SAND2017-7581D

Automated Data Entry, Analysis, Visualization, and Export for the HERMES III and Saturn Accelerators

Adam Circle
Rensselaer Polytechnic Institute
Mechanical Engineering, B.S.
Dec. ’19

Sean Coffey
Debra Kirschner
Above Ground Testing Accelerator Operations
Organization 1342

Sandia National Laboratories, PO Box 5800 MS-1106
Albuquerque, NM 87185-1106

U.S. Department of Energy
July 26, 2017

Abstract

The HERMES III accelerator at Sandia National Laboratories is the world’s most powerful gamma ray simulator, and fires as many as six shot per day. Similarly, the Saturn accelerator is an x-ray simulation source that is fired up to three times per week. These accelerators produce large quantities of high fidelity data in 370 and 270 data channels, respectively, during each shot: far too much to be processed by hand. Herein we demonstrate a Python-based all-in-one data manipulation program that facilitates rapid review and evaluation of HERMES III and SATURN shot results.

Introduction

The HERMES III and Saturn accelerators advance the National Nuclear Security Administartion’s national security mission by enabling the testing of critical electronic systems against bursts gamma ray radiation. Data processing applications currently in place on these accelerators are written in National Instruments’ LabVIEW program; although LabVIEW is excellent for creating user-friendly graphical user interfaces (GUIs), it relies on a proprietary graphical programming language that is difficult to review and verify for many scientists that are not familiar with the program. For this reason, we have chosen to replace LabVIEW data processing functions with equivalent functions in Python, ensuring transparency and simple customization to customer criteria [1].

Program Design

We designed the new data manipulation program as a LabVIEW-Python hybrid, taking advantage of LabVIEW’s user-friendly GUIs and Python’s data processing power and transparency. To this end, we worked with Enthought’s Canopy LabVIEW Python Integration Toolkit, which allows Python scripts to interact with LabVIEW GUIs.

The program was designed to:

- read data from a variety of file formats.
- automatically perform sophisticated statistical analysis using transparent algorithms.
- automatically create and save publication-grade bar, line, and polar graphs.
- automatically generate comprehensive reports on shot performance.
- automatically generate database-format spreadsheets for long-term internal recordkeeping.
- integrate seamlessly with LabVIEW.

In addition, the program was required to be modular, robust, scalable, and broadly configurable.

Results

The Python program we developed from these criteria presents a significant improvement in data analysis procedures from prior methods. A single file, `algorithms.py`, contains all statistical analysis algorithms used by the program for facile distribution and review. Functions specific to HERMES and Saturn are contained in `main_hermes.py` and `main_saturn.py`, respectively. More specialized and sophisticated algorithms, such as a cable attenuation compensation algorithm, are implemented in a file of their own, and can be easily integrated into the underlying program flow.

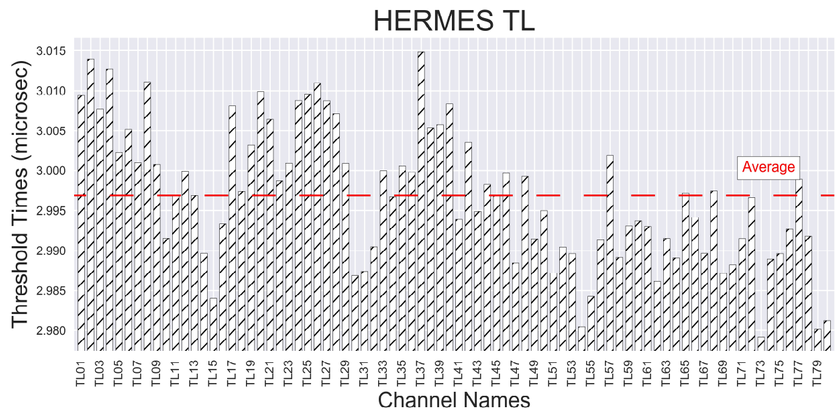

Figure 1: An example bar graph produced automatically by the new data manipulation program. Standard deviation, time spread, and outlier channels are automatically determined as well and are listed below the graph in the shot report.

Visuals generated by the program have exceeded user expectations. Previously, graphs created using the LabVIEW programs contained lots of extraneous metadata and could not be used in publications due to their low resolution. With the new Python data manipulation program, high resolution figures and graphs are automatically generated with properly scaled axes and units, meticulous formatting, and pertinent statistics alongside the graph.

All of the aforementioned content is automatically condensed and formatted into a printable Word document that can be distributed to customers rapidly. While these reports focus on only the most critical accelerator data channels, they are also customizable, and the program allows the user to add other graphs and charts to the final report. A preexisting LabVIEW GUI will be reconfigured for use with the Python backend; the integration of the two programs is pending, as the development of the backend is ongoing.

Conclusions

The new data analysis and manipulation program represents a significant improvement in the data acquisition operation since the implementation of the LabVIEW program. The program is modular, well-documented, and transparent. We aim to simultaneously accommodate senior scientists seeking a higher understanding of the underlying processes and algorithms and technicians working to deliver high quality results to customers as quickly as possible. Future work will expand data processing capabilities and use LabVIEW to simplify user interaction.

References

S. K. Coffey, A. Circle, *et. al.*, “Hardware and Software upgrades for the Saturn Data Acquisition Triggers and Time base”, Proceedings of the 20th IEEE International Pulsed Power Conference, Vol. 1, 2015, pp. 775-784.

U.S. DEPARTMENT OF ENERGY
National Nuclear Security Administration

Sandia National Laboratories is a multimission laboratory managed and operated by National Technology and Engineering Solutions of Sandia, LLC., a wholly owned subsidiary of Honeywell International, Inc., for the U.S. Department of Energy’s National Nuclear Security Administration under contract DE-NA-0003525. SAND #