4-19-2024

Implementation of Python Based High Voltage Tests for GEM Detectors

John Paul Hernandez
Florida Institute of Technology

Implementation of Python Based High Voltage Tests for GEM Detectors

John Hernandez

Faculty Advisor: Dr. Marcus Hohlmann, Dept. of APSS, Florida Institute of Technology

Graduate Student Advisor: Erick Yanes, Dept. of APSS, Florida Institute of Technology

INTRODUCTION & BACKGROUND

- The Compact Muon Solenoid, CMS, and other detectors at LHC are in the process of being upgraded for the HL-LHC (High-Luminosity Large Hadron Collider) which will produce more than 5 times the particle interactions than of the current LHC
- One upgrade to CMS is the introduction of new GEM detectors (Gaseous Electron Multiplier), GE2/1 and ME0 shown at right are new detectors to CMS and therefore must be tested thoroughly prior to being installed.

PROBLEM STATEMENT

- Each of the new detectors must undergo a series of 8 quality control tests prior to installation
- Quality Control 6 or QC6 tests for High Voltage stability uses LabView scripts to run its subtests
- LabView is a Windows only program & some QC6 scripts currently have bugs; would it be possible to replace those LabView scripts using Python?

METHODOLOGY

- Python scripts were written from scratch to perform the necessary QC6 subtests
- 4 Python Scripts + 1 TOML configuration file to run 3 subtests
- CAEN SY5527 HV Power Supply
- Pycaenhv Wrappers

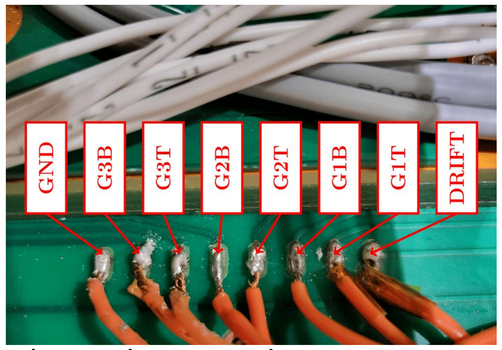

Figure 1: Shows the HV Pads on M8 corresponding to the Channels above

QC6-OVERVIEW

- Meant to clean each foil of any potential imperfections
- Ensures the foil can not only handle HV but also remain stable at HV for long periods of time; hours & sometimes even days

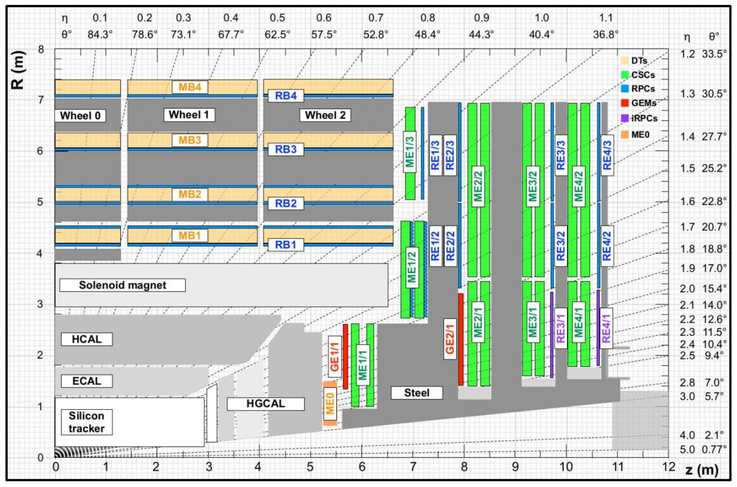

Figure 2: GE1/1 installed currently, while ME0 and GE2/1 will be new additions to the HL-LHC (1)

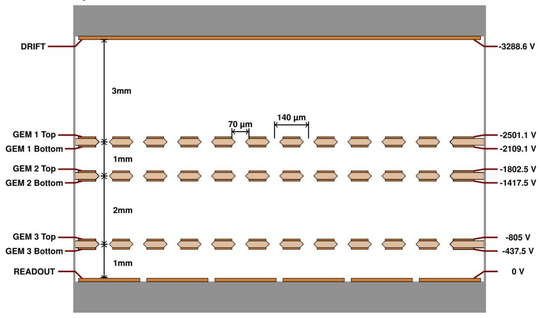

Figure 3: Depicts a GEM cross-section & shows where each 'Channel' is

STRESS TEST

- Increases voltage across each of 3 foils, one at a time until there are 5 discharges or until the final voltage of 650V is held for 60 seconds on each foil

Figure 4: HV Monitoring through Grafana program during Stress test

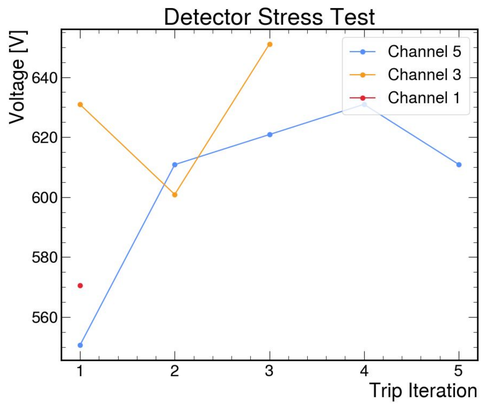

Figure 5: Plot of Stress Test

IV SCAN

- Raises voltage incrementally to 4600V split across all 7 channels
- Records current and voltage every 200V up to 4600V

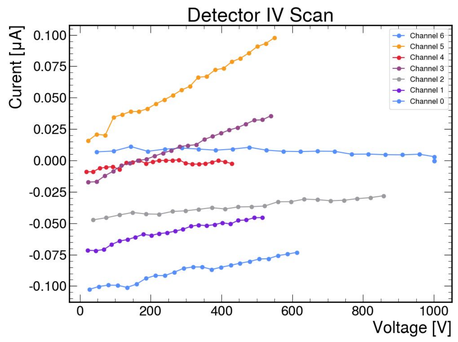

Figure 6: A plot of the IV Scan must be linear to pass

SHORT STABILITY TEST

- Combined test with IV Scan
- Holds 4600V across the chamber for a period of 2 hours
- Allowed 3 trips prior to test failure

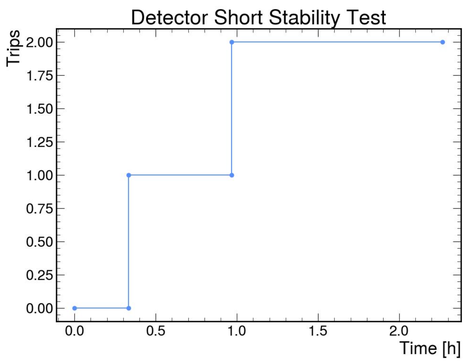

Figure 7: Short Stabilty Test Plot

LONG STABILITY TEST

- Similar to Short Stability Test, ramps up the same way
- 3 top foils held at 580V for a period of 15 hours
- Must have less than 1 discharge per hour

SIGNIFICANCE & FUTURE WORK

- Writing QC6 tests in Python provides a streamlined approach to QC testing as plots are made with Python anyway
- These Python based QC6 tests could also be applied detectors other than GEMs

REFERENCES

1) The Phase-2 Upgrade of the CMS Muon Detectors. Technical report, CERN, Geneva, 2017. URL https://cds.cern.ch/record/2283189. This is the final version, approved by the LHCC.