CanSat 2023
Post Flight Review (PFR)

Team 1082
PWr Aerospace

Introduction

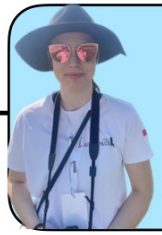
Tobiasz Puślecki

Presentation Outline

Section	Presenter
Introduction	Tobiasz Puślecki
Systems Overview	Konrad Łebek
Concept of Operations and Sequence of Events	Hubert Kulik
Flight Data Analysis	Hubert Kulik
Failure Analysis	Hubert Kulik
Lessons Learned	Tobiasz Puślecki

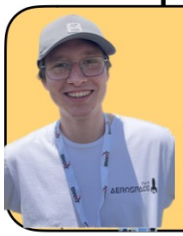
Team Organization

1st Doctoral
Tobiasz Puślecki
- Team leader
- Electronics and Software Engineering



2nd Master
Katarzyna Ignatowicz
- Finances and support

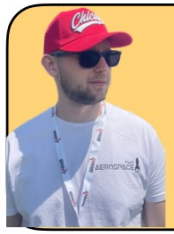
2nd Bachelor
Jakub Kaszowski
- Leader of Electronics
- Electronics Engineering



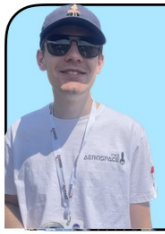
1st Bachelor
Tomasz Drewniak
- Leader of Mechanics
- Mechanical Engineering

3rd Bachelor
Eunika Puślecka
- Finances and support

3rd Bachelor
Hubert Kulik
- Electronics and Software
- Engineering

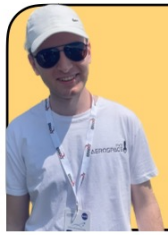


1st Bachelor
Konrad Łebek
- Mechanical Engineering

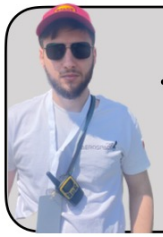


1st Bachelor
Tymoteusz Puślecki
- Public Relations

Dr hab. inż Paweł Kabacik
- Faculty Advisor



1st Bachelor
Adam Sułkowski
- Mechanical Engineering



Mateusz Pasierbek
- Tour supervisor

System Overview

Konrad Łebek

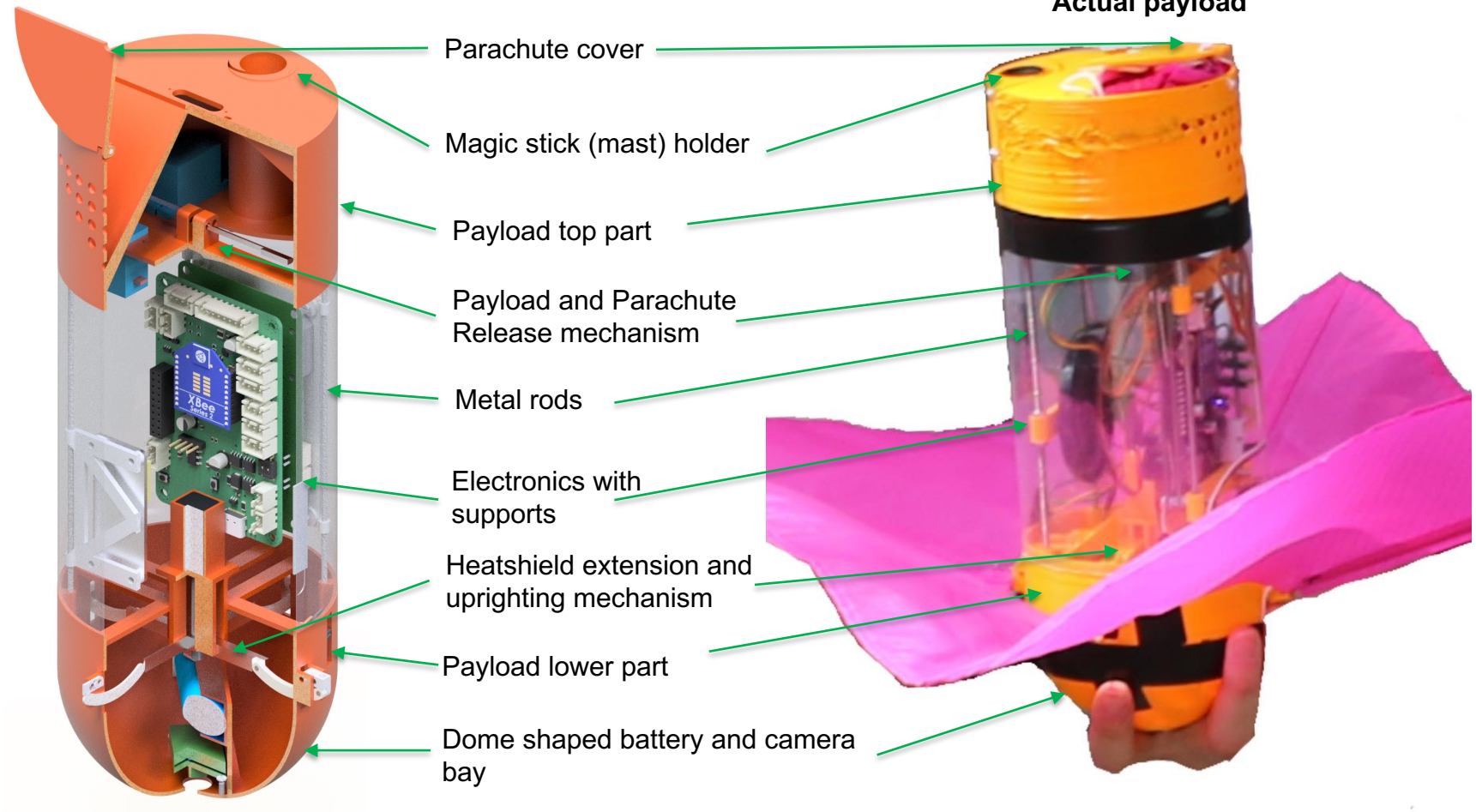
Payload Design Description (1/6)

Payload Major Parts and Components

CAD model for better visibility

Major structural components

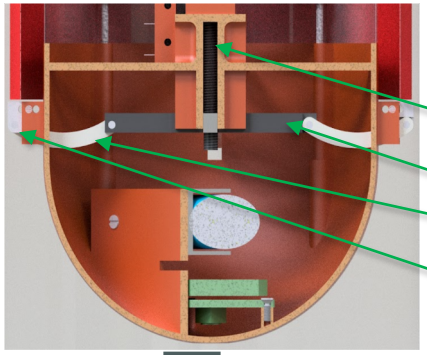
Actual payload



Payload Design Description (2/6)

Payload Major Parts and Components

CAD model



Uprighting and heatshield extension mechanism closeup

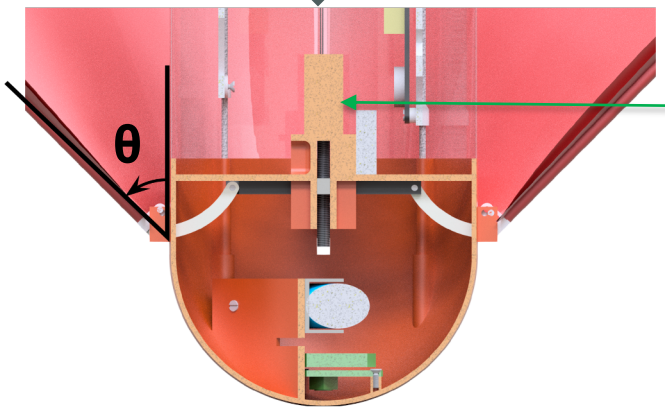
Closed heatshield

Rotating screw

Linearly moving cross

Linkages

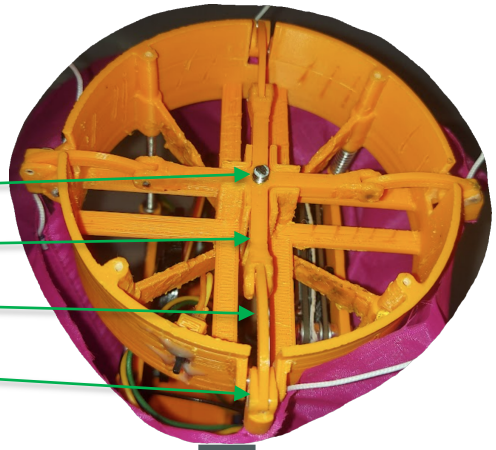
Rotating pivots



DC engine inside the mechanism

Open heatshield

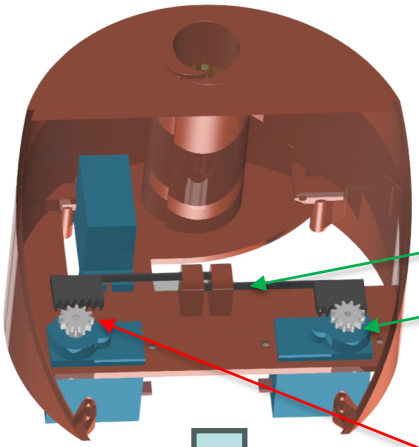
Actual payload (bottom view)



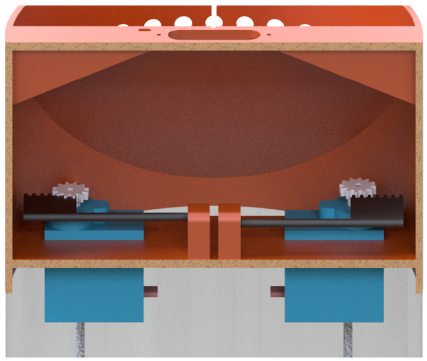
Payload Design Description (3/6)

Payload Major Parts and Components

CAD model before release



CAD model after release



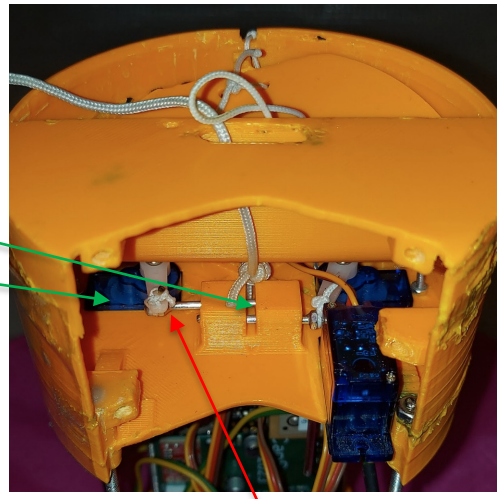
Payload release and parachute opening mechanism closeup

Released pin

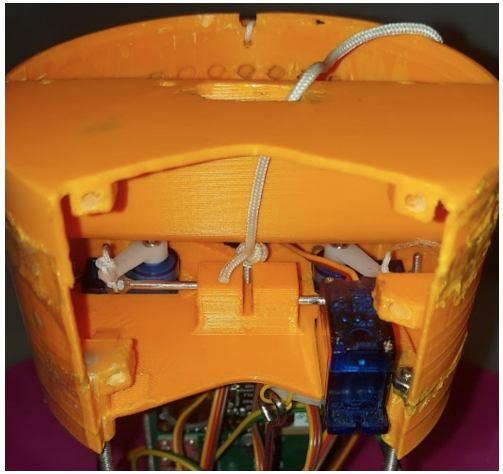
Servo

Rack and pinion

Actual payload before release



Actual payload after release



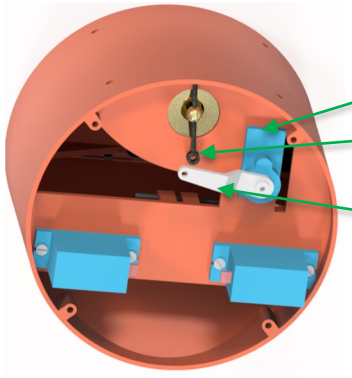
The servo pulls the pin out with the use of a pitman arm

Payload Design Description (4/6)

Payload Major Parts and Components

Mast release mechanism

CAD model before mast release



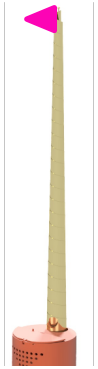
Servo

Release pin

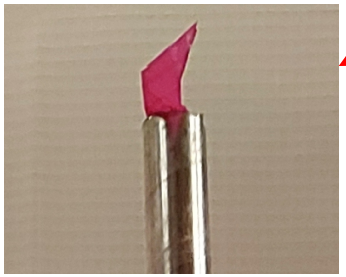
Pitman arm

Actual payload before mast release

CAD model after mast release



Actual payload with extended mast shown



Flag on the tip of the mast

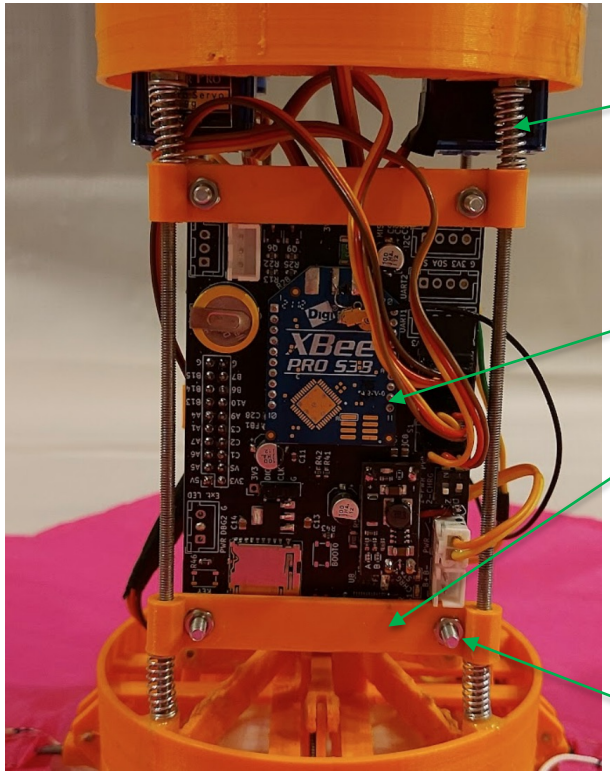
Actual payload after mast release

Payload Design Description (5/6)

Payload Major Parts and Components

Electronics mounting in the actual payload

Front of the electronics board



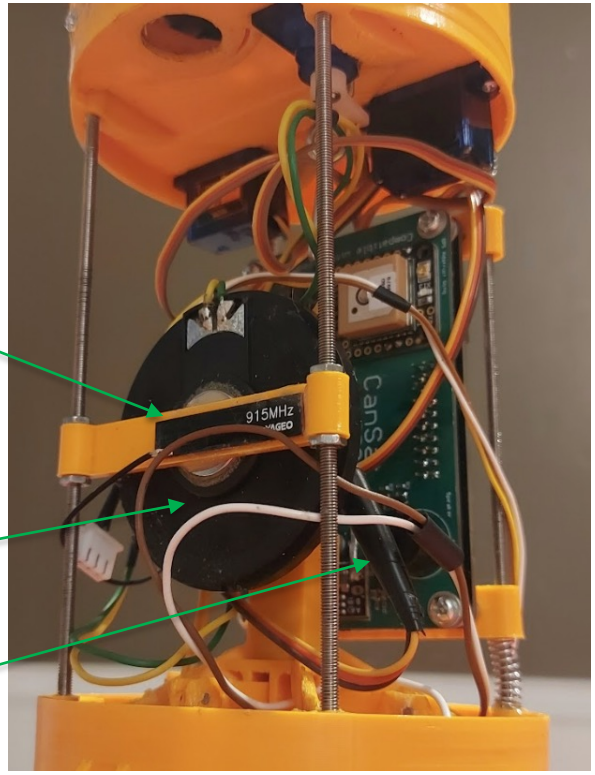
Springs to absorb the shocks

XBee

3D printed supports

Screws

Rear of the electronics board with the antenna and buzzer visible



Xbee antenna

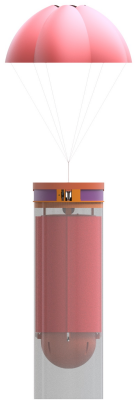
Buzzer that is louder than 92 dB

Just a buzzer

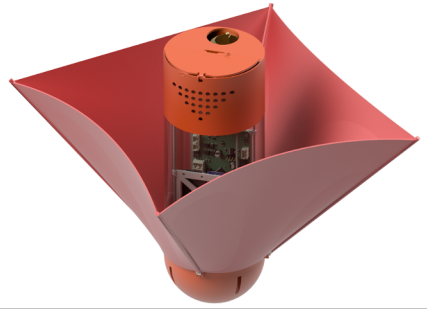
Payload Design Description (6/6)

Different payload states during the mission

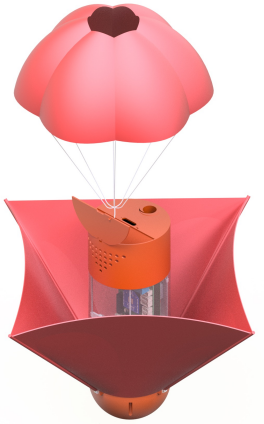
After separation



Heatshield aerobraking



Parachute descent

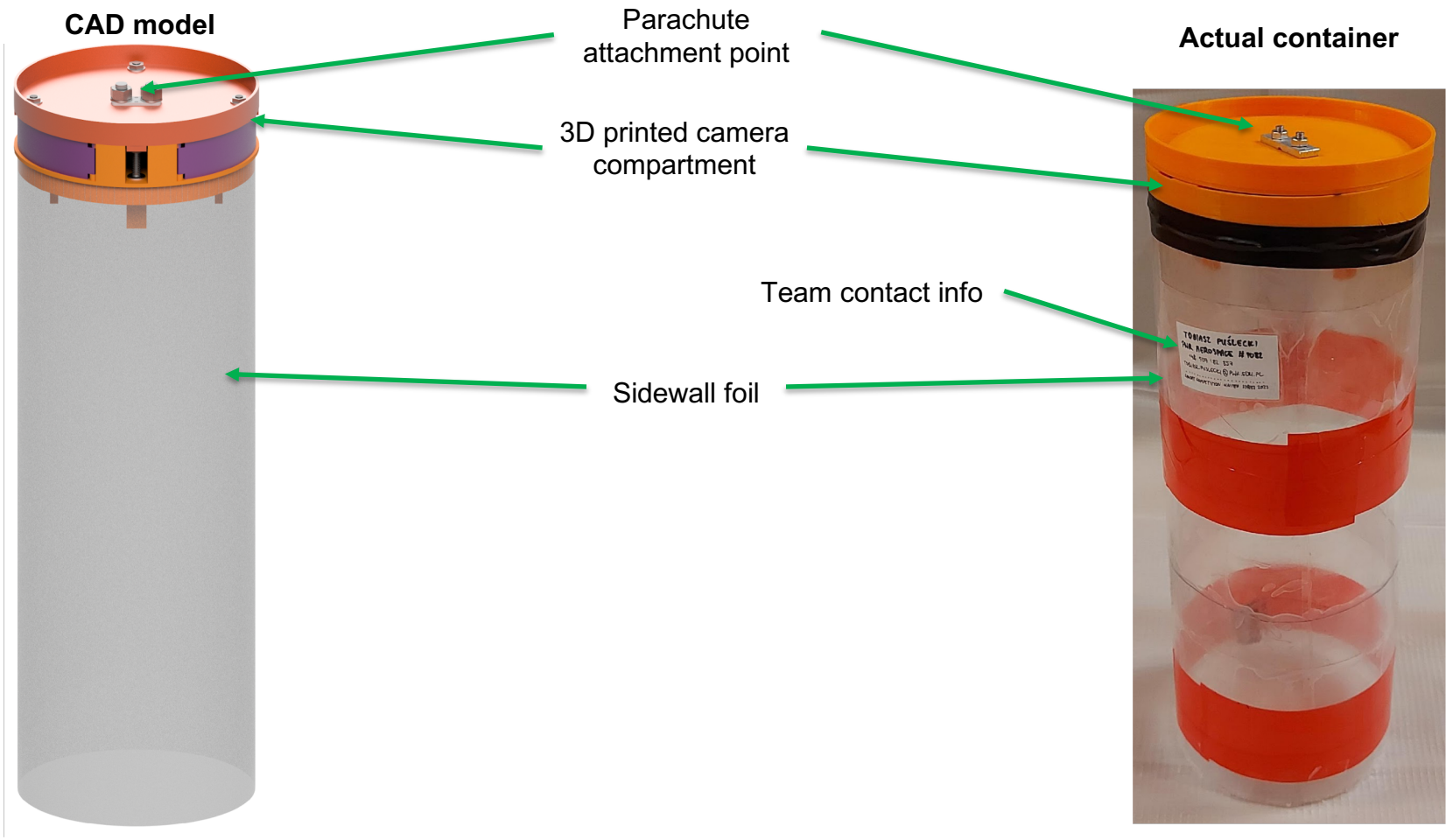


Landing and uprighting

Mast deployment

Container Design Description (1/2)

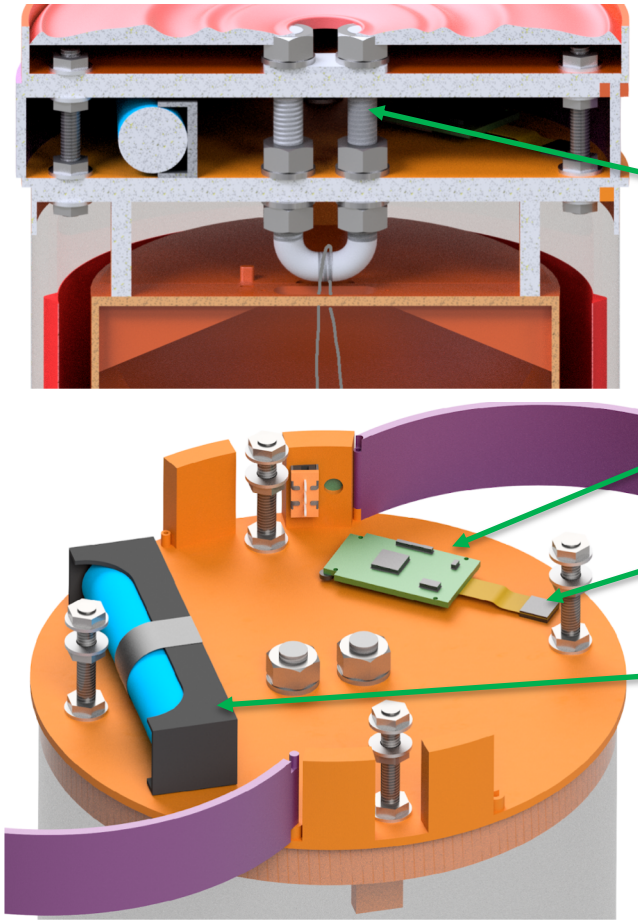
Container Major Parts and Components



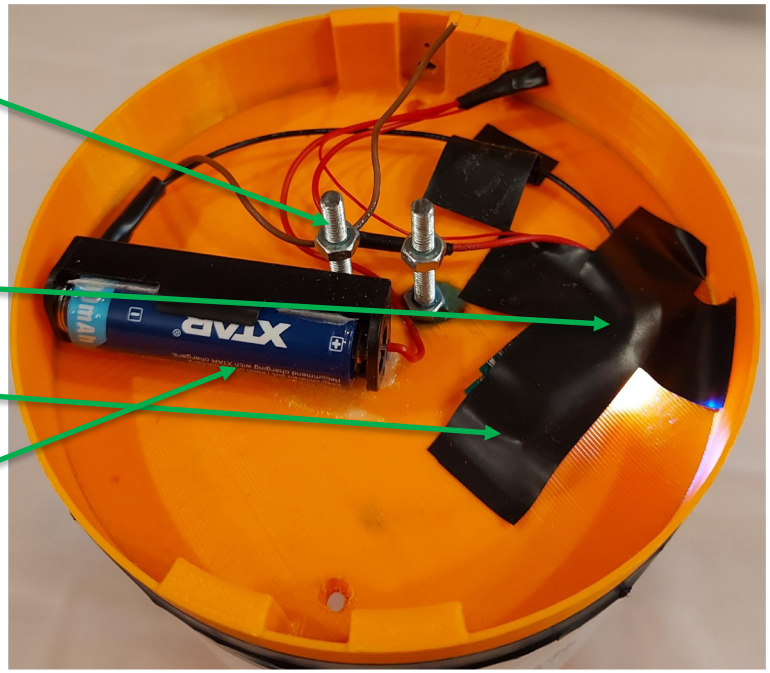
Container Design Description (2/2)

Container Major Parts and Components

CAD model



Actual container



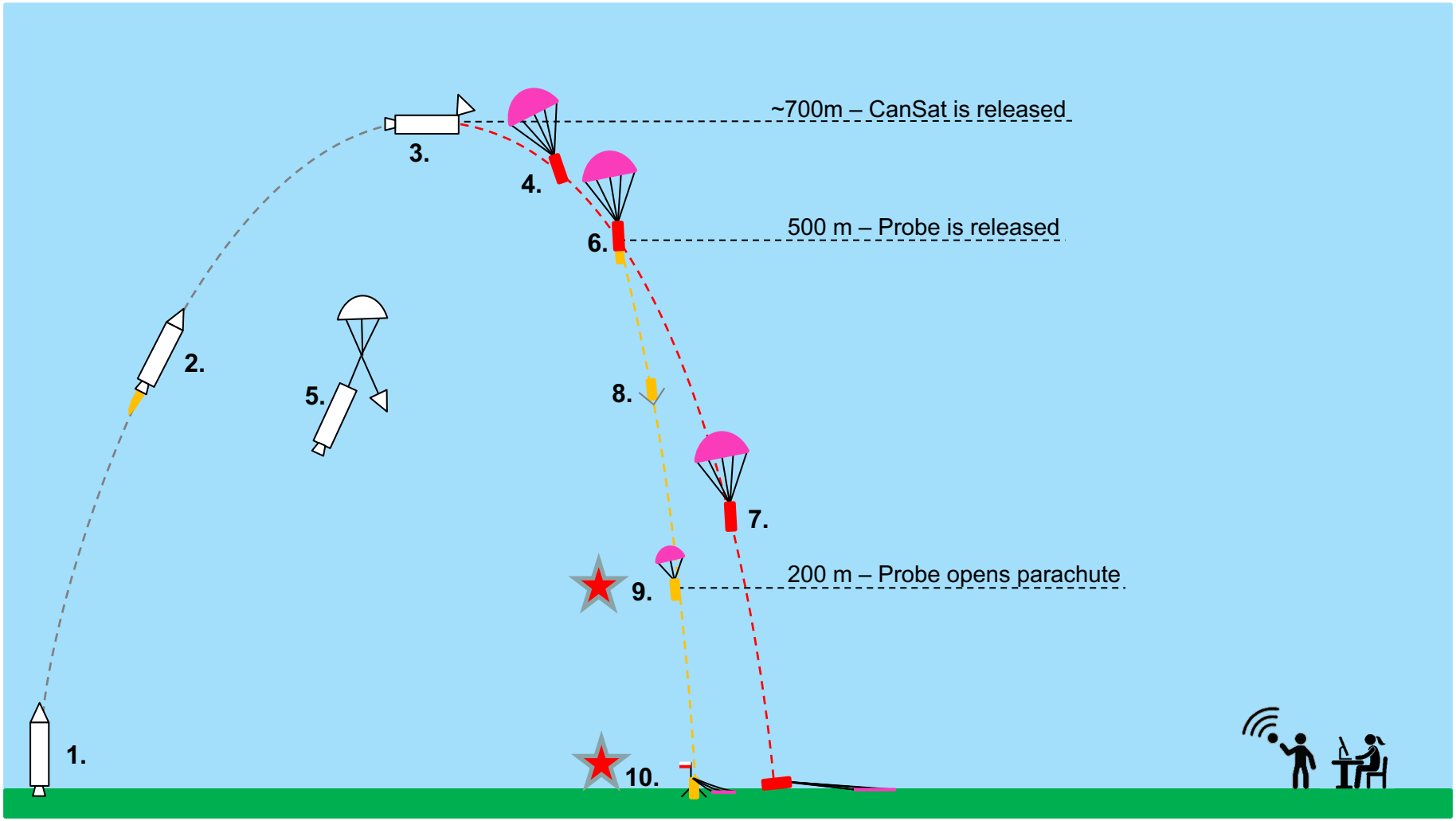
Concept of Operations and Sequence of Events

Hubert Kulik

Comparison of Planned and Actual CONOPS

Stage	Activities
Pre-launch activities	• Arrival at launch site • CanSat preparations • CanSat assembly and weighing • Turning CanSat for official inspection
Launch	• Setting ground station at designated place • Placing CanSat in rocket compartment • Execution of launch sequence • USB stick delivery to judges
Recovery and further actions	• CanSat probe recovery • Data gathering and presentation preparing

Comparison of Planned and Actual SOE



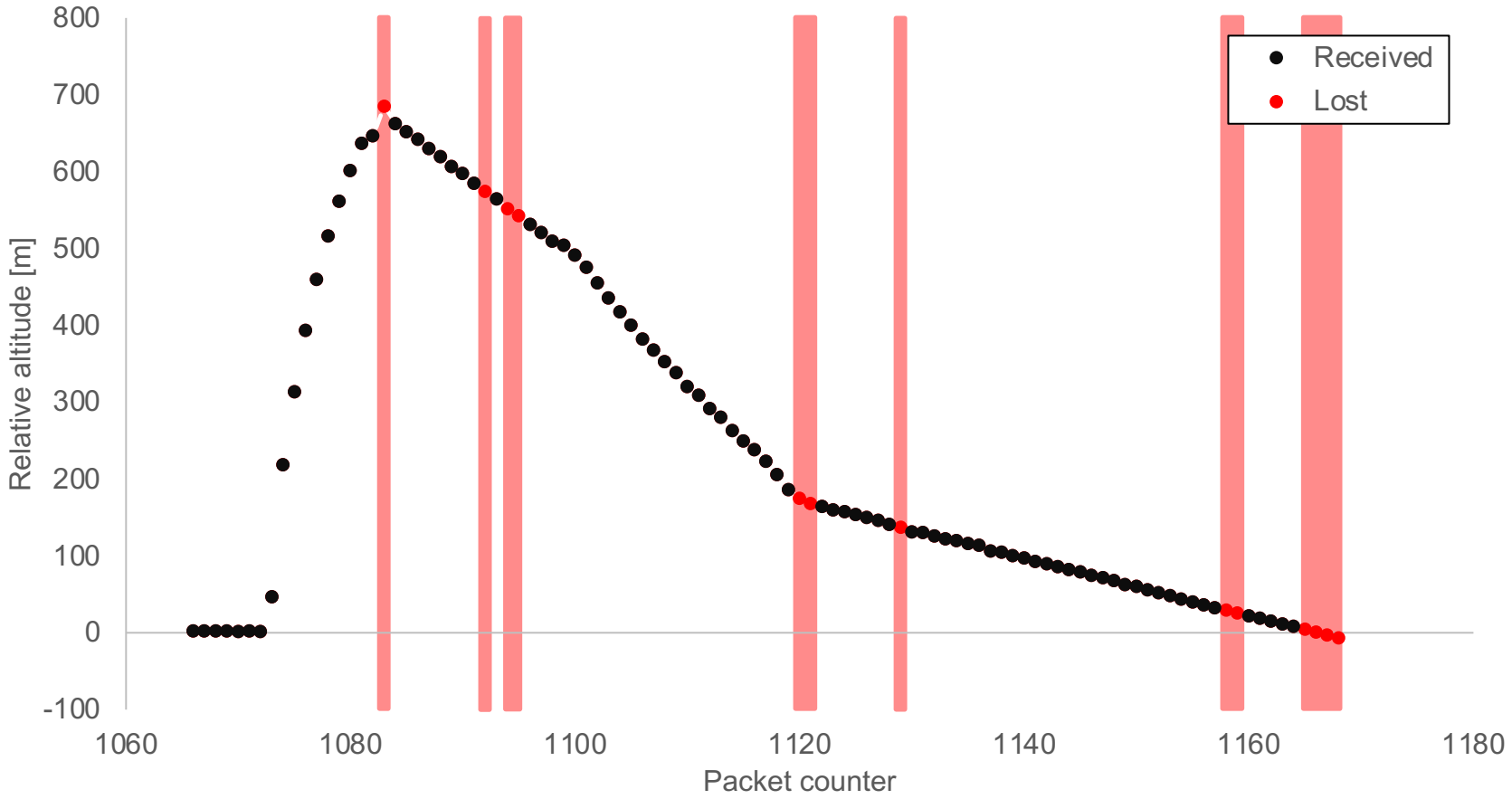
Comparison of Planned and Actual SOE

Planned Sequence of Events	Actual
Place CanSat in the rocket	Success
Take the rocket to the launch site	Success
Power on the ground station (GS)	Success
Send calibration commands from GS to container	Success
Launch sequence execution	Success
Deployment from rocket (~700m)	Success
Descending using the first parachute at a rate of 15 m/s (+/- 5ms)	Success
Deployment of payload (~500m)	Success
Heatshield opening, descending at a rate of 20 m/s or less	Success
Deployment of second parachute, slow down to 5 m/s (~200m)	Partially
Touchdown, upright, rise a flag, stopping telemetry	Partially
Recovery of CanSat with working buzzer	Partially
Gathering microSD card from CanSat	Success

Flight Data Analysis

Hubert Kulik

Payload Altitude

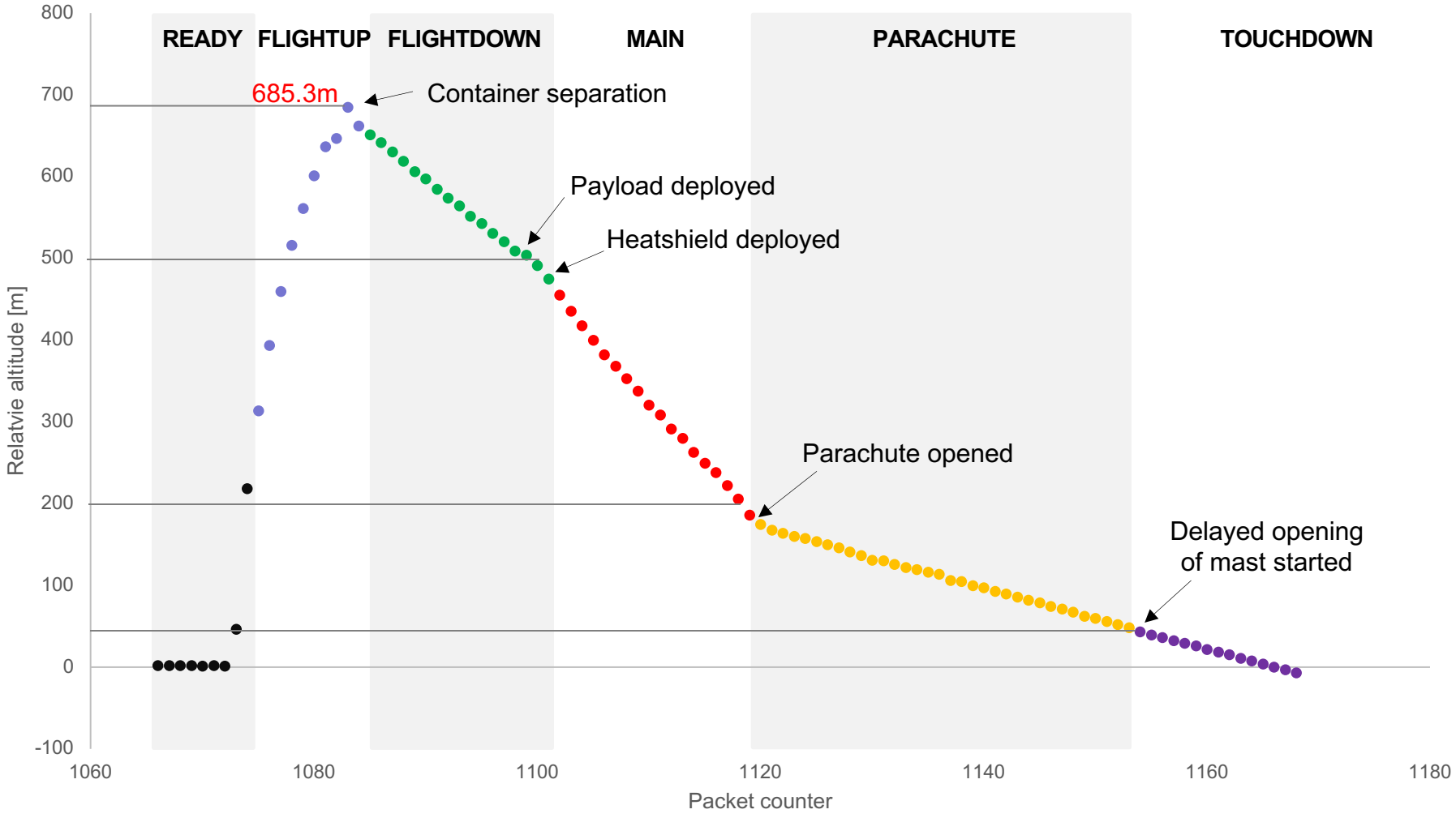


Altitude was calculated using data from pressure sensor.

Further analysis will be performed using data from Payload sd card.

We have received **90 out of 103** sent packets.

Payload Altitude

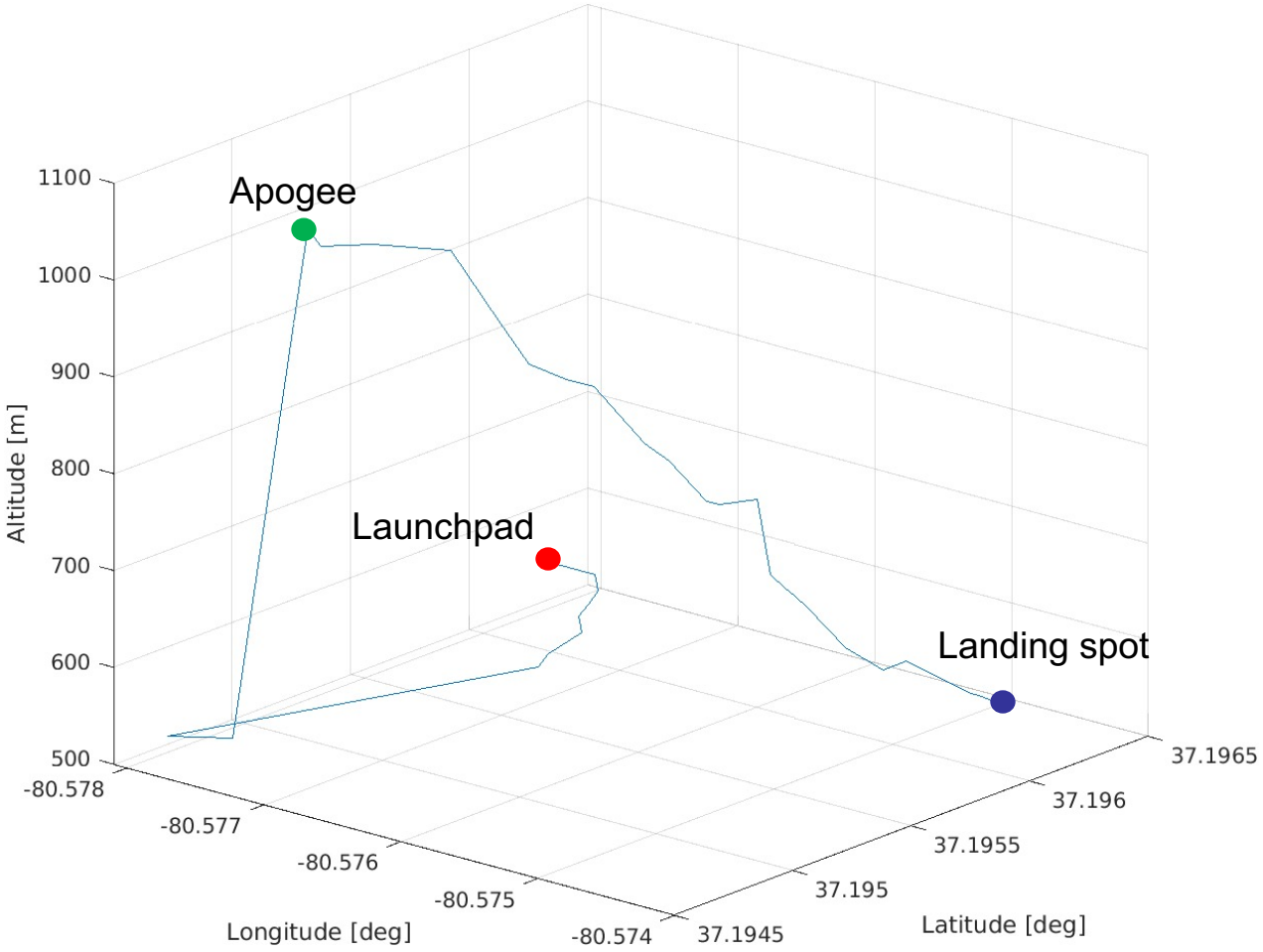


In container: 10.83 m/s

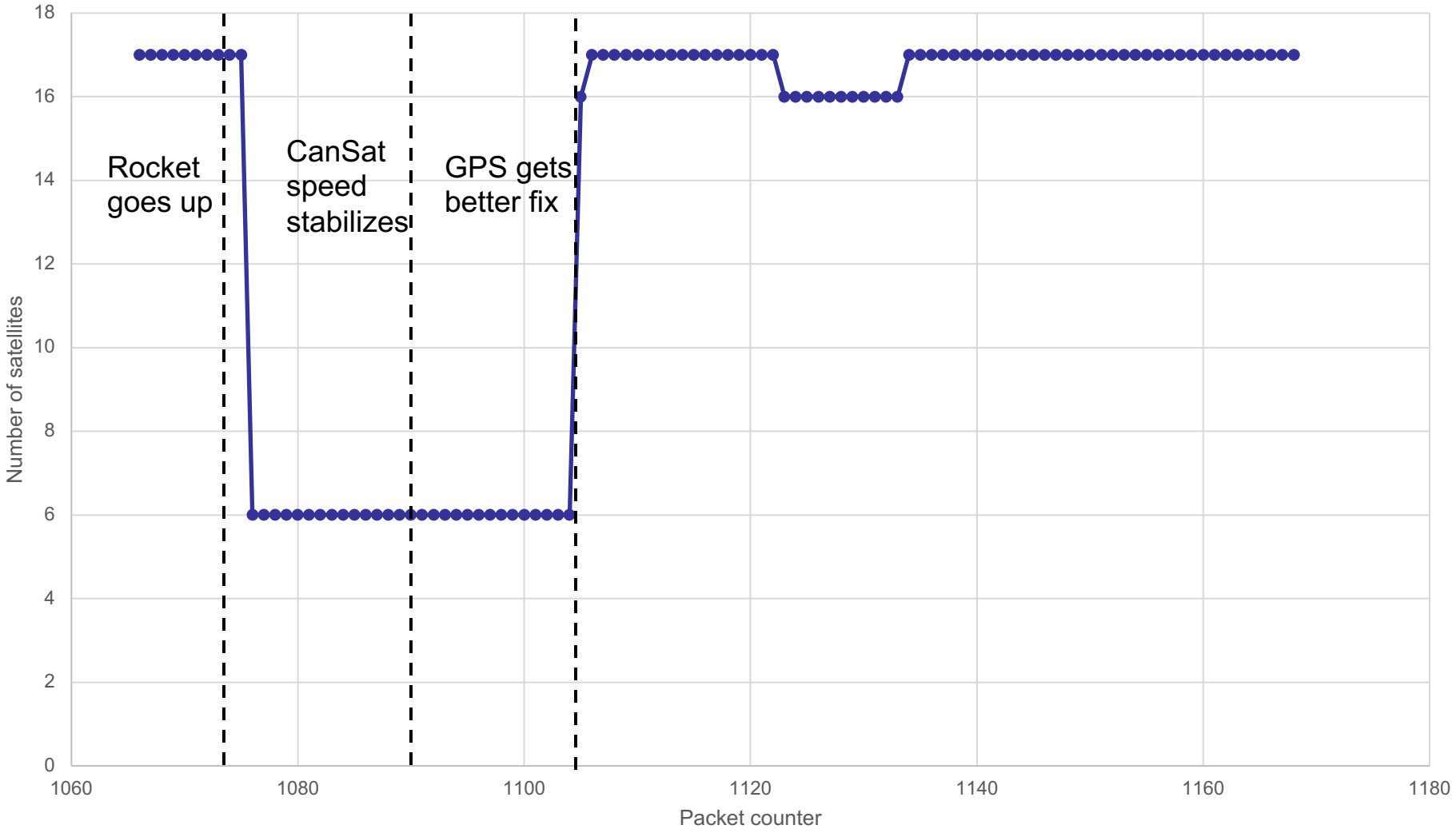
Heatshield: 15.26 m/s

Parachute: 3.73 m/s

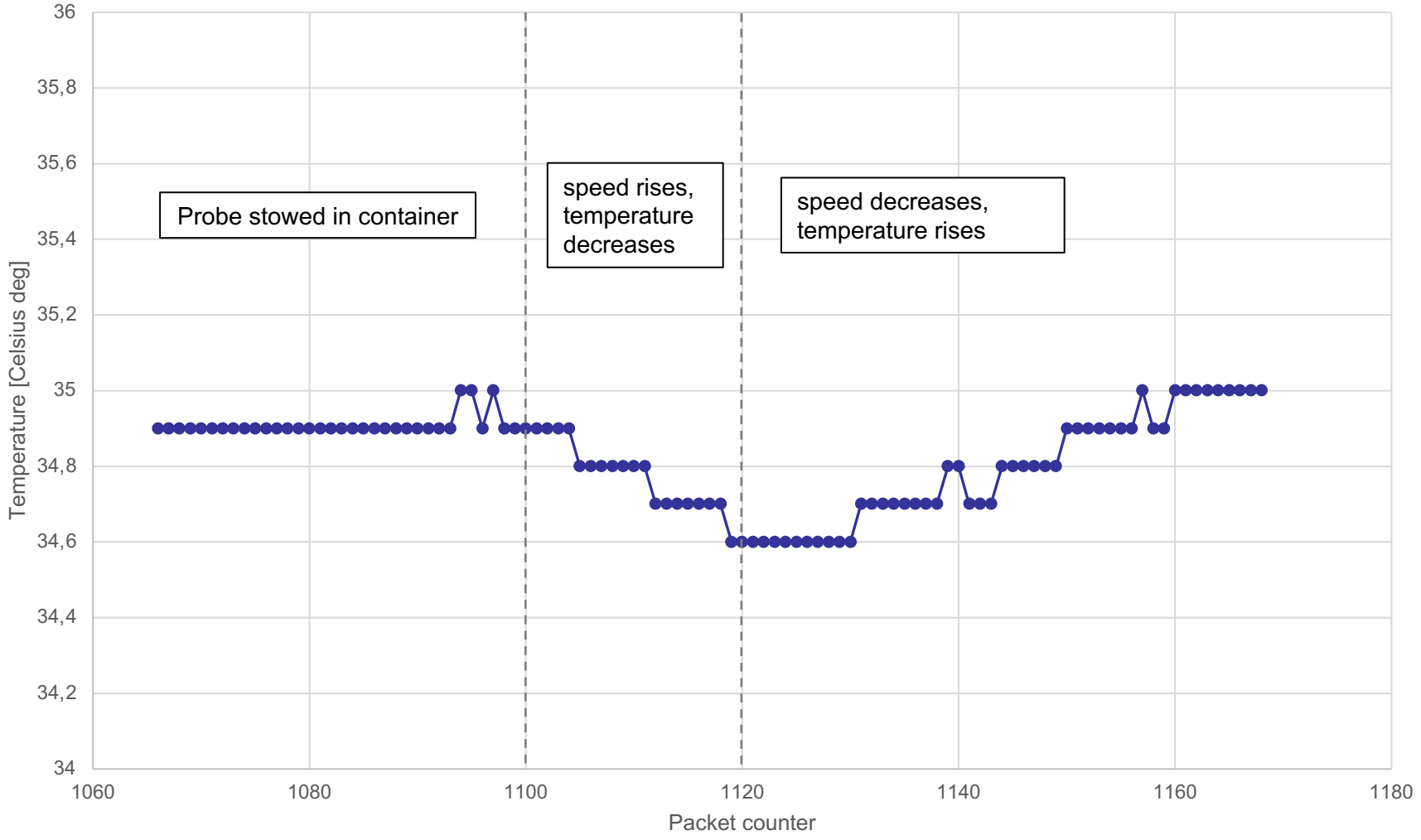
GPS 3D Position



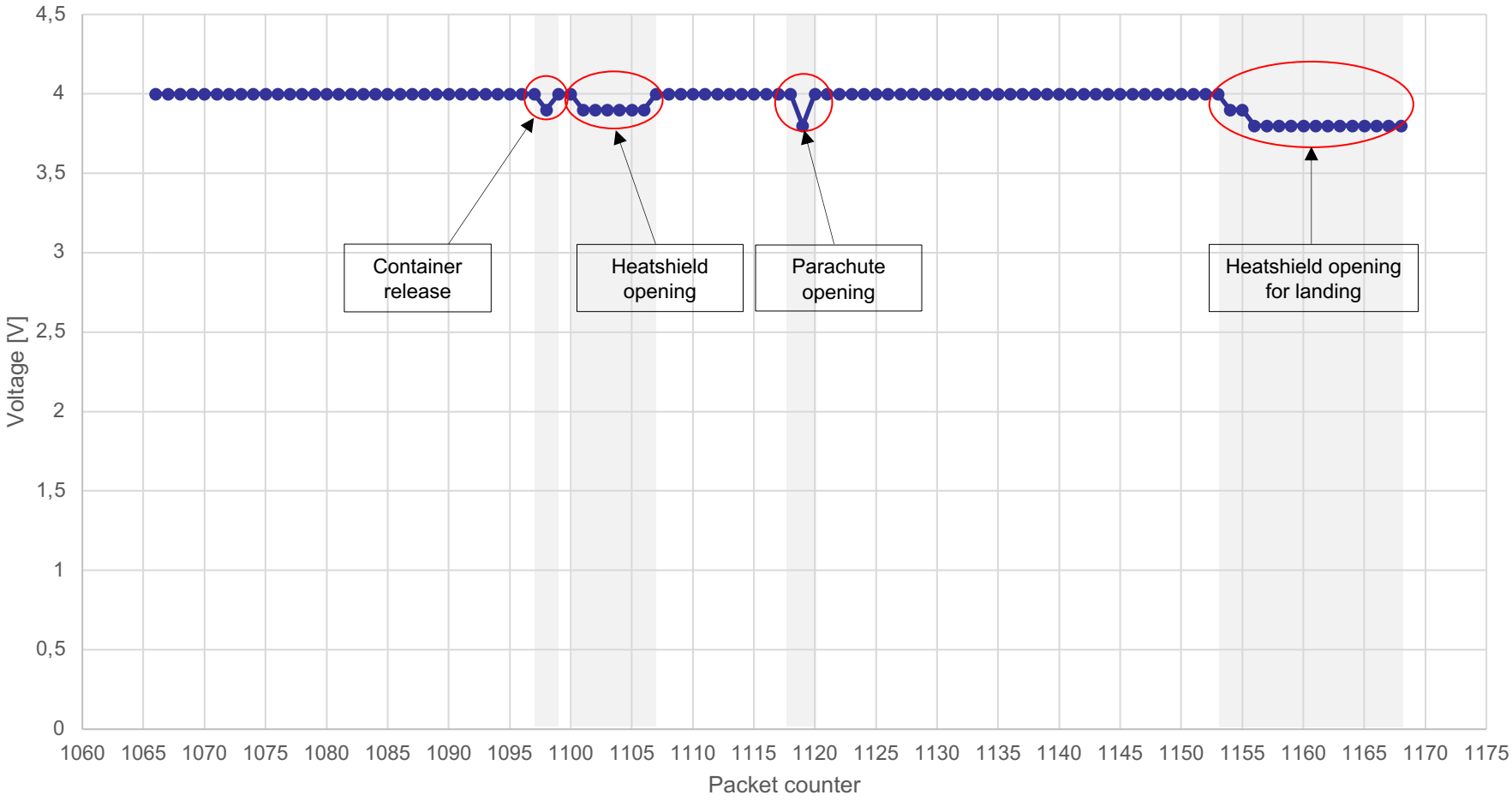
GPS Satellites



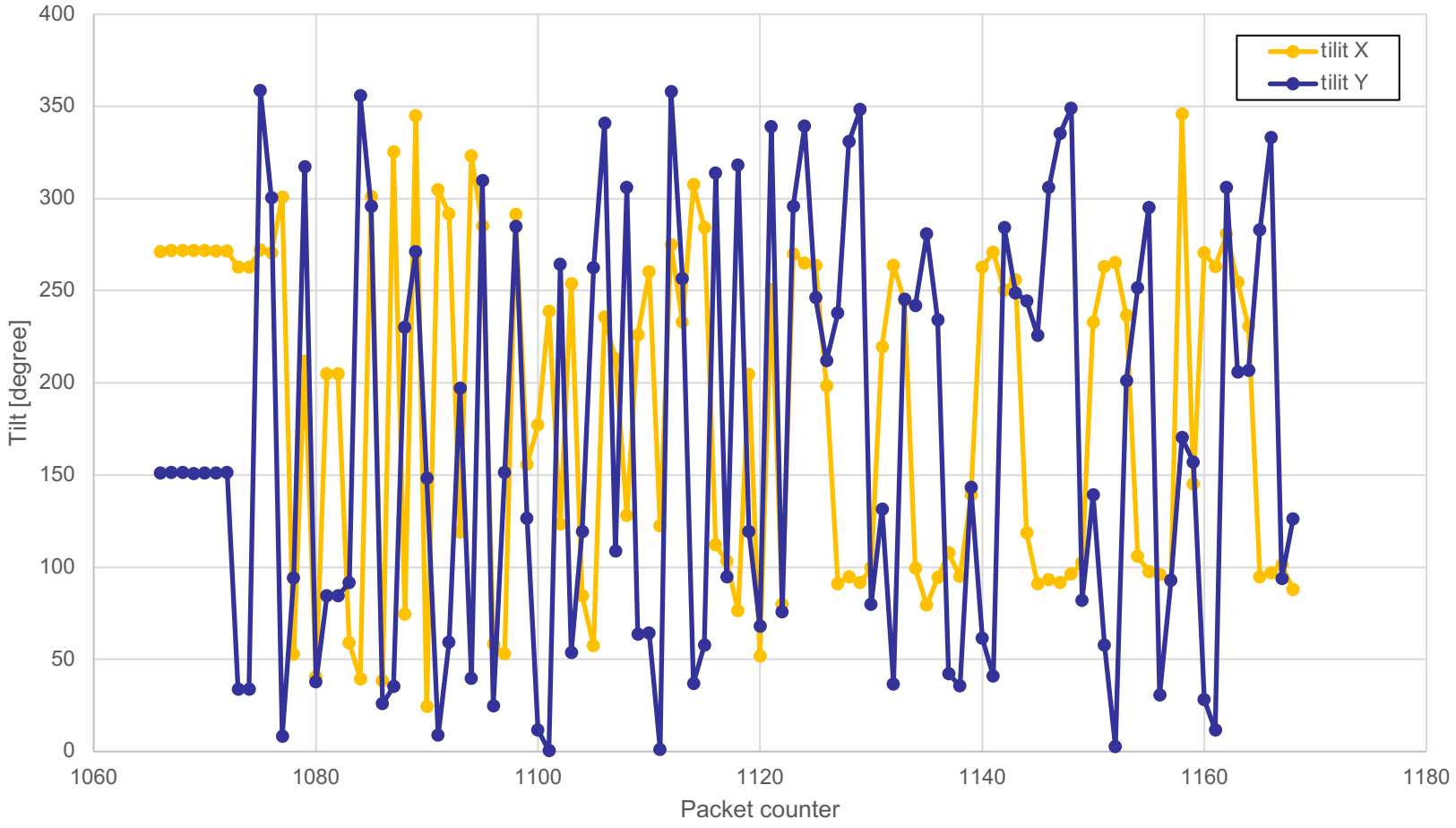
Payload Temperature



Payload Battery Voltage



Tilt Sensor Data



We noticed aliasing. Details will be provided in the following slide

Payload Camera Video

Bonus Container Camera Video

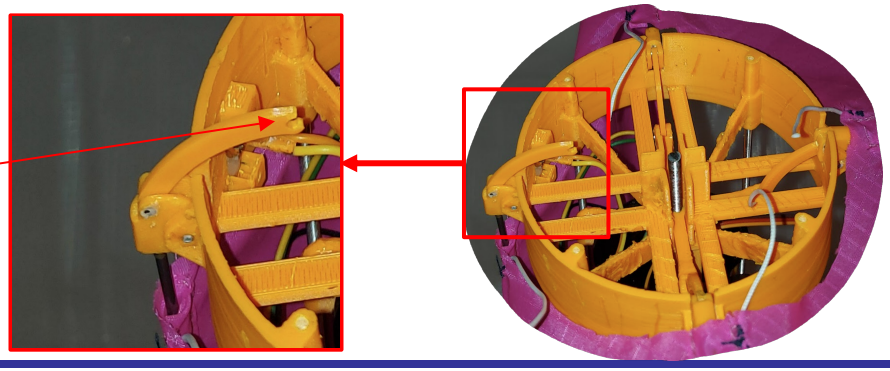
Failure Analysis

Hubert Kulik

Failure Analysis

Failure	Root Cause	Corrective actions
Uprighting mechanism failed	Uprighting leg collapsed under the stress of the landing. Caused by the high latteral speed due to wind.	Proper materials used F.E. aluminium instead of 3D printed ASA. Higher safety margins for unexpected environmental factors.
Payload parachute descents speed was to low	No testing of the parachute descent speed was done before the launch.	The parachute should be tested with the proper weight before launch.
Some packets were lost	Not enough motor EMI shielding, probably hand-held radio (460MHz) second harmonic interference with XBee radio (915MHz). Line-of-sight was broken by the launchpad geometry	Changing one of the radios frequency. Better EMI management (shorter cables, shielding, keeping the distance)

The failed linkage that prevented the uprighting



Lessons Learned

Tobiasz Puślecki

Lessons Learned

What worked?
We found our payload and container
Ground station sent calibration command and received telemetry
Packet transmission frequency met requirements
Plotting worked properly

What didn't work?
We lost 13 packets
Slower than expected descent
Upright mechanism didn't work

Lessons Learned - Conclusion

- Amazing adventure!
- Sim mode is necessary ☺
- Nice to see you again!
- We know how to work in team project!