

An alternative to Cobalt-60 for TID testing of electronic systems

Vincent Girones, Jérôme Boch, Frédéric Saigné, Tadec Maraine, Alain Carapelle, Arnaud Chapon, Rubén García

► To cite this version:

Vincent Girones, Jérôme Boch, Frédéric Saigné, Tadec Maraine, Alain Carapelle, et al.. An alternative to Cobalt-60 for TID testing of electronic systems. DEM 2024, May 2024, Avignon, France. . hal-04582179

HAL Id: hal-04582179 https://hal.science/hal-04582179

Submitted on 21 May 2024 $\,$

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers. L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

An alternative to Cobalt-60 for TID testing of electronic systems with high-energy X-ray generators.

Vincent Girones¹, Jérôme Boch¹, Frédéric Saigné¹, Tadec Maraine¹, Alain Carapelle², Arnaud Chapon³, Rubén García Alía⁴

1 Université de Montpellier, IES - UMR UM/CNRS 5214, France. 2 Centre Spatial de Liège (CSL), 4031 Angleur, Belgium. 3 ATRON METROLOGY, Cherbourg en Cotentin, France. 4 CERN, CH-1211 Genève 23 Switzerland.

1. Introduction

To perform TID testing, we study the use of a high-energy X-ray generator allowing to obtain photons up to 320 keV. These conditions are far from optimal for component testing where the goal is to achieve a high penetration depth and an energy deposition that does not depend on the Z of the material. This is the reason why we have decided to cut the low

Benefits of X-ray:

- Easier radiation safety issues.
- More economical (purchase and maintenance).
- Easy to collimate.
- Higher dose rate offering reduced testing time.





energy photons. This cut is realized with a lead (Pb) filter.

0.01 0.05 0.1 50 Photon energy (MeV)

2. High energy X-rays

The TASMICs tool has been used to simulate our Spectrum. The lead filter reduces low energies below 100keV while only slightly altering high energies.



4. Results

Custom-Made CMOS Capacitor (100nm oxide):



2024

- > With basic components and a **BEOL with low-Z** materials, **no gap** is observed between all irradiation conditions.
- > The addition of a high-Z material as BEOL induces dose enhancement and more degradation for irradiation with many low-energy photons (Al+PB filtered X-rays slightly and many with Al filtered X-rays only).



3. Methods

- For all components pins are grounded.
- The final results are presented in $Gy(SiO_2)$.
- We will use 60-Co source as a reference as is it usually considered to perform TID tests on electronic devices and systems.
- The effect of dose rate is studied with the two rates proposed for 60-Co.
- - > Same trend as Au metalized MOS capacitor are measured with commercial MOS fets. > Use filter and cut low energies offer closer result to 60-Co whatever the X-ray voltage from 320kV to 250kV.



5. Conclusion

Degradation closer to 60-Co has been obtained with X-ray irradiation when photons with low energy photons were cut (i.e. when a lead filter is used). But a difference of degradation remains. The degradation difference can be attributed to several factors: the contributions of packaging or backscattered photons in Back End Of Line (BEOL) stack (contacts, metal layers, insulating layers) that can induce a significant TID contribution in the sensitive oxide.



The results presented in this paper have been obtained in the framework of the EU project RADNEXT, receiving funding from the European Union's Horizon 2020 research and innovation programme, Grant Agreement no. 101008126. X-rays and 60Co tests were performed using the PRESERVE Platform, which was funded by the Occitanie Region and the EU.

