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

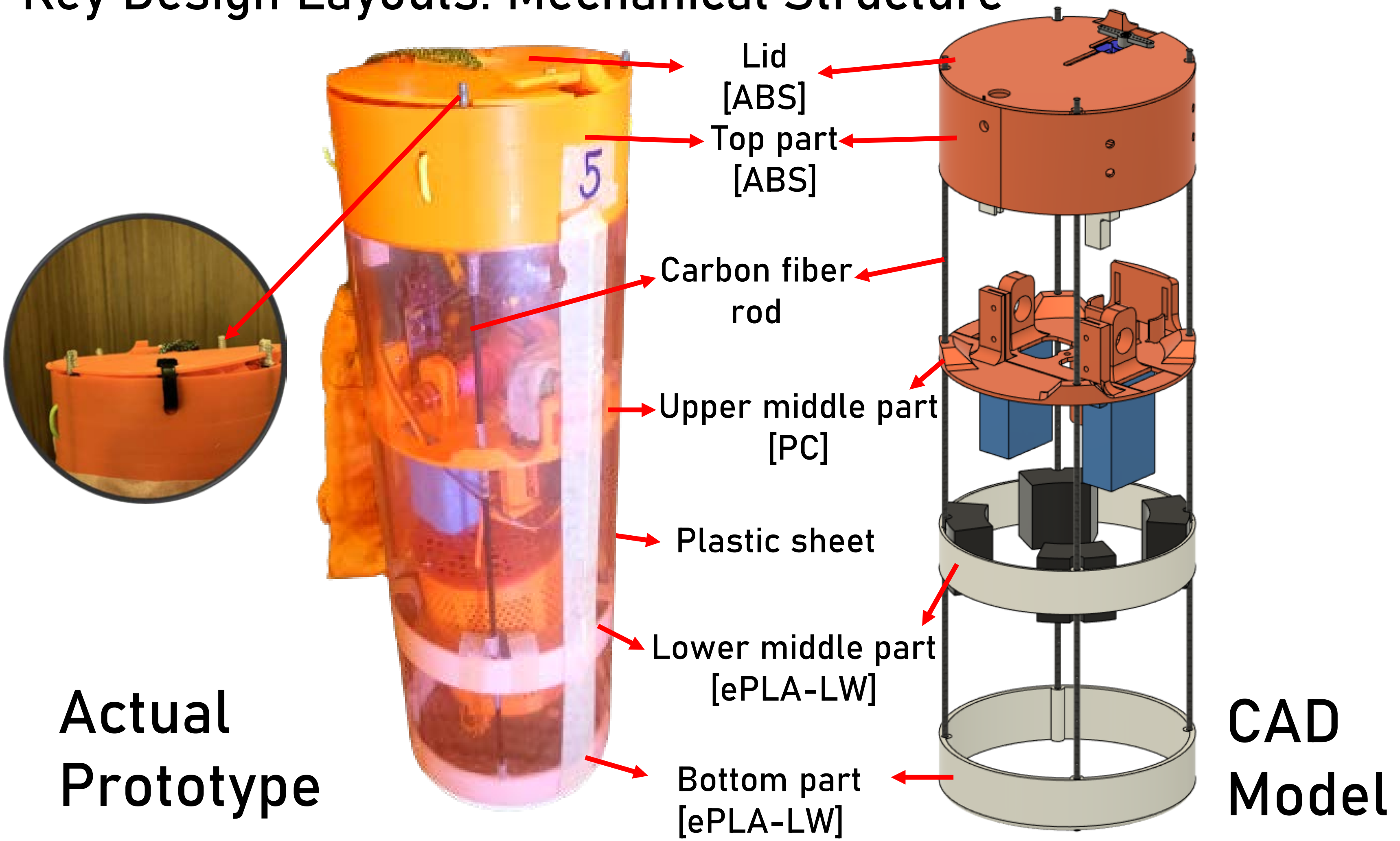
Team Descendere #1022

Presentation Outline

System Overview

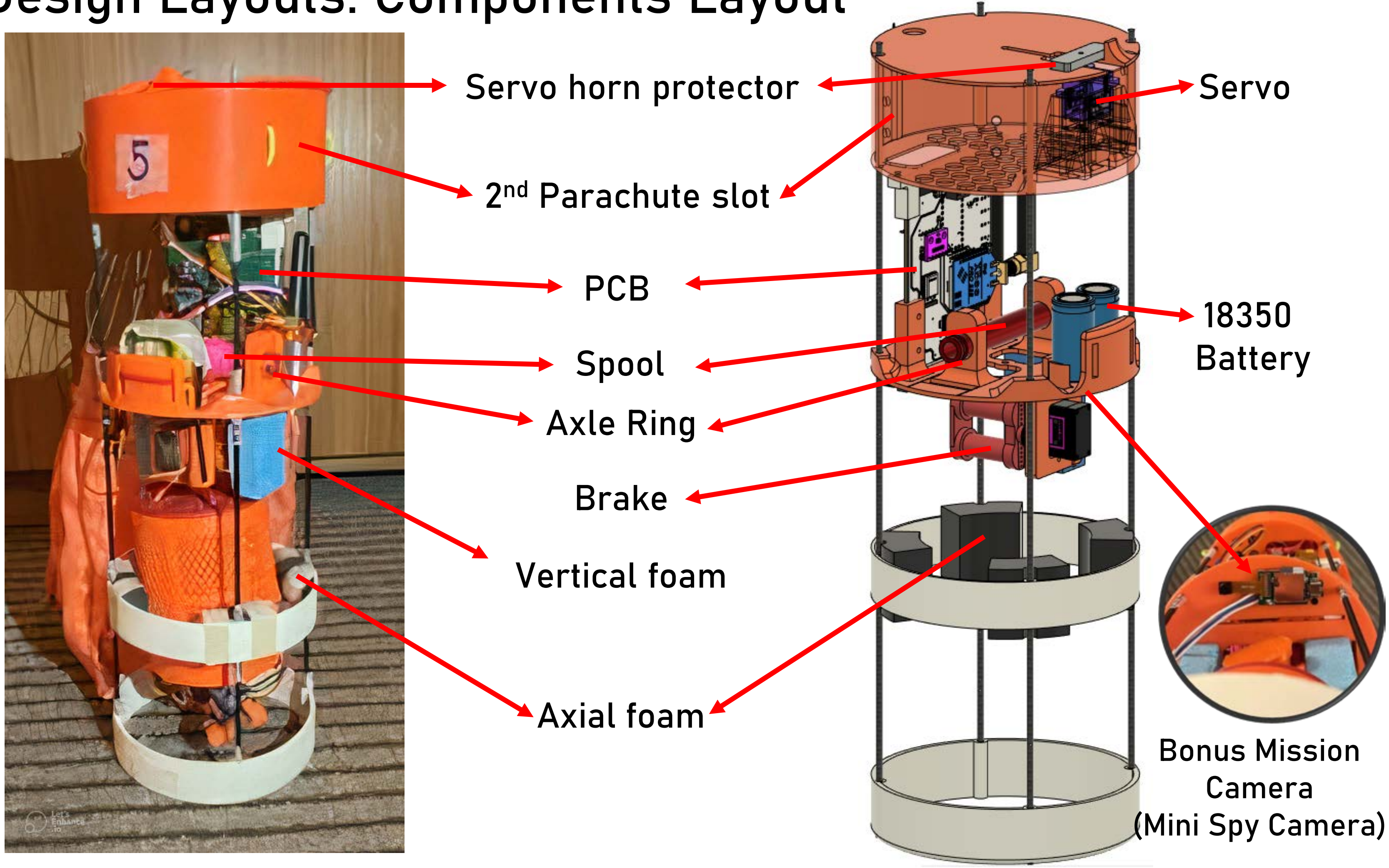
Container Design Description

Key Design Layouts: Mechanical Structure



Container Design Description

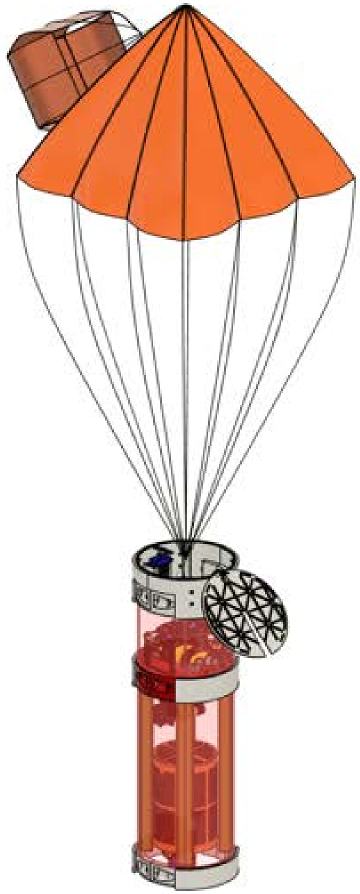
Key Design Layouts: Components Layout



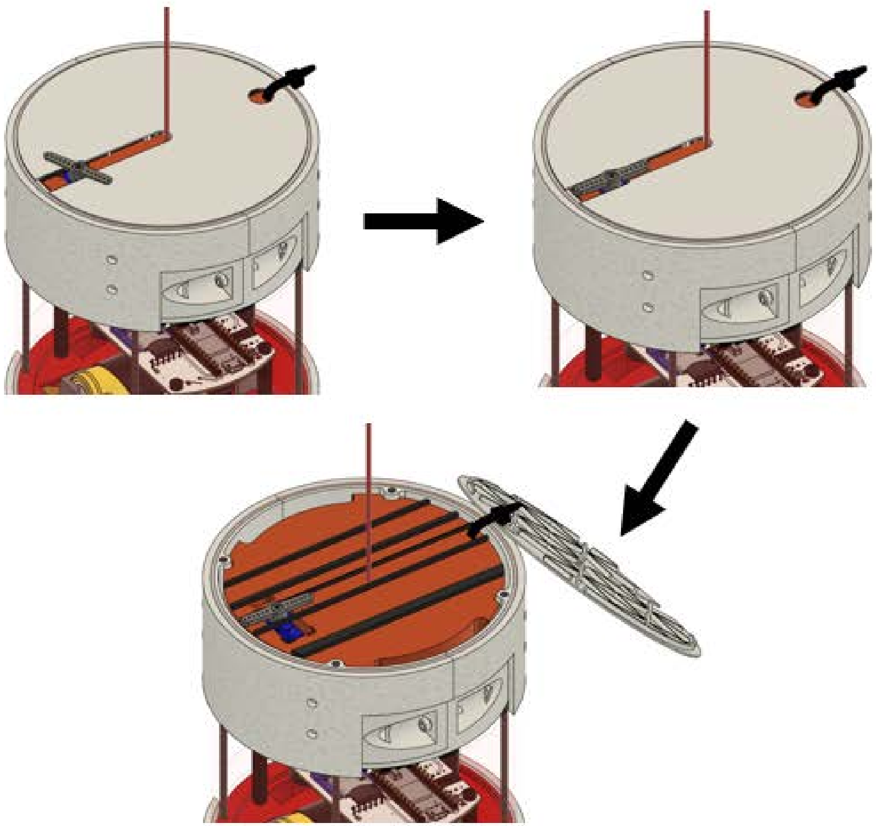
Container Design Description

Key Design Layouts: Descent Control

1st Stage



2nd Stage

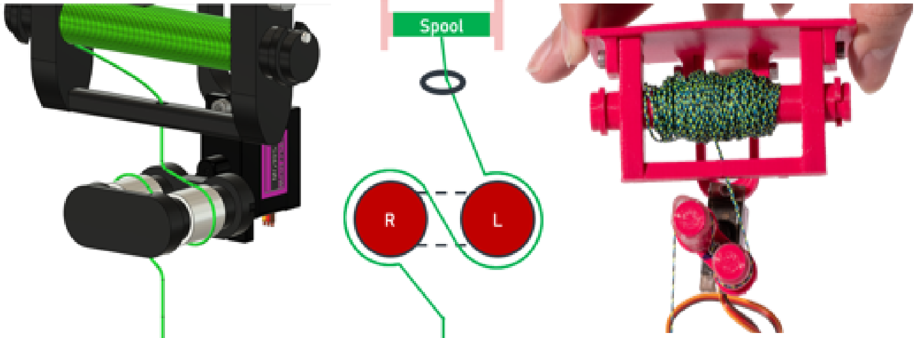


Detailed view on parachute deploy system

Key Design Layouts: Tethered payload deployment

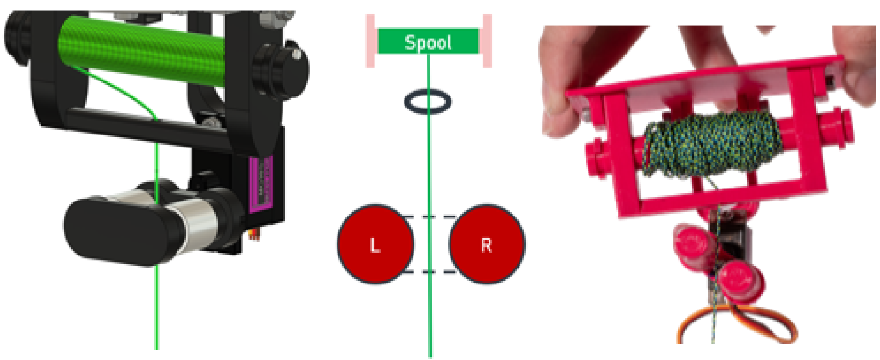
- The brake is split into two phases
  Release and *Brake*

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.



CAD 2D Graphic Prototype

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

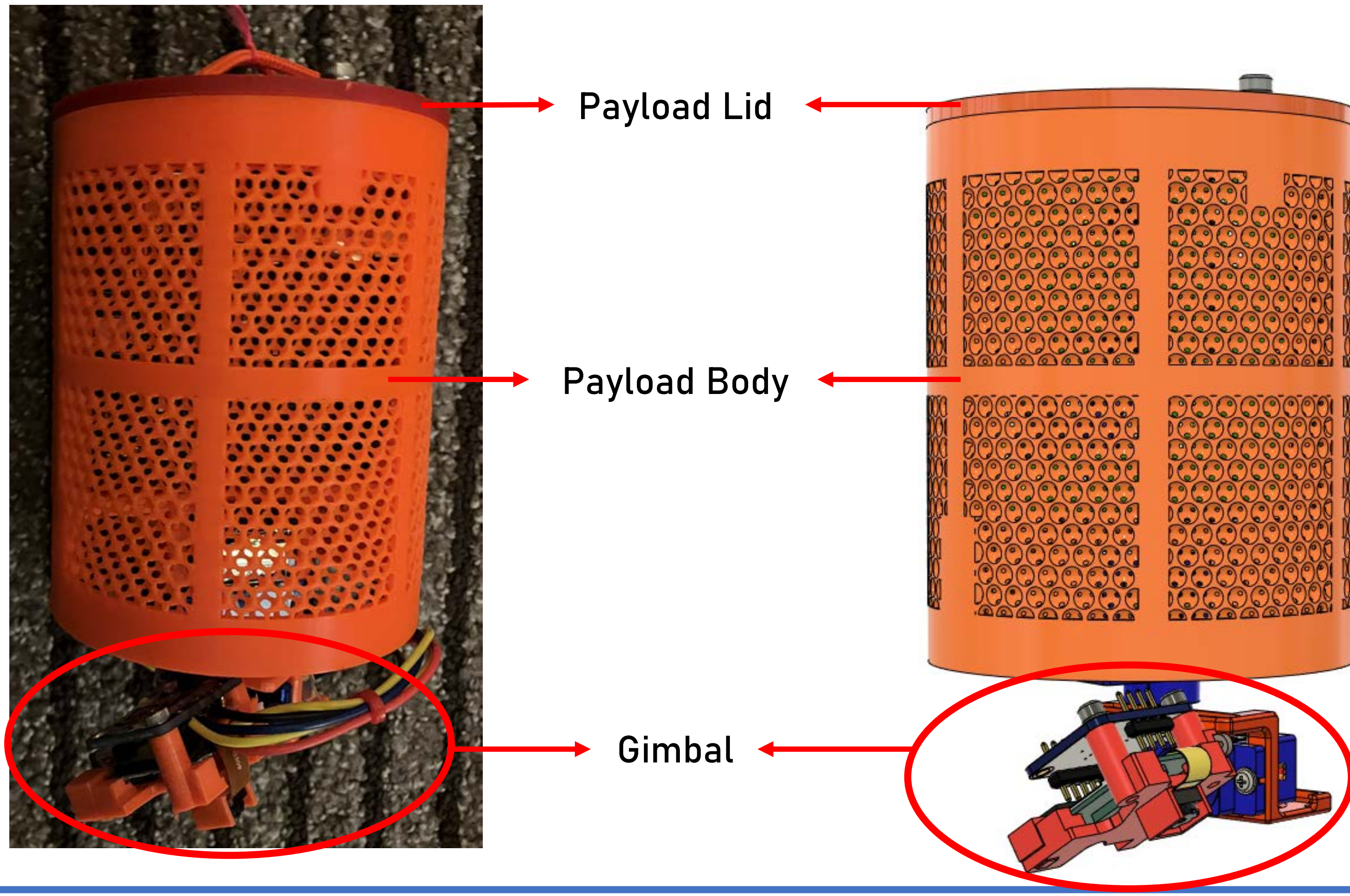


These two steps will be repeated until the payload is fully deployed.

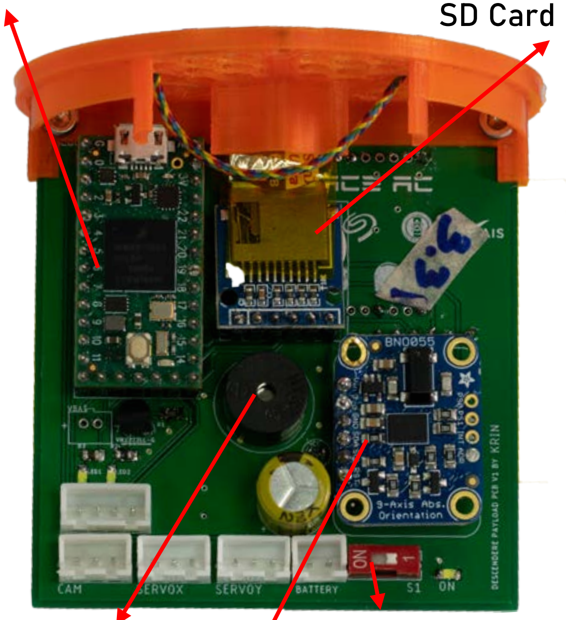
Key Design Layouts: Tethered payload deployment

Payload Design Description

Key Design Layouts: Mechanical Structure



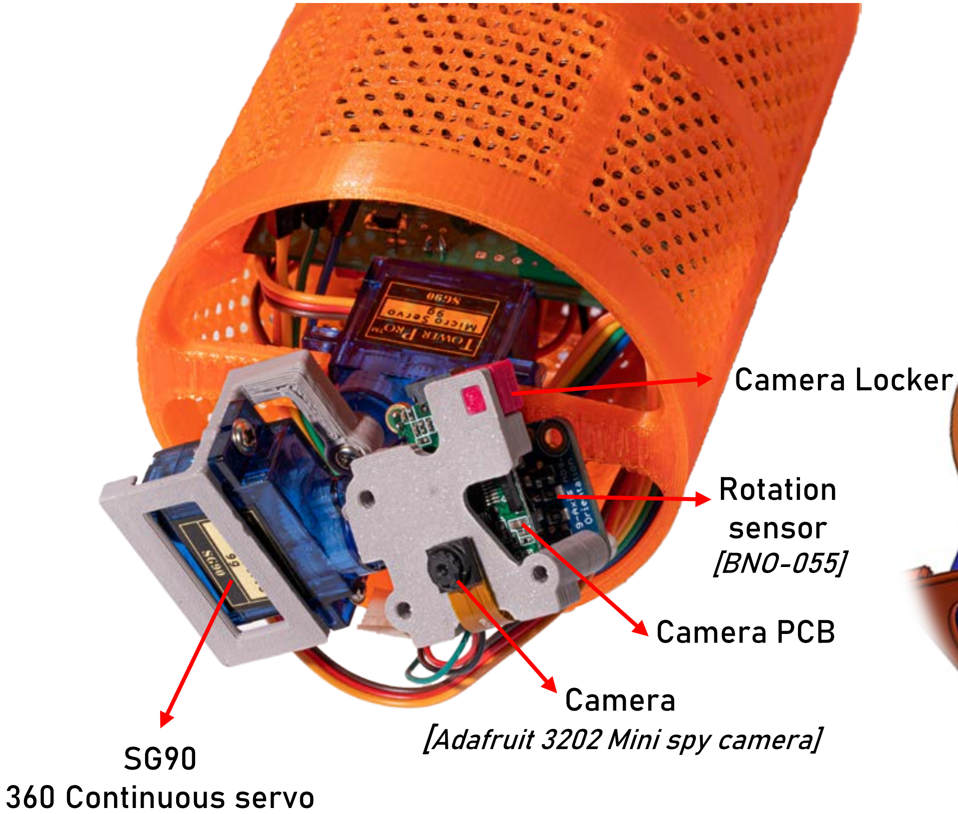
Key Design Layouts: Components Layout

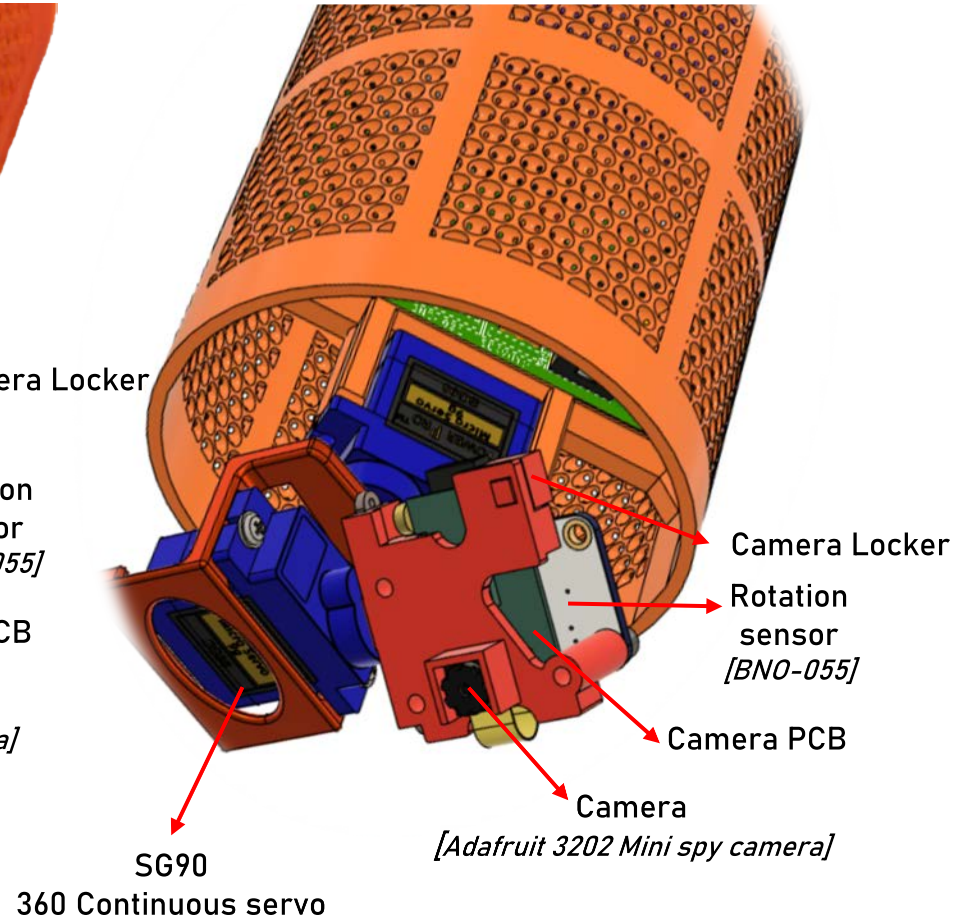


PCB is bolted to the lid

Payload Design Description

Key Design Layouts: Camera Gimbal





Concept of Operations and Sequence of Events

Planned and Actual CONOPs

Mission Timeline	Planned	Actual	Note
Pre-Launch	Team Briefing	✓ ✓	Roles and responsibility of all team members are revised
	Set-up GCS, Operations Check	✓	Set-up all the instruments required
	CanSat Final Checking	✓	Visual Inspection of the readiness of all mechanism
	Load CanSat into the Rocket	✓	Put the CanSat in the rocket payload section
	CanSat begins collecting telemetry data	✓	-

Planned and Actual CONOPs

Mission Timeline	Planned	Actual	Note
Launch	CanSat is launched in the atmosphere	✓	The rocket is launched from the launch site
	CanSat continues to receive telemetry data	✓	-
Rocket Seperation	CanSat is ejected from the rocket around 670 – 725m	✓ ✓	With the ejection charge, the CanSat is ejected from the rocket.
	CanSat parachute is deployed	✓	The parachute is inflated

Planned and Actual CONOPs

Mission Timeline	Planned	Actual	Note
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.	✓	The tether is fully deployed
Landing	Landing	✓	The CanSat has landed to the touch down position

Planned and Actual SOE

Mission Timeline	Planned	Actual
Arrive of Launch Site	8.00 a.m.	9.00 a.m.
Telemetry Check	8.10 a.m.	9.05 a.m.
Brake Mechanism Test	11.20 a.m.	11.30 a.m.
Payload Deployment Test	11.45 a.m.	11.40 a.m.
Registration and Delivery of CanSat	12.00 p.m.	11.50 a.m.

Planned and Actual SOE

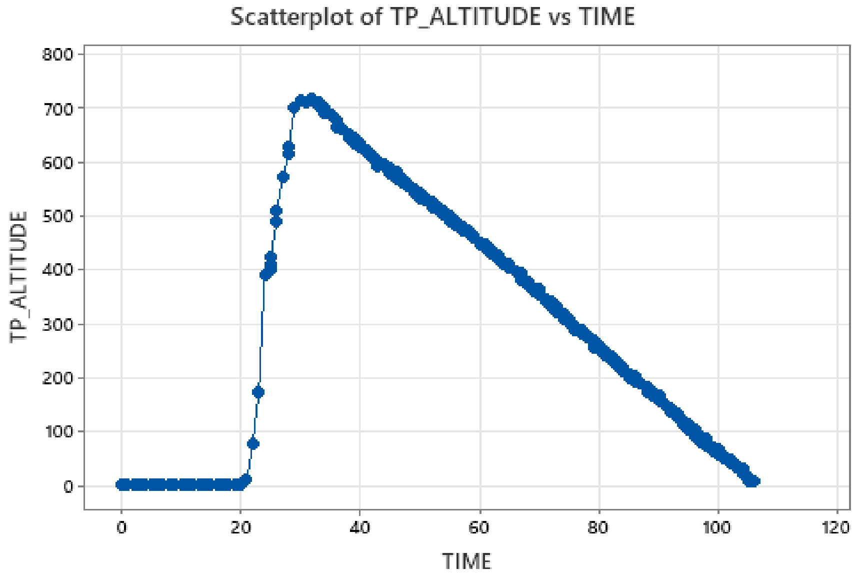
Mission Timeline	Planned	Actual
Preparing the CanSat for the launch	12.30 p.m.	12.40 p.m.
Ground Station Transfer	1.00 p.m.	1.20 p.m.
Power on the CanSat and telemetry check	1.20 p.m.	1.25 p.m.
Transporting the CanSat to the rocket	1.25 p.m.	1.30 p.m.
Rocket Launch	1.30 p.m.	1.35 p.m.

Planned and Actual SOE

Mission Timeline	Planned	Actual
CanSat Landing	1.35 p.m.	1.36 p.m.
CanSat Recovery	1.40 p.m.	1.40 p.m.
Checking the GCS data	1.40 p.m.	1.40 p.m.
Submitting the CanSat data to the Jury	1.45 p.m.	1.43 p.m.
PFR Preparation	5.00 p.m.	5.00 p.m.

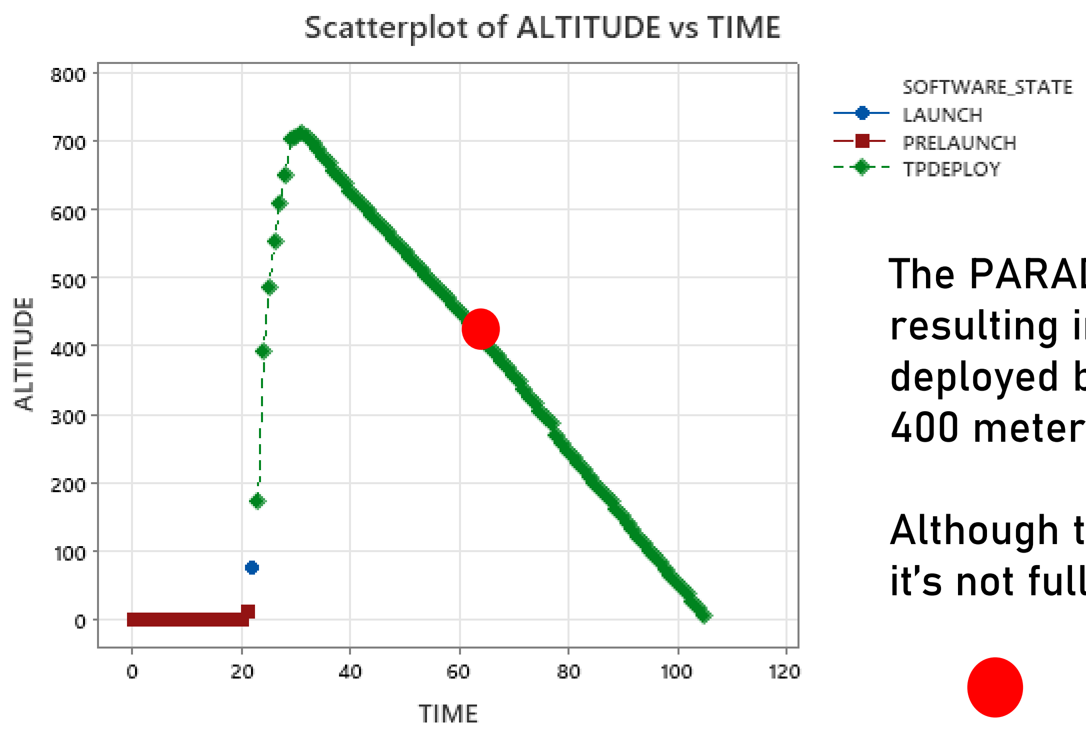
Flight Data Analysis

Payload Altitude Plot



As with the payload, the container's altitude fluctuated during the rocket launch and then began to fall after reaching apogee.

Second Parachute Deployment

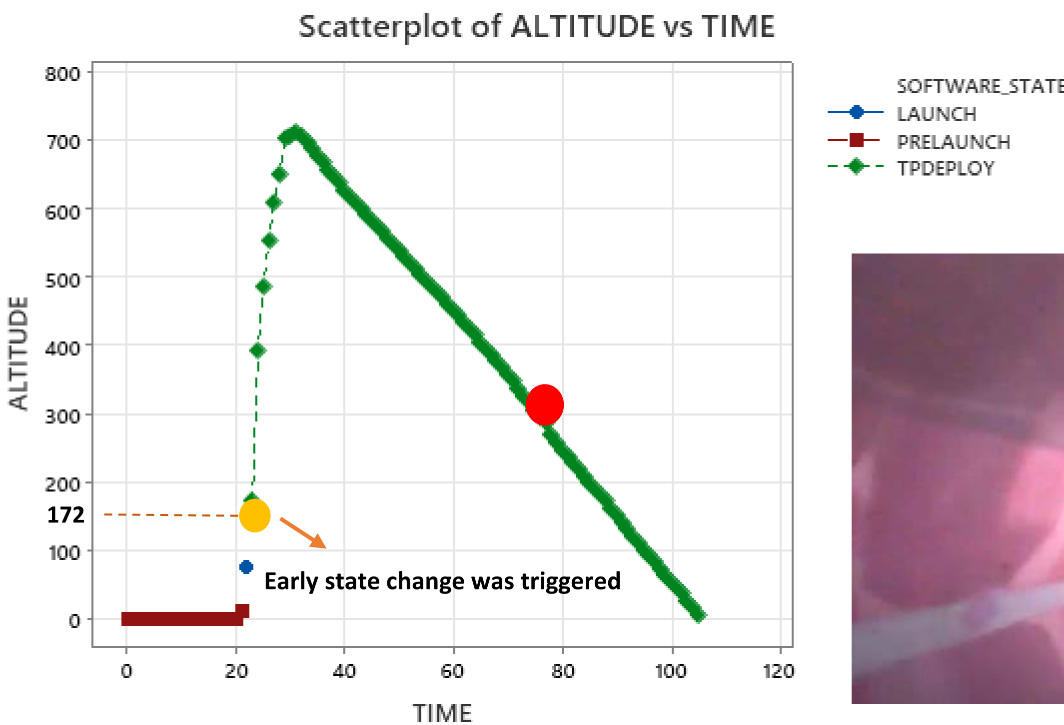


The PARADEPLOY state is triggered early, resulting in the second parachute being deployed before the CanSat descends to 400 meters.

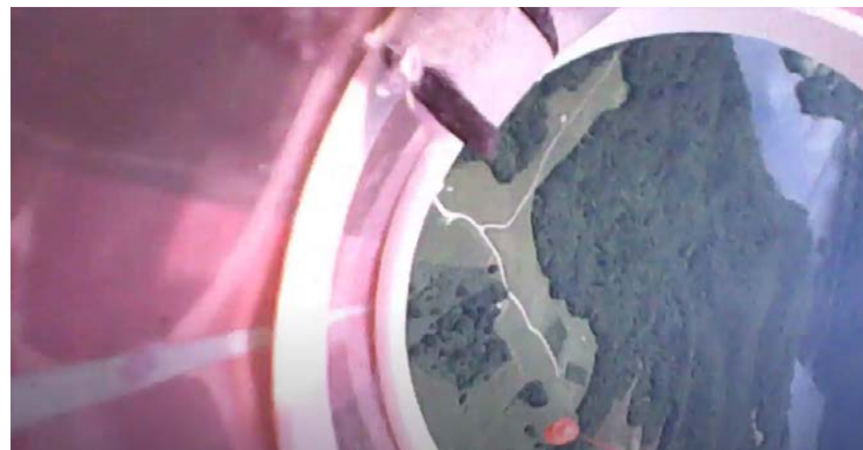
Although the second parachute is deployed, it's not fully inflated during descent.

400 meters altitude

Payload Deployment



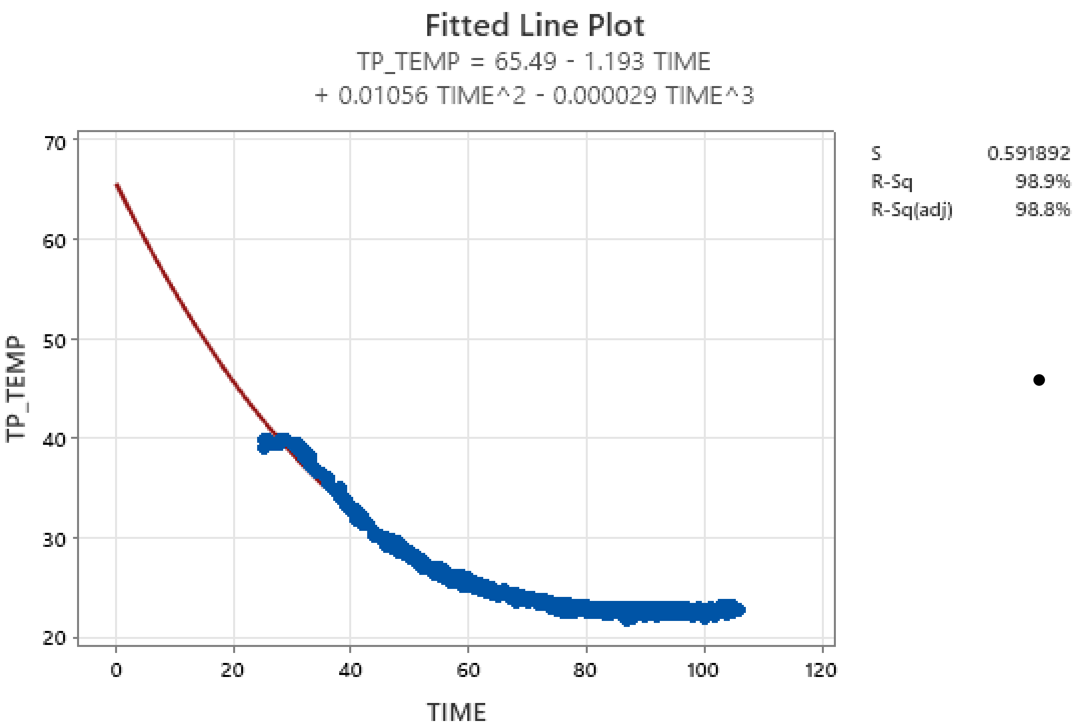
300 meters altitude



Despite early deployment triggered by the software, because of the malfunction of the data sampling ,the payload is deployed from the container at 172 meters.

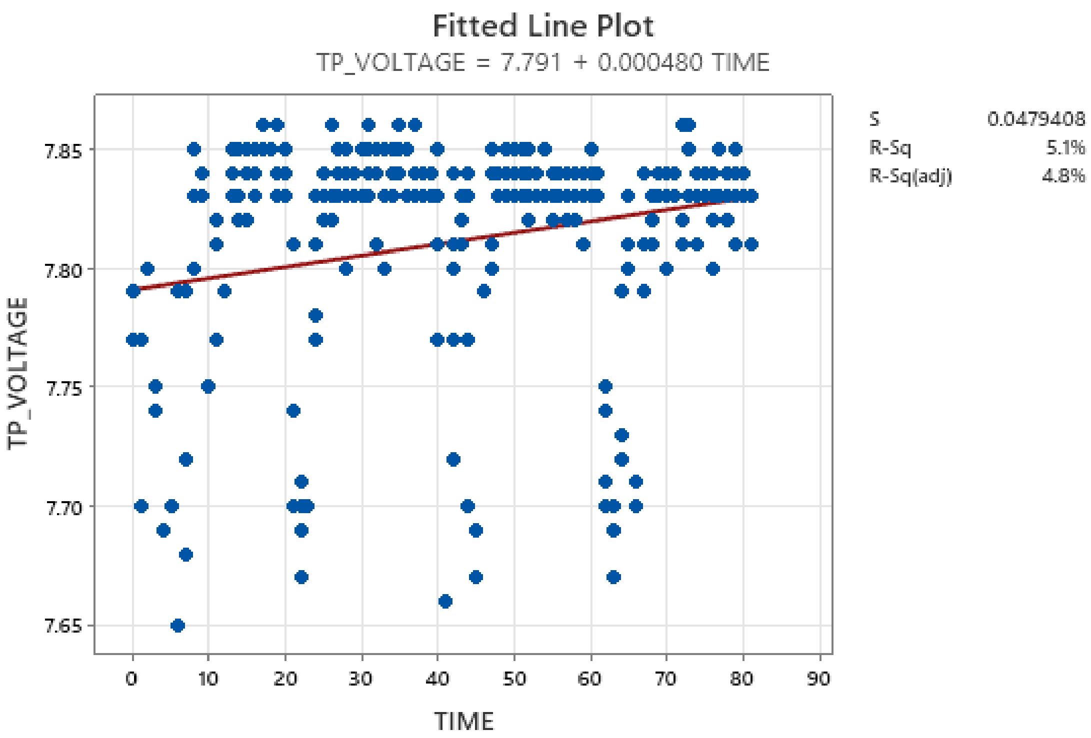
Payload Temperature Plot

Difference between the estimated and real data plot

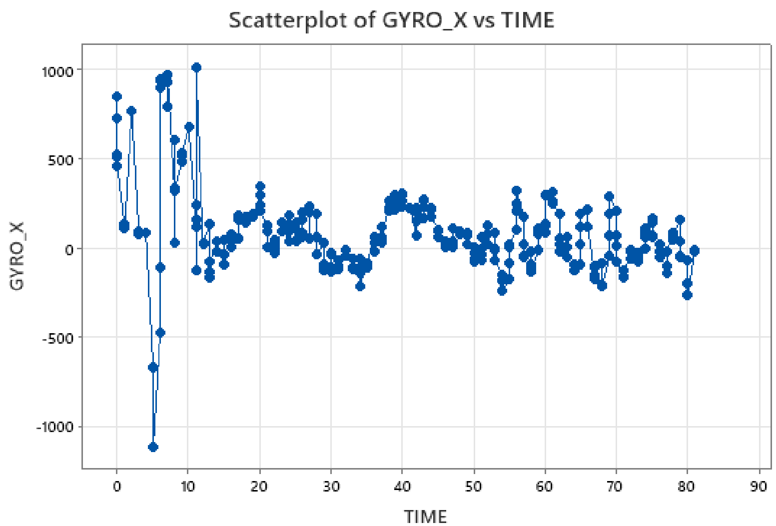


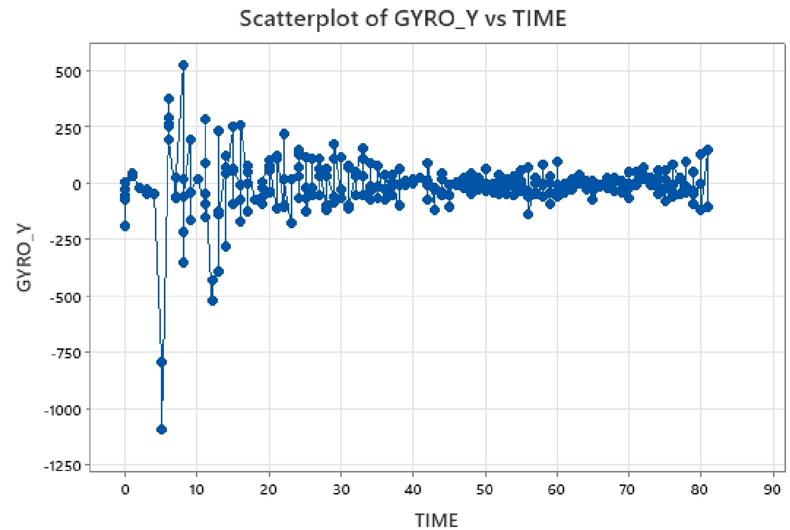
- The temperature is higher when the payload is placed in the rocket, and then lower when the payload has already been ejected out of the rocket.

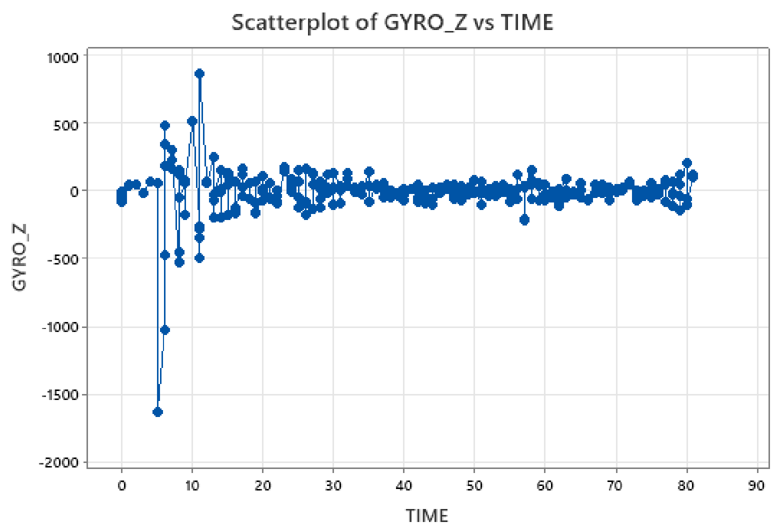
Payload Battery Voltage Plot



Tilt Sensor Plot

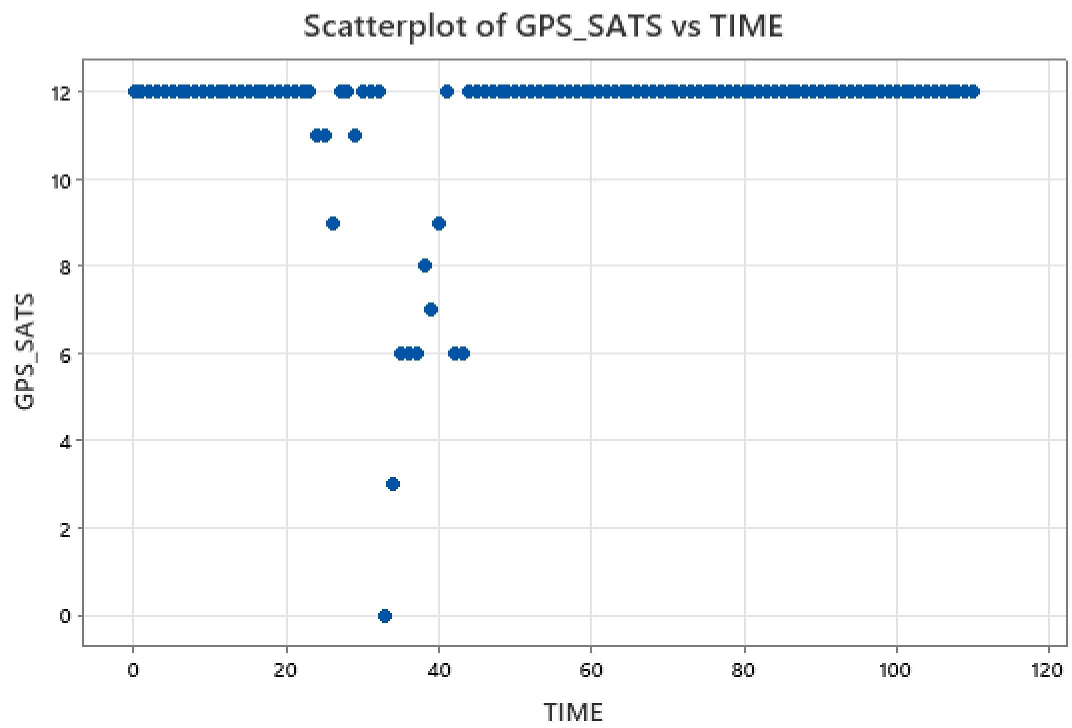






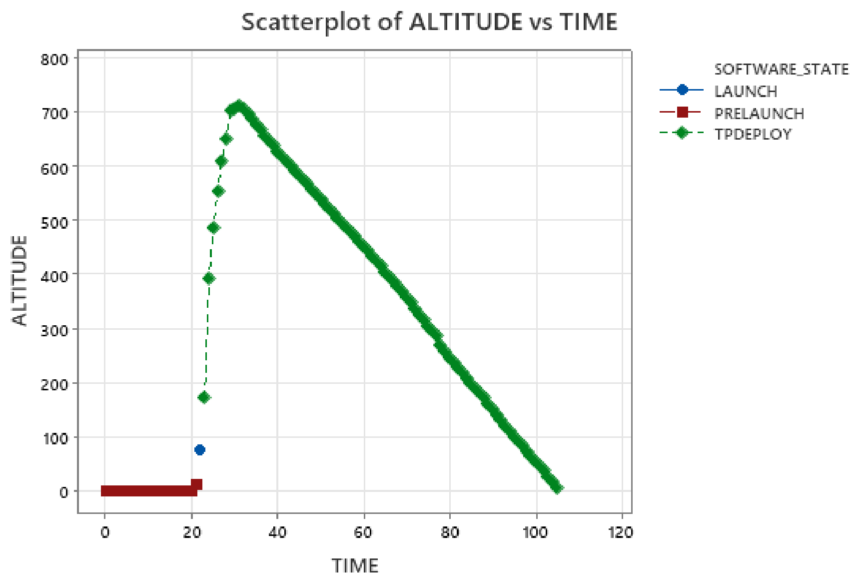
The Number of Satellites used in GPS

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



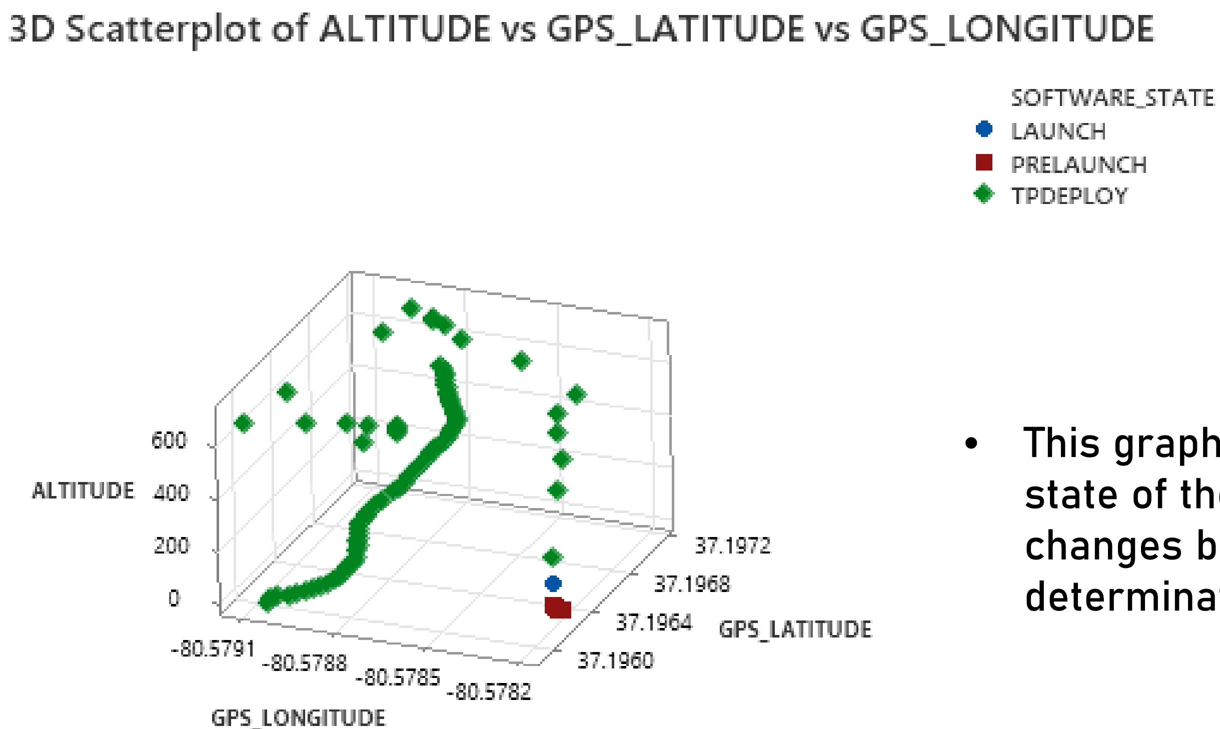
- From the descriptive statistics analysis, the mean of the number of satellites used in GPS is 11.378, which is more than 4, making the GPS data reliable.

Container Altitude Plot



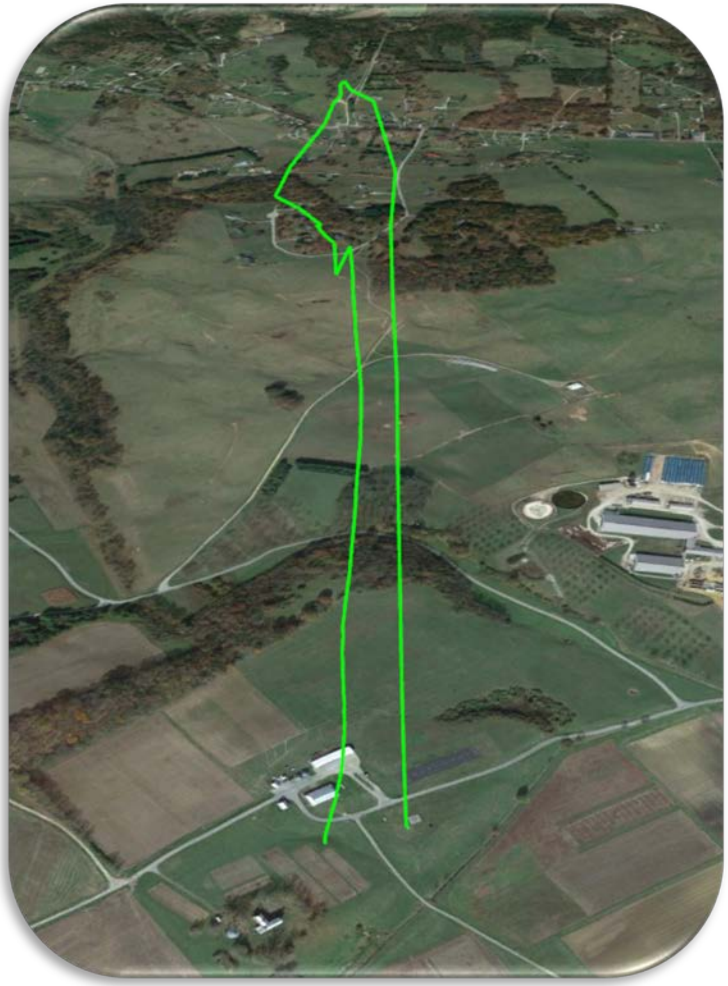
As with the payload, the container's altitude fluctuated during the rocket launch and then began to fall after reaching apogee.

Container GPS Position Plot



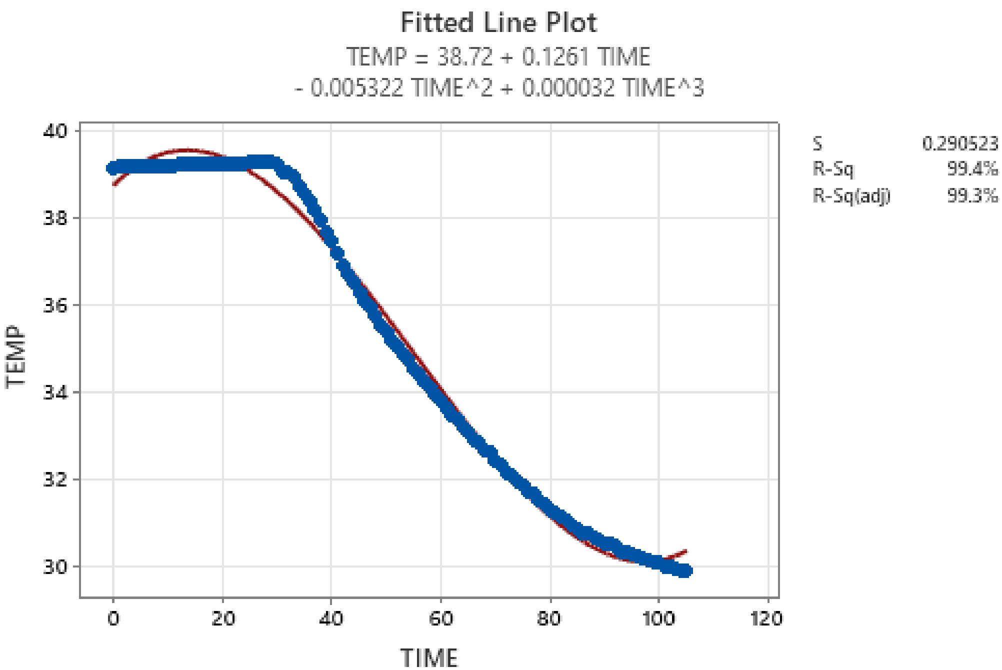
- This graph shows that the state of the operation changes before the determinated altitude.

Container GPS Position Plot



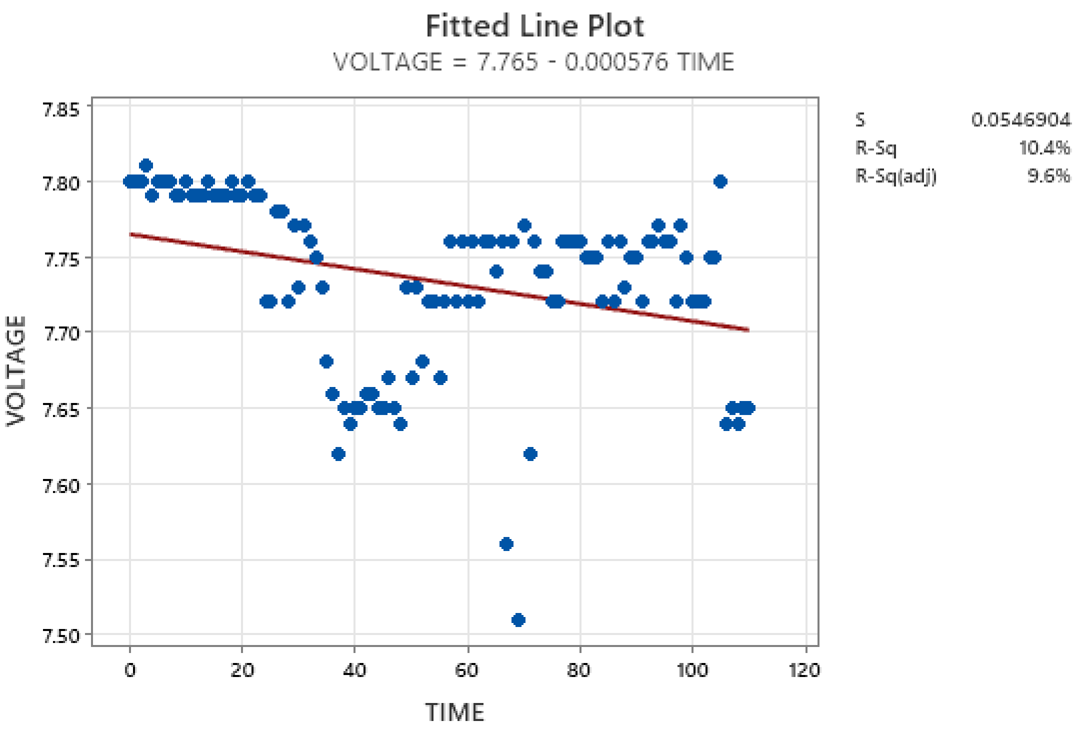
Google Earth plot of position data

Container Temperature Plot



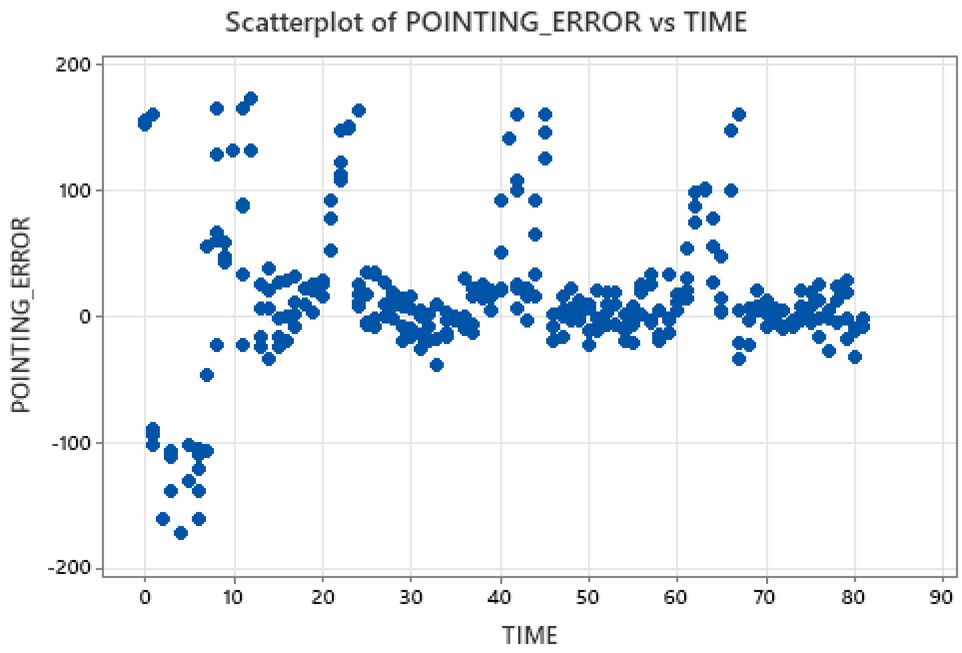
- When the payload is loaded in the rocket, the temperature is higher, and when the payload is propelled out of the rocket, the temperature is lower.

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

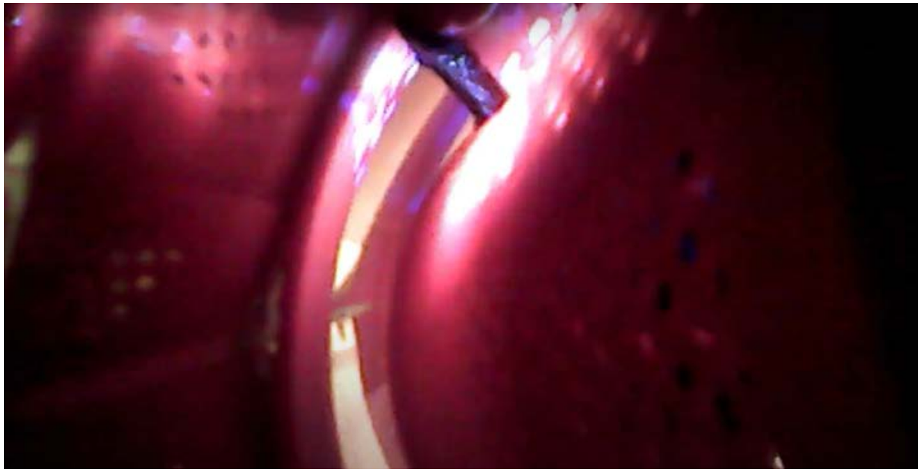


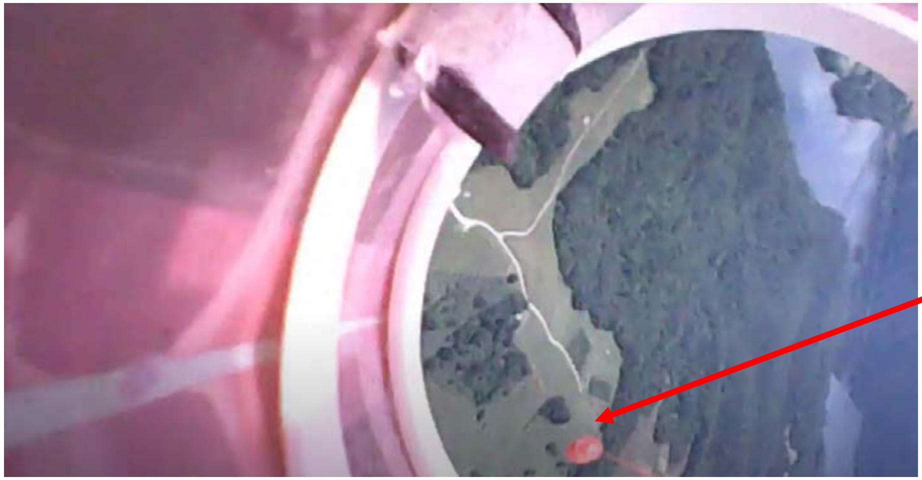
- From the descriptive statistics analysis the mean of the pointing error of the bonus camera is equal to 16.14 which is lower than 20 degree.

Payload Camera Video

Payload Camera Video

Bonus Camera Video

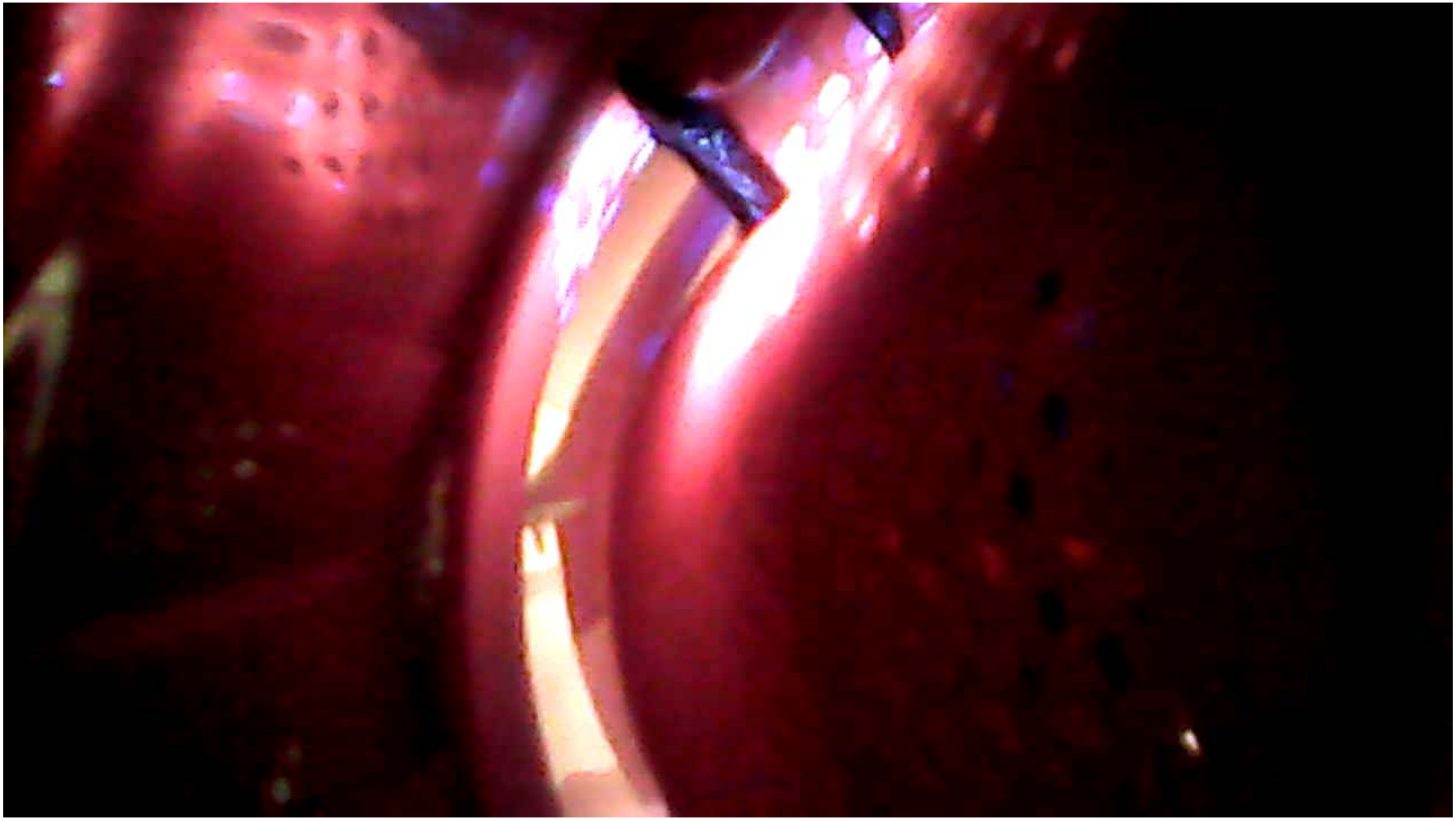




Deployed payload

Bonus Camera Video

Bonus Camera Video



Failure Analysis

Failure Analysis

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

Failure Analysis

Failures: 2nd Parachute wasn't fully inflated

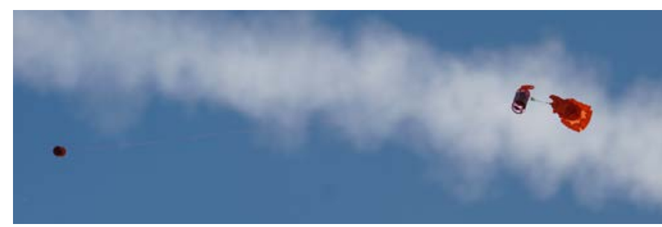
Because of the parachute lines entanglement, the CanSat descent rate does not correspond to the calculation.

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

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.

Lesson Learned

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.

- Altitude used in state detection algorithm is already sampled from raw data. This should've eliminated possible error from the data. However, an error has leaked into state calculation. Meaning more than 2 error values must be present in the raw data.

Conclusion

- For the verification of the quality of the CanSat in any subsystem testing, the CanSat manufacturing process should be made more affordable to be repeated.

- During the tests of the product, the effect of the variables other than the independent variables should be more controlled to get useful information to improve the design.

- In any space project, the preparing of the spare parts is required.