From ULiège to Space: it is not rocket science

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Redu Space Services for ESA

04/12/2024

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Get to Know Me!

Maxime Alves

MSc in Aerospace Engineering

- From country of waffles and good beers 🇧🇪
- CubeSat Test Engineer at the CubeSat Support Facility
- CubeSat System Engineer for *FYS!*
- Internship at arcsec space, developed new torque allocation algorithms for a 4-RW configuration

My (still rather short) Career Odyssey

University of Liège
BSc in civil engineering

Technische Universität München
Erasmus

RSS for ESA
CubeSat System and Test Engineer

2018 – 2021 | 2021 – 2023 | Oct 2022 – Mar 2023 | Mar 2023 – Sept 2023 | Nov 2023 – …

University of Liège
MSc in aerospace engineering

arcsec
Internship and Master Thesis
“*Advanced Torque Allocation Strategies for ADCS Actuators on CubeSpec Mission*”

From ULiège to Space: it is not rocket science

1. My Day Job
2. The CubeSat Support Facility
3. ESA Academy: Because Space Needs More Than Astronauts
4. Conclusions and Lessons Learned

My Day Job

It’s Just a 8-to-5 (With Fewer Coffee Breaks and More Excel Sheets)

ESA UNCLASSIFIED – Releasable to the Public

What is ESA?

Europe's Gateway To Space

WHAT	22 Member States, 5000 employees
WHY	Exploration and use of space for exclusively peaceful purposes
WHERE	HQ in Paris, 7 sites across Europe and a spaceport in French Guiana
HOW MUCH	€6.68 billion = €12 per European per year

What is ESA?

What Does ESA Do?

ESA is active across **every area** of the **space sector**

World leader in **science** and **technology**

Over 80 satellites developed, tested, and operated **since 1975**

More than 220 launches from Europe's Spaceport in Kourou

All of this is possible thanks to the collaboration of member states

What is ESA?

The 4 Pillars

Science & Exploration

Exploring our Solar System and unlocking the secrets of the Universe

- Space science
- Human & robotic exploration

Safety & Security

Monitoring space and protecting our planetary environment

- Asteroids
- Space junk
- Safety from space
- Space weather

Applications

Using space to benefit citizens and meet future challenges on Earth

- Earth observation
- Telecommunications
- Satellite Navigation
- Downstream

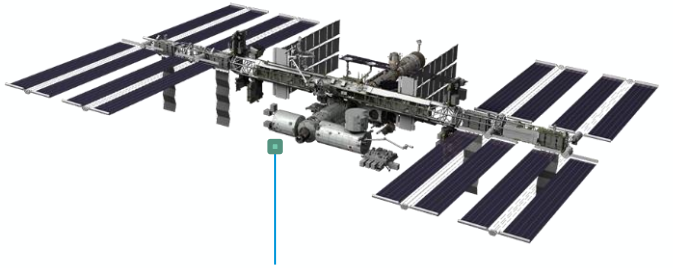
Enabling & Support

Making space accessible and developing the technologies for the future

- Building missions
- Space transportation
- Flying missions

What is ESA?

ESA's Locations



Columbus Module (ISS)

Moscow

Washington

Houston

Maspalomas

Santa Maria

Kourou

Malargüe

New Norcia

Perth

Salmijaervi (Kiruna)

Brussels

ECSAT (Harwell)

ESTEC (Noordwijk)

EAC (Cologne)

ESA HQ (Paris)

ESOC (Darmstadt)

Oberpfaffenhofen

Toulouse

ESEC (Redu)

ESAC (Madrid)

Cebreros

ESRIN (Rome)

- ESA sites
- Offices
- ESA Ground Station
- ESA Ground Station + Offices
- ESA sites + ESA Ground Station

What is *Fly Your Satellite!* Programme?

Quick Overview of ESA Academy

18+ y/o — **ESA ACADEMY**

TRAINING

TRAINING SESSIONS
- Online training sessions
- Onsite training sessions
- Hybrid training sessions

ONLINE LEARNING LIBRARY

PROJECTS

EXPERIMENTS
- Large Diameter Centrifuge
- Parabolic Flights
- Drop Towers
- Orbital Robotics Laboratory
- Space Rider
- International Space Station

SATELLITES
- Fly Your Satellite
- Fly Your Satellite - Design Booster
- Fly Your Satellite - Test Opportunities

ROCKETS
- Fly a Rocket
- REXUS/BEXUS

ENGAGEMENT

SCHOLARSHIPS
- Summer schools
- Academic programmes

INTERNSHIPS

CONFERENCES
- Student sponsorships
- European Space Education Conference

ADDITIONAL LEARNING OPPORTUNITIES
- Downstream hackathons
- Student Aerospace Challenge
- European Rocketry Challenge
- External partners' training courses

CAREERS FOR YOU

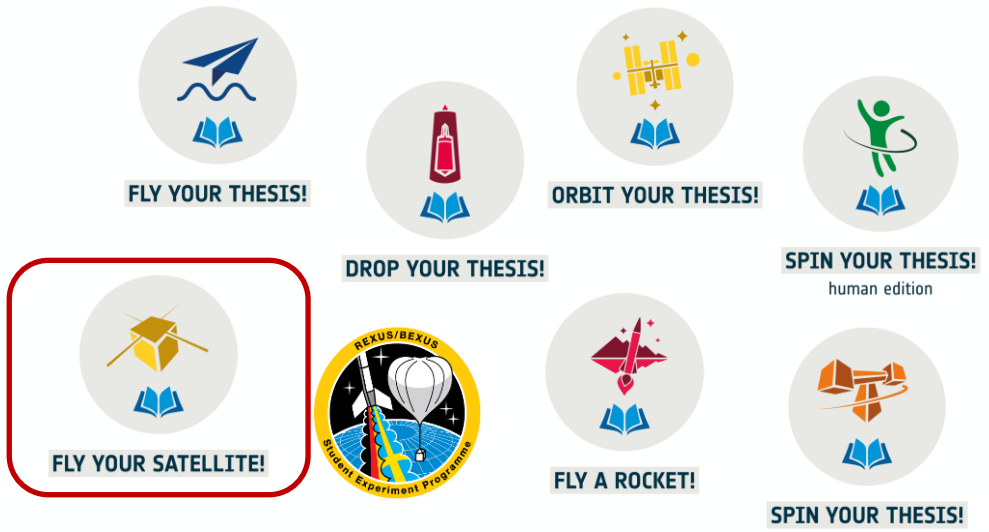
BOOK A SPACE PRO

EDUCATION WEB TV

What is *Fly Your Satellite!* Programme?

Quick Overview of ESA Academy

Hands-on Programmes

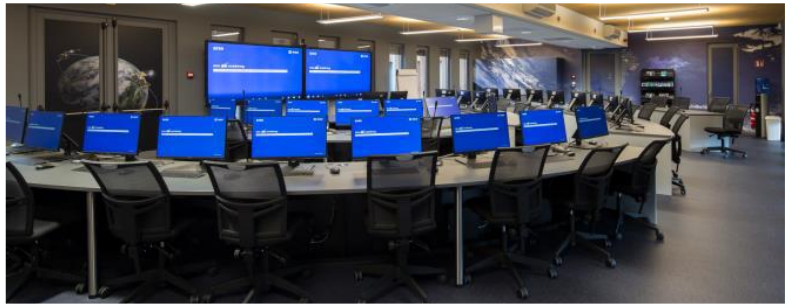


Training & Learning Programme

Gravity-Related Research	Spacecraft Operations and Communications	Concurrent Engineering	Human Space Physiology
Remote Sensing	Clean Space / Space Debris	Space System Engineering	Space Law
Science Operations Scheduling	Standardisation	Satellite System Design	Product Assurance
Technology Transfer & Innovation	Small Satellites / CubeSats	...	

CubeSat Support Facility

Training & Learning Facility



Student Sponsorships

What is Fly Your Satellite! Programme?

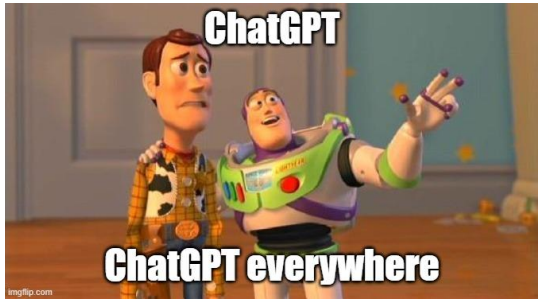
Guiding Principles

- **Complement academic education** in space-related disciplines, increase **employability** and stimulate **innovation & entrepreneurship** in response to community needs
- Offer **cyclic, recurrent** theoretical and practical training opportunities; continuous evaluation & evolution
- Build on close coordination / collaboration with
  - **ESA experts** across all domains
  - European **academic institutions & organisations**
  - European **space industry**
- **Transfer space expertise, know-how and standard professional practice**
- **Participation**
  - Free of charge
  - Open and competitive across Member States
  - Transparent eligibility & selection criteria
  - Various entry levels

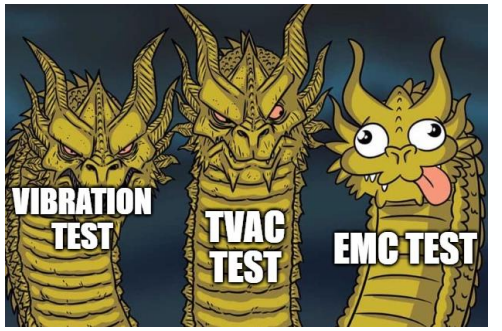
What is *Fly Your Satellite!* Programme?

Help to **identify** and **solve** technical and programmatic **issues**

Point-of-contact with ESA Experts and facilities



Review and **help** to improve **documentation**



Help to **prepare test campaigns** and to access the CSF

Sharing lessons learned from past projects

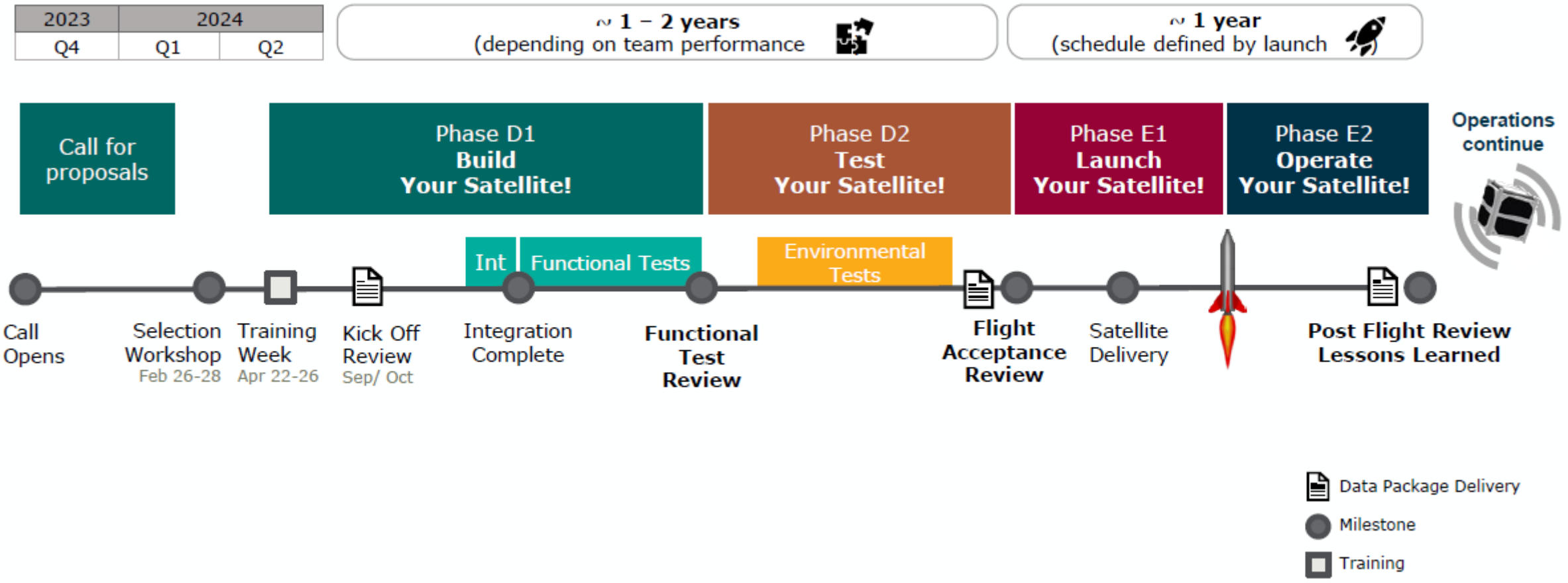
Aid on **project management** aspects

Support all the way through **launch** and **operations**

Launch!!!!!!!!!!!!!!!!!!!!

What is *Fly Your Satellite!* Programme?

Programme phases and timeline for *FYS!4*



What is *Fly Your Satellite!* Programme?

Programme phases and timeline for *FYS!4*

Phase D1 **Build Your Satellite!**

Kick Off Review
- Satellite Project File (derived from Satellite Proposal)

Subsystem development and verification activities
- Equipment Qualification Status List

Software Development
- None, internal documentation/repository

FlatSat
- None, internal documentation

Assembly & Integration
- Assembly & integration procedure
- Interfaces Verification Report

Functional Test Campaign
- Full Functional Test Specification & Procedure
- Mission Test Specification & Procedure

Phase D2 **Test Your Satellite!**

Environmental Test Campaign
- Updated Structural & Thermal Analysis
- Vibration Test Specification & Procedure
- Declared Materials List
- TVAC Test Specification & Procedure

Ground Station & Operations
- Ground Station Test Report
- Operations Manual
- Operational Procedures Validation

Requirements Compliance
- Technical Specification Compliance Matrix
- FDS Compliance Matrix

Legal & Regulatory
- Space Debris Mitigation Report
- Legal & Regulatory Status Report

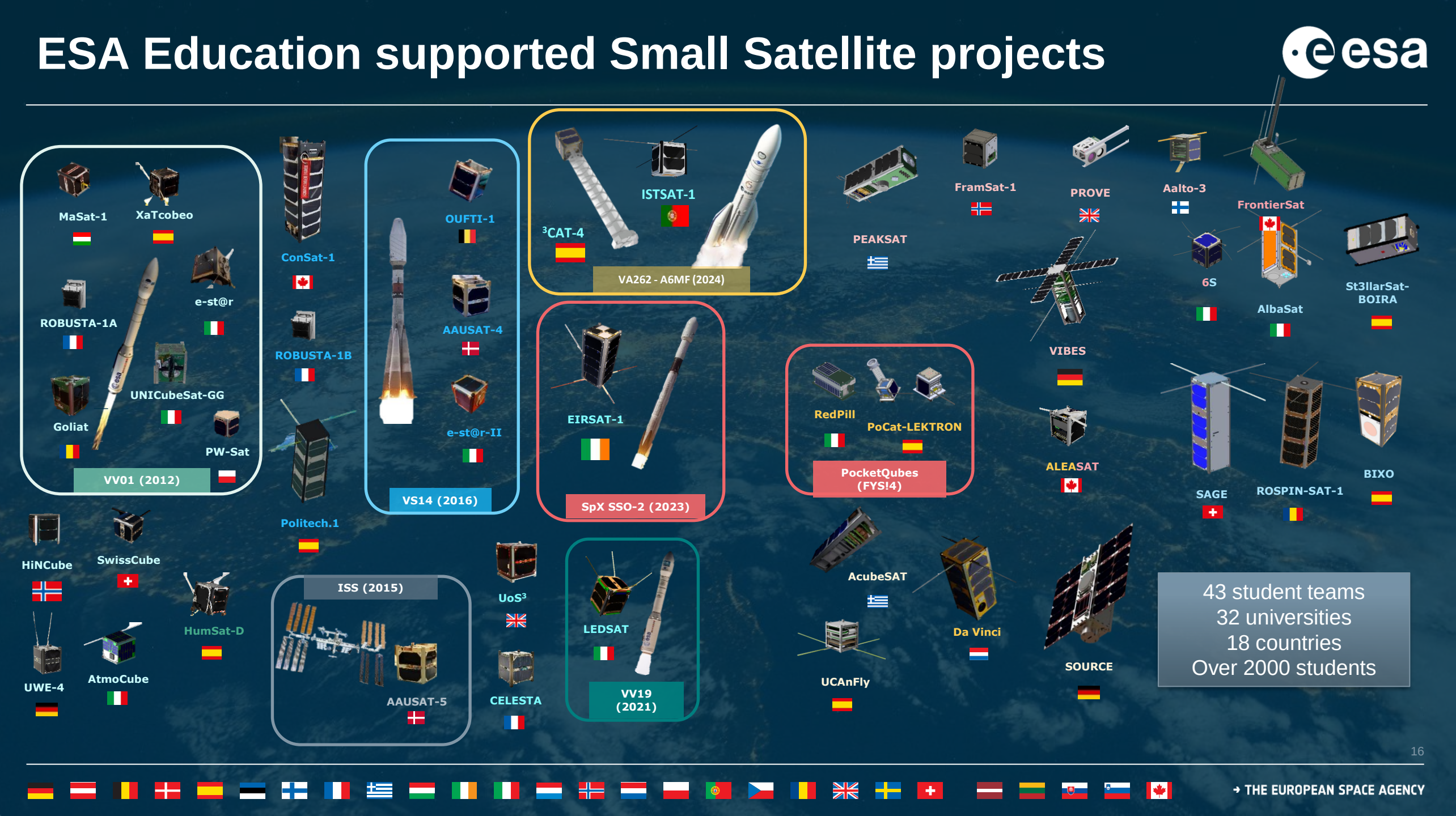
Phase E1 **Launch Your Satellite!**

Launch campaign
- Launch & Safety Data Package
- Pre-flight check-out procedure
- Interface Control Document

Phase E2 **Operate Your Satellite!**

Final Review
- Post Flight Report: Mission Results & Lessons Learned

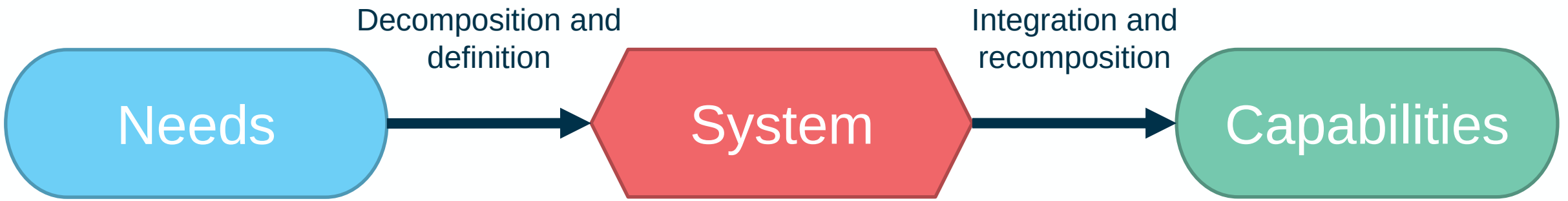
ESA Education supported Small Satellite projects



43 student teams
32 universities
18 countries
Over 2000 students

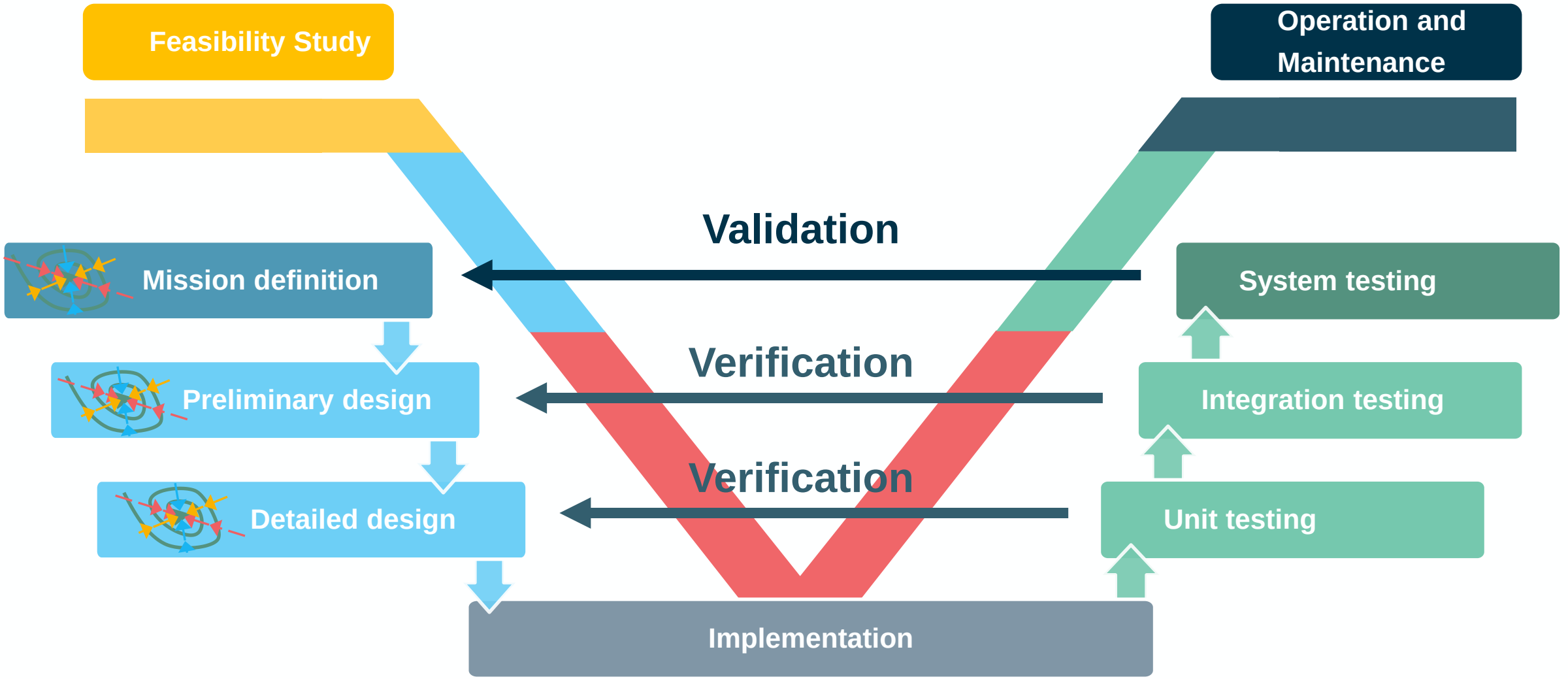
My Day Job

One Model to Rule Them All! – The V-model



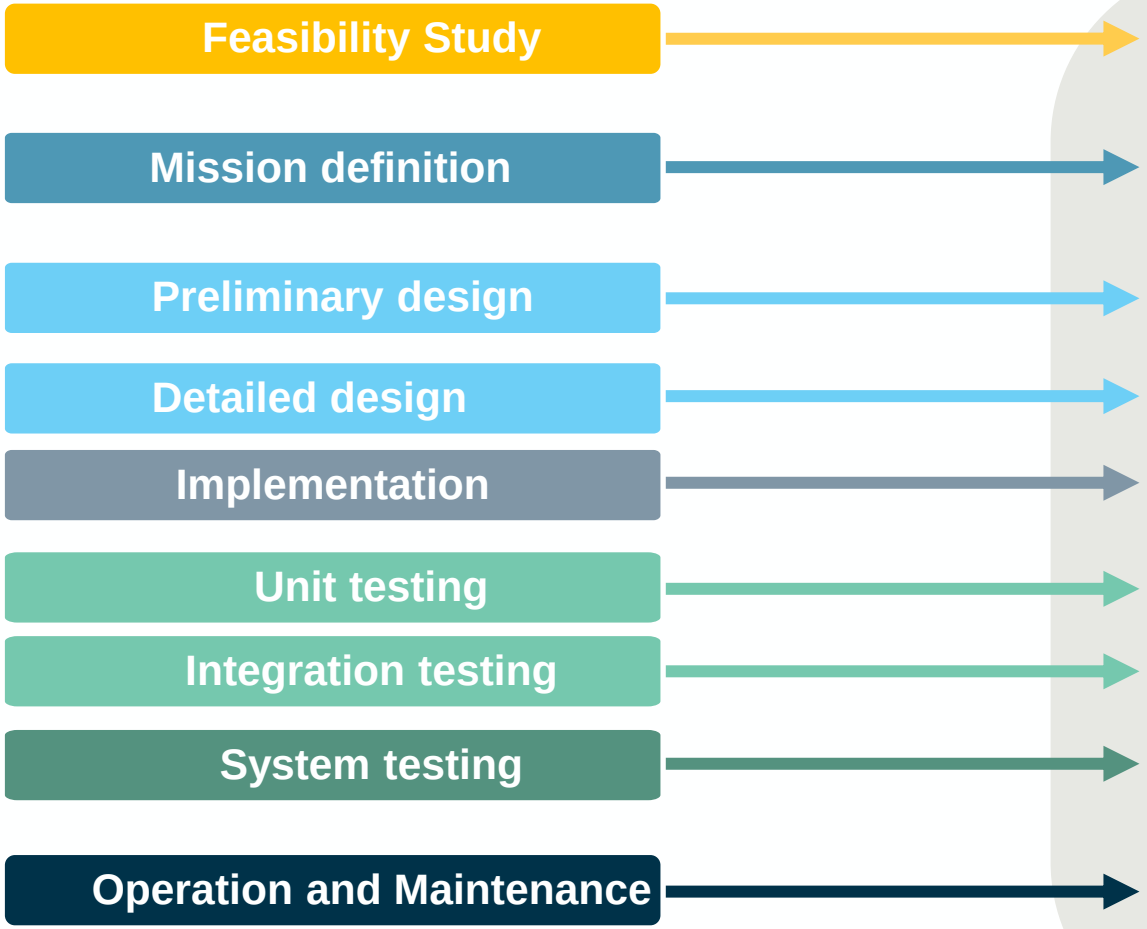
My Day Job

Ok man, now really tell us about your job



My Day Job

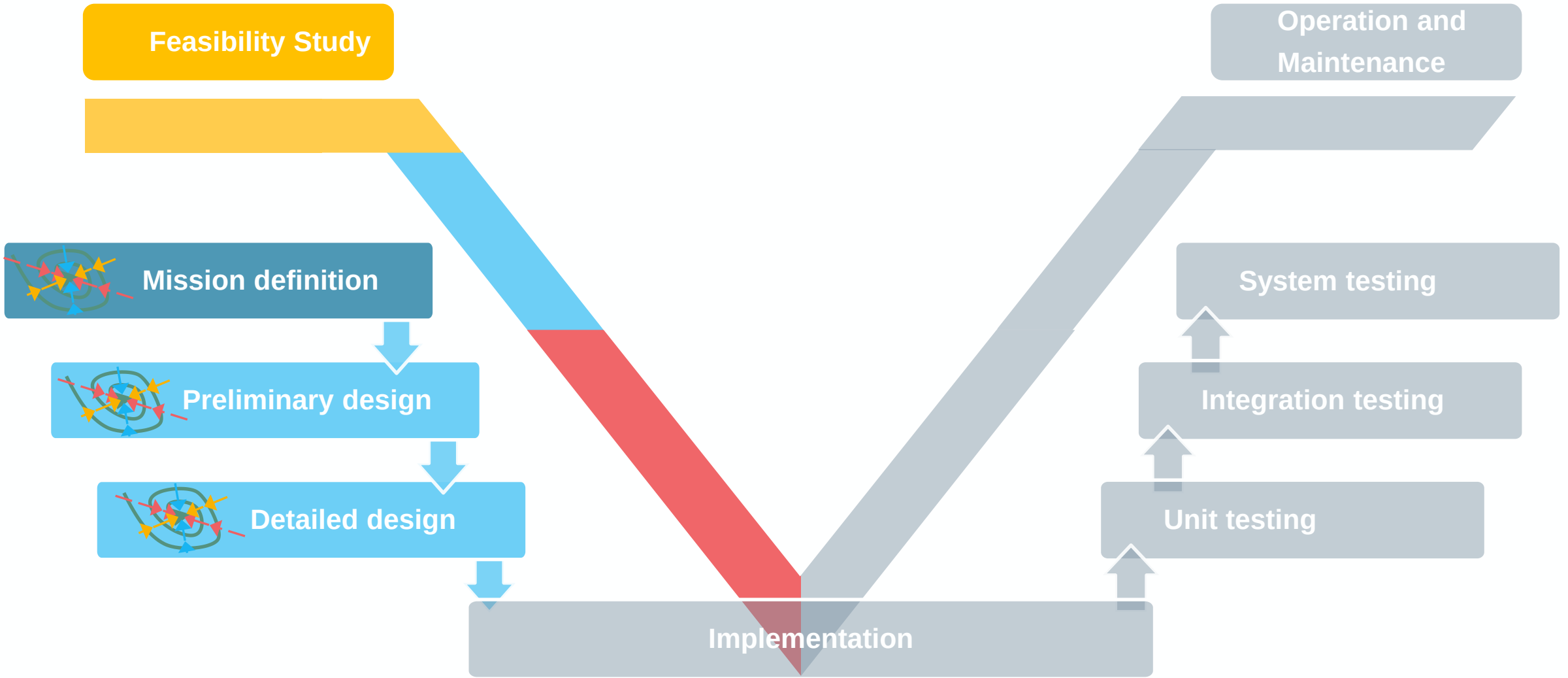
Ok man, now really tell us about your job



- Is the house free and the market open
- Why are we cooking the dinner, for whom, and what we would like to eat
- Get the recipe
- Make a shopping list, of both food and tools
- Go to the market
- Taste the food for quality
- Taste the different elements of the dish
- Taste the final result
- Welcome guests, make sure they have everything they need and enjoy the evening

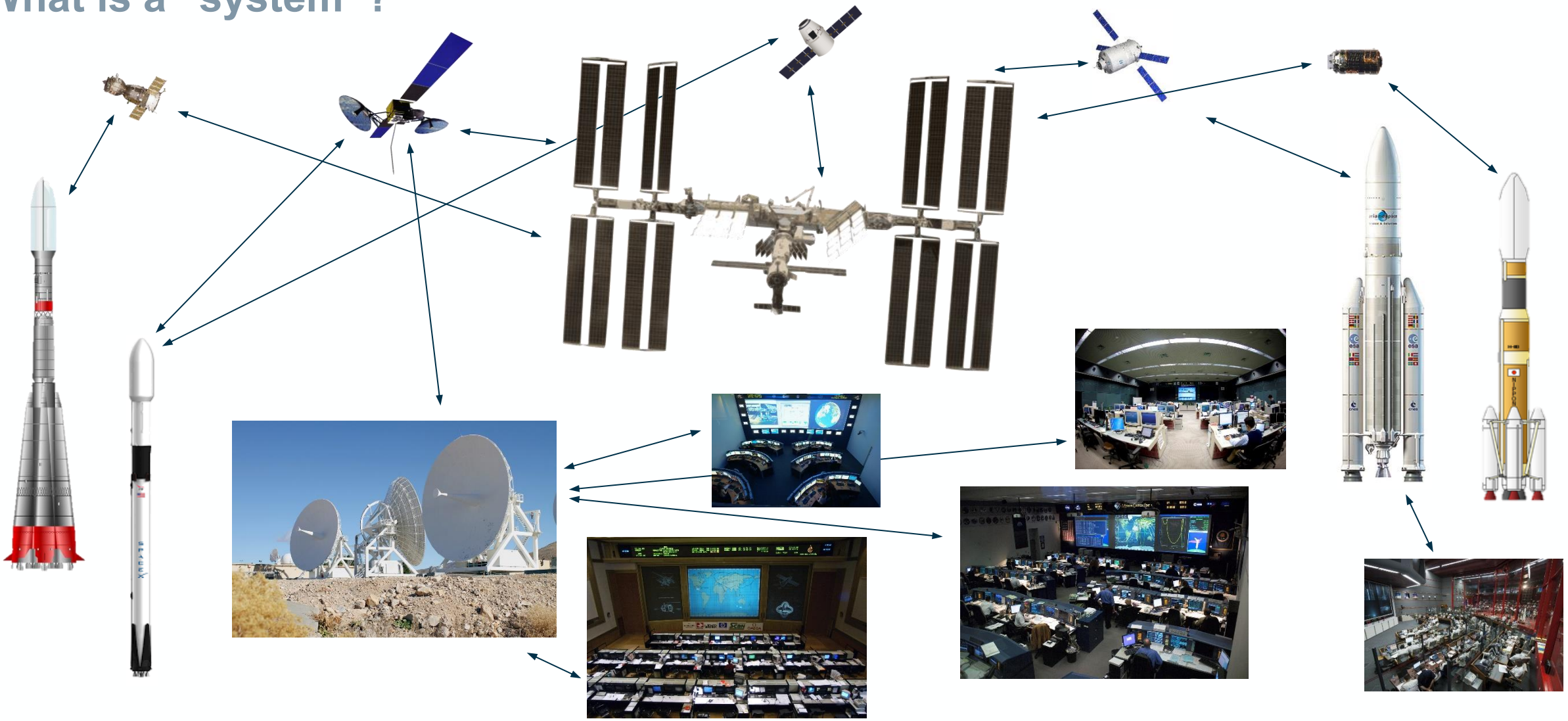
My Day Job

Chapter One – System Engineer: Connecting the Dots (and Wires)



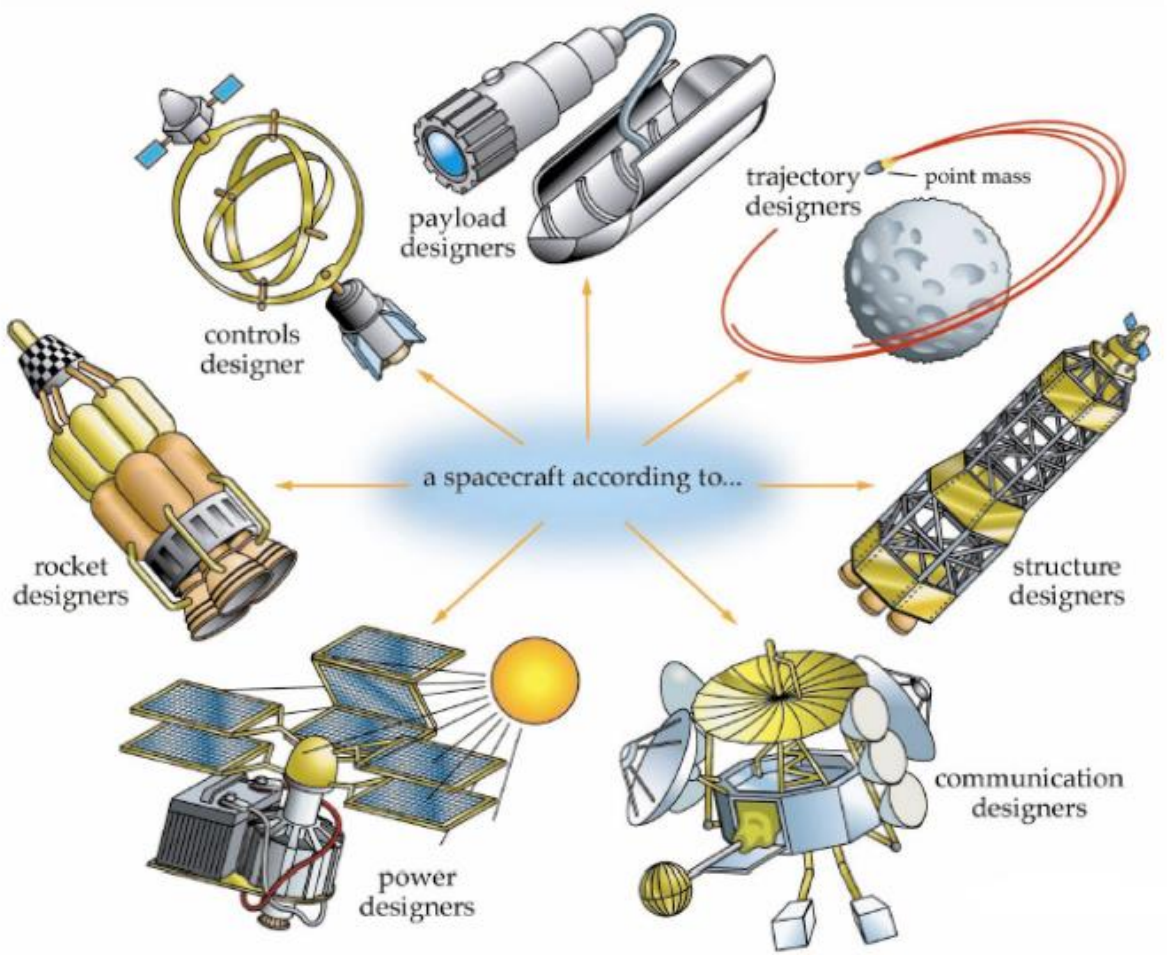
My Day Job: System Engineer

What is a “system”?



My Day Job: System Engineer

Complex “systems”



Architect

Define the **fundamental organisation** of a system and its **composition of elements**, and the **relationships** between each other and with the environment

\+

Designer

Create a product or system, and plans to **develop** and **use it**

=

System Engineer

Do both!

They help **create the design** and **maintain its integrity** throughout its lifecycle

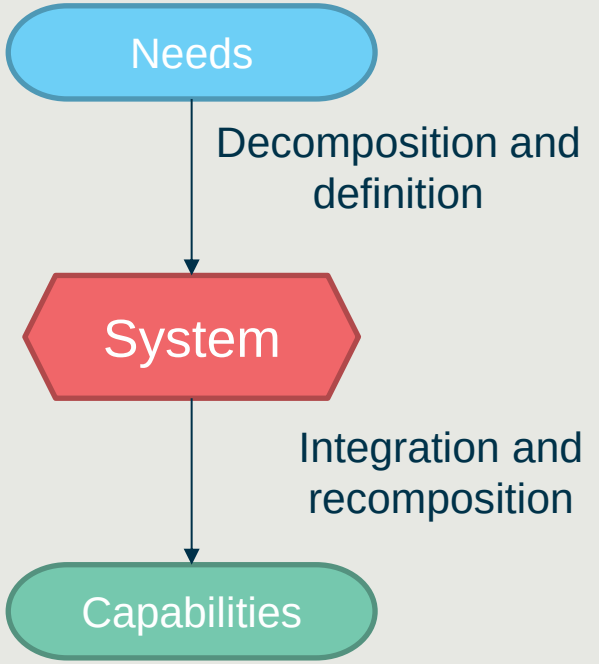
My Day Job: System Engineer

What is “system engineering”?

Essential requirements and constraints identified by stakeholders that a system shall fulfil to achieve a goal.

Interdisciplinary approach governing the total technical effort to transform requirements into a system solution.

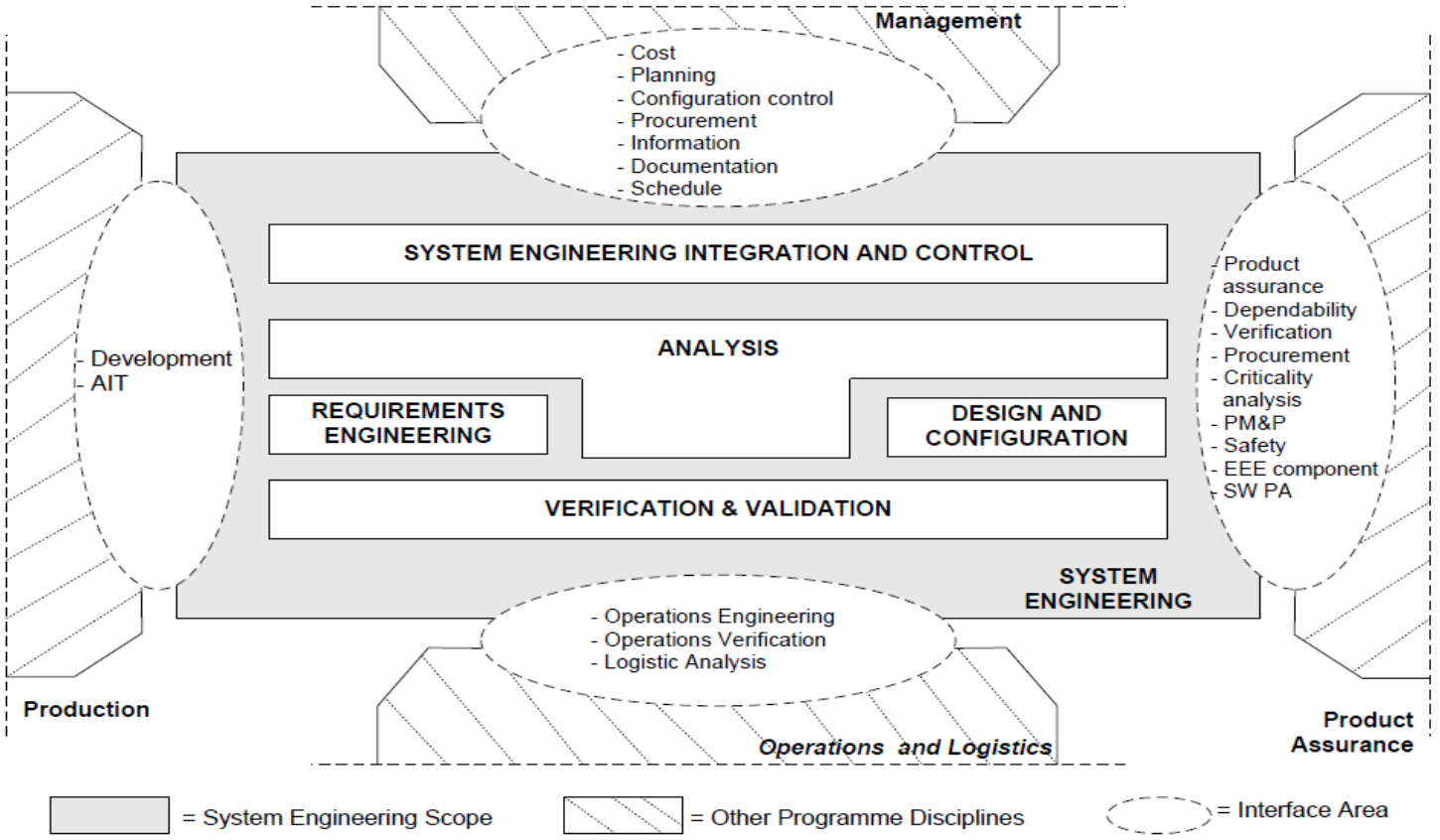
Functions and performances measures a system shall integrate to meet the identified need and achieve a goal



→ The objective of system engineering is to obtain a product which provides capabilities that satisfy the stakeholder needs within pre-established limits of **cost** and **time**.

My Day Job: System Engineer

The Scope of the Systems Engineering Role

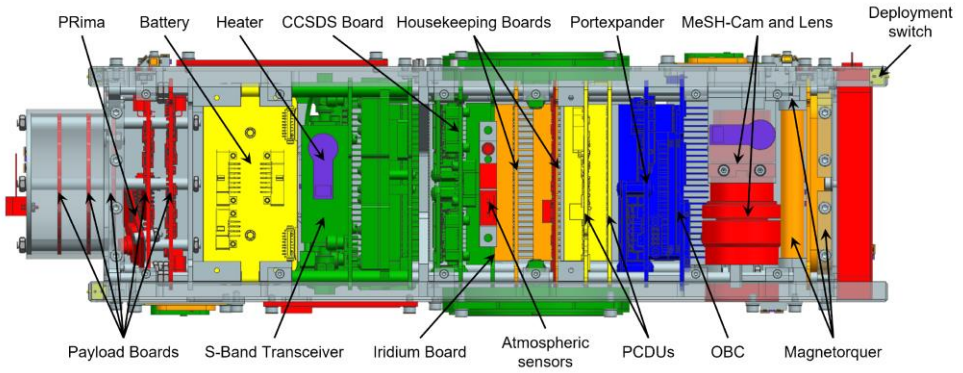


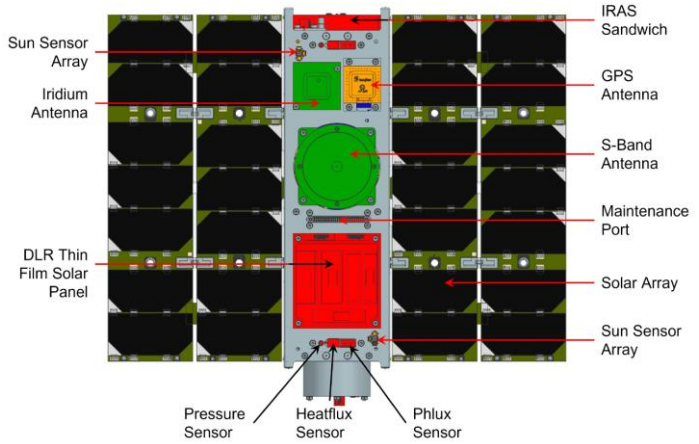
Duties

- Integration and control
- Requirement engineering
- Analysis
- Design and consolidation
- Verification

My Day Job: System Engineer

FYS!3 – SOURCE





Goals

Education Objectives

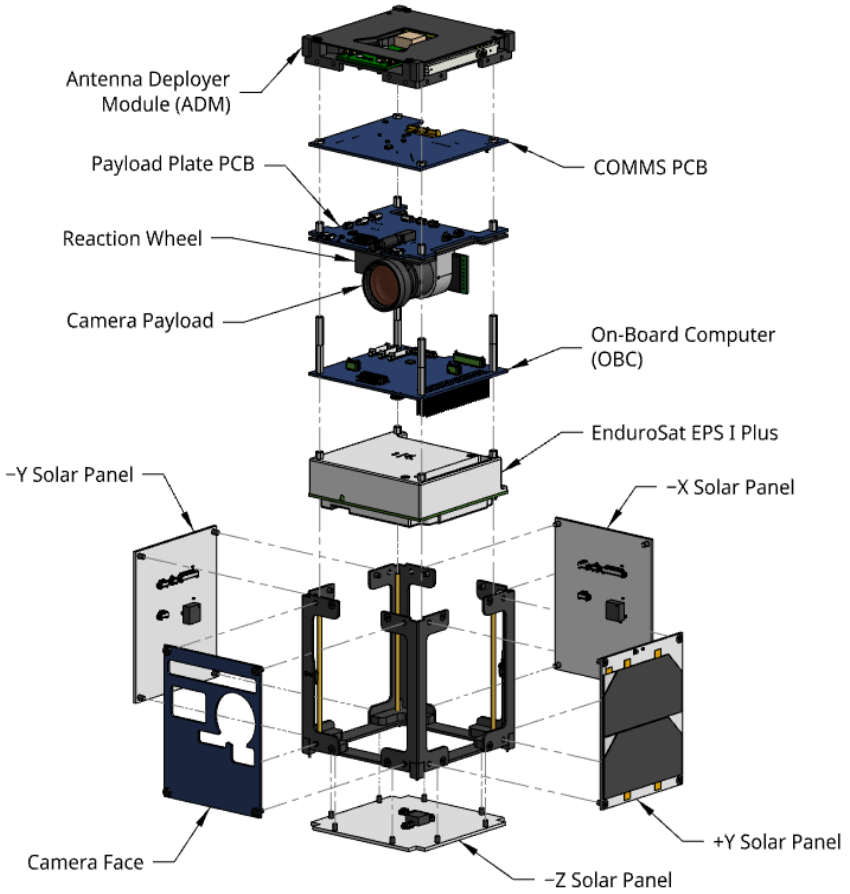
- To involve more than 100 students in SOURCE to gain technical and procedural knowledge across all mission phases of the satellite system
- To design and document a CubeSat platform to serve as a replicable model for future projects by Ksar and IRS

Mission Objectives

- To validate platform technologies by collecting at least 1 MB of performance data from the different payloads
- To investigate the interaction between re-entry objects and the outer atmosphere by collecting in-situ measurement data and images

My Day Job: System Engineer

FYS!4 – ALEASAT



Goals

Education Objectives

- To provide UBC and SFU students with the opportunity to design, build, and operate a spacecraft.
- To support educational outreach activities for university and secondary school students.

Mission Objectives

To provide the amateur radio community a training satellite to assist in disaster mitigation and relief via on-demand satellite imagery.

My Day Job: System Engineer

FYS! Design Booster

What?

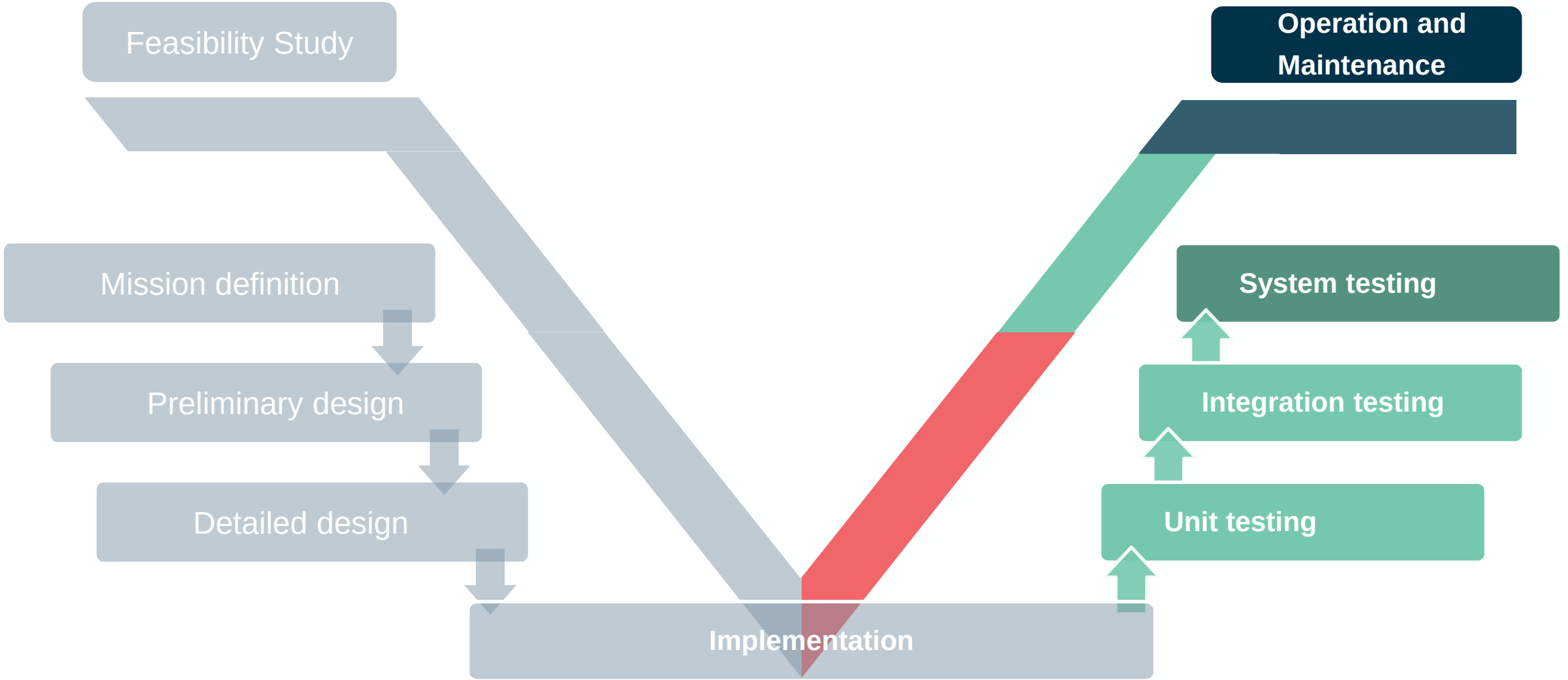
- Receive support in early phases of the mission, when important design choices are made
- Facilitate execution of future project phases (planning, verification, operations, legal…)

How?

- Design is reviewed by ESA specialists, who identify potential issues and assist in solving them
- Students attend training and webinars and be introduced to common practices in space
- Conduct trade-offs, run analysis, and evaluate options while balancing scope and resources
- Prototyping and development models to characterise functionalities and performances
- More advanced teams may perform environmental test campaigns on their subsystems at the CSF in ESEC

My Day Job

Chapter Two – Test Engineer: Breaking Things for Science



My Day Job: Test Engineer

What is “AITV”?

Goals

- Ensure that the spacecraft can be **built** and **tested**
- Ensure that the **design** can be **verified** from component- to system-level
- Ensure the **functionality** and **performance** meet expectations
- Ensure the **needs** of the **stakeholders** are met

Definitions

- **A**ssembly: **physically** combining different pieces to form a higher-level system
- **I**ntegration: **functionally** combining different pieces so they **operate together** as a higher-level system
- **T**est: measure system **characteristics**, **performance** or **functions** under certain **representative conditions**
- **V**erification: process to **demonstrate** the system **design** and **production** against its **specifications**

My Day Job: Test Engineer

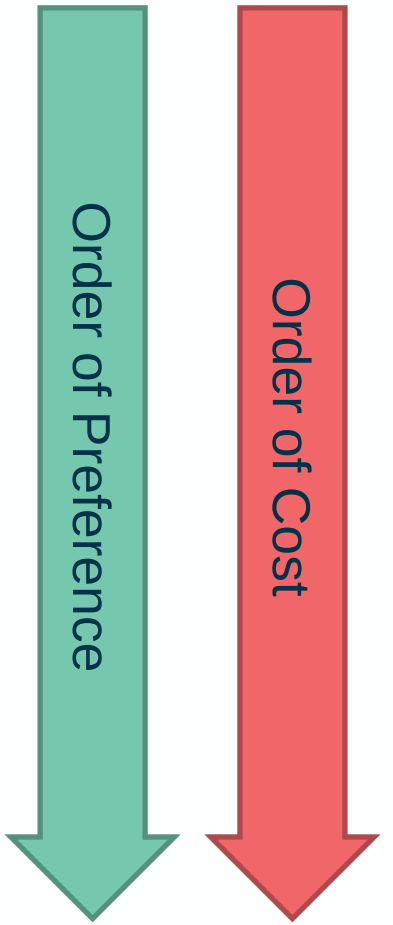
Verification Methods: iRat

Inspection
Conformance evaluation by observation and judgement accompanied as appropriate by measurement, testing or gauging
→ **Look**

Review of Design
Conformance evaluation by using approved records or evidence that unambiguously show that the requirement is met
→ **Write**

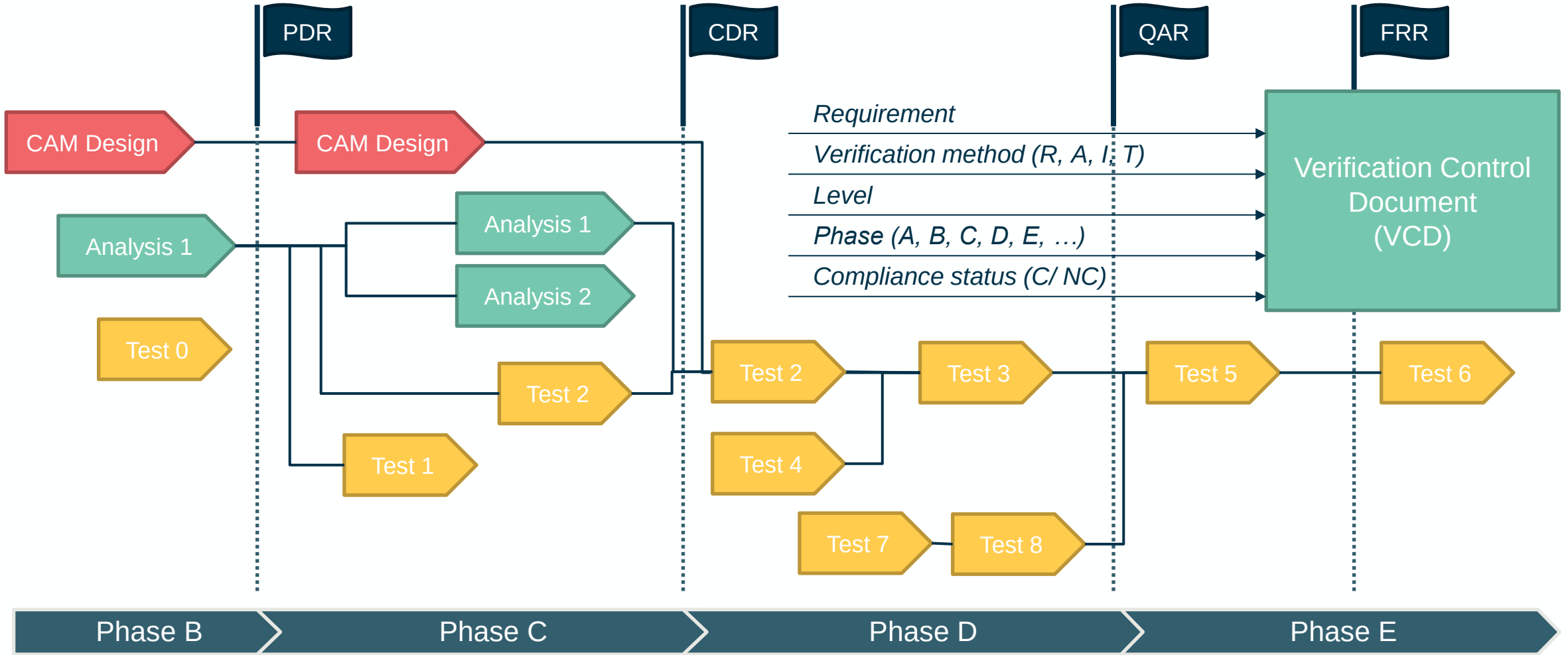
Analysis
Conformance evaluation utilizing techniques and tools
→ **Calculate**

Test
Measurement of product characteristics, performance or functions under representative environments
→ **Try**



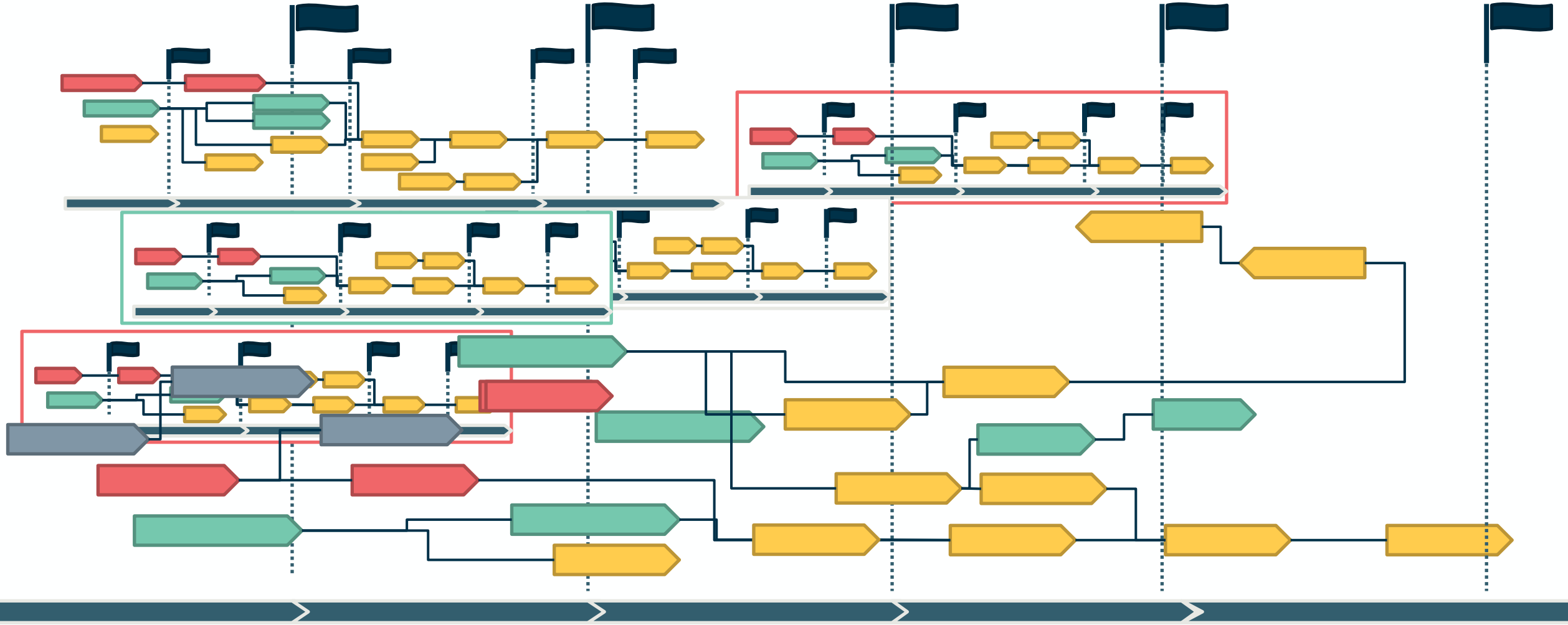
My Day Job: Test Engineer

The Verification Process



My Day Job: Test Engineer

But this is part of a much larger picture…



My Day Job: Test Engineer

Why Testing?

1. Design Verification

Verify that the design is working according to your expectations under the predicted environment

2. Assembly Behavior

Detect & verify unexpected issues when complex interactions between parts/subsystems are involved

3. Push it over the edge!

“Push your design to its limits” and understand its behaviour or response to unexpected situations

My Day Job: Test Engineer

How to Test? The different purposes behind “Testing”

Qualification Testing

- Test against the **design**
- The objective of qualification testing is the formal demonstration that the design implementation and manufacturing methods have resulted in **hardware conforming to the specification requirements**

- The qualification test levels shall exceed the maximum predicted levels by a **factor of safety** which assures that, even with the **worst combination of test tolerances and uncertainties**, the flight levels shall not exceed the qualification test levels. It covers build-to-build variations

- The qualification testing shall be conducted on dedicated **model (HW)** not flight that are produced from **the same design, using the same materials, tooling, methods and processes as the flight item**

Acceptance Testing

- Test against the **product**
- To demonstrate **conformance to specifications** and to act as quality control screens to **detect manufacturing defects and workmanship errors**

- Shall be conducted on flight models:
  - As formal tests to demonstrate the adequacy and **readiness for delivery** and subsequent **usage**;
  - Shall not create **conditions that exceed safety margins or cause unrealistic modes of failure** (the acceptance margins are environmental conditions more severe than expected during flight, but less severe than qualification)

- Shall be conducted on all the **flight products** (incl. spares)

My Day Job: Test Engineer

How to Test? The different purposes behind “Testing”

Proto-flight Testing

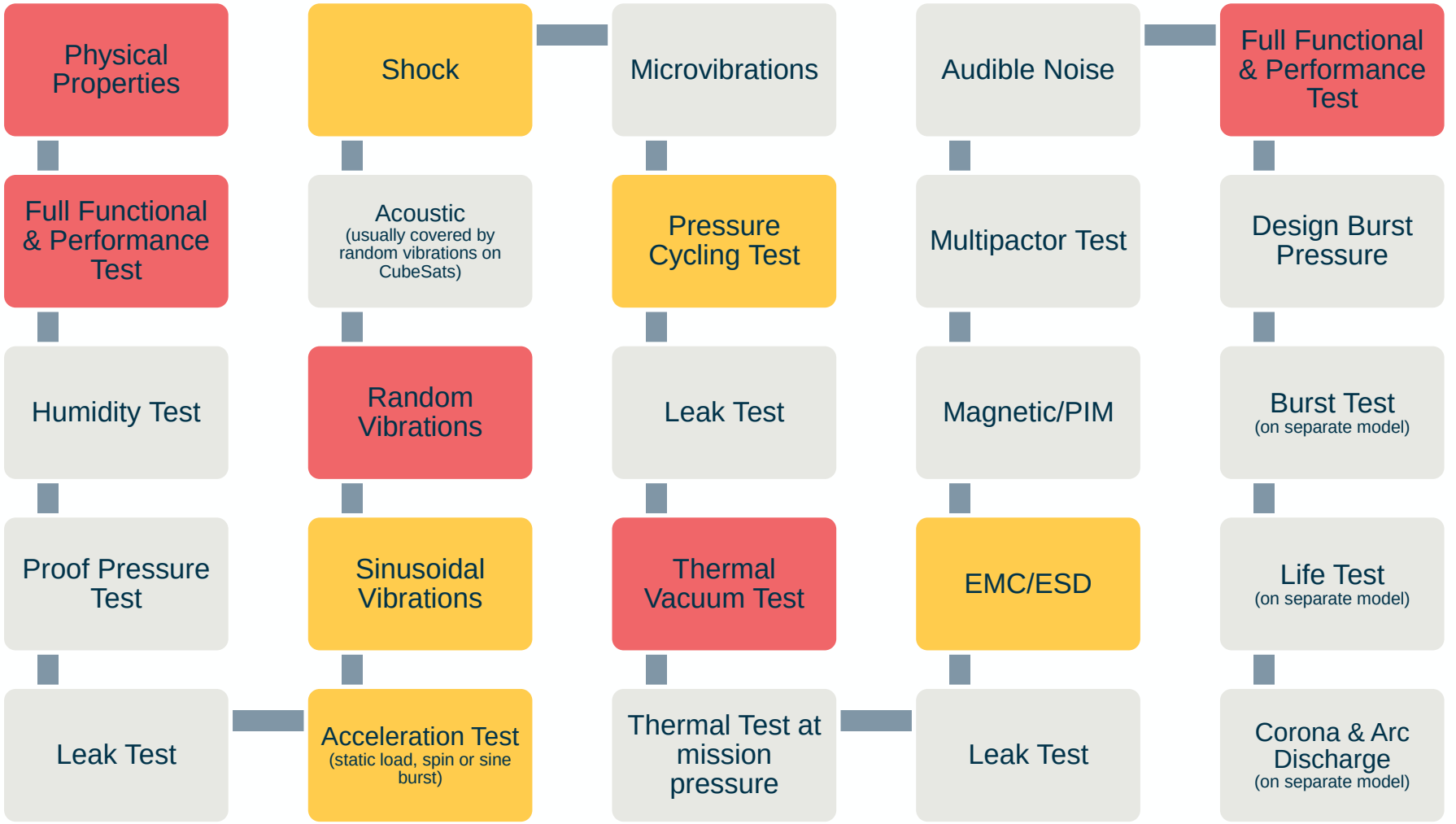
- A PFM is a popular approach to the construction and testing of the final flight Spacecraft, possibly with design heritage, and an experienced system developer. It shall be conducted on all the **products that will fly**
- The proto-flight approach (see ECSS-E-ST-10-02C) can present a **higher risk** than the prototype approach in which design margins are demonstrated by testing of a dedicated qualification product yet with considerable **advantages in cost and schedule reduction**
- A strategy to minimize the risk can be applied by **enhancing development testing**, by increasing the design factors of safety and by implementing an adequate spare policy
- The proto-flight test levels and durations shall be as follows:

Proto-flight test levels: as qualification margins
Proto-flight test durations: as acceptance durations

My Day Job: Test Engineer

Testing Sequence

Golden rule:
"Test as you fly, fly as you test"



My Day Job: Test Engineer

Verification Control Document

ID	Rqt. Name	Requirement	R	A	I	T	Verification	Close-out Reference
STR-DES-013	Structural stiffness	The structural stiffness of the PhotoSat primary structure shall guarantee a fundamental frequency above 600 Hz, to avoid dynamic coupling.		X		X	The structural stiffness of the PhotoSat contraption shall guarantee a fundamental frequency above 600 Hz, to avoid dynamic coupling.	A: Payload Structural Analysis Report, page 6, section 7
PAY-INT-020	Power interface	The PhotoSat Camera shall accept power at 5.0 ± 1.0 V.	X			X	Review of electrical design. Functional test.	R: Payload Definition File, page 4, section 3.2
PAY-LOG-040	Payload verification - TV tests facility	It shall be possible to test the PhotoSat subsystems on the Small Space Simulator thermal vacuum chamber of the CubeSat Support Facility at ESA/ESEC-Galaxia.	X				Review of interface definition. Inspection of as-built hardware.	R: Payload Definition File, page 7, section 4.1 and page 8, section 4.2

My Day Job: Test Engineer

Verification vs. Validation

Verification

Process which demonstrates through the provision of objective evidence that the product is designed and produced according to its specifications and the agreed deviations and waivers and is free of defects.

→ "***Did we build the system right?***"

VS

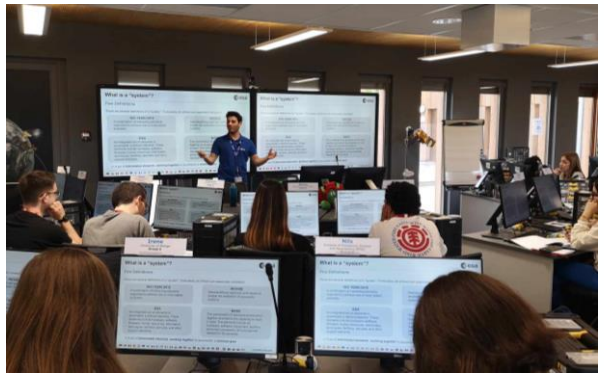
Validation

Process which demonstrates that the product is able to accomplish its intended use in the intended operational environment

→ "***Did we build the right system?***"

My Day Job

Chapter Three – Trainer: Because Even Stars Need a Coach



CubeSats Concurrent Engineering Workshop

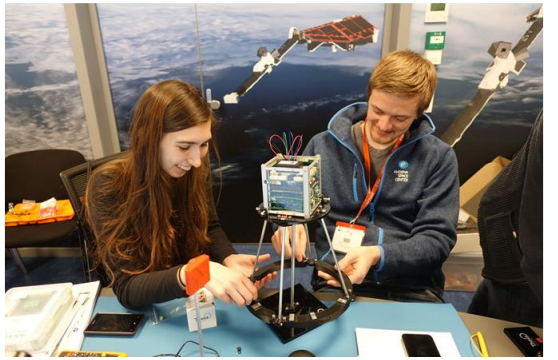
4-day training course

Apply concurrent engineering practices while designing a CubeSat mission

CubeSat Summer School

4-week training course

Mix of lectures and hands-on activities covering the entire project lifecycle of a satellite mission, including project management, legal, cybersecurity, economic aspects and entrepreneurship



CubeSat Hands-on Training Week

5-day training course

Get hands-on experience with CubeSats and apply theoretical knowledge obtained from classroom lectures

Spacecraft Testing Workshop

5-day training course

Receive lectures on testing and prepare and execute an environmental test campaign at the CubeSat Support Facility

The CubeSat Support Facility

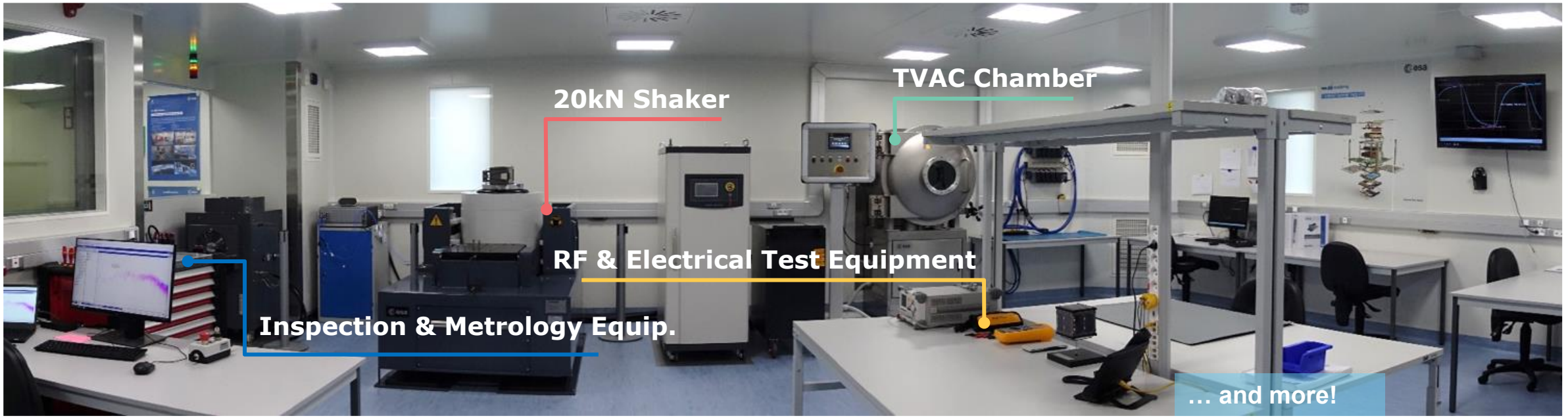
Where CubeSats learn to survive (and Students learn to thrive)

The CubeSat Support Facility

What is the CSF?

The **CubeSat Support Facility** is an **Assembly, Integration and Verification facility**, designed and equipped according to **professional quality standards**. It was inaugurated in 2018.

It is composed of an **ISO-8 cleanroom** facility and a small workshop. It hosts a variety of equipment that is readily available for visiting students.



The CubeSat Support Facility

Why does the CSF exist?

The CSF is not only a testing laboratory – it is also an **educational facility!**

Its main purpose is to support the AIV activities of **ESA Academy's hands-on programmes** by providing…

Support in the preparation and execution of **verification activities**

"Easy" access to a test facility **all year round**

A classroom environment, where students can learn **best practices** and **get hands-on experience**.

The CubeSat Support Facility – Vibration Tests

Purpose of Vibration Tests

Why shaking my CubeSat??

Qualification/Acceptance

- **The spacecraft hardware can withstand, and function** as needed after (and during, for any equipment that must operate during launch) exposure to cyclic loading associated with launch vibration and, to some extent, verify the fatigue life of the materials;
- Electrical **connectors will remain seated** during the launch environment;
- The satellite will maintain **general integrity**, e.g., no bolted joints loosening because of lost fastener preload and no parts coming loose or free from containment
- The satellite meets any specified constraints on natural frequencies (typically applies to the launch configuration in order to avoid dynamic coupling with the launch vehicle and subsequent high loads).

Correlation

To acquire data that will enable correlation/validation of the finite element model for use in coupled loads analysis and any other important analyses.

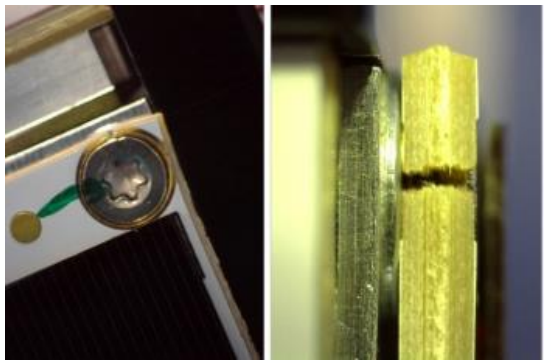
The CubeSat Support Facility – Vibration Tests

Possible Failures

Reminder

Under a single application of stress/loads, a failure can happen such that:

- Rupture, crack
- Collapse (severe structural failure)
- Yielding, resulting in permanent deformation (relevant if degrading form, fit, or function)



How to anticipate this?

Two structural specifications must be considered when planning for testing:

- **Strength**: the highest load a structure can withstand (or the highest stress a material can withstand) without failure
- **Life**: the number of cycles (or duration) of load or stress before failure
  → under cyclic stress a crack may be generated and then propagate to rupture (fatigue of metals)

A structure or material can undertake defined stresses (cycles) or loads before failure occurs.

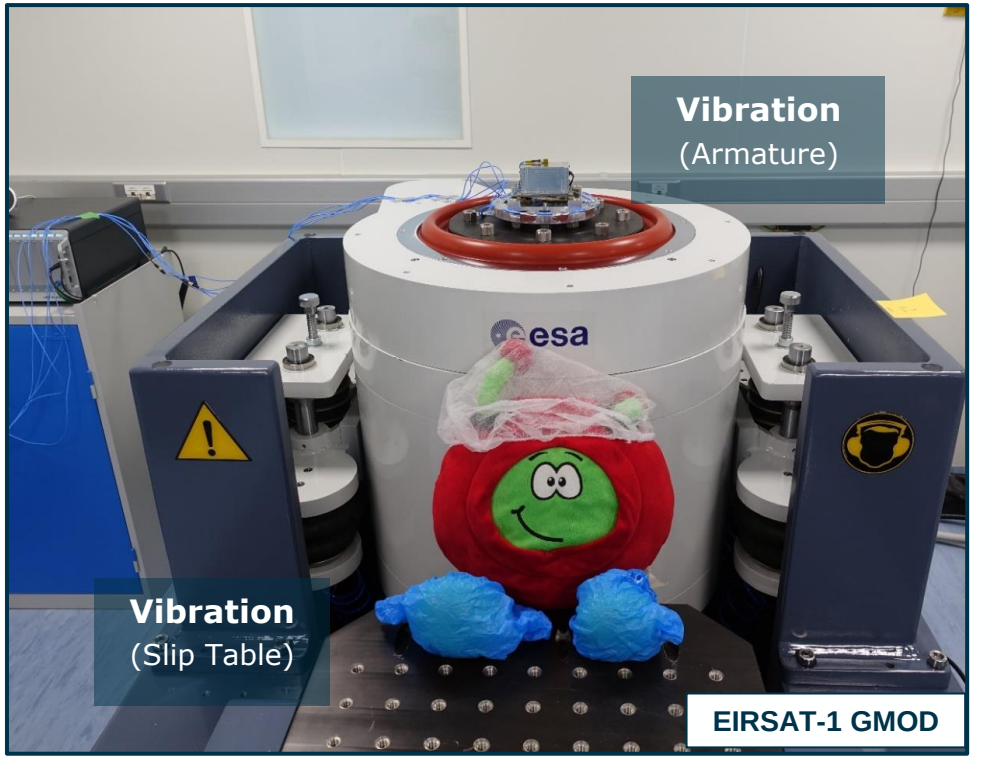
The CubeSat Support Facility – Vibration Tests

Hardware: Electrodynamic shaker

20kN Electrodynamic Shaker

Equipment that **inputs force that is proportional to an electrical current** (drive) passing through a coil of wire moving a permanent magnet (armature):

- Force causes an acceleration that **depends on the amount of mass moving** (DUT + Armature and others)
- Slip table enables **3-axis vibration tests**, Oil is used to reduce friction
- **Closed-loop system**: Current is automatically adjusted until the control channel measures the desired acceleration

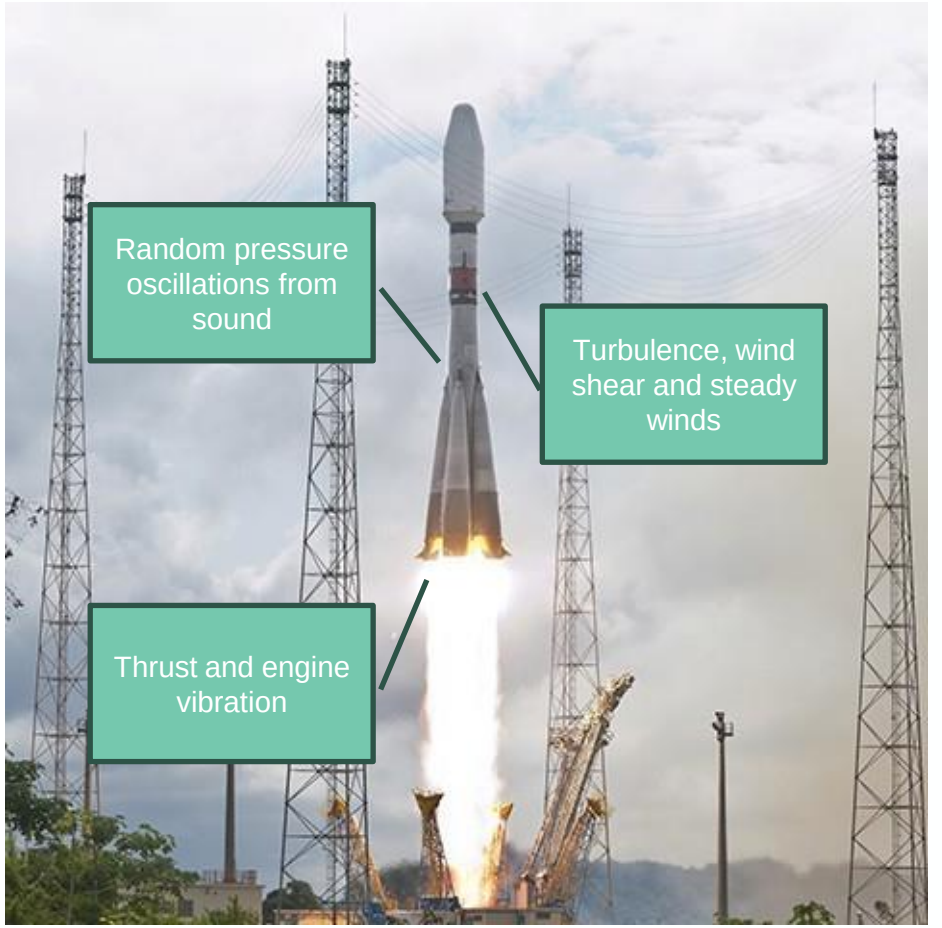


The CubeSat Support Facility – Vibration Tests

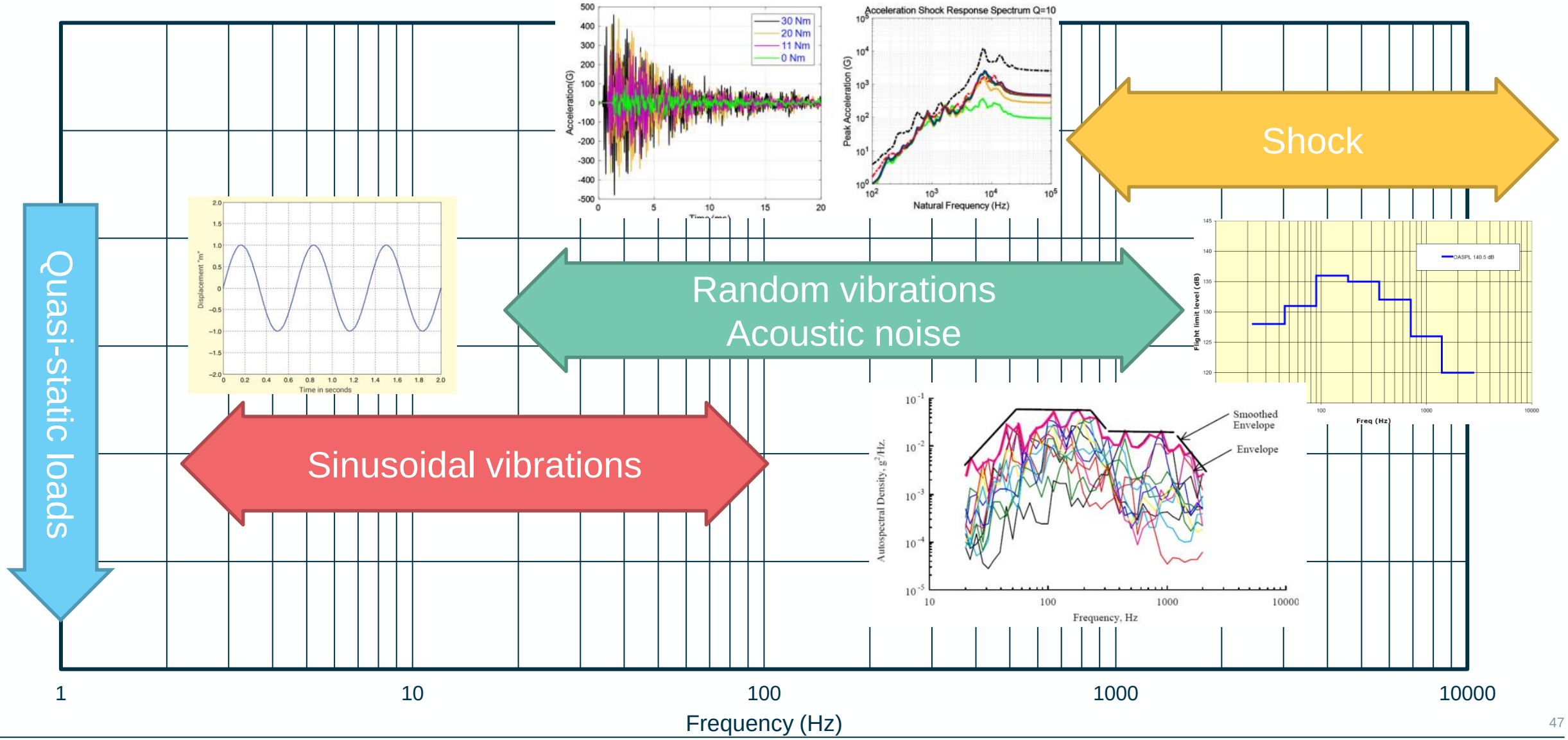
Withstand what exactly? Environment during Launch!

Harsh Launch Environment

- Rocket Motor Ignition Overpressure
- Lift-off Loads
- Engine/Motor Generated Acoustic Loads
- Engine/Motor Generated Structure-borne Vibration Loads
- Engine/Motor Thrust Transients
- Pogo Instability, Solid Motor Pressure Oscillations
- Wind and Turbulence, Aerodynamic Sources
- Liquid Sloshing in Tanks
- Stage and Fairing Separation Loads
- Pyrotechnic Induced Loads
- Depressurisation

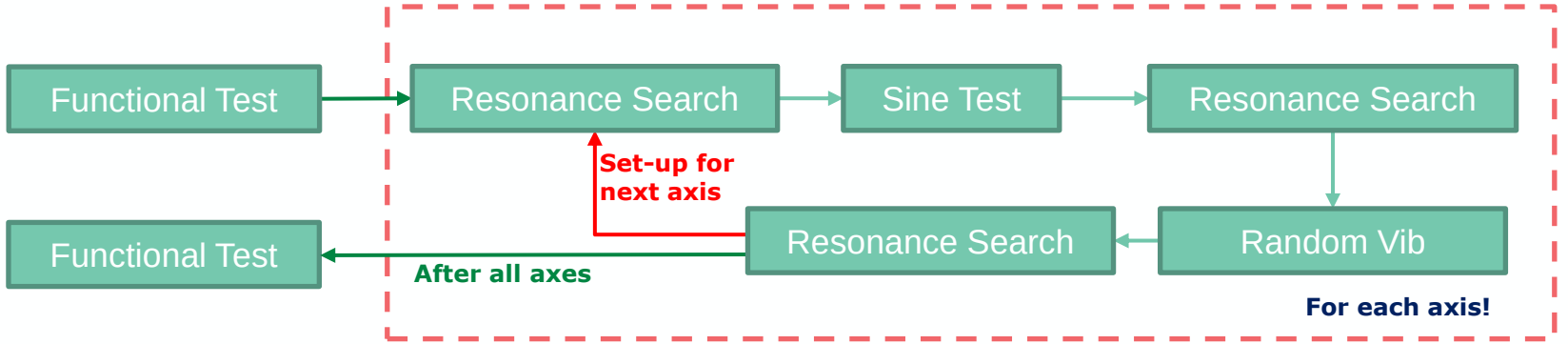


The CubeSat Support Facility – Vibration Tests



The CubeSat Support Facility – Vibration Tests

Typical Test Sequence

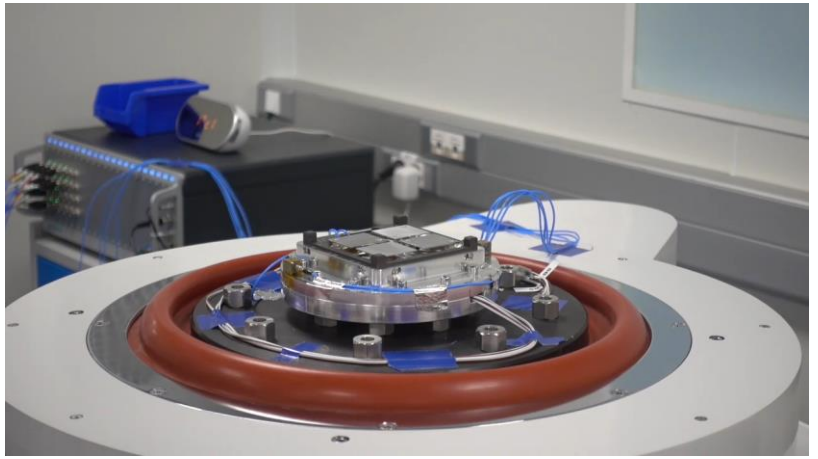


ISTsat SpareSat Random Vibration Test (Aug 2022)

Good to Know

Reduced functional tests are performed only at the **beginning** and **end** of the vibration campaign, to establish a functional comparison. However, visual inspections and vibration test result analyses are carried out frequently

ISTsat SpareSat Quasi-Static Vibration Test (Aug 2022)



EIRSAT EMOD-TCA Sine Vibration Test (Nov. 2019)

The CubeSat Support Facility – Vibration Tests

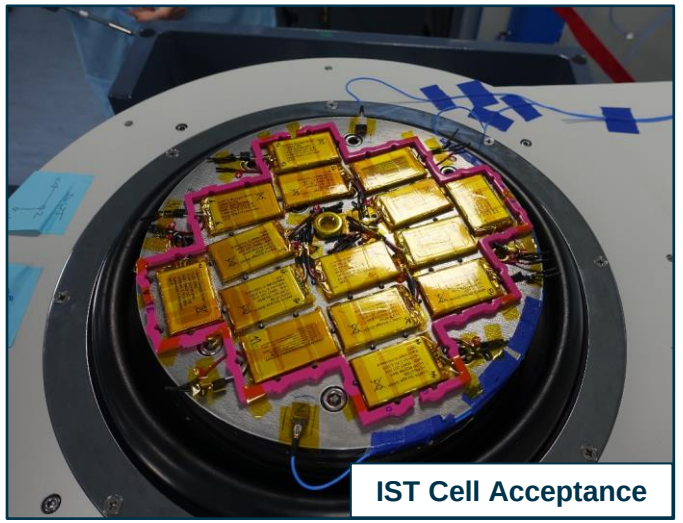
Examples: Subsystem-level Vibration Tests


IST Pack Qualification


EIR ADM Qualification


EIR EMOD Qualification


EIR GMOD Qualification


IST Cell Acceptance


LEDSAT LED Controller Board

The CubeSat Support Facility – Thermal Tests

Purpose of Thermal Tests

Why cycling my CubeSat??

Qualification/Acceptance

- Demonstrate survivability under the extreme temperature ranges experienced in space, including both high and low extremes
- Verify that the test article can successfully turn on and function at both high and low temperatures. Ensure no functional deterioration or performance degradation occurs over the expected operational temperature range
- Confirm that the thermal performance aligns with design specifications and manufacturing tolerances. Environment stress screening for unit acceptance
- Detect latent defects through thermal cycling and exposure to temperature extremes, ensuring long-term reliability

Correlation

To acquire data that will enable correlation/validation of the thermal model

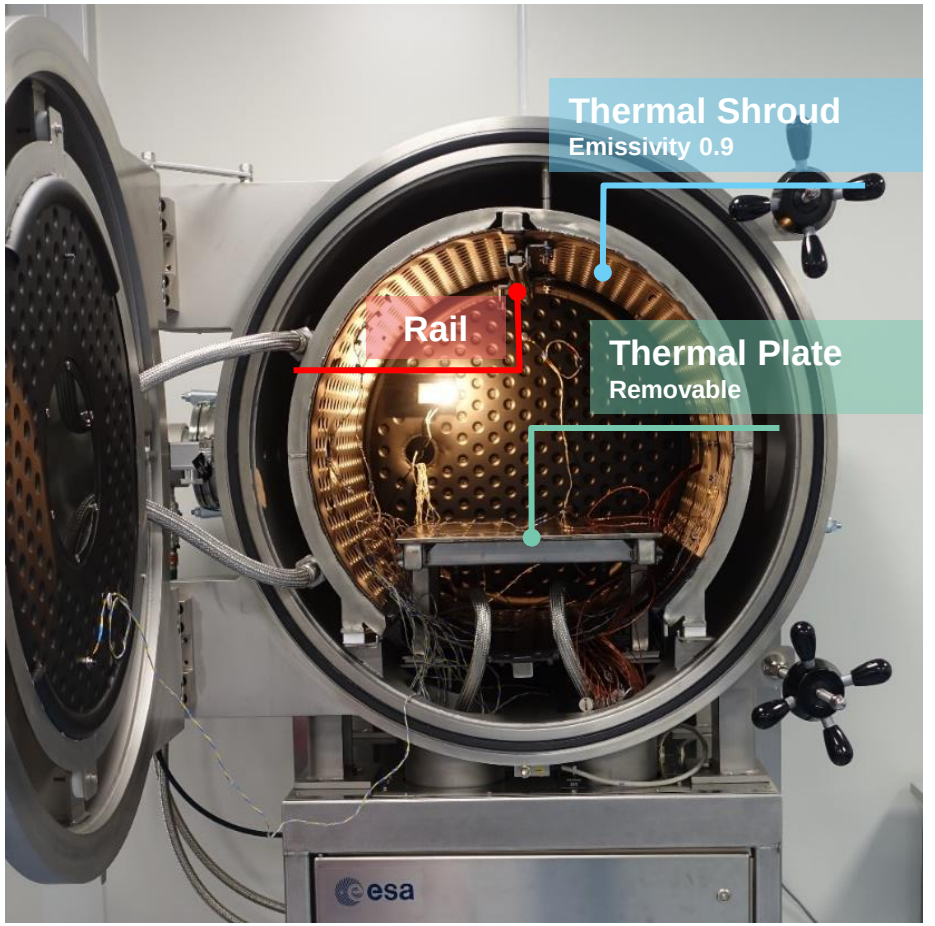
The CubeSat Support Facility – Thermal Tests

Thermal-Vacuum Chamber (TVAC)

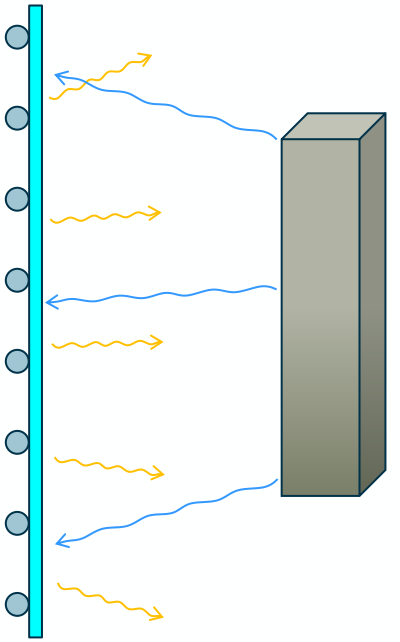
➔ Used to perform **thermal-vacuum cycling and functional tests, thermal-balance tests** and others.

Key Figures	
Temperature Range	**-60C** to **+100C**
Ultimate Vacuum	~ 10^{-7} mbar
Useful Size (⌀) x (L)	600 mm x 700 mm

➔ **Consider the limitation and added values of testing with thermal shrouds and plate!**



Thermal shrouds and Plate



Only thermal shrouds and plate
Flux homogeneity: very good
Flux/temperature knowledge: very good

The CubeSat Support Facility – Thermal Tests

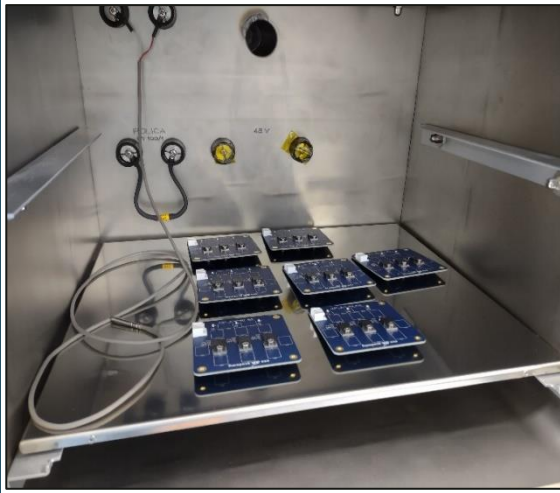
Vacuum Oven

- ➔ Can be used for **bake-out** of subsystems, harnesses and other support equipment.
- ➔ May also be used for **curing glue** and other processes (shorten curing time)

Bake-out is normally requested by the launch authority. Example for CubeSats:

- At least 25 hours at 50 degrees

Key Figures	
Temperature Range	Ambient to +200C
Ultimate Vacuum	~ 10^{-2} mbar
Useful Size (⌀) x (L)	405 x 340 x 370 mm



The CubeSat Support Facility – Thermal Tests

Thermal Test Overview

Thermal Vacuum Test

System level test **under vacuum conditions** at minimum and maximum - to be expected – temperatures

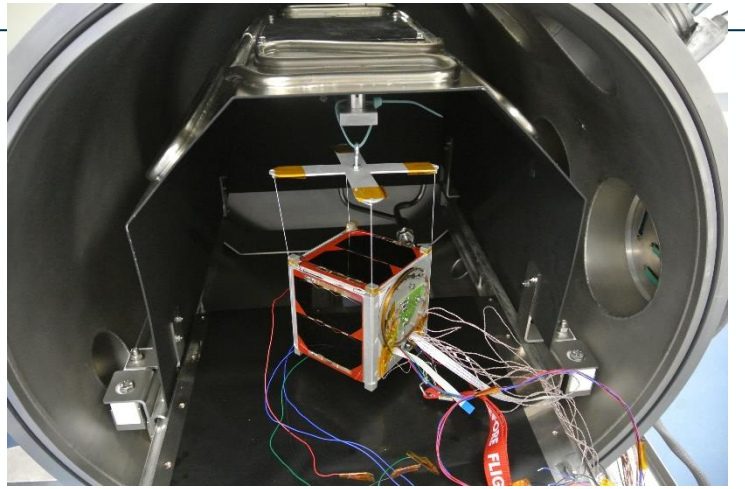
Thermal Cycling Test

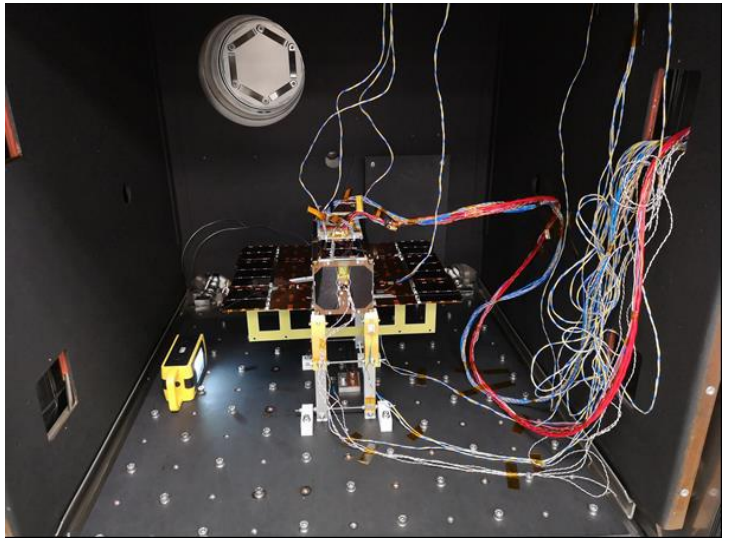
Product assurance (PA) **test** under ambient pressure or vacuum to acceptance (FM) or qualification (QM/PFM) temperature range.

Thermal Balance Test (“the” thermal test)

Thermal model correlation and thermal design verification

Often these tests are combined





OPS-SAT in RUAG Vienna TVac chamber
Credit: TU Graz & partners

The CubeSat Support Facility – Thermal Tests

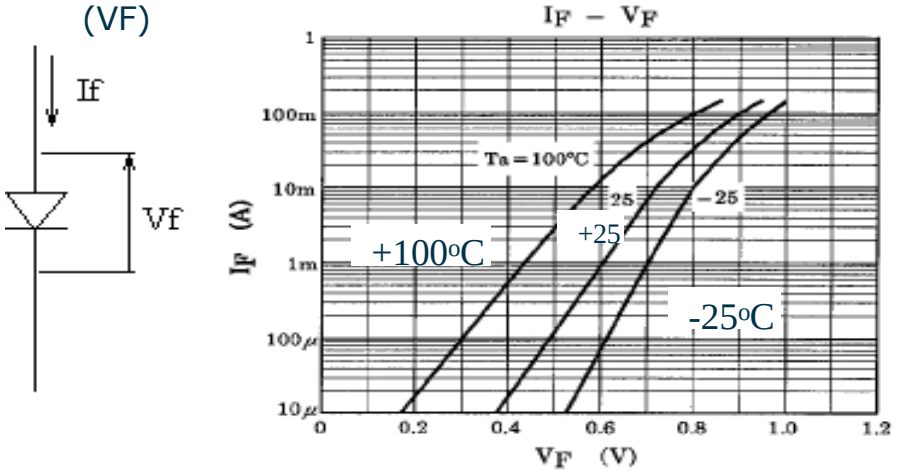
Why doing Thermal Tests?

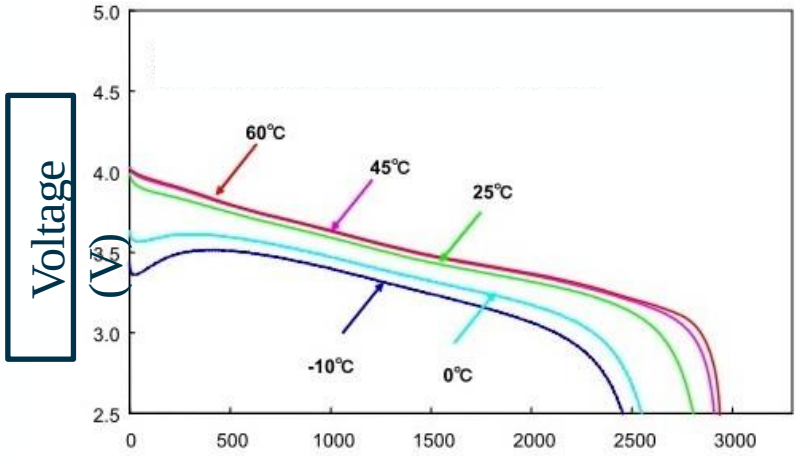
- Semiconductor characteristics depend on temperature:
  - Items that worked at room temperature **may not work** at high or low temperatures with the same performances

Dependence of lithium-ion battery **discharge characteristics** on temperature:

- Ion conductivity depends on temperature. The lower the temperature, the lower the conductivity, increase of internal impedance

Forward current (IF) and Forward voltage (VF)





The CubeSat Support Facility – Thermal Tests

Why doing Thermal Tests?

Semiconductors

Semiconductor characteristics depend on temperature

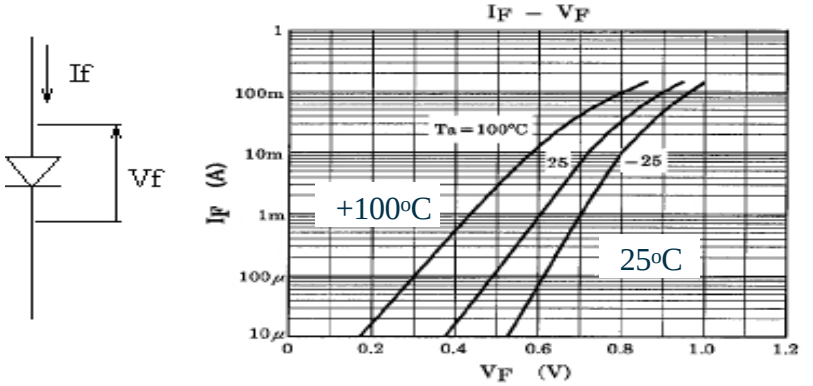
Items that worked at room temperature may not work at high or low temperatures with the same performances

Discharge characteristics

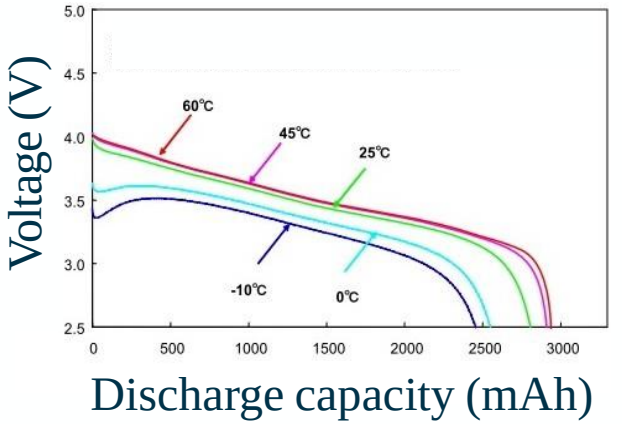
Dependence of lithium-ion battery discharge characteristics on temperature

Ion conductivity depends on temperature. The lower the temperature, the lower the conductivity, increase of internal impedance

Forward current (IF) and Forward voltage (VF)



Voltage – Discharge capacity under different thermal conditions

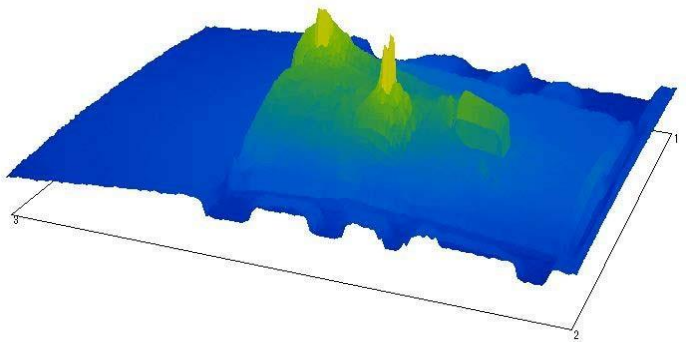


The CubeSat Support Facility – Thermal Tests

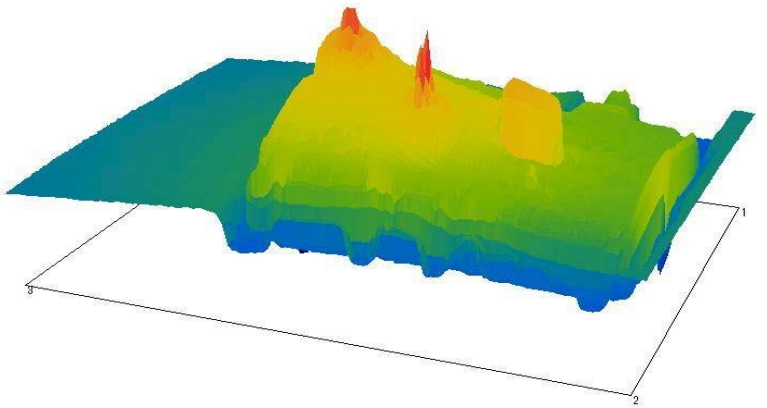
Why doing Thermal Tests?

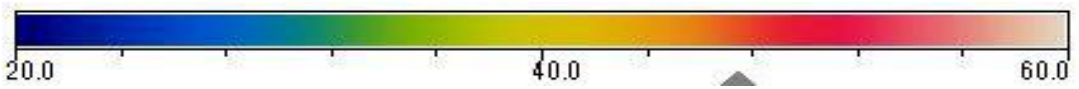
PCB temperature distribution in Vacuum

Atmosphere



Vacuum

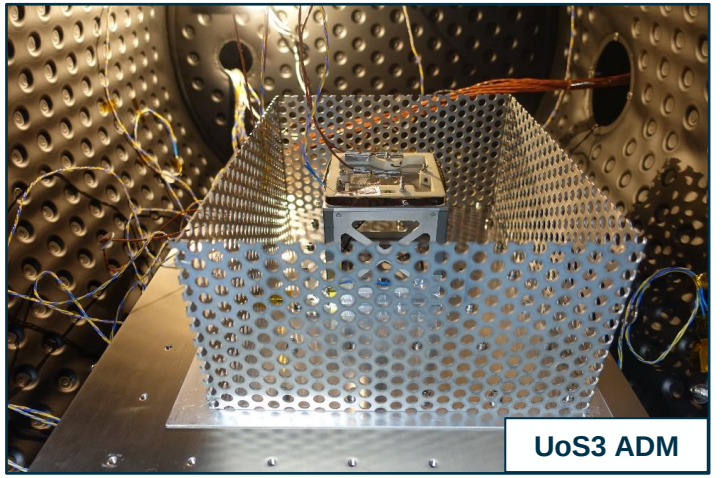


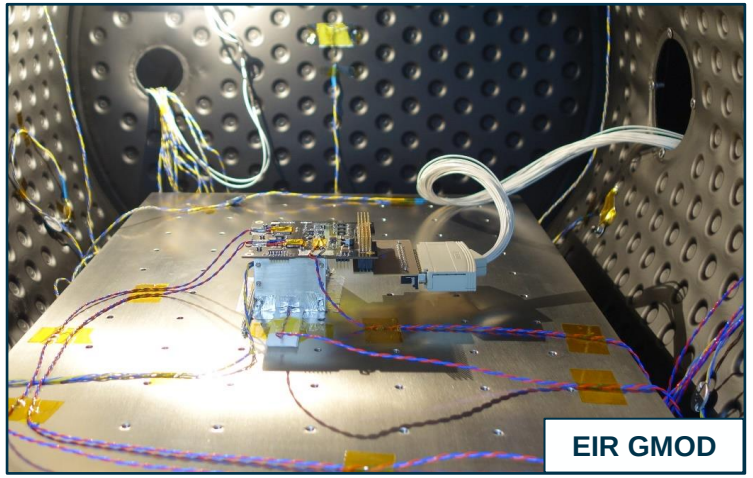


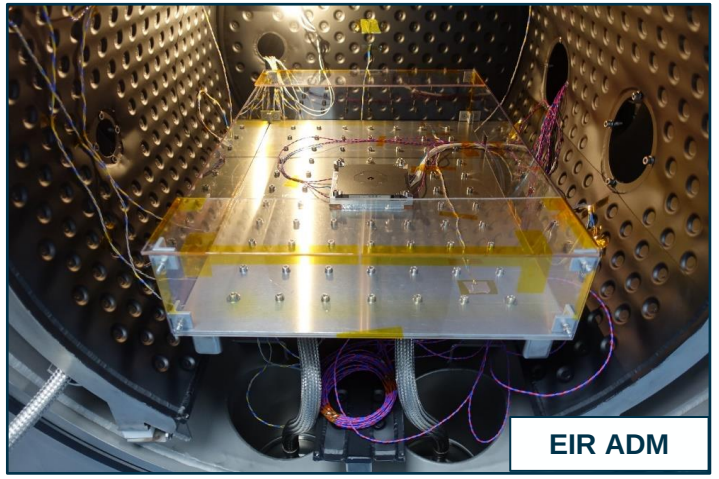
The CubeSat Support Facility – Thermal Tests

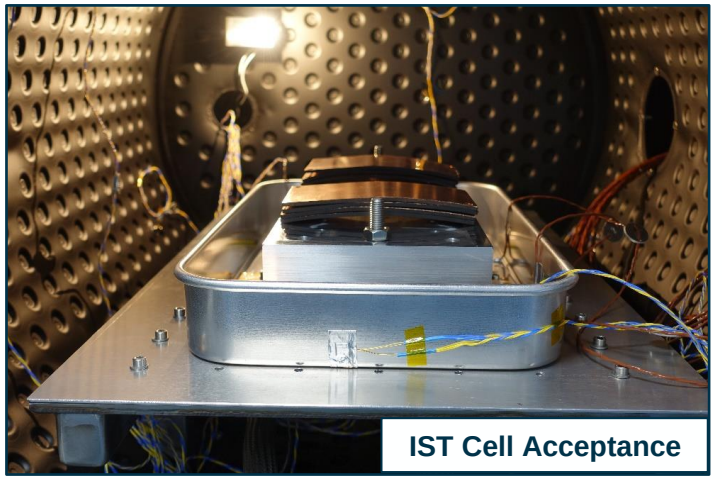
Examples: Subsystem-level Thermal Tests

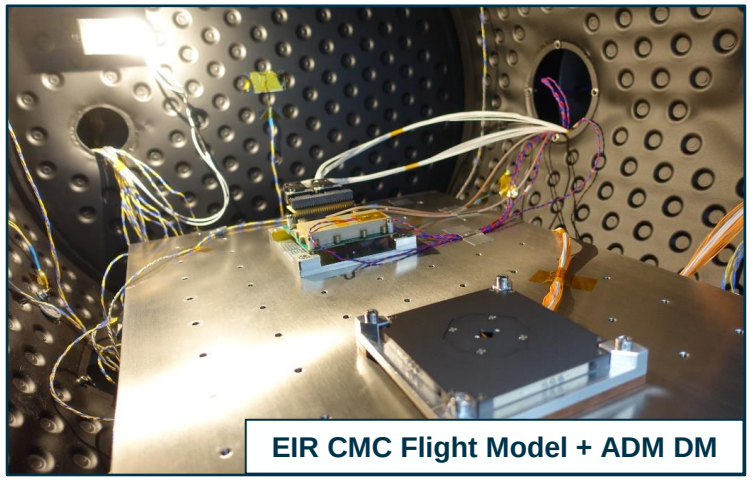

3Cat-4 NADS Qualification


UoS3 ADM


EIR GMOD

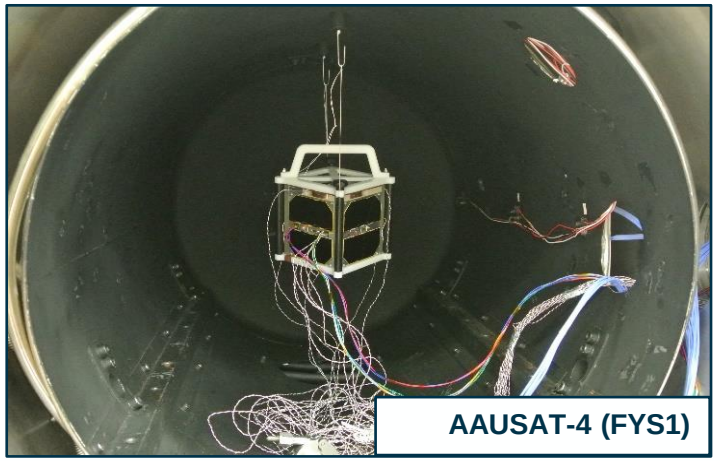

EIR ADM


IST Cell Acceptance

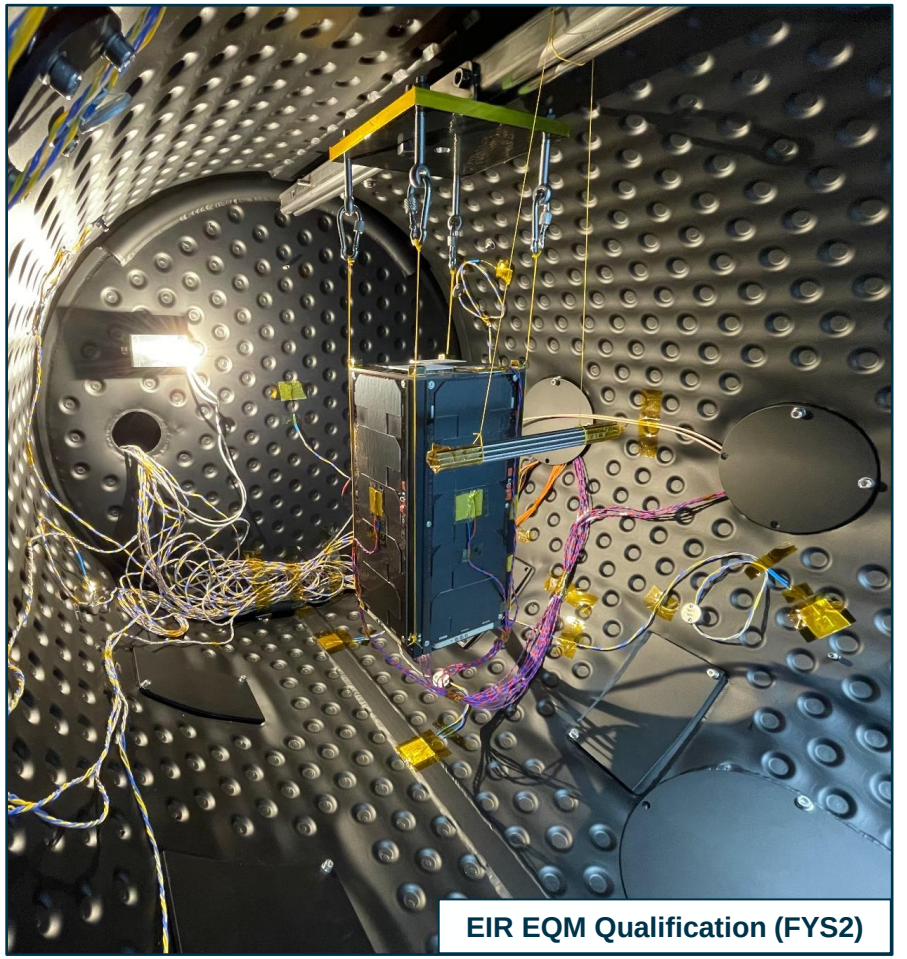

EIR CMC Flight Model + ADM DM

The CubeSat Support Facility – Thermal Tests

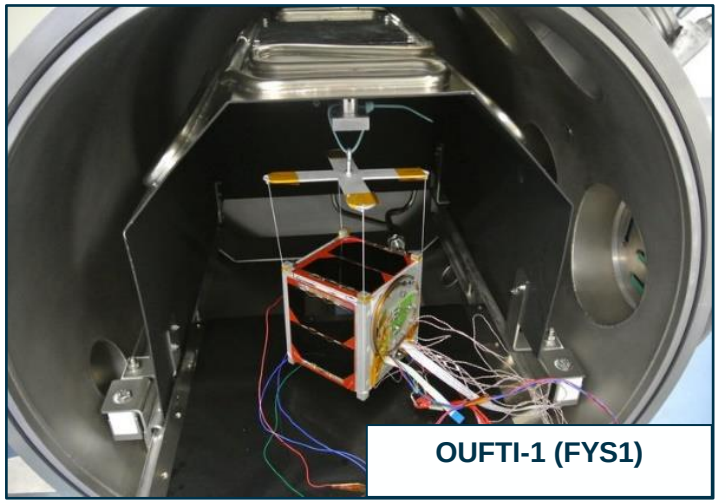
Examples: System-level Thermal Tests



AAUSAT-4 (FYS1)



EIR EQM Qualification (FYS2)



OUFTI-1 (FYS1)

ESA Academy: Because Space Needs More Than Astronauts

ESA UNCLASSIFIED – Releasable to the Public

What does ESA Academy offer?

ESA Education 2030 programme architecture

STEM LEARNING & INSPIRATION

esero framework

LEARN WITH SPACE

ESERO-LED with ESA SUPPORT

- NATIONAL TEACHER/ EDUCATOR TRAINING
- DIDACTICS RESOURCES
- PROJECTS

- NATIONAL 3rd PARTIES COLLABORATION

ESA-LED with ESERO SUPPORT

- INTL TEACHER/ EDUCATOR TRAINING WORKSHOPS (ESEC)
- INTL TEACHER/ EDUCATOR TRAINING CONFERENCES
- INTL COMMUNITY OF PRACTICE

LET SPACE INSPIRE YOU

- SPACE EVENTS
- THE ESA EXPERIENCE
- ASTRONAUT ACTIVITIES
- PLAY & EXPLORE

- CAREERS FOR YOU
- BOOK A SPACE PRO
- EDUCATION WEB TV
- EUROPEAN SPACE FOR EDUCATION CONFERENCE

ESA ACADEMY

ENGAGEMENT

- SCHOLARSHIPS
- INTERNSHIPS
- CONFERENCES
- ADDITIONAL LEARNING OPPORTUNITIES

TRAINING

- TRAINING SESSIONS
- ONLINE LEARNING LIBRARY

PROJECTS

- EXPERIMENTS
- SATELLITES
- ROCKETS

What does ESA Academy offer?

ESA Academy

18+ y/o — **ESA ACADEMY**

TRAINING

TRAINING SESSIONS
- Online training sessions
- Onsite training sessions
- Hybrid training sessions

ONLINE LEARNING LIBRARY

PROJECTS

EXPERIMENTS
- Large Diameter Centrifuge
- Parabolic Flights
- Drop Towers
- Orbital Robotics Laboratory
- Space Rider
- International Space Station

SATELLITES
- Fly Your Satellite
- Fly Your Satellite - Design Booster
- Fly Your Satellite - Test Opportunities

ROCKETS
- Fly a Rocket
- REXUS/BEXUS

ENGAGEMENT

SCHOLARSHIPS
- Summer schools
- Academic programmes

INTERNSHIPS

CONFERENCES
- Student sponsorships
- European Space Education Conference

ADDITIONAL LEARNING OPPORTUNITIES
- Downstream hackathons
- Student Aerospace Challenge
- European Rocketry Challenge
- External partners' training courses

CAREERS FOR YOU

BOOK A SPACE PRO

EDUCATION WEB TV

Training and Learning Programme

Facility

Training and Learning Facility ESA/ESEC-Galaxia (BE) + online

What

1–4 week intensive training sessions delivered by ESA, industry and academic experts

When

Continuous, 1-2 sessions per month

Who

Individual

Bachelor/Master/PhD -> + vocational / YP

Opportunity

Regular calls for applications

Training and Learning Programme

Portfolio

Clean Space Training Course	Introduction to Space Law Training Course	Space Debris Training Course
CubeSat Summer School	Spacecraft Communications Training Course	Space Weather Training Course
Concurrent Engineering Challenge	Earth Observation Remote Sensing Workshop	Spacecraft Testing Workshop
Navigation Training Course	Product Assurance Awareness Training Course	Standardization Training Course
Human Space Physiology Training Course	Cybersecurity	…

Training & Learning Facility

Early Careers at ESA

- Student Internship Programme
- Young Graduate Trainee Programme
- National Trainee Programme
- Conference Student Sponsorship Programme
- Academic Scholarship Programme

Student Internships

Students in final year of their Bachelor’s degree
or studying for a Master's degree

Space Sector experience as part of the studies
- ✓ Fulfilling internship requirements for graduation
- ✓ Final Thesis contribution

3 - 6 month placement, can be split into two parts

Around 100 students each year, e.g. around 75 at ESTEC

Opportunities published in autumn
Apply here

Young Graduate Trainees (YGT)

Recent Masters Degree graduates, with limited professional experience

Preparation for a job in Europe’s space industry / research institutes

One-year contract, a second year extension may be granted

Rich personal and professional experience of living and working in another country in a diverse and international environment

Young Graduate Trainees (YGT)

More than 100 opportunities every year

YGT opportunities in engineering, science, IT, natural/social science, business and administration

- February – March: Publication of YGT opportunities on Careers at ESA
- March – May: Pre-selection and interviews of shortlisted candidates
- June: Outcome of interviews and final selection made by ESA
- September - October: Take up duty for successful candidates

Explore our Young Graduate Trainee opportunities here

National Trainees

Young, recent master graduates from Belgium, Estonia, Ireland, Luxembourg and Switzerland

Bilateral agreements between ESA and the national space entities

On-the-job training – tutor supervision and guidance

One-year contract, with a possible extension for an additional year

25 national trainees every year

Recruitment procedure is run by the national agencies and ESA's HR

Conference Student Sponsorship Programme

Enrolled in a tertiary education academic programme

Present your work at a space-related conference

Expected cost covered: registration fee, travel and accommodation costs (up to a ceiling amount)

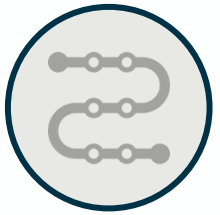
Opportunities are published throughout the year
Apply here

Academic Scholarship Programme

Students that are fully graduated from the first cycle (Bachelor’s degree) before the beginning of the Master’s programme

Access space-related second cycle academic programme (awarding a Master’s degree)

Tuition fees

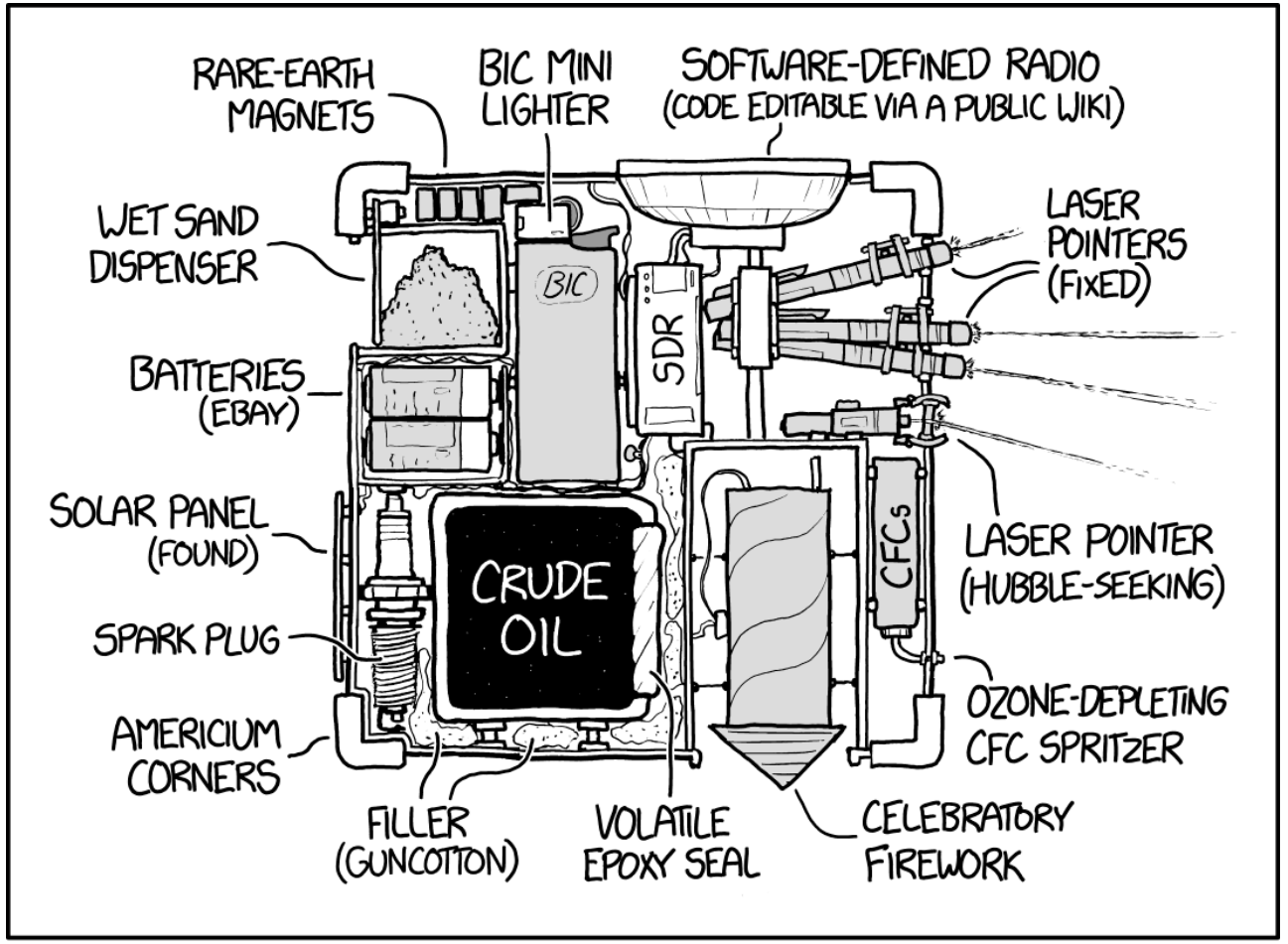


Opportunities are published throughout the year
Apply here

Conclusions and Lessons Learned

ESA UNCLASSIFIED – Releasable to the Public

Q&A



Thanks for the attention!
Looking forward to seeing you again!

Contact

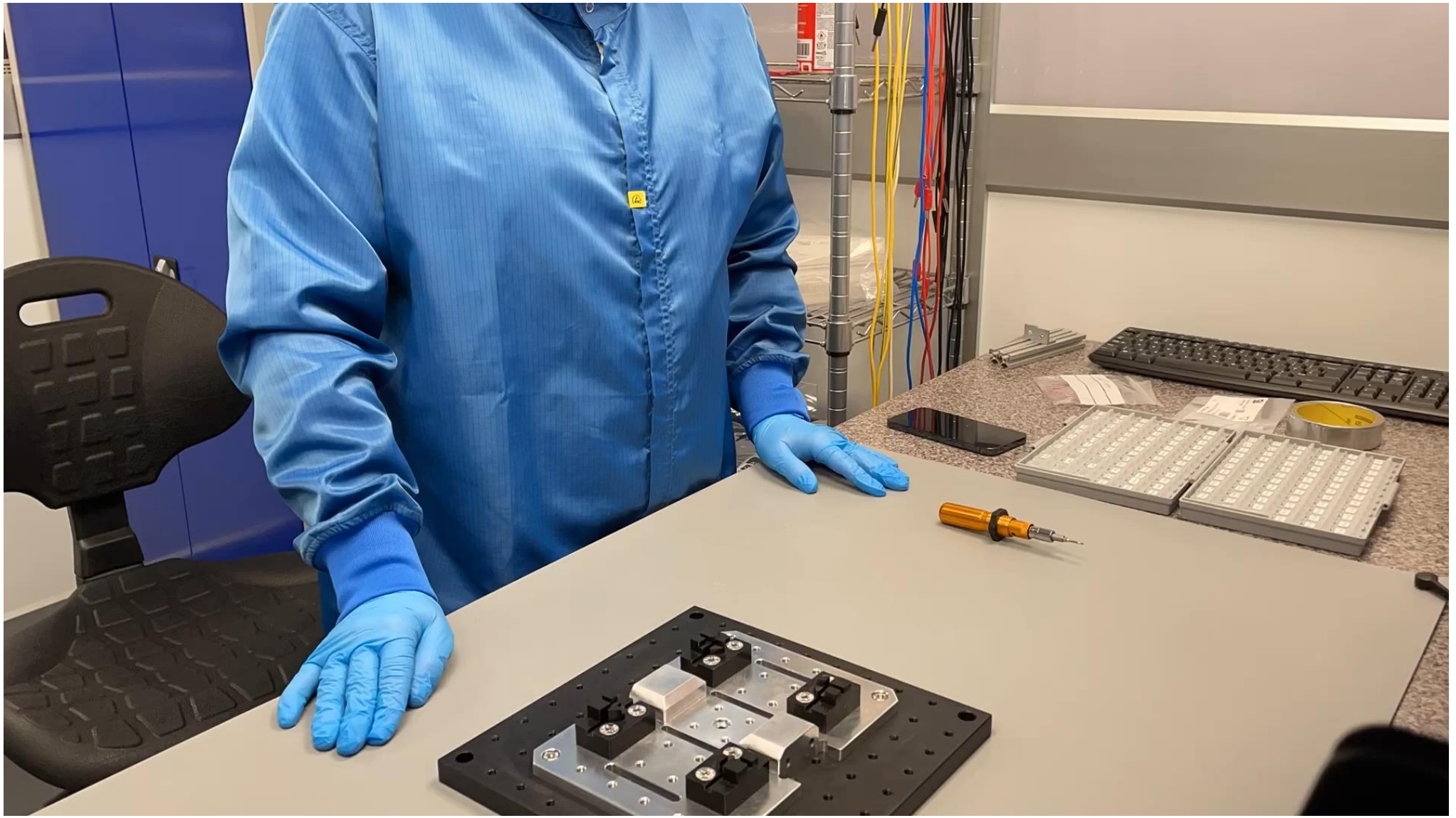
maxime.alves@ext.esa.int

cubesats@esa.int

Bonus Slides: EIRSAT-1

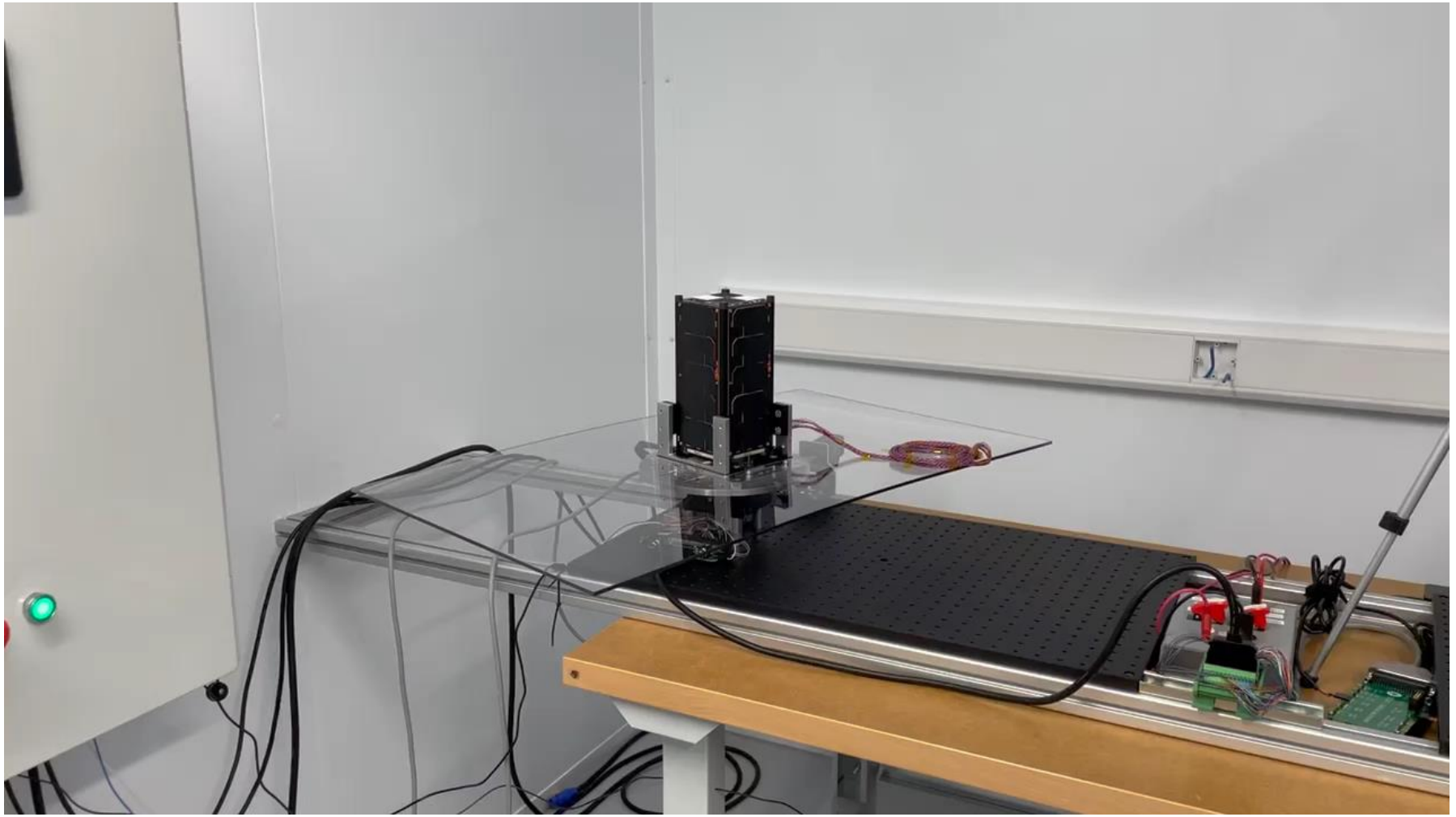
ESA UNCLASSIFIED – Releasable to the Public

Assembly and Integration

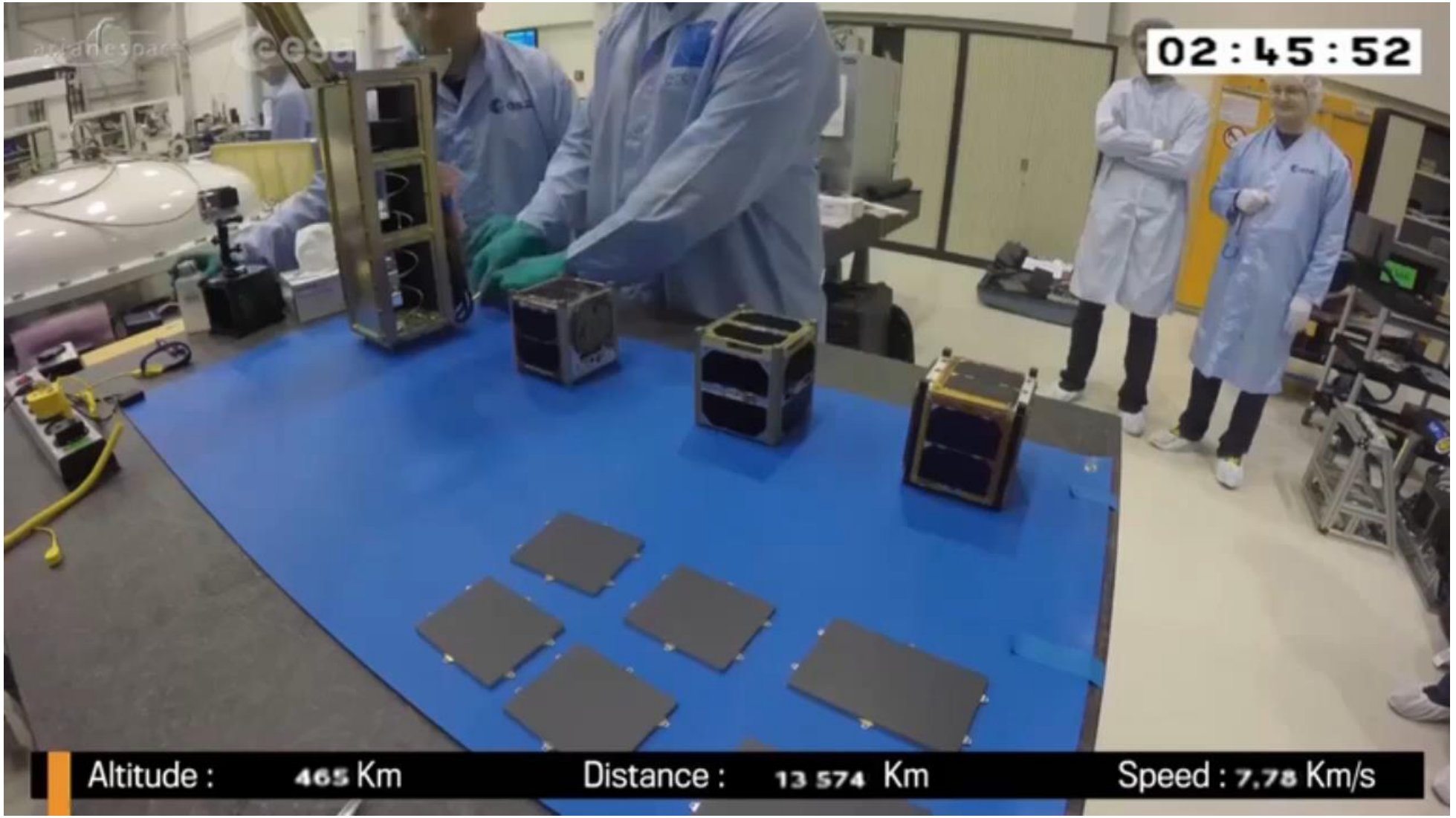


Testing

Example: Antenna Deployment Module (ADM)



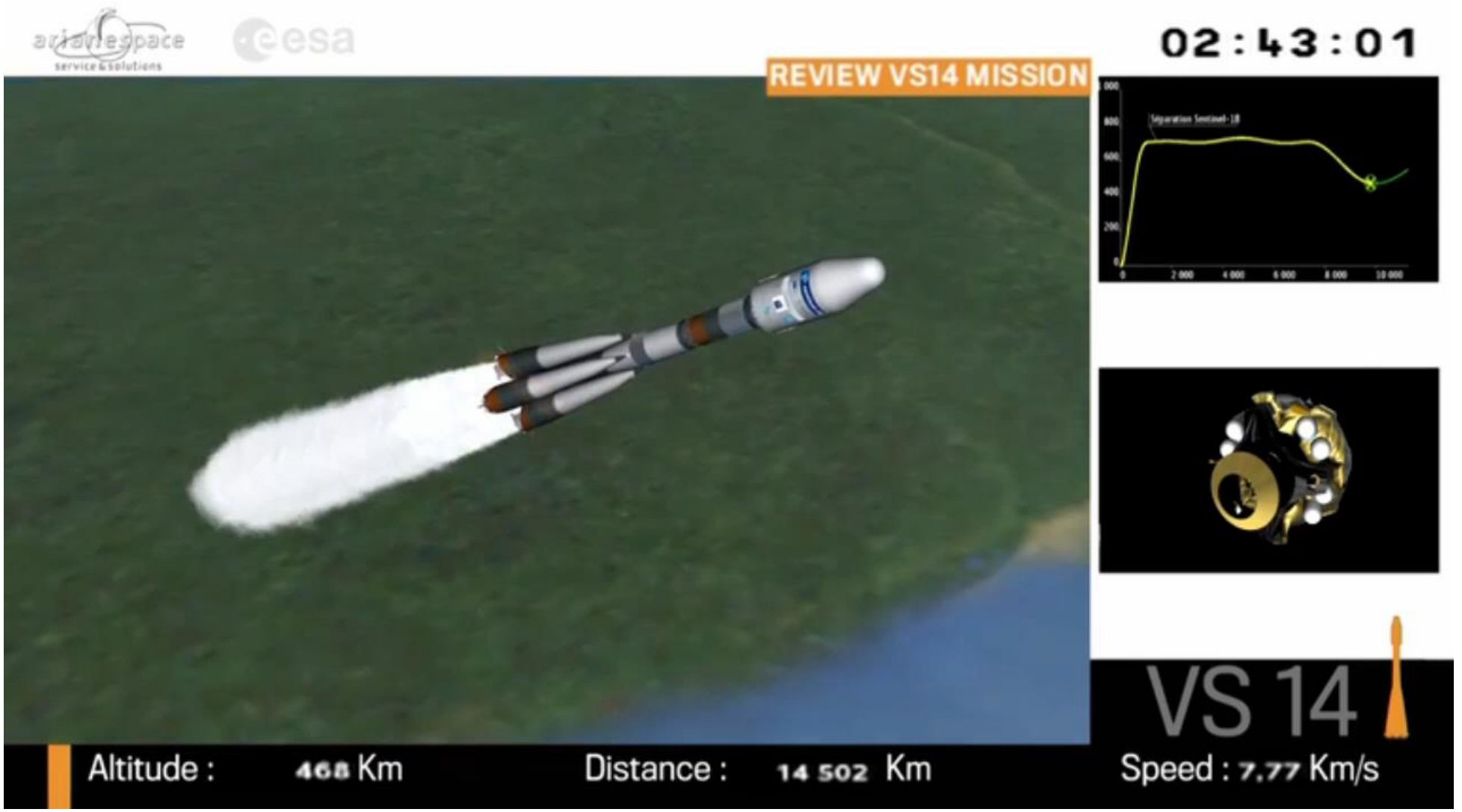
To Launcher integration



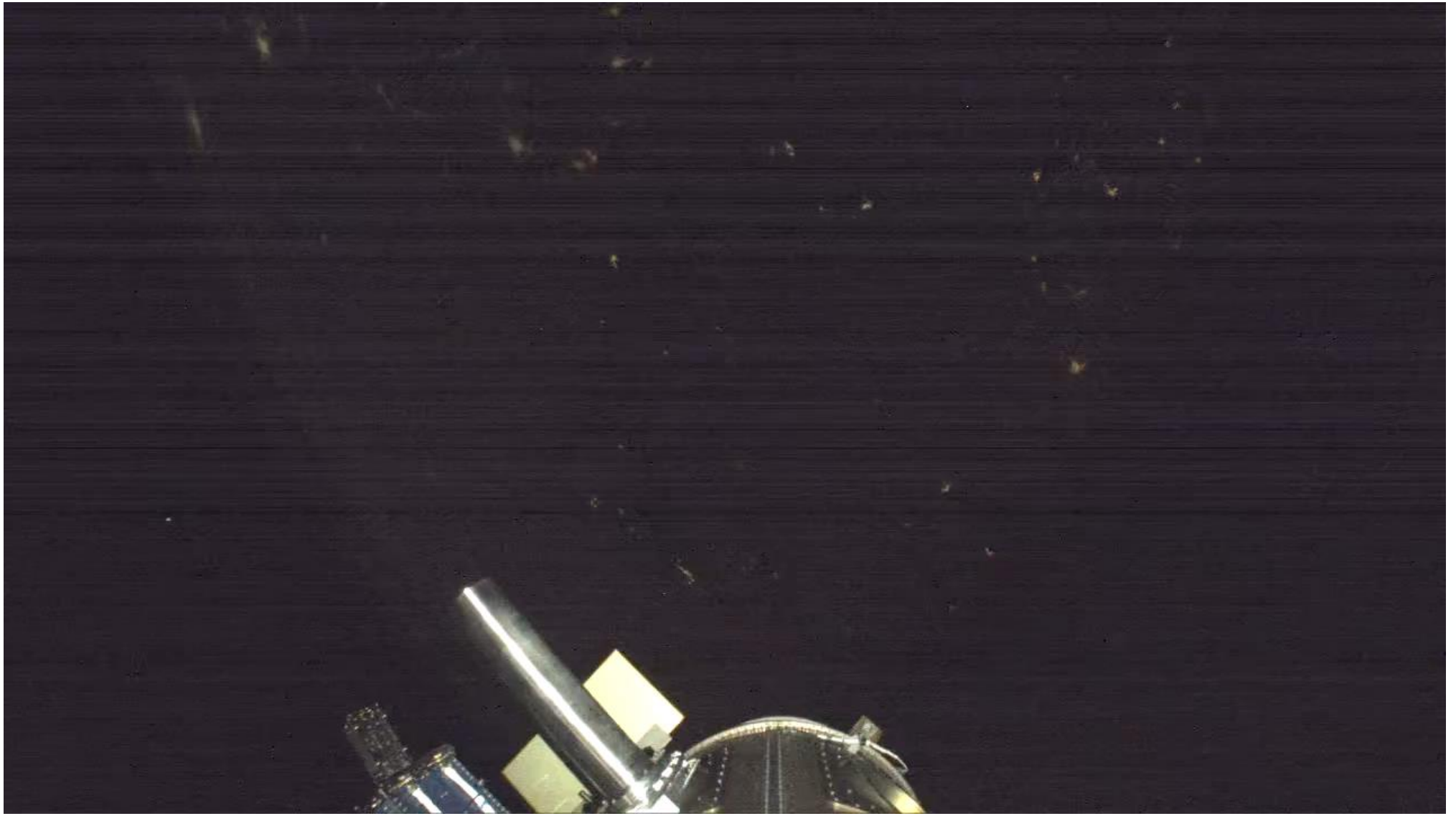
Building up the launcher

Launch!

See you space cowboy!



Very Recently….



Not all launches are alike…