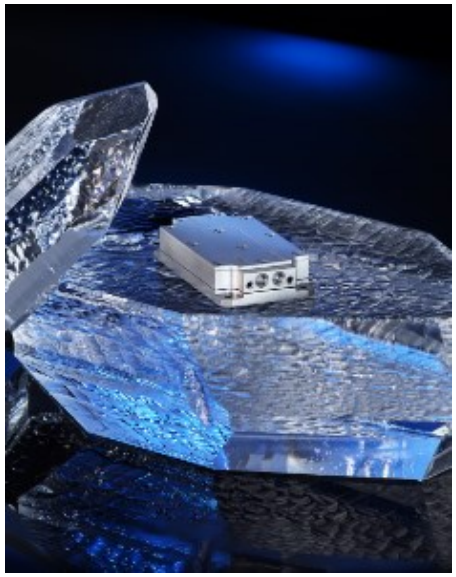
AR ELECTRONIQUE



SUMMARY

About AR Electronique

- Activity fields
- Product Overview

Space products

- Heritage
- SMD Xtal resonators
- New Space / nanOSTAR-SP

ESCCON 2023
The European Space Components Conference
7 - 9 March 2023 | Toulouse | France
esa

ar ELECTRONIQUE

AR ELECTRONIQUE / Key dates

➔ *34 years of high end expertise!*

2023 – New Space

- nanO-SP
- LEO constellations

2015 – Space

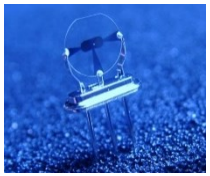
- USO / SAR filters

2008 – La Fayette site

- MIL-Airborne products
- Int devt (CA, USA, IS)

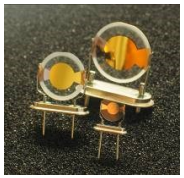
2000 – 1st BAW Filters

- Ecole-Valentin premises
- Radiocoms apps



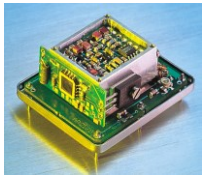
1996 – First Xtal resonators

- Sartrouville Unit
- Europe activities (I, D, UK)



1991 – First Oscillators

- ASIC functions
- Broadcast applications / France

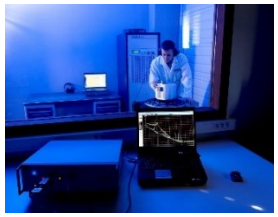


1989 – Start-up

- Spin Off CNRS/LPMO
- Test equipments

ar ELECTRONIQUE

AR ELECTRONIQUE



Identity

- Registrated May 1989, Besançon
- French independant Company
- SAS, Share capital: 1 004 619 €

ARE team

- 45 employees
- 15 Engineers / Ph D's
- 25 experienced technicians

Technical infrastructure

- 1 800 sqm of industrial facilities
- **Resonators** development and manufacturing facility
- **Electronic** development and manafacturing of **oscillators**
- **In house Metrology** & tests

ACTIVITY DOMAIN

→ *RF products*

AR Electronique designs and manufactures RF products and T/F systems for professional, defense , airborne and space applications

- ***Xtal resonators***

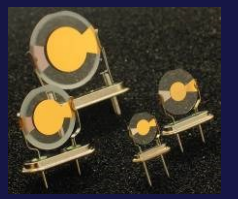
Lapping

Optical polishing

Métallization

Assembly

Vacuum housing



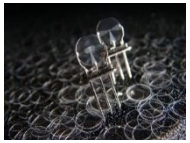
- ***RF and T/F devices***

Xtal Oscillators & RF Sources
Piezoeectric filters

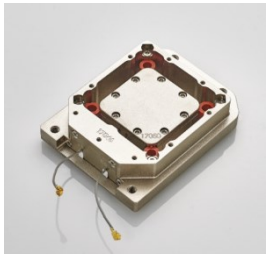
Design, Development & Manufacturing

- **Mil Aero & Space BAW Resonators**
  - Quartz for oscillators (high stability, Ultra low G-sensitivity)
  - Resonators for RF filters (Quartz / LiTaO3)





- **Oscillators & RF Sources (COTS, Specific products)**
  - Leading Edge performance (Ultra Low Phase Noise, very high stability, High reliability)
  - Harsh environment

Embedded Oscillator (MIL-Airborne)

- **Piezoelectric BAW Filters**


- **In house metrology & tests**
  - Fcy stability / ADEV / Retrace
    Phase noise / Spectral purity
  - Environmental tests
    Temp / vacuum / vibration / shocks


ar ELECTRONIQUE

MARKET SHARES

Professional

- Instrumentation / Test bench
- Telecommunication / Broadcast

Civil airborne & Space

- Radionavigation / Satcom
- SAR Satellites / Earth Observation
- New-Space

Defense

- Radiocommunication
- Radionavigation
- Radars, seekers & on board equipments

ar ELECTRONIQUE

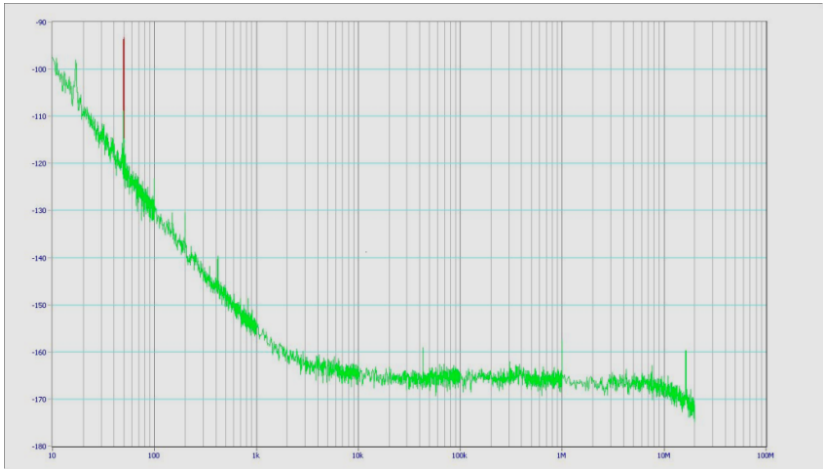
AR ELECTRONIQUE

Space products

- Heritage
- SMD Xtal resonators
- New Space / nanOSTAR-SP

ARE Space Projects / Product examples

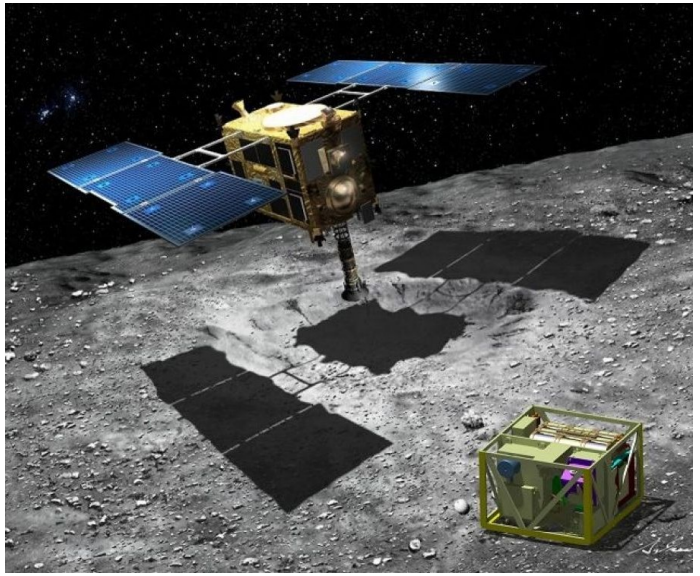
CUSTOMER	CNES (France)
PROJECT	T2L2 / JASON 2 (LEO) Scientific satellite 2008
PRODUCT	**100MHz XO - FM** Very low phase noise Milled case, 34x47x13 mm
COMPONENTS	COTS Xtal: HQ, std
LEVEL	MIL-STD 883
WORKMANSHIP	J-STD-001 Class 3
STATUS	In orbit over >10 years

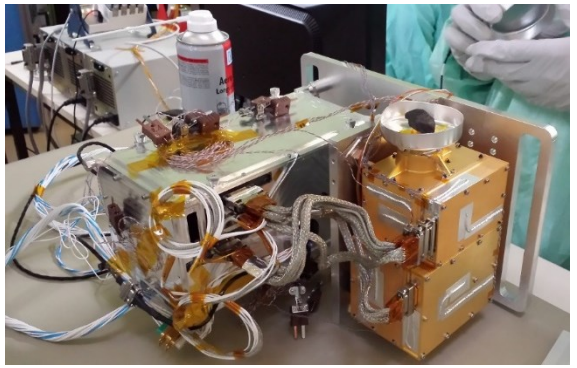


ar ELECTRONIQUE

ARE Space Projects / Product examples

CUSTOMER	IAS (Orsay-France)
PROJECT	Scientific Space Mission **MASCOT** Lander MicrOmega instrument, HAYABUSA 2 (Europe / Japan) 2015
PRODUCT	**20MHz / 300MHz TCXO** **EM / QM / FM** CO8 RW case
COMPONENTS	MIL std Xtal: AT cut, MIL std
LEVEL	MIL-STD 883
WORKMANSHIP	J-STD-001 Class 3
STATUS	Successful mission

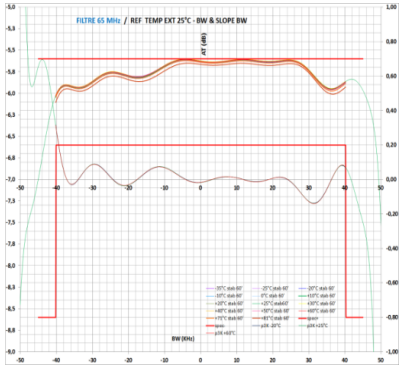


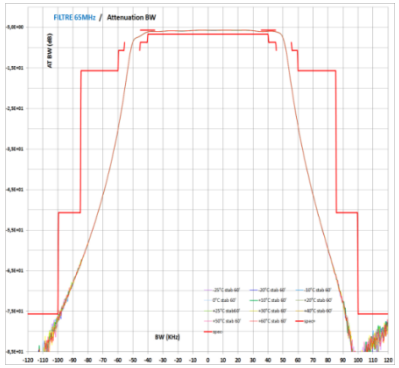


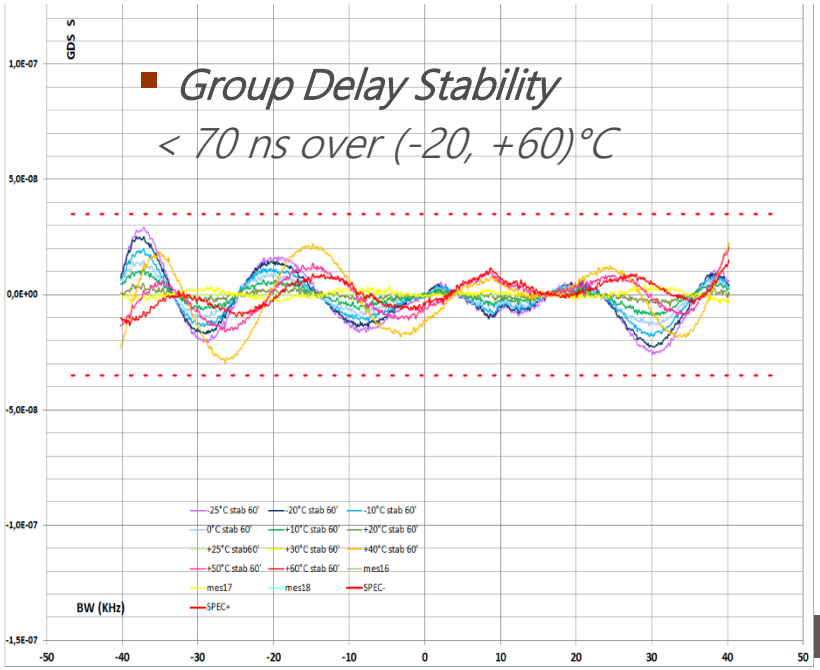
ar ELECTRONIQUE

ARE Space Projects / Product examples

CUSTOMER	North American Tier 1
PROJECT	SAR GPS Satellite 2016
PRODUCT	60MHz Xtal Filter 90kHz BW Ultra low GDS Oven controlled Milled case
COMPONENTS	QPL, MIL 55310 Lev C Xtal: IBE, swept, ESCC 3501,Lat 3-C
LEVEL	MIL-STD 55310 - C
WORKMANSHIP	ESA-Q-ST-70-08/38
STATUS	EM delivered



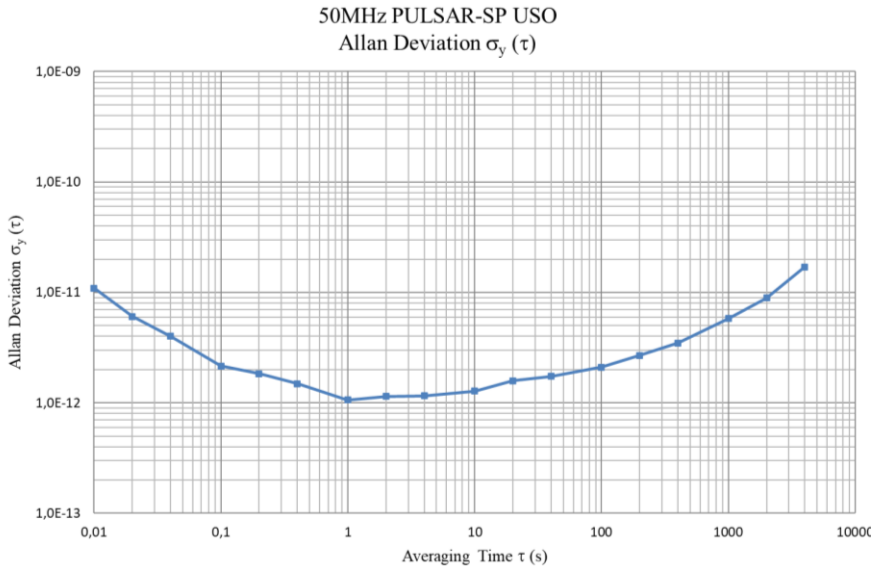




ar ELECTRONIQUE

ARE Space Projects / Product examples

CUSTOMER	European Tier 1
PROJECT	SAR Satellite Radar 2016
PRODUCT	50MHz USO – FM/QM High stability Very low phase noise Milled case
COMPONENTS	QPL, ESA / MIL Std Xtal: HQ, swept, ESCC 3501,Lat 2-B
LEVEL	Full Class-S level MIL-STD 55310 – C
WORKMANSHIP	ESA-Q-ST-70-08/38
STATUS	FM/QM delivered In orbit since end of 2022



AR ELECTRONIQUE

Space products

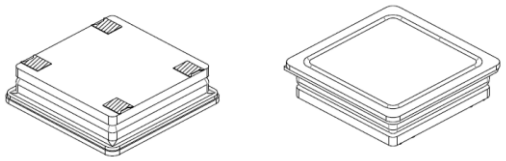
- Space Heritage
- SMD Xtal resonators
- New Space / nanOSTAR-SP oscillator

Xtal resonators / SMP8

Design, manufacturing and evaluation of SMD Crystal Resonators for Space Applications

A key point for oscillator size reduction.

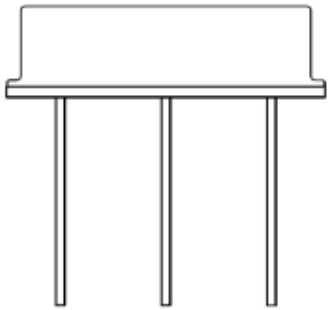
SMP8
SMD package



8.0 x 8.0 x 2.5 mm

VS.

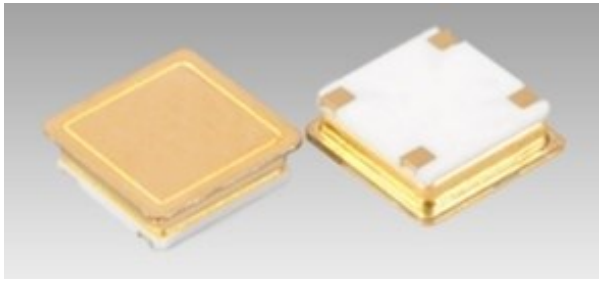
TO8-500
Through Hole package



∅ 13.0 mm x 4.5 mm (height)

This work has been performed within a CNES RCS Action

Xtal resonators / SMP8 product range



Fcy range

- 20-120 MHz Fcy range
- AT / SC Cut

Enclosure

- SMD resonator design for achieving a state of the art Low g-sensitivity

Material

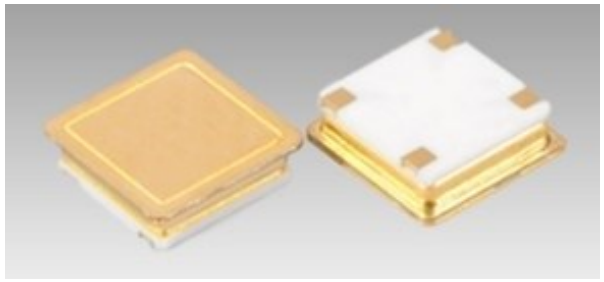
- Swept
- Shortly, ARE plan to use high purity premium quartz material from CRISTAL INNOV French manufacturer.

Manufacturing

- According to ARE PID 002 (CNES approved)

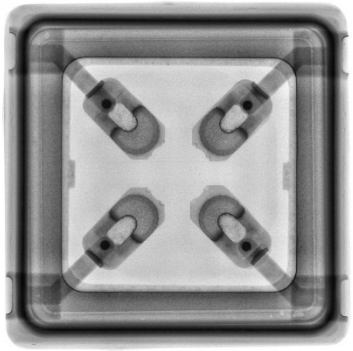
ITAR Free

Xtal resonators / SMP8



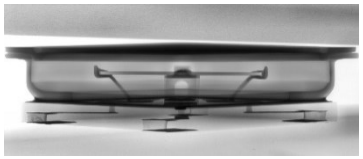
Crystal resonator Manufacturing

- Batches of 20, 50, 100 and 120 MHz resonators for New Space applications



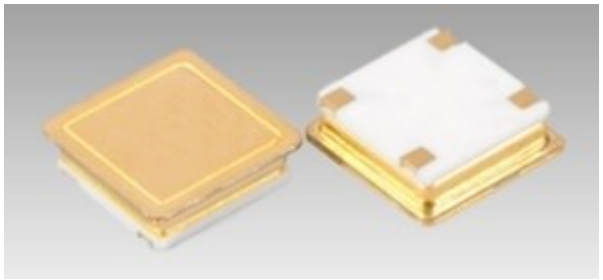
Manufacturing characterisation

- Crystal motional parameters
- Frequency stability vs. temperature
- Aging : 3.0 E-8 / month (max) @ 100 MHz
- Phase Noise
- g-sensitivity : 1.5 E-10 /g (typ) @ 100 MHz
- Fine Leak Test
- X-ray inspection



ar ELECTRONIQUE

Xtal resonators / SMP8



➔ Successfull evaluation of SMP8 resonators according to ESCC 2263501

GROUP 2 :

- Thermal Shock Step Stress (§ 7.3.2)
- Vibration Step Stress (§ 7.3.3) : 20g, 30g et 50g
- Mechanical Shock Step Stress (§7.3.4) :
  - 50g ½ sinus 6ms.
  - 100g ½ sinus 6ms.
  - 1500g ½ sinus 0.5ms.
  - 2000g ½ sinus 0.1ms.
- Accelerated Damp Heat (§ 7.3.5)

GROUP 4 :

- Aging

RGA and DPA are now in progress at CNES's Analysis Laboratory

ar ELECTRONIQUE

AR ELECTRONIQUE

Space products

- Heritage
- SMD Xtal resonators
- New Space / nanOSTAR-SP

AR ELECTRONIQUE

AR Electronique New Space products …

… derived from fully qualified MIL/Airborne oscillators

AR ELECTRONIQUE

Starting point

nanOSTAR-S

Miniature OCXO – nanostar S

- Low volume : 20 x 20 x 10 mm
- Low weight : < 10g

Rugged design

Fully qualified on MIL-Airborne projects
High reliability : 900 000 hours MTBF
Robustness to random vibration and shocks
COTS Components
ARE In House HQ SC-cut Crytal resonators

High performances under environment

Fast Warm-Up : < 30 s @ +25°C
Low Power Consumption : < 700 mW @ +25°C (VCC=3V3)
High Frequency Stability : ±5.0 E-9 in [-20°C; +70°C] (10 MHz)
Low Phase Noise : < -135 dBc/Hz @ 100 Hz offset (100 MHz)
Low Aging : < 5.0 E-9 / month @ 10 MHz
Low g-sensitivity : < 2.0 E-10 /g
10 - 60 MHz (direct frequency)
60 - 120 MHz (with internal freq. Multiplier)

AR ELECTRONIQUE

Design steps

nanOSTAR-SP

1. Candidate Components list for space environment
2. Heavy ions evaluation (SEE)
3. Re-design of the OCXO
4. HQ crystals with Swept material
5. Resonators and Oscillators batch manufacturing
6. Radiation characterisation up to 40 krad (TID)
7. Thermal & Mechanical Environment evaluation

This work is carried out within an ongoing CNES RCS Action

Compact OCXO / nanOSTAR-SP

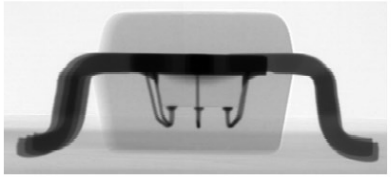
➔ Qualification Program

Phase	Activity	Q4-21	Q1-22	Q2-22	Q3-22	Q1/Q2-23
P1	**Radiation Analysis** COTS HCMOS components Heavy Ions / SEL SET	*EEE HCMOS Components* UCLouvain				
P2	**EM units production** 2 batches 10MHz / 100MHz		*Xtals*	*Oscillators*		
P3	**Qualification** Radiation LDR 40 krad TID					*Lot 1* TRAD Tests & radiations
P4	**Qualification** Temperature Vibration + Shocks Life test 1000 hours					*Lot 2* *Lot 3* *Lot 4*

ar ELECTRONIQUE

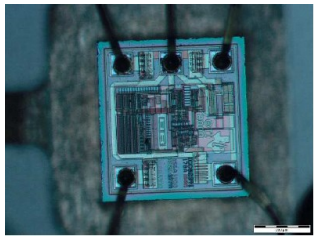
AR ELECTRONIQUE

Candidate Components idenfication & Sample preparation : Done



4 CMOS function (LDO, OPA, MOSFET, Logic Gate)
1 Bipolar function (bipolar Transistor)

1. Component selection on Automotive parts (if available)
2. 4 alternative parts per function
3. Component construction analysis
4. Samples mounting on daughter boards
5. Samples delidding with acid-etch process (TRAD laboratory)

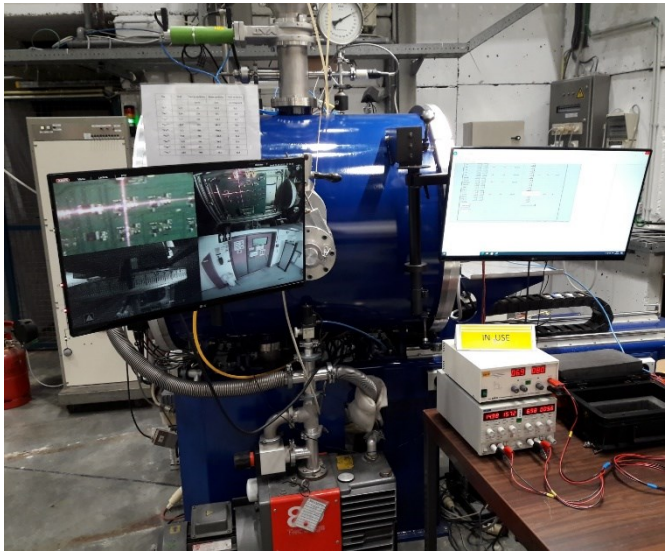


This work is performed within an ongoing CNES RCS Action

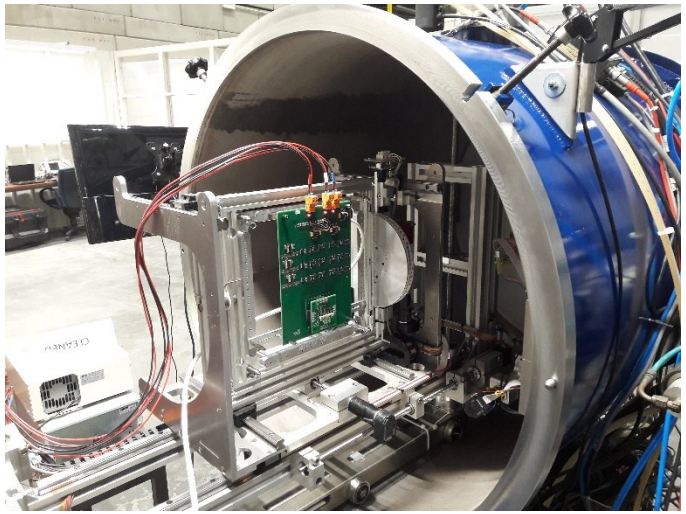
AR ELECTRONIQUE

SEE evaluation : Done

- Heavy ions beam test
- 23 component references tested
- 89 component samples tested



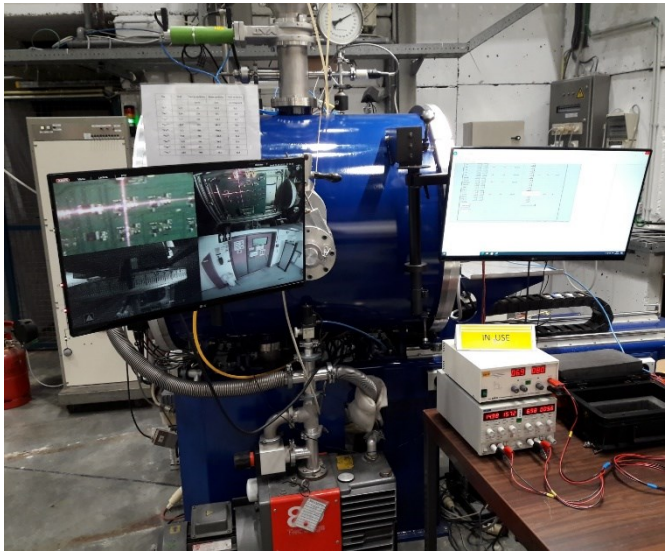
Ion Beam Test Location :
HIF evaluation performed at UCL
in Louvain-La-Neuve (BE)
Cyclotron Research Center (CRC).



Ion Beam parameters :
Ion $^{103}Rh^{31+}$, 46,1 MeV.cm²/mg,
Fluence : 1E7 particules/cm²,
Flux : 1E4 ions/s
Duration : 1000 s

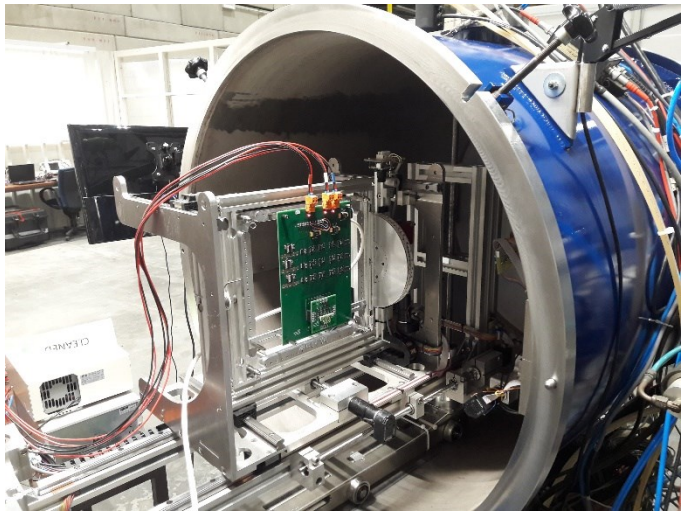
AR ELECTRONIQUE

SEE evaluation results



At least 2 references per function is **SEL-free** with up to 46,1 MeV.cm²/mg => Successful

LDO components seems to be critical items regarding SEE under heavy ions with only 1 SEL-free part on 6 candidate references tested. => Successful



AR ELECTRONIQUE

Re-Design & Manufacturing

nanOSTAR-SP

Minor Nanostar PCB re-design in order to fit with SEE qualified components footprints.	Done
HQ crystals with Swept material manufacturing & Testing	Done
Oscillators batch manufacturing	Done

AR ELECTRONIQUE

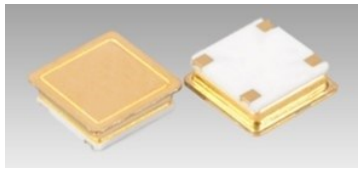
Evaluation to be finalised

nanOSTAR-SP

Radiation evaluation up to 40 krad (TID) at TRAD Co60 facility Q2 2023
(design already successfully evaluated up to 100 krad in 2019)

Thermal & Mechanical Environment evaluation Q2 2023
(design already successfully qualified for military airborne applications)

Conclusion



SMP8 XTAL Resonator

nanOSTAR-SP

ARE Solutions for Space applications

- SMP8 Space resonator
  (ESCC 2263501 qualified)

- Miniature OCXO for New Space application
  10 – 120 MHz
  SEL-free
  New Space Evaluation finalized May 2023
  High performances :
  - 20 x 20 x 10 mm
  - Fast Warm-Up : < 30 s @ +25°C
  - Low power consumption : < 700 mW @ +25°C (VCC=3V3)
  - High Frequency Stability : ±5.0 E-9 in [-20°C; +70°C] (10 MHz)
  - Low Phase Noise : < -135 dBc/Hz @ 100 Hz offset (100 MHz)
  - Low aging
  - Low g-sensitivity : < 2.0 E-10 /g
  - 10 - 60 MHz (direct frequency)
  - 60 - 120 MHz (with internal freq. Multiplier)

Web site :
www.ar-e.com

➔ *Many thanks for your attention !*

Contact:

Patrick Bellenger - Sales
patrick.bellenger@ar-e.com

Pierre Boillot - Engineering
pierre.boillot@ar-e.com

Emmanuel Girardet - CEO
emmanuel.girardet@ar-e.com