Piensatelliittitoiminnan mahdollisuudet käytännön sovellutuksissa

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Cube satellites

Finland and cubesats, two examples:
- Aalto-1 and Suomi 100

World, cubesats and their possibilities

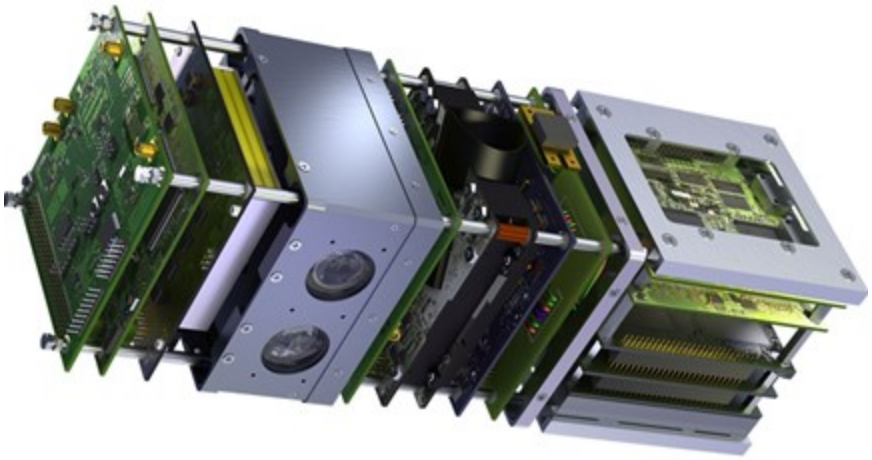
Cubesat: Background

Space technology has become a staple in every-day life, and has broadened humanity's horizon tremendously.

The concept of small satellites (less than 500 kg) offers a potential way to speed up development.

This concept has been around since the 60's, but thanks to smaller electronics and standards has now shrunk to "pocket size".

→ Especially good for smaller institutes such as universities



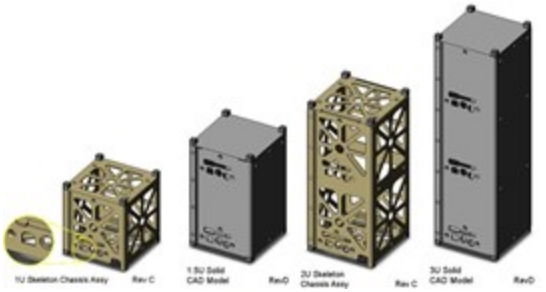
The Small Satellite Concept

Standard form factor and electrical details.

Deployment pod.

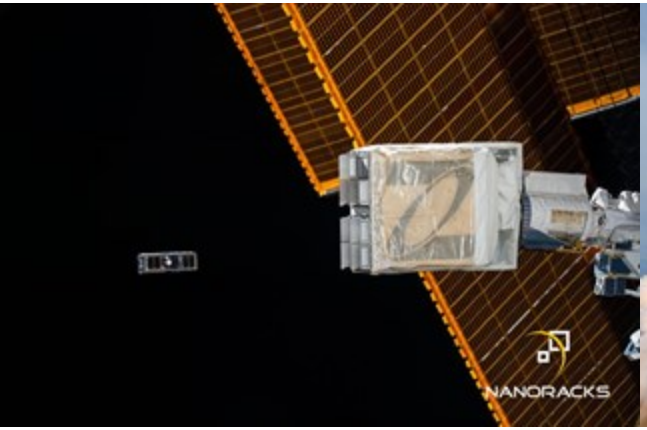
Hundreds launched, hundreds more in queue.

Used by Universities, private companies, NASA/ESA etc..



Courtesy of Pumpkin Inc.

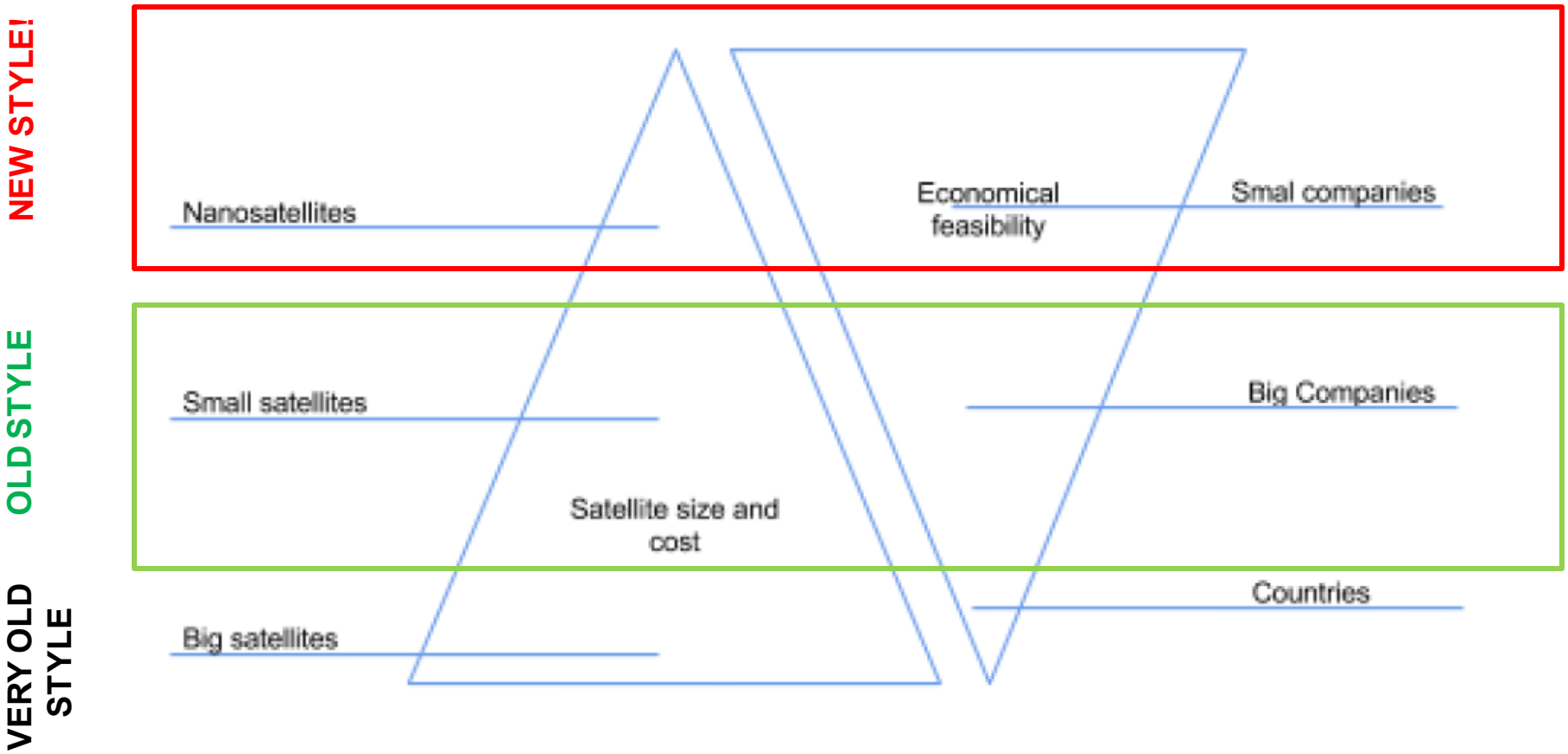
Courtesy of ISISPACE bv.



Courtesy of ISRO

Courtesy of ESA

Small satellites: game changers



CubeSats (and generally small sats) have as a rule of thumb inferior payload capabilities due to power, mass and volume restrictions
→ temporal resolution can however be improved.

Aalto-1: Start of The Aalto Small Satellite Program

The First Finnish Student satellite project.

4 kg, “3 Cube Unit” nanosatellite

UHF and S-band link to ground.

Development times:

- Aalto-1: 6-7 years.
- Aalto-2: 4-5 years.
- Suomi 100: 1-2 years.

Courtesy of ISISPACE bv.

Aalto-1 satellite

Mission goals:

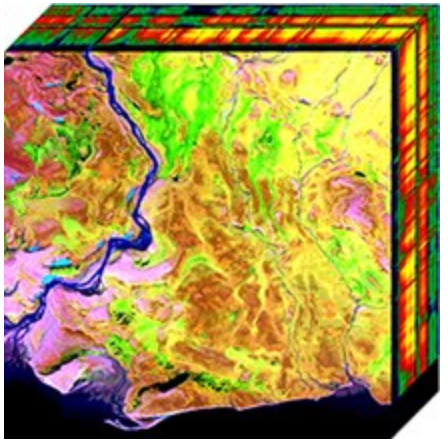
- Tech demo
- Science
- Education

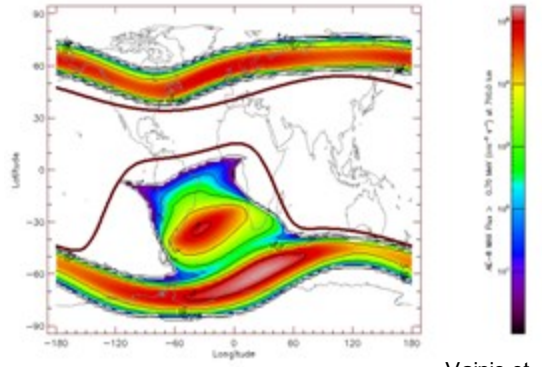
Advanced payloads:

- Hyperspectral imager by VTT.
- Orbital radiation monitor by HU & TU.
- Plasma “brake” by FMI.

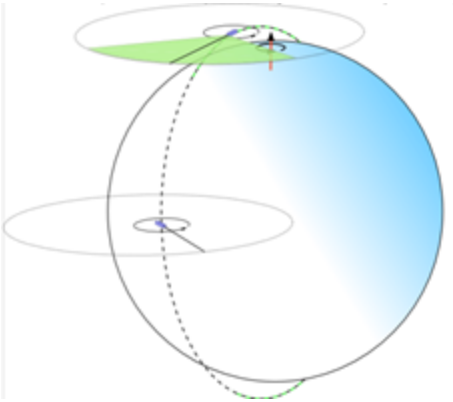
Planned mission duration is 2 years.

Ground station is here in Otaniemi (on the roof).



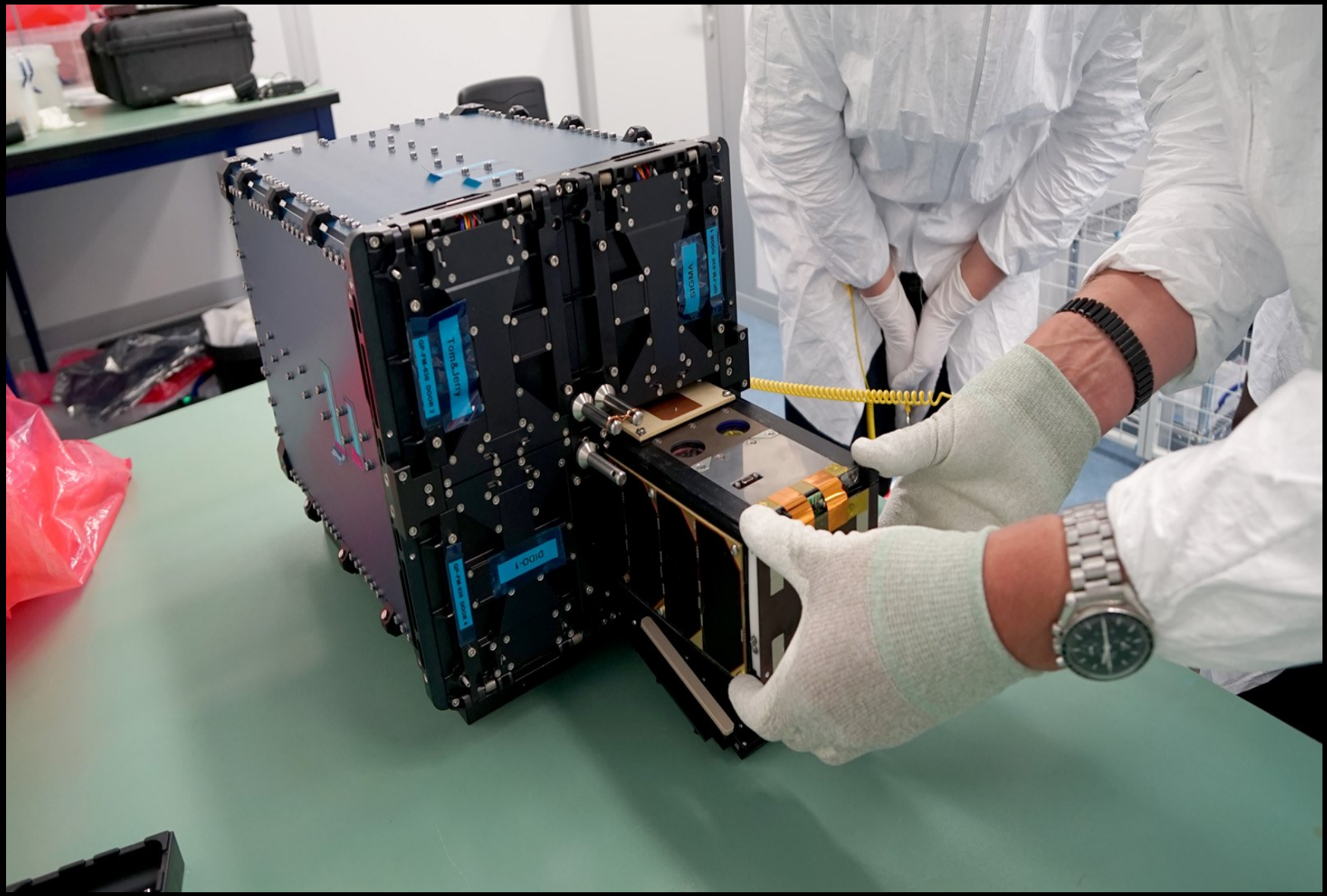


Vainio et. al. 2012



A!
Aalto University

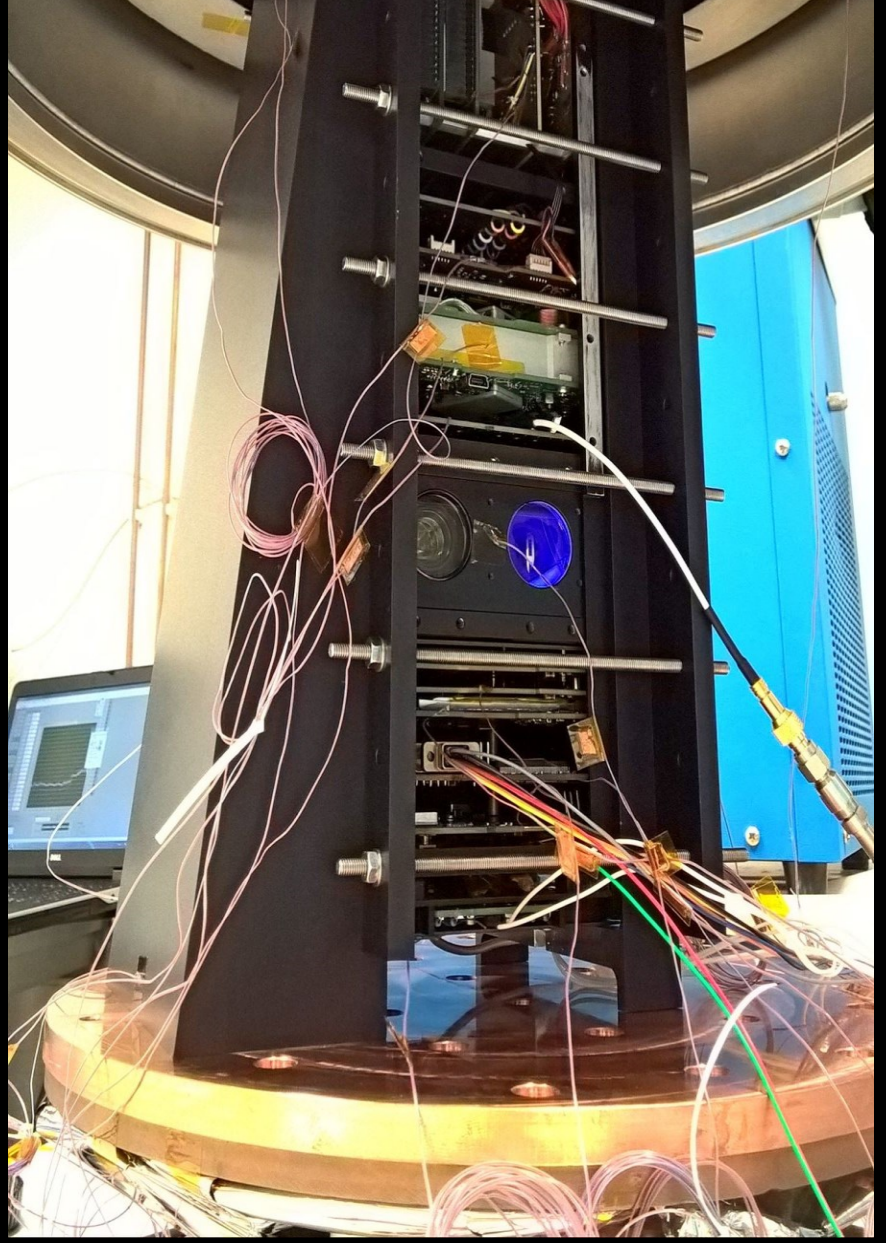
Aalto-1
The Finnish Student Satellite



Aalto University

Aalto-1

The Finnish Student Satellite



Aalto University

Aalto-1

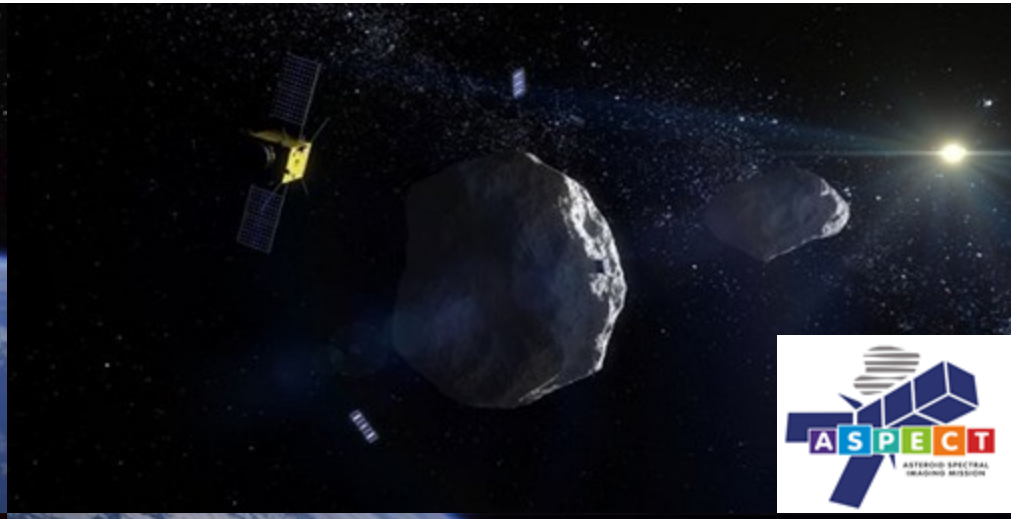
The Finnish Student Satellite

Aalto University

Aalto-1

The Finnish Student Satellite

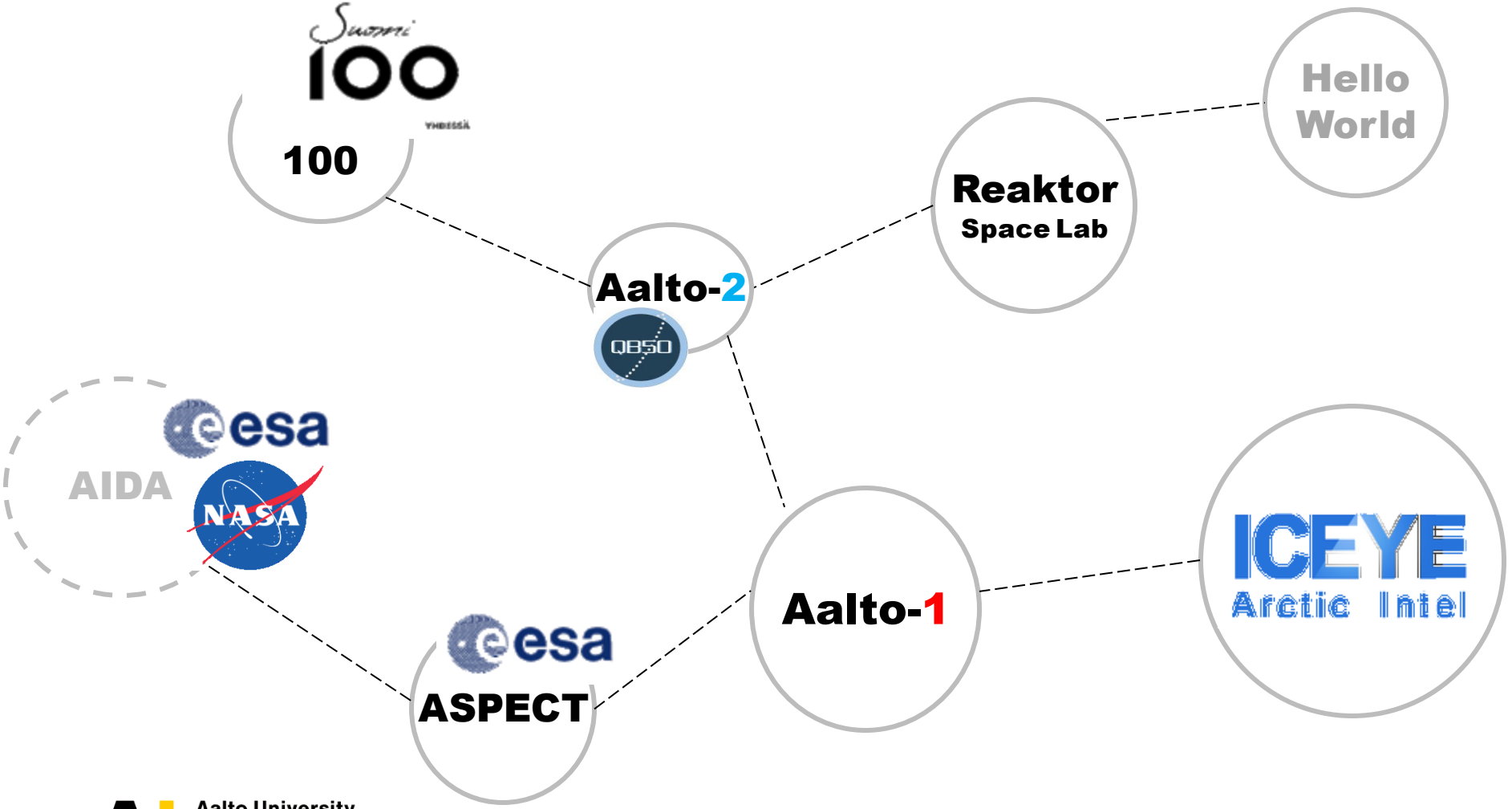
Future Small Satellite Directions



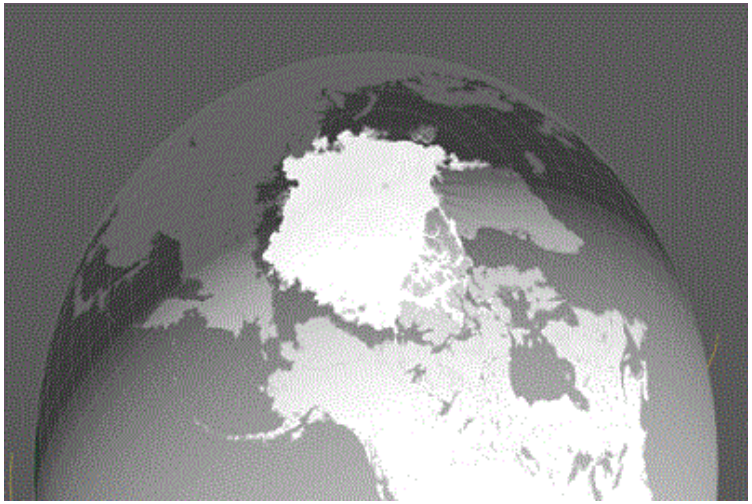

Courtesy of NASA

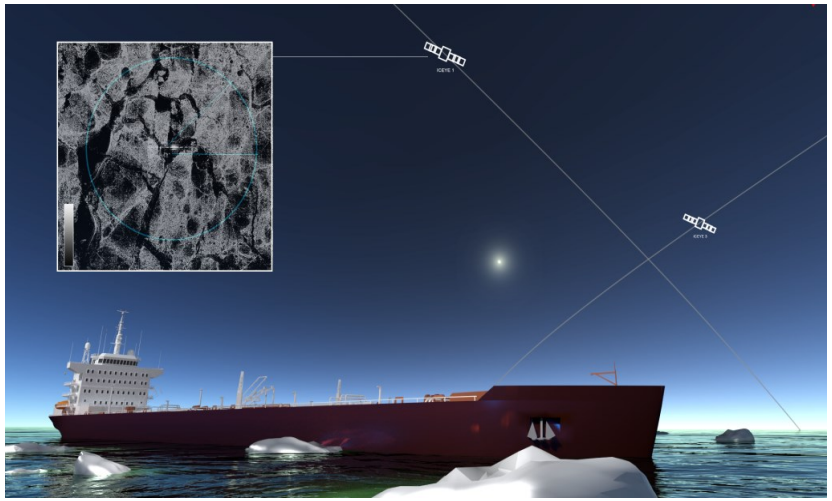

Courtesy of Uni. Michigan

Small satellite game changers in Finland



Aalto University cubesat program spin offs (1/2)





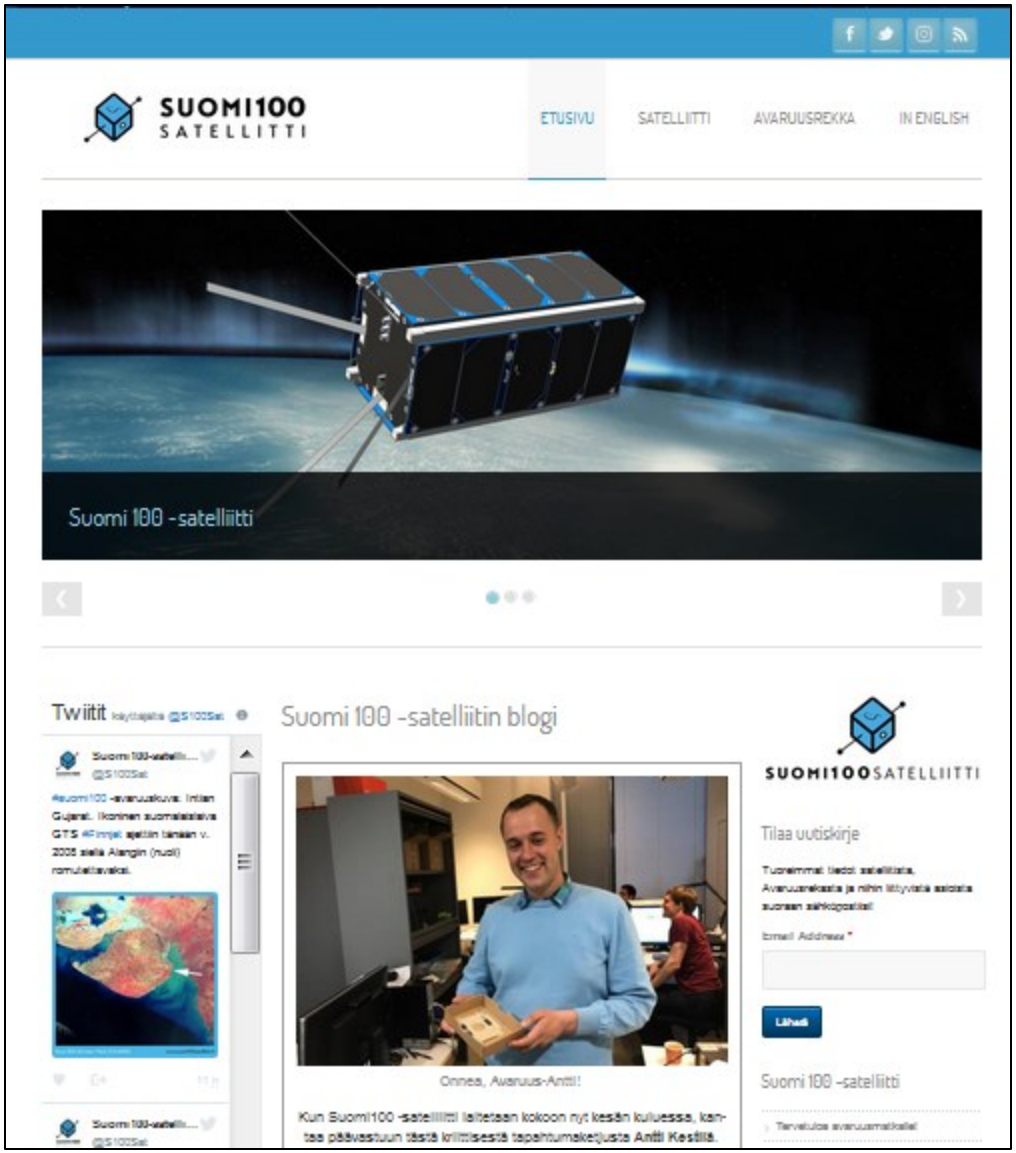
ICEYE

Aalto University cubesat program spin offs (2/2)

http://suomi100satelliitti.fi/

Suomi 100 satellite

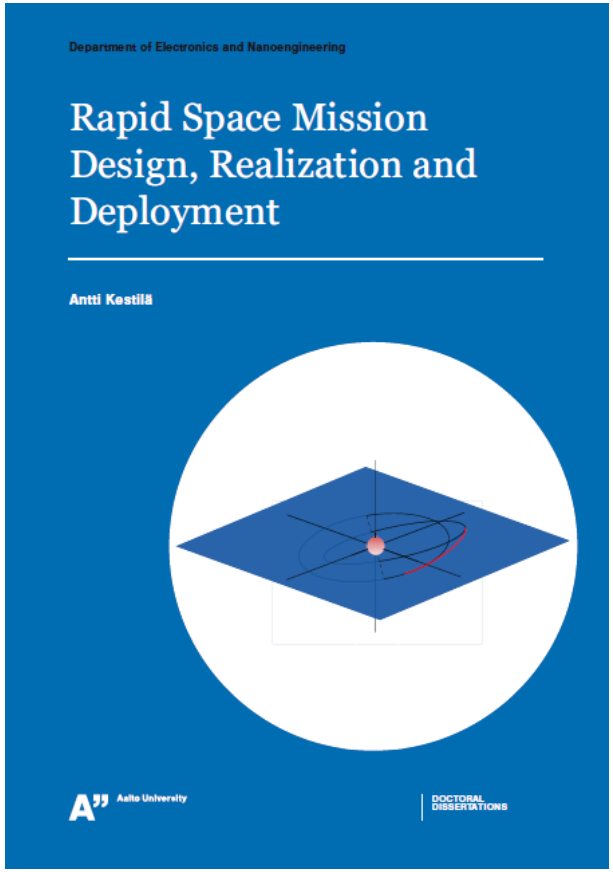
Suomi 100 - satelliitti

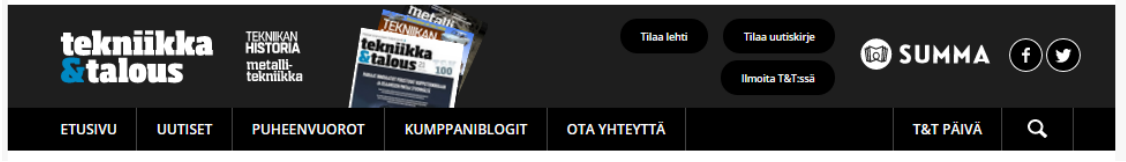


http://suomi100satelliitti.fi/

http://suomi100satelliitti.fi/avaruusrekan_kiertue

Suomi 100 – satelliitti:
Suomen 1. “*Cubesat-tohtori*” *(9.6.2017)*





Antti Kestilä
Aalto-yliopisto


AVARUUS | Tero Lehto 10.6. klo 10:12

Suomessa syntyy jo uusia nanosatelliitteja - Suomi 100 -satelliitti matkaan itsenäisyyspäivän tienoilla

3d-tulostaminen nopeuttaa piensatelliittien kehitystä. Kuvassa Suomi 100 -satelliitin 3d-tulostettu mallikappale.

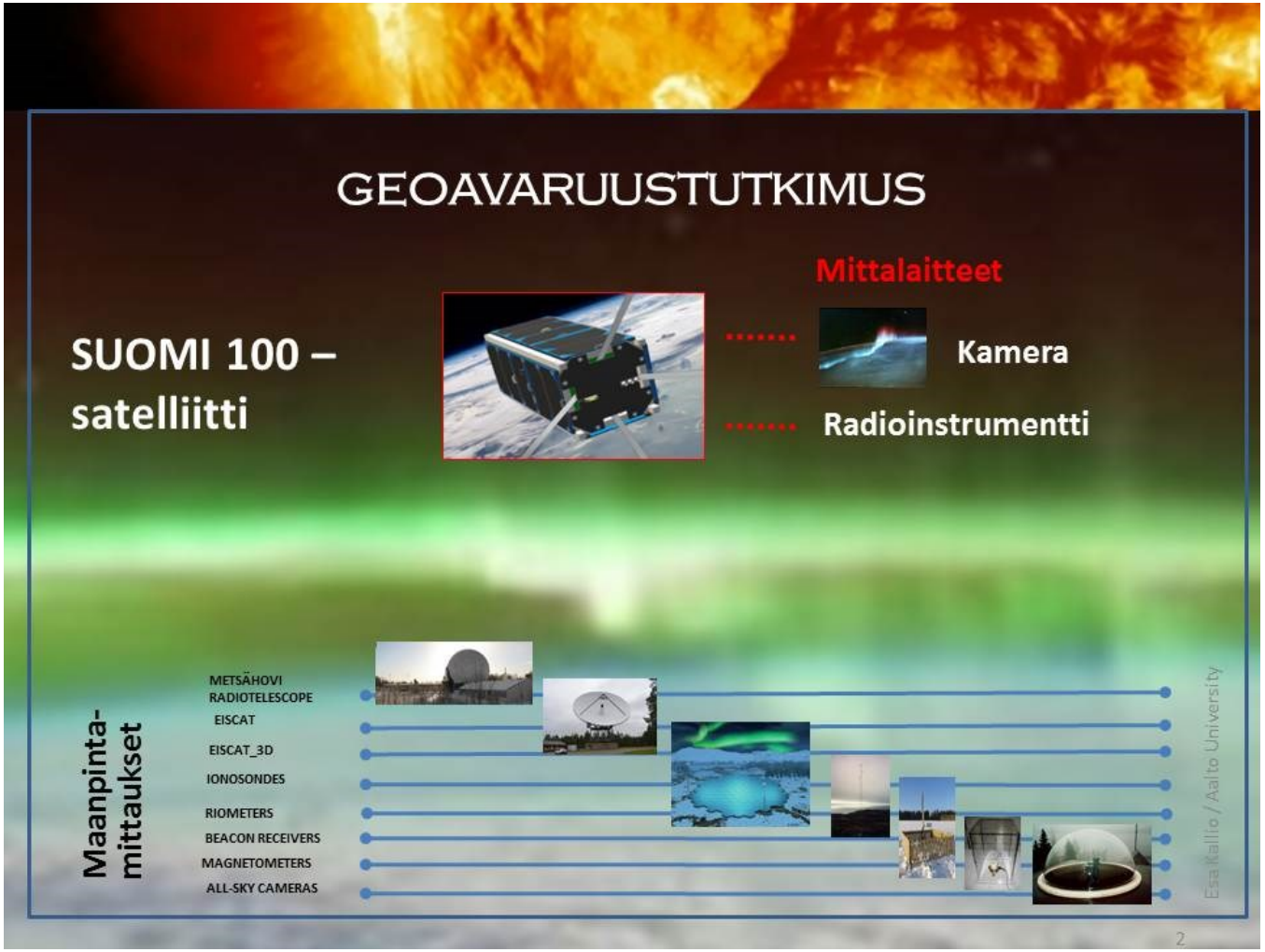
JAA ARTIKKELI

Ensimmäisenä alkanut opiskelijoiden satelliittiprojekti, Aalto-1 on viimein pääsemässä tavoitteeseensa, kun se on määrä laukaista kiertoradalleen kesäkuussa.

Uusin satelliittiprojekti Suomi 100 on yhden kuution kokoinen cubesat-piensatelliitti, jonka hyötykuormaa ovat kamera ja radiomittalaite.

Satelliitti on tarkoitus viedä polaarikiertoradalle 550–650 kilometrin korkeuteen. Laukaisuraketin mukana lähtee primäärisatelliitti ja lauma muita piensatelliitteja

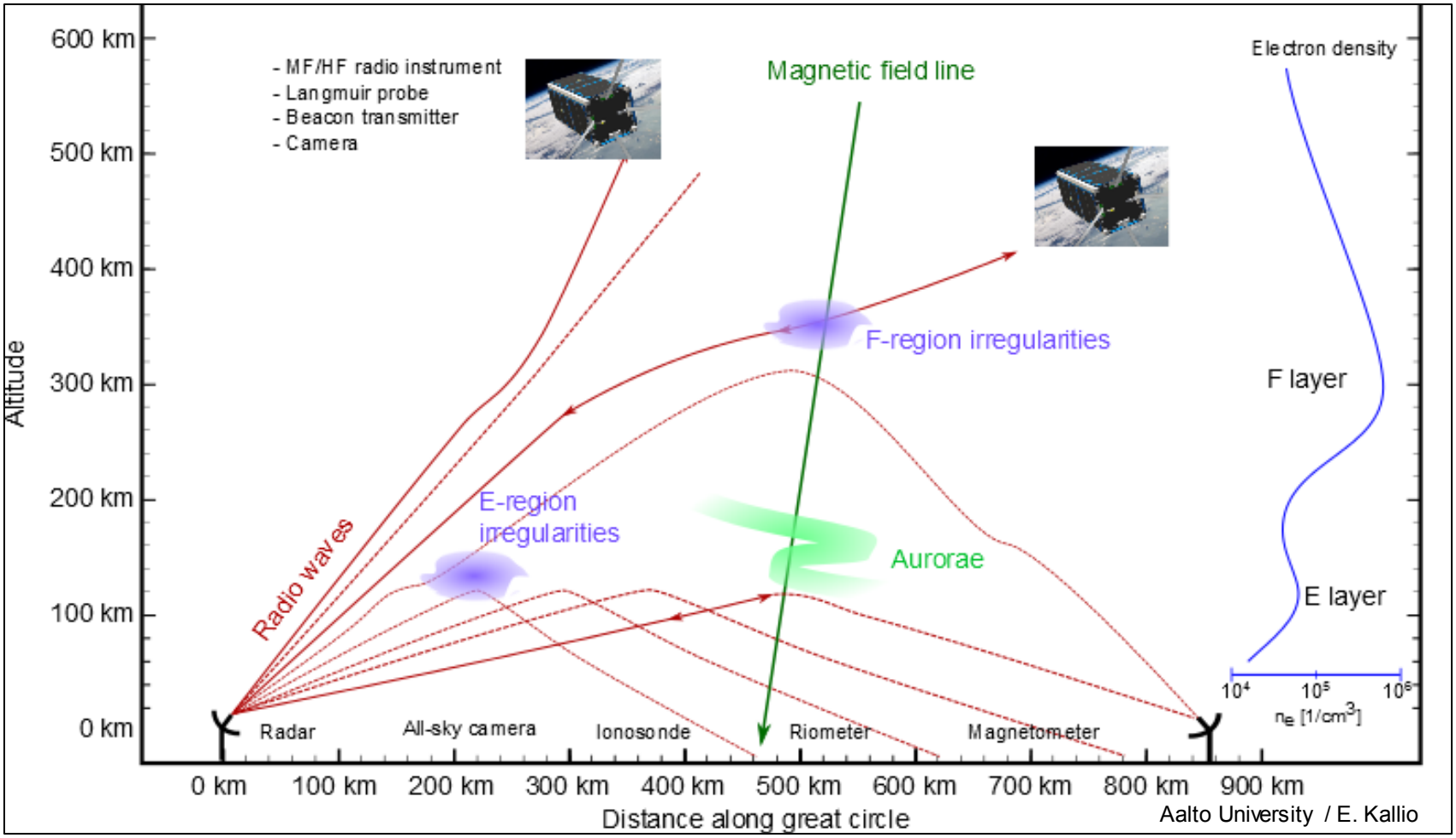
Suomi 100 satellite: Geospace research and space infrastructure



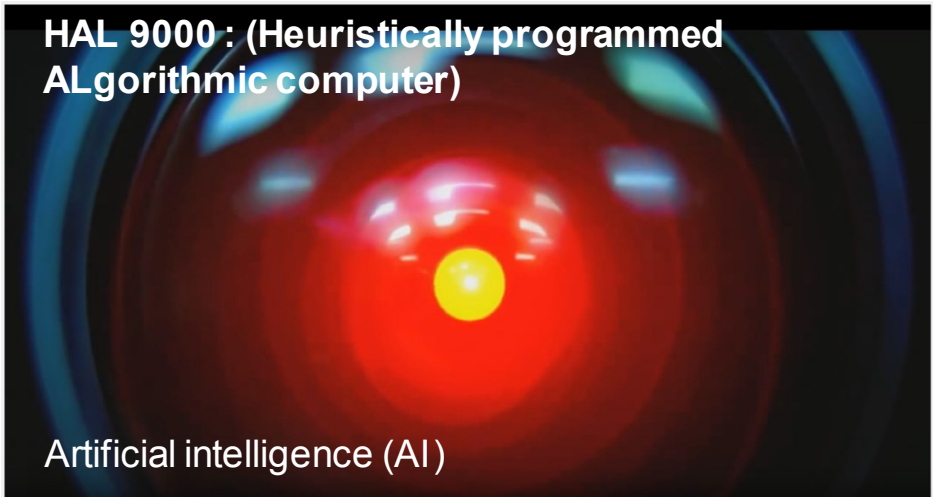
Suomi 100 satellite: The wide-angle camera

- **8 mm lens: < 260 m/pixel from 650 km**
- 35 mm lens: < 60 m/pixel from 650 km
- 70 mm lens: < 30 m/pixel from 650 km

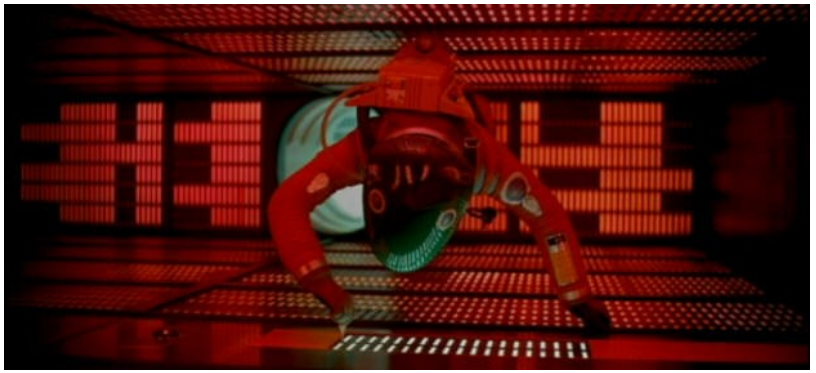
Space infrastructure: Radio waves, communication and radio instrument in the Suomi 100 satellite



Smart small satellite space infrastructure



2001--A Space Odyssey

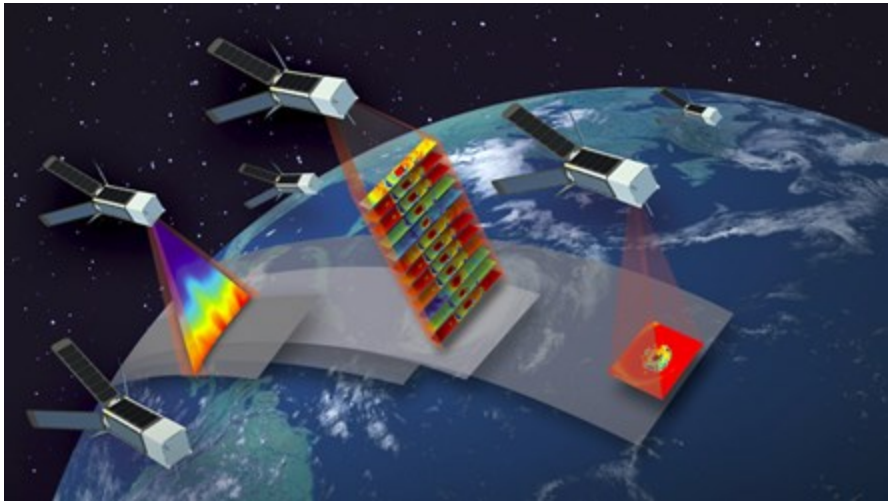


Machine learning & Go

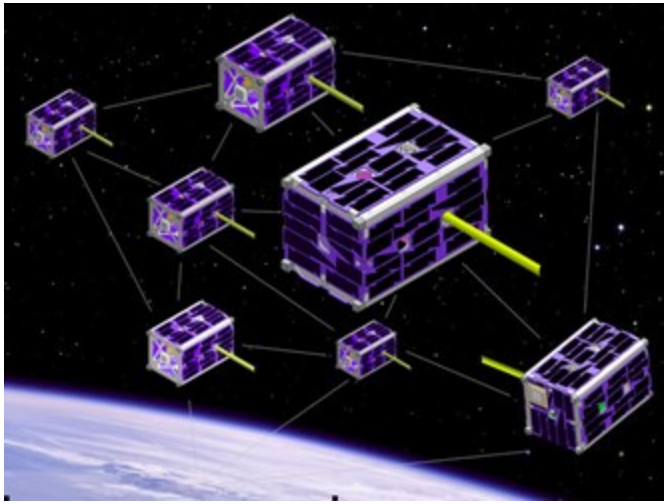
DeepMind's program AlphaGo beat Fan Hui, the European Go champion, five times out of five in tournament conditions, the firm reveals in research published in Nature on 27 January, 2016

Constellation small satellite missions

Aalto-1 helped understand the most promising aspect of small satellites → as they are relatively cheap, many can be produced and deployed to specific orbits.
These are called constellations, and in some cases, swarms.



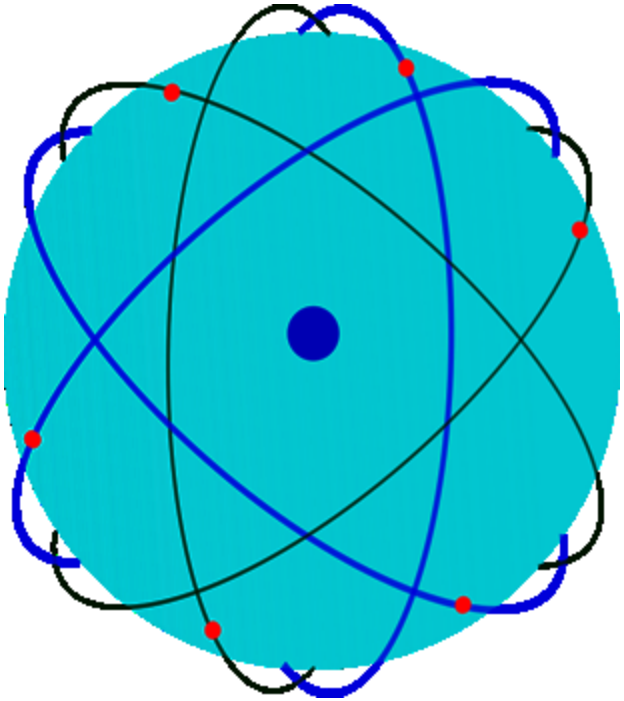
Court. JPL NASA



Court. NASA

Constellation

‘Walker’-constellation with specific orbit parameters performed best.

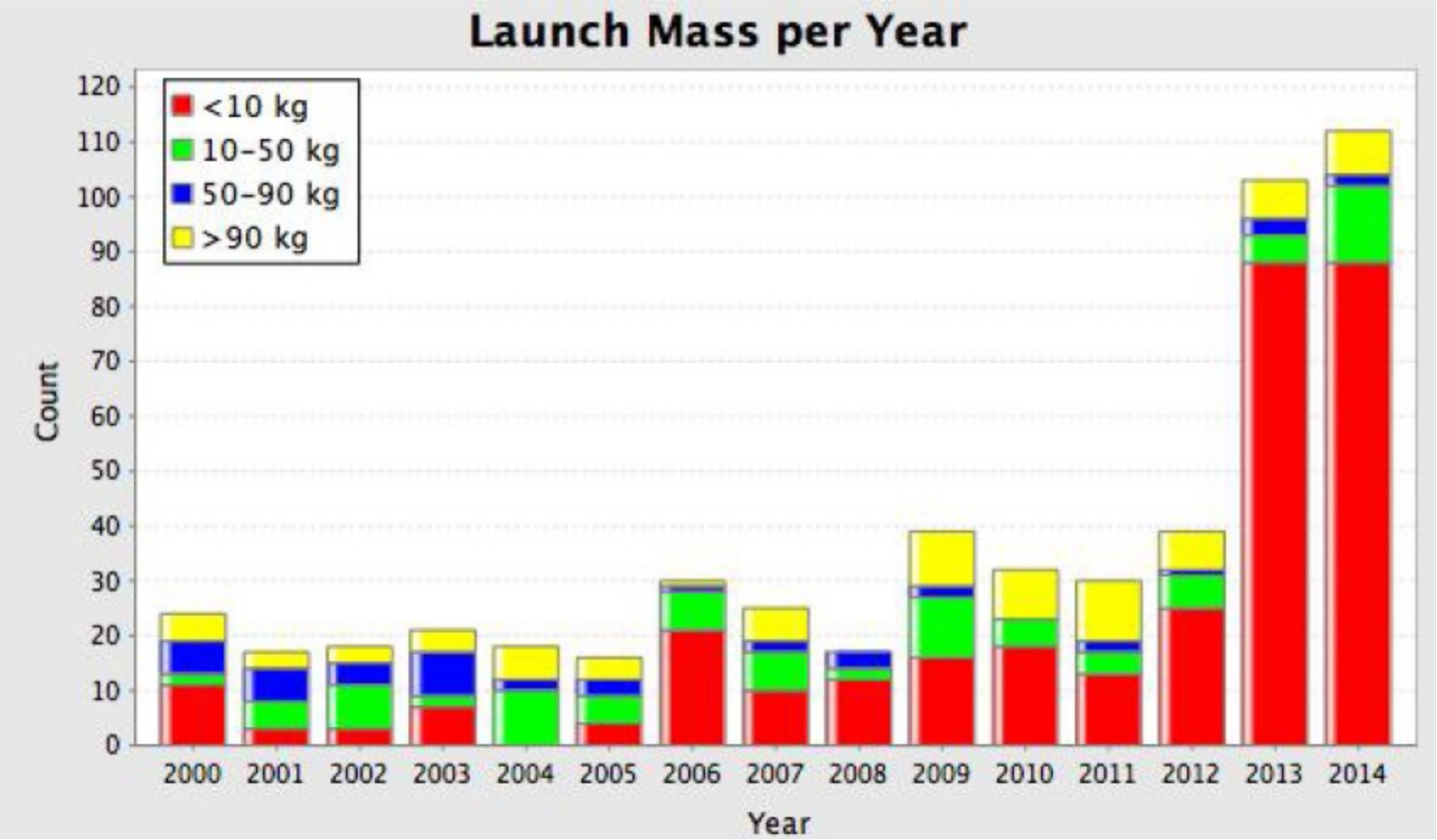


Requirements and challenges:

- Launch opportunities.
- Propulsion in practise required.
- Ground segment.

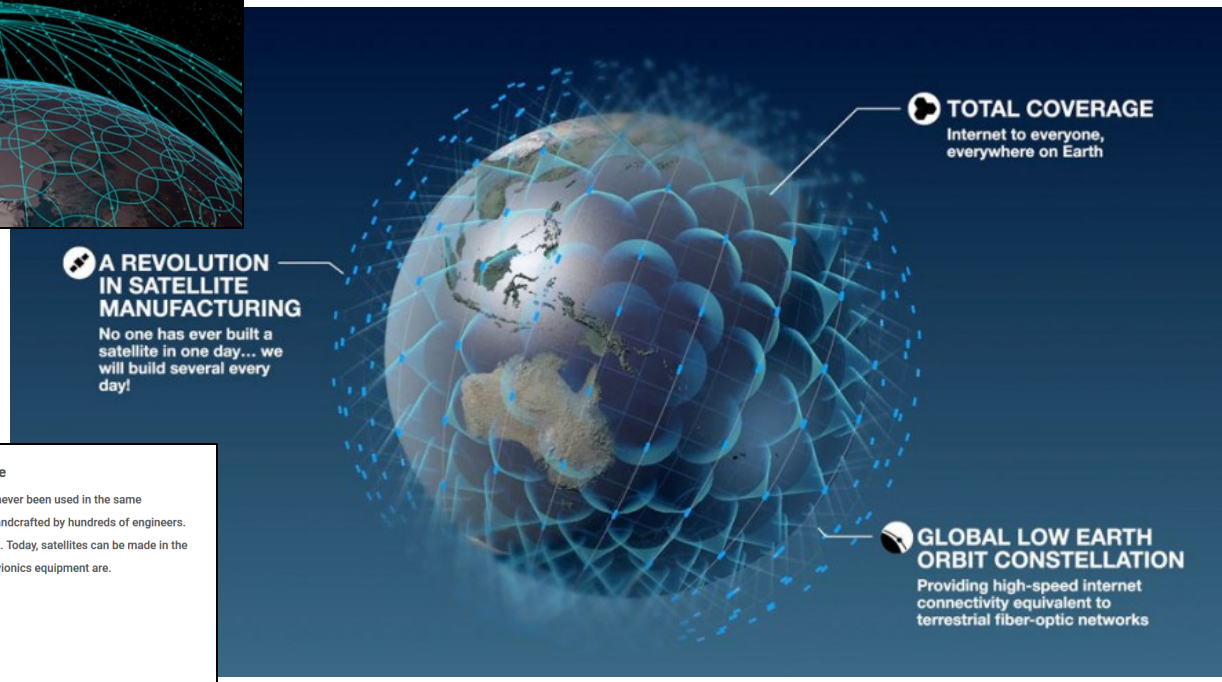
- Each satellite should have similar properties
  → repeatable manufacturing process.

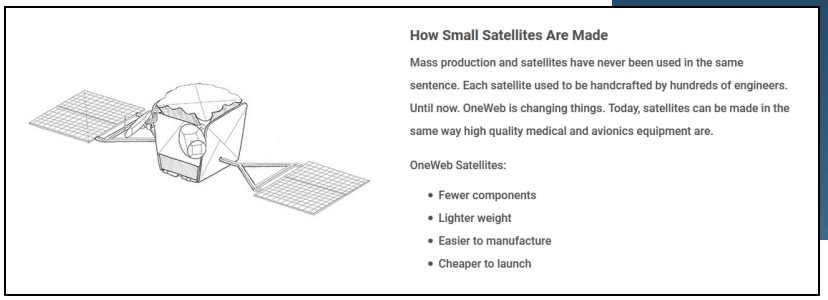
Increasing amount of small (< 10 kg) satellites



M. Swartwout, *2015 IEEE Aerospace Conference*, pages 1–12, March 2015.

Examples of new satellite companies (1/2): OneWeb's *space internet*

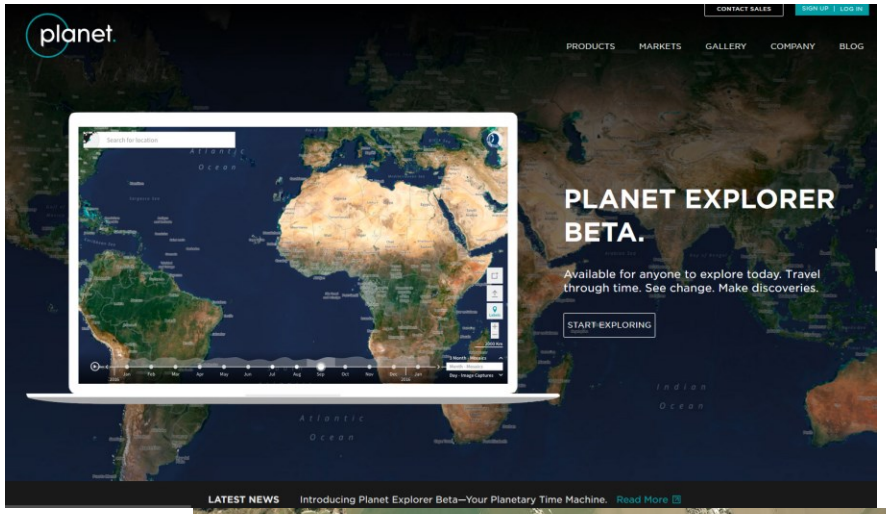




http://oneweb.world/#technology

Examples of new satellite companies(2/2): Planet

https://www.planet.com/



Concluding remarks

Small satellites, cubesats, are ready to open new possibilities for society, business and science

“New space”: Space open for everybody, not only for large countries and large organizations

Finland just took its first step toward “space infrastructure” by Aalto University’s cubesatellites

Small satellites provides new possibilities, today!