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 : Co\textsuperscript{60} irradiation facility**

- **De-capping facilities**

- **LASER test bench for SEE characterization**

- **Californium test for SEE sensivity assessment**
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Material testing

- De-capping facilities

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Total Ionizing Dose testing
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Single Event Effect testing
Material qualification & characterization facilities

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 < $10^{-5}$ 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 < $10^{-5}$ mbar
- Temperature range: -190°C to +190°C
- Rising and decreasing speed: up to 10°C/minute
- 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 < $10^{-6}$ 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 < $10^{-6}$ 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:** $6 \times 10^7 \text{ cm}^{-2}\text{s}^{-1}$
- **High current mode:** $3 \times 10^{11} \text{ cm}^{-2}\text{s}^{-1}$
- **Irradiation area:** 30 x 30 cm
- **Vacuum:** $< 10^{-5} \text{ mbar}$ or inert atmosphere
- **Temperature range:** -150°C to +200°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: $^{60}\text{Co}$ irradiation facility

- GAMRAY for Total Ionizing Dose Testing
GAMRAY: Co$^{60}$ irradiation facility

Panoramic Cobalt-60 source
Gamma irradiation for TID testing

- 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°C)
- Useful irradiation volume: 45 m$^3$

→ Allow to access to the degradation induced by cumulated dose on samples (MIL-STD-883 Method 1019, ESA/SCC 22900)
GAMRAY: Co$^{60}$ irradiation facility

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 sensitivity assessment
De-capping facilities

De-capping Laboratory

• Mechanical de-capping
• Chimical de-capping
X-Ray inspection

- Visual inspection
- Chip position
- Package thickness

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

Mechanical de-capping

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

- Diamond disc
- Device opening
- Device cutting

- Diamond wire
- Device opening
- Device cutting
Chimical de-capping

- Acid attack
- Plastic packages
- Mask used to define the size opening
Laser test bench for SEE characterization

LASER Laboratory
Laser test bench for SEE characterization

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 8µm
- 3 motorized linear stages (X, Y, Z), resolution 0.3µm
- Tests performed on front or back side scanning of the delidded device

- Efficient tool for the designers
- Help to Improve the hardening process
Californium Test

- Mean LET = 43 MeV.cm$^2$.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
Thank you for your attention, any question?