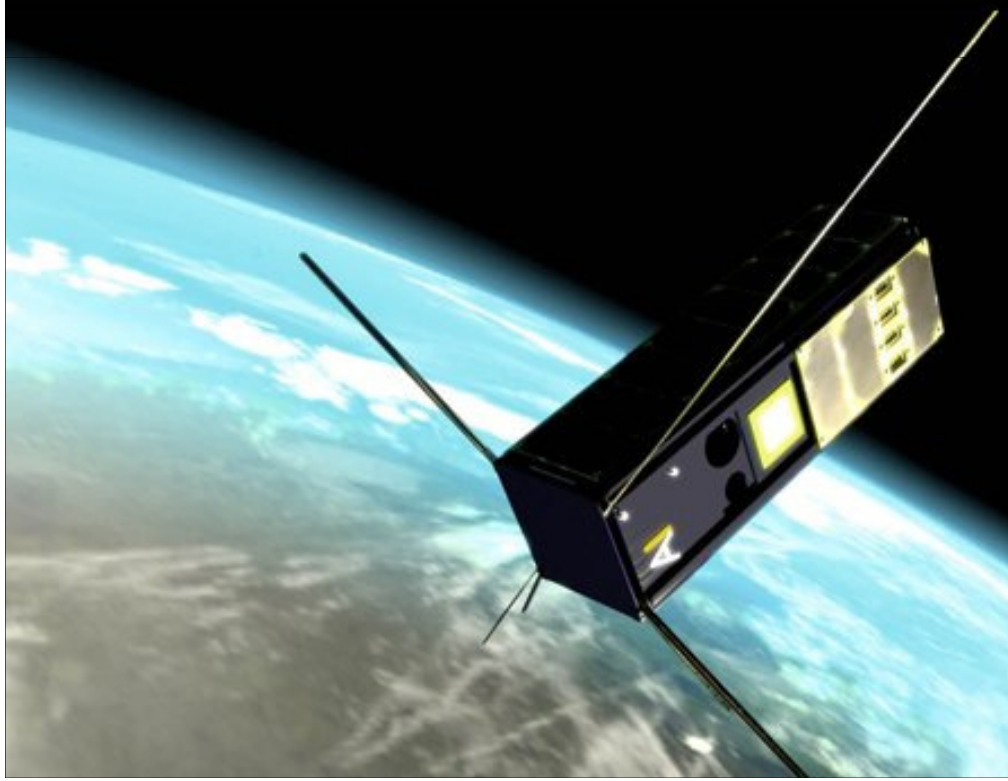
Nanosatellites and space technology education in Finland

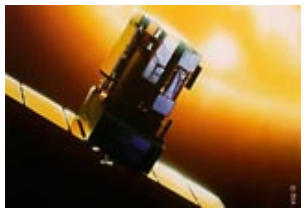
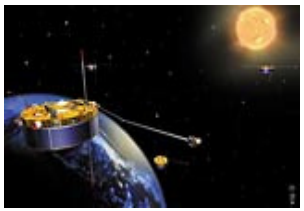
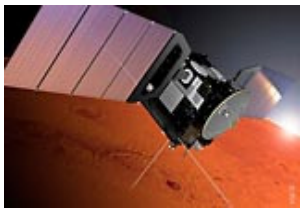


Jaan Praks, Dr.Sc.

Department of Radio Science and Engineering
Aalto University

Aalto-1
The Finnish Student Satellite

Full member of ESA for 19 years

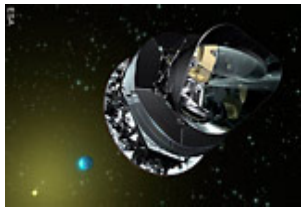


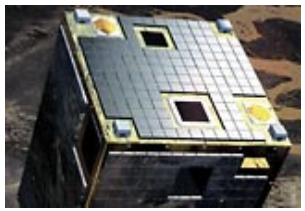
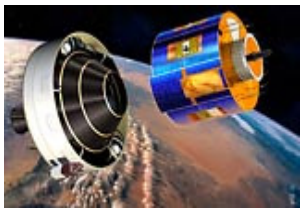
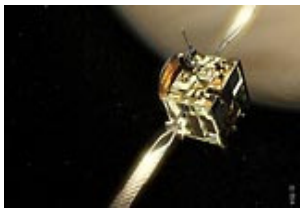








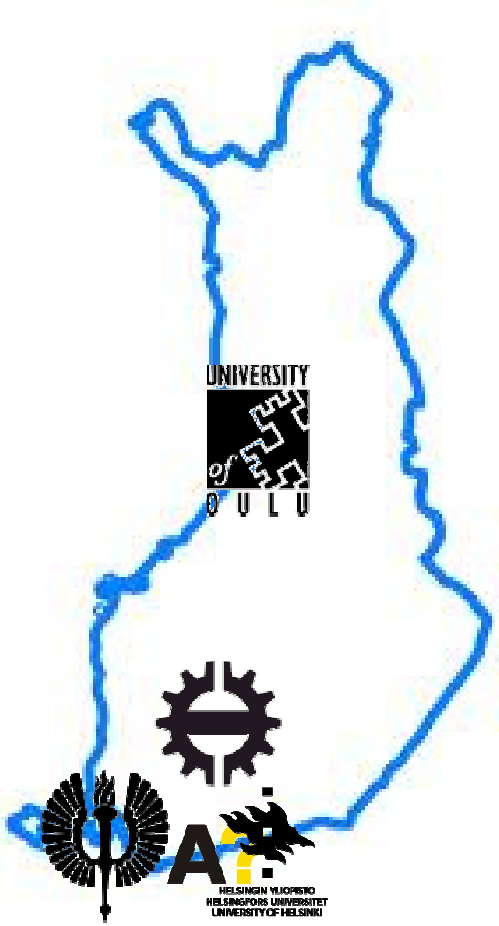



Soho (1995)
Cassini-Huygens(1997)
XMM-Newton (1999)
Proba (2001)
Cluster-II (2002)
Envisat-1 (2002)
Integral (2002)
MSG (2002)
Mars Express (2003)
Smart-1 (2003)
Rosetta (2004)
Venus Express (2005)
Galileo (2005 & 2008)
Goce (2009)
Planck (2009)
Herschel (2009)
SMOS(2009)
Cryosat 2 (2009)
ADM-Aeolus
SWARM
BepiColombo

Space topics at Finnish Universities

- Aalto University
  - Space Technology and Science
  - Robotics
  - Erasmus Mundus SpaceMaster programme
- Helsinki University
  - Master's Degree Programme in Space Sciences
- University of Turku and Tuorla Observatory
  - Astronomy and space physics
- University of Oulu
  - Space physics
- Tampere Technical University
  - Some courses in Space Technology

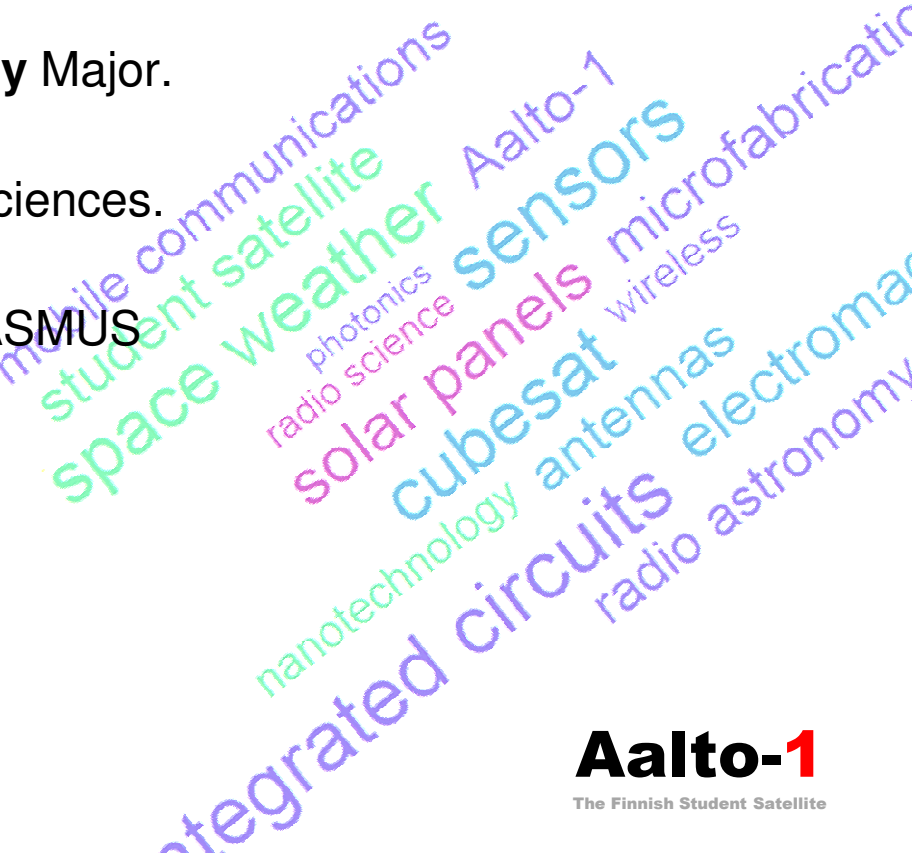


A?

Aalto starts new Master programmes in 2015

A new Master programme on **Nano and Radio Sciences** starts in autumn **2015**.

- New **Space Sciences and Technology** Major.
- Tight integration with radio- and nanosciences.
- Collaboration with Joint European ERASMUS MUNDUS Space Master programme.
- Collaboration with Nordic Five Tech.



Aalto-1

The Finnish Student Satellite

New professors on Space topics at Aalto University Department of Radio Science and Engineering

A!
Aalto University

Aalto-1
The Finnish Student Satellite

Tuija Pulkkinen

Space Science

Esa Kallio

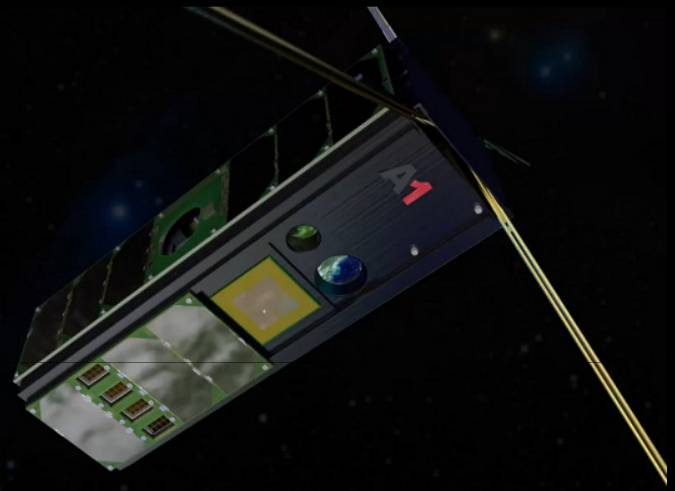
Space Science and Technology

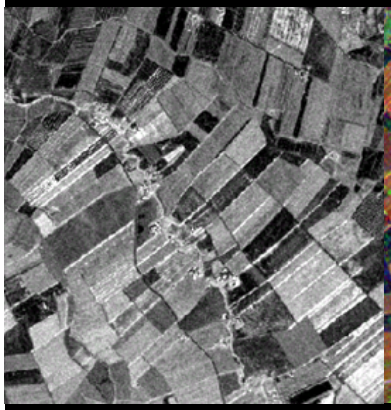
Anne Lähteenmäki

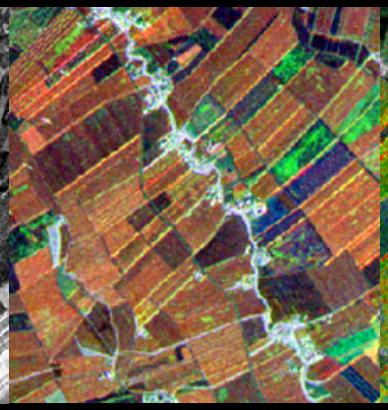
Radio Astronomy

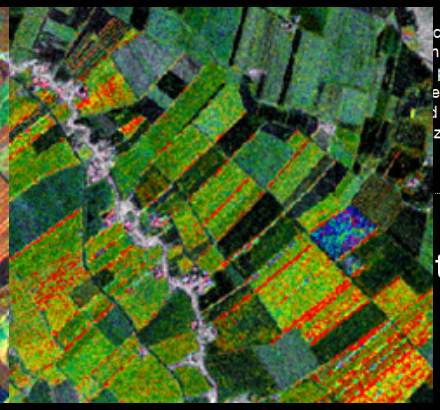
Jaan Praks

Microwave Remote Sensing





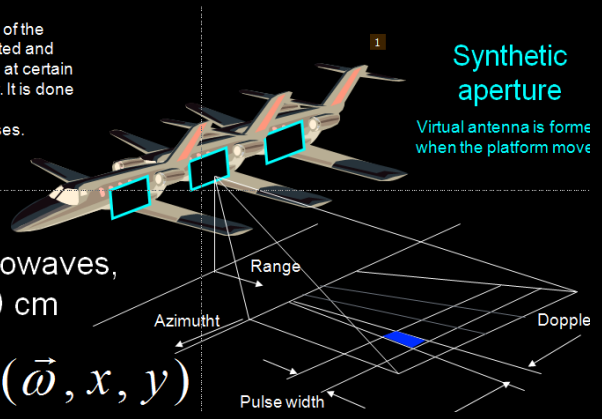




ckscattering of the
n of transmitted and
polarization at certain
en geometry. It is done
d receiveing
zed EM pulses.

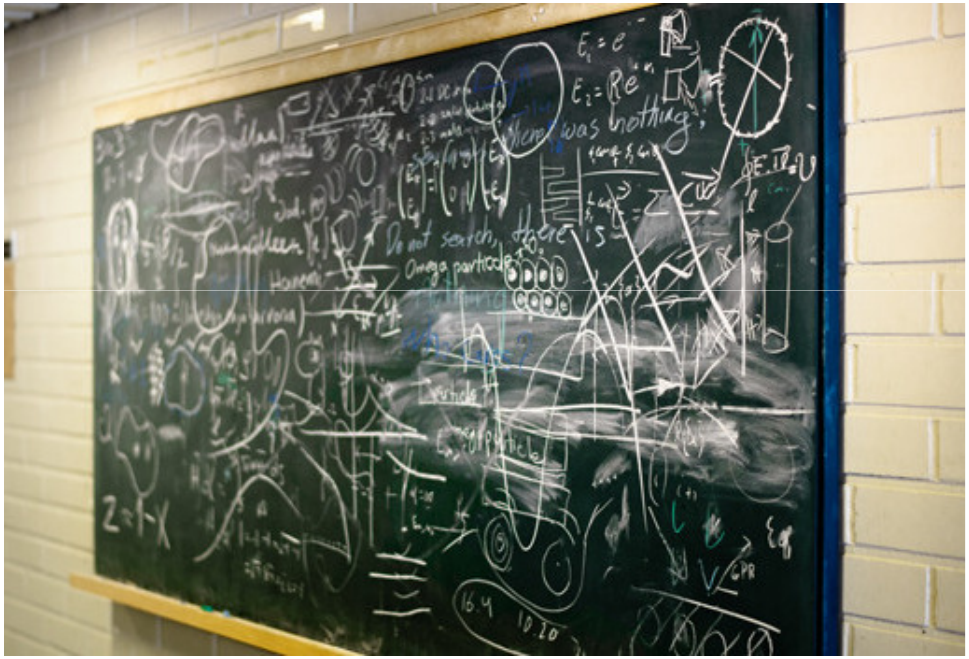
t microwaves,
.. 100 cm

$$\beta(\vec{\omega}, x, y)$$



Space related research topics at Department of Radio Science and Engineering

- Space weather
- Ionosphere
- Planetary atmosphere
- Asteroids
- Nanosatellites
- Microwave instruments
- Satellite sensors
- Radio astronomy
- Nanosatellite platforms
- Airborne microwave remote sensing
- Millimeter wave technology

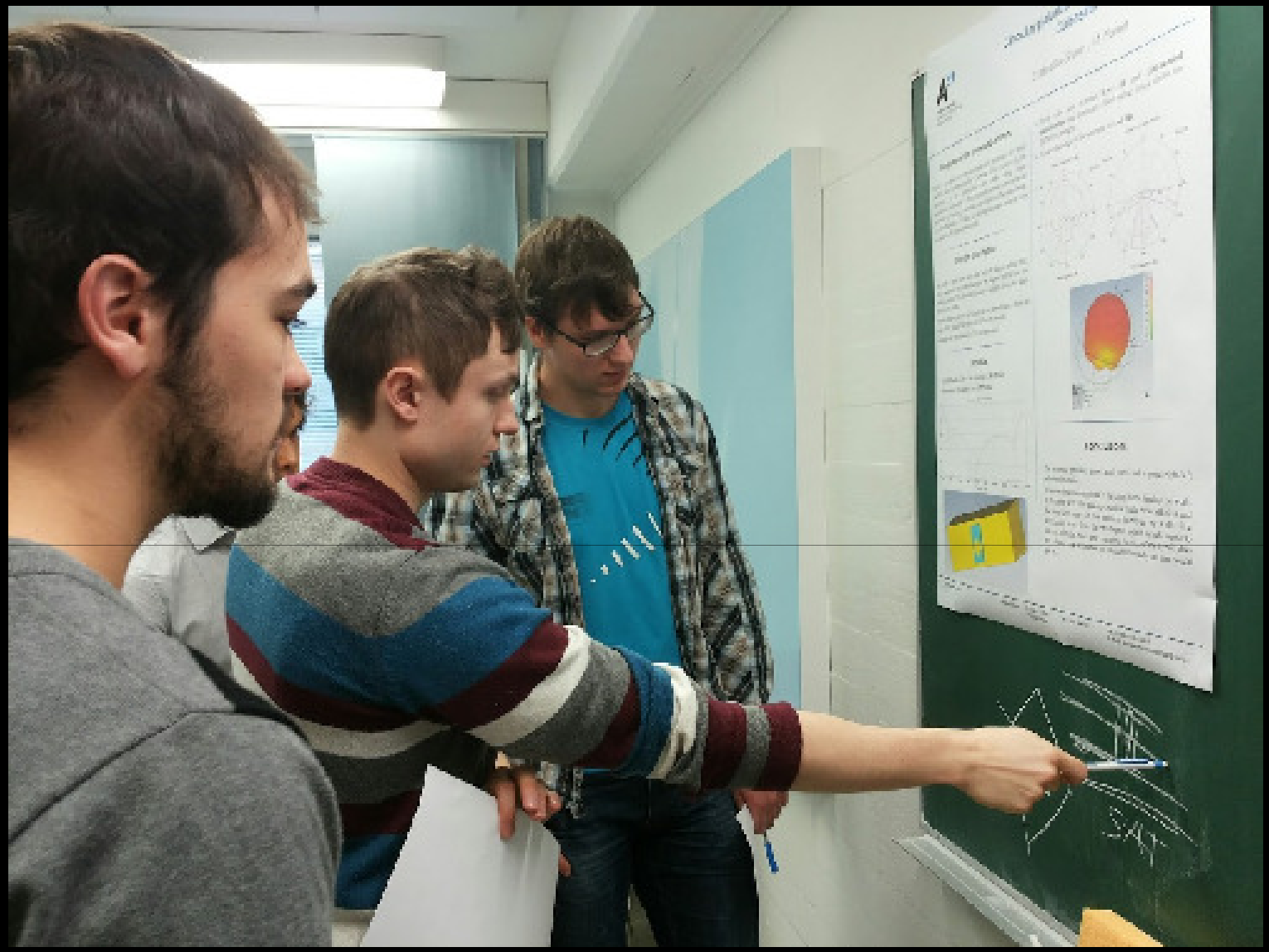


Education: Learning by doing

Aalto University

Aalto-1

The Finnish Student Satellite



A!
Aalto University

Aalto-1
The Finnish Student Satellite

A!
Aalto University

Aalto-1

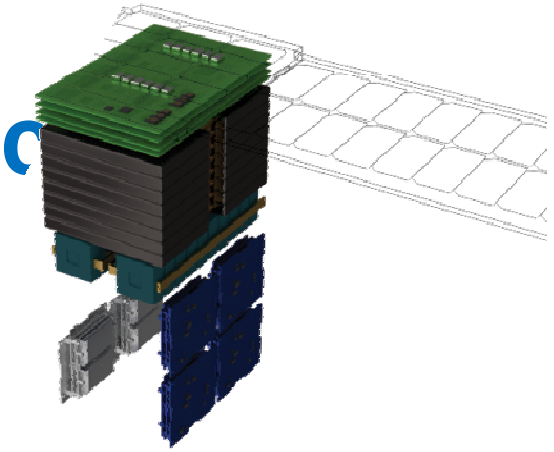
The Finnish Student Satellite

LUMA program for gymnasiums

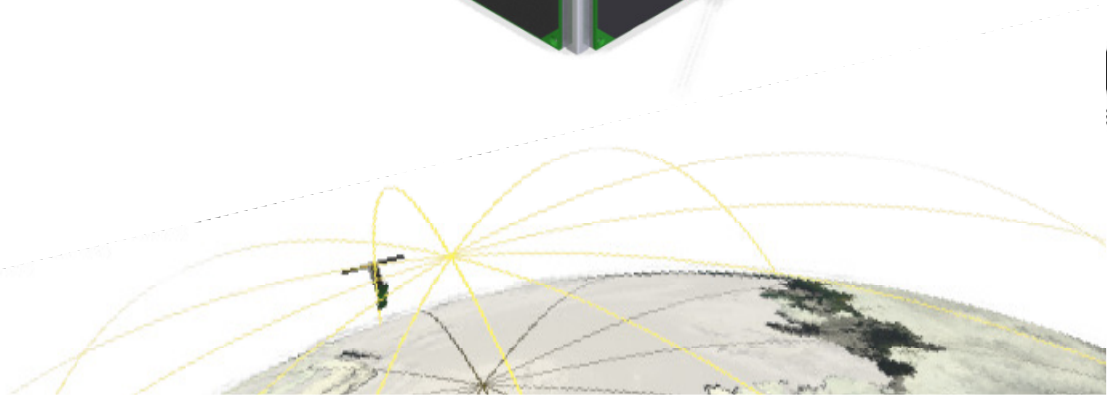
Aalto-1

The Finnish Student Satellite

Current small satellite projec at Aalto University



- Aalto-1 CubeSat
- Aalto-2 CubeSat
- ICEYE spin-off project



Aalto University

VTT

University of Helsinki

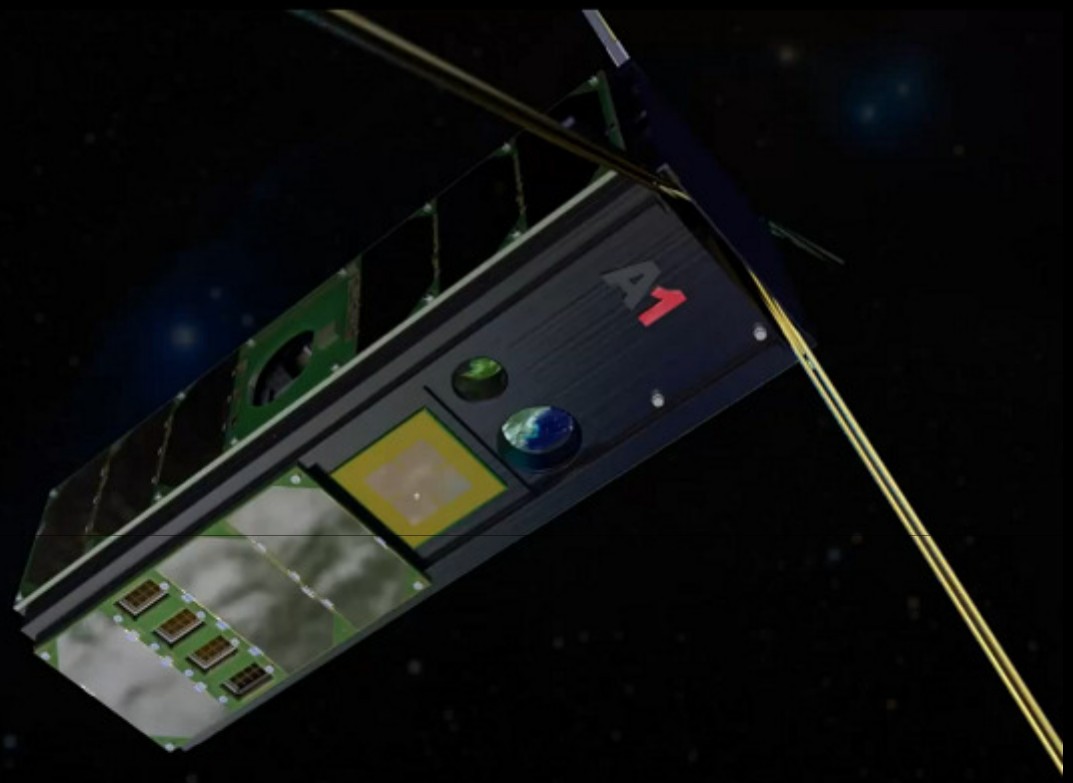
UNIVERSITY OF JYVÄSKYLÄ

ASRO

DLR

Aalto University
Multidisciplinary Institute of Digitalisation and Energy

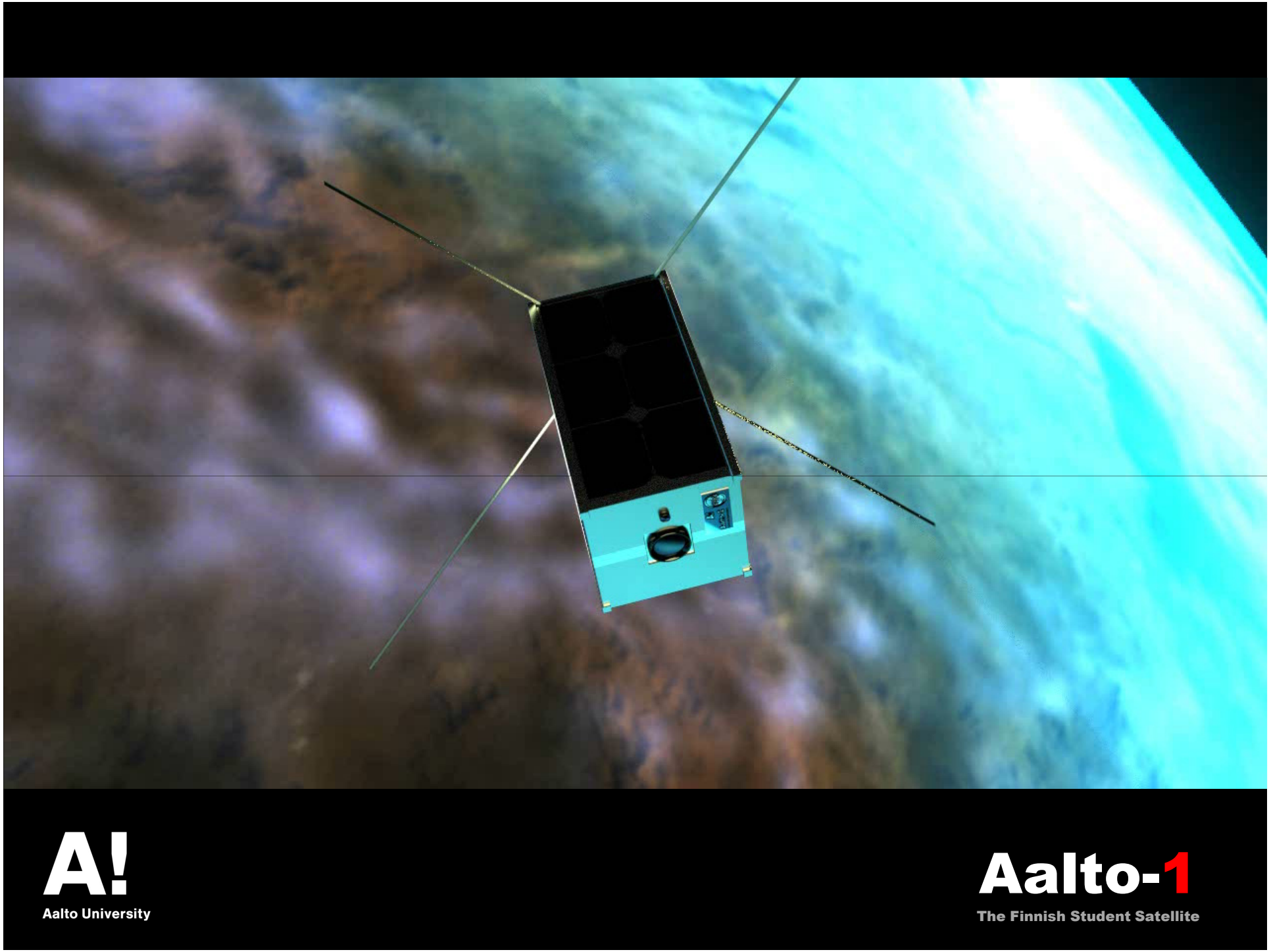
Turun yliopisto
University of Turku



Aalto-1

The Finnish Student Satellite

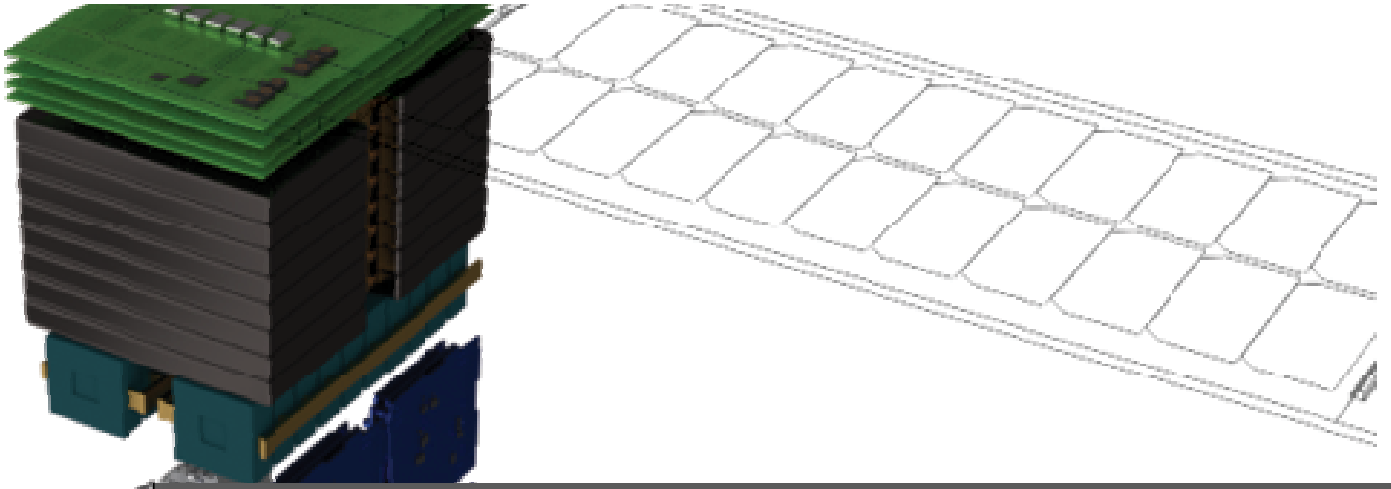
Aalto-2



A!
Aalto University

Aalto-1

The Finnish Student Satellite



ICEYE

Arctic Intel

ICEYE
Arctic Intel

Nanosatellites as education platform

Aalto University

Aalto-1

The Finnish Student Satellite

A!
Aalto University

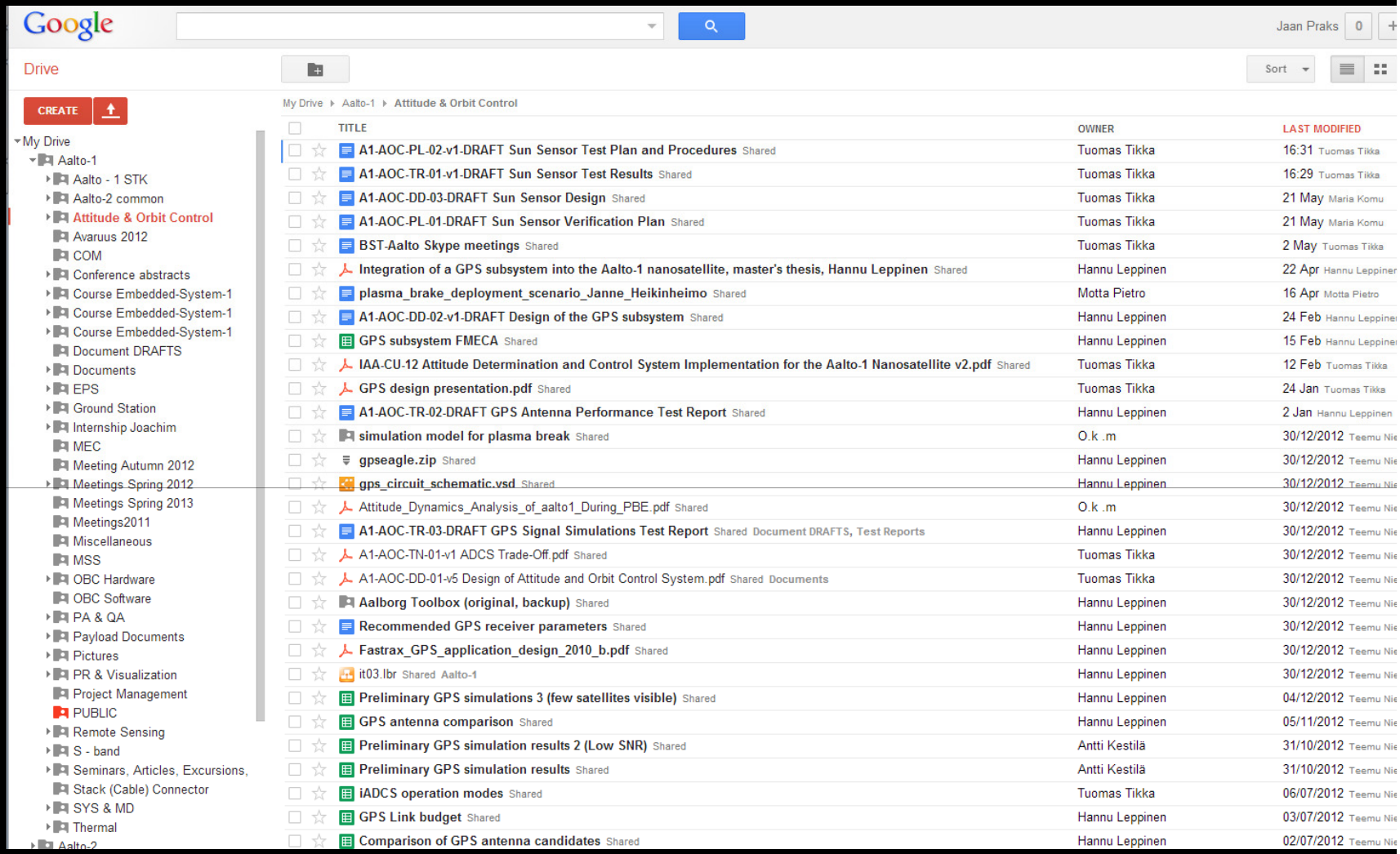
Aalto-1
The Finnish Student Satellite

Increasing hands-on teaching

Aalto University

Aalto-1

The Finnish Student Satellite

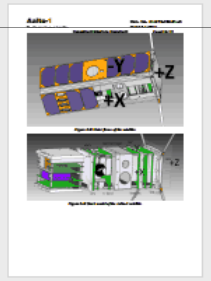


A!
Aalto University

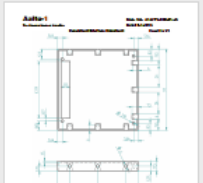
Aalto-1
The Finnish Student Satellite

8

9



10



Aalto-1
Experiment Interface Document

Aalto University

School of Electrical Engineering

	Name	Signature	Date
Prepared by	Antti Kestilä, Antti Näsilä, Maria Komu, Jaan Praks, Anssi Hakkarainen		08.01.2013
Checked by	Antti Kestilä		08.01.2013
Approved by	Antti Kestilä		08.01.2013

- Open access to results
- Self assessment
- Peer review
- Expert reviews

Assessment Application

Applies to Aalto-1 project related work in courses

- S-92.3192 Spacial Assignment in Space Technology
- S-92.3200 Student Satellite Project

Applicant details

Applicant Name	
Period under assessment	
Assessed work topic(s)	
Membership in team and names of other team members	

Workload

Topic	Used hours
Background Research	
Meetings (inc. conference lectures)	
Software writing	
Hardware building and prototyping	
Testing	
Documentation writing	
Other (what?)	
Total	

Brief work description

Should contain:

- Conclusions
- Work definition and goal of the work
- Material (is this work based on previous work, book, other thesis etc)
- Methods (how the work is done, inc. software and tools used etc)

Aalto University

Aalto-1

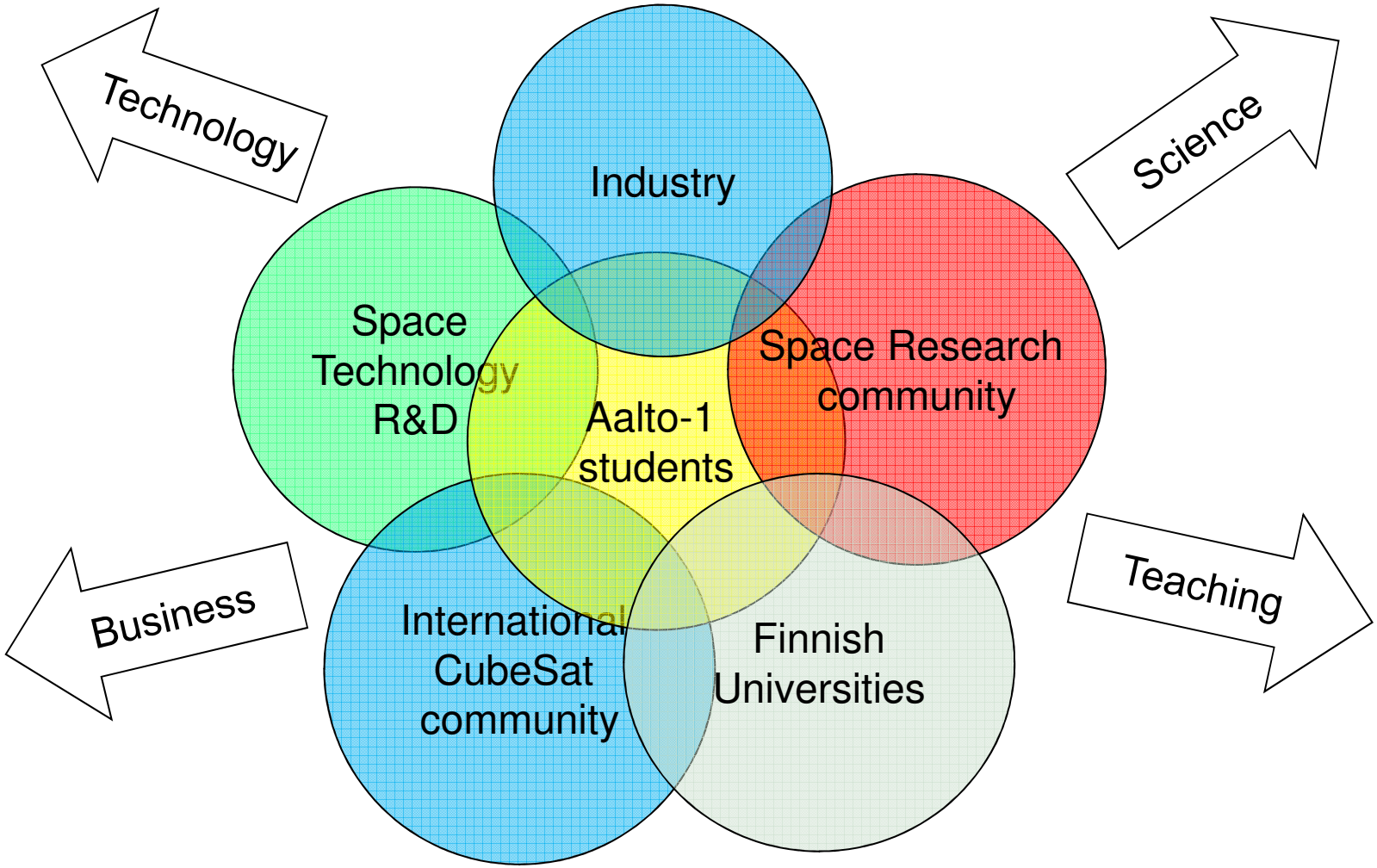
The Finnish Student Satellite

A!
Aalto University

Aalto-1

The Finnish Student Satellite

Challange and opportunities for students



Small satellite development and test laboratory

A!
Aalto University

Aalto-1
The Finnish Student Satellite

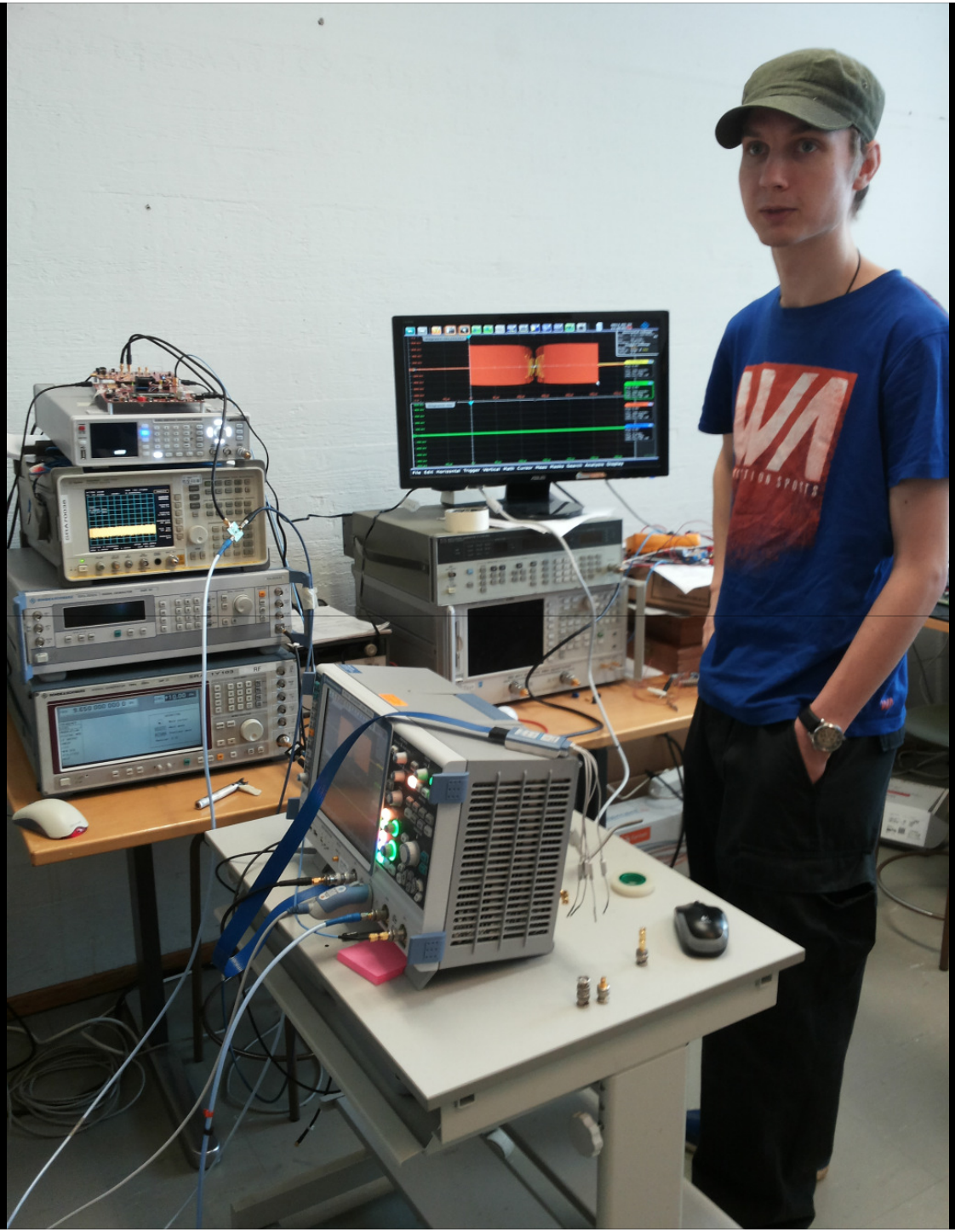
Vacuum

Thermal

Aalto-1

The Finnish Student Satellite

A!
Aalto University



Aalto-1

The Finnish Student Satellite

A!
Aalto University

Aalto-1

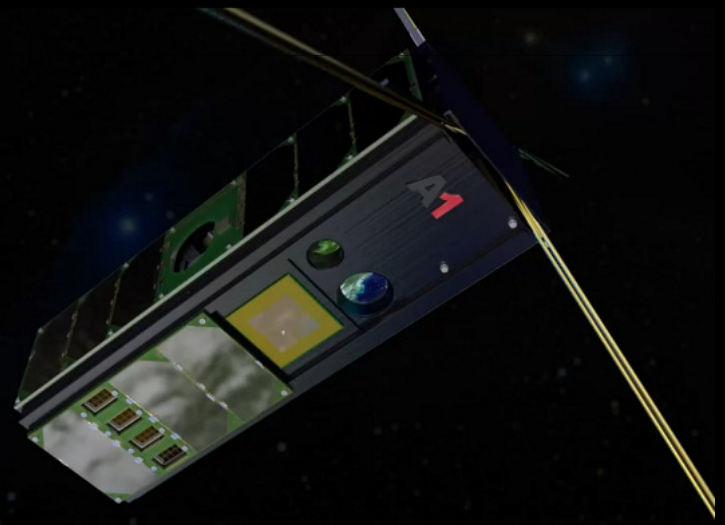
The Finnish Student Satellite

A!
Aalto University

Aalto-1

The Finnish Student Satellite

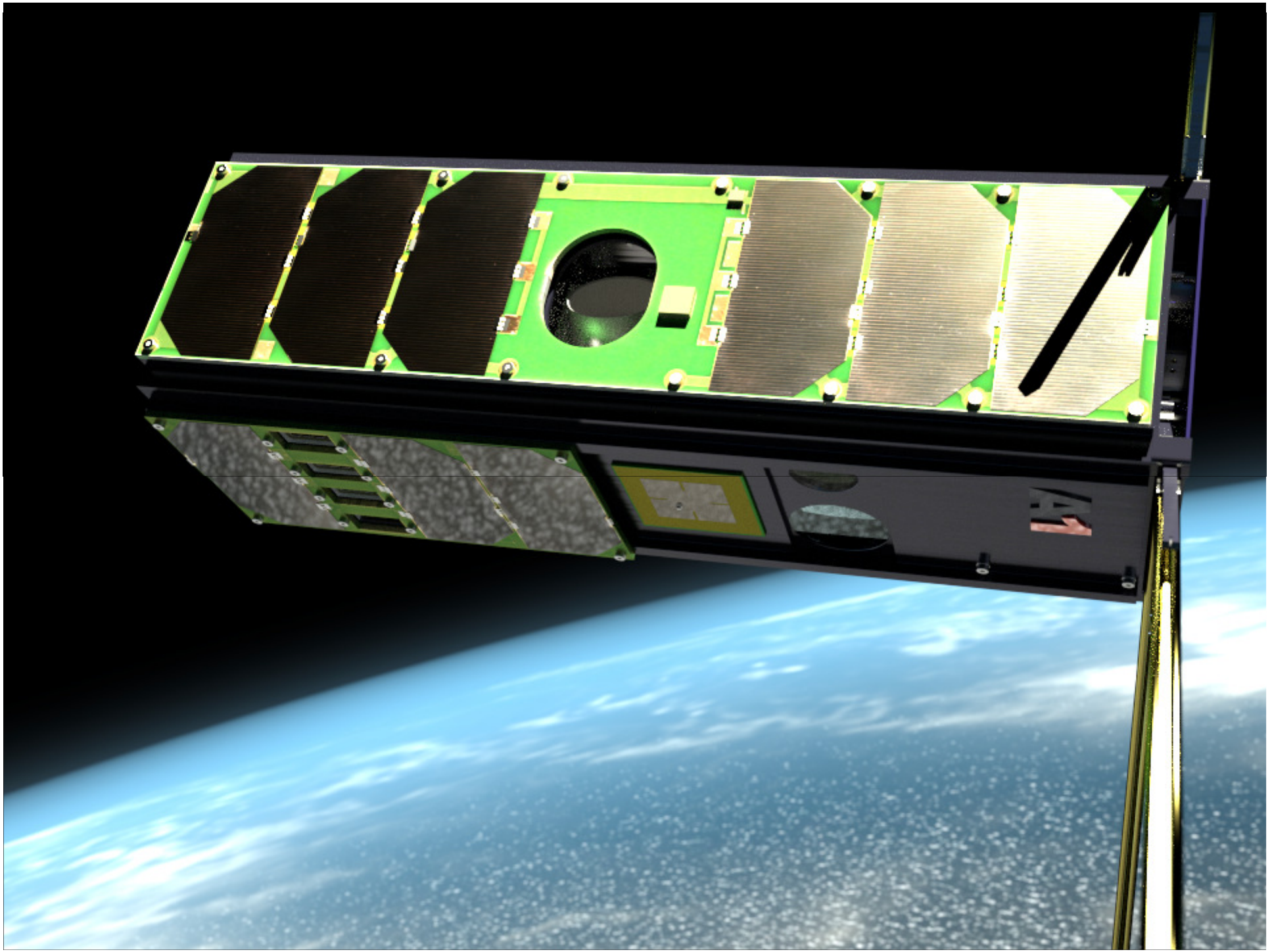
Aalto-1 status

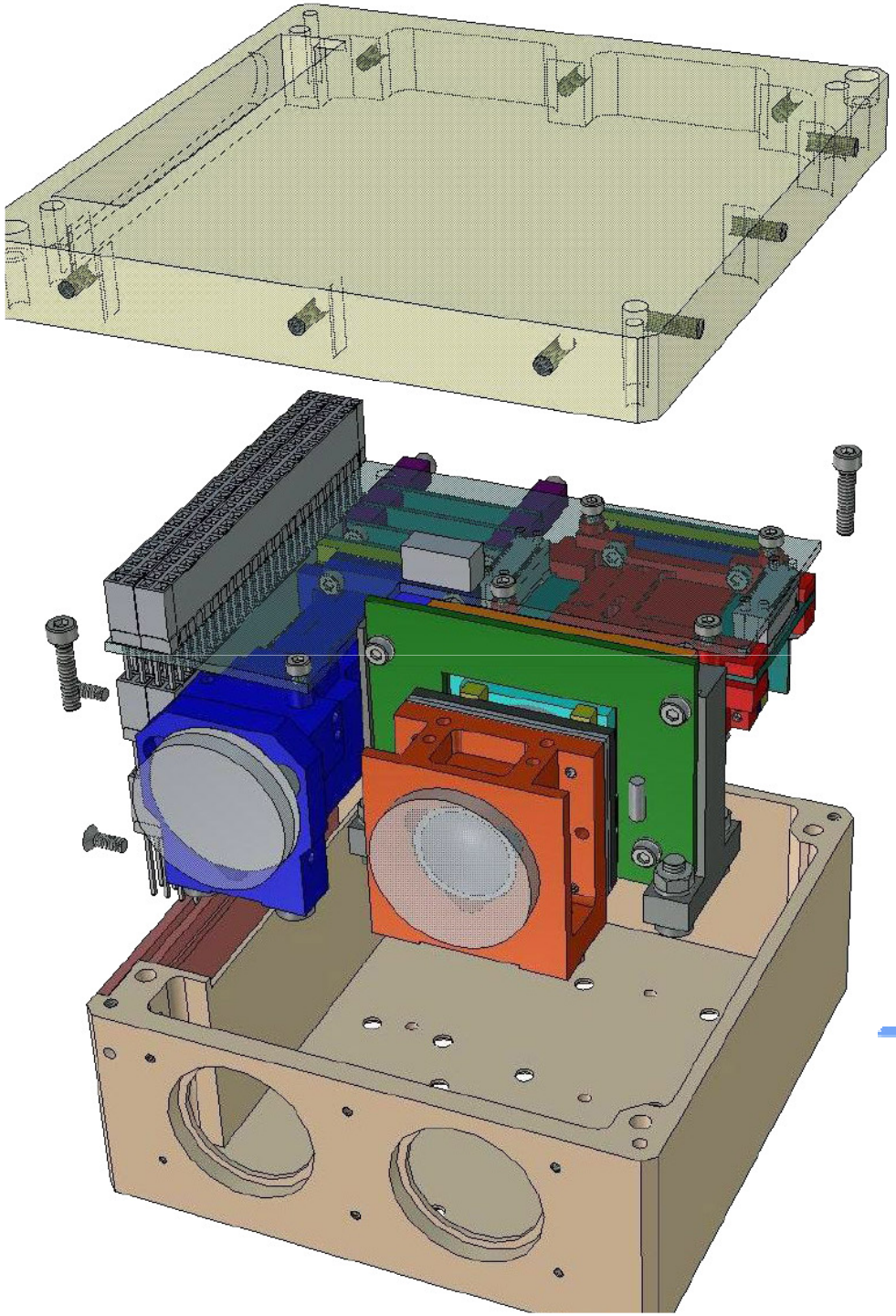


Aalto University

Aalto-1

The Finnish Student Satellite

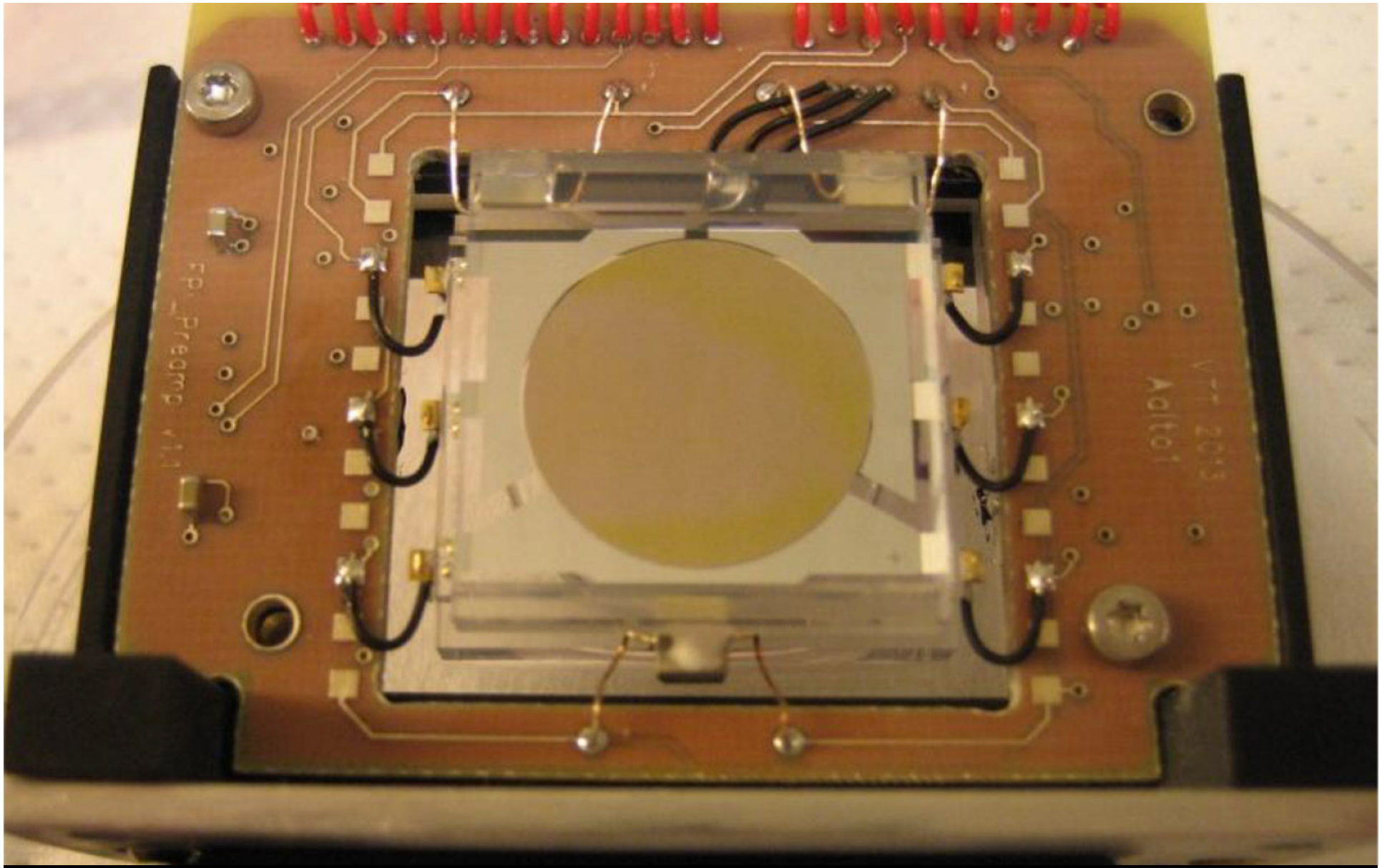




AaSI – Fabry-Perot Spectral Imager

Aalto-1

The Finnish Student Satellite



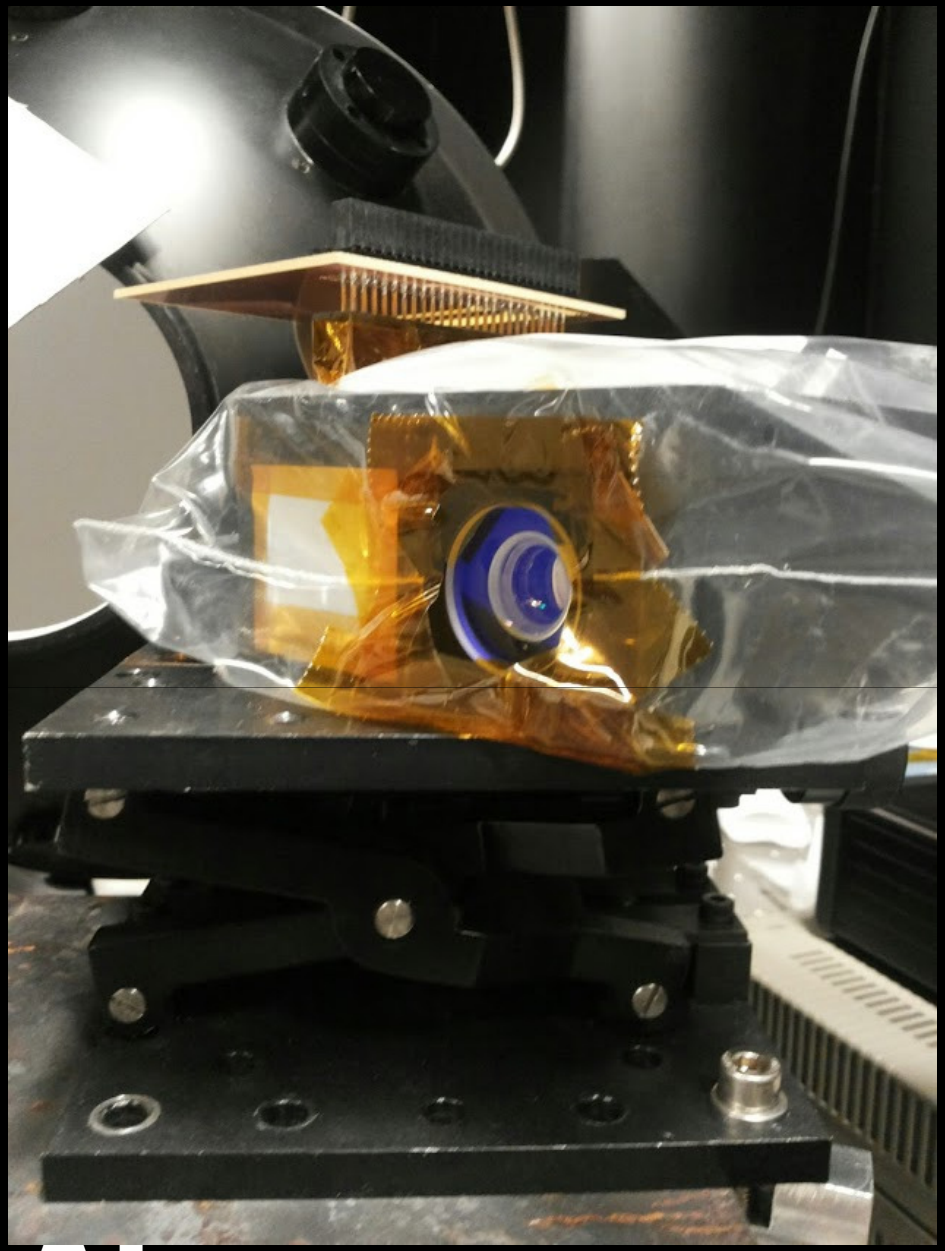
Aalto University

AaSI Fabry-Perot filter

VTT

Aalto-1

The Finnish Student Satellite



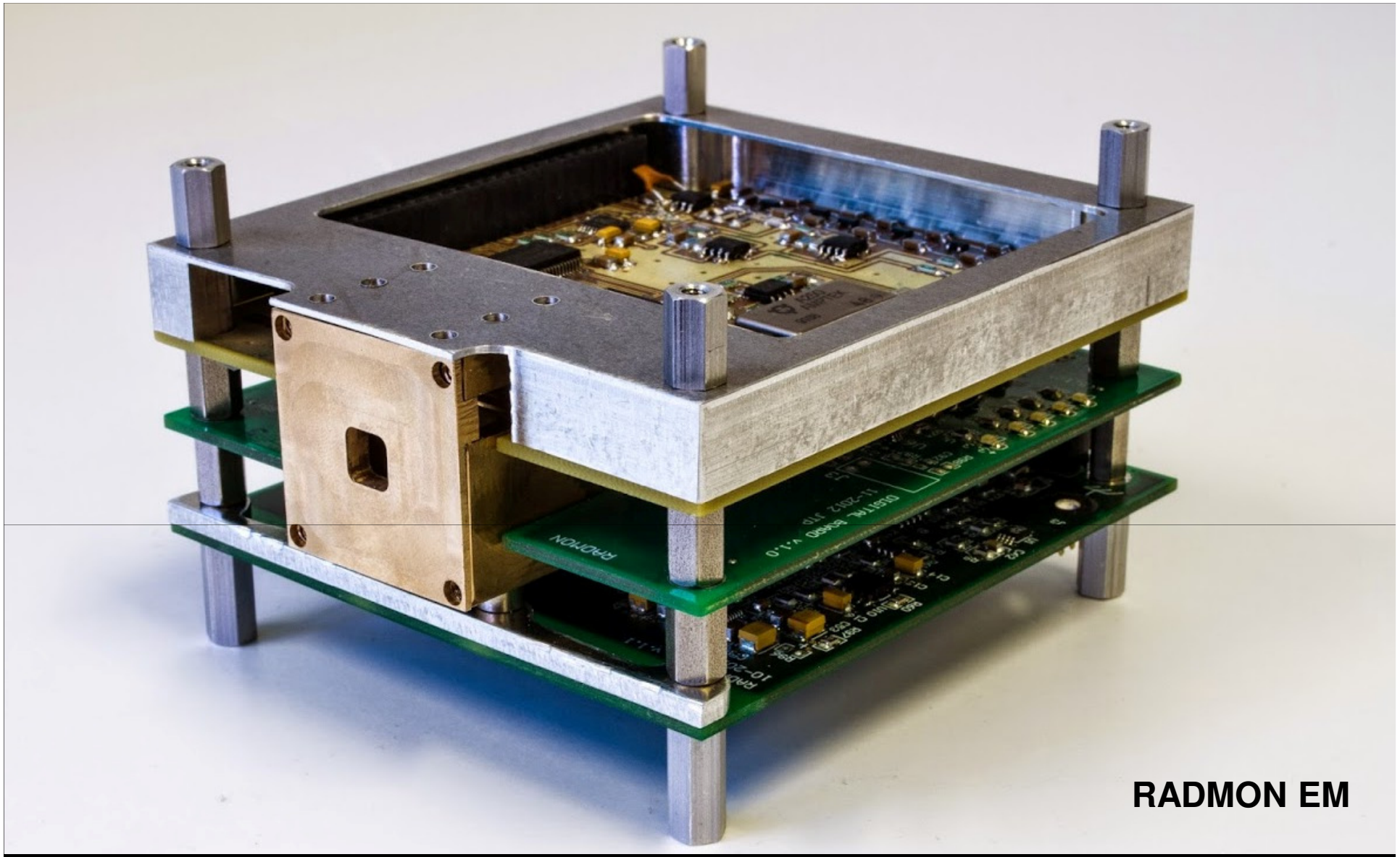
AaSI
Spactral Imager
EM

EM-model under tests

Aalto University

Aalto-1

The Finnish Student Satellite

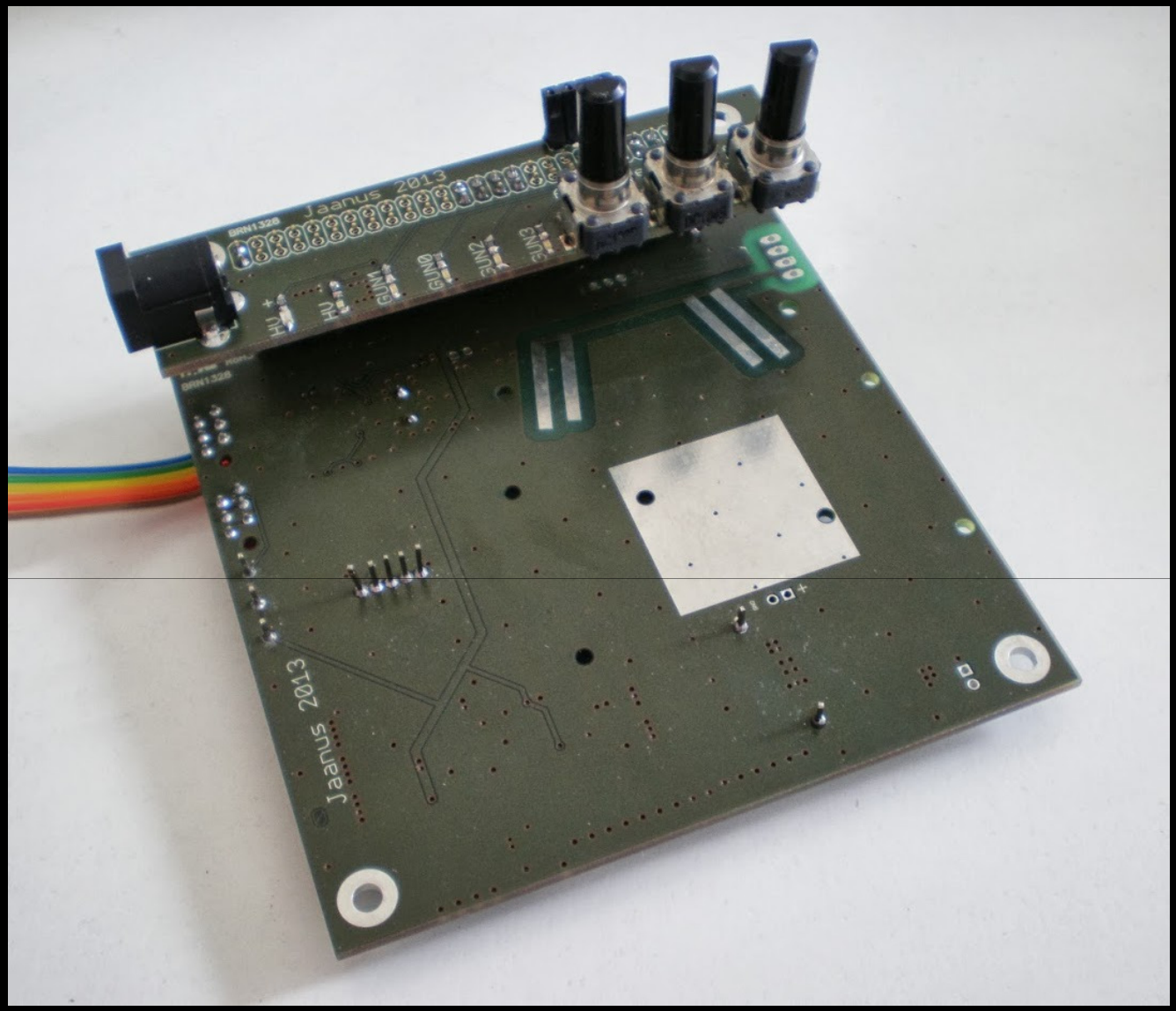


University of Helsinki

Turun yliopisto
University of Turk

ASRO

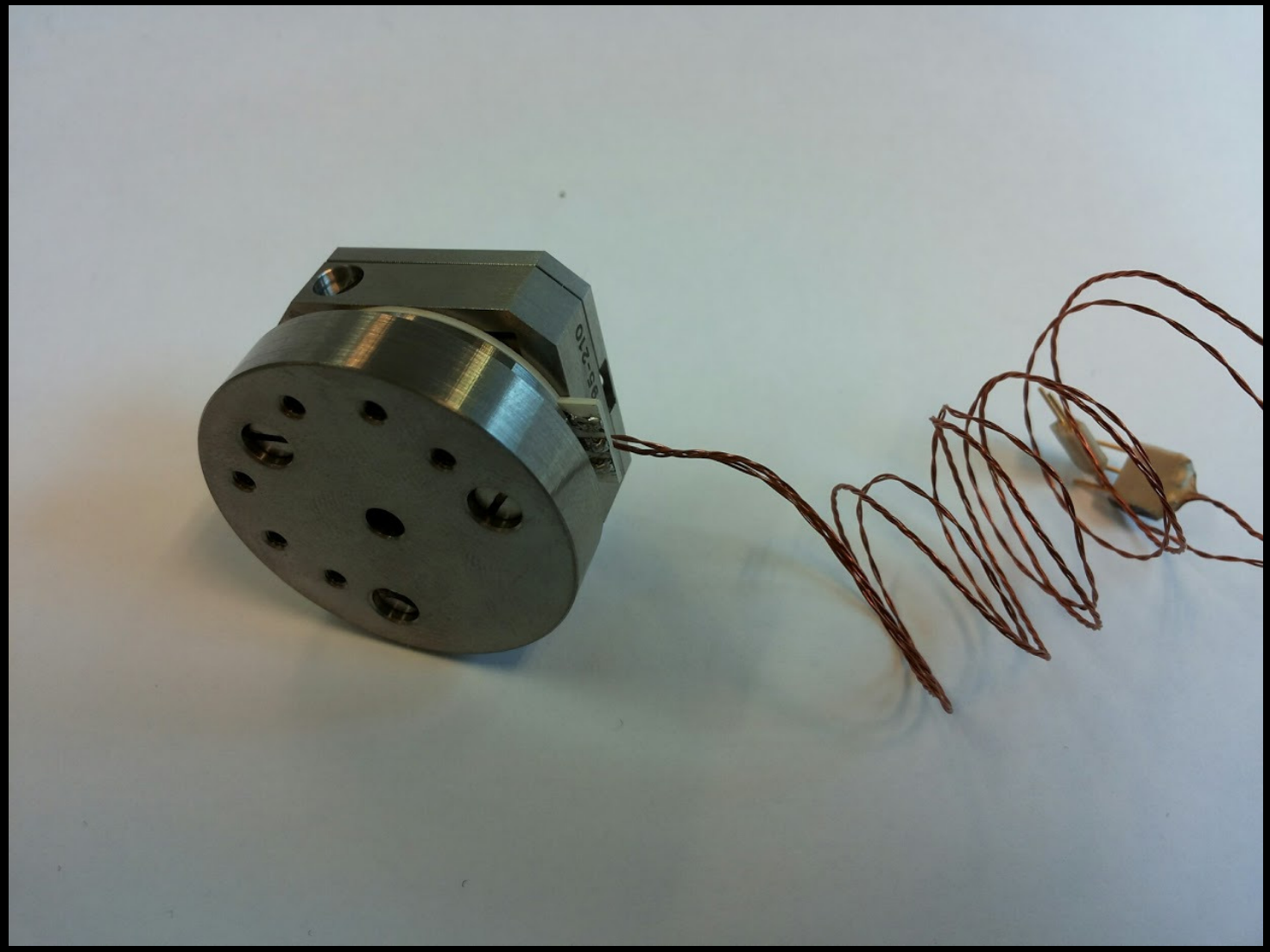
Aalto-1
The Finnish Student Satellite



Motor driver board, ESTCube

Aalto-1

The Finnish Student Satellite



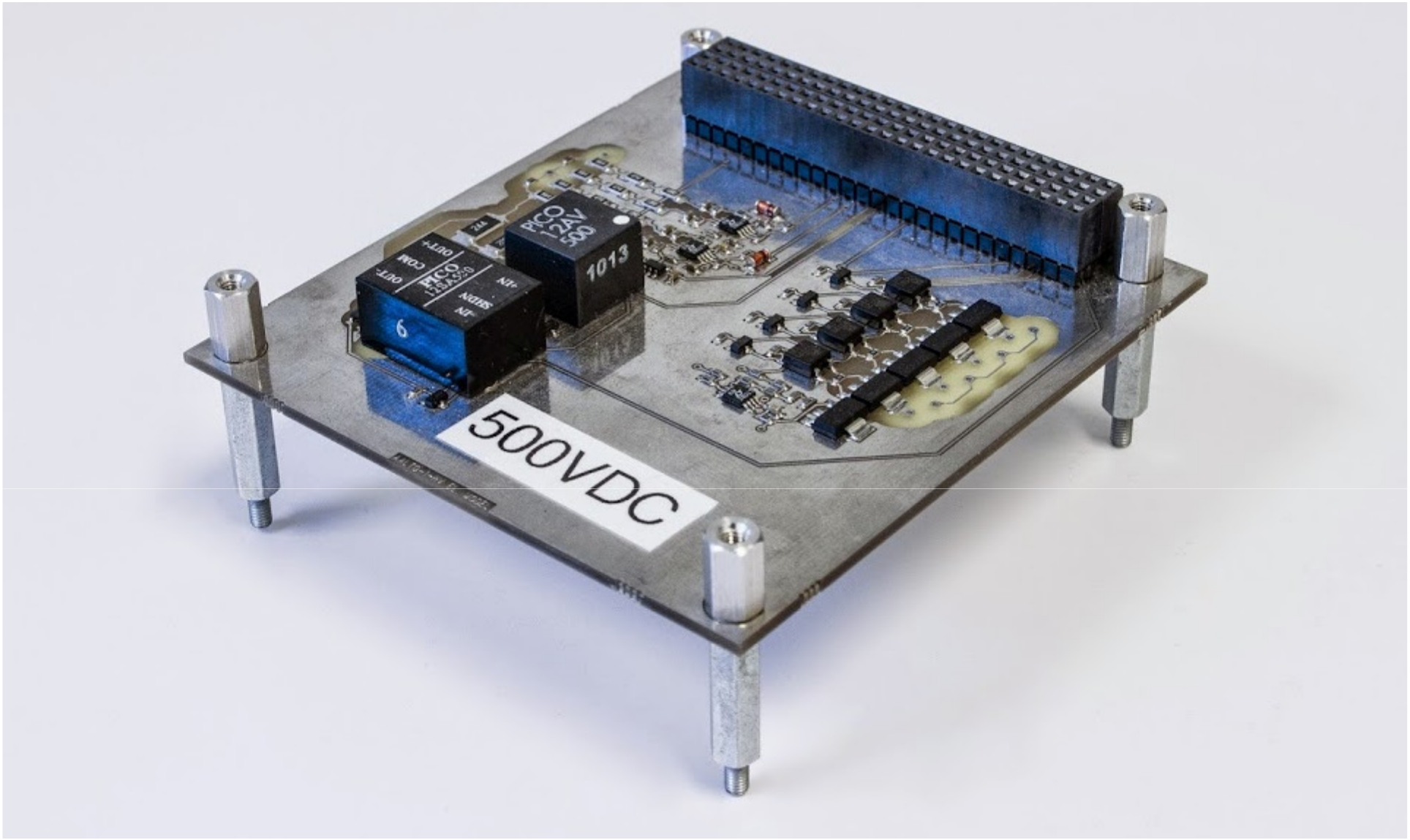
Reel motor by DLR

DLR

ESTCUBE

Aalto-1

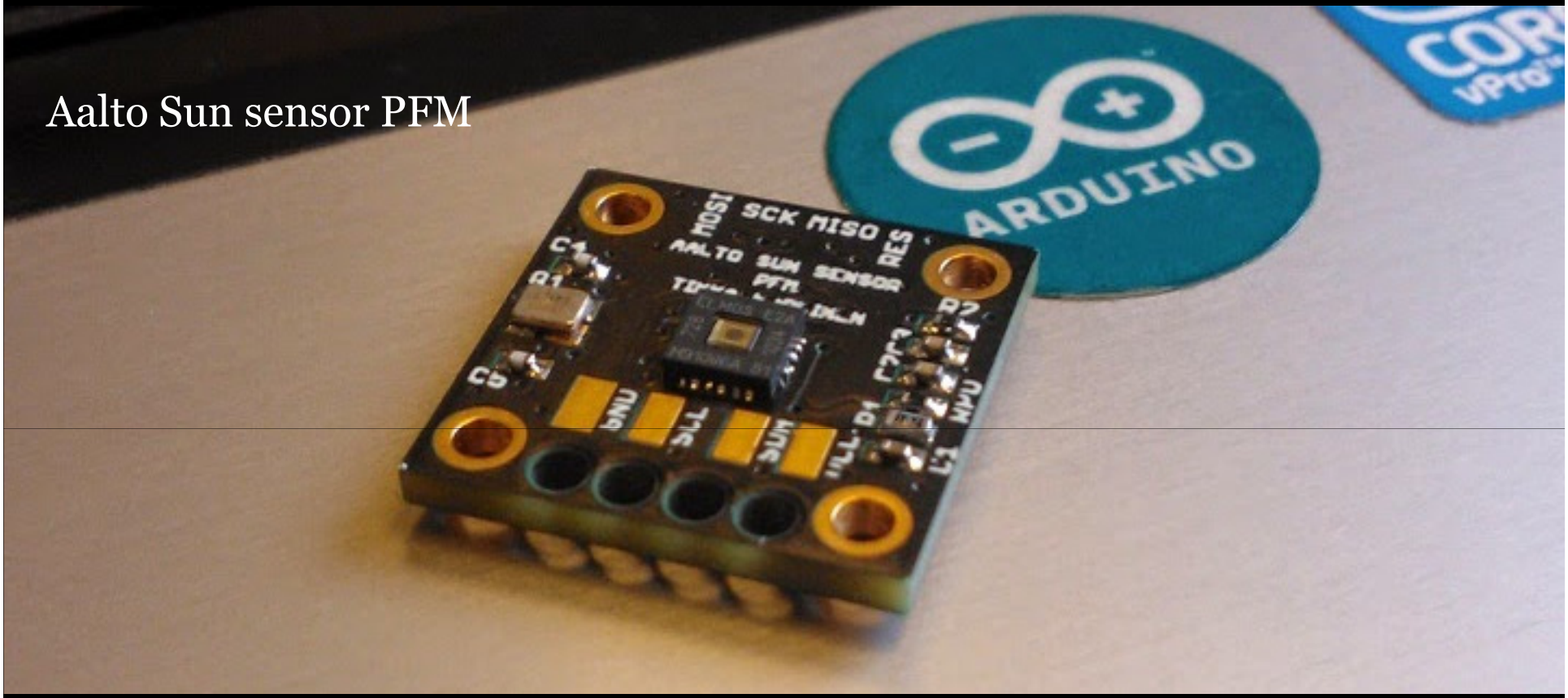
The Finnish Student Satellite



Aalto-1

The Finnish Student Satellite

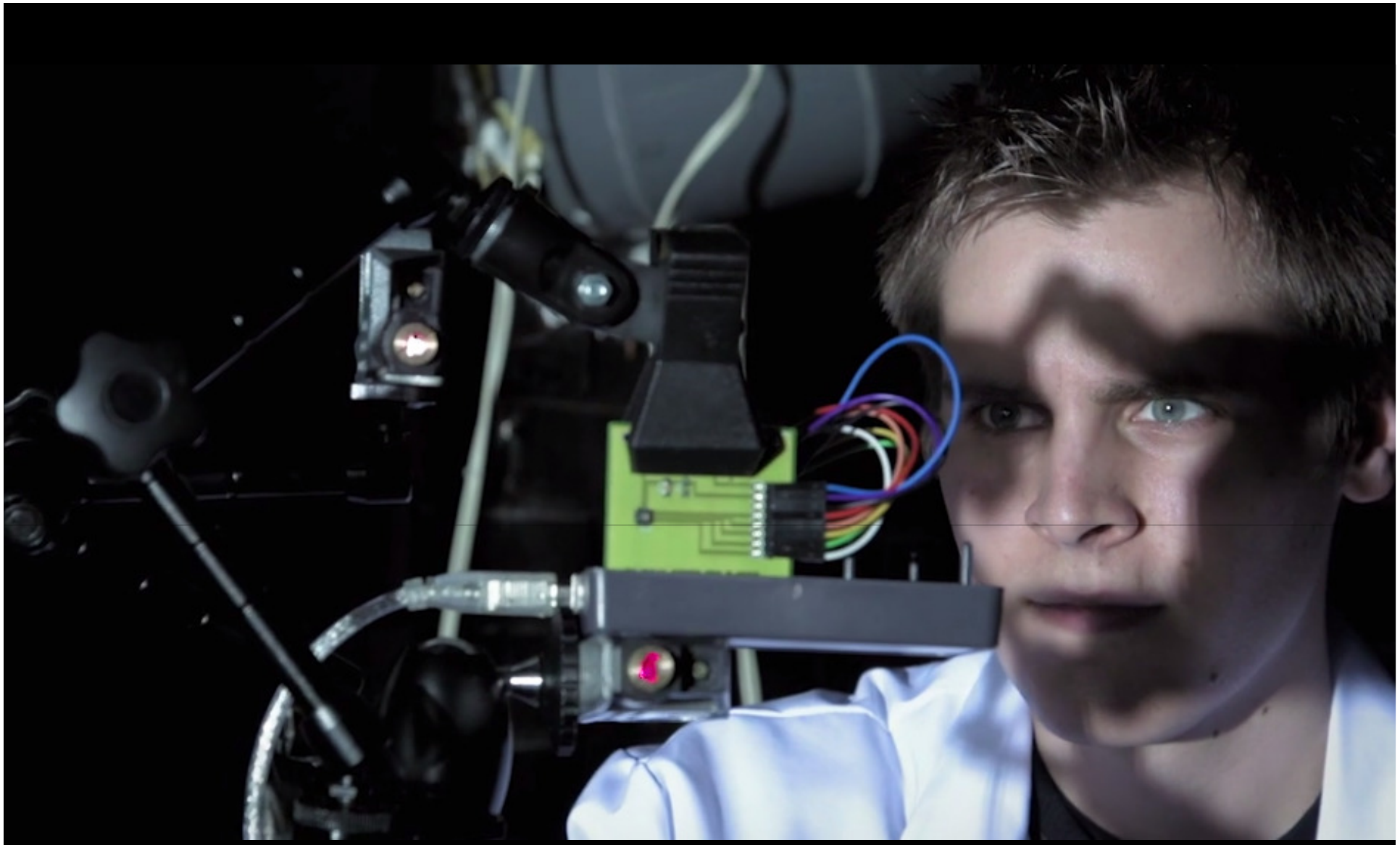
Aalto Sun sensor PFM



Aalto University

Aalto-1

The Finnish Student Satellite



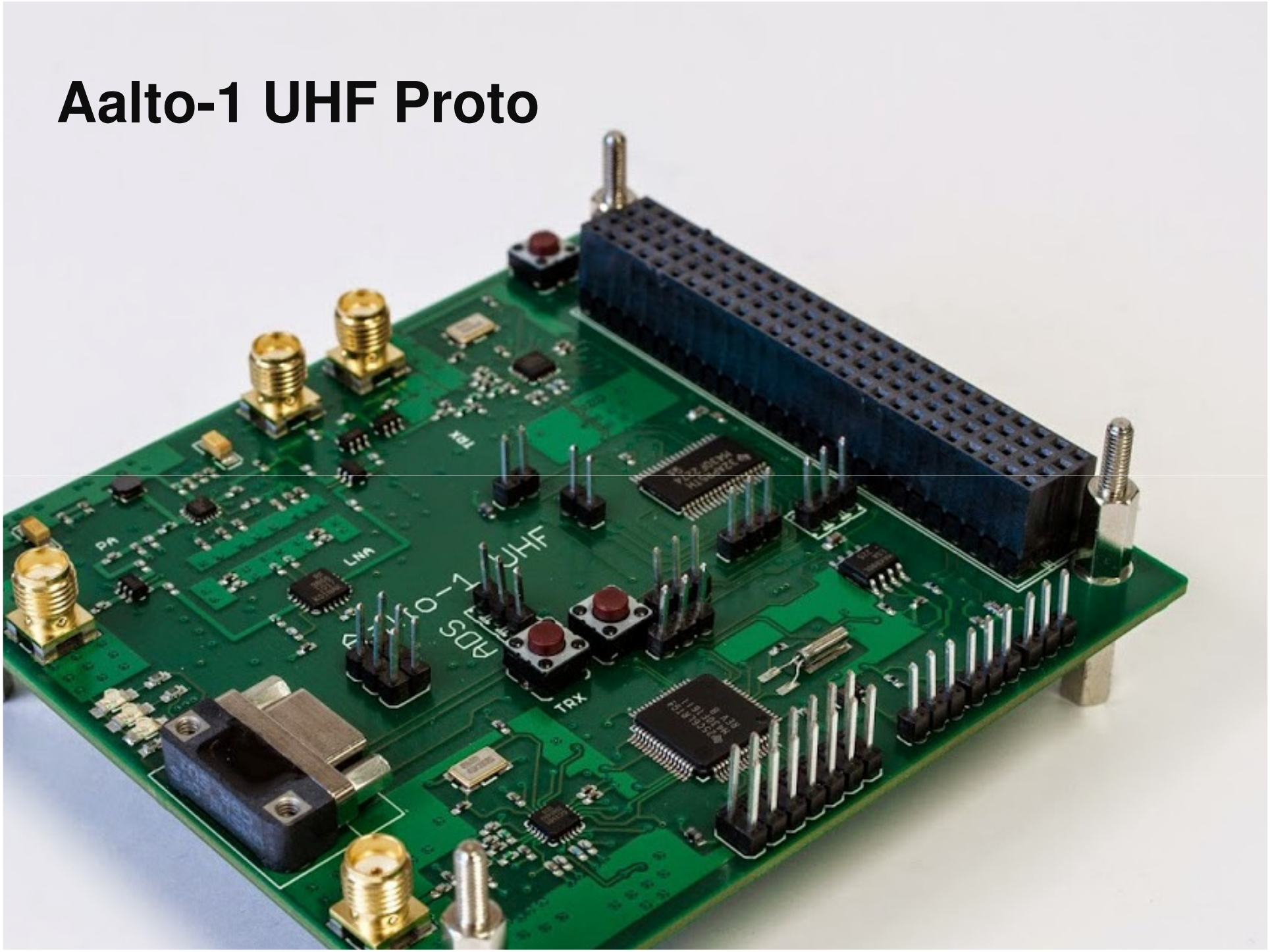
Aalto University

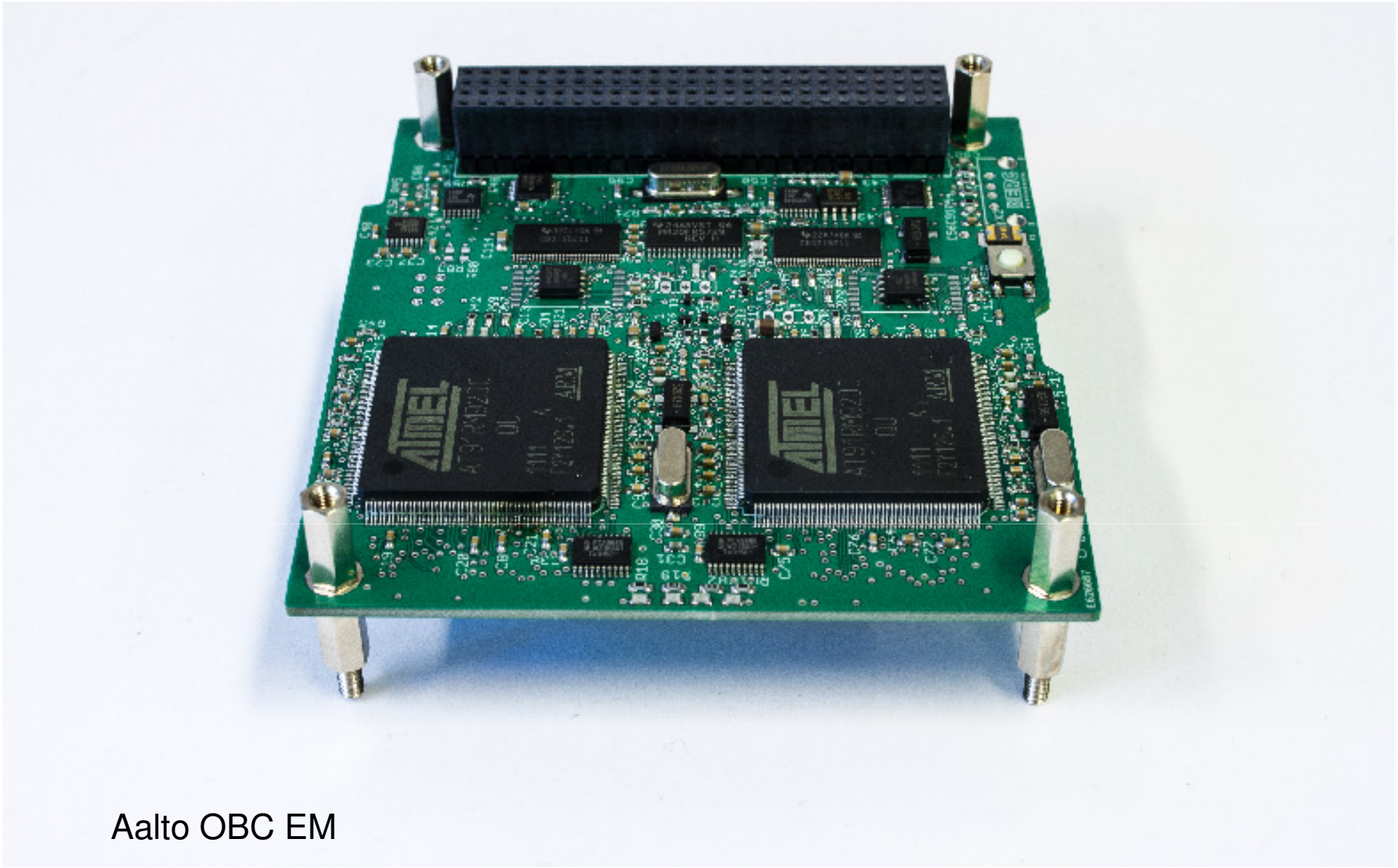
Sun sensor calibration measurements

Aalto-1

The Finnish Student Satellite

Aalto-1 UHF Proto





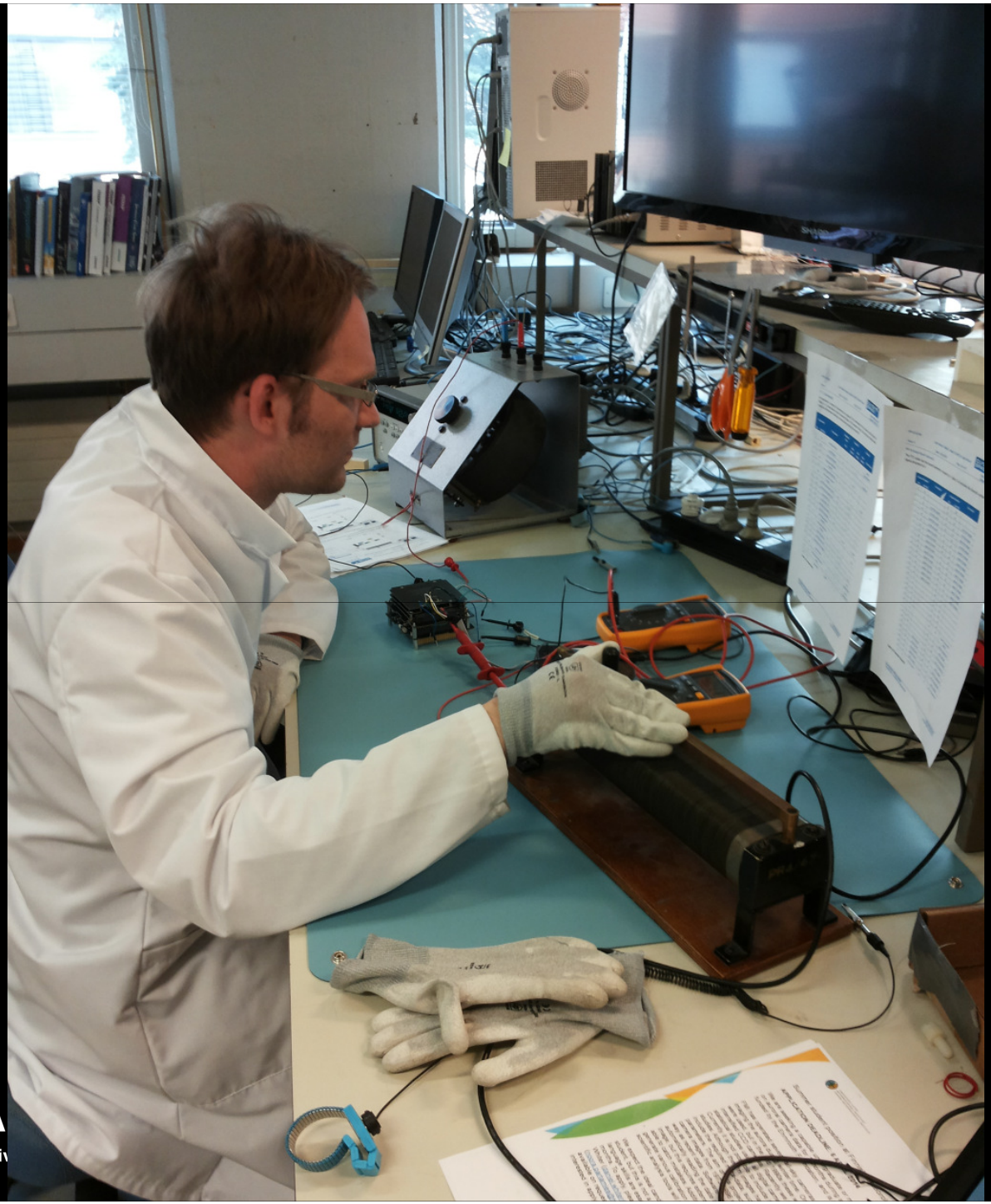
Aalto OBC EM

Aalto University
School of Electrical
Engineering

Aalto-1
The Finnish Student Satellite

A!
Aalto University

Aalto-1
The Finnish Student Satellite



A

Aalto Univ

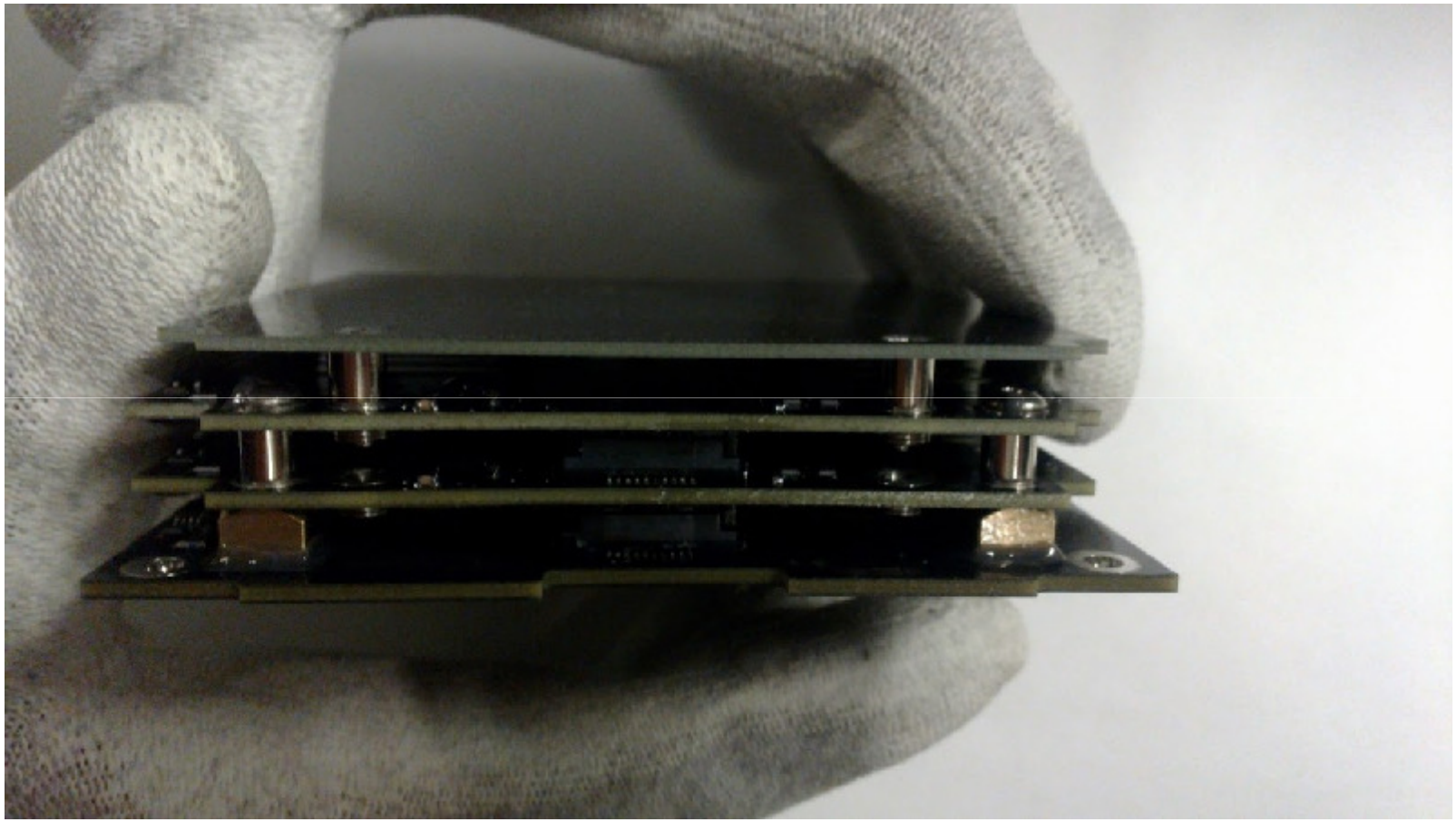
Aalto-1

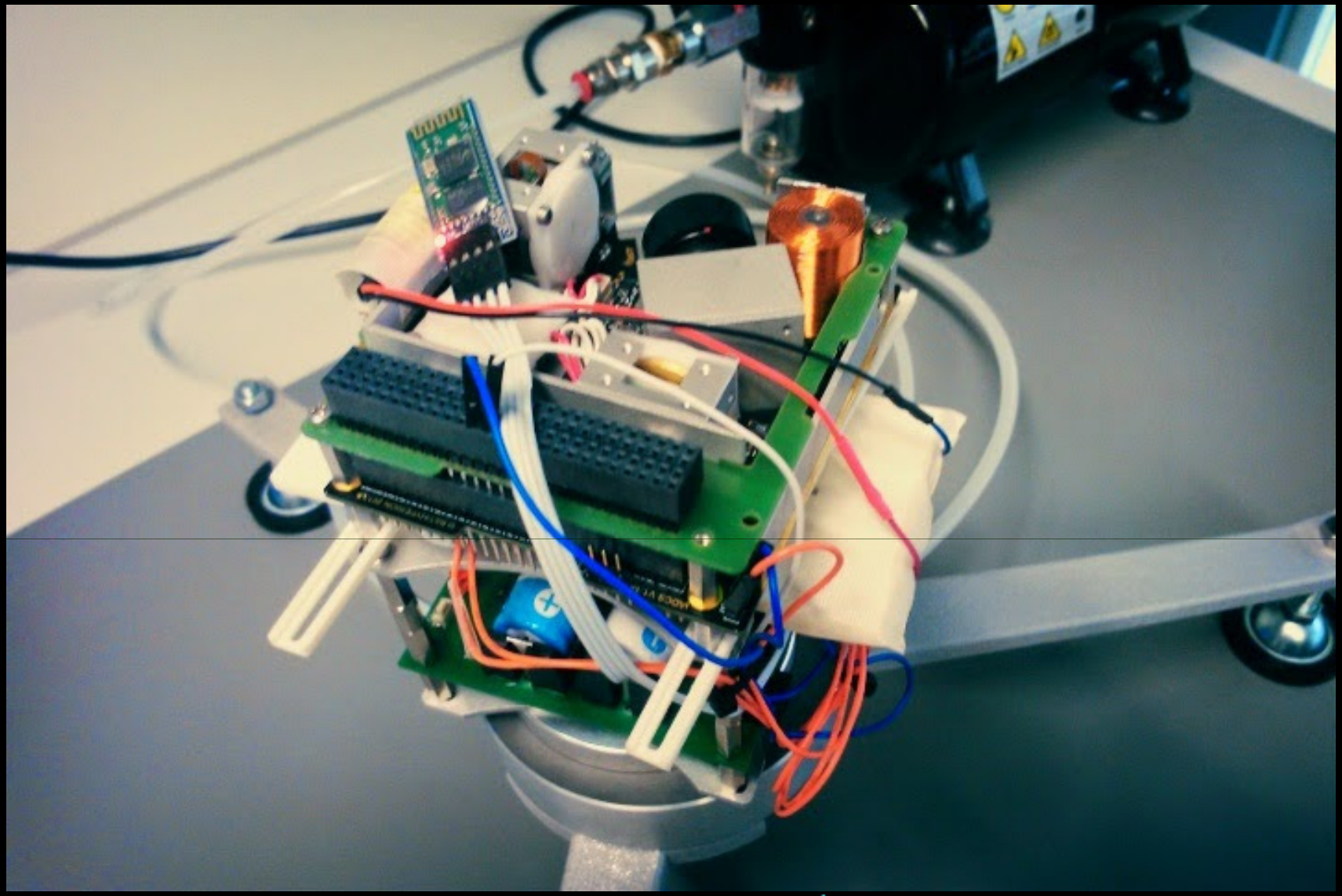
The Finnish Student Satellite

Aalto-1

The Finnish Student Satellite

EPS EM





iADCS EM in test bench

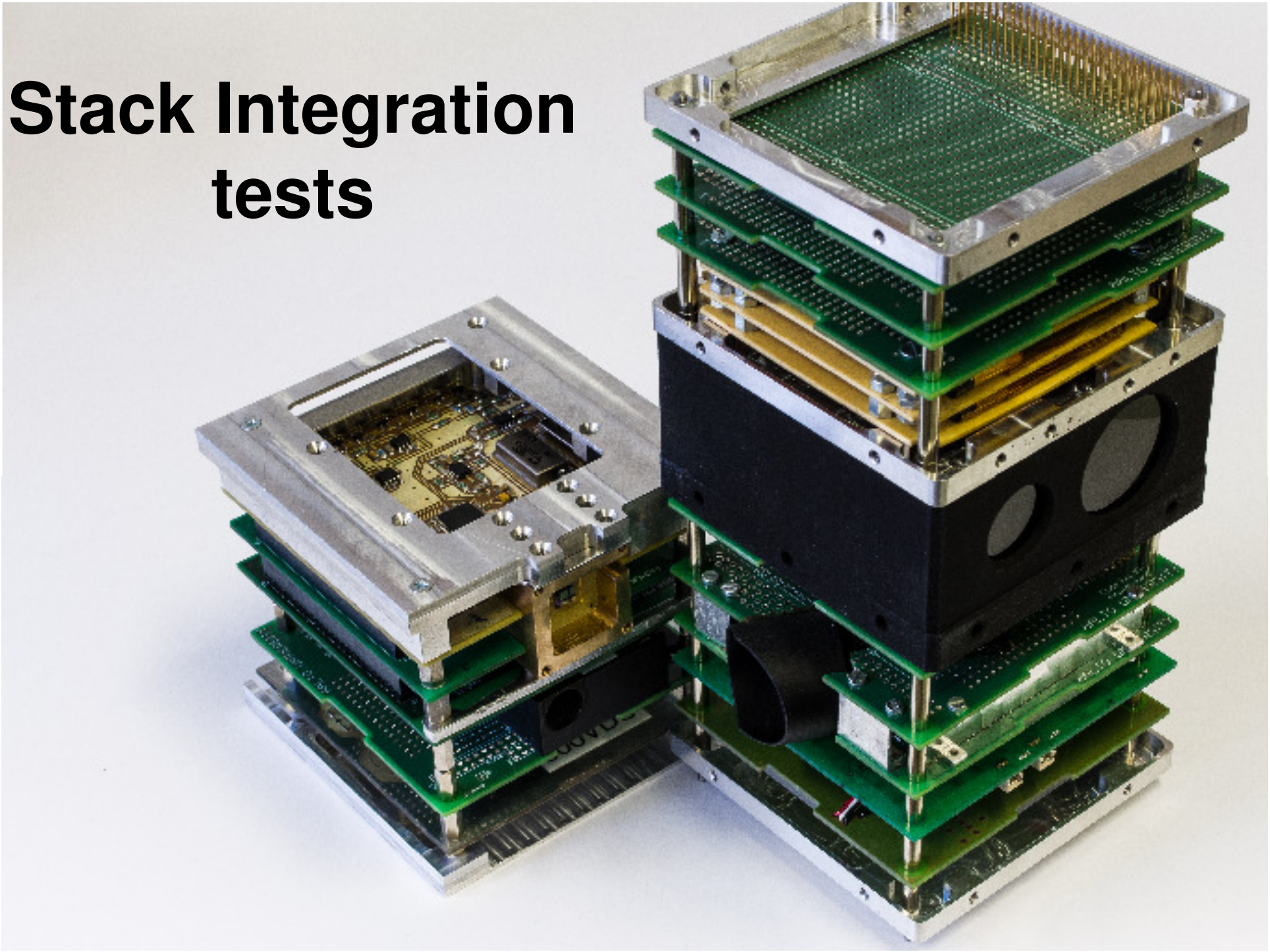
Aalto University

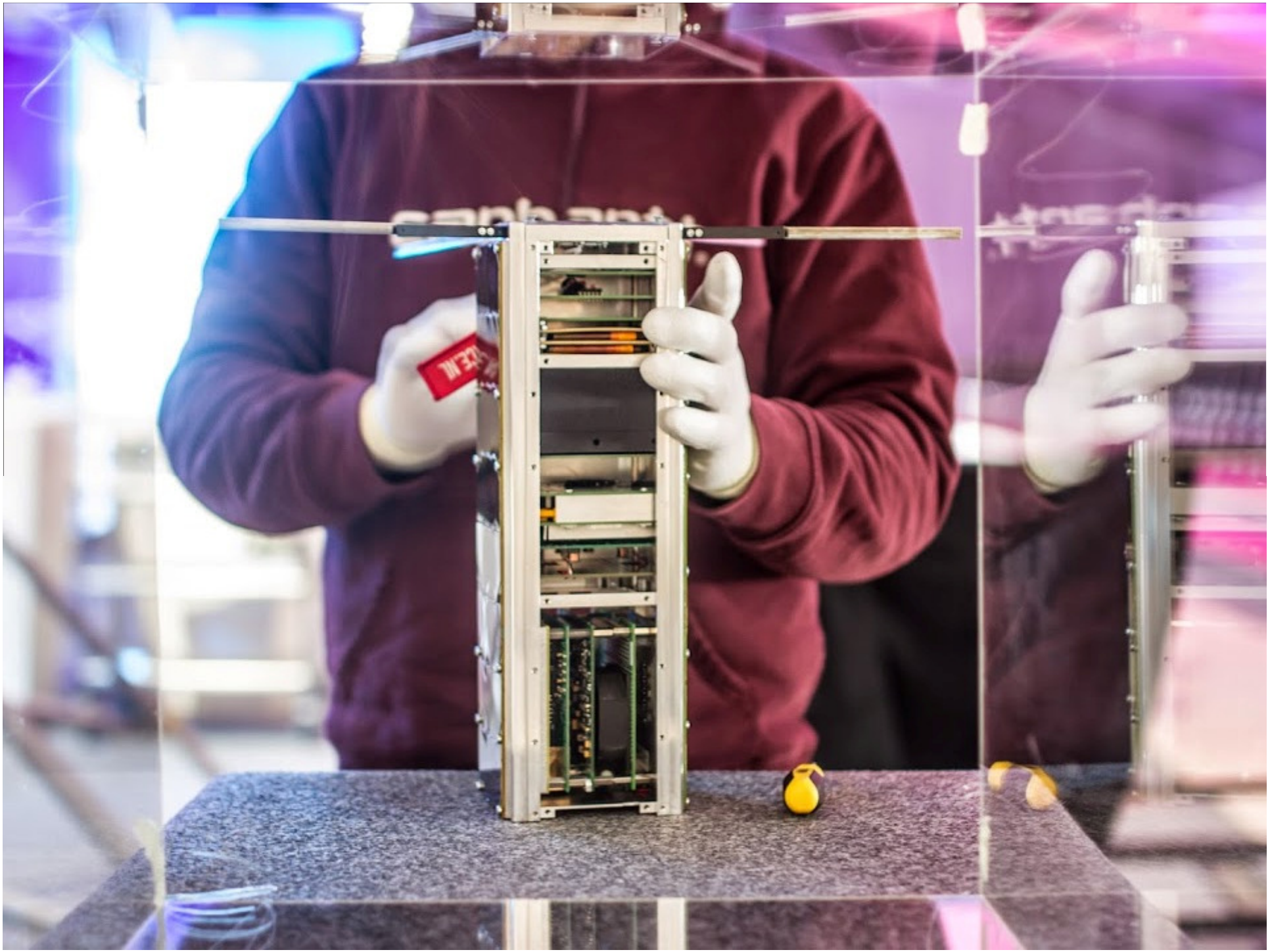
Berlin Space Technologies

Aalto-1

The Finnish Student Satellite

Stack Integration tests





A!
Aalto University

Aalto-1

The Finnish Student Satellite

Ground Station

OH2AGS

Address: Otakaari 5 A,
Espoo, Finland.
60.188732 N and
23.830764 E

Capability:

- VHF
- UHF
- S-band

Aalto-1

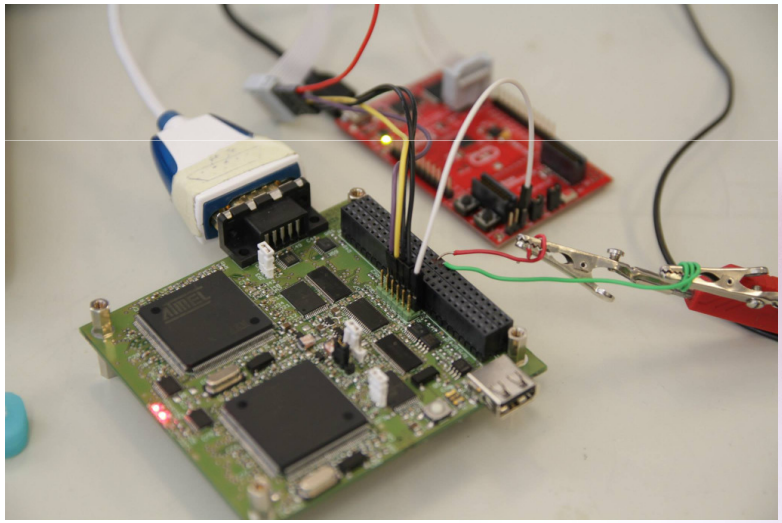
The Finnish Student Satellite

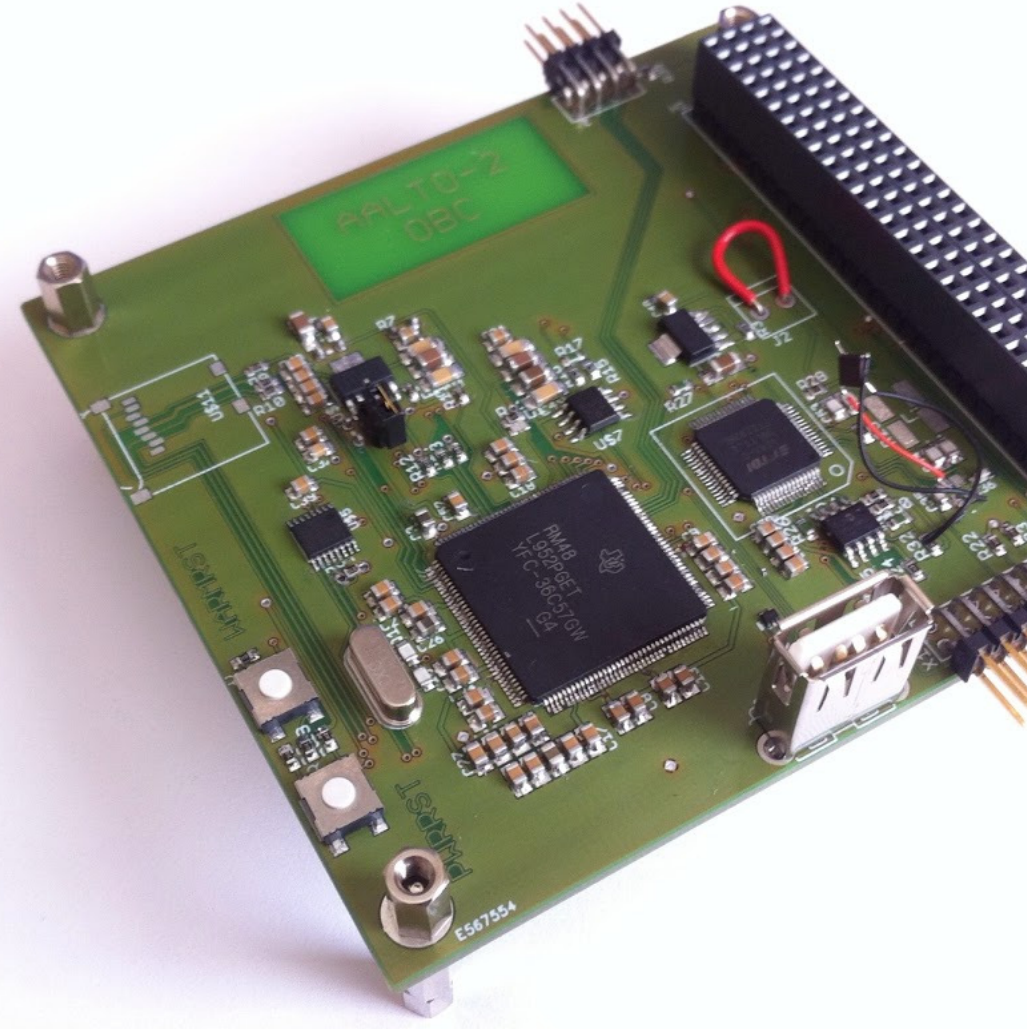
Aalto-2
and
ICEYE

Aalto University

Aalto-1
The Finnish Student Satellite

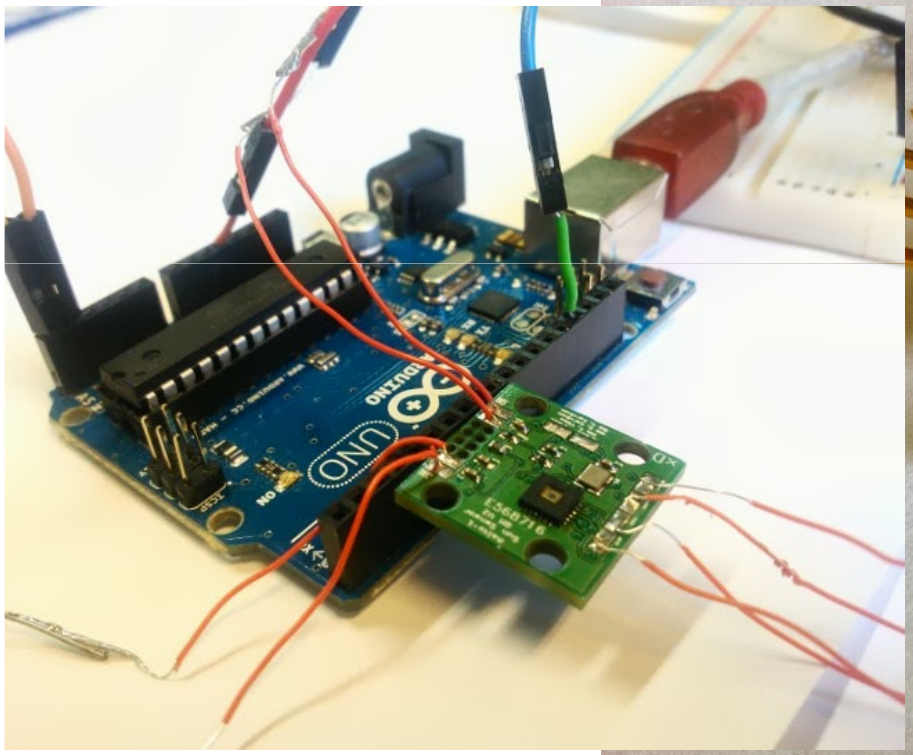
On board digital signal processing and data handling

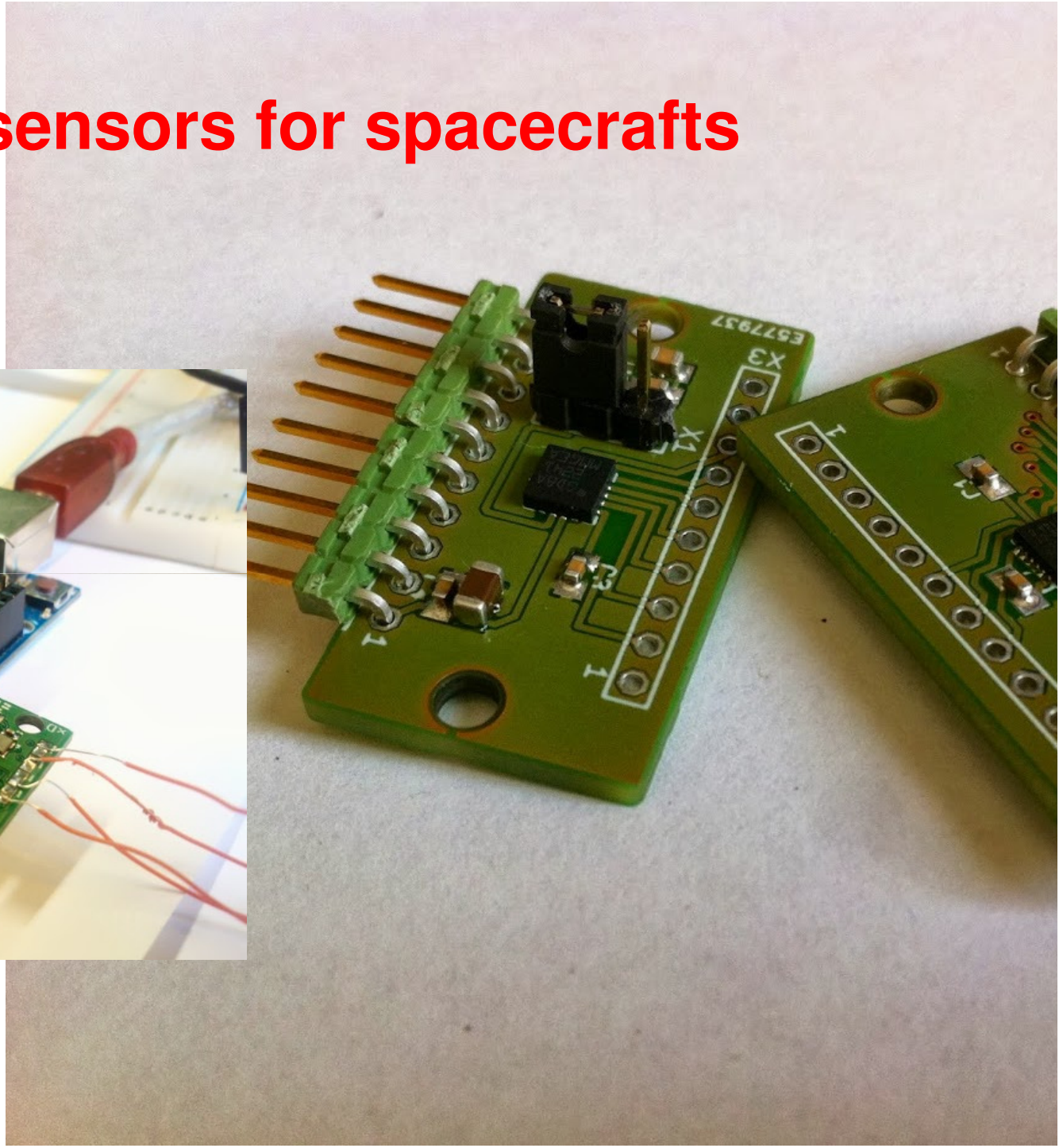




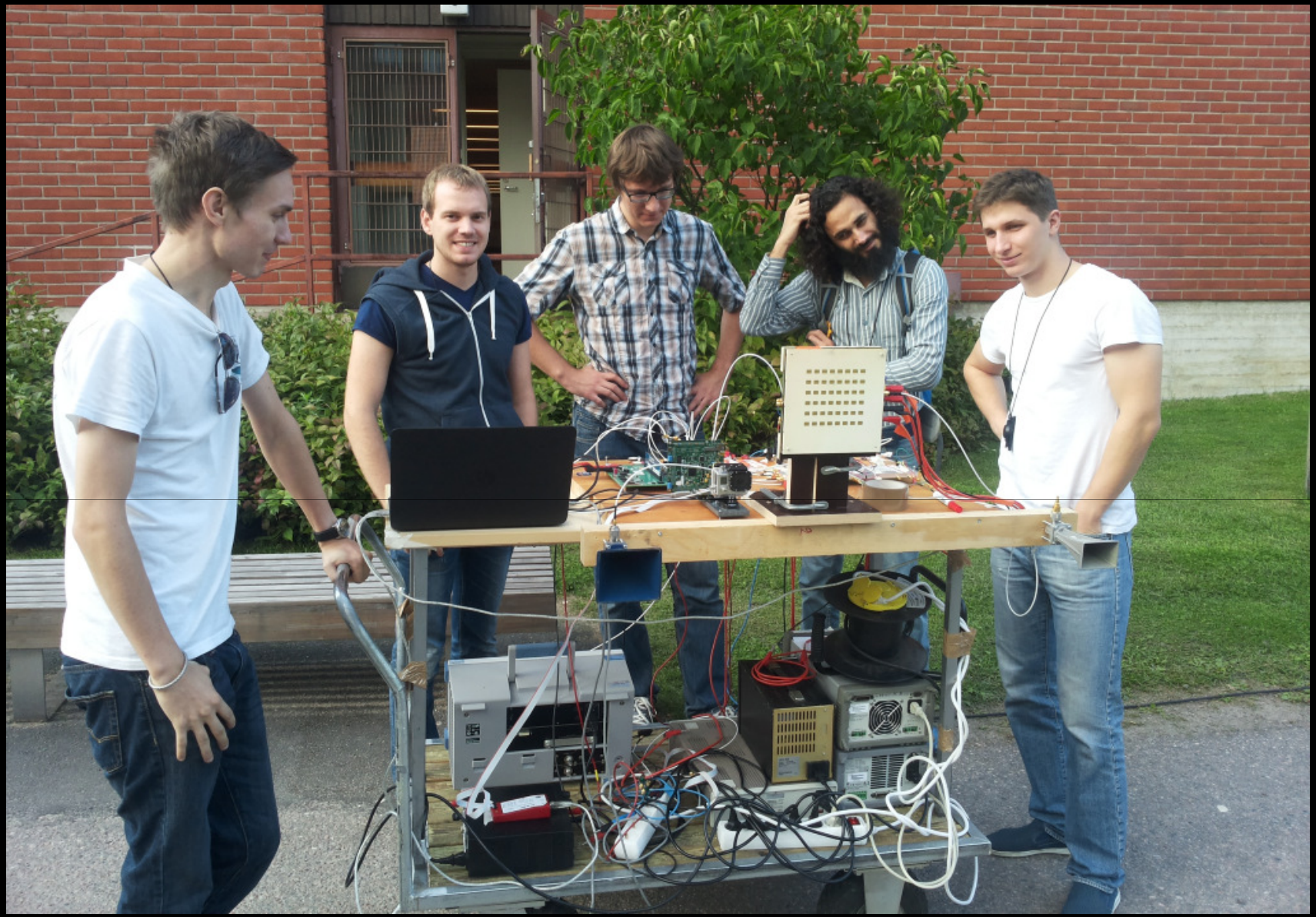
Aalto University
School of Electrical
Engineering

Affordable sensors for spacecrafts





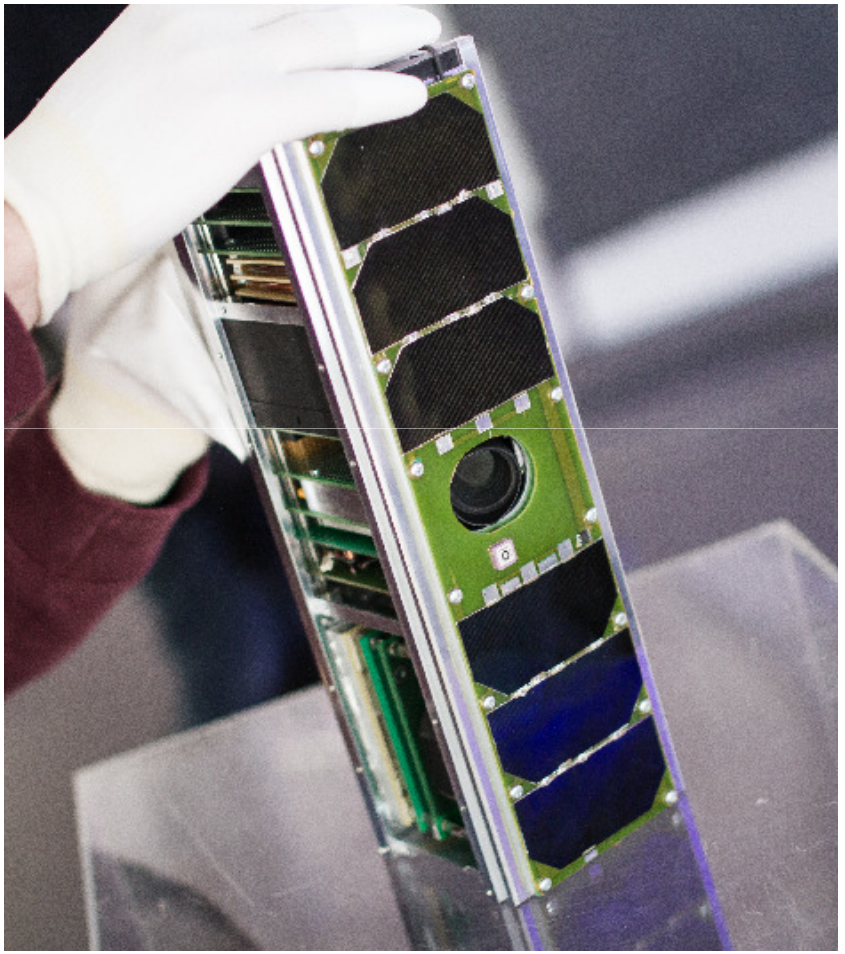
Aalto University
School of Electrical
Engineering



Short Skyvan aircraft

Testing and standardisation

- **Testing Center for small satellites at Aalto University**
- **Participation in international activities on nanosatellite testing and standardisation**

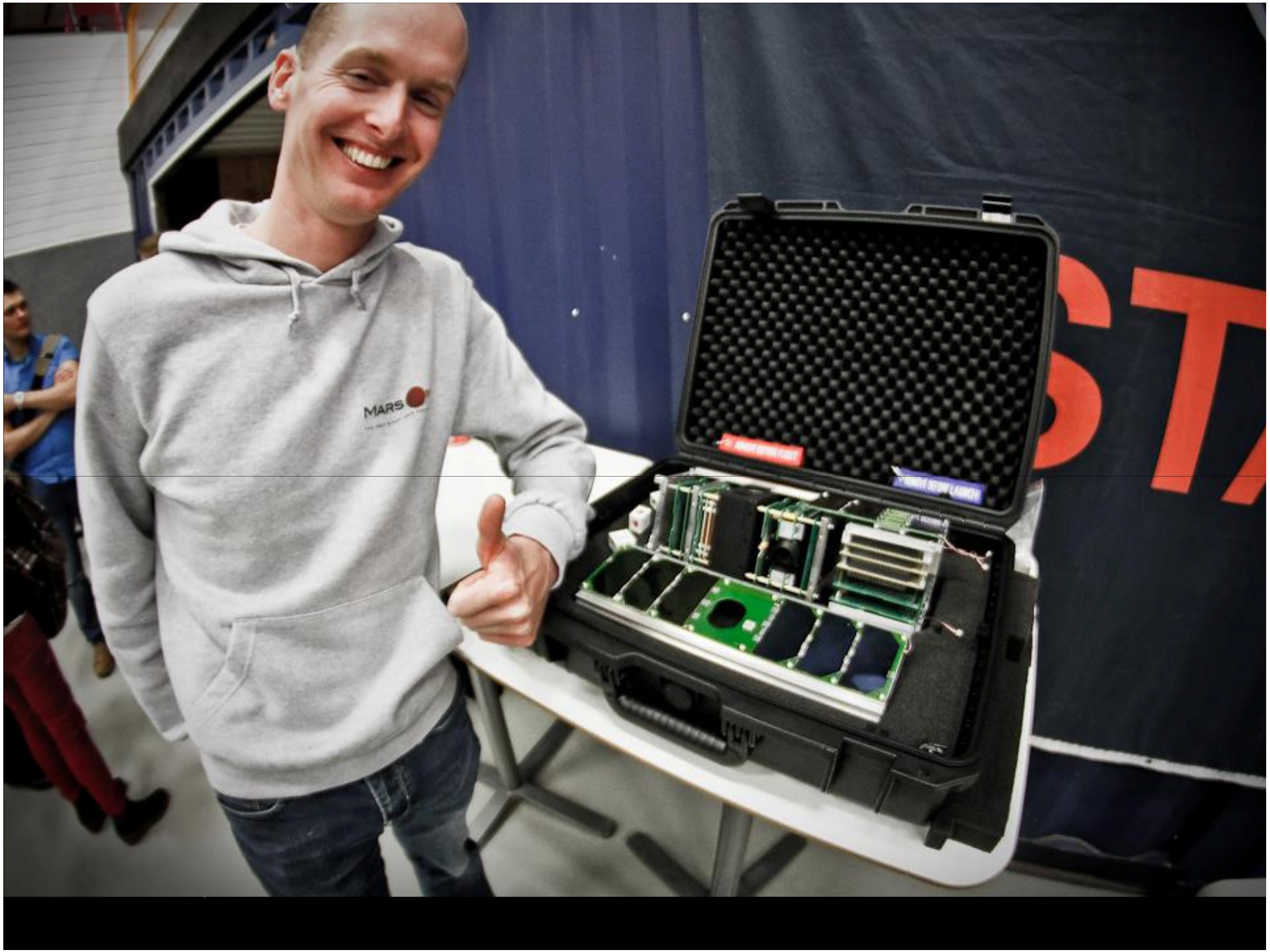


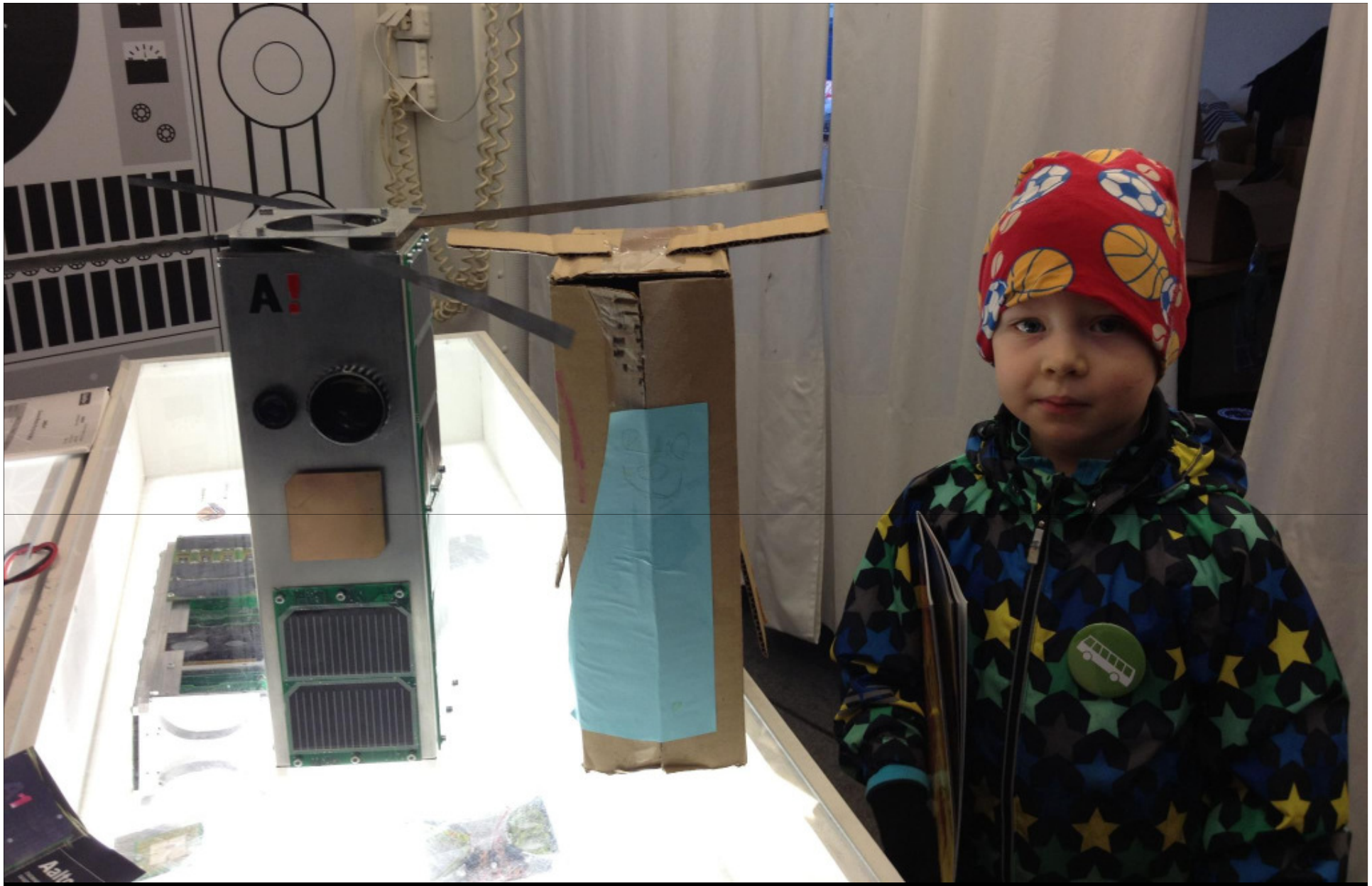
A!
Aalto University

Outreach

A!
Aalto University

Aalto-1
The Finnish Student Satellite


MARS



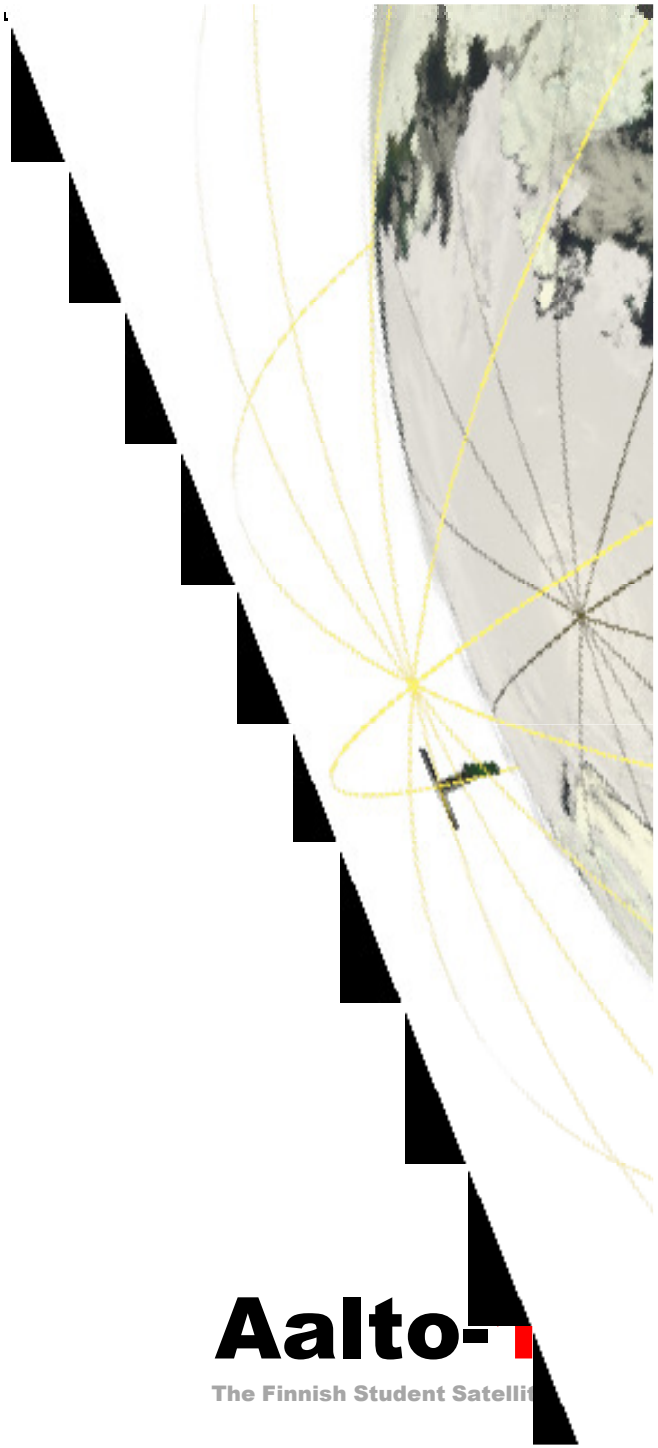
A!
Aalto University

Aalto-1

The Finnish Student Satellite

Future directions

- **Nanosatellite instruments and science**
  - Microwave remote sensing
  - Radio Frequency Interference
  - Space Weather and Ionosphere
  - Novel concepts
- **Spin-off and entrepreneurship**



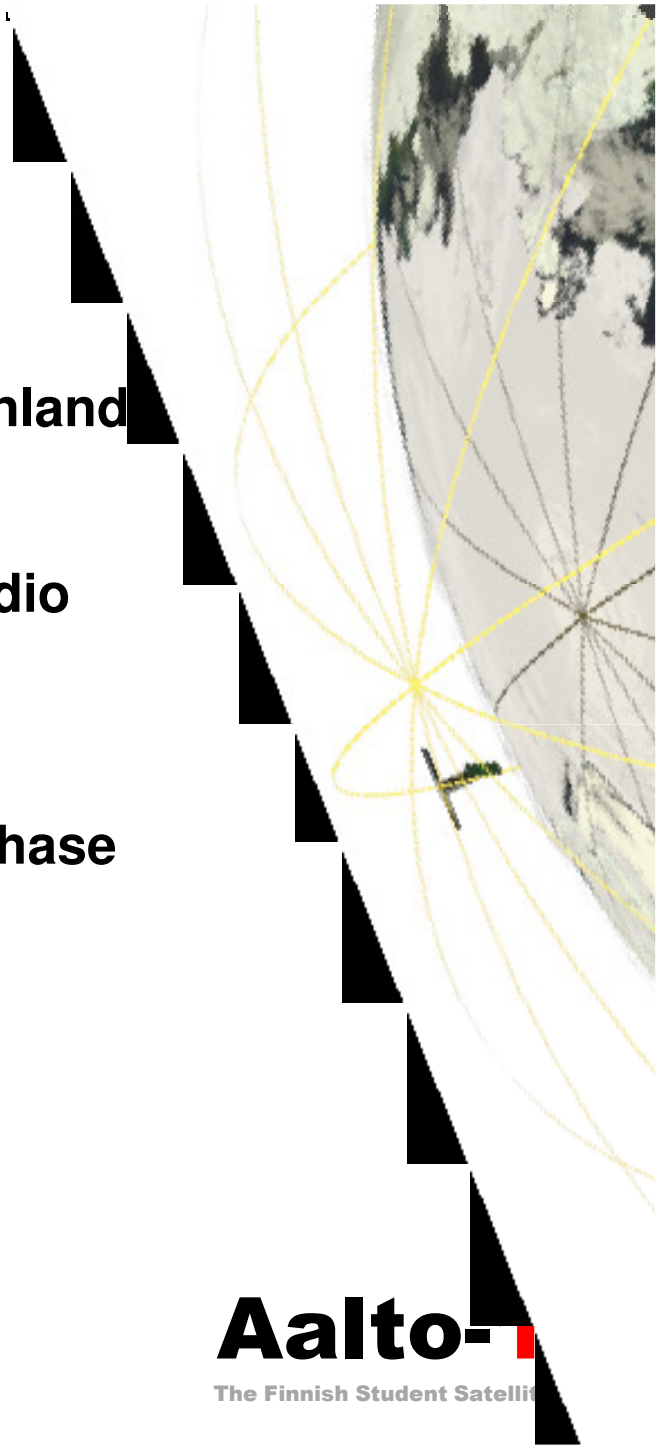
Aalto University
School of Electrical
Engineering

Aalto-
The Finnish Student Satelli

Conclusions

- Space technology education growing in Finland
- Aalto University investing in future space technology
- New Master's Programme on Nano and Radio Sciences starting 2015

- Aalto-1 is in integration and qualification phase
- Aalto-1 looking for launch in summer 2015
- Aalto-2 is
- ICEYE radar installed to SkyVan aircraft
- Aalto-3 ideas on the table




Thank you!
REMOVE BEFORE LAUNCH