American Astronautical Society

CAN SAT COMPETITION

Version 1.0

Team 2050 – KoNaR Can

Post Flight Review (PFR)

Presentation Outline

Systems Overview

Concept of Operations and Sequence of Events

Flight Data Analysis

Failure Analysis

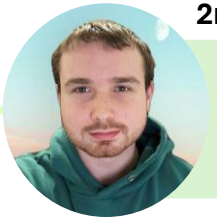
Lessons Learned

Team Organization

dr inż. Robert Muszyński
- Faculty Advisor

1st Master

Krzysztof Kowaczek
- Team leader
- Electronics
- Software



2nd Bachelor

Mateusz Wojtaszek
- Electronics
- Software

2nd Bachelor

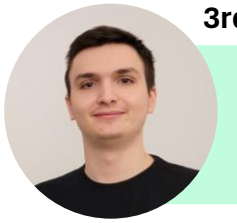
Mateusz Morawiak
- Finances & support
- Public Relations

3rd Bachelor

Natalia Nienartowicz
- Mechanics

1st Master

Tomek Lubelski
- Electronics
- Software



3rd Bachelor

Paweł Iwańczyk
- Mechanics

3rd Bachelor

Patryk Peroński
- Electronics

3rd Bachelor

Kamil Winnicki
- Mechanics

3rd Bachelor

Mateusz Zolisz
- Ground Station

KoNaR CAN INTO SPACE

Systems Overview (1/4) – CDR vs Final Design

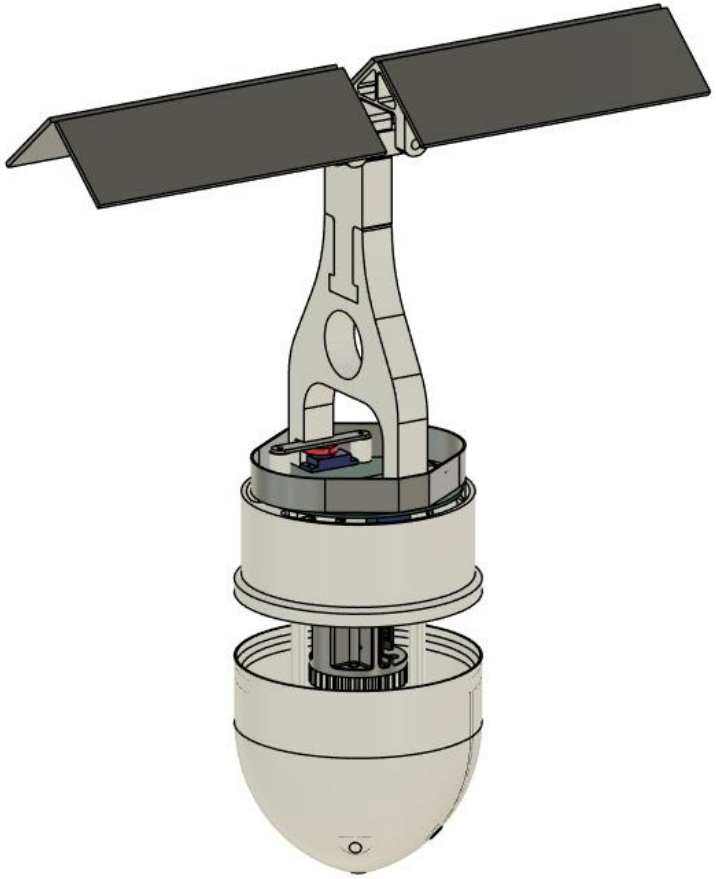
CDR Design

In the last stage of work on our CanSat, the following problems appeared:

- Too much weight
- Too tight fit in the rocket
- Problems with carbon fibre manufacturing
- Procurements problems

Unfortunately, we had to change the heatshield design to solve them.

All other elements of our CanSat remained mostly unchanged.



Final design

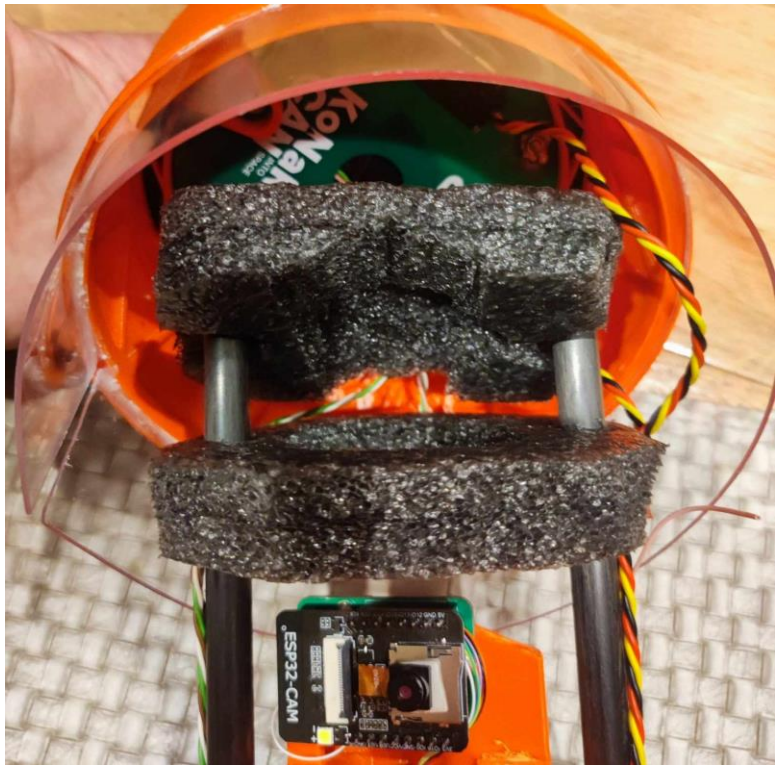
Systems Overview (2/4) – Final Design

Aerobrake
folded position

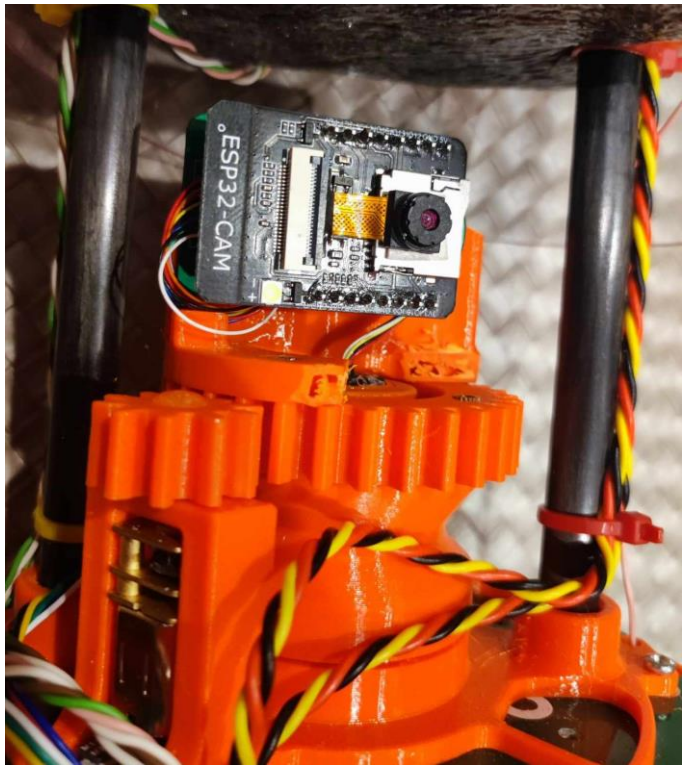
Aerobrake unfolded

Payload without
aerobrake

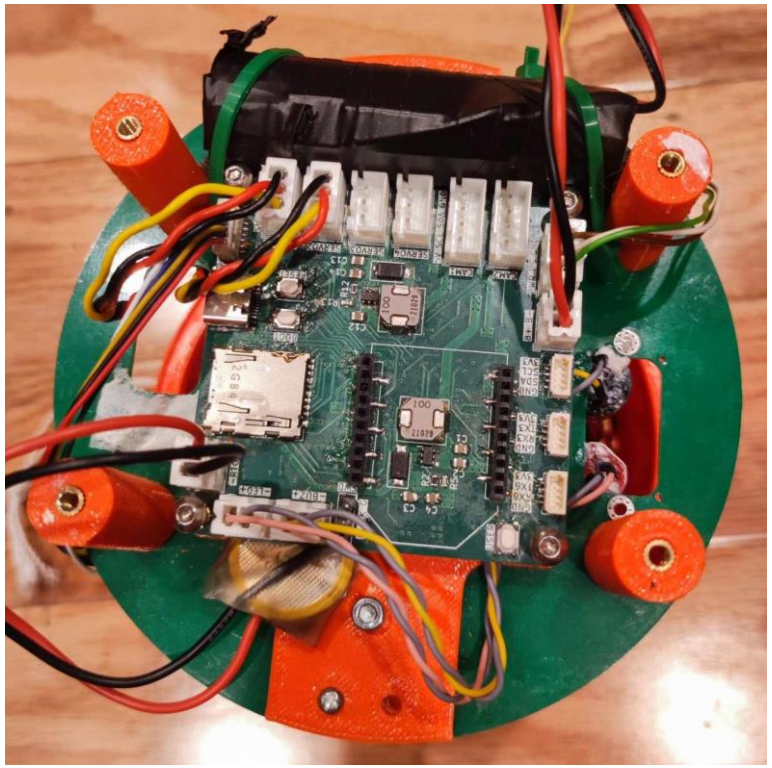
Systems Overview (3/4) – Final Payload Design Specification



Egg compartment



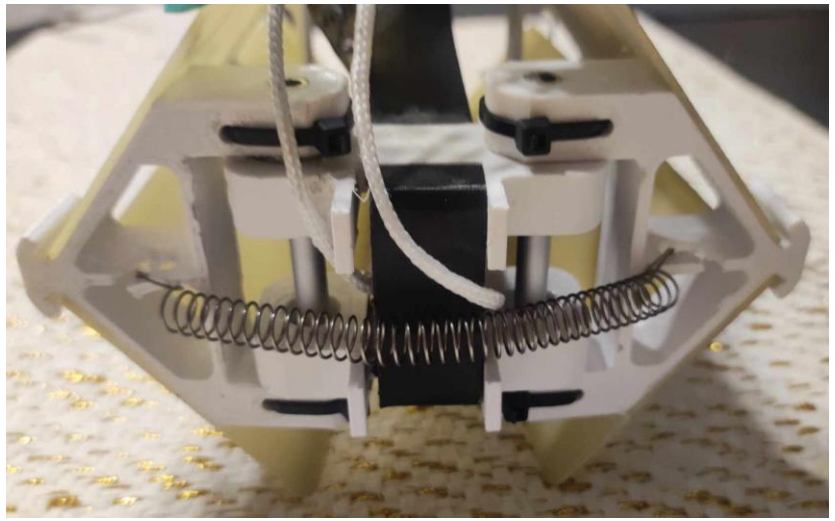
Camera stabilization mechanism



Electronics mount in nosecone

Systems Overview (4/4) – Final Aerobrake Design Specification

Pre-deployed configuration



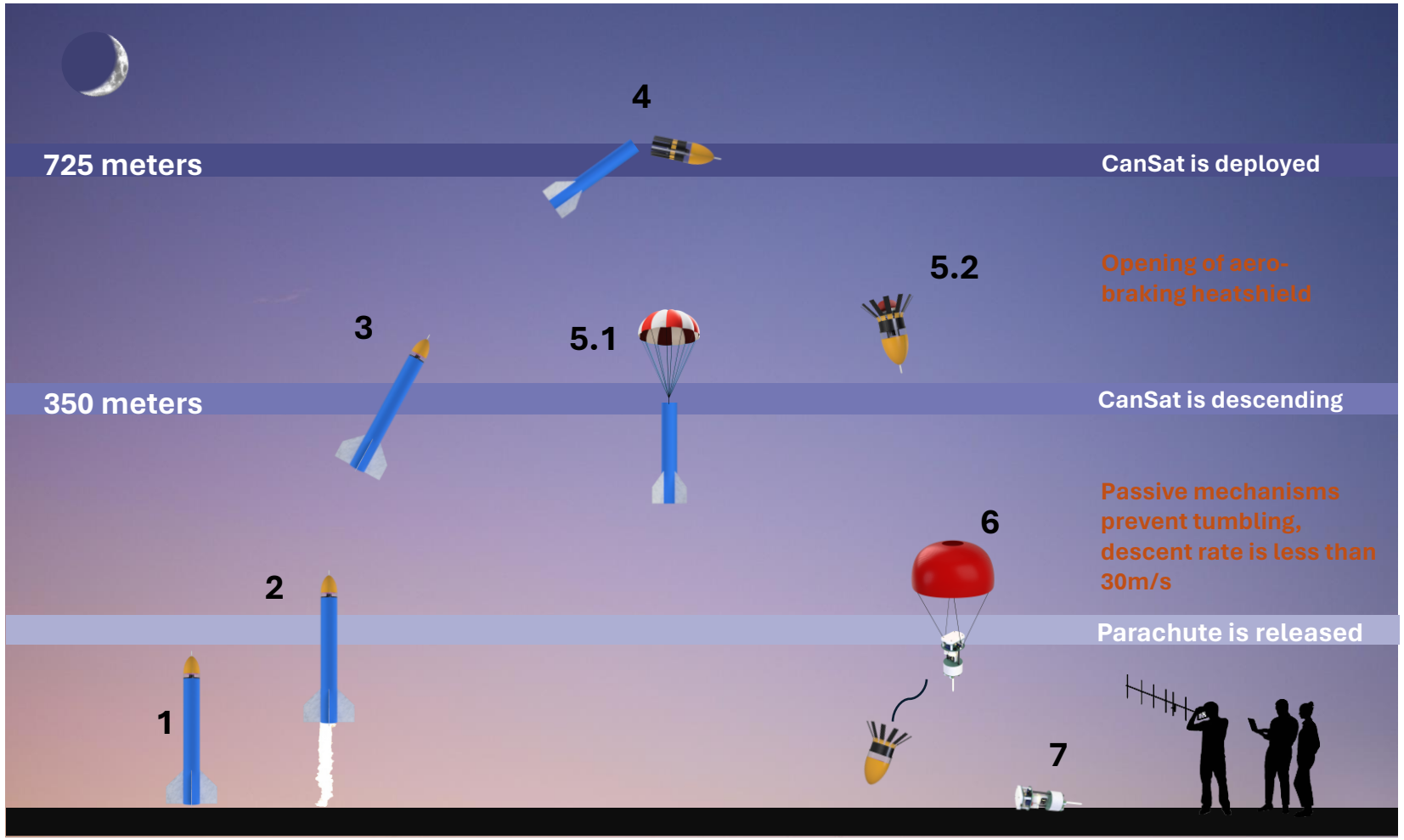
Aerobrake opening mechanism with spring

Deployed configuration

Concept of Operations and Sequence of Events (1/4) - Preparations

Stage	Activities
Pre - Launch	Arrival at launch site
	CanSat preparations, assembly and weighing
	Official CanSat inspections
Launch	Preparing ground station at designated place
	Placing CanSat in the rocket
	Execution of launch sequence
	Delivery of USB sticks to judges
Recovery and next steps	Stopping telemetry at landing, CanSat recovery with working buzzer, Data recovery from SD cards.
	Data gathering for final presentation

Concept of Operations and Sequence of Events (2/4) - The Plan



Concept of Operations and Sequence of Events (3/4) - The Plan

Number of operation	Description
1	Place CanSat into a rocket, then place it on the launch pad and Telemetry synchronization with Ground Station.
2	Rocket launch.
3	Speed measurement during ascent. Camera is recording.
4	At height about 700 meters, CanSat is deployed from the rocket.
5.1	The rocket is descending on its own parachute.
5.2	The CanSat is descending with a speed 10 - 30 m/s using the aerobrake.
6	Areobraking heatshield release, parachute deployment at 100 meters.
7	Stopping telemetry at landing, Cansat recovery with audio beacon enabled, data recovery from SD cards.

Concept of Operations and Sequence of Events (4/4) - The Reality

The mission went mostly as planned, except for a few minor things:

The CanSat state machine switched its state during ascent earlier than excepted.

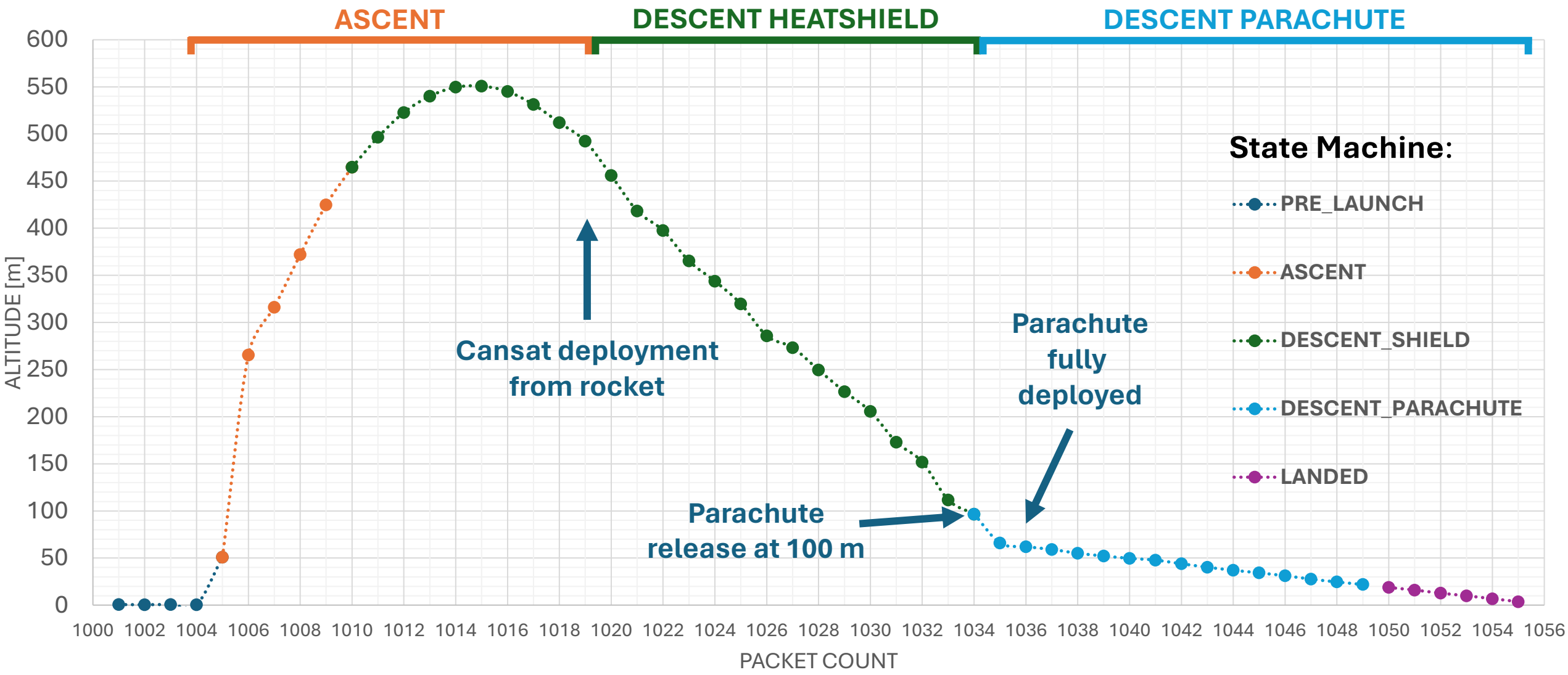
Tumbling after CanSat deployment led to a problem with the descending speed measurement using Pitot's pipe.

Trouble with aerobrake structural integrity led to aileron loss and a slightly faster descent than anticipated (but still in acceptable range).

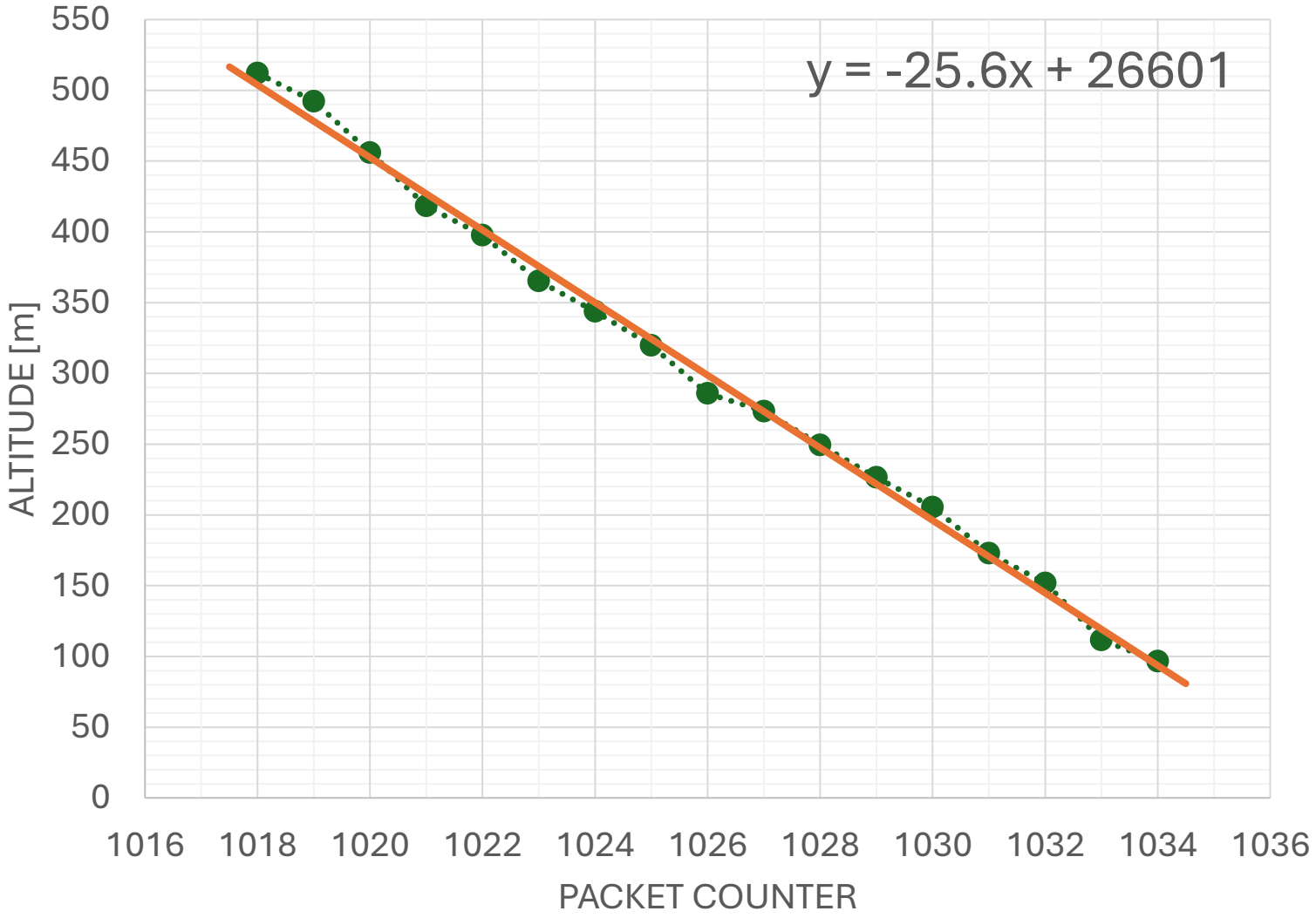
The maximum altitude was lower by 150 meters than anticipated.

In the end, these malfunctions didn't affect the mission outcome. We were able to recover the Cansat in one piece (egg still intact) and we collected all mission telemetry.

Payload altitude plot



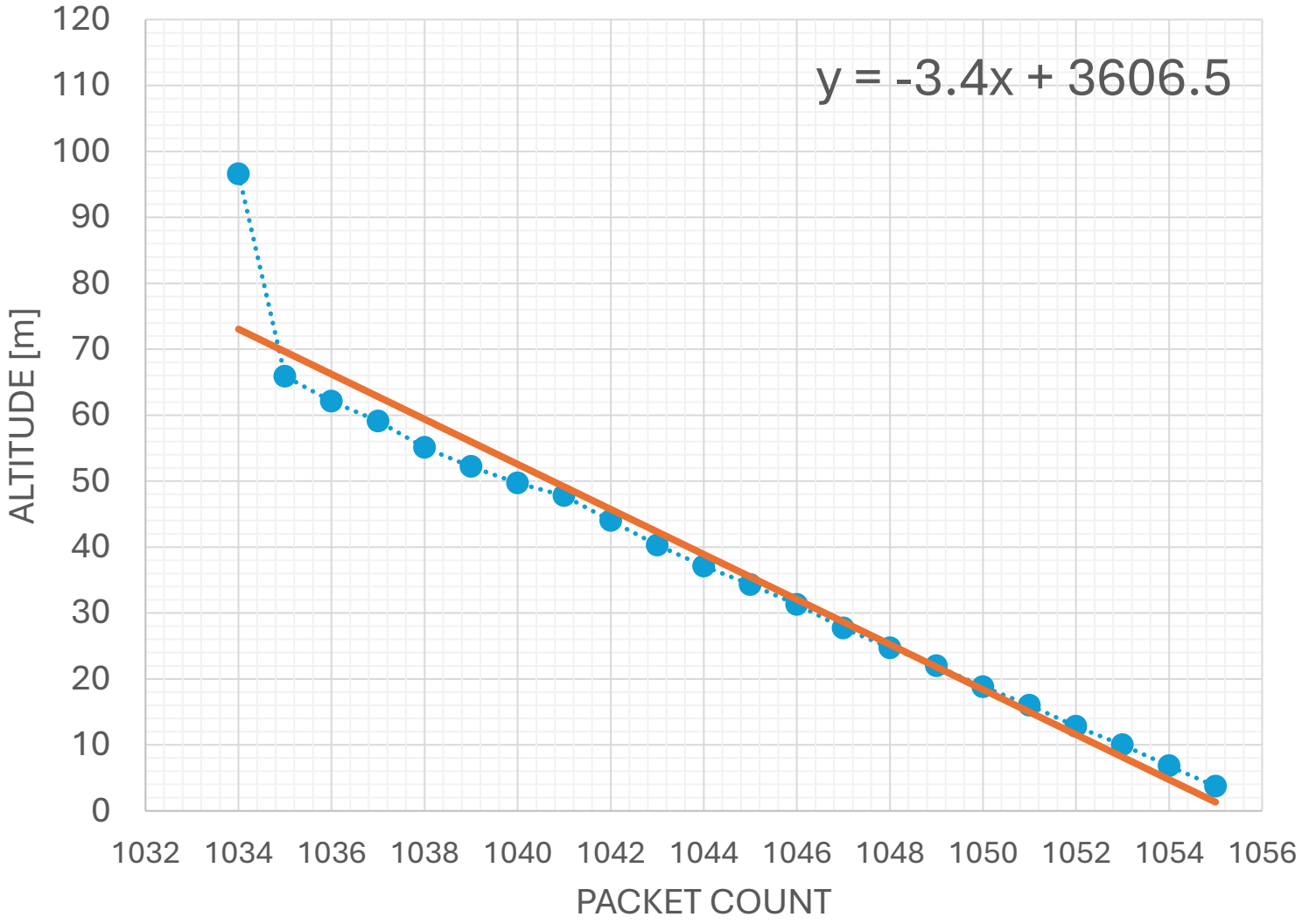
Aerobreaking Descent Rate Plot



The aerobraking speed calculated from altitude change over time is about **25.6 m/s**.

This value was acquired using the linear regresion plot function in Microsoft Excel.

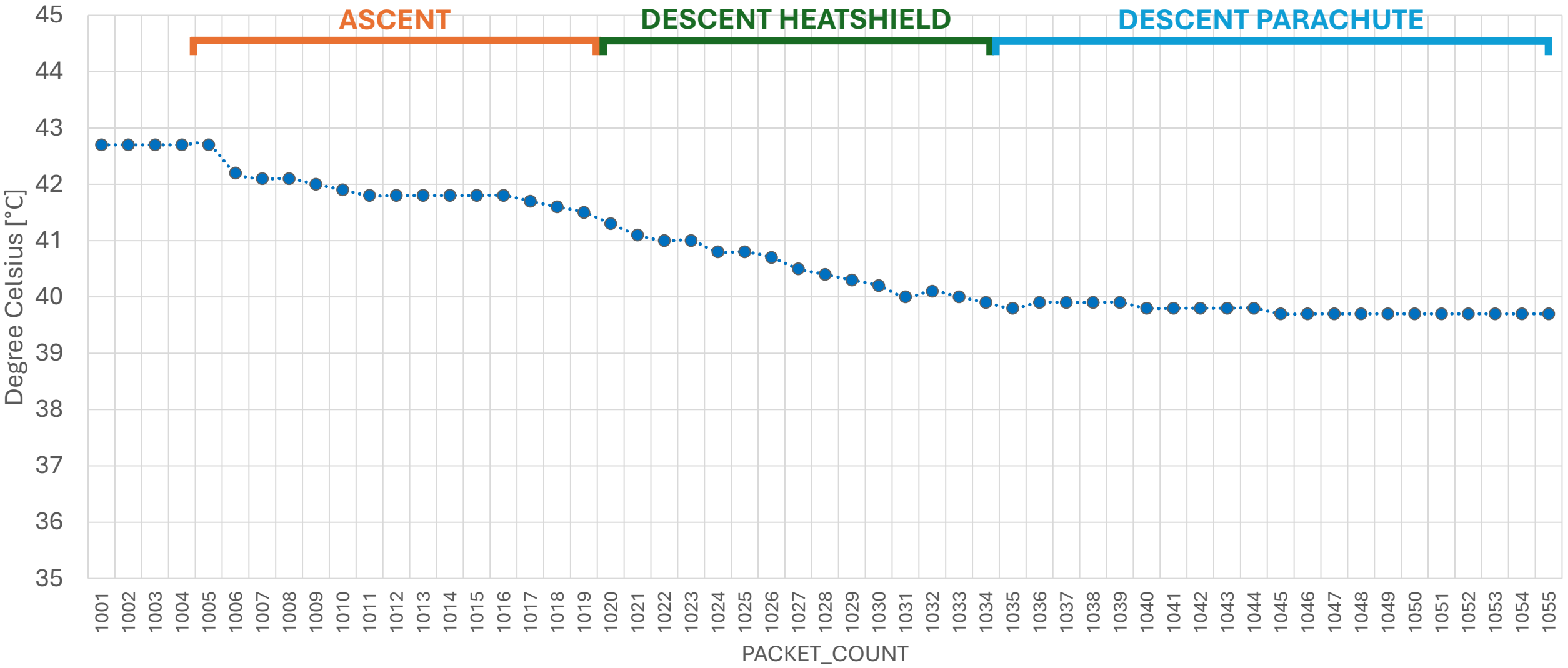
Parachute Descent Rate Plot



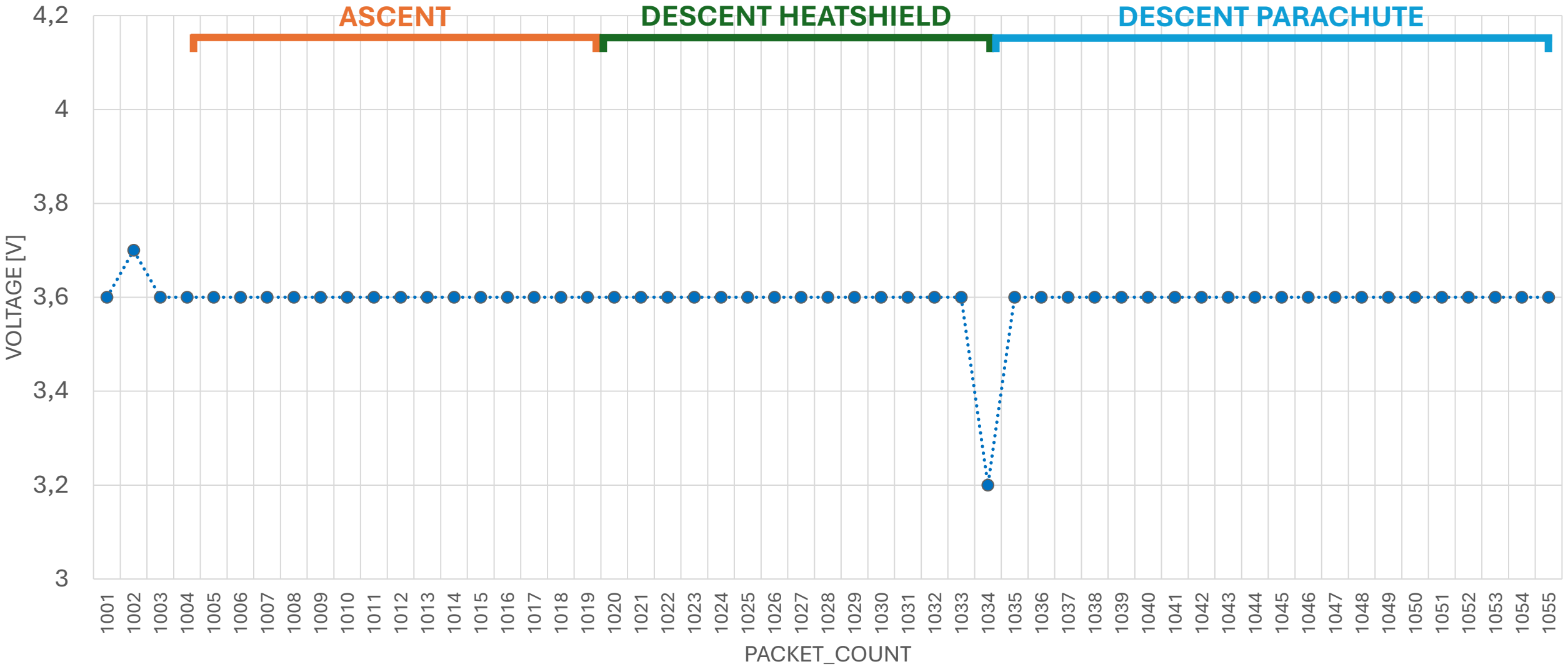
The parachute descending speed calculated from altitude change over time is about **3.4 m/s**.

This value was acquired using the linear regresion plot function in Microsoft Excel.

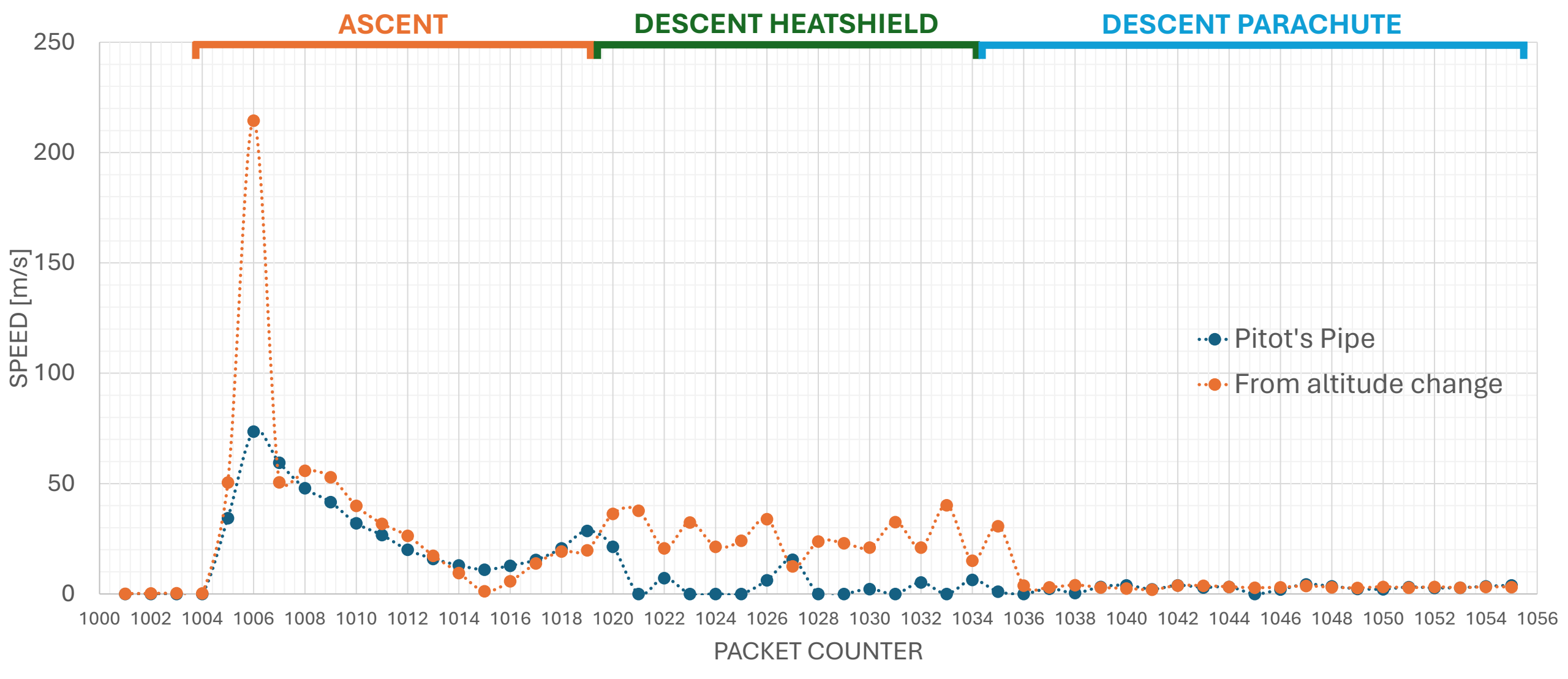
Temperature Sensor Data



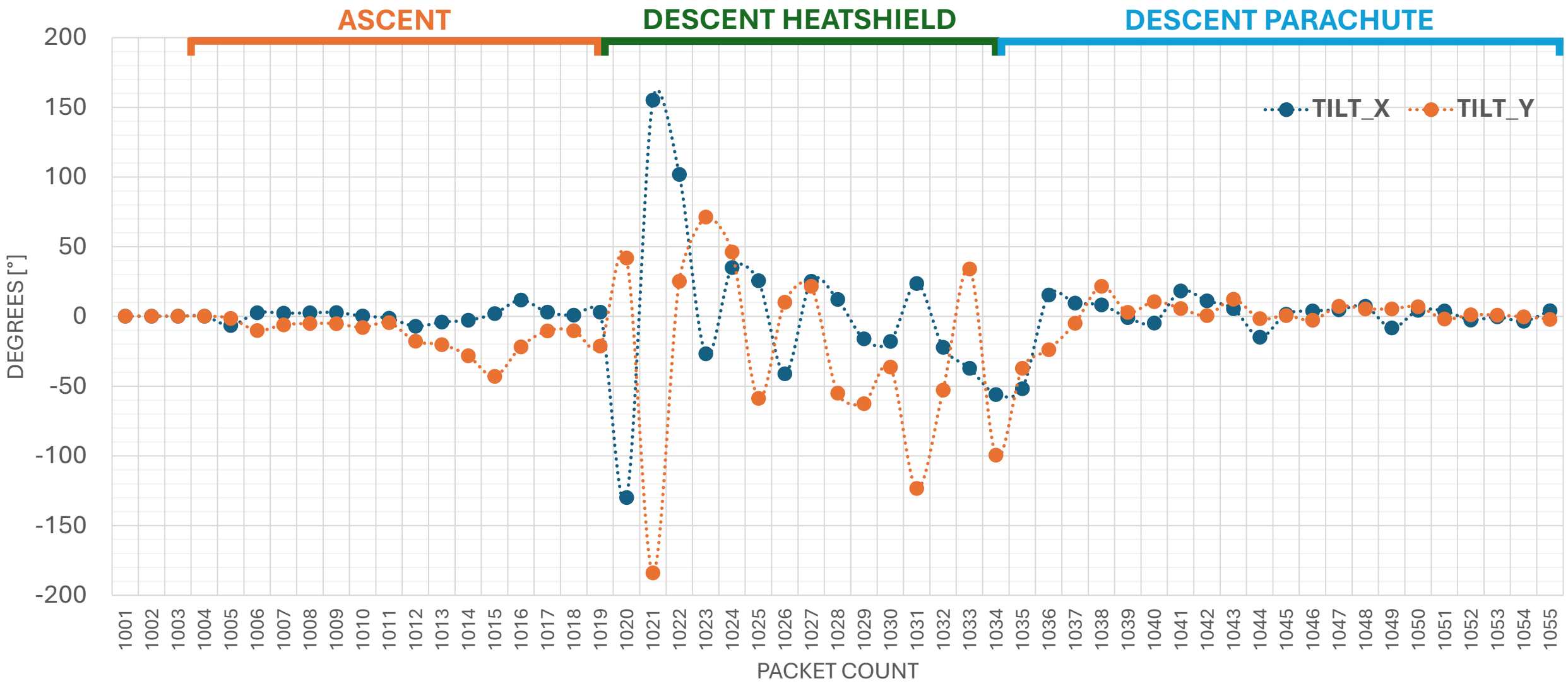
Battery Voltage Plot



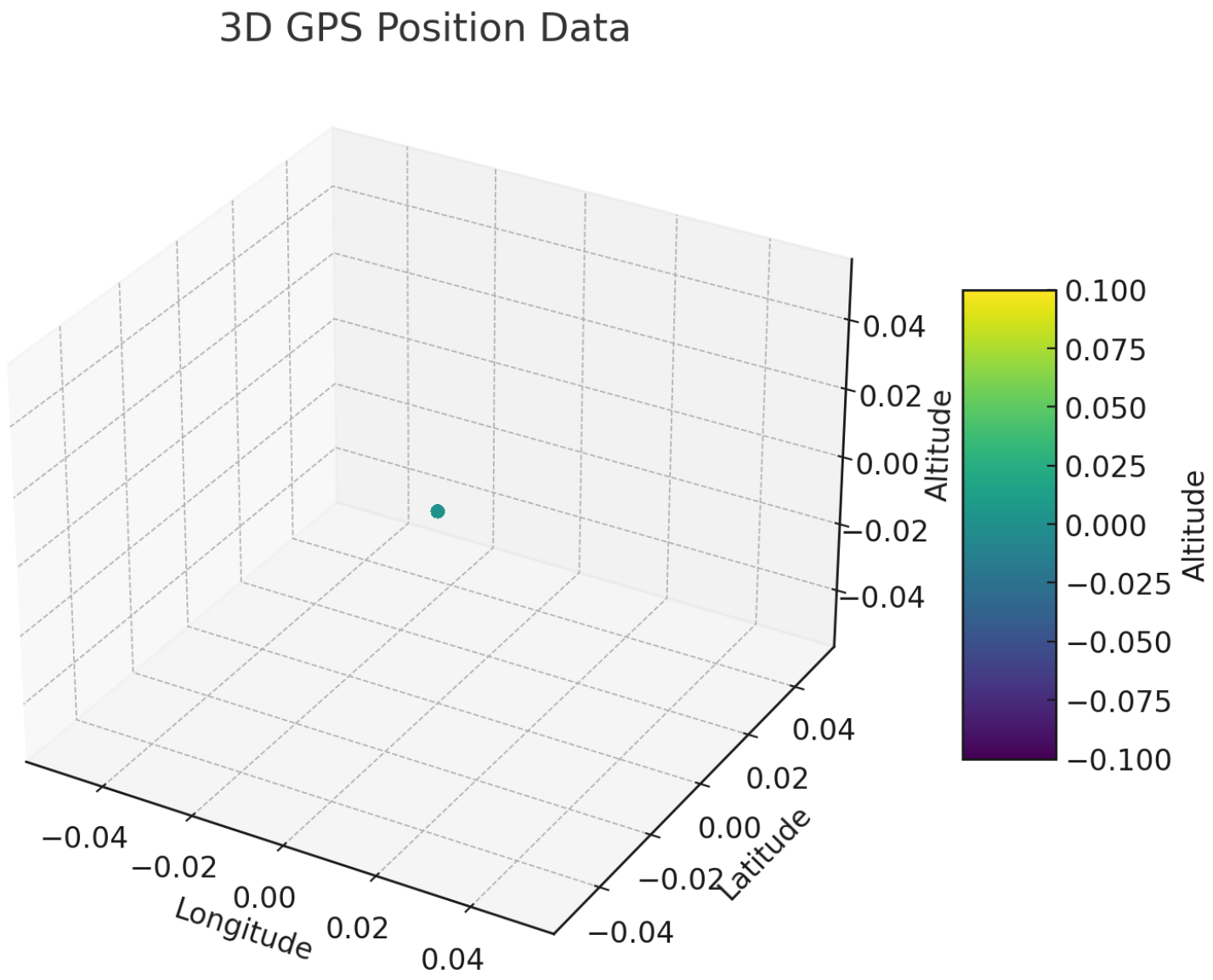
Pitot’s Pipe Speed Plot



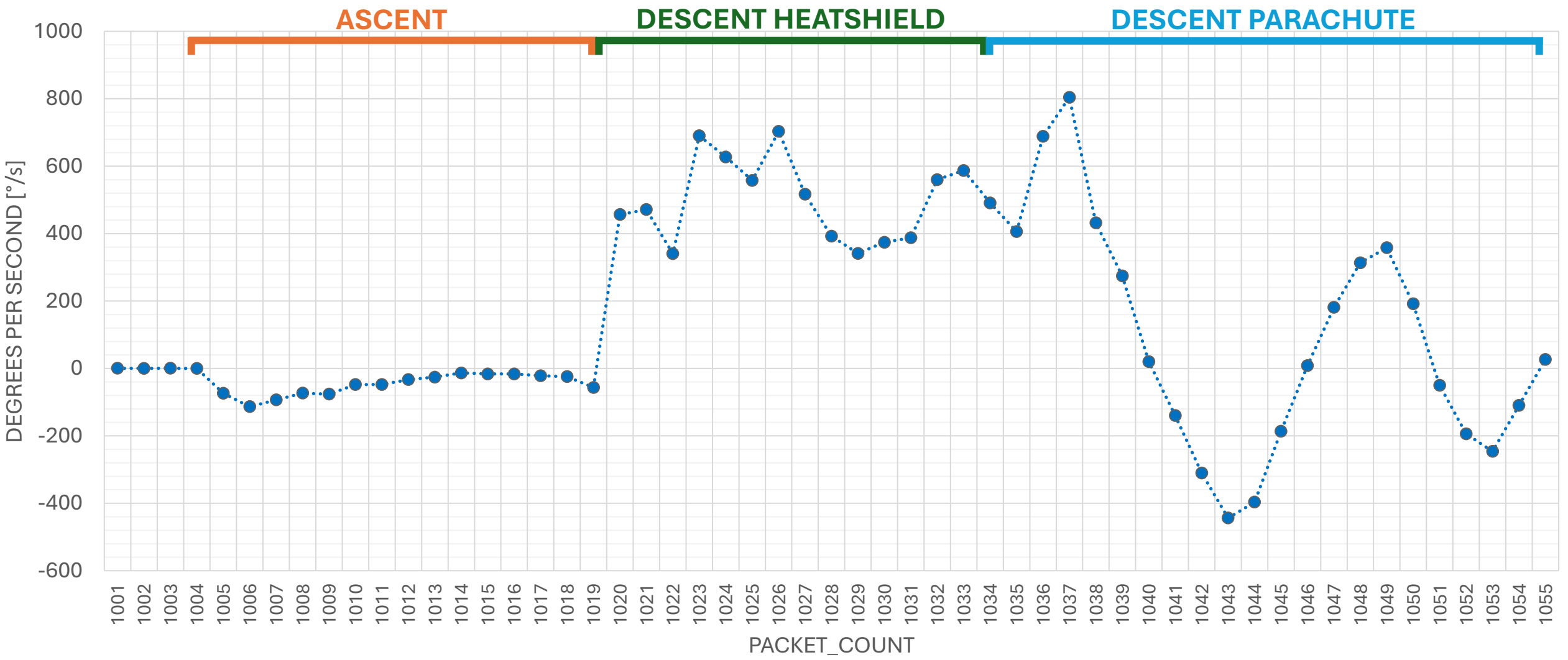
Payload accelerometer plots – TILT_X & TILT_Y



Payload GPS position plot

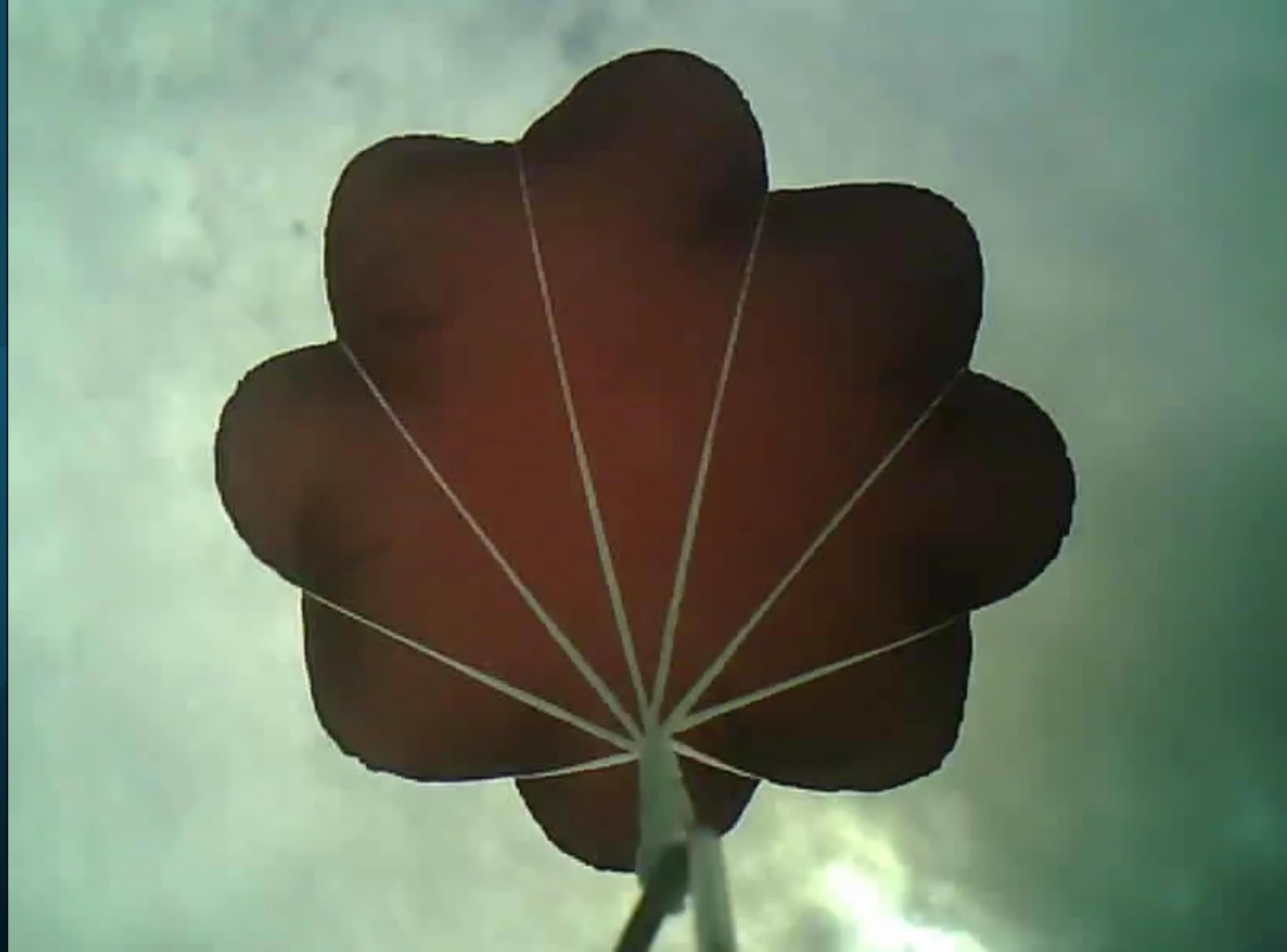


Payload rotation plots – ROT_Z



Payload Camera Video

Bonus Camera Video



Failure Analysis

Detected errors:

Manufacturing error led to insufficient structural strength of the ailerons

Imperfect Operation of the State Machine

Non-functional GPS module

These errors were not critical for the mission – the CanSat and egg survived.

Insufficient structural strength of the ailerons

Root causes:

- Manufacturing error led to insifficient strengh of one of 3D printed parts and it’s failure

Corrective actions:

- Conduct more tests of manufactured parts with more strict passing conditions.

Imperfect Operation of the State Machine

Root causes:

- Large pressure fluctuations during ascent;
- Too loose state change conditions.

Corrective actions:

- More tests with noisy data;
- Reduce the frequency of checking the altitude condition.

Non-functional GPS module

Root causes:

- Insufficient GPS tests;
- Acquiring a Fix Point proved to be challenging at the flight location.

Corrective actions:

- Conduct more tests of the GPS module in various atmospheric and topographical environments to ensure reliability and accuracy;
- Acquire a better GPS module;
- Perform preliminary tests in the launch side area to verify it's performance before the main flight.

Lessons Learned

- Everything should be tested before being used in project
- A lot about creating software for devices such as satellites
- More aerodynamics simulations and calculation should be performed
- We learned how to make good communication with the satellite
- We learned how to work and manage in team project