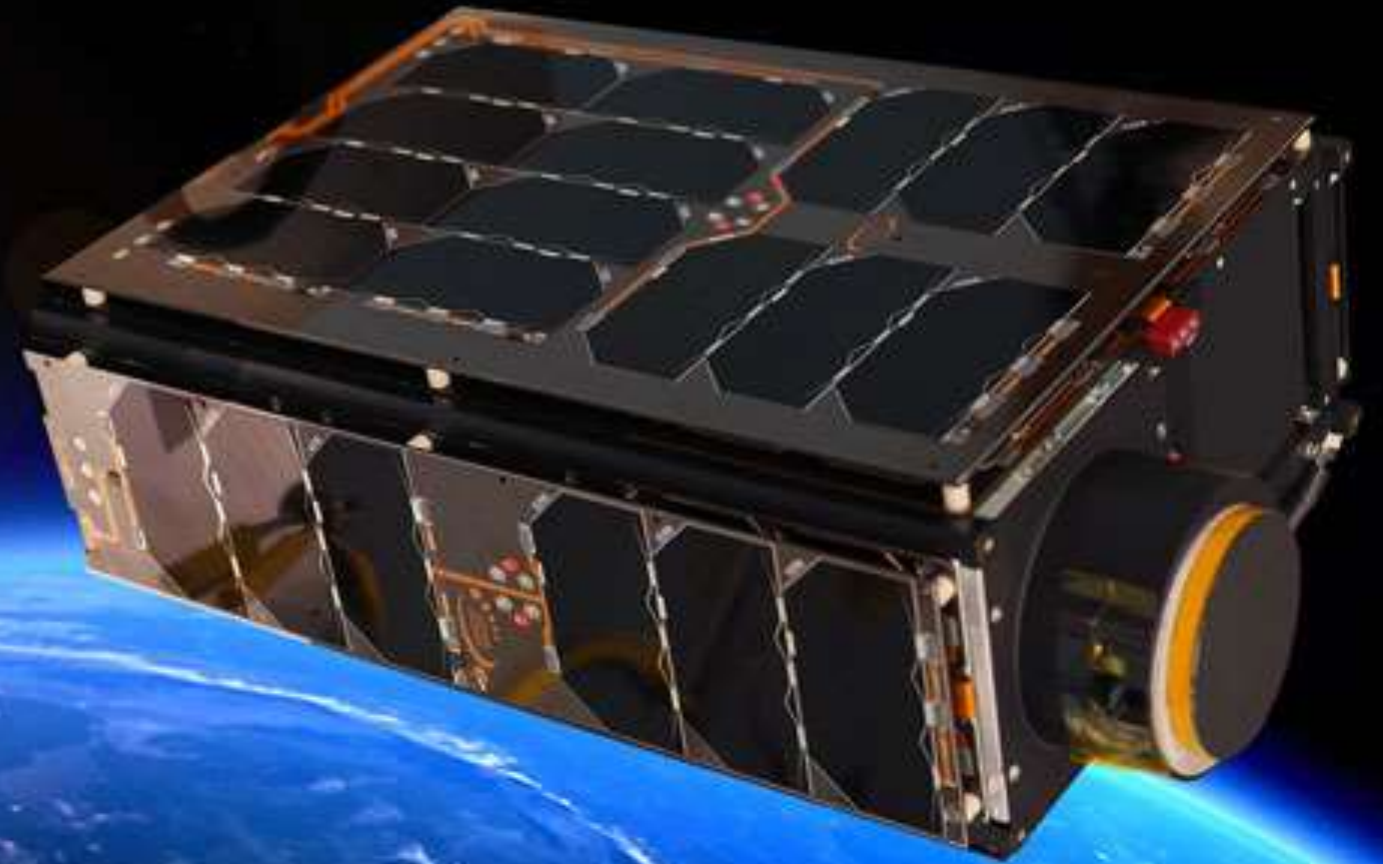




ISIS – Innovative Solutions In Space
SpaceTech Event – June 2019 - ESTEC

TURN-KEY MISSIONS FOR CUBESATS



Jeroen Rotteveel

- MSc Aerospace Engineering (1999 – 2006)
- Co-Founder & CEO of ISIS (2006 - ...)
- Chairman of SpaceNed (2016 - ...)
- Starwars Fan (198# - December 12, 2017)
- Lego Collector (1985 - ...)
- Space Professional / Nerd / Geek / what-have-you
- Treasurer of AMSAT-NL (2010 - ...)
- Treasurer of Delfi-Foundation (2009 - ...)

- And many **more...**



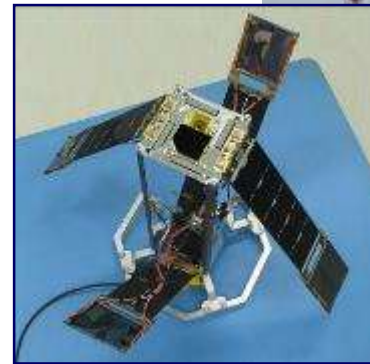
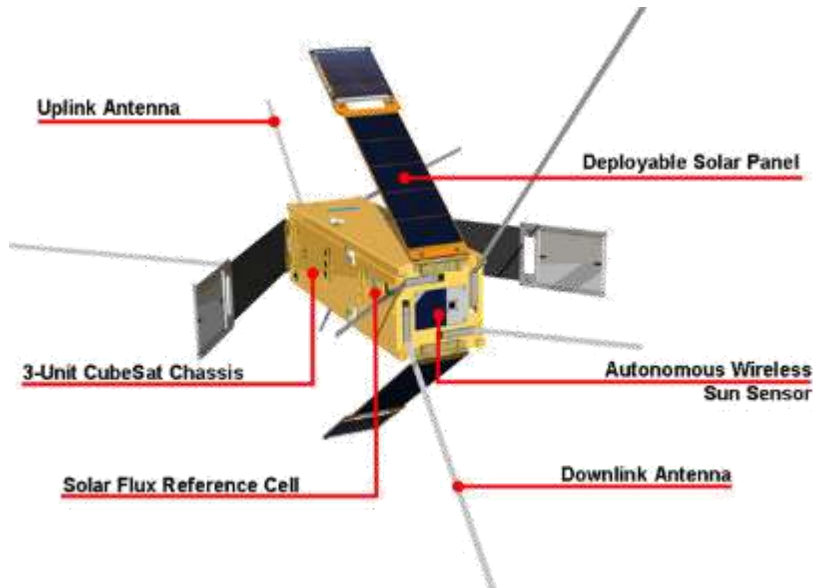
A long time ago...



A long time ago...

November 2004 - Delfi-C3 Starts

- 4th Dutch Satellite after ANS, IRAS and SlosSat
- 1st Dutch university satellite to be actually launched in to orbit (28 April 2008)
- Project largely run by students
- Industry payloads



Delfi-C3 Students at work



April 2005 – the idea was born



January 6, 2006 – ISIS founded



Young Entrepreneur Ruimtevaart
Delftse branie brengt doorbraak
in markt voor kleine satellieten

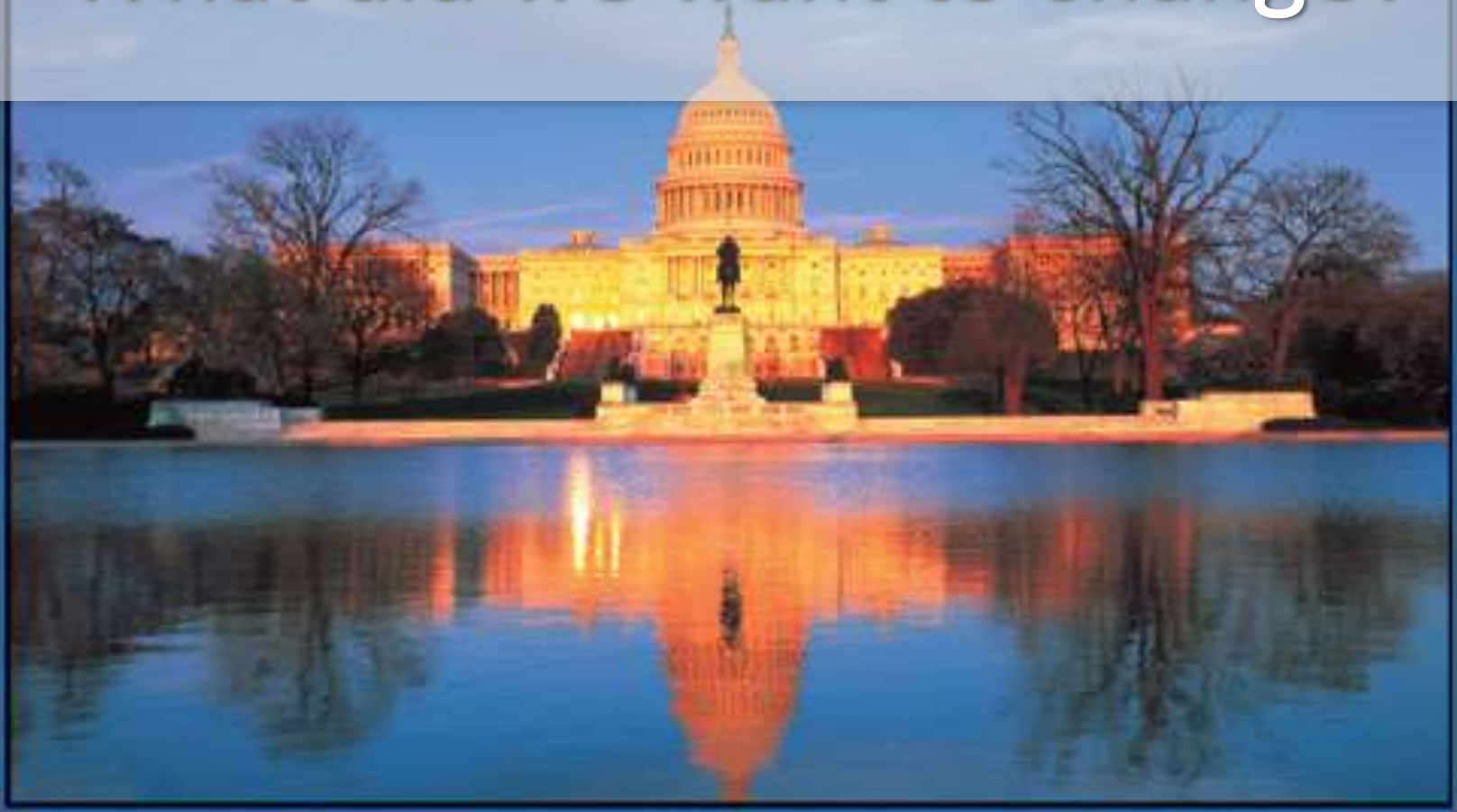
Why start a space company?

The best way to become a millionaire in the space business is to start as a billionaire...

... space is a great way of losing a lot of money real fast....



What did we want to change?



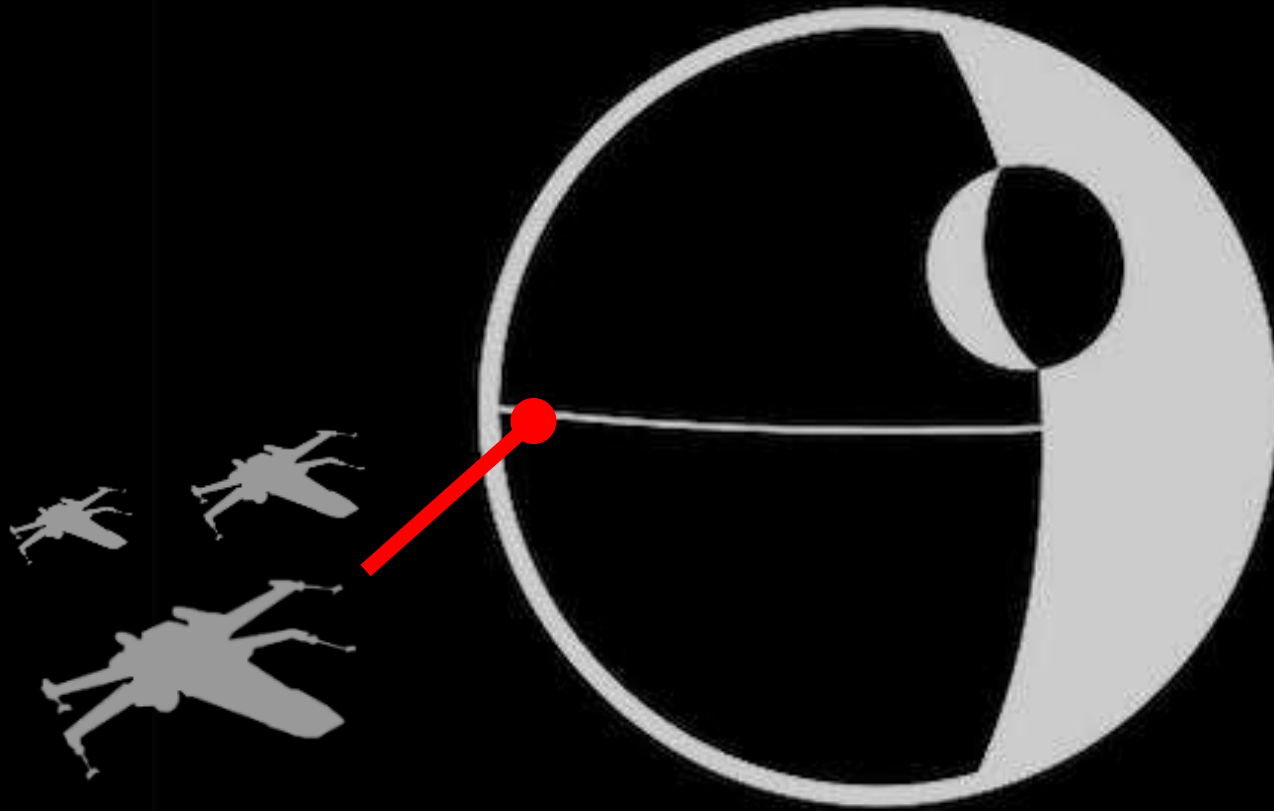
GOVERNMENT

IF YOU THINK THE PROBLEMS WE CREATE ARE BAD,
JUST WAIT UNTIL YOU SEE OUR SOLUTIONS.

What did we want to change?



What did we want to change?



TOO BIG TO FAIL



Small is beautiful...

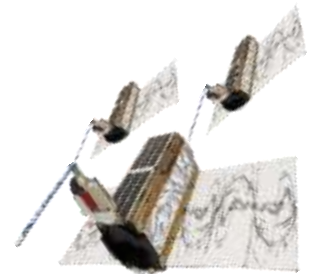
Delfi-C3



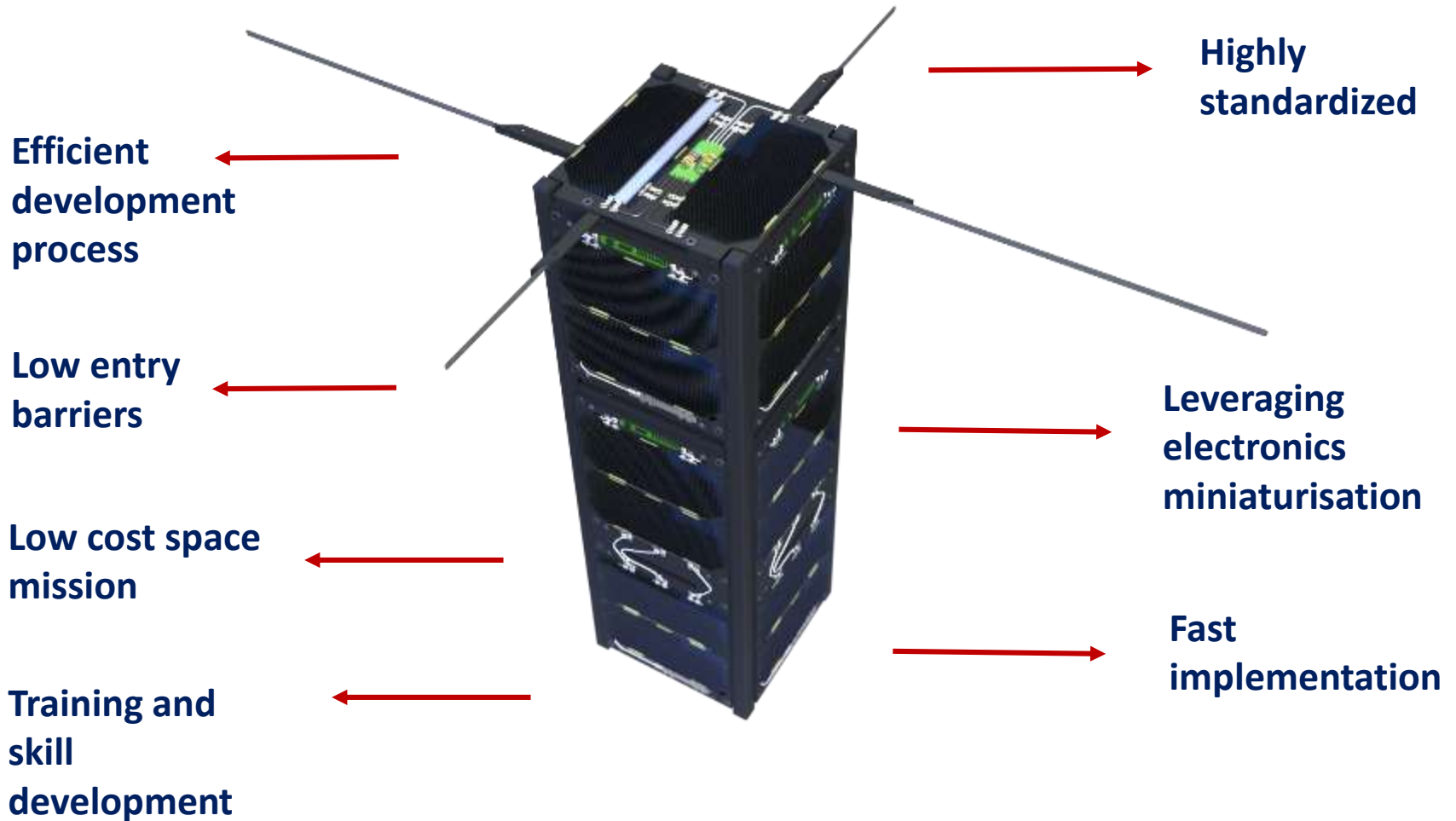
Envisat (ESA)



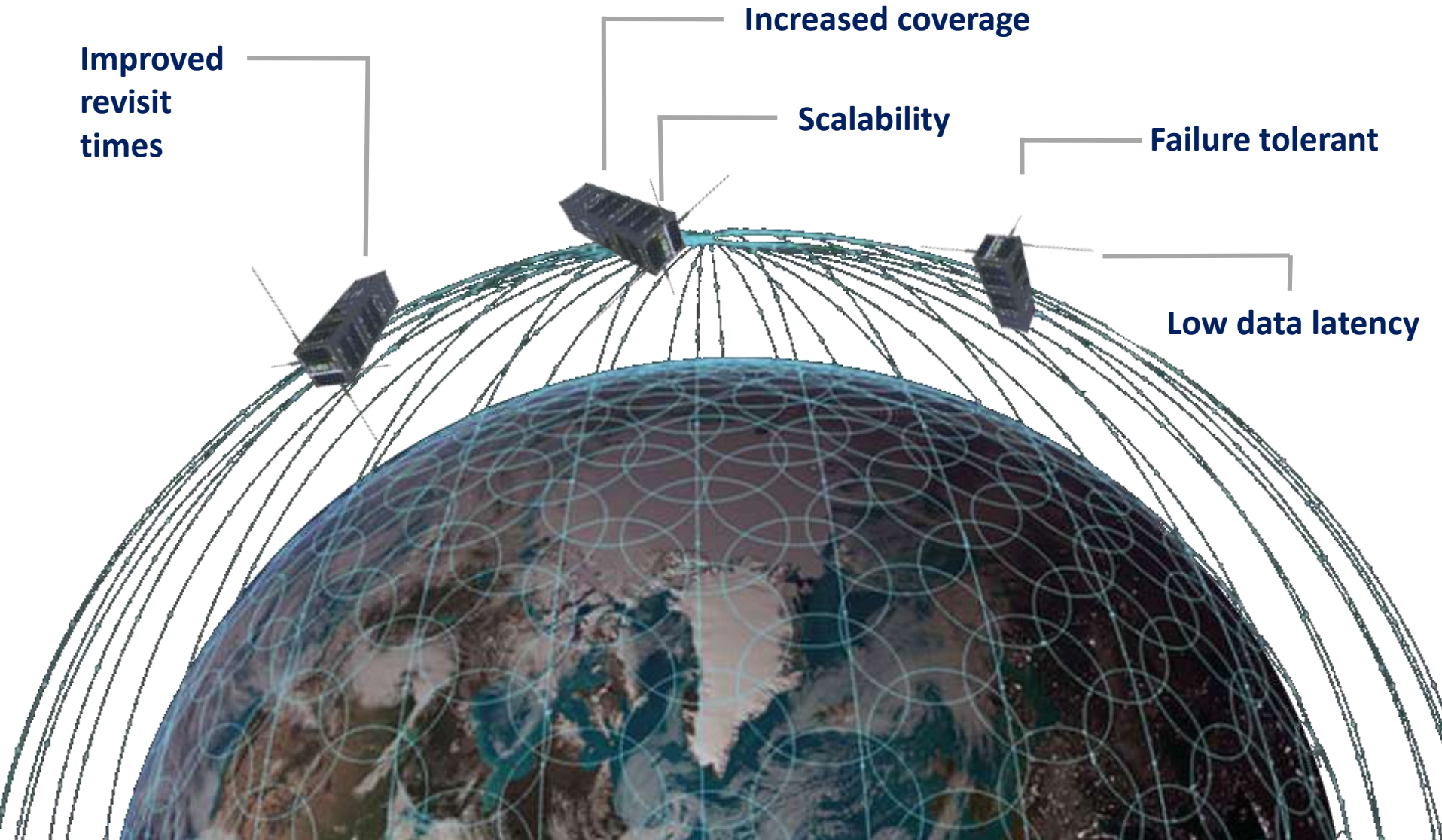
Nanosatellites as disruptive innovation



Advantages of a **nanosatellite**



Advantages of many nanosats



Applications and services

Nanosats enable multiple applications



Nanosatellites and CubeSats modular spacecraft



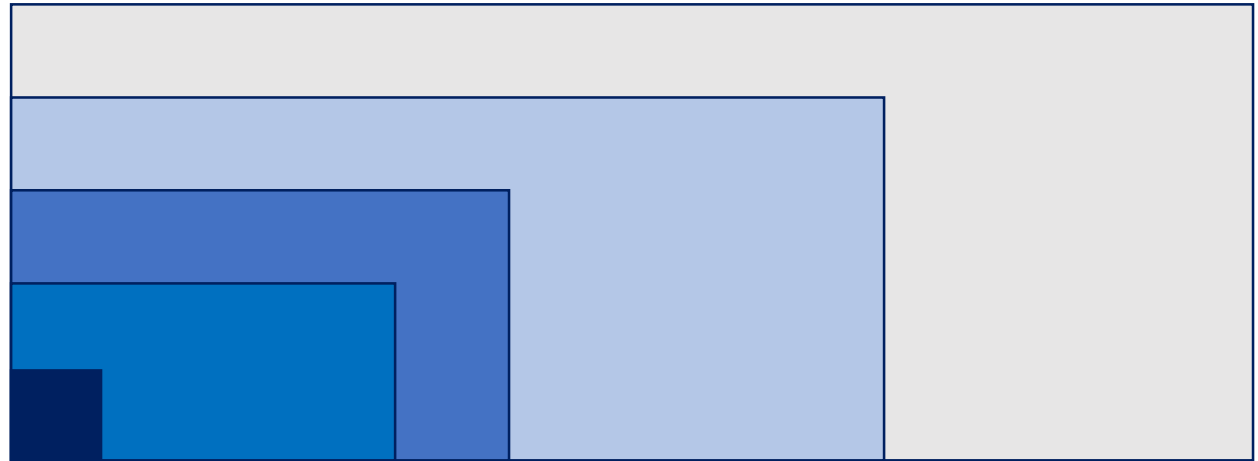
< 100 kg Microsat

< 50 kg Small Microsat

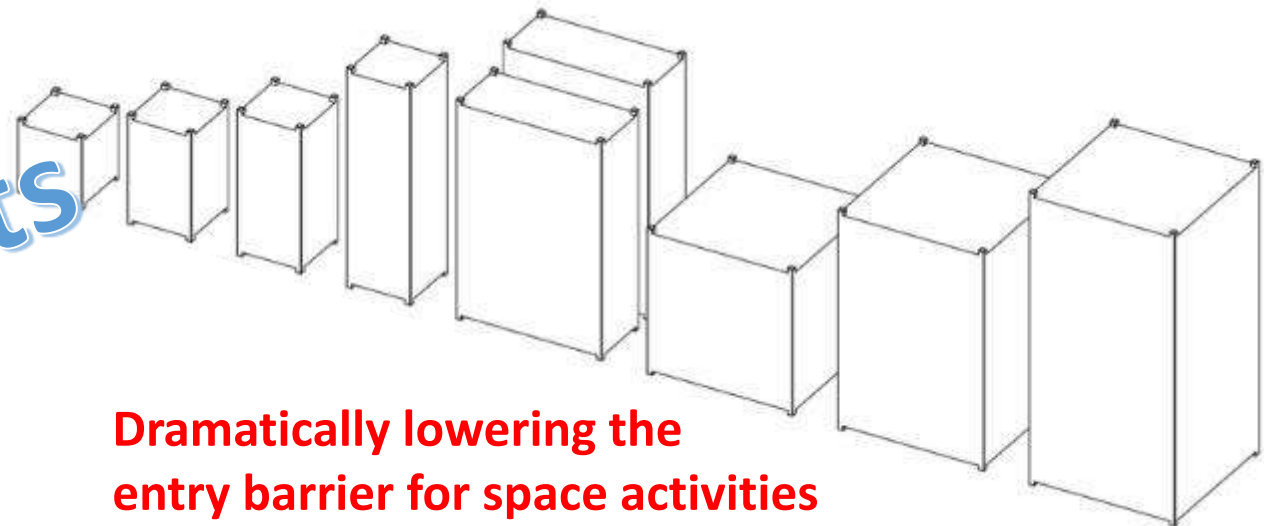
<24 kg Large Nanosat (12U
CubeSat)

<10 kg Nanosat (6U CubeSat)

<1 kg Picosat (1U CubeSat)



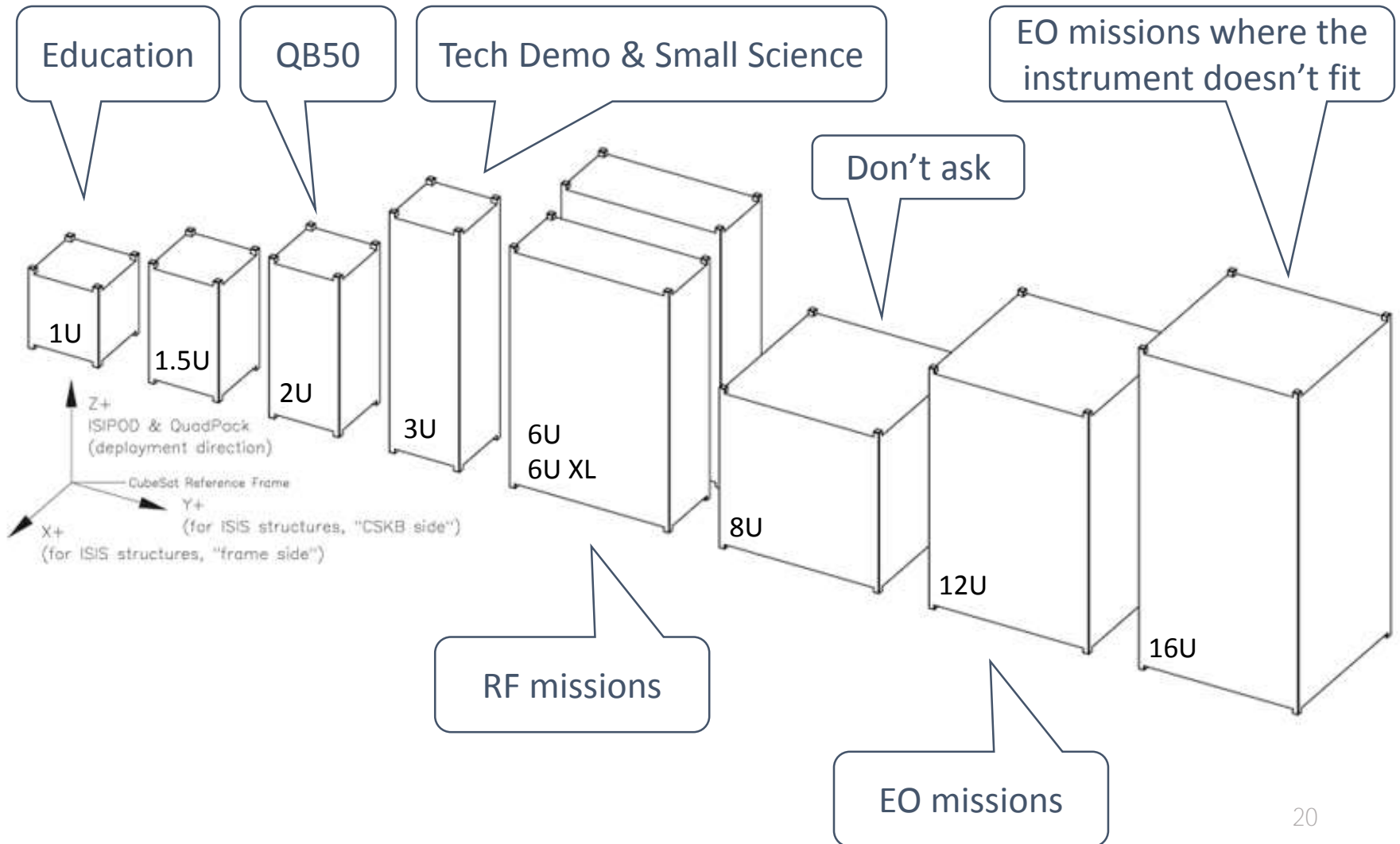
CubeSats



**Dramatically lowering the
entry barrier for space activities**

CubeSat Sizes and Mission Classes

Form follows function...

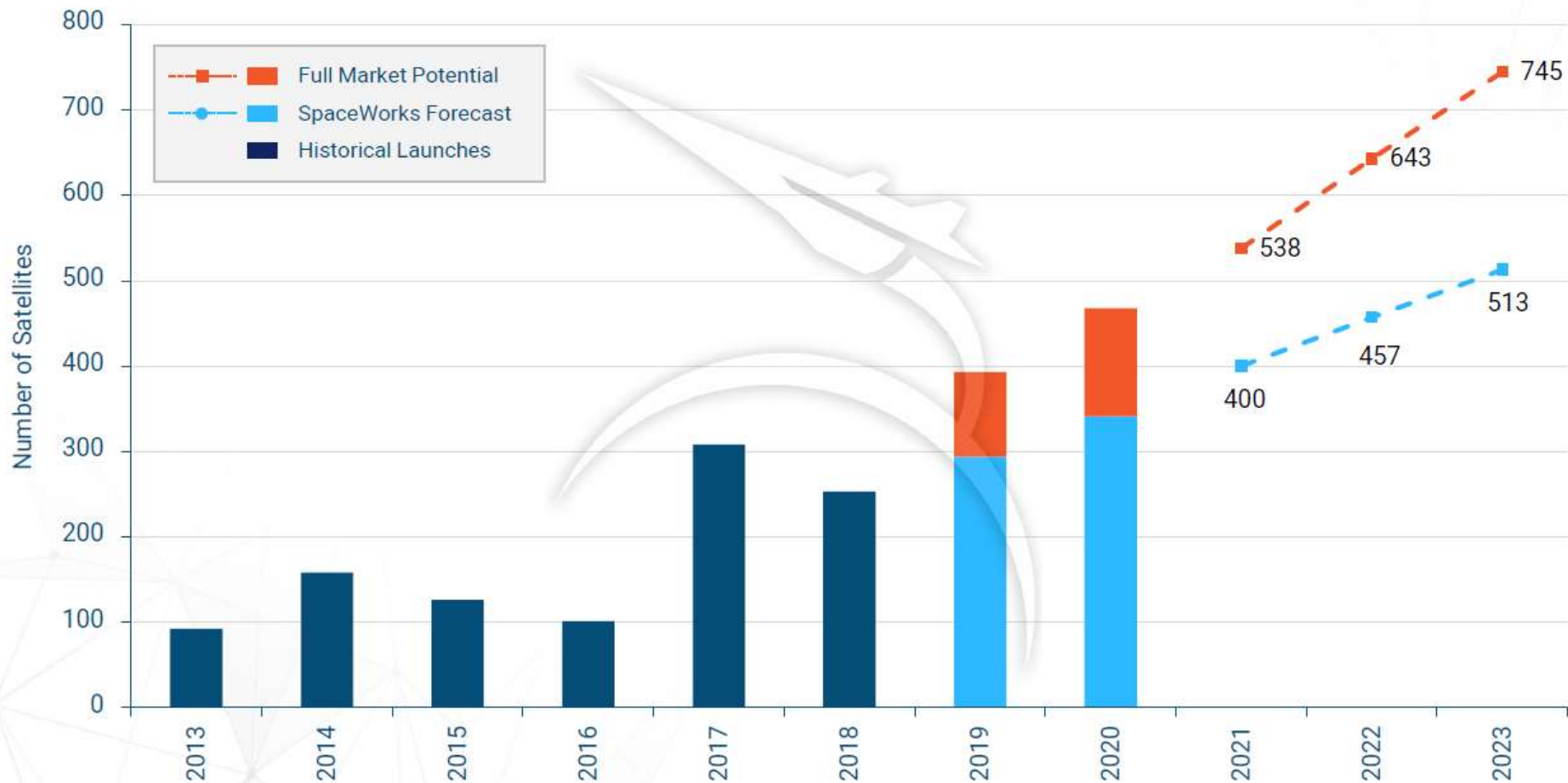


Galactic Domination &
Planetary Assimilation



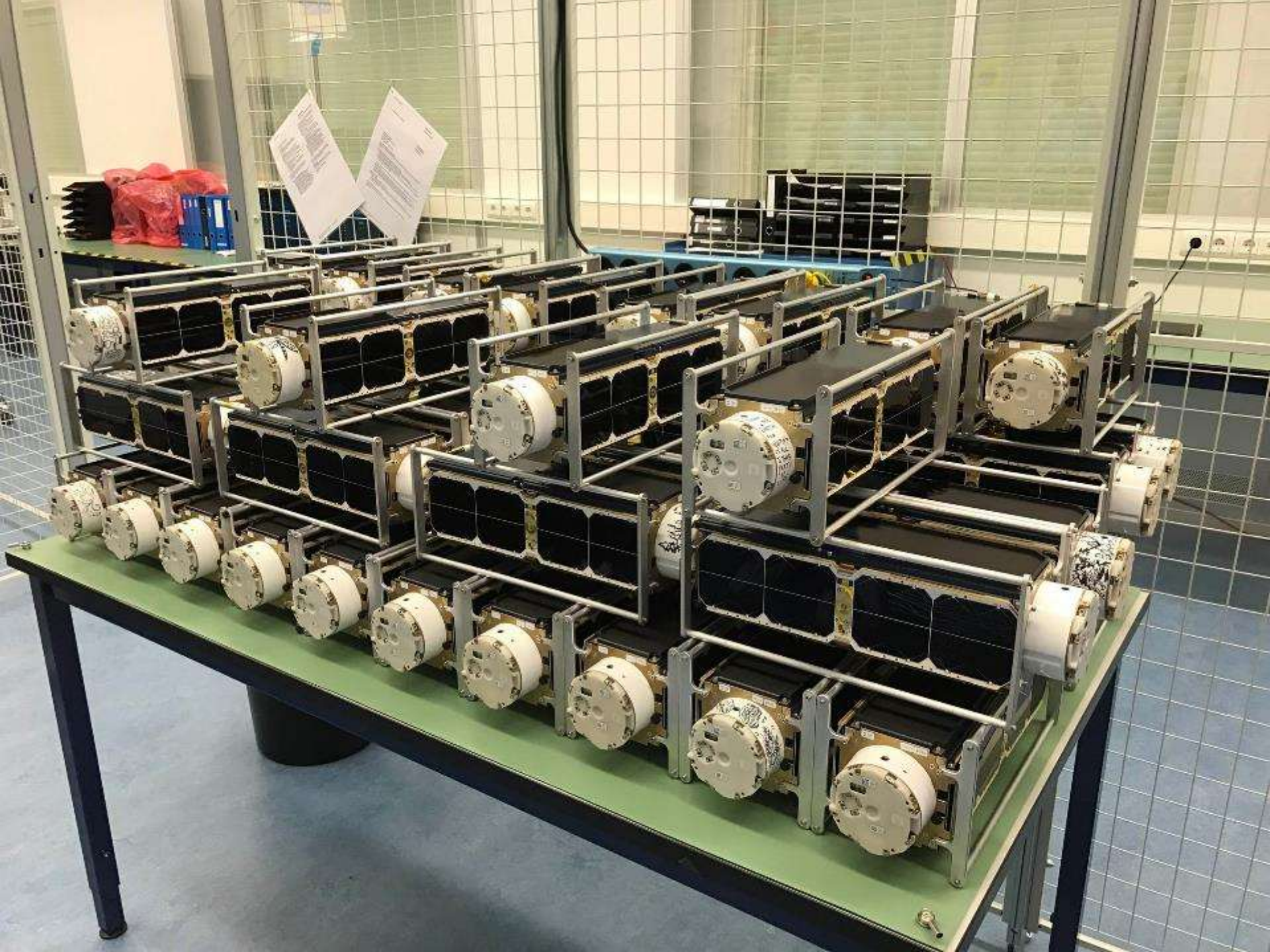
27×10^9 Unit CubeSat

A growing market for nanosatellites (spaceworks commercial)



The space sector is changing out of the laboratory, into the factory







ISIS – Innovative Solutions In Space

Facts & Figures

13 

YEARS IN SPACE

90 


EMPLOYEES

76 

CUBESAT PRODUCTS AVAILABLE

2 

SPIN-OUT COMPANIES

335 

SATELLITES LAUNCHED

6 JAN 2006 TO DATE

11 

NUMBER OF SATELLITES CURRENTLY OPERATED/MONITORED FROM OUR CONTROL ROOM

1kg  25kg 

LIGHTEST SAT HEAVIEST SAT

5 

LONGEST DURATION ISIS SATELLITE IN ORBIT (YEARS)

300 

ANTENNAS DELIVERED

25 

GROUND STATIONS DEPLOYED



15 February 2017
World record of integrating 101 satellites on a single rocket



More information on www.isispace.nl

Recent Highlights

Some ISIS group achievements from the last year

Strategic teaming with research institutes



Sent a science payload to far side of the moon



Royal Dutch air force as a customer

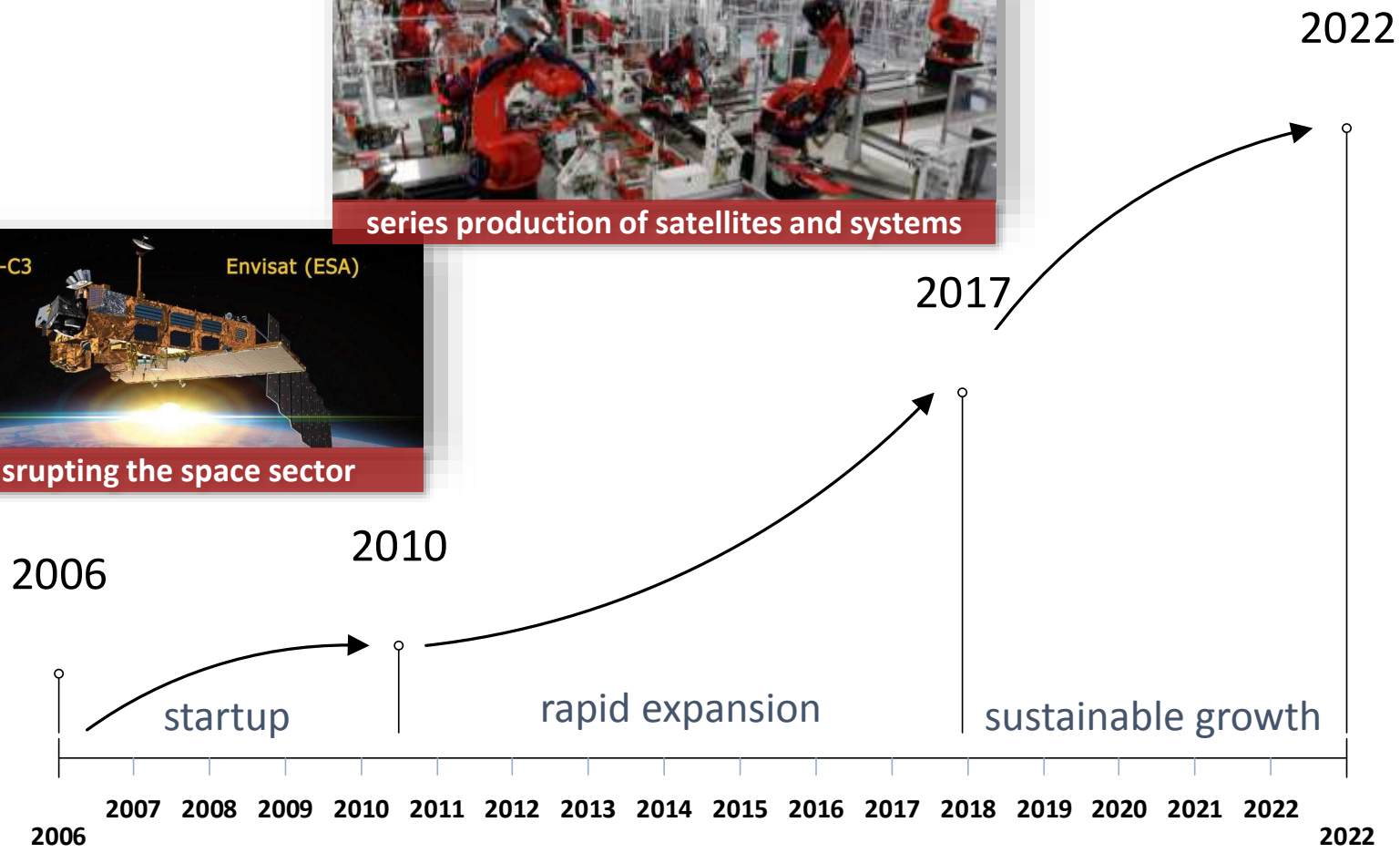
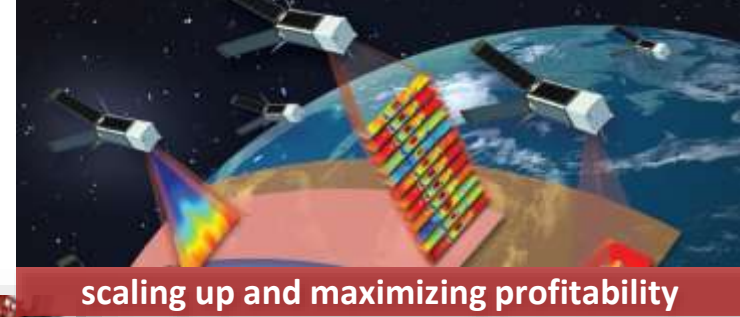


Commercial customer for IoT satellites



ISIS growth path

From 2006 to 2022





FunCube-1 /

Educational

In operation (2013)



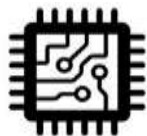
- Amateur CubeSat
 - Designed, built and financed by volunteers and supporters of AMSAT-UK and AMSAT-NL
- Education outreach for space science
 - Carry a material science experiment
- UHF to VHF Transponder payload embedded

■ 1U CubeSat mission

- 1st satellite with a primary mission of educational outreach
- 1st 1U CubeSat with a linear transponder



ISIS involvement:





- 1st mission goal
 - Demonstrate Piezo actuated optical bench with FBG interrogator in space
- 2nd mission goal
 - Demonstrate Piezo-electric power generation in space
- 3rd mission goal
 - Demonstrate novel CubeSat avionics

■ 3U CubeSat mission

- Flight project sponsored by EC FP7, completed June 2017
- First NL CubeSat fully operated under NL Space Law on commercial frequencies
- Successfully flight qualified new CubeSat power system

ISIS involvement:





- 1st mission goal
 - Proof of concept for in-situ micro-g research
- 2nd mission goal
 - Perform end-to-end operations validation
- 3rd mission goal
 - Perform a set of microgravity experiments

■ 3U CubeSat mission

- Payload samples to be temperature controlled throughout the mission
- In-situ analysis of experiment samples
- Achieved 3-axis pointing (coarse) with magnetic actuation only

ISIS involvement:



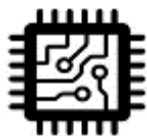


- Measure the Earth thermal radiation budget
 - Study the average Earth thermal balance over a year
- Technology demonstration
 - KUL ADCS for fine pointing with star tracker and reaction wheels

■ 3U CubeSat mission

- Same instrument to measure both the incoming solar flux and the emitted Earth flux
- Project developed under the supervision of ESA technical experts
- Partnership with amateur radio community, transponder included

ISIS involvement:



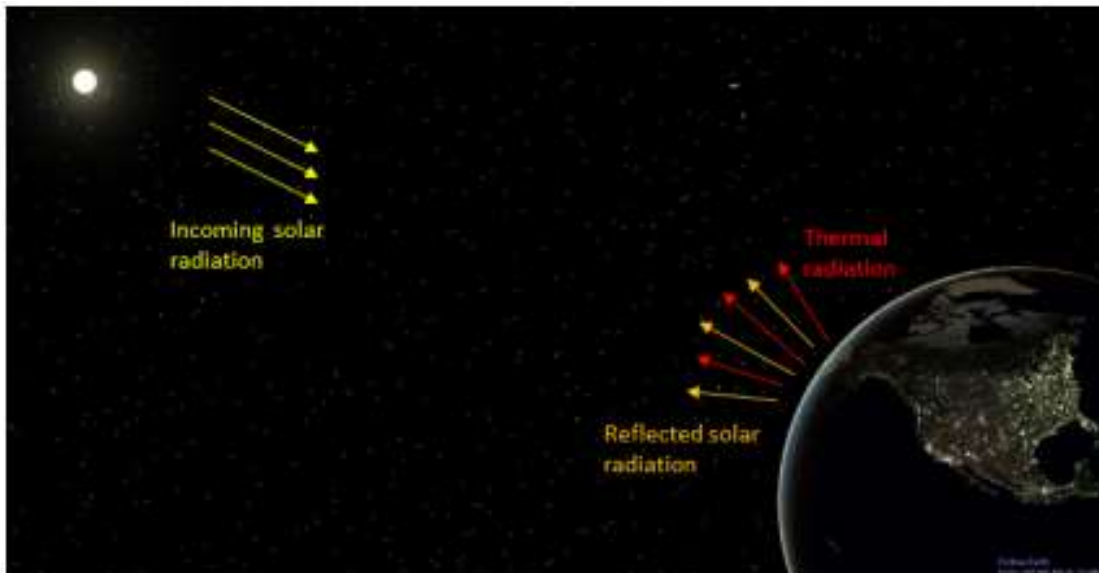
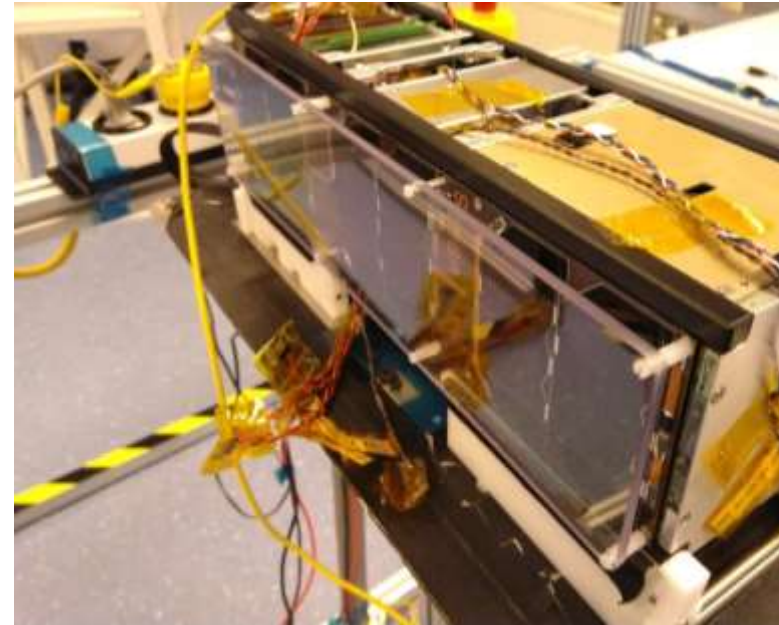
SIMBA

Mission overview



■ Instrument

- Active cavity radiometer
- Measure radiated flux in both visible bands and infrared



Hiber-1 & Hiber-2

IOT / Remote Monitoring

In development



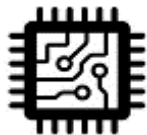
- 1st satellite goal
 - Demonstrate end-to-end functionality
- Final goal
 - Global IOT service

■ 6U CubeSat mission

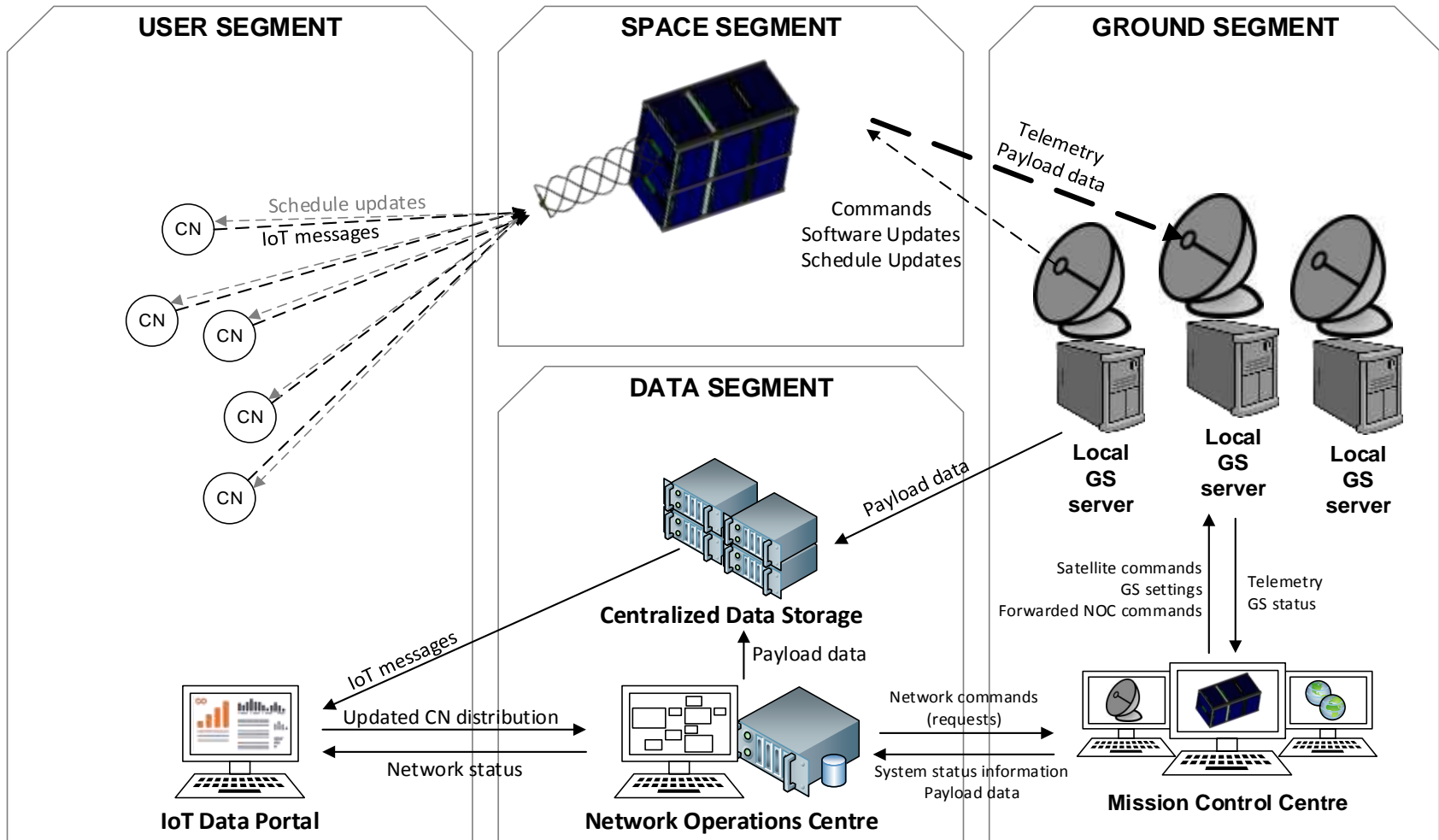
- Hosts RF payload connecting multimillion low power devices
- Compact Bus in scalable constellation



ISIS involvement:



Hiber – Satellite IOT System overview



BRIK-II DUTCH Airforce Satellite

To be Launched (2020)



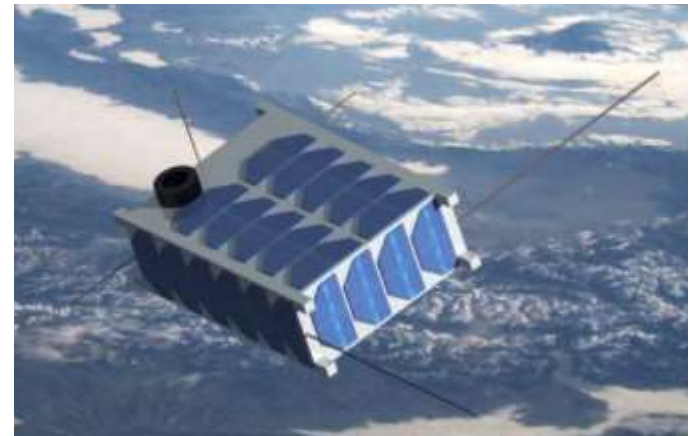
- Technology demonstration
 - Several military on ground application
- Final goal
 - Show the CubeSat can enable fast and efficient technology demonstration within military



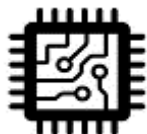
Koninklijke luchtmacht

■ 6U CubeSat mission

- Independent NL mission
- Dutch Airforce Precursor satellite



ISIS involvement:



Spectrolite

Air Quality Monitoring



In development



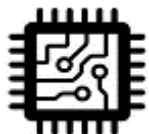
- 1st mission goal
 - Demonstrate novel spectrometer
- 2nd mission goal
 - Measure NO₂ emissions
- 3rd mission goal
 - Localize emission sources

■ 12U CubeSat mission

- Integrated design team of SME's and traditional industry
- First mission with strong optical alignment and thermal constraints



ISIS involvement:



AMS

Agricultural Monitoring



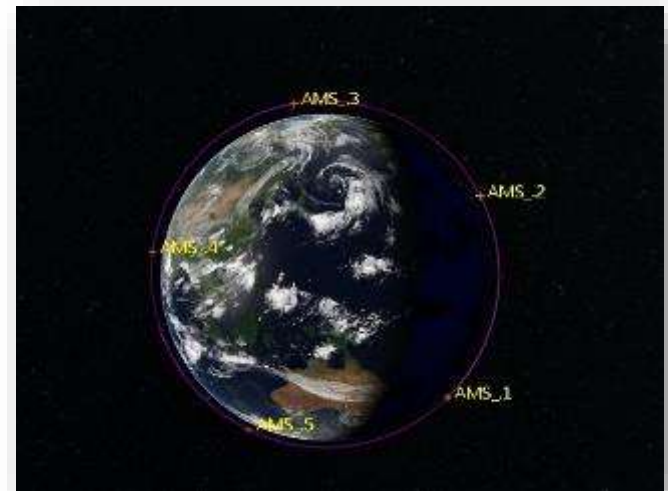
In development



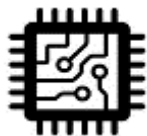
- 1st mission goal
 - Demonstrate MWIR instrument in a CubeSat
- 2nd mission goal
 - Provide Soil Moisture Data In Real Time
- 3rd mission goal
 - Develop Commercial Scalable service

■ 16U CubeSat mission

- First 16-U Mission
- Accommodate Cooling and fine pointing
- Collaboration between satellite builder, instrument developer and data processing organisation



ISIS involvement:





Netherlands China Low Frequency

Part of a roadmap

Science

Step-wise approach - science from day one

Lunar Orbit

2015-2018

RFI, SkyMap, Solar Physics, Jupiter/saturn,
21cm global signal

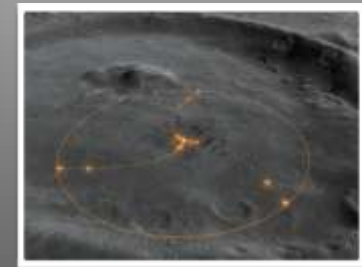
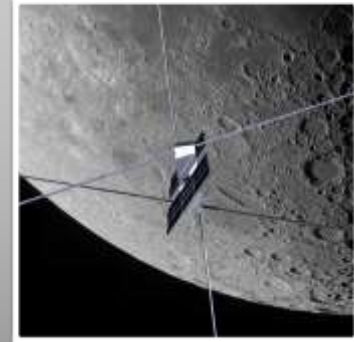
Antenna calibration and gain control

Space qualification analogue and digital
components

Single Antenna Demonstrator

2018-2022

2022-2030



Nano-sats in Lunar Orbit & at the surface

RFI, SkyMap, Solar Physics, Jupiter/Saturn, 21cm global signal,
Extra-Galactic sources, radio transients

Interferometry in space, deployment on the lunar surface, additive manufacturing

Inter-satellite communications & swarm technologies

Multi-element Demonstrator

Nano-sats in Lunar Orbit or Sun-Earth L2

SkyMap, Solar Physics, Jupiter/Saturn, 21cm tomography, Extra-Galactic sources, transients

Interferometry in space, deployment on the lunar surface, additive manufacturing

Inter-satellite communications & swarm technologies

Multi-element Interferometer

Old Challenges: Schedule

Kick off: April 2016



Interface defined: November 2016



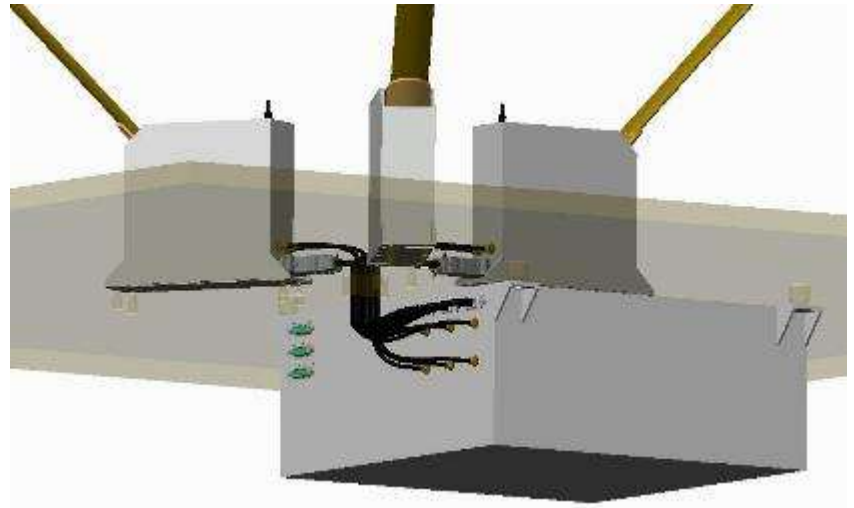
FM Delivery: March 2018



Design flow

Design philosophy: build fast and often

1st concept: January 2017



1st prototype: April, 2017



Design flow

Design philosophy: build fast and often



2nd prototype: November, 2017

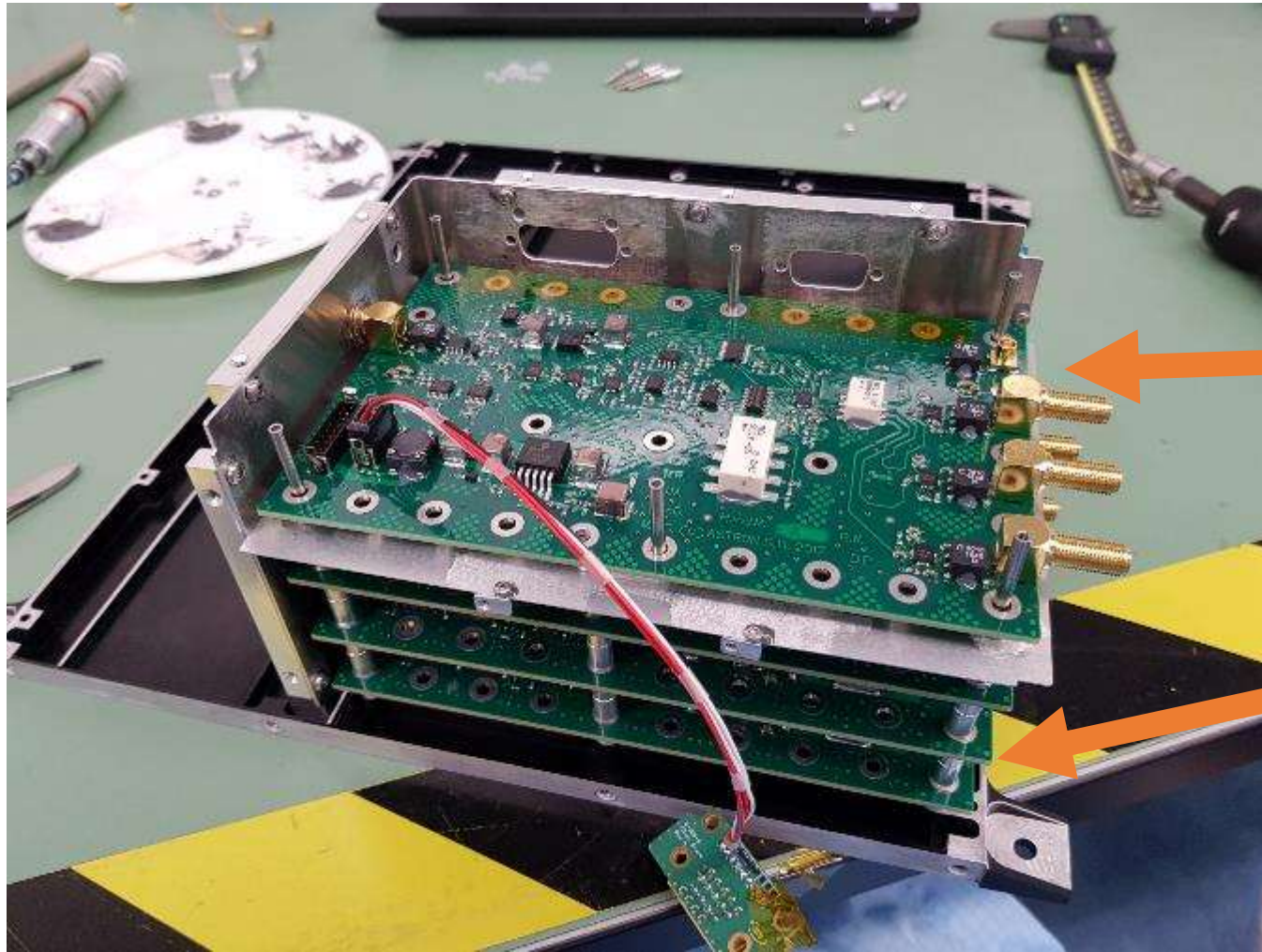


FM: March, 2018

The Hardware



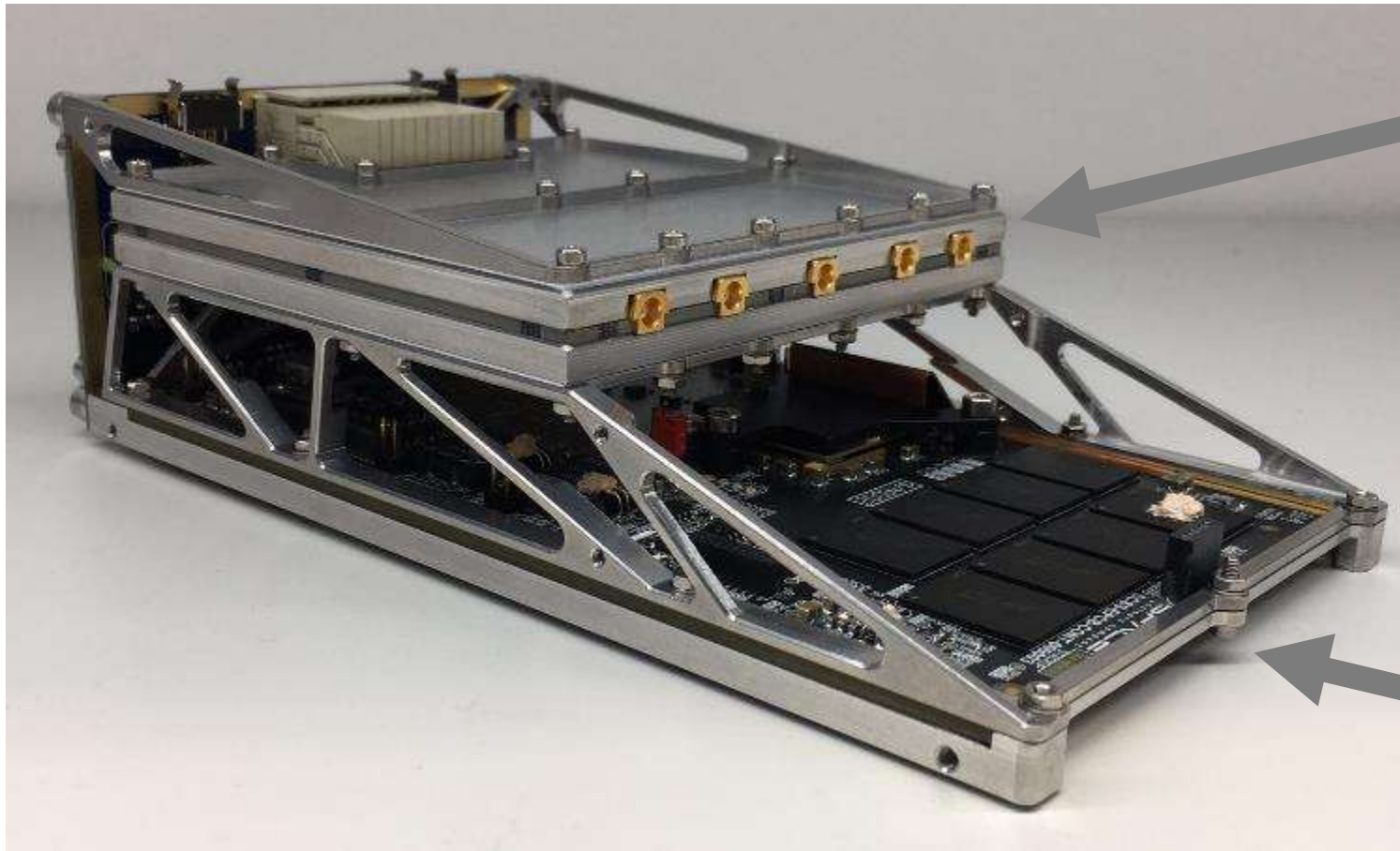
Internal Electronics: Analog Chain



← Calibrator

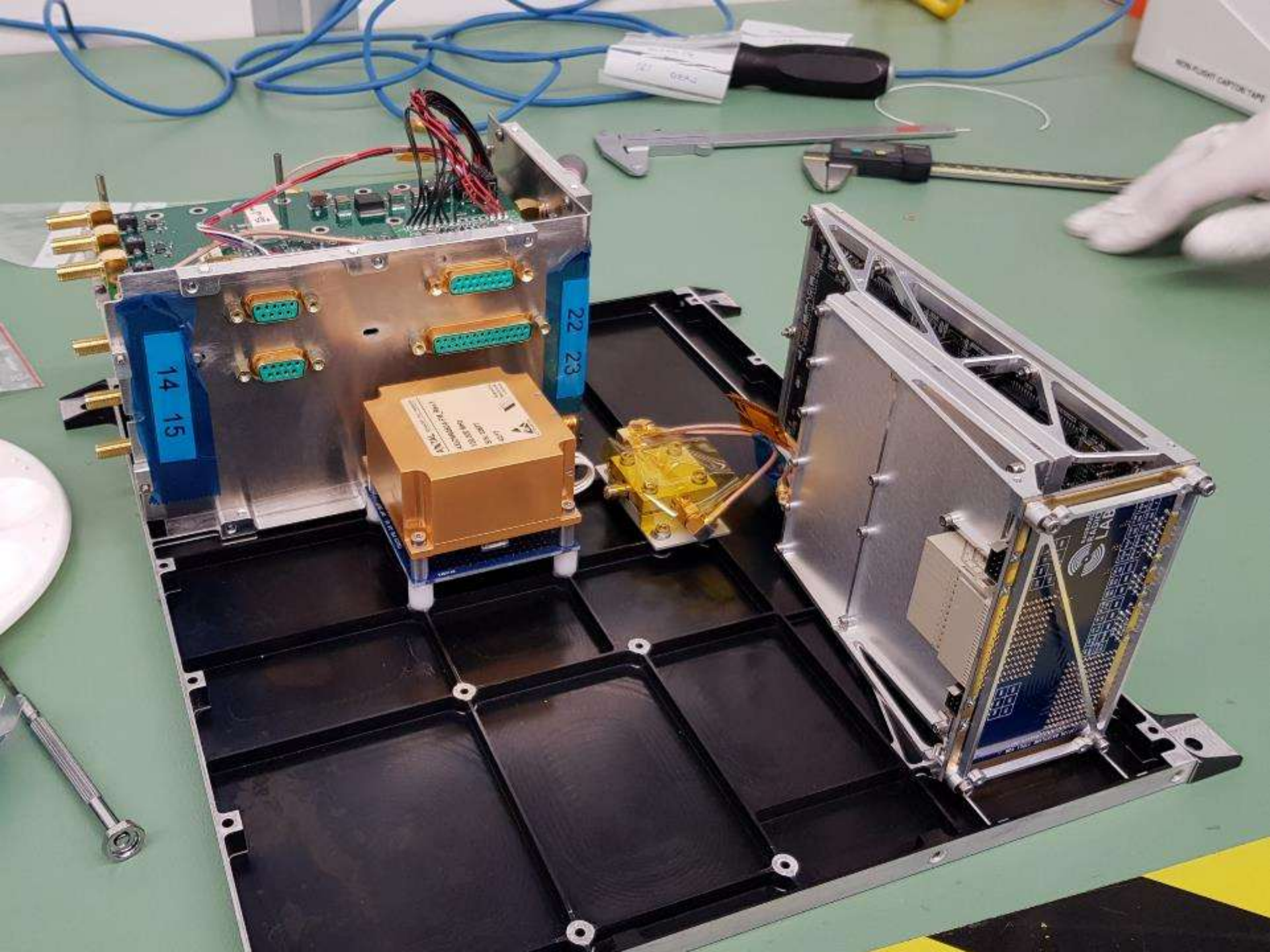
← Analog Input System

Internal Electronics Box: Receiver



ADC

Digital receiver



Internal Electronics: Interface electronics



Power system

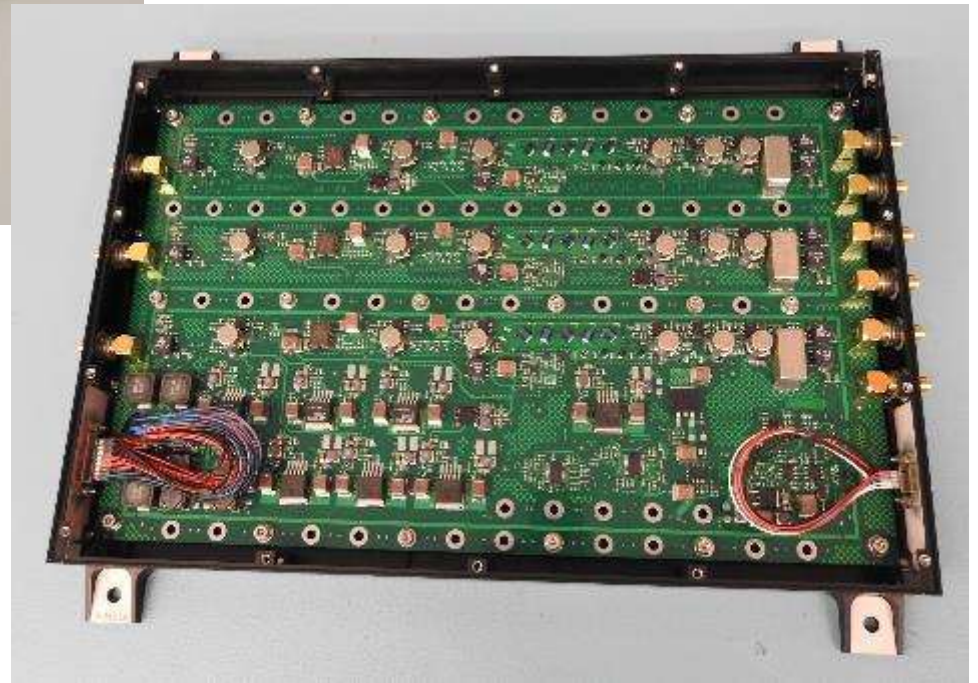
Motor drive system

CDHS system

Final Result:



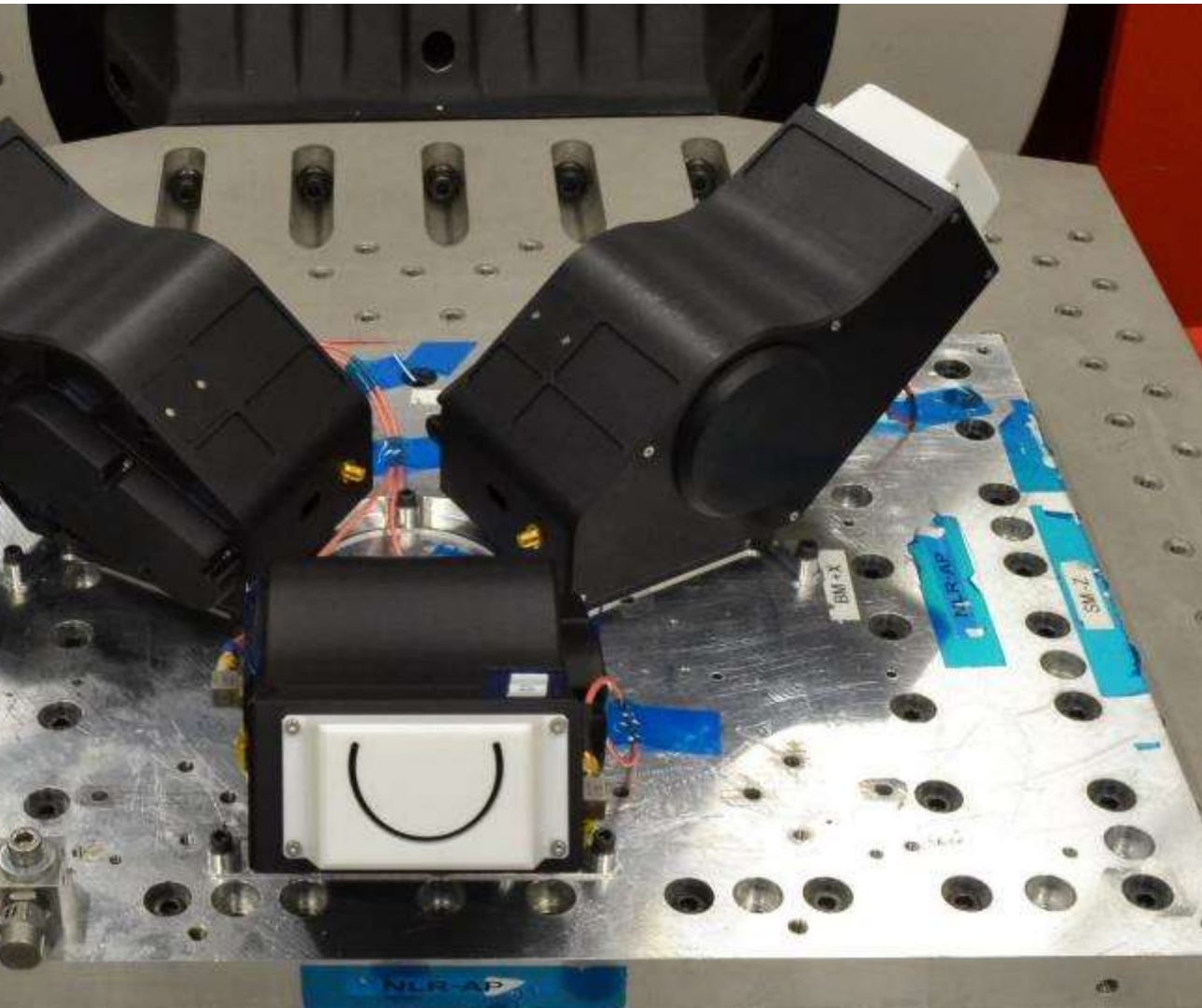
LNA box



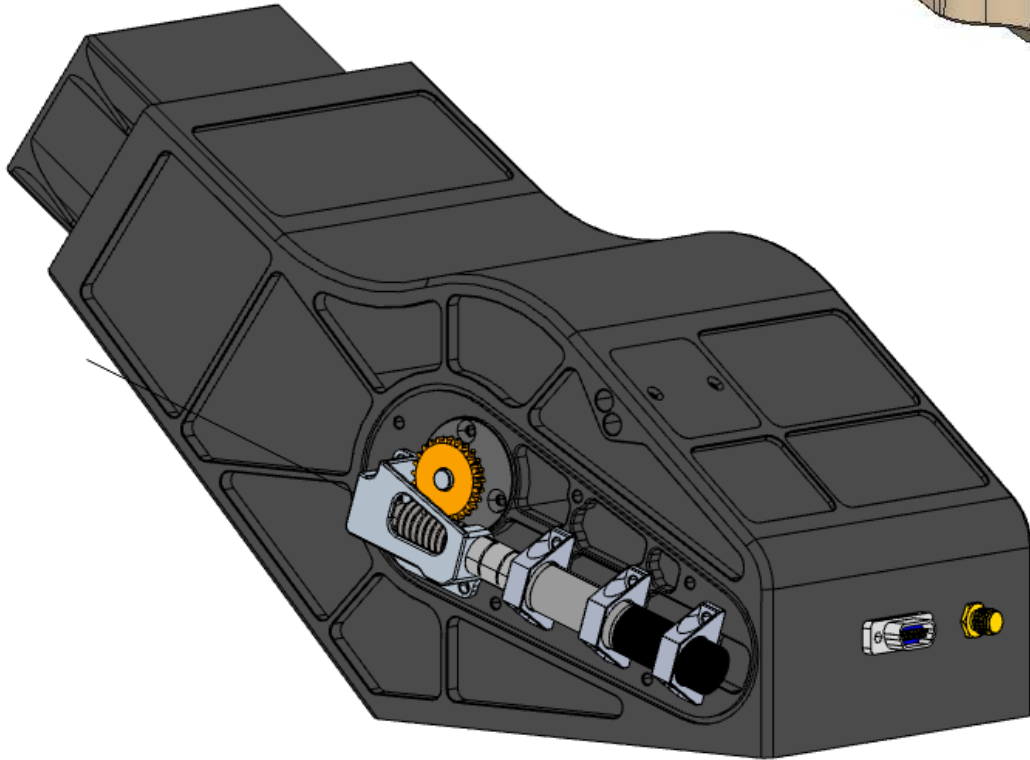
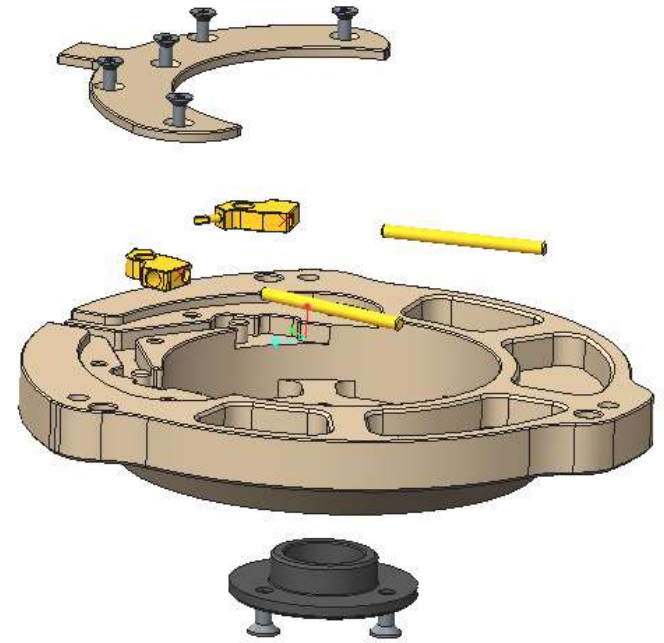
Antenna system



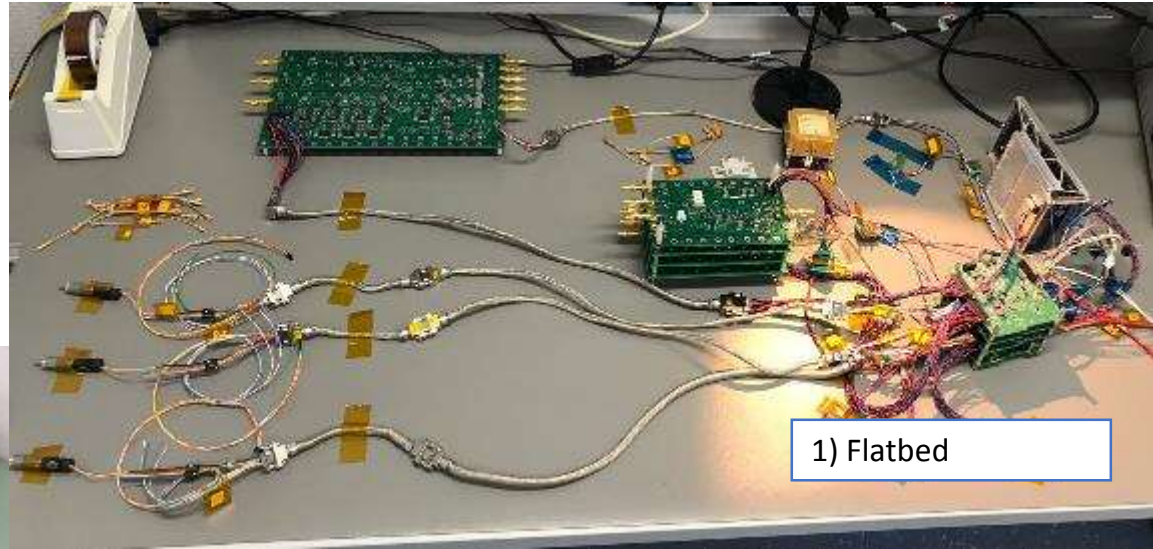
Antenna system



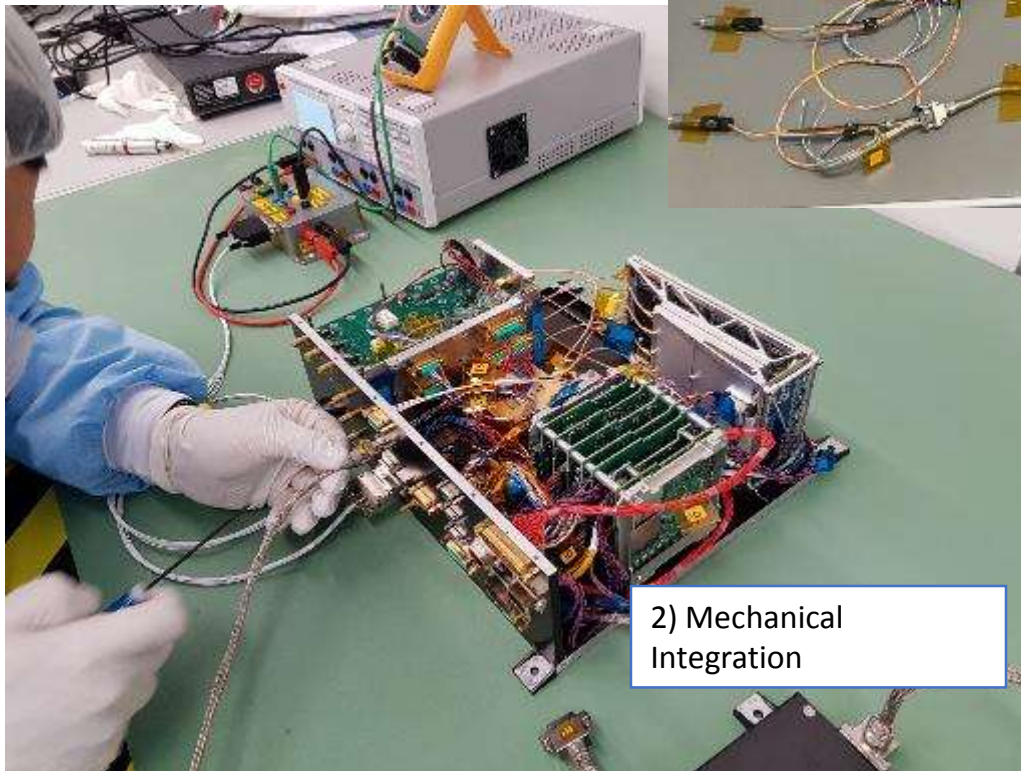
Antenna system



Testing following the CubeSat approach:



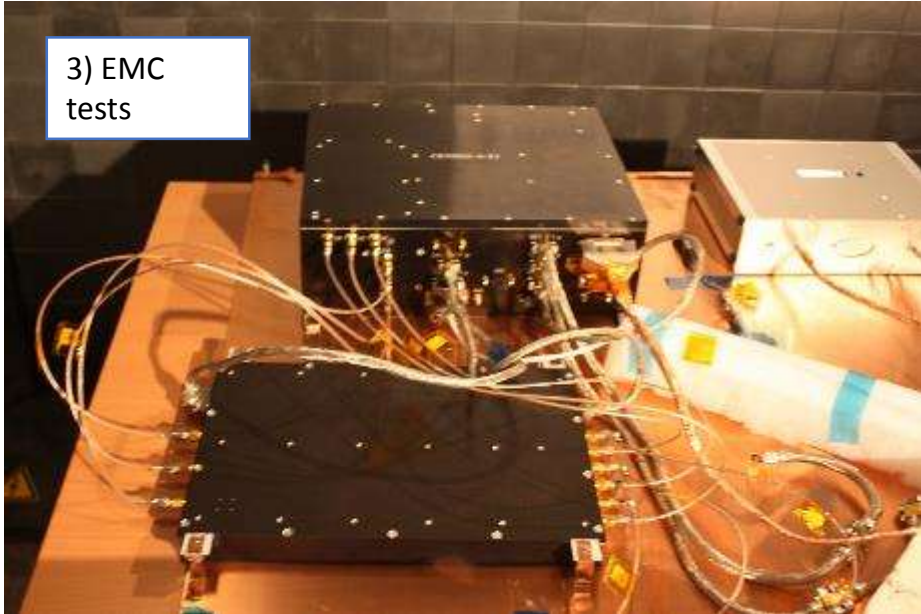
1) Flatbed



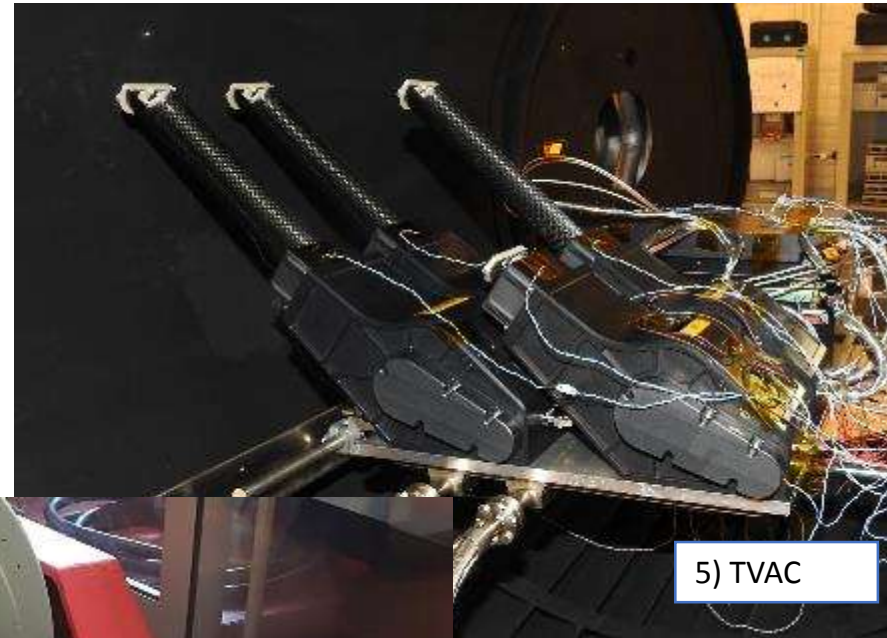
2) Mechanical Integration

Testing following the CubeSat approach:

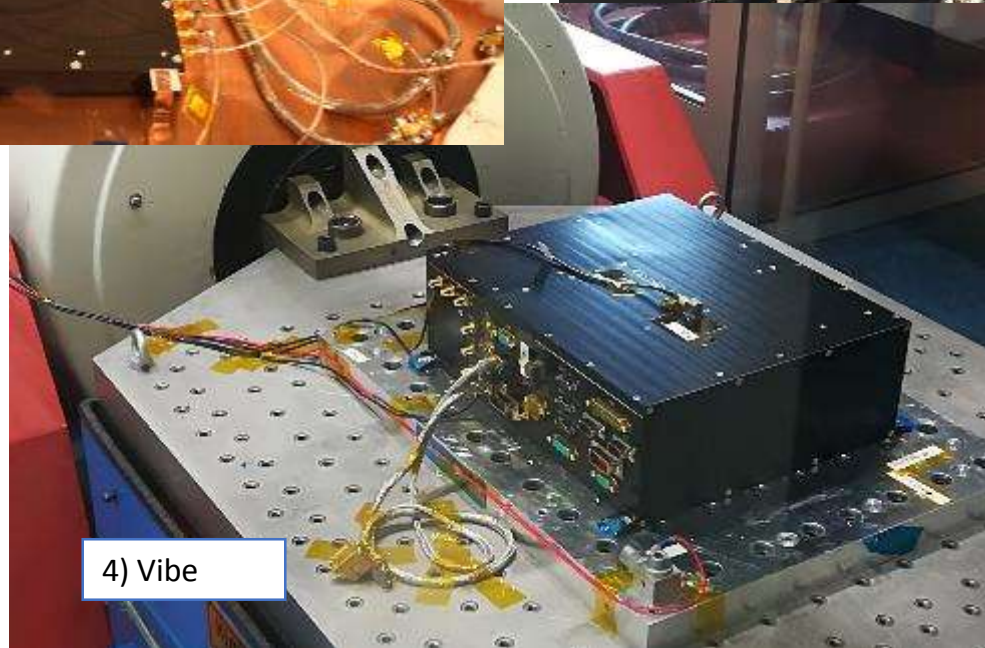
3) EMC tests



5) TVAC



4) Vibe



Testing following the CubeSat approach:



6) End to end



Icon: Person with suitcase, Person with backpack, Arrow

Arrival / Departure / Transfer

Flight information display board showing various flight details.

400-161-5166

Vending machine displaying various snacks and drinks.

扫码电子屏幕二维码 轻松购



7) Satellite integration



7) Satellite integration



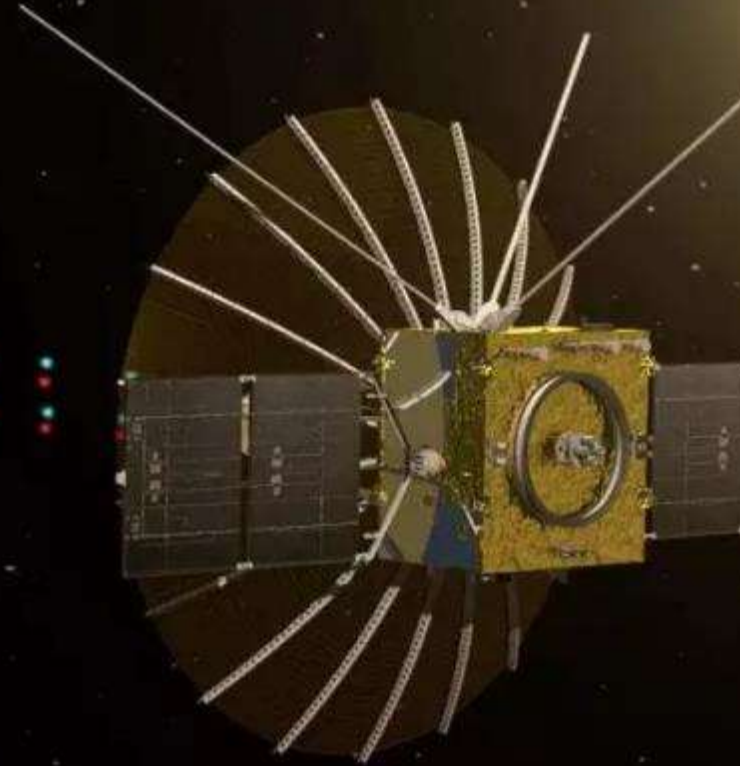
7) Satellite integration



7) Satellite integration

Launched May 21st 2018





Lunar Insertion: May 25th, 2018

Antenna Deployment: later this year / early 2019



Earth

Moon

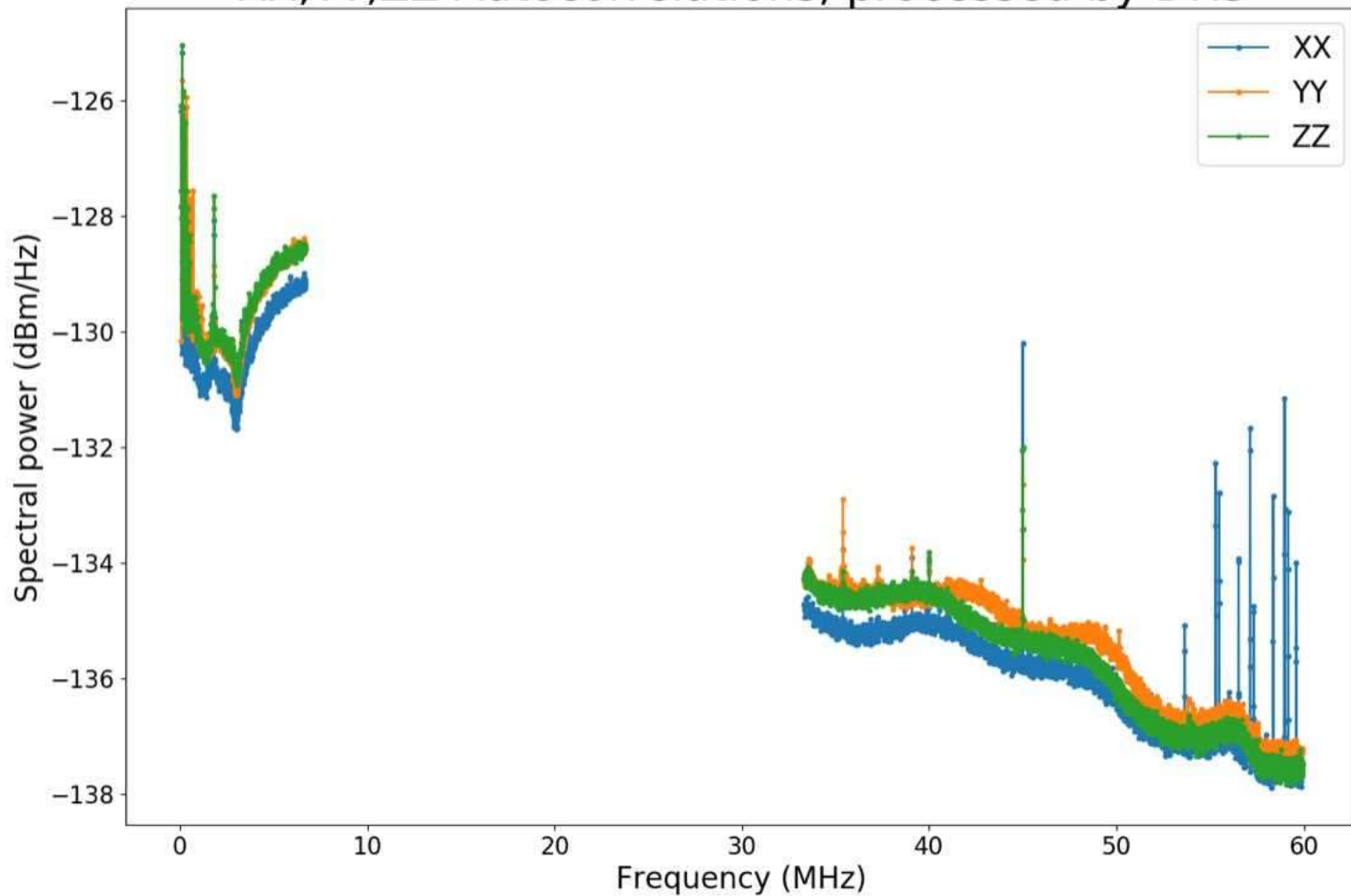
NCLE Antenne

CE4

文件: C:\Users\A\Desktop\低频开机数据20190122 2019/1/22, 15:58:57

EE	EE	EE	EE	EE
EE	EE	EE	EE	EE
EE	EE	EE	EE	EE
01	C7	36	47	5C
02	58	00	00	00
03	00	00	40	04
04	E1	2E	AC	00
05	11	3F	71	02
06	00	00	00	00
07	00	00	00	00
08	00	00	00	00
09	62	30	32	33
0A	21	00	00	00
01	DB	36	47	5C
02	6C	00	00	00
03	00	00	40	04
04	DF	2E	AC	00
05	E0	3E	71	02
06	00	00	00	00
07	00	00	00	00
08	00	00	00	00
09	62	30	32	33
0A	21	00	00	00
01	EF	36	47	5C
02	80	00	00	00
03	00	00	40	04
04	DE	2E	AC	00
05	B3	3E	71	02
06	00	00	00	00
07	00	00	00	00
08	00	00	00	00

XX,YY,ZZ Autocorrelations, processed by DRS





The Future

NEXT EXIT

What will the next 5 years bring?

2018-2023

- Growth to satellite-as-a-service provider for ISIS
- Maturisation of Nanosatellite systems
 - Reliability
 - Capability
 - Price/Performance
- Access to Space
 - Improved rideshare
 - Dedicated/semi-dedicated options
- New markets
 - Defense and security → niche markets
 - Science and Exploration → co-passengers / scouts
 - Non CubeSat Market → apply benefits/methods
- Sustainable Use of Space
 - Debris mitigation
 - Active Debris Removal



A new era for space technology

If we can make room for new ideas, the space sector can truly transform!



Thank you for your attention!



Jeroen Rotteveel

j.rotteveel@isispace.nl

www.isispace.nl | www.isilaunch.com | www.cubesatshop.com

