Single Events Effects (SEE) data post processing GUI

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1. Introduction

The Space Power team at Texas Instruments (T.I.) develops radiation hardened power products for usage in Space and Hi-Reliability applications. As space environments have the potential to impact the performance of semiconductors devices, integrated circuits due to radiation exposure, one of the requirements is the validation of such devices under heavy-ion bombardment with certain effective Linear Energy Transfer. During testing, the integrated devices are bombarded with heavy-ions, while monitoring signals for excursions from typical operating levels. For example, an LDO regulating to a fixed output voltage is monitored for voltage excursions that meet certain trigger level conditions (typ. 5% window trigger around nominal). The voltage excursion data is captured and stored for further analysis.

Important definitions:

Linear Energy Transfer - The equivalent light energy transfer obtained by tilting the device under test with respect to the beam axis, hence increasing the path length of the ion and the total energy deposited. Measured in MeV*cm²/mg of material.

Flux - The number of ions passing through a unit area perpendicular to the beam, in one second. Units: ions/cm²/sec

Fluence - The flux integrated over time. Units: ions/cm²

Threshold LET - Minimum LET to cause an effect at a particle fluence of $1*10^7$ ions/cm². Typically, a particle fluence of $1*10^5$ ions/cm² is used for SEB and SEGR testing.

Multiple Bit Upset (MBU) - An event induced by a single energetic particle such as a cosmic ray or proton that causes multiple upsets or transients during its path through a device or system.

Single Hard Error (SHE) - SEU which causes permanent changes to the operation of a device.

Single Event Latchup (SEL) - Condition which causes loss of device functionality due to a single event induced high current state.

Single Event Burnout (SEB) - Condition which can cause device destruction due to a high current state in a power transistor.

Single Event Gate Rupture - A single ion induced condition in power MOSFETs which may result in the formation of a conducting path in the gate oxide.

Single Event Upset (SEU) - Change of state or transient induced by an energetic particle such as a cosmic ray or proton in a device.

2. Problem & Hypothesis

As SEE raw data can be as high as a few Gigabytes, the responses of the Graphical User Interface (GUI) to the user interaction is a key design factor. The team currently has a basic GUI on Spotfire, however such complex tools result in an overhead when managing such file sizes. A software programmed in a language like Python® with less overhead is used for data-science, thus it is a potential solution to develop a sustainable GUI to significantly reduce processing time.

3. Objectives

The goal of this project is to create a visual interface to facilitate the SEE (Single Event Effect) data visualization, processing and reporting. As SEE raw data can be as high as a few Gigabytes, the responses of the GUI to the user interaction is a key design factor.

- Selection of development tool
- Front-End GUI
- Class based back-end for event driven events.

4. Methodology

Create a GUI which satisfies the processing needs for space power division.

- Review of best & modern practices for Big Data handling in Python.
- Decide best tool with Texas Instruments team for data processing.
- Request user feedback for desired waveforms to observe.
- Determine inputs/outputs for GUI
- Construct GUI on Python with given radiation files.
- Compare the Spotfire with our redesigned version.
- Export tool to Texas Instruments.

5. Expected Results

Functional and scalable and modifiable tool that enables the user to:

- 1. Request statistical data from different experiments
- 2. View desired waveforms faster than when using Spotfire®
- 3. The tool should allow add-ons with ease.

6. Timeline

Month	Tasks
September 2022	Literature review: Understanding how radiation affects semiconductor devices. Present proposal
October 2022	Study tools with Big data capabilities, select tool based on time and cost performance.
November 2022	Programming with Python Reading a file menu Database translation from LabView to a Python Dictionary
December 2022	Select for keys and values to be used for plotting signals
January 2023	Study Big data practices like subsampling or equation extraction
February 2023	Handle Test files to develop GUI
March - April 2023	Test the developed GUI for time Validate the usability and time reduction Provide ways to save waveforms for comparison.

References

[1] "Draft single event effect specification," NASA. [Online]. Available: https://radhome.gsfc.nasa.gov/radhome/papers/seespec.htm. [Accessed: 13-Oct-2022].

[2] Texas Instruments Incorporated, Single-Event Effects Test Report of the TPS7H1101A-SP LDO," Dallas, TX, USA, Feb. 2020. Accessed: Oct., 15, 20222. [Online]. Available: https://www.ti.com/lit/rr/slvk045/slvk045.pdf

[3] *Single Event Effects Test Method and Guidelines*. European Space Components Coordination ESCC Basic Specification No. 25100 pp1-3. Available: https://escies.org/download/specdraftapppub?id=3095

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