

TRAD TEST FACILITIES

Presented by Dr. Pierre Garcia



- **Material qualification & characterization facilities**
 - ▶ UV ageing
 - ▶ Thermal cycling
 - ▶ Proton solar wind irradiation

- **VEISpa : electron irradiation facility**

- **GAMRAY : Co⁶⁰ irradiation facility**

- **De-capping facilities**

- **LASER test bench for SEE characterization**

- **Californium test for SEE sensivity assessment**

- **Material qualification & characterization facilities**
 - ▶ UV ageing
 - ▶ Thermal cycling
 - ▶ Proton solar wind irradiation
- **VEISpa : electron irradiation facility**

- **Material testing**
 - GAMRAY : Co
 - De-capping facilities
 - LASER test bench for SEE characterization
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- Material qualification & characterization facilities
 - ◆ UV ageing
 - ◆ Thermal cycling
 - ◆ Proton solar wind irradiation

Total Ionizing Dose testing

- VEISpa: electron irradiation facility
- **GAMRAY : Co⁶⁰ irradiation facility**

- De-capping facilities
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- Material qualification & characterization facilities
 - UV ageing
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- VEISpa : electron irradiation facility

- **Single Event Effect testing**

- De-capping facilities
- LASER test bench for SEE characterization
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TRAD Material Laboratory



- UV irradiation

- Thermal cycling

- Solar wind
proton irradiation

- Material characterization &
functional testing

Solar simulator for UV irradiation



- Up to 15 suns
- In-situ monitoring (UV flux and sample temperature)
- Irradiation area: 60 x 60 mm (10% homogeneity)
- Chamber pressure <math>< 10^{-5}</math> mbar
- In accordance with ECSS-Q-ST-70-06C

→ Adapted to ageing tests for materials that are directly exposed to space environment (paints, coatings, polymers...)

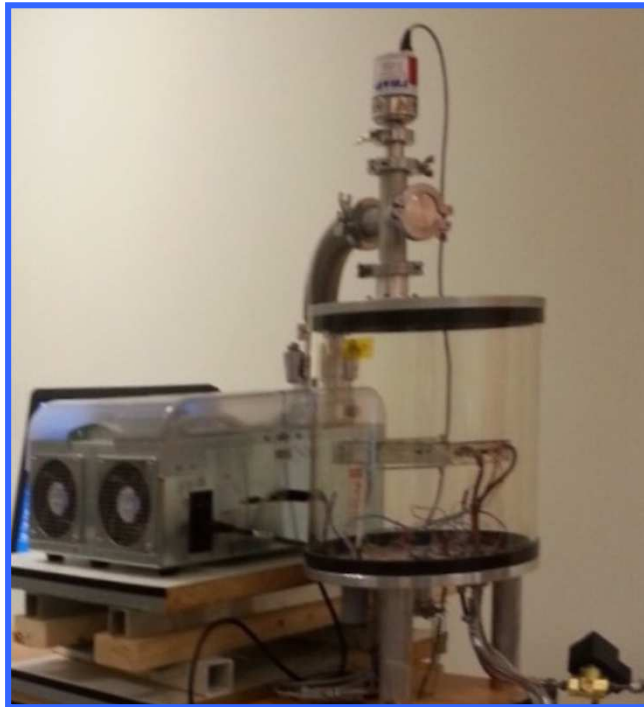
Atmospheric thermal cycling



- Inert atmosphere (N, Ar or He)
- Temperature range: -170°C to +400°C
- Rising and decreasing speed: up to 20°C/min
- Chamber dimensions: 35 x 33 x 33 cm
- In-situ electrical measurements
- In accordance with ECSS-Q-ST-70-04C

→ Allows to assess thermal effects, particularly at high temperature (400°C)

CryoVax – Vacuum thermal cycling



- Chamber pressure <math>< 10^{-5}</math> mbar
- Temperature range: -190°C to +190°C
- Rising and decreasing speed: up to 10°C/min
- Chamber dimension: 1 plate of 20 x 11 cm
- In-situ electrical measurements
- In accordance with ECSS-Q-ST-70-04C

→ Allows to assess thermal effects under vacuum environment, especially at very low temperature

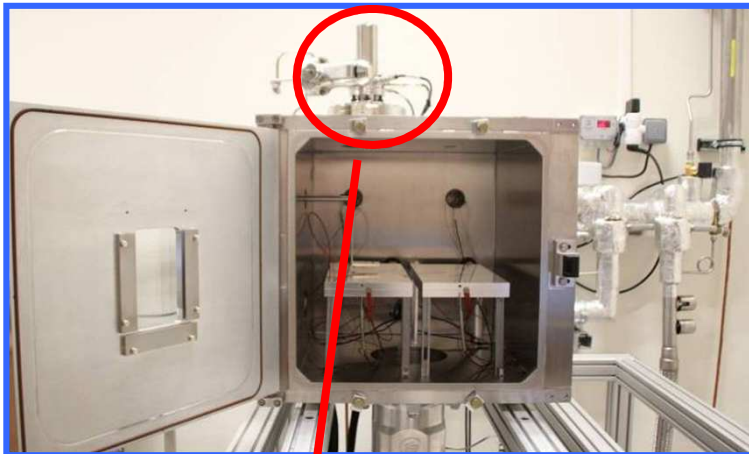
ThetaVax – Vacuum thermal cycling



- Chamber pressure <math>< 10^{-6}</math> mbar
- Temperature range: -170°C to +200°C
- Rising and decreasing speed: up to 10°C/min
- Chamber dimension: 2 plates of 15 x 30 cm
- In-situ electrical measurements
- In accordance with ECSS-Q-ST-70-04C

→ Allows to assess thermal effects under vacuum environment

SWIPI – Solar Wind Proton Irradiation

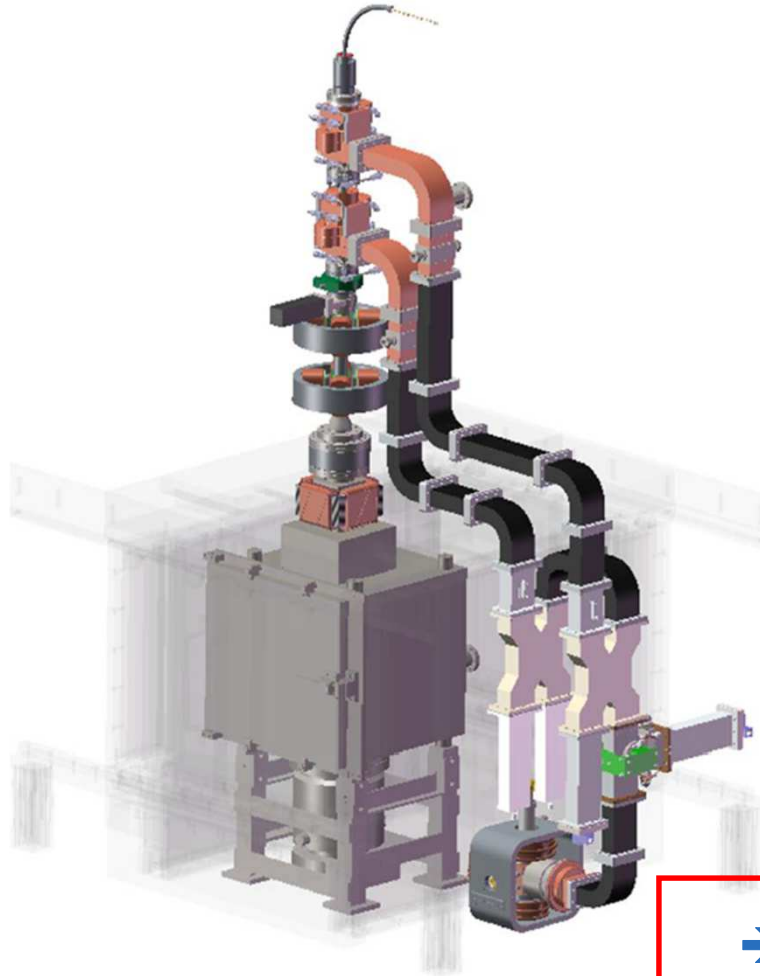


- Energy: 300eV to 5keV
- Chamber pressure <math>< 10^{-6}</math> mbar
- Temperature range: -170°C to +200°C
- In-situ electrical measurements



→ Adapted to ageing tests for materials that are directly exposed to space environment (paints, coatings, polymers...)

Vacuum Electron Irradiation facility for Spatialization



- Type: LINAC
- Energy: 1 to 4 MeV
- Low current mode: $6 \cdot 10^7 \text{ cm}^{-2} \cdot \text{s}^{-1}$
- High current mode: $3 \cdot 10^{11} \text{ cm}^{-2} \cdot \text{s}^{-1}$
- Irradiation area: 30 x 30 cm
- Vacuum $< 10^{-5}$ mbar or inert atmosphere
- Temperature range: -150°C to $+200^{\circ}\text{C}$
- In situ-electrical measurements

→ Synergistic effects of temperature and radiation with in-situ electrical measurements

Material characterization & functional testing

- **Optical measurements**
 - Transmission
 - Reflectivity / absorptivity
- **Electrical measurements**
 - Voltage tests
 - Insulation resistance (surface, transverse)
- **Optical microscope observation/photo**

- **GAMRAY for Total Ionizing Dose Testing**



Panoramic Cobalt-60 source Gamma irradiation for TID testing

Irradiation Room



Control Room



- 14.8 TBq on 04-Sept-15
- 2 main energies at 1.17 and 1.33 MeV
- Dose rate: 10rad(Si)/h to 4krad(Si)/h (without shielding)
- Regulated temperature: 20°C (±2°)
- Useful irradiation volume: 45 m³

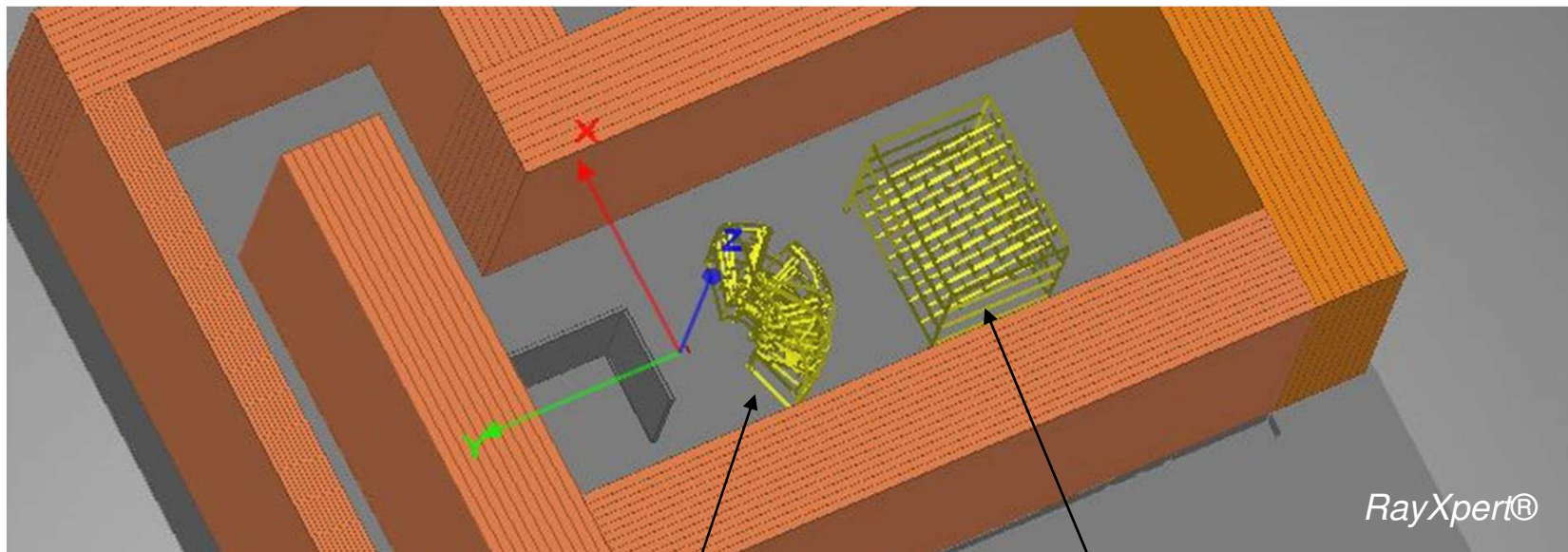
→ Allow to access to the degradation induced by cumulated dose on samples (MIL-STD-883 Method 1019, ESA/SCC 22900)



Source holder

Bias board structure allow to perform irradiation from 10rad(Si)/h to 1.5krad(Si)/h without shielding

- **Next improvement: New bias board structure**



Circular to improve homogeneity and for space efficiency

Dedicated to low dose rate

Single Event Effect testing

- **De-capping facilities**
- **LASER test bench for SEE characterization**
Sensitive area zoning
- **Californium test for SEE sensivity assessment**

De-capping Laboratory



• Mechanical de-capping

• Chemical de-capping

X-Ray inspection



- Visual inspection
- Chip position
- Package thickness

→ Checking integrity/configuration of electronic devices before de-capping operation

Mechanical de-capping



Milling machine

- Specific de-capping for ceramic package
- Thinning for flip-chip
- Failure analysis



Cutting disc

- Diamond disc
- Device opening
- Device cutting



Wire saw

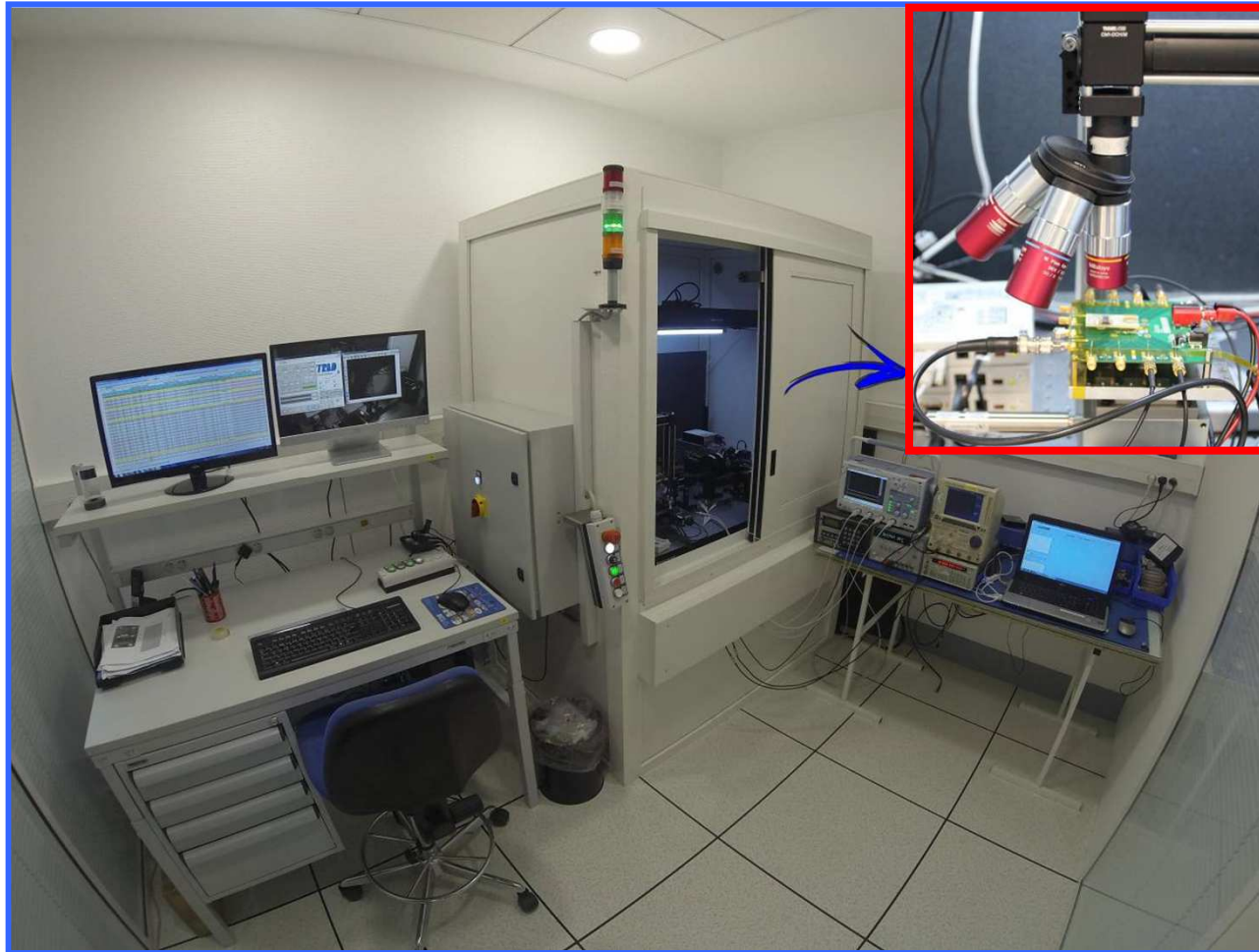
- Diamond wire
- Device opening
- Device cutting

Chemical de-capping



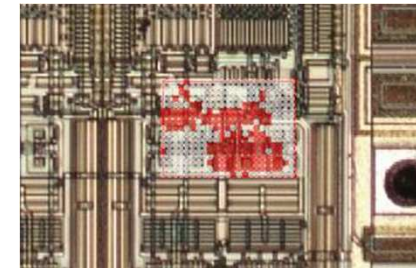
- Acid attack
- Plastic packages
- Mask used to define the size opening

LASER Laboratory

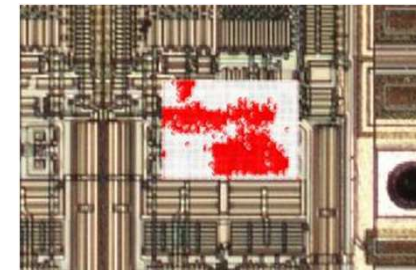


Pulsed Laser Test

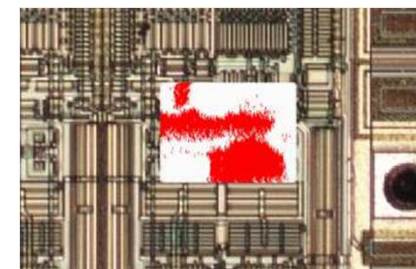
- Laser Nd:YAG with wavelength 1064nm
- Pulse duration : 790ps
- Can be triggered from single shot to 50kHz frequency pulse
- Energy : 0.06 – 135.9 nJ/pulse
- Spot size: 1.8, 2.6 and 8 μ m
- 3 motorized linear stages (X, Y, Z), resolution 0.3 μ m
- Tests performed on front or back side scanning of the delidded device
- Efficient tool for the designers
- Help to Improve the hardening process



8 μ m
step



4 μ m
step



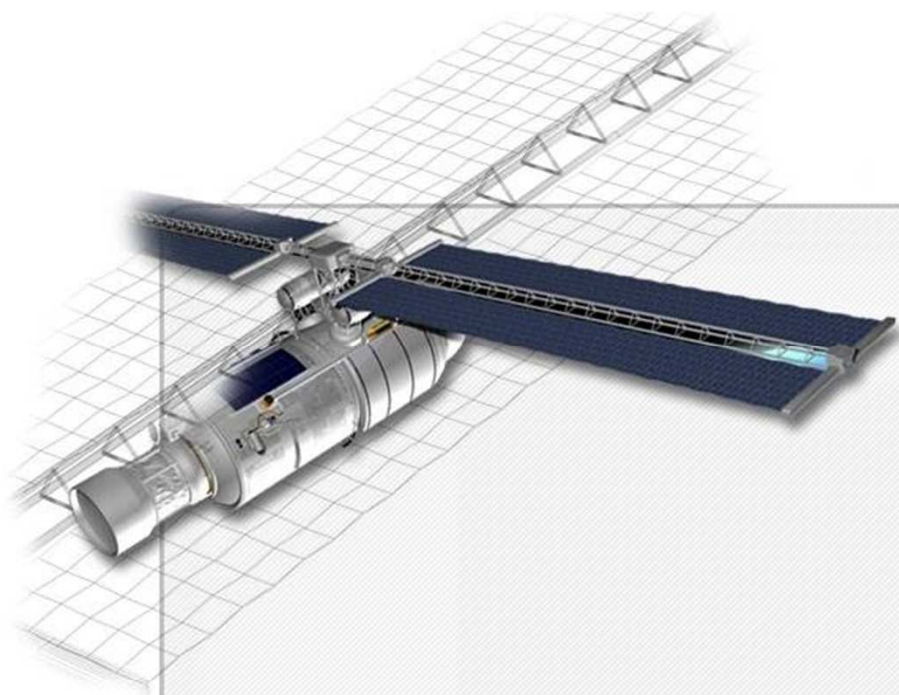
2 μ m
step

Californium Test

- Mean LET = 43 MeV.cm².mg⁻¹
 - Mean Range = 14 μm
- Tests performed under vacuum on delidded device
- Test bench evaluation/validation or SEE sensitivity assessment



- **Aim of this presentation was to give you a global overview of all the facilities available at TRAD**
- **Facilities dedicated for Material testing**
- **Facilities dedicated for TID testing**
- **Facilities dedicated for SEE testing**



TRAD TEST FACILITIES

Thank you for your attention,
any question ?

