CanSat 2022
Post – Flight Review (PFR)
Outline
Version 2.0

Team Descendere #1022

Presentation Outline

Team Organization

Team Leader
Kittipon Amornprasertkij

Faculty Advisor
Joshua Staubs, Ph.D.

Mechanics [Descent Control Design, Mechanical Subsystem]
- **Leader** Nuchit Vichitkijja
  - Kittipon Amornprasertkij

Programming [Communication & Data, Flight Software Design, Ground Control Subsystem]
- **Leader** Krissada Singhakachain
  - Thasvarit Krueklai
  - Arkkhanirut Pandej

Electronics [Sensor Subsystem, Electrical Power System]
- **Leader** Suvijak Piyanopharoj
  - Pitiphoom Achapramote
  - Krin Kaweewongsonthorn
  - Shinakrit Laokittichai

Mission Objective

- The CanSat contains 2 parachutes. first parachute will change the descent rate to 15 meters per second, the second parachute will be inflated at an altitude of 400 meters and change the descent rate to 5 meters per second.

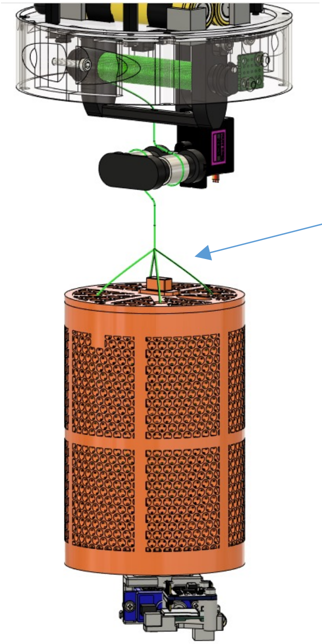
The second parachute
(simply placed on top of the container)

The first parachute
(store under the upper lid of the container)

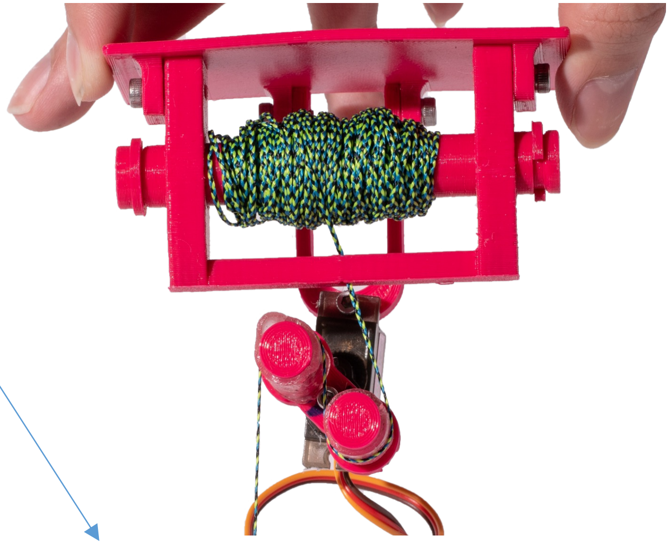
Mission Summary

- The CanSat is made up of the container and the payload, with the 10 meters tether, will be deployed at 300 meters

10 meters tether



3D CAD showing the payload deployment



Brake Mechanism

Used to control the payload deployment

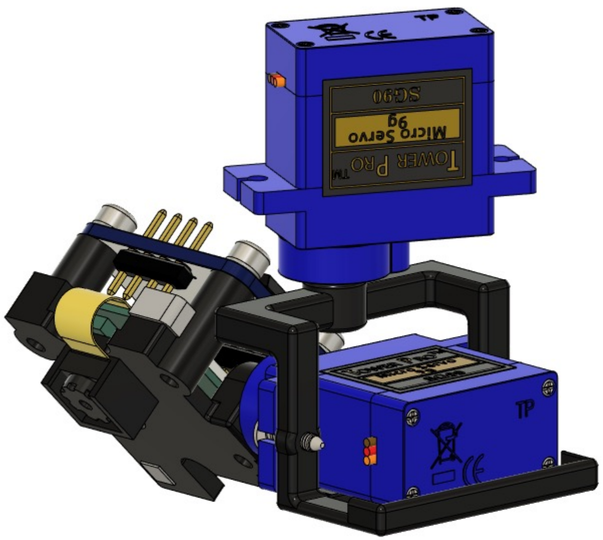
Mission Summary

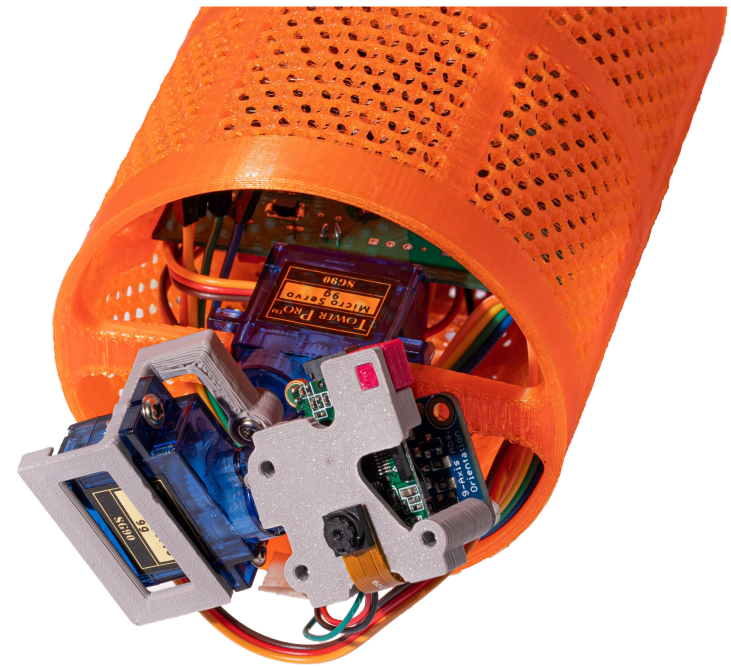
- The telemetry is received after the CanSat has already been turned on.

GCS after the CanSat has turned on.

Mission Summary

- The payload shall maintain the orientation of a video camera pointing in the south direction with a point of 45 degrees downward.





Camera Gimbal used to control
the direction of the video camera.

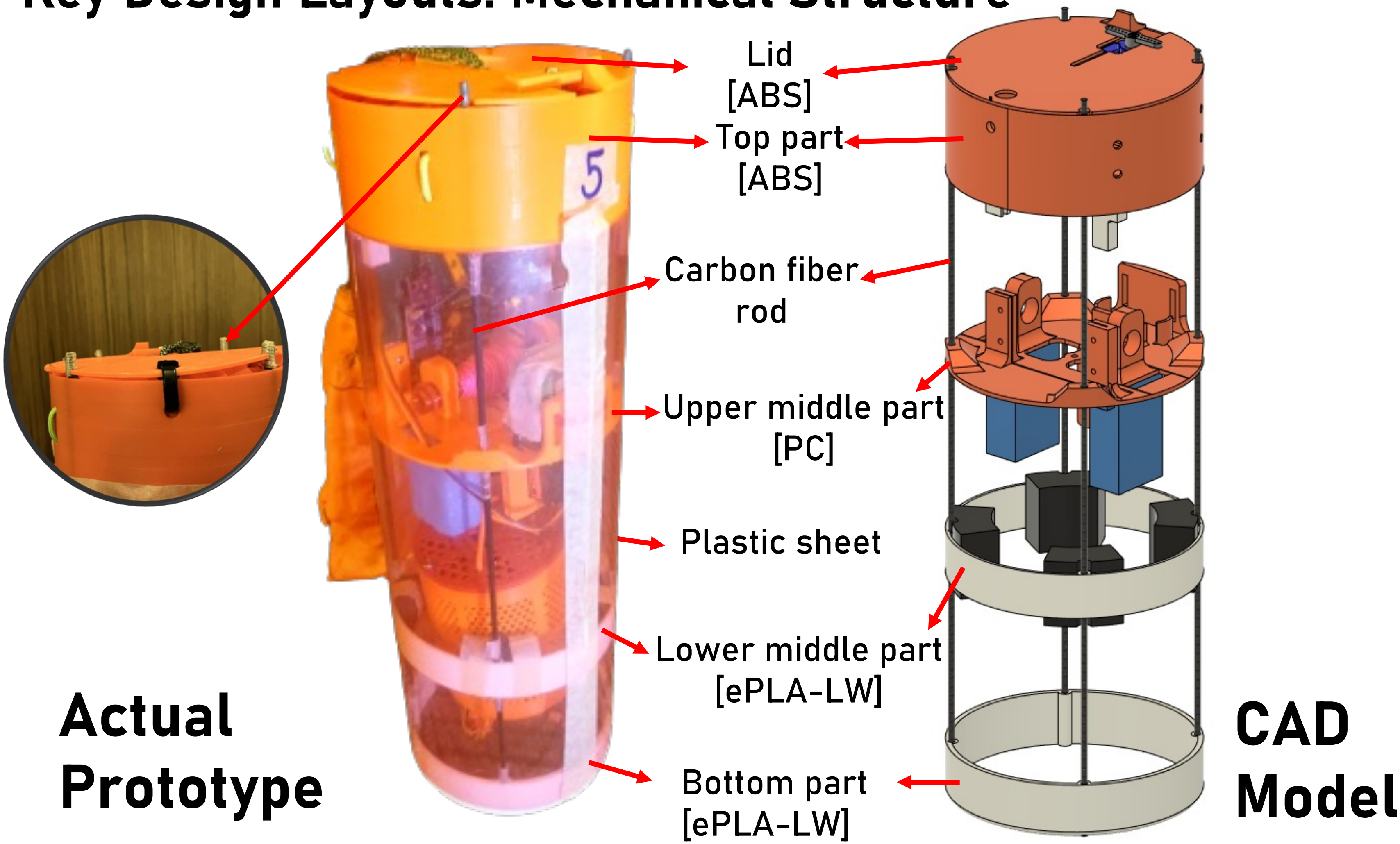
Bonus Objective

- The container shall contain a video camera to record the deployment of the payload.

Bonus Camera

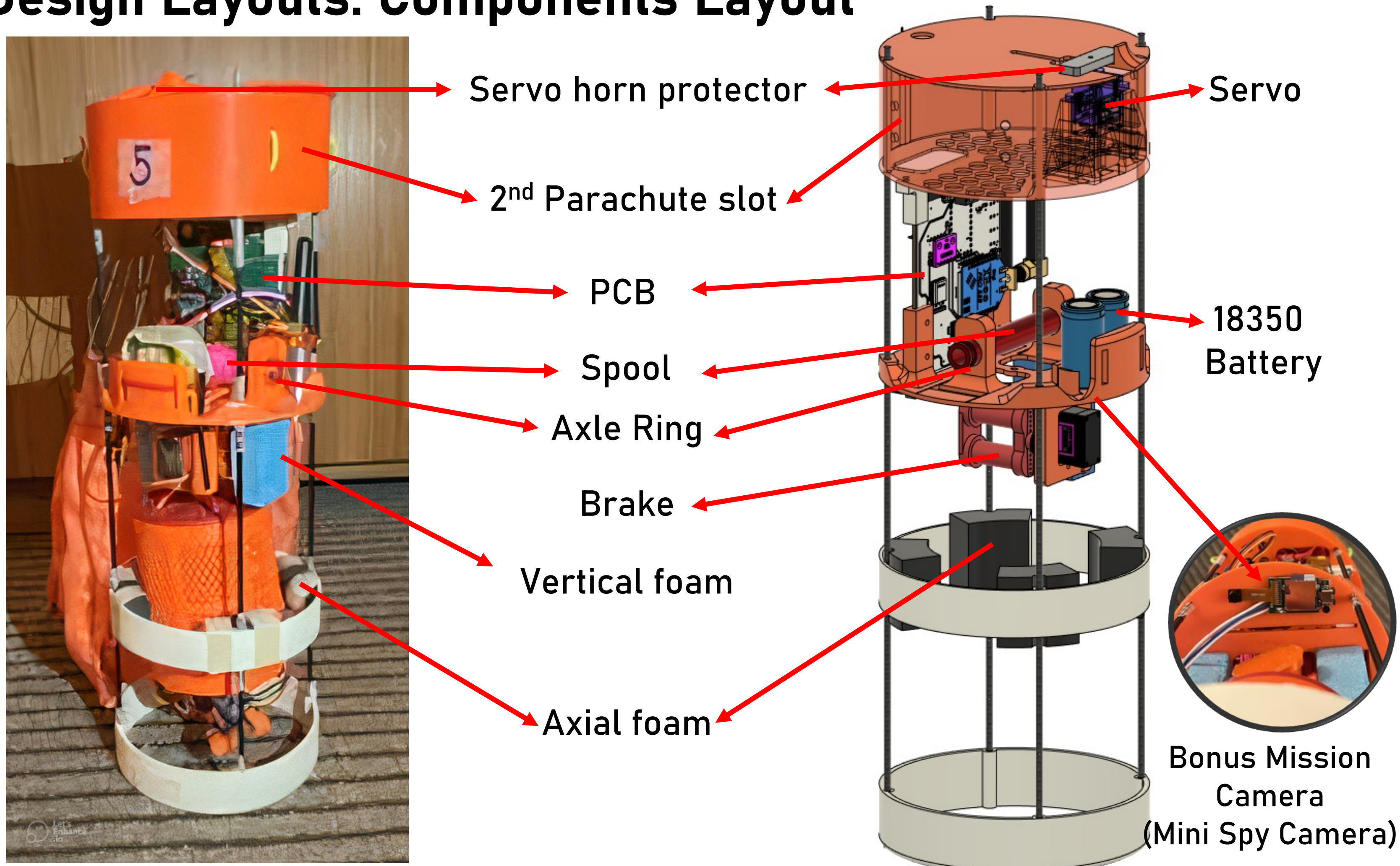
System Overview

Key Design Layouts: Mechanical Structure

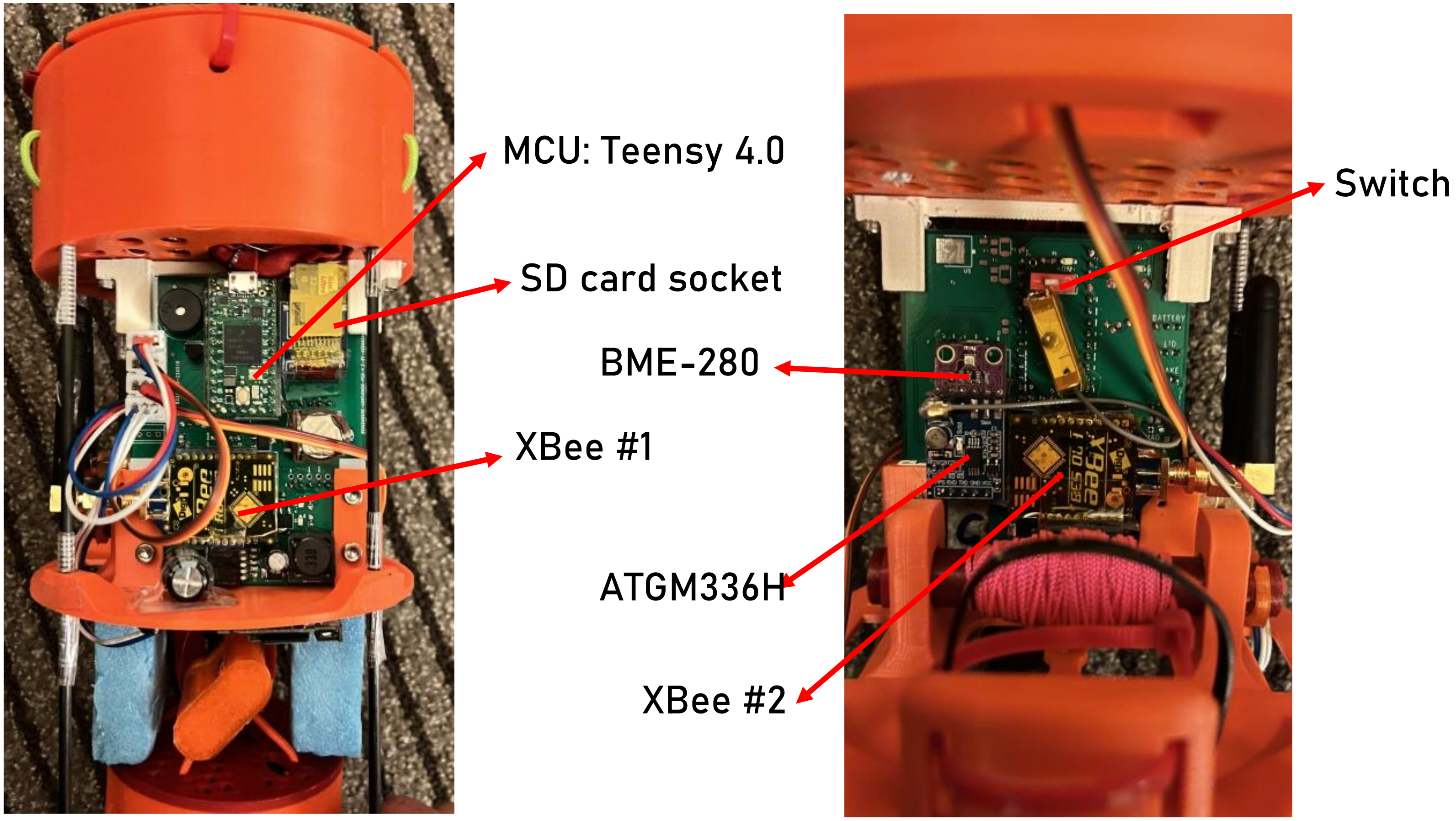


Container Design Description

Key Design Layouts: Components Layout



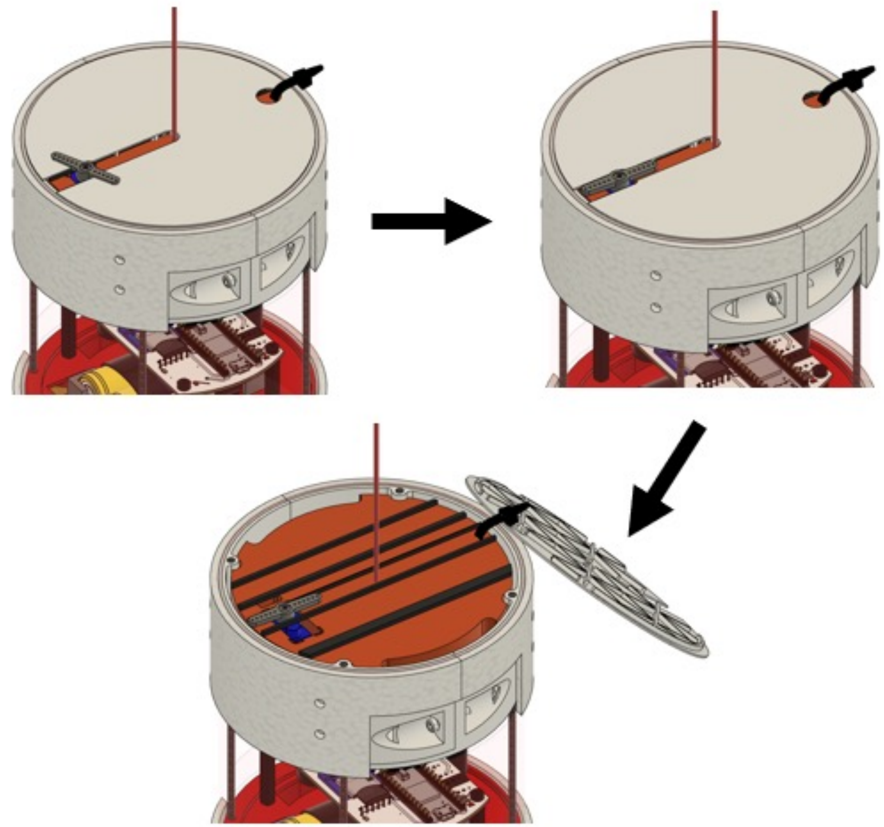
Key Design Layouts: Components Layout



Key Design Layouts: Descent Control

1st Stage

2nd Stage



Detailed view on parachute deploy system

Key Design Layouts: Tethered payload deployment

- The brake is split into two phases
  Release and *Brake*

Release – Once the payload transitions from a stowed configuration to deployed configuration, the brake will tilt and fully let go of the tether, causing the payload to free fall for 2 meters.

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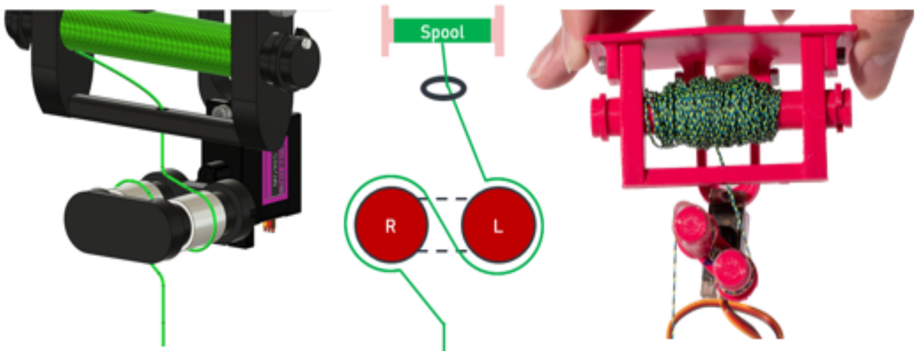
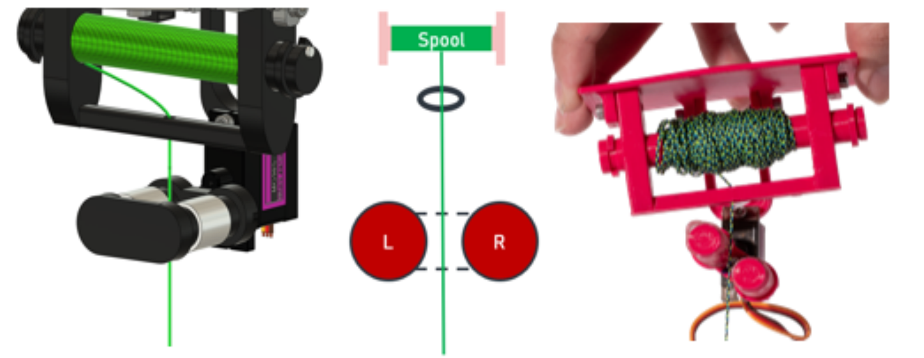


CAD | 2D Graphic | Prototype

Brake – The brake will tilt back to restrict the tether and gently stall the payload into the stationary position.

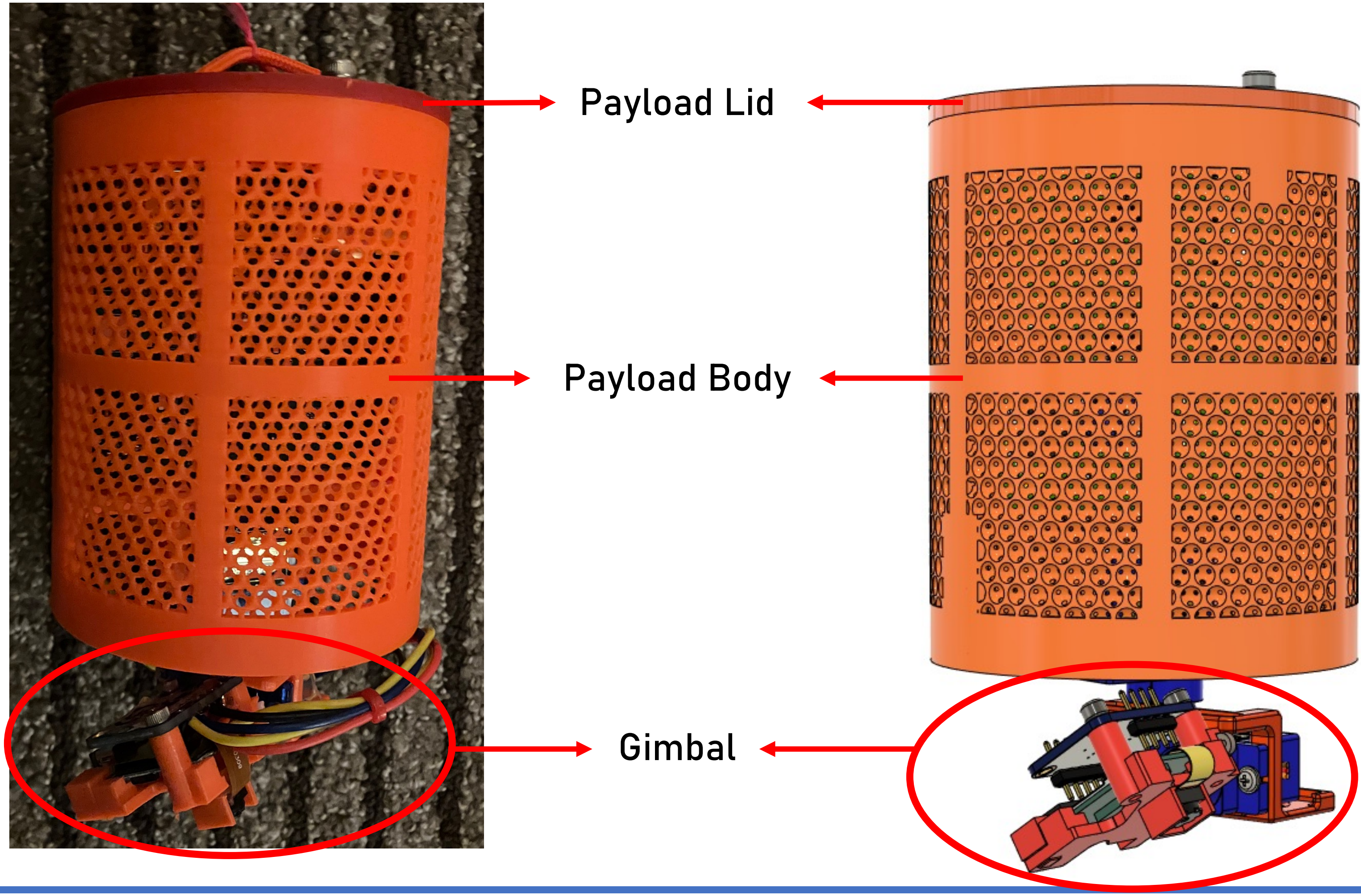


These two steps will be repeated until the payload is fully deployed.

Container Design Description

Key Design Layouts: Tethered payload deployment

Key Design Layouts: Mechanical Structure



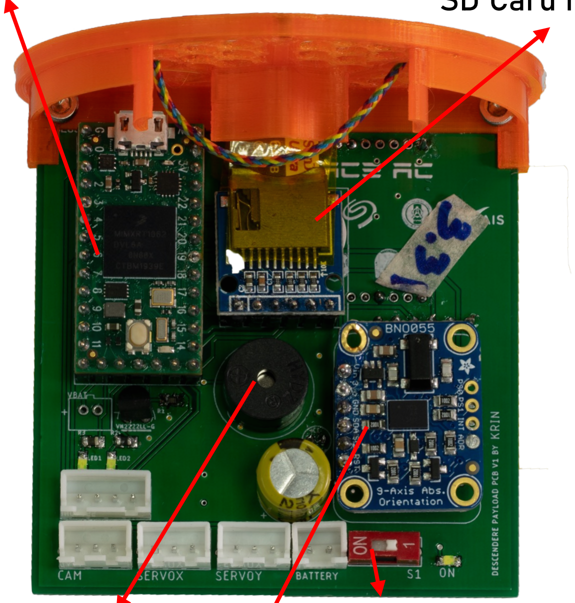
Key Design Layouts: Components Layout

PCB is bolted to the lid

Front side

MCU *[Teensy 4.0]*

SD Card reader



Buzzer

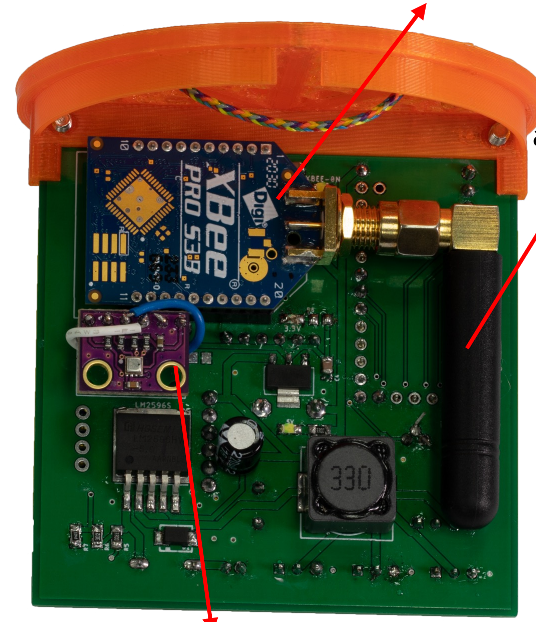
Switch

Rotation sensor
[BNO-055]

Back side

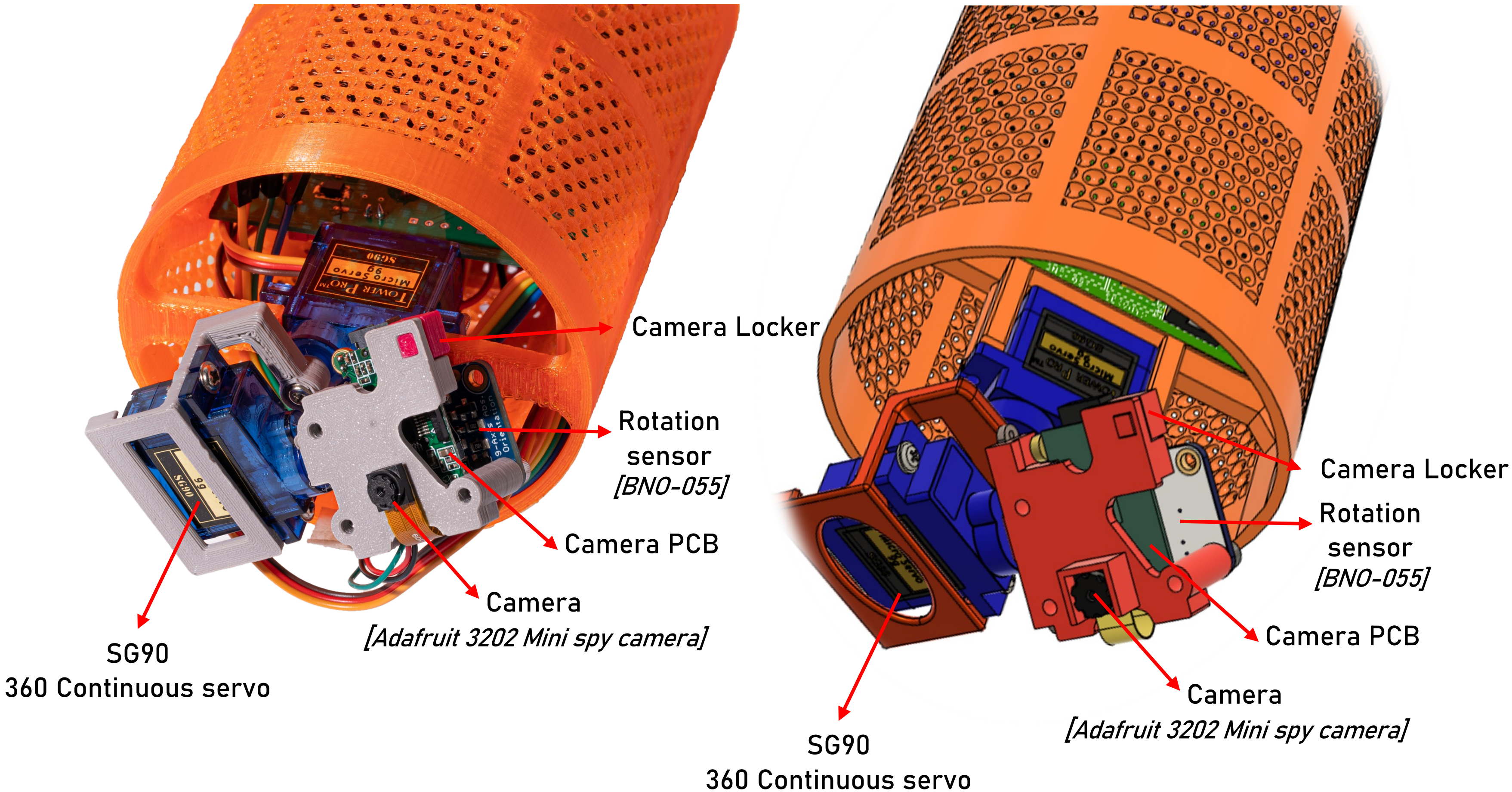
XBee 900 MHz

Duck antenna



Air pressure & temperature sensor
[BME-280]

Key Design Layouts: Camera Gimbal



Concept of Operations and Sequence of Events

Planned and Actual CONOPs

Mission Timeline	Planned	Actual
Pre-Launch	Team Briefing	✓
	Set-up GCS, Operations Check	✓
	CanSat Final Checking	✓
	Load CanSat into the Rocket	✓
	CanSat begins collecting telemetry data	✓

Planned and Actual CONOPs

Mission Timeline	Planned	Actual
Launch	CanSat is launched in the atmosphere	✓
	CanSat continues to receive telemetry data	✓
Rocket Seperation	CanSat is ejected from the rocket around 670 – 725m	✓
	CanSat parachute is deployed	✓

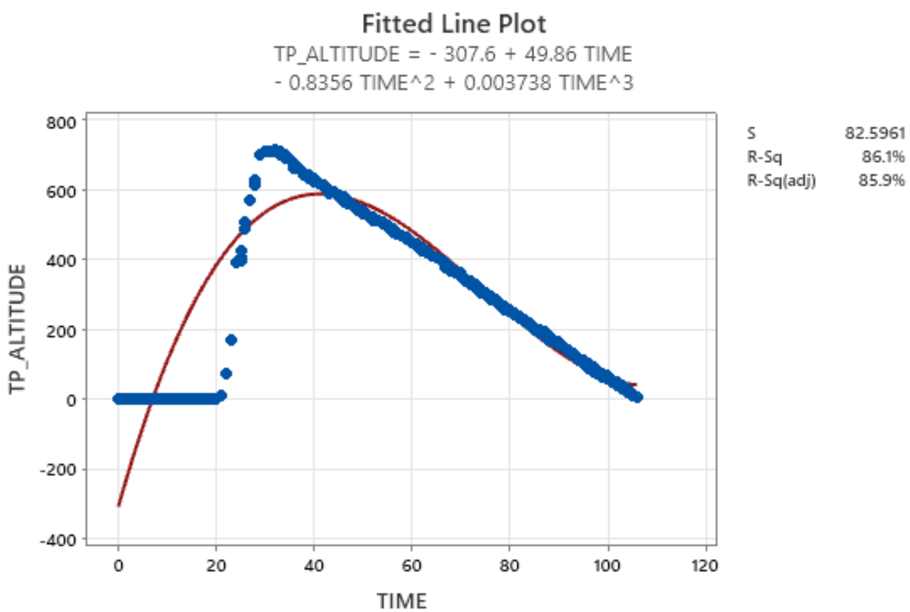
Planned and Actual CONOPs

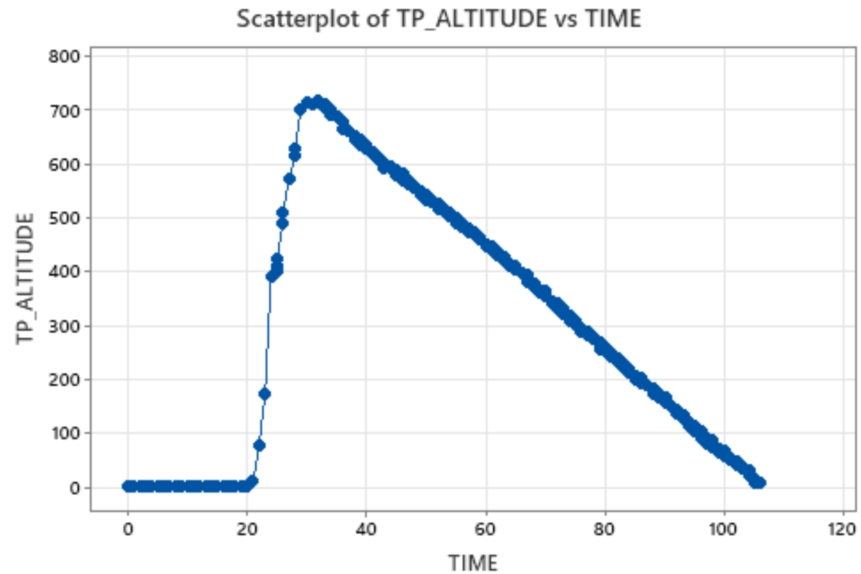
Mission Timeline	Planned	Actual
Second Parachute Deployment	At 400 m, the second parachute deployed	✗
Payload Deployment	At 300 m, the tethered payload started to release.	✗
	The 10 m distance of the tether is deployed in 20 seconds.	✓
Landing	Landing	✓

Flight Data Analysis

Presenter

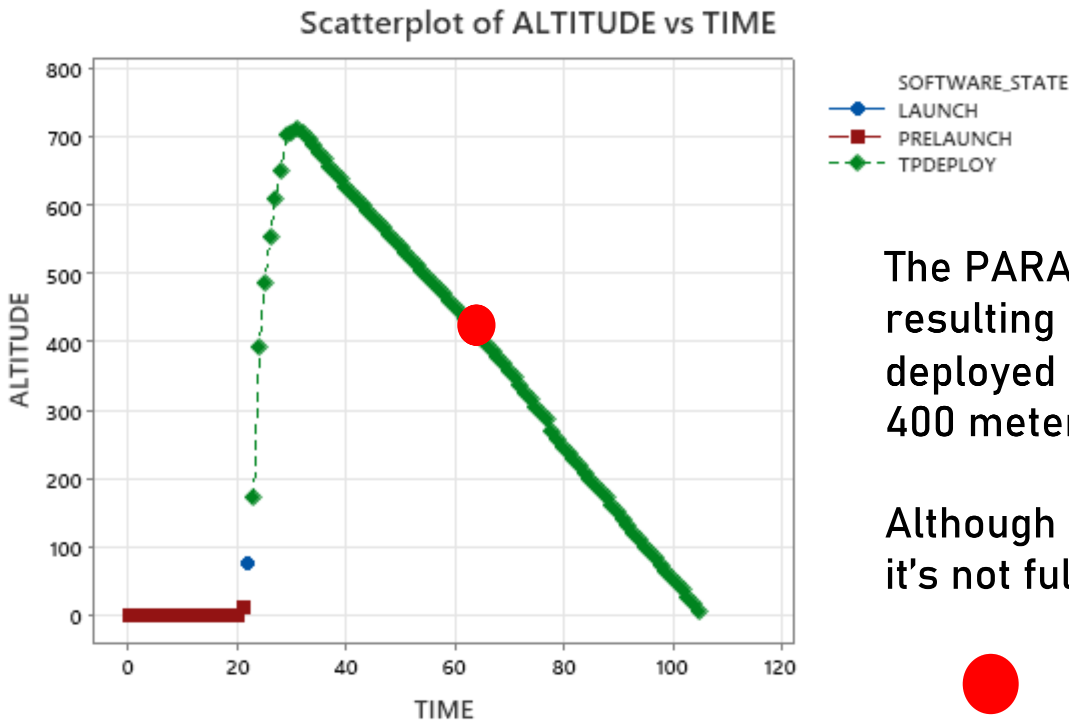
Payload Altitude Plot





The Rocket launch has reached the altitude if 675 – 720 as expected, the fitted line graph has been calculated with the R – Sqare value of 86.1%

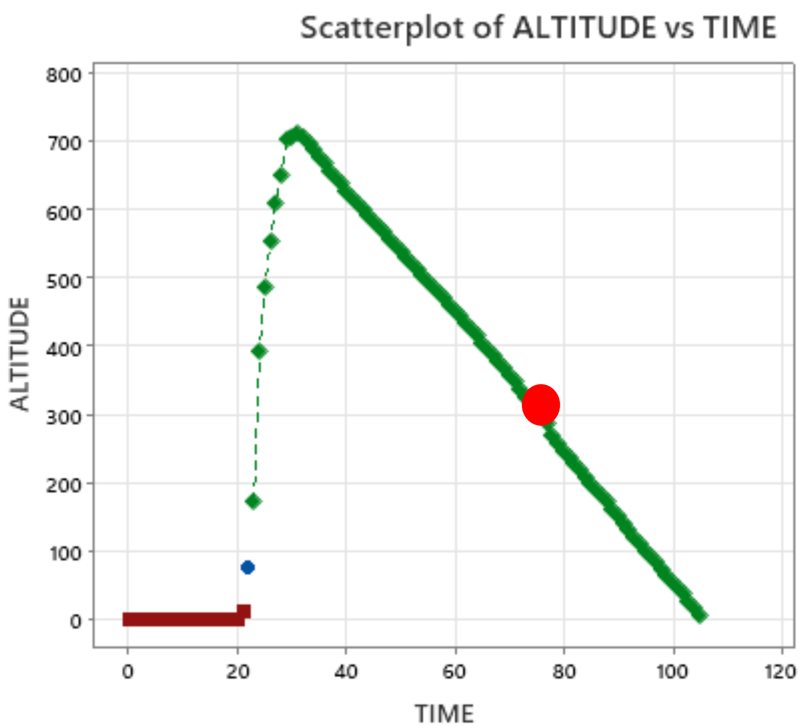
Second Parachute Deployment



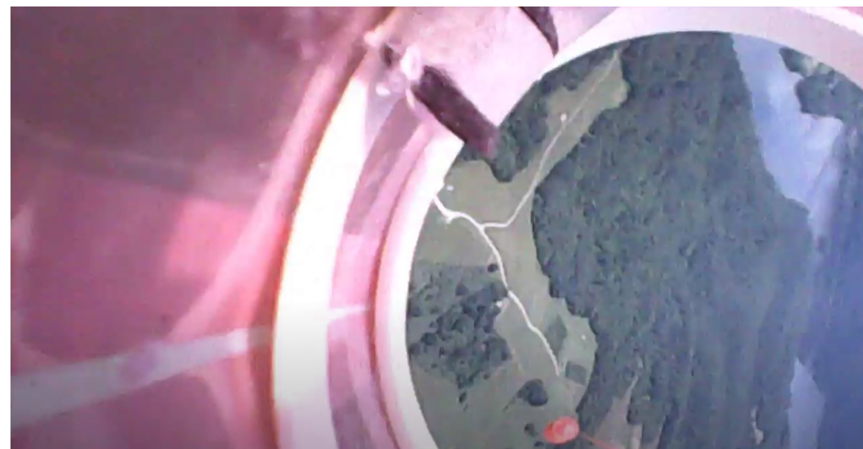
The PARADEPLOY state is triggered early, resulting in the second parachute being deployed before the CanSat descends to 400 meters.

Although the second parachute is deployed, it's not fully inflated during descent.

● 400 meters altitude



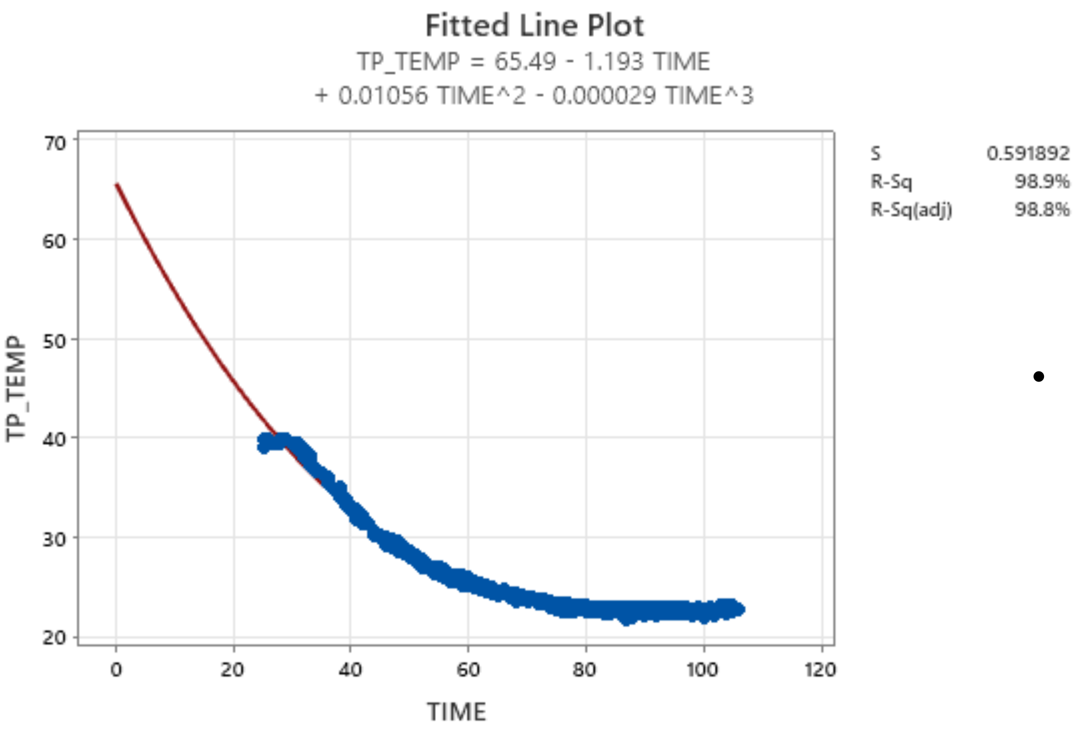
● 300 meters altitude



Despite early deployment triggered by the software, the payload is deployed from the container.

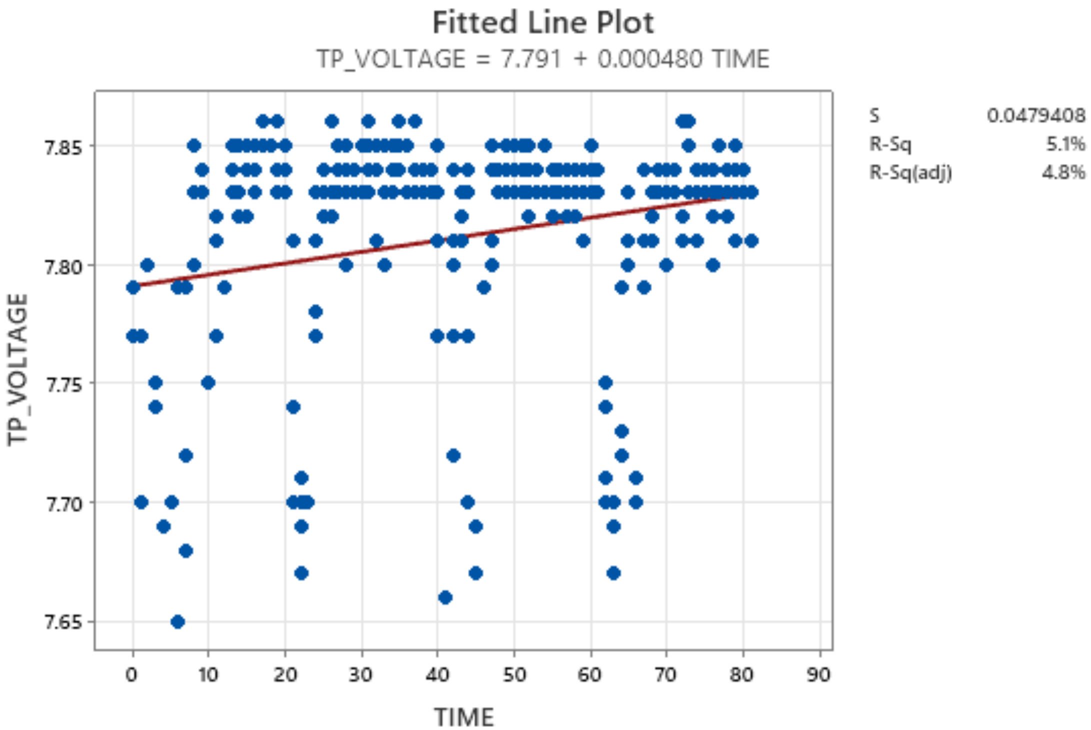
Payload Temperature Plot

Difference between the estimated and real data plot

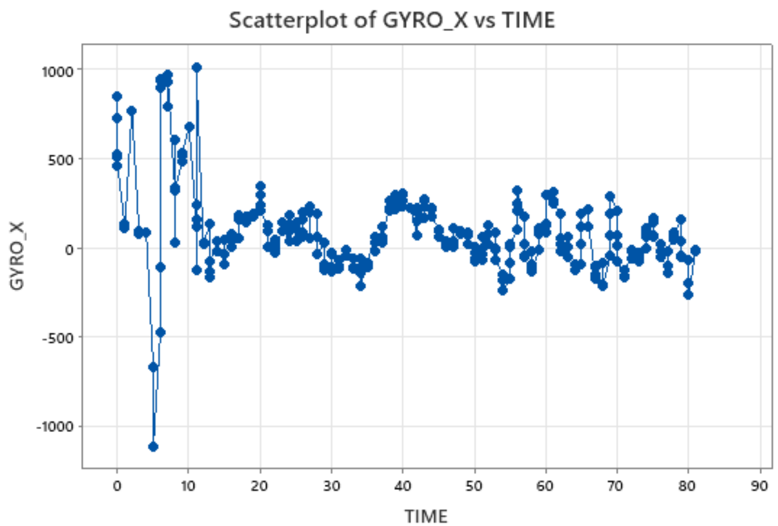


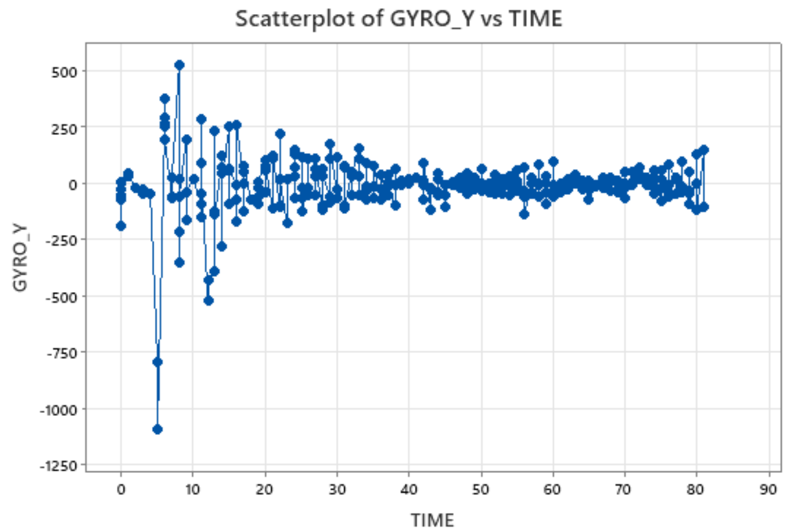
- The temperature is higher when the payload is placed in the rocket, and then lower when the payload has already been ejected out of the rocket.

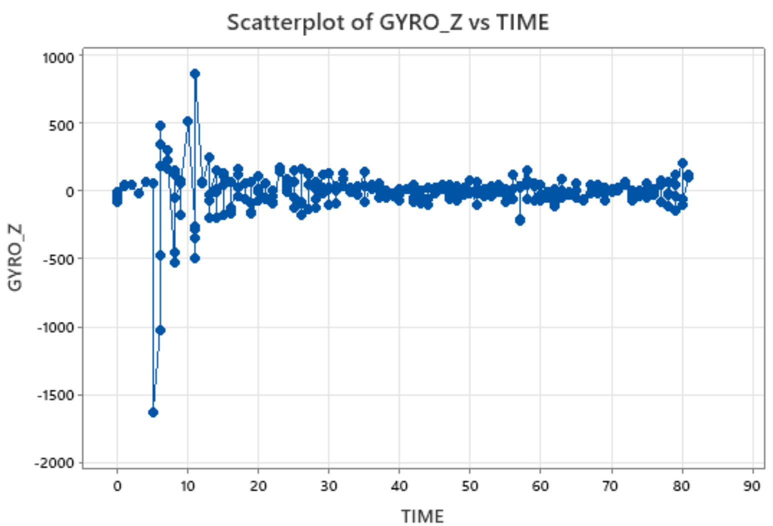
Payload Battery Voltage Plot



Tilt Sensor Plot

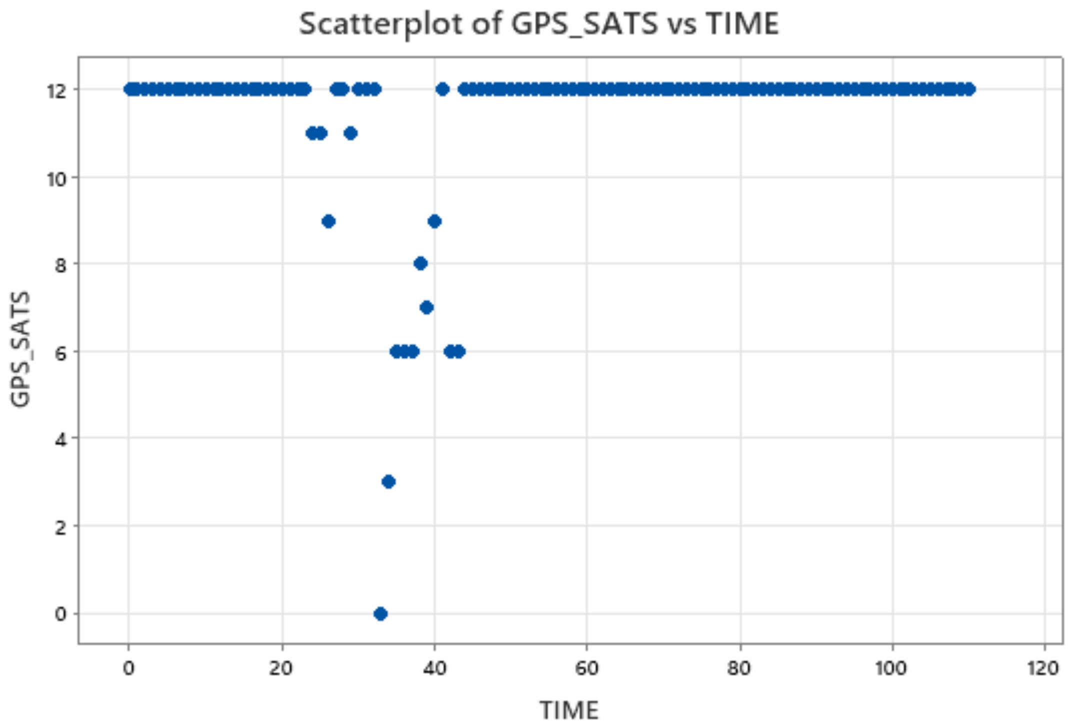






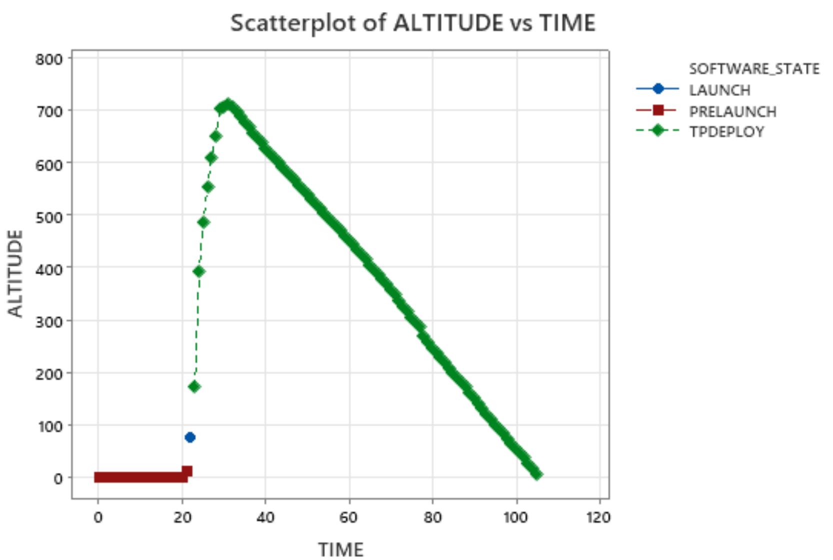
The Number of Satellites used in GPS

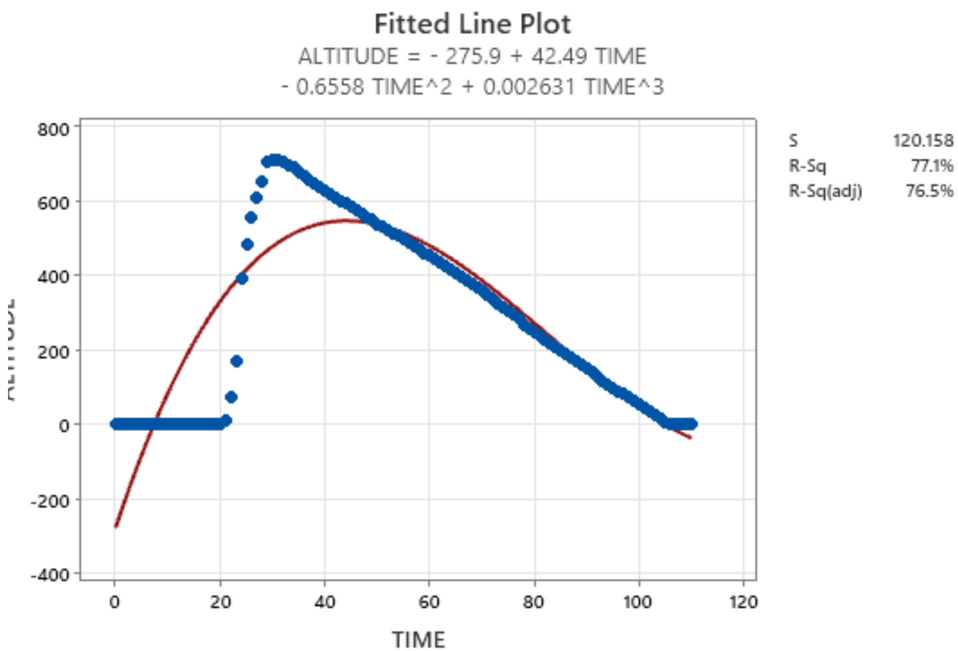
Variable	N	N*	Mean	SE Mean	StDev	Minimum	Q1	Median	Q3	Maximum
GPS_SATS	111	0	11.378	0.186	1.964	0.000	12.000	12.000	12.000	12.000



- From the descriptive statistics analysis, the mean of the number of satellites used in GPS is 11.378, which is more than 4, making the GPS data reliable.

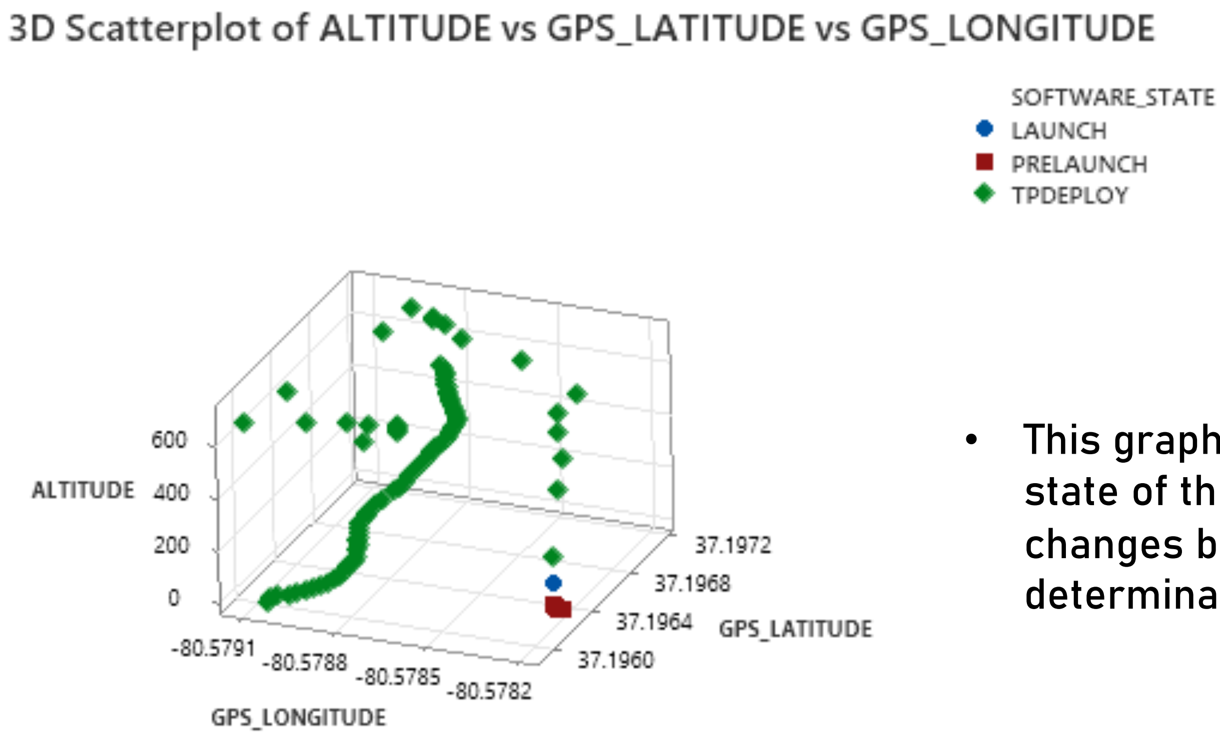
Container Altitude Plot





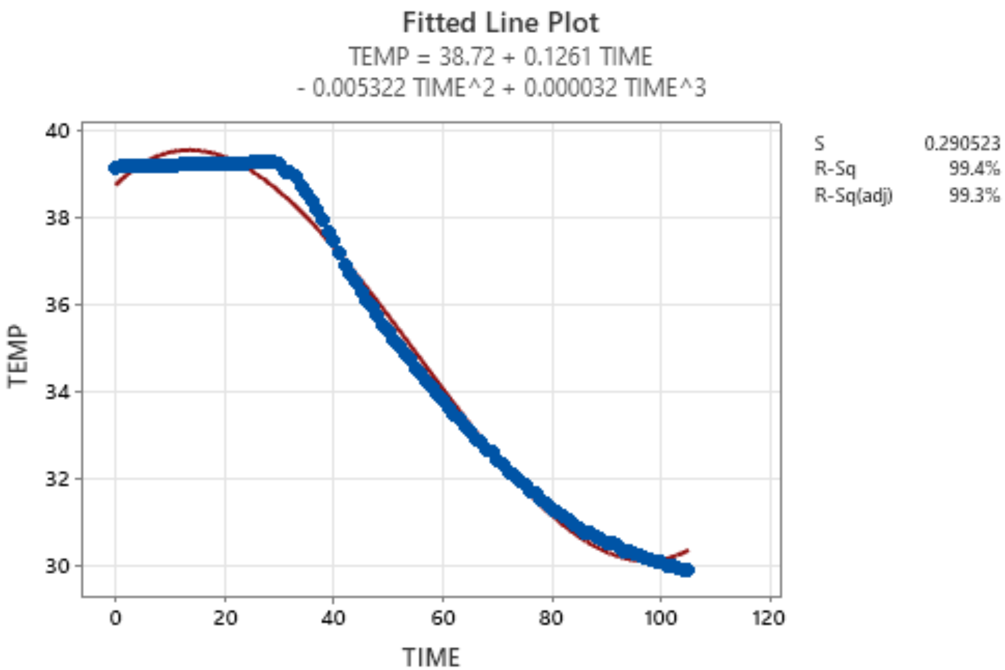
With the R – Square Value of 77.1% the container altitude plot can be predicted with the cubic equation.

Container GPS Position Plot



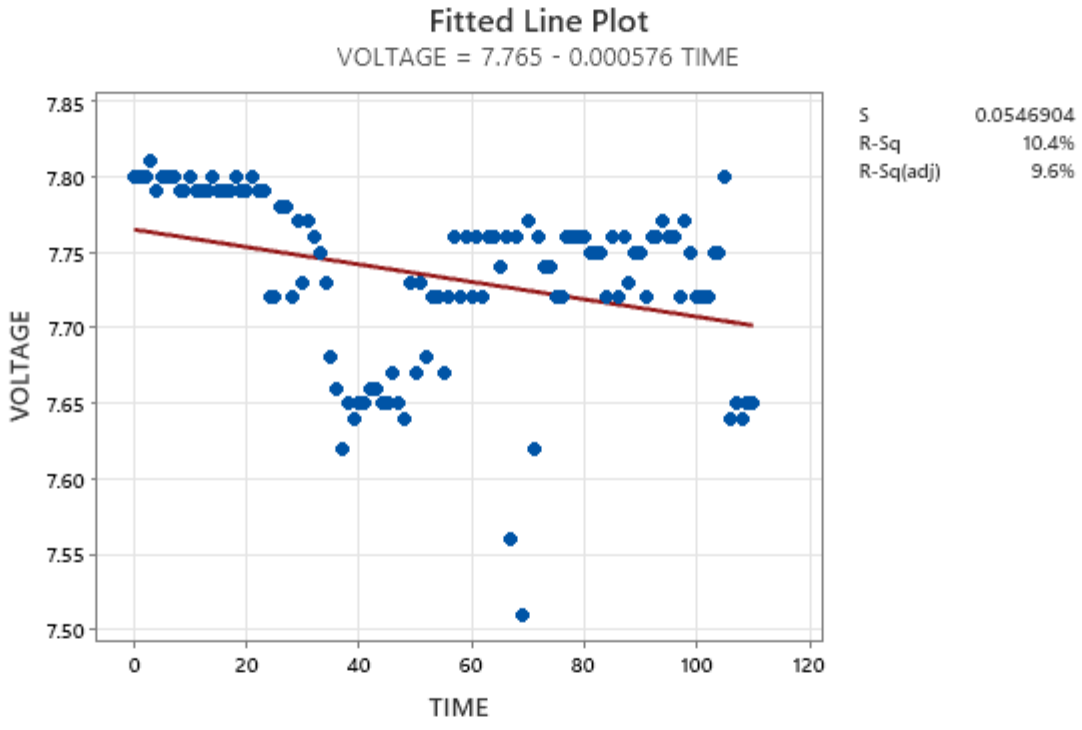
- This graph shows that the state of the operation changes before the determinated altitude.

Container Temperature Plot



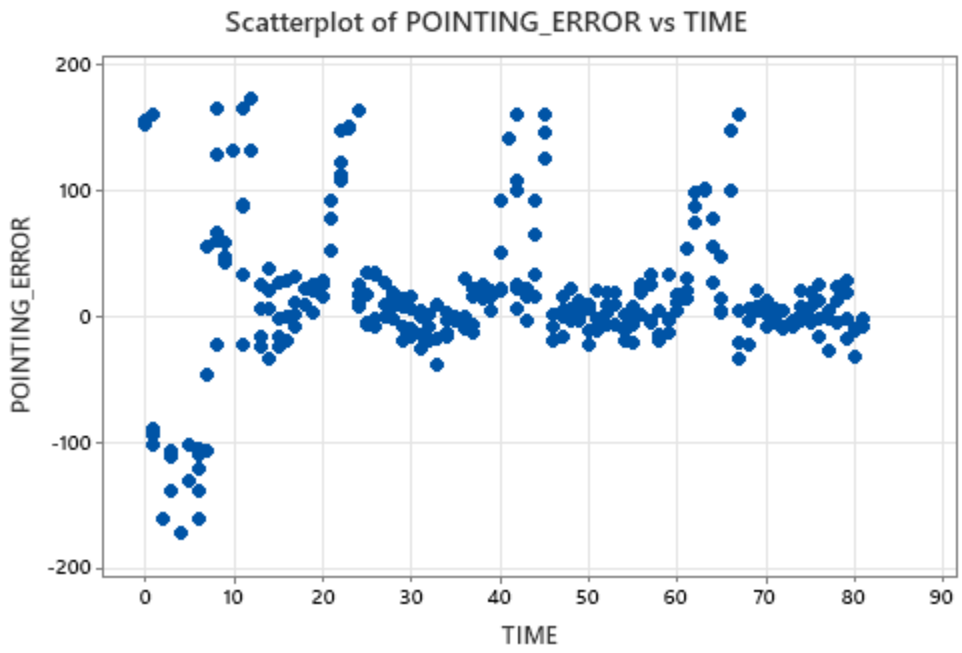
- When the payload is loaded in the rocket, the temperature is higher, and when the payload is propelled out of the rocket, the temperature is lower.

Container Battery Voltage Plot



Payload Camera Video

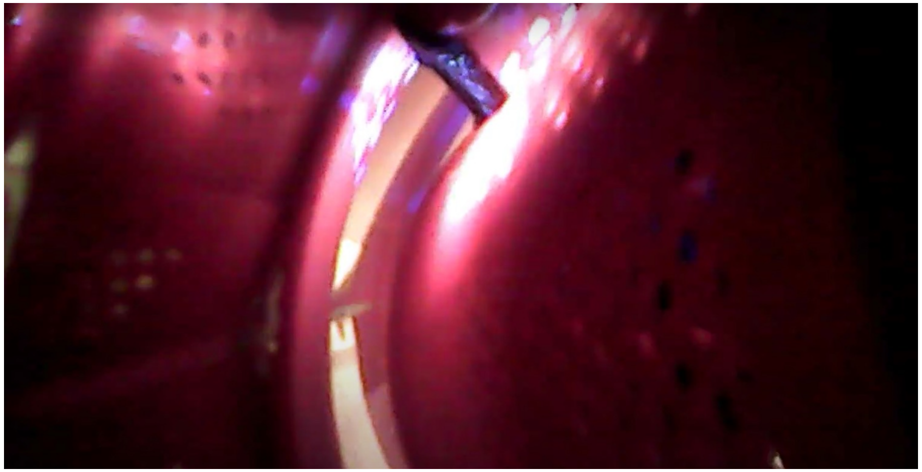
Variable	N	N*	Mean	SE Mean	StDev	Minimum	Q1	Median	Q3	Maximum
POINTING_ERROR	297	0	16.14	3.38	58.30	-172.67	-7.44	5.72	26.52	173.09



- From the descriptive statistics analysis the mean of the pointing error of the bonus camera is equal to 16.14 which is lower than 20 degree.

Payload Camera Video

Bonus Camera Video



Bonus Camera Video

Failure Analysis

Failures: 2nd Parachute wasn't fully inflated

Because of the parachute lines entanglement, the CanSat descent rate does not correspond to the calculation.

Root Cause: The second parachute was deployed when it was still in the rocket because of altitude jump in the program. CanSat with the second parachute which was still in the horizontal position was rotating around itself, causing the parachute lines to be entangled.

Parachute lines after recovery

```
17:37:50,28,66.45,581.65,39.21
17:37:50,28,76.67,591.87,39.21
17:37:50,29,95.49,610.69,39.21
17:37:50,29,120.61,635.82,39.20
17:37:50,29,346.15,861.35,39.21
17:37:50,29,172.43,687.63,39.21
17:37:51,29,171.36,686.56,39.20
17:37:51,29,184.40,699.61,39.20
```

Altitude error

CanSat after the ejection

Failure Analysis

Failures: 2nd Parachute wasn't fully inflated

Corrective action: The system that detect apogee if the CanSat falls below 20 meters from its peak altitude is triggered which caused this early state change. This system was put in place to prevent entire mission failure in case the rocket doesn't reach the expected altitude. However, after analyzing altitude captured from the actual launch, **an absence of this system would prevent the early state change**.

Failures: Tethered payload deployed before determined altitude

Root Cause: Because of the altitude jump in the program.

Corrective Action: The system that detect apogee if the CanSat falls below 20 meters from its peak altitude is triggered which caused this early state change. This system was put in place to prevent entire mission failure in case the rocket doesn't reach the expected altitude. However, after analyzing altitude captured from the actual launch, **an absence of this system would prevent the early state change**.

CanSat after the ejection

Lesson Learned

Presenter

What Worked

- The GCS crew was able to capture a picture of the ground upon request.
- Recovery crew was able to locate the rocket body, container with GPS coordinates.
- The brake system can deploy the tether payload to the distance of 10 meters in 20 seconds
- Camera gimbal was able to pointing 45 degrees downward towards the south direction
- The parachute deployment system was able to deploy the second parachute.

What didn’t work

- For passive stability control, a hexagonal closed packed doesn’t provide stability to the design as much as we expected.

Conclusion