

# A?

Aalto University  
School of Electrical  
Engineering

# Aalto-1

## Mission Results (so far)

*J. Praks<sup>1</sup>, P. Niemelä<sup>1</sup>, A. Näsilä<sup>2</sup>, H. Leppinen<sup>1</sup>, B. Riwanto<sup>1</sup>, A. Kestilä<sup>1</sup>, T. Tikka<sup>4</sup>, N. Jovanovic<sup>1</sup>, A. Punkkinen, N. Silva<sup>1</sup>, R. Vainio<sup>3</sup>, P. Janhunen<sup>5</sup>, L. Nyman<sup>1</sup>, J. Finnholm<sup>1</sup>*

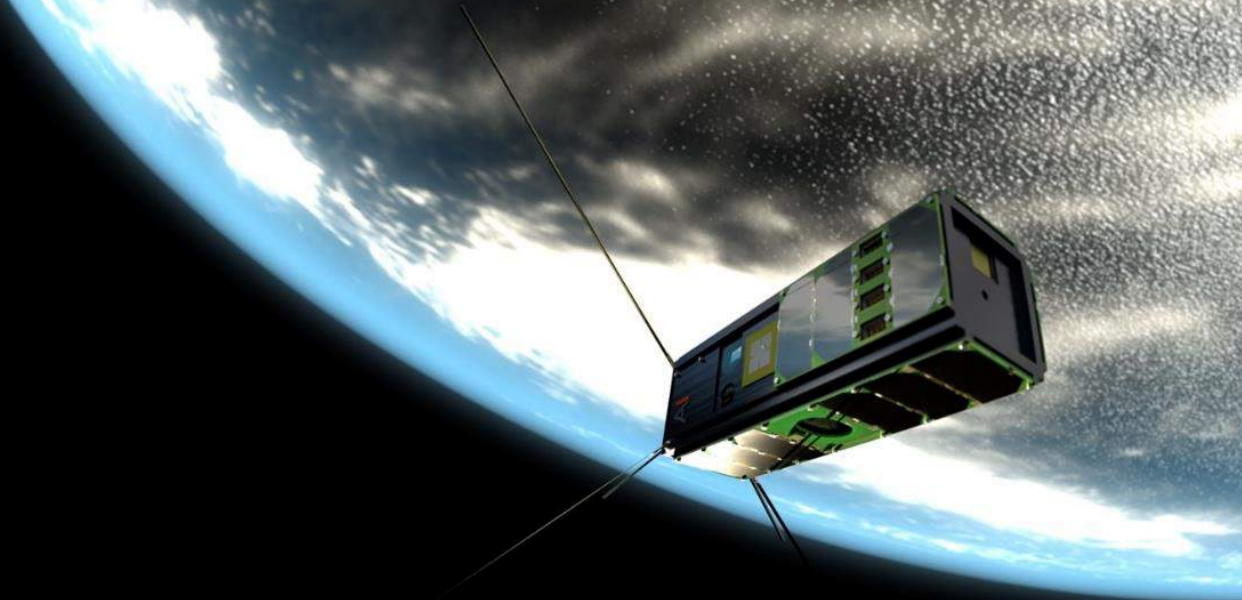
*<sup>1</sup> Aalto University, Finland*

*<sup>2</sup> VTT Technical Research Centre of Finland, Finland*

*<sup>3</sup> University of Turku, Finland*

*<sup>4</sup> Reaktor Space Lab, Finland*

*<sup>5</sup> Finnish Meteorological Institute, Finland*



# Aalto-1

**3U (4 kg) CubeSat**  
**3 payloads**  
**3-axis stabilization**



*Redundant  
UHF COM*

*Redundant  
OBC on Linux*

*Spectral Imager AaSI*

*ADCS Star tracker*

*S-band COM*

*GPS*

*EPS*

*Electronguns*

*Plasma Brake*

*RADMON*







**Aalto-1  
2010**



Turun yliopisto  
University of Turku



# A!

Aalto University



University of  
Helsinki



# NOKIA



TARTU OBSERVATORY  
space research centre

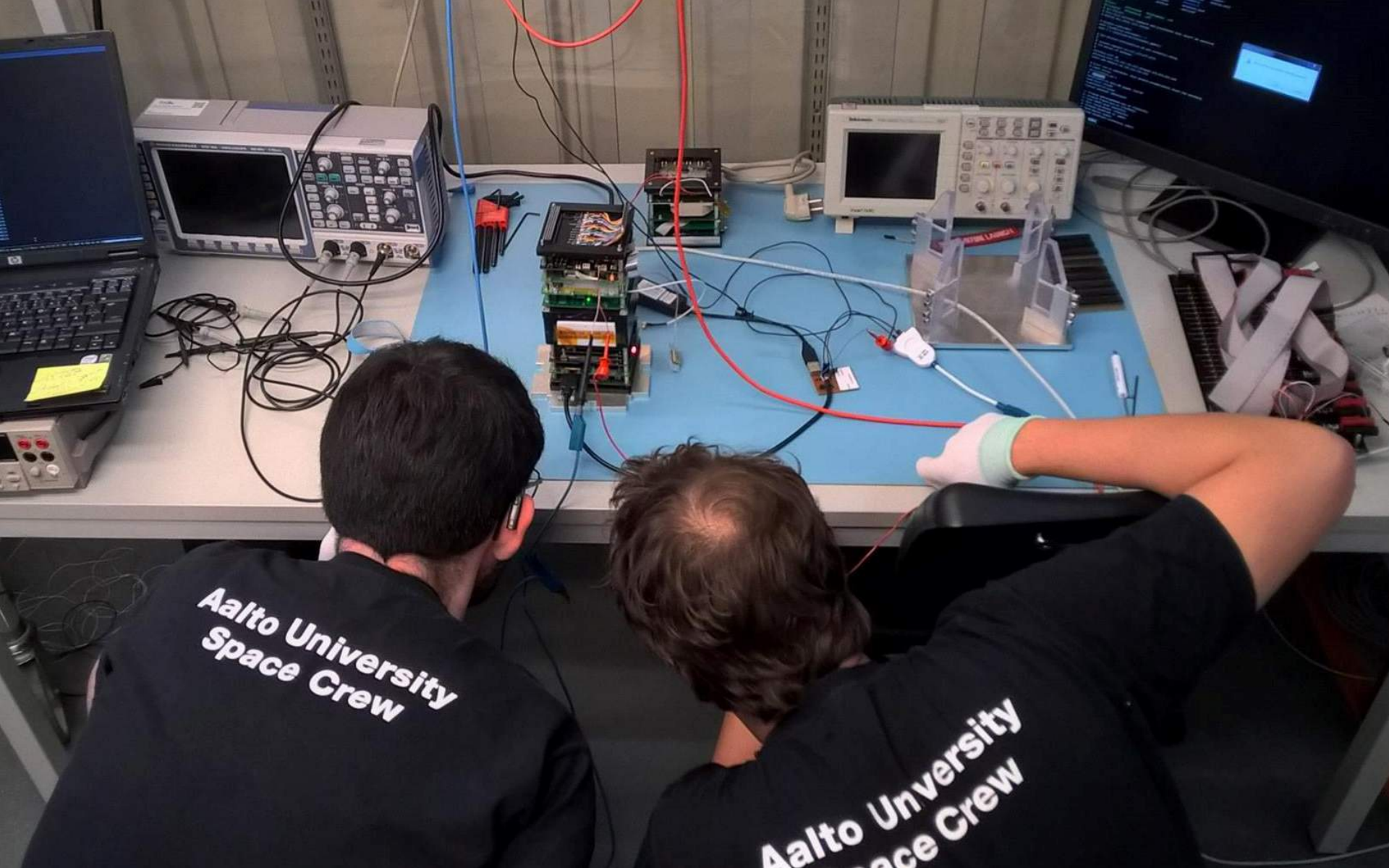


HYPERION TECHNOLOGIES

# TURKU AMK \*







Aalto University  
Space Crew

Aalto University  
Space Crew





# MCA - Metsähovi Compact Array

## Astronomical radio interferometer for research and education

### Background

Metsähovi Radio Observatory obtained as a donation four 5.5-metre parabolic dish antennas, decommissioned from their use in commercial satellite communication.

The antennas are being turned into astronomical radio telescopes capable of single-dish radio astronomy and satellite communication. The main goal, however, is to connect all four telescopes to work together as the only stand-alone radio interferometer in the Nordic countries.

Depending on funding, the first individual telescopes are expected to be working in 2017, and the "Metsähovi Compact Array" (MCA) interferometer fully operational in 2020-2022.

### Hands-on education

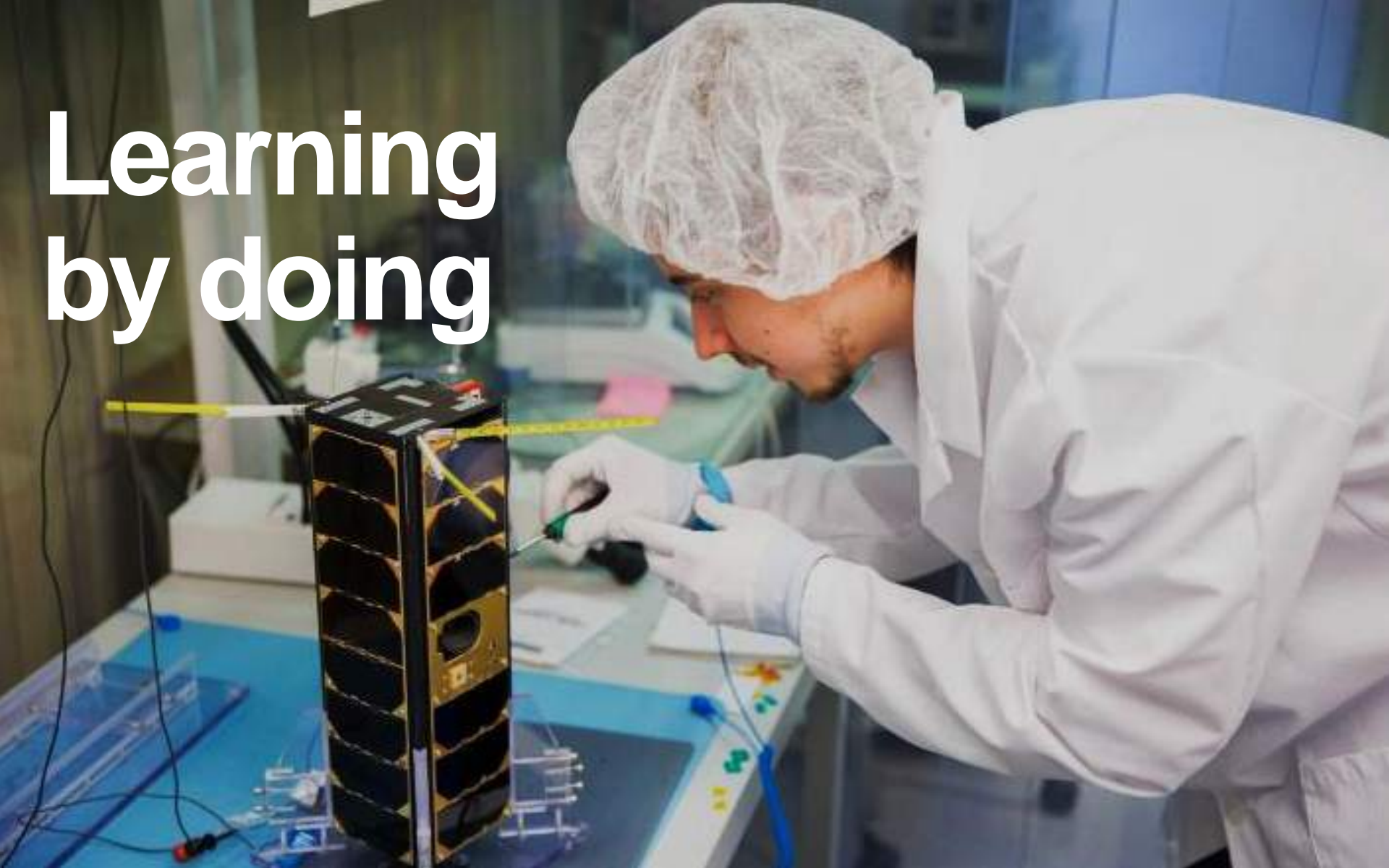
The MCA project opens a great variety of hands-on learning opportunities for many disciplines already in the construction phase. It offers a rare opportunity in astronomy, radio

### Science with MCA

The MCA supports and expands research done using Metsähovi telescopes. It can be used

# Bottom up

# Learning by doing





# Spring 2016







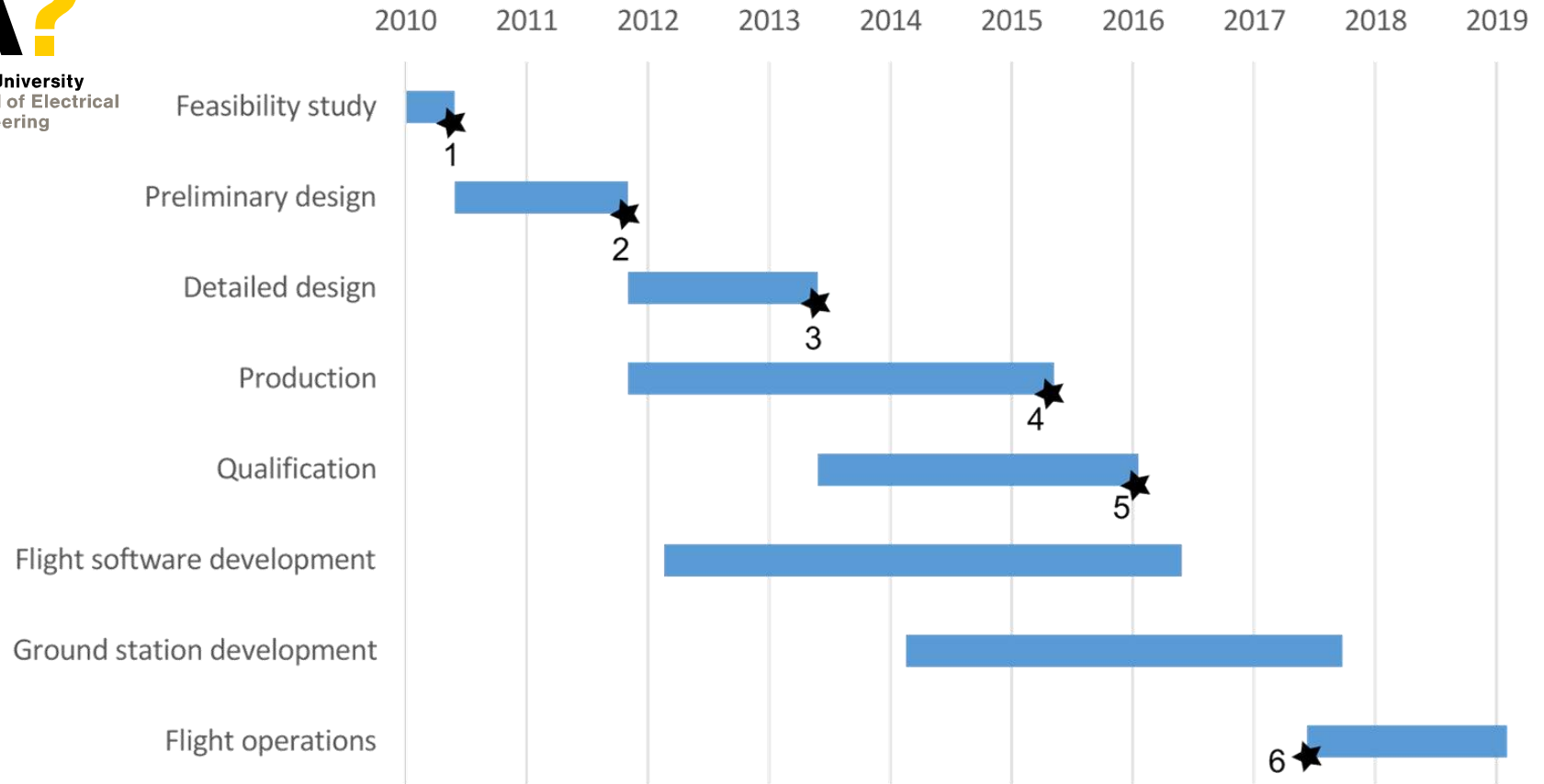








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1 Initial report published; 2 Preliminary design review; 3 Critical design review;  
4 Test readiness review; 5 Flight readiness review; 6 Launch





# Launch

*Launch 23th June 2017 03:59 UTC on Indian PSLV-C38*

*Deployed 04:22 UTC to 486 x 519 km, sun synchronous  
inclination 94.45° orbit*

**NOKIA**



Turun yliopisto  
University of Turku

Together  
ahead.

RUAG



Aalto University



समय 13:50

Credits - ISRO



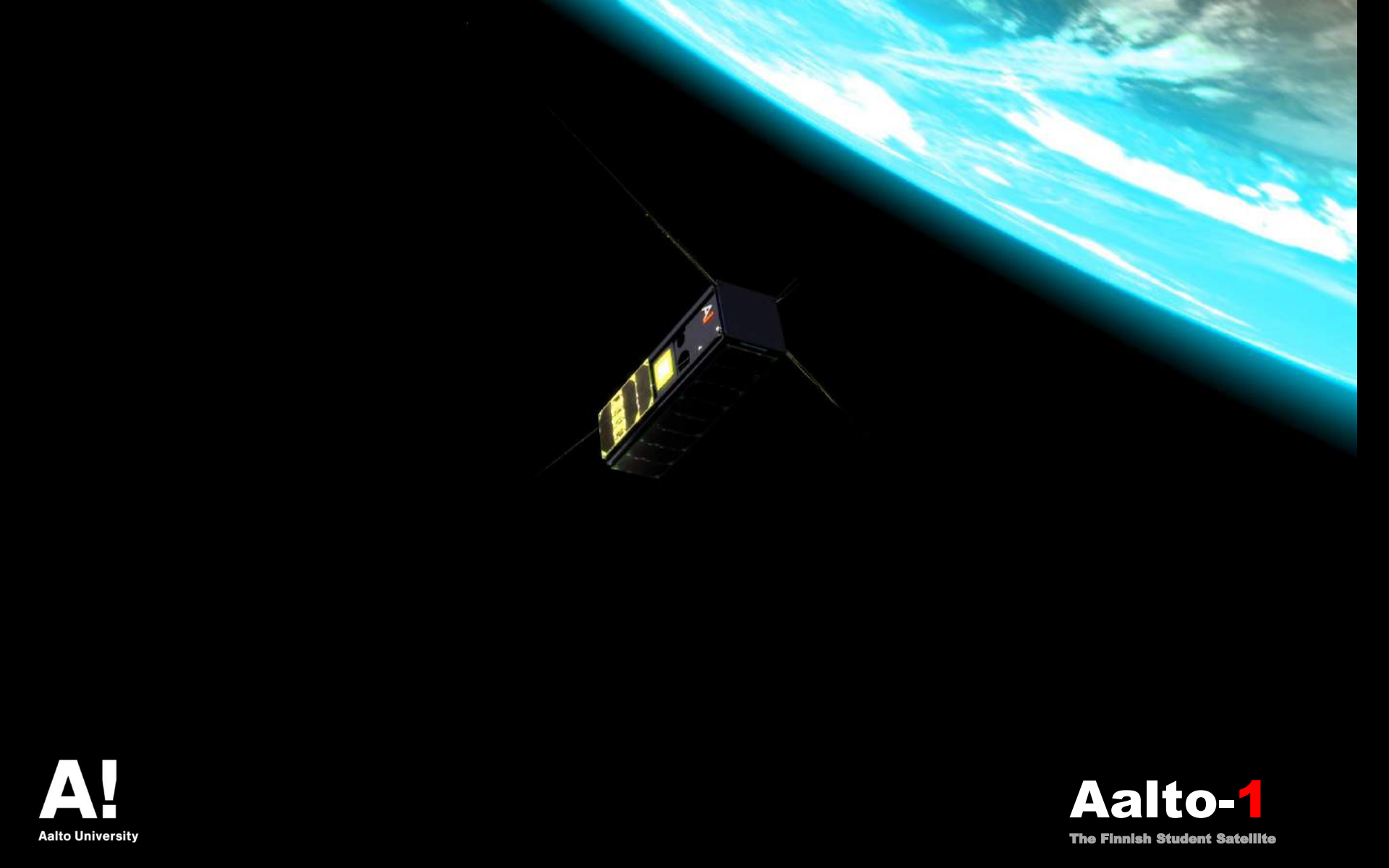




# First contact

*First contact was established with the satellite during the first overpass.*





Launch

Separation

Commissioning

Science phase

Decommissioning

# 2 year mission

## Earth Observation and Radiation

- Spectral Imaging IOD
- Radmon IOD

## Plasma Brake deployment

- Satellite spin-up
- Deployment IOD

## Plasma Brake Demonstration

- Negative mode IOD
- Positive mode IOD
- Deorbiting IOD





# GPS

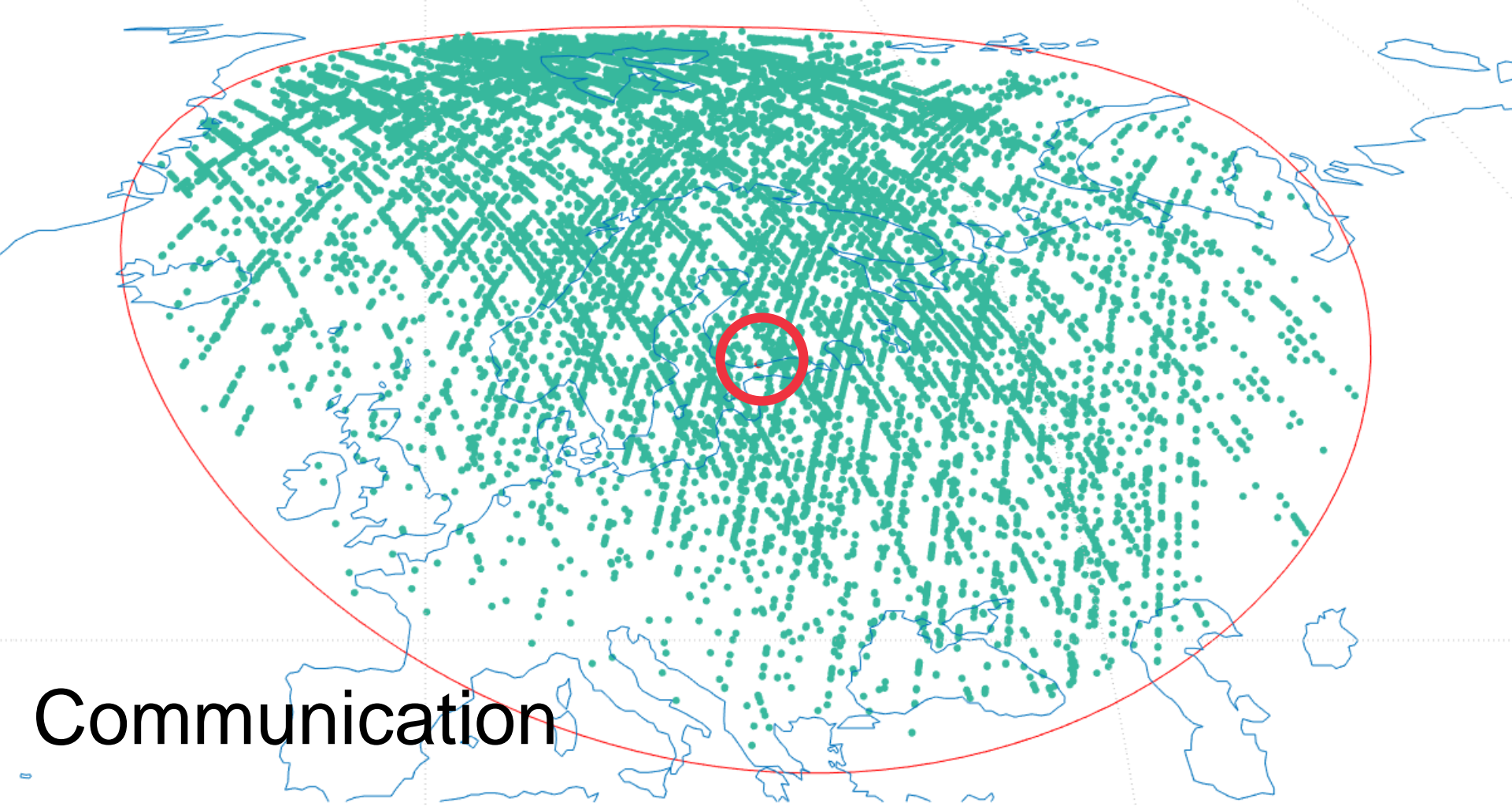
Fastrax IT03 GPS module  
ADA-15S antenna



The first commissioned subsystem  
29 June 2017

Tumbling causes slow signal fading, making  
it harder to acquire the initial GPS fix (10 min)

Used to compute state vector, delivered to NORAD for space object  
identification



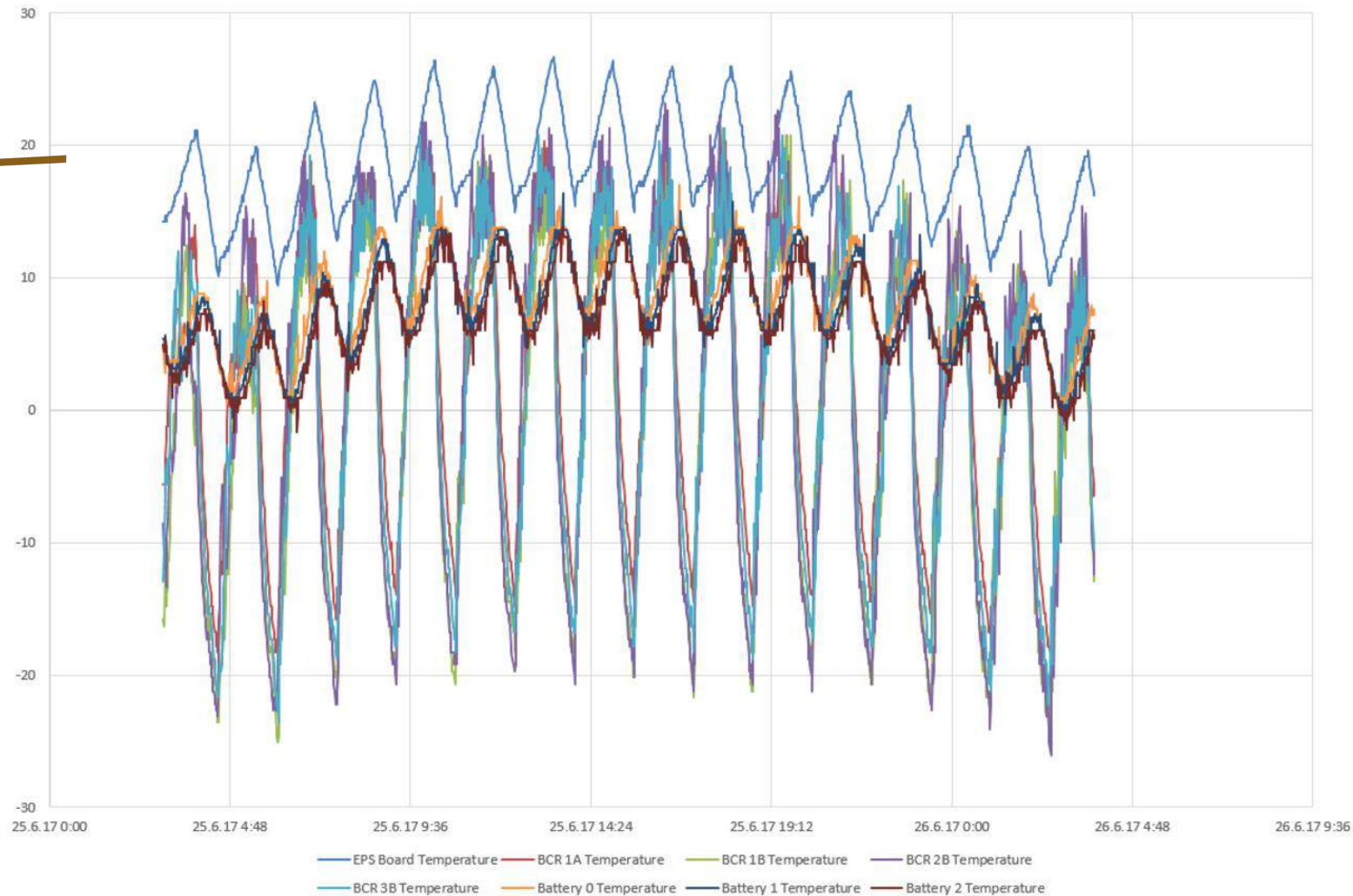
# Communication

Communication packet loss map. RFI over Europe hinders communication.

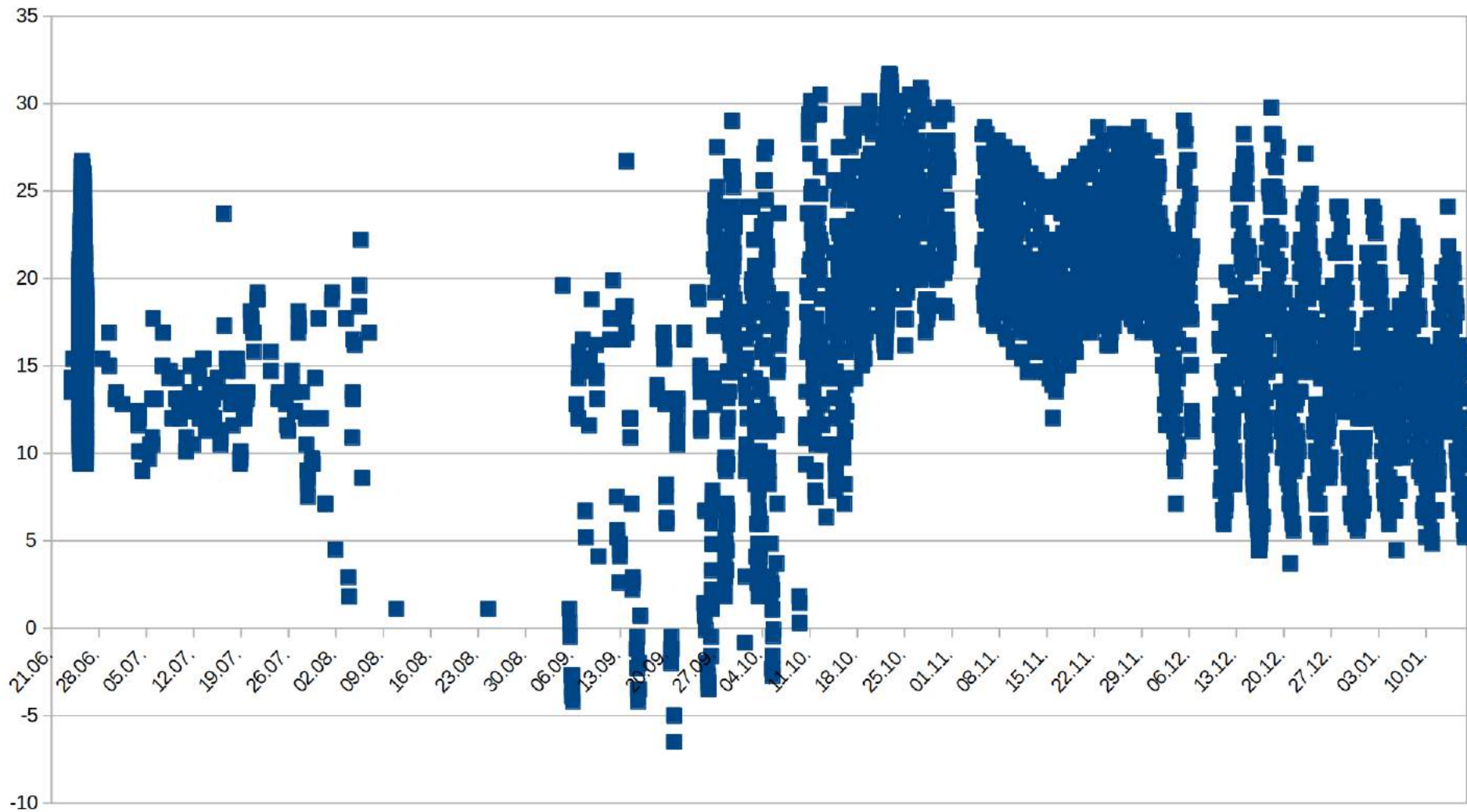


# System temperatures

Aalto-1 EPS system temperatures

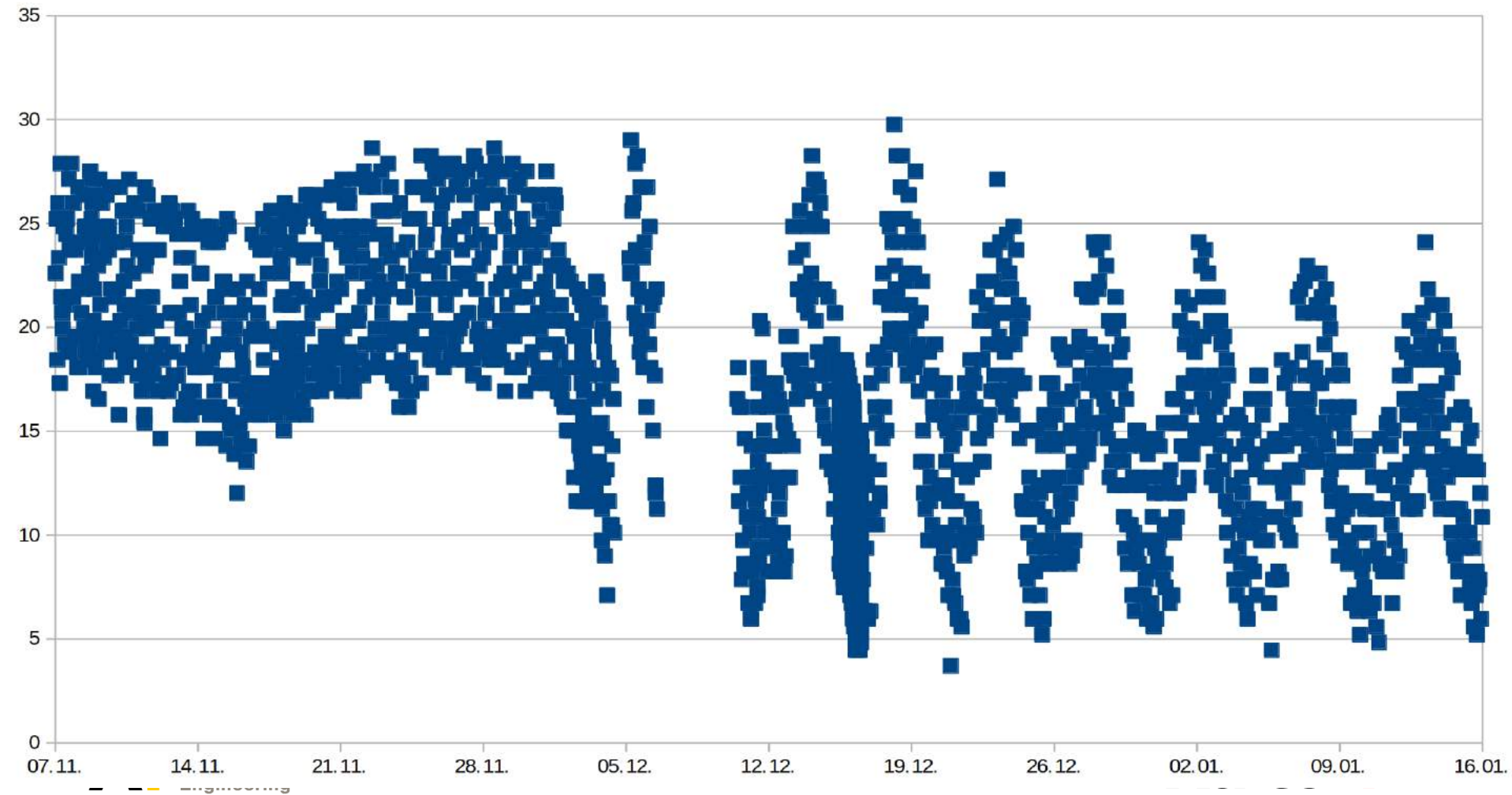


■ EPS Board Temperature °C

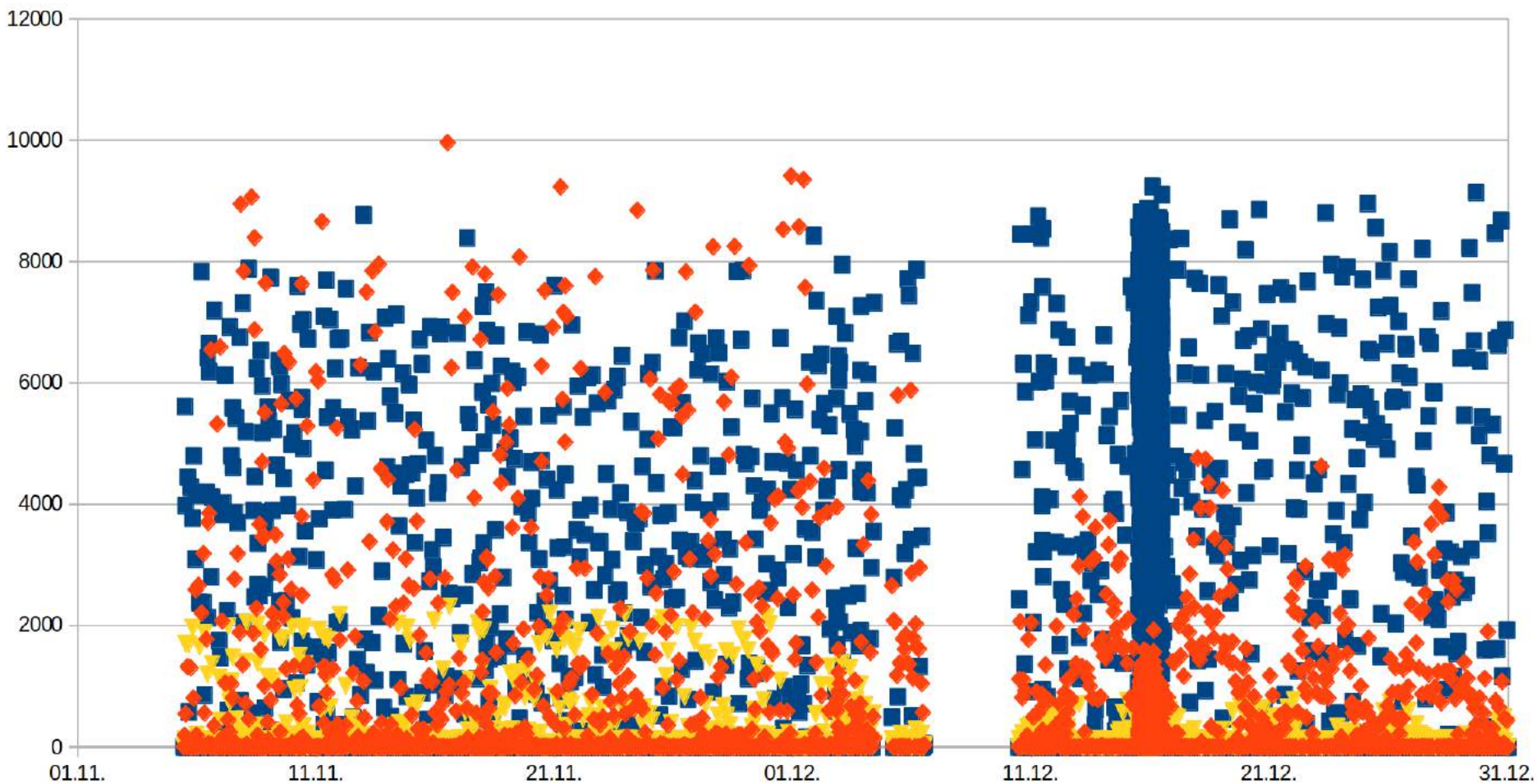




■ EPS Board Temperature °C

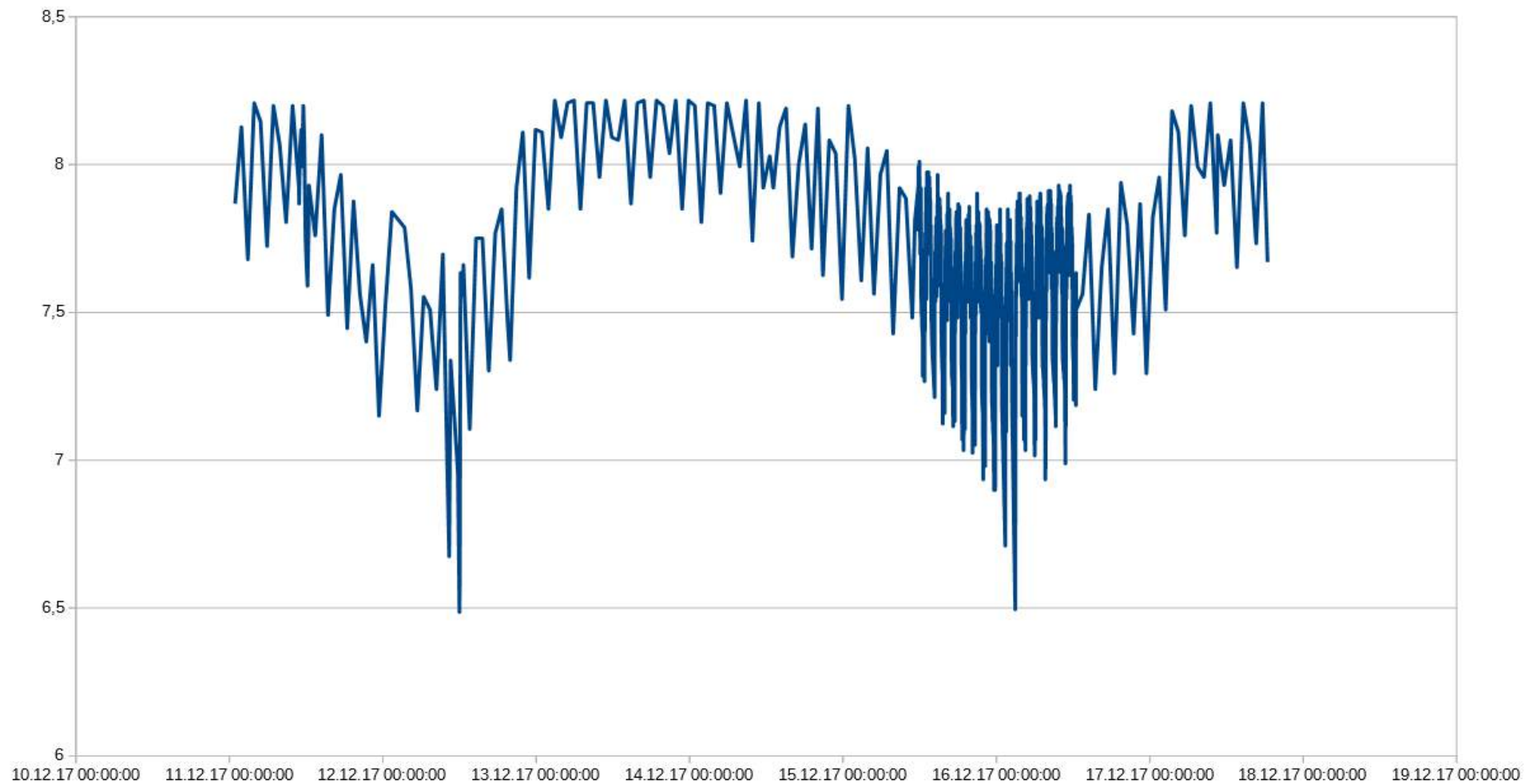


◆ BCR2 Power W ▼ BCR3 Power W ■ BCR1 Power





PCM Bat Voltage V



# OBC

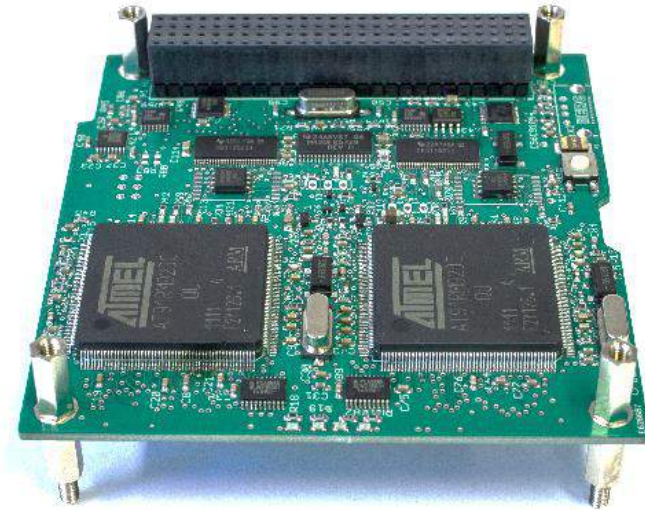
Two cold-redundant ARM AT91RM9200 OBCs  
Governed by arbiter and watchdog  
Linux OS

256 MB RAM

Clock speed 150 MHz

Mass: 75.0 g

Power consumption(EM): 0.25 W - 0.45 W from 3.3 V

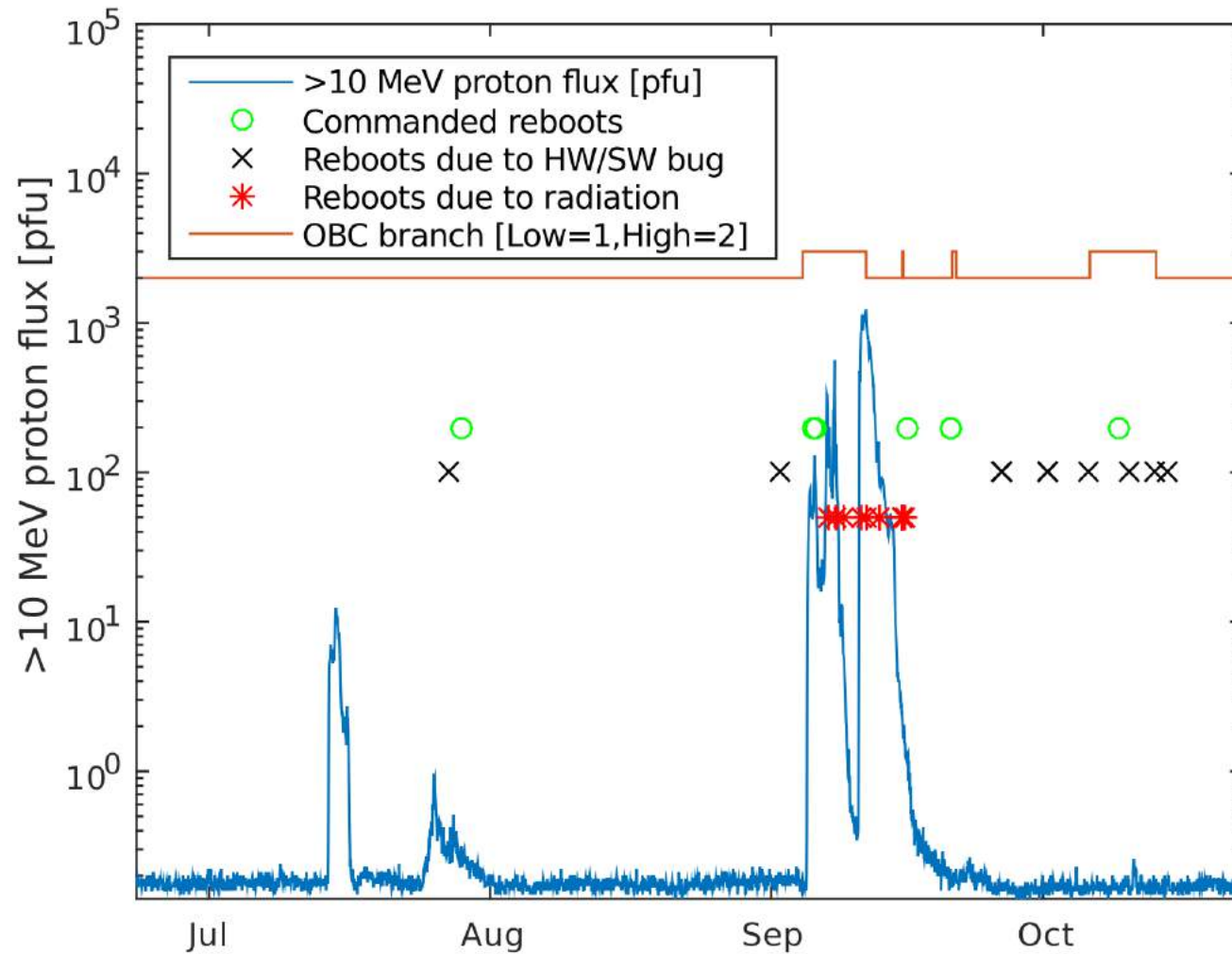


Aalto OBC EM

## Non-volatile memory

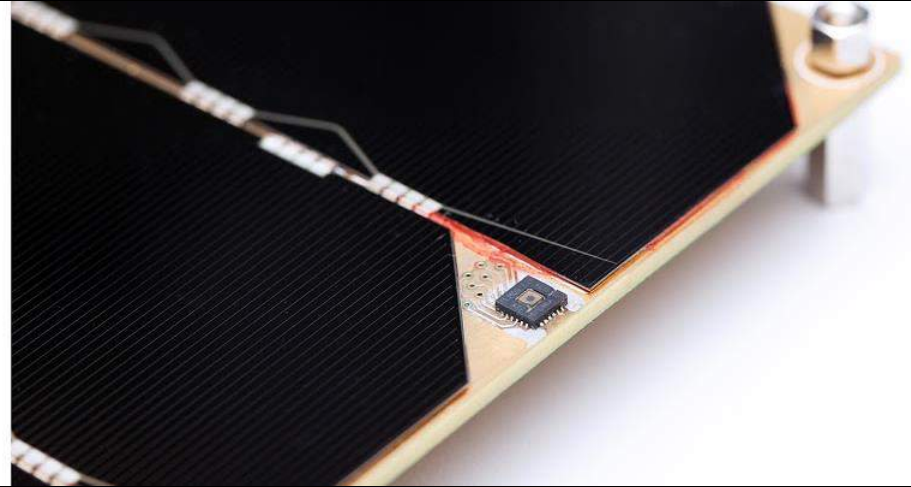
	Component	Capacity
Parallel/NOR flash	S29JL064J	64 Mbit, 8 MB, 7.6 MiB
Dataflash	AT45DB642D	64 Mbit, 8 MB, 7.6 MiB
NAND flash (OBC FM)	S34ML02G1	2 Gbit, 250 MB, 238 MiB





# Sun sensors

Aalto University



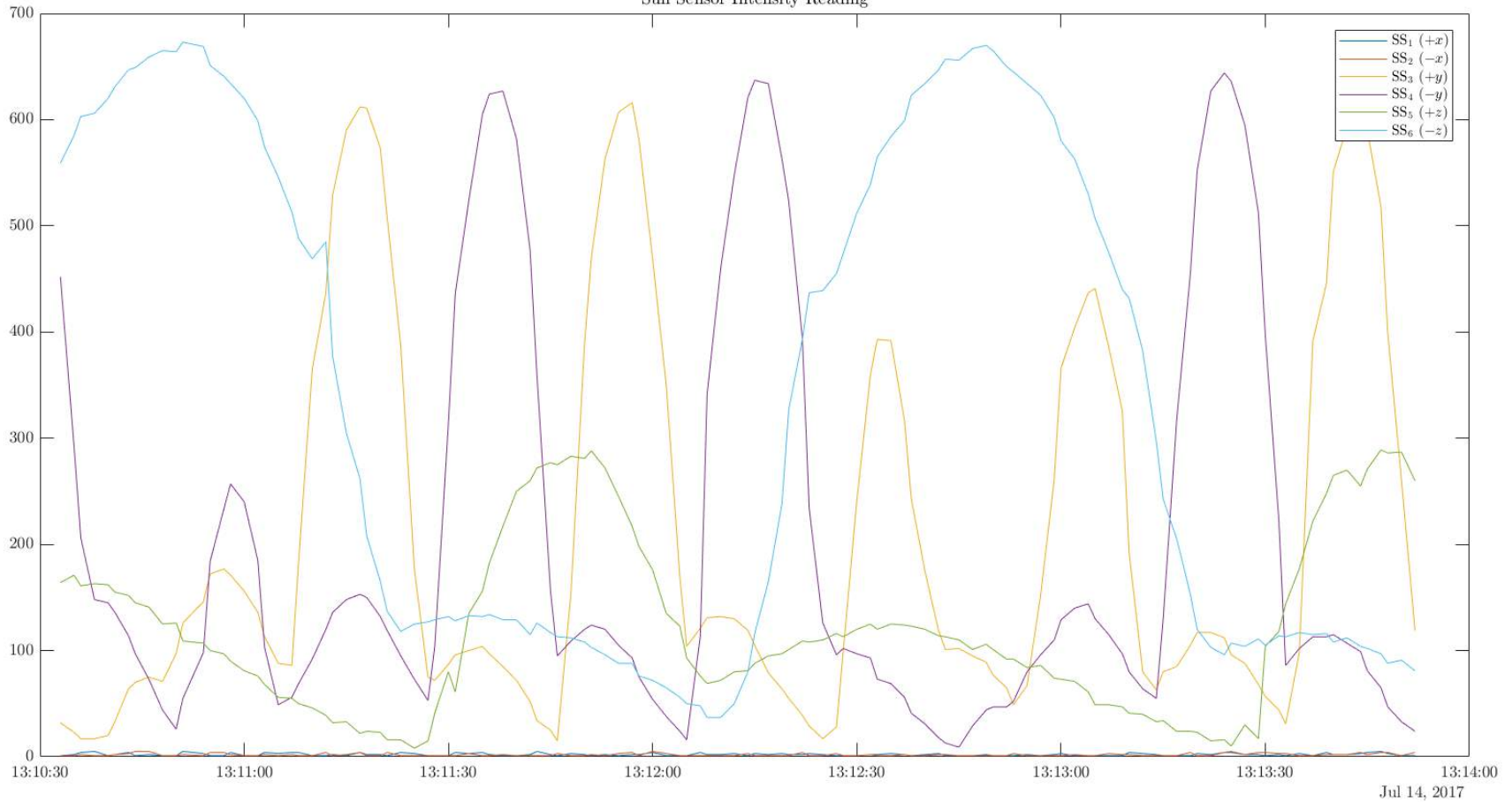
Accuracy: 3 degrees 1-sigma

Dimensions: Total: 18 \* 18 \* 6 mm; External: 5 \* 5 mm

Power consumption: 8 mW measured (EM)

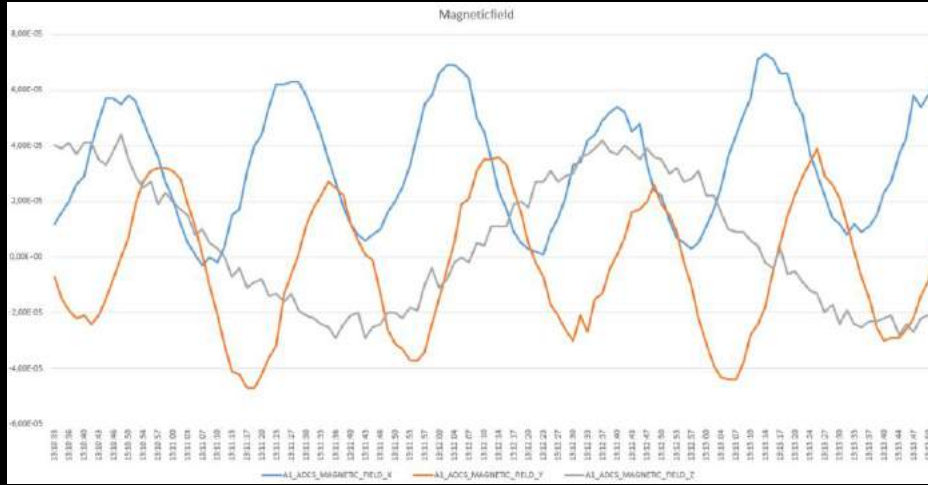
Power: 5V, Data: I2C, internal SPI

Sun Sensor Intensity Reading



Sun sensor readings 14. July 2017





Mass: 330 g  
Power: 1.4 W nominal  
Integrated star tracker

Status: sensors commissioned  
Detumbling started in September  
iADCS system boots after 90 sec of B-dot



# iADCS 100

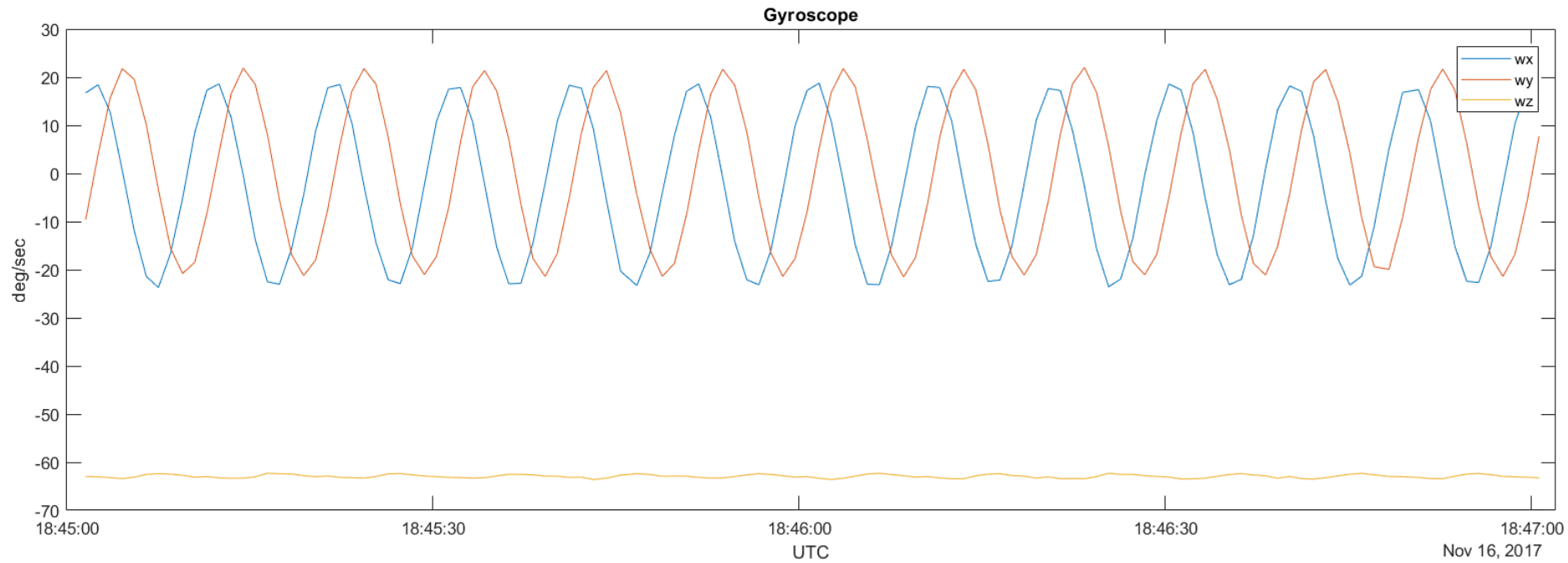
BST, Hyperion Technologies



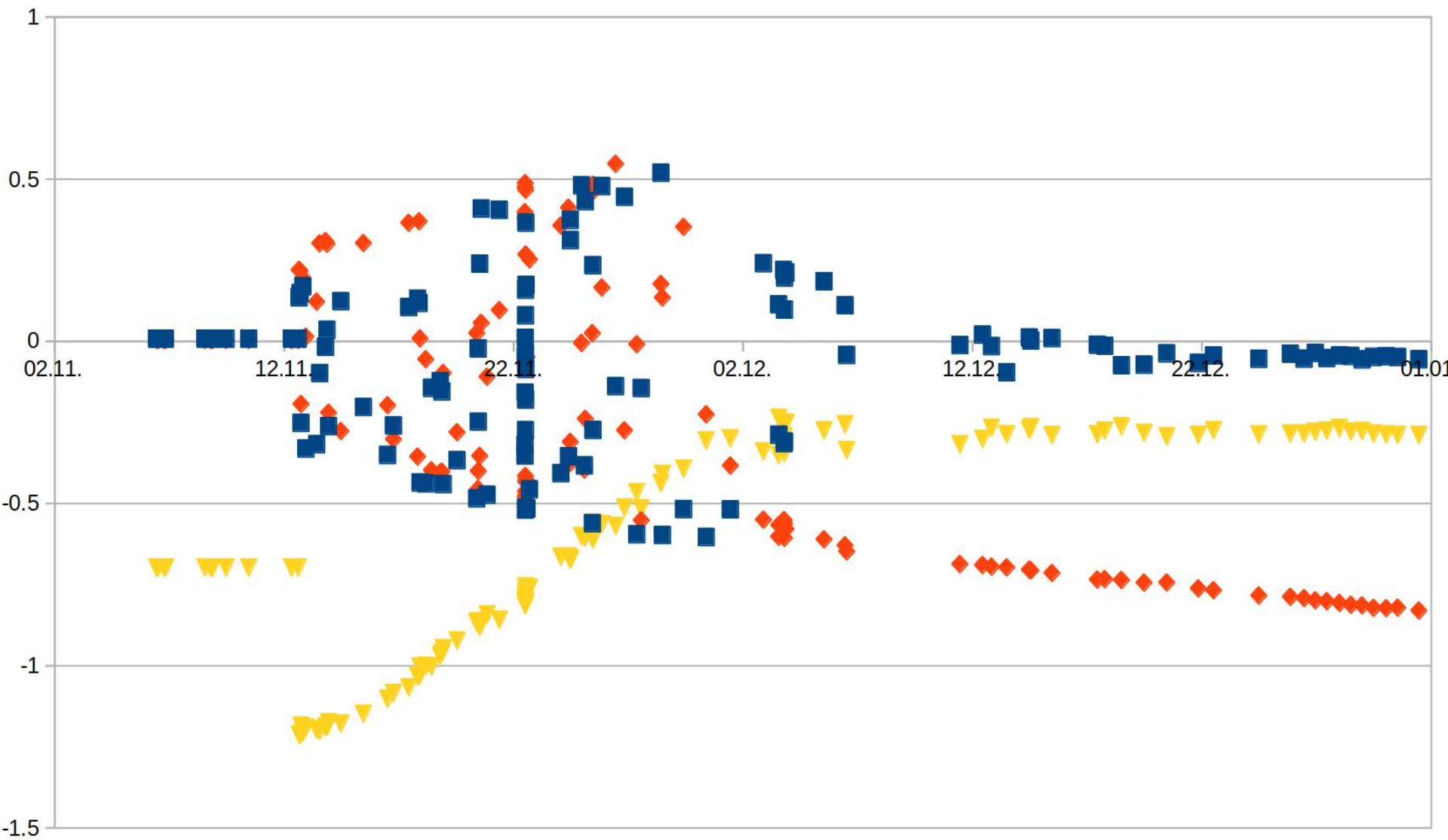
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■ Gyro 2 X rad/s    ◆ Gyro 2 Y rad/s    ▼ Gyro 2 Z rad/s

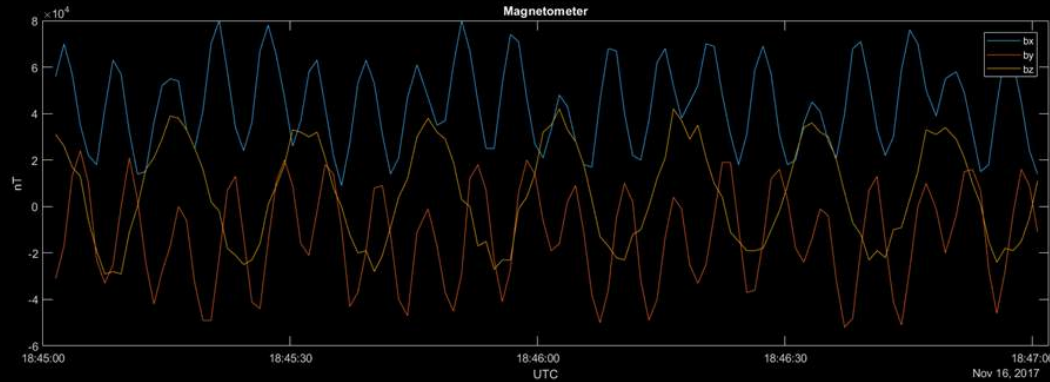




# Sattelite attitude

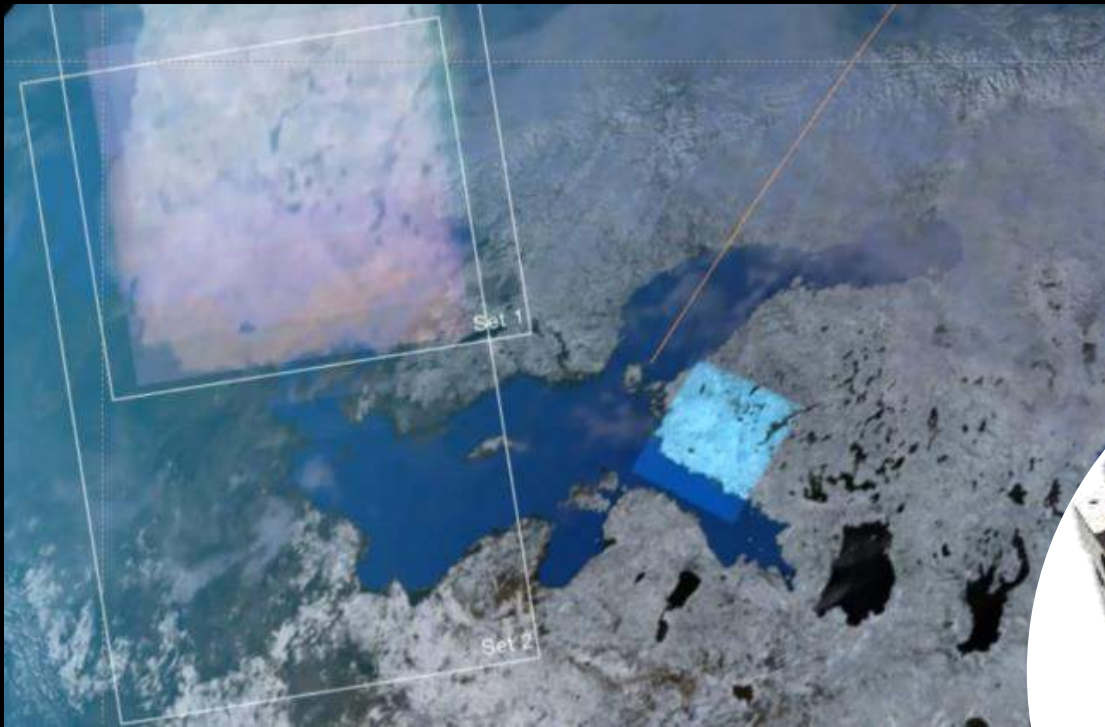
16 Nov 2017

Current tumbling rate  $60^\circ / \text{sec}$

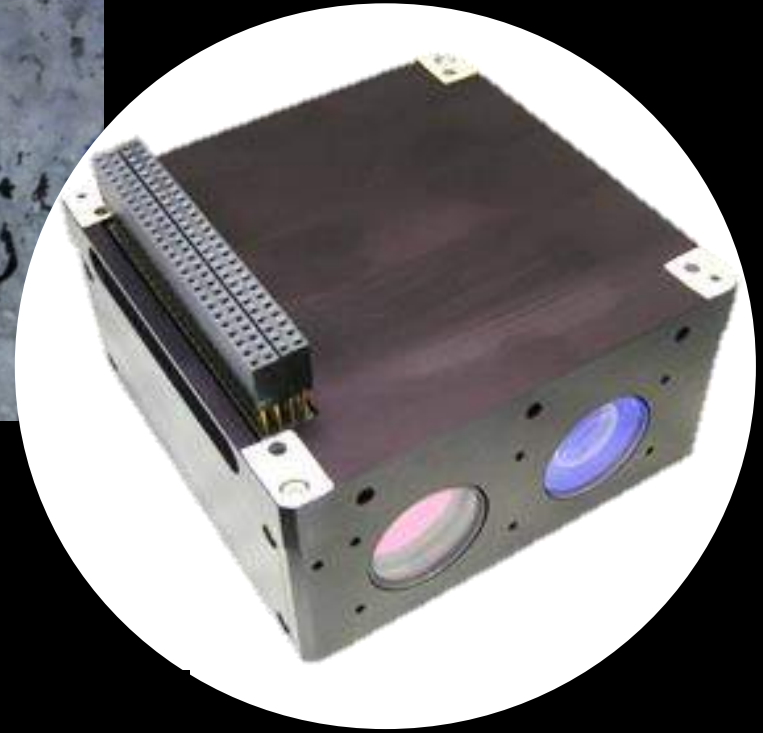


# AaSI

VTT, Finland



Mass: 592 g  
Power: max 2.5 W  
500-900 nm  
Configurable ~20 nm spectral lines

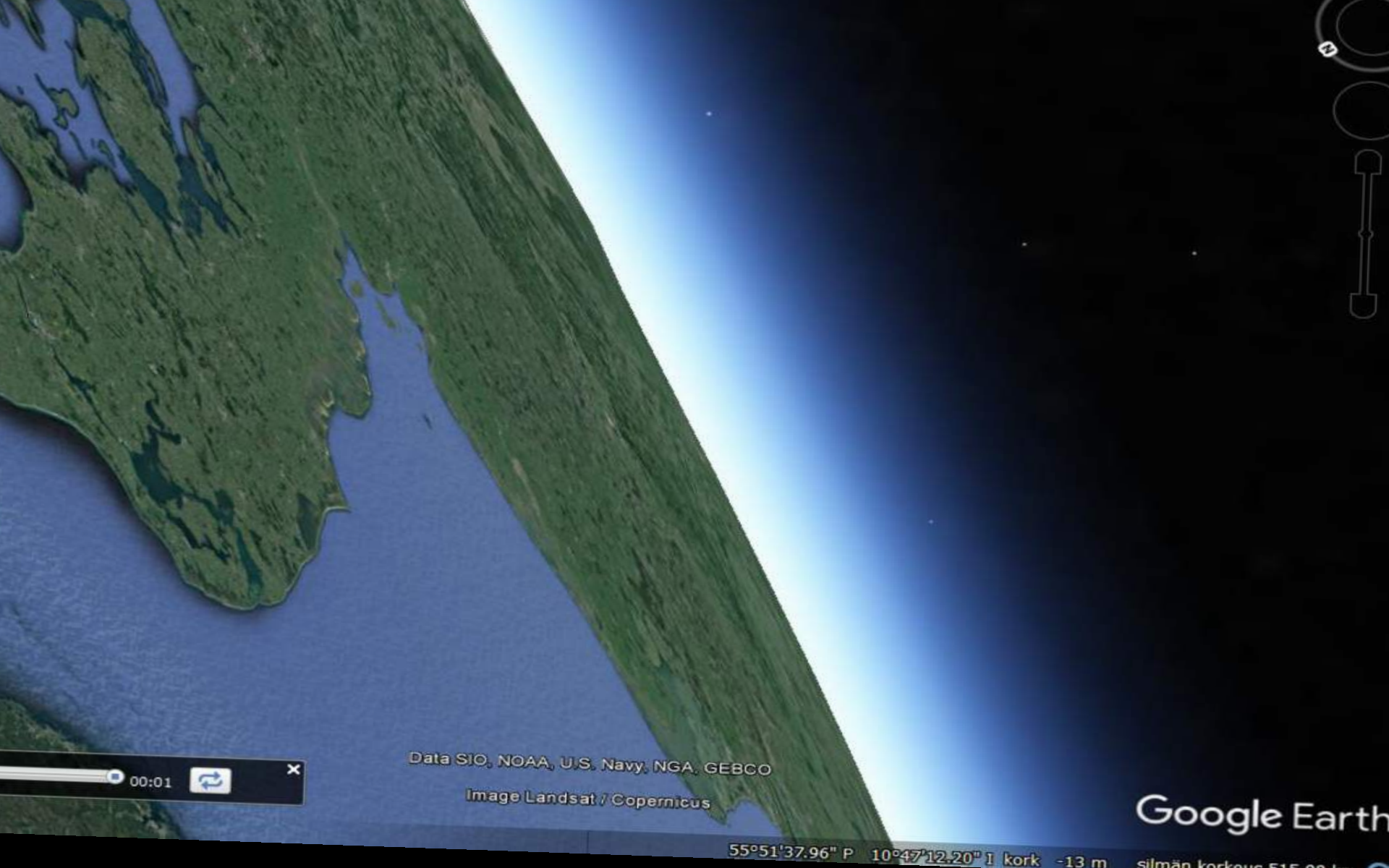


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First image  
516 km over Northern Norway  
VIS camera  
05.07.2017 09:43 UTC





00:01  X

Data SIO, NOAA, U.S. Navy, NGA, GEBCO

Image Landsat / Copernicus

Google Earth

55°51'37.96" P 10°47'12.20" I kork -13 m silmän korkeus 515.00 km

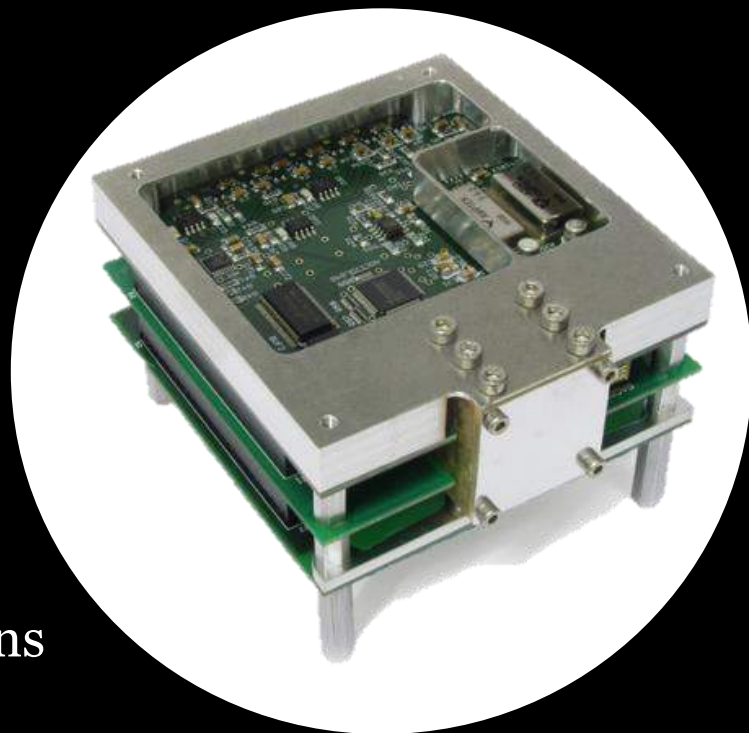


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# RADMON

University of Turku, University of Helsinki



Particle detector measuring the flux of  
>700 keV electrons and >10 MeV protons

Mass: 354 g

Power consumption: 1 W



University of  
Helsinki



Turun yliopisto  
University of Turku

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# Plasma Brake

Finnish Meteorological Institute

Spin up phase

Mass: 259 g

Power consumption: 1 – 1.6 W

Tether length: 100 m

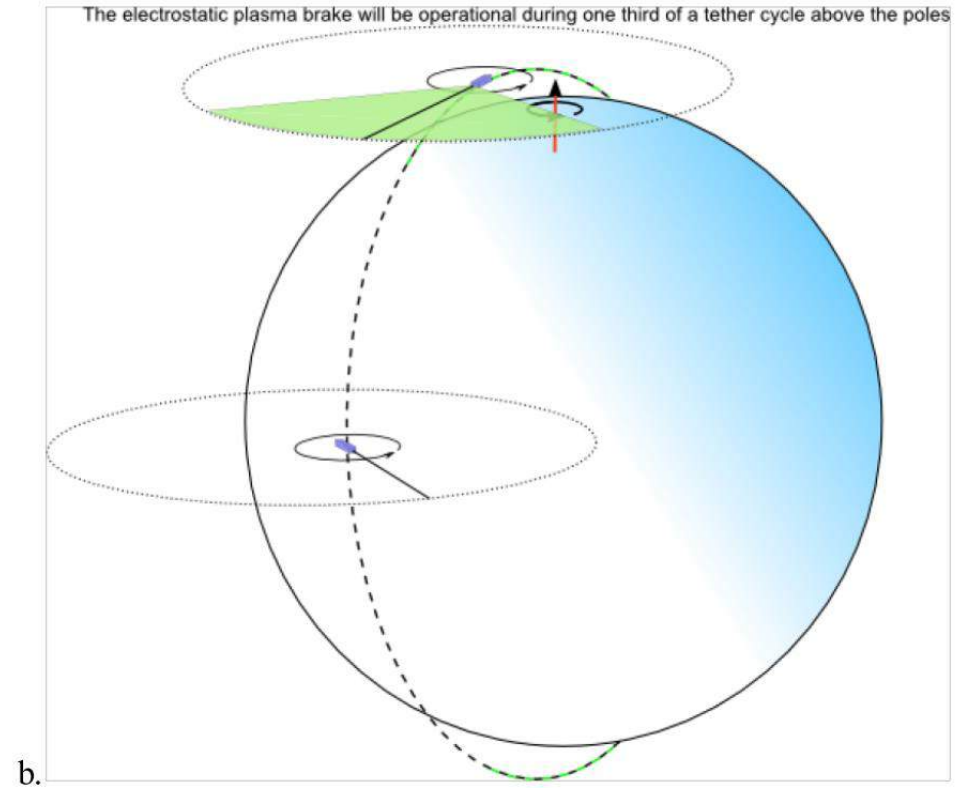
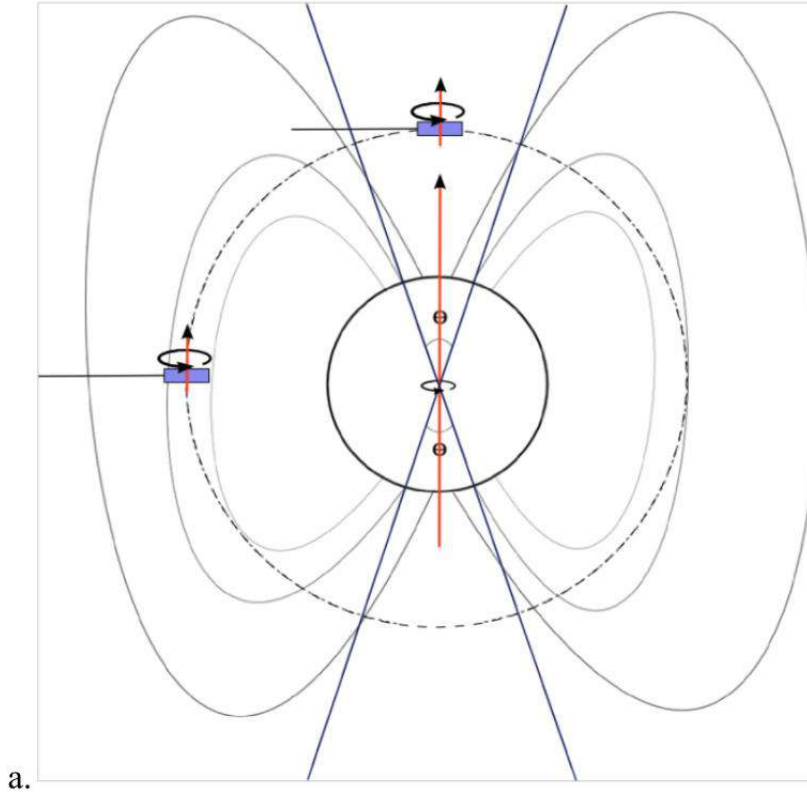
Applied voltage: 1000 V

Not commissioned yet.



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# Deorbiting Experiment with Plasma Brake





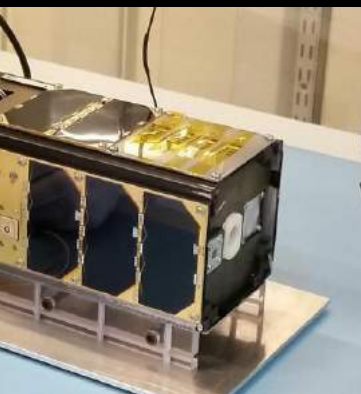
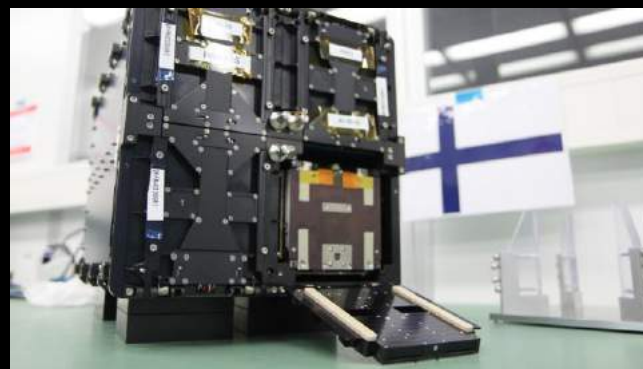
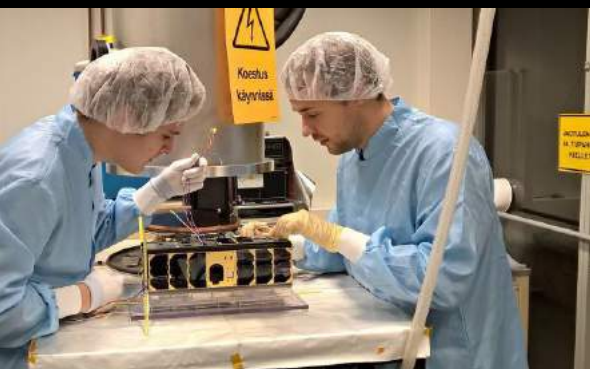
# Dream big!





**Keysto success:  
Careful gardening**





# Thank you!

Contact: [jaan.praks@aalto.fi](mailto:jaan.praks@aalto.fi)

