

the esa earth observation Φ -week

EO Open Science and FutureEO

12–16 November 2018 | ESA–ESRIN | Frascati (Rome), Italy

From Student Projects to Satellite Constellations

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School of Electrical
Engineering



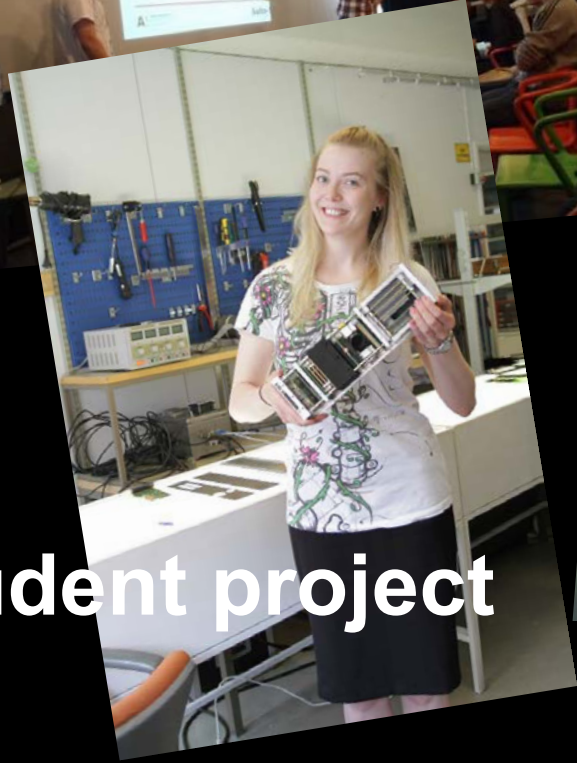
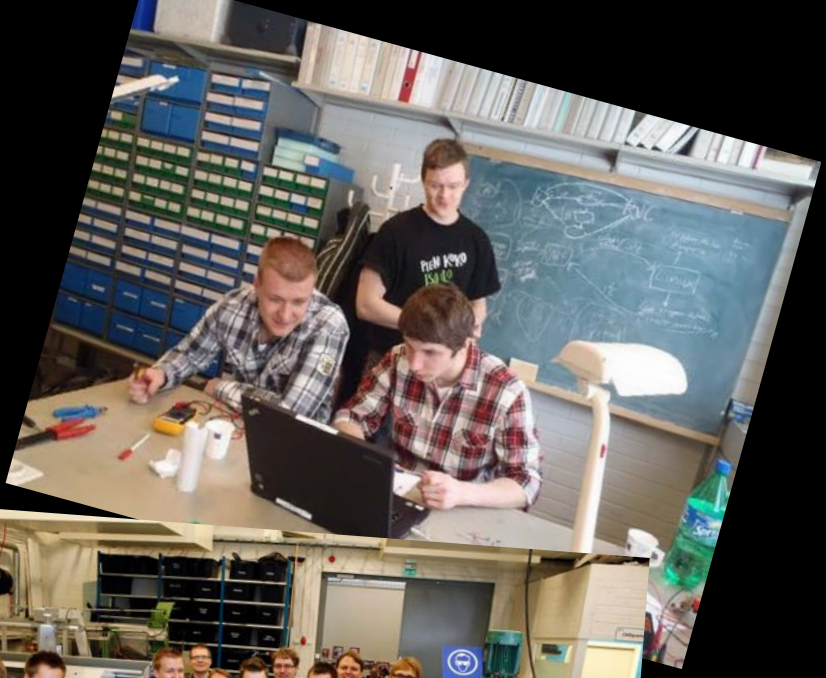
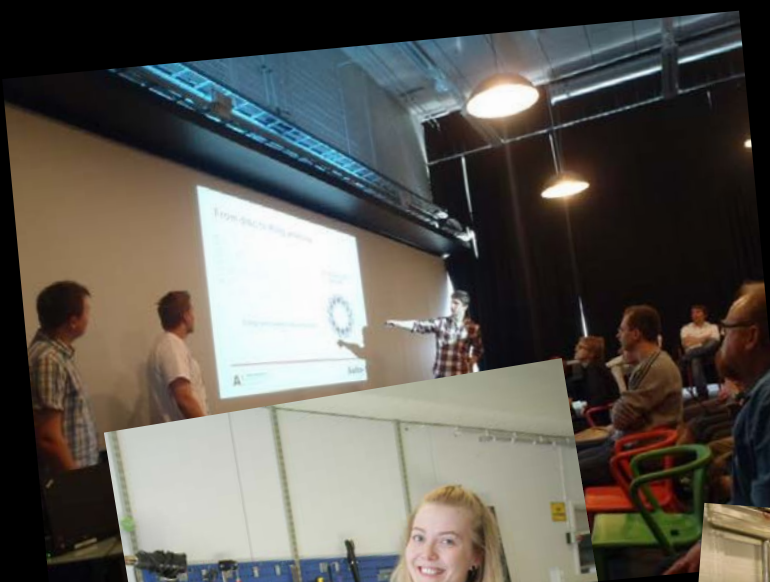
Innovation better, or cheaper, or both

Mervin Kelly, Bell Labs

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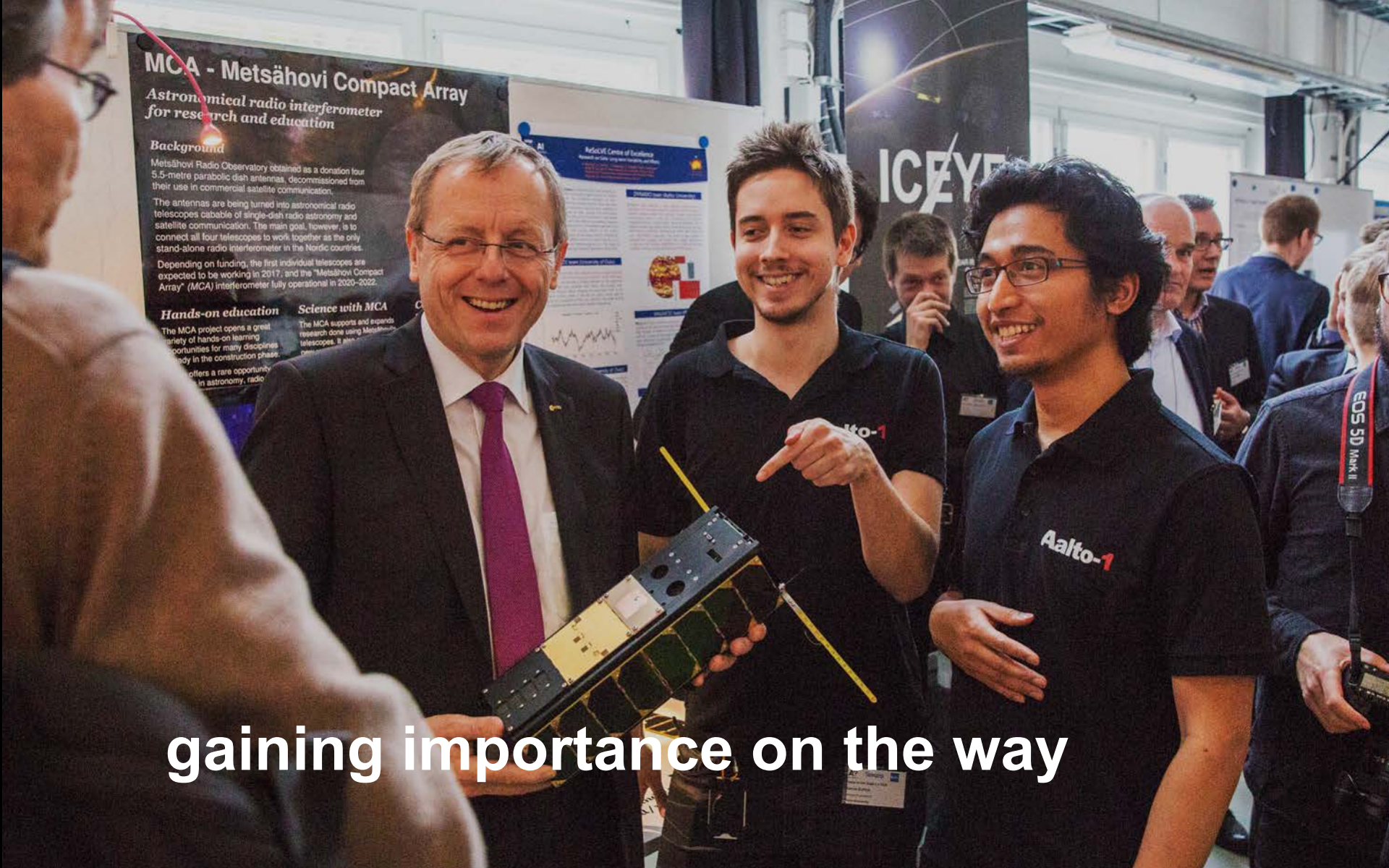
A CubeSat in Finland



Student project

growing professional





MCA - Metsähovi Compact Array
Astronomical radio interferometer for research and education

Background
Metsähovi Radio Observatory obtained as a donation four 5.5-metre parabolic dish antennas, decommissioned from their use in commercial satellite communication. The antennas are being turned into astronomical radio telescopes capable of single-dish radio astronomy and satellite communication. The main goal, however, is to connect all four telescopes to work together as the only stand-alone radio interferometer in the Nordic countries. Depending on funding, the first individual telescopes are expected to be working in 2017, and the "Metsähovi Compact Array" (MCA) interferometer fully operational in 2020-2022.

Hands-on education
The MCA project opens a great variety of hands-on learning opportunities for many disciplines already in the construction phase. It offers a rare opportunity in astronomy, radio

Science with MCA
The MCA supports and expands research done using Metsähovi telescopes. It also

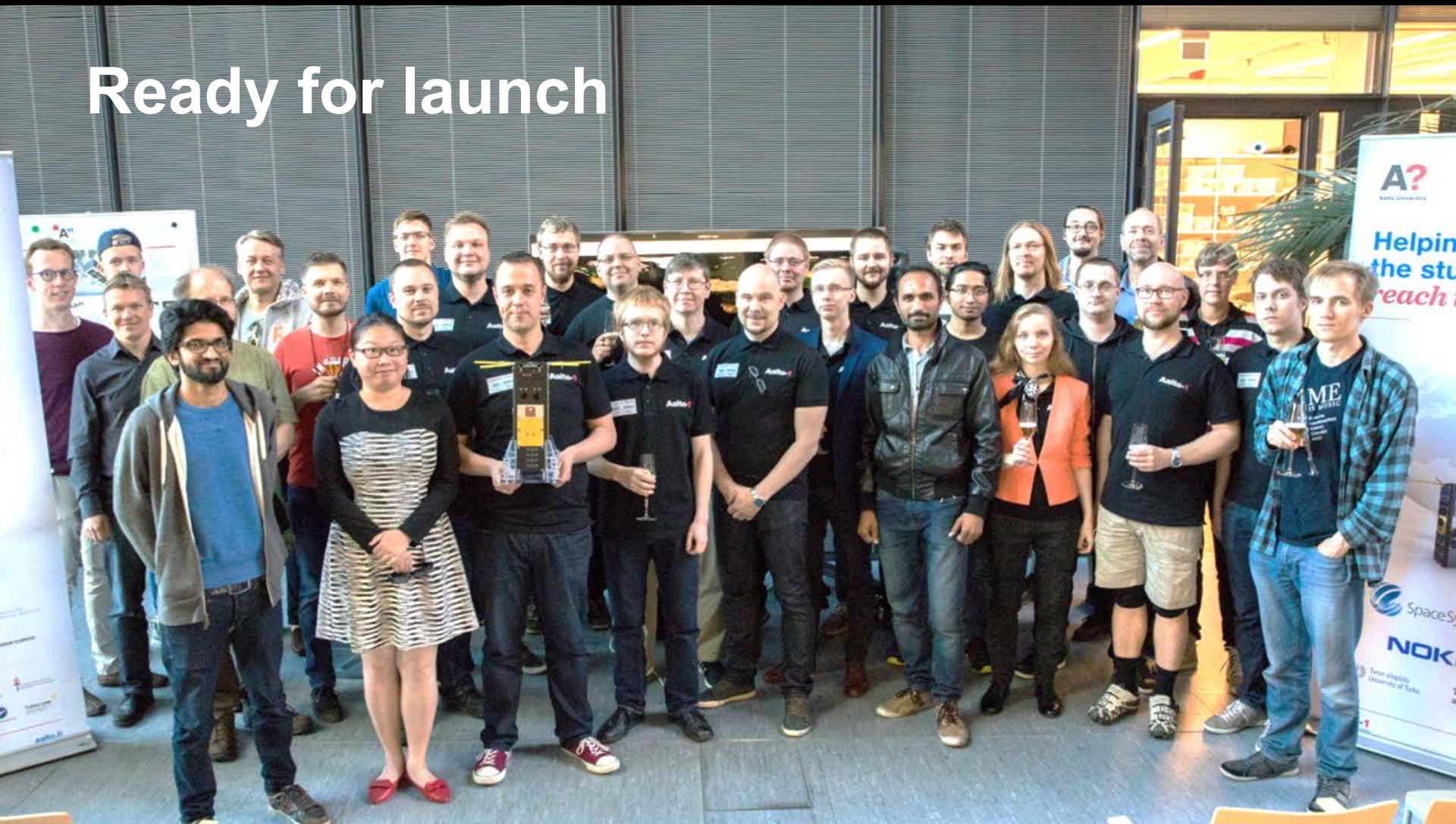
ICEYE

gaining importance on the way

A group of five young men are gathered around a table outdoors, working on a project. The table is covered with various electronic components, including a laptop, a breadboard, and a power supply. One student is pointing at the equipment while others look on. The background shows a brick building and greenery.

Students start new projects

Ready for launch





Making Finnish space history

Aalto-1

- Launch 23th June 2017 03:59 UTC on Indian PSLV-C38
- Deployed 04:22 UTC to 486 x 519 km, sun synchronous inclination 94.45° orbit

NOKIA

SSF



Turun yliopisto
University of Turku

Together
ahead.

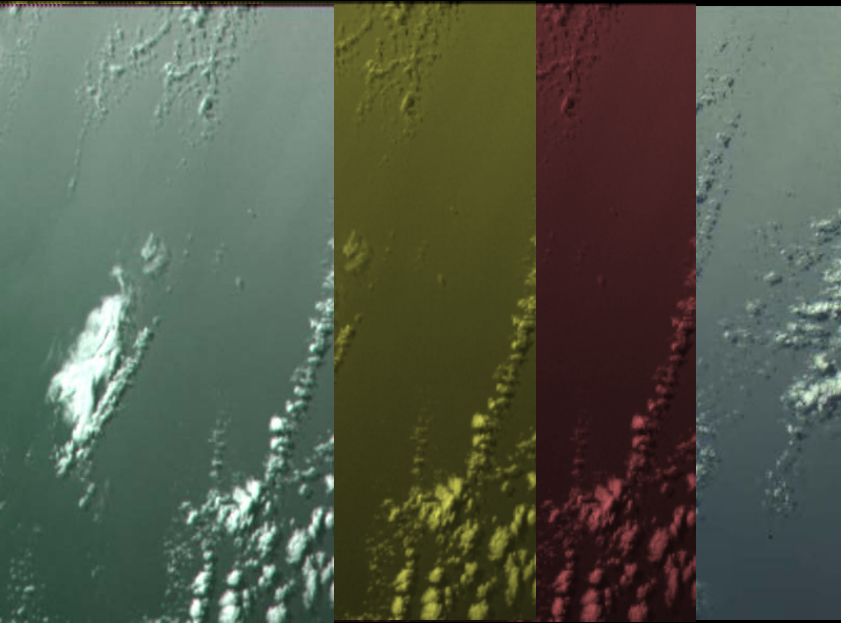
RUAG

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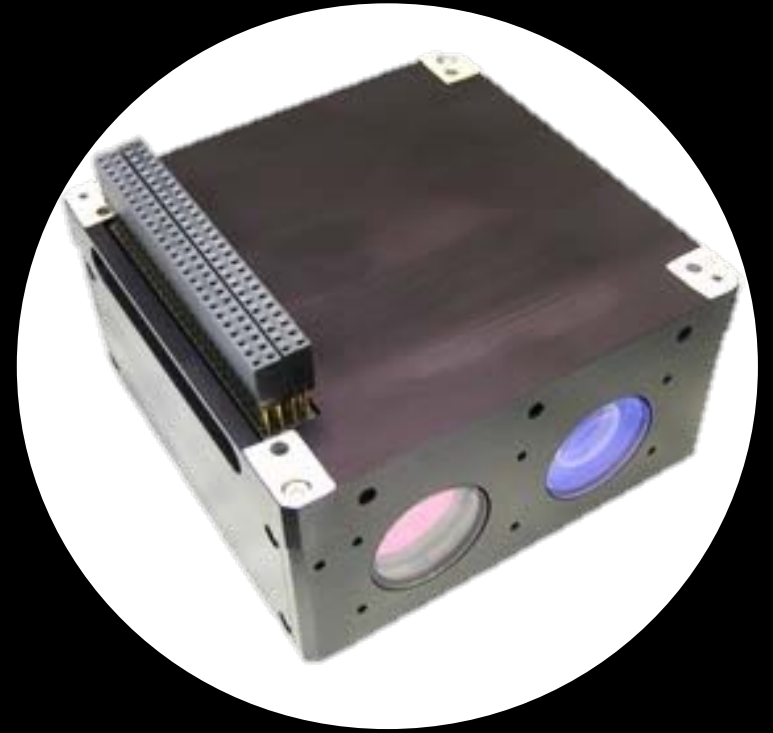


Spectral imager
Mass: 592 g
500-900 nm

New instruments

AaSI

VTT, Finland





EO

First image
516 km over Northern Norway
VIS camera
05.07.2017 09:43 UTC

science

CubeSat influence in Finland

- Finnish Space Law
- Finnish Registry of Space Objects
- New funding program
- Space Agency?
- New generation of doers



Työ- ja elinkeinoministeriö
Arbets- och näringsministeriet



Ministry of Economic Affairs
and Employment of Finland

Avaruusesineiden rekisteri / Register över rymdföremål / Registry of Space Objects

Avaruusesine / Rymdobject / Space Object	Aalto 1	ICEYE-X1
Toiminnanharjoittaja / Verksamhetsutövaren / Operator	Aalto yliopisto	Iceye Oy
Lähtäjättilä (t) / Utsändande stat (er) / Launching State (s)	Suomi / Finland, India / India	Suomi / Finland, India / India
Kansallinen rekisterinumero / National Registernummer / National Registration number	FIN-1-SAT-2017	FIN-2-SAT-2018
Tunniste / Beteckning / Designator	NSSDCA/COSPAR ID: 2017-036L; NORAD Catalog Number: 42775	COSPAR ID: 2018-004D
Avaruusesineen yleinen tarkoitus / Rymdföremålets allmänna syfte / General Function of the Space Object	Aalto-1 is an educational satellite project with mission goal in technology demonstration of three payloads; demonstration of miniature hyperspectral Earth Observation camera; demonstration of miniature radiation monitoring instrument; demonstration of electrostatic deorbiting device.	Experimental satellite, carrying a synthetic aperture radar. Data will be provided commercially.
Laukaisuaika / Tidpunkt för utsändande / Time of launch	23rd June 2017	12th January 2018, 03:59
Laukaisupaikka / Plats för utsändande / Place of Launch	Satish Dhawan Space Centre, Sriharikota, India	Satish Dhawan Space Centre, Sriharikota, India
Laukaisuväline / Uppsändningsanläggning / Launch Vehicle	ISRO PSLV-XL	PSLV-XL C40
Kiertoaika / Omloppstid / Nodal Period	94.71 min	95 min
Kaltevuuskulma / Banplanets lutning / Inclination	97.45°	97.56°
Etäpiste / Apogeeum / Apogee	513 km	511 km
Lähispiste / Perigeum / Perigee	503 km	499 km

A common story for many countries



Launched nanosat



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Where we are now?

WORLD'S LARGEST SAR SATELLITE CONSTELLATION

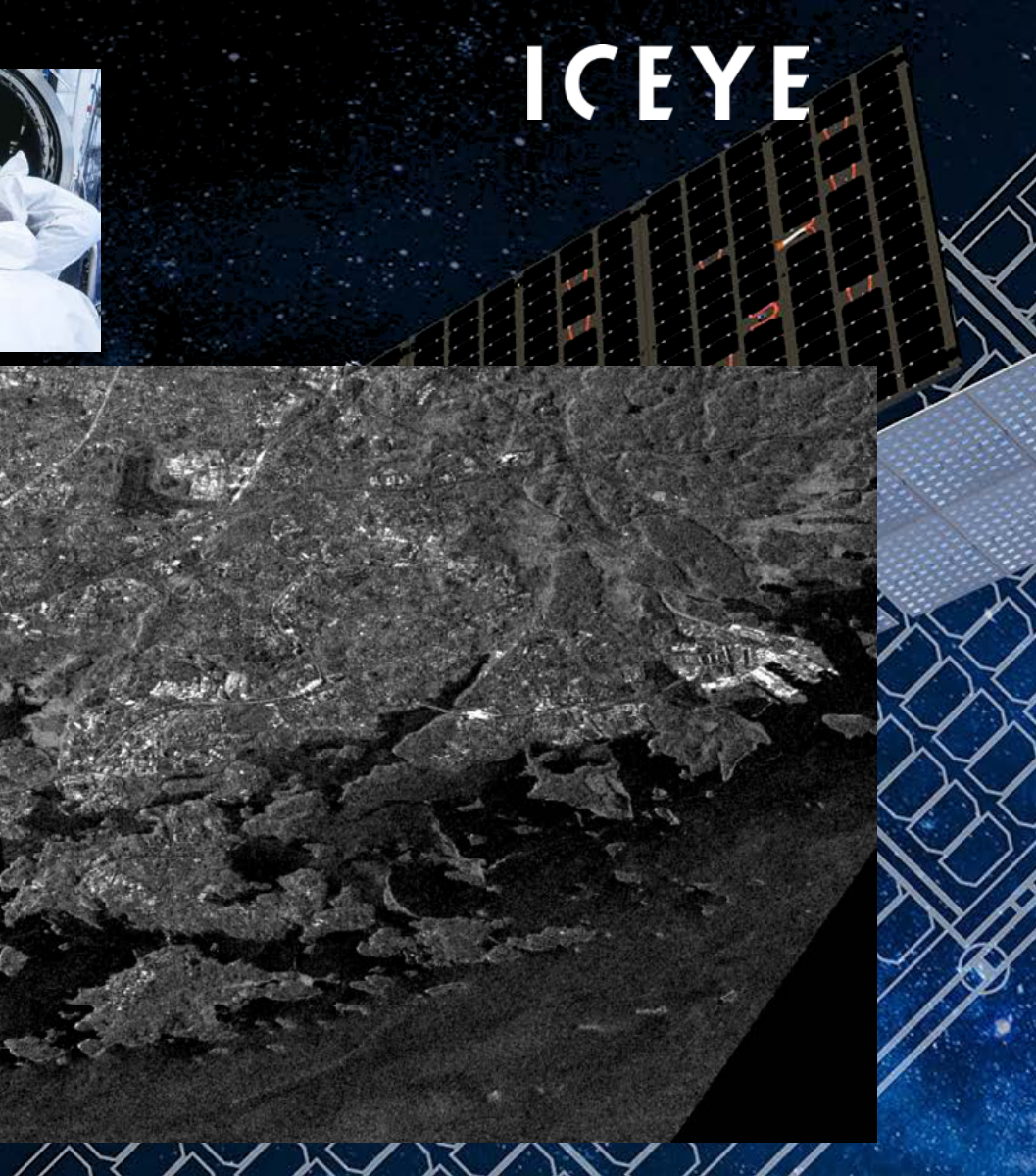
ICEYE

- **3h Response Time** Around the Globe



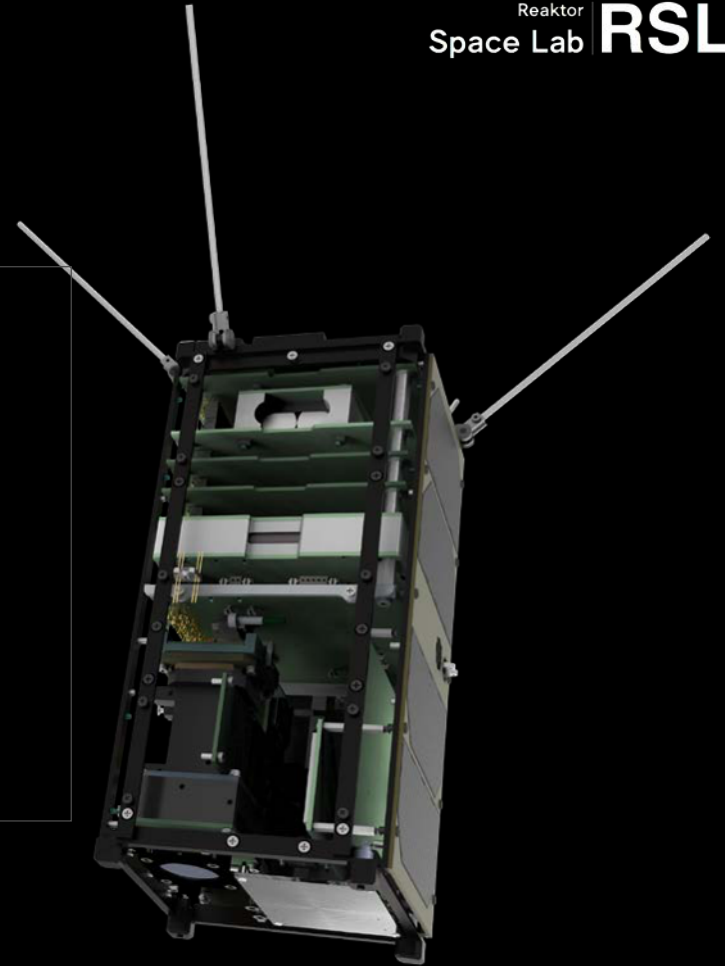
CubeSat generation is grown up

ICEYE

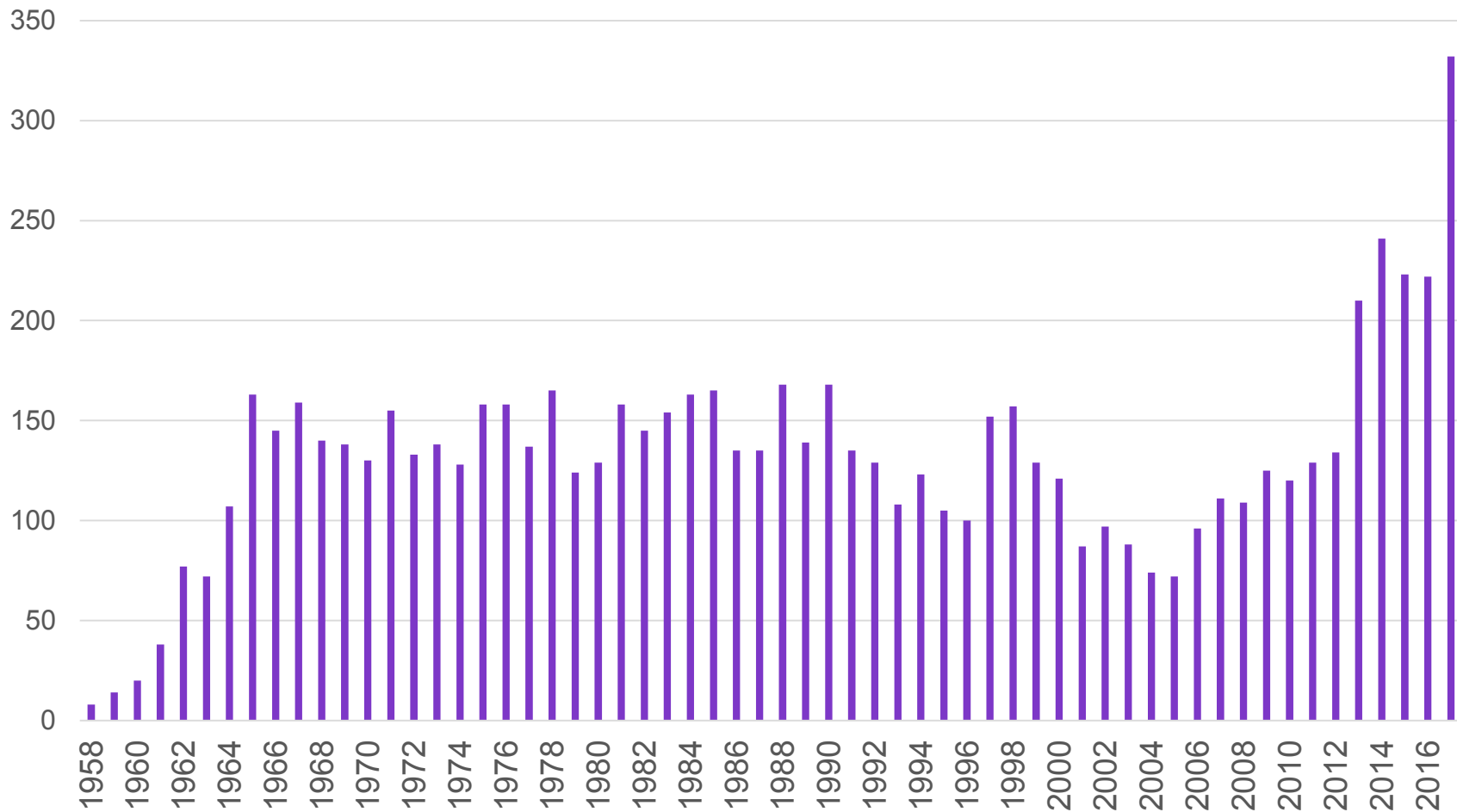


Reaktor Hello World

- 2U CubeSat
- Payload: Hyperspectral SWIR imager
→ Tunable in 1000 – 1600 nm
- Launch: H2/2018



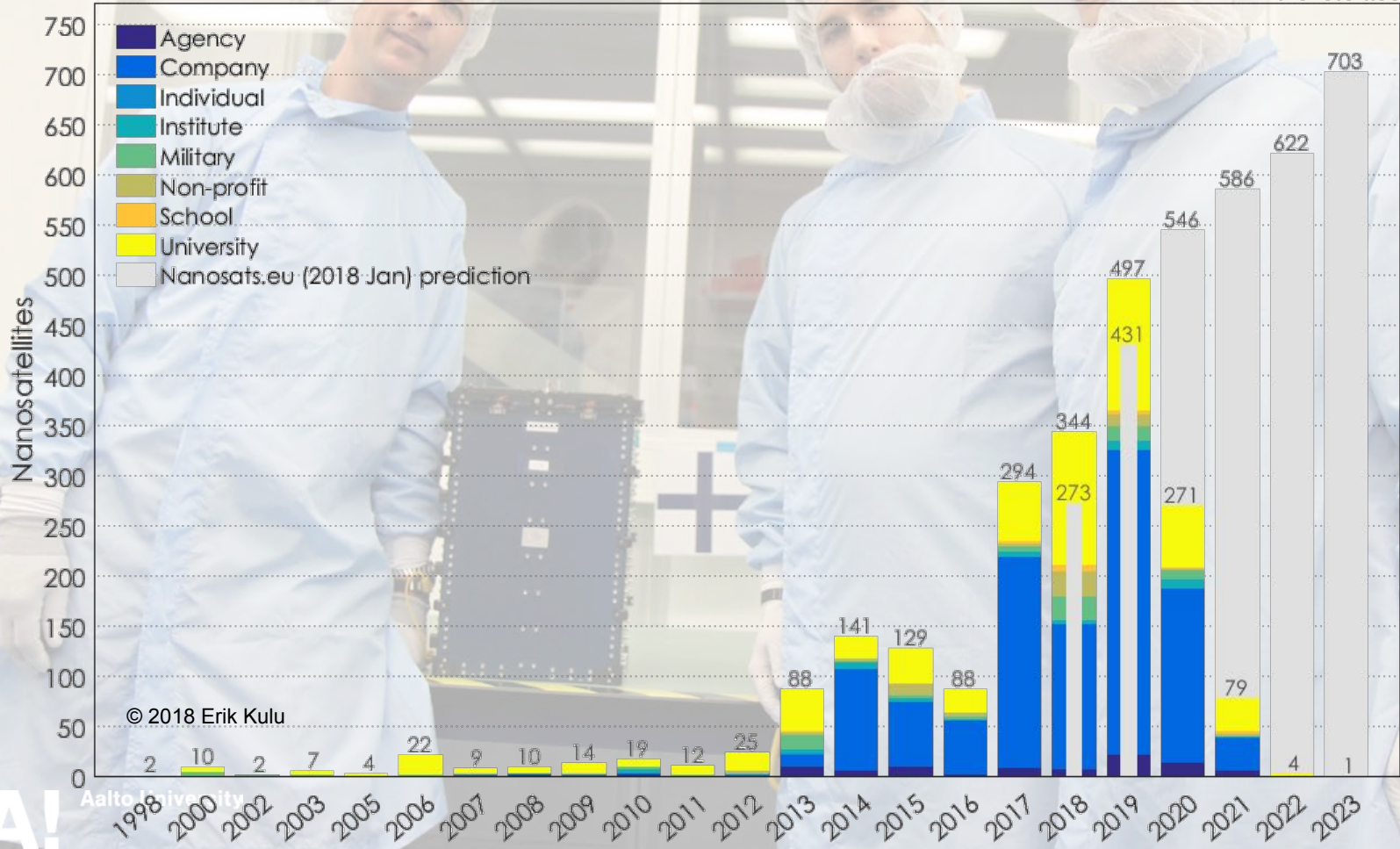
Amount of launched space objects per year (UNOOSA register)



2018/10/28

Nanosatellite launches by organisations

www.nanosats.eu



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CubeSats goes mainstream

Modular scalable

Commercial
satellite platforms

According to nanosats.eu

Nanosats launched: 966

Operational: 459

CubeSats launched: 878

Nanosats destroyed on launch: 86

Most nanosats on a rocket: 103

Countries with nanosats: 58

Companies in database: 323

CubeSat as innovation platform

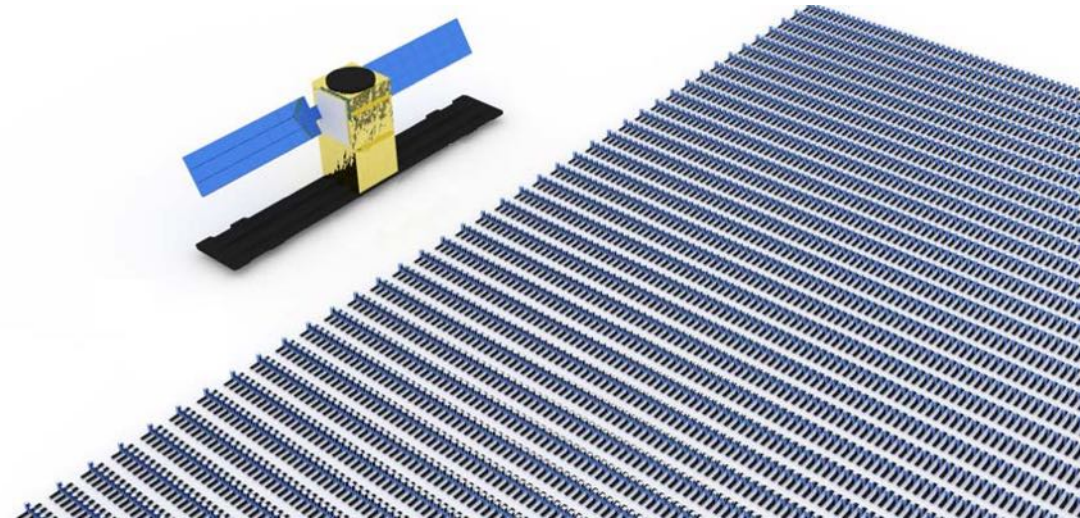
CubeSat has become popular innovation and in-orbit demonstration platform.

Large deployable antennas, telescopes, tethers, radars, spinning radiometers, optical links etc.

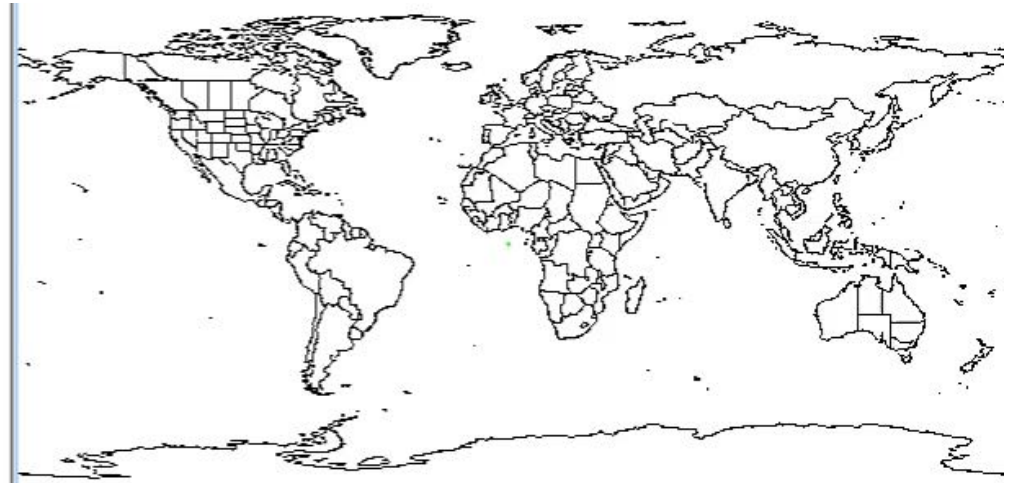
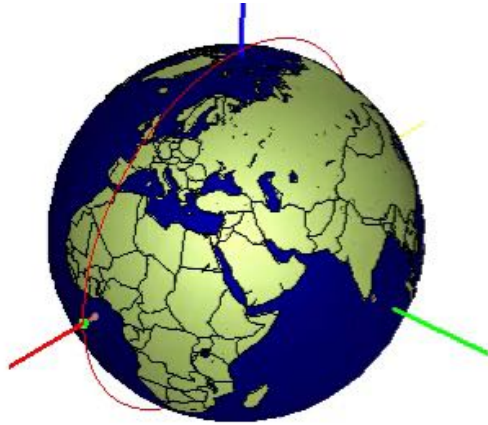
EO Constellations

Low cost small satellites enable large satellite constellations, providing:

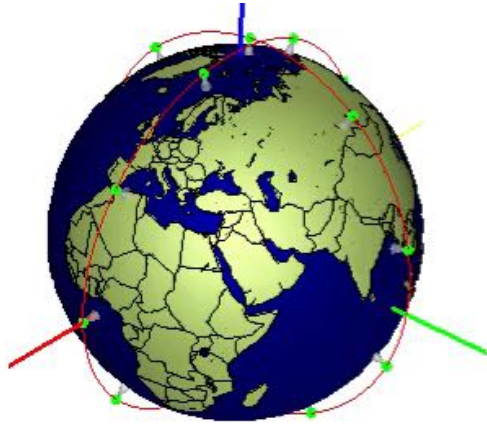
- Affordable global coverage for sensors and communication
- Unprecedented resolution in time and space
- Access to space for small countries and new science



Shift from single satellite observation...



...to observation constellations



Small satellite goes EO business

The image shows two technicians in a cleanroom environment working on a small satellite. They are wearing blue lab coats and hairnets. The satellite is mounted on a metal frame and is partially covered with gold and silver thermal insulation. The background is a clean, white wall with blue acoustic panels.

Revisit time

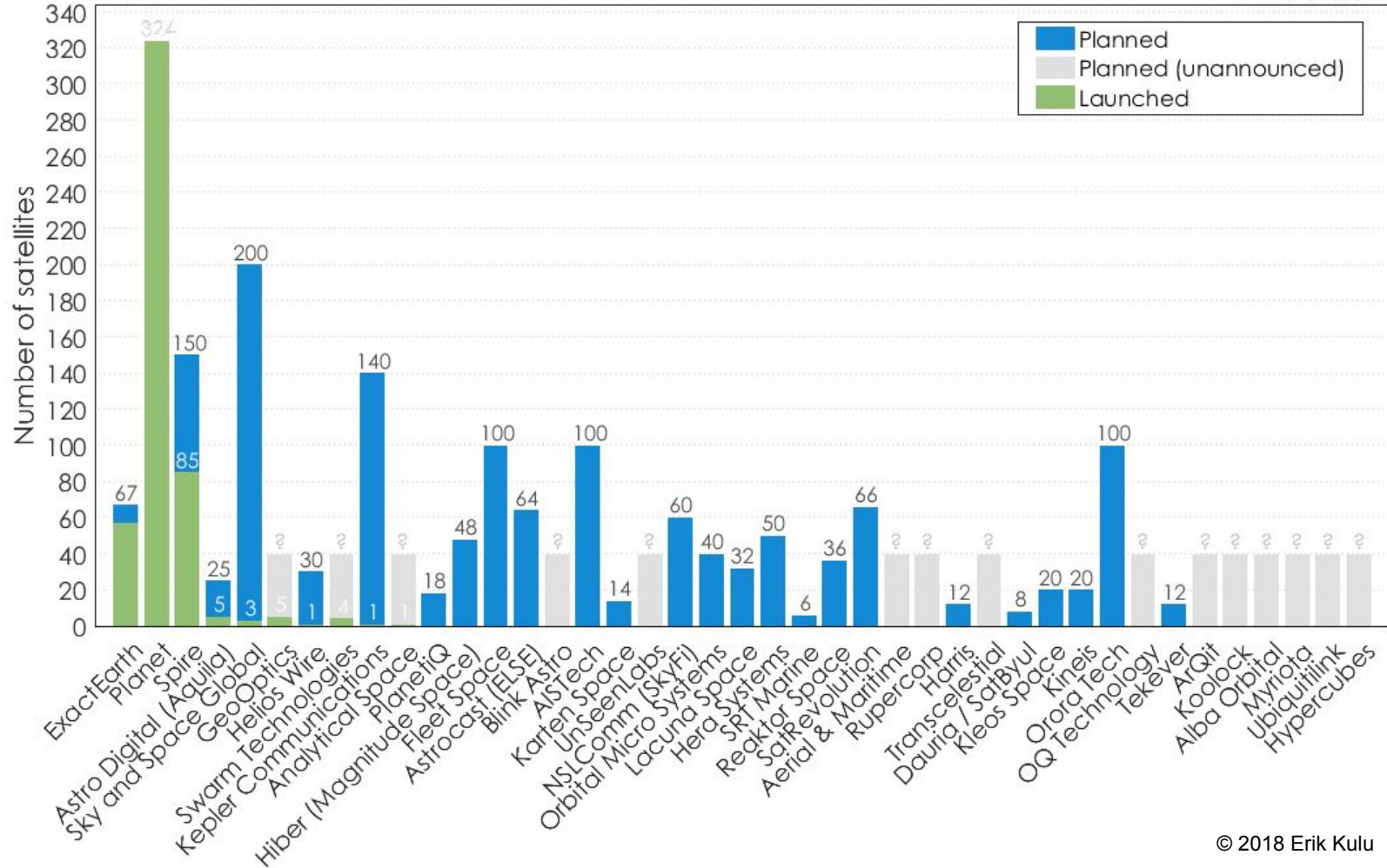
is currently the most important asset in small satellite business proposals.

Small satellites cannot (yet) compete in EO data quality with big satellites.

Nanosatellite constellations

2018/10/28

www.nanosats.eu

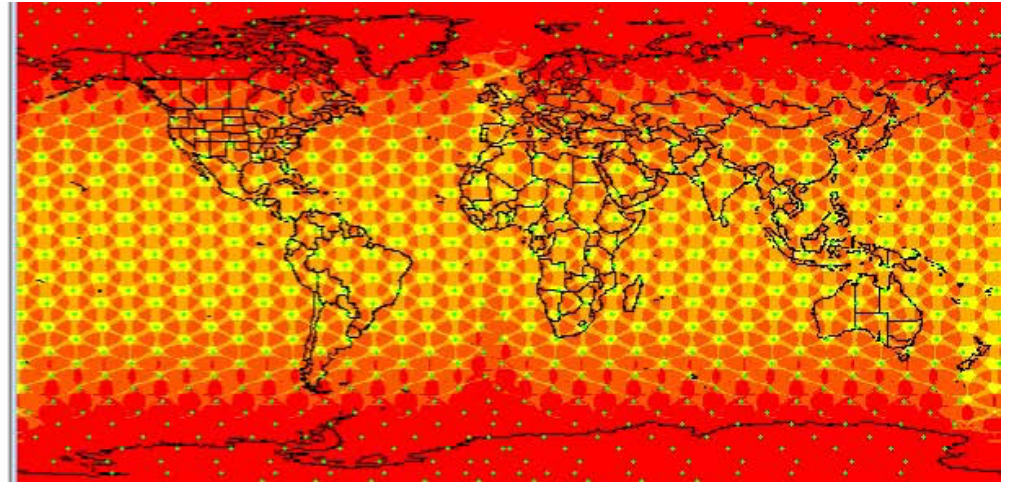
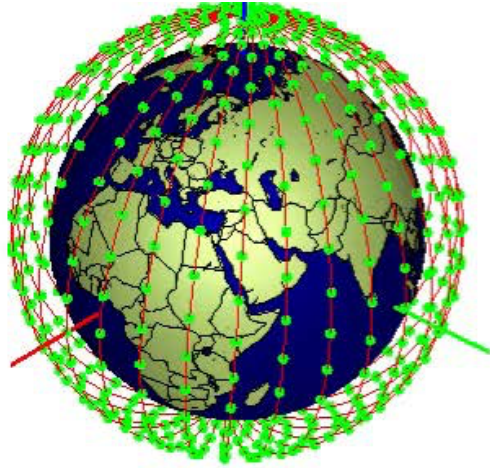


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Towards Earth System sensor network

Earth Observation in real time



Future EO Satellites



Small satellites will grow

Big satellites will shrink

Price will drop

More observation parameters

- **channels, angles, bands, bandwidths, frequencies, resolutions**

Shorter revisit

Higher resolution

Multi parameter observations

Advanced microwave

Companion satellites

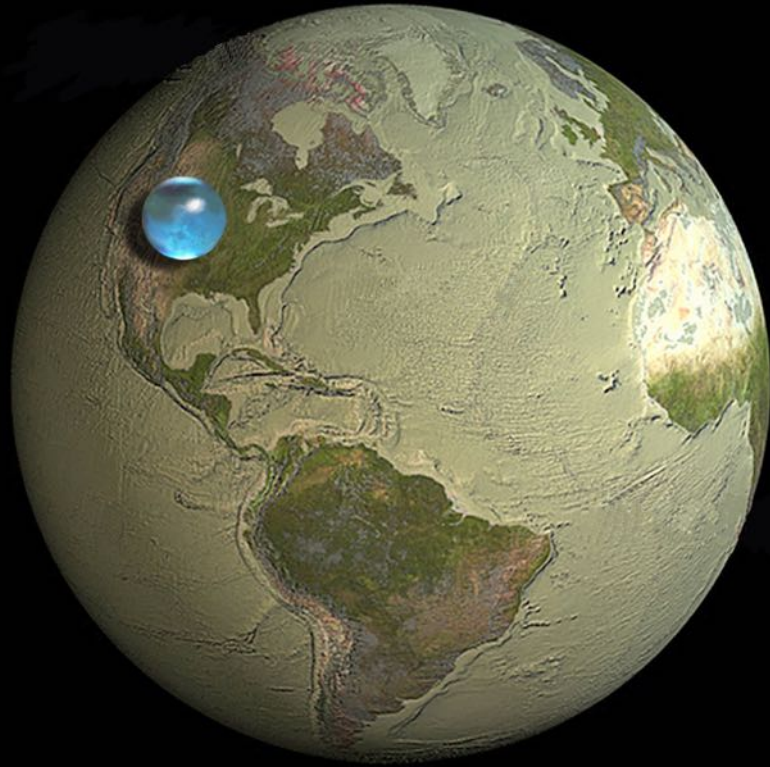
Multi-level autonomous collaboration between sensor platforms

Automated AI based decision making

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**Why do we need so
many satellites?**



Additionally to our fields,
we need to garden our
OCEANS



Additionally to our fields,
we need to garden our
OCEANS and
ATMOSPHERE



Additionally to our fields,
we need to garden our
OCEANS and
ATMOSPHERE.

This is the only way to
sustain civilization for 10
billion people.

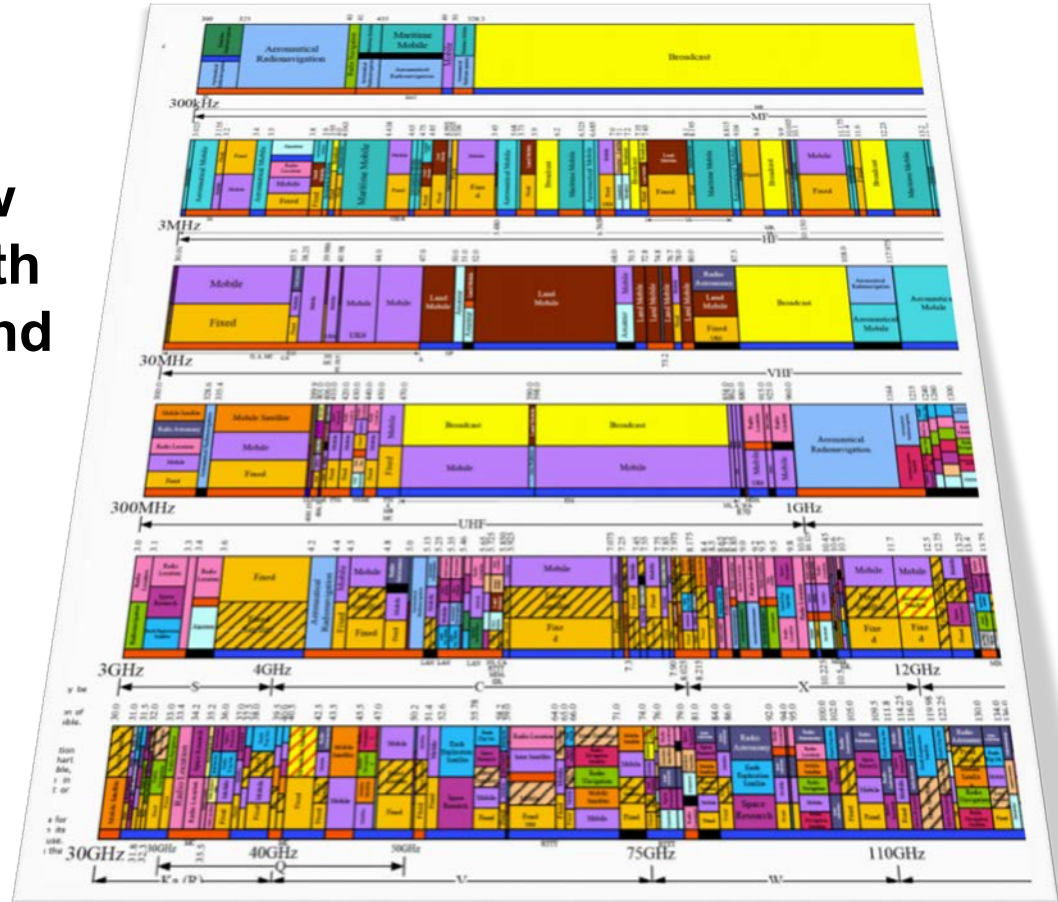
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Challenges to tackle

Radio Frequency Allocations

It is difficult to secure new satellite constellations with needed communication and imaging frequencies.



Radio Frequency Interference

Radio Frequency Interference hampers increasingly microwave measurements.

Space Debris

A satellite view of Earth's atmosphere, showing a dense field of space debris. The debris includes various pieces of metal, plastic, and other materials, some of which are large and clearly visible, while many others are small and scattered throughout the atmosphere. The Earth's surface is visible on the left side, showing blue oceans and white clouds.

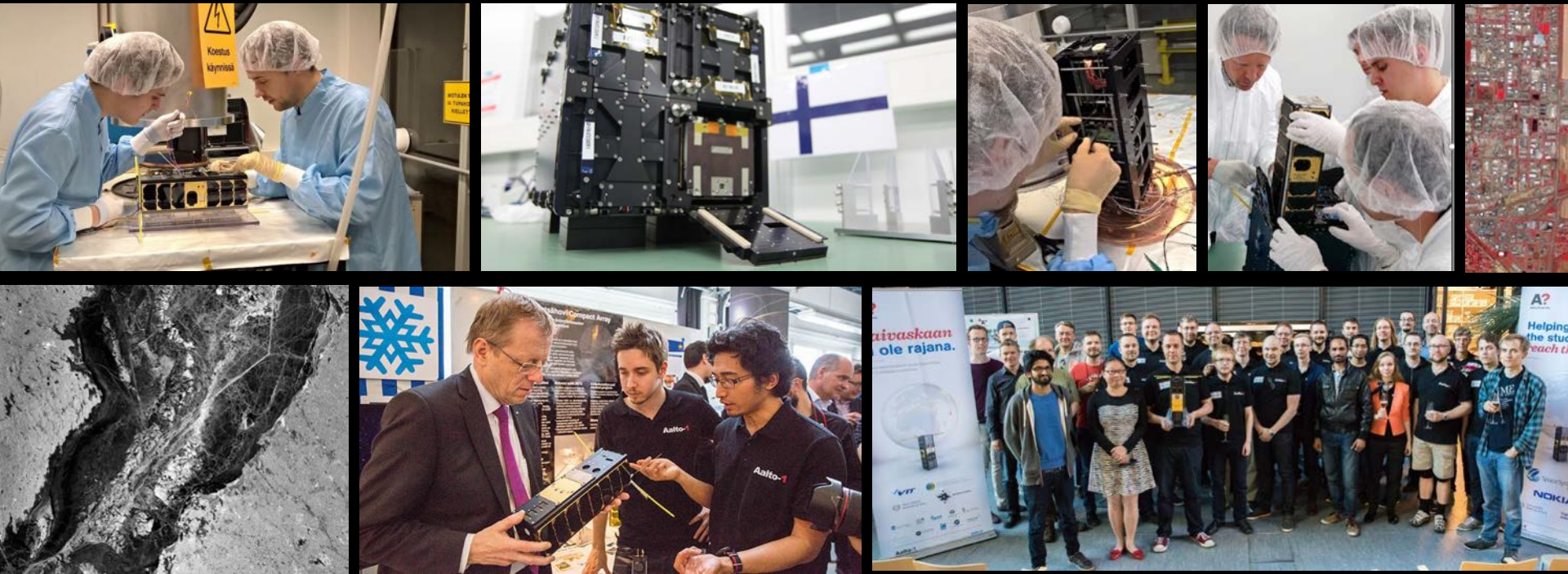
Increasing amount of debris is a serious problem for future business and science.

More affordable launches

Launching constellations to many orbital planes is still very expensive



We shall keep the next generation exited about space and EO!



Thank you for your attention!

Welcome to <http://spaceworkshop.fi>, the biggest New Space happening in the region.





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Engineering



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