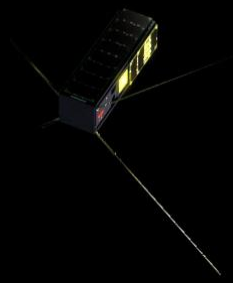
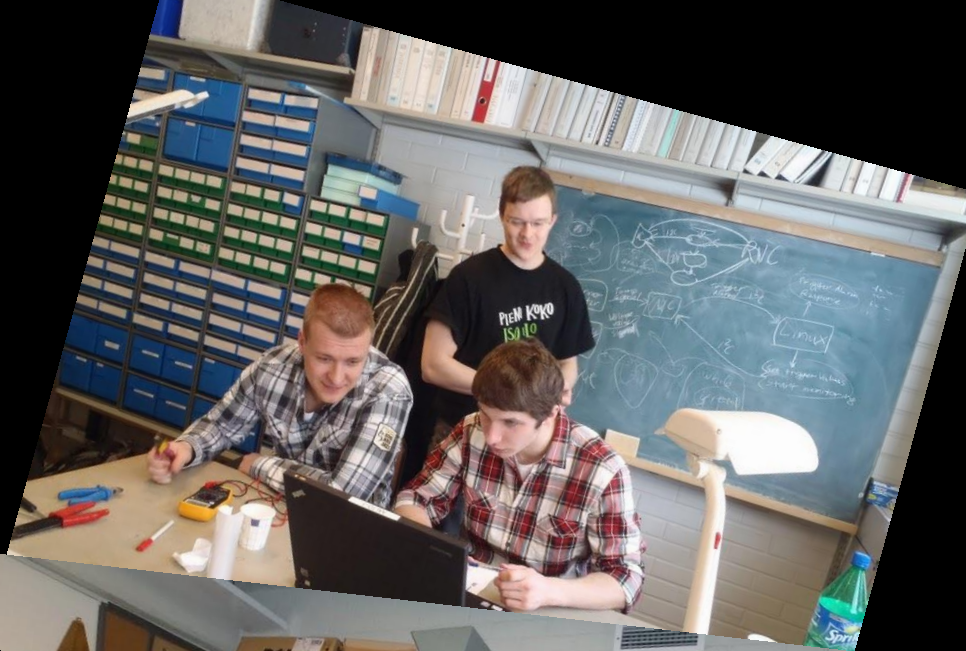
Earth Observation mission built by a student community



J. Praks, A. Kestilä,
T. Tikka, M. Hallikainen.
Department of
Radio Science and Engineering
Aalto University

Dream of own satellite 2010



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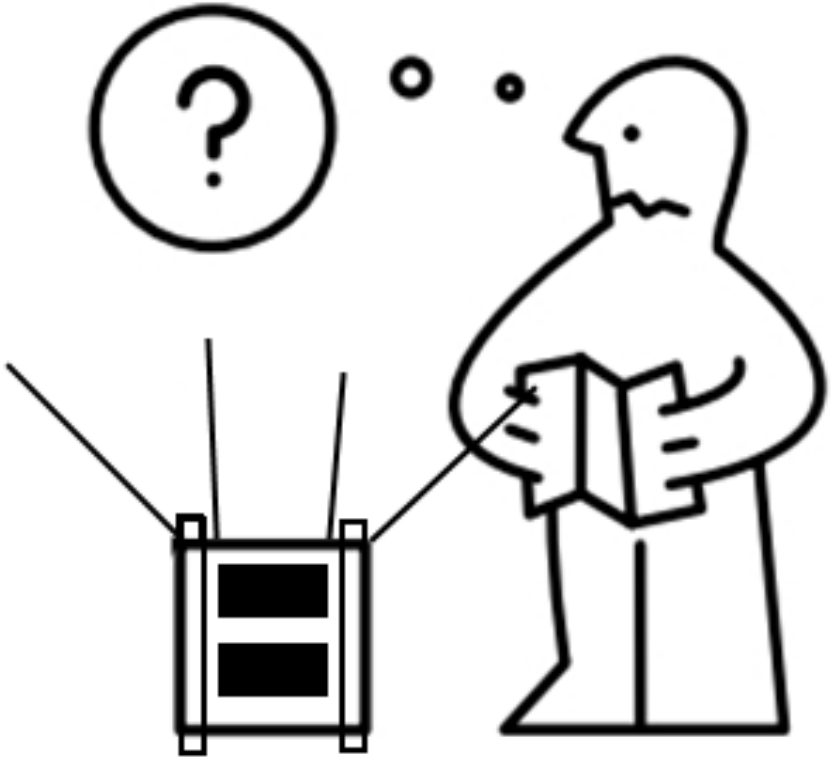
A!
Aalto University
ASRO
Turun yliopisto
University of Turku
A?
Aalto University
Multidisciplinary Institute of
Digitalisation and Energy
DLR
University of
Helsinki
VTT
UNIVERSITY OF JYVÄSKYLÄ
Space Systems
Finland
RSI
SOLUTIONS
IBST
Berlin Space Technologies

How to build a satellite?

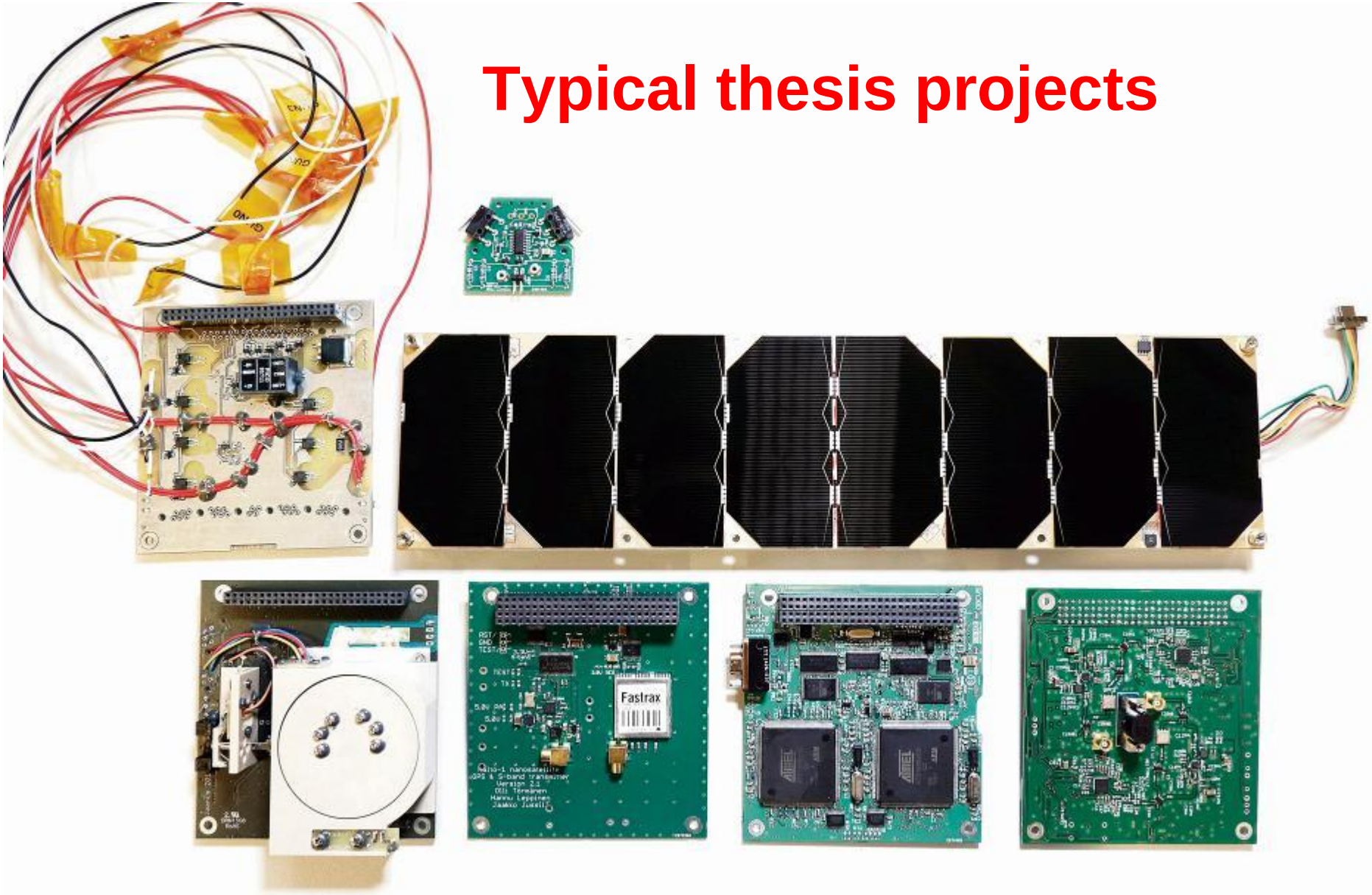


Satellite project integration to curriculum

- **The satellite project was integrated with Master thesis projects and special assignments**

- **The project worked together with many teachers in many disciplines**
- **The satellite project provided topics in:**
  - remote sensing, space technology, radio engineering, electronics, mechanical engineering, software engineering and others

Typical thesis projects



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Systems engineering challenges in a student project

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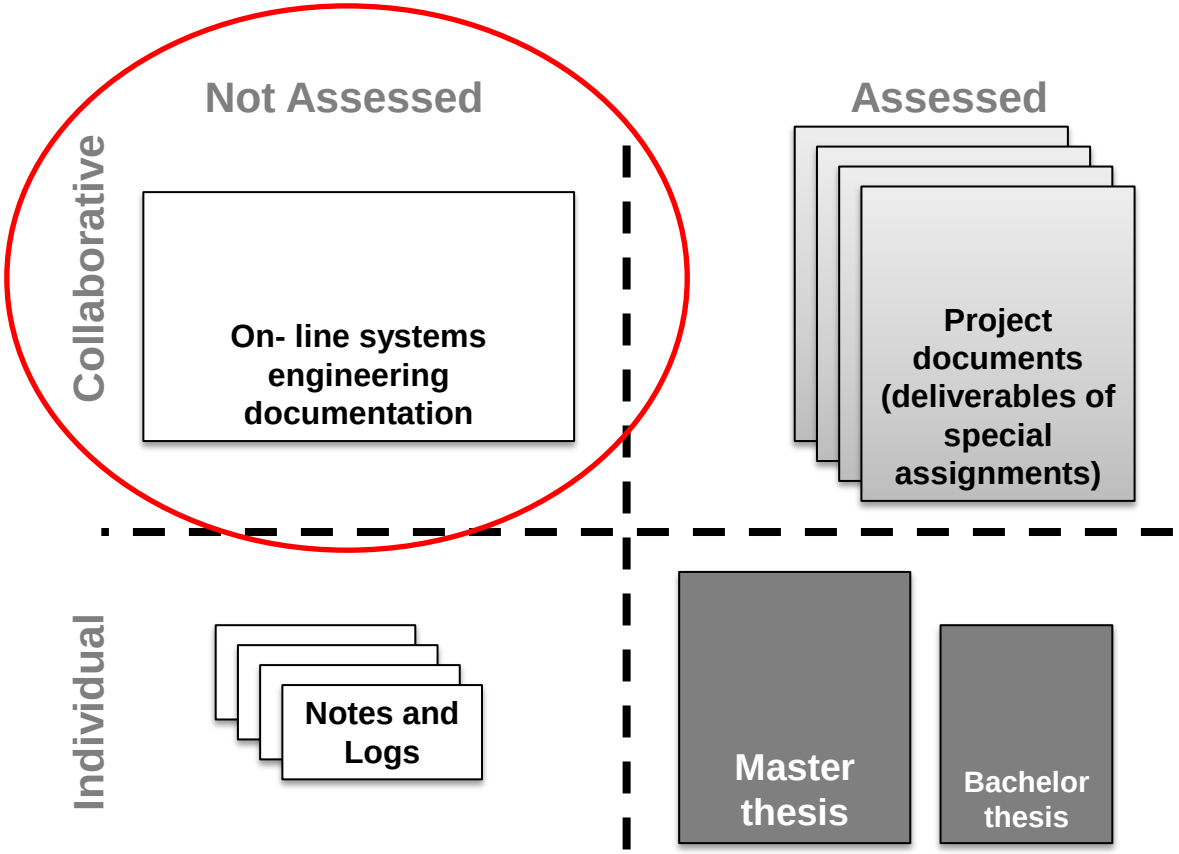
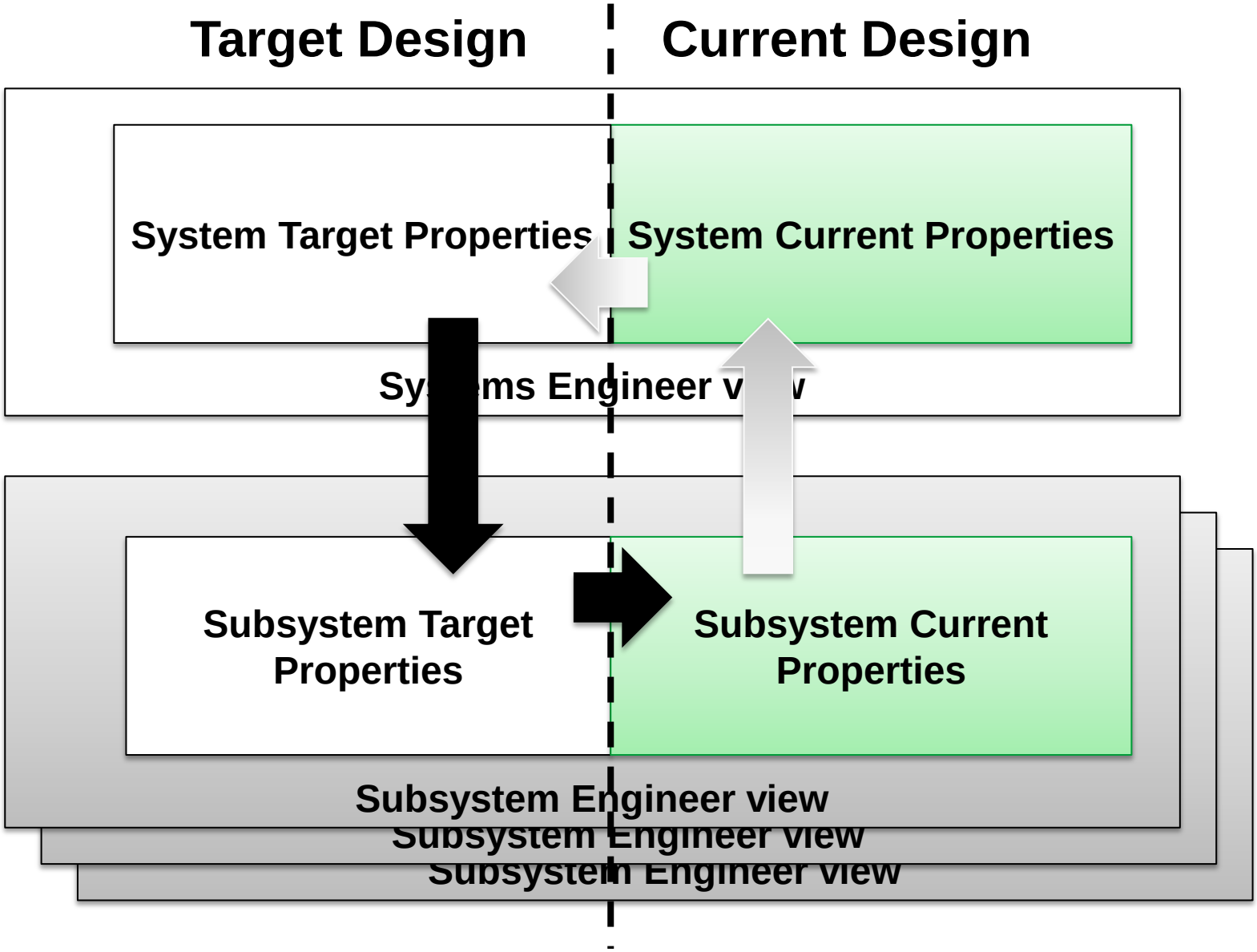
Tailored documentation approach for student projects

A documentation approach was developed which includes systems engineering, supervising and assessment.




Target Design
Current Design
System Target Properties
System Current Properties
Systems Engineer view
Subsystem Target Properties
Subsystem Current Properties
Subsystem Engineer view
Subsystem Engineer view
Subsystem Engineer view

Reviews

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Student workshops and courses

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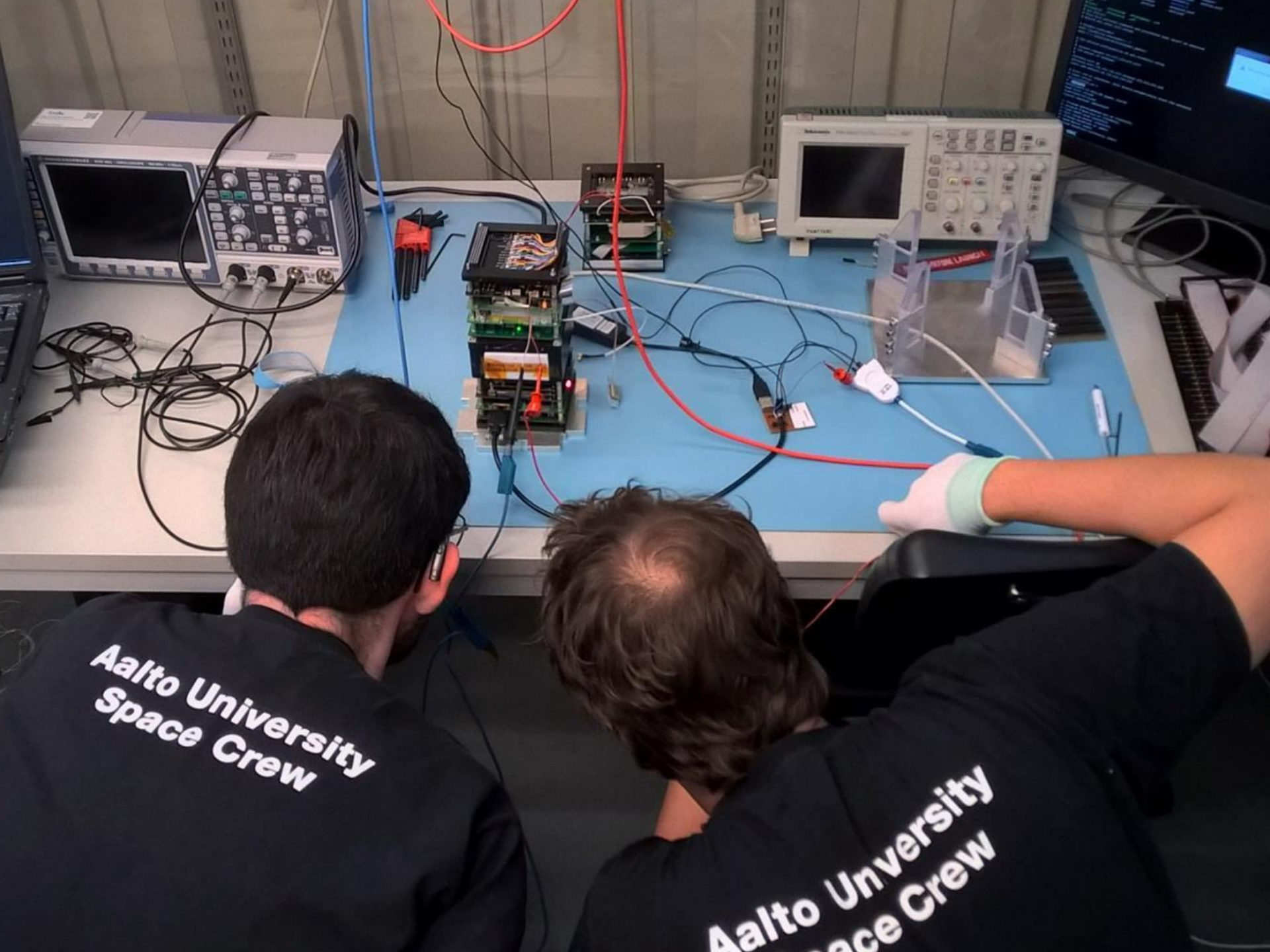
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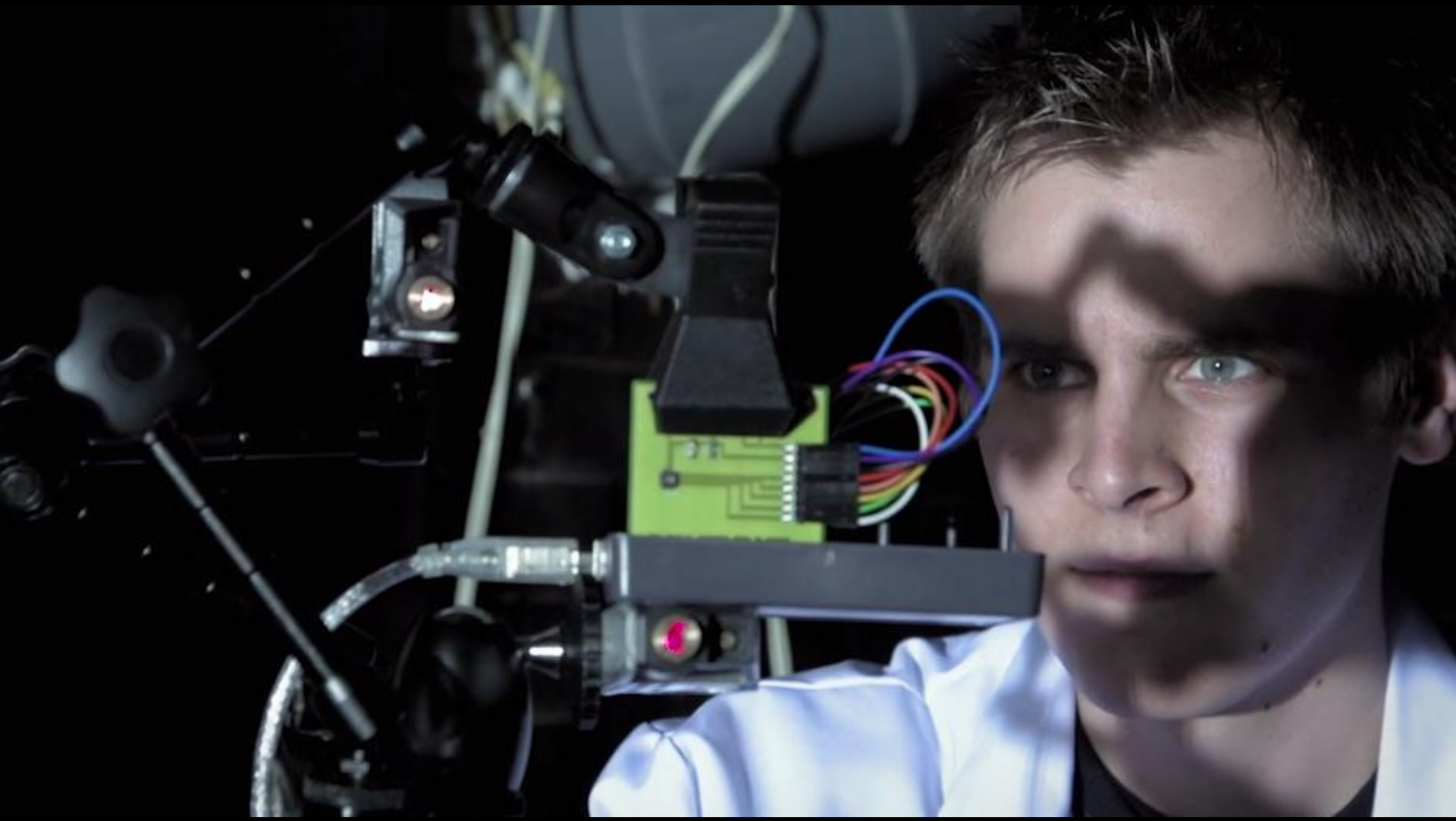
Space Crew
Aalto Unversity
ace Crew



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Sun sensor calibration measurements

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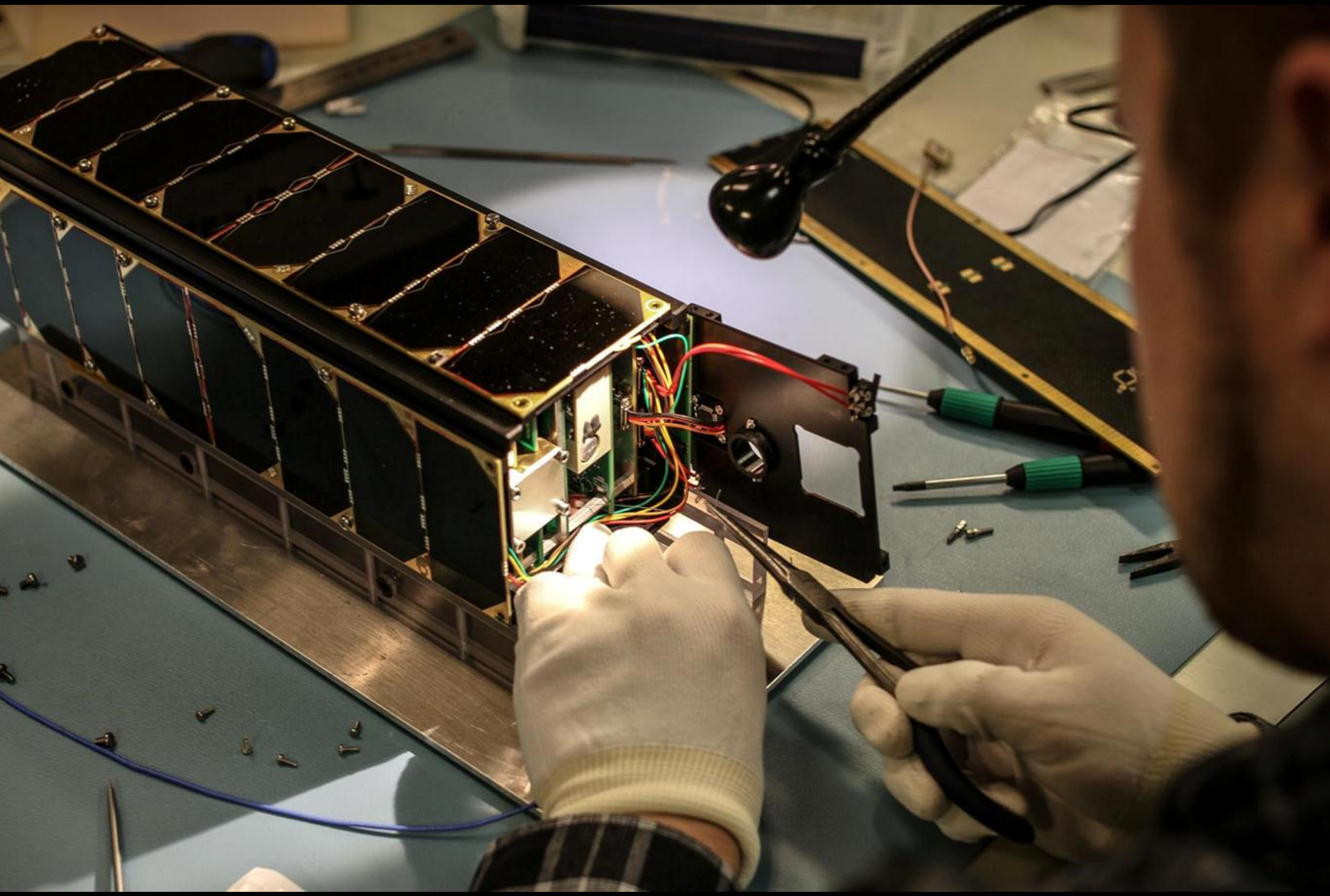

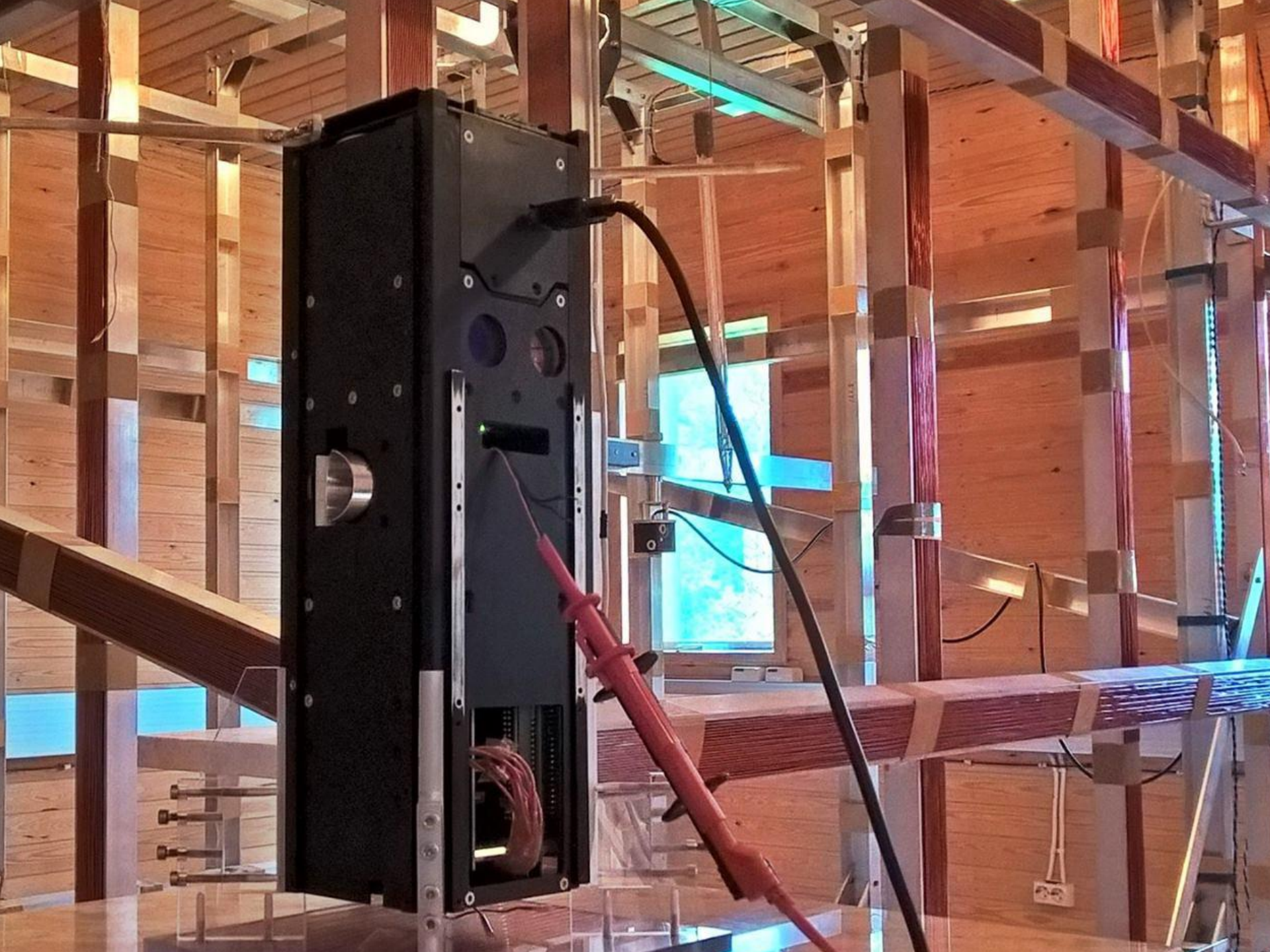

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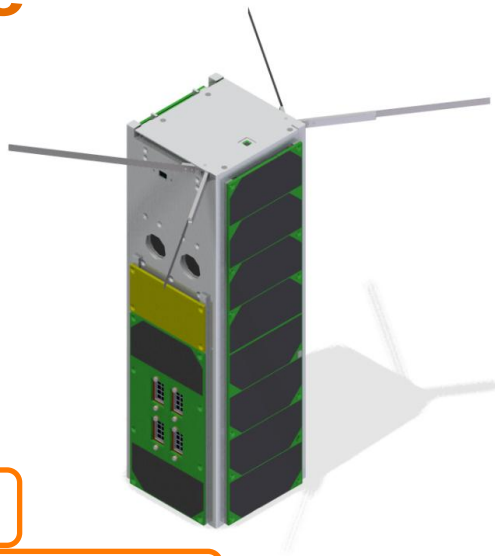
Aalto-1 CubeSat project timeline



Concept

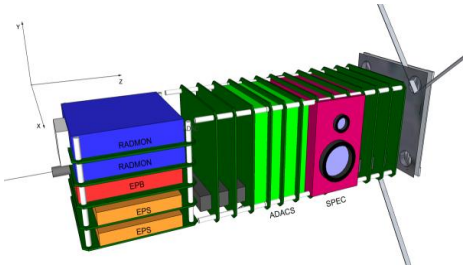
Preliminary design

Design

Manufacturing

Testing

Launch



2010 2011 2012 2013 2014 2015 2016

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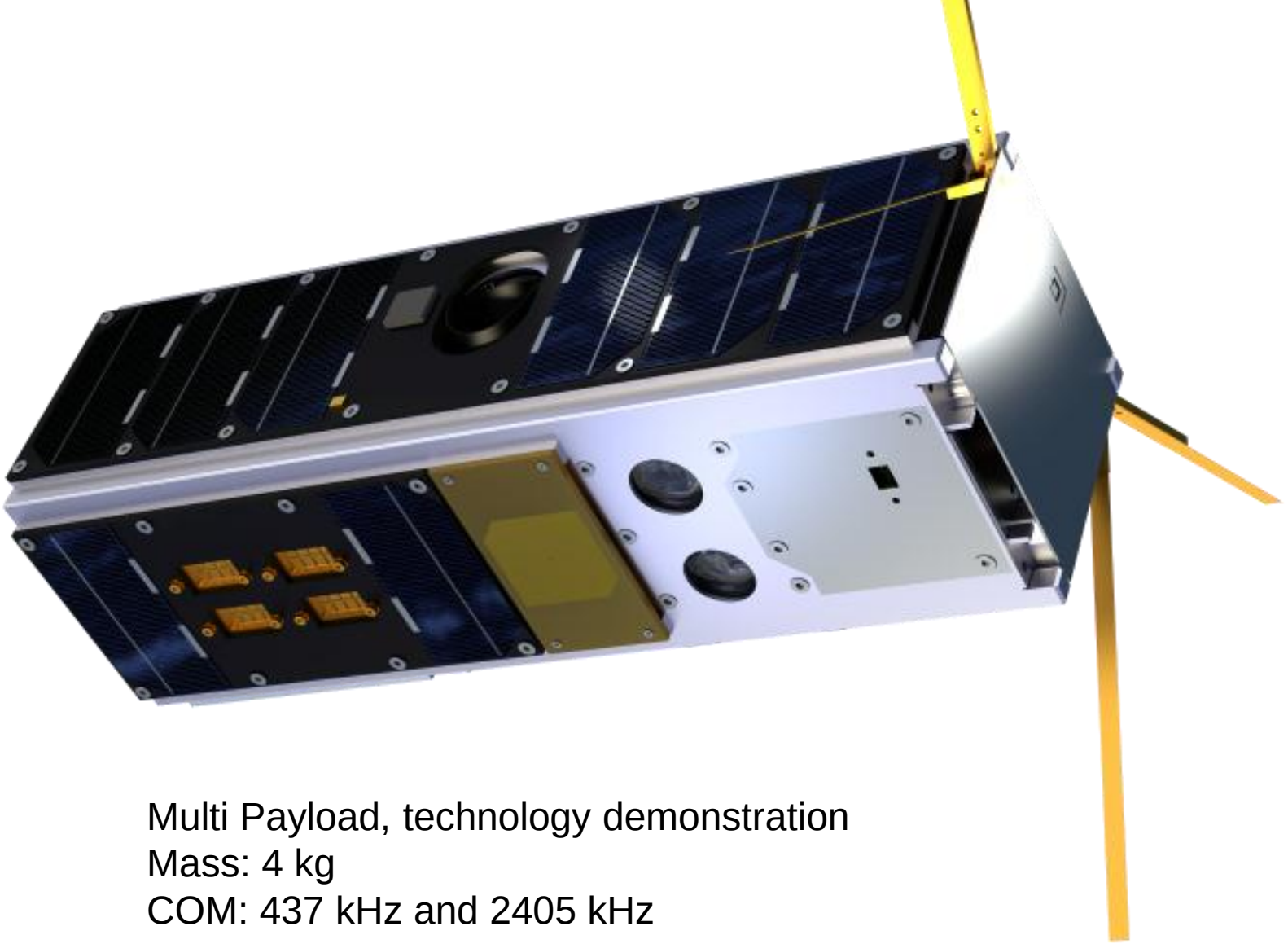

Multi Payload, technology demonstration
Mass: 4 kg
COM: 437 kHz and 2405 kHz

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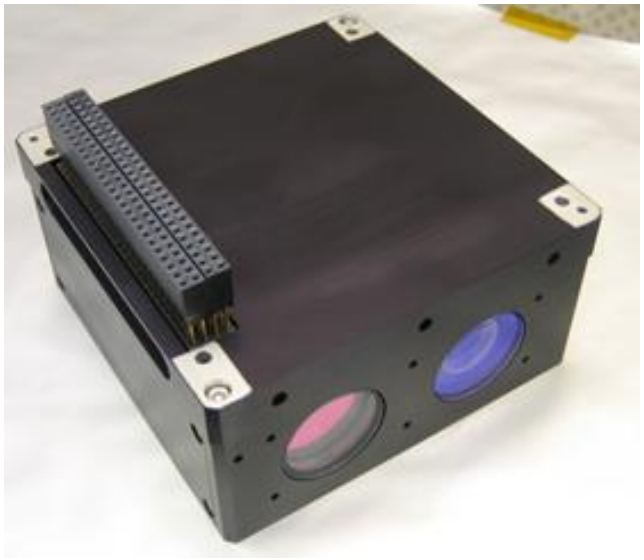
Payloads



AaSI (VTT)

Mass: 592 g

Power: max 2.5 W

Plasma Brake (FMI)

Mass: 259 g

Power consumption: 1-1.6 W

1000 V high voltage generation

RADMON (Univ. Of Turku, Univ of Helsinki)

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

Mass: 354 g

Power consumption: 1 W

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School of Electrical
Engineering

HELSINGIN YLIOPISTO
HELSINGFORS UNIVERSITET
UNIVERSITY OF HELSINKI

VTT

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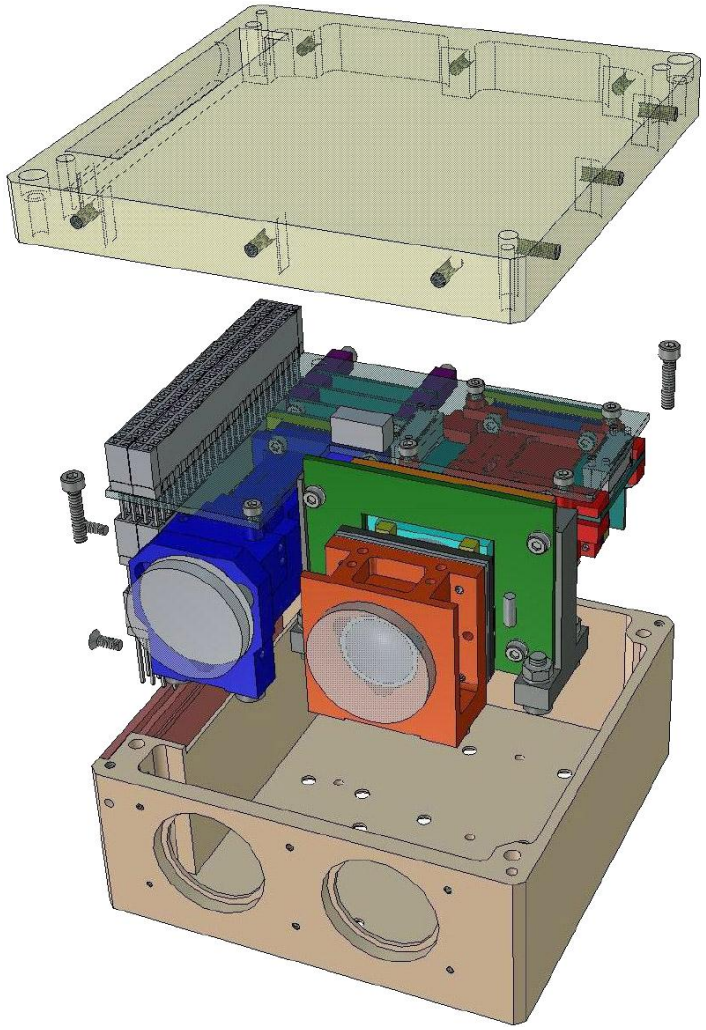


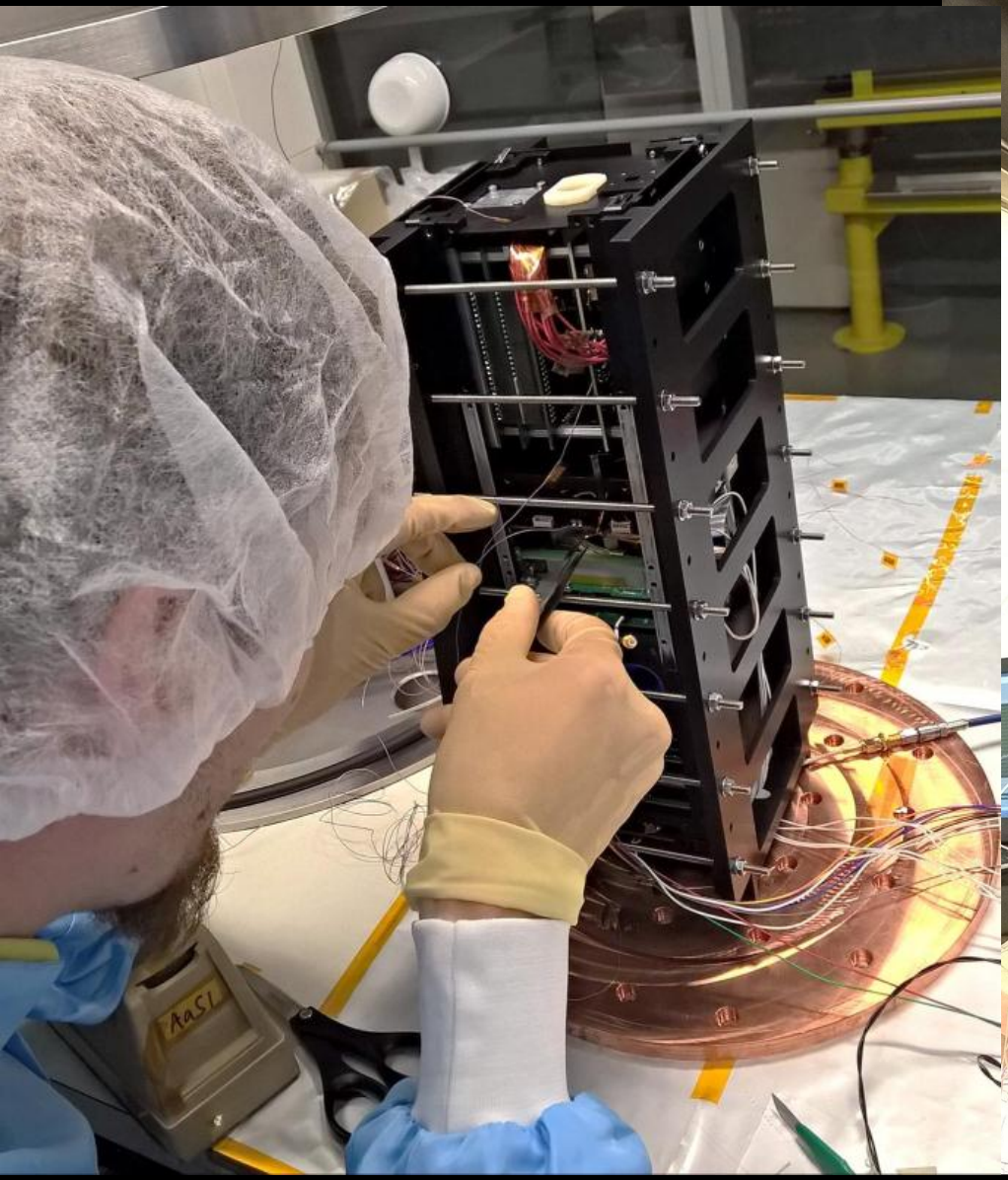
Earth Observation payload

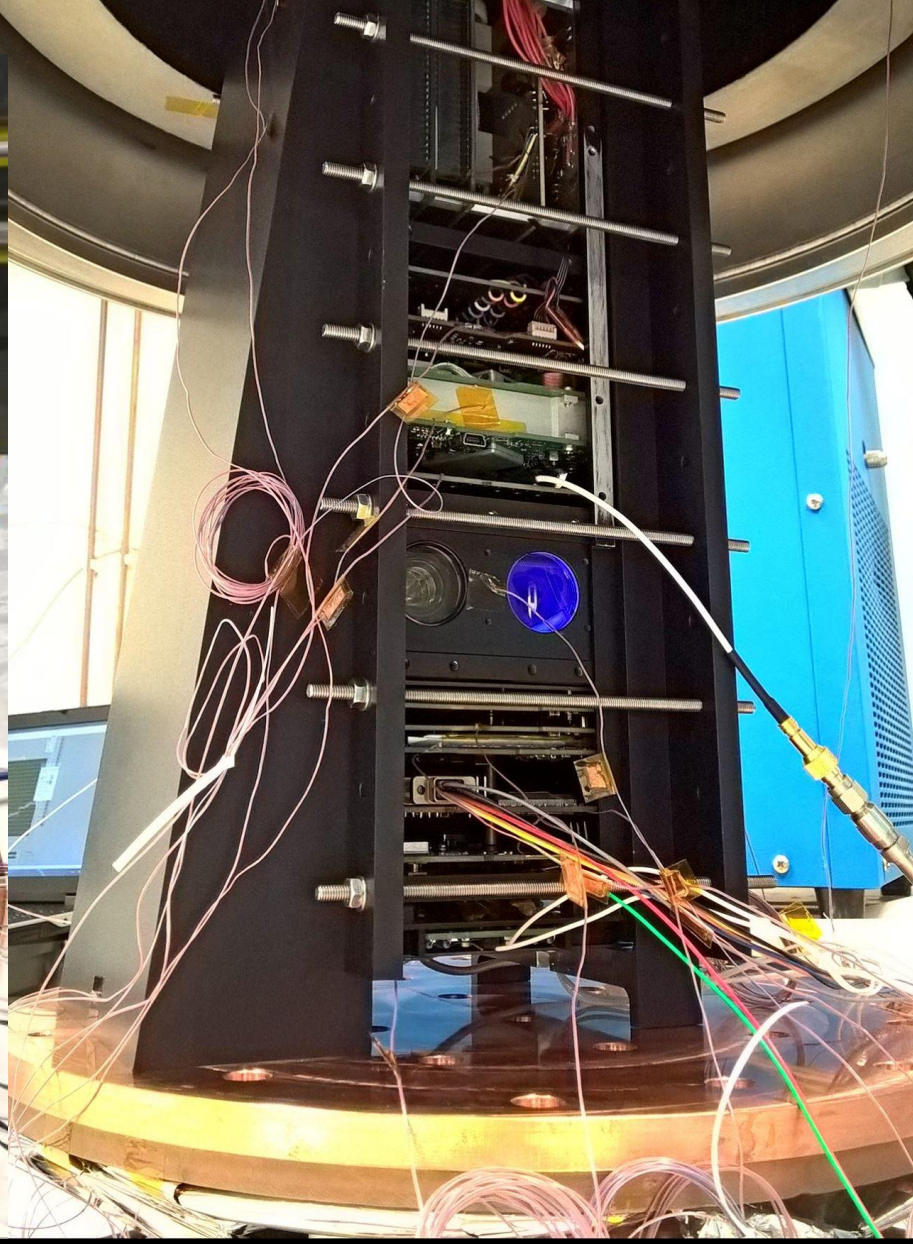
AaSI – Fabry-Perot Spectral Imager

Fully adjustable spectral band configuration

Mass 592 g
Dimensions: Compatible
Power consumption:
+5V: 1.1 W - 2.1 W
+12V: 0.2 W - 0.4 W
Ground resolution 200 m
Spectral resolution < 20 nm
Spectral range 500 – 900 nm

VTT esa Aalto-1
The Finnish Student Satellite





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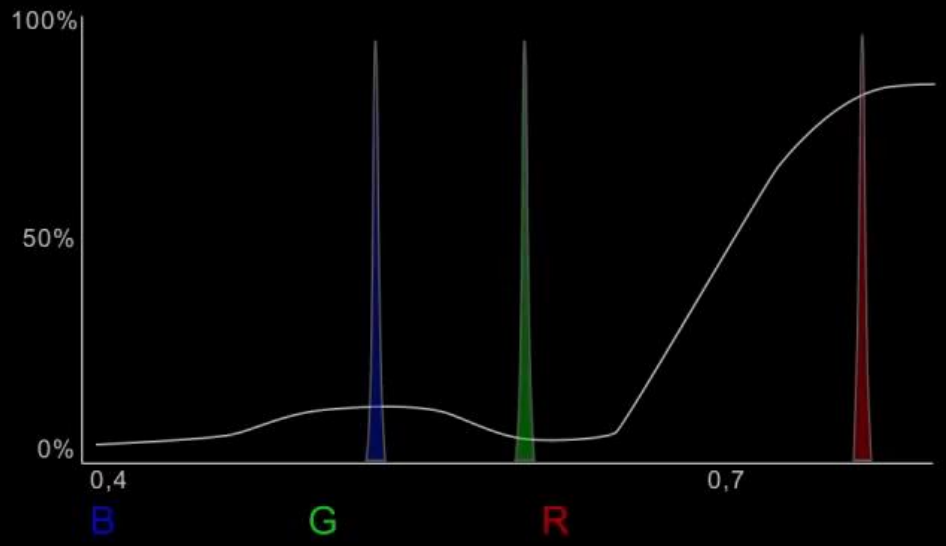
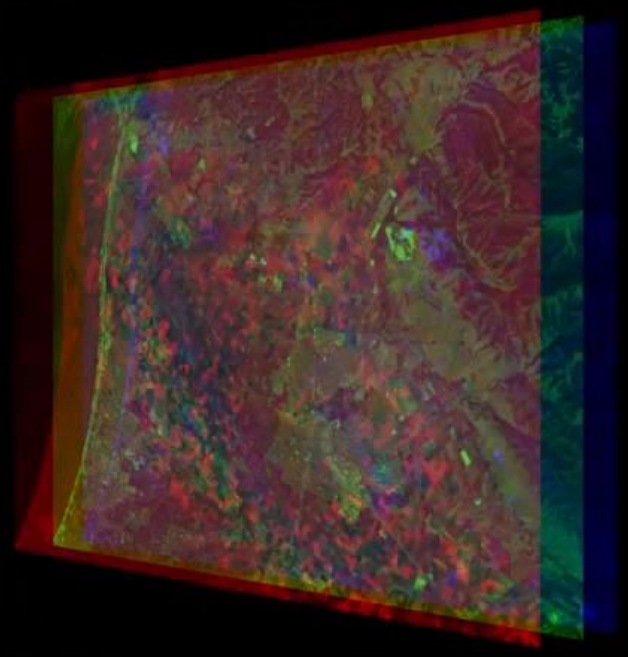
Spectral imager

Vegetation reflectance





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Aalto-1 team is preparing for launch

Aalto-1 is booked to SpaceX launch with Falcon 9

Launch is expected in the beginning of 2016

Launch & Deployment — Contact & Commissioning — AaSI & RADMON — Plasma brake — Decommissioning

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Core team has been around 20 students every year

Aalto-1

The Finnish Student Satellite

Educational results

During 6 years of the project

- **~ 100 students participated**
- **~70 students made special assignments in satellite project**
- **28 Bachelor theses were written on satellite related topics**
- **11 Master theses on Aalto-1 satellite**
- **9 Master theses on related topics**
- **(additional 10 Master theses on RADMON instrument in Univ. of Turku and Univ. of Helsinki)**
- **12 students proceeded to doctoral studies**

- **~20 conference papers by students**
- **3 published journal publications**

CubeSat generation skillset

- **Project working skills**
- **Practical problem solving skills**
- **Good technical ability in engineering**
- **Fascinated by space technology**
- **Good connection to international community**
- **Good connection to industry**
- **Entrepreneur minded**

CubeSat generation wants to build more satellites

An satellite EO spin-off company founded by project students

ICEYE
Arctic Intel

Future

The Aalto-1 is waiting for launch – the CubeSat generation is looking for new challenges

Coming changes

- **Amount of EO satellites will increase rapidly**
- **Small EO platforms and low orbits will commercialize**
- **Space debris will be an increasing problem**

- **New, innovative EO consumer products**
- **Temporal coverage will increase**
- **New concepts, big data, sensor networks**

Conclusions

A CubeSat project is a wonderful tool to inspire and empower the students

Pros

- **CubeSat suits well for project based teaching**
- **CubeSat project creates strong student community**
- **Enforces interdisciplinary cooperation in teaching**
- **Project provides students with connections to science and industry**
- **Entrepreneur-spirited**

Cons

- **Launch is still expensive**
- **Timeframe for teaching project should be shorter**

Thank you!

Free
to dom
suc
ceed

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