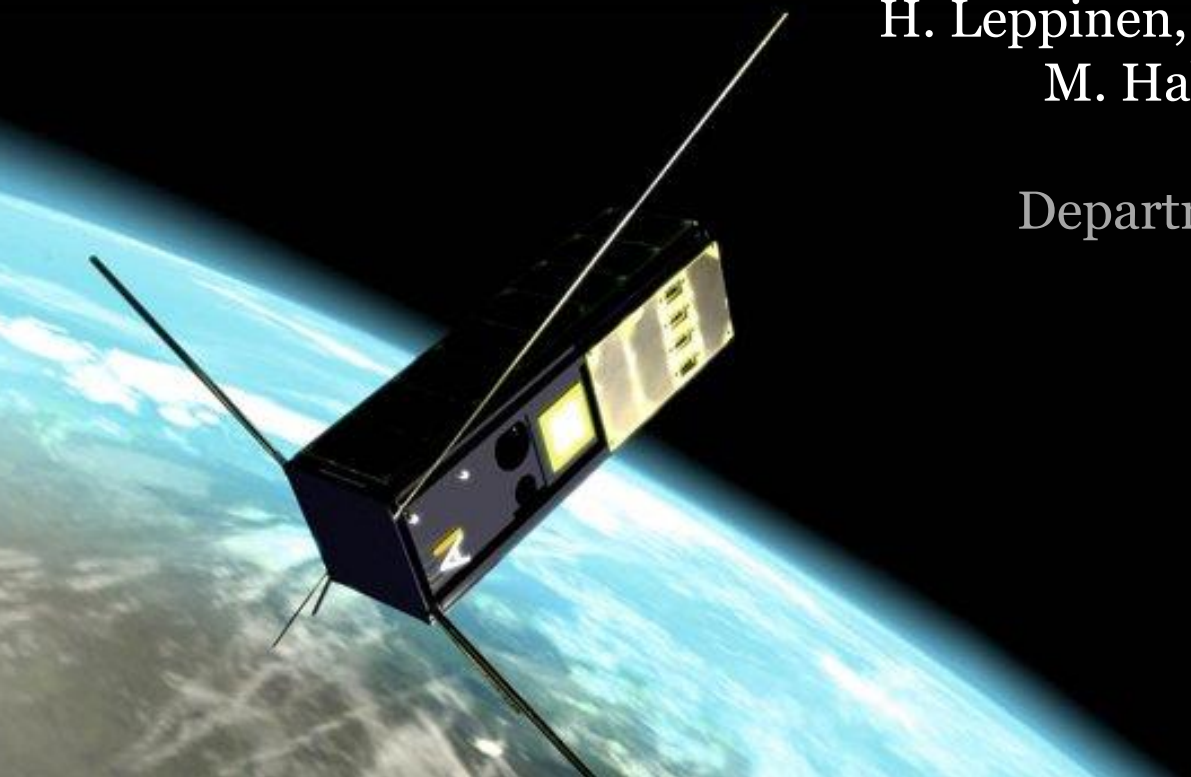
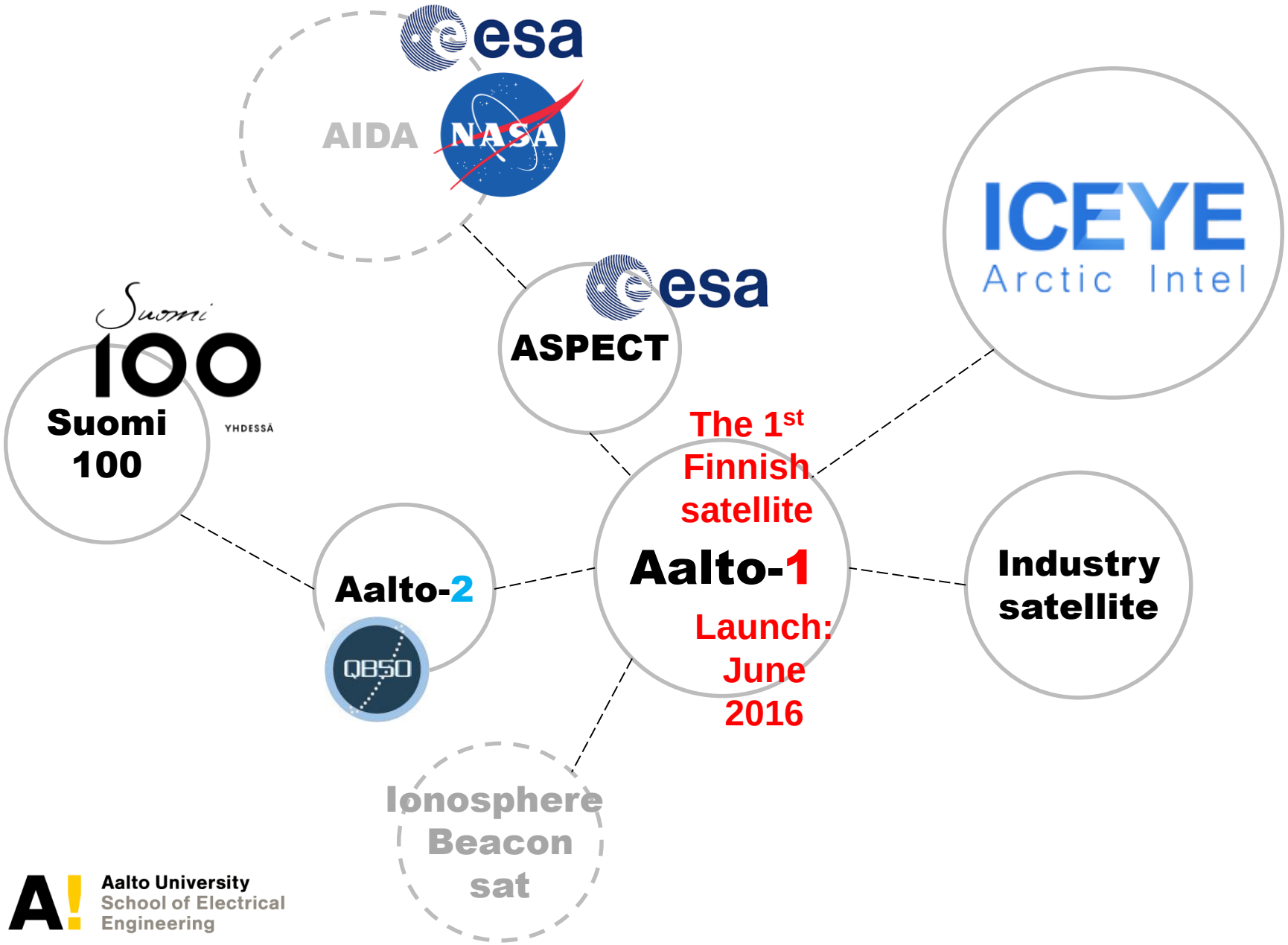
Nanosatellite research at Aalto University



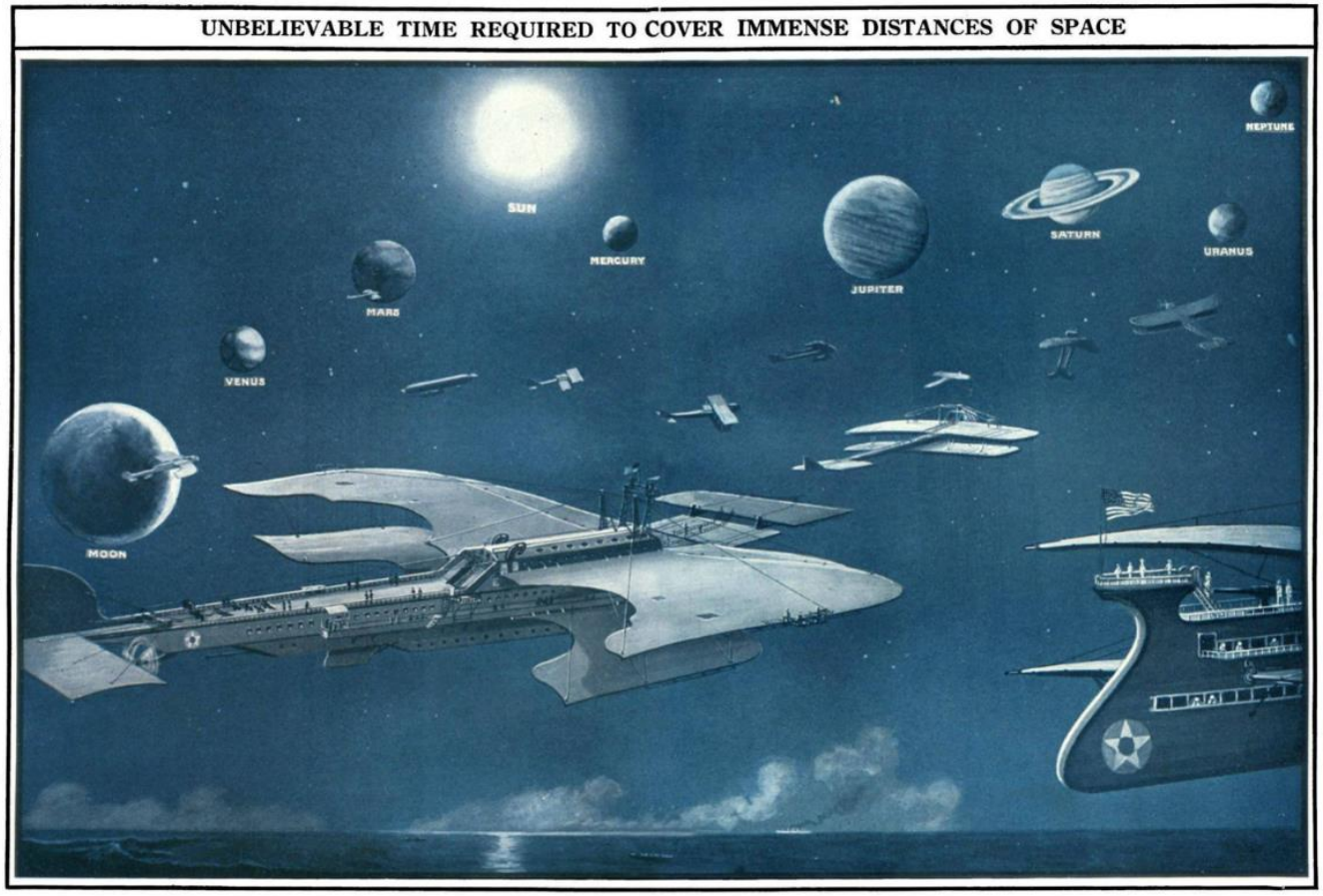
Esa Kallio, J. Praks, A. Kestilä, T. Tikka, H. Leppinen, N. Jovanovic, B. Riwanto, M. Hallikainen and many others

Department of Radio Science and Engineering
Aalto University



Aalto University
School of Electrical
Engineering

Space missions



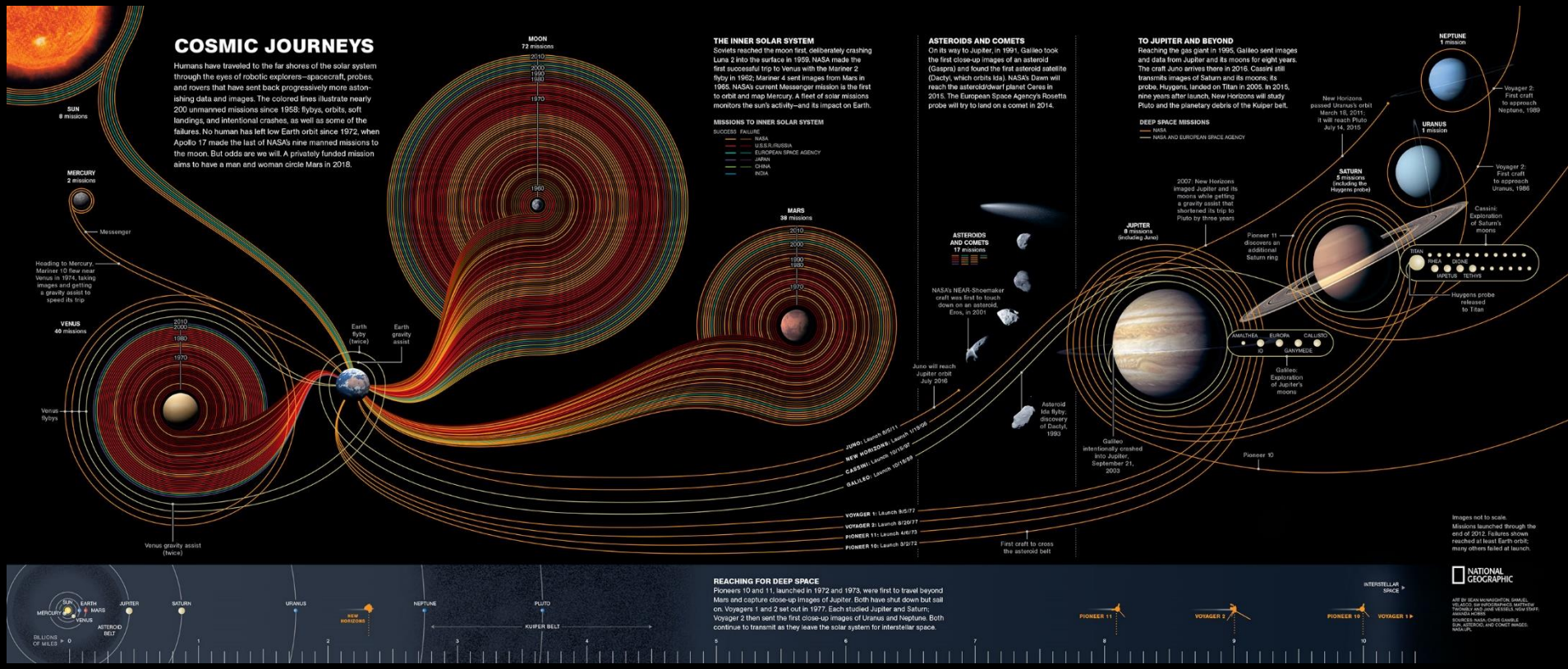
IF MAN SHOULD INVADE SPACE—A RACE FOR SUN, MOON, AND PLANETS AT THE TERRIFIC SPEED OF TWO MILES A MINUTE

Man has invaded space—not in airplanes which would fall to pieces with age before Earth's near neighbors were visited, but with thoughts which travel faster and work more miracles even than the light of the sun. Standing on his own tiny planet, an infinitesimal atom in a boundless universe, he can with cunningly contrived pieces of glass bring many thousands of other worlds to him, and make them tell him their story. By measuring the speed of light, he can tell their distance; by splitting up their faint rays of light, he can judge of what they are made. Though they be a million times as big as he, yet standing on his little spot of earth, he can weigh them as he would weigh a pound of sugar. Keeping track of their movements, he can tell where they will be hundreds of years in the future.

Source: Our Wonder World – A Library of Knowledge in Ten Volumes, 1915

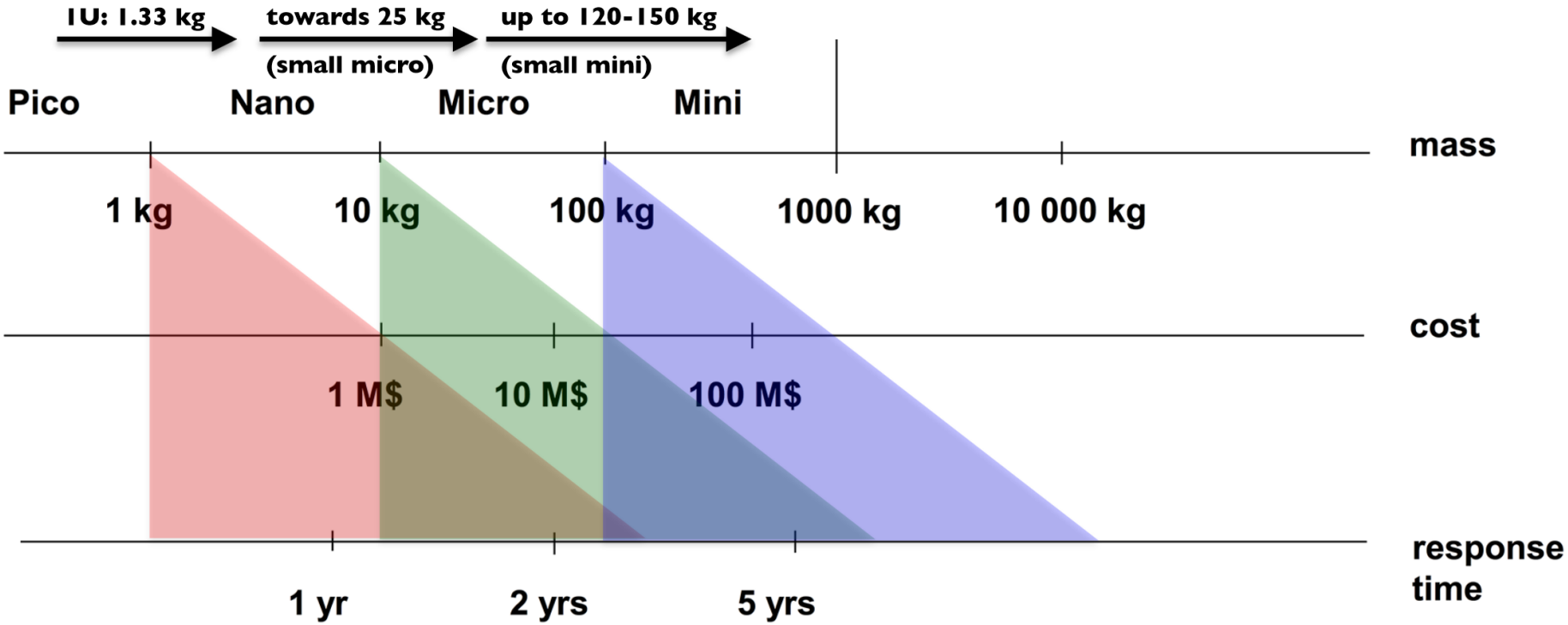
Cosmic journeys

The colored lines illustrate nearly 200 unmanned missions at 1958 - end of 2014



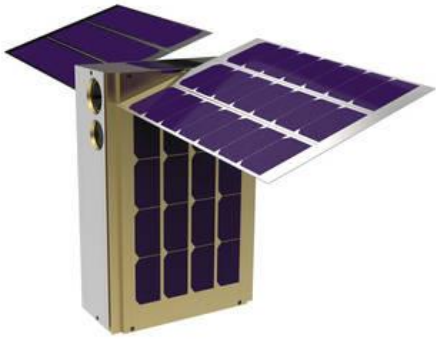
http://www.5wgraphics.com/img/newsletter/50-years-of-exploration.jpg

From large satellites to small satellites



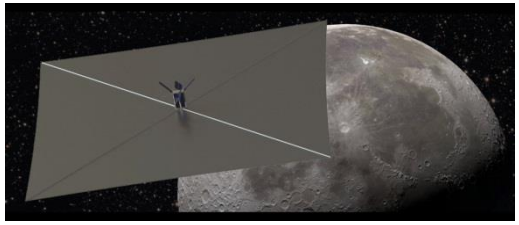
Based on: Sandau, Rainer; Brieß, Klaus; D'Errico, Marco (2010): „Small satellites for global coverage: Potential and limits". In: *ISPRS Journal of Photogrammetry and Remote Sensing*. 65 (6), S. 492-504, DOI: 10.1016/j.isprsjprs.2010.09.003.

USA and cubesats

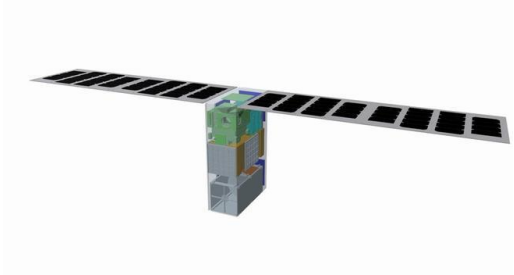


Luna H-Map: Lunar Polar Hydrogen Mapper

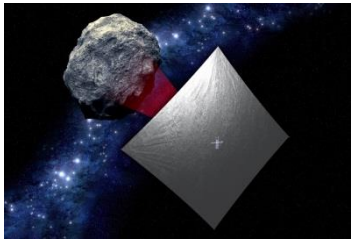
IceCube



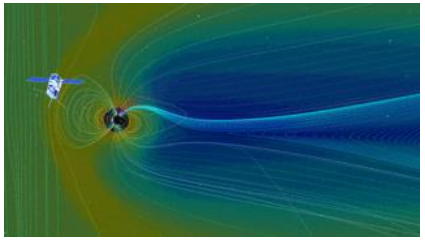
Lunar Flashlight



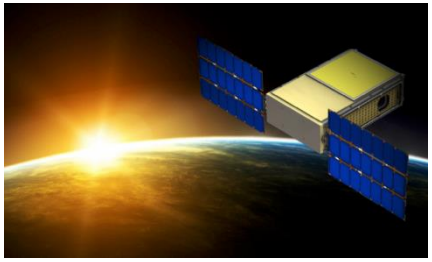
Skyfire



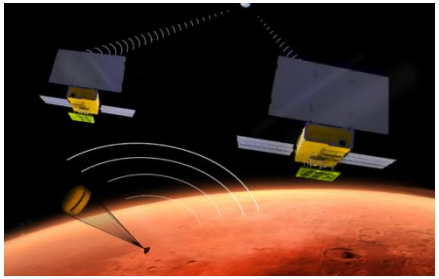
NEA Scout: Near-Earth Asteroid Scout



CuSP: CubeSat to study Solar Particles



BioSentinel



Mars Cube One (MarCO)

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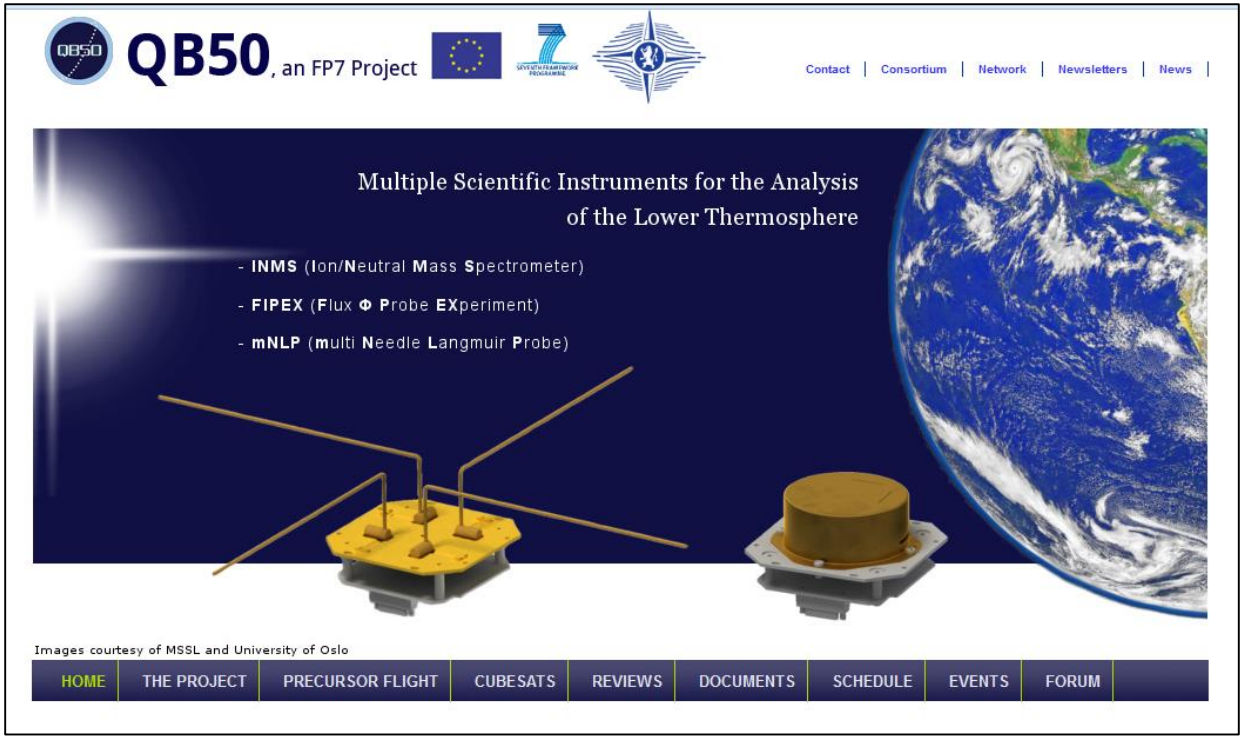
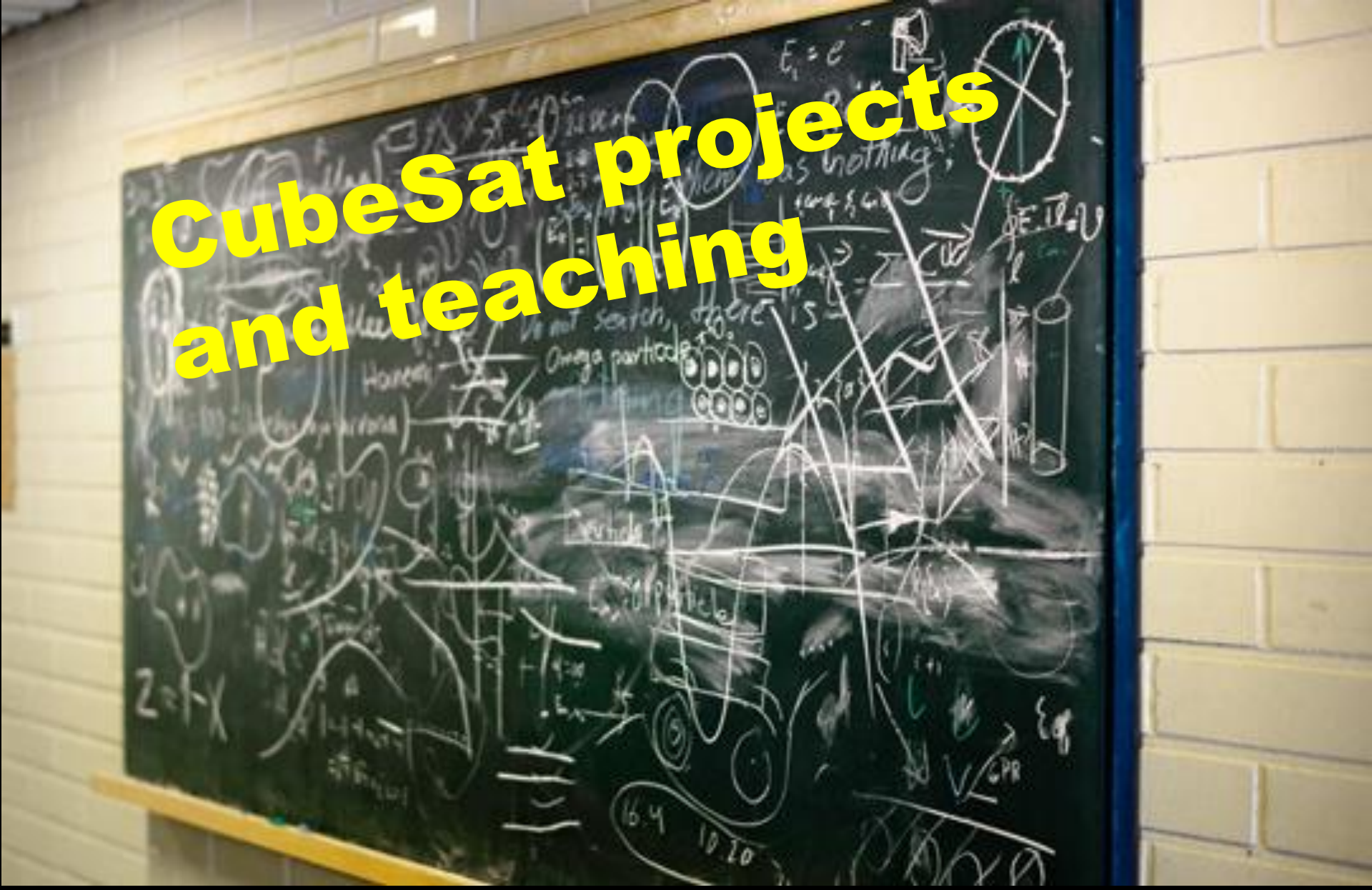
Europe and cubesats

The QB50 mission will demonstrate the possibility of launching a network of 50 CubeSats built by Universities Teams all over the world as a primary payload on a low-cost launch vehicle to perform first-class science in the largely unexplored lower thermosphere.



Dream of own satellite 2010



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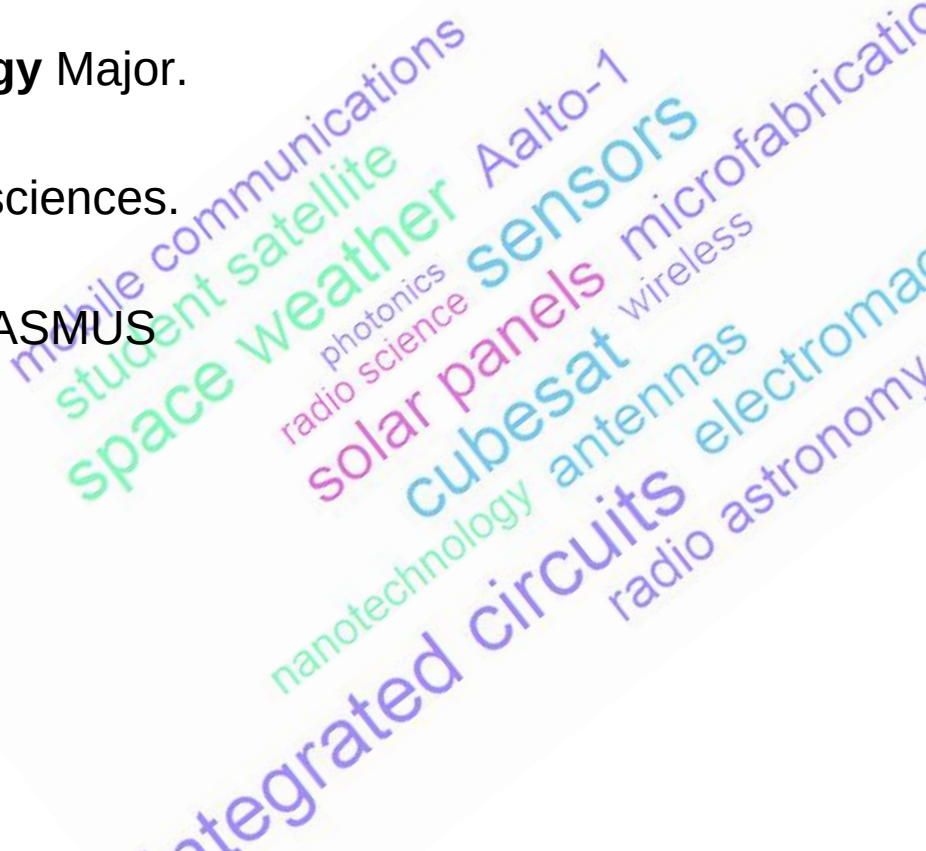
Satellite project connection to curriculum

- **Most of the satellite was built in Master thesis projects and special assignments**
- **The project worked together with many teachers in many disciplines**
- **The satellite project provided topics in:**
  - Space science, space technology, remote sensing, radio engineering, electronics, mechanical engineering, material sciences, software engineering and others

Aalto new
Master programmes in 2015

A new Master programme on **Nano and Radio Sciences** started 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.



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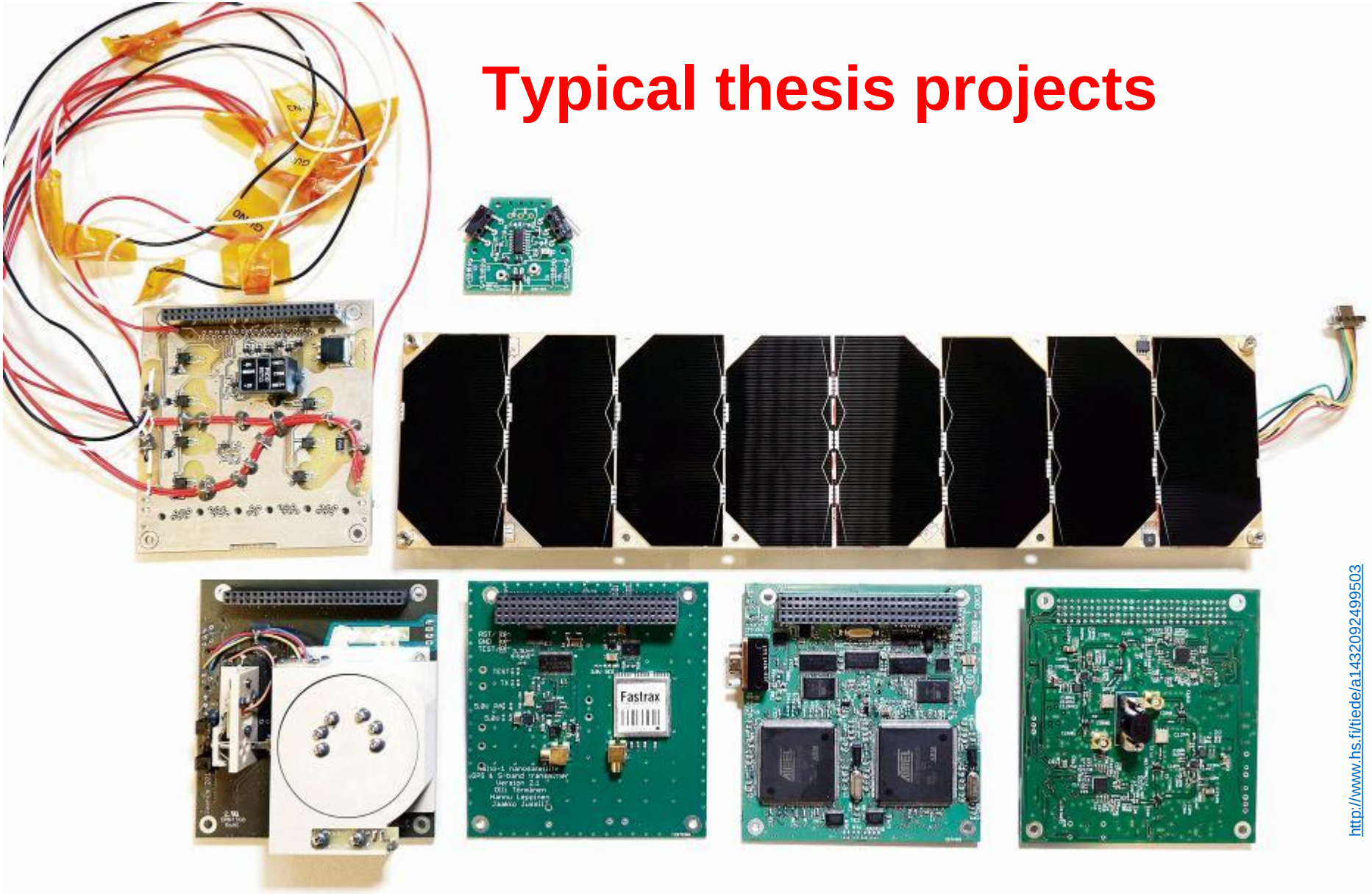
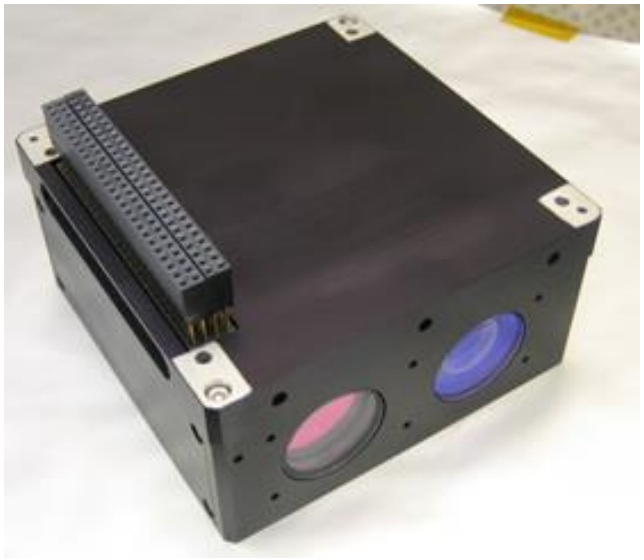
Typical thesis projects



http://www.hs.fi/tiede/a1432092499503


Aalto University
ASRO
Turun yliopisto
University of Turku
Aalto University
Multidisciplinary Institute of
Digitalisation and Energy
Aalto University
DLR
VTT
University of
Helsinki
UNIVERSITY OF JYVÄSKYLÄ
SpaceSystems
Finland
RSI
SOLUTIONS
IBST
Berlin Space Technologies
Multi Payload, technology
demonstration
Mass: 4 kg
Aalto-1

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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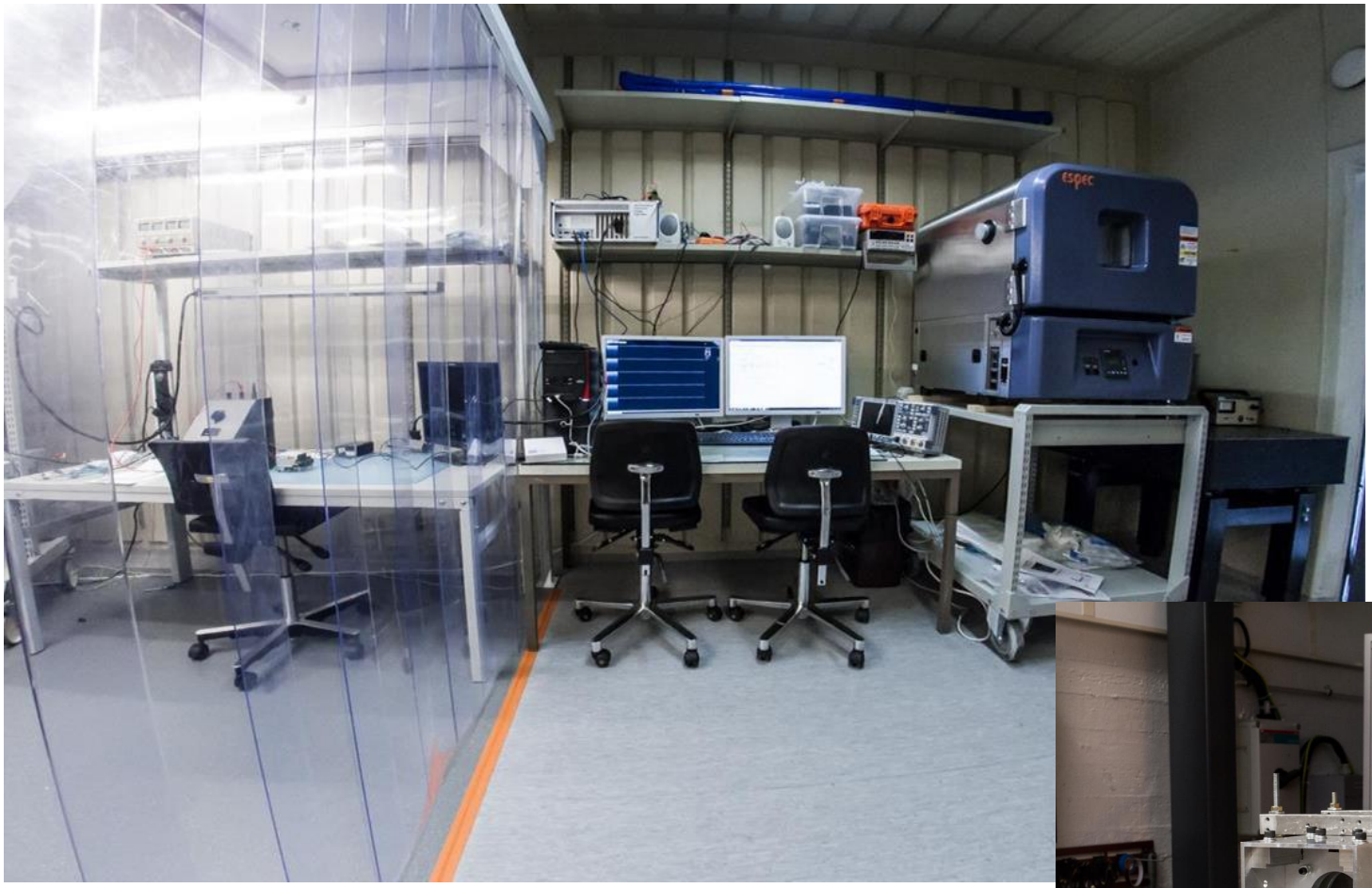
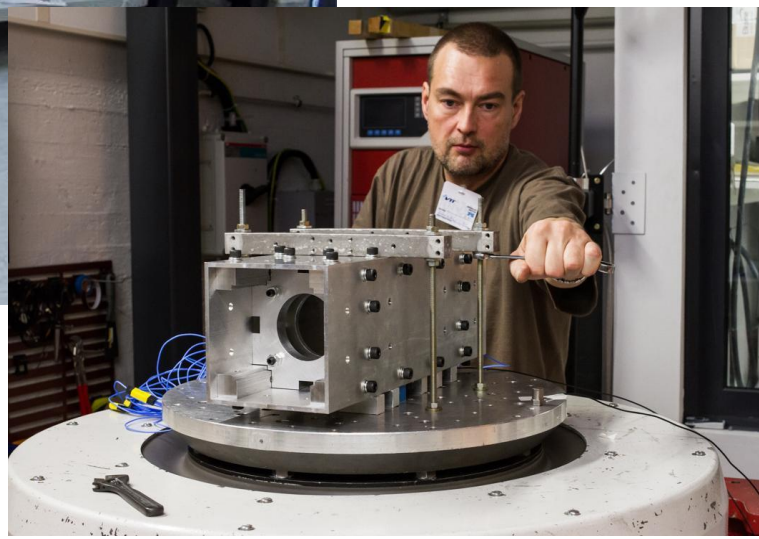
HELSINGIN YLIOPISTO
HELSINGFORS UNIVERSITET
UNIVERSITY OF HELSINKI

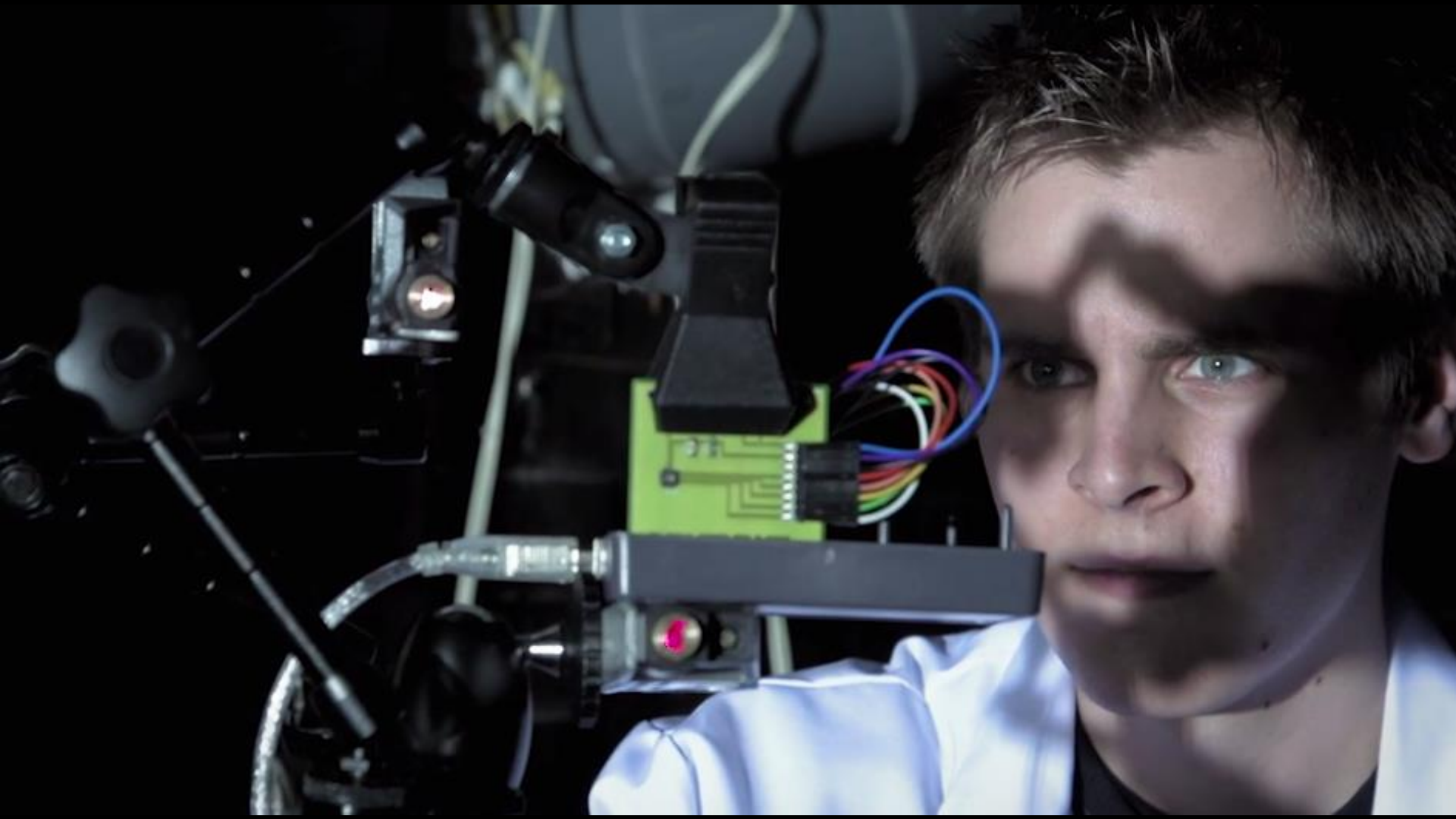
VTT

Aalto-1
The Finnish Student Satellite

Test and development facilities







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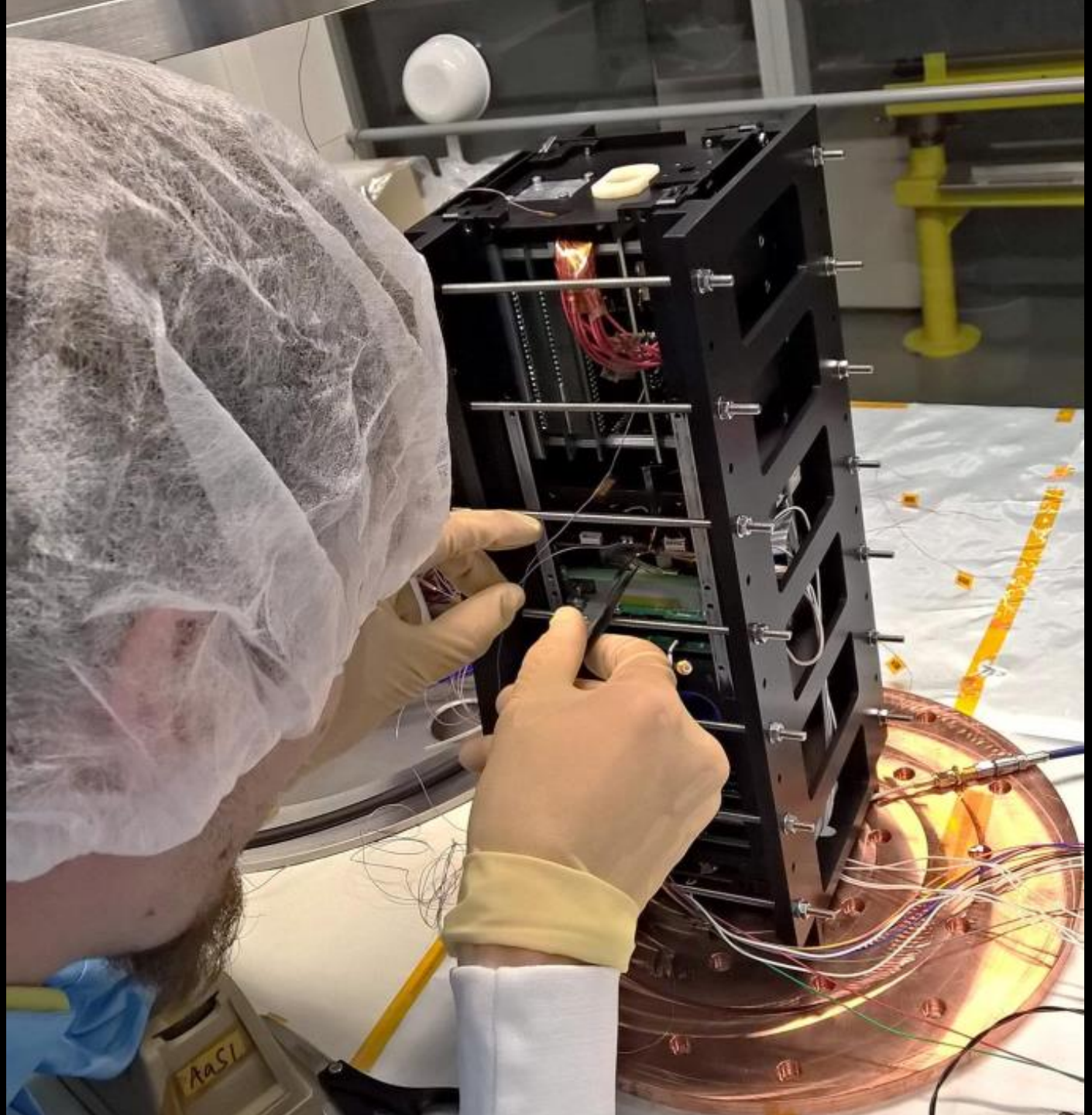
Sun sensor calibration measurements



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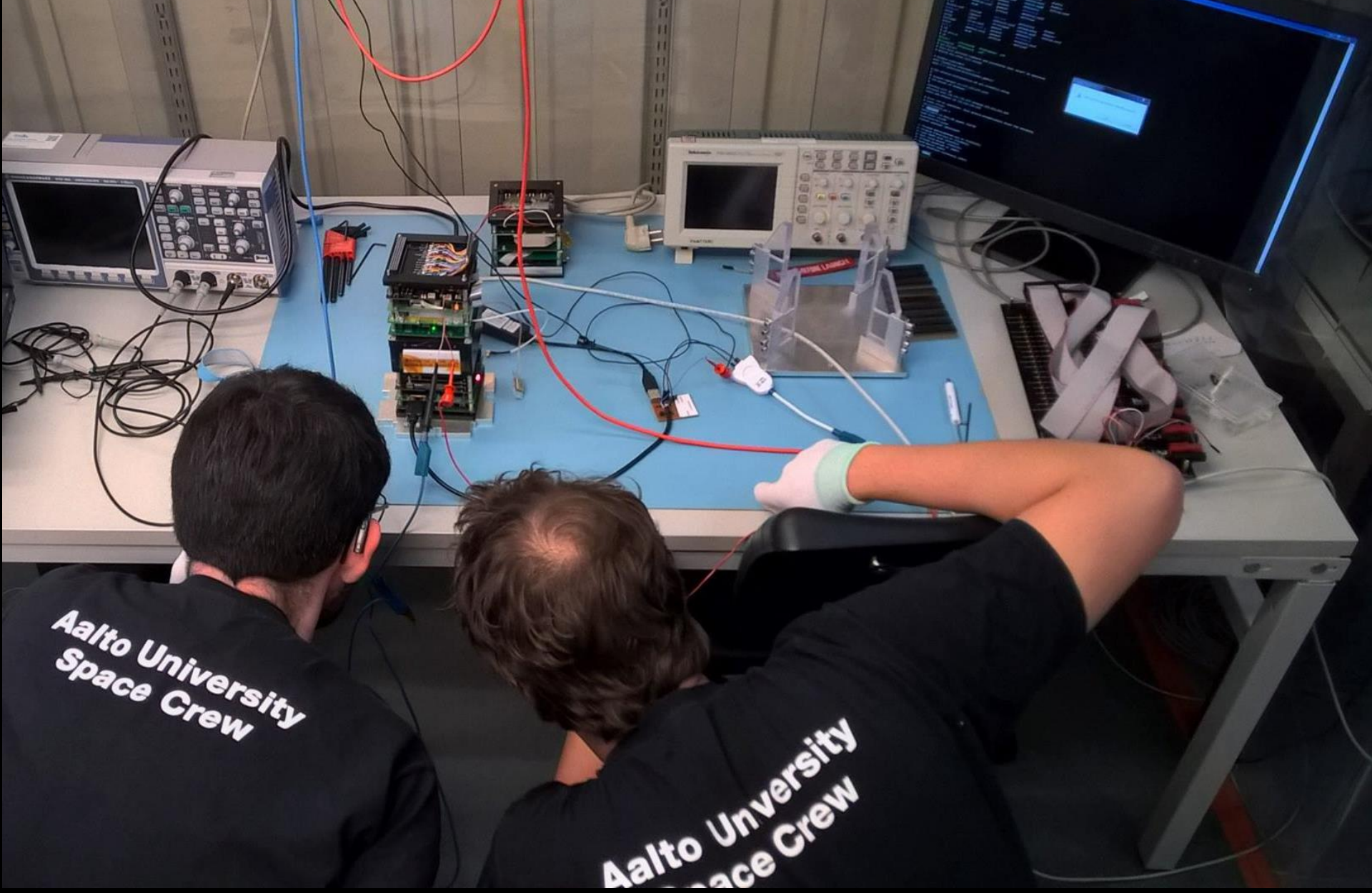

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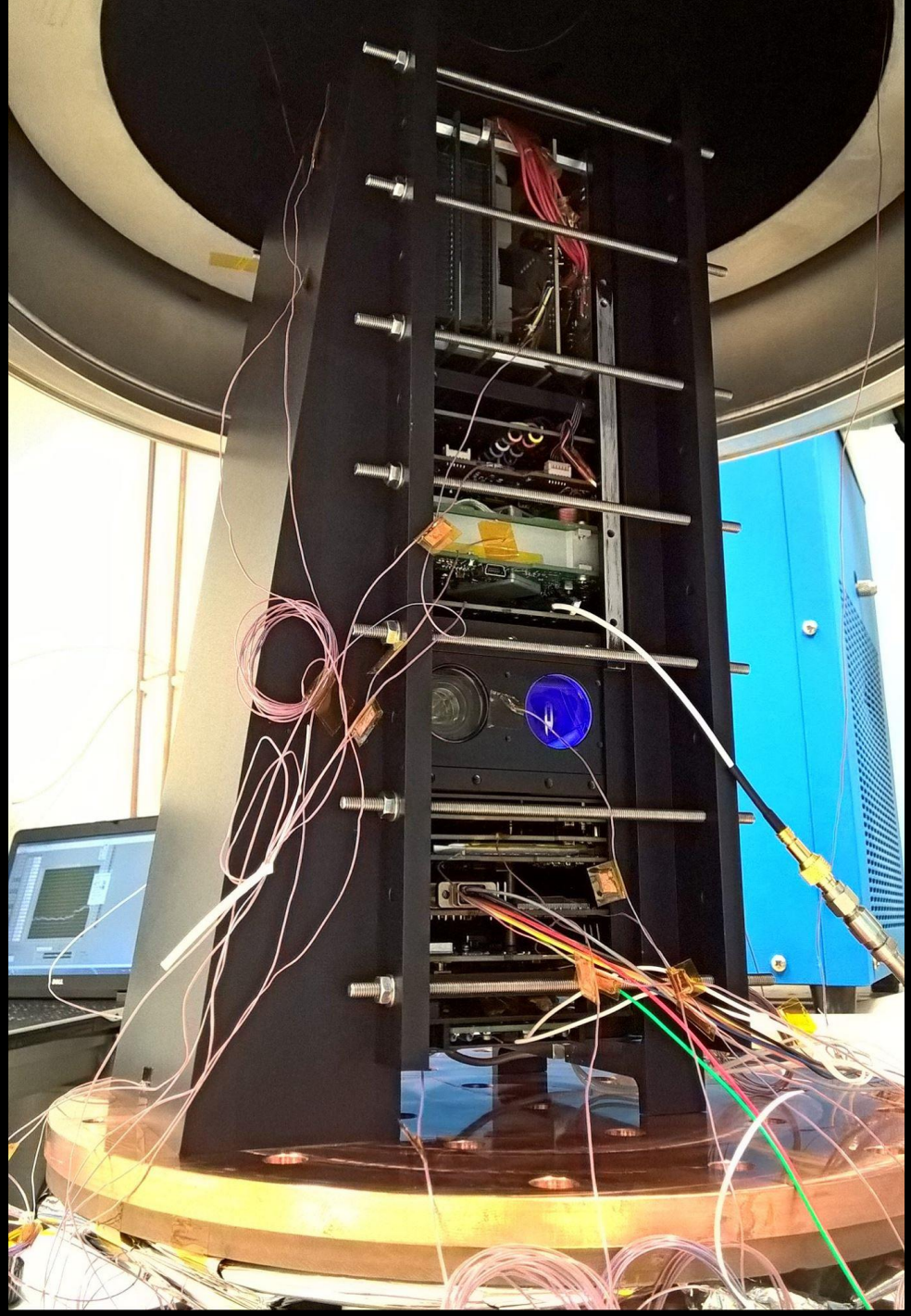

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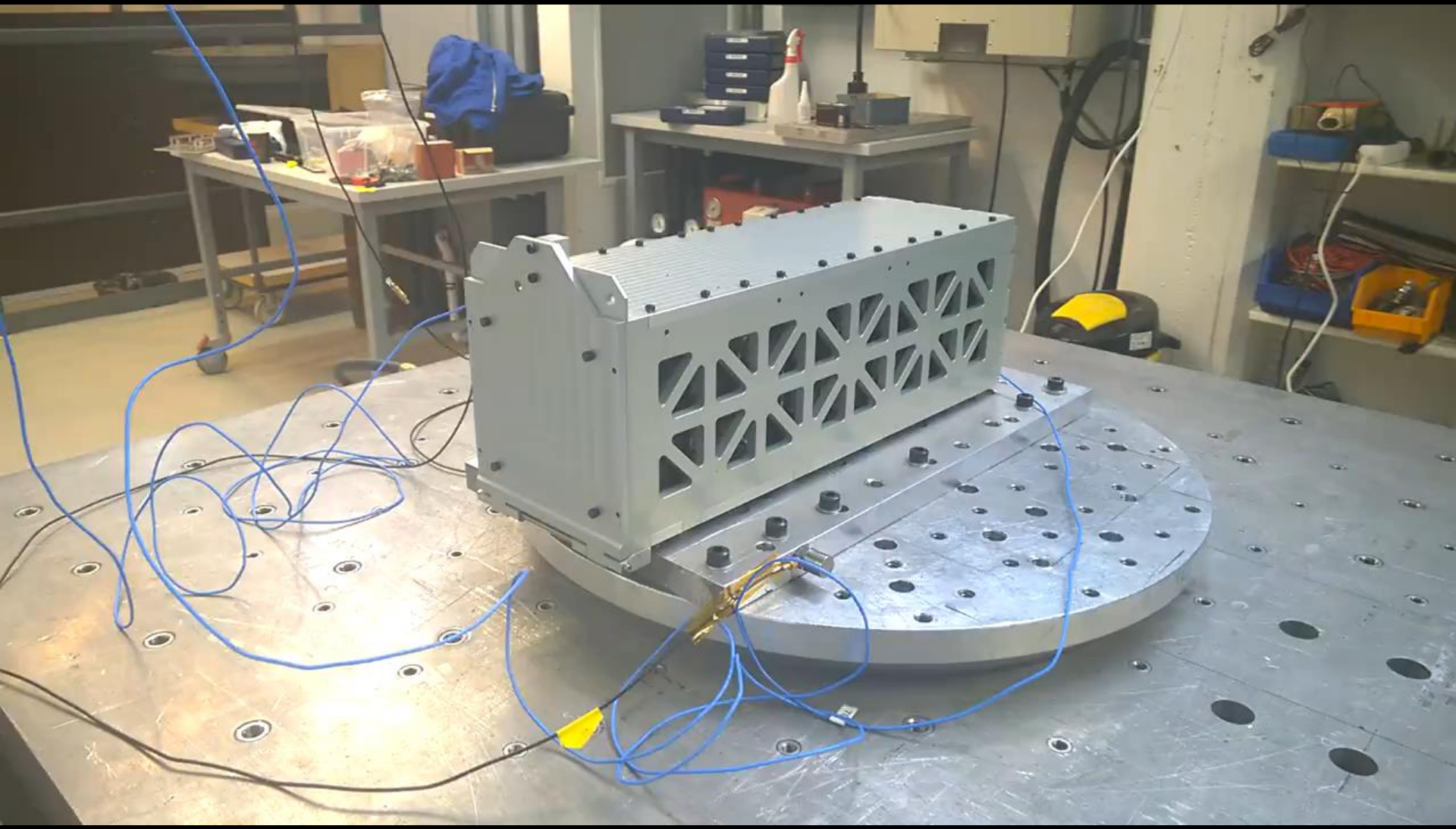

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Aalto-1

The Finnish Student Satellite

Aalto-1

The Finnish Student Satellite

Aalto-1 launch

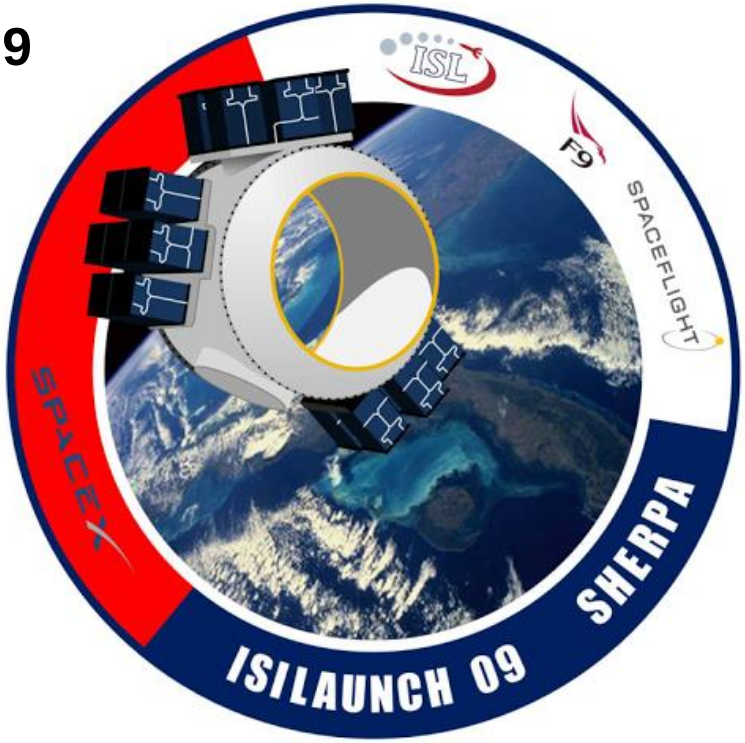
Aalto-1 is booked to SpaceX Falcon-9

Launch: June 2016

Seconday payload contains 14 CubeSats

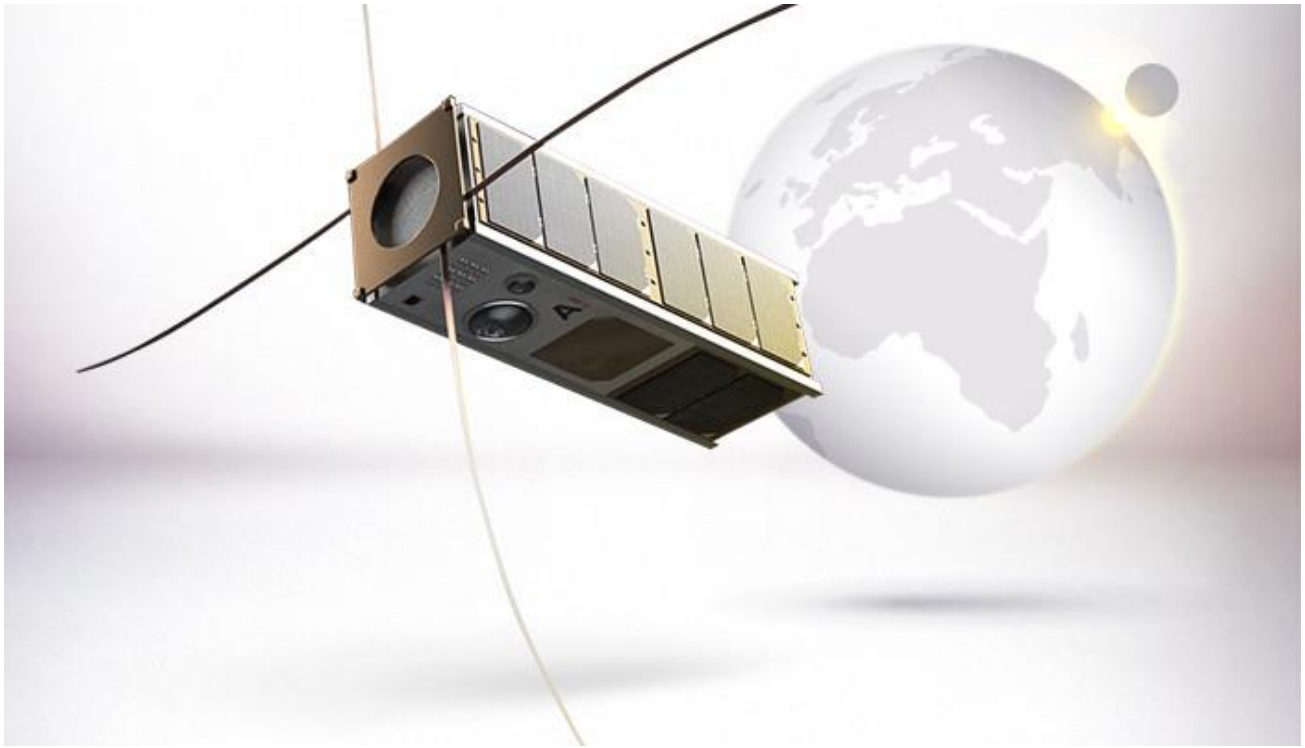
The launch is delayed because of launch failure in July 2015

Price of the launch 240 k€



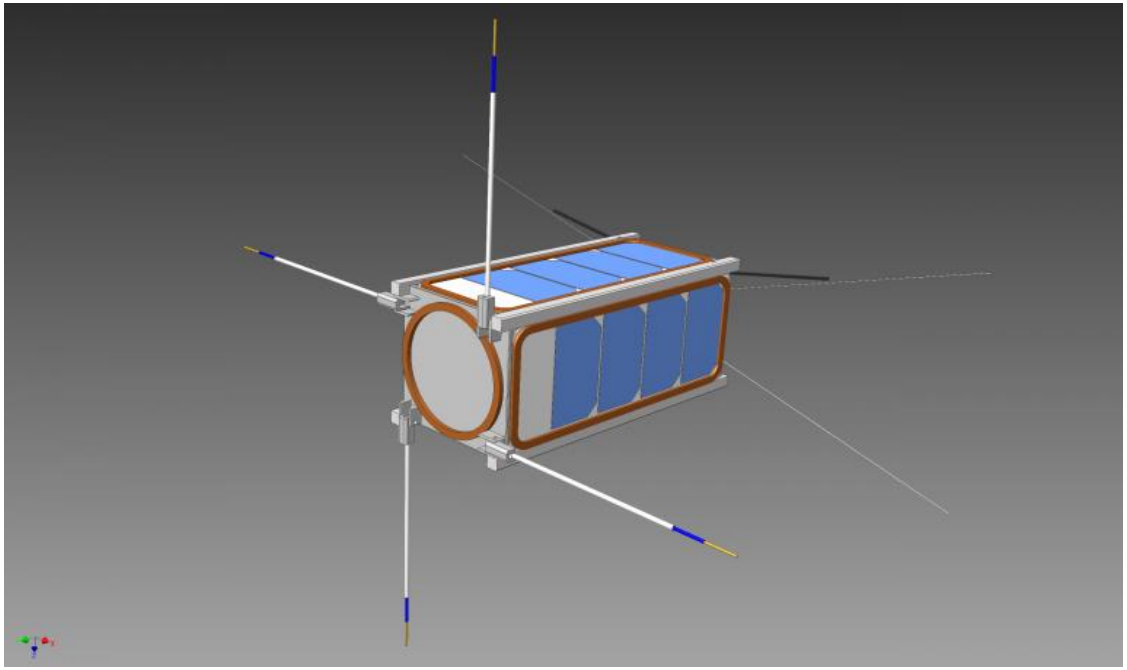
Aalto-1 cubesat science

- Launch: June 2016
- **Earth observation**
- **Space weather: energetic particles**



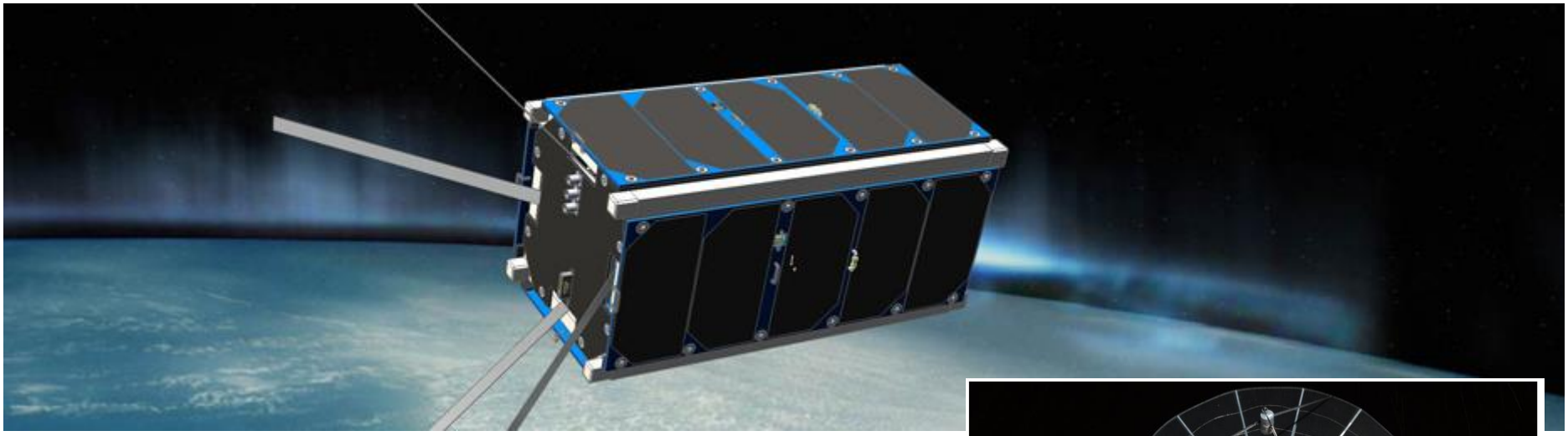
Aalto-2 cubesat science

- Launch: Dec. 2016
- Payload: Langmuir probe
- Science: **Space weather / ionosphere**



http://cubestar.no/index.php?p=1_13_Scientific-experiment

Suomi100 satellite



- **Launch: 2017**
- **Payload: auroral camera & radio wave instrument**
- Science: **Space weather & ionosphere**

http://suomi100satelliitti.fi/

Aalto University
School of Electrical Engineering

Possible future projects (1/2): ESA's Asteroid Impact Mission with Cubesats

- ESA's The Asteroid Impact Mission (AIM) plan
- Five cubesat proposals

- ASPECT: VTT Technical Research Centre of Finland, University of Helsinki, Aalto University

- A CubeSat equipped with a near-infrared spectrometer to assess the asteroid composition and effects of space weathering and metamorphic shock, as well as post-impact plume observations.

ESA/ScienceOffice.org

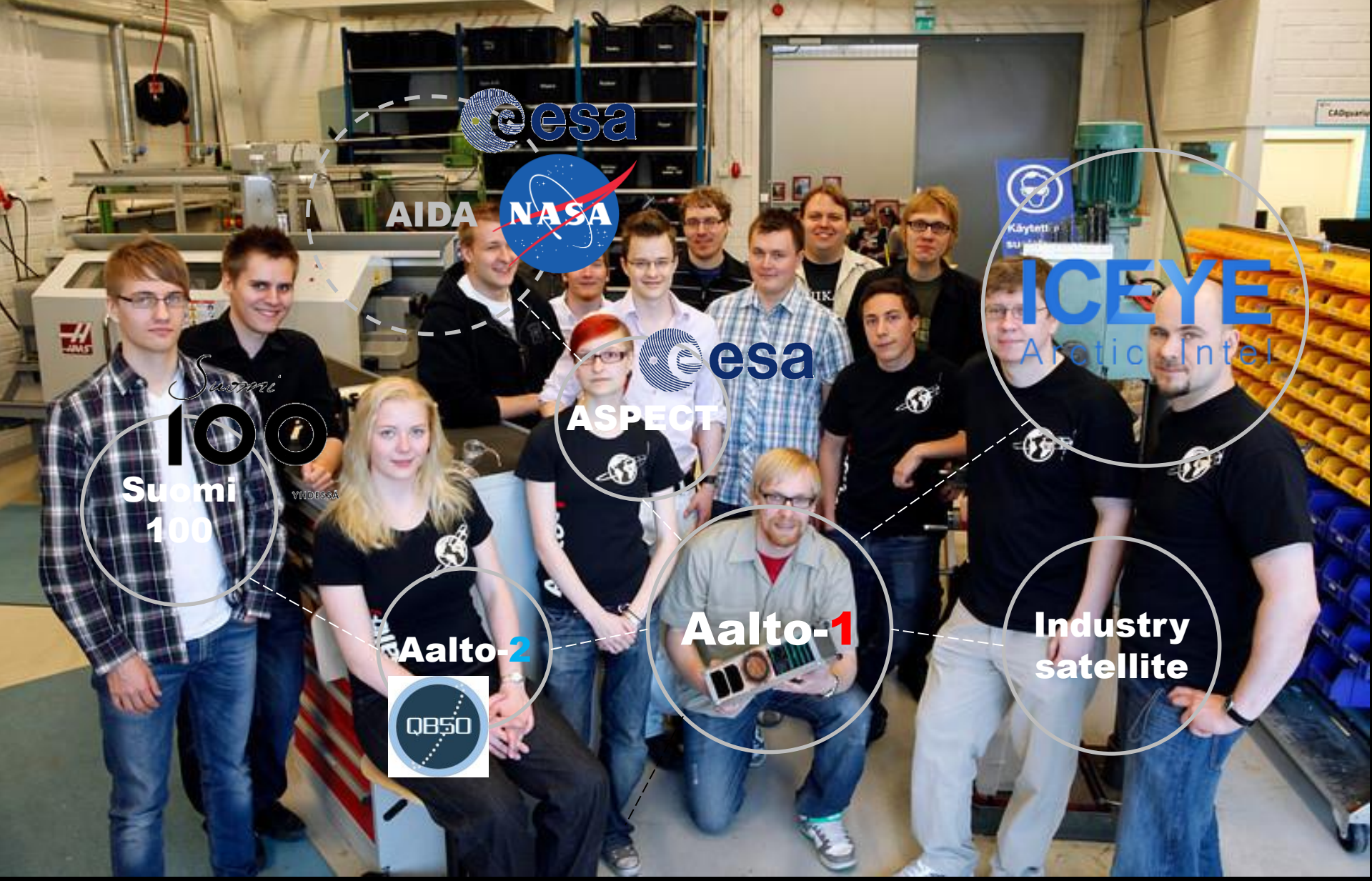
Possible future projects (2/2): Pulsar-based navigation

Nanosatellites are ideal platforms for the pulsar navigation.

Based on comparing received pulsar signal time-of-arrival (TOA) with expected TOA, accurate navigation can be achieved.

Developed for X-ray and radio frequencies in several research groups.

Aalto University has been developing a radio pulsar navigation system.



Aalto University

DRIVERS OF THE NEW SCIENCE AND TECNOLOGY:

Enthusiasm, passion, spirit, teachers, students, fun!