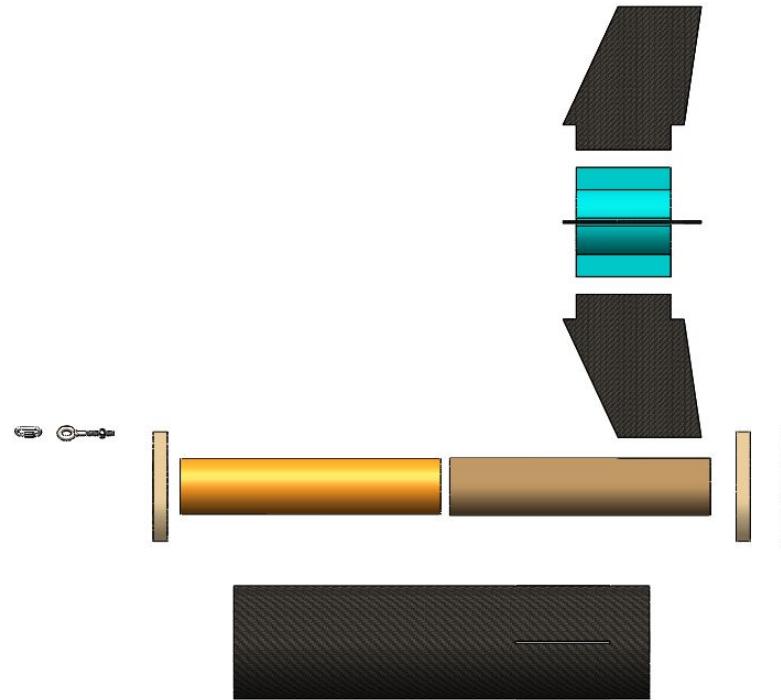
Yeild Stress:899 psi

**Failed - Physical Testing Needed**



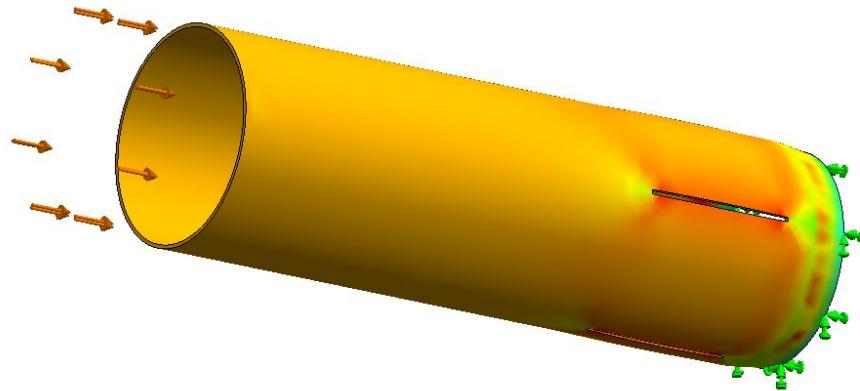
**UCLA**  
Bearospace

# Lower Body Tube - Assembly



**UCLA**  
Bearospace

# Lower Body Tube - Testing



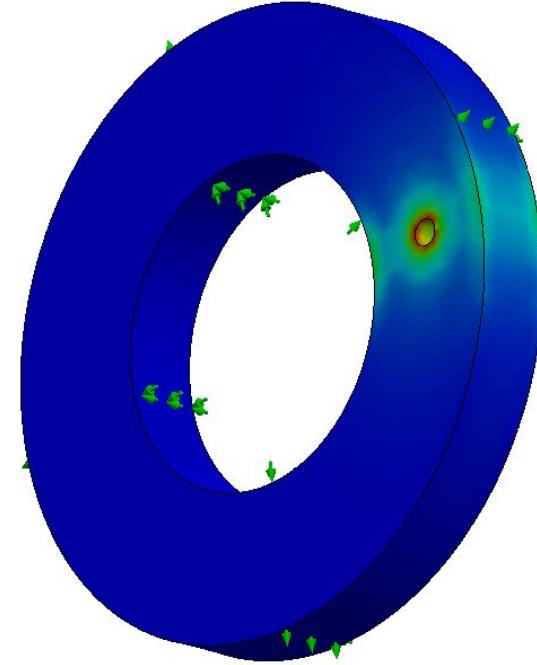
## Normal Stress:

Force Imposse: 208.5 lbf

Max Stress Felt: 130 psi

Yeild Stress:13500 psi

**Passed**



## Shear Stress:

Force Imposse: 27.8 lbf

Max Stress Felt: 139

Yeild Stress:899 psi

**Passed**

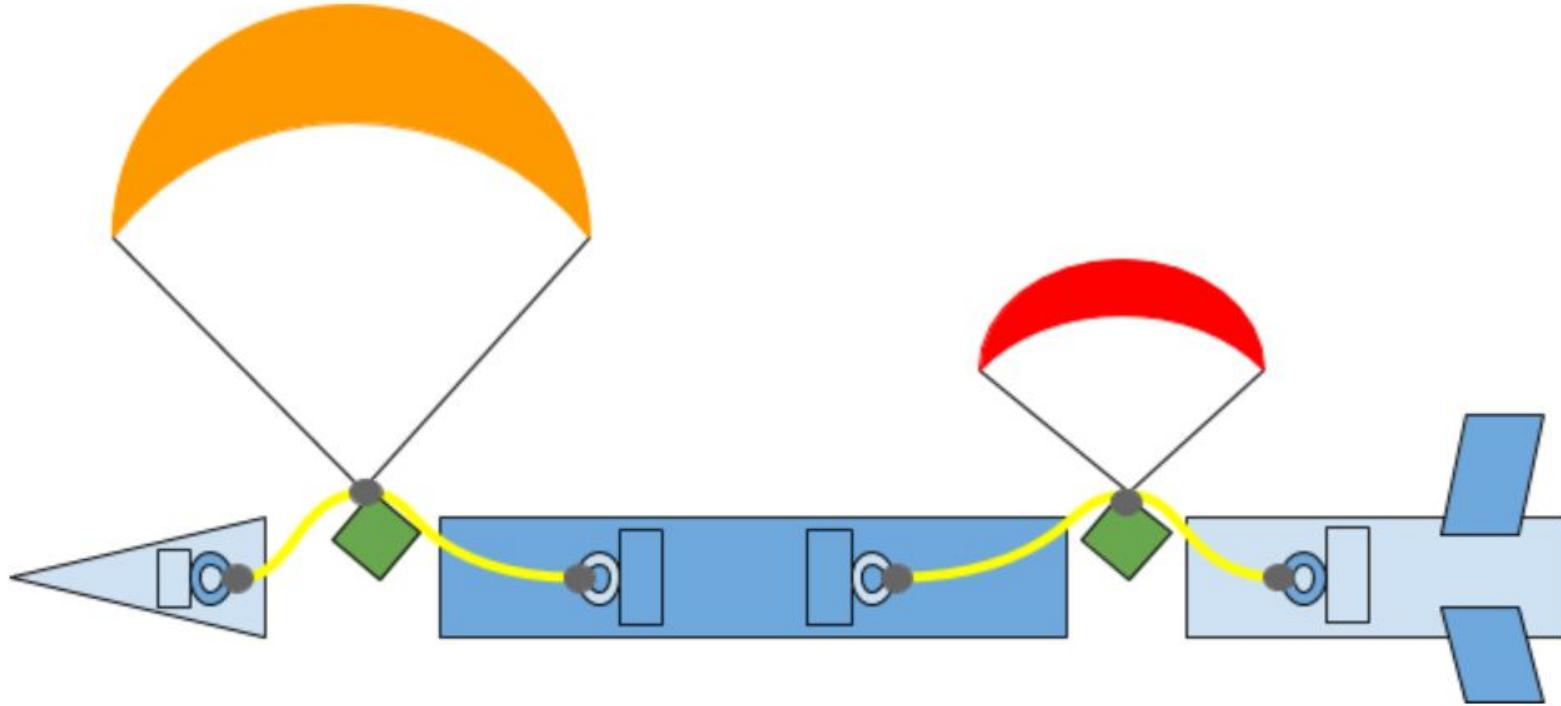


**UCLA**  
Bearospace

# Recovery Subsystem

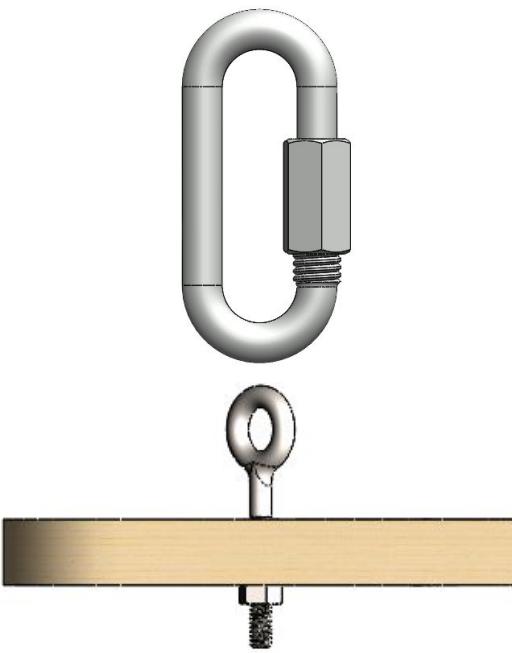


**UCLA**  
Bearospace



**UCLA**  
Bearospace

# Recovery Components



## Main Recovery Harness

- 10 ft ripstop nylon parabolic parachute ( $C_d = 0.97$ )
- 20 ft, 0.5 in flat kevlar shock cords
- 1 ft fire shroud

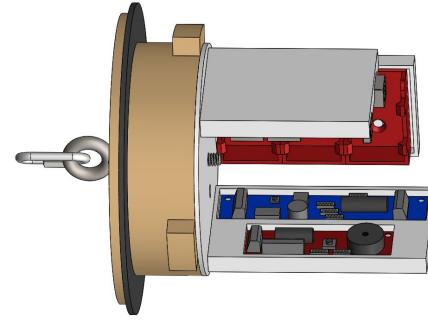
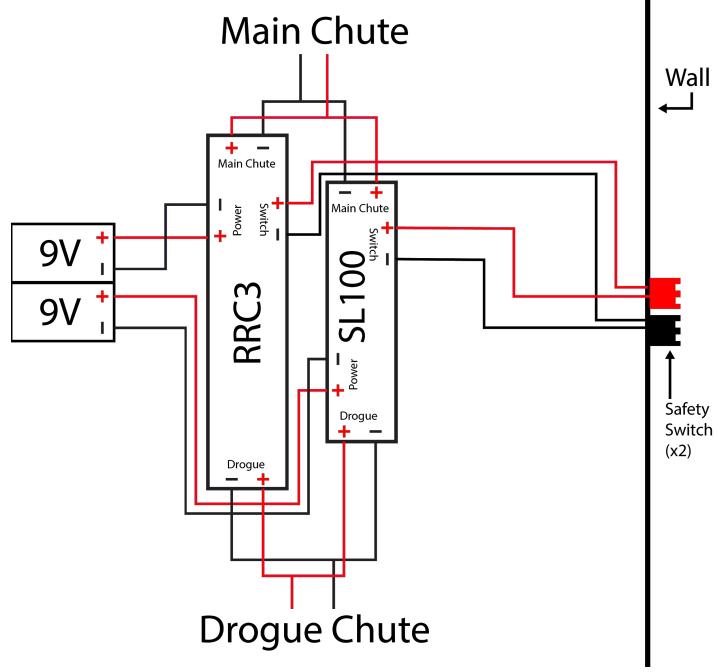
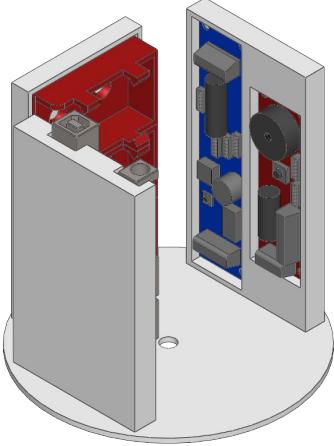
## Drogue Recovery Harness

- 3 ft ripstop nylon elliptical drogue chute ( $C_d = 0.8$ )
- 23 ft, 0.5 in flat kevlar shock cords
- 1 ft fire shroud



**UCLA**  
Bearospace

# Avionics

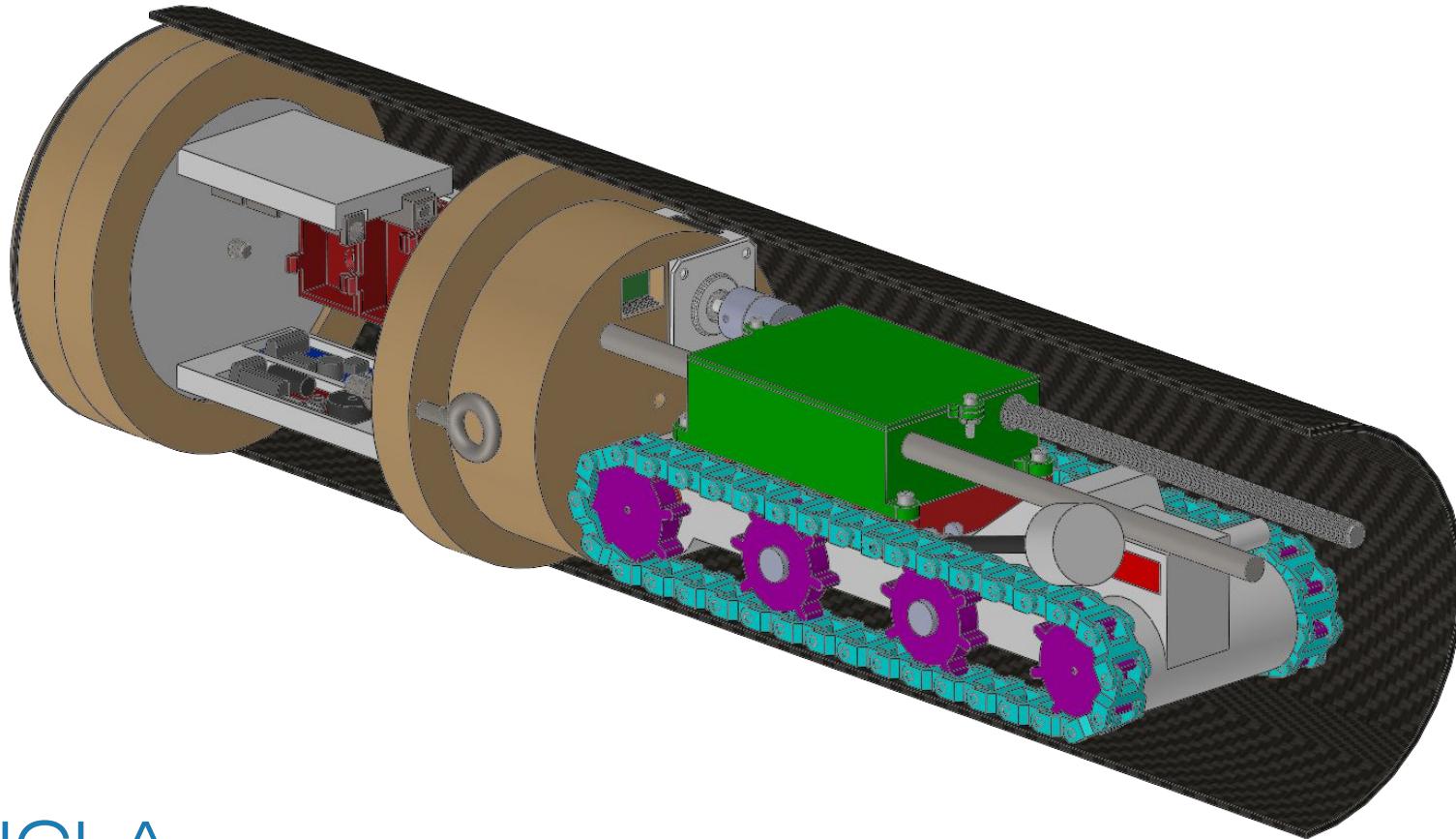


UCLA  
Bearospace

# Scientific Payload

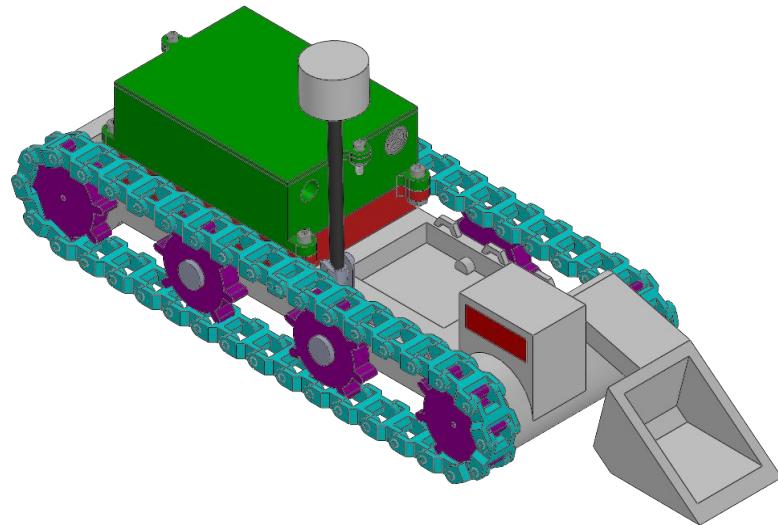
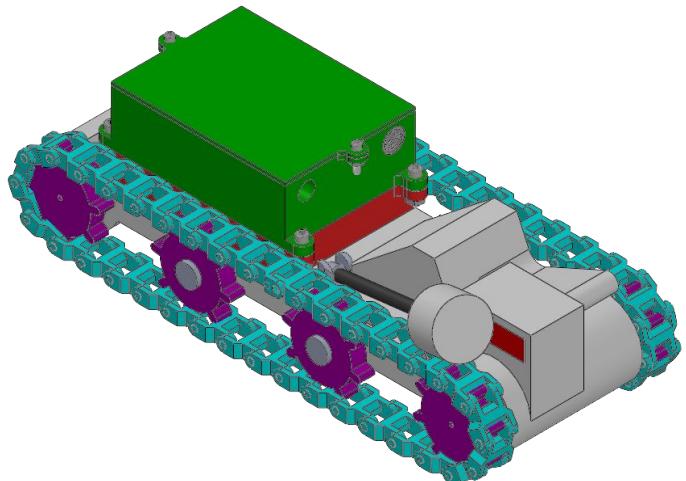


**UCLA**  
Bearospace

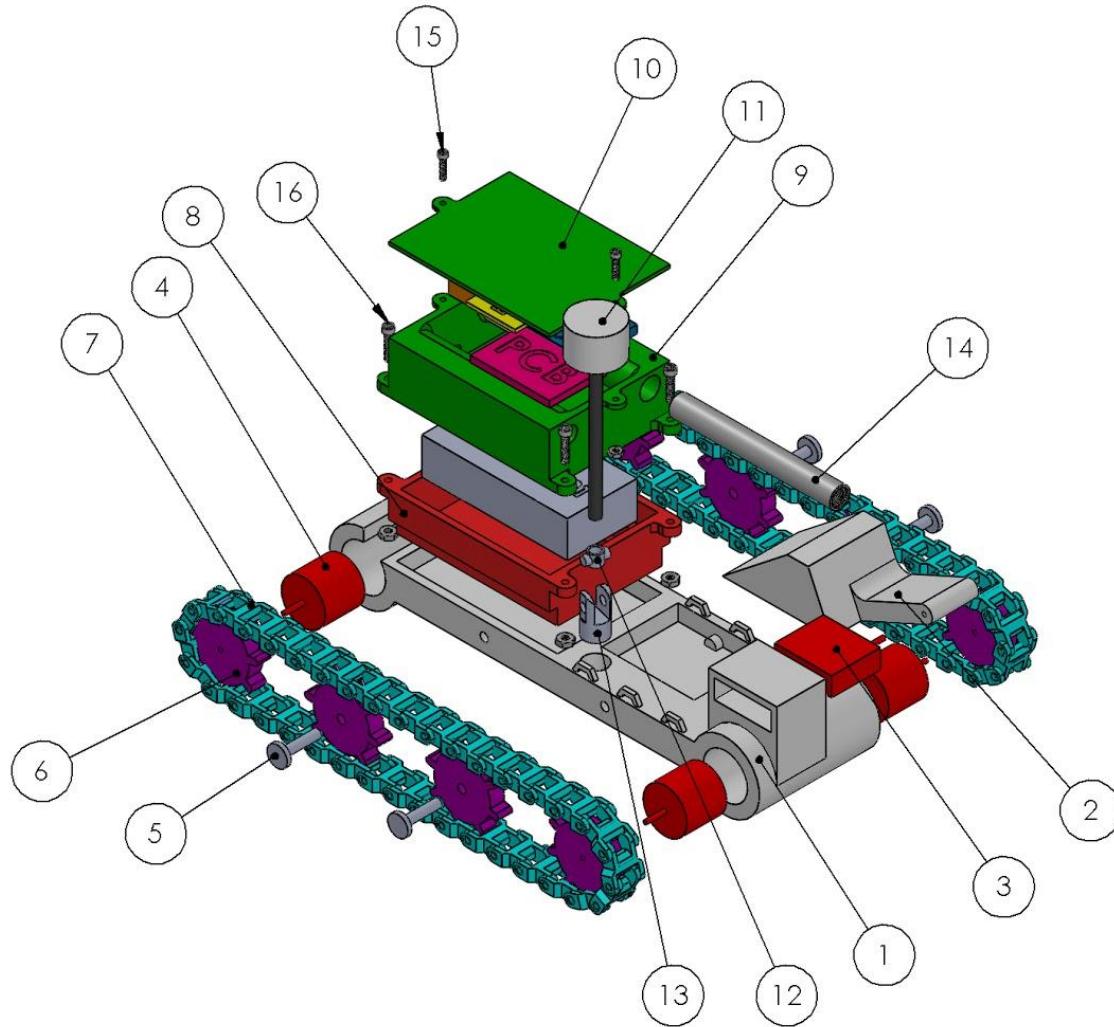


**UCLA**  
Bearospace

# Rover

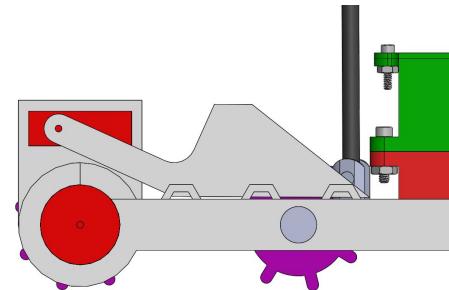
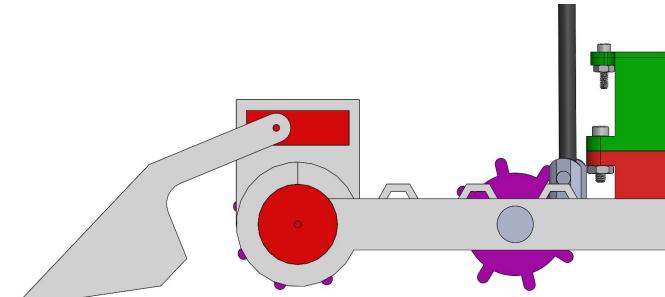
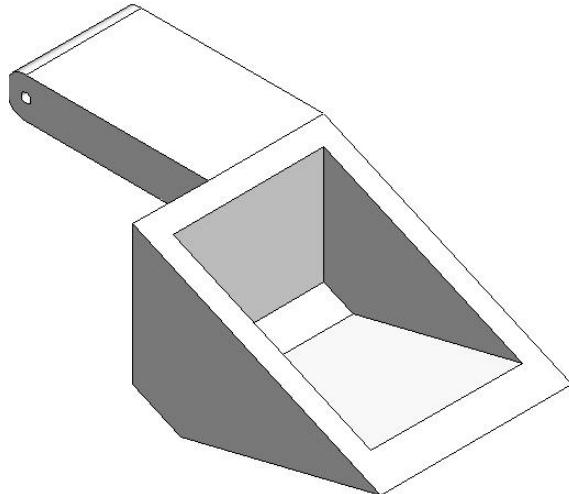


UCLA  
Bearospace



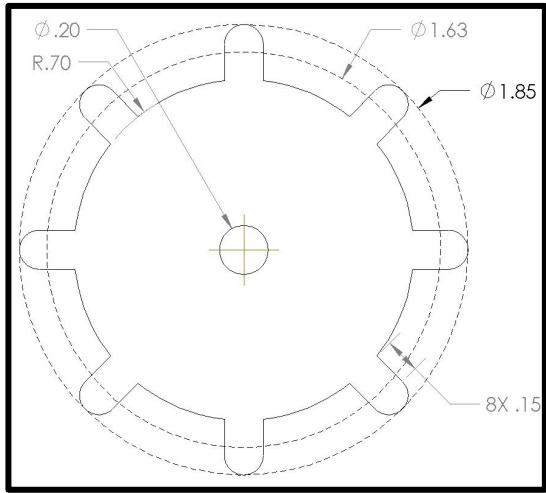
**UCLA**  
Bearospace

# Collection Method

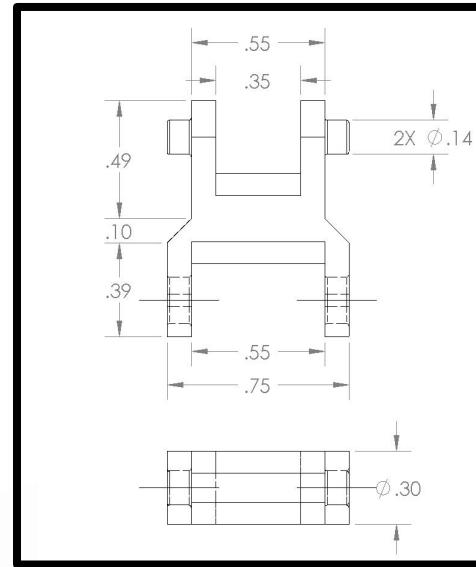


**UCLA**  
Bearospace

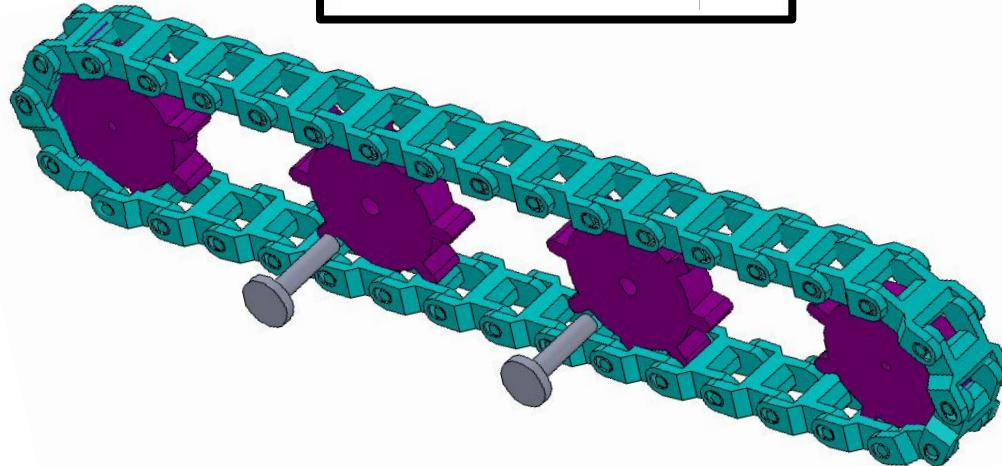
# Treads



Treads

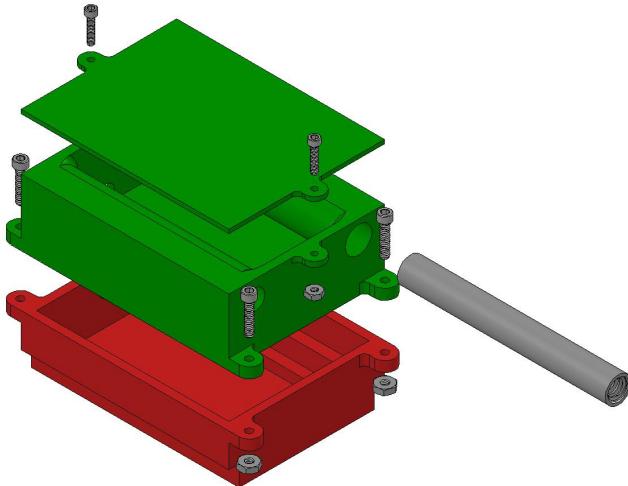


Wheels



**UCLA**  
Bearospace

# Rover Electronics



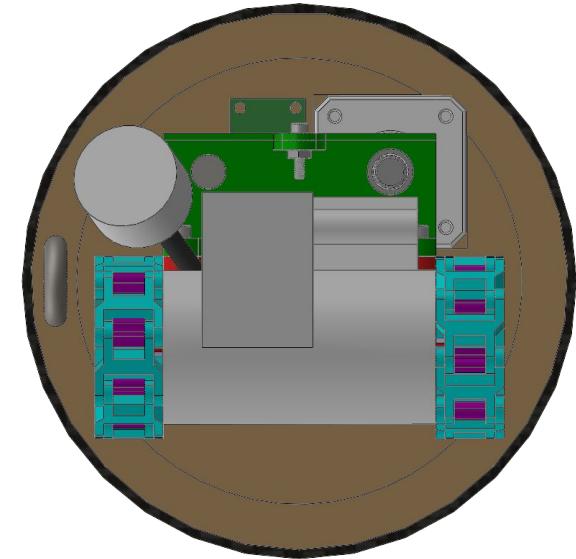
- Flight Controller
- Antennas
- Receiver
- Video Transmitter
- Motors
- Electronic Speed Controllers
- Power Supply



# Rover Antenna

$$P_r = \frac{P_t G_t G_r \lambda^2}{(4\pi R)^2}$$

<b>RX/VTX</b>	<b>Output Power (W)</b>	<b>Sensitivity (dBm)</b>	<b>Received (dBm)</b>
RX	0.1	-104	-74.94
VTX	0.2	-90	-71.94

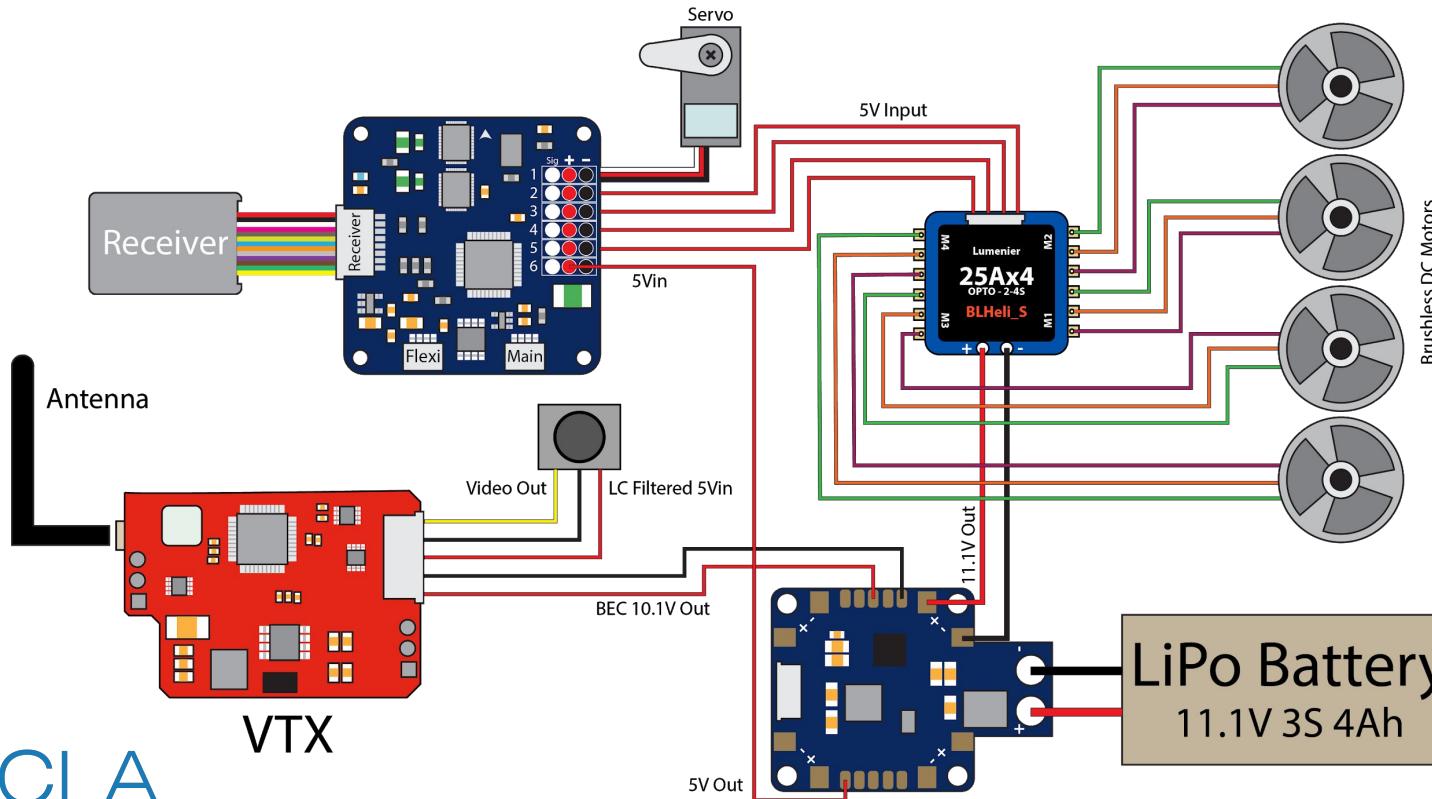


Circularly polarized  
directional antenna  
(1.6dBi)



**UCLA**  
Bearospace

# Rover Electronics Schematic



**UCLA**  
Bearospace

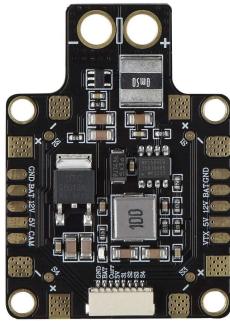
# Current Ratings

ESC



25A continuous each

PDB



50A continuous each

DC Motor



11A max draw

LiPo Battery



50C rating x 4Ah =  
200A discharge rate



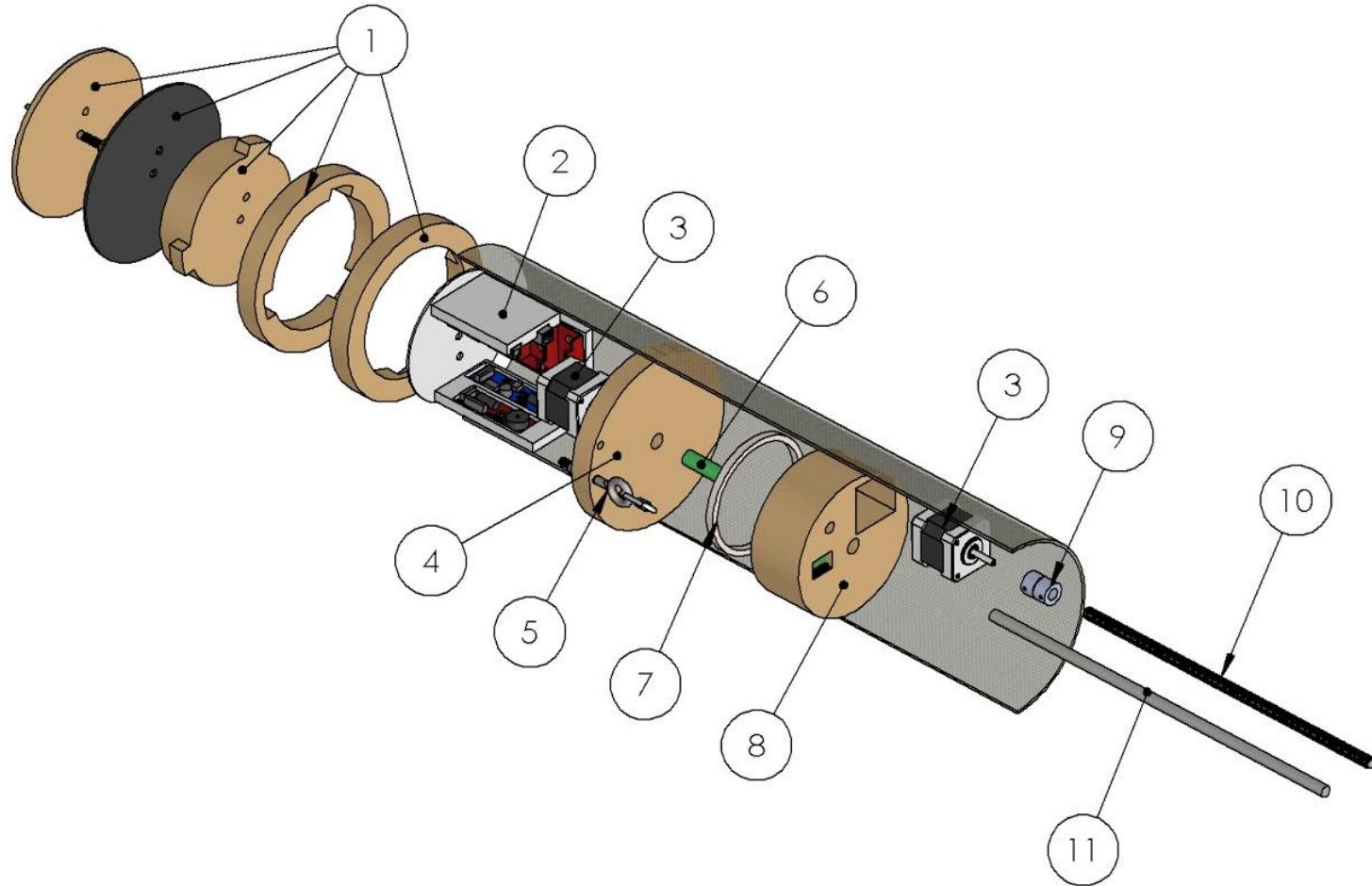
UCLA  
Bearospace

# Electronic Overview

Section	Part	Voltage Range (V)	Current Draw (mA)	Hours (h)	mAh
Controls	DC Motor	6.6 - 7.2	1250	0.5	625
	DC Motor	6.6 - 7.2	1250	0.5	625
	DC Motor	6.6 - 7.2	1250	0.5	625
	DC Motor	6.6 - 7.2	1250	0.5	625
	Servo Motor	5	80	0.5	40
	CC3D	5 - 15	70	4	280
	Receiver	10	30	4	120
	Total	-	<b>5180</b>	-	<b>2940</b>
Video	Transmitter	7.4 - 25.2	90	4	360
	Camera	5	90	4	360
	Total	-	<b>180</b>	-	<b>720</b>
<b>Final Total</b>			<b>5360</b>		<b>3660</b>

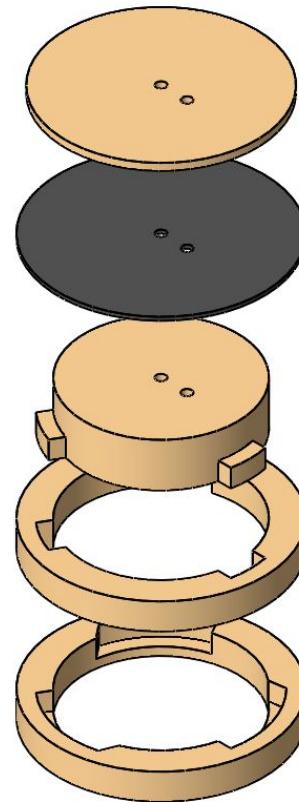
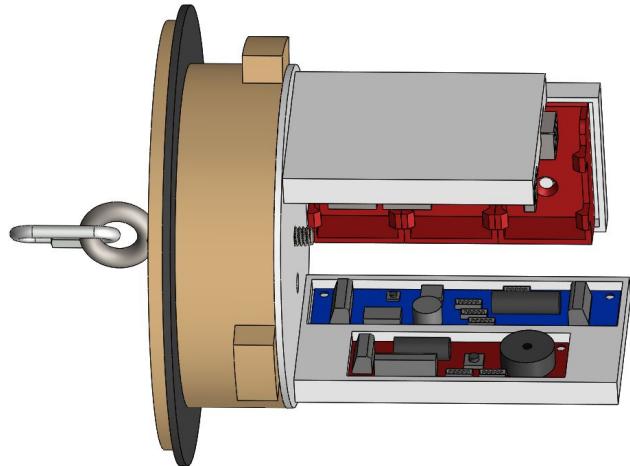


# REA



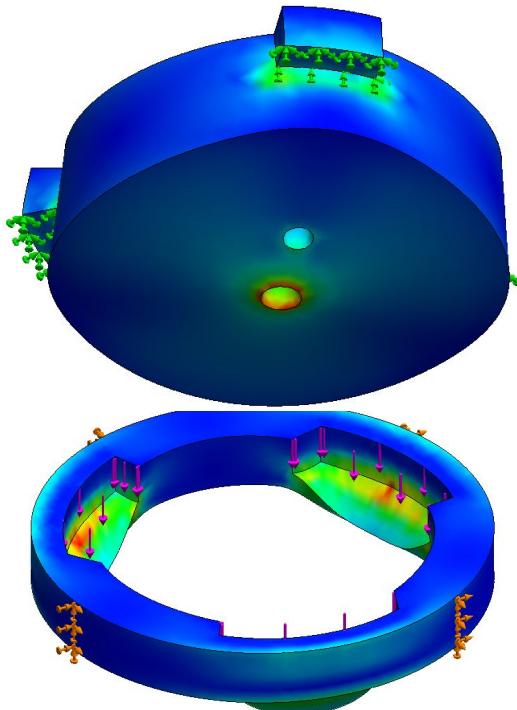
**UCLA**  
Bearospace

# Locking Mechanism



**UCLA**  
Bearospace

# Locking Mechanism - Testing



## Normal Stress:

Force Imposse: 27.8 lbf

Max Stress Felt:

Top: 103 psi

Bottom: 169 psi

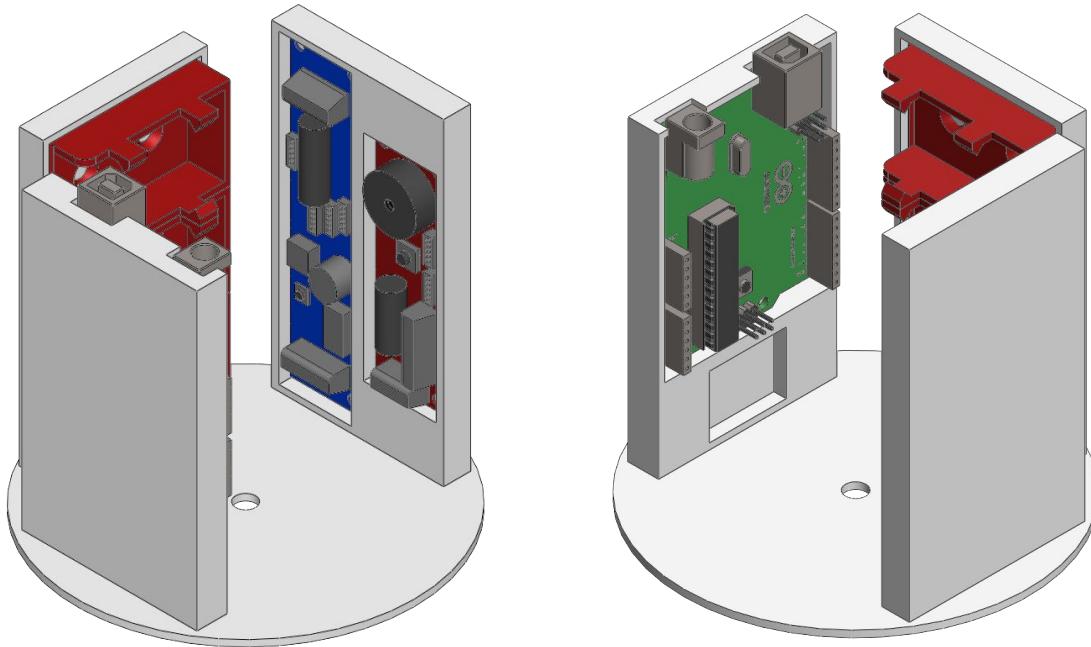
Yeild Stress: 899 psi

**Passed - Physical Testing Planned**



**UCLA**  
Bearospace

# Electronics Bay



## Altimeters

- Stratologger SL 100 Altimeter
- RRC3 Sports ALtimeter

## REA

- Arduino Uno
- BMP180

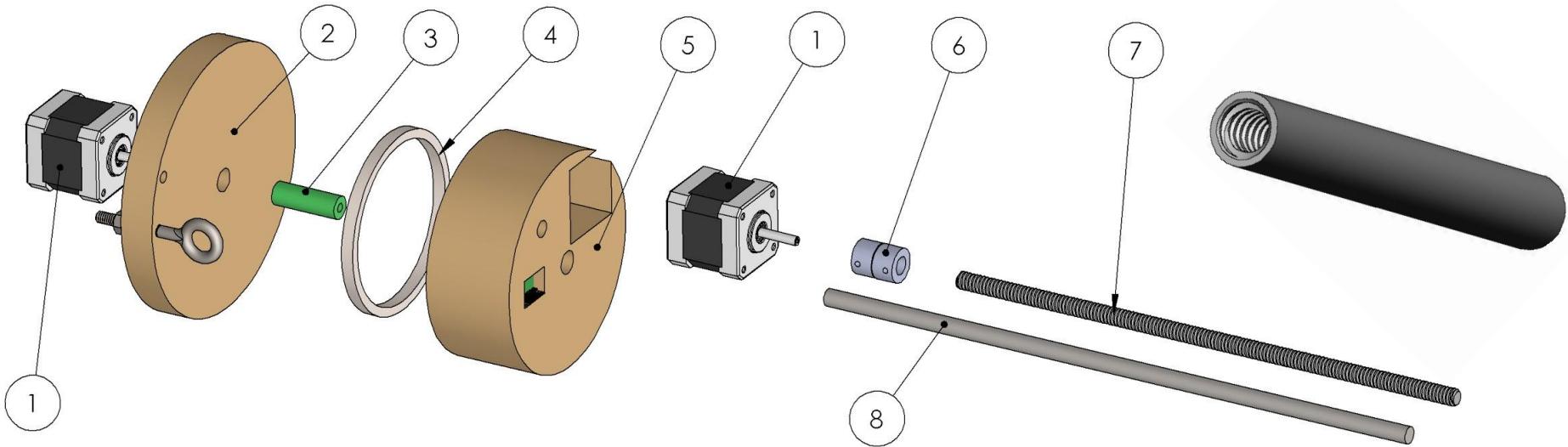
## Power

- 3x 9V Battery



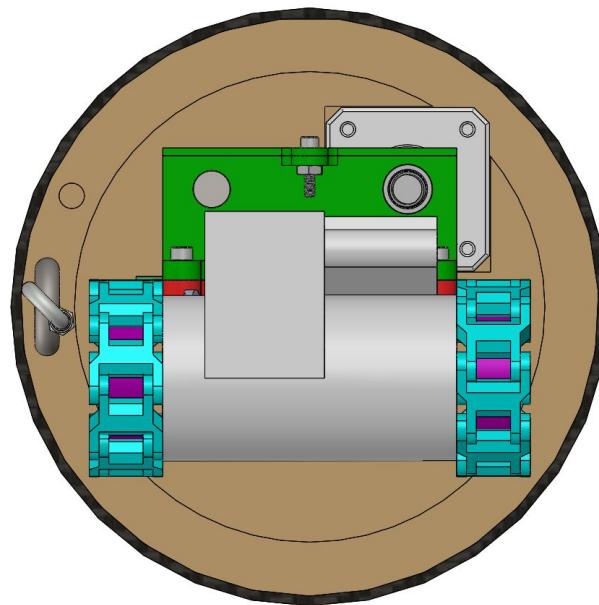
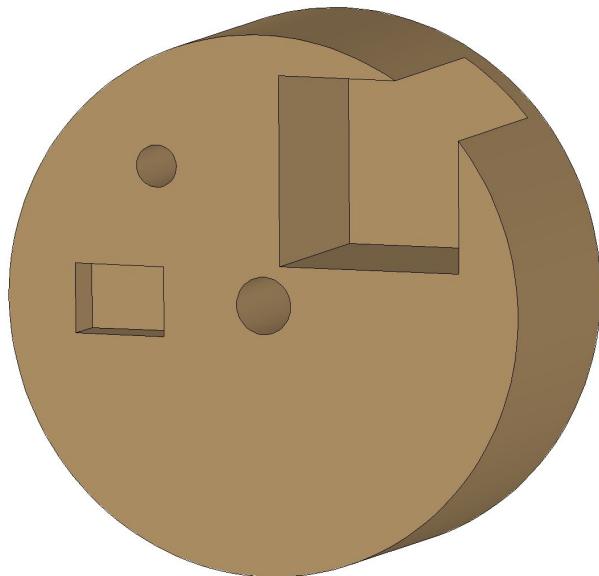
**UCLA**  
Bearospace

# Rover Deployment



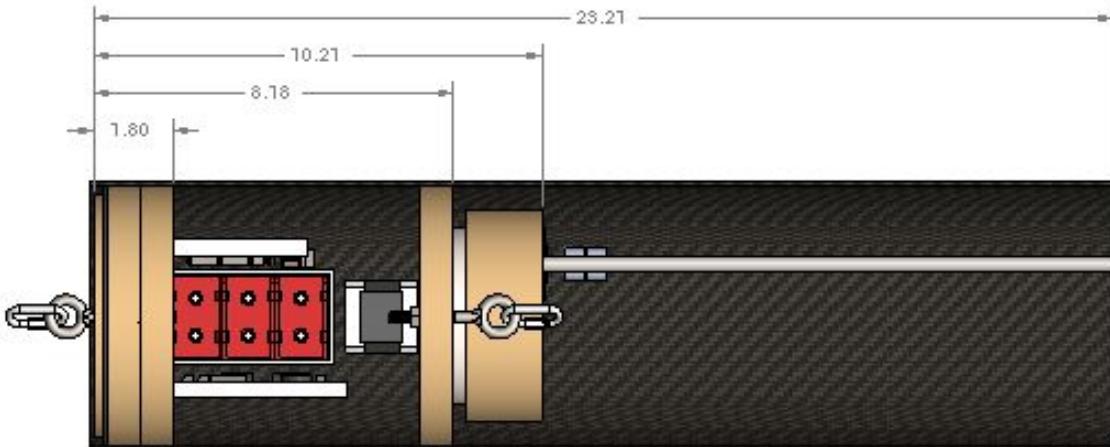
**UCLA**  
Bearospace

# Unique Geometry - Circular Block Holder



**UCLA**  
Bearospace

# Rover Deployment Electronics

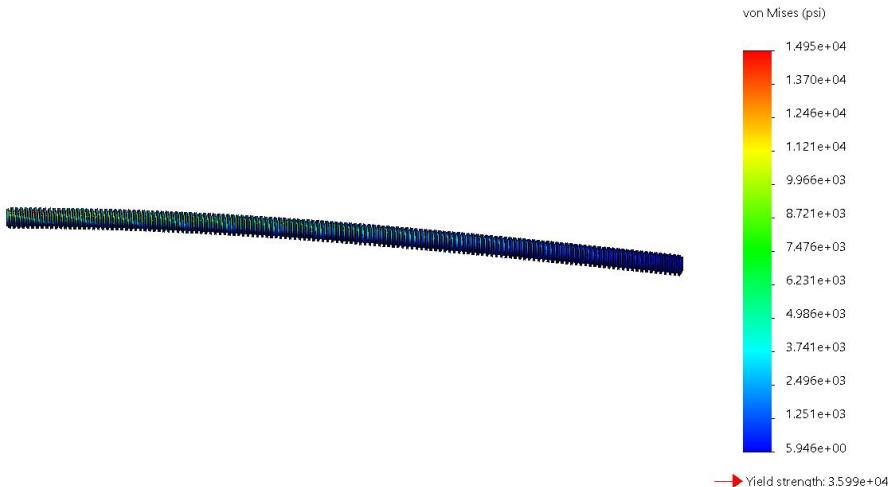


- Microcontroller: Arduino Uno
- Pressure Temperature Sensor: BMP 180
- Accelerometer+Gyroscope Sensor: MPU6050
- Motor Driver: A4988 Stepper Motor Driver
- Stepper Motors: 2x NEMA 17
- Power Supply
  - 9V Alkaline Battery
  - 12V Alkaline Battery



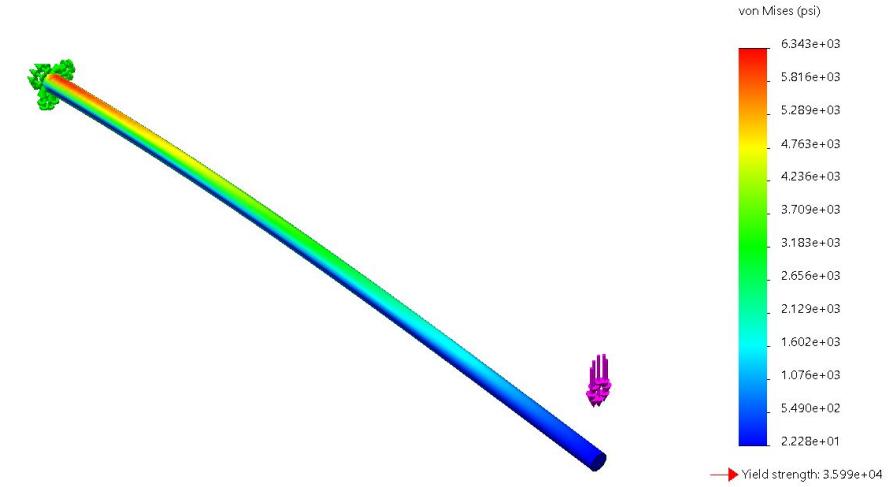
**UCLA**  
Bearospace

# Rover Deployment - Testing (Beam Bending)



## Threaded:

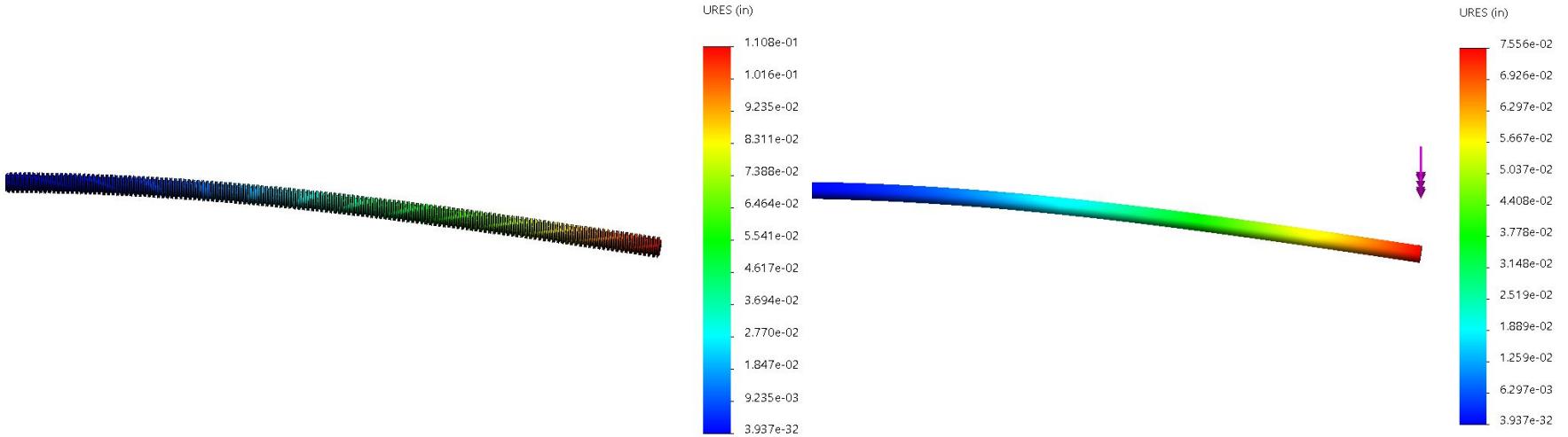
Force Imposed: 2.33 lbf  
Max Stress Felt: 14950 psi  
Yield Stress: 40000 psi  
**Passed**



## Unthreaded:

Force Imposed: 2.33 lbf  
Max Stress Felt: 6343 psi  
Yield Stress: 40000 psi  
**Passed**

# Rover Deployment - Testing (Deflection)



# Questions?



**UCLA**  
Bearospace