CU in Space - Mission Summary

University of Colorado Boulder

Engagement

This year, our team launched the CU Space Engagement Initiative to inspire a future generation of scientists, engineers, and astronauts. Throughout the season, we were dedicated to igniting a spark of curiosity and innovation in young minds across diverse communities through our outreach and social media platforms.

Outreach

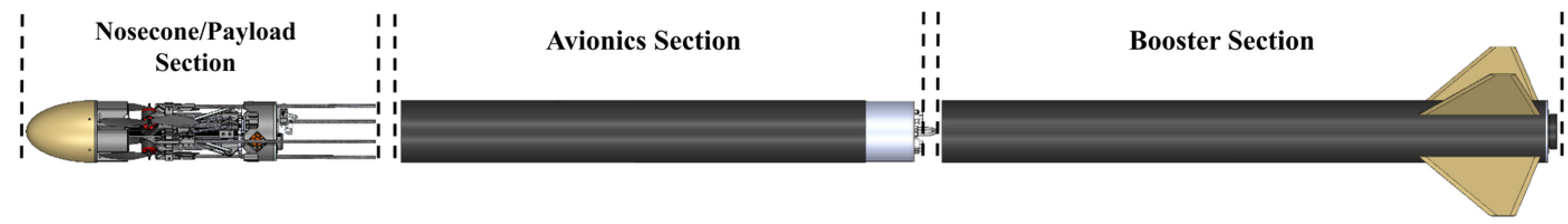
From hands-on coding to immersive engineering presentations and launching rockets, we aimed to give a large number of children, regardless of background, a glimpse into the engineering world.

We ran events for the following schools/organizations (417 students total):

- Westlake Middle School (276), Hillel Academy (68), Montview Robotics (54), Native American Center for Excellence (19)

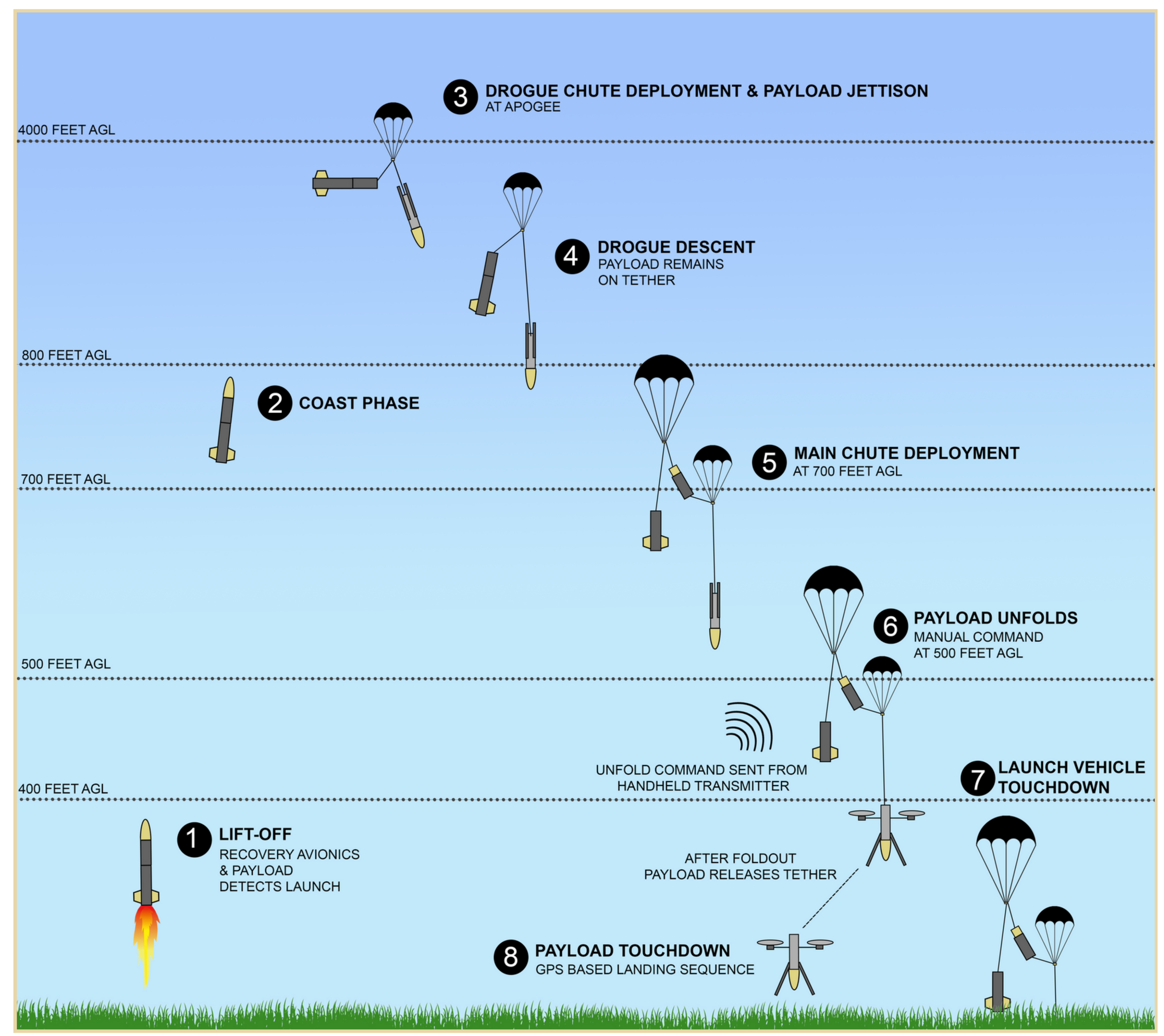
NASA USLI '23/'24

The Challenge: Integrate a quadcopter payload lander into our launch vehicle to safely land 4 STEMnauts.



Key Design Components:

- Foldout landing legs and propeller arms
- Pixhawk 6c Mini for autonomous landing



Team Values

We believe diversity drives innovation. That's why our program is designed to be as inclusive as possible, welcoming students from a multitude of degrees, disciplines, and cultural backgrounds.

- **Aerospace Engineering**
- **Mechanical Engineering**
- **Computer Science**
- **Engineering Management**
- **Engineering Physics**
- **Applied Math**

Inclusivity

We aim to create an inclusive environment for students to gain leadership opportunities and hands-on experience while growing as a team.

As a rookie team, we offered open membership to anyone wishing to help, regardless of technical background or experience.

Empowerment

Striving for change and equality in the Aerospace industry, CU in Space is proud that women make up 43% of our leadership team.

Additionally, 60% of the team consists of people from historically underrepresented backgrounds in engineering.

Social Media

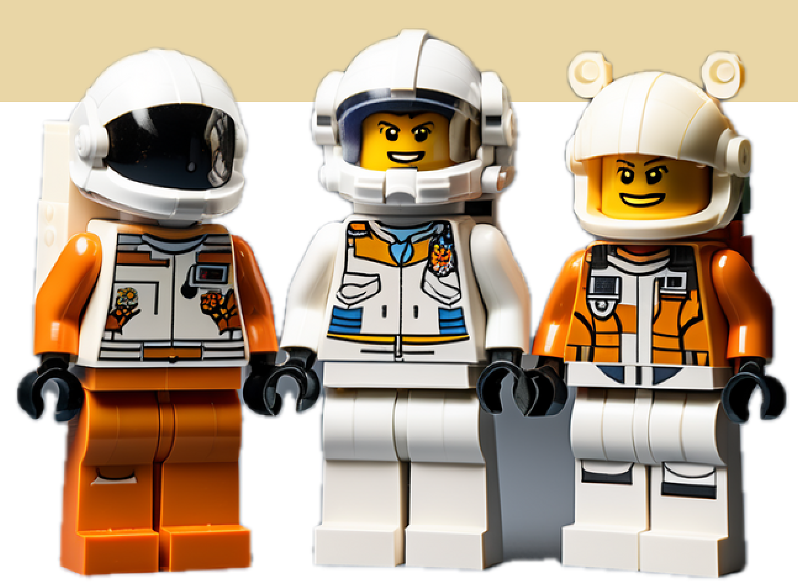
@cuboulder_usli

Along with season updates, our team also used social media to break down space and science topics weekly, such as Astronaut Training, Asteroid Mining, and the Hubble Space Telescope.

@cuboulder_usli

#CUSpaceEngage #STEMEducation #SpaceEngagmentInitiative

STEMnauts



Our Stemnauts represent our team's dedication to inclusivity. Designed by our community on social media, our Buffnauts reflect our team's varied backgrounds and dreams, including our beloved mascot.

CU in Space - Design and Testing

University of Colorado Boulder

Launch Vehicle

Nosecone Section

The nosecone is made of custom molded fiberglass. It is part of the quadcopter and will be released from the launch vehicle during controlled descent.

Recovery Section

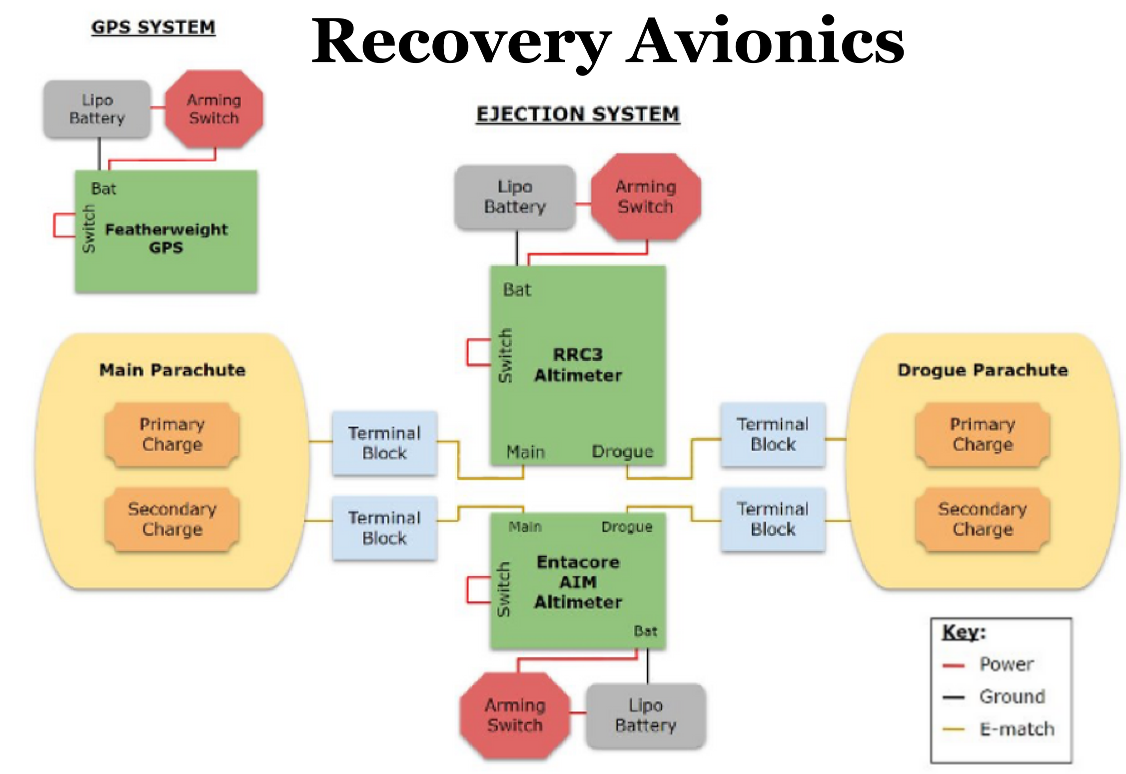
Primary Altimeter: RRC3 Sport
Secondary Altimeter: Entacore AIM
Drogue Chute Diameter: 2 ft
Drogue Descent Rate: 82 ft/s
Main Chute Diameter: 9 ft
Main Chute Descent Rate: 7 ft/s
GPS Tracker: Featherweight GPS

Flysheet Overview

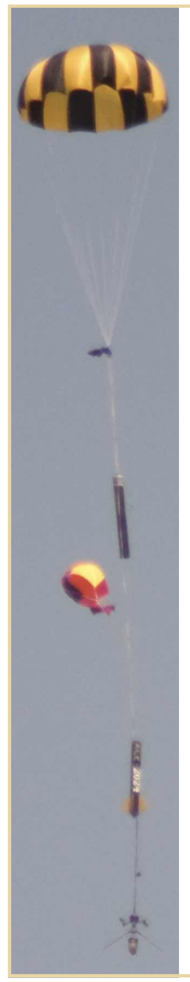
Motor: L1170
Fins: G10 Fiberglass
Airframe Material: Blue Tube 2.0
Stability Margin (on rail): 3.08
Diameter: 6.154 in.
Rocket Length: 103 in.
Gross Liftoff Weight: 42.3 lbs.
Predicted Apogee: 4,251 ft.

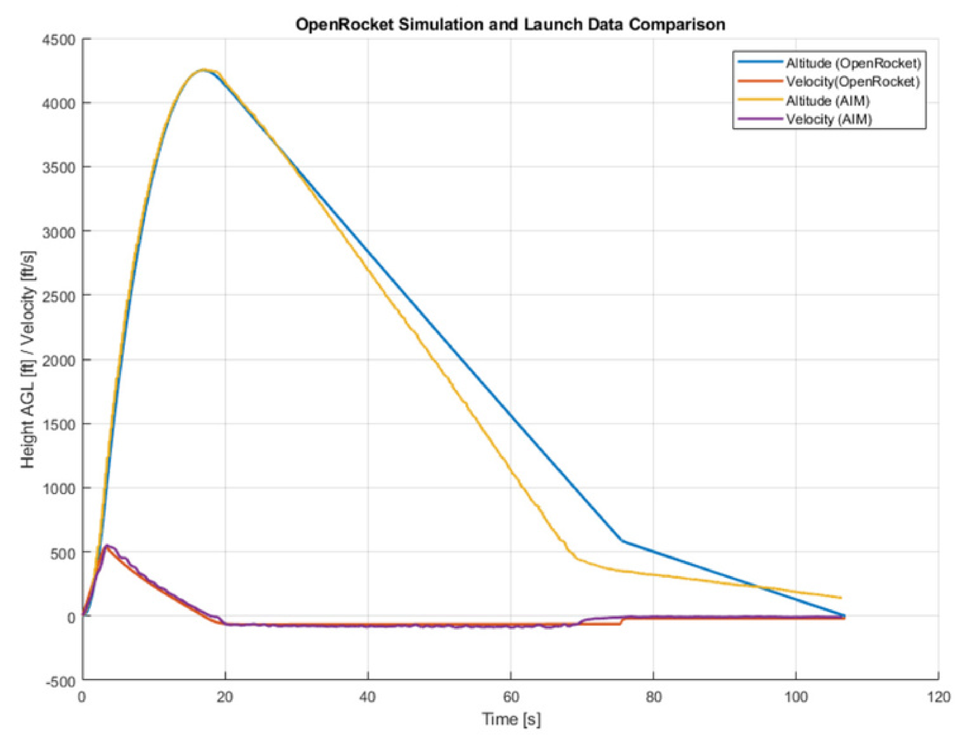
Descent Configuration

Recovery Avionics



Flight Data and Simulation





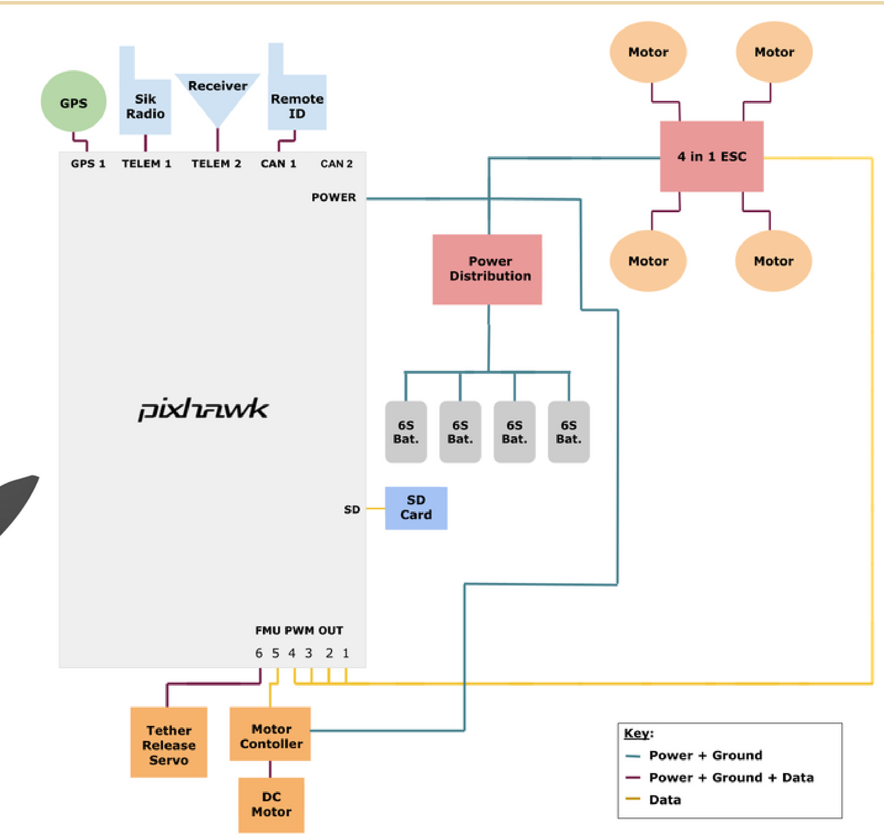
← *Payload*

Payload

Foldout Mechanism

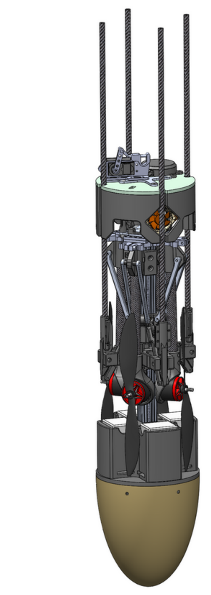
To deploy the propeller arms and landing legs, we used a 12V DC motor inside the nosecone to drive a leadscrew mounted gantry.
Twelve linkages are attached to the gantry, enabling them to actuate when the nosecone motor rotates. The linkages are comprised of machined aluminum and 3D printed carbon-fiber reinforced PA6 nylon to suit the weight and strength requirements of each linkage.

Payload Avionics

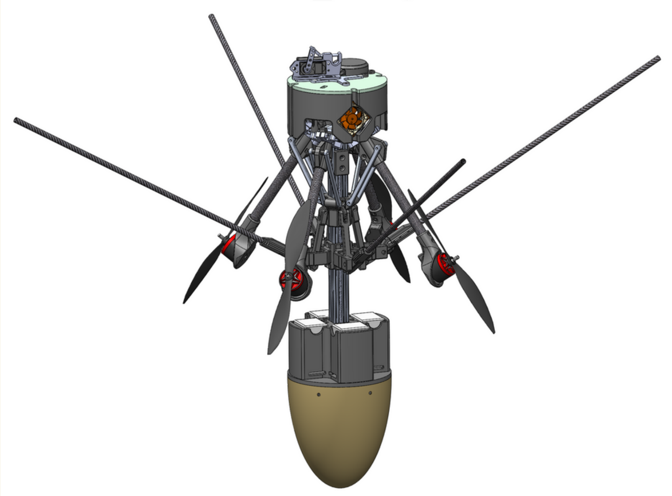


The payload uses a Pixhawk 6C Mini as the flight computer to autonomously land in a predetermined location with wireless control through QGroundControl. After the main chute event, ground station will send a signal to unfold the payload, then trigger a servo releasing it from the launch vehicle.
The image shows the last launch vehicle demonstration flight with the payload in the unfolded state ready for release from the launch vehicle by triggering the tether release servo.

Folded State

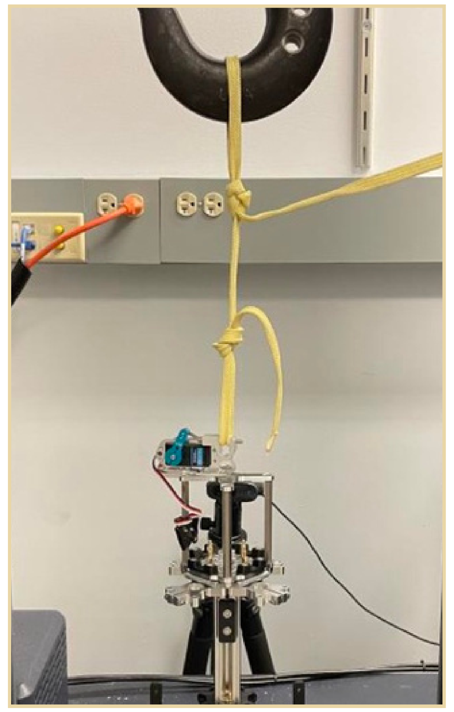


Mid-Deployment



Unfolded State

Testing and Manufacturing

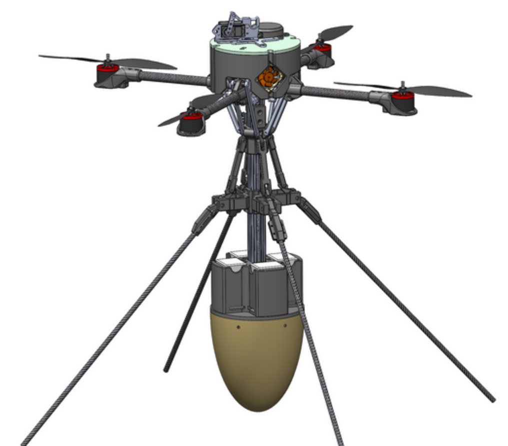


Specific subsystems of the full launch vehicle and payload system were extensively tested. Tensile testing of the tether release servo pin to ensure payload, capable of withstanding loads of up to 570N, remains attached to the vehicle by shock chord following main chute event.

Two subscale launches were completed to ensure recovery avionics functionality.

Payload in Landing Configuration:

- Payload arming tests were completed to simulate the fold out mechanism of the drone when separated from the launch vehicle.



Human Survivability

The Pixhawk 6C Mini is the flight computer used to control the payload, but it also contains several relevant sensors used to measure the survivability of the STEMnaut. To measure the human survivability of the STEMnauts placed inside the payload, different values of interest were measured with the instrumentation contained within the flight computer.

Metric	Max Allowable	Max Recorded
Acceleration X (0.1-1 sec Sustained)	10G	1G
Acceleration Y (0.1-1 sec Sustained)	10G	0.6G
Acceleration Z (0.1-1 sec Sustained)	20G	0.6G
Vibration	5 m/s^2 (8 Hours Sustained)	5.1 m/s^2 (< 1 second)
Temperature	35°C	24.9°C