EU Perspective and European Commission Activities in the area of Space EEE Components

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BEHIND DG DEFIS

The **European Commission Directorate General for Defence Industry and Space** is in charge of:

- upholding the competitiveness and innovation of the European Defence industry by ensuring the evolution of an able European defence technological and industrial base,
- implementing the **EU Space programme**,
- defining and implementing the **Space R&D via Horizon Europe programme**
- implementing the **IRIS²** infrastructure, and developing and implementing space-related initiatives and strategies.

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EU Space Programme (2021–2027)

EU Space Missions:

Existing:

- Galileo
- European Geostationary Navigation Overlay System (EGNOS)
- Copernicus

New:

- Space Situational Awareness (SSA)
  - Space Surveillance and Tracking; Space Weather Events; Near-Earth Objects
- Governmental Satellite Communication (GOVSATCOM) and Secure Connectivity (IRIS²)

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EU-funded space R&I focuses on

Technologies responding to EU flagship programmes needs: Copernicus, Galileo/EGNOS, IRIS^2, SSA, GOVSATCOM,

Developing **space critical technologies for EU non-dependence** (including EEE) and **fostering EU competitiveness** world-wide from low TRL up to market uptake.

Developing **new downstream applications** leveraging the synergies between EU Space missions

Supporting Space Entrepreneurship and business acceleration

Supporting the EU independent **Access to Space**, through R&D activities and the emergence of new launch systems

Enabling in-space operations & services such as on-orbit servicing, assembly, debris removal, or logistics services

Advancing emerging technologies e.g. in the area of quantum, robotics and propulsion technologies, AI/ML, space weather and space science

+ EDF Space

European Commission

#EUSpaceResearch

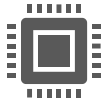
EU Space EEE Components

European Commission strategy and initiatives

European Commission

EU Technology Sovereignty - Space Critical Technologies and EEE

- To strengthen the competitiveness of the EU space industry and its strategic autonomy, the EU funds and directly manages the development of critical space technologies and EEE via its Space R&I Programme
- This programme started in 2009 and along the years, especially from 2014 on, has focused on reducing EU space technologies dependencies from outside Europe



EU **Microelectronics** stakeholders have a **broad range of capabilities** to design and manufacture Integrated Circuits (IC), based on Silicon-type materials, as well as III-V compounds

A broad range of **EEE components** are critical for space applications, therefore consistent investments and a development strategy has been followed for components families particularly important for EU Space missions.

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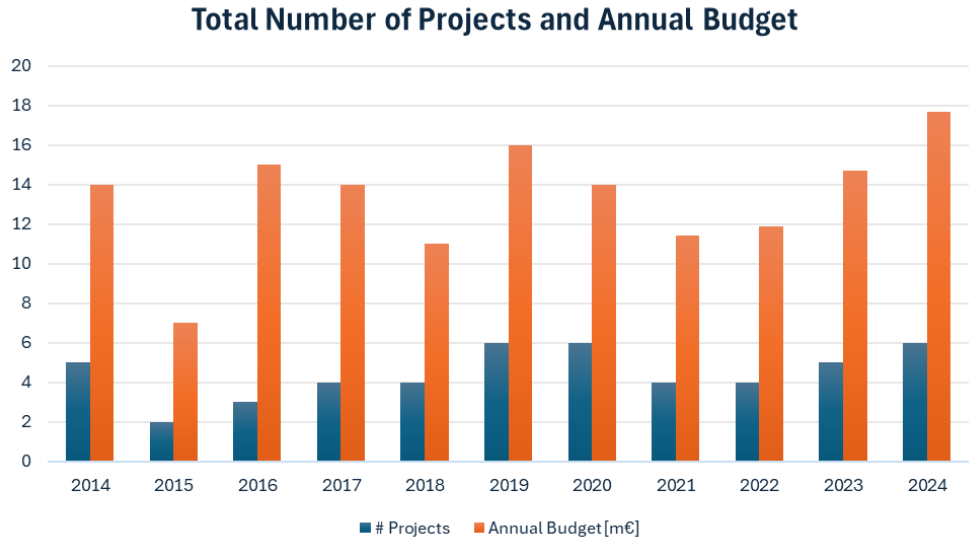
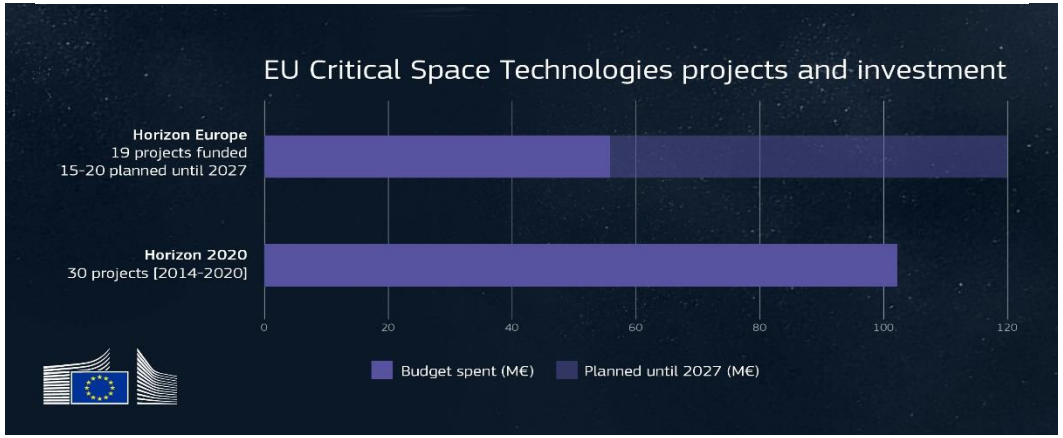
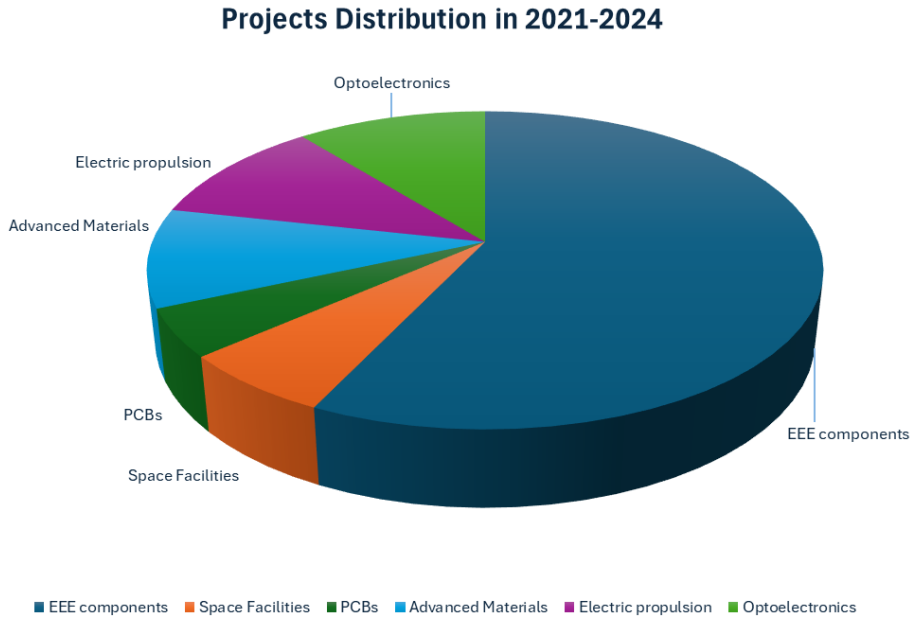
Overview of EU investments and development activities in the area

- In the last 10 years, the European Commission has consistently invested in developing critical space technologies, with a large share represented by EEE components







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EU Strategy for Space EEE components

- In response to global supply chains vulnerabilities and emerging needs to get unrestricted access to cutting edge semiconductors for remaining competitive, in 2023 the EU launched the Chips Act for boosting EU-based semiconductor manufacturing
  - Leverage effect and overall mobilisation of public and private investments for almost €100 billions
- This has led to the creation of new semiconductor lines complementing the available technology nodes and establishment of **novel pilot lines**
  - **FAMES**: Focused on **UDSM FD-SOI technology** for non-volatile memories, RF, and 3D integration.
  - **APECS**: Advancing **heterogeneous system integration** and packaging technologies.
  - **NanoIC**: Developing ultra-advanced **chips beyond the 2nm process**, targeting 1nm to 7A technology.
  - **WBG**: Pioneering **Wide Band Gap** materials for next-generation semiconductor applications.
  - **PIXEurope**: Enhancing **photonic integrated circuits** to bolster Europe's leadership in advanced photonics

- The **EU Space R&D** and its part related to EEE for EU non-dependence aims at investing in critical supply chains. Therefore, developing space focused products exploiting the semiconductor capabilities enabled by the Chips Act and terrestrial businesses
  - In the current Horizon Europe MFF, by 2027 the Commission will invest up to €120 millions

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The EU Observatory of Critical Technologies (OCT)

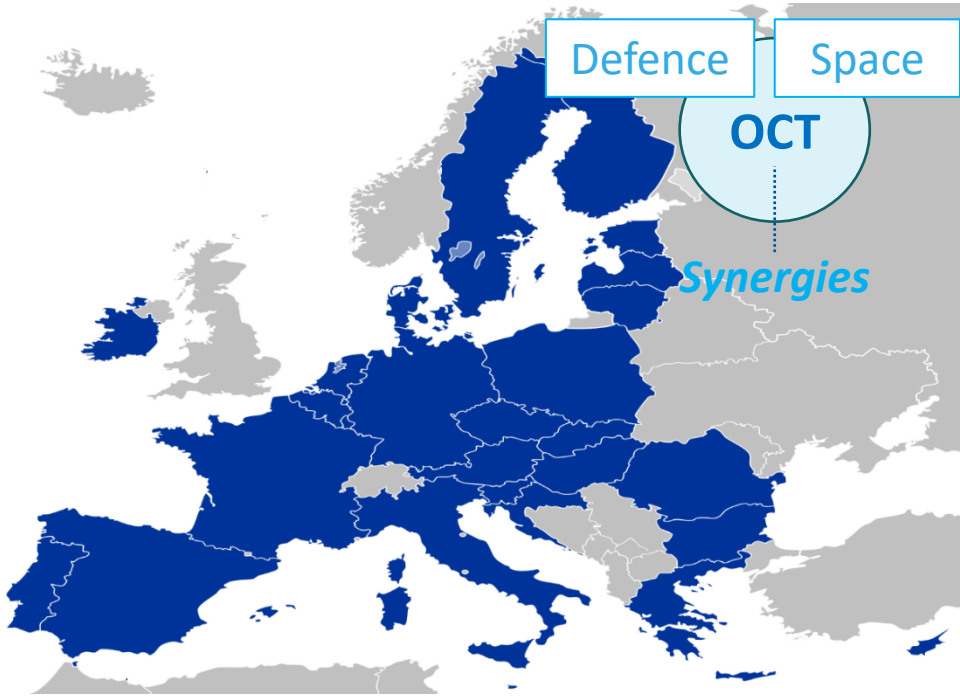
A tool supporting EU strategic autonomy and aiming at constantly monitoring the supply chains robustness, dependencies and gaps in the area of **space and defence**. Fully **driven by the European Commission**. It covers from materials, components up to systems.

Ursula von der Leyen: *"Contribute to EU's technological sovereignty by reducing risks of dependencies on others, for things we need the most".*

The OCT has already produced a number of **EU Classified Reports** with focus on Space and Defense applications

- In consultation with Industry
- Discussed with EU Member States

- The **OCT** is developing **technological roadmaps** which are implemented via the **EU R&I Space and Defence Programmes**
  - GaN for Space and Defence RF Applications and Robotics Manipulators are currently under finalisation



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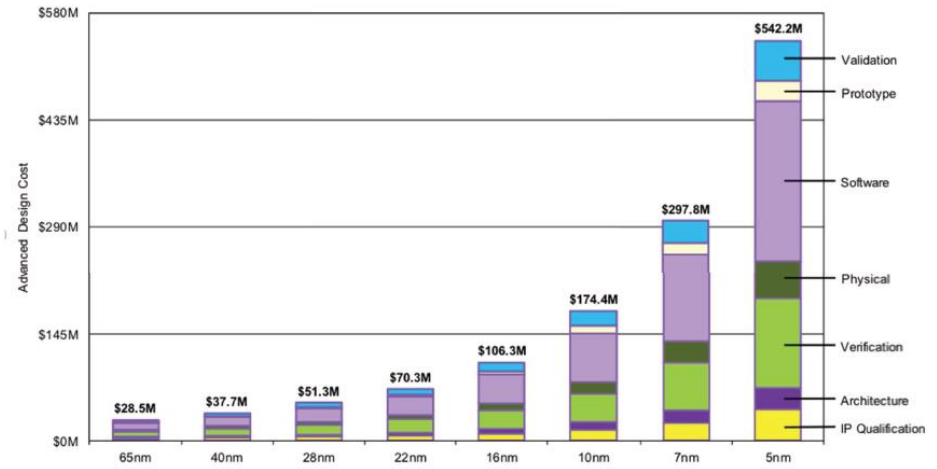
UDSM status and trends for Space applications

- **EU** foundries/IDMs can currently provide **FDSOI technology up to 22nm**, both GlobalFoundries and STMicroelectronics processes are used for designing EU space grade EEE components (FPGA, ASICs…)
- **Smaller** technology **nodes** (FDSOI or FinFET process on 16/12, 7nm) will be **necessary** for meeting **future space requirements** in terms of power dissipation and computational speed, especially for the payload
- For example, for active antennas based on Digital BFN, 7nm FinFET technology is considered a suitable candidate for meeting stringent dissipation requirements relevant for large constellations

UDSM future space missions enabler and costs

- Developing the next EU Space components based on UDSM is now considered essential. All space areas covered by EU Space missions include requirements such as:
  - **Payload flexibility and reconfigurability**. E.g. in Telecom, need to adapt the payload in-flight to cope with changing customer needs over time, adaptation to different traffic types and profiles
  - **Increased on-board processing**. E.g. In EO, need to increase data speed handling, signal pre-conditioning and data reduction to ground station
- In parallel, development costs have increased substantially. Design, EDA, IP core, tape-out, packaging has exceeded 50% after the 22nm technology node
- **Volumes** and/or **IP re-use strategy** is key for ensuring a **sustainable business case in space**



Source: IBS

EU based rad-hard FPGAs Strategy

1. **Exploit previous EU investments** for the development of a family of European rad-hard FPGAs space qualified (65nm, 28nm)
    - For example, the 28nm European rad-hard FPGA NG-ULTRA has recently completed the space qualification campaign and has been inserted into EU Space missions (e.g. Galileo 2nd generation, Copernicus)
2. **Prioritise the development of high-capacity FPGAs ≤ 7nm** with a large number of LUTs, embed AI accelerator and security features
    - Move towards more advanced technology nodes, therefore support the development of the next EU rad-hard FPGA based on UDSM
3. Ensure the **adoption of EU FPGAs by European space users** through demonstration of technical maturity, adapted technical support, and tools

Radiation robustness of 7nm FinFET

- Based on preliminary data available through our development projects and literature, Single Event Effects (SEE) appear to be:
  - Low overall sensitivity
  - Depending on the LETs level overall better performance than 16/12nm
  - Static SEE shows immunity to Single Event Latchup (SEL) up to 69 MeV.cm²/mg
- In 2021, the European Commission kicked off the project DUROC, aiming at:
  - Prepare the next generation of SoC FPGA (ULTRA7) in 7nm FinFET
  - Specify and design the next generation of SoC architecture ULTRA7
  - Develop a dedicated test chip to:
    - **Validate radiation performance of rad-hard library**
    - **Validate reliability and radiation hardening performance of 7nm FinFET**

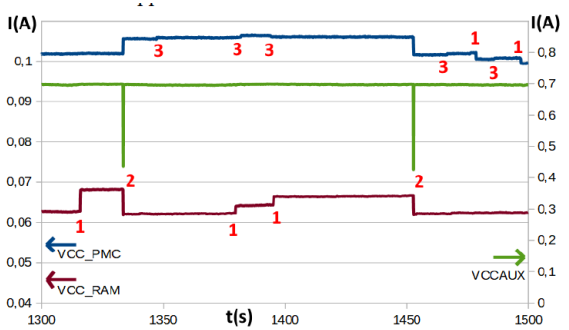


Figure 7: Current monitoring with the different events shown

Test performed on Xilinx Versal in 7nm FinFET

"7nm FinFET technology heavy ion SEL evaluation using Xilinx Versal as case study" – A. Dufour et al.

DUROC

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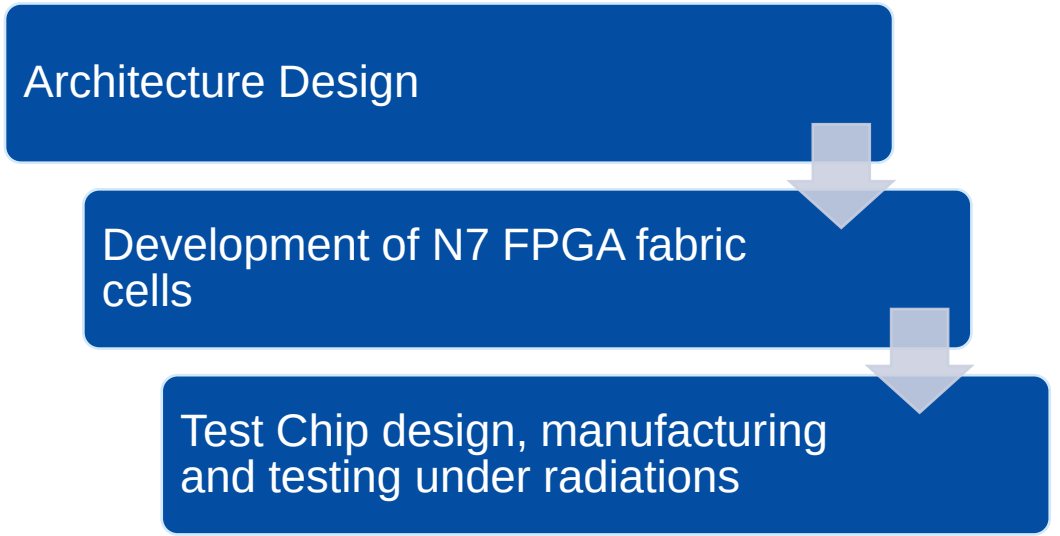
European rad-hard FPGA based on 7nm

- As a follow up of the DUROC preliminary investigations and increased level of performance required by new EU Space missions (e.g. IRIS^2) the **European Commission/DG-DEFIS** has decided to invest in the **development of the next European rad-hard FPGA 7nm**
- The target is to reach a FM by 2028
- In February 2025, the Commission kicked off a second project on 7nm, PUMA, covering specific building blocks for the development of the rad-hard N7 FPGA
- Additional follow up EU space projects, planned in 2026/2027, aimed at covering the missing elements in terms of full FPGA fabrication, industrialisation and space qualification



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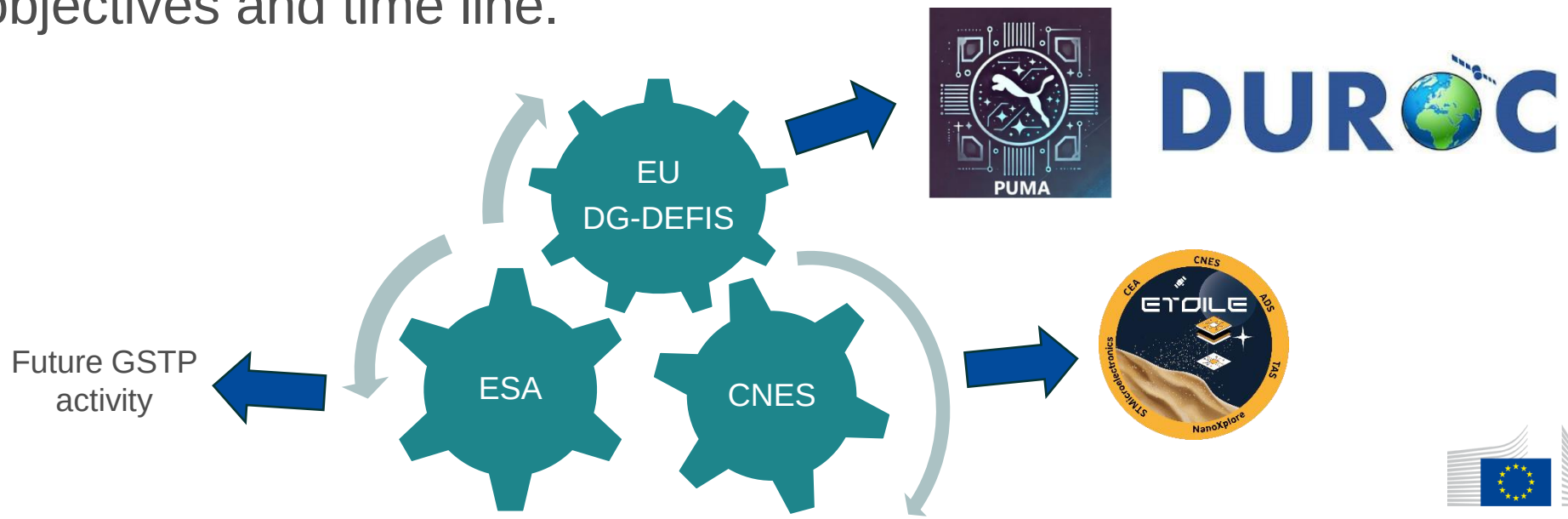
Coordination at European level – Space FPGA7

- The European Commission/DG-DEFIS has implemented a close coordination **with ESA and CNES** with the intention to join forces, coordinate resources and technical results of respective projects on FPGA7. A ‘Tiger Team’ approach has been established.
- Different projects are implemented in a complementary way sharing the same final objectives and time line.



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EU Strategy for Space Microprocessors

- The European Commission objective is to implement development activities exploiting the **synergies** between the current development of EU based standard cells library and IPs portfolio for the next **FPGA and Microprocessors based on 7nm technology**
  - Increase and secure competitiveness of EU space industry in Telecom, Nav and EO payloads in response to EU space missions
- COM/DEFIS will initiate **in 2025 the developments for the next EU Space 7nm Microprocessor** targeting **chiplet architecture** with benefits for both space and defence:
  - High levels of integration
  - Flexibility to re-use key IPs for other future products
  - Flexibility to optimise specific functions, IPs, as a function of different parameters (e.g. speed, power consumption,…)
  - Cost savings in the long term

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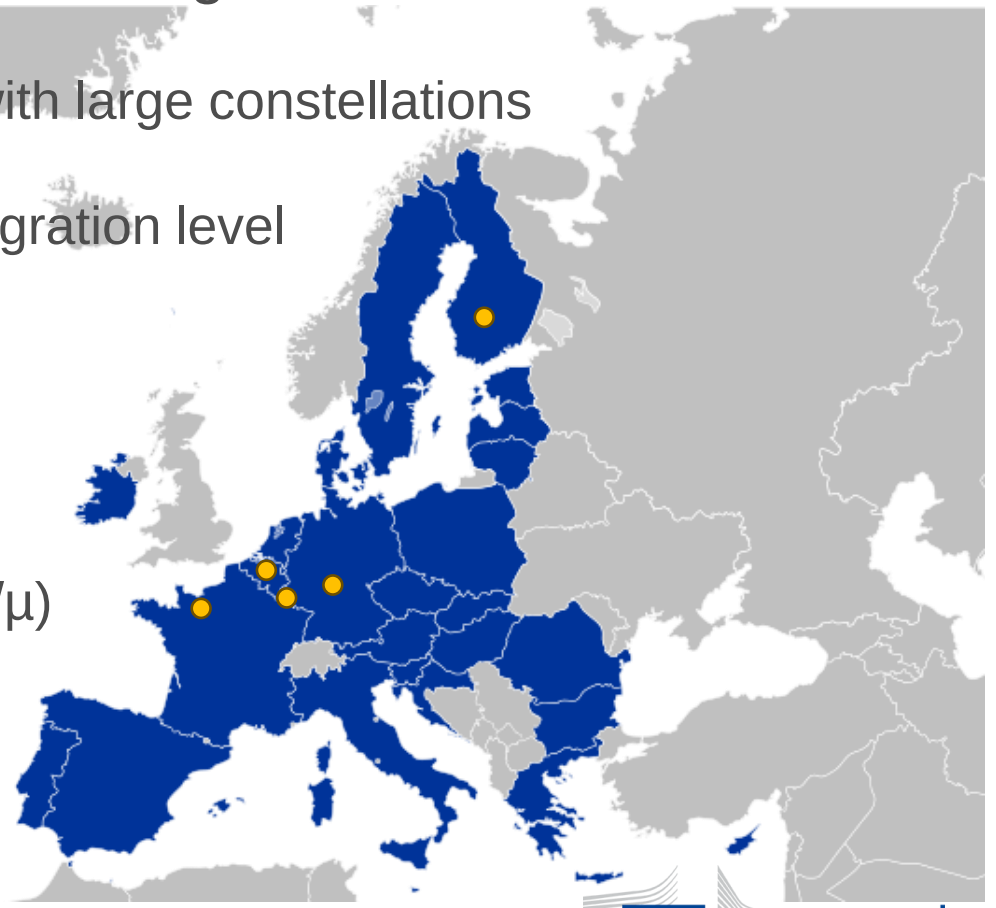
Current radiation testing facilities in EU

- Demand for heavy-ions radiation testing is increasing due to several factors:
  - **Increased use of COTS** components combined with large constellations
  - **Increased complexity** of EEE parts with high integration level
- The available irradiation facilities in Europe:
  - Do not satisfy the demand for beam time
  - Do not cover high energy (from 100MeV/µ to GeV/µ)
- Available non-EU irradiation facilities often prioritise national demand



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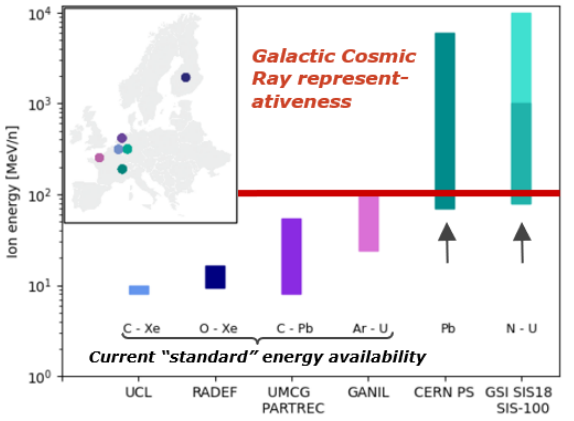
New high-energy facility funded by EU

- In 2023, the European Commission kicked-off a development project responding to the EU Space programme aiming at **building an irradiation facility suitable for testing space EEE parts**
- Within the project HEARTS, a high-energy (up to 5GeV/μ) testing facility is under construction at CERN and GSI, aimed at responding to the needs of the European space industry
- The HEARTS facility will represent the EU solutions to the alternative sites in U.S.A. of Brookhaven National Laboratory and NASA Space Radiation Laboratory



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Status of HEARTS: High-Energy Accelerators for Radiation Testing and Shielding

European Commission
Space Project - HEARTS

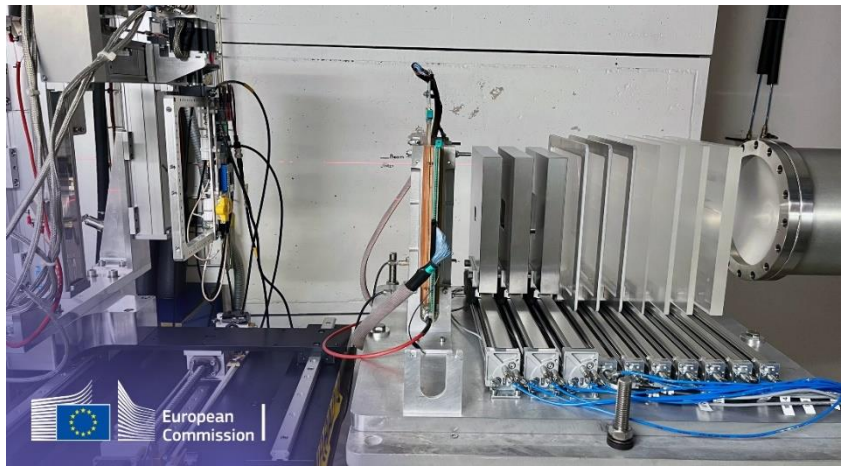
Schedule

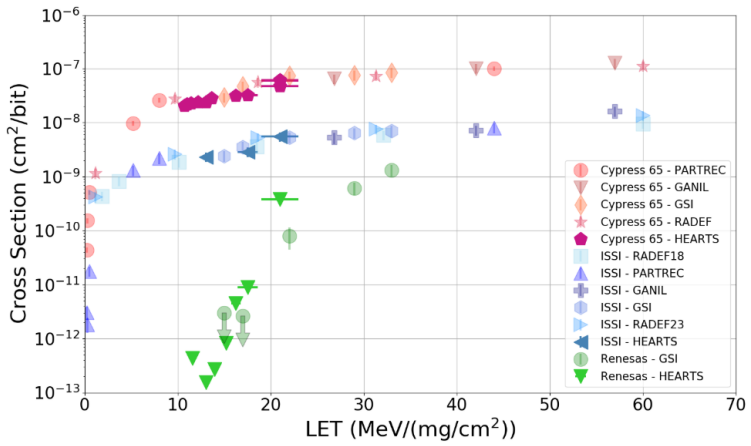
2023 | 2024 | TODAY | 2025 | 2026

Routine access from external Users for microelectronics testing, testing guidelines established

Project progressing very well:

- Facility setup and evaluation, tuning of CERN T8 ion beam and related beam proprieties
- HEARTS 2024 first test campaign performed on real devices, readiness evaluation for radiation effects testing in accordance with user needs:
  - 10 user groups, 7 industrial/commercial teams
  - 168h beam time
- Plan to have a 2025 test campaign including more complex devices (e.g. SoCs, memories…)





Comparison of SEU cross sections obtained at HEARTS@CERN with those retrieved at other heavy ion facilities

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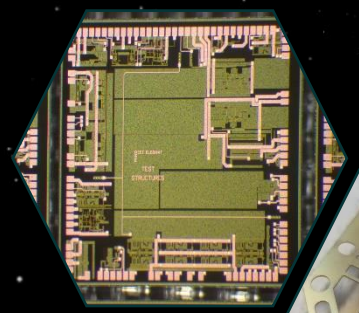
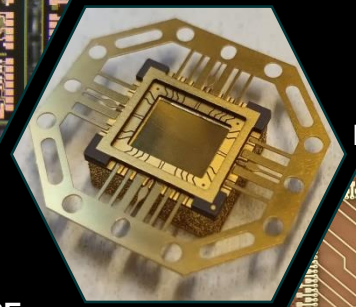
COM-DEFIS Critical Space EEE – Current Development Focus

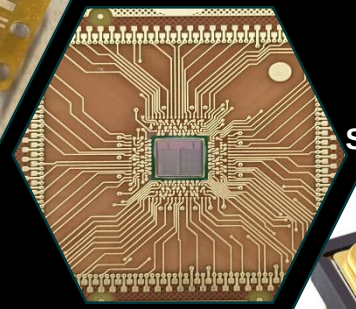
FPGA



Advanced Packages

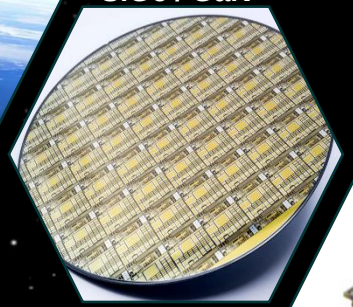


ASIC / Microprocessor

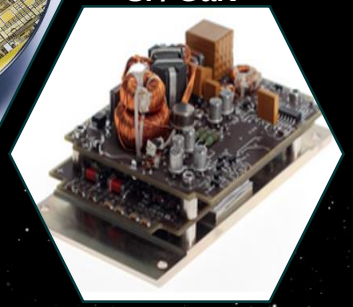


Solar Cells

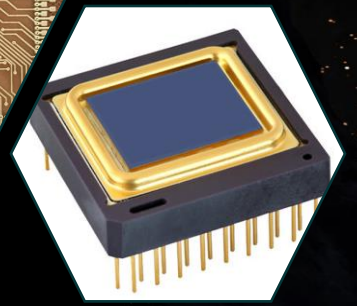
RF Components SiGe / GaN



Power Components Si / GaN



Space Detectors



Supporting technological requirements <u>driven by EU Space missions</u>:

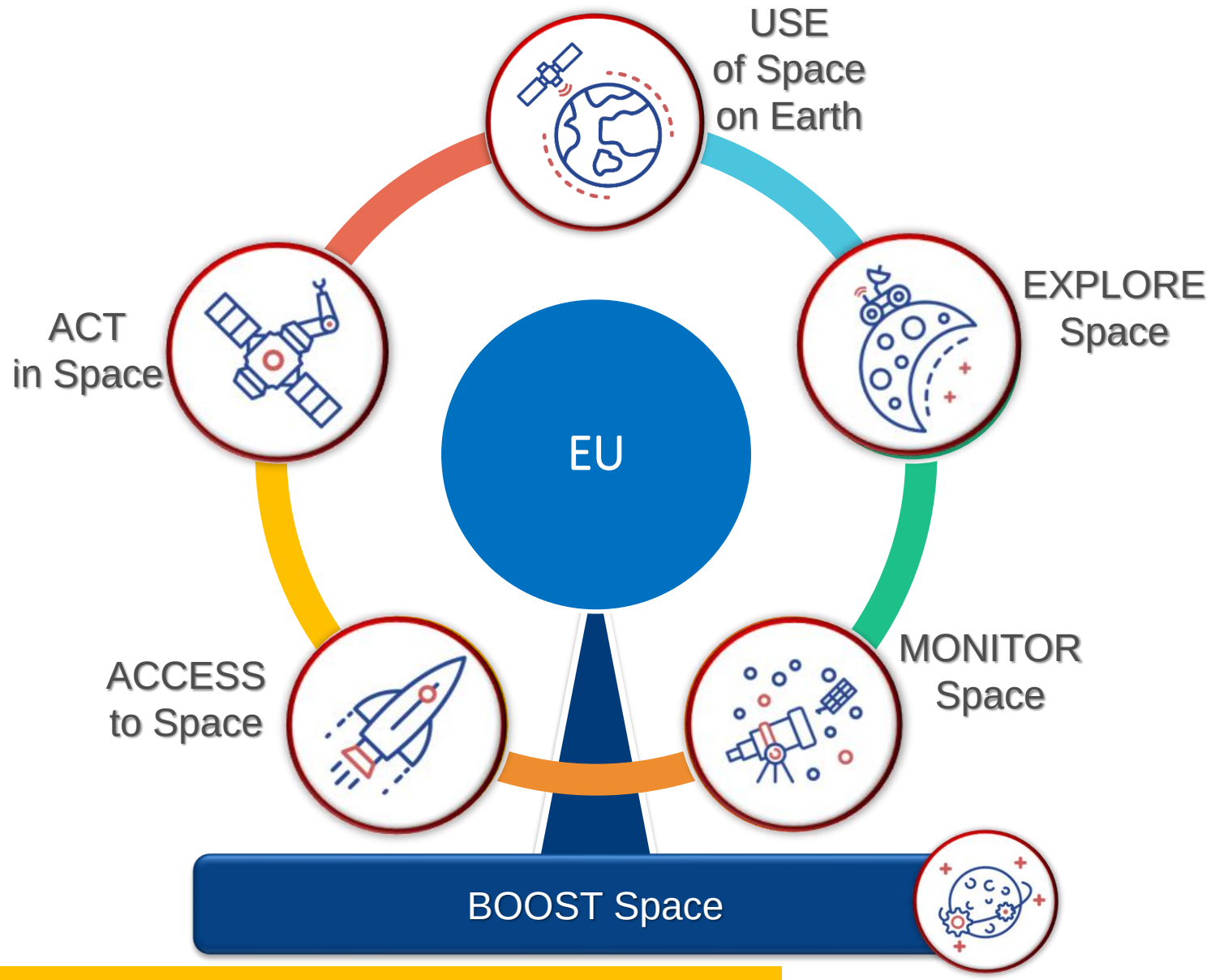
- High Speed
- High Resolution
- High Power Density
- High Frequency
- High Efficiency

*Not exhaustive list of components

Horizon Europe – Space R&D Programme

FROM R&I TO STRATEGIC CAPABILITIES

WP2025 → 33 topics
~ €330 million



Expected timelines:
WP adoption: End of April
WP publication: Mid of May
R&I Space Programme Info Day: 13 May

WP2025 not yet adopted and published – draft information only

Boosting Space (EU non-dependence)

RIA

- **HORIZON-CL4-2025-02-SPACE-71: Space Critical EEE Components for EU non-dependence – RISC-V Microprocessor on 7nm**
- **HORIZON-CL4-2025-02-SPACE-72: Space Critical Equipment and Related Technologies for EU non-dependence – Chip Scale Atomic Clocks and Solar Cells**
- **HORIZON-CL4-2025-02-SPACE-73: Space Critical EEE Components for EU non-dependence – Connectors**
- **HORIZON-CL4-2025-02-SPACE-74: Space Critical EEE Components for EU non-dependence – Advanced Packages and Memories**

- Guidance document for the topics (technical annex) will be provided with the WP publication

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WP2025 not yet adopted and published – draft information only

Thank you

Any Question?

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