Aging Analysis of Micromegas Detectors for ATLAS New Small Wheel

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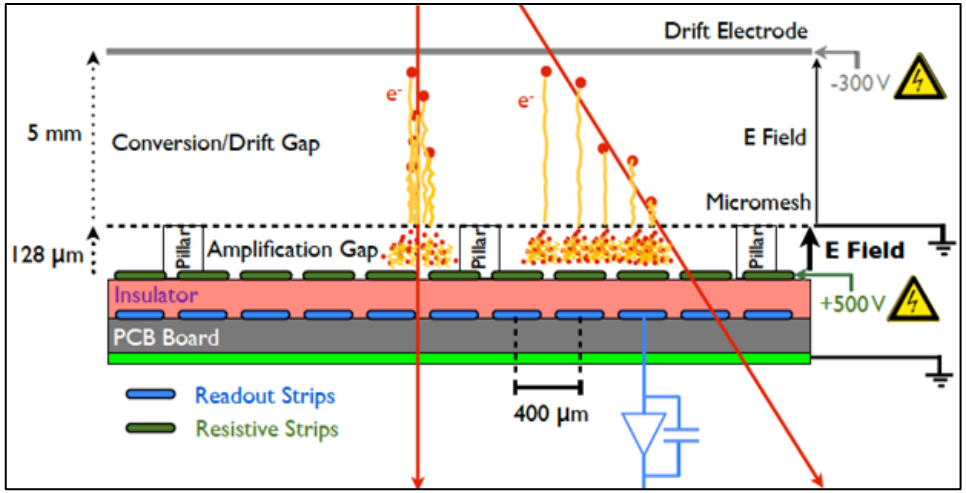
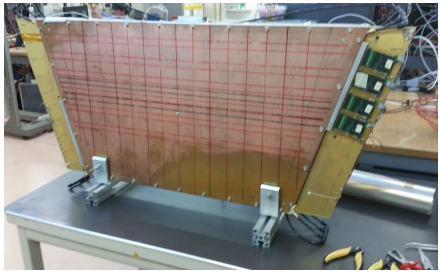
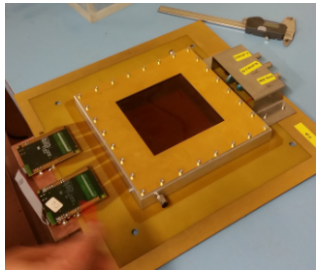
Overview

1. Introduction to Micromegas
2. Overview of experimental setup and aging tests
3. Characterization of aging in GIF++
4. Future studies

Micromegas Detectors



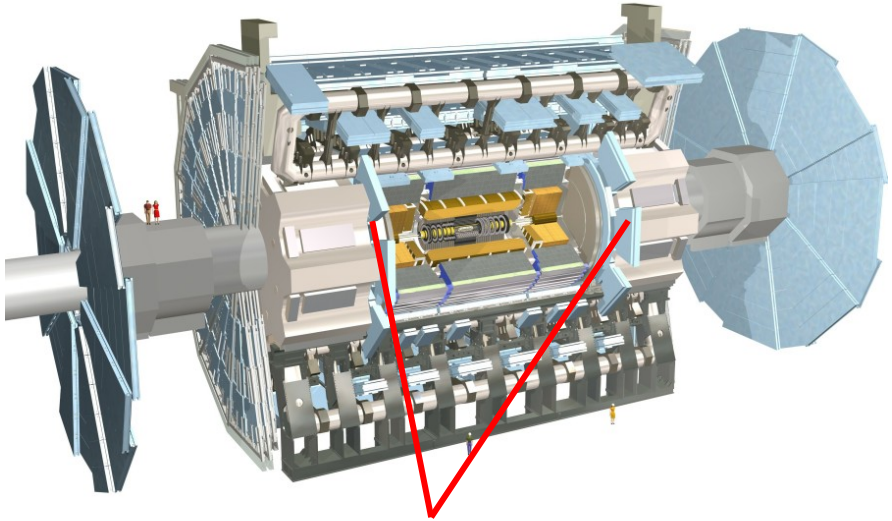




Operating Principle:

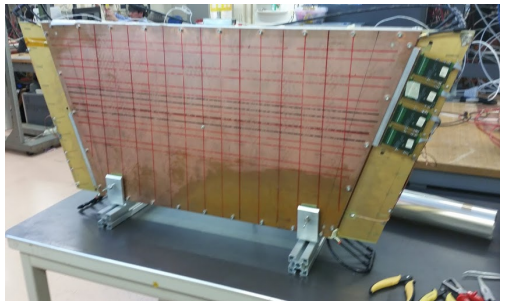
1. Charged particles traversing the drift gap ionize the gas and release electron-ion pairs
2. Ionization electrons drift towards the amplification gap while ions drift towards the drift electrode
3. These electrons drift through the mesh and are multiplied in the amplification gap in an avalanche process before being released on the resistive strips
4. Ions produced in the amplification region are quickly evacuated by the mesh

HL-LHC ATLAS New Small Wheel Upgrade



New Small Wheels will replace Small Wheels in HL-LHC upgrade to ATLAS

- ATLAS phase-I upgrade for better trigger performance (2018)
- MM will be part of New Small Wheel (NSW) upgrade to muon spectrometer as part of this 2018 upgrade
- preparation for High Luminosity Large Hadron Collider (HL-LHC) upgrade (2022)

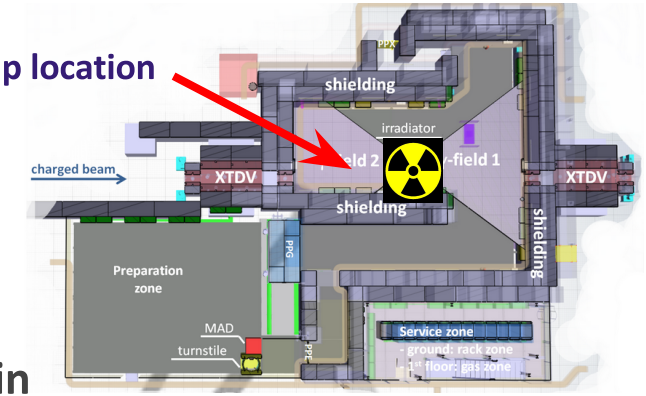


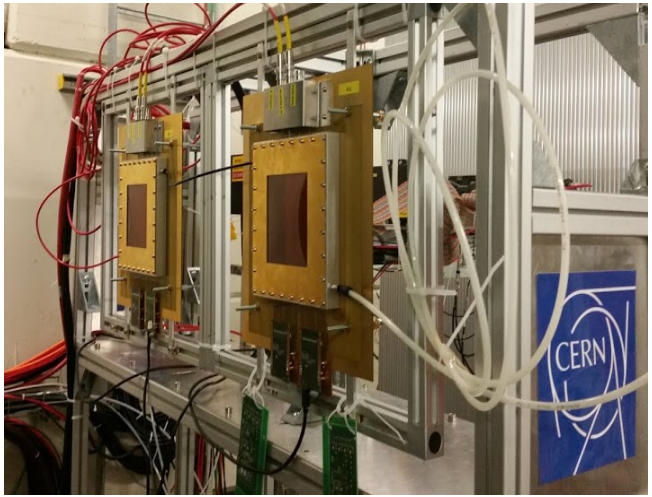
The current MMSW (Micromegas Small Wheel) prototype

Aging Tests at Gamma Irradiation Facility (GIF++)

Goal: Predict how the MM detector will behave after several years in HL-LHC (ATLAS New Small Wheel Upgrade)

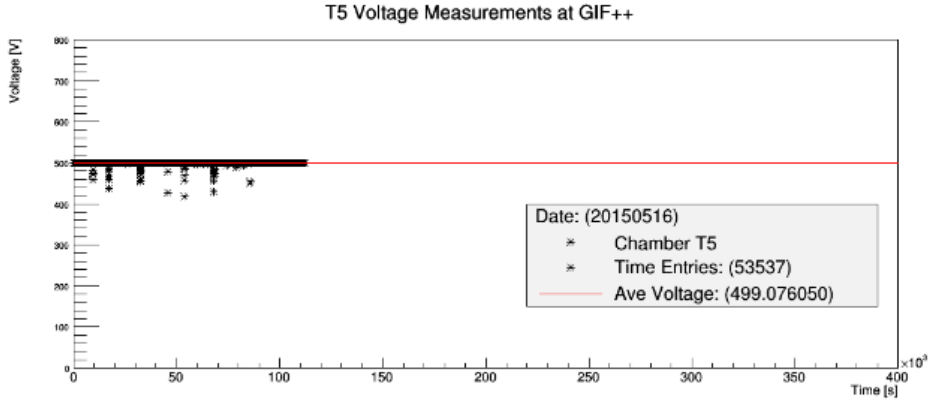
→ Radiation aging tests

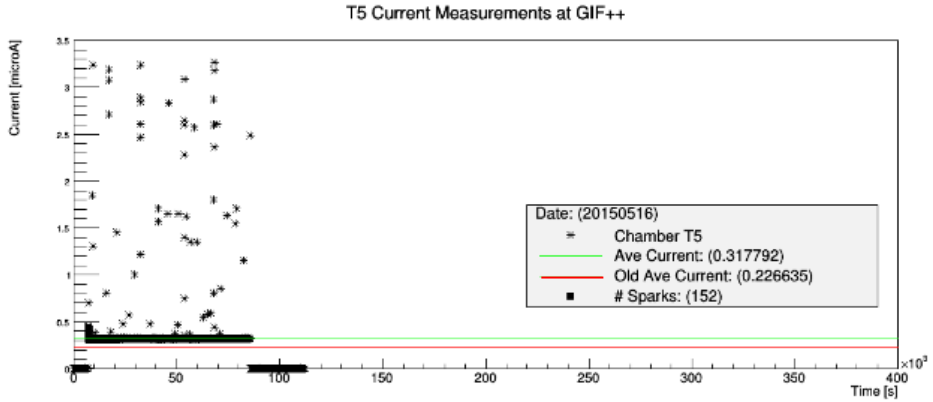




- GIF++ Facility in Prévessin
- Monitoring of current behavior during exposure to source (16.65 TBq Cs 137)
- Study of detection rate using data acquired from front end electronics with & without source
- Comparison of gain, efficiencies and noise rate prior to and after irradiation
- General performance study

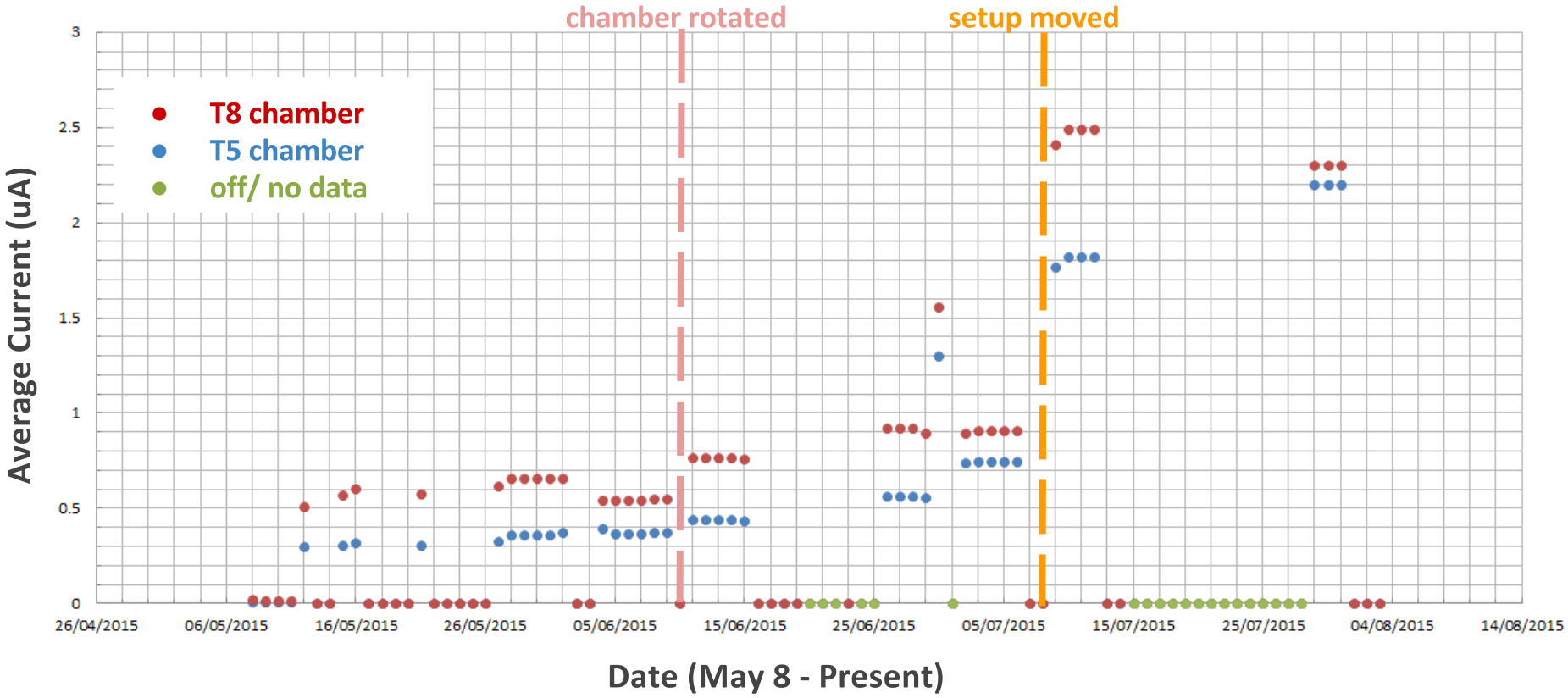
Current and Voltage Stability





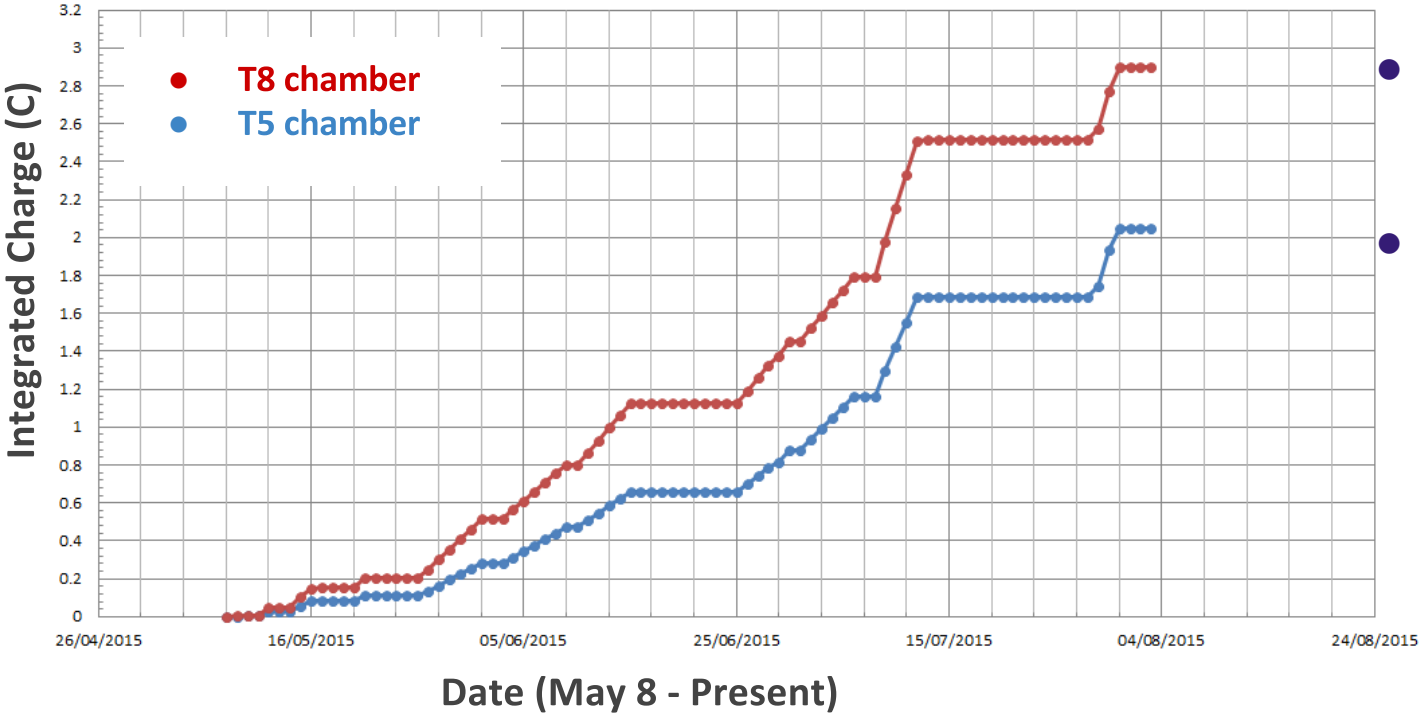
- **Monitor chamber behavior,** including **current and voltage** for daily record
- **Investigate features** (sparking, increasing current, etc)
- Determine **average current** & **integrated charge** → aging

Average Current Record



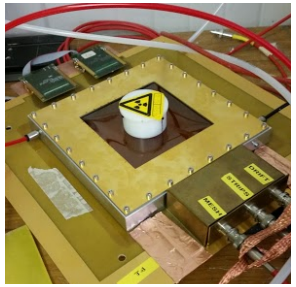
Integrated Charge

Integrated Charge = ∑ (Current*Time)

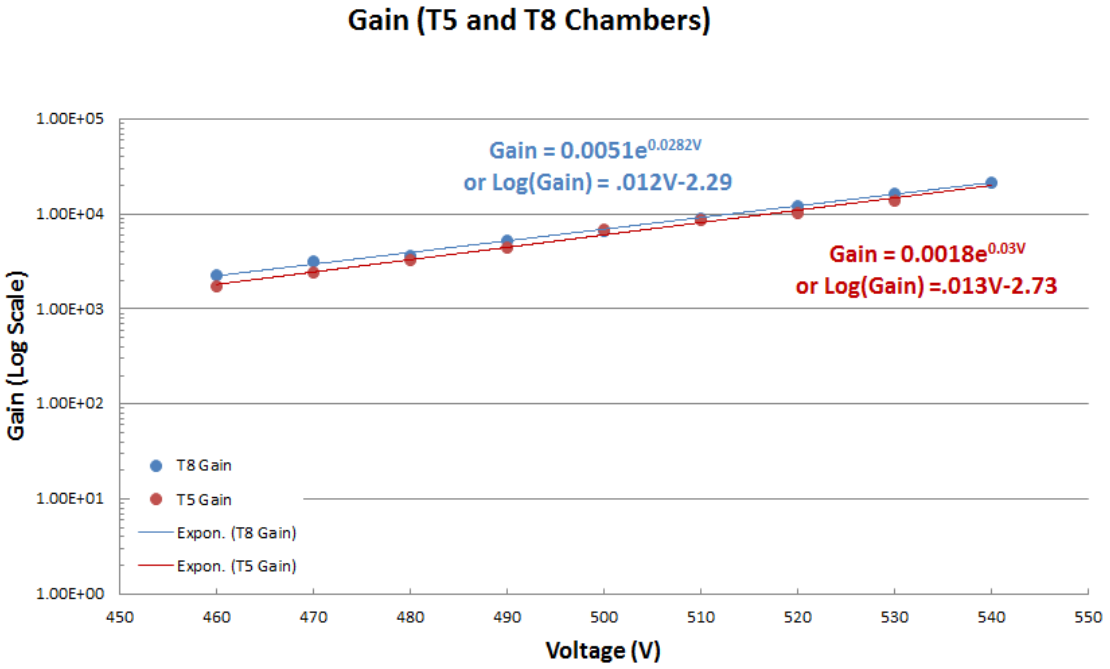


- **Aging test:** total charge over time in GIF++
- Goal: simulate **10 years of HL-LHC**
  - 100C of GIF++ on small T chamber

T-Chamber Gain Analysis



- Measurement using Fe55 source in lab
- Max rate of about 13000 Hz
- Resistive detector: higher detector current → lower gain in amplification gap
- Compare to Gain measured in GIF++
- Look for evidence of aging effect

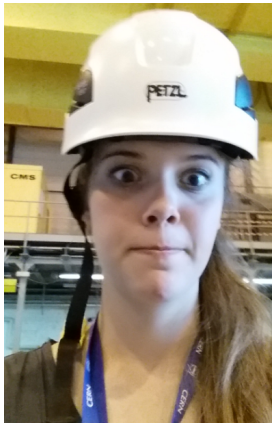


$$G = I / (e*R*220)$$

Gain = total current / (e^- charge*incoming rate*primary e^-s per photon)

What's Next?

- Continued record & monitoring of chamber behavior with further aging
- Correlations with other variables in GIF++ bunker (temperature, pressure…)
- GIF++ rate/gain determination
- Testing on larger MMSW prototype
- Preparation for HL-LHC & NSW upgrade



Thank You!!