Discover the space sector with EmTroniX

Telecom Nancy x EmTroniX – Denis COAT, Laura TOURNACHE

January 2024

Agenda

The space ecosystem

Space project development

Competences involved

Technical challenges

Focus on the JuRa project

EmTroniX key space projects

Space ecosystem

Space agencies

https://flatearth.ws/space-agency

EmTroniX

The French ecosystem

EmTroniX

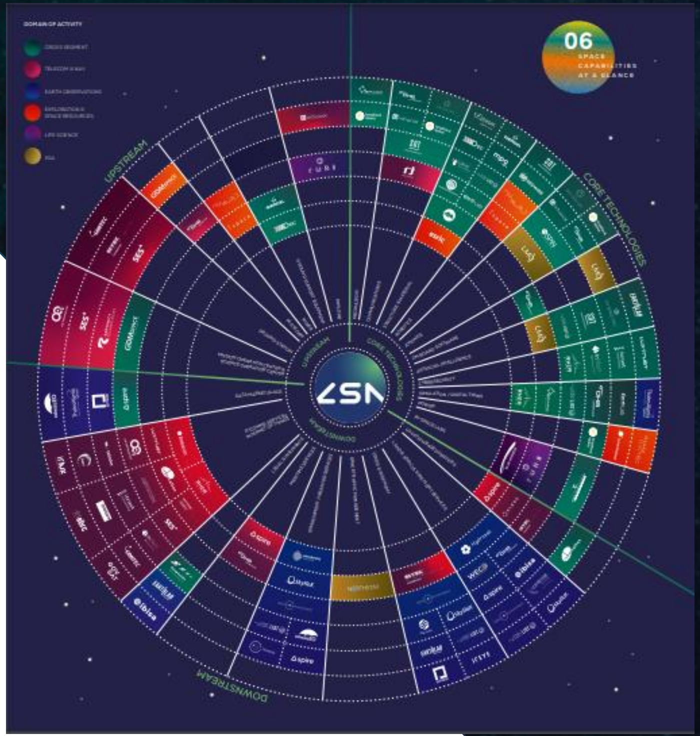
Space education and careers in Luxembourg

LUXEMBOURG
SPACE AGENCY

Current space sector-space directory

LUXEMBOURG SPACE AGENCY

Space segment | Ground segment | In-space operations | Analytics / Services



50 companies and **research labs**, employing more than **800 people**.

European Space Education Resources Office (ESERO)

LUXEMBOURG SPACE AGENCY

esero part of ESA:

- Develops new and interactive ways to take space into the classroom
- National competitions such as CanSat
- Space Goes to School
- ISS call
- …

What are the needs in the industry?

Engineers – Engineers - Engineers

Aerospace engineers, AI, Software, Machine learning, electronics, telecommunications, robotics, orbital dynamics,…

… but not only!

Regulatory experts, communications, international relations, education, ethics experts,….

And entrepreneurs!

With a combination of technical, business and managerial skills!

Relevant "New Space" topics

- Earth observation
- Communication and navigation
- Innovative launch systems
- Debris and waste management
- Law & space policy
- Medicine
- Exploration
- Food & nutrition
- Material & design
- Tourism

Get to know ESA

Get to know ESA

esa
space solutions

THE EUROPEAN SPACE AGENCY

Purpose of ESA

To provide for and promote, for exclusively peaceful purposes, cooperation among European states in space research and technology and their space applications.

Facts and figures

- Over 50 years of experience
- 22 Member States
- 8 sites across Europe and a spaceport in French Guiana
- Over 80 satellites designed, tested and operated in flight

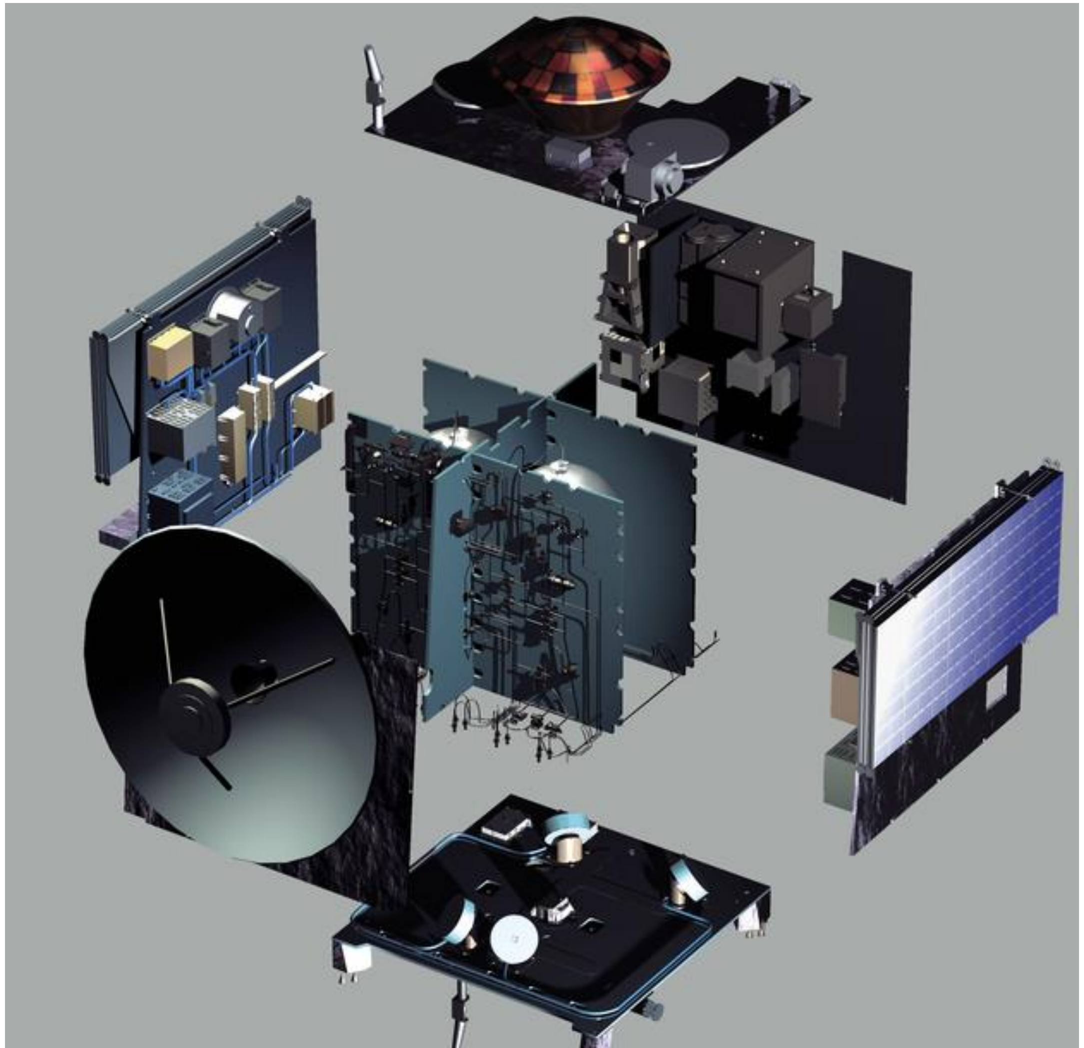
ESA UNCLASSIFIED

EmTroniX

Get to know ESA

Space project development

But first… What is a satellite ?


https://sci.esa.int/web/mars-express/-/28777-exploded-view-of-mars-express-spacecraft

Avionics

- Computers
- Flight software
- Attitude Orbit Control System
- Harness

Structure

- Primary structure
- Brackets and covers
- Panels
- Fasteners

Power

- Solar panels
- Power Conditioning and Distribution Unit
- Batteries

Telecommunication

- Antennas
- Radio

Propulsion

- Thrusters
- Tanks
- Pipes and valves
- Controllers

Thermal

- Sensors
- Passive elements (heat sinks, Multi Layer Insulation, thermal fillers..)
- Active elements (e.g. heaters, heat pipes…)

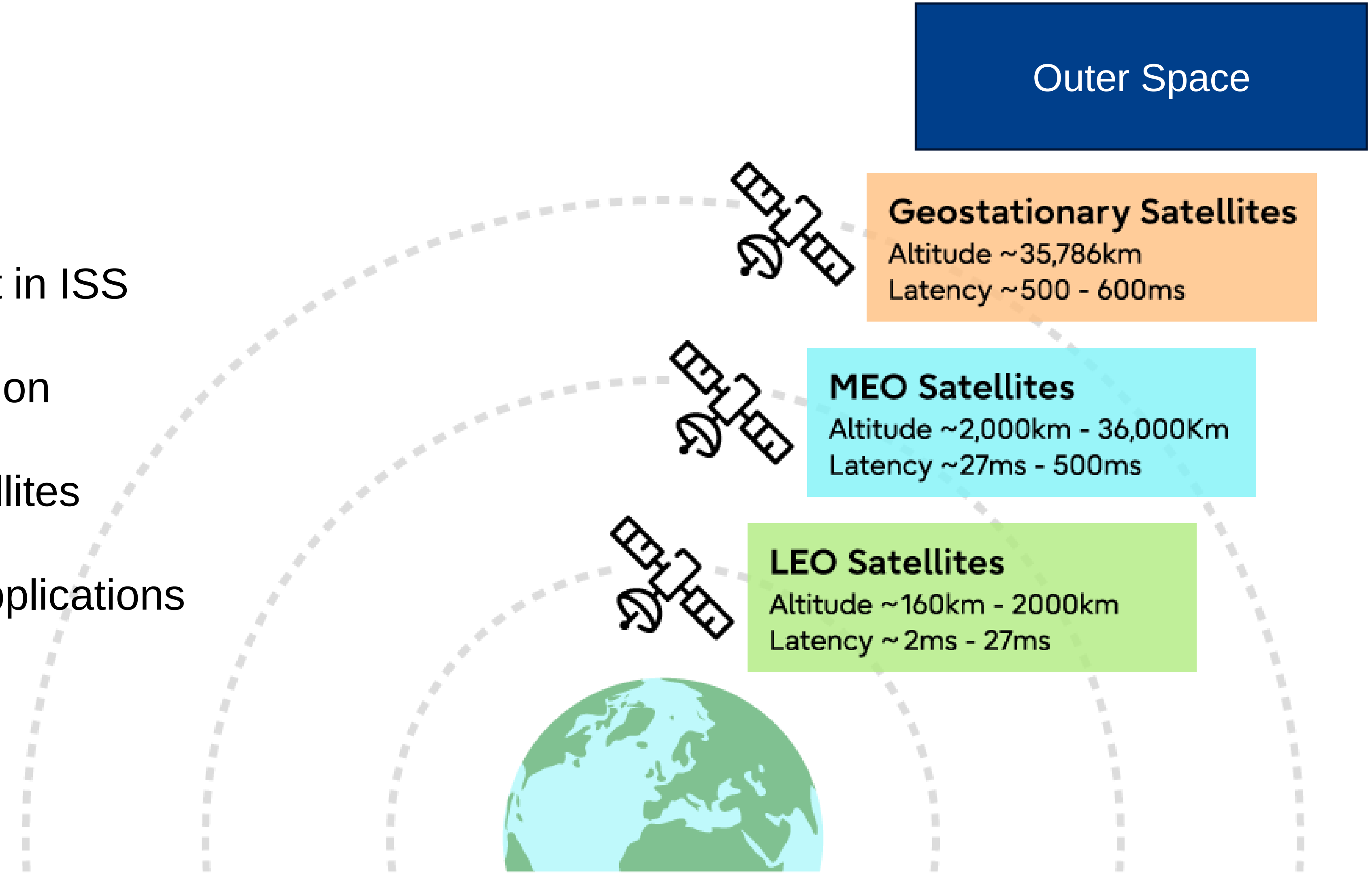
Payloads = Mission

- Telecom
- Earth Observation
- Science
- Navigation
- Technology demonstration

Different satellite's altitudes

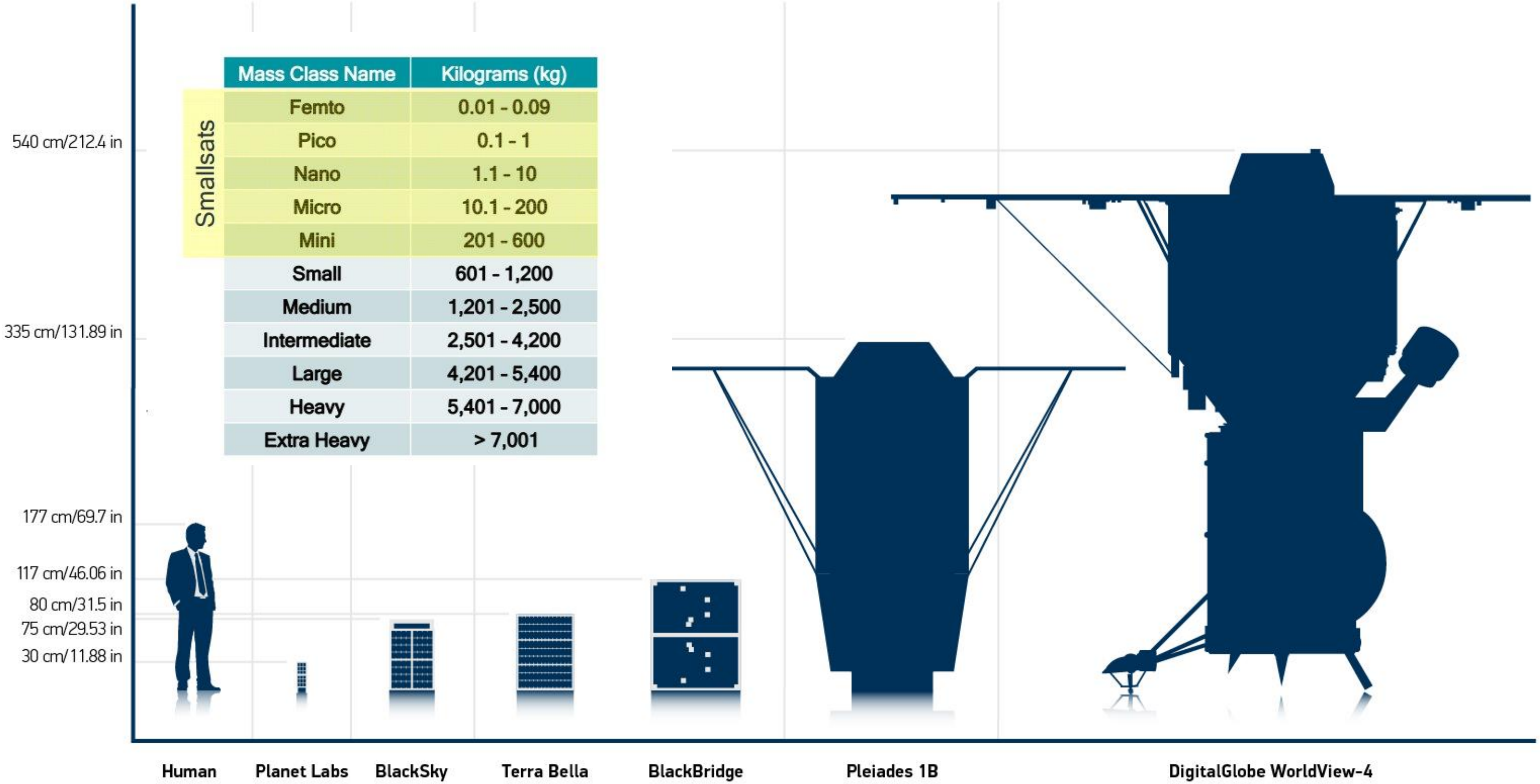
Durations

- Minutes / hours: CANSAT
- Weeks: Science experiment in ISS
- Months: In orbit demonstration
- Years: Communication satellites
- Many years: Deep space applications



https://www.fujitsu.com/global/vision/insights/22-leo-satellite-broadband/

Different sizes, different masses



	Mass Class Name	Kilograms (kg)
Smallsats	Femto	0.01 - 0.09
	Pico	0.1 - 1
	Nano	1.1 - 10
	Micro	10.1 - 200
	Mini	201 - 600
	Small	601 - 1,200
	Medium	1,201 - 2,500
	Intermediate	2,501 - 4,200
	Large	4,201 - 5,400
	Heavy	5,401 - 7,000
	Extra Heavy	> 7,001

La taille du satellite WorldView-4 comparée à Pléiades et d’autres satellites d’observation. Infographie publié par Digital Globe

Many things depend on space

Earth observation

Weather

Environment

Telecommunication

Position(GNSS)

5G/IoT/data exchange

Broadcasting

Traffic Monitoring
(Planes, boats…)

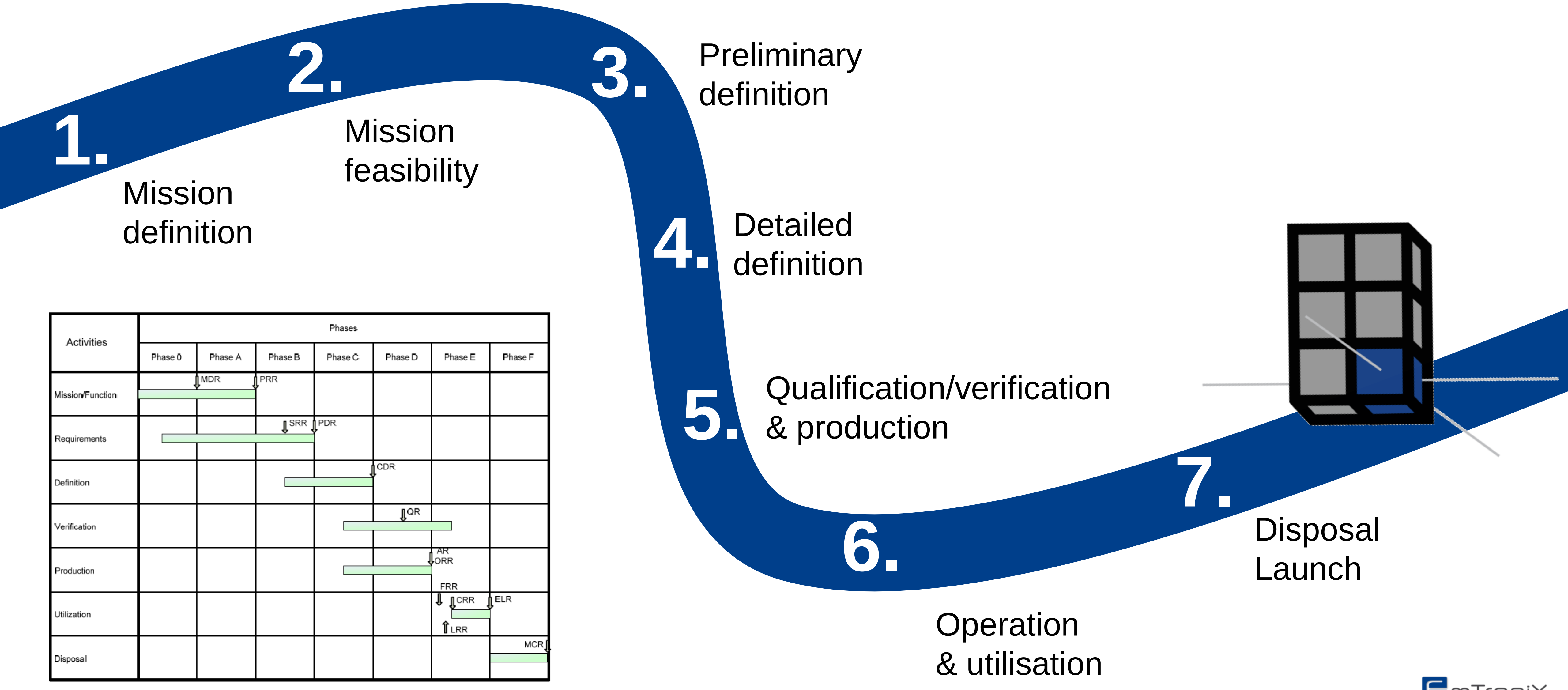
Military

Other Services

Medical/Biological applications

And even more…
Robotics (arms…)
Specific sensors (Radiations…)

Space project milestones



Space project milestones - detailed

1. Mission definition

- Define the need
- Create initial requirement

MDR
Mission Definition Review

2. Mission feasibility

- Initial technical designs
- Assess feasibility & risks
- Release final technical requirement specs

PRR
Preliminary Requirements Review

3. Preliminary definition

- Define hardware models, plans, schedule
- Develop design
- Start procurement

SRR *(Spacecraft side)*
Systems Requirements Review
PDR
Preliminary Design Review

Space project milestones - detailed

4. Detailed definition

- Finalise the design
- Define the interface
- Build engineering models
- Plan assembly, integration, verification & testing
- Start user manual

CDR:
Critical design review

5. Production& Qualification/verification

- Build qualification hardware
- Complete qualification testing & verification activities
- Build flight hardware
- Complete acceptance testing and authorise delivery

QR:
Qualification Review
FAR:
Flight Acceptance Review
ORR:
Operational Readiness Review

6. Operation & utilisation

- Operation
- Ground segment activities

FRR:
Flight Readiness Review
LRR:
Launch Readiness Review
CRR:
Commissioning Result Review
ELR:
End of Life Review

EmTroniX **is not a prime contractor**,
meaning we are not a satellite provider.

(But) we are proving **electronics and software solutions** for those who are building them.

That is why, **we are involved from the 3rd milestone to the end!**

Challenge time

For you, what is New space ?

1. An industry where businesses are the main actors
2. A zone further away we want to explore
3. The area between the Earth and Deep Space

The “New Space” approach

The goal: make the space sector affordable, cost efficient and highly reliable!

How?

→ **COTS component** (**C**ommercial **O**n **T**he **S**helf) compared to radiation tolerant or even hardened

- 2.7€ for the automotive version
- In stock.

- 200€ for the space version
- Ask for a quote…

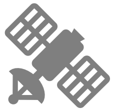
- 3€ for the automotive version
- In stock.

- 1500€ for the space version
- Ask for a quote…

- Packaging
- Lots
- Tests
- Documentation (certificates)

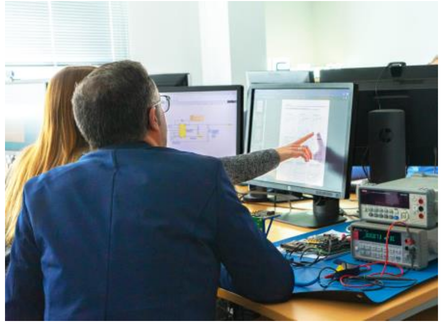
Space Grade Components don’t always exist

The “New Space” approach

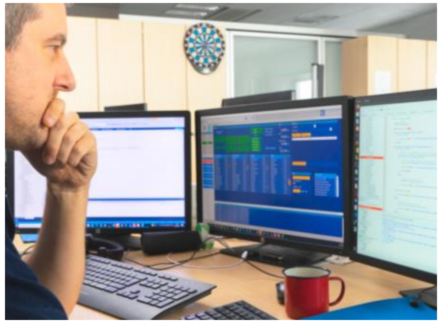
		
Temperatures	-40°C up to 125°C	-40°C up to 80°C
Vibration levels	15g (engine)	24g
Shocks	50g (crash, wheels)	1500g
Accelerations (QSL)	1500g (wheels)	15g
Atmosphere	1 atm	1 atm to void
Corrosion	All kind of fluids	Mainly ionization and gases
Radiations	None	Fully exposed
Electro Static Environment (ESD)	Similar	
Electro Magnetic Environment (EMC)	Similar	
Safety related topics + Cyber	ISO	Coming
Standards	ISO	ECSS, ISO
Quality Management	Strong management	Strong management

Competences and resources involved

Engineering at EmTroniX

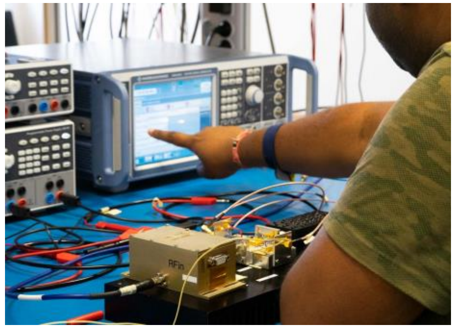


Electronics design

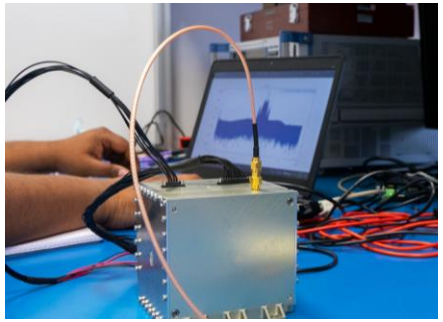


Embedded Software

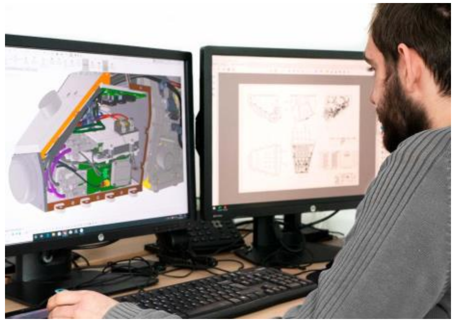
FPGA/VHDL



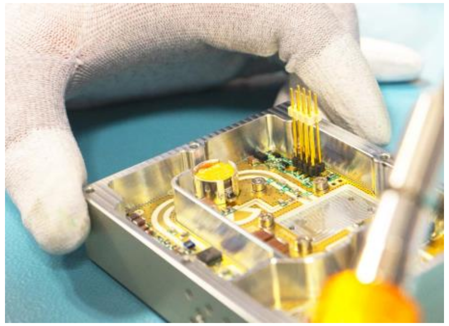
RF design



Digital signal processing



Mechanical design



Assembly

Production at EmTroniX (1/3)

Hand-made assembly

Pick & Place machine

Semi-automatic SMT stencil printer

Vapour-phase reflow

Oven

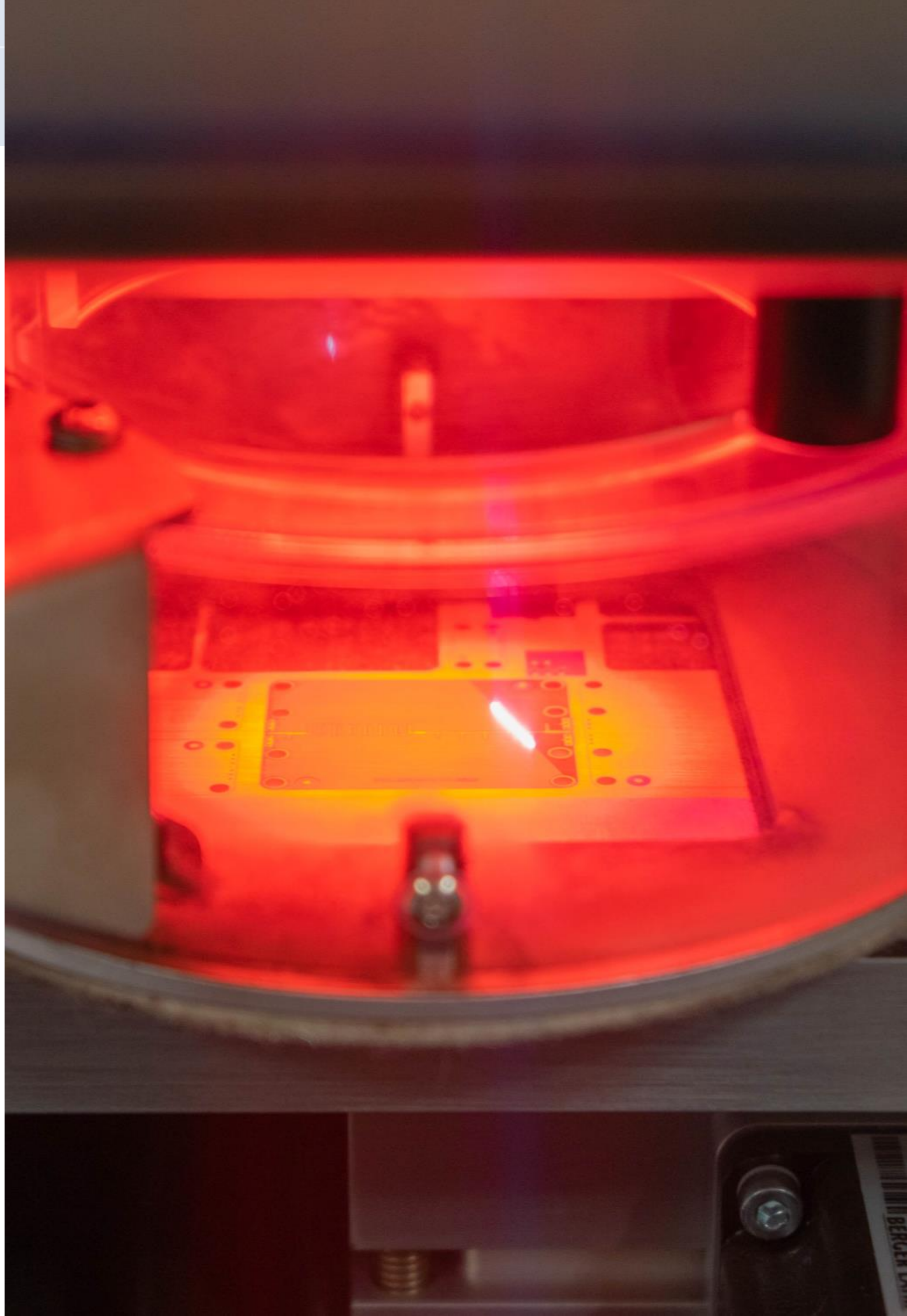
Dry cabinet

Production at EmTroniX (2/3)

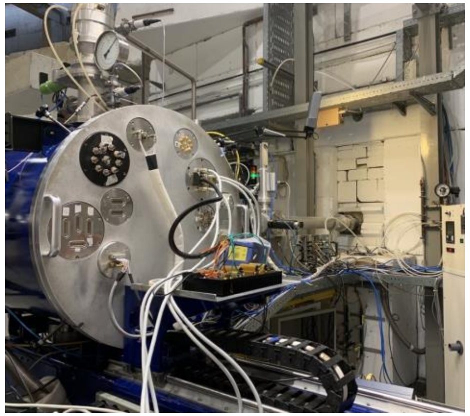
RF Laser Milling Circuit Board Prototyping

Multi-Layers Hydraulic Press

Galvanic Through-hole plating

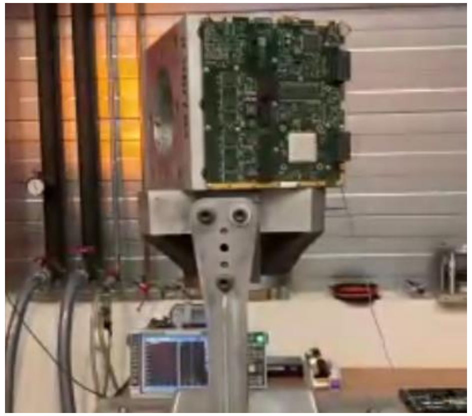


Testing - External facilities

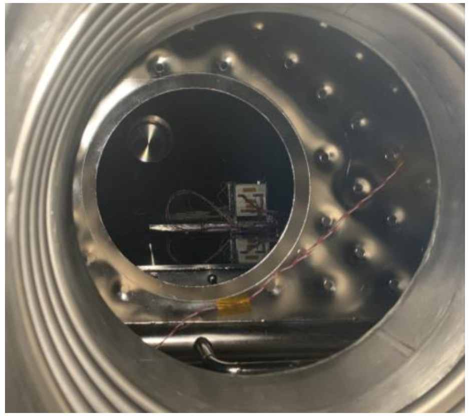


Radiation

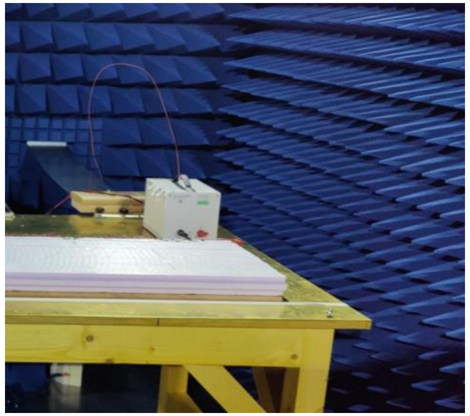
Vibration



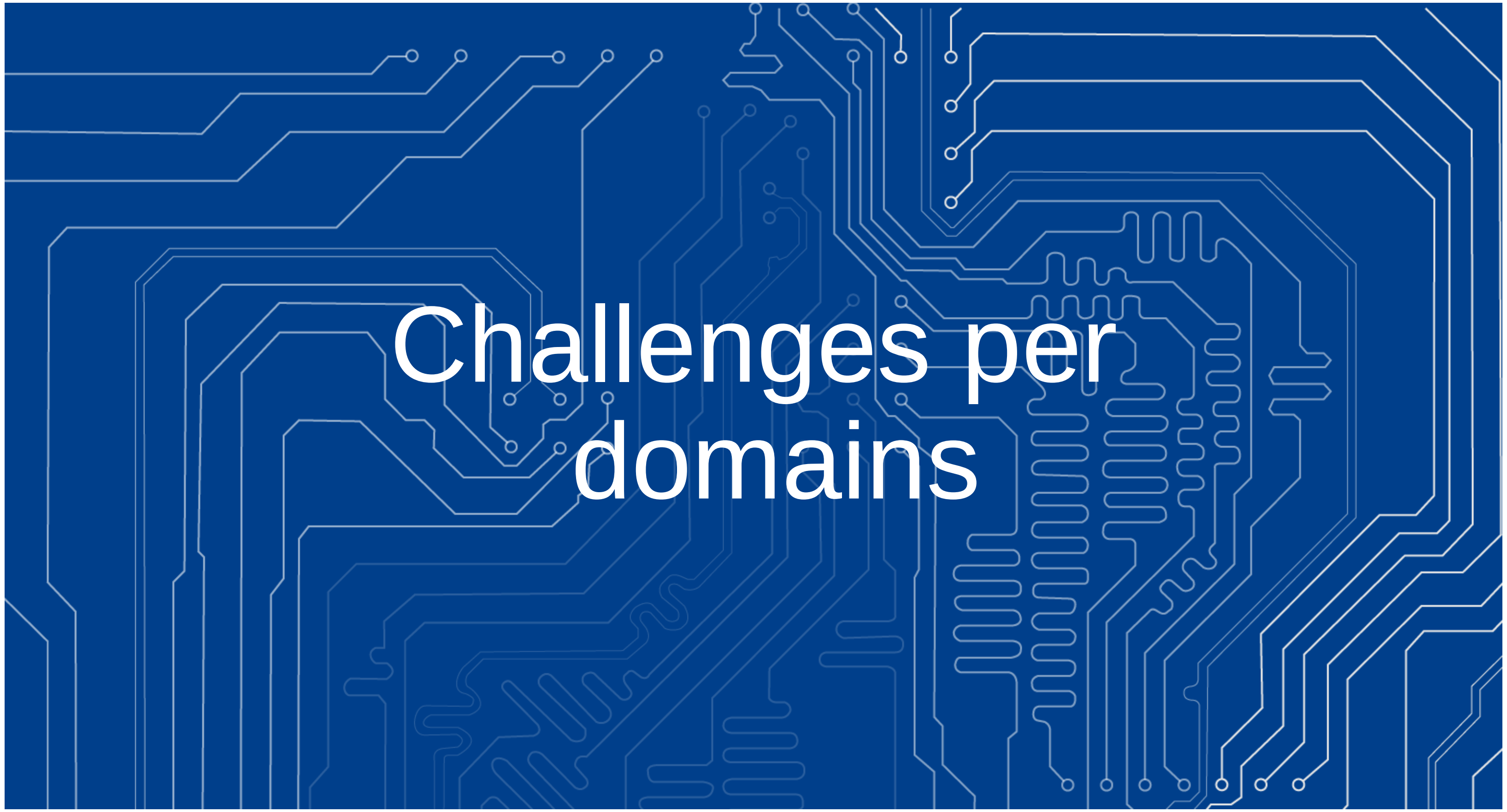
Shock



Vacuum



EMC



Challenges per domains

Electronics – Technical challenges

Processing Performance

- Core Processing Power over the years
- Power Trees to distribute energy
- Clock Tree to distribute accurate clock signals
- Memories
- High Speed Links

Environment

- Mechanical
- Void
- Radiation

Radio and Signal Processing Performance

- Highly Efficient RF chains
  - Low Noise figure
  - Wide Frequency ranges
  - Efficient Power amplifiers
- Analog <> Digital converters – high speed – low noise
- Filtering

Highly Reliable Electronics Production

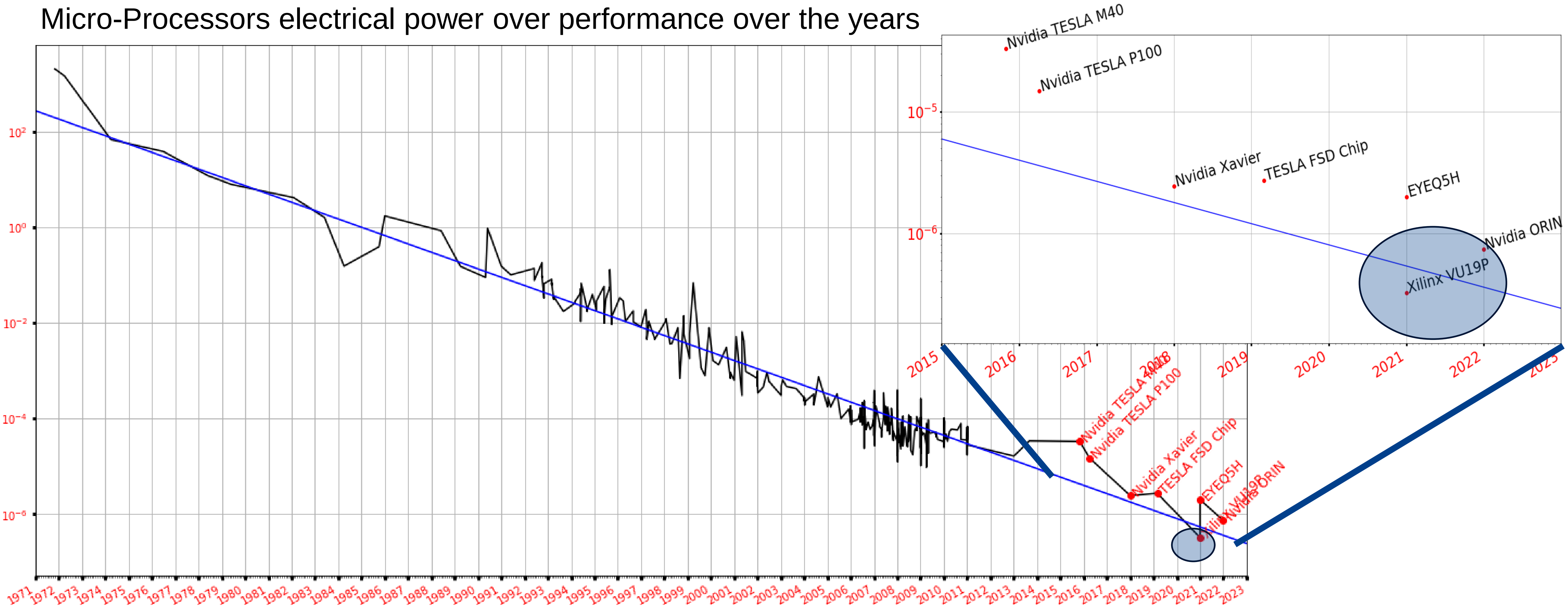
- Production technical risks
- Ensuring Quality at low production volumes

System Approach

- Functional and Safety Analysis

Processing power over the years

Micro-Processors electrical power over performance over the years



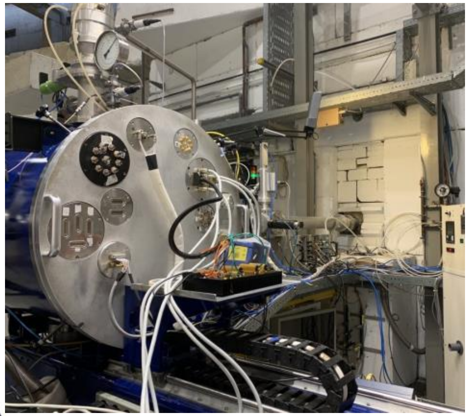
The Moore's law seen from the computing power point of view.

XILINX Virtex UltraScale+ is one of the most powerful and efficient System On Chip today

Processing power

Variant	CPU cores (P+E)*	GPU cores	GPU EU	Graphics ALU	Neural Engine cores	Memory (GB)	Memory Bandwidth (GB/s)	Transistor count
A15 Bionic	5 (2+3)	5	80	640	16	4	34.1	15 billion
	6 (2+4)	4	64	512				
		5	80	640		4-6		
M2	8 (4+4)	8	128	1024		8–24	102.4	20 billion
		10	160	1280				
M2 Pro	10 (6+4)	16	256	2048		16–32	204.8	40 billion
	12 (8+4)	19	304	2432				
M2 Max	12 (8+4)	30	480	3840		32–96	409.6	67 billion
		38	608	4864				
M2 Ultra	24 (16+8)	60	960	7680	32	64–192	819.2	134 billion
		76	1216	9728				

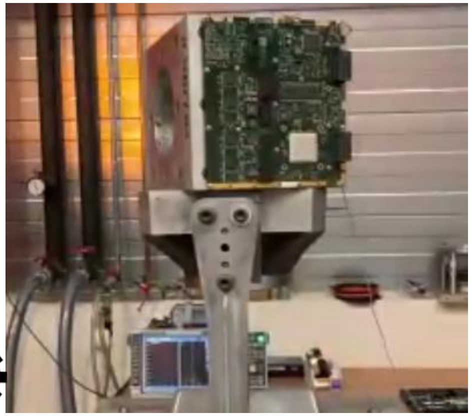
Tests - Environment



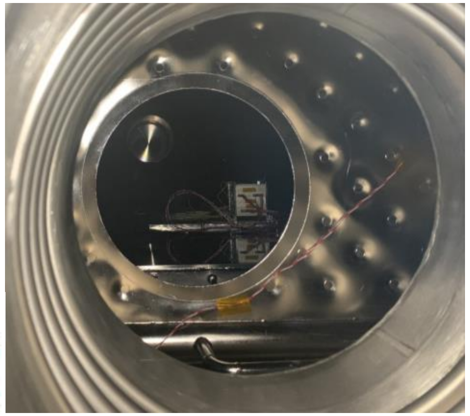
Radiation

Vibration

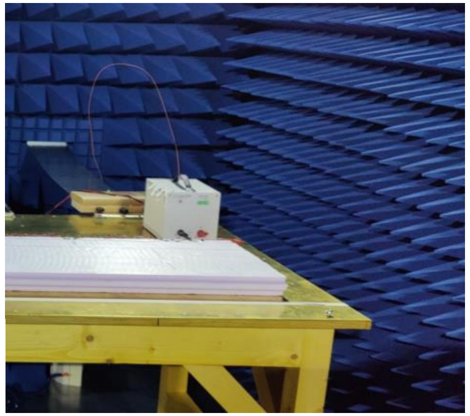
Temperature



Shock

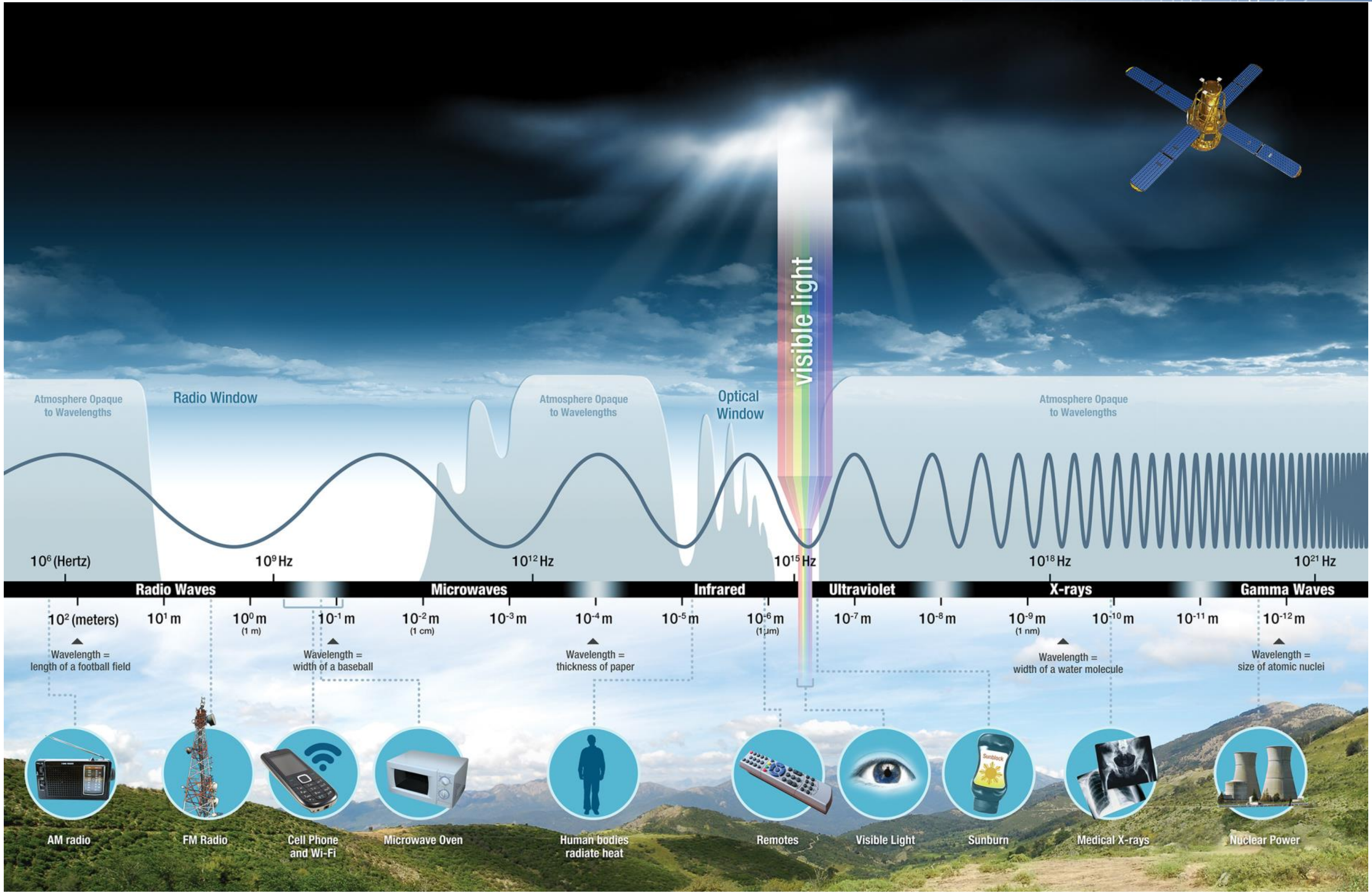


Vacuum



EMC

Radiation landscape



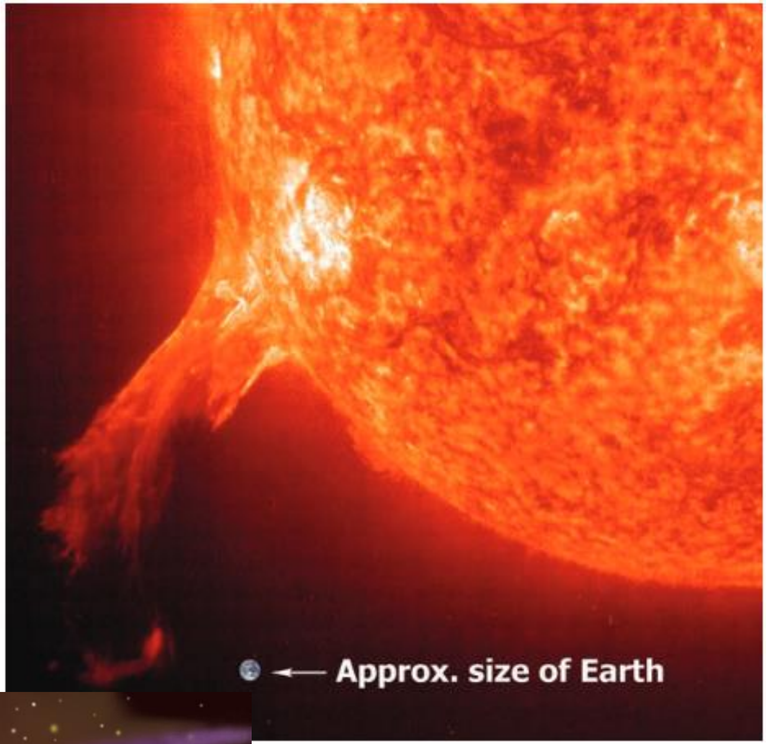
https://www.nasa.gov/missions/analog-field-testing/why-space-radiation-matters/

Radiation

Space radiation is made up of:
- **particles** trapped in the Earth's magnetic field
- **particles** shot into space during solar flares (solar particle events)
- **galactic cosmic rays**, which are high-energy protons and heavy ions from outside our solar system

Charged particles are deviated by magnetic fields
Rays are efficiently filtered by atmospheric layers

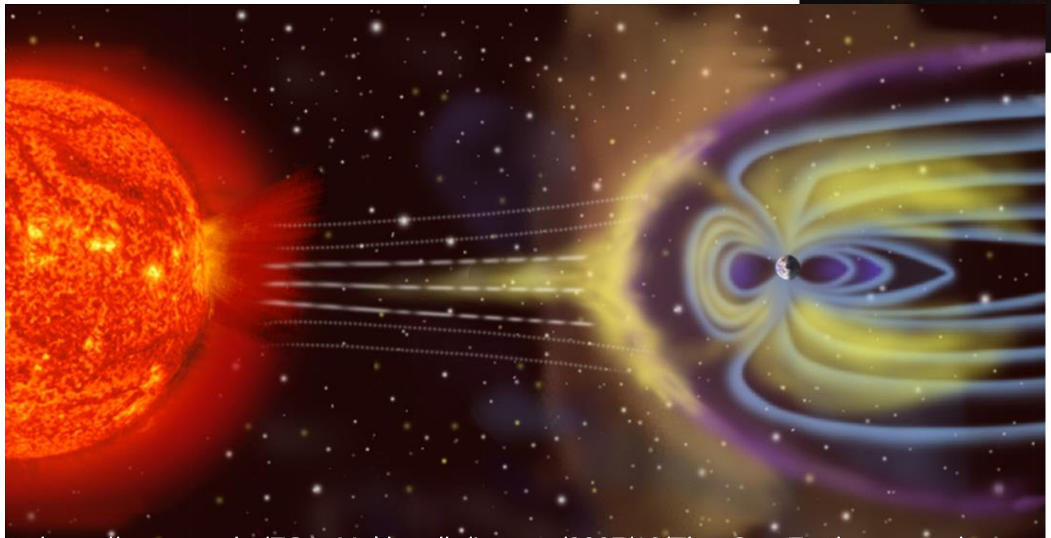
Space exposure to radiation highly depends on position/orbit and duration.



https://www.researchgate.net/figure/Size-of-earth-compared-to-the-sun-and-a-solar-flare-credit-jplnasagov_fig1_327993737

Effects:
- **Total Dose:** long term exposition to radiation that affects components for long term

- **Single Events** triggers deviations, latch ups, upsets, that could be definitive or recoverable (after power cycling)



https://www.esa.int/ESA_Multimedia/Images/2007/10/The_Sun-Earth_connection

Radiation - Tools

Poisson Law:

The probability p of n events occurring in time τ (related to the observation period) is given by a Poisson distribution such that:

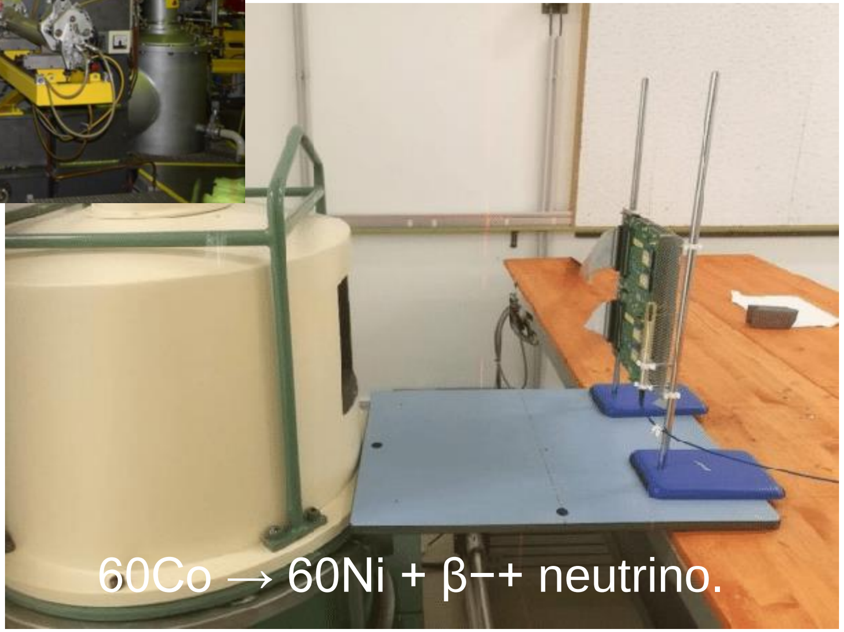
$$p(n, w\tau) = e^{-w\tau} (w\tau)^n / n!$$

“w” (also named λ) is the average number of events occurring per the observation period (per active year for example).

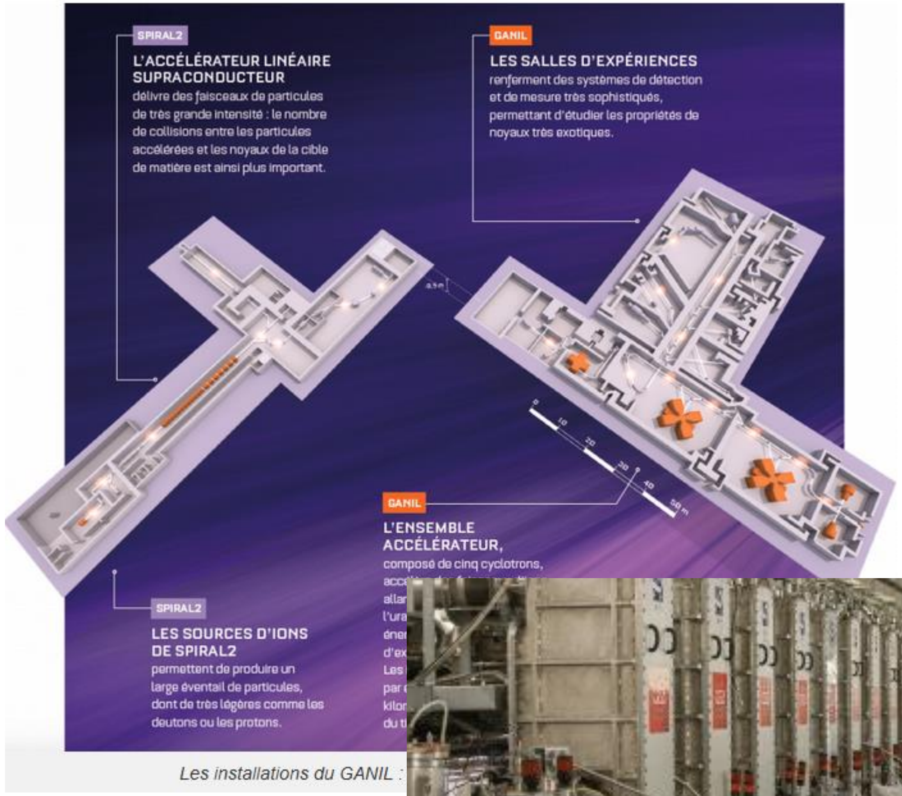
Submitted to a controlled flux of particles, the mean number of **S**ingle **E**vents is used to determine the behaviour of the components in space during the mission and the best way to mitigate them.

Radiation – Test facilities

https://www.lavenir.net/regions/brabantwallon/2016/08/19/endroits-meconnus-de-lucl-le-cyclotron-letape-avant-lespace-WS2EXMDUGBE3FAEMJZWFPTBALQ/



https://www.researchgate.net/figure/IDE3380-DUTs-installed-at-the-ESTEC-Co-60-facility-for-TID-testing_fig4_351752080



https://www.ganil-spiral2.eu/fr/le-ganil/presentation/linstallation-ganil/

UCL in Belgium

GANIL in France

Mechanics

Weight

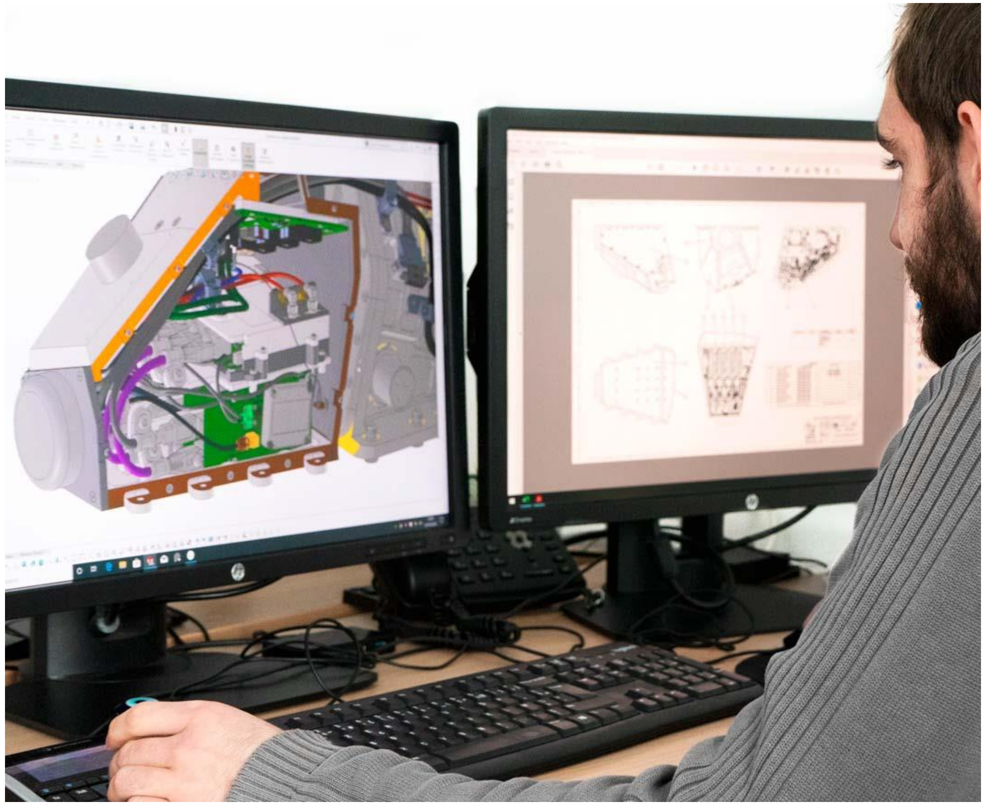
- **$10,000 to $20,000 to launch 1 kilogram in Low Earth Orbit**

Dimensions – tolerances

- Critical dimensions could lead to huge problems if not well designed

Thermal management of a harsh environment

- -65ºC to +125 ºC in LEO outside the CubeSat
- -40°C to +80°C inside the CubeSat



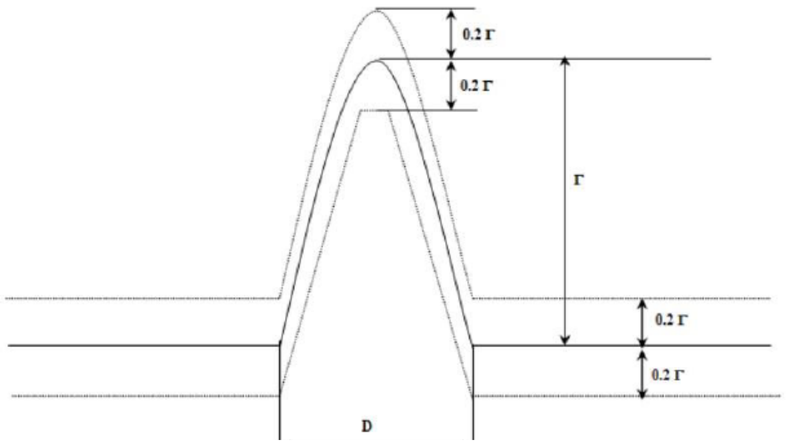
Testing outside the company

4.1 TEST PROGRAMM

Shocks up to 1500g !

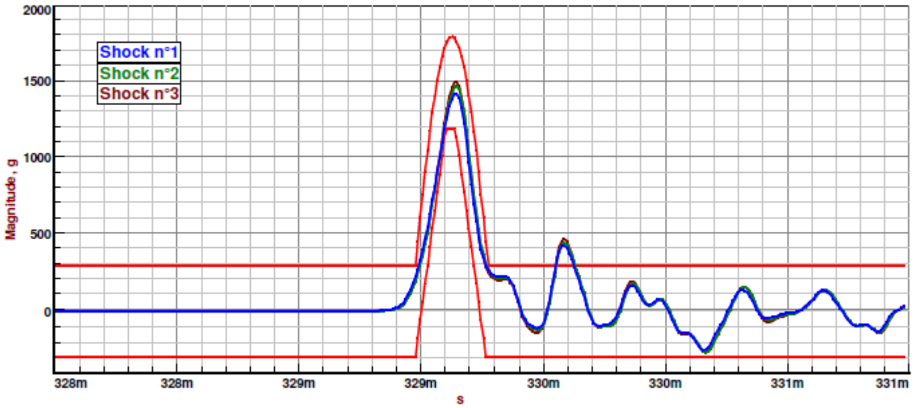
4.1.1. SHOCK TEST – 1500g/0.3ms (*)

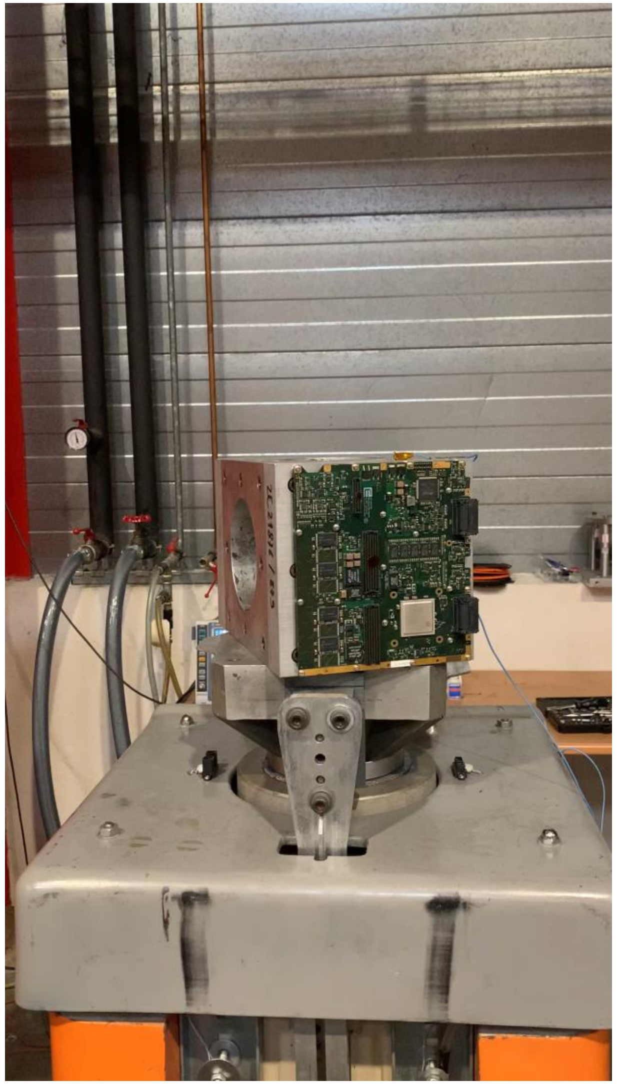
STANDARD / METHOD OF REFERENCE: IEC 60068-2-27



Test ref. 2E21876	**Specimen**: PCB	**Axis: X**
Date: 14/06/2022	**Title**: Shock test	**Function**: g(t)

Control + tolerances





EmTroniX

Testing outside the company

Vibrations up to 24g

4.1 TEST PROGRAMM

4.1.1. RANDOM VIBRATION TEST

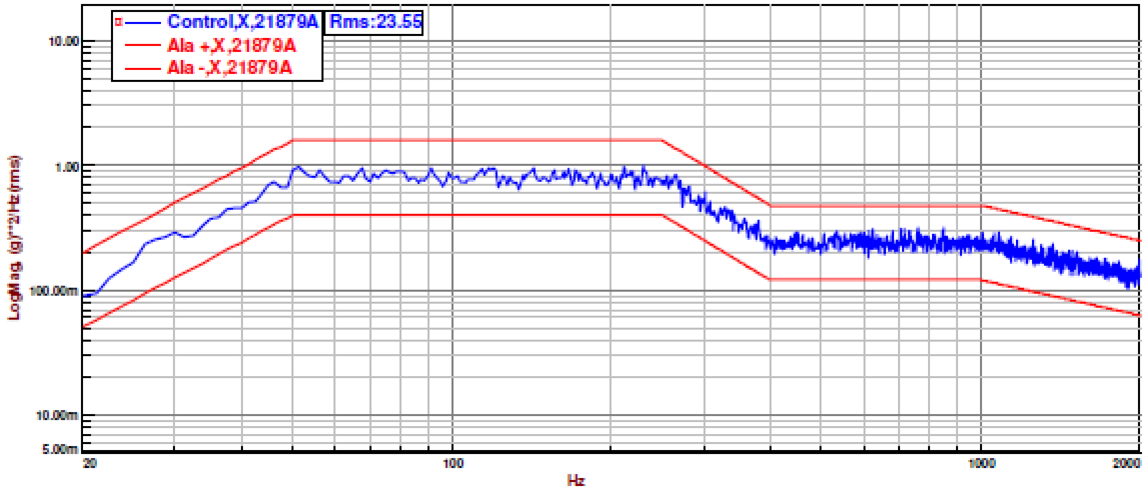
STANDARD / METHOD OF REFERENCE: NF EN 60068-2-64

FREQUENCY (HZ)	AMPLITUDE (G^2/HZ)
20	0,1
50	0,8
250	0,8
400	0,24
1000	0,24
2000	0,125

Frequency bandwidth: 20-2000Hz
RMS acceleration: 23.
Duration per axis: 3 n
Number of axes: 3

Test ref. 2E21879	Specimen: electronic board	Axis: Y
Date: 14/06/2022	Title: Random vibration test	Function: PSD

Control + tolerances

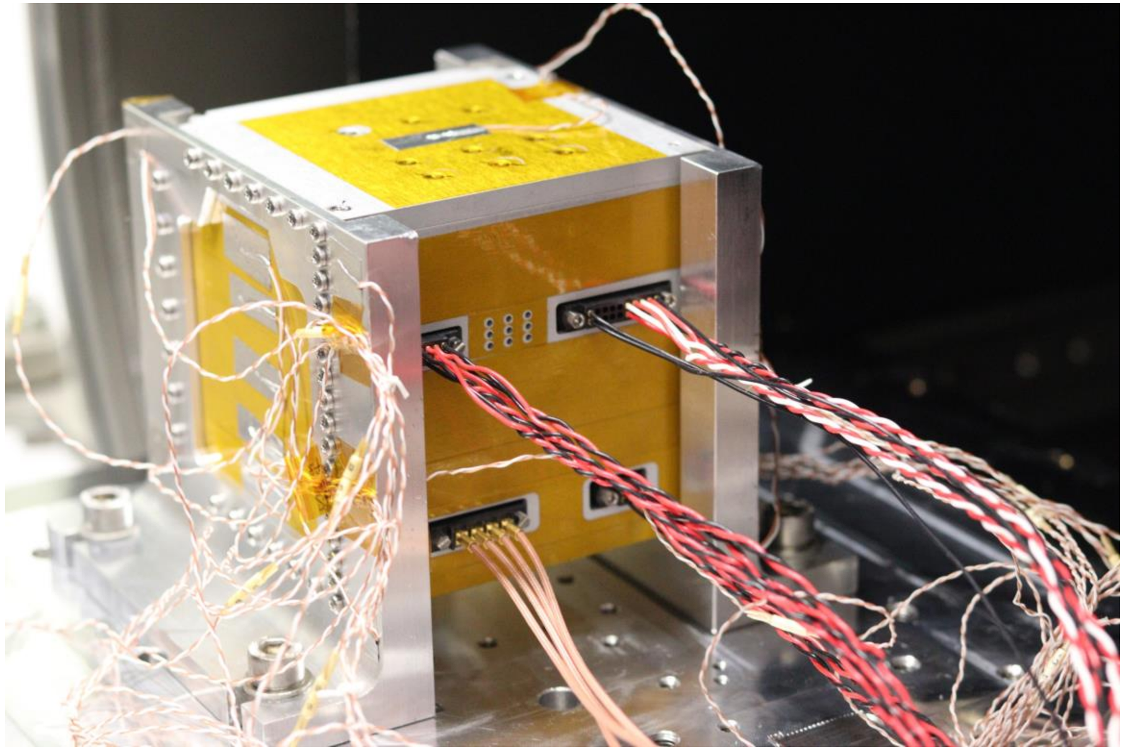


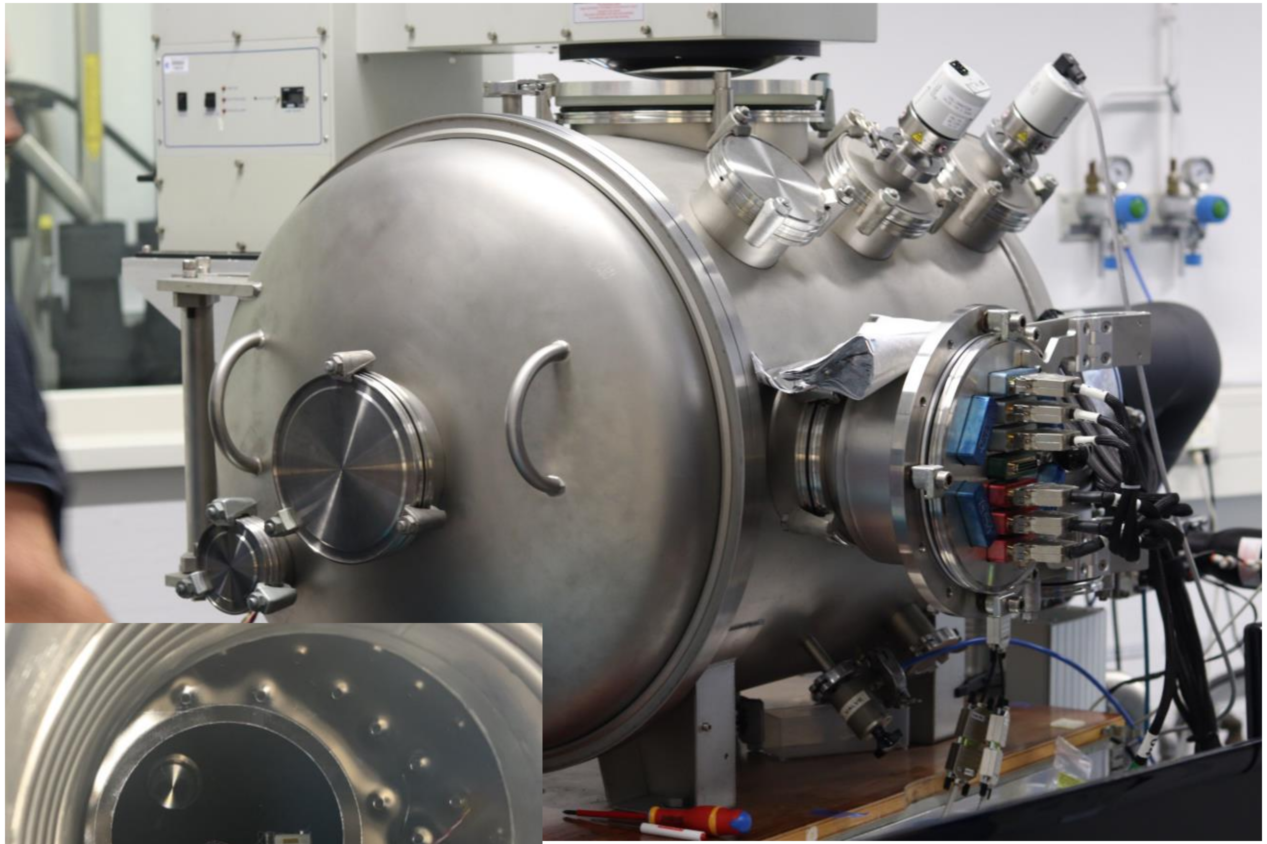
Testing outside the company

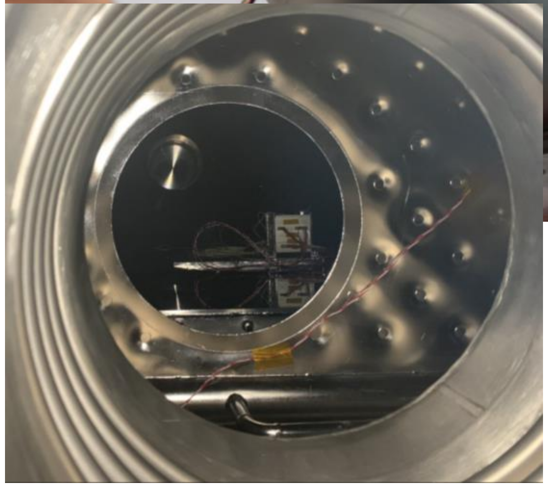
Testing in Vacuum conditions at temperature limits. (Thermal analysis + Outgassing)

Lowest achievable pressure [mbar]: 3.10 – 7

No convection only conduction and radiation !







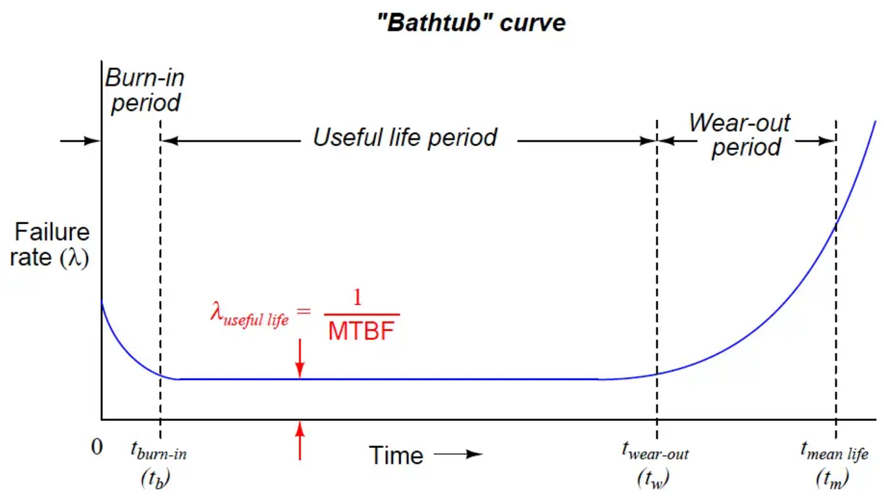
Testing inside the company

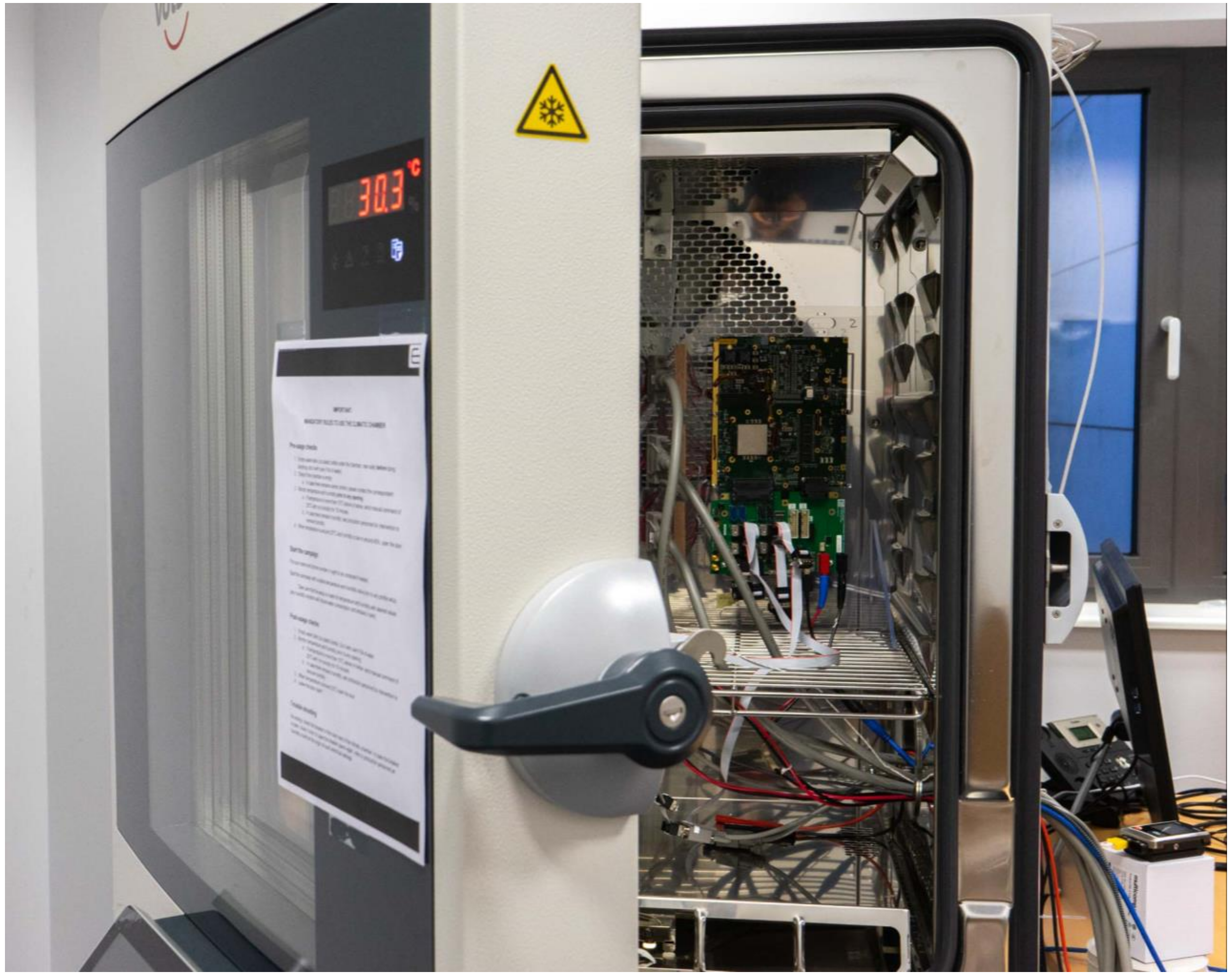
Life testing

- Cycling 500 to 2000 cycles
- Example of an acceleration next page

Burn in

- To reveal early phase failures





Functional limits, worst case analysis

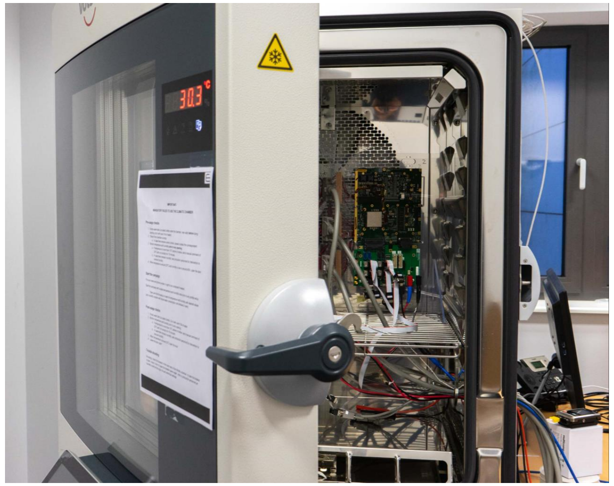
Testing inside the company

Life testing

- Real operation
  - 20000 cycles for 3 years
  - -10°C to 40°C
- Testing
  - Cycling 1000 cycles for less than 3 months
  - From -40°C up to 105°C

$$AF = \left(\frac{f_0}{f_t}\right)^m \left(\frac{\Delta T_t}{\Delta T_0}\right)^n e^{1414\left(\frac{1}{T_0}-\frac{1}{T_t}\right)}$$

deg C per minute
lower test temperature °C
T_t = upper temperature at test (C)
dwell time (at either extreme) mins.
total time per cycle (mins)
f_0 = frequency of cycles in operation (number per day)
f_t = frequency of cycle at test (number per day)
ΔT_t = temperature excursion at test (C)
ΔT_0 = temperature excursion at operating (C)
m = 1/3
n = 1.9
T_0 = upper temperature at operating (C)
Exponent factor = 1414 (activation energy = 0.12eV)
T_t = upper temperature at test (Kelvin)
T_0 = upper temperature at operating (Kelvin)
AF = acceleration factor



Testing outside the company

Electro-Magnetic Compatibility challenge

1. Do not disturb others
2. Withstand the environment

The main test classes for EMC:

- Conducted Emission
- Radiated Emission
- Conducted Susceptibility
- Radiated Susceptibility

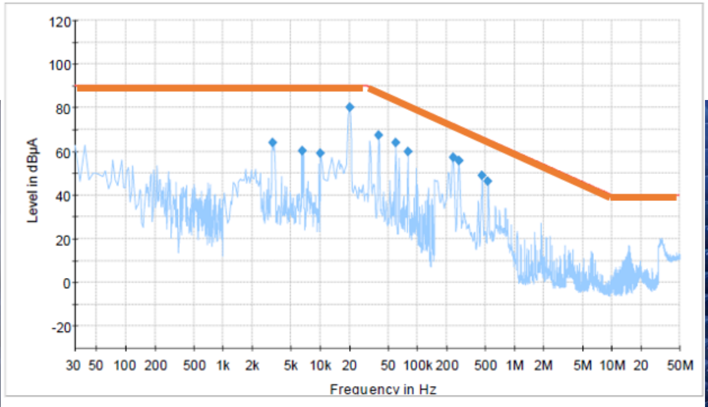


Figure 5.9 Test result E-CP-08-01a

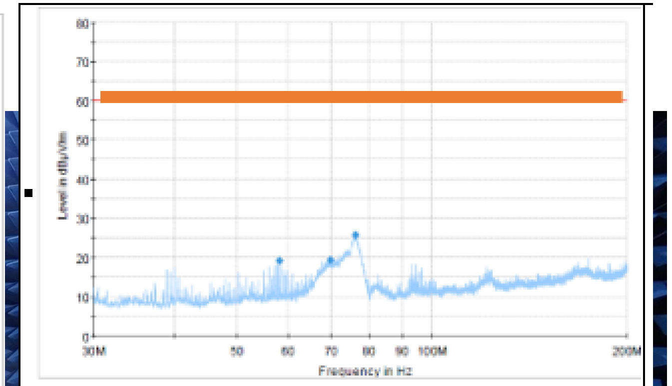
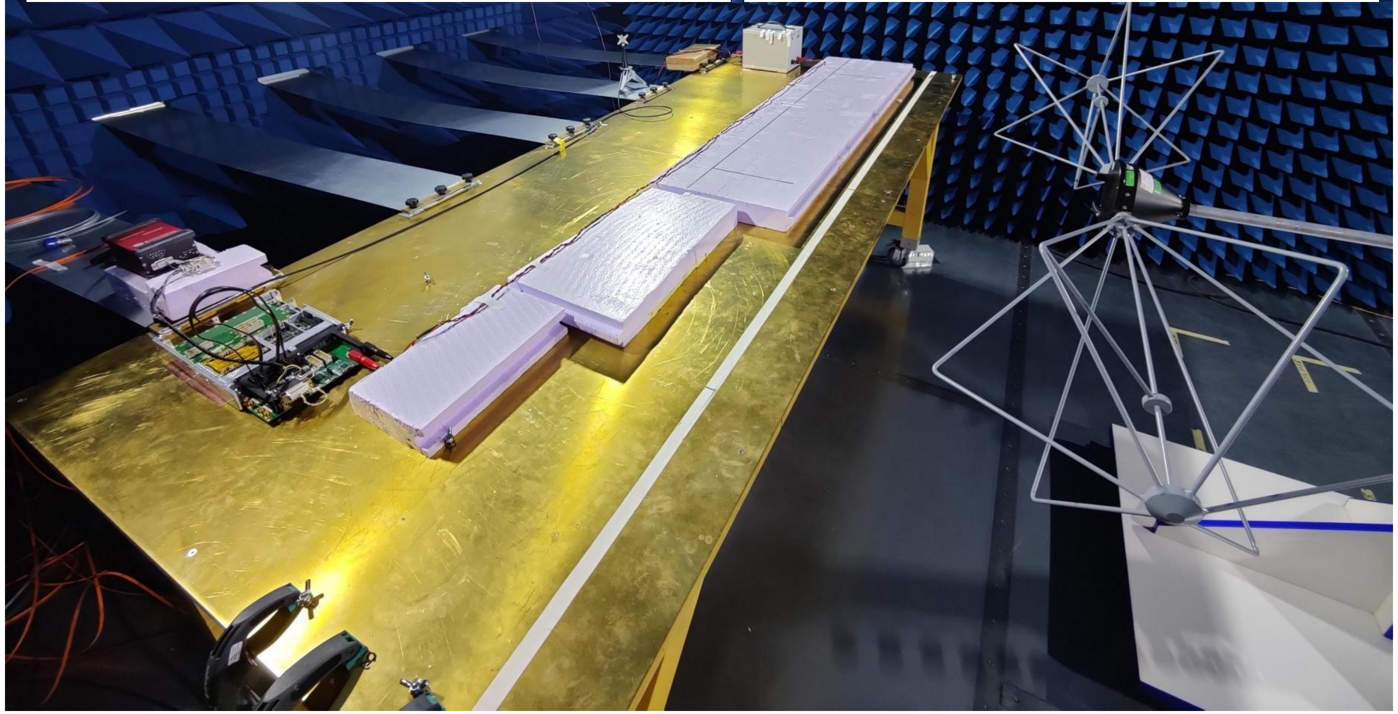


Figure 5.19 Test result E-RE-01_v-2



Radio Frequency

The ‘dream’

<u>Wide frequency Transceivers</u>

- Wide frequency band
- Large signals dynamics
- Low Spurs
- High Image rejection
- Low Phase Noise

<u>High data rate</u>

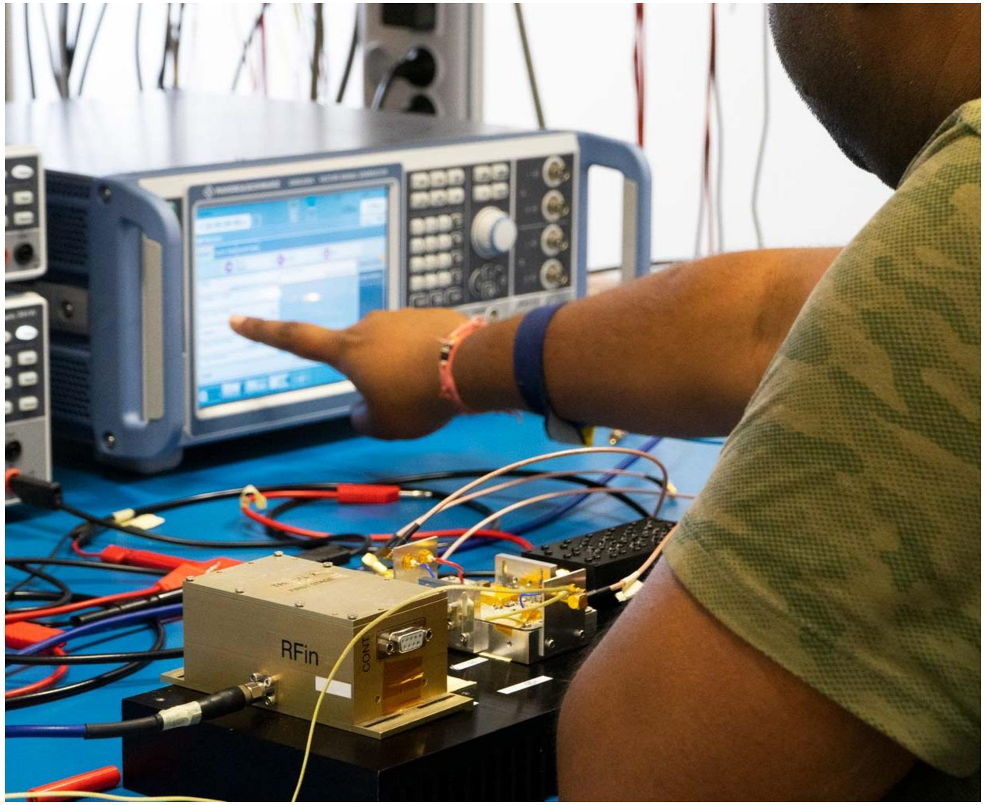
- Complex modulation & demodulation
- Wide sampling bandwidth & processing

<u>High reliability</u>

- Signal to Noise Ratio
- Error detection / correction

<u>High efficiency</u>

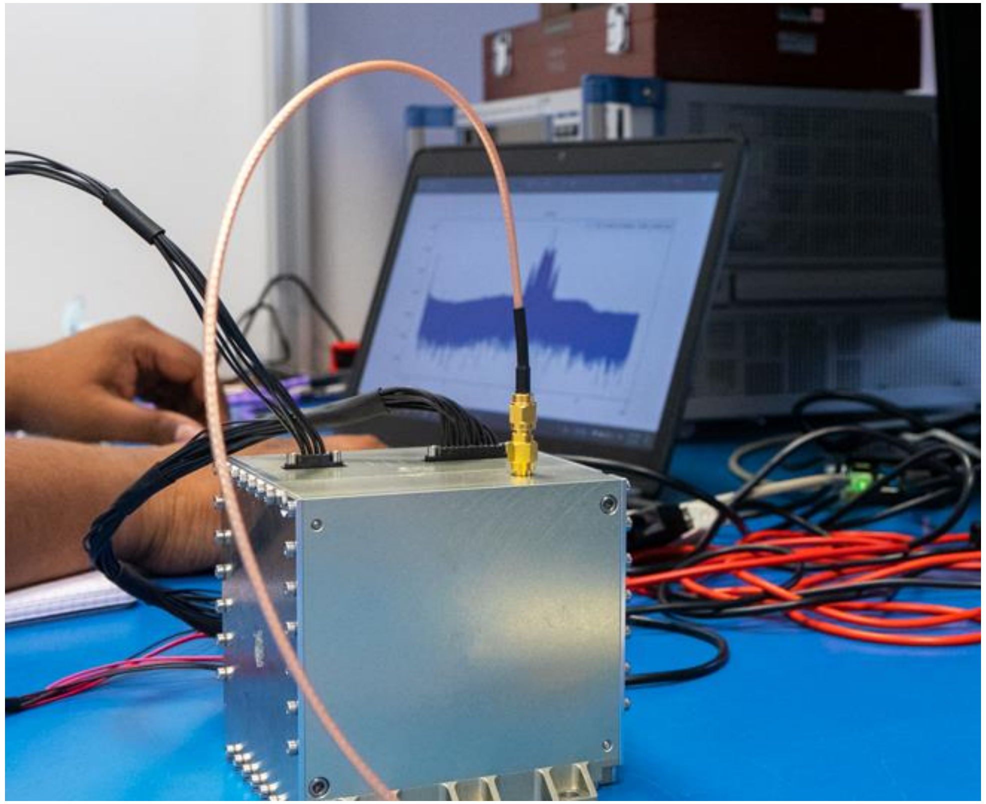
- Usually efficiency is quite low from 10% to 20% from power supply and RF dBm output



Signal processing

Modulators/Demodulators

- Complex modulations processing (from BPSK to APSK/QAM)
- High Doppler rate/vs Bit rate
- Frequency & Phase control loop
- Acquisition & Tracking
- Cognitive algorithms
- Baseband processing & Filtering



Low Level Layer Protocols

- Error correction
- Bit coding/decoding
- Encryption/decryption

What is Space software?

Two domains : Flight (Embedded Software) and Ground (Control, Support and Exploitation)

<u>Flight software:</u>

- On-Board Computer
- Observation and Processing (Communication, Cameras, ...)
- Data transfer

Highlights:

- Real time (execution time must be deterministic)
- Multiple Computers, processors and FPGA with distributed tasks.
- Redundancy and errors detection and mitigation.

Connex Industries: Automotive, Aeronautics, Defence

<u>Ground software:</u>

- Satellite/Flight Control
- Data Management
- Ground Support Equipment (Antennas, data centres...)
- Pre-launch phase : Integration, Validation, Simulations

Connex Industries: Automotive, Big Data, Telecoms

Technologies

Programming Languages:

- Embedded software : ADA, C, VHDL
- Ground software : Python, Java, C++, Web...

Domains :

Development, Integration, Validation, Tooling

Entities :

„Old School“ : ESA, Ariane Espace, Thales Alenia Space...

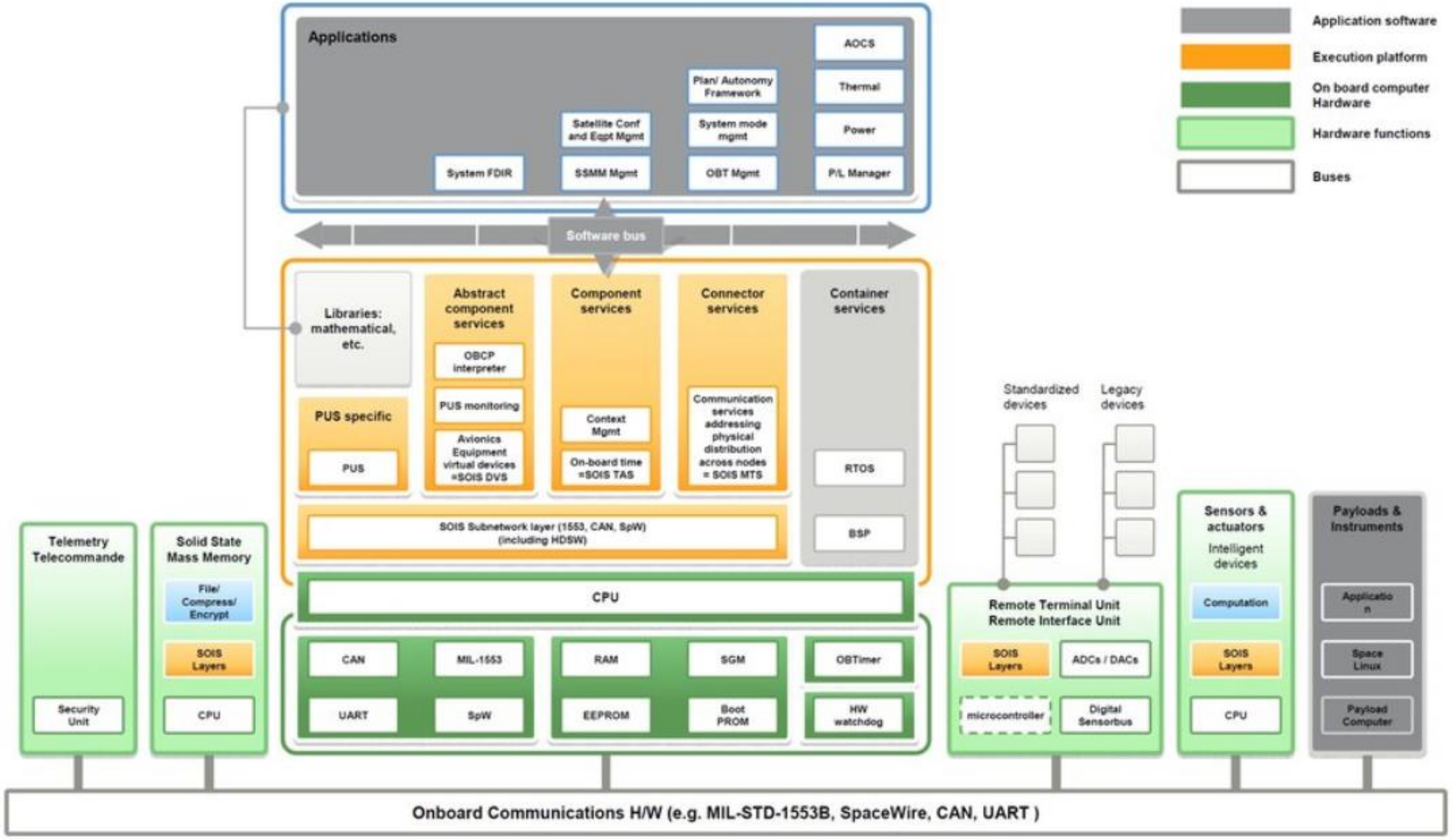
- Highly Critical Software – High reliability
- Dedicated/Specialized Products

„New Space“ : SMEs, Startups, Universities, Non-Specialized Industries

- Less Critical Missions
- Components On The Shelves (From Automotive for example)
- Startup/SMEs : Nanosat, Low Earth Orbit, Experiments, R&D...

SW architecture example

Hypervisors are sometimes needed for some complex integrations

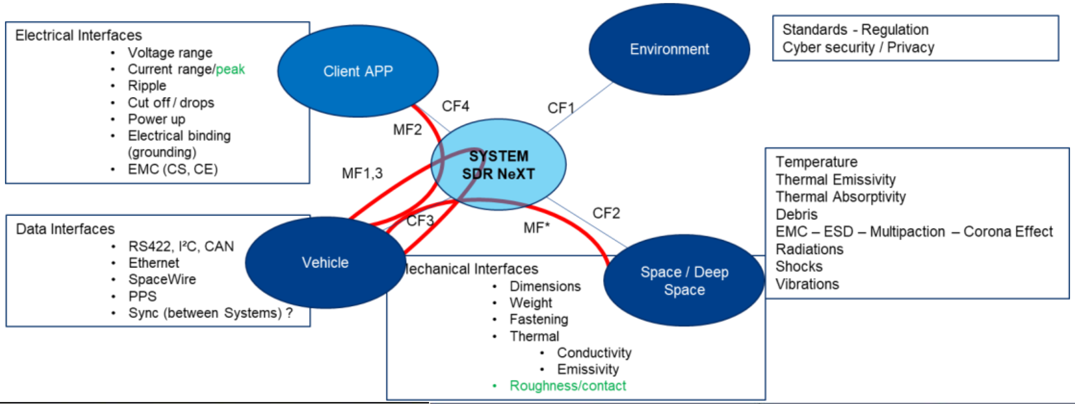


https://www.esa.int/Enabling_Support/Space_Engineering_Technology/Onboard_Computers_and_Data_Handling/Architectures_of_Onboard_Data_Systems

System approach

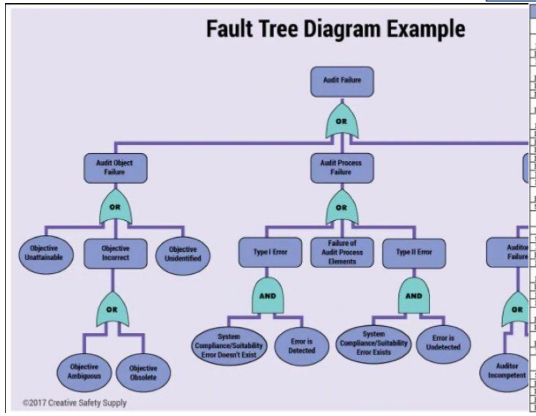
Functional Analysis

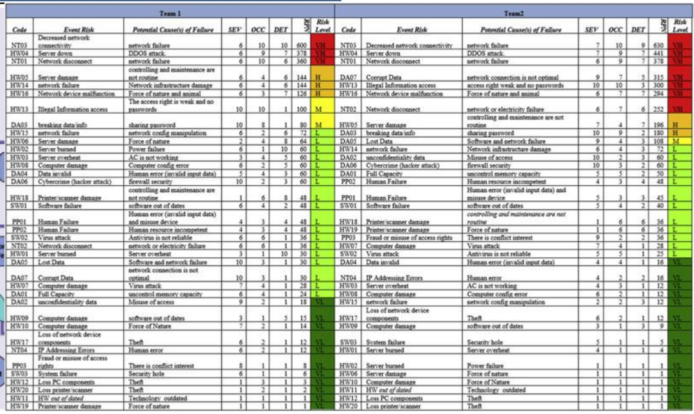
- Describe the life cycle of a system from design to refurbishment
- Describes interactions with outer elements
  - Constraints
  - Main functions



Safety/quality analysis

- Feared events quotation
  - Space reference
  - Automotive reference
- Failure trees
  - From feared events down to causes and combinations
- **F**ailure **M**odes **E**ffects and **C**ritical **A**nalysis
  - From defects to consequences





Model Based

- System Engineering
  - Follows the functional analysis
- Design (software)

Requirements

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System approach - Safety

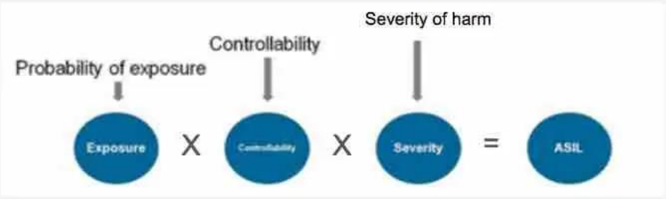
Feared events quotation

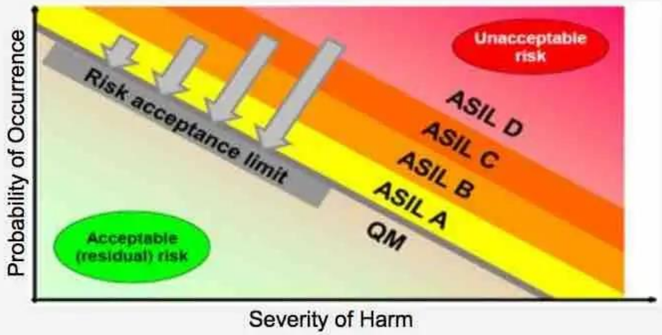
- Space reference more on the severity
- Automotive reference considering severity, exposure rate and mitigation capabilities

Severity category	Severity level	Description of consequences (failure effects): Dependability effects (as specified in ECSS-Q-ST-30)	Description of consequences (failure effects): Safety effects (as specified in ECSS-Q-ST-40)
Catastrophic	1	Failure propagation (refer to 4.2c)	Loss of life, life-threatening or permanently disabling injury or occupational illness.
			Loss of an interfacing manned flight system.
			Severe detrimental environmental effects.
			Loss of launch site facilities.
			Loss of system.
Critical	2	Loss of mission	Temporarily disabling but not life-threatening injury, or temporary occupational illness.
			Major detrimental environmental effects.
			Major damage to public or private properties.
			Major damage to interfacing flight systems.
			Major damage to ground facilities.
Major	3	Major mission degradation	
Minor or Negligible	4	Minor mission degradation or any other effect	

Functional Safety and Automotive

ASIL - Automotive Safety Integrity Level





Severity S	Exposure E	Controllability C: C1	C2	C3
S1	E1	QM	QM	QM
	E2	QM	QM	QM
	E3	QM	QM	ASIL A
	E4	QM	ASIL A	ASIL B
S2	E1	QM	QM	QM
	E2	QM	QM	ASIL A
	E3	QM	ASIL A	ASIL B
	E4	ASIL A	ASIL B	ASIL C
S3	E1	QM	QM	ASIL A
	E2	QM	ASIL A	ASIL B
	E3	ASIL A	ASIL B	ASIL C
	E4	ASIL B	ASIL C	ASIL D

- Objective: Freedom from unacceptable risk of physical injury or of damage to the health of people (including via property or the environment)
- Examples: ISO 26262 (Road Vehicles Functional Safety), ISO 25119 (Tractors and Machinery for Agriculture and Forestry), IEC 62304 (Medical Device Software) …

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Cybersecurity

Why is it needed?

The importance of defending space assets and activities from cyber-attacks will increase as space becomes more strongly integrated in other sectors

ESA plans to address cyber security at various levels of innovation, specifically regarding technology and engineering

Flexibility and security by design

- Taking into account the rapidly changing nature of the cybersecurity threat

Integration of security into the ESA system engineering process

- Including the approach is a systematic way

First cybersecurity ‘Centre of Excellence’ for space assets

Identifying the System/Sub-Sytems interfaces and attack surfaces

Artificial Intelligence

AI, and in particular ML, still has some way to go before it is used extensively for space applications

Where today

- **Satellite operations**
- **Systems** analyzing the huge amount of data that comes from each space mission

Future implementations

- AI currently lacks the reliability and adaptability required in new software; these qualities will need to be improved before it takes over the space industry.
- Innovative security concepts, mechanisms and architectures.
- Advanced Concepts Team (ACT) is developing new concepts based on AI.

Modern Quality Challenge (NewSpace)

- From „Quick and Dirty“ (2000‘s) to professionnal (2020‘s) product
- Pareto Law (80-20):
  - 80-20: 80% of the work done with 20% of the effort
  - So, 20% remains to be done → 80% of the effort
  - *...80% of an exam preparation done with 20% of the effort...* ☺
- /!\ Devil is in the details ← ***Technical Expertise*** growing !!!
- Modern Quality: is ***NOT*** a Controller but a Facilitator
- **Modern Space Quality:**

→ **Final Decision** belongs to **Project Office** (PM, SE, PA) **+ Customer**.

(=customer oriented beyond marketing blabla)

→ **Risk based decision** balancing with **cost** and **schedule**

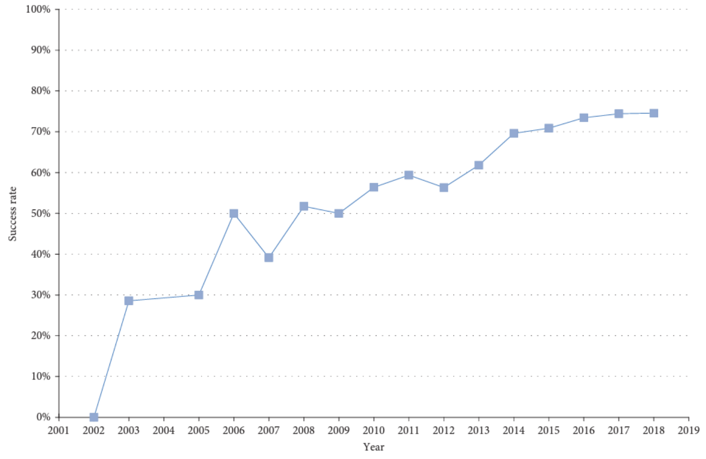
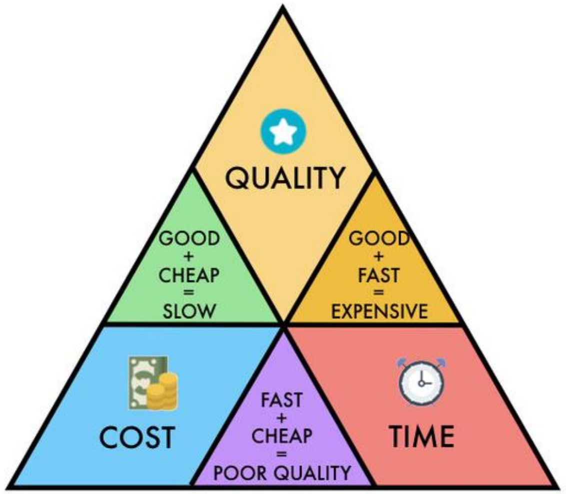


FIGURE 10: Success rate of CubeSat missions as a function of time.

T.Villetla et all, « Towards the Thousandth CubeSat: A Statistical Overview”; nternational Journal of Aerospace Engineering 2019(3):1-13 DOI:10.1155/2019/5063145



https://www.linkedin.com/pulse/triangle-dilemma-quality-cost-time-dr-lynda-wee/

Quality – Standards

ECSS stands for:

European **C**ooperation for **S**pace **S**tandardisation

The European Cooperation for Space Standardization is an initiative established to develop a:

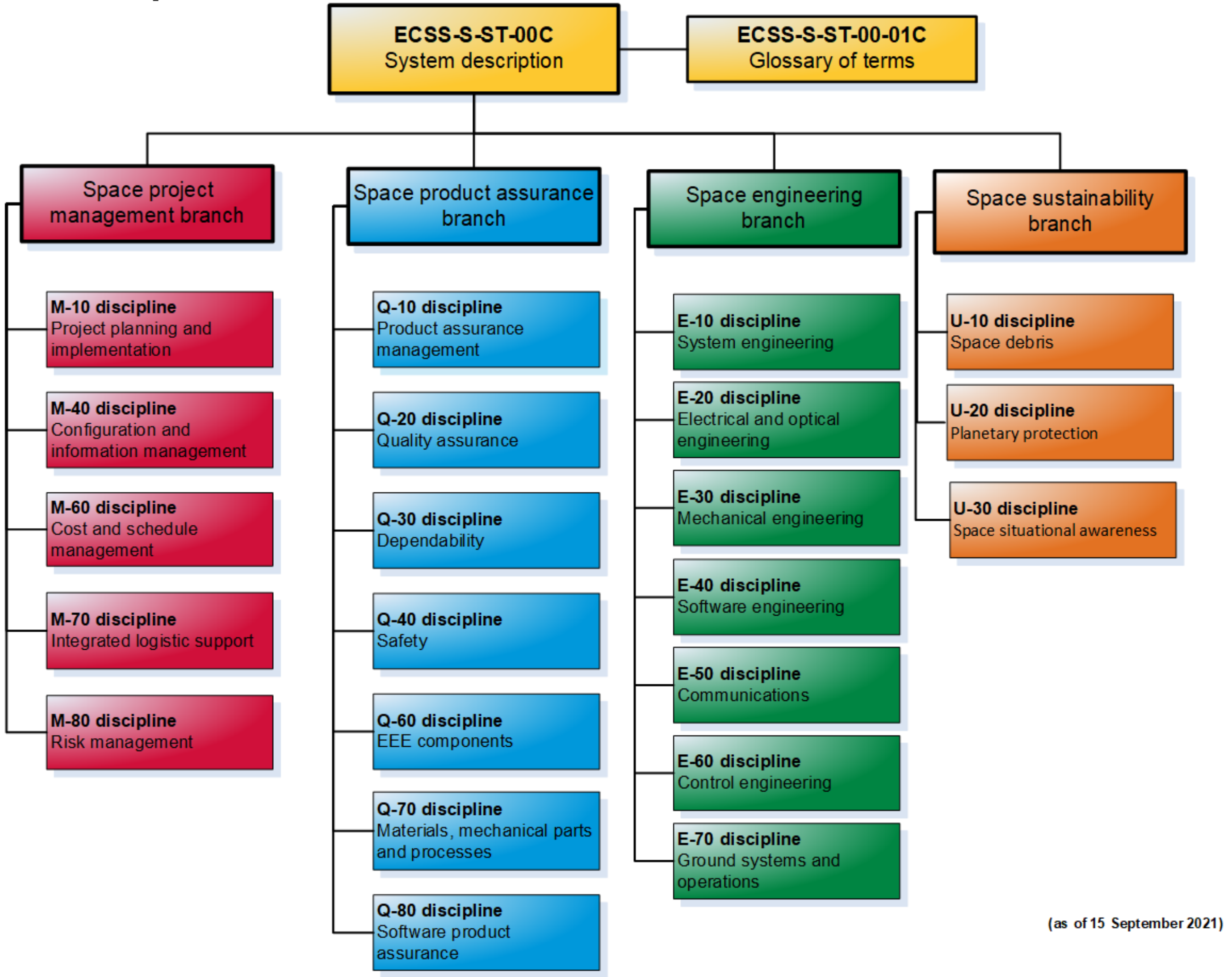
- coherent
- single set
- user-friendly

standards for use in all European space activities.

CCSDS stands for:

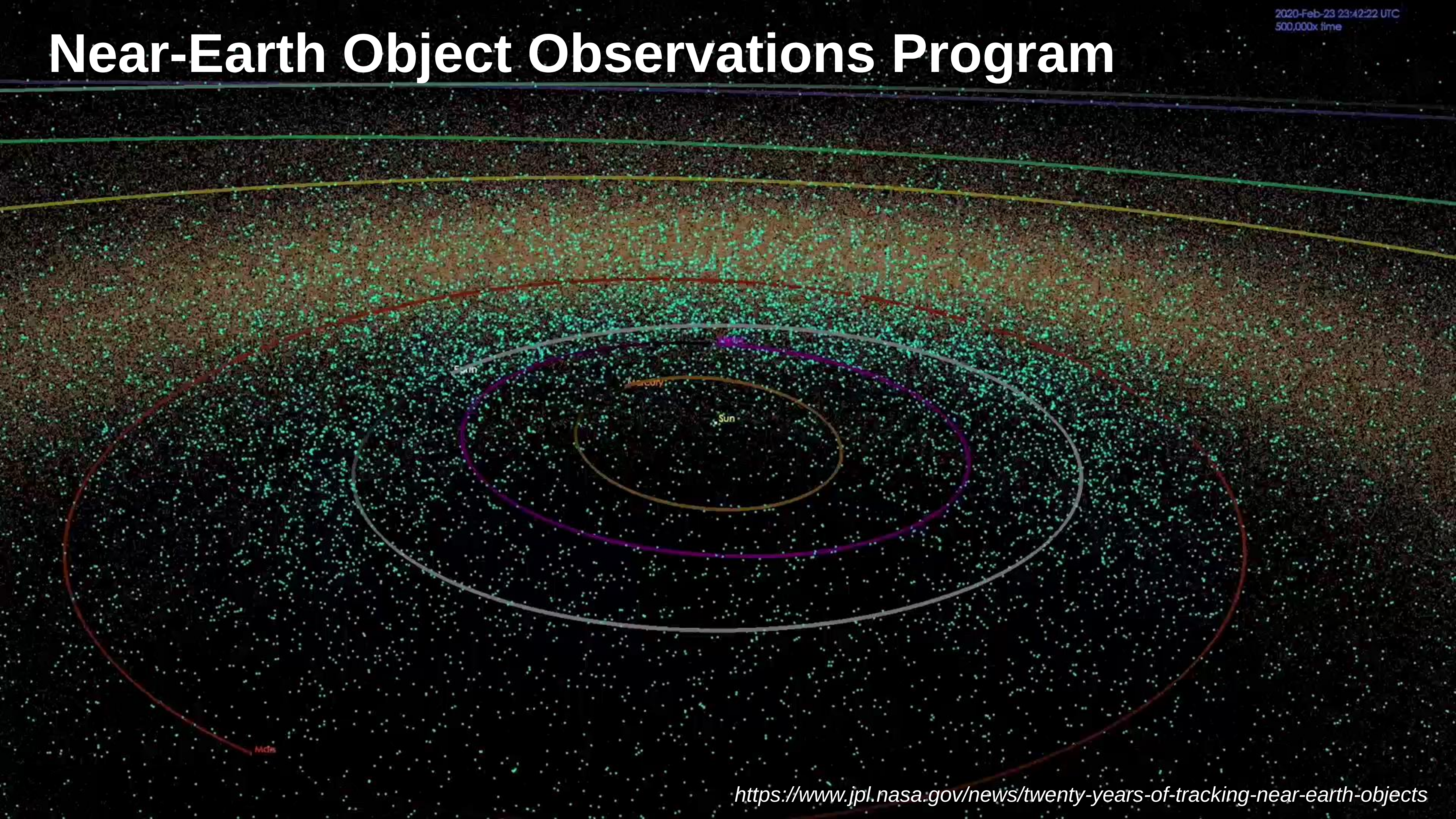
Consultative **C**ommittee for **S**pace link **D**ata **S**ervices

ECSS Disciplines



Project example

Near-Earth Object Observations Program



https://www.jpl.nasa.gov/news/twenty-years-of-tracking-near-earth-objects

(99942) Apophis

Discovered: June 2004

Dimensions: 325m diameter, 45million tons

(Eiffel tower: 330m, but 7300 tons)

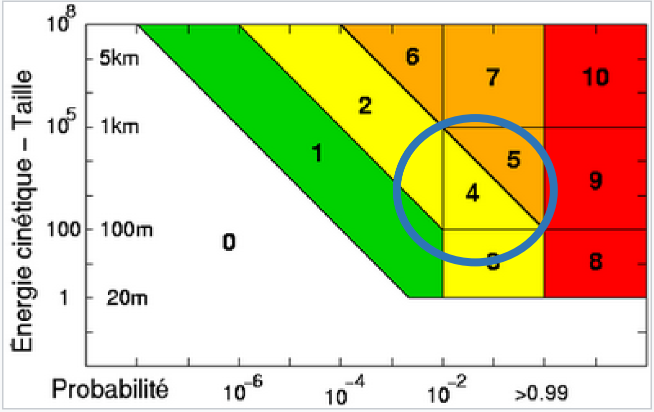
Impact speed if any: 12.62km/s

Energy: 3.6e18 Joules corresponding to 800 Megatons of TNT equivalent.

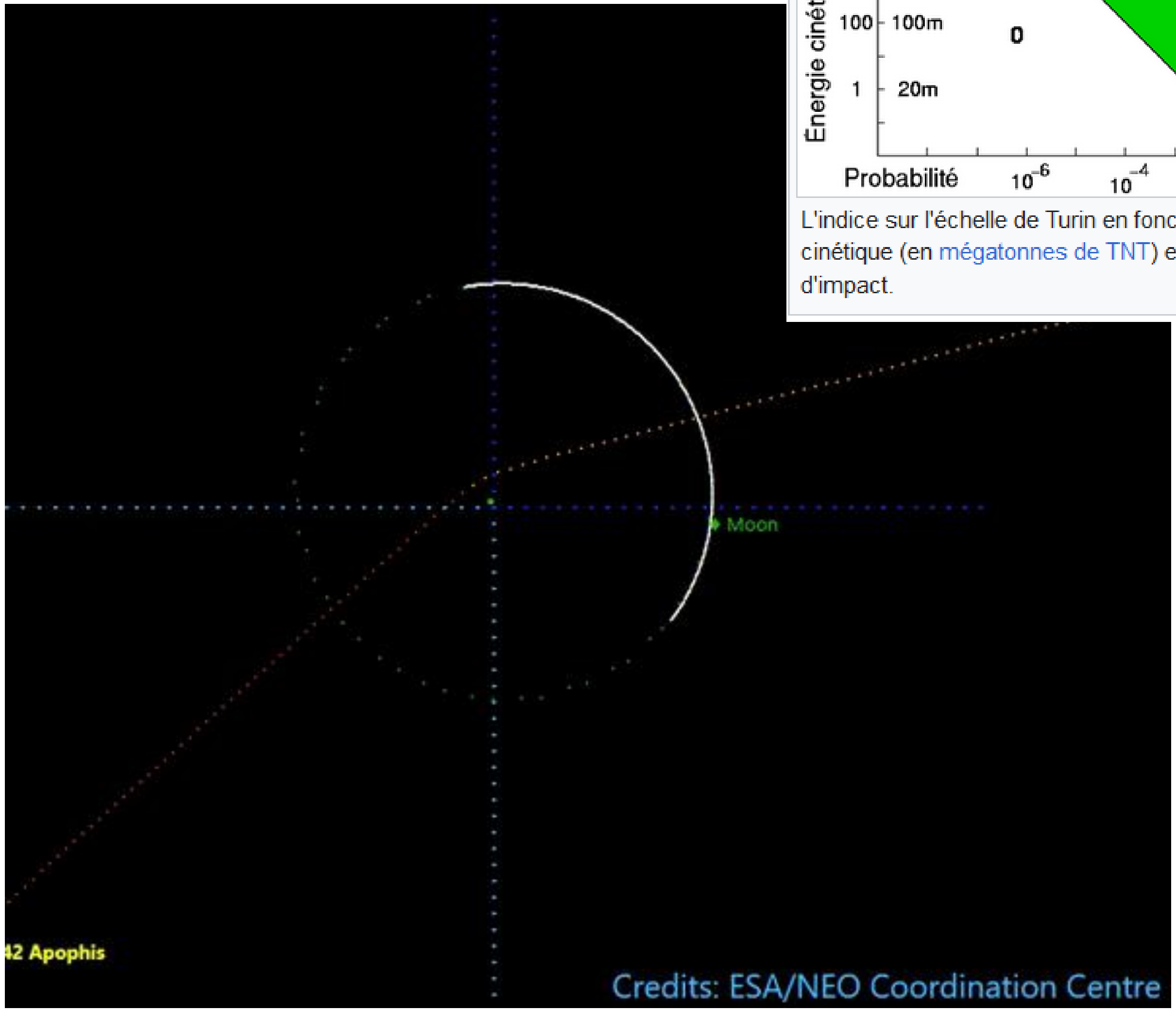
1st collision forecast: April 2029

Now discarded to a nearby trajectory at 30 000km (1/10th of the earth/moon distance) in 2016

2nd collision possibility: April 2036 with very low risk



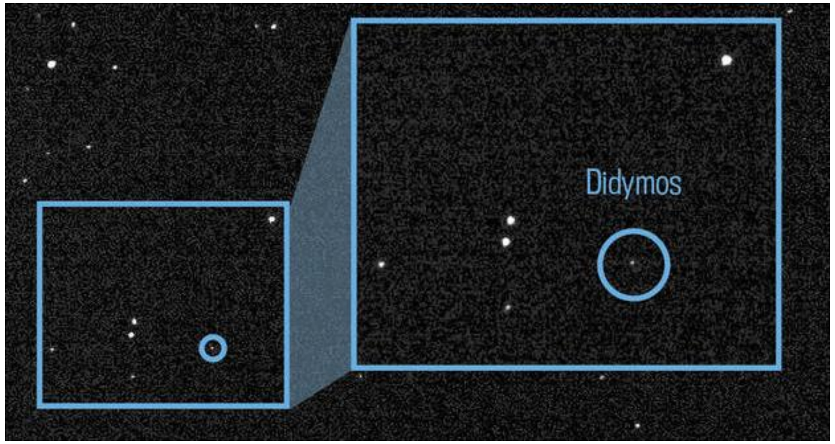
L'indice sur l'échelle de Turin en fonction de l'énergie cinétique (en mégatonnes de TNT) et de la probabilité d'impact.



NASA Double Asteroid Redirection Test (DART) Mission

DART is the world's first planetary defense test mission

- On Sept. 26 2022, DART intentionally crashed into Dimorphos, the asteroid moonlet of Didymos
- The kinetic impact into Dimorphos was supposed to slightly change its motion in space
- From 20 million miles away from DART Camera experts were uncertain whether DART would be able to spot the asteroid yet.
- The mission was a first success as DART crashed as expected on asteroid surface



https://www.lessentiel.lu/de/story/rakete-wird-in-asteroid-crashen-nasa-veroeffentlicht-foto-des-ziels-247191609297

Question

Does somebody know the goal of the Hera mission?

Hera - Project presentation

Launch date: October 2024

Prime: GomSpace (JUVENTAS) / ESA (HERA)

Goal: planetary defense mission.

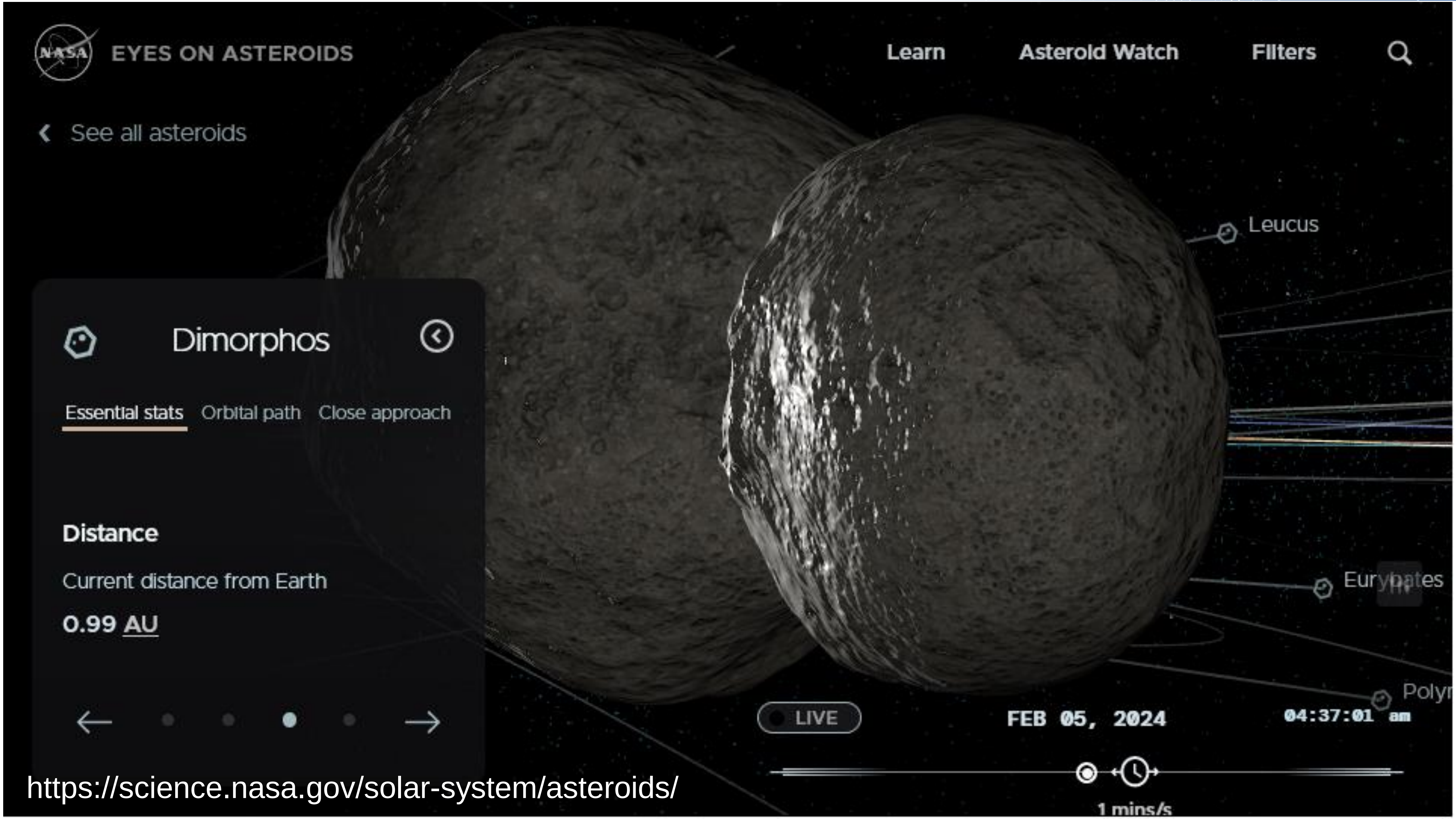
EmTroniX participation: develop the low frequency radar that will map the impact left by DART.

More in this video

Challenge time

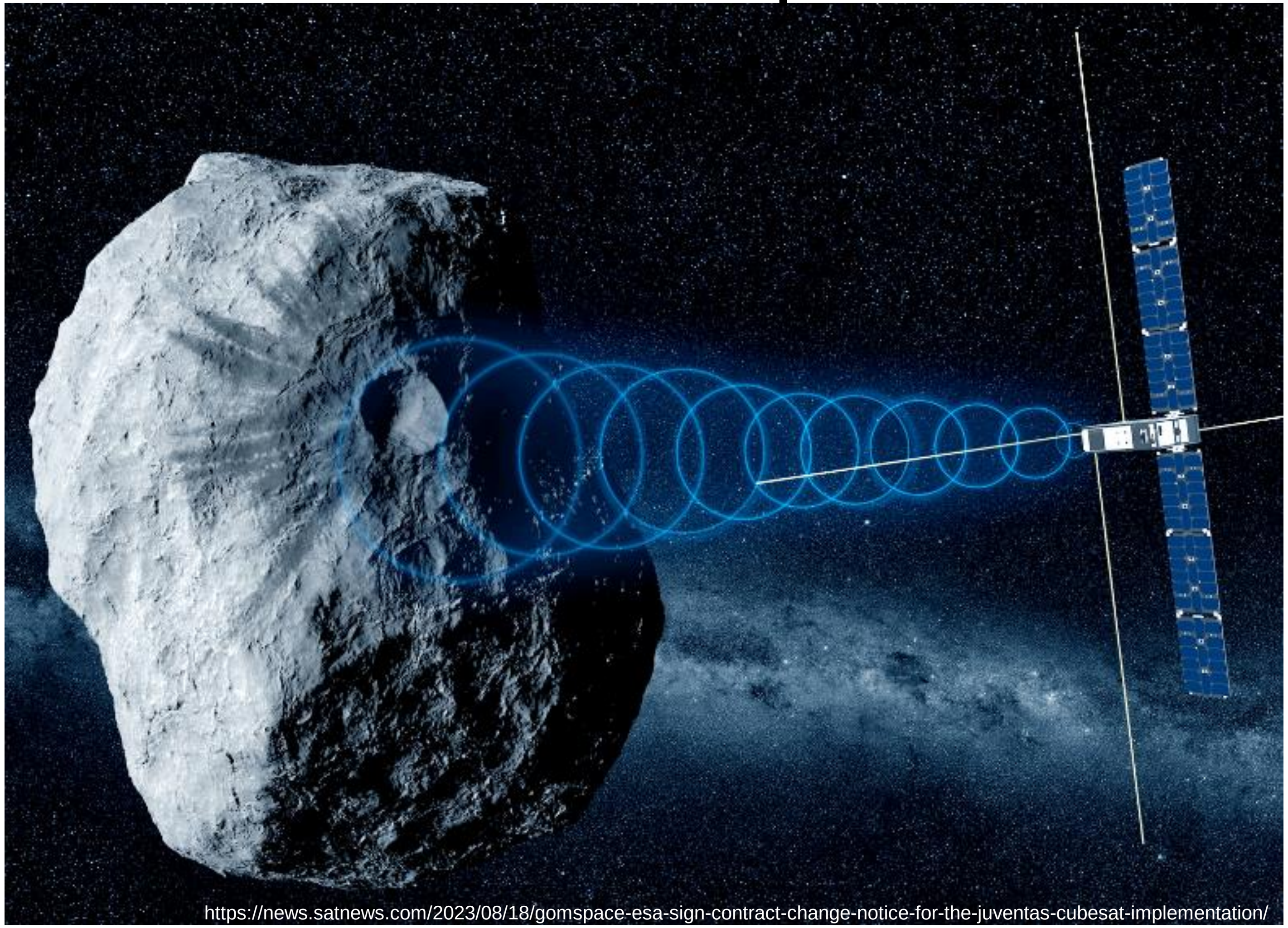
Does somebody know who is Brian May?

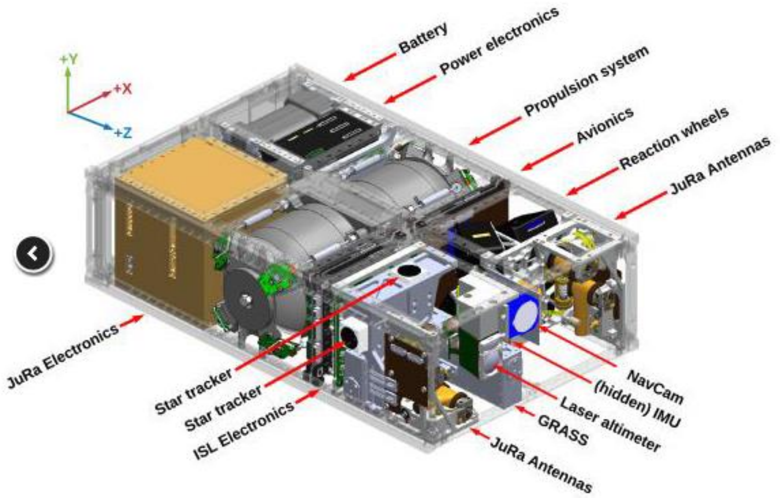
JUVENTAS – Dimorphos



https://science.nasa.gov/solar-system/asteroids/

JUVENTAS – Setup

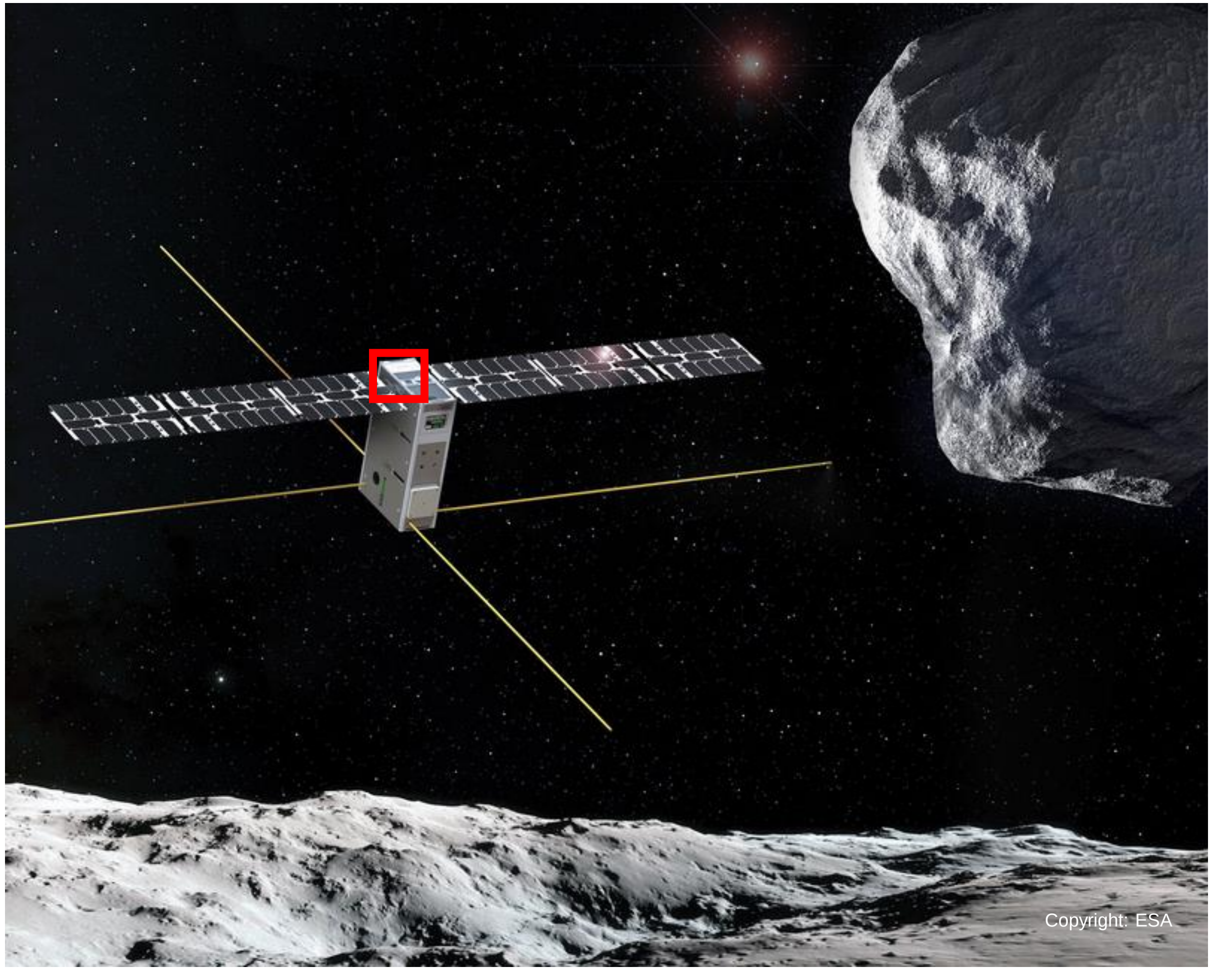


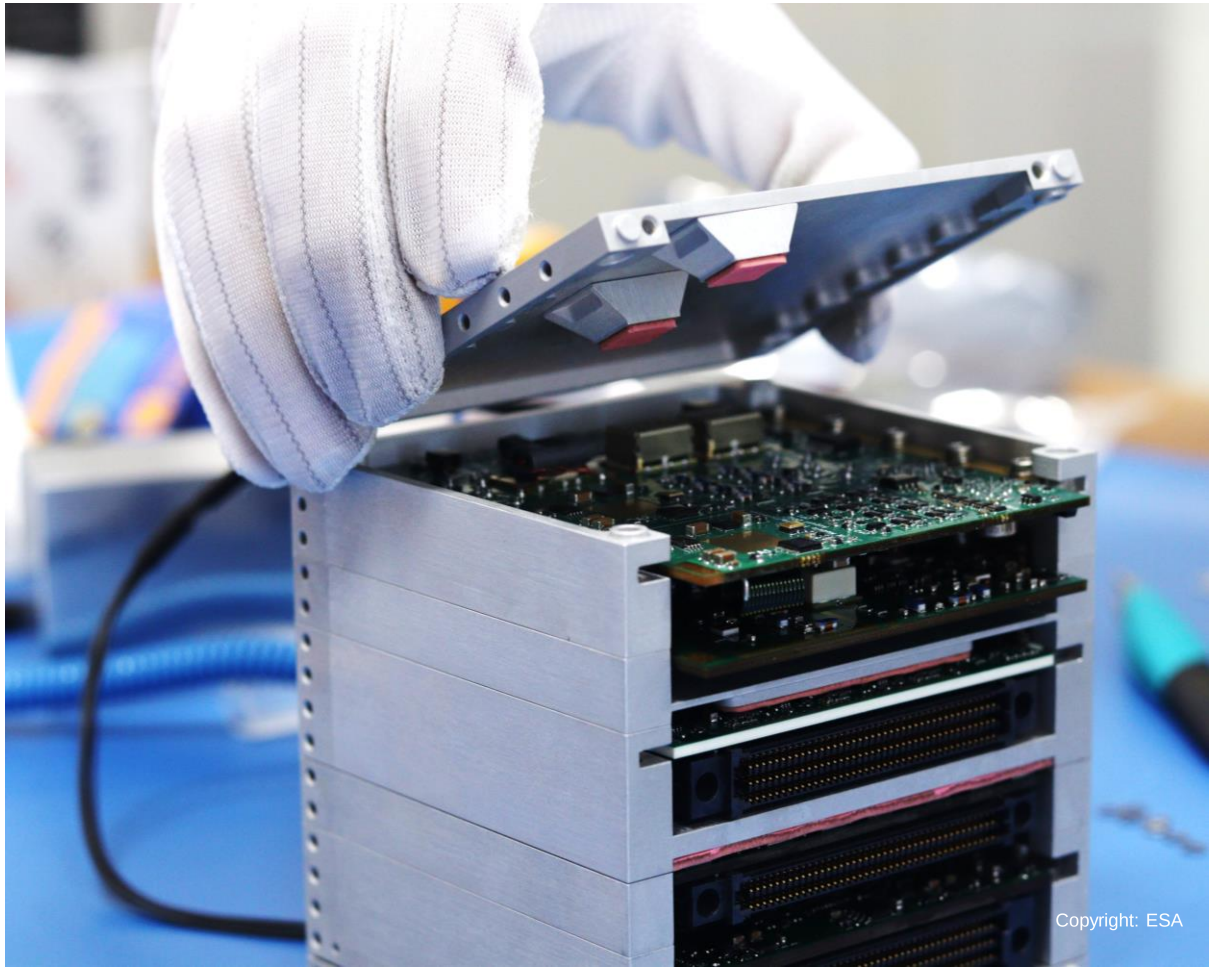


https://www.nanosats.eu/sat/juventas

Launch (Forecast): 08/10/2024
Arrive to Didymos: 28/12/2027

The kind of **payloads** we are designing & producing





Into details

Our Software Defined Radio – Global architecture

Power board

Satellite platform interface

- Main power supplies
- Radiation tolerant processor
- Housekeeping
- Communication Interfaces

Processing board

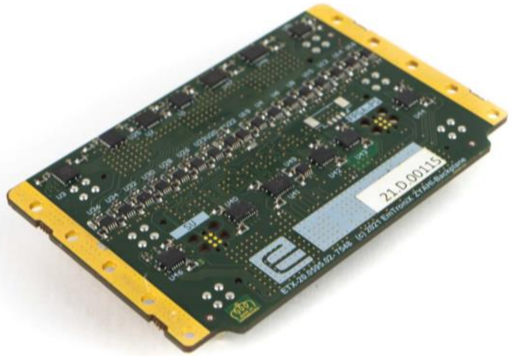
Core computing of the Payload

- FPGA & SoC
- DDR3 memory
- Golden image
- Three (3) User image
- Mass Memory (NAND)
- Power supplies

Transceiver board

Clocks & IF sampling

- Low Phase Noise TCXO
- Synchronous & flexible Clock tree
- Dual channels High Speed ADC& DAC



Back-plane

Connect the core of our SDR together

- Power distribution
- Debug & Service connectors
- Communication means
- High-speed buses interfaces

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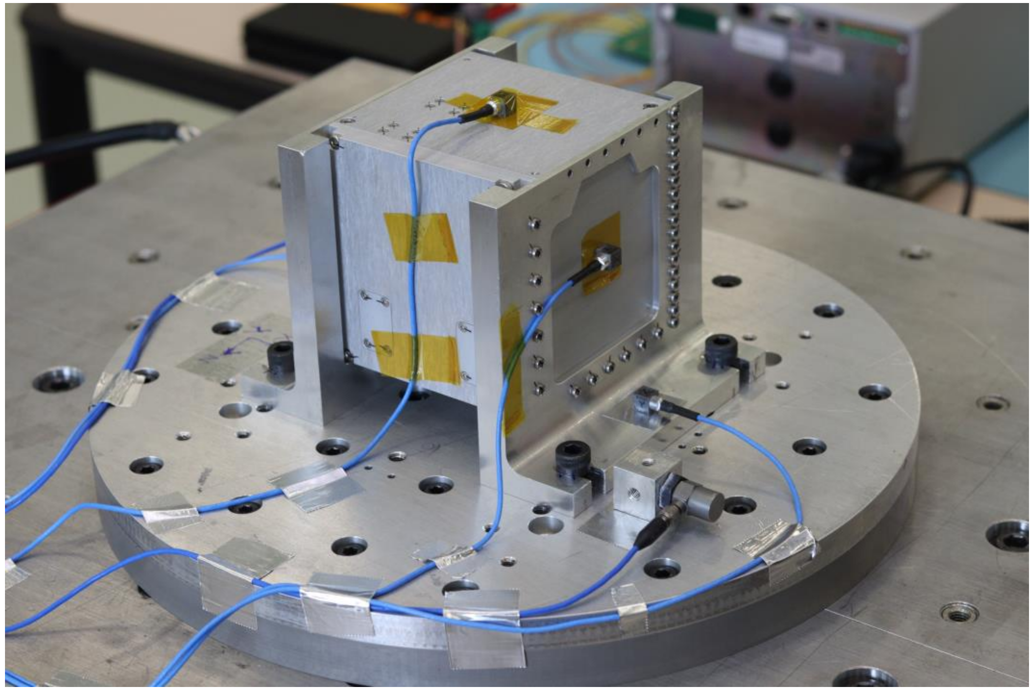
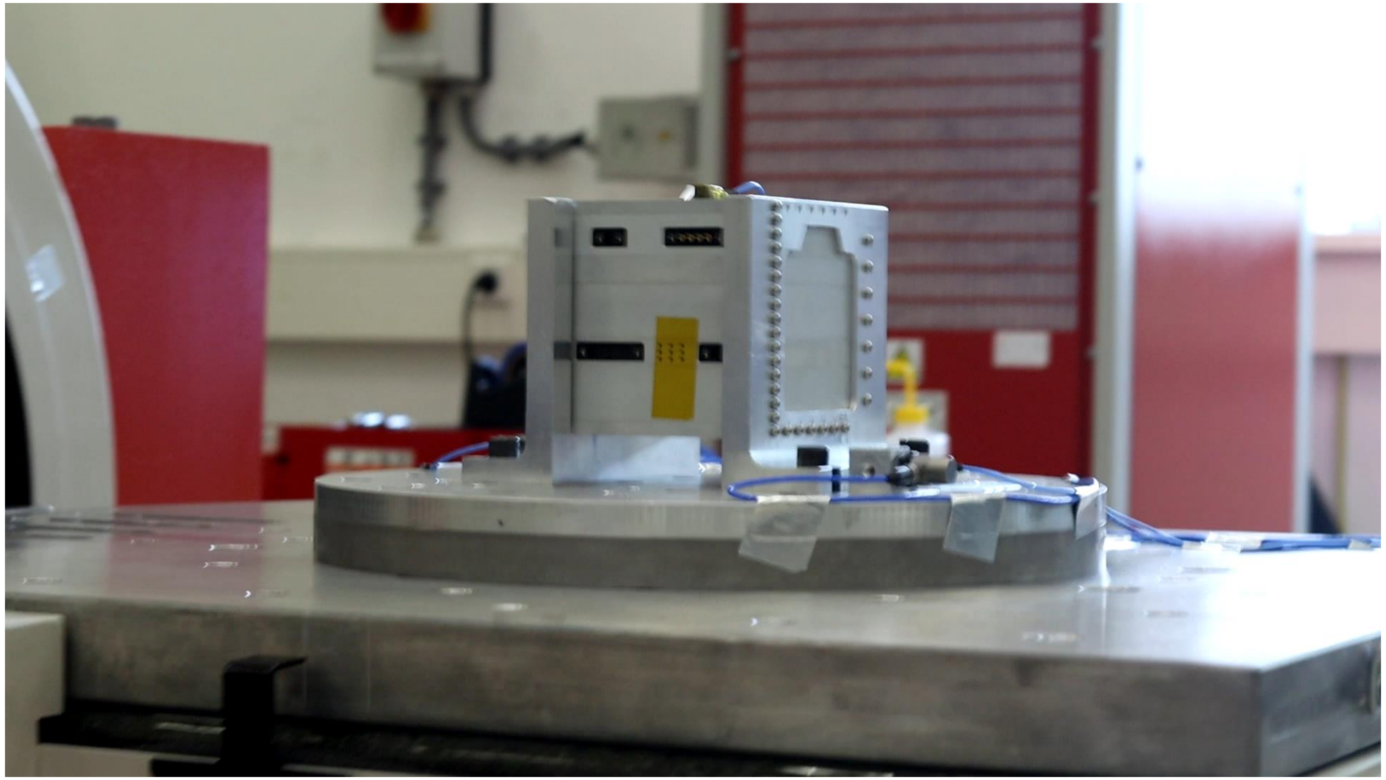
Testing at ESTEC (ESA)

Vibrations up to 24g

Reference sensors to monitor and measure the test





Key EmTroniX space projects

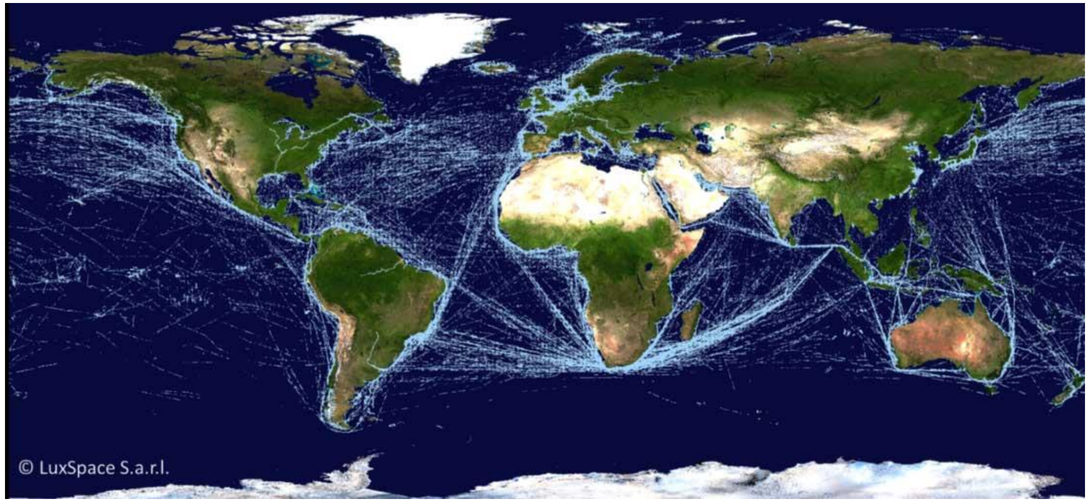
Space projects

AISSat-1

2008

OHB LuxSpace

- AIS Receiver, Downlink and TM
- On-Board-Computer interface
- Solar Panels Power tracker and Battery Power management
- Baseband AIS Digital Sampler
- GPS antenna

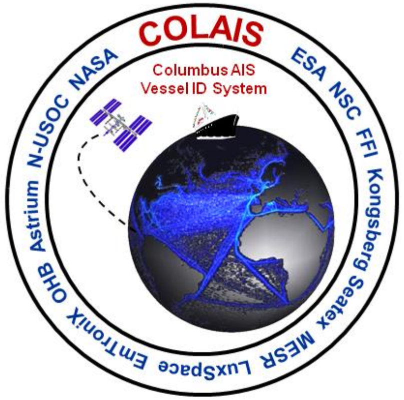


COLAIS

2010

OHB LuxSpace

- FPGA & ASIC based AIS Receiver
- Operated on board of the ISS
- RF front end
- Analog processing chain
- Digital Signal Processing
- FPGA synthesized processor
- ISS interface
- Power management



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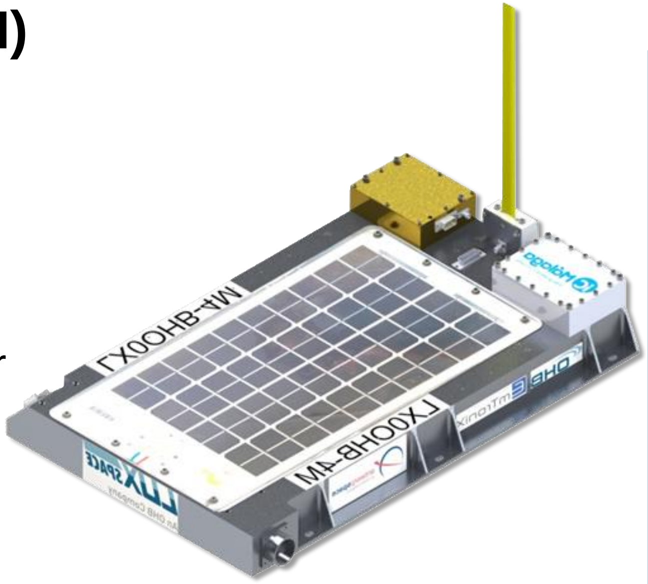
Space projects

Lunar Pathfinder (4M)

2014
OHB LuxSpace

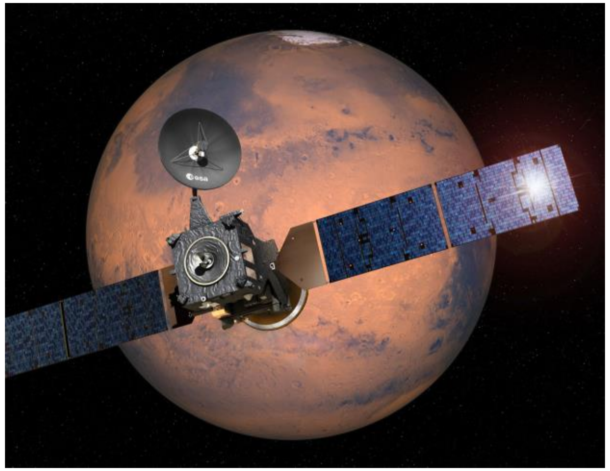
- Electronic development
  - OBC interface
  - Downlink modulator
  - Battery protection
  - Battery Charger
- Satellite Assembly
  - Electronics
  - Satellite harness
  - Batteries (Lithium & Li-Ion)
  - Solar panel
  - Antenna
  - Additional payload



SDR Autonomous transceiver for Mars orbiter

2018
QinetiQ / ESA

- FPGA-based digital implementation in view of a future flight-qualified unit.
- DSR-based flexible architecture
- Efficient DSP algorithms for automatic identification of received signal attributes
- Multi data rate design supporting various phase modulation schemes
- Support of high Doppler Dynamics and severe SNR conditions



Space projects – Current projects

ScienceTaxi Electronics and Software

2021 - 2024
Yuri

Next generation micro-gravity experiment platform.
Development of highly reliable electronics on a complete system
High efficiency full electronic system (9 PCBs) :

- Using in-house ECCS compliant LCL
- Managing Real time operation of experiments (up to 40)
- Controlling ambient temperature and Local gravity (Moon, Mars or Earth)
- Interfacing with different vehicles and ISS
- Balancing power to maximize experiments' availability

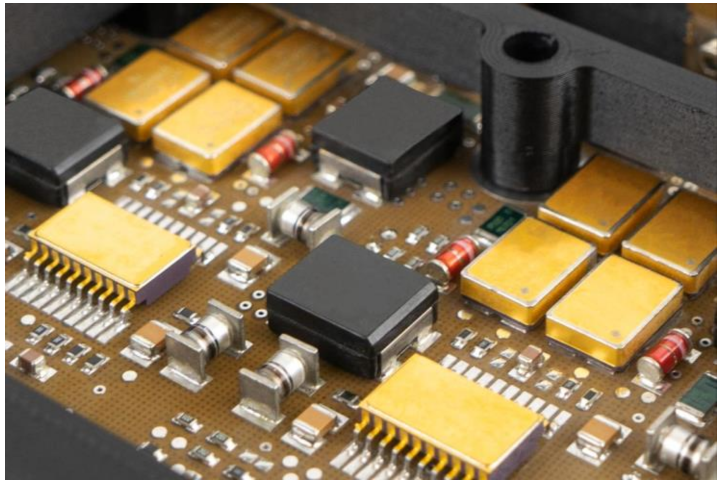
EGSE to support

- Easy installation of Science Shells
- Experiment simulation

Altius

2019 - 2023
ESA / QinetiQ / OIP

- System level analysis
- Electronics design and PCB layout of the optical mechanism motor drivers
- Mechanism Firmware algorithms and specification
- Engineering, Structural/Thermal and Flight models
- Full ECSS electronics development



Conclusion

This is not an end…

Space is **accessible** through a large set of contributors

Projects are very **attractive**

(New) talents needed for many projects

We are hiring!

THANK YOU

electronics and software solutions

EmTroniX