CanSat 2023

Post Flight Review (PFR)

Version 1.0

Team 1032

Yes we CANSAT

Presentation Outline

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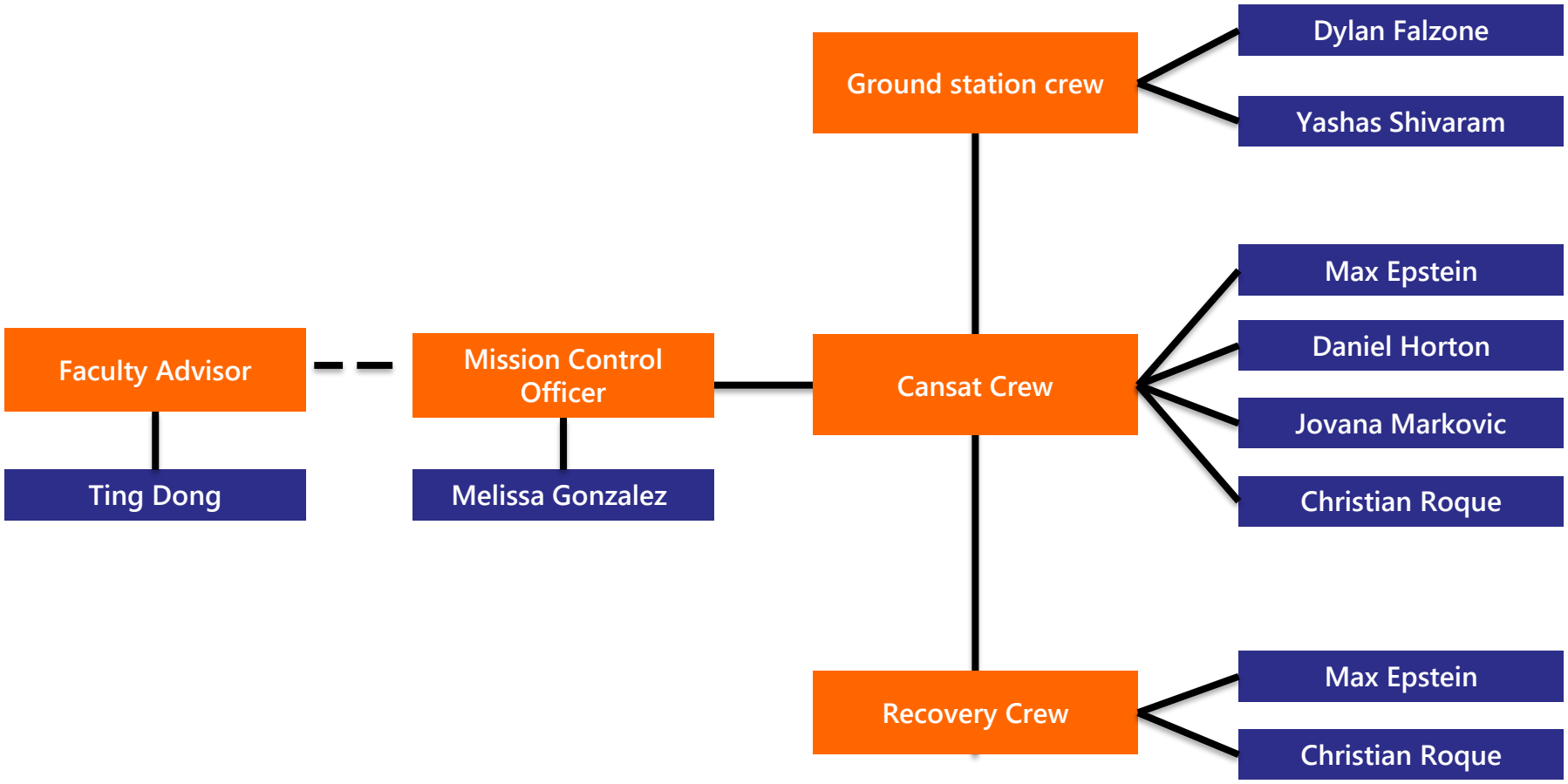
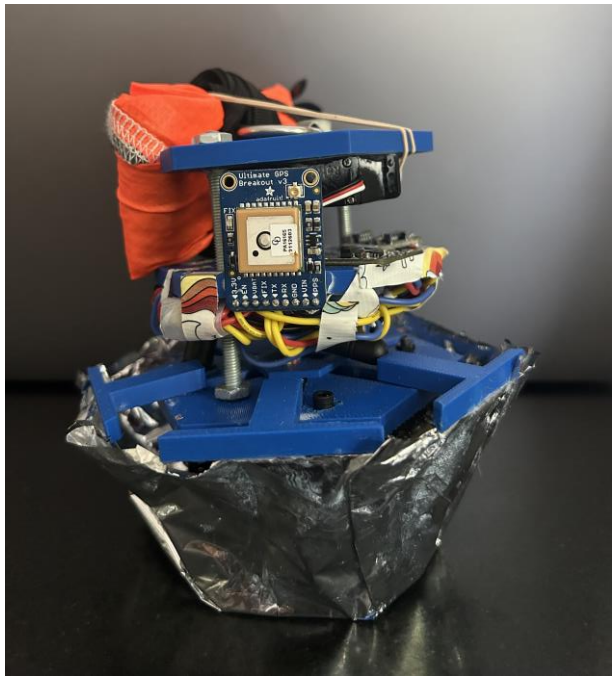
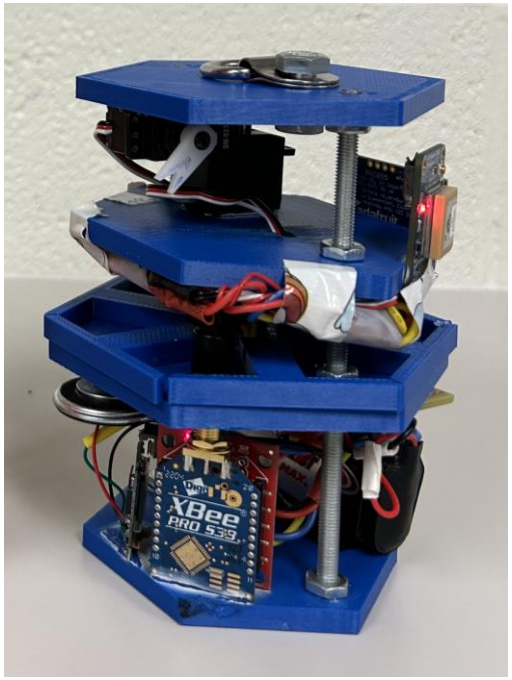
Team Organization



Systems Overview: Payload (1/2)

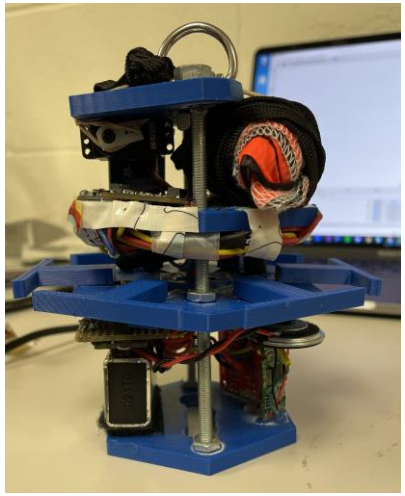
- When released from the can, the payload automatically deploys a spring-loaded aerobraking heatshield.
- At 200 meters, the servo motor arm rotates to release the rubber band holding the parachute in place.
- Our bottom-heavy design allows the payload to passively land upright.

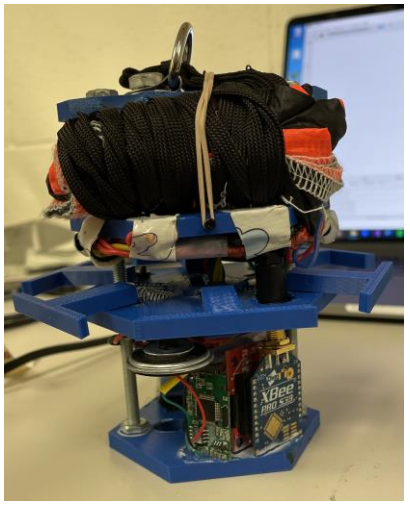




Systems Overview: Payload (2/2)

- **Major Components:**
  - **Electrical:**
    - Arduino nano Microcontroller
    - Adafruit Ultimate GPS
    - Xbee Radio
    - BMP280 pressure/temperature sensor
    - BNO055 tilt sensor
    - Adafruit mini spy camera
    - Uxcell 1W speaker
    - Energizer 9V battery
  - **Mechanical:**
    - 6-armed spring mechanism for the heatshield
    - Tie down ring for parachute and attachment to Canister
    - Servo Motor
    - Mylar heatshield (see on previous slide)

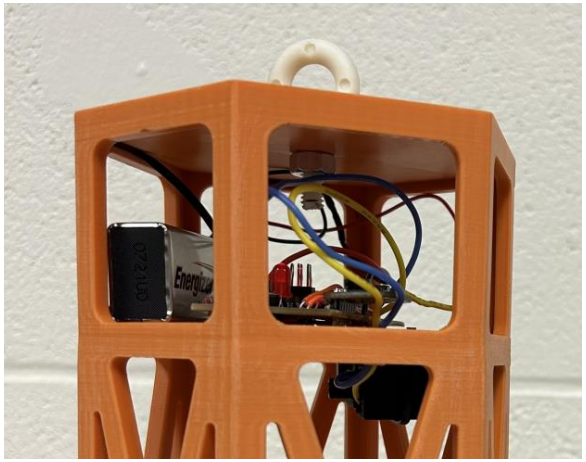




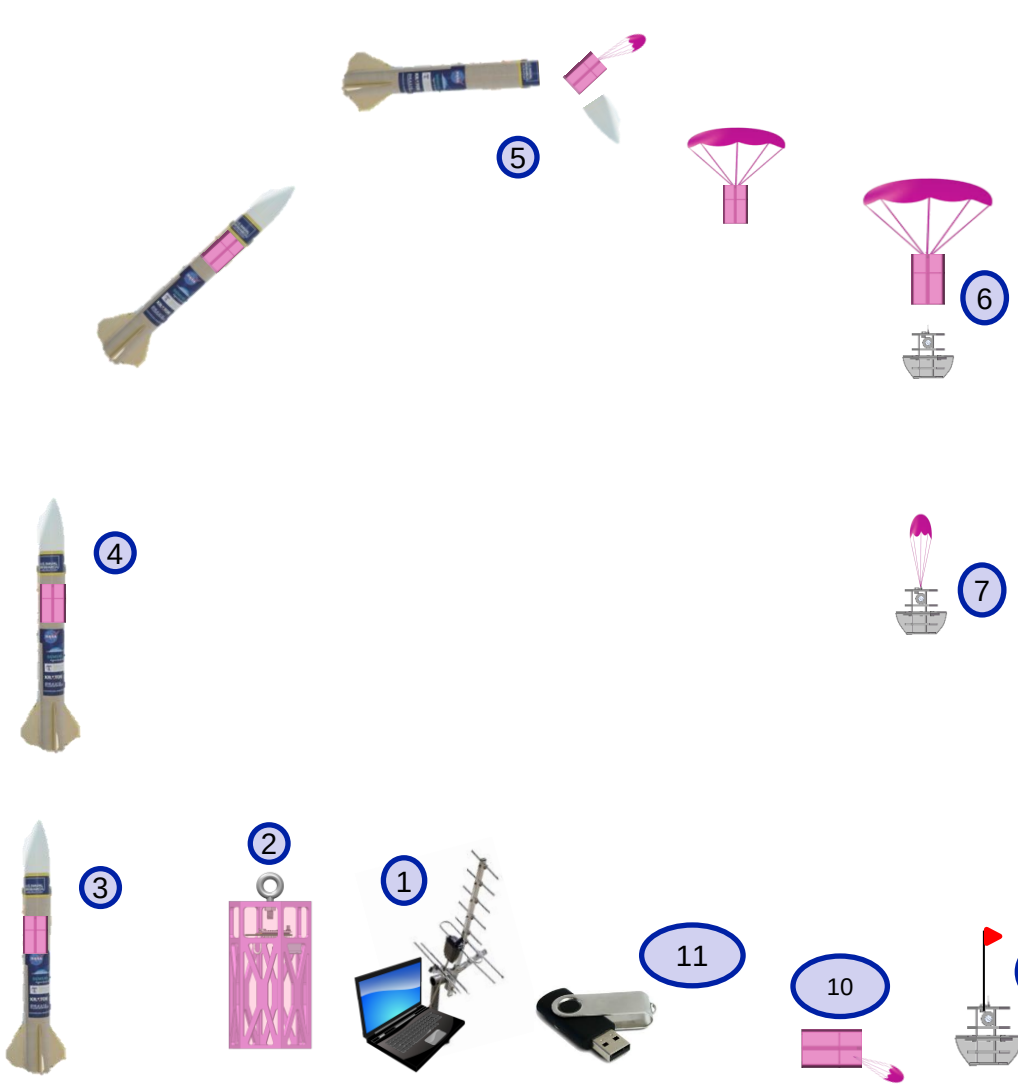
Systems Overview: Container

- **The can uses a linear actuator fed through the payload's parachute ring to secure it during initial descent.**
- **At 500m, the linear actuator retracts, deploying the payload.**

- **Major Components:**
  - **Electrical:**
    - Energizer 9V Battery
    - BMP280 Pressure Sensor
    - Arduino Nano
  - **Mechanical:**
    - Linear Actuator
    - Fiberglass eyebolt
    - Shrink Wrap



Concept of Operations



1. Set up ground station
2. Power on CanSat
3. Place CanSat into rocket
4. Rocket is launched
5. At 670-725m the CanSat separates and parachute opens
6. At 500m a probe will be released from the CanSat, which will deploy an aerobraking heat shield, with a camera facing the ground at all times
7. At 200m the probe will deploy a parachute too reduce descent rate
8. Probe will land upright
9. Probe will deploy a flag 500mm above the base of the probe
10. Recovery crew tracks and collects CanSat
11. FSW obtains and saves flight data & video recording to thumb drive

Sequence of Events

Planned Sequence	Field Operations
Check-in and weigh CanSat	**Successful**
Load CanSat into rocket and place on launch stand	**Successful**
Set up GS and send calibration command to CanSat	**Successful**
Launch	**Successful**
CanSat separation from rocket at apogee	**Successful**
CanSat deploys parachute, slowing descent to 15 +/- 5 m/s	**Successful**
At 500m, deploy the probe from the canister	**Failure**
Payload deploys aerobraking heatshield and descends at 20 m/s or less	—
At 200m, servo deploys the payload parachute, slowing descent to 5 +/- 1 m/s	**Parachute successfully deployed, but Payload never separated from the canister**
Payload lands upright	—
Flag is deployed	**Failure, Did not attempt.**
Buzzer is activated and the CanSat is recovered	**Successful**
Telemetry is saved to .csv and thumb drive is submitted	**Successful**
Descent video is recovered from camera microSD	**Failure, video files corrupted**

Flight Data Analysis (1/10)

- **Payload was not released from the can during descent**
- **The linear actuator holding the payload in place did not retract, keeping the payload inside the can**

State Change from Rocket Separation to Payload Deployment

1032	21:53:00	512	F	R	522.15	N	N	N
1032	21:54:00	513	F	R	508.18	N	N	N
1032	21:55:00	514	F	P	498.4	P	N	N
1032	21:57:00	515	F	P	474.53	P	N	N

Flight Data Analysis (2/10)

- **The heat shield was not deployed since the payload was never released from the canister**
- **Had the payload been released from the can, the spring-loaded heat shield would have deployed automatically**

State Change from no Heatshield Deployment to Heatshield Deployment

1032	21:53:00	512	F	R	522.15	N	N	N
1032	21:54:00	513	F	R	508.18	N	N	N
1032	21:55:00	514	F	P	498.4	P	N	N
1032	21:57:00	515	F	P	474.53	P	N	N

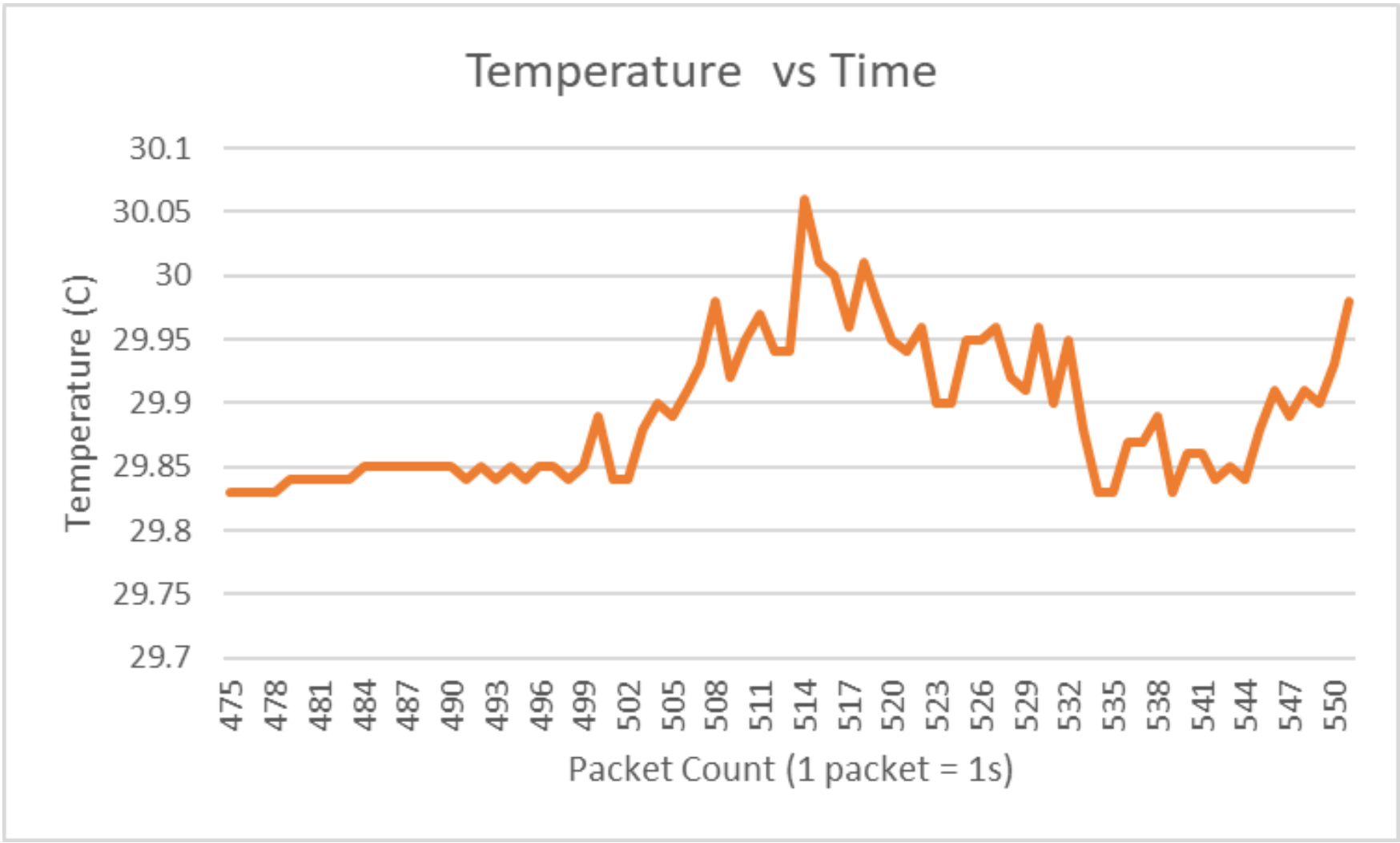
Flight Data Analysis (3/10)

- **Parachute deployment system allowed the parachute to release when the altitude reached 200 meters**
- **The servo motor rotated, releasing the rubber band and deploying the parachute, but the payload remained stuck in the canister.**

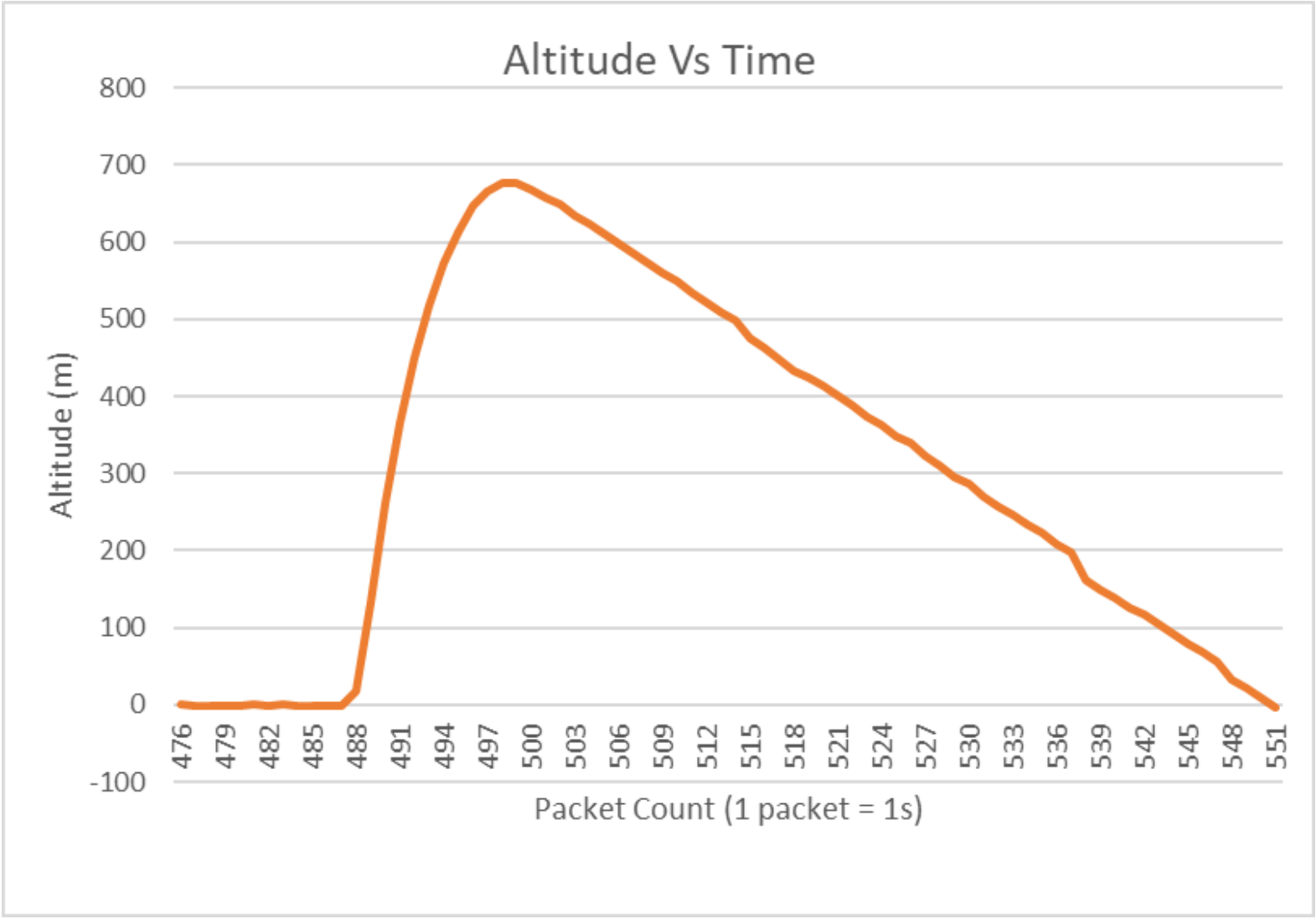
State Change from no Parachute Deployment to Parachute Deployment

1032	22:17:00	535	F	P	222.51	P	N	N
1032	22:18:00	536	F	P	208.31	P	N	N
1032	22:19:00	537	F	D	197.1	P	C	N
1032	22:22:00	538	F	D	160.85	P	C	N

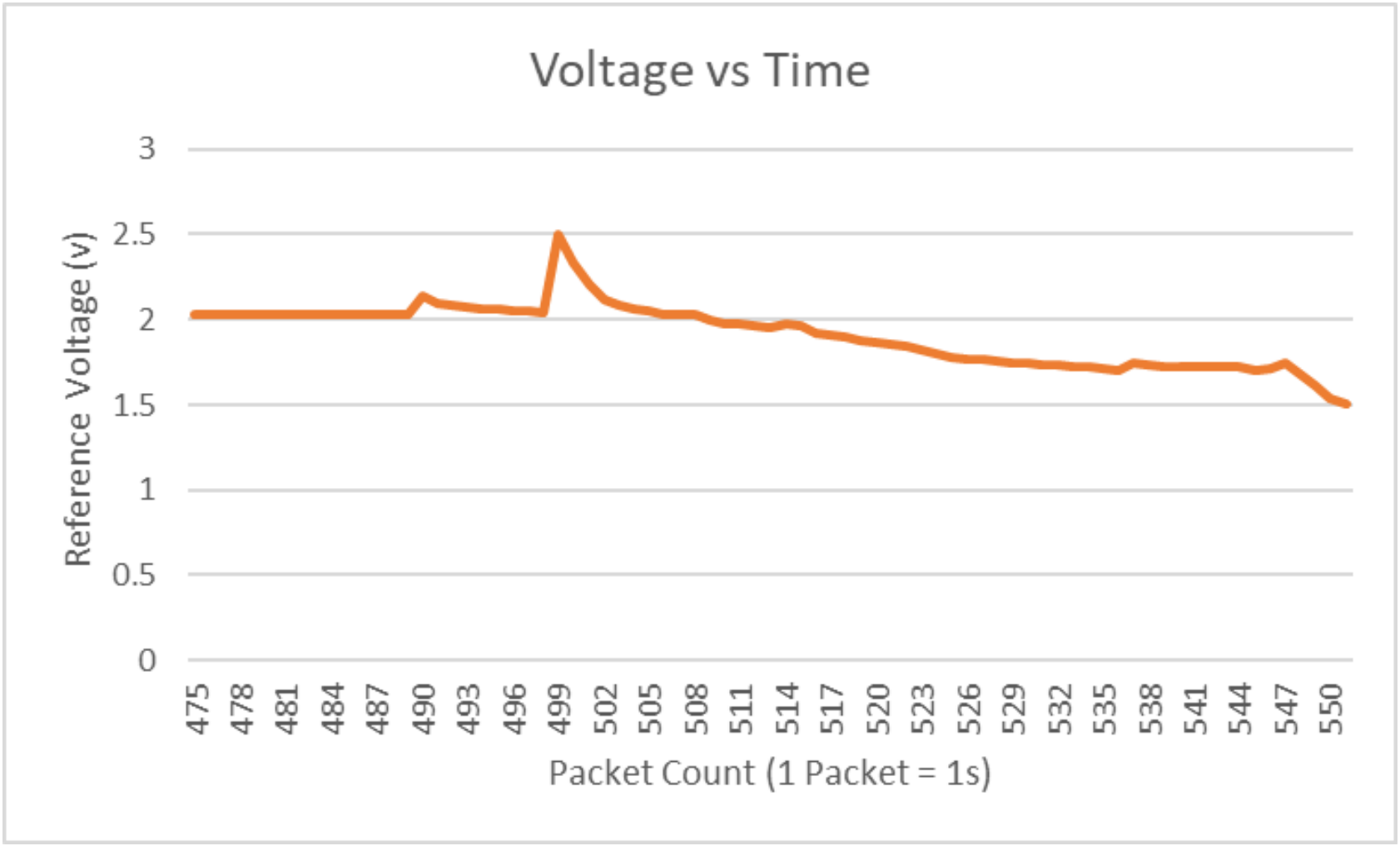
Flight Data Analysis (4/10)



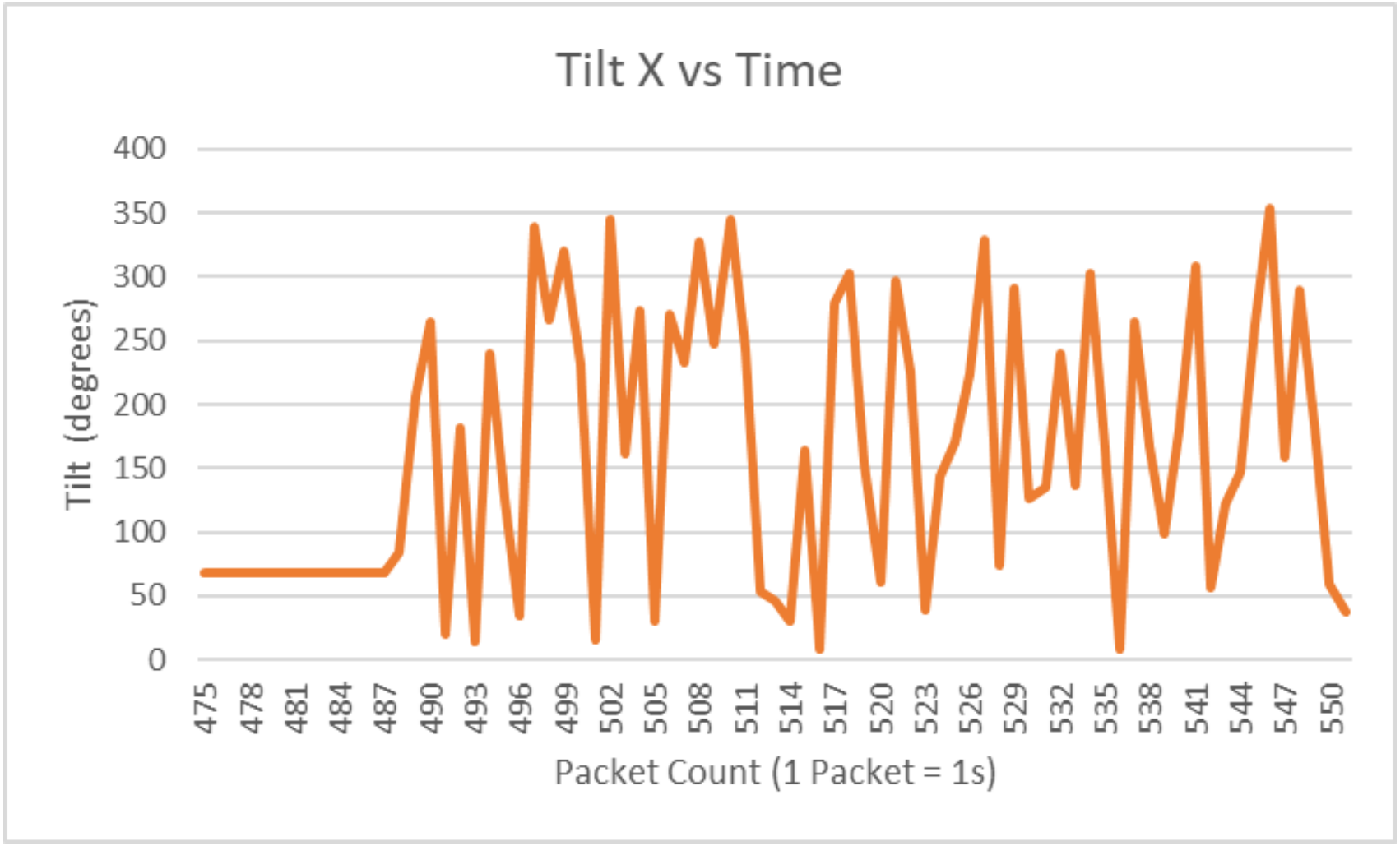
Flight Data Analysis (5/10)



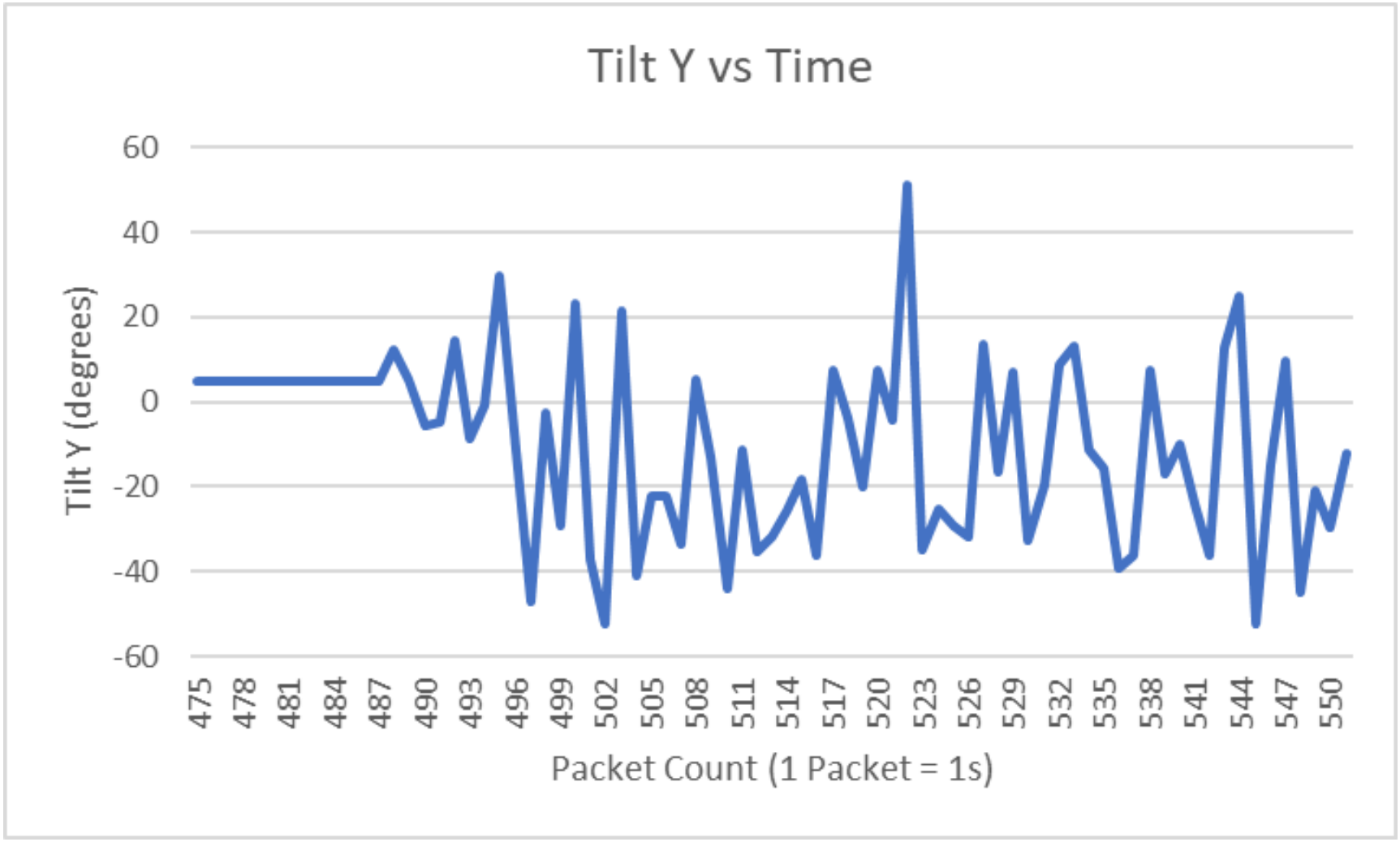
Flight Data Analysis (6/10)



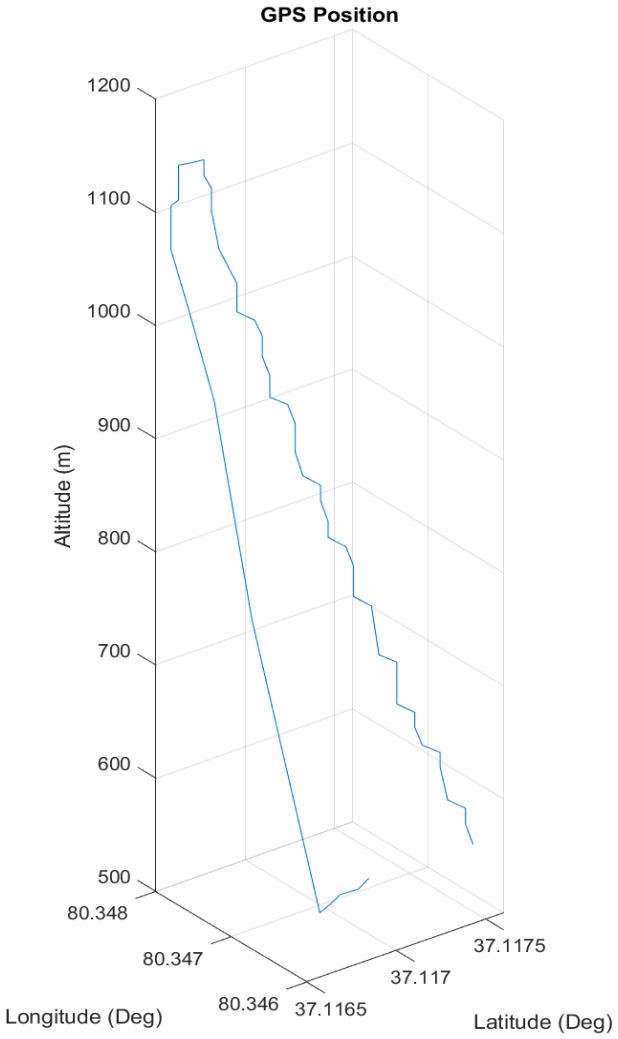
Flight Data Analysis (7/10)



Flight Data Analysis (8/10)



Flight Data Analysis (9/10)



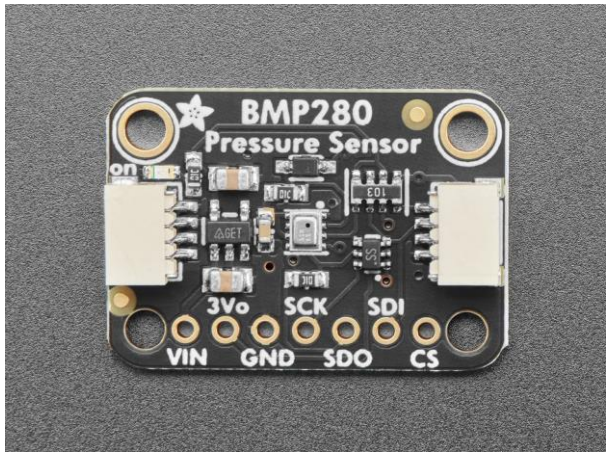
Flight Data Analysis (10/10)

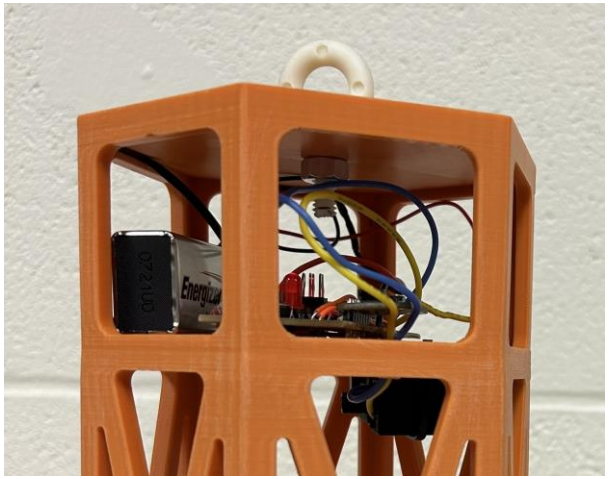
- **During flight the payload camera was activated as expected, but upon recovery, the video files were corrupted and unviewable.**

- **The bonus camera objective was not attempted.**

Failure Analysis (1/3)

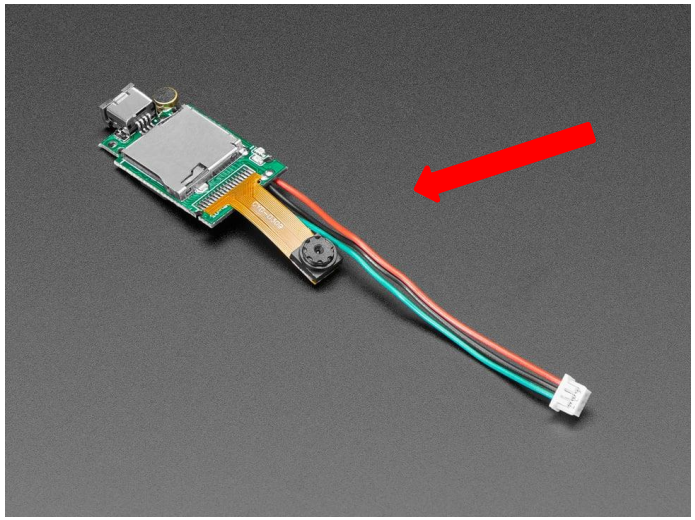
- **Separation failure:**
  - Failure: the payload did not separate from the container resulting in the entire CanSat impacting the ground at once.
  - Root Cause: The container's altitude value did not exceed 670m, the hardcoded threshold for apogee. As a result, the linear actuator was not retracted, and the payload was not released.
  - Corrective Actions: Calibrating the container at the launch pad instead of the tents, lowering the expected apogee below the given value, or not hardcoding a value at all.

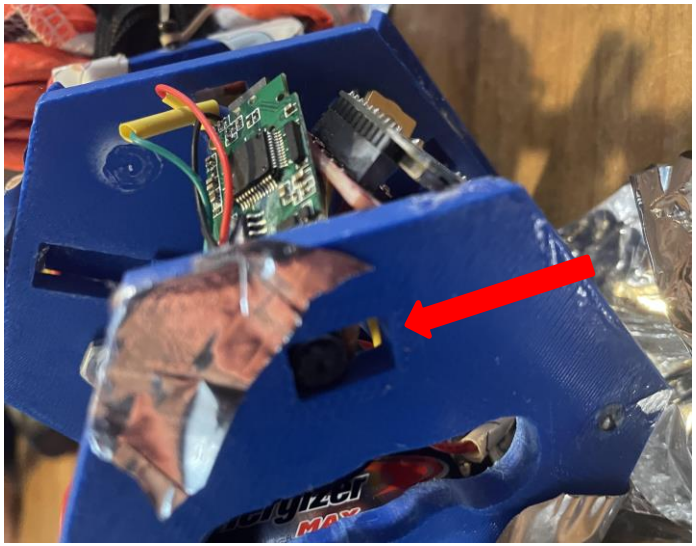




Failure Analysis (2/3)

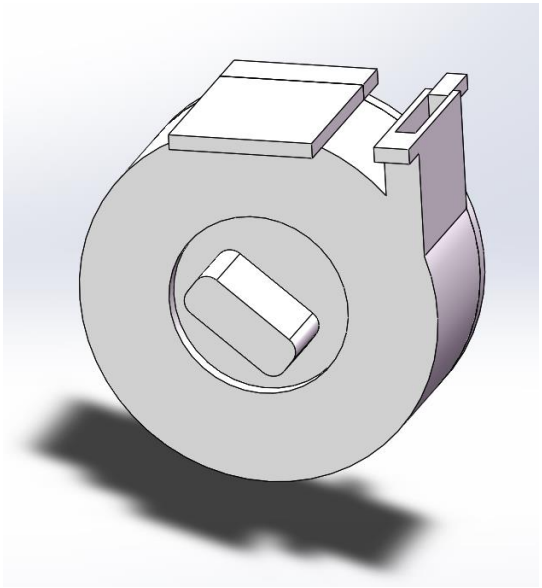
- **Camera failure:**
  - Failure: The payload camera was properly activated and deactivated as intended, however, the AVI (video) files it saved to the microSD card became corrupted.
  - Root Cause: Unknown, potentially excess heat in soldering, or the force from impact.
  - Corrective Actions: Begin component selection earlier to ensure reliability.





Failure Analysis (3/3)

- **Flag Mechanism failure:**
  - Failure: The flag mechanism was so heavy that it had to be removed from the payload to ensure it was within required weight.
  - Root Cause: The use of a clock spring and a tape measure made it significantly heavy.
  - Corrective Actions: Design a lighter mechanism.



Lessons Learned (1/2)

- **What worked:**
  - Accurate telemetry data received throughout flight
  - Canister parachute slowed descent within accepted range
  - Audio beacon activated upon landing
  - Payload parachute mechanism would have worked as intended
  - Canister, payload, and electronics were all mostly intact upon landing

- **What didn't:**
  - Flag mechanism not implemented due to complications and weight constraints
  - Video files saved to the microSD were corrupted
  - Container and payload failed to separate during flight

Lessons Learned (2/2)

- **Conclusions:**
  - Order parts sooner to protect against supply chain issues.
  - Proper time management, especially in the manufacturing process is critical
  - Code can be more effective if memory use is managed properly.
  - Overall, we think we did well for our first attempt at competition!