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APPLICATION OF A SCINTILLATOR DETECTOR AS A FAULT TOLERANCE SYSTEM FOR FPGA

Abstract

Given the problematic generated by energetic particles on electronic space systems (mainly in FPGAs) due to its susceptibility to Single Event Effects (SEE), and the difficulty on totally protecting it from interaction with these, it is desirable to identify the variations on the flux of ionizing particles, allowing to run an adaptive fault tolerance technique in the FPGA in accordance with the local environment.

In this proposal we show a newfangled fault tolerance system, base on a scintillator detector for sensing the surrounding flux of ionizing particles, which allows a module of the FPGA to select the proper fault tolerance technique to be implemented at each time.

The proposed system allows to increase the reliability of FPGA-COTS in space applications while decreasing the power consumption associated to the operation of fault tolerance techniques, achieved by selecting the proper one only when it is required, resulting in an adaptive system.

Composed by an optically isolated scintillator plastic and MPPCs (Multi Pixel Photon Counter), the detector is set to identify the energy transferred by ionizing particles onto the plastic through the high speed processing of the signal, being of special interest those over a threshold that could generate an SEE. This allows for a real time surveillance of the flux of energetic particles near the electronic devices, e.g. the FPGA controlling all the other systems. The system will come specially handy with abnormally high particle fluxes (caused by, for example, solar flares), which can occur at any moment, and for which any other FPGA would be unprepared to deal with. Various geometric configurations of the scintillator would also allow for a wider coverage of detection, as it would be possible to fully surround the electronics with these probes.

As a first test of the detector and its components against rough mechanical conditions and extreme temperatures, and in collaboration with Autonomous University of Sinaloa (UAS), a first detector has been lifted with a meteorological balloon to a stratospheric flight with a pair of independent scintillator plastics, coupled with two MPPCs each, for counting cosmic rays and allowing a post-flight analysis of the detector.