

# New Generation of Rad-Hard SoC FPGA

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ESCCON 2023



# Company Overview

March 2023

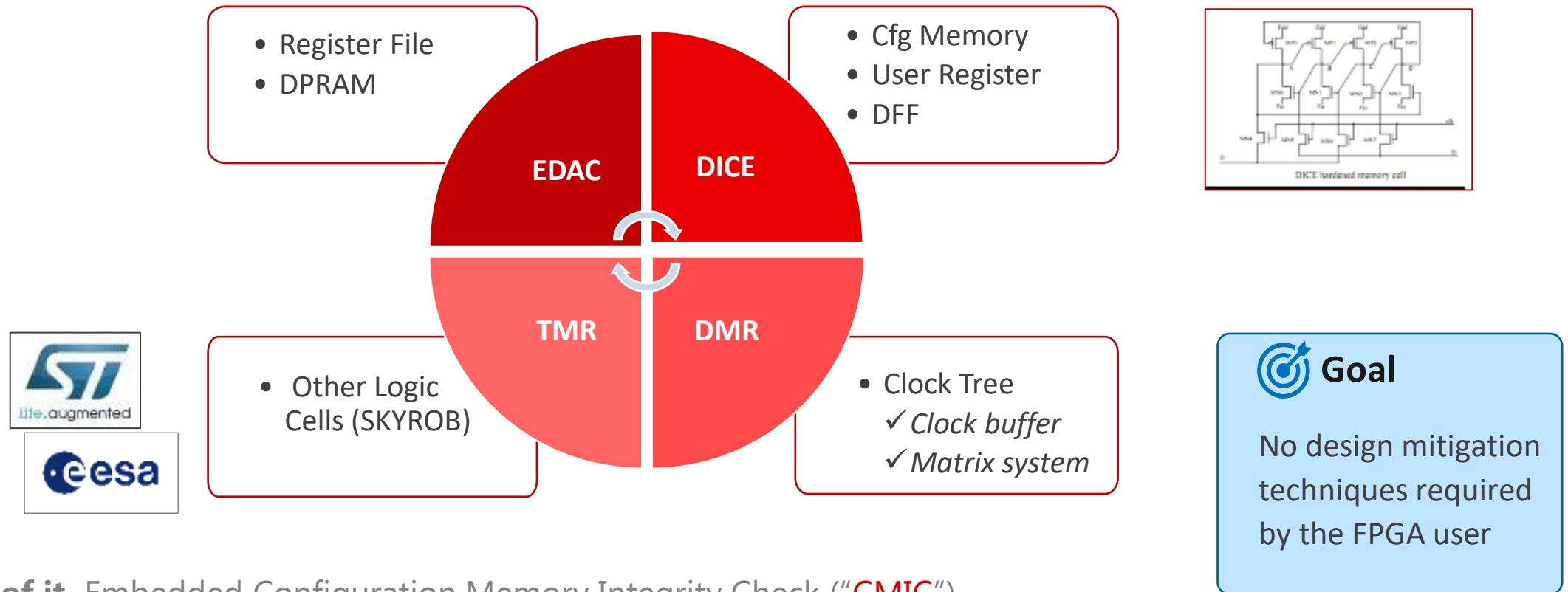
- NanoXplore is a privately owned company created in 2010
- Fabless semiconductor company located in France
  - Headquartered in Sèvres
  - 70+ R&D engineers
  - 100+ end-users around the world
  - €10m+ sales in 2022
- The company is focusing on developing rad-hard FPGA and SoC FPGA qualified for Hi-Rel applications



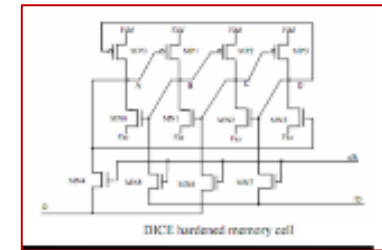
# NX value proposition

Rad-Hard By Design (RHBD)

All logic of NX FPGAs is hardened by design (RHBD) and simulated with TFIT software



On top of it, Embedded Configuration Memory Integrity Check ("CMIC")



# NG-MEDIUM

ESCC9000 qualified (CQ352 & CLGA625)



European Space Agency  
Agence spatiale européenne

## Certificate of Qualification No. 382

This is to certify that NanoXplore, Sèvres , France has been qualified by ESA for the supply of Integrated Circuits, Silicon, Monolithic, 35KLUT Radiation-Hardened FPGA (NG-Medium) , for use in ESA space programmes, according to ESCC Generic Specification 9000 and associated Detail Specification 9304/010 as recommended by the Space Components Steering Board.

This certificate is valid until August 2024.



Head of the Product Assurance  
and Safety Department

Date  
31 August 2022

NG-MEDIUM LGA625 CERAMIC PACKAGE	
930401002A	NX1H35 LGA625 ESCC9000 Part (land without column) (-55°C -> +125°C)
NG-MEDIUM CQ352 CERAMIC PACKAGE	
930401001A	NX1H35AS CQ352 ESCC9000 Part (-55°C -> +125°C)



# NG-ULTRA

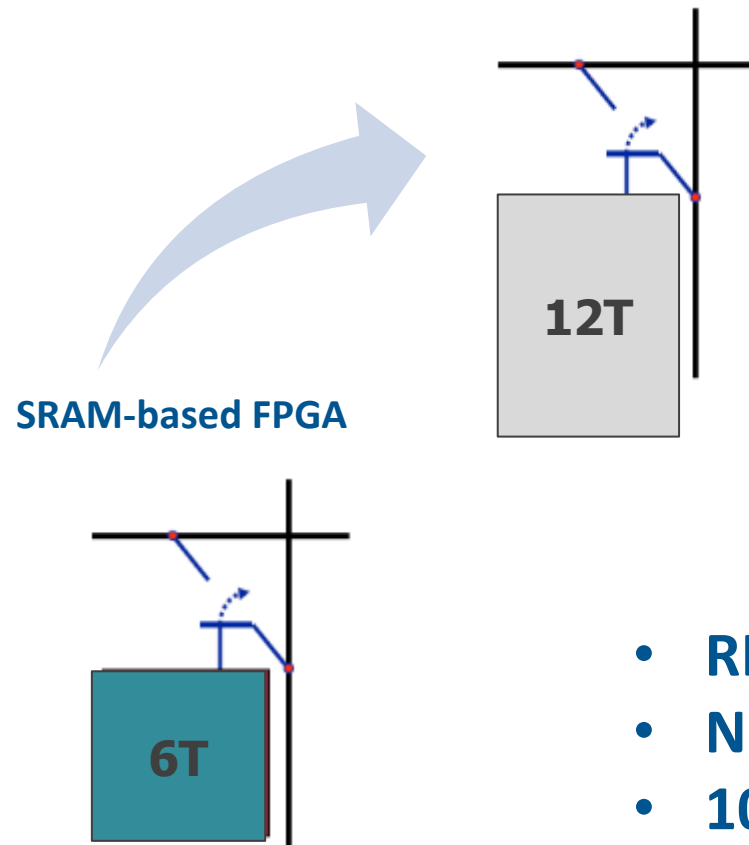
28 nm FDSOI



# NG-ULTRA Overview

28 nm Radiation Hardening

## NX RHBD SRAM-based FPGA



- Rad-hard SoC FPGA manufactured on STM 28nmFDSOI Space process
  - Digital IPs (Standard Cells)
  - Analog Ips
- PL resources are hardened by design (RHBD)
  - SRAM config DICE (Dual Interlocked Cells)
  - DFF, PLL, IO buffer ...
- Embedded EDAC for user memory

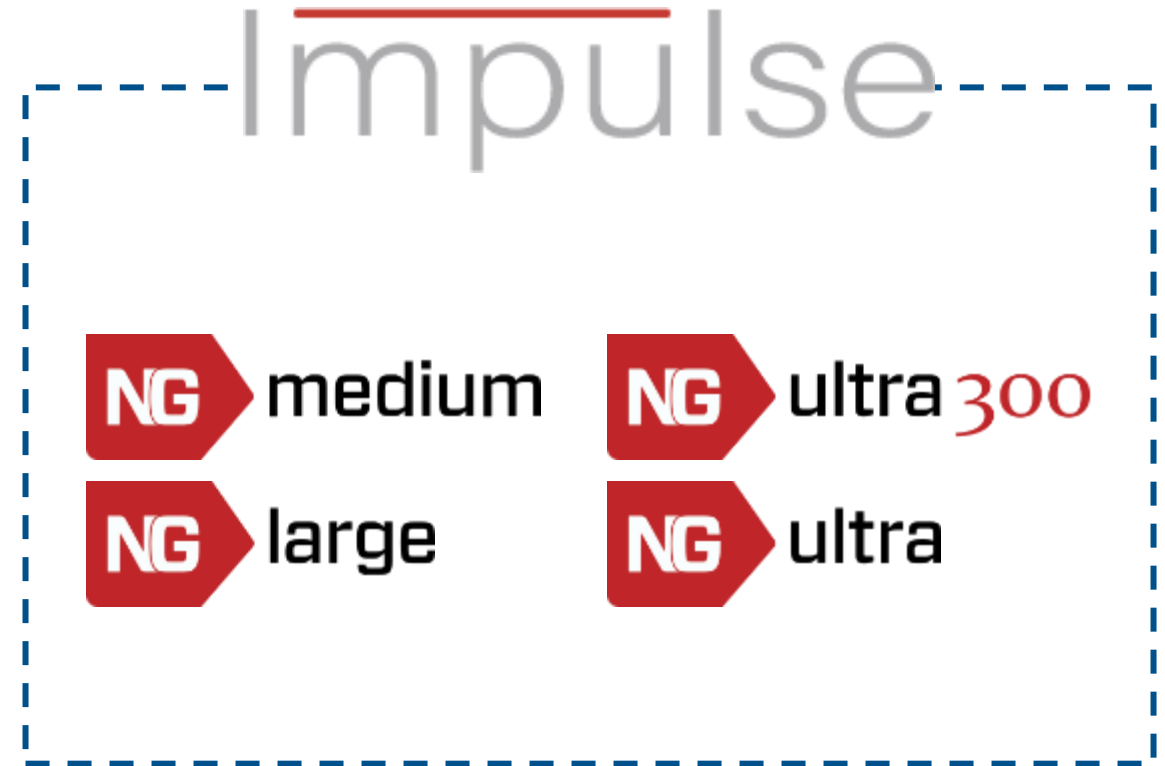
- **RHBD & SOI = SEE immune**
- **No design mitigation techniques required by the user**
- **100 % usable ressources**



# Rad-hard FPGA Offering

Complete rad-hard FPGA offering and associated tools

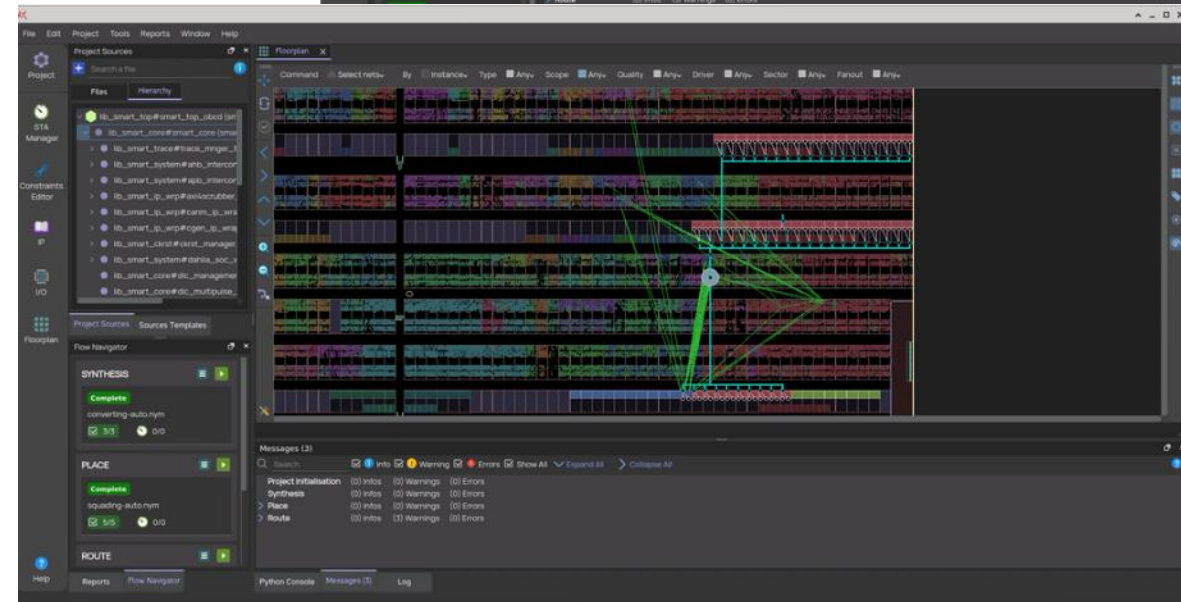
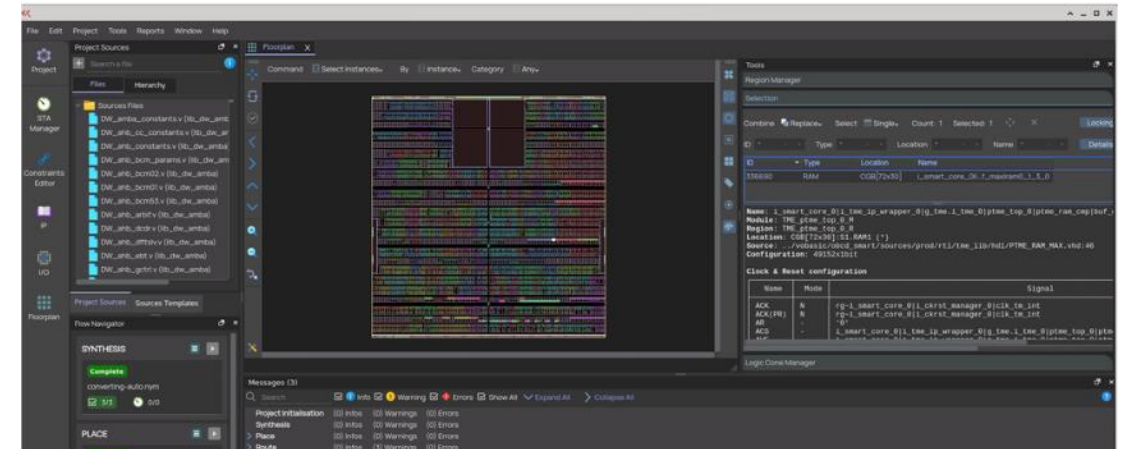
- NX offers a complete rad-hard FPGA offering with all associated tools
- IMPULSE is the programming tools that generate any VHDL into bistream generation
- All required tools ecosystem and IPs to develop simple to complex design

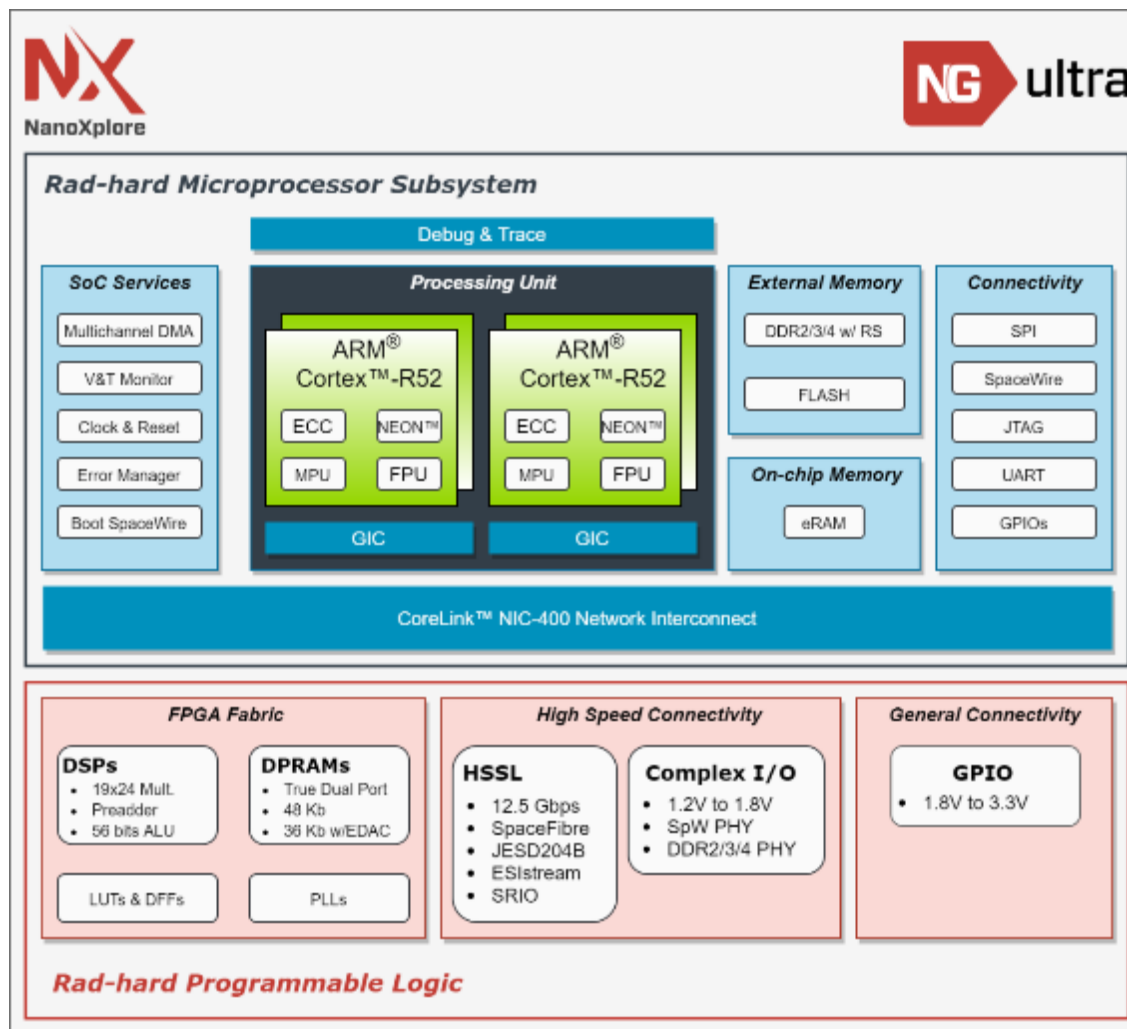


# What is Impulse ?

## Impulse

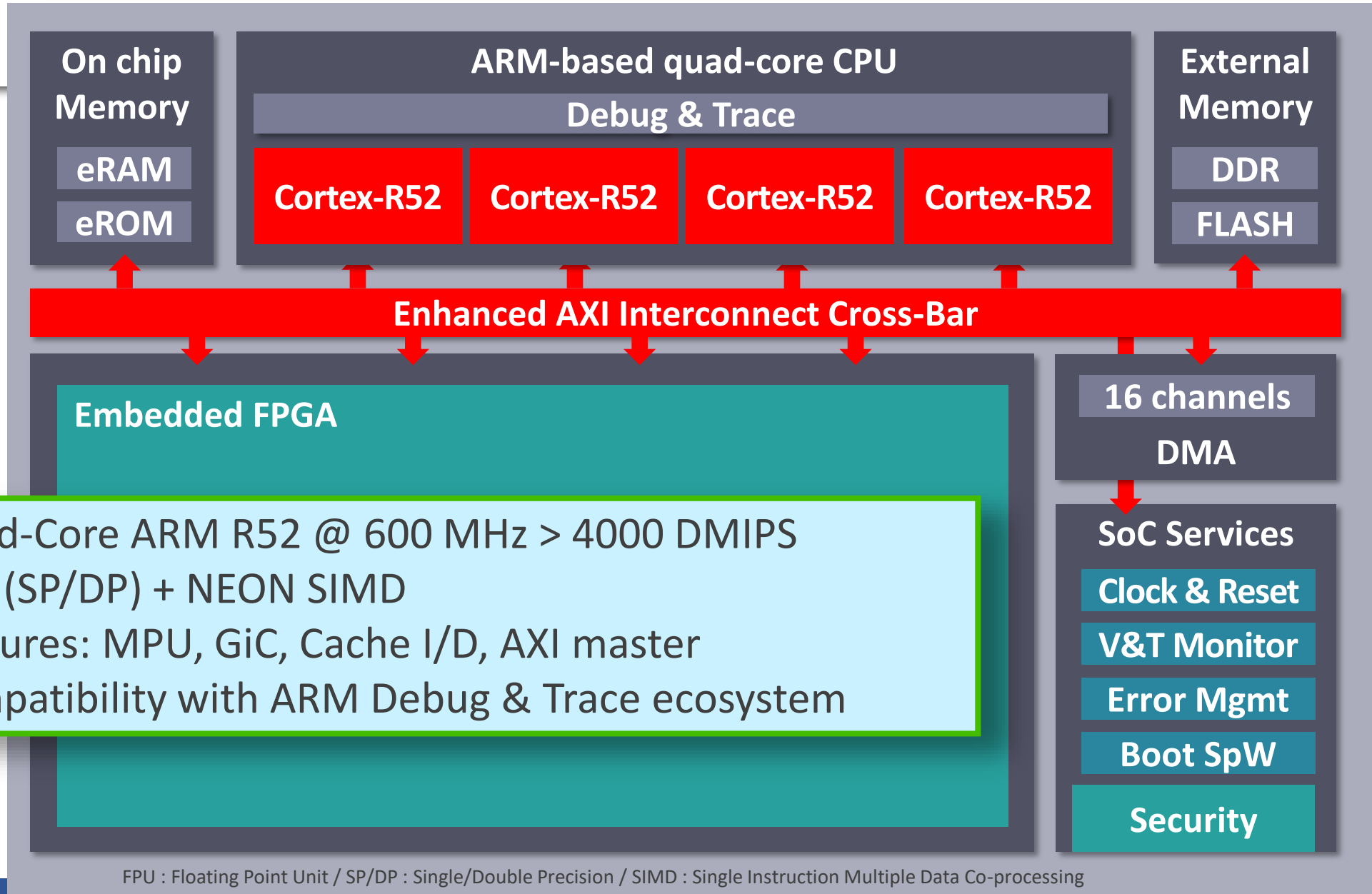
- ✓ More user friendly
- ✓ Better performance
- ✓ More features
- ✓ New GUI





- Quadcore ARM R52 @ 600MHz each
- 500KLUT density
- SpW & DDR 3&4 PHY hard-coded
- 32 HSSL @ 12.5 Gbps
- Radiation performances
  - TID 50krads(Si)
  - SEL and SEE immune

# New Generation of Rad-Hard SoC



- Quad-Core ARM R52 @ 600 MHz > 4000 DMIPS
- FPU (SP/DP) + NEON SIMD
- Features: MPU, GiC, Cache I/D, AXI master
- Compatibility with ARM Debug & Trace ecosystem

FPU : Floating Point Unit / SP/DP : Single/Double Precision / SIMD : Single Instruction Multiple Data Co-processing

- Generic build system for embedded software
    - Including Makefiles and generation instructions
    - Generic linker script
  - Ready to use drivers
    - Flash, Clock & Reset, DMA, DDR, UART, eRAM, GIC...
    - ARM R52 init (crt0, handler, MPUs, stack...)
    - HAL and Helpers
  - Example applications & demo
- Easy to use

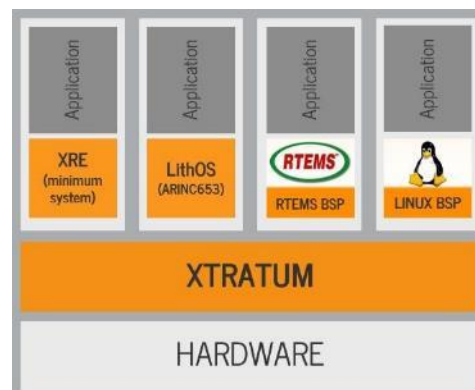
- ✓ Debugging facilities:
  - Lauterbach (debug & trace)
  - OpenOCD support
- ✓ Flash programmer
- ✓ Bitstream loader
- ✓ Memory dumper using DAP (debug access port)
- ✓ BL1 signer
- ✓ Read temperature sensor



➤ More on the way...

# OS Supports

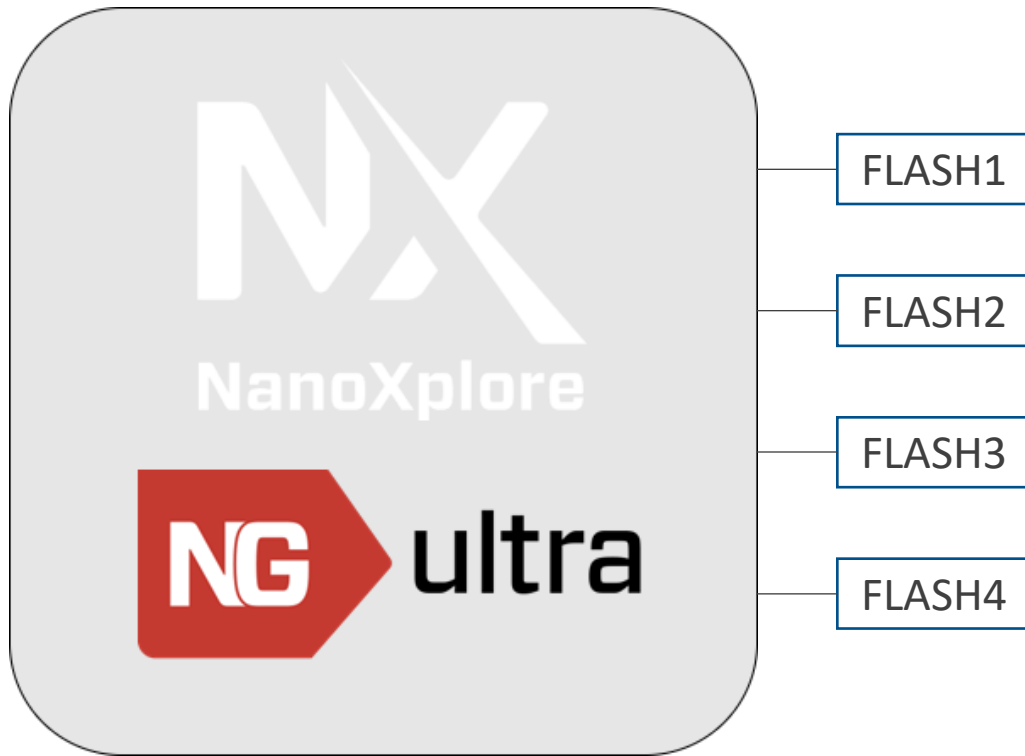
For NG-ULTRA



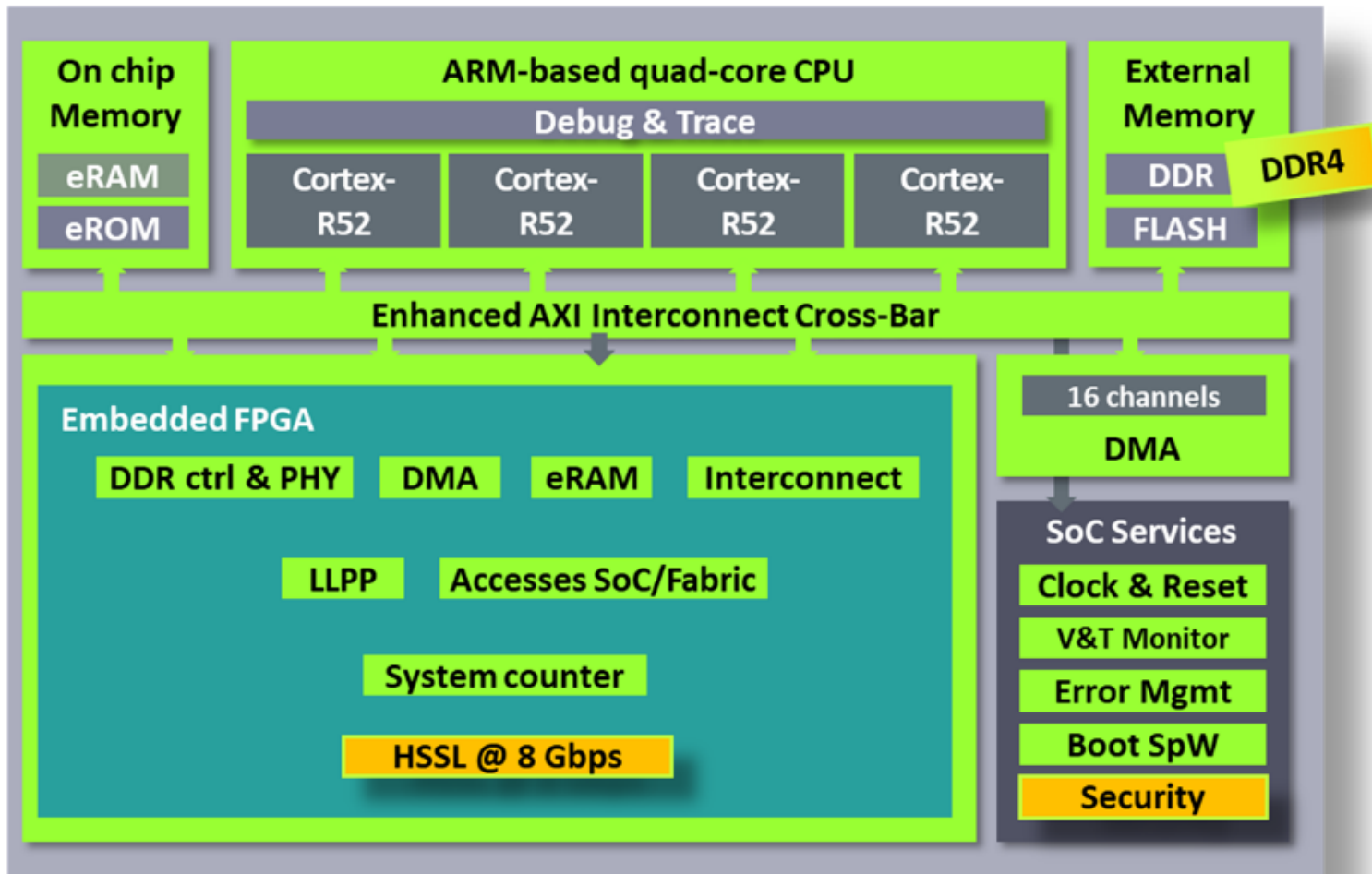




- BL1 authentication signature
- BL1 integrity verification
- Bitstream encryption
- Anti-rollback protection
- Lifecycle management
- Security information stored in OTP



- 4 parallel SPI interfaces controlled by the boot loader
- FLASH mode:
  - SEQUENTIAL
  - TMR
    - Parallel read
    - NG-ULTRA performs the majority-voting
    - The last memory can be used for an application purpose



## Functions

Validated

## Functions

Ongoing validation

# Radiation tests

Status and activities

- UCL / HIF campaign done in Dec 2020 and in June 2021 on NG-Ultra v1 Bring-up board
- Configuration memory
  - No errors detected up to 62MeV/g/cm<sup>3</sup>
- DFF
  - No errors detected up to 62MeV/g/cm<sup>3</sup>
- PLL
  - Good radiation performance for the PLL
  - No SEFI
- 3 new heavy ions campaigns planned in 2023
- **Latchup free, SEU Immune**



# Having a European FPGA + SoC Is not a dream anymore !

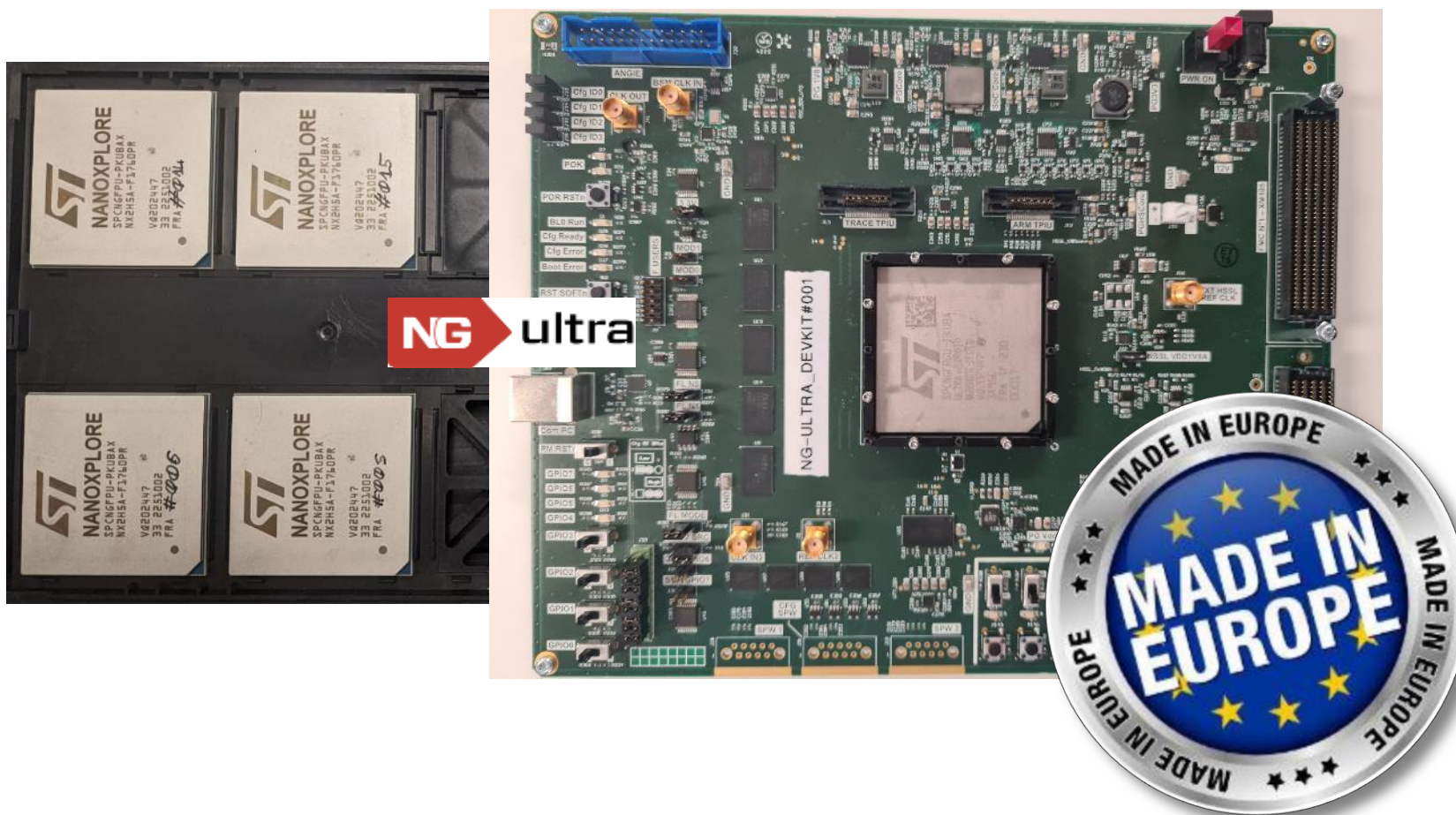




# V1 samples tested since Q4 2020



# V2 prototypes and evaluation kit available





Part Number	Designation	Status
NG-ULTRA DAISY CHAIN ORGANIC PACKAGE		
NX2H540TSC-FF1760DC	NX2H540 FF1760 Daisy Chain package	now
NG-ULTRA ORGANIC PACKAGE FF1760		
NX2H540ATSC-FF1760PR	NX2H540 FF1760 Prototype	now
NX2H540ATSC-FF1760M	NX2H540 FF1760 Military Part	Q2'23
NX2H540ATSC-FF1760E	NX2H540 FF1760 eq. ESCC9000P (-40 -> +125°C)	H2'23
NG-ULTRA EVAL KIT		
NX2H540ATSC-EK	NX2H540TSC Evaluation Kit	now

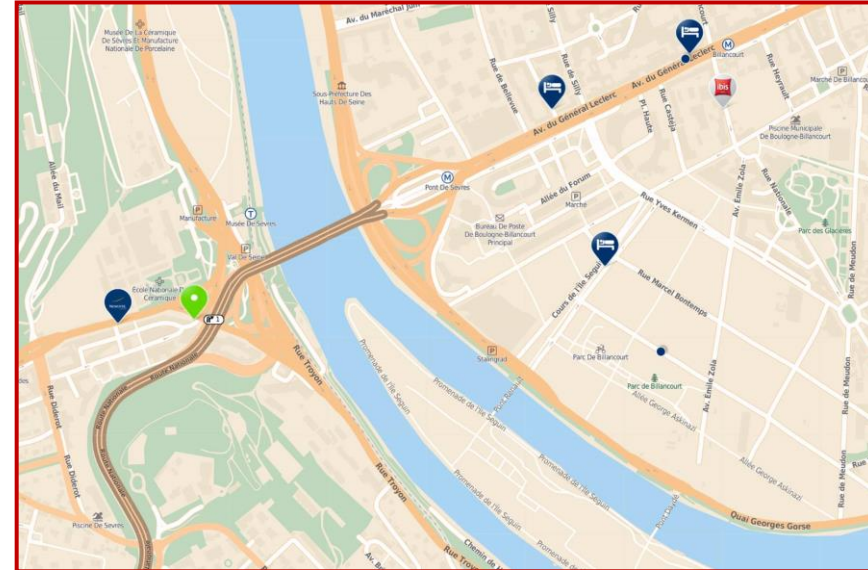


# Roadmap

28 nm FDSOI

- Most rad-hard cost-effective FPGA
  - 10x bigger than NG-MEDIUM
  - 2x faster than 65nm
  - Embedded ADC and DAC
  - Small form factor in BGA 484
  - Immune to SEE
  - ...
- 
- ULTRA 300 is coming soon...

# Thank you



**Jean-Louis FRIGOUL**

Head of Marketing & Sales

[jfrigoul@nanoxplore.com](mailto:jfrigoul@nanoxplore.com)

<http://nanoxplore.org>

Documentation :

<https://nanoxplore-wiki.atlassian.net>



**1 rue de la Cristallerie - 92310 - SEVRES, France**

**Mobile: + 33 (0)7 69127172**

