Results of ME234/2-001 CSC Anode Front End Data Analysis

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($www-hep.phys.cmu.edu/cms/COSMIC/00/test\_run.html$)

- **What was measured**
- **Calibration with ALCT**
- **Noise rate**
- **Efficiency, Timing**

What was measured

- **Use of test pulse from ALCT**
  - threshold and noise calibration
  - delay calibration
  - parallel readout (TDC + ALCT)

- **Noise rate**
  - trigger from pulser
  - 32 μs TDC window

- **Cosmic Muon Trigger data**
  - efficiency vs HV scan at Qthr=20 and 40 fC
  - BX efficiency at HV = 3.6 - 3.9 kV
  - data with Cs137 (rate of 18 kHz/wire group)
  - crosstalks

Calibration

- Two ways for the test pulse:
  - ALCT to CMP16 chip on AFEB
    (Qthr, noise and delay calibration)
  - ALCT to CSC test cathode strip
    (coarse check of dead/discon. channels, incl. wire group and prot. board)
  - both are useful

- Threshold calibration:
  - Qin (fC) = Cinj(pF) $*$ Uin(mV), Cinj = 0.24 pF
  - Qthr defined as Qin for efficiency of 50%
  - adjust Udiscr of each CMP16 chip to get Qthr = 20 fC for all 24 chips
  - accuracy is better than 10 % (Fig.1a,b)
  - noise (σ) 2.4 fC

- Delay calibration:
  - ALCT time bins 25 nsec long
  - scan delay in ALCT delay chips with 2 nsec step (16 steps total)
  - define delay ($\pm$ 1 ns) at the step where ALCT has two bins with $\sim$ equal occupancies (Fig.2)
    (N.Bondar, L.Gorn)

- **Anode wire groups noise rate:**
  - use DAQ with 32μs TDC window and trigger from pulser
  - takes $\sim$ 1.5 h to get 10% accuracy (at trigger rate of 30 Hz)
  - no way of using ALCT (0.8 μs max. window)
  - AFEB intrinsic noise rate is $\sim$ 0 at Qthr=20 fC
  - wire group rate $\sim$ 10-30 Hz at HV=3.6 kV (Fig.3a) (including the cosmic muons)
  - slow increase with HV (Fig.3b)
  - confirmed with scaler measurement

- **Anode eff. vs HV at Qthr=20 and 40 fC**
  - μ trigger, two sets of data with vertical track in 3 reference layers (1-3-5 and 2-4-6, HV const)
  - fit efficiency curve for each wire group with Gauss error function, two parameters(HV50 and σ)
  - HV50 is HV for eff. of 50%
  - HV50 vs wire group distributions (Fig.4) complement gas gain Cs137 data
  - max. deviation $\pm$ 100 V within one layer
  - having fit for each wire group in the layer allows to get eff. at any HV and find the start of the plateau as the min. HV for, say, eff. of 98%
  - plateau starts at HV=3.45-3.50 kV for Qthr=20 fC and HV=3.60-3.65 kV for Qthr=40 fC (Fig.5a,b)

- **Wire group cluster size**
  - defined as the number of adjucent wire groups with at least one hit in each of them
  - at HV=3.6 kV and Qthr=20 fC fraction of CL2 size $<$ 5%, all others $<$ 1.5% (Fig.6a,b)
  - fraction goes down with higher Qthr

- **Time distr. at Qth=20 fC and HV=3.6 kV**
  - one vert. track with hits in layers 1,6
  - drift time (relatively to the mean), layer by layer (Fig.7a)
  - time for the 1-st,..4-th hit from $\geq$ 4 (Fig.7b), σ for the 2-nd hit 4.7 ns, eff. ($\geq$ 4) is 99.7 $\pm$ 0.1%
  - eff. in 25 ns window vs window offset (Fig.7c), max eff. of the 2-nd hit 96.2% and range of 10 ns