TARTU OBSERVATORY
space research centre

ESTCUBE
per solem ad astra

ESTCube-1 mission results: Status on September 23, 2014

Mart Noorma and ESTCube-1 team

ESTCube-1 mission objectives

Scientific

- Test the deployment of a 10 m tether
- Measure the force being excerted to tether

Educational

- Support student learning at Estonian universities
- Promote STEM subjects

Outreach

- Provide Estonians with a mission to be proud of

ESTCube-1 mission in numbers

- 504 days of successful work in space
- 328 million kilometers travelled
- 4000 communication sessions
- 230 images of the Earth
- 70 public presentations
- 7 keyword search results in WoS
- 9 Close Approach Notifications
- 2 tether deployment tests

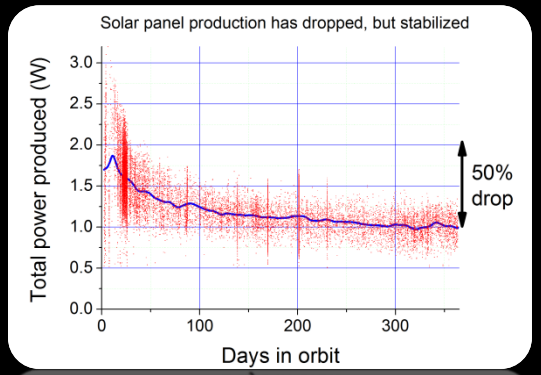
Detailed mission objectives

- Develop and characterize novel CubeSat subsystem solutions and test E-sail components
  - Electrical Power
  - Structure and Communication
  - Imaging
  - Command and Data Handling
  - Attitude Determination
  - Attitude Control
  - Tether Deployment
  - Tether
  - Electron Gun

Electrical Power

Electrical Power System works

- Pajusalu, M. et al. Design of the Electrical Power System for the ESTCube-1 satellite. *Latv. J. Phys. Tech. Sci.*, 2012, **49**(3), 16–24.
- Pajusalu, M. et al. Electrical Power System for ESTCube-1: a Fault-tolerant COTS Solution. In *63rd IAC*. Naples, 2012.
- Pajusalu, M., et al. Analysis of the electrical power system for ESTCube-1. In *64th IAC*. Beijing, 2013.
- Pajusalu, M., et al. Comparison of simple-to-produce custom solar panel simulator approaches for developing nanosatellite power systems. In *64th IAC*. Beijing, 2013.
- Pajusalu, M., et al. Design and Testing of the Electrical Power System for ESTCube-1. *Proc. Est. Acad. Sci.*, 2014, **63** (2S).



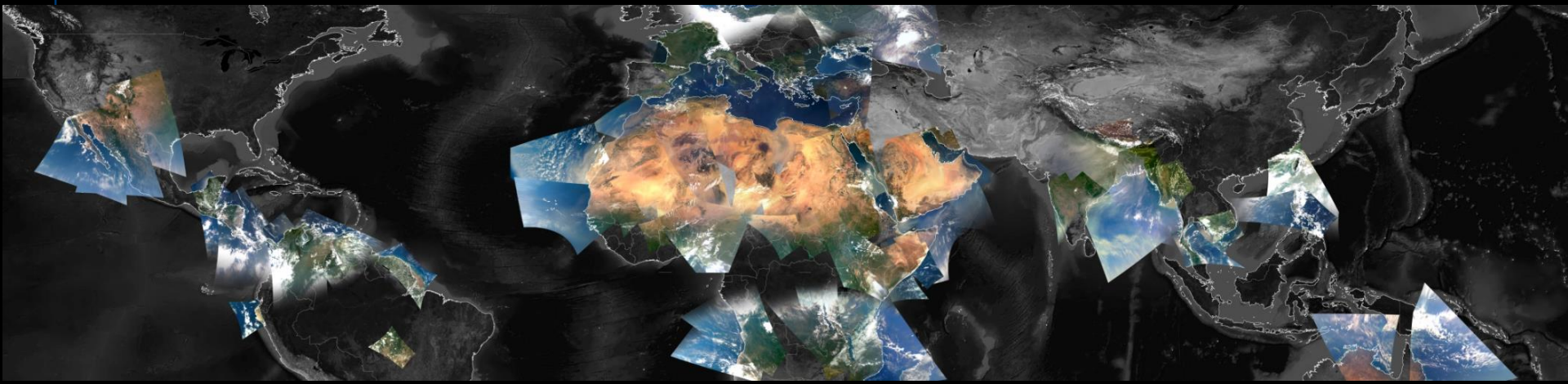
Structure and Communication

- Structure and antenna deployment work
- Communication work

Imaging

- Imaging system works

- Kuuste, H., et al. Imaging system for nanosatellite proximity operations. *Proc. Est. Acad. Sci.*, 2014, **63**.
- Slavinskis, A., et al. ESTCube-1 attitude determination: in-flight experience. In the 4S Symposium. Majorca, 2014.
- Slavinskis, A., Eherpais, H., Kuuste, H., Sünter, I., Viru, J., Kütt, J., Kulu, E., Noorma, M., Flight results of ESTCube-1 attitude determination system, submitted to Acta Astronautica in September 2014.



Command and Data Handling

- CDH system works
- Laizans, K., et al. The design of fault tolerant Command and Data Handling Subsystem for ESTCube-1. *Proc. Est. Acad. Sci.*, 2014, **63**.

Attitude Determination

- Attitude determination meets requirements

- Slavinskis, A. et al. Magnetic attitude control algorithms for ESTCube-1. In *63rd IAC*. Naples, 2012.
- Slavinskis, A., et al. High spin rate magnetic controller for nanosatellites. Acta Astronautica, 2014, 95, 218–226.
- Slavinskis, A., et al. ESTCube-1 attitude determination: in-flight experience. In the 4S Symposium. Majorca, 2014.
- Slavinskis, A., Eherpais, H., Kuuste, H., Sünter, I., Viru, J., Kütt, J., Kulu, E., Noorma, M., Flight results of ESTCube-1 attitude determination system, submitted to Acta Astronautica in September 2014.

Attitude Control

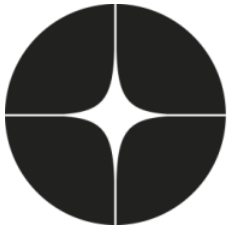
- Attitude Control meets requirements partially, but sufficiently to enable the tether deployment experiment
- Slavinskis, A. et al. Magnetic attitude control algorithms for ESTCube-1. In *63rd IAC*. Naples, 2012.
- Slavinskis, A., et al. High spin rate magnetic controller for nanosatellites. Acta Astronautica, 2014, 95, 218–226.

Tether Deployment

- Started on September 16, 2014
- Tether end mass and reel locks burned
  - Feedback method: power consumption
- Reeling commenced
  - Feedback method: power consumption and gyros
- Images taken
- No conformation of tether deployment
- Next steps:
  - reverse spin at maximum rate
  - repeat the reeling procedure

Experiment ToDo list

- Full characterization of Attitude Control
- Test of advanced functionality of Imaging System
- Test of Electron Gun
- Monitoring long-term performance of all satellite subsystems



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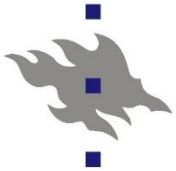

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