OPS-SAT-1 re-entry data

6th International Space Debris Re-Entry Workshop

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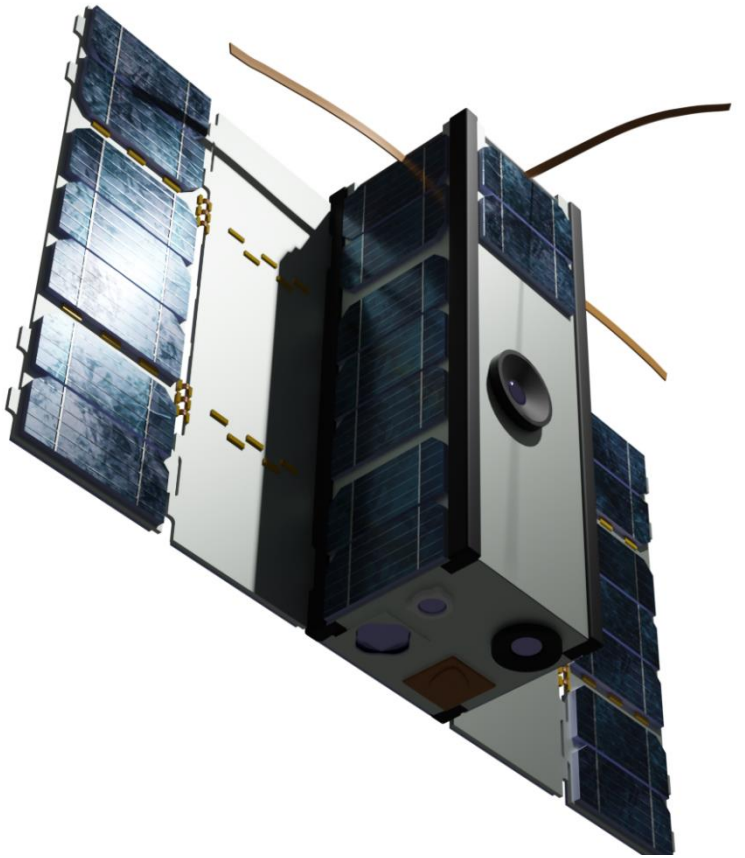
OPS-SAT-1 Mission

- Launched 18 December 2019
- Re-entry 22 May 2024
- In-orbit lab for industry, academia and research
- 285 experiments by 134 teams from 19 countries conducted
- Examples:
    - AI and image recognition
    - FPGA experiments
    - Astrometry
    - Autonomous navigation
    - Live communication



Re-entry preparation and expectations

- We expected to experience
  - increased temperatures
  - spin-ups
  - potential outage of S-Band communication due to spin
  - dramatically increasing altitude loss, the lower we get

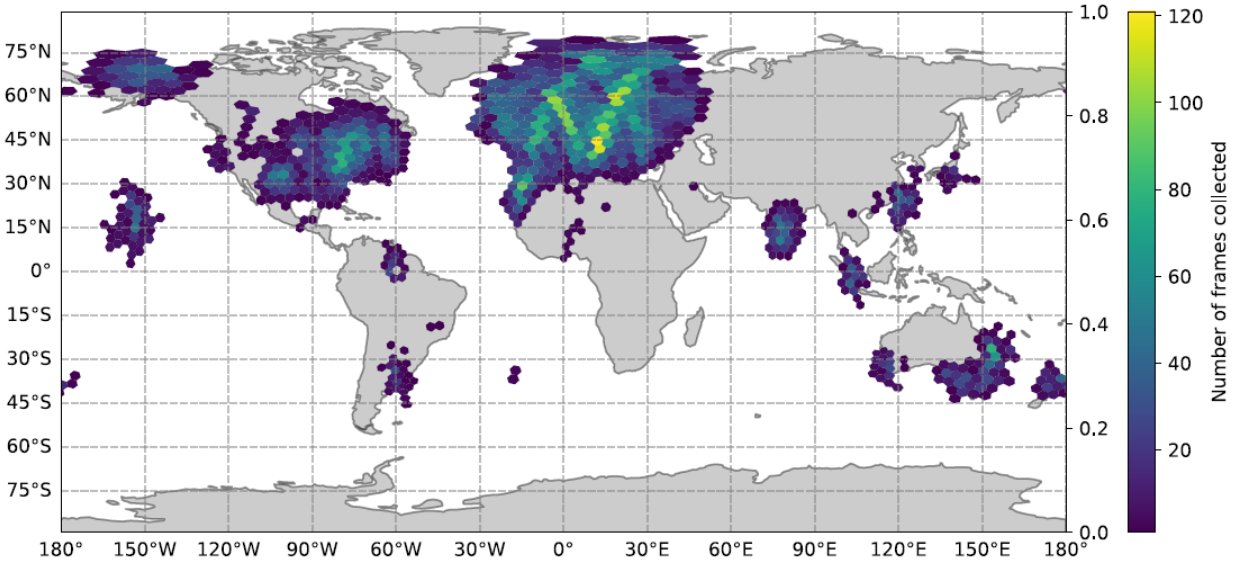
- Preparations:
  - Horizontal pointing – drag reduction as early as possible
  - UHF campaign – **implementing relevant telemetry as UHF beacon** and gathering radio amateur support worldwide
  - Additional UHF station – adding UHF commanding capacity

UHF Radio Campaign

- OPS-SAT was able to send packets in UHF, which can be picked up by radio amateurs, e.g. SatNOGS
- We prepared a new set of UHF packets to monitor temperatures, power, spinrates for the deorbiting campaign
- We build an infrastructure to process those packets and display the results in realtime for the public
- Achieved public engagement all over the world

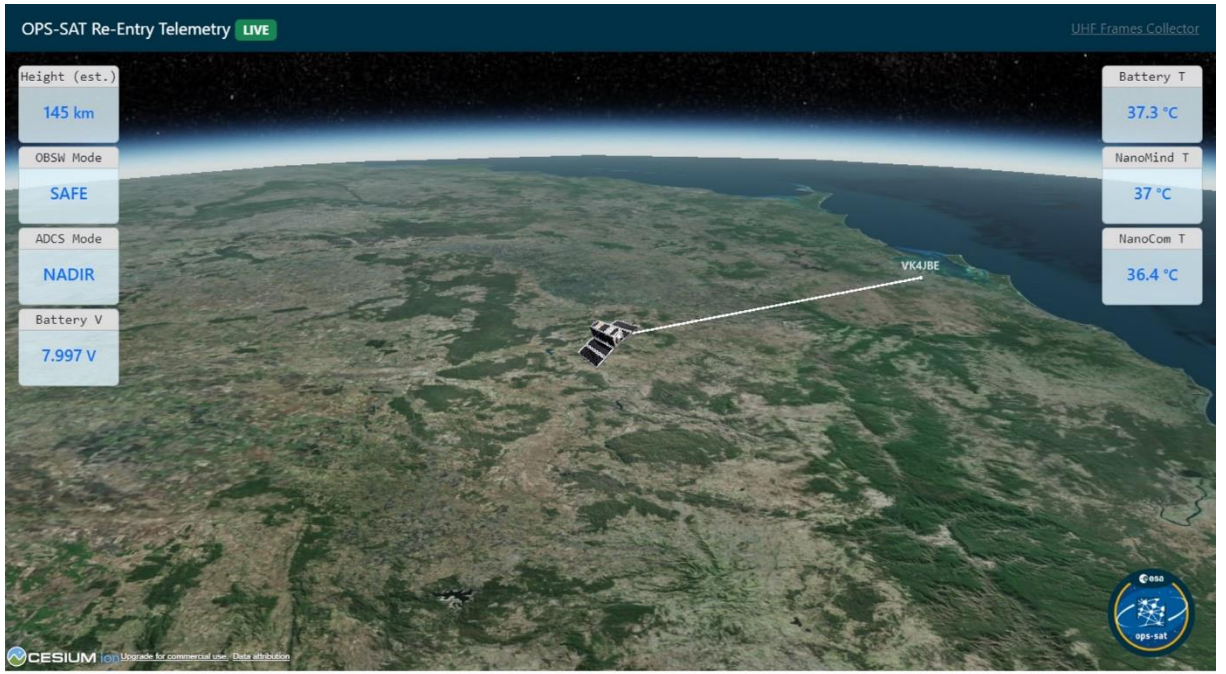
- Last contact with OPS-SAT over Australia, May 22 21:30 UTC by SatNOGS station
- All next passes failed

- 16500 frames were collected from May 1st until re-entry



Public Interest and Engagement

Real time TM Dashboard and Position/Orbit Visualizer



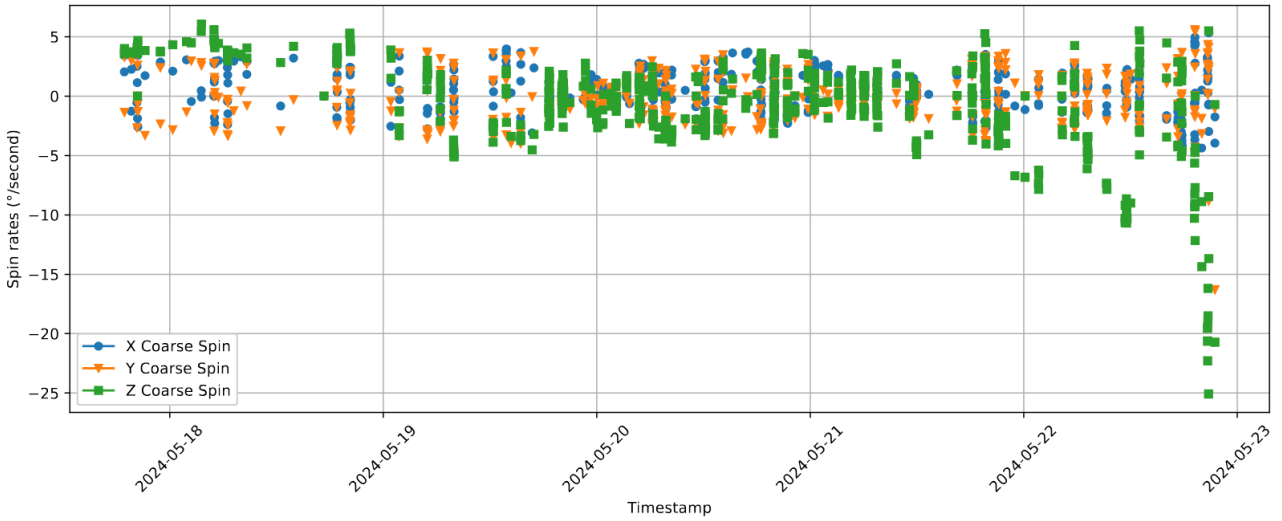
What did we observe

- S-band worked almost until re-entry
- TLE predictions became more and more unreliable
- Drag reduction concept was proven

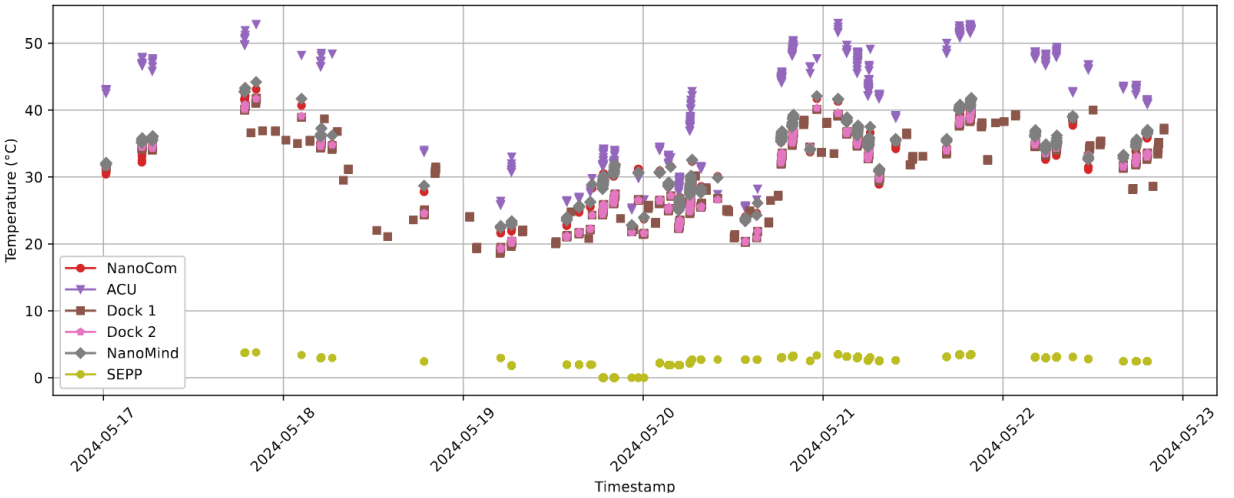
Find the reentry dataset and examples here:

- https://opssat.esa.int/ops-sat-1/reentry_dataset/

- Spin rates – spin up and spin down



- Internal temperatures
  - Show no significant increase



Data overview

- TLE Data (Celestrak)
- UHF Campaign Data (Beacon TM)
- UHF Beacon signal and further Beacon TM

- Celestrak CelesTrak: Special Data Request Form
- OPS-SAT: OPS-SAT Space Lab | Notebook
- SatNOGS: SatNOGS DB - OPS-SAT

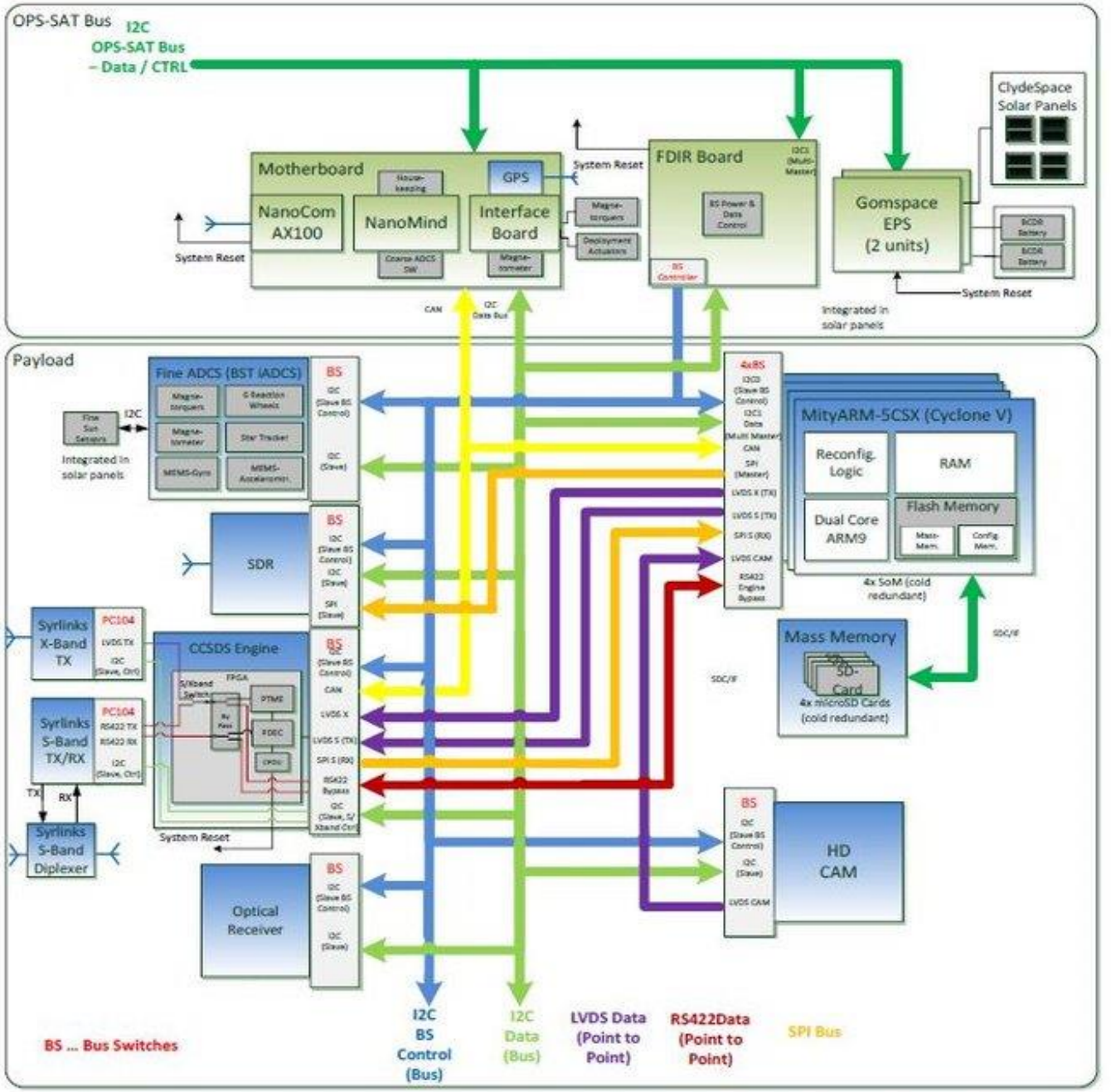
Acknowledgements and Future

- The OPS-SAT Space Lab Team:
  - David Evans – ESA
  - Dominik Marszk – ESA
  - Nuno Carvalho – Telespazio Germany
  - Tim Oerther – Terma Germany
  - Guilhem Honoré – ESA Trainee
  - Frederik Dallomo – ESA Trainee
- A special thanks to the amateur radio community and SatNOGS.

- Find news on [OPS-SAT Space Lab (esa.int)]
- OPS-SAT VOLT experiment registration is open!
- Contact us via [Esoc-Ops-Sat@esa.int]

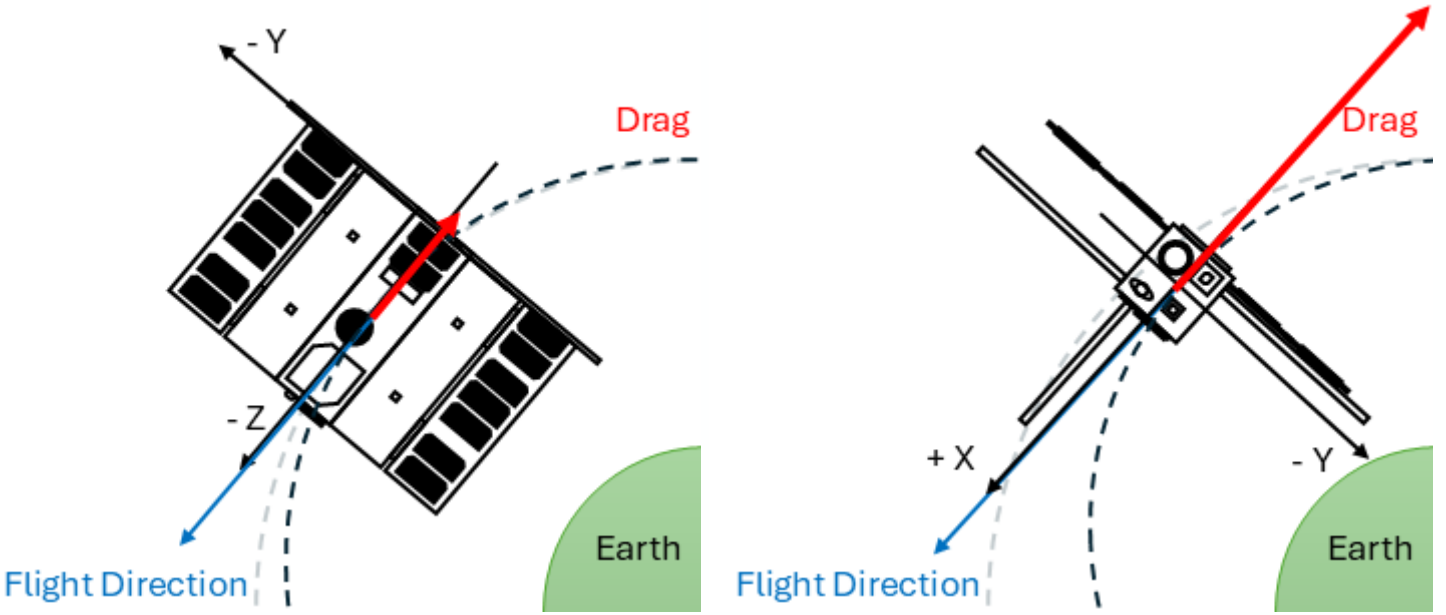
OPS-SAT-1 Mission - System

- Split of platform and payload to ensure safe experimentation
- Platform:
  - OBC, coarse ADCS, Power
- Payload
  - Payload computer
  - Fine ADCS
  - Camera
  - SDR
- Communications:
  - UHF, S-Band (up & down)
  - X-Band (only downlink)

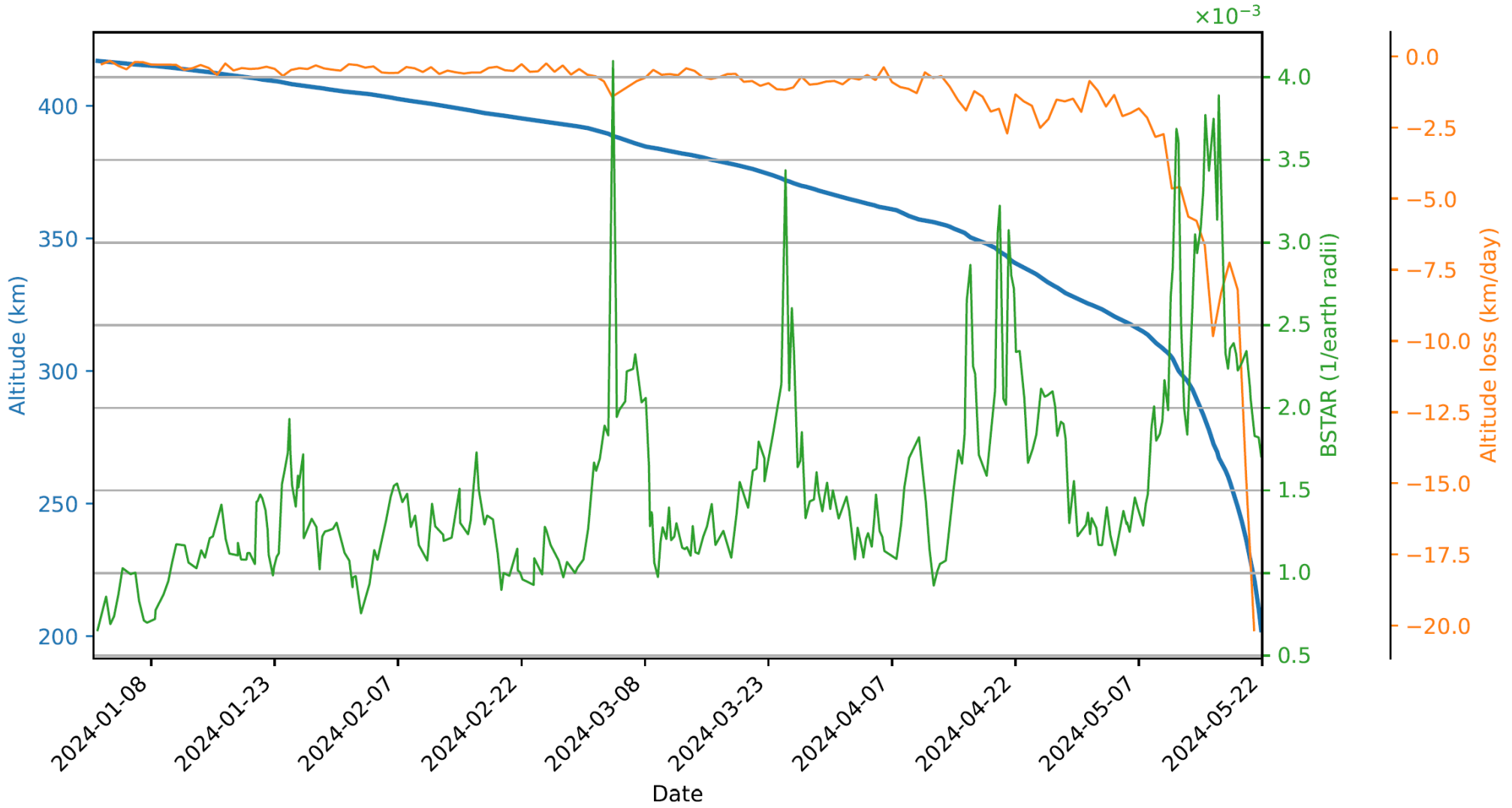


Drag reduction concept

- Horizontal pointing (HoPo)
  - Point –Z-Axis in flight direction, point +Y to nadir
  - -X axis with maximum number of solar arrays generally points to sun
- Fine ADCS RWs used as actuators in combination with coarse ADCS sensors
- HoPo consisted of different fine ADCS modes orchestrated via an application on the payload computer

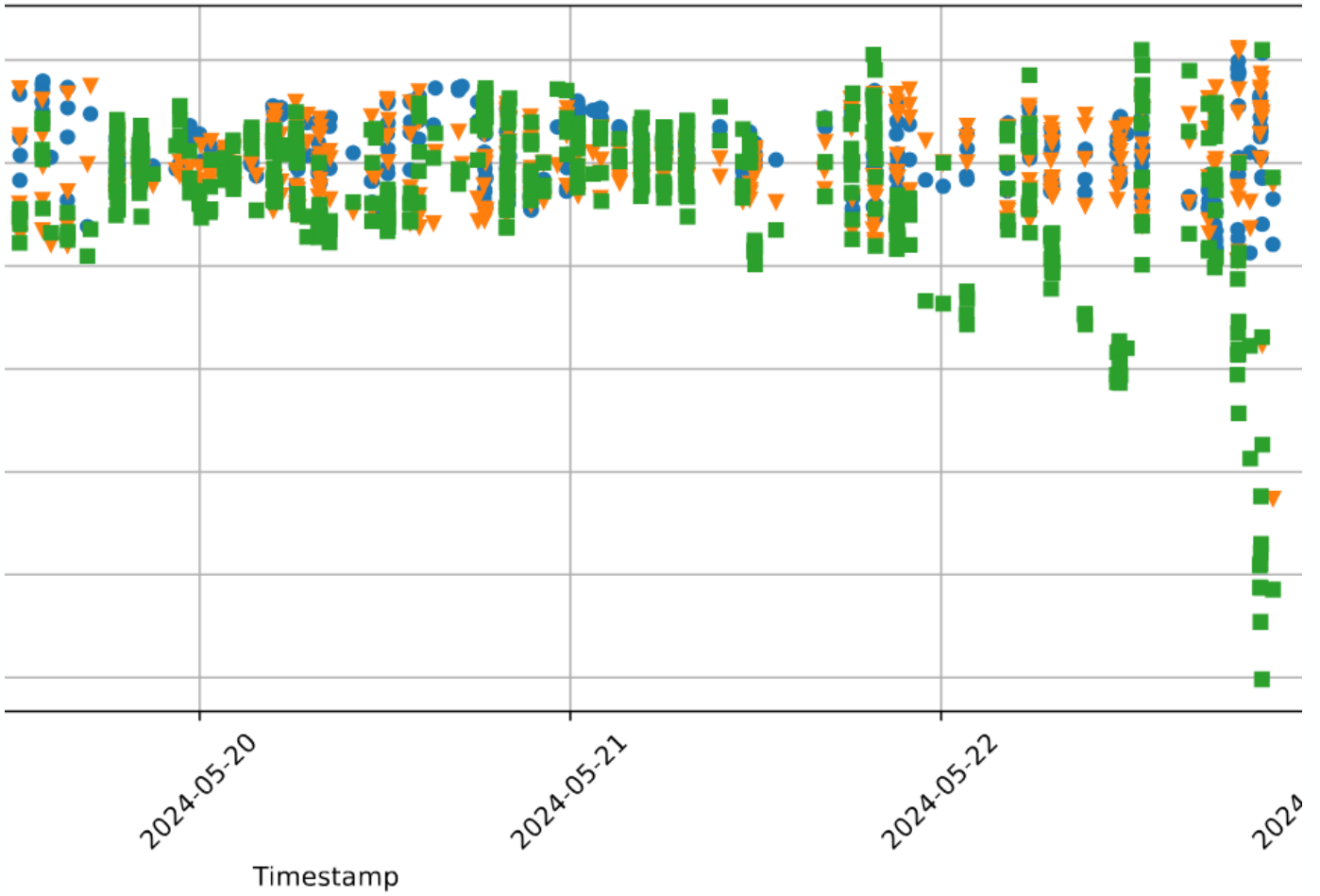


Drag reduction concept results



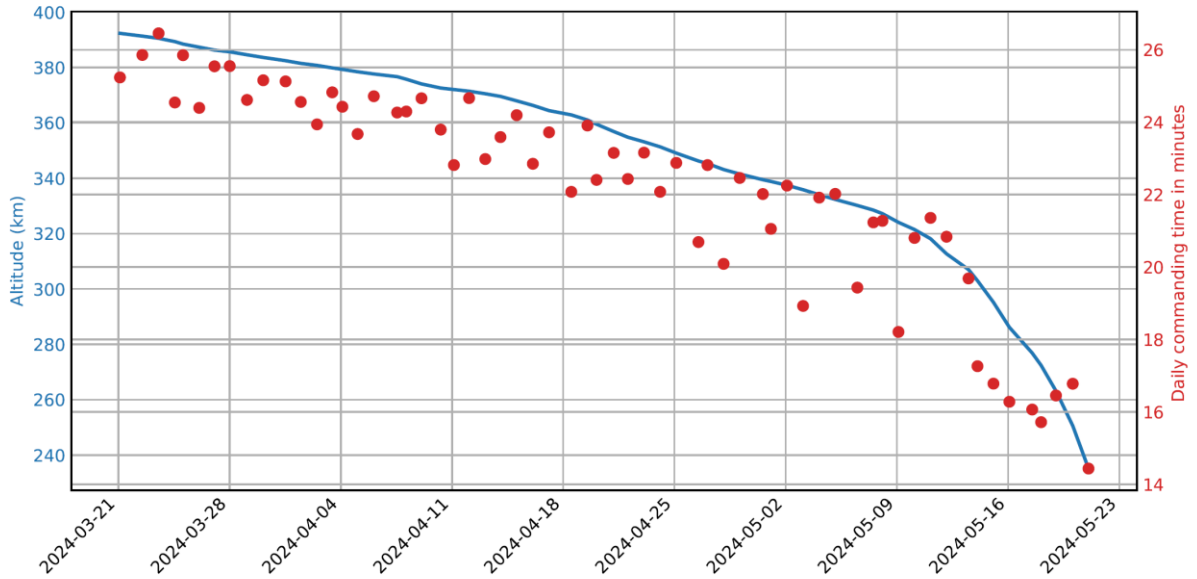
What did we observe

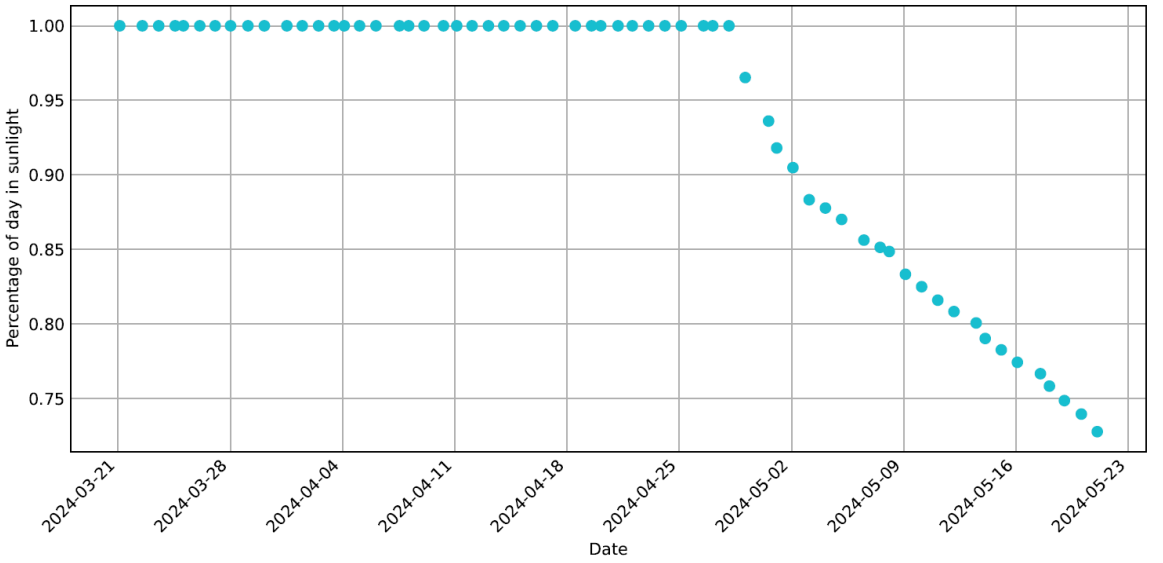
- Spin rates – spin up and spin down
- On the last day we saw a spike in spinrate, which also spins back down



Operational Challenges at EOL

- Change in orbit leads to shorter passes and eclipses
- Eclipses cause reduction in available power
- Reduction in power leads to decision to turn off payload computer
- Mission planning concept was adapted





Operational Success at EOL

- Last experiments were conducted until morning of 22 May 2024

- 19 May – Protostar Labs, Croatia – FPGA experiment for anomaly detection
- 19 May – University of Stuttgart, Germany – Real time communication and Rust flight software
- 20 May – University of Oxford, UK – Live Space-to-Ground Communication with QUIC
- 21 May – Politecnico di Milano, IT – CubeSat Autonomous Navigation Demonstration
- 22 May – Hellenic Space Industry, Greece – Live Space-to-Ground TCP/IP Connectivity

- Last pass 22 May –21:30UTC
- Re-entry 20min later