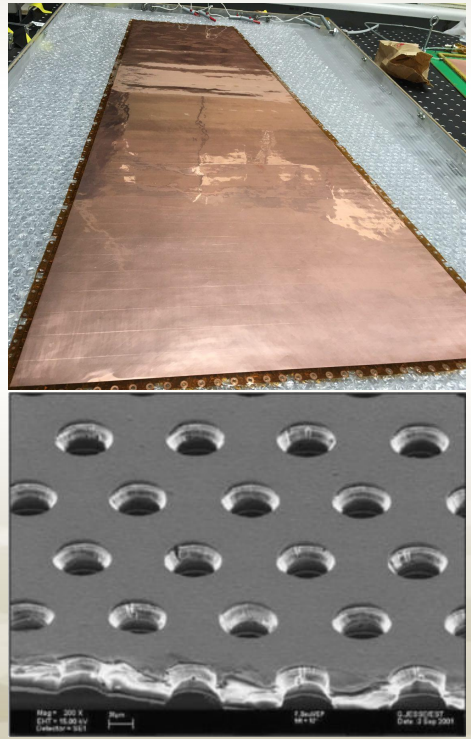
Assembly and Quality Control Testing of Mass Produced GEM Detectors for CMS Upgrade

Sarah Arends

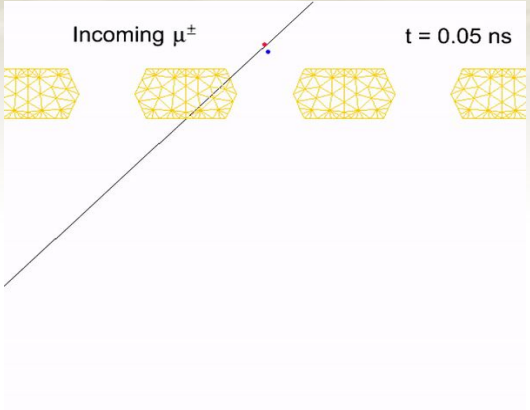
The GEM Detector

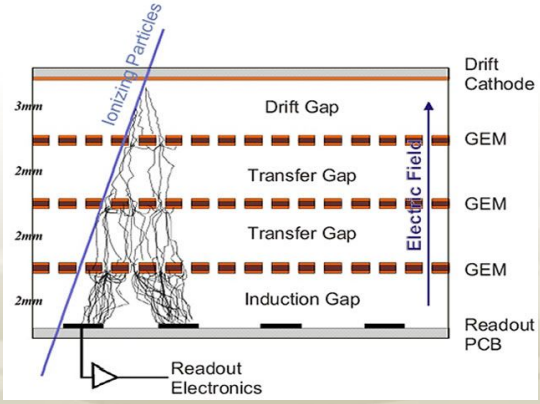
- Gaseous ionization detector
- Triple stack of GEM foils inserted between drift and charge collection electrode, readout electronics
- Kapton foil coated in copper on both sides
- Microscope holes with 140μm pitch



The Electron Avalanche

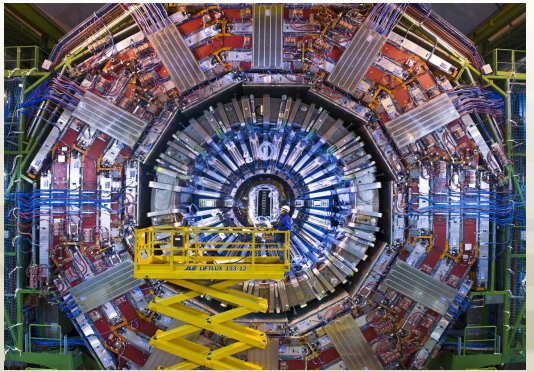
- Muon ionizes gas molecule to produce initial electron-ion pair
- Signal amplified in foils, determined by applied voltage
  - Electrons energized by strong field in foil holes
  - Cause more ionizing collisions with gas molecules





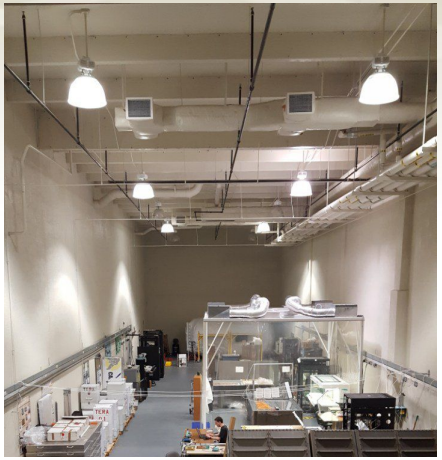
Why GEMs?

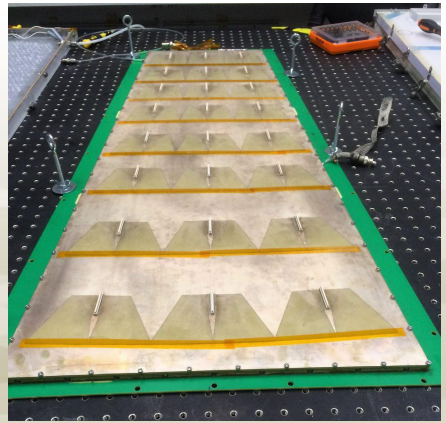
- Phase II upgrade of CMS
- Improve redundancy of tracking, higher momentum resolution
- 160 1-meter long GEM detectors
  - CERN and 5 external sites



Assembly

- Process completed in class 1000 cleanroom at Florida Tech
  - Prevent damage to foils
- Preparing drift and readout
- Assembling the stack
  - Consists of GEM foils and spacing frames
- Insert stack into drift, stretch foils
- Close with readout



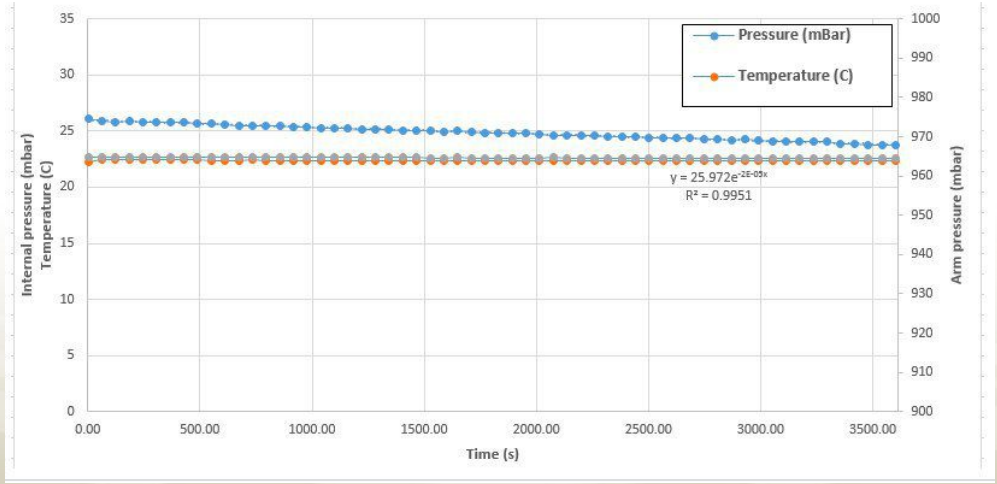


Quality Control Testing

- QC tests ensure optimal performance for several different criteria
- During assembly
  - Resistance measured across foils (~GOhm)
- After assembly
  - High voltage test
  - Gas pressure test
  - Gain uniformity

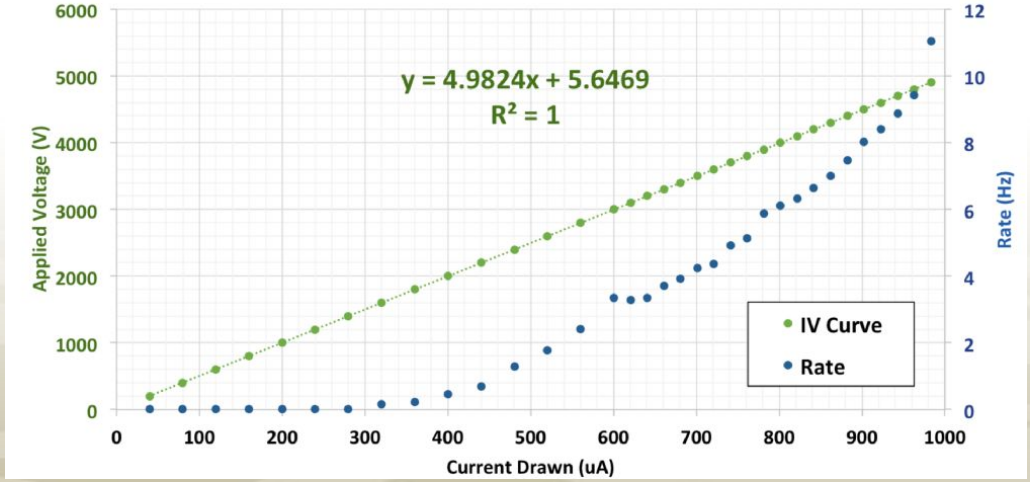
Pressure Test

- Chamber must be mostly gas tight to prevent Ar/CO2 exiting, other gases entering
- After flushing with gas, pressurized chamber to 25 mbar using CO2 gas
  - Leakage below 1 mbar/hour is accepted



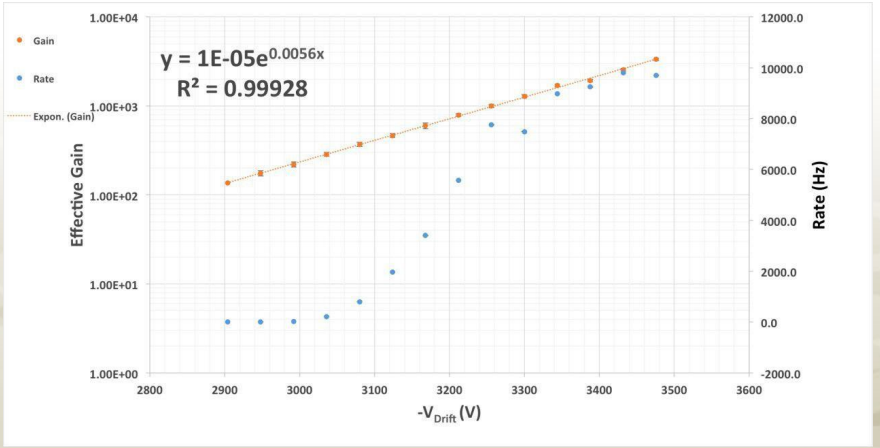
High Voltage Test

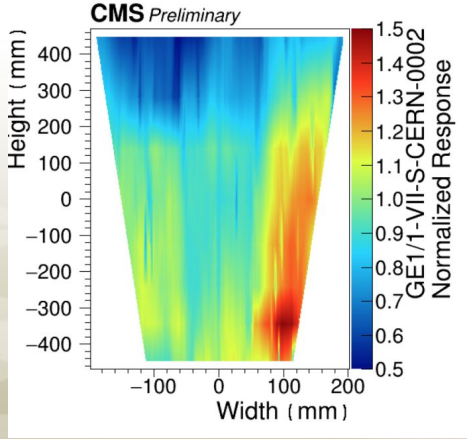
- Produce IV plot of GEM detector
  - Voltage applied in steps, current and rate recorded
- Identify spurious signals, potential faults in HV circuit
- Detector is flushed under CO2 gas
  - CO2 won't ionize, expect no signals



Gain Response and Uniformity

- Gain and incident rate of detector measured to confirm functionality at high rates
- Response uniformity across detector for set gain





The Final Product

- Batches of detector components arrive from CERN in kits
  - Assembly and quality control testing
  - Vertical storage under gas flow until completion
- Completed kits will be returned to CERN
  - Installation scheduled for 2019

Questions?