Status of the Medium-Sized SRS Readout Electronics for Muon Tomography using GEMs

Kondo GNANVO
Florida Institute of Technology, Melbourne, FL

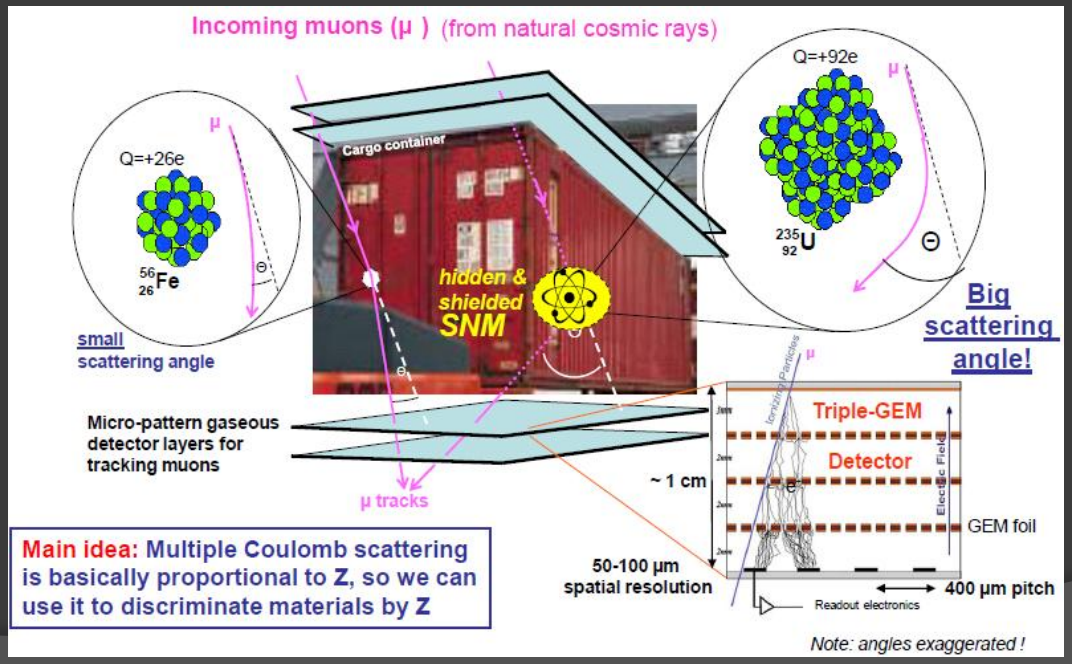
OUTLINE

- Cosmic Ray Muon Tomography (MT) using GEMs
- MT station prototype with the medium-size SRS Electronics
- DATE with UDP for the data acquisition
- AMORE for monitoring and data analysis
- Preliminary results of Cosmic ray Muons Data with GEM/SRS
- Conclusion & Perspectives

Cosmic Ray Muon Tomography (MT) using GEMs

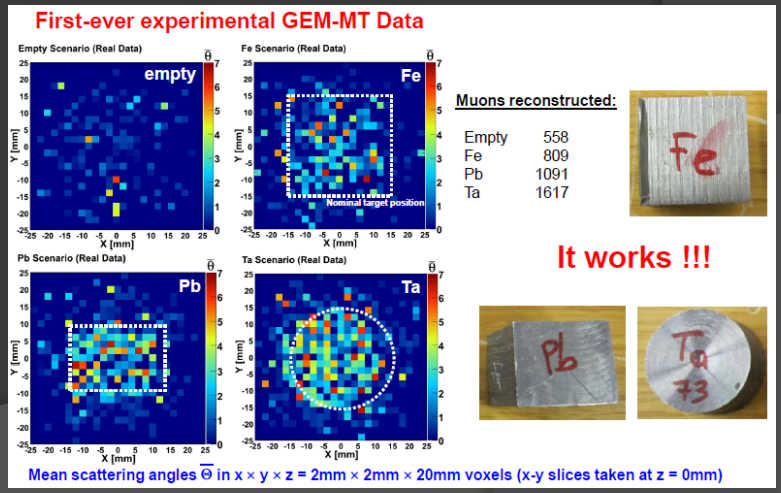
Application

- To detect high-Z material smuggled
- Measurement of the deflection of cosmic muon by the material through Multiple Coulomb scattering
- Need large area detectors with excellent position to track the cosmic muons => GEMs



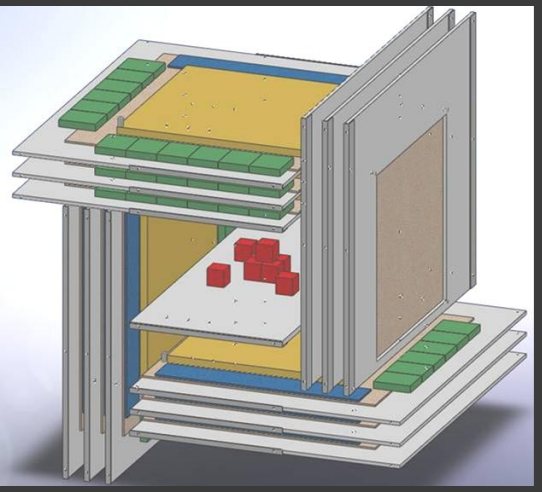
Proof of the concept with minimal MT station prototype (2009)

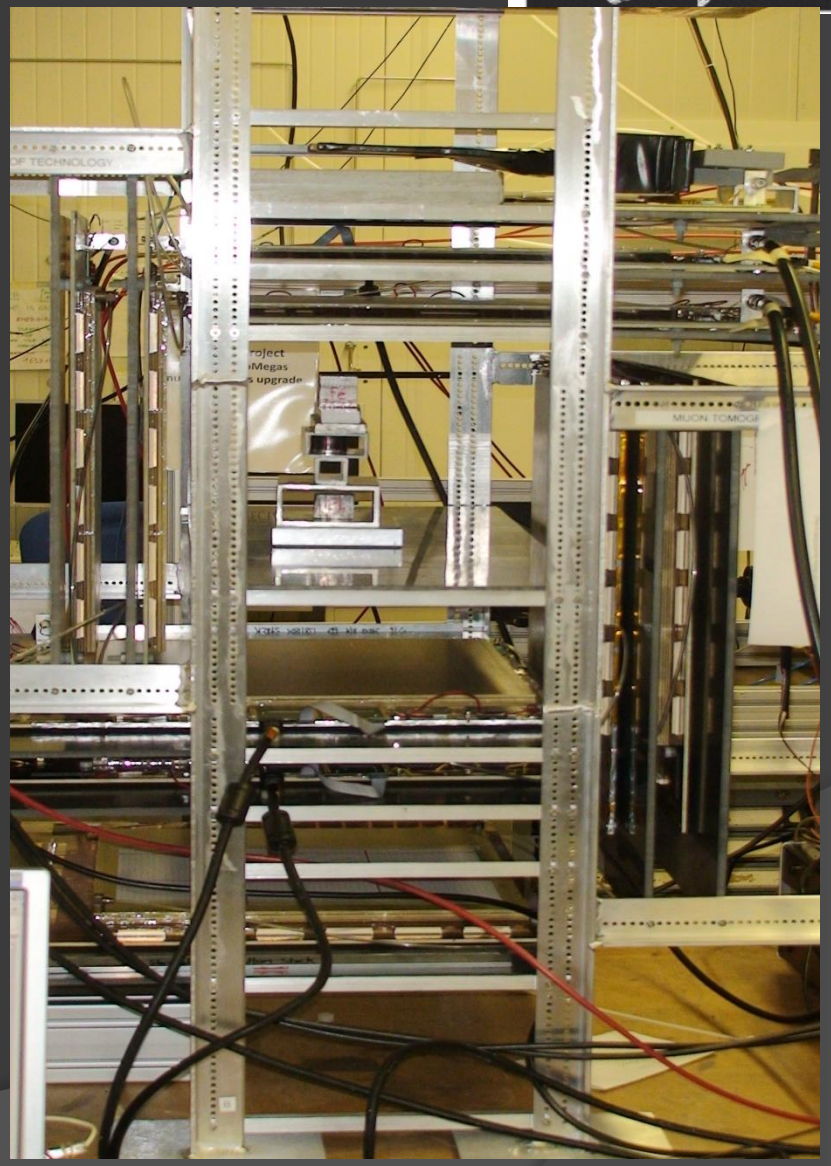
K. Gnanvo & *al* .*"Imaging of high-Z material with a minimal prototype of a Muon Tomography station based on GEM detectors for nuclear contraband detection.*", Nucl. Instr. and Meth. A (2011), doi:10.1016/j.nima.2011.01.163



MT Station with the Medium-Sized SRS Electronics

- Full Cubic foot size MT Station
  - 30 x 30 cm^2 GEM detectors
  - 10 chambers: top, bottom & side station
  - SRS + APV chips: read out ~16K channels
  - Scintillator / PMT for external trigger
  - DATE + AMORE for daq & analysis

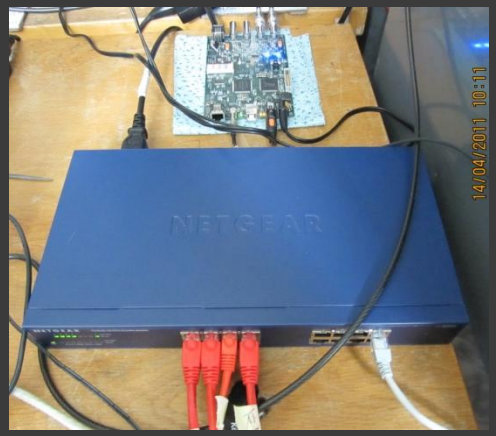




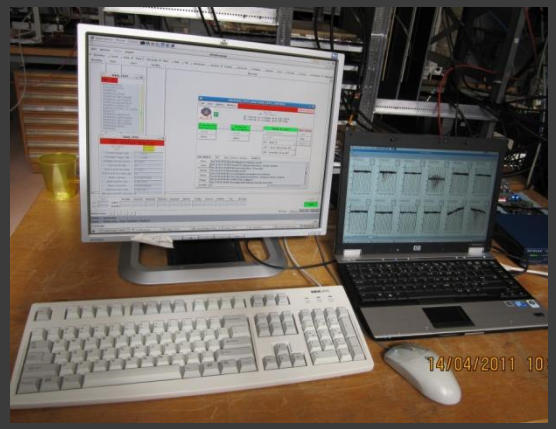
Medium-size SRS Electronics for Muon Tomography

Trigger PMT

GEM test setup



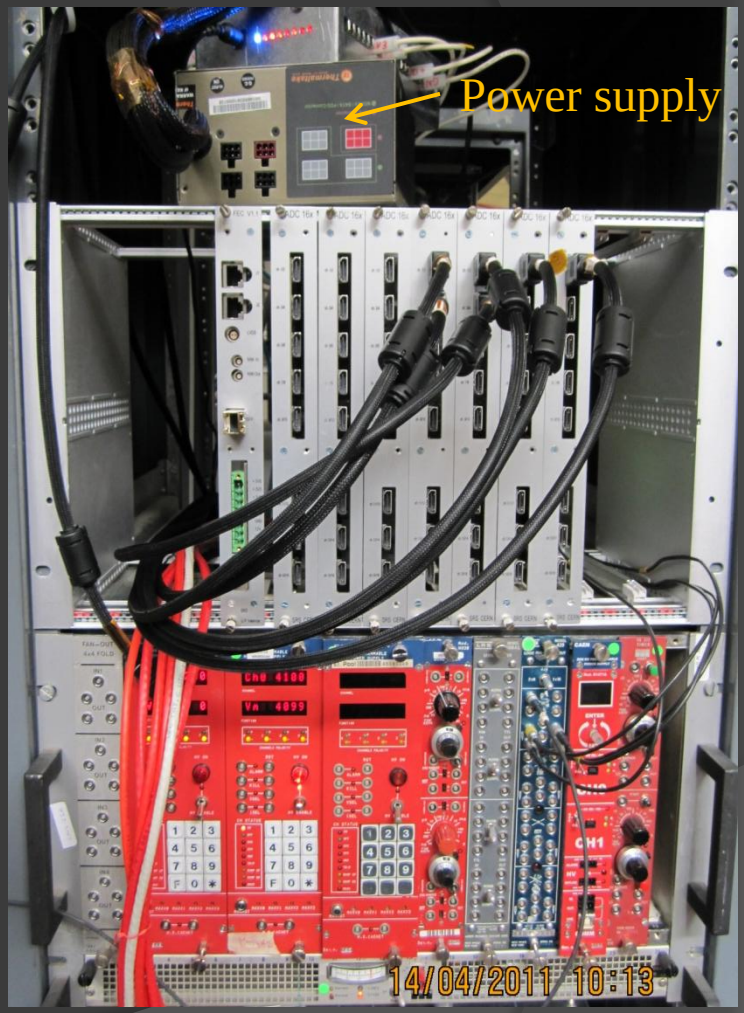
Network switch



DATE and AMORE PC

Back side of SRS
FEC interface

Power supply



Front side of SRS: C-Cards interface
HV supply for the GEMs

DATE Framework with UDP equipment for the SRS Data Acquisition

(Filippo Costa, ALICE DAQ)

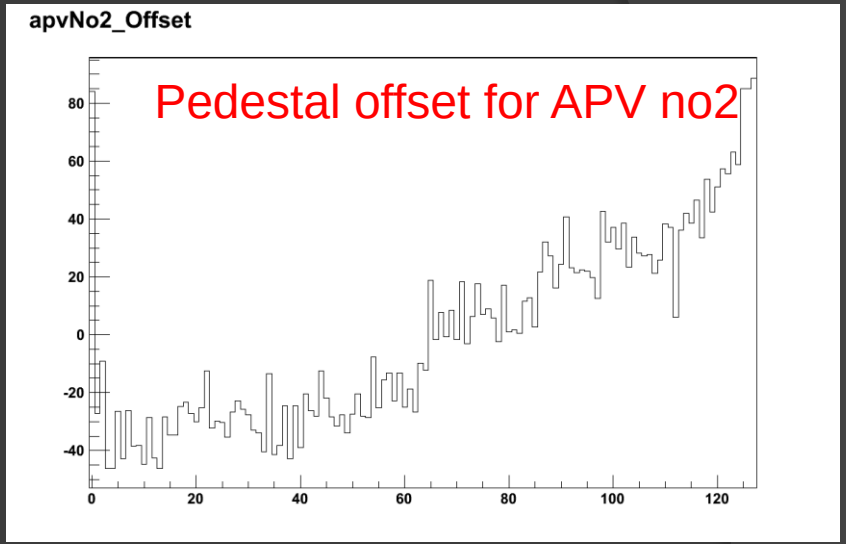
- DATE: ALICE DAQ software
  - Data Acquisition & Test Environment on Linux SLC5
  - Many features available , user friendly GUI for run control environment, basic online monitoring of the raw data, electronic logbook.
- Data transfer to the DATE PC through Gigabit Ethernet via UDP:
  - One Ethernet port on the FE card connected to another port on the DATE PC via a copper cable or optical fiber cable data, (1Gb/s to 10 Gb/s throughput)
  - Network switch to handles as many as the 8 UDP ports for MT application
    - 4 tested so far successfully
    - Some configuration issues with the Ethernet switch to be addressed for data transfer with more than 5 cards
- "Slow Control" for the system configuration
  - C script for Initialization of the FEC, ADC boards, APV hybrids and the network configuration …
  - DATE execute the C-code at Start of Run to configure the system

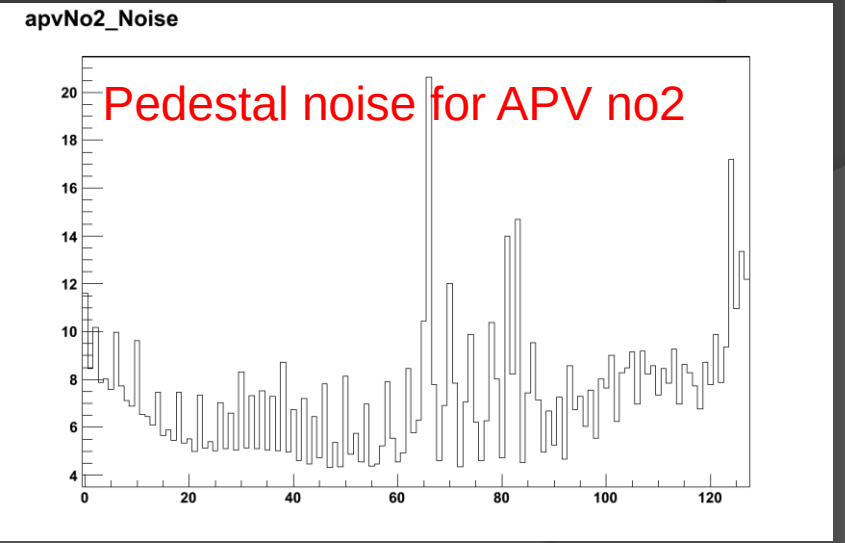
AMORE for monitoring and data analysis

- AMORE is ALICE Data Quality Monitoring Software framework
- Automatic MonitoRing Environment founded on ROOT & DATE Monitoring Library
- Communication between publisher and clients through DIM a publish/subscribe system developed at CERN
- Flexibility to do offline data analysis (pedestal subtraction, zero suppression …)
- Simple POCA reconstruction algorithm will be integrated for real time imaging of the Muon Tomography scenario

Preliminary results: Pedestal run

- Baseline correction, pedestal subtraction, zero suppression
  - First step: computation of raw pedestal data
    - Pedestal offset needed to correctly calculate the baseline correction data
  - Second step: common mode offset calculated for each time frame for each event
    - Accurate common mode offset requires the raw pedestal offset data as input
  - Third step: Computation of fine pedestal data
    - Meeds the common mode offset data of step#2
    - correction, pedestal offset subtraction
  - Pedestal data are stored in root files and uploaded by AMORE before the start of run

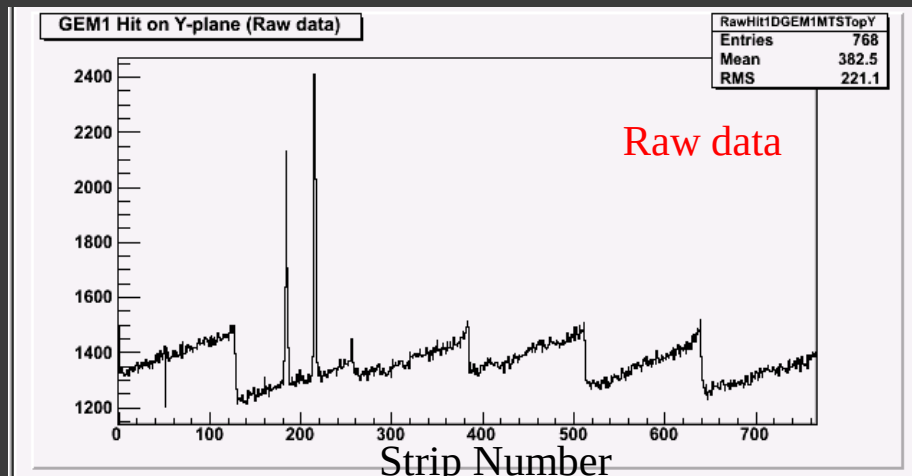


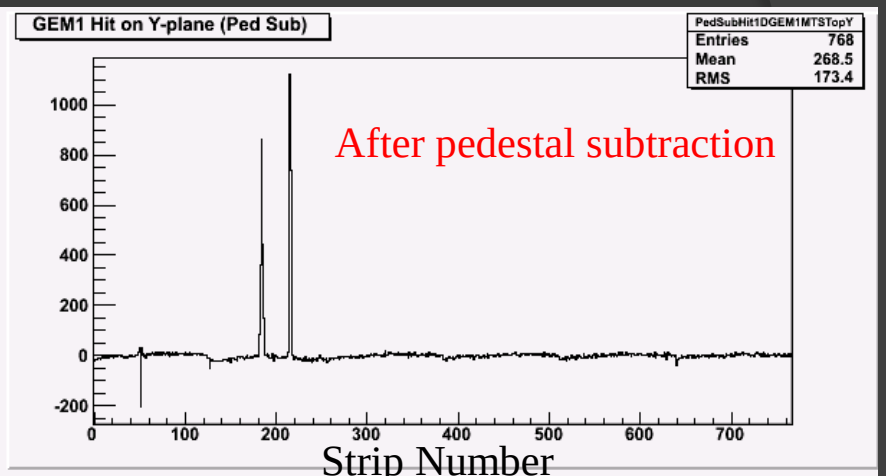


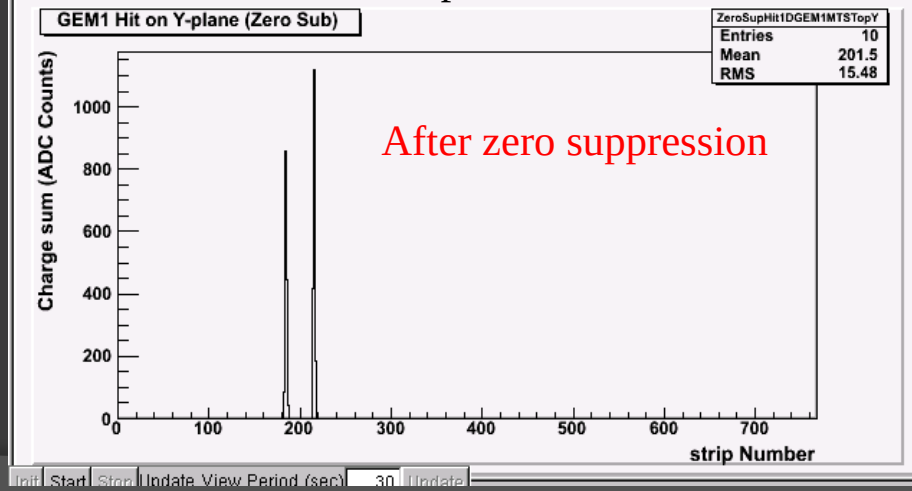
Preliminary results: Zero suppression

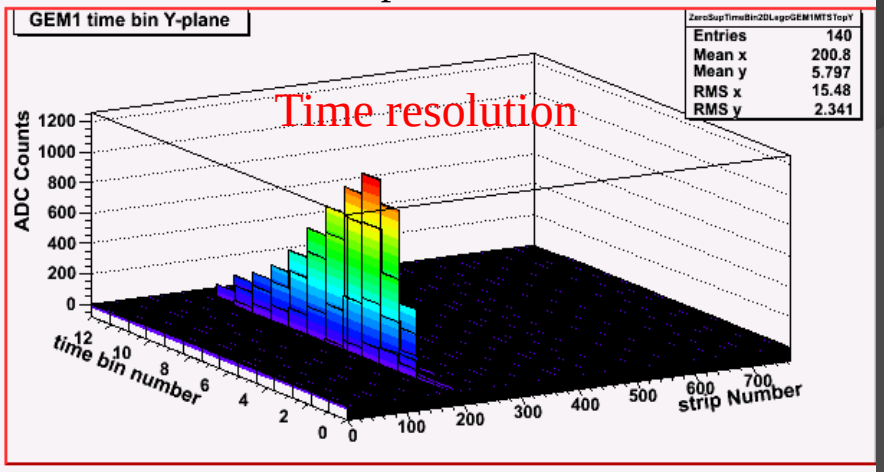
The zero suppression is performed at 3 sigma of the pedestal noise for each channel

- Accurate zero suppression required common mode correction for each time frame for each event



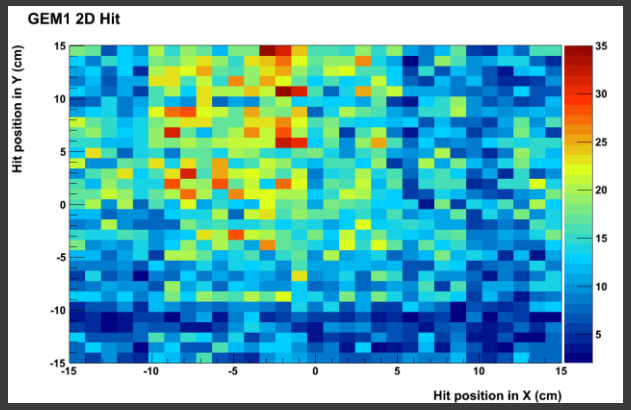




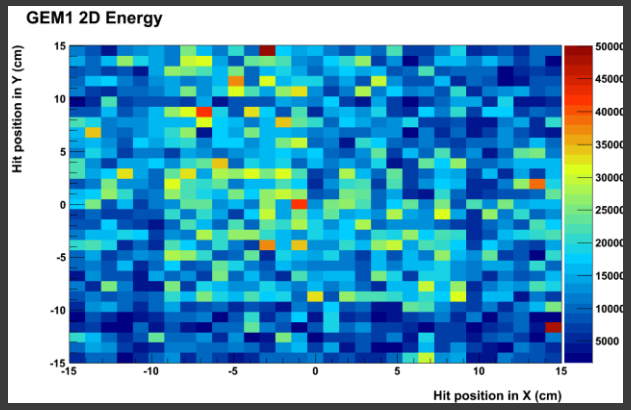


Preliminary results: Test of GEM1

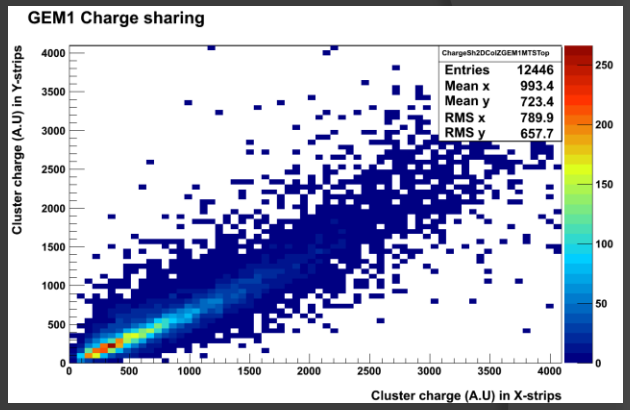
2D hit distribution



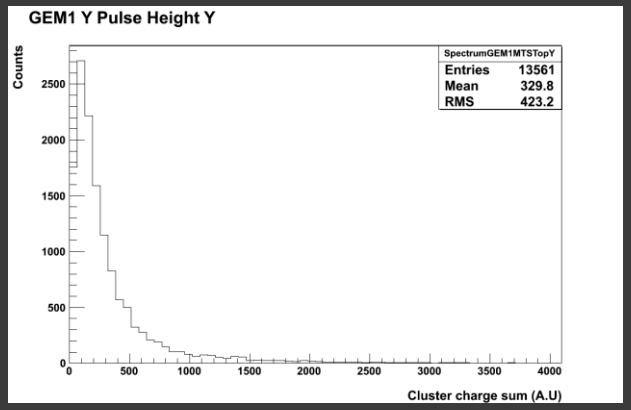
2D charge distribution



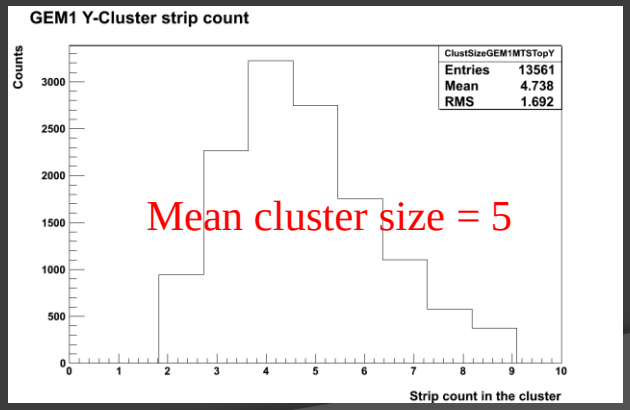
X/Y charge sharing



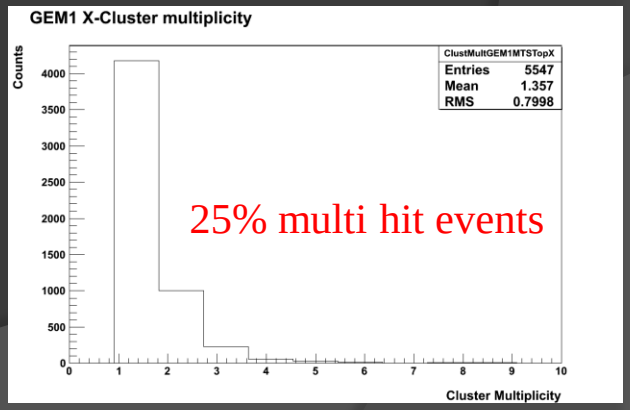
MIP spectrum



Cluster size distribution

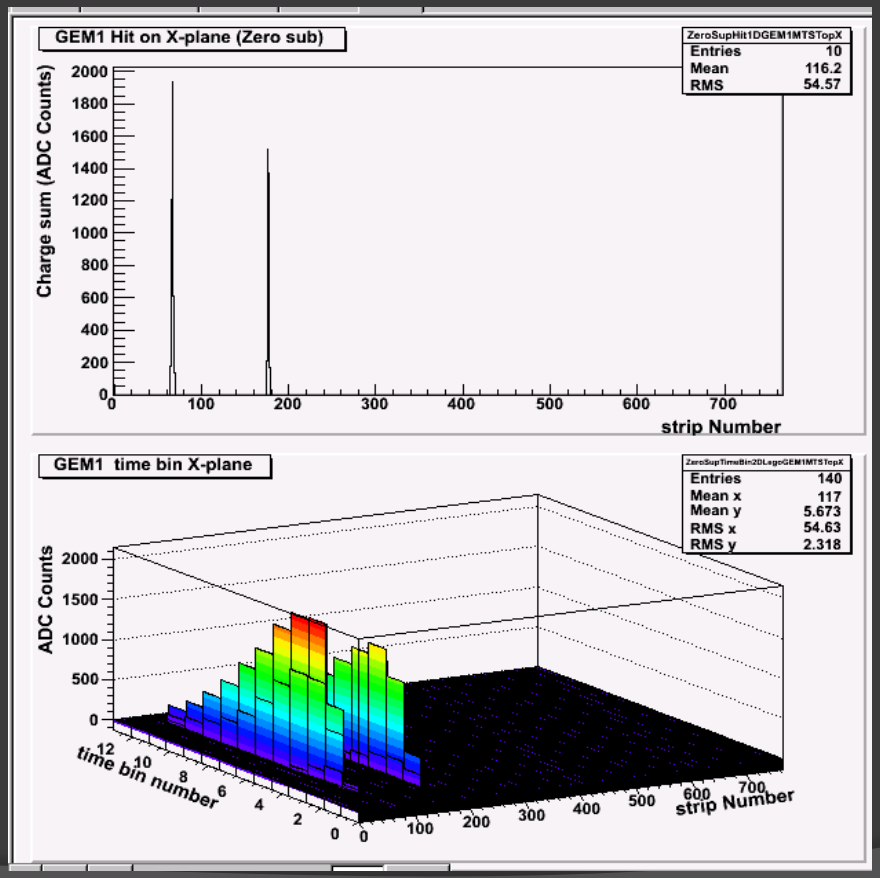


Cluster multiplicity

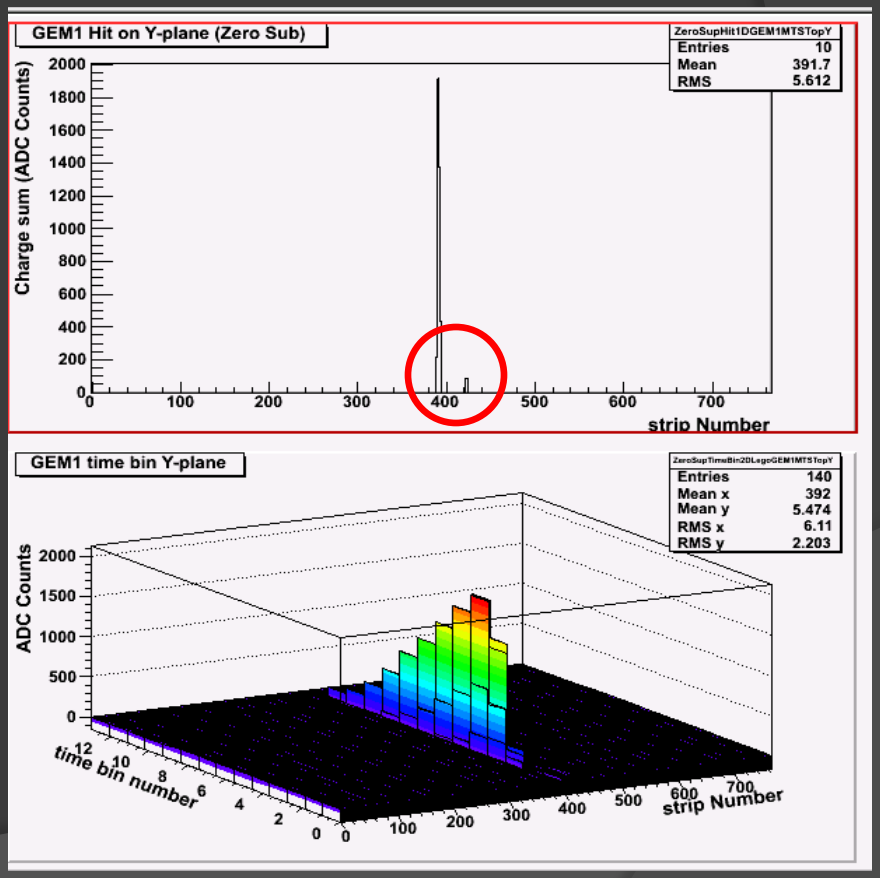


Preliminary results: APV channel crosstalk

Double muon hits

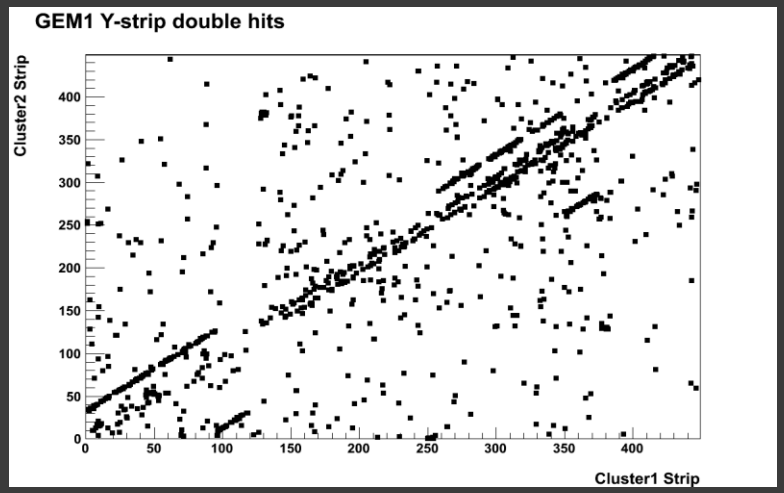


APV channel crosstalk

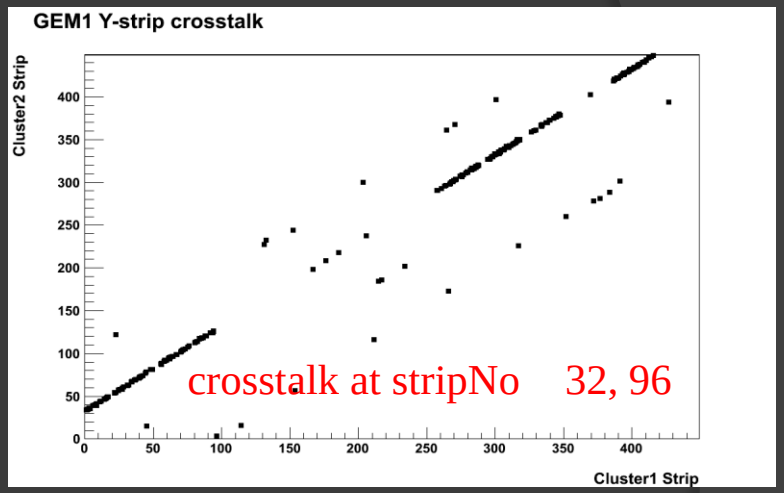


Preliminary results: APV channels cross talk

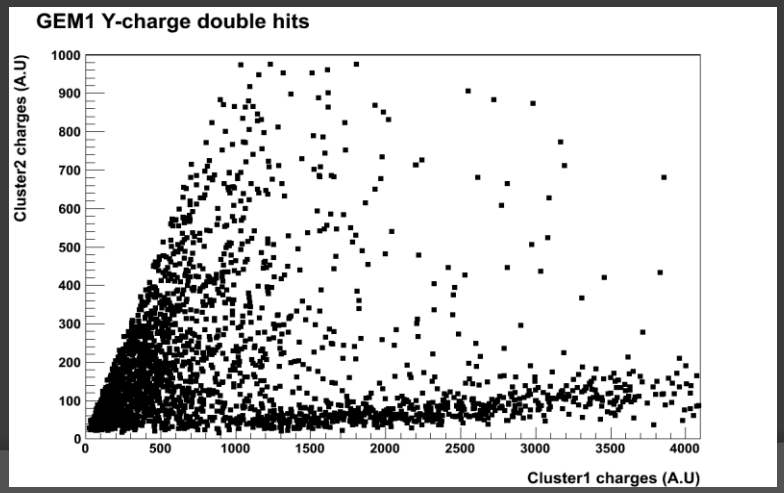
Double hits position correlation



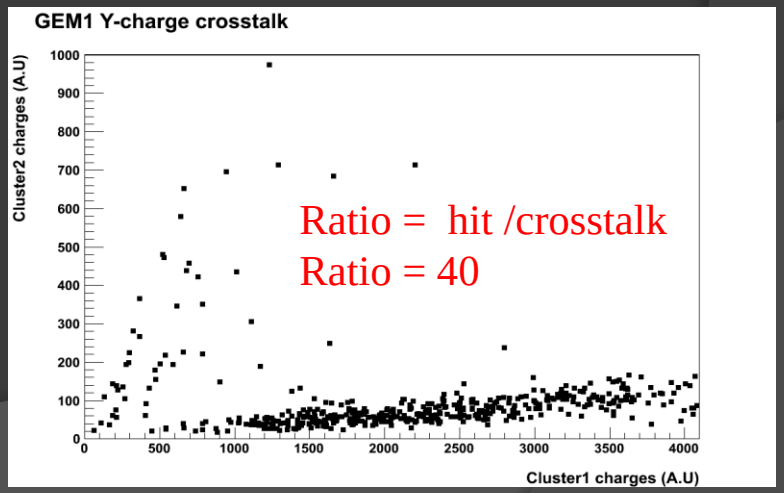
crosstalk position correlation



Double hits charge correlation



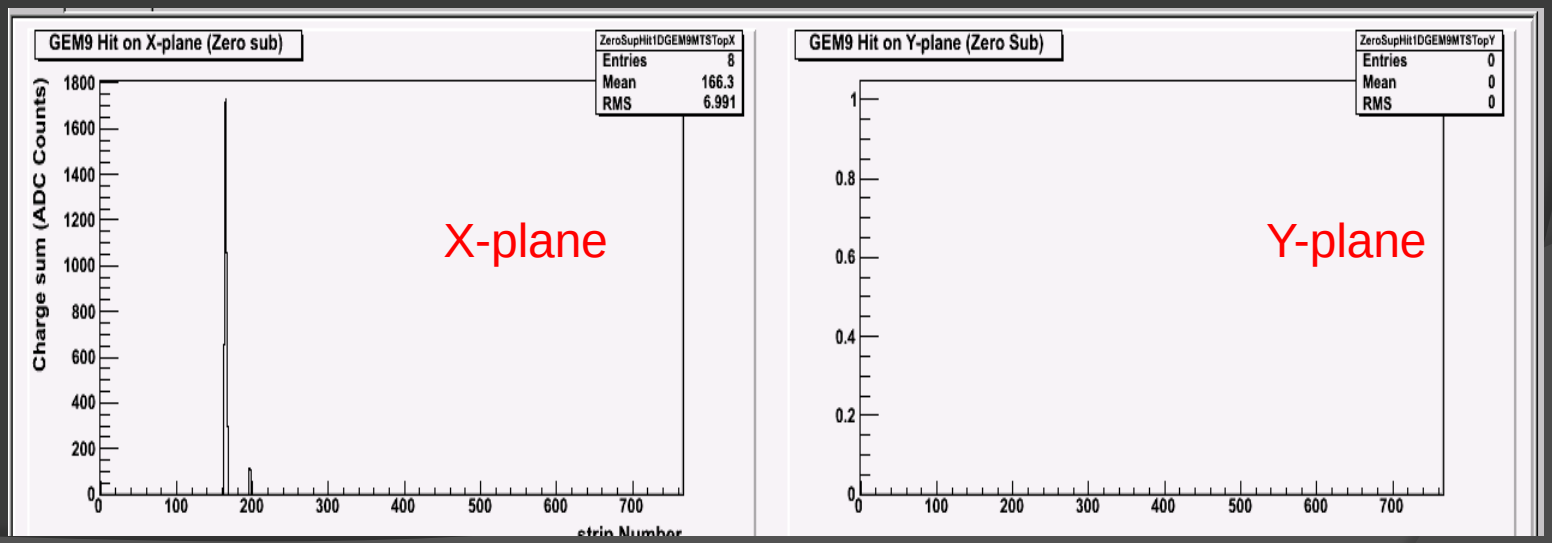
crosstalk charge correlation



Preliminary results: Missing Hits

- 50% of the events record hit on only one axis of the detector
  - Happens equally on X or Y plane and also equally for all 12 hybrids.
  - Not a hit lost during zero suppression
  - Not software related
    - No packet lost during data transfer to DATE or bug in AMORE analysis code

- We suspect a problem external trigger input signal to the 4 FEC boards
  - Maybe trigger signal jitter in the NIM fan out module or inside the FEC board
  - Data lost due to the delay causes by the jitter
  - We are investigating the issue.



Conclusion & Perspective

- Where we are now
  - We have successfully tested the medium size SRS electronic system with a commercial network switch supporting 9KB jumbo frames
  - We took up to 600 Gb data with the 4 FEC/ADC cards and 16 APVs
  - DATE and AMORE used with the UDP equipment implemented by ALICE DAQ team
  - A very advanced data analysis tool based on AMORE is tested and available for SRS users
  - We still have some few issues to address
    - i.e. the data transfer via e network switch with more than 4 FEC/C-card
    - Some tuning of the trigger delay in each card to avoid the missing hits
- Where we want to be in the next few weeks
  - The production APV25 hybrids is on going at Hybrid SA company and a first batch is going to be tested on site on Monday 04/18
  - We will hopefully get 300 hybrids by early May (160 for MTS Florida Tech)
  - We plan to equip our 10 detector with this system to mount a cubic foot size MTS for the next round of cosmic ray muons data taking