Electromechanical Recovery System (ERS)

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AGENDA

1. Project Overview
2. Nose Cone Release
3. Surgical Tubing Spring
4. Parachute Testing
5. Drogue Parachute Release
6. Conclusion
7. Questions?

Introduction

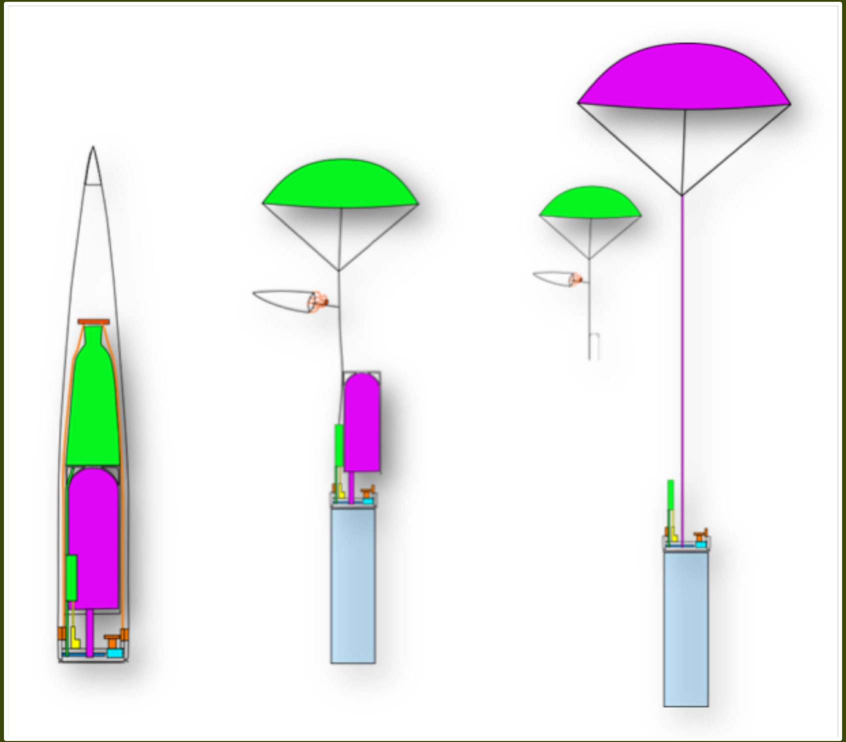
Portland State Aerospace Society

- LV3.1 will launch April 2020
- LV4 will be the 100 km rocket - competing in the Base 11 Space Challenge
- Design, build, and test a flight ready, two-stage recovery system
  - Fly on LV3.1
  - Scale to meet LV4 requirements

Mission Statement

- Our team will design, build, and test a flight-ready system that will successfully recover LV3.1 and scale to function as the recovery system for LV4.
- The new recovery system must be fully electromechanical, eliminating the current need for pyrotechnics during parachute deployment.

Project Overview



Three main goals

1. Deploy the drogue parachute
2. Deploy the main parachute
3. Recover the rocket in two reusable pieces

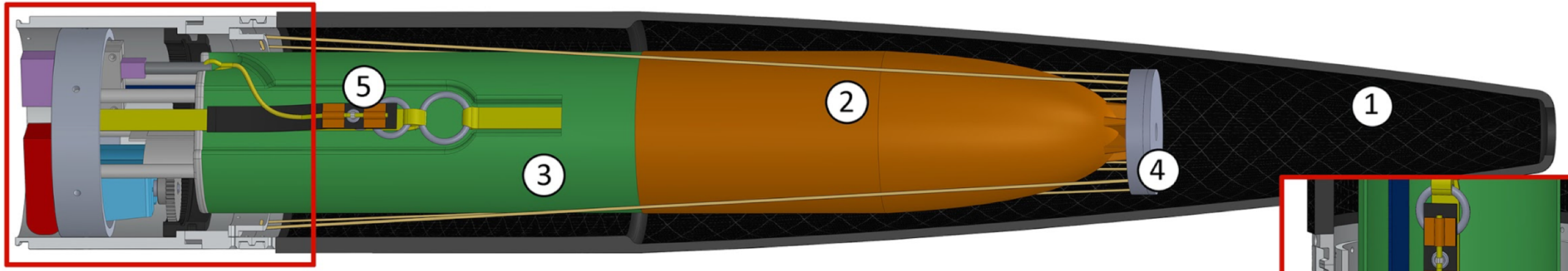
General System Design

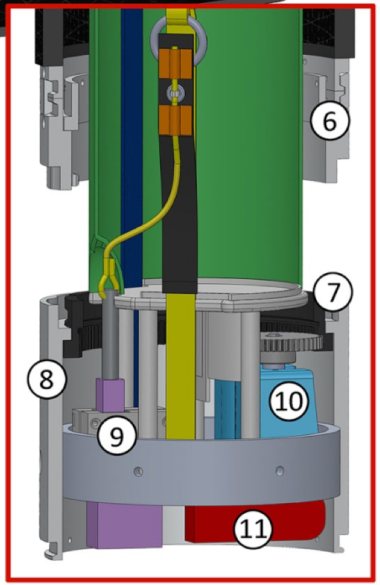
1. Accelerometer senses apogee
2. Nose cone is released
3. Elastic bands retract to separate the nose cone from the rocket body
4. Drogue parachute inflates
5. Drogue parachute is released, inflating the main parachute
6. Land!

Product Design Specification

Category	Customer Need	Priority	Engineering Target	Final Design
Volume	Must fit in the LV3 and LV4 nose cone	High	12466.60cc	6292.63cc
Impulse	Must support LV3 and LV4 estimated dry mass	High	LV3(25kg)/LV4(>50kg)	≥68kg
Weight	Should be as lightweight as possible	High	<5kg/Max 10kg	6.4kg
Construction	Must be fully electromechanical	High	No Pyrotechnics	Fully Electromechanical
Operation	Fast drogue deployment	Med	1-3s	1.15s
Operation	Main parachute deployment at desired altitude	Med	1000 ft	Electronically Controlled

Overall System Configuration





Components

1. Nose Cone
2. Drogue Parachute Cup
3. Main Parachute Cup
4. Surgical Tubing Assembly
5. Three Ring Release
6. Upper Ring
7. Twist Coupling
8. Lower Ring
9. Linear Actuator
10. Motor
11. Power Supply

Twist Coupling Mechanism

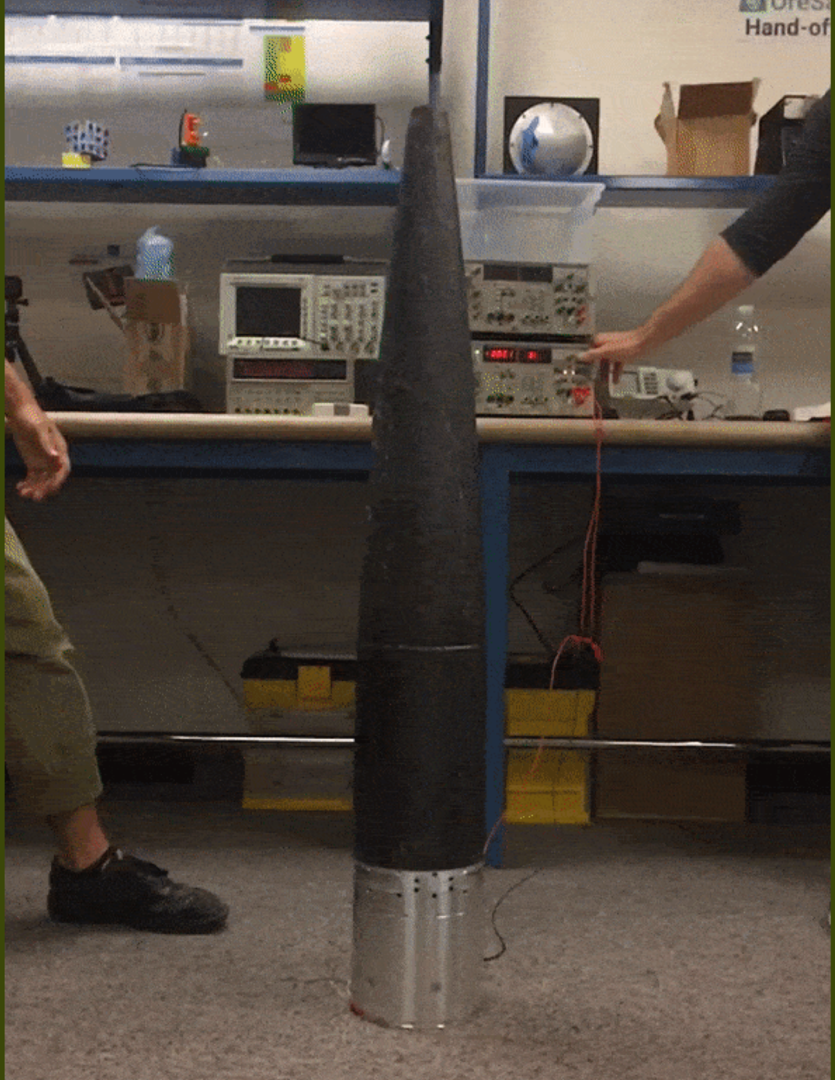
- Increasing the distance the twist coupling travels decreases the possibility of early deployment due to vibration
- Maintaining a low coefficient of friction by pairing delrin with 6061 aluminum
- Top ring holds the nose cone and ejects from the body of the rocket and uses anti-rotating grooves

Nose Cone Release

- Signal sent from the LV3.1 computer to Arduino which controls a brushless motor.
- Motor rotates twist coupling aligning pins for release.
- Nose cone is ejected from the force of surgical tubing.

Surgical Tubing Spring

- Surgical tubing lines eject the nose cone away from the rocket body
- Line attached to inside of nose cone and drogue parachute cup
- PSAS “Flip Cup” assists drogue parachute deployment

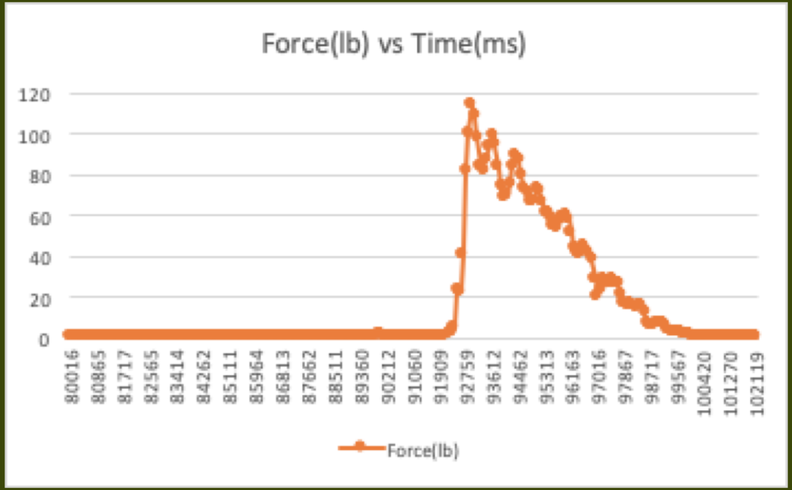


Parachute Testing

- Parachute deployment from cup with Z-Fold Technique
- Measure peak load and map force curve
- Verify required strength for webbing/shock cord and anchor points

Parachute Testing Results

- Requires +60 mph
- Z-fold works as planned
- Peak load: 114 lb @ 70 mph
- Extrapolated load for worst case
  - 87 mph (~4s of free fall after apogee)
  - 150 lb “shock” force

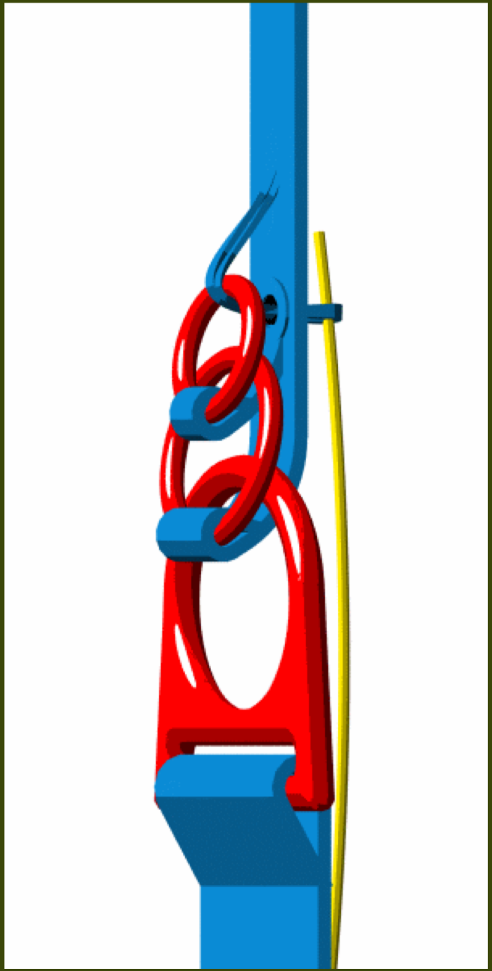


Drogue Parachute Release System

3-Ring Release

- Designed by Bill Booth (1978)[1]
- Each ring in the series multiplies the mechanical advantage → 100:1
- Effortless release
- Able to withstand the shock of parachute deployment

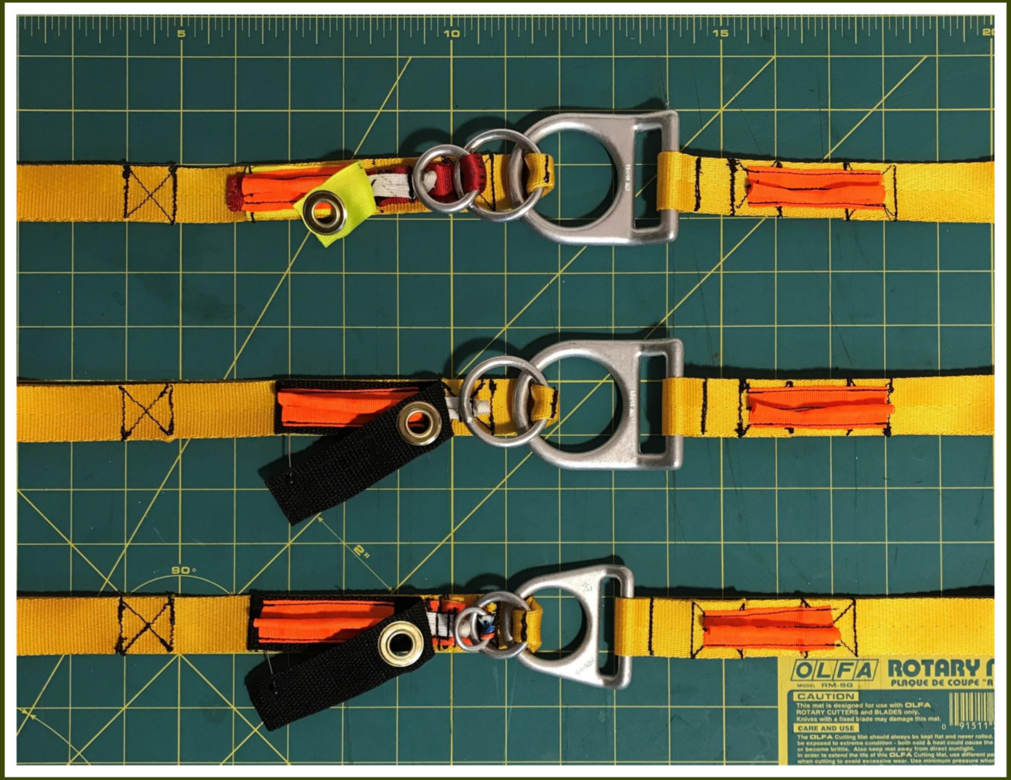
[1] Booth, W., "Means for releasably attaching strands," 4337913, December 4, 1979.



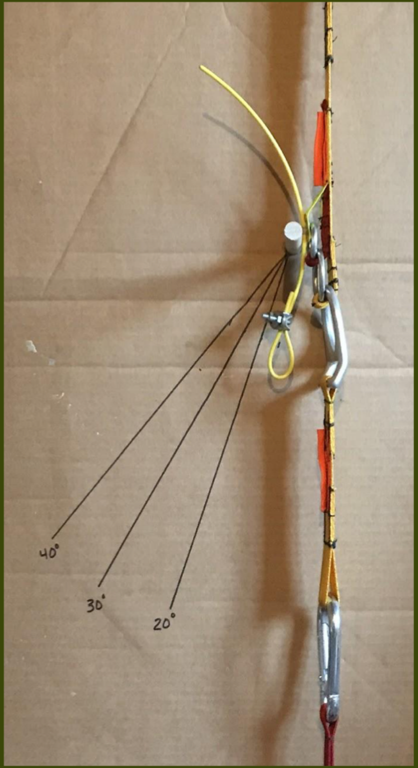
Drogue Parachute Release System

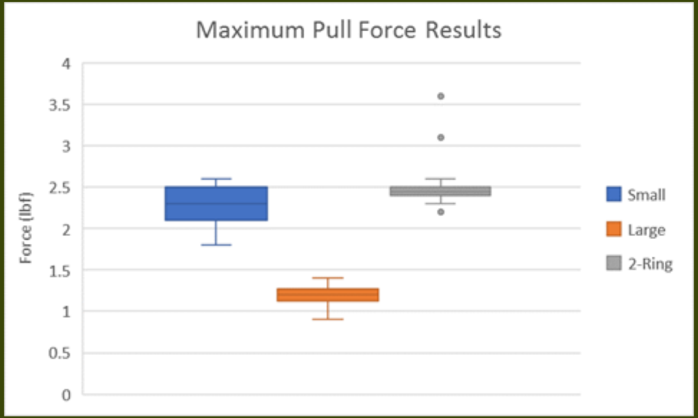
3-Ring Release Testing

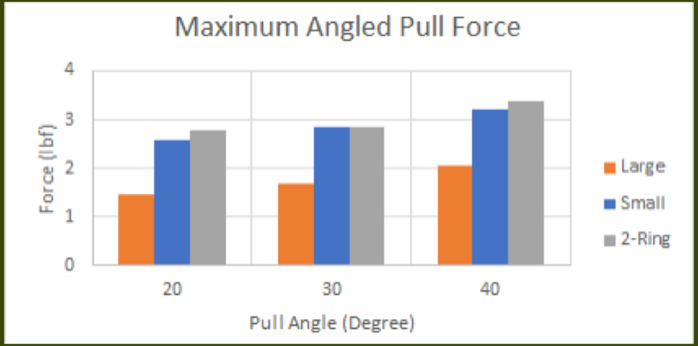
- Large 3-Ring, 2-Ring, Small 3-Ring
- Force to actuate
- Actuating at different angles
- Orientation of the system



Drogue Parachute Release System





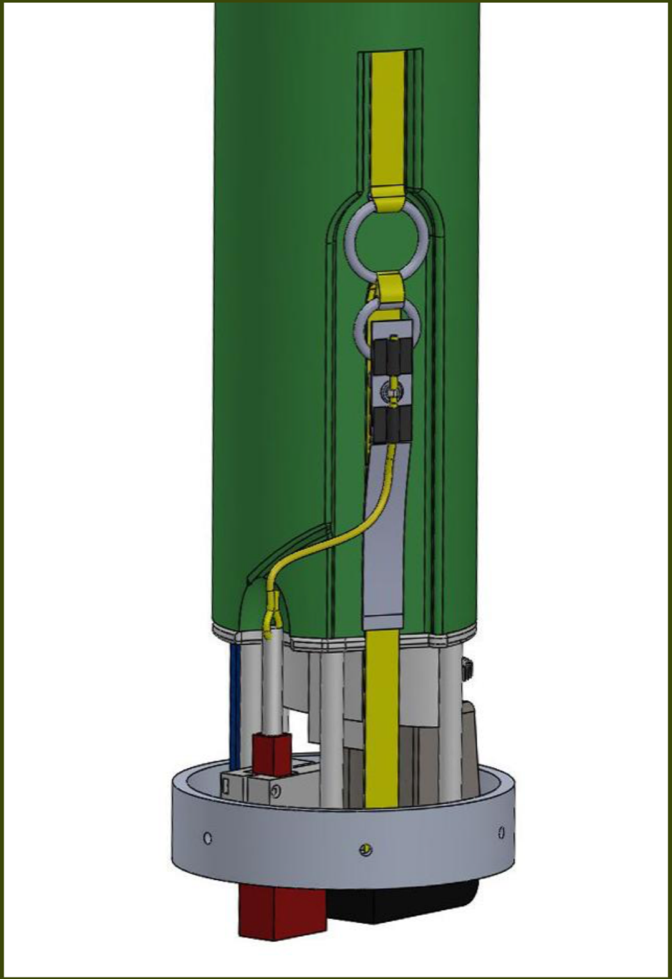


Drogue Parachute Release System

Final Design[2]

- Small 3-Ring in “upside down” orientation
- Activated by linear actuator
- Webbing with large ring passes through main cup / pulls main cup away with release

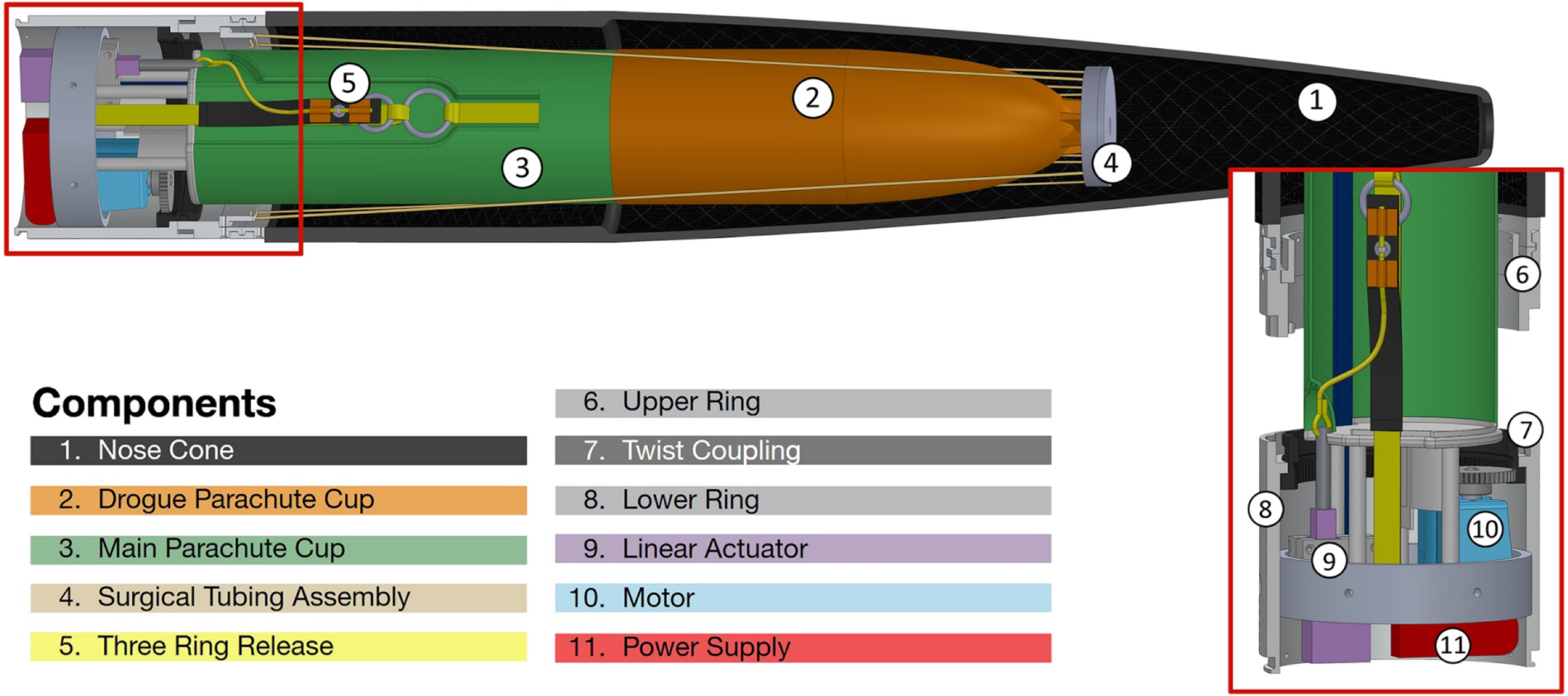
[2]House, Marie, "The Design and Development of an Electromechanical Drogue Parachute Line Release Mechanism for Level 3 High-Power Amateur Rockets" (2019). University Honors Theses. Paper 753.



Conclusion

- In October, we presented our design at the International Astronautical Congress in Washington DC
- A new team will finish integrating and scaling this system for the 100-km rocket

Questions?



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