



STRATEGIC COMPONENTS : CNES ACTIVITIES

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CNES OVERVIEW

CNES STRATEGIC COMPONENTS

COMPONENTS MANUFACTURERS IN FRANCE

ZOOM ON KEY TECHNOLOGIES DEVELOPMENT

CNES EXPERTISE LAB & RADIATION LAB

FUTURE CHALLENGES

4 strategic priorities

Geared to the key challenges of the coming decade. We are serving all public policies supported by the space sector. These priorities are laid out in the CNES-government contract for 2022-2025, under the banner "New Spaces".



Strengthen our strategic independence



Extend our scientific excellence



Sustain a competitive space ecosystem



Work towards a sustainable world

+100 space projects

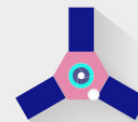
Currently led by CNES in 5 key domains.



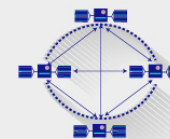
Space transportation



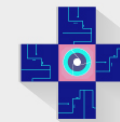
Science



Defence



Telecommunications



Earth observation

45 Nations

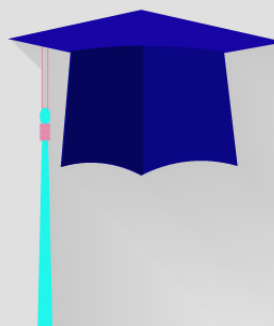
we are working with around the world.



2,400 employees

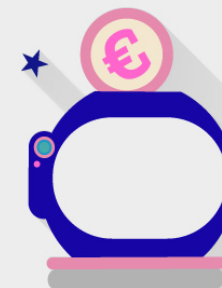


at 4 centres



100 doctoral

and post-doctoral research grants awarded every year to French and foreign students.



€37

Mean yearly per-capita amount that France devotes to space, the world's 2nd largest space budget.



2,566 million euros

Budget for 2022, including France's contribution to ESA of €1,184m.

CNES by the numbers



>40 firms

Receive support every year from CNES to develop and diversify the French and European space ecosystem, including new entrants and start-ups in the space sector.

Objectives

- Master new technologies and their failure mechanisms
- Improve space environment knowledge and Radiation hardening assurance
- Develop expertise and capabilities

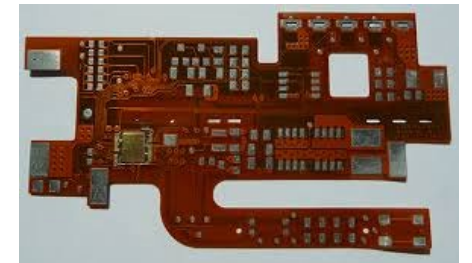
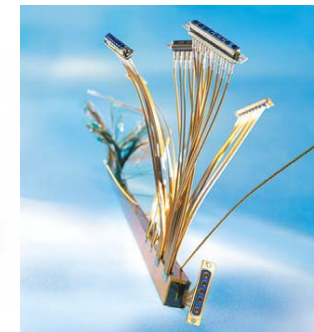
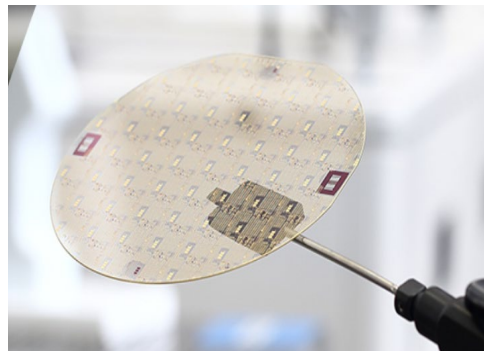
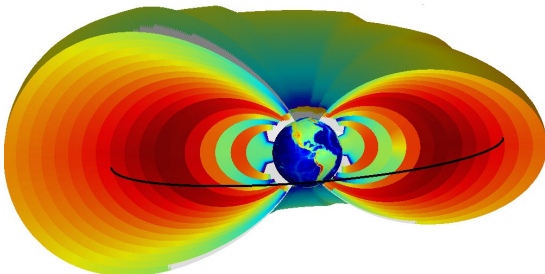
2 - 3M€/year

30 to 200k€/action

Activities on all electronic components & technologies

- Survey & Assessment of COTS
- New technologies survey and evaluation : UDSM, GaN, Optical connectors, Passives etc.
- Innovative assembly & mounting solutions, PCB
- Radiation studies : Environment, Effects on components, Test means ...
- Expertise lab

TRL
2→5



Objectives :

- Reinforce European Non Dependence
- Increase European Competitiveness
- Adapt for Space and Evaluate existing commercial technologies
- Establish viable European supply chain with strategic partnerships

2,8M€/year

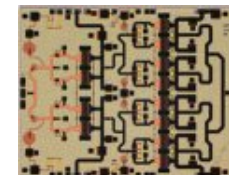
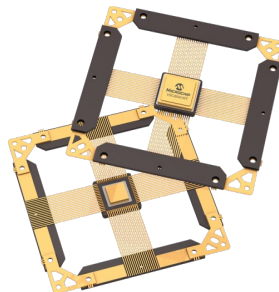
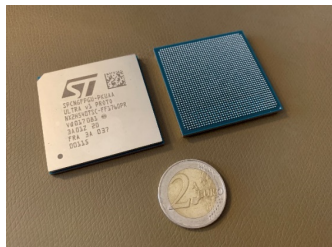
100k€ to 1M€/action

Key technologies Development, Space Evaluation, Market introduction

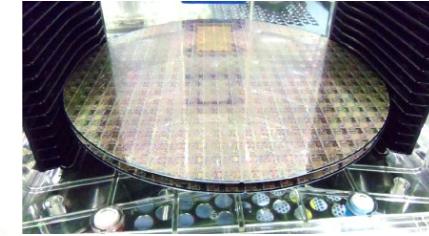
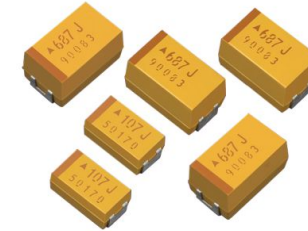
- FPGA NG (NanoXplore, STMicroelectronics)
- Microprocessors and Microcontrollers (MICROCHIP)
- Data Conversion (TELEDYNE-E2V)
- RF GaN (UMS)
- Power GaN (ST)
- Discretes, Integrated Circuits (ST)
- Oscillators, Resonators, Quartz material (AR Electronique, EZUS-Cristal Innov)

TRL
4→7

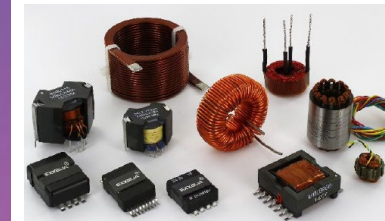
CTB Coordination and Roadmap



Components Manufacturers in France



- Wide range of products
- Space is a niche market
- Synergies with Defense, Aeronautics



NanoXplore NG-ULTRA FPGA

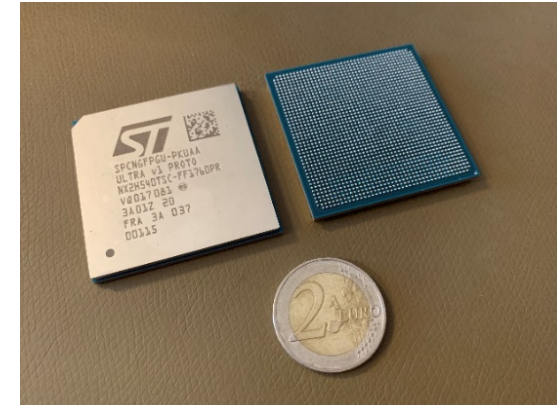
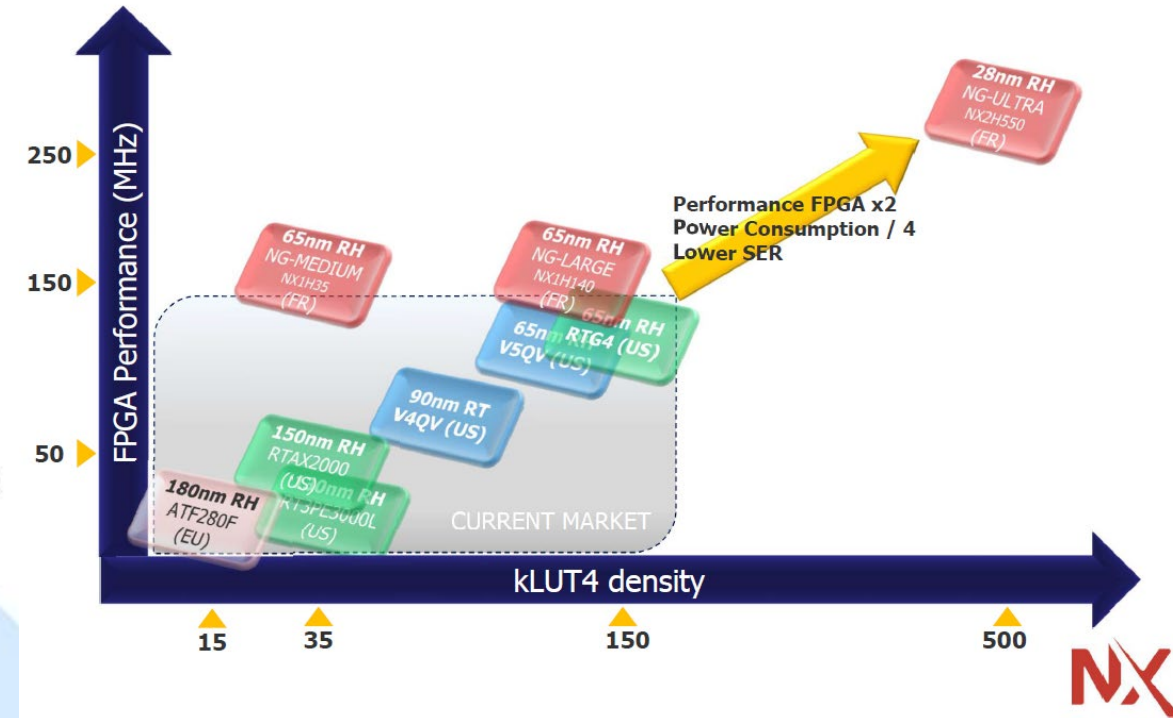
Rad-Hardened by design SRAM-Based FPGA

NX design, ST 28FDSOI techno,

ST Non-hermetic Flip-chip BGA1752

Supply chain :

The NG-ULTRA is based on SME technology from NX but 100% industrialised by a fully trusted space supply chain from ST

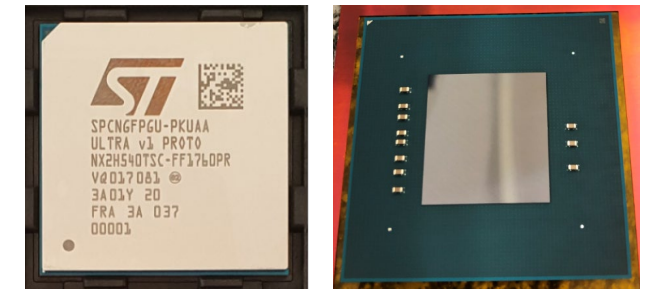
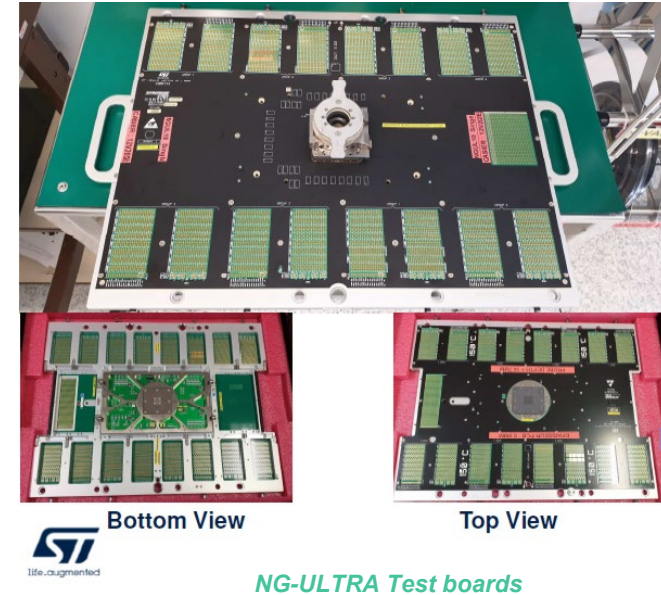


NanoXplore NG-Ultra FPGA status

- NG-Ultra v2: Including NG-Ultra v1 bug corrections and HSSL up to 8Gbps
 - Validation in progress :
 - Main bug Fix V1/V2 confirmed OK!
 - HSSL : validation in progress
 - Prototypes / Eval Kit availability for customers: Q1/2023

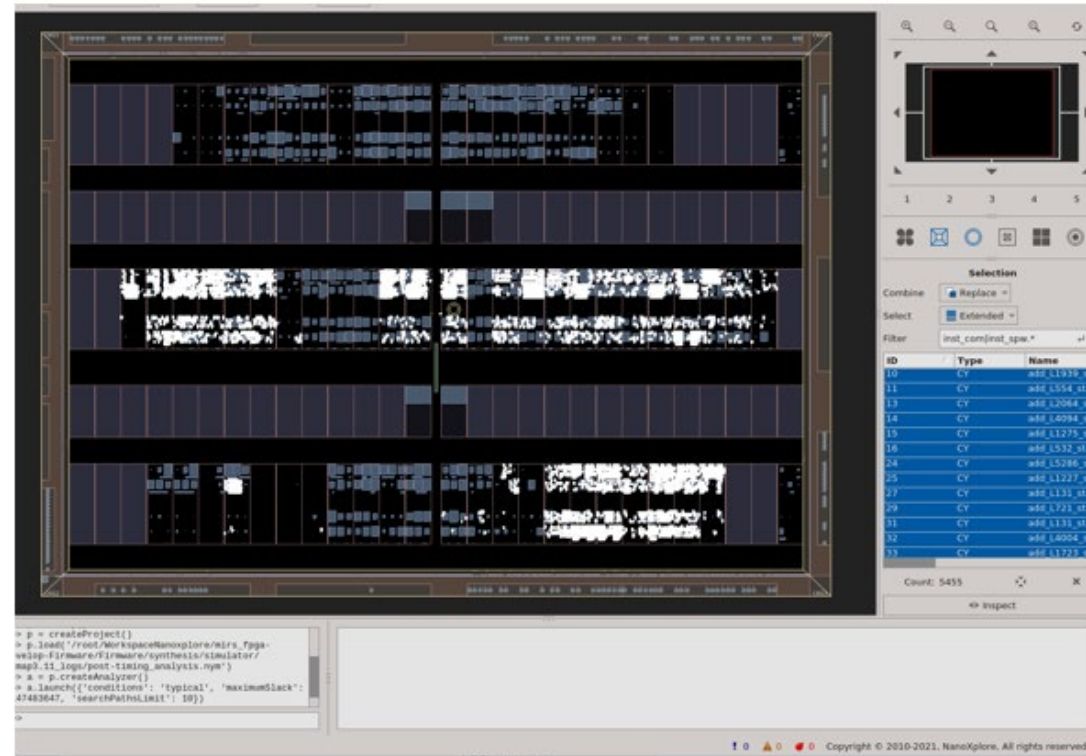
- Non hermetic Organic Flip-Chip assembly derisk/evaluation:
 - New assembly line in ST Rennes
 - Validation on-going with dedicated Test-Vehicle → Process frozen, qualified in Q1/23

- Qualified organic Flip-Chip FF1760 according ESCC9000P : Q4/2023



IMPULSE Tool : Continuous improvement with regular releases :

- KO done July 2021
- Routing capabilities improved (60% for NG-Ultra big designs, still improving), an effort will be done on frequency → **on-going**



Microchip Rad-hard SoC Microprocessors

SAMRH71 : First Rad-Hard by design ARM Cortex M7 MPU

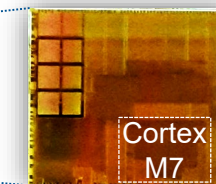
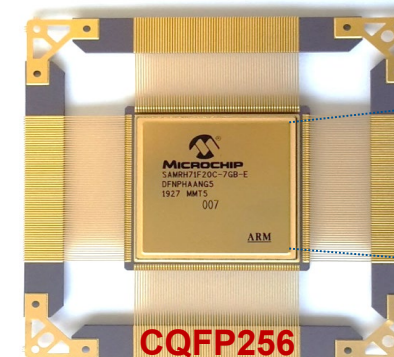
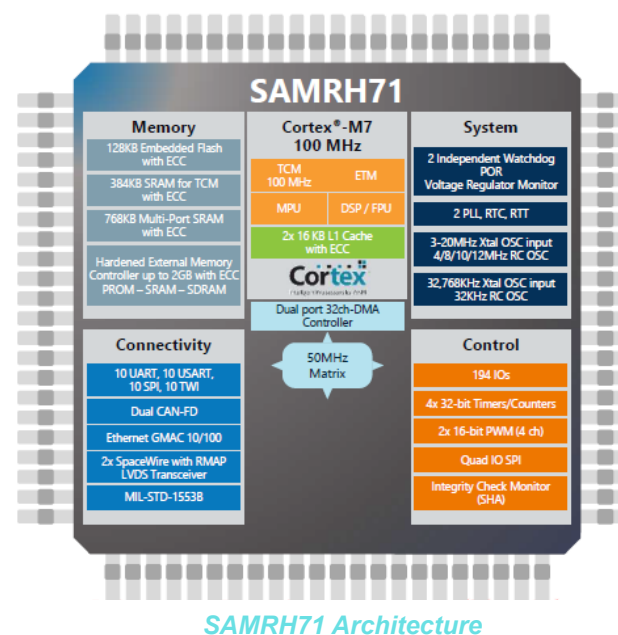
MCHP design, 150nm ATMX150RHA technology

CQFP-256 hermetic package : ESCC qualified → Flight models available

BGA-625 Plastic package qualification according MCHP internal spec : Q1/23

Radiations
TID 150krad (Flash limited to 20krad)
SEL immune up to 62 MeV
SEU LET >20Mev.cm2/mg (Xsection <10-9 cm2/word)

2.14 DMIPS/MHz vs 0.8 LEON3 FT
3 to 5 more performant /LEON3 on customer use case
Spacewire 200 Mbit/s w integrated LVDS
Same mW/DMIPs ratio than AT697F => 9mW/DMIPS



128KB Flash ☒ ECC
1MB SRAM ☒ ECC
(384KB TCM) ☒ ECC
Int/Ext Mem ☒ ECC

>200 DMIPS
TCM / MPU / ICM
FPU / DSP
Dual CAN FD
Ethernet TSN 10/100
SpaceWire 200Mb x2
1553 M/S



➤ **Next generation Rad-Hard MPU and MCU : Radiation & Architecture assessment in progress**

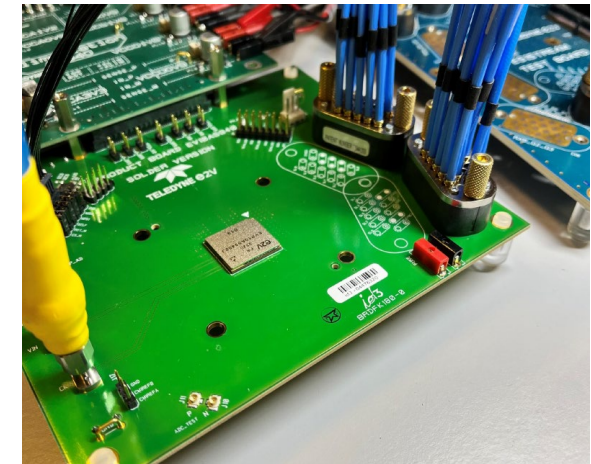
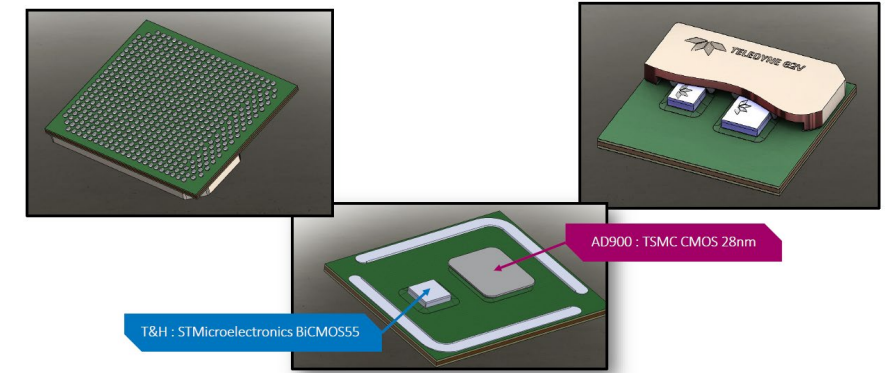
- Design completed → CDR done in december 21
- Assembly of prototypes done (Q2/22)
- 1st Demonstration in ELECTRONICA Nov.22
- Characterization in progress :
 - Ultra wide input bandwidth 33 GHz (-3 dB)
 - Single ended analog and clock inputs to ease RF interfaces
 - Low power: max 2.5 W (at 12.8 Gbps)
 - Digital features: DDC with I/Q decimation (x2 to x1024), Multi-NCOs (x4), Fast Frequency Hopping (3 hop modes) and Beamforming
 - Multi ADC synchronization
 - Organic Flip-Chip SiP
- Assembly derisking in progress
- Radiations tests results : Q2/23
- Qualified part : 2024

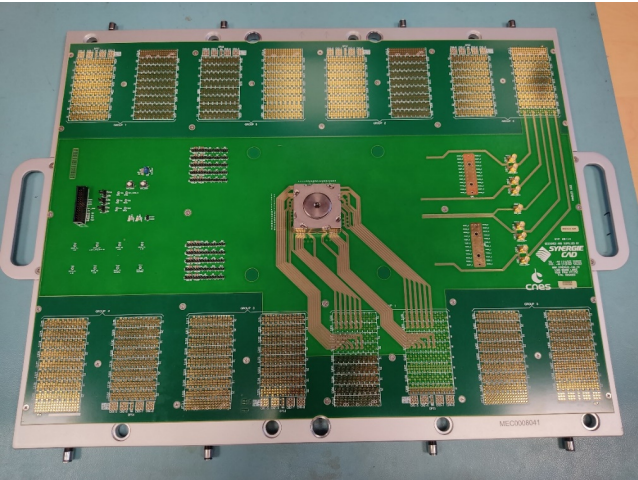
Supply chain



AS940 : What it looks like

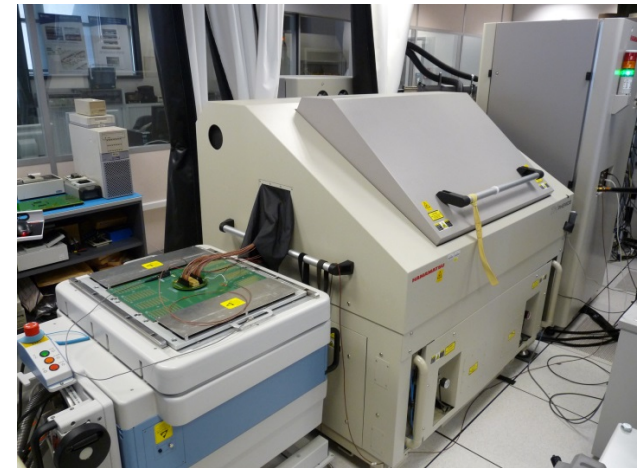
First 3D views



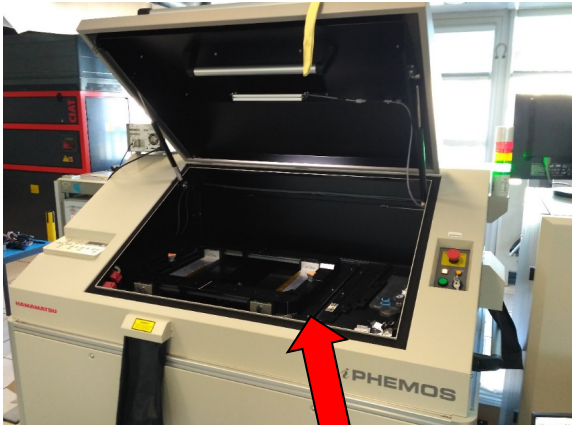


NG-LARGE test board

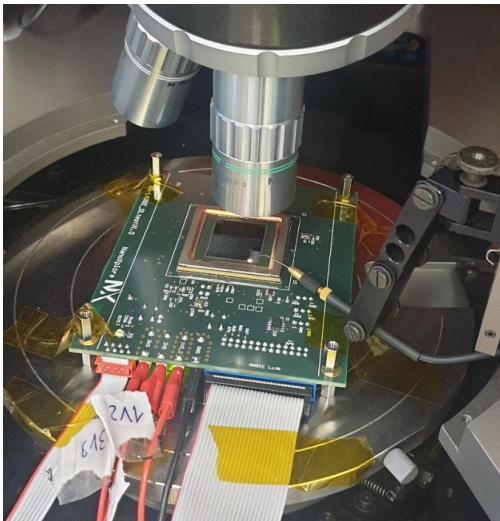
Advantest V93K tester



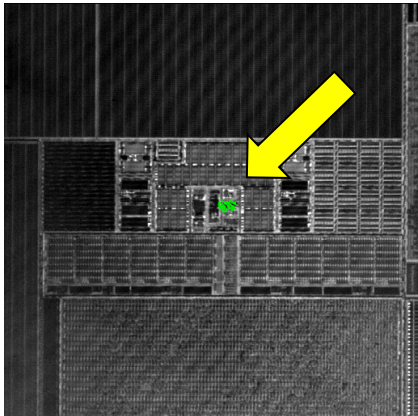
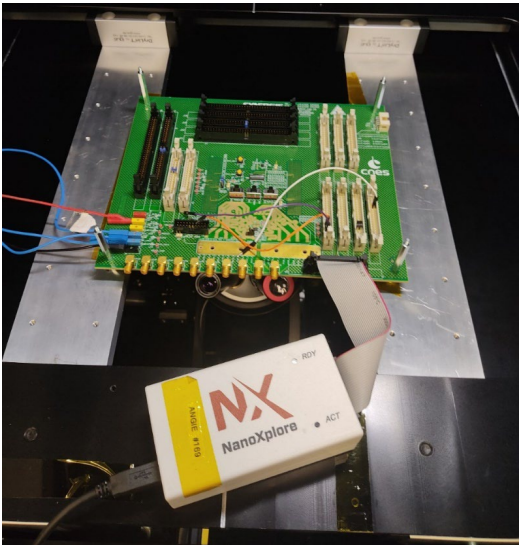
Laser platform for advanced technologies



NG-LARGE Probing

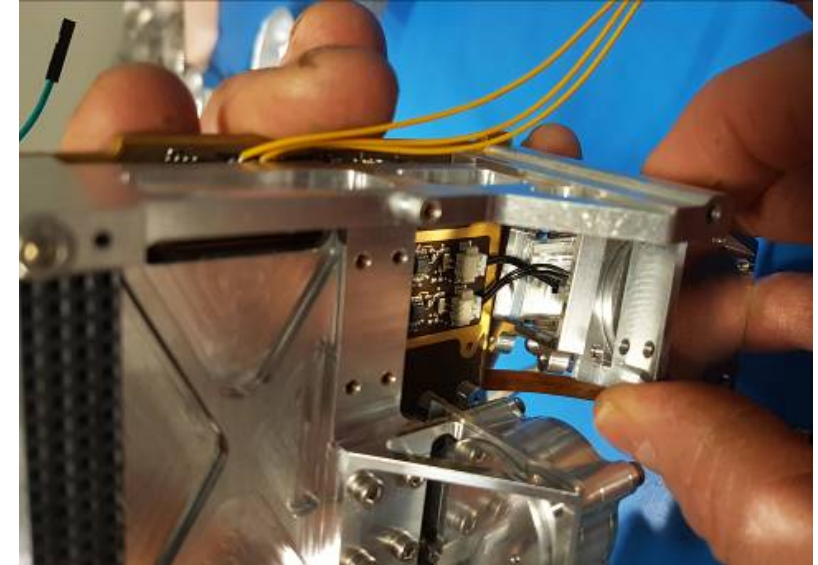
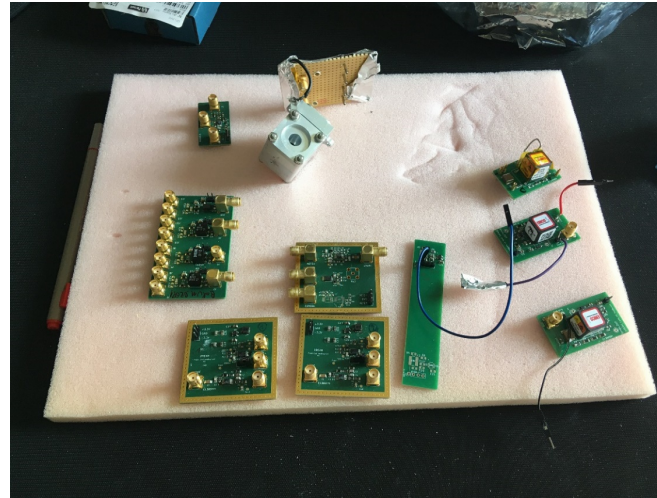


NG-ULTRA emulation



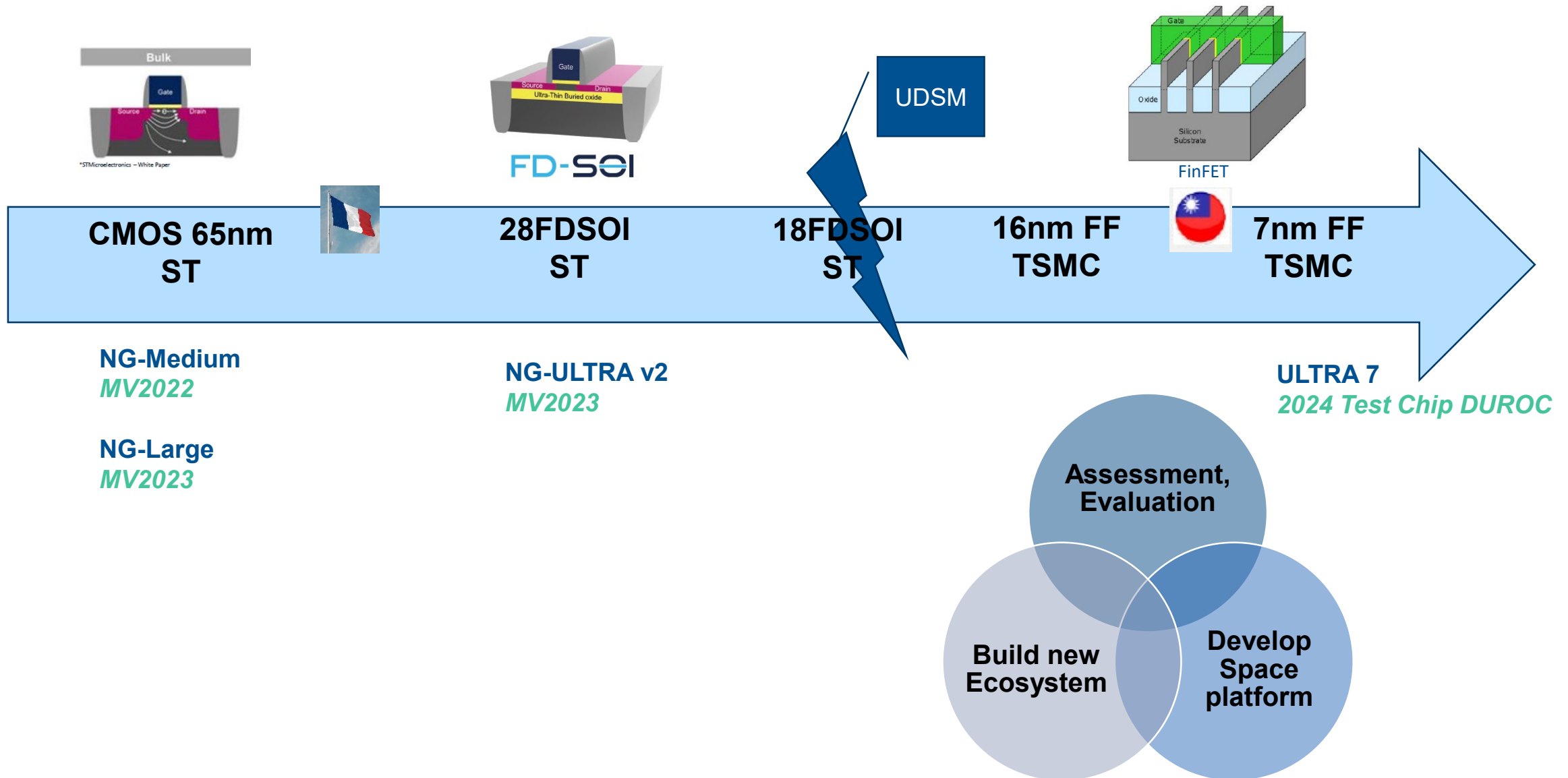
Sensitive area to SEE

- R2D2 lab (Radiation Reliability, Detection and Devices test lab) - CNES



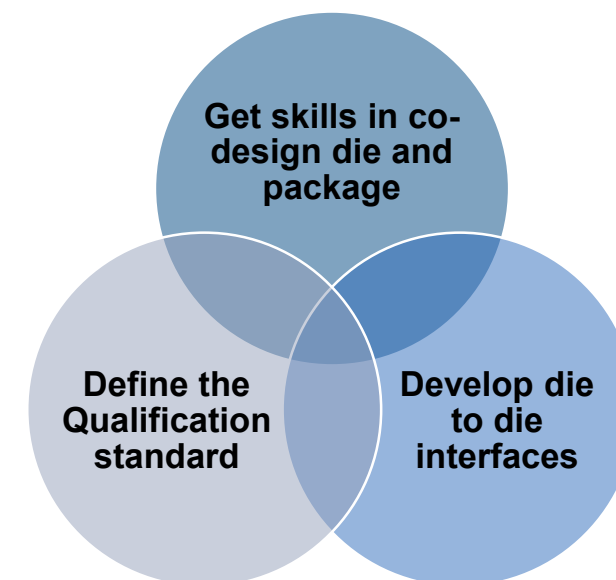
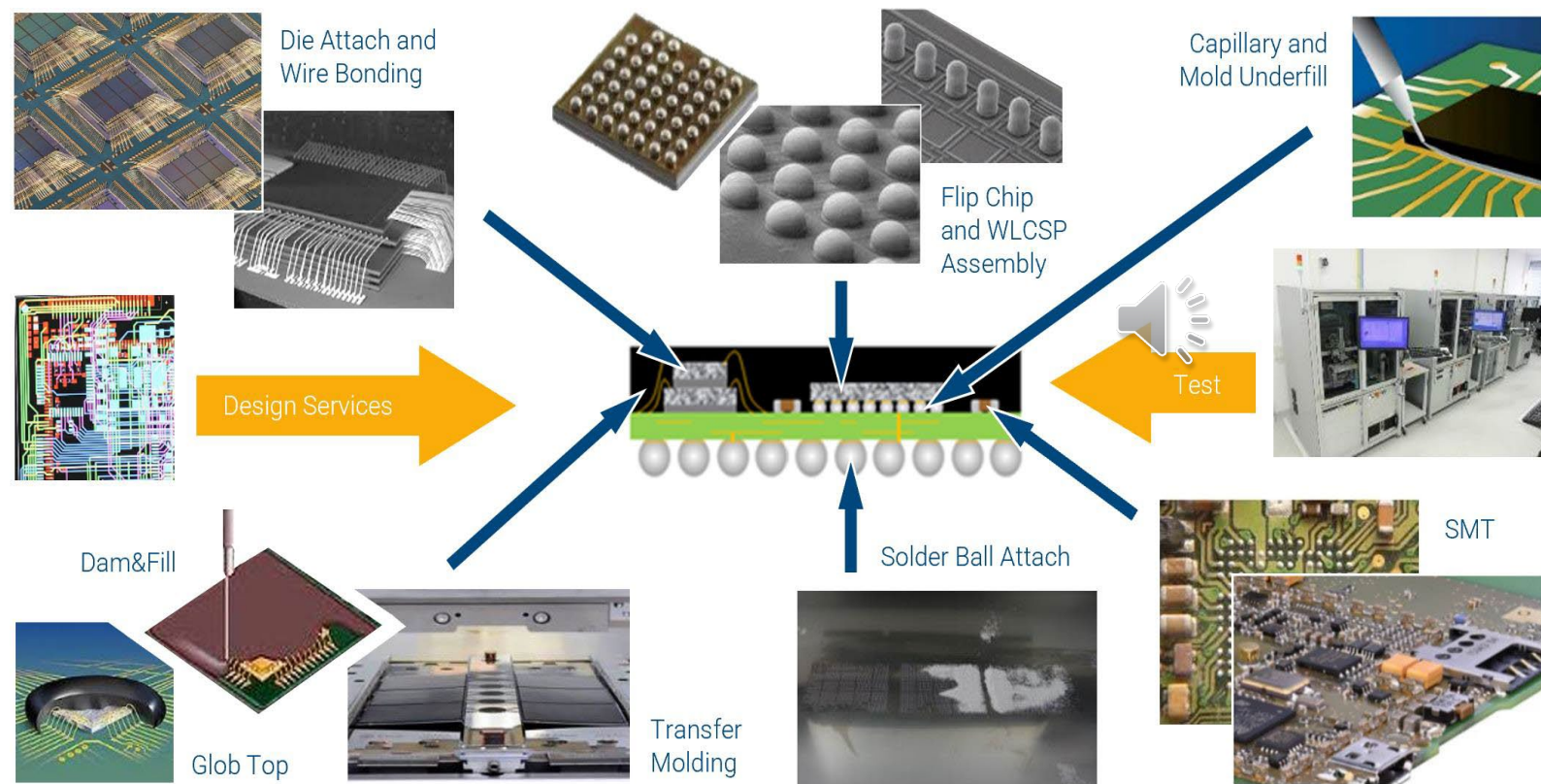
- To Develop and Calibrate Radiations experiments for environments studies
- To setup test bench for radiations tests on components
- Use of sources with vacuum chamber for detectors calibration and test bench setup

Next challenges : Advanced technologies



Next challenges : System In Package SiP

- Complex module using a variety of die, technologies, both digital and analogue
- Increase the integration and the functionality
- Key to use UDSM technologies





Thank you for your attention !

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