Single Events Effects (SEE) data post processing GUI

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Executive Summary

The development of a responsive **I**nteractive **G**raphical **U**ser Interface (GUI) for the visualization, data-wrangling and reporting of SEE data in python is propose. The GUI will handle large amount of data using large data techniques that could potentially reduce processing time when compared to commercially available programs. The GUI will use an existing python module that provides basic functions to open, organize and post-process **S**ingle **E**vent **E**ffect (SEE) datasets. The objective of the GUI is provided a visual and interactive platform to accelerate the data processing and reporting during and post the SEE data collection.

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 (I.C.) due to radiation exposure, one of the requirements is the validation of such devices under heavy-ion bombardment with certain effective Linear Energy Transfer (LET_{EFF}[1]). 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 capture and store for further analysis. As different system level solutions can be used to mitigate such problems and all applications are different in essence, data is capture with tighter trigger and post process with different levels such as: 3%, 5%, or 10%. For a given device, different system levels conditions are adjusted while monitoring the device sensitivity (excursions from normal operation) in order to create sensitivity plots. System levels conditions can include: C_{OUT}, V_{IN}, V_{OUT}, I_{OUT}, and Temperature. These details are ultimately used by customer to extrapolated rate of failures for a given mission profile (Flux[2], Fluence[3], Highest LET_{EFF}).

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 Giga Bytes, the responses of the GUI to the user interaction is a key design factor. The team currently have a basic GUI on Spotfire, however such complex tools result in an overhead when managing such file sizes. A software language like Python® with less overhead is used for data-science, thus it is a potential solution to develop sustainable GUI to significantly reduce processing time.

Currently many open-source tools are available on python for the creation of GUI and dashboard. PyQt5 (or PySide), Dash, Panel to name a few. The team is tending towards a Dash (Plotly) or Panel dashboard as they offer the more complex interaction with out of the box components, however if these libraries ultimately results on “slow” GUI response a PyQt5 may be the best solution.

The project must be broken in a few milestones as:

- Package (library) selection.
- Front end design
- Back end design
- Enhancements

1. LET_{EFF}= Effective Light 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. Effective LET = Incident LET x $1/\cos\theta$ where θ is the tilt angle of the device.[2]
2. Flux=The number of ions passing through a unit area perpendicular to the beam, in one second. Units: ions/cm^2/sec.
3. Fluence=The flux integrated over time. Units: ions/cm^2.

- Depending on the knowledge of the students we may want to re-write the main data processing module to follow best python practices: like classes, error handling, vectorization, others…

Project objectives

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

Methodology

The students will have create a GUI that satisfies the processing needs for various teams, thus the process or methodology includes the following

- Review of best practices for Big Data handling in Python
- Review modern concepts in handling Big Data
- Decide on best tool with Texas Instruments team that can handle and speed the data processing
- Request feedback on what users want to observe or waveforms that might be useful for the user.
- Request total amount of inputs the user has to enter.
  - Divide the data by File selection
  - Scope selection
  - Signal to be plotted
- Create GUI on python;
- Obtain radiation files to test solution
- Compare obtained solution with Spotfire®
  - Processing time for statistics
  - Processing time in waveforms
  - Ease of use
  - Cost
- Export tool to Texas Instruments.

Expected outcomes and impact

The students must develop a 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.

The impact on student will be dual on technical skills as well as softskills acquired.

1. Soft skills
    a. Team Building and managing
    b. Interacting with clients to meet their needs
    c. Presentation skills for various audiences
    d. Research Skills:
        i. Literature review
        ii. Compare and contrast
2. Technical Skills
    a. Best practices for Big Data management
    b. Learning or expanding their knowledge on Python.
    c. Test knowledge on radiation effects on ICs.

Time schedule

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

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Skills to be developed by the students

A list of skills the students will acquire as a result of their participation in the project, such as:

1) Technical and scientific skills

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- Learn the basic of data collection for Electrical and SEE performance validation.
- Learn industry and academic python skills like: NumPy, Pandas, SciPy to names a few.

2) Multi-disciplinary teamwork and collaboration:
   - The students are expected to collaborate with TI employees to develop and optimal solution that ultimately helps in the data processing.
3) Technical report writing, academic paper preparation and presentation through their participation in the IAP conference.
   - The students are expected to provide a Guide in the usage of the Interface.

Metrics to Judge Project Success

- Functional GUI in Python
  - GUI allows selection of signals
  - Plots the desired waveform
- Program does not freeze due to the large number of data point that it handles.
- Measurement of processing time is significantly reduce when compared to commercially available solutions.

Budget

Reference material and photocopies	$200.00
Student stipend	$1,000
Miscellaneous Materials and supplies	$300.00
Total budget	$1500.00

References

[1] WWW.areo-space.nasa.gov Strategic Enterprises of NASA

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