HPRC Project Presentation Night

2022 - 2023

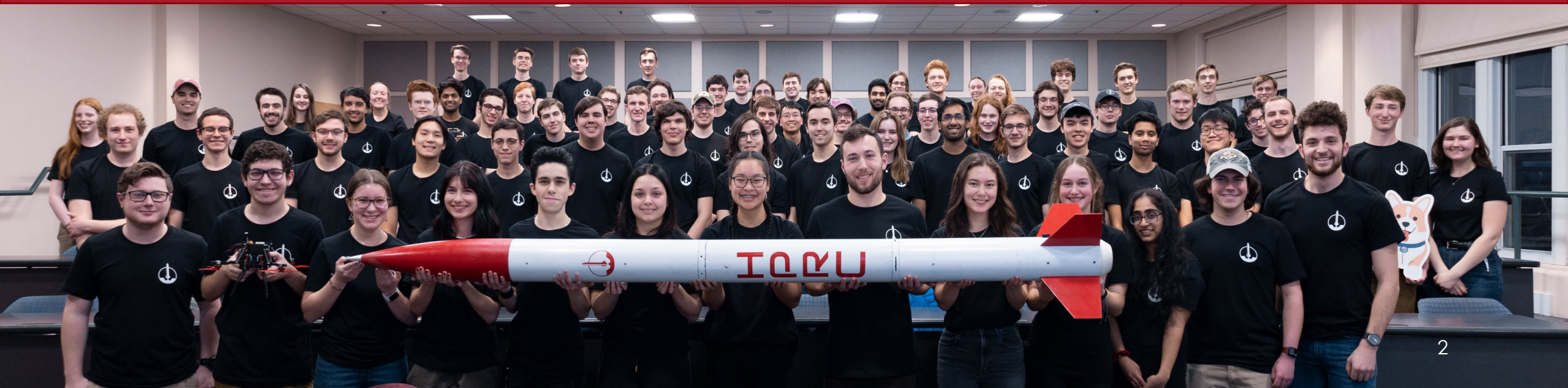
Agenda

01 Team Introduction

02 Mission Profile

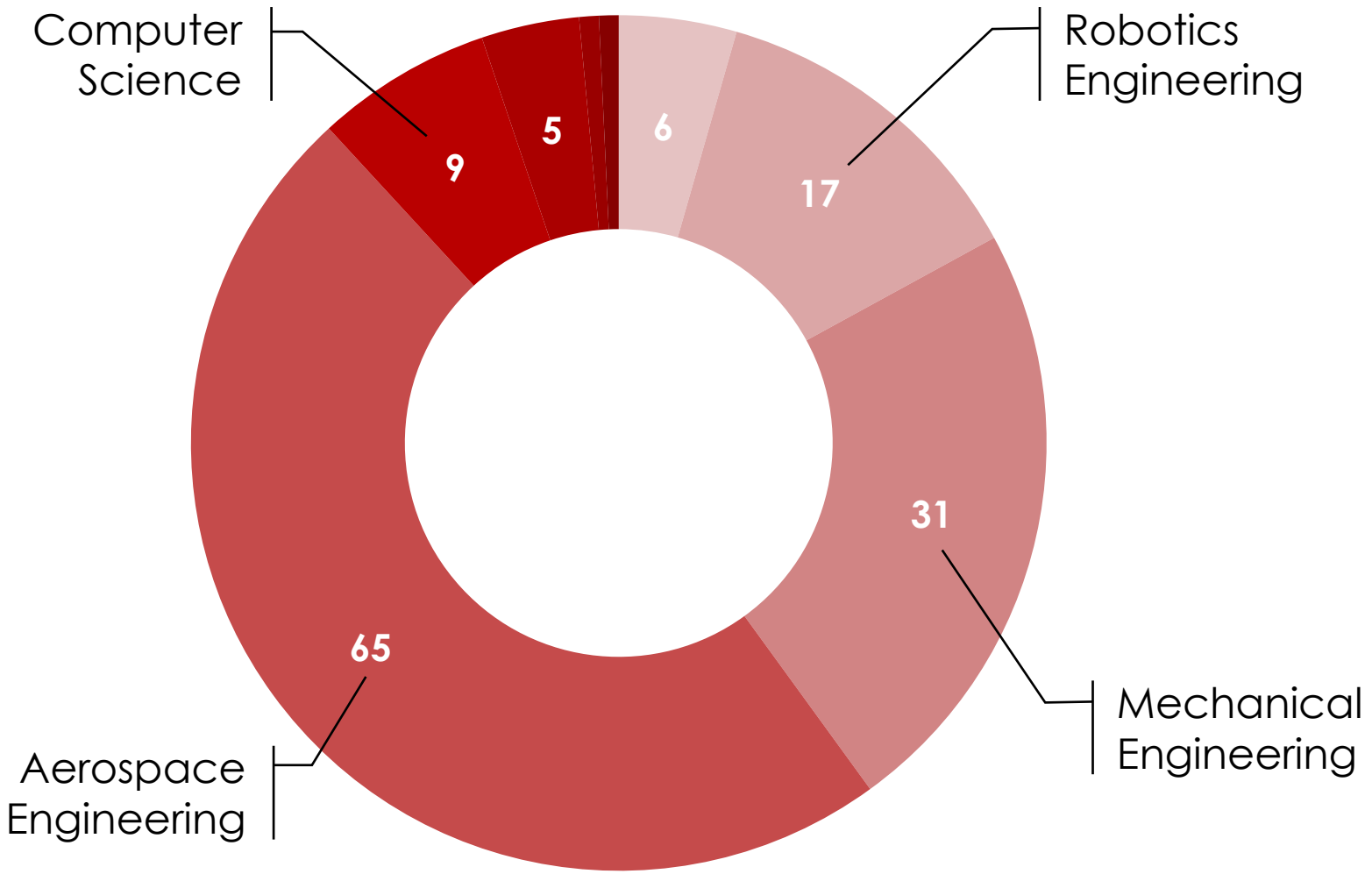
03 Technical Case Studies

04 Conclusion and Future Steps

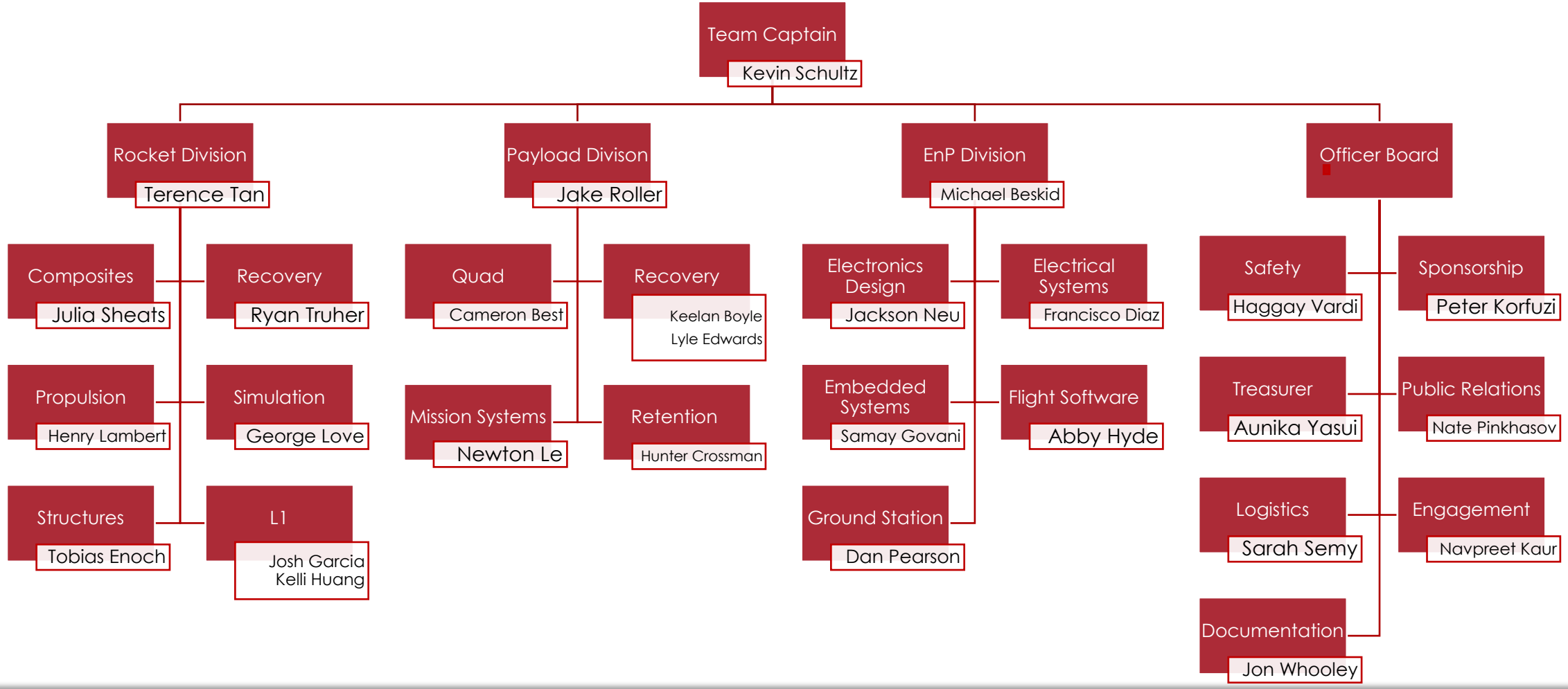


Our Team

100+ Students
8+ Majors
3 Divisions



Team Structure



Our Goals

Mission Design
&
Execution

Technical
Documentation

Inclusivity
Education &
Engagement

Team History

Founded in 2018

Major Growth from 2019-2022

Transitioned to IREC in 2022

Intercollegiate Rocket Engineering Competition

- Spaceport America, NM
- 10,000 ft Target Altitude
- 160 Student Teams

2022 Reflection

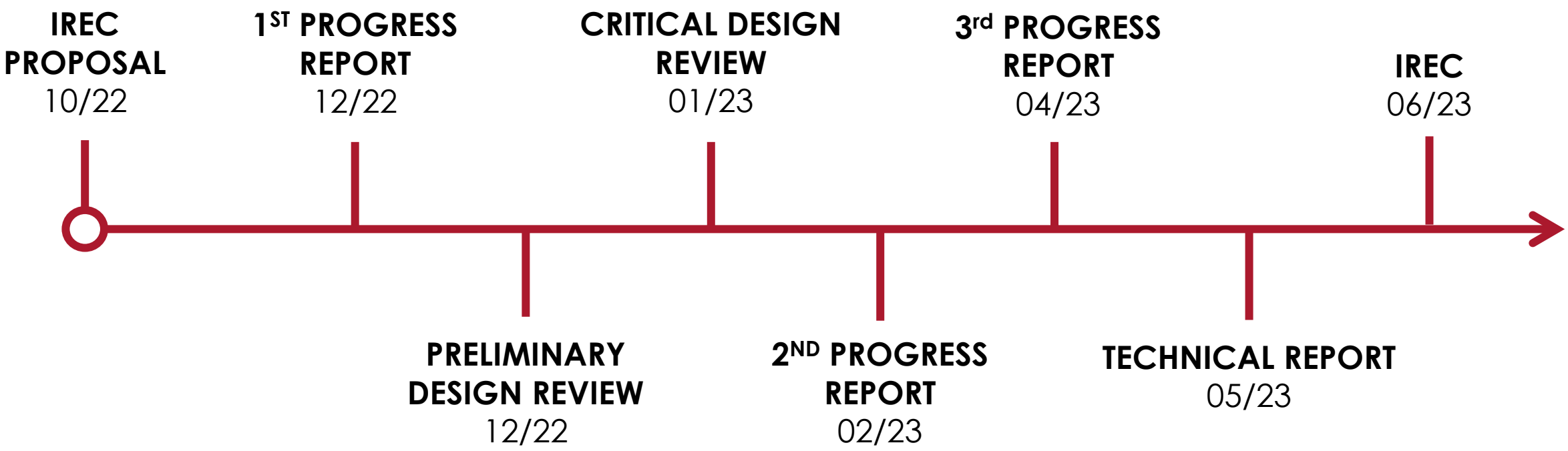
Challenges

- First time at Spaceport America
- Vehicle broke up during flight
- Lessons learned on safety and checklists

Scores & Awards

- Team Sportsmanship Award
- 3rd in Technical Report
- 11th in Design Quality
- 48th Overall

Milestones


IREC PROPOSAL
10/22
1ST PROGRESS REPORT
12/22
PRELIMINARY DESIGN REVIEW
12/22
CRITICAL DESIGN REVIEW
01/23
2ND PROGRESS REPORT
02/23
3rd PROGRESS REPORT
04/23
TECHNICAL REPORT
05/23
IREC
06/23

Mission Goals

Rocket

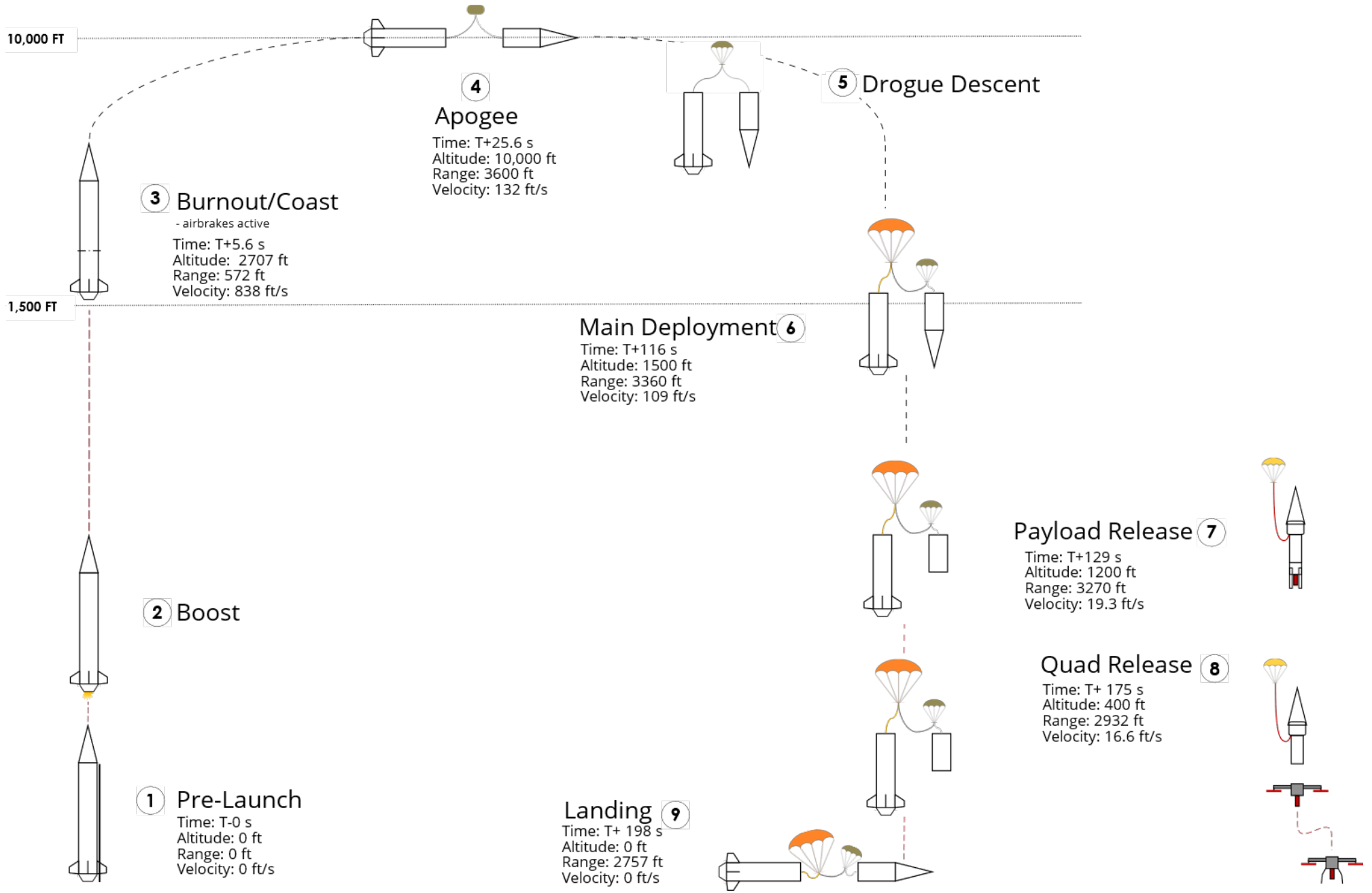
Reach an apogee of 10,000 feet
Safely deliver robotic payload

Electronics & Programming

Track and monitor vehicles
Control airbrake actuation

Payload

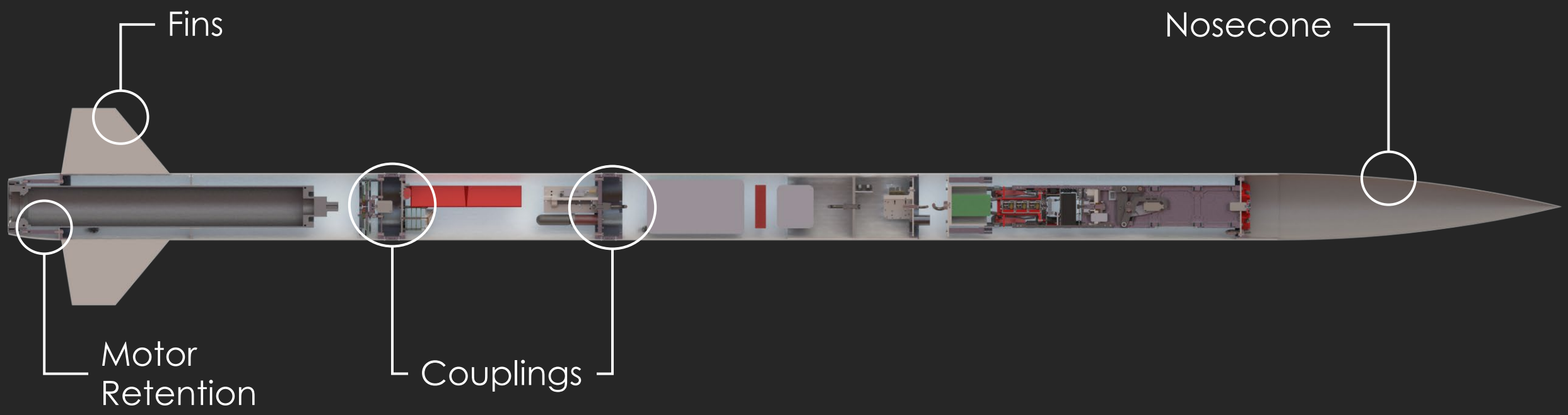
Deploy weather station packages from autonomous quadcopter
Fly to designated GPS waypoints
Transmit data for analysis


10,000 FT
4
Apogee
Time: T+25.6 s
Altitude: 10,000 ft
Range: 3600 ft
Velocity: 132 ft/s
5 Drogue Descent
3 Burnout/Coast
- airbrakes active
Time: T+5.6 s
Altitude: 2707 ft
Range: 572 ft
Velocity: 838 ft/s
1,500 FT
Main Deployment 6
Time: T+116 s
Altitude: 1500 ft
Range: 3360 ft
Velocity: 109 ft/s
Payload Release 7
Time: T+129 s
Altitude: 1200 ft
Range: 3270 ft
Velocity: 19.3 ft/s
Quad Release 8
Time: T+ 175 s
Altitude: 400 ft
Range: 2932 ft
Velocity: 16.6 ft/s
2 Boost
1 Pre-Launch
Time: T-0 s
Altitude: 0 ft
Range: 0 ft
Velocity: 0 ft/s
Landing 9
Time: T+ 198 s
Altitude: 0 ft
Range: 2757 ft
Velocity: 0 ft/s

Structures

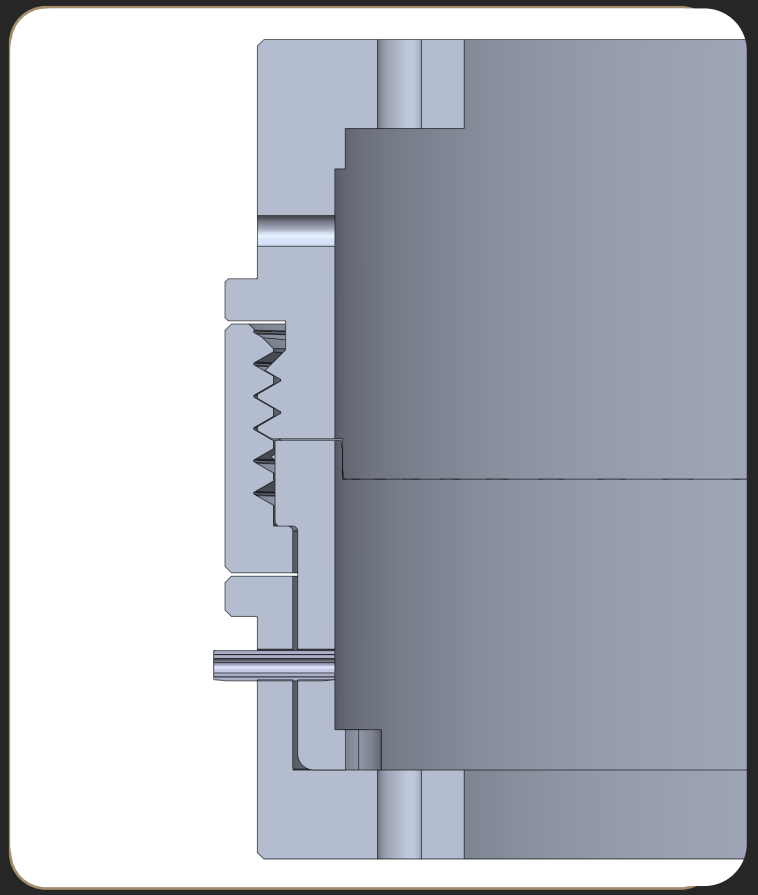
Strength

Ease of Assembly

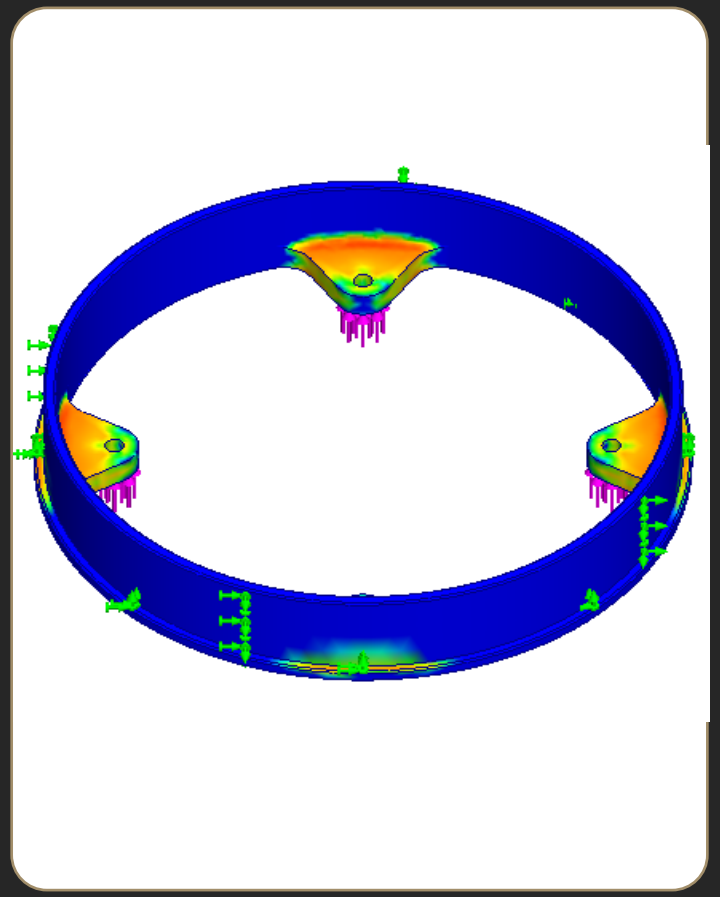

Fins
Nosecone
Motor
Retention
Couplings

Couplings

Complete Engineering Design Cycle



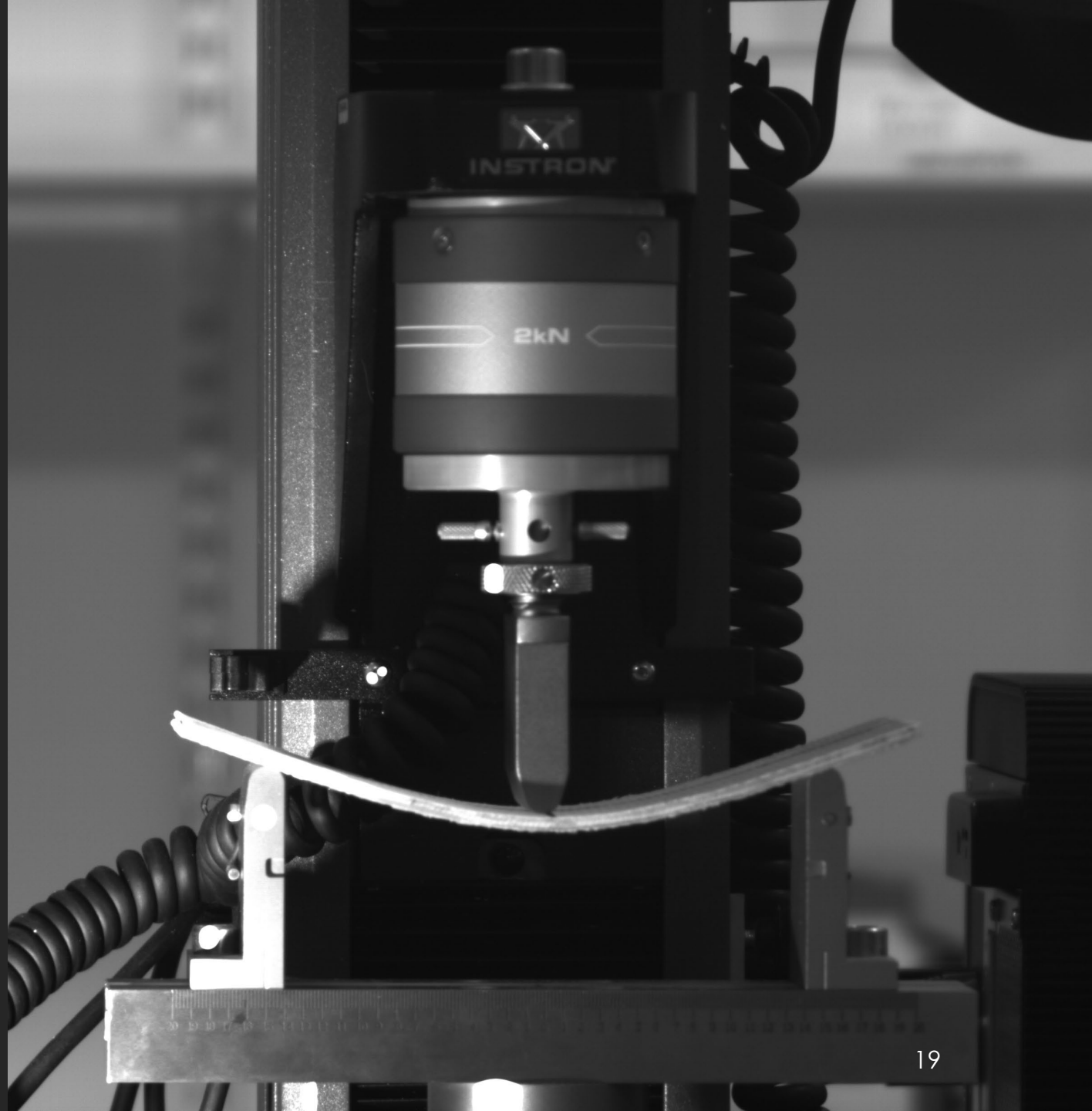
Design



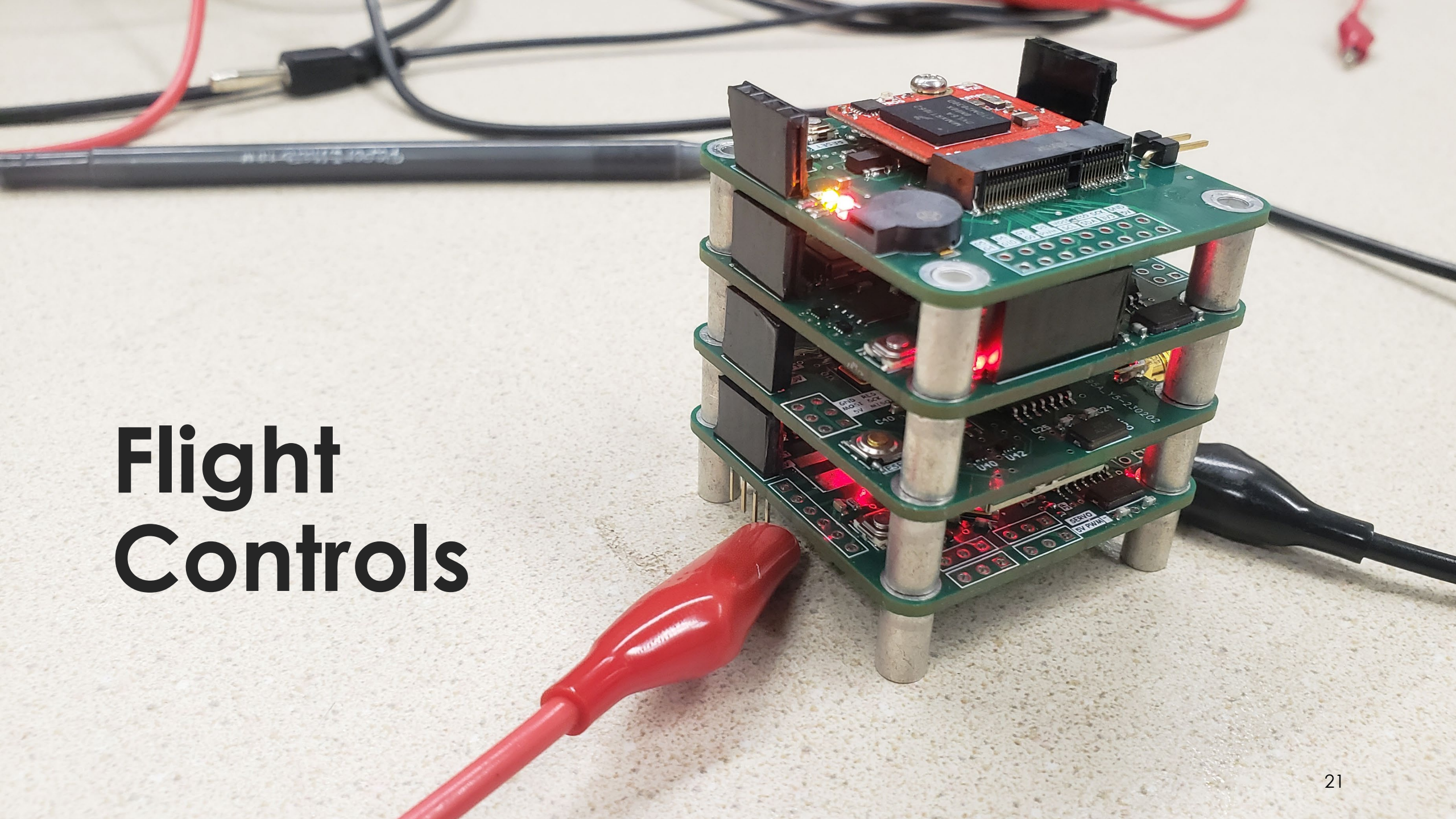
Analysis

Manufacture

Composite Materials



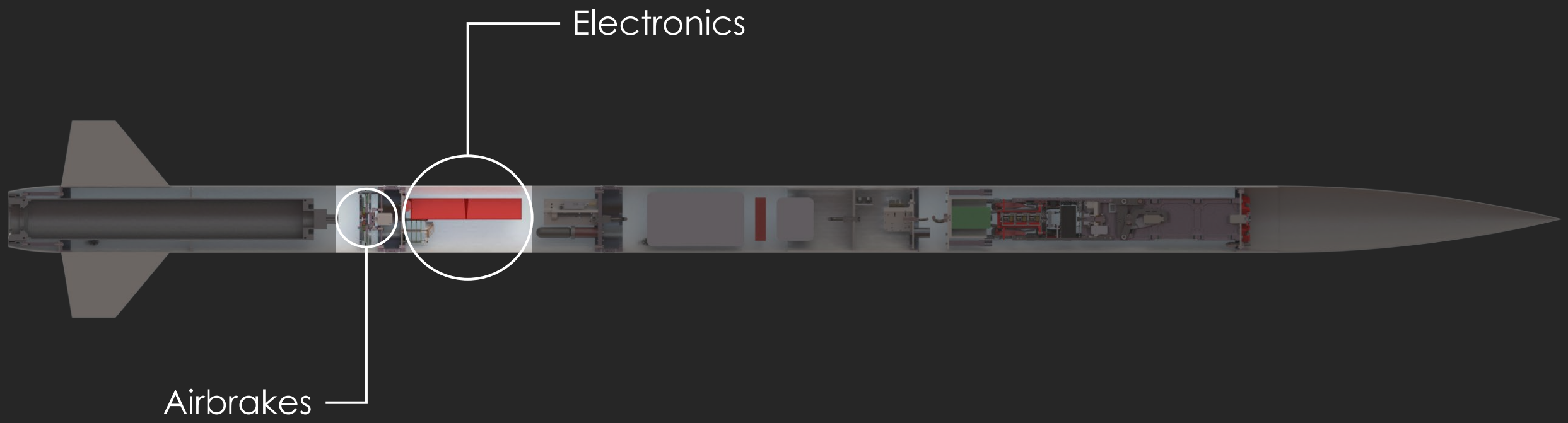

HPRC



Flight Controls

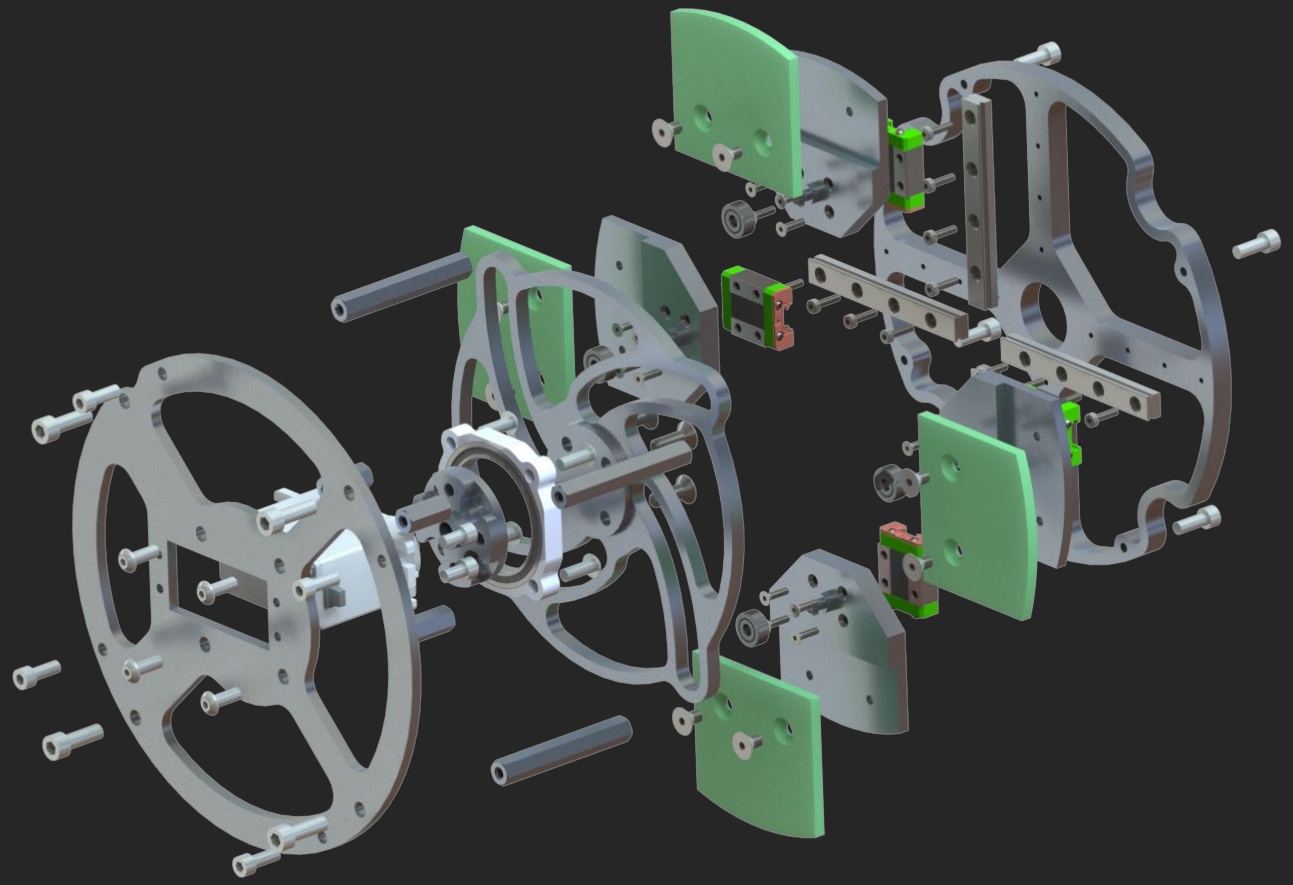
High-performance

Robust Design Principles


Electronics
Airbrakes

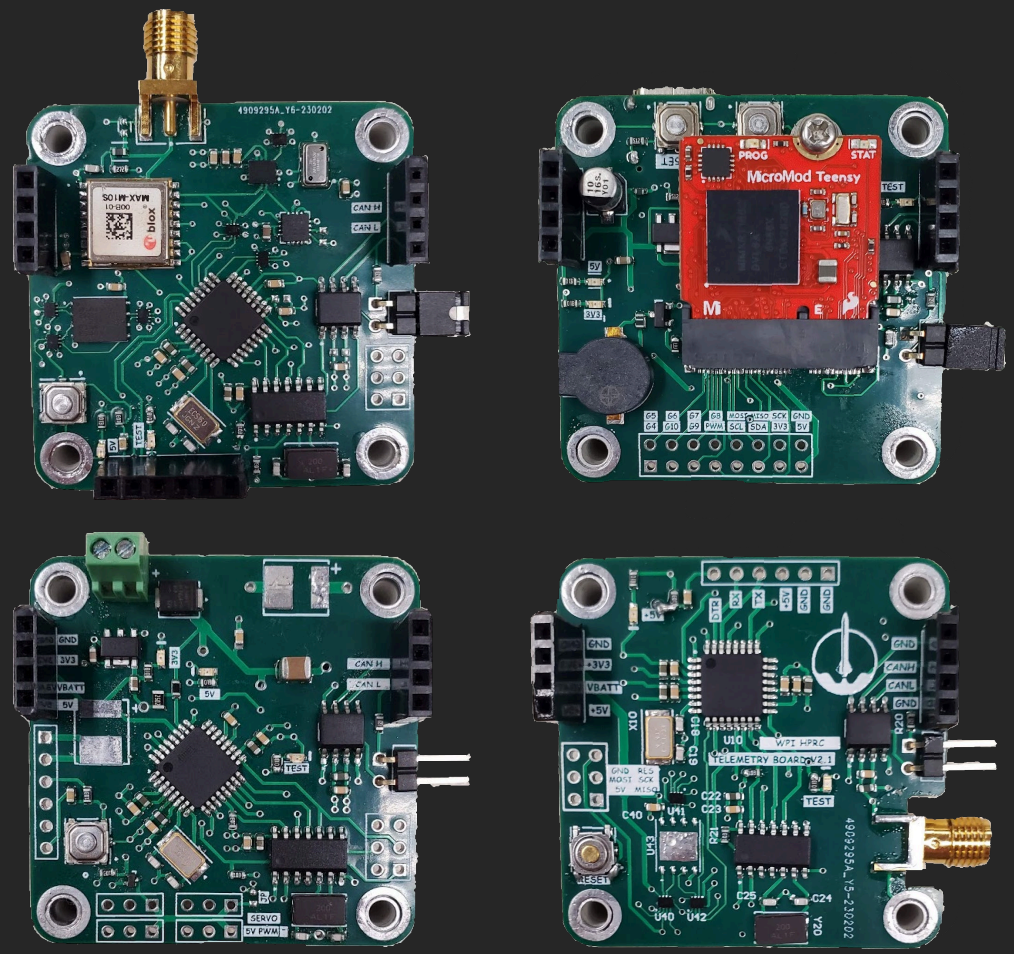
Airbrakes

Mechanical Design



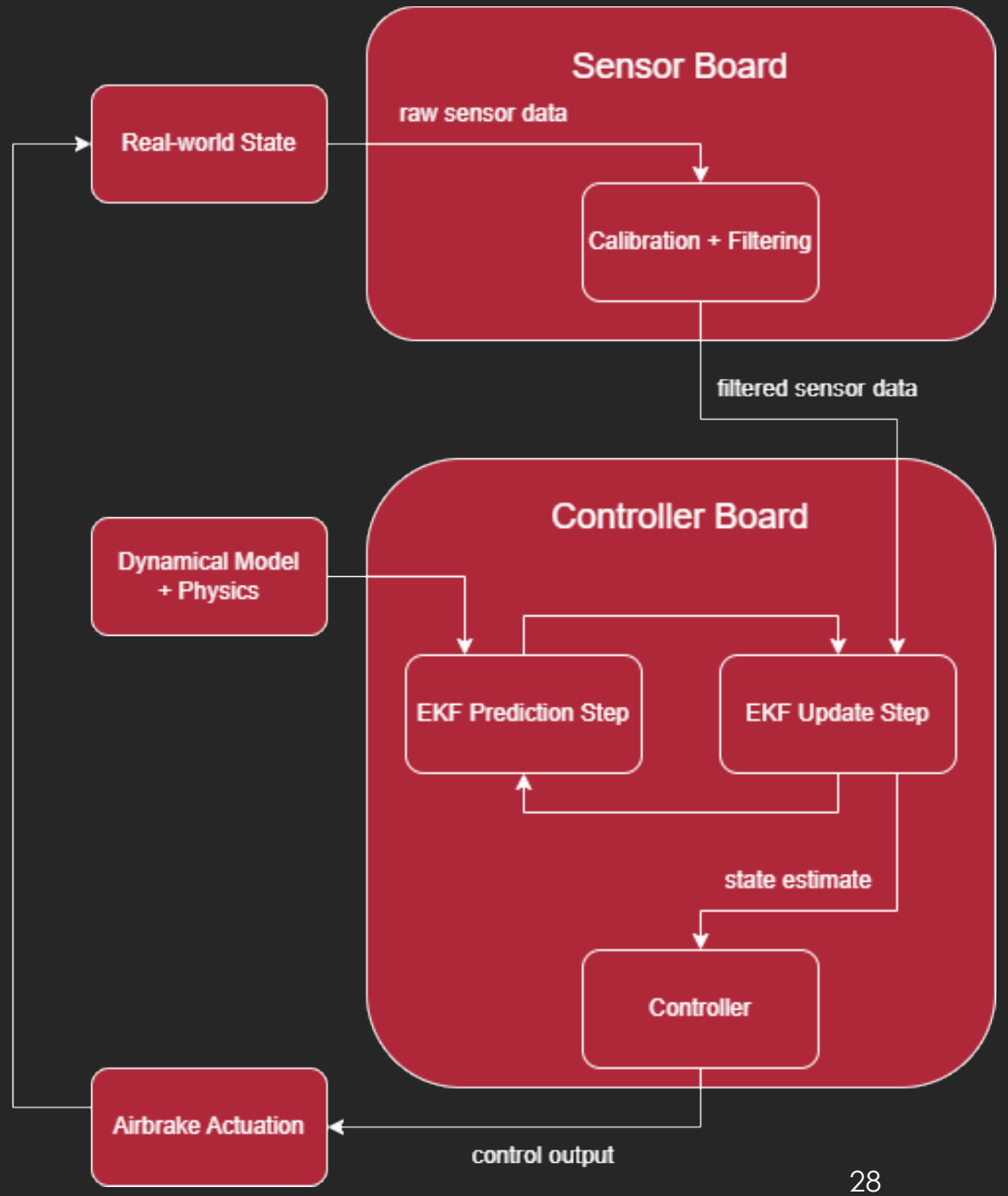
Simulation and Controls

Electronics



Flight Computer

```
        }
        break;
    case PRELAUNCH:
        // detect acceleration of 3G's
        if (launchDetect())
        {
            avionicsState = BOOST;
            boostTimer.reset();
            state_start = millis();
        }
        break;
    case BOOST:
        // Stay in this state for at least 3 seconds to prevent airbrake activatio
        if (boostTimer.check() == 1)
        {
            if (motorBurnoutDetect())
            {
                // airbrakeServo.enable;  // Add this back in when using the stack
                burnoutTimer.reset();
                state_start = millis();
                avionicsState = COAST;
                // airbrakesTimer.reset();
                break;
            }
        }
```



Vehicle Status

Battery: V

Pressure: 0.00 inHg

Temperature: 30.00 °F

Humidity: NaN %

Vehicle State

Pre-Launch

Airbrakes: 0%

Flight Clock:

00:38:21.688

> Console

Clear

Resolution: − 1 +

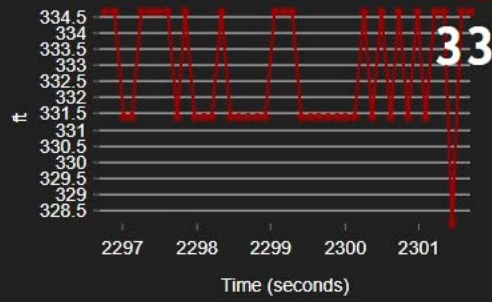
```
[00:22:33.82]>Connecting to receiver...
[00:22:33.86]>Connected to receiver.
>
```

Gyroscope

Pitch (X)	Roll (Y)	Yaw (Z)
0.3 dps	-0.01 rpm	0.18 dps

Altitude (MSL)

View Gauge



334.66 ft

100%

Velocity

View Graph

ft/s

000

Max: 54.46

Acceleration

View Gauge

0.99 G

100%

WPI HPRC

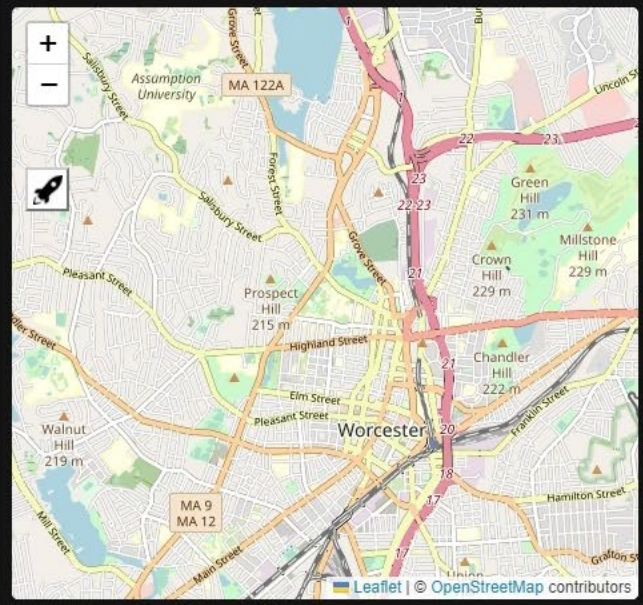
Capricornus GS

Status | Disconnect | Settings

Receiver: Connected RFS: 120ms LAT: NaNms

Rocket: Disconnected RFS: -ms LAT: -ms !

Disconnected



Mission Timeline

Boot	Pre-Launch	Boost	Coast	Apogee	Drogue	Quad Deploy	Main	Landing
37:17	37:35	00:00	00:00	00:00	00:00	00:00	00:00	00:00

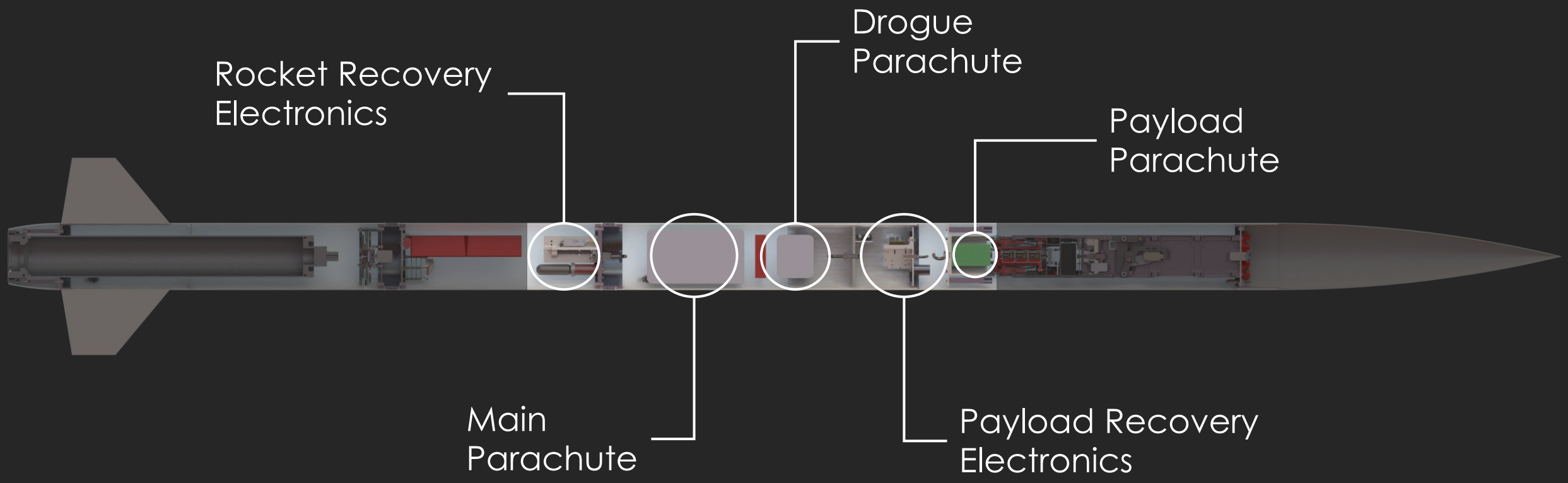
March 26, 2023

20:23:31 EDT


Recovery

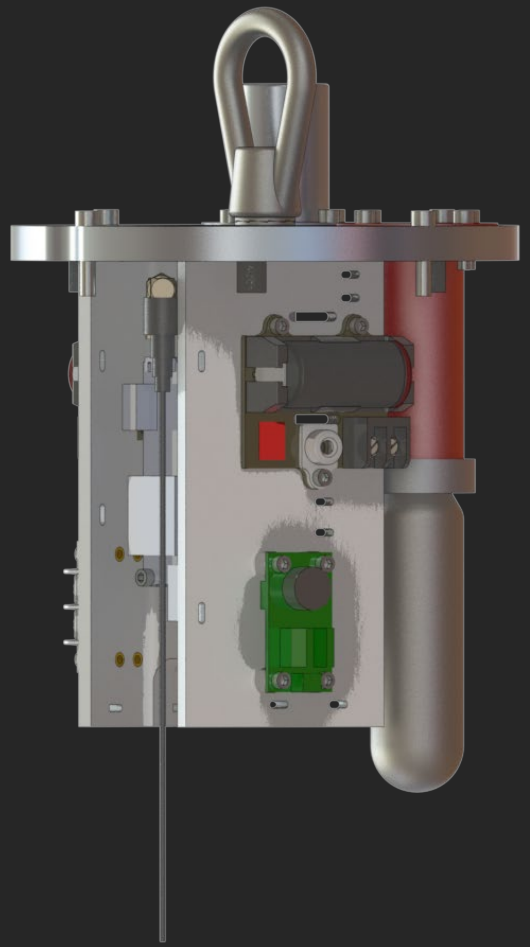
Safety

Reliability

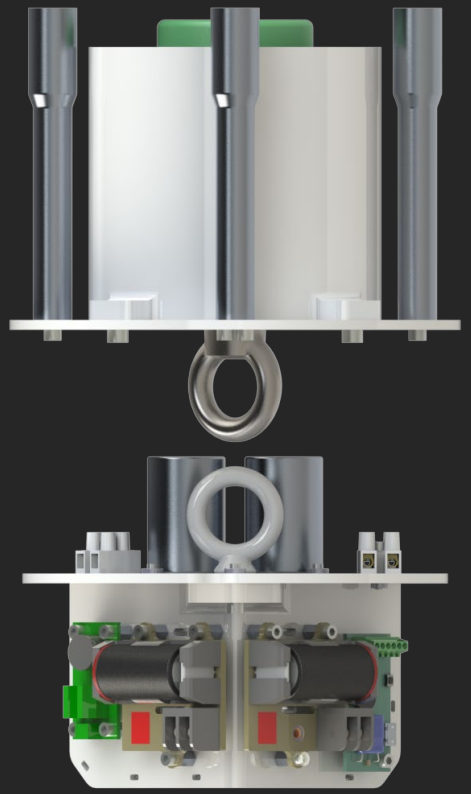

Rocket Recovery Electronics
Drogue Parachute
Payload Parachute
Main Parachute
Payload Recovery Electronics


Ground 0

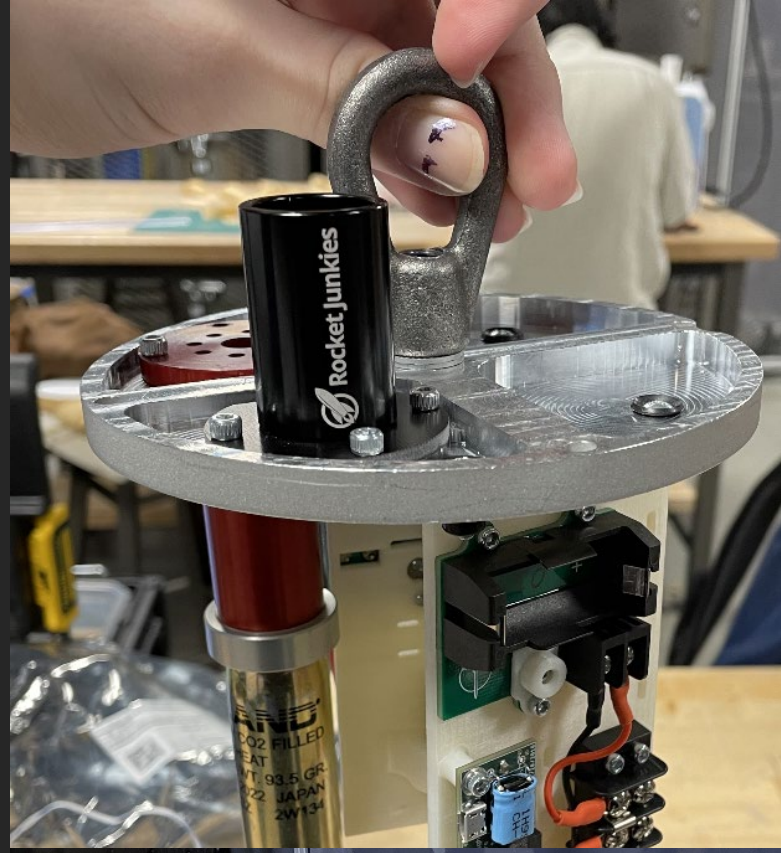
Redundant Design

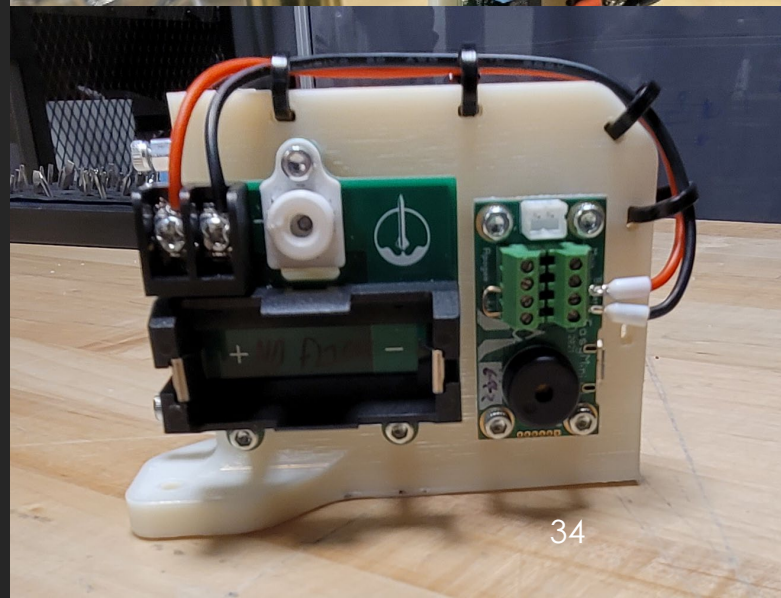


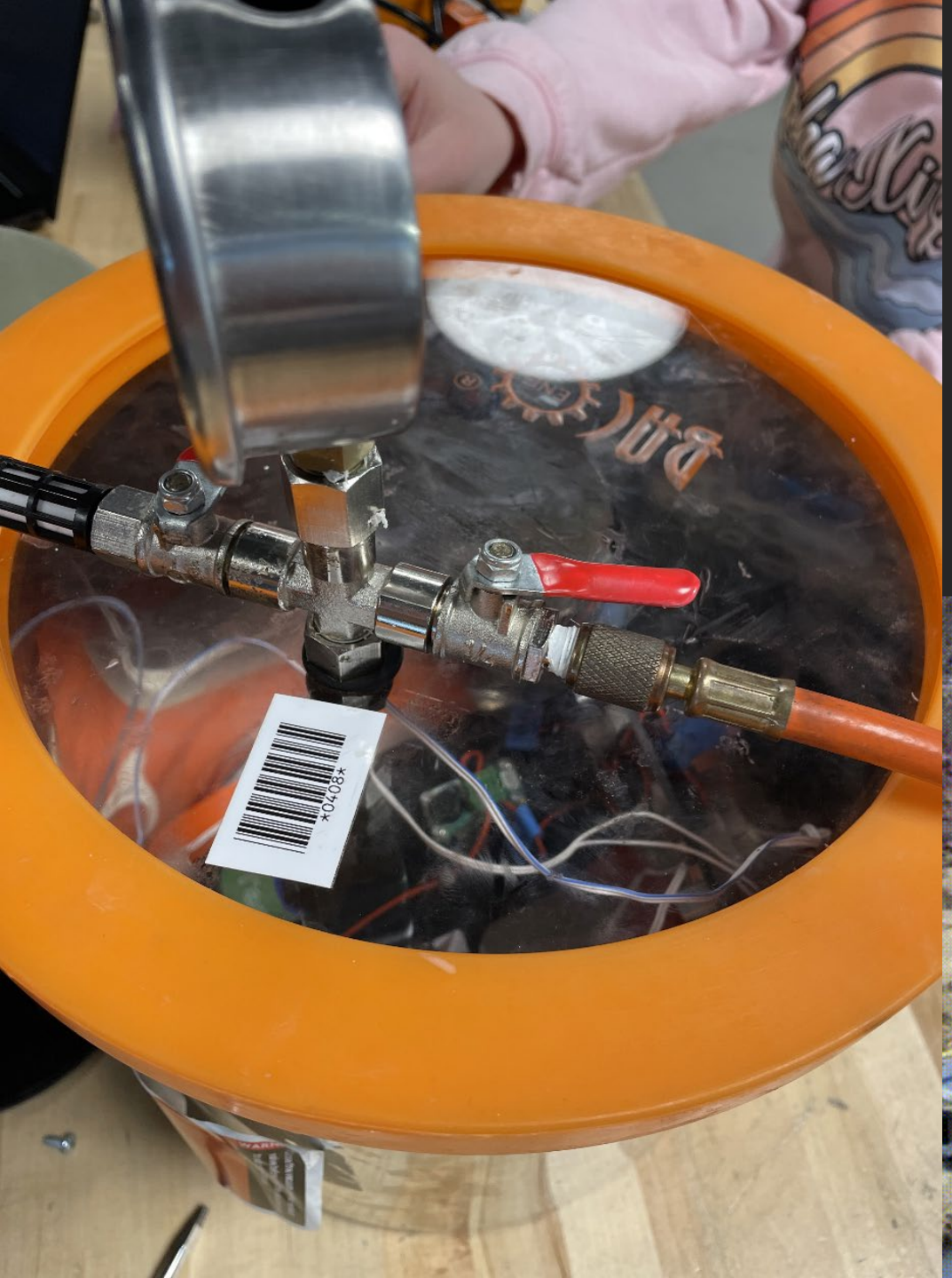
Rocket Recovery



Payload Recovery







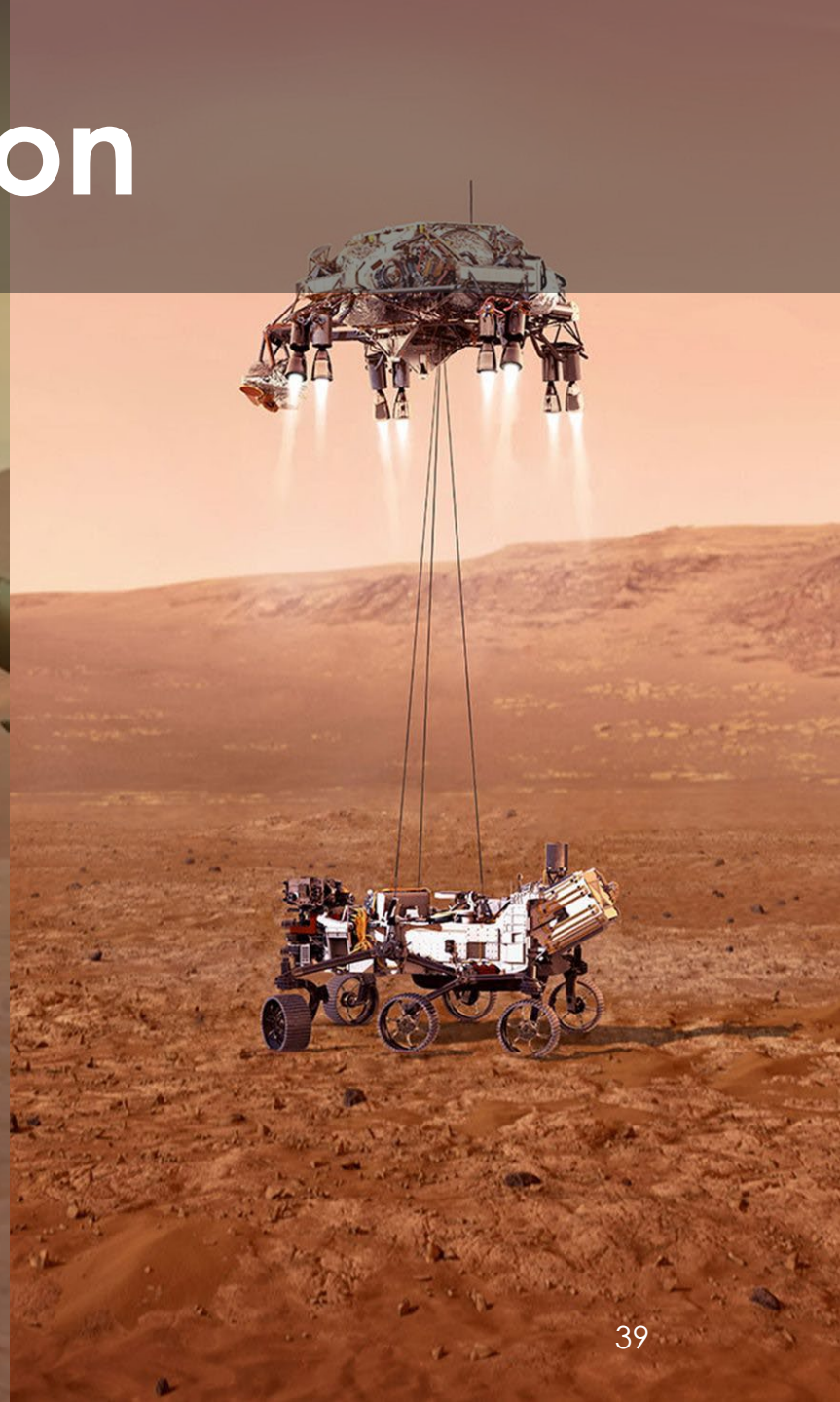
Testing

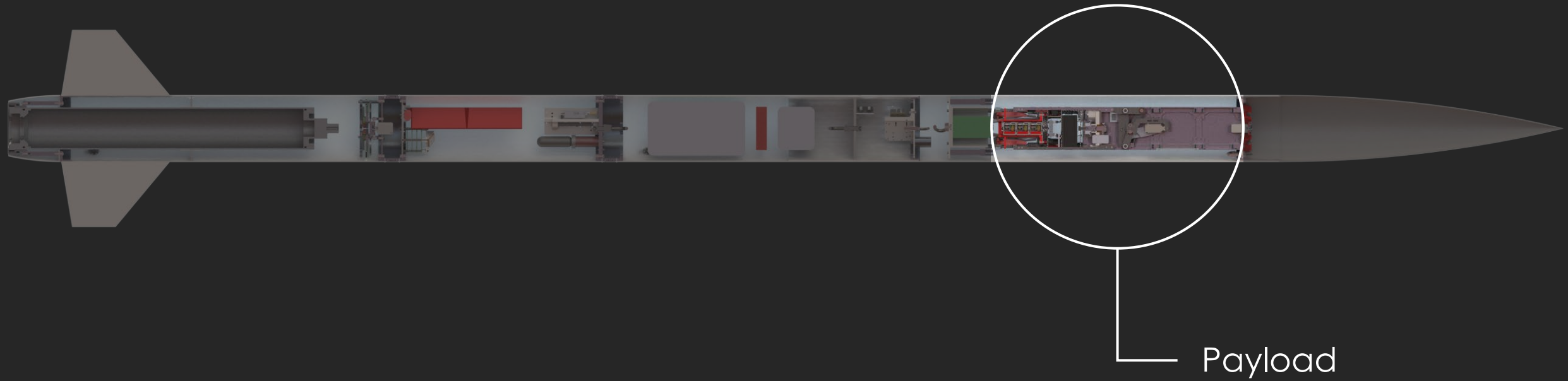
Subscale Launches

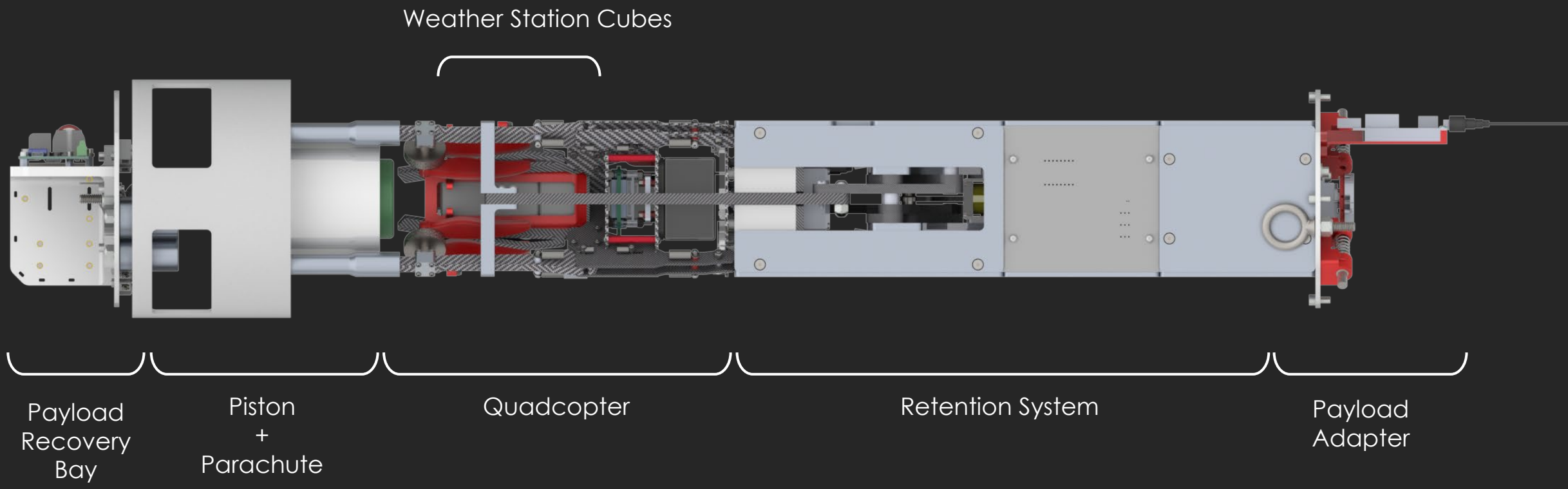
Payload

Weather Station Mission

Mission Inspiration

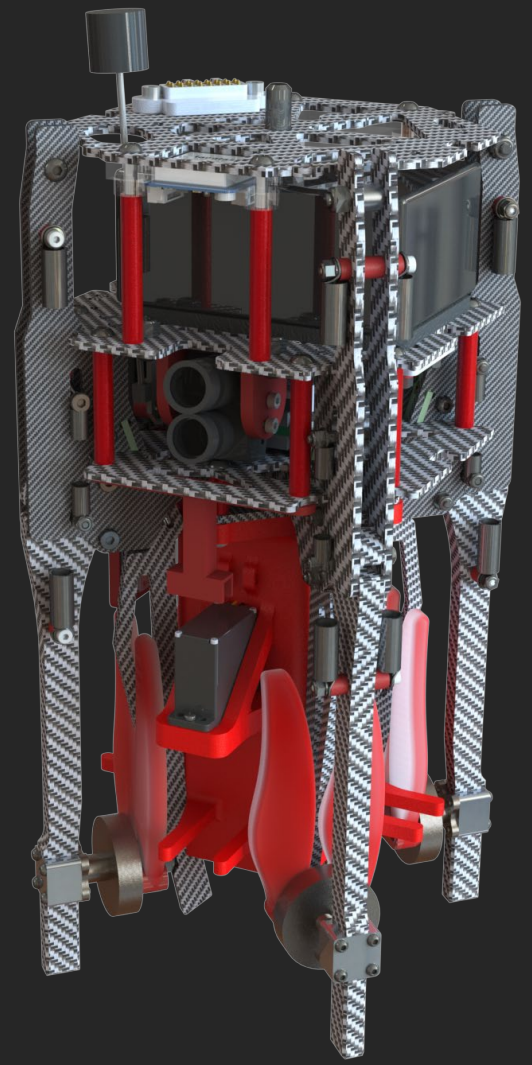



Payload



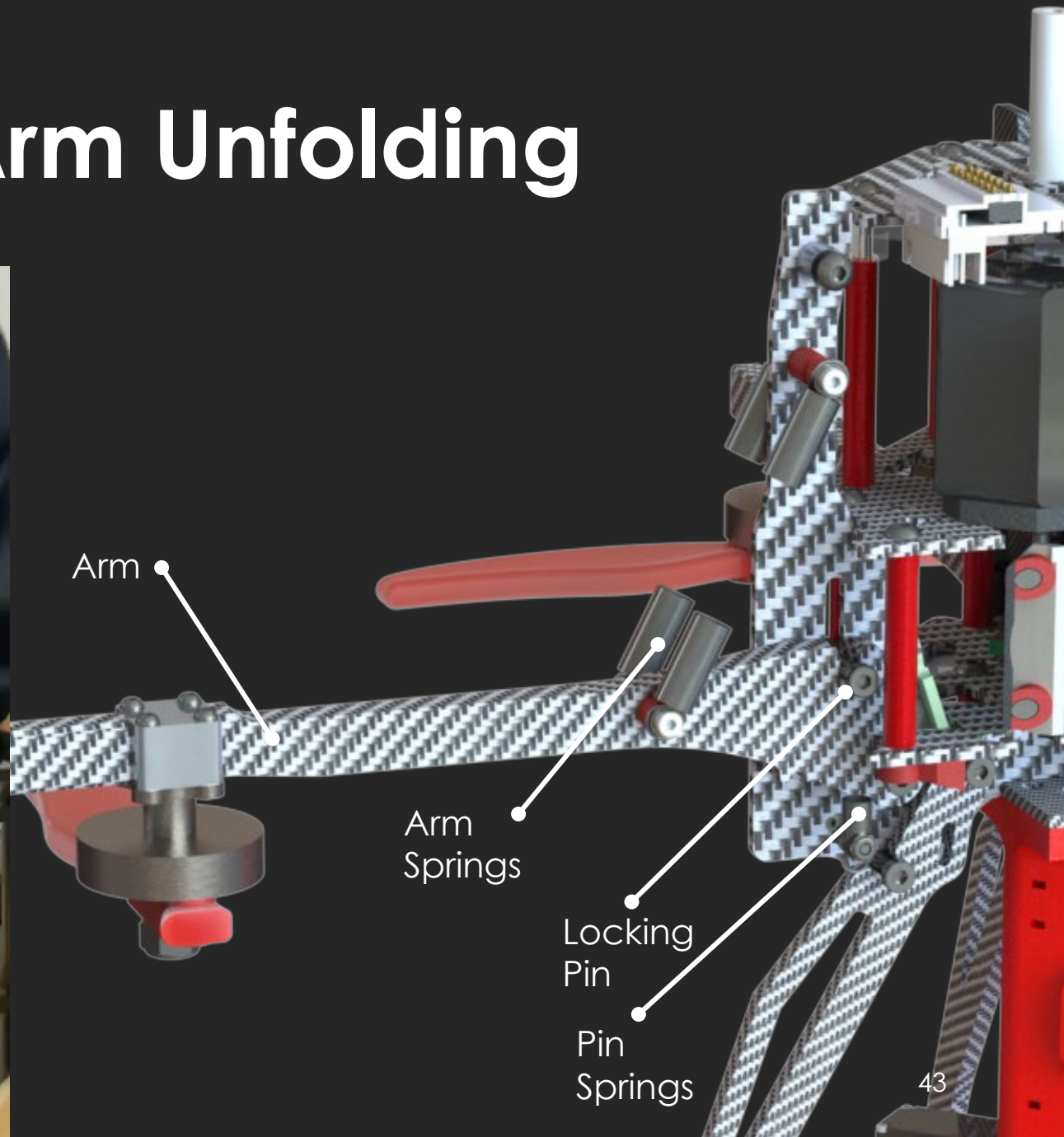
Payload System Architecture

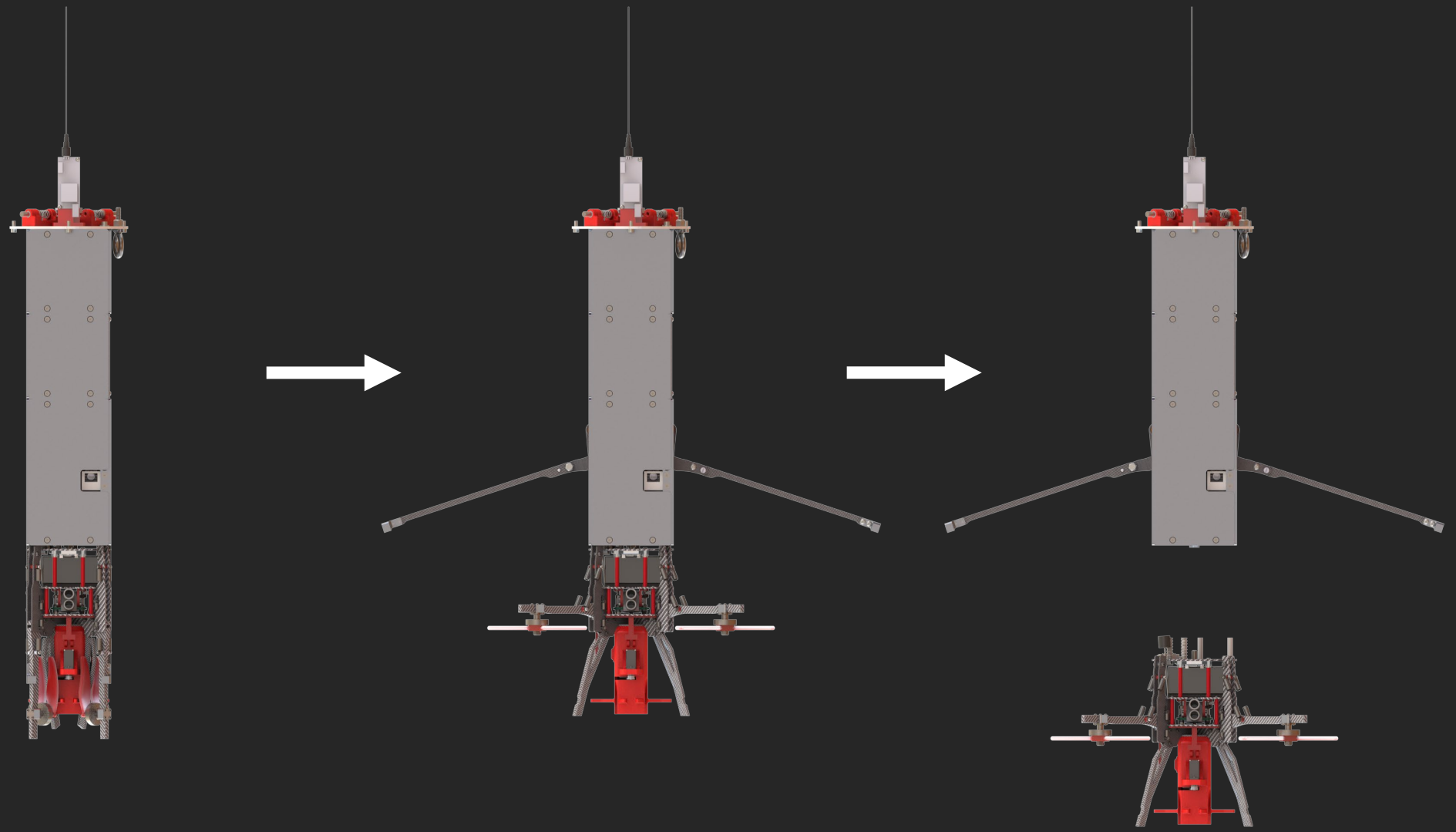
Quadcopter



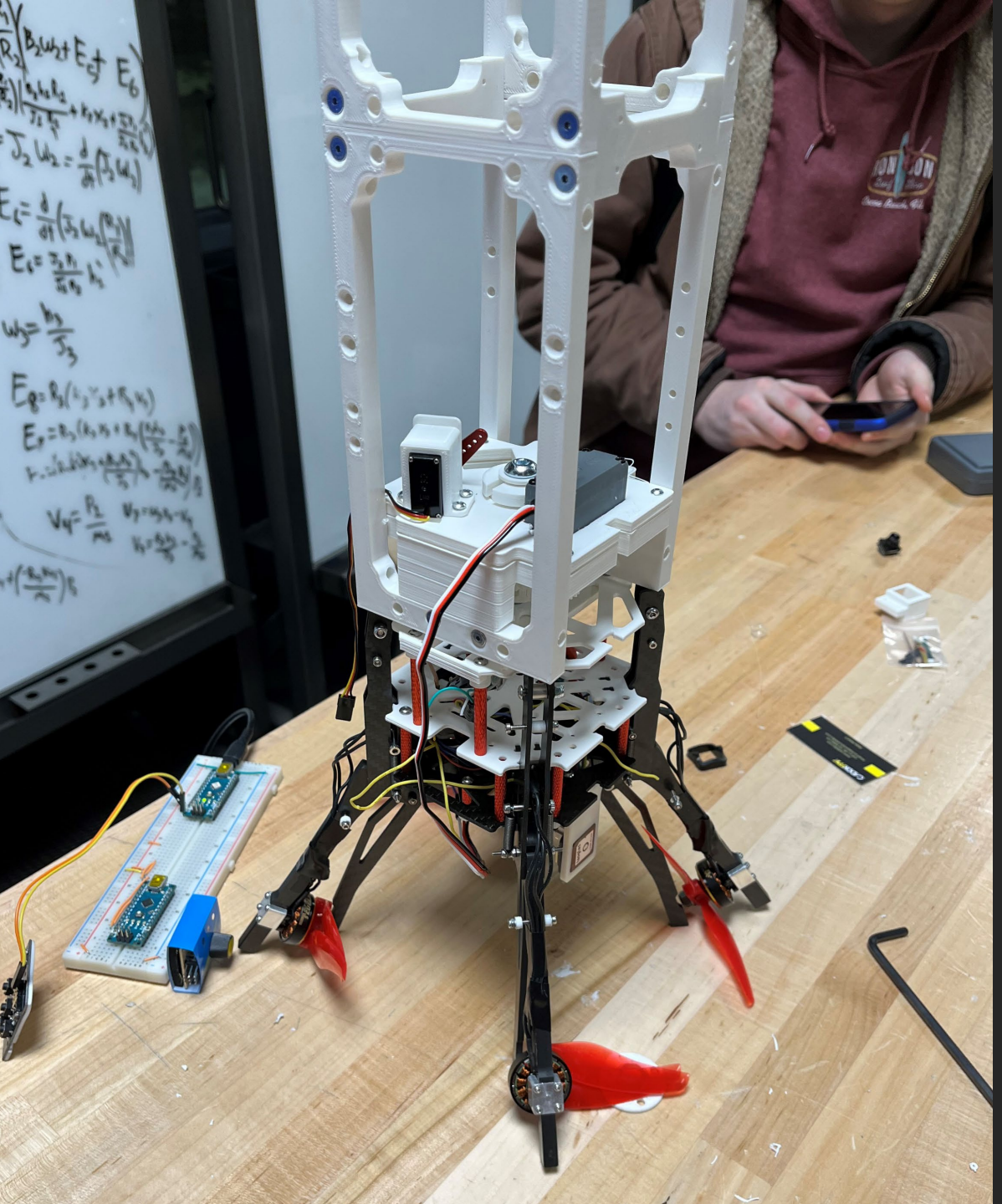
Folded Quad

Quadcopter Arm Unfolding

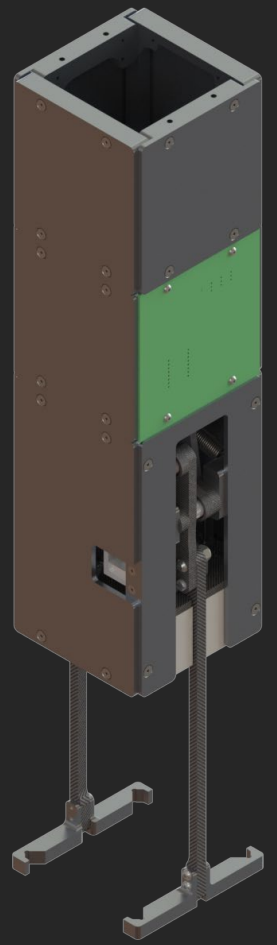




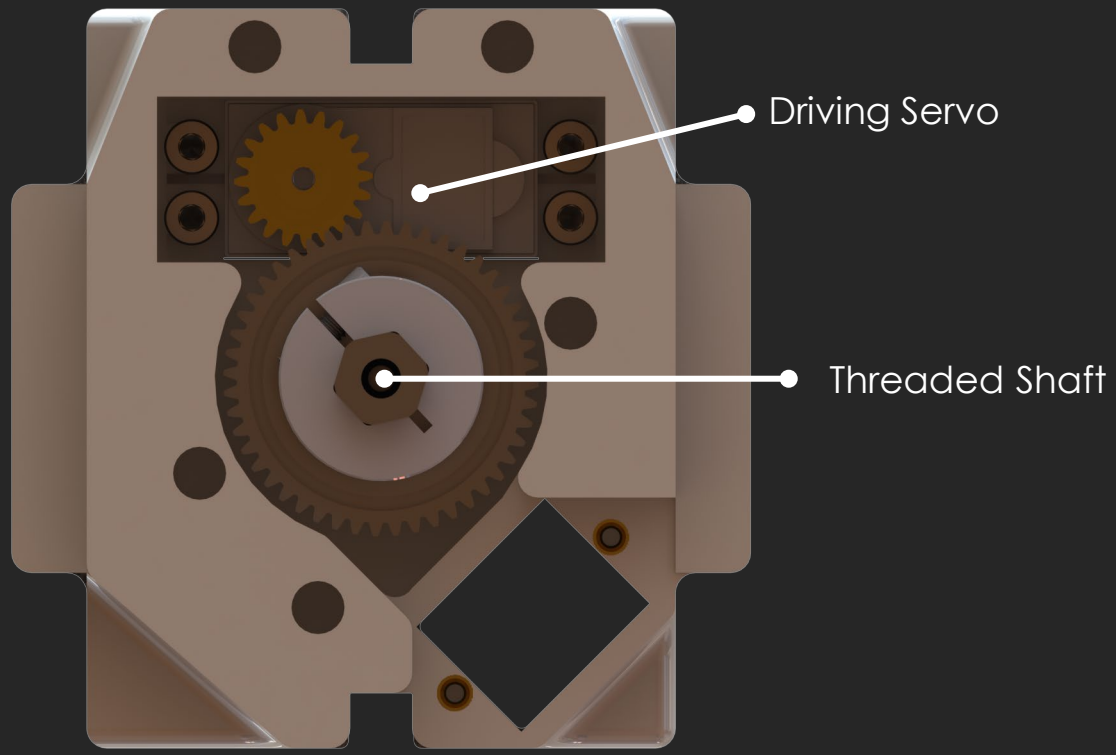
Deployment Scheme



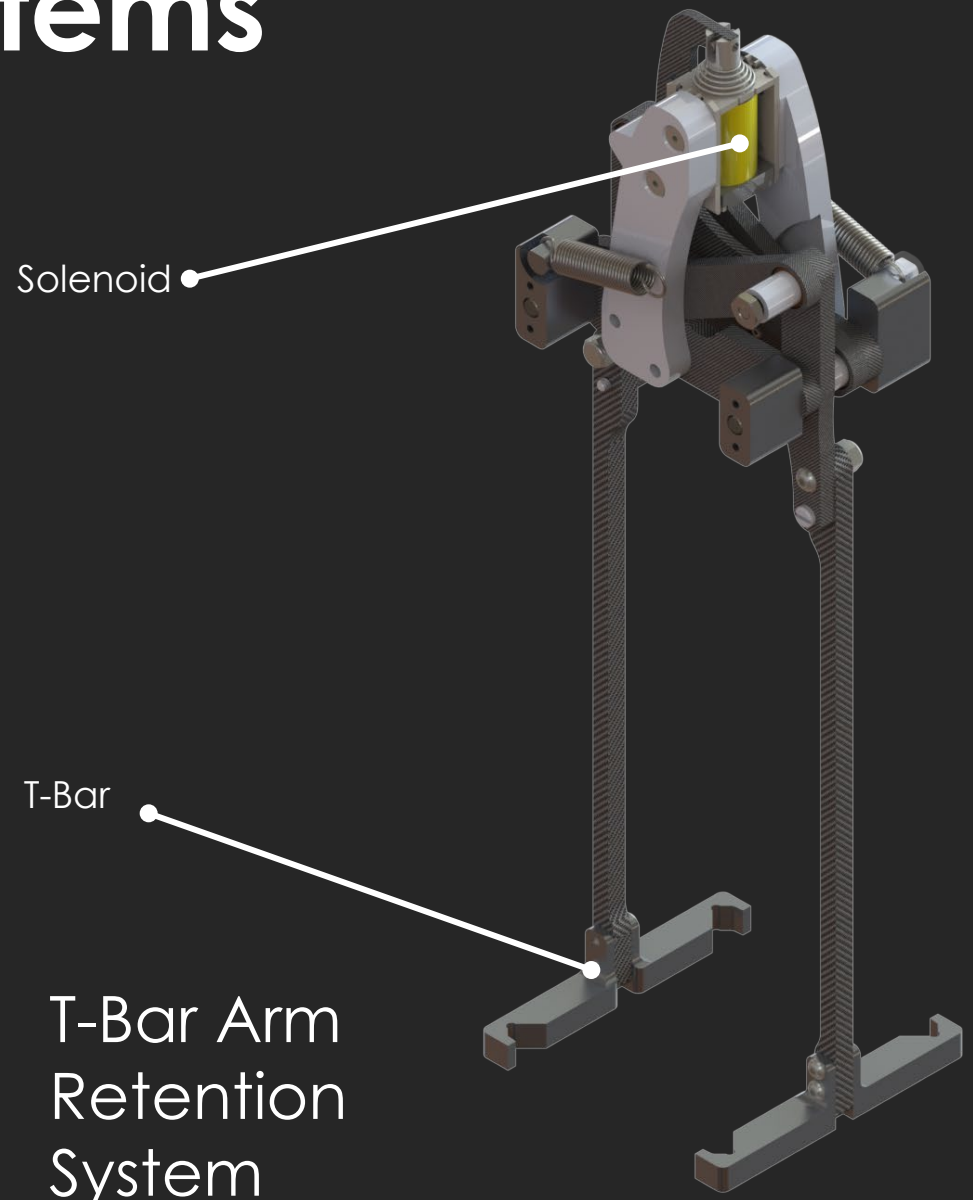
Payload Retention



Locking Systems



Quadcopter Locking Screw System



T-Bar Arm Retention System

Quadcopter Flight Testing

First Person View Signal with
On Screen Display

Terence testing Throw Mode

Weather Station Structure

Cube Shell

Snap-fit design

Battery

15 Minutes of Data

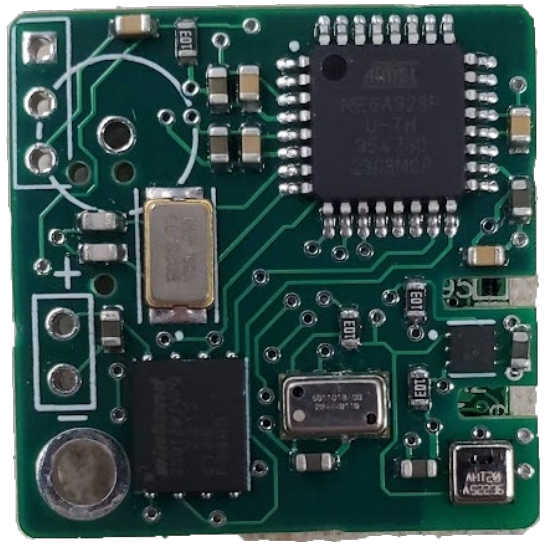
Electronics

Pressure
Humidity
Temperature
Transmitter

Heat sink

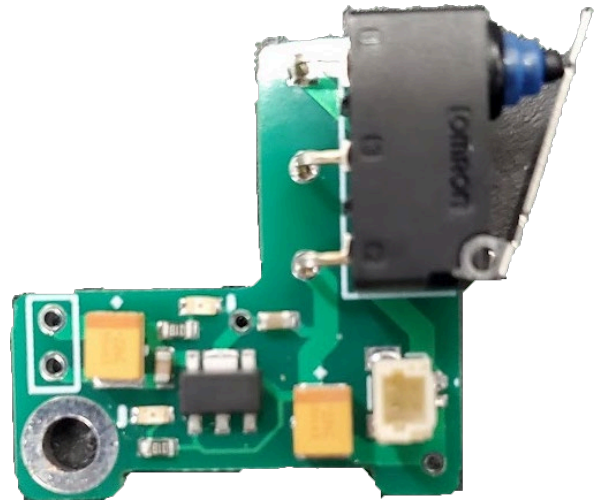
Cooling

Weather Station Electronics



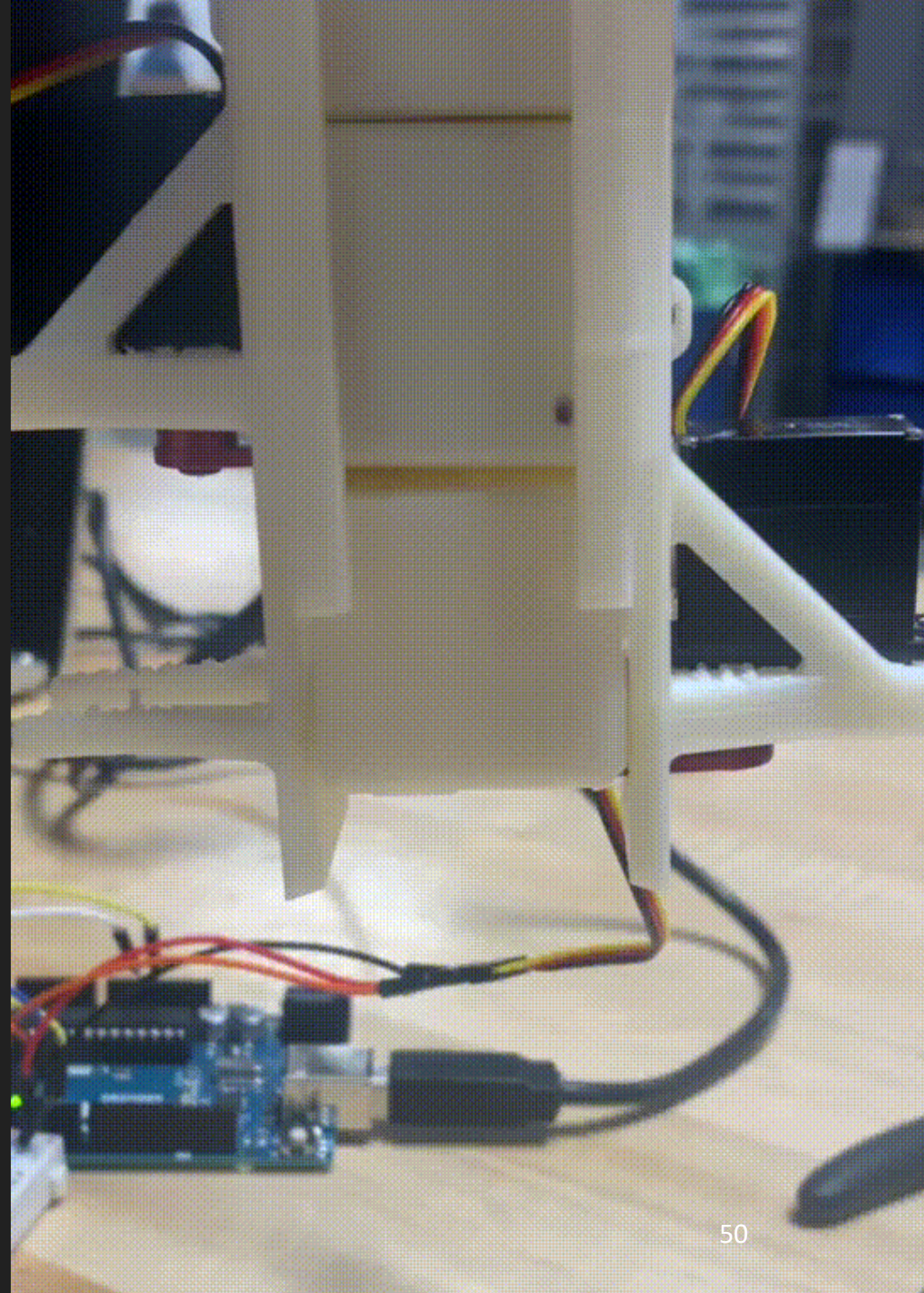
Weather Station PCB
(Front)

Weather Station PCB
(Back)



Power Delivery PCB

Weather Cube Deployment




Education

Member Engagement

Research & Development

Community Outreach

L1 Program

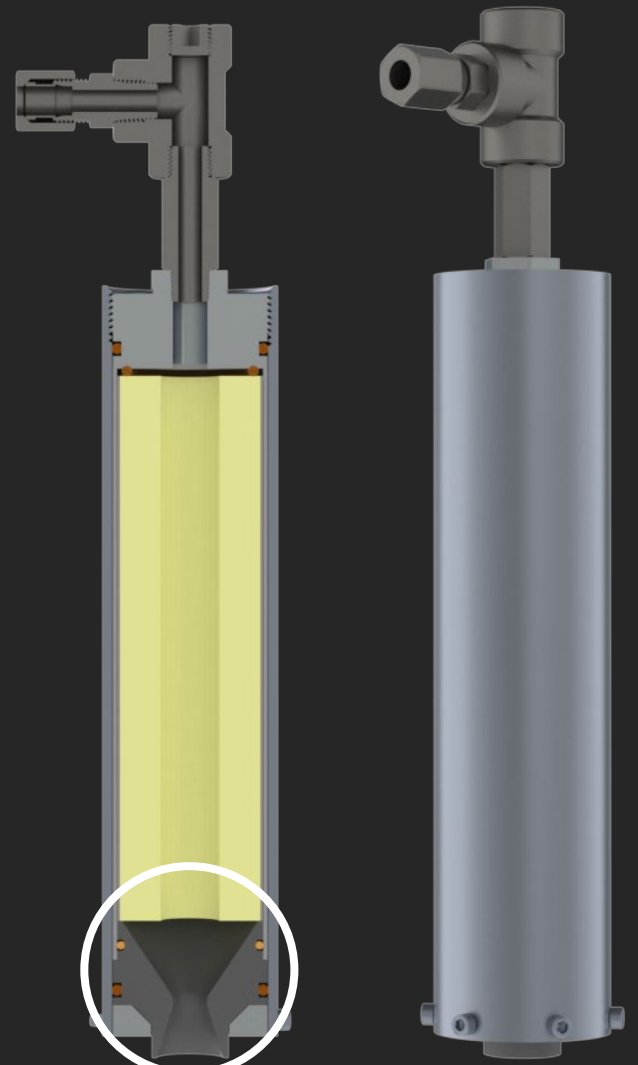
Workshops

Design and Assembly

Launch

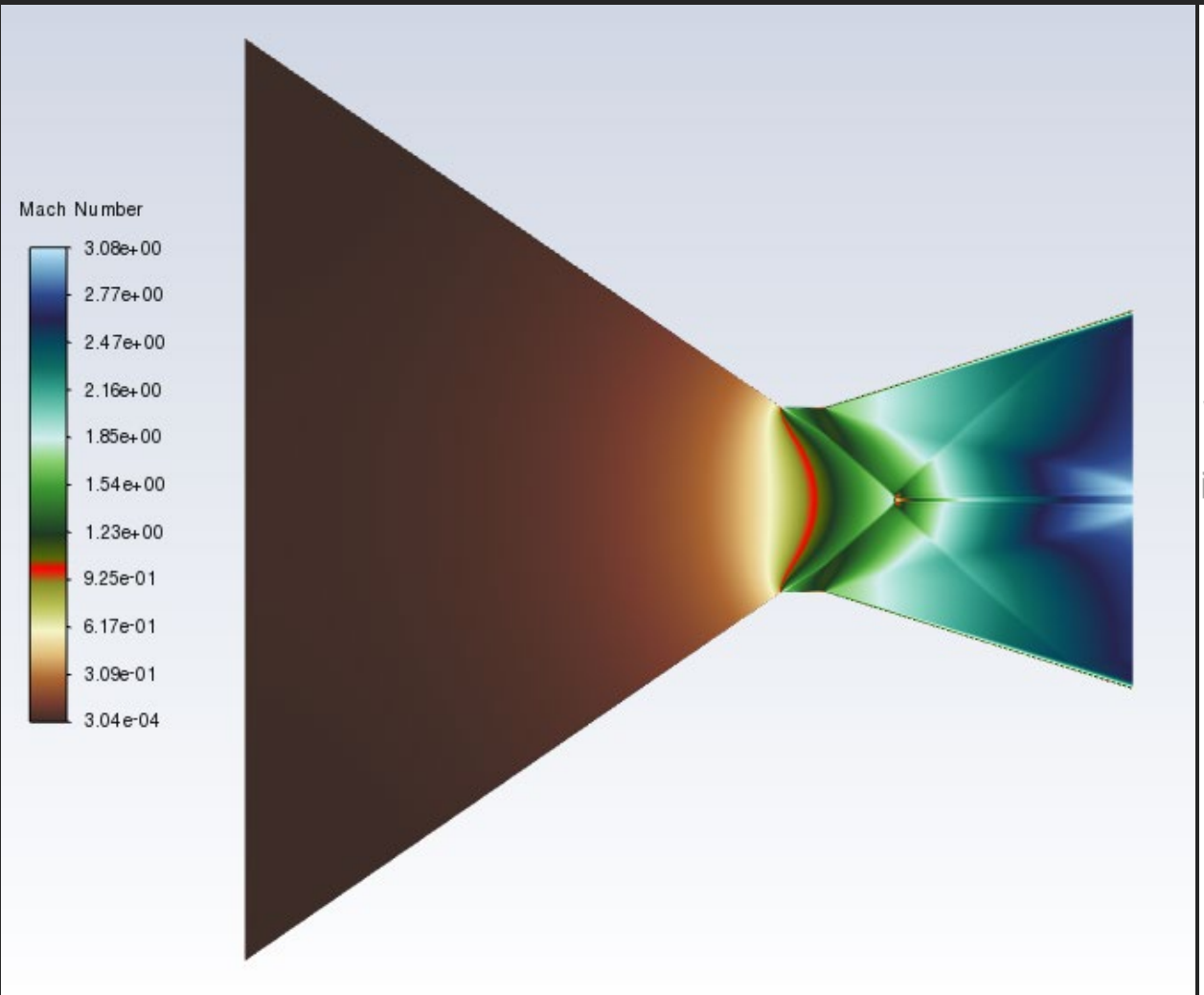
Test
Stand

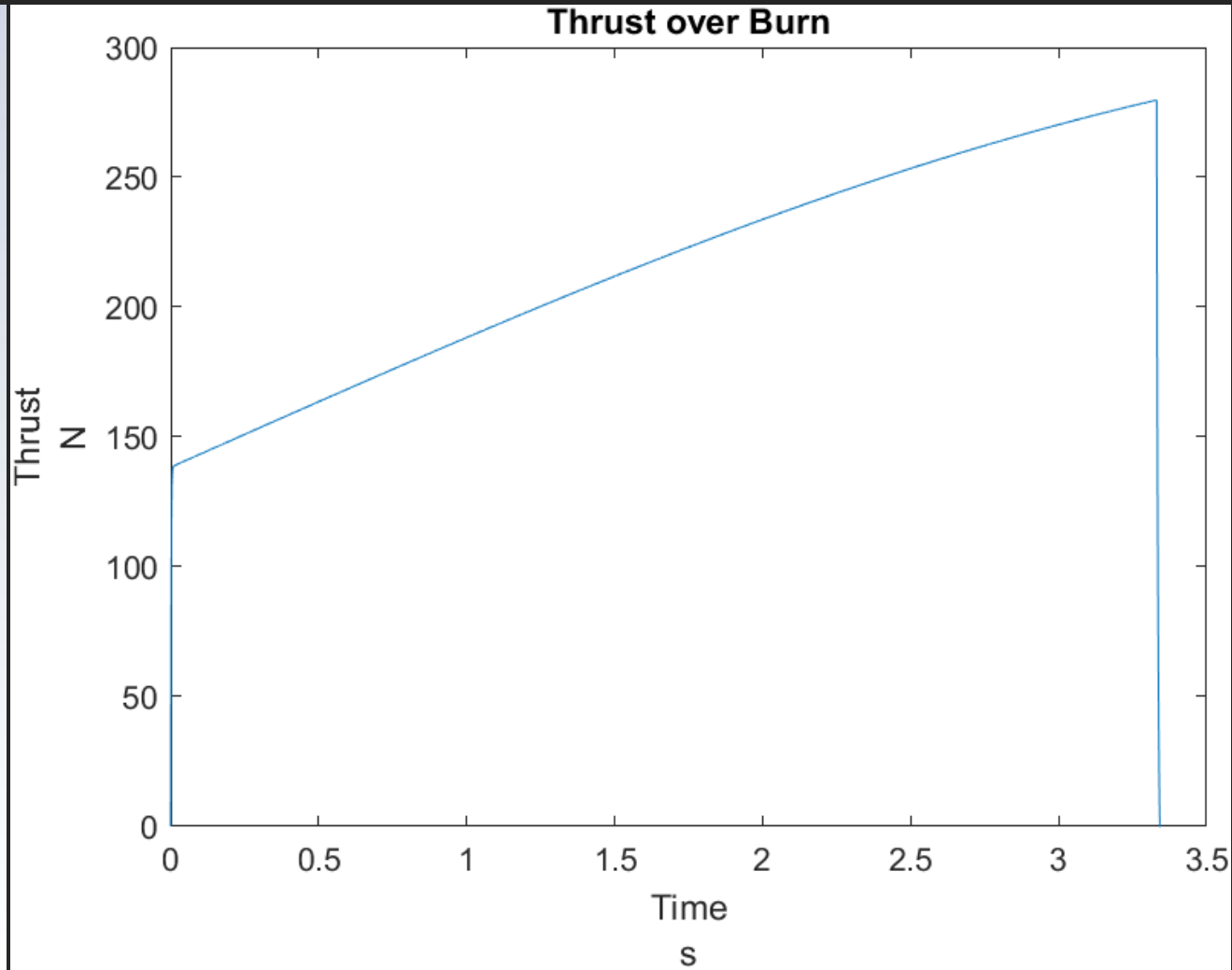
Propulsion



Motor

Propulsion


Mach Number
3.08e+00
2.77e+00
2.47e+00
2.16e+00
1.85e+00
1.54e+00
1.23e+00
9.25e-01
6.17e-01
3.09e-01
3.04e-04


Thrust over Burn
Thrust
N
300
250
200
150
100
50
0
0
0.5
1
1.5
2
2.5
3
3.5
Time
s



Basics of High Power Rocketry
WPI High Power Rocketry Club

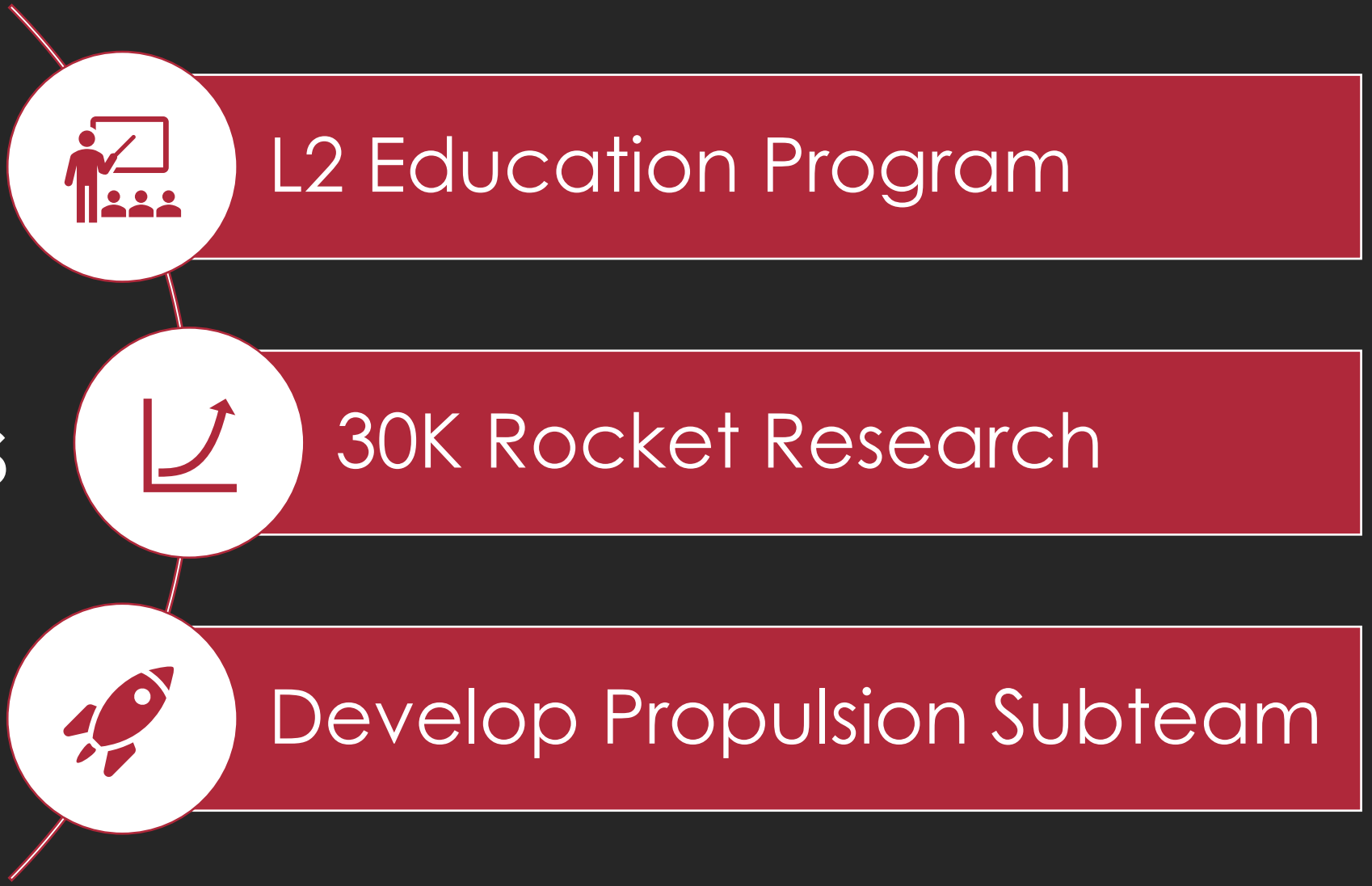
Outreach



WPI

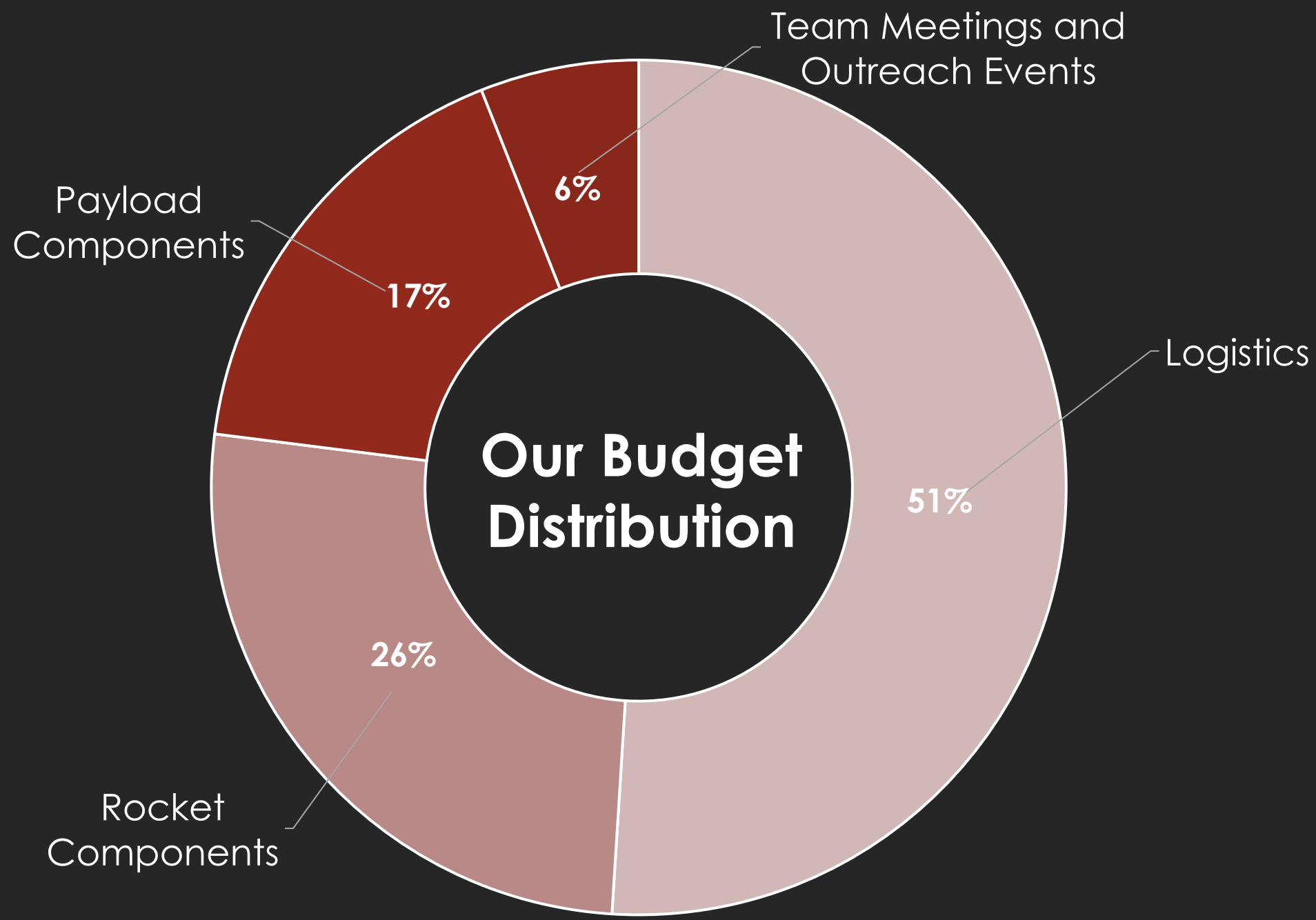
Competition

Future Plans




Altium
Test Devices by SCHENCK
GIVING DAY
DONORS
ERAD
endaq
atomic machines
Collins Aerospace
BLUE ORIGIN
TINKER BOX
WPI

Sponsors


Our Budget Distribution
Team Meetings and Outreach Events
6%
Payload Components
17%
Logistics
51%
Rocket Components
26%

HPRC
WPI AIAA

Breakout Rooms

1. Composites
2. Structures
3. Recovery
4. Propulsion
5. Simulation
6. Payload Division
7. Embedded Systems & Flight Software
8. Electrical Systems & Electronics Design
9. Ground Station
10. Education
11. Event Organization/Management

Our Website

aiaa.wpi.edu/hprc

Our Instagram

@wpi_hprc

Thank You For Attending!