CNES-ESA Final Presentation Days 2013
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Radiation tests under controlled temperature and vacuum conditions: why and how

ALTER TECHNOLOGY TÜV NORD
Innovation Department

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INDEX

- Why:
  - Motivation for radiation tests under controlled temperature

- How:
  - Liquid Nitrogen Proposed setup
  - Future Options: Helium close loop

Why Low Temperature Radiation

- Some future missions could lead to the necessity of low temperature electronics.
  - To save power that is used to keep electronics warm
  - Supporting electronics for cold sensors

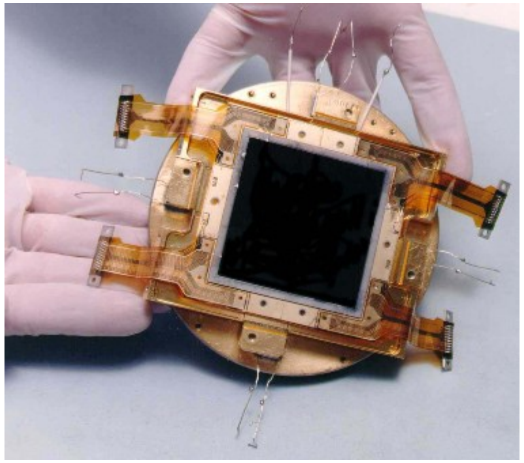
- Annealing recovery is reduced at low operating temperatures

- Working environmental conditions. For example:
  - Detectors for space telescopes
  - Mars Temp: 140K aprox
  - Lunar South Pole Temp: 40K
  - Jupiter Moons. Ej. Titan:
    - Temp: 75K to 125K
    - 5Krad/month at 10cm depth

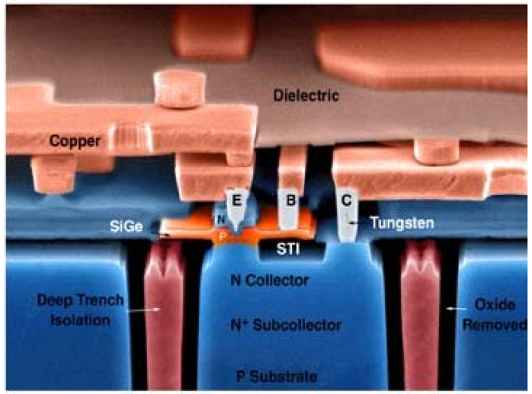
(Boeing Presntation at MEWS22)

Low Temperature Electronics

- Performance of standard electronics can be improved by cooling.
- Astronomy detectors and associated electronics.
- Si long channel FETs and p-MOSFETS for cryogenic temperature operation.
- SiGe HBT (Heterojunction Bipolar Transistors) have higher gain when the temperature drops. It can operate at very low temperature without heat.



E2v CCD Sensor



After Dr. John D. Cressler (Georgia Institute of Technology)

Why Low Temperature Radiation

ACTIVE RESEARCH FIELD

CRYOGENIC ELECTRONICS FOR SPACE APPLICATIONS

Evaluation of Ge based FETs working at 4K.

Development of very low noise SiGe based bipolar transistors.

Development of AsGA HEMTs.

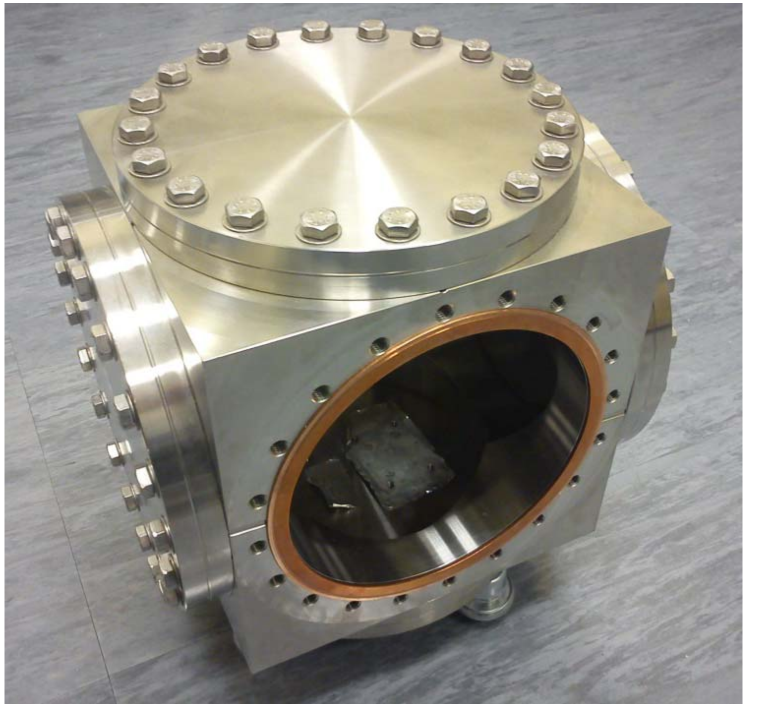
Radiation hardness

Controlled Atmosphere

- Vacuum (Optionally)
  - Some sensors operate in vacuum
  - To prevent water condensation

- Metal sealing: wide temperature range and no outgassing

- Capability of simulation of other planetary atmospheres
  - Ej. Mars: 8mbar of CO_2



Vacuum Chamber

Proposed Setup for Radiation tests under controlled temperature and vacuum

Liquid Nitrogen Deposit

Turbo Pump System

Climatic Chamber

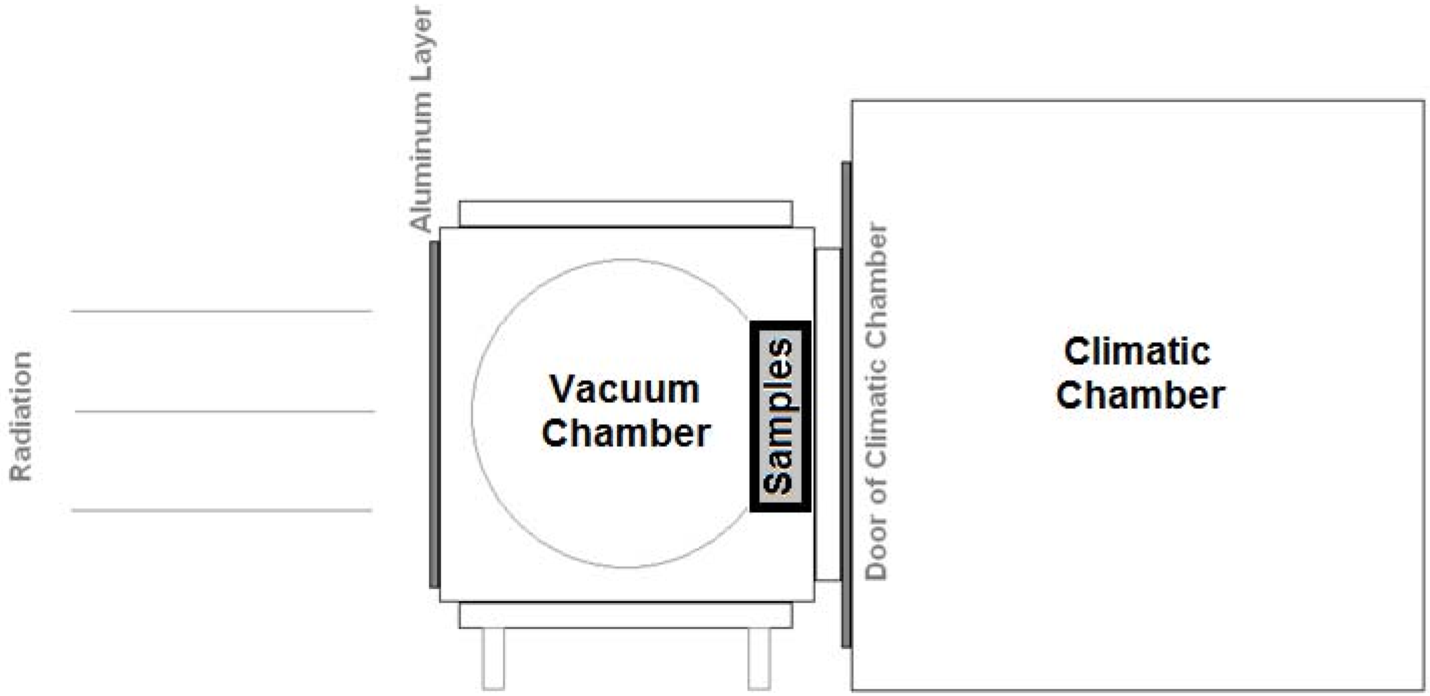
Radiation

Vacuum Chamber

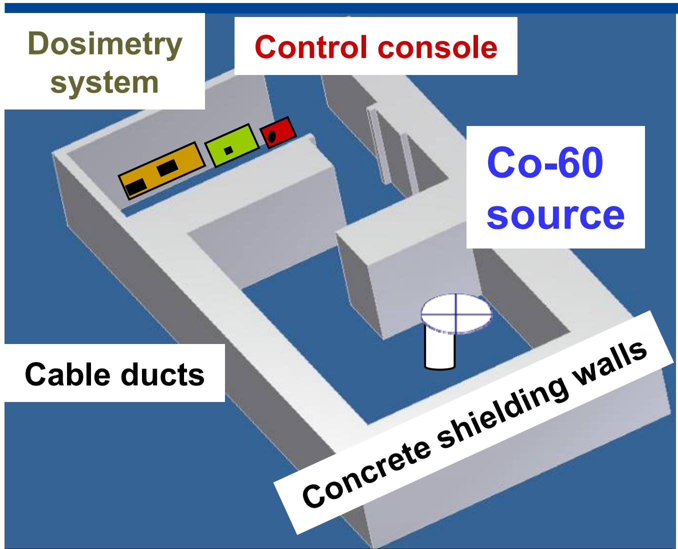
Feed-throughs

Proposed Setup for Radiation tests under controlled temperature and vacuum

- Radiation cross the front tap (steel or aluminium)
- Temperature controlled on the samples with PID control loop and thermocouples in direct contact with the DUT.
- Feed-through for electrical, optical, thermocouples, etc.



RADLAB Facilities outline



Bunker volume
5.8 m x 4.8 m x 3 m

1. Co60 nominal activity 444 TBq (12 kCi)
2. Range of dose rate :
   0.36 - 360 Gy/h // 36rad(Si)/h to 36krad(Si)/hr.
3. Dose rate uncertainty ≤ 10%
4. Maximum radiation field non-uniformity of 10% in a wide surface
5. Gamma-ray dose rate calibrated to ≤ 5 %.
6. Dosimetry traceable to international standards and patterns.
7. Environmental conditions (temperature, humidity) controlled and monitored.
8. Different field size and dose rate can be achieved by attenuation. i.e. 1 m of distance: 120 Gy/h (200 rad/min), min 5x5 cm2 and max 43x43 cm2

RADLAB outline ALTER – CNA.

Due to the short distance between both facilities, the tandem ALTER / CNA provides an ideal frame to offer a comprehensive radiation laboratory to characterize, validate and test all EEE component types under gamma radiation.

ALTER Innovation Project

The work presented is under the developments of an ALTER Internal Innovation Project that is not completed yet.

Already performed:

- Temperature and Vacuum Setup
- Development of LabView PID loop program for the temperature control at the samples site
- Verification of the thermal stability in the samples area within the vacuum chamber
- Verification of feasibility at radiation facilities.

To be done:

- Dosimeter analysis with the shielding of the front cover including uniformity characterization
- Actual Tests (foreseen for next months)

Proposed Setup for Radiation tests under controlled temperature and vacuum

FOR LOWER TEMPERATURES
(under evaluation)

- Liquid Helium close loop cryostats
- Cavity big enough for components
- Temperatures down to some K or even less.
- Vacuum Feed-throughs for in-situ measurements

Conclusions

- Some future missions will lead to the necessity of low temperature electronics.
- Some components have to work at low temperature to improve their performances (i.e. sensors).
- Annealing effects are reduced at low operating temperatures.
- No real knowledge of possible influence of actual operating conditions on radiation degradation.

- ALTER TECHNOLOGY is prepared to perform radiation test at temperatures down to liquid nitrogen (-190ºC) and up to more than 200ºC and is studying the setups needed for lower temperature testing.

TÜV NORD Aerospace

ALTER TECHNOLOGY Member of TÜV NORD

THANK YOU FOR YOUR ATTENTION

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