FLIGHT READINESS REVIEW

University of South Florida

Society of Aeronautics and Rocketry

2017 - 2018

AGENDA

1. **Launch Vehicle**
2. Recovery
3. Mission Performance Predictions
4. Launch Vehicle Testing
5. Payload
6. Safety
7. Educational Outreach

LAUNCH VEHICLE DIMENSIONS

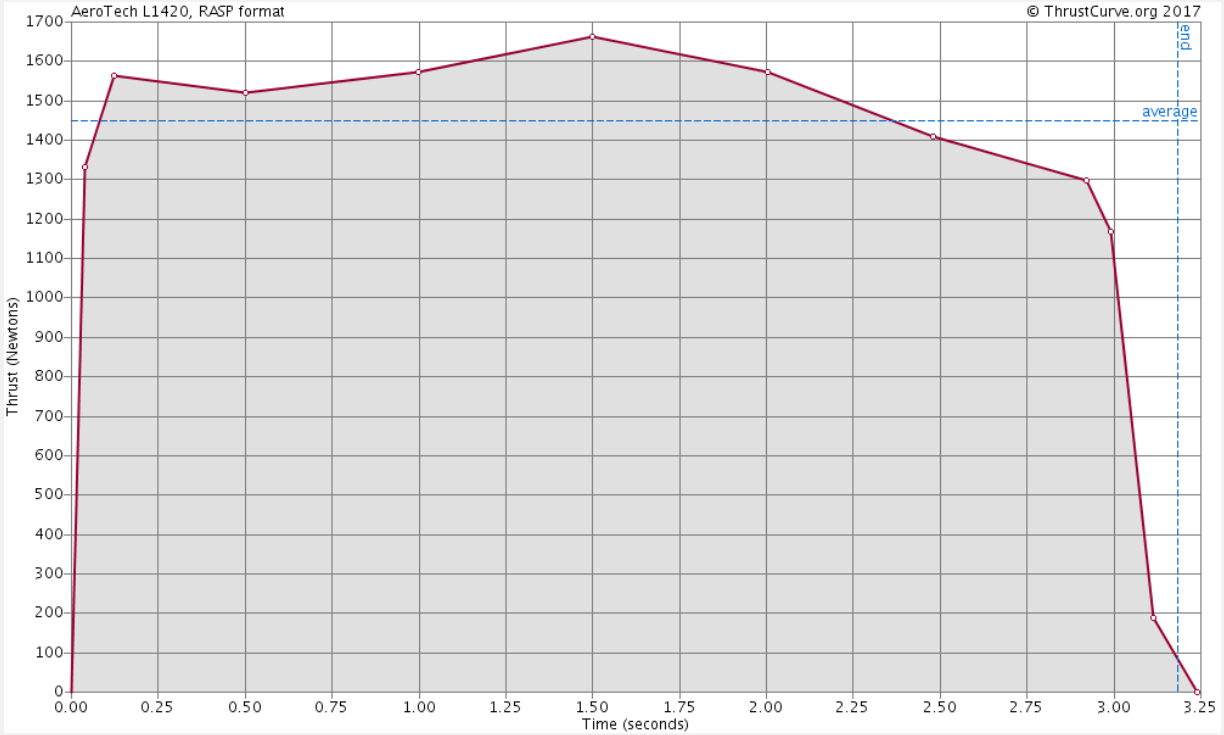
Diameter	5.148 in
Length	111 in
Projected Unloaded Weight	34.4 lbs
Projected Minimum Ballasted Weight	46.4
Projected Fully Ballasted Weight	48.8 lbs
Ballasted Weight	Up to 4.44

KEY DESIGN FEATURES OF LAUNCH VEHICLE

- Aerotech L1420 75mm Motor
- Four Sections
  - Nosecone
  - Rover Compartment
  - Main Altimeter Bay
  - Booster Section
- Recovery
  - One parachute for rover compartment and nosecone
  - One parachute and one drogue for Main Altimeter and Booster Section
- Adjustable Ballast System
  - Removable Ballast for Nosecone shoulder to manipulate flight path and apogee to launch day conditions
- Payload
  - Deployable Rover

LAUNCH MOTOR

Aerotech L1420	
Average Thrust	1420 N
Maximum thrust	1814 N
Total Impulse	4603 Ns
Burn Time	3.2 s
Case Info	CTI Pro75-4G



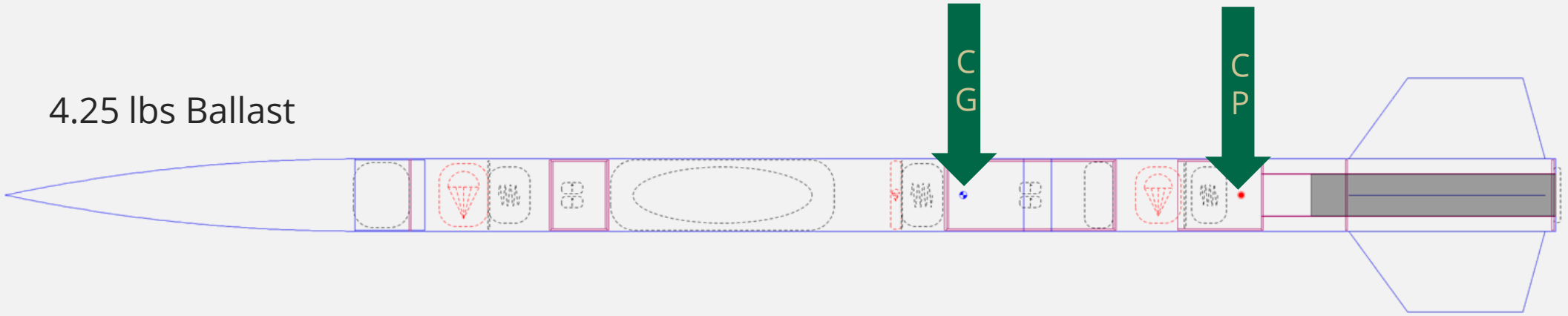
ROCKET FLIGHT STABILITY

- Due to adjustable ballast system the stability has been calculated at maximum ballast and minimum ballast

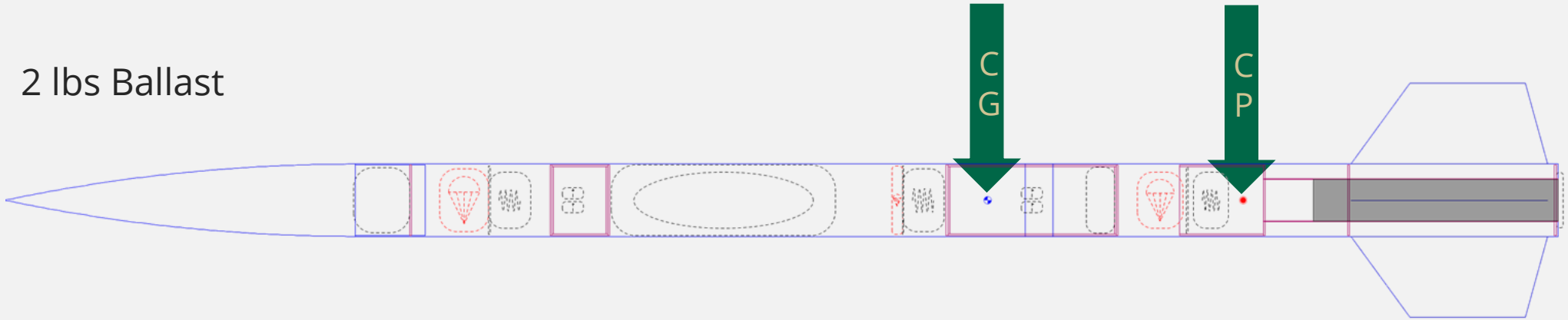
Configuration with Aerotech L1420		
Ballast	4.25 lbs	2 lbs
Center of Pressure	88.308 in	88.308
Center of Gravity	68.34 in	70.072
Static Stability Margin	3.88 cal	3.54 cal

ROCKET FLIGHT STABILITY

4.25 lbs Ballast



2 lbs Ballast



FLIGHT CHARACTERISTICS

Ballast	4.25
Projected Apogee	5303
Thrust-to-Weight Ratio	7.07:1
Max Velocity	602.89
Max Acceleration	224.28
Exit Rail Velocity	57.7
Exit Rail Stability	3.95

MASS STATEMENT & MASS MARGIN

System Name	Projected Weight (max ballast) (lbs)
Loaded Rocket (motor & max ballast)	48.7
Nosecone (bulkhead & G10 Shoulder)	5.5
Rover Compartment (airframe, payload altimeter bay & rover)	14.9
Booster Section (airframe, motor mount & recovery equipment)	10.125
Main Altimeter Bay (G10 coupler, bulkheads, altimeters & recovery equipment)	7.175
Parachutes	1.5
Max Ballast Allocated	4.25
Aerotech 75mm L1420 Motor (Total / Propellant)	9.5/5.64

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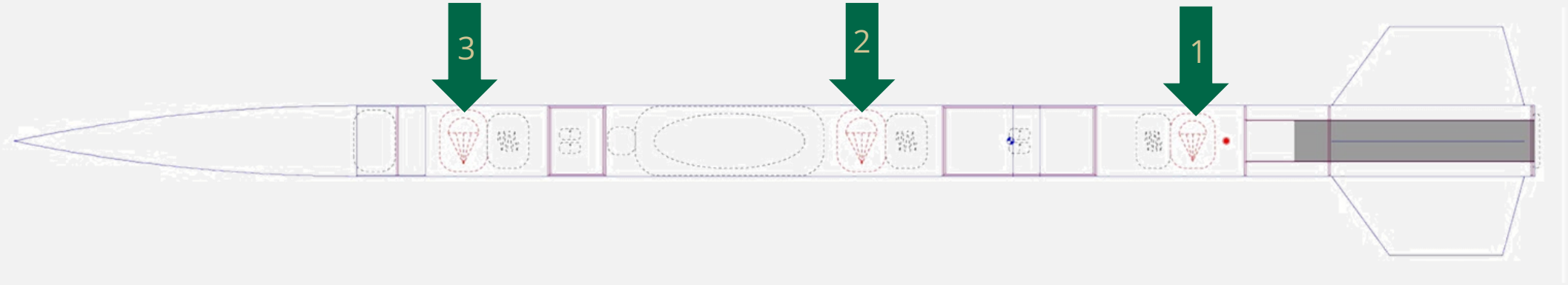
RECOVERY OVERVIEW

1. Drogue parachute: Attached to shock cord that is attached to a U-bolt
2. Booster Section parachute: Attached to shock cord that is attached to a U-bolt
3. Rover Compartment parachute: Directly attached to nosecone U-bolt and Payload Altimeter Bay U-bolt



DROGUE PARACHUTE

Name	28 inch SkyAngle Classic II drogue
Deployed at	Apogee
Material	Zero-porosity 1.9 oz. silicone-coated balloon cloth
Surface Area (sq ft)	4.4
Drag Coefficient	.8
Number of Lines	3
Line Length (in)	28
Line Material	3/8” tubular nylon (950 lbs)
Attachment Type	Heavy-duty 1,500 lb. size 12/0 nickel-plated swivel

BOOSTER SECTION MAIN

- Larger parachute then noted in CDR
- Heavier Booster Section made change necessary

Name	Fruity Chutes Iris Ultra Light 66” Chute
Deployed at	950 ft
Material	.66 oz ripstop nylon
Surface Area (sq ft)	47.5
Drag Coefficient	2.2
Number of Lines	10
Line Length (in)	66
Line Material	200# Spectra Nanoline
Attachment Type	No swivel, plan to purchase and equip a 500# ball bearing swivel

ROVER COMPARTMENT & NOSECONE MAIN

Name	SkyAngle Classic II 60
Deployed at	800 ft
Material	Zero-porosity 1.9 oz. silicone-coated balloon cloth
Surface Area (sq ft)	39.3
Drag Coefficient	1.89
Number of Lines	3
Line Length (in)	60
Line Material	3/8” tubular nylon (950 lbs)
Attachment Type	Heavy-duty 1,500 lb. size 12/0 nickel-plated swivel

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KINETIC ENERGY

Kinetic Energy at Key Phases (ft – lbs)				
	Nosecone	Rover Compartment	Main Altimeter Bay	Booster Section
Drogue Deployment	1.03	2.85	1.37	3.54
Main #1 Deployment	421.39	1168.07	561.86	1449.00
Main #2 Deployment	204.69	567.39	272.92	703.85
Touchdown	20.25	56.16	33.9	64.44

Altitude Predictions with Various Ballast					
Wind Speed (mph)	**Total Ballast Weight (pounds)**	**Projected Apogee (feet)**	**Wind Speed (mph)**	**Total Ballast Weight (pounds)**	**Projected Apogee (feet)**
0	4.2500	5283	11	3.2500	5289
1	4.1875	5284	12	3.1250	5288
2	4.1250	5285	13	3.0000	5289
3	4.1000	5285	14	2.8750	5289
4	4.0000	5283	15	2.7500	5288
5	3.8750	5301	16	2.6250	5288
6	3.8125	5285	17	2.5000	5288
7	3.6875	5289	18	2.3750	5289
8	3.6250	5282	19	2.2500	5291
9	3.5000	5282	20	2.0000	5288
10	3.3750	5287			

PREDICTED DRIFT

Booster Section and Altimeter		
Wind Speed (mph)	**Wind Speed** (ft./s)	**Drift** (ft.)
0	0	0
5	7.33	601.33
10	14.67	1202.67
15	23.46	1804.00
20	29.33	2405.33

Nosecone and Rover Compartment		
Wind Speed (mph)	**Wind Speed** (ft./s)	**Drift** (ft.)
0	0	0
5	7.33	586.67
10	14.66	1173.33
15	23.46	1760.00
20	29.33	2346.67

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GROUND TEST PLAN & PROCEDURE

Objective

- This test will determine the vehicle's ability to separate with various shear pin sizes and black powder amounts.

Ground Test 1

- Drogue – 2 g black powder; 2 x 2-56 shear pins
- Main 1 – 4 g black powder; 4 x 2-56 shear pins
- Main 2 – 2 g black powder; 3 x 2-56 shear pins

Ground Test 2

- Change to Main 1 – 2 x 2-56 and 2 x 4-40 shear pins

FULL SCALE GROUND TEST

Ground Test 1 - Nosecone Section

Ground Test 1 - Booster Section

FULL SCALE FLIGHT SIMULATION

Full Scale Launch Simulation	
Apogee	5295
Time to Apogee	19.08
Max Velocity	616.58
Max Acceleration	228.54
Ground Hit Velocity	15.52
Total Flight Time	96

LAUNCH #1

Full Scale Launch #1 Analysis	
Motor	Aerotech L1420
Ballast	None
Apogee	5578 ft
Time to Apogee	18.1s
Max Velocity	551 fps
Descent Rate	22 fps - Booster 41 fps - Payload & Nosecone
Total Flight Time	198.7 s - Booster 83.2 s - Payload & Nosecone

LAUNCH #1 RECOVERY

- Booster Section slightly damaged
- Booster Section drifted due to pre mature separation
- Nosecone landed in power lines

LAUNCH #2

Full Scale Launch #2 Analysis	
Motor	Aerotech L1420
Ballast	2lbs - Nosecone 2.25 lbs – Main Alt Bay
Apogee	5407 ft
Time to Apogee	18.2 s
Max Velocity	549.5 fps
Descent Rate	28 fps – Booster 97 fps – Payload & Nosecone
Total Flight Time	84.525 s

LAUNCH #2 RECOVERY

- Booster landed successfully
- Nosecone landed in marsh
- No structural or electrical damage occurred

LAUNCH #2 SOLENOID TEST

- Results
  - Test was overall failure
  - Pins were forced out of sockets and bent at 45 degree angle
- Action Plan
  - Upgrade with stronger solenoids
  - Use four solenoids instead of 2

LAUNCH VEHICLE REQUIREMENTS

Vehicle

Recovery

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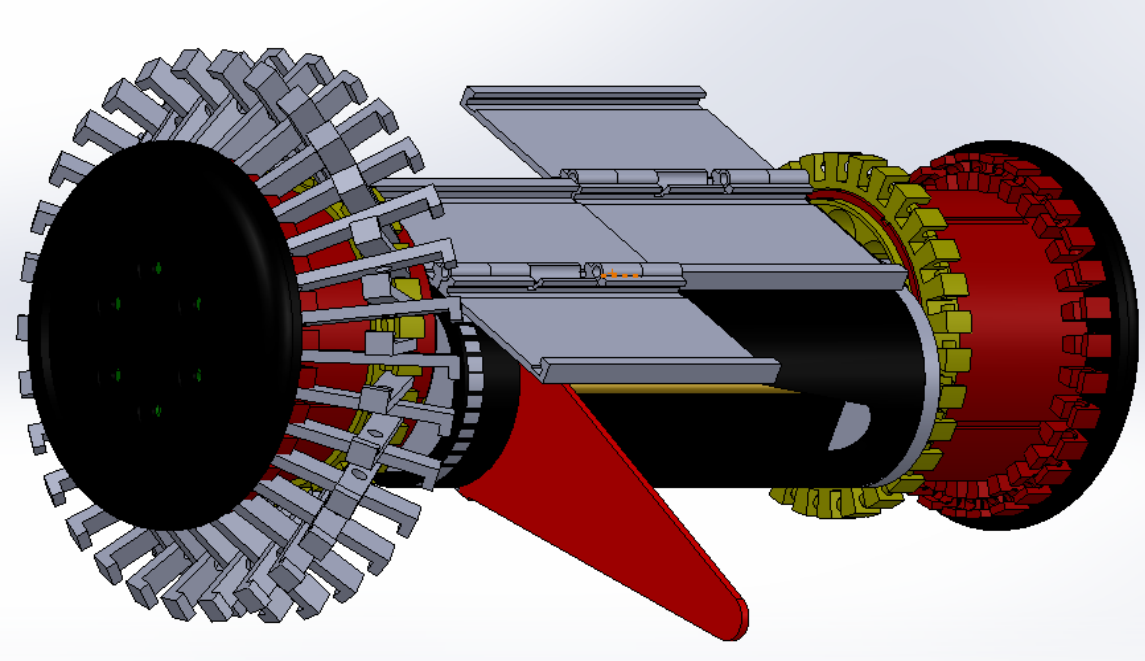
PAYLOAD CHARACTERISTICS

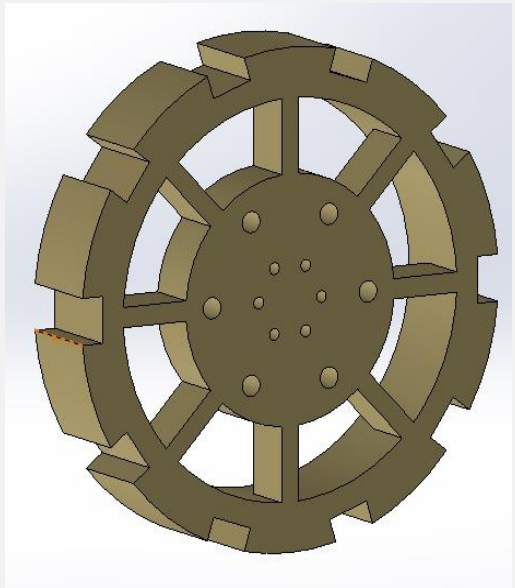


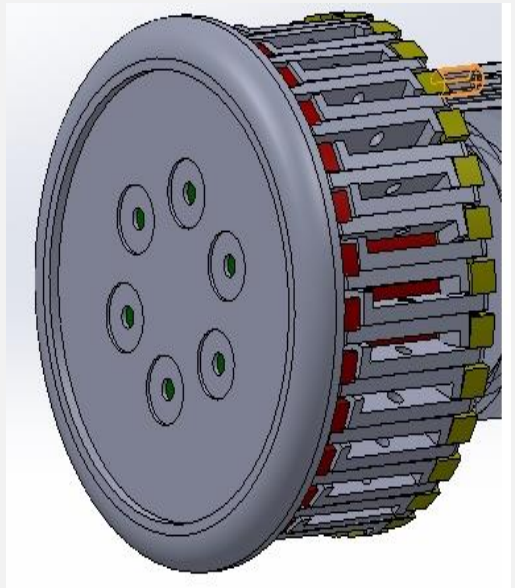
Note: The right wheel is not pictured with its extendable legs

	Prototype	Final (projections)
Weight	7 lbs	7 lbs
Height	5 in	5 in – Compacted 8.5 in - Expanded
Length	13 in	14.5 in
Motor	12V DC	12V DC

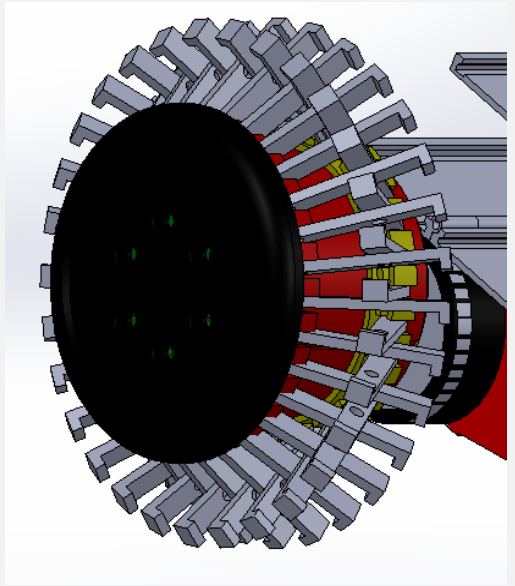
KEY DESIGN FEATURES – EXPANDING WHEEL

- Results of testing showed a need for design change
- Expanding wheel allows for more clearance and traction





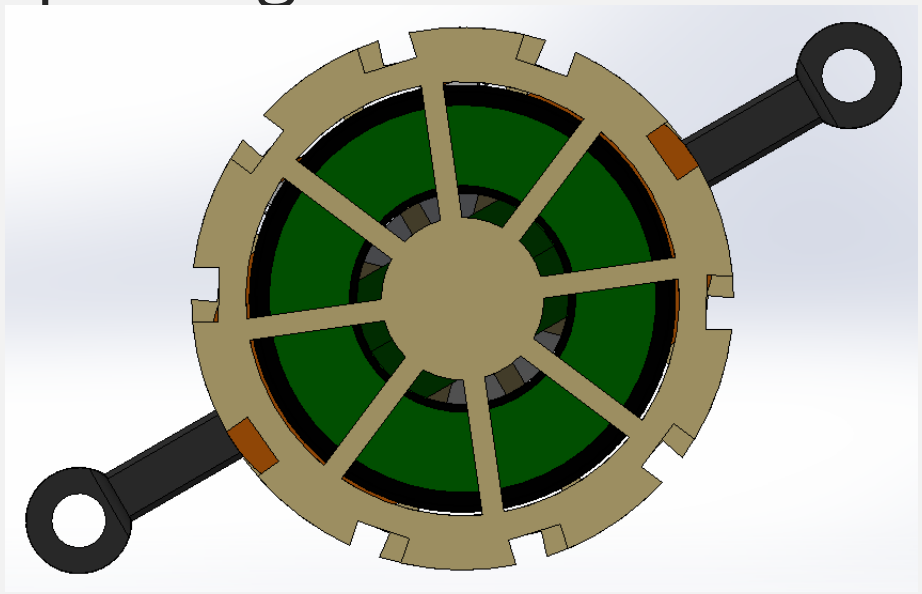
Compacted

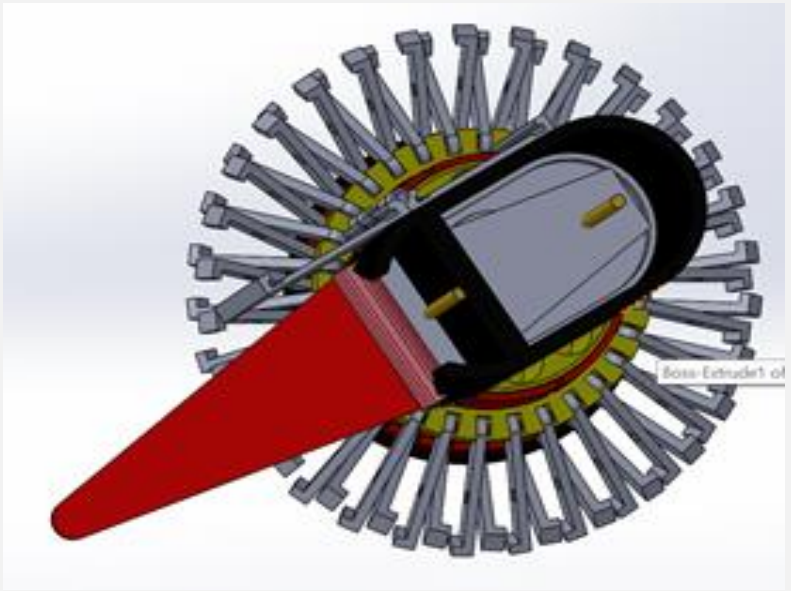


Expanded

KEY DESIGN FEATURES – NEWTONIAN LEG

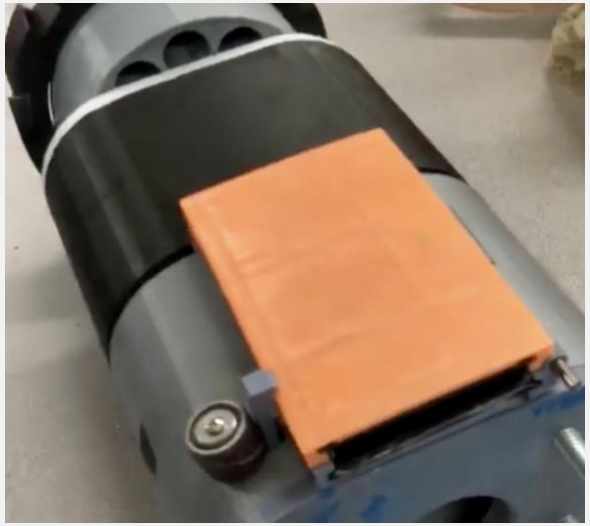
- Expanding wheel designed made it necessary for larger Newtonian leg
- Allows for linear translation, prevents unwanted spinning



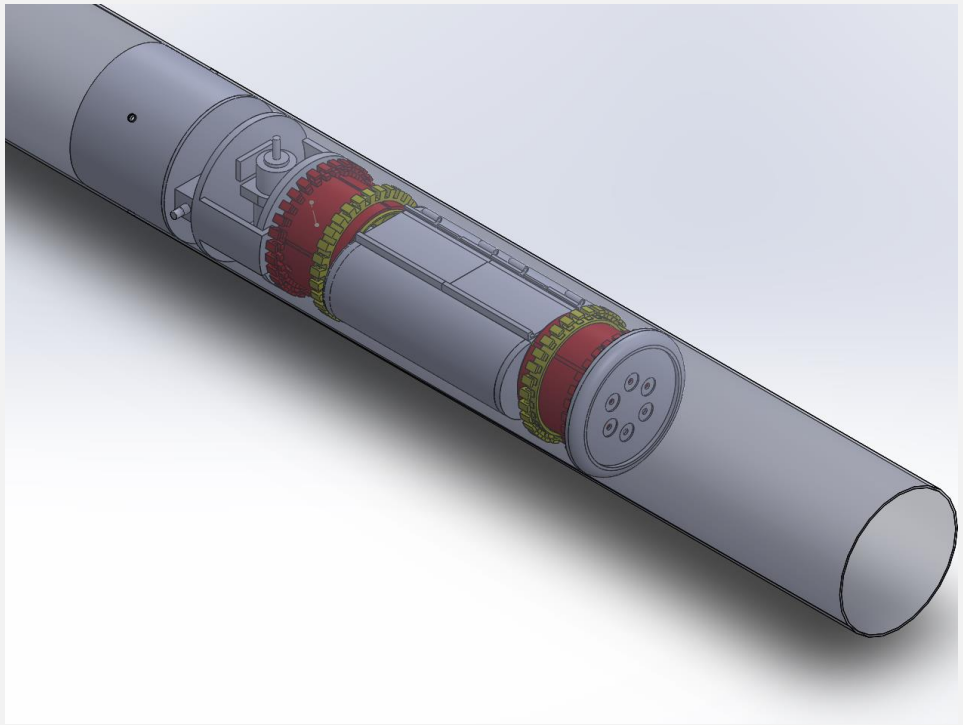


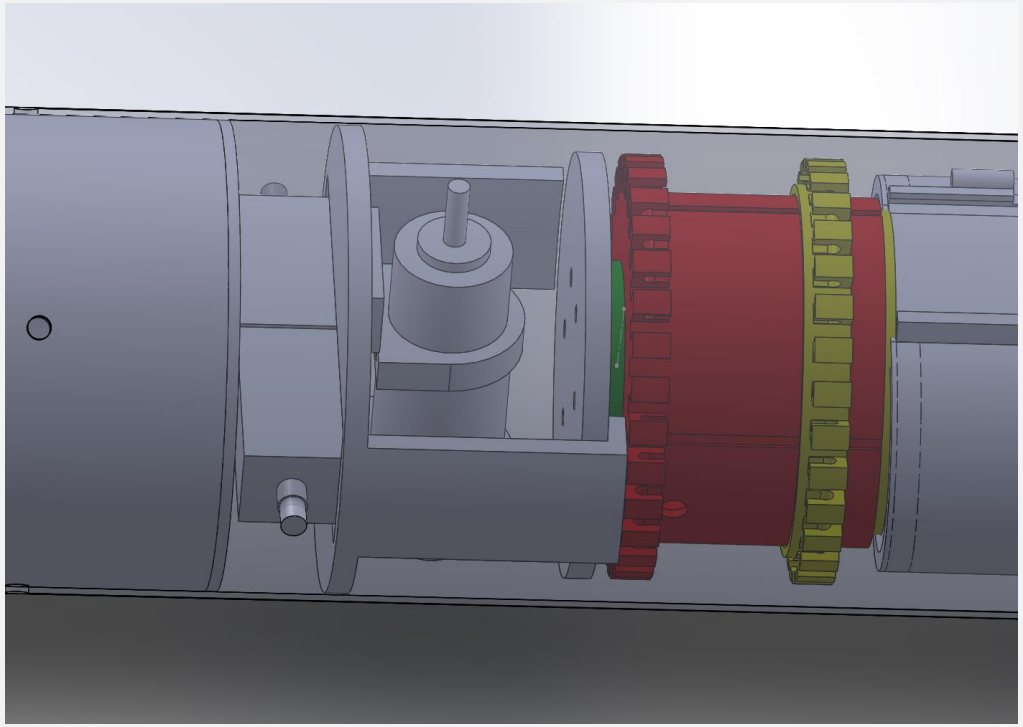
KEY DESIGN FEATURES – SOLAR PANELS

- Bi-fold design
- 12 5V Solar Cells
- 3D Printed compartment with Torsion Spring



DEPLOYMENT SYSTEM





PAYLOAD INTEGRATION

Loading the Payload

- Situated on a precisely designed retention system intended to discourage movement during flight and prevent premature release after separation
- Rover and deployment system are located aft the Rover Compartment Airframe and will be loaded into the appropriate section before final assembly

Payload Deployment

- Deployment system will start via a connection from a high gain antenna from a remote laptop to the microcontroller and Arduino inside the system
- Once activated the rover will move in a forward motion to exit the open end of the Rover Compartment Airframe

PAYLOAD REQUIREMENTS

Mission requirements to be verified during March launch

- At landing, the team will remotely activate a trigger to deploy the rover from the rocket.
- After deployment, the rover will autonomously move at least 5 ft. (in any direction) from the launch vehicle.
- Once the rover has reached its final destination, it will deploy a set of foldable solar cell panels.

Team Derived Requirements

- Deployable rover will travel at least 10 ft after departing from launch vehicle.
- The rover will have the capability to distribute power from its solar cells to its batteries.

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SAFETY

- Just one big thing

FOLLOW THE CHECKLIST!

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OUTREACH OVERVIEW

- All 14 events completed
- Total students reached – 1653
- Survey for last event – 55 students

Student Survey Data				
	How informational was it?	How were the presenters?	How fun was it?	How was it overall?
Poor	6%	0%	6%	0%
Average	15%	9%	39%	24%
Good	35%	39%	30%	46%
Great	44%	52%	26%	30%

SOCIETY OF AERONAUTICS AND ROCKETRY

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