Update on SBS GEM prototypes tests at FNAL (Oct. 2013) and JLab (March 2014)

Kondo Gnanvo

Outline

- Preliminary results from the GEM tests at JLab (March 2014)
 - Performances of the SBS GEM Modules
 - Preliminary results on APV25 electronics latency and timing

- Update on the GEM tests at FNAL Test Beam (October 2013)
 - Spatial resolution of SBS GEM
 - Efficiency of the SBS GEM modules

UVa GEMs @ JLab Test Beam (March 2014):

- Two SBS GEM Module: SBS2 ($50 \times 50 \text{ cm}^2$) and SBS3 ($60 \times 50 \text{ cm}^2$);
- 20×20 cm² read out during the test
- Trigger: Coincidence between PMT-Scintillators upstream and Lead Glass downstream
 - 2 Scint. Are 16×16 cm² side by side, and 4×3 cm² Lead glass blocks (10×10 cm²)
- Readout System: APV25-SRS + DATE DAQ



UVa GEMs @ JLab Test Beam: Typical event

- Data on April 02, 2014: Last day of the beam in Hall A
- CW beam with Carbon target: very low intensity → low trigger rate
- Gas mixture ArCO2 (75/25) \rightarrow 3950 kV on the divider
- 64 K Events saved into raw data files with APV25-SRS \rightarrow with 6 apv25 time sample



UVa GEMs @ JLab Test Beam: ADC distribution plots

SBS50x50 cluster Charge Distr in X-Strips (53918 / 64000) SBS50x50 cluster Charge Distr in Y-strips (51937 / 64000) Frequency Frequency Entries Entries SBS2_50×50 Mean 510.6 SBS2_50×50 Mean 421.3 RMS RMS 409.2 364.2 **X-strips Y-strips** Cluster charge sum (A Cluster charge sum (A.U) Saturation of the APV25 SBS60x50 cluster Charge Distr in X-Strips (52010 / 64000) ter Charge Distr in Y-strips (59346 / 64000) Frequency Frequency Entries Entries SBS3_60×50 498.8 SBS3 60×50 632.8 Mean Mean RMS RMS 409.6 431.7 Y-strips **X-strips** Cluster charge sum (A.U) Cluster charge sum (A.U)

UVa GEMs @ JLab Test Beam: Average ADC distribution vs cluster position



SBS50x50 Mean ADC spatial Distr. in X (53918 / 64000)







UVa GEMs @ JLab Test Beam: Cluster Multiplicity

Average number of cluster per event per detector plane



SBS50x50 cluster Multiplicity in Y (51937 / 64000)

SBS50x50 cluster Multiplicity in X (53918 / 64000)

UVa GEMs @ JLab Test Beam: Cluster Size

Average number of hits per event cluster

SBS50x50 cluster Size in Y (51937 / 64000)

SBS weekly Meeting

SBS50x50 cluster Size in X (53918 / 64000)

UVa GEMs @ JLab Test Beam: APV25 timing analysis

Very preliminary (Xinzhan Bai)

10

UVa GEMs @ JLab Test Beam: APV25 timing analysis

Very preliminary (Xinzhan Bai)

- Shaping time distribution over all apv25s: mean @ 57 ns (expected value is 50 ns)
- APV latency: delay between the apv trigger and the data → Need to adjust this measured parameter with the apv latency set by initializing the SRS
- Triggered particles ??? \rightarrow The pic at 15 ns \rightarrow event synchronized with the trigger???
- Background: remaining of the distribution???

UVa GEMs @ FNAL Test Beam (Oct. 2013): 120 GeV Proton Beam

SBS1_50×50: Resolution studies from track fit residuals

- Tracking: Linear fit in X and Y using the single hit from the 3 small trackers
- Exclusive residual : SBS1 data point excluded from the track fit
- Inclusive residual : SBS1 data used for the track fitting
- Resolution: Width ($\sigma_{resolution}$) of the Gaussian fit to the combined exclusive and inclusive residual distribution: $\sigma_{resolution} = \operatorname{sqrt} (\sigma_{exclusive} \times \sigma_{inclusive})$

SBS1_50×50: Position scan & resolution

- Zero suppression: $5 \times \sigma$ cut pedestal noise for each channel
- Clusterization: One or more hits per cluster
- HV: 4100 V on the voltage divider
- Uniform resolution over the 9 position scanned in X and Y
 - (75 μm average for X-strips and 75 μm for Y-strips)
- Pic on P5 → beam close to the spacers inside the chamber
 - Degradation of the resolution

SBS1 Hit Position Map

SBS1 50×50 : HV scan

100 90 Efficiency plateau around 4100 kV at 4 sigma cut 80 Charge sharing slightly dependent of the HV \rightarrow from 70 Efficiency (%) the same charging up effect of the readout board 60 50 expected increase of cluster size with the HV in both ----SBS1 (cut = 5 Sigma) 40 X-strips and Y-Strips ----SBS1 (cut = 4 Sigma) 30 20 3900 3700 3800 4000 4100 4200 4300 HV on the divider (V) Cluster size vs. HV charge sharing 2.1 3.5 Bottom strips ADC (top strips) / ADC (bottom strips) 2.05 average nb of strips per cluster Top strips 3 2 2.5 1.95 2 1.9 1.5 1.85 1.8 1 3750 3850 3950 4050 4150 3750 3850 4050 4150 4250 4250 3950 HV on the divider HV on the divider SBS weekly Meeting 4/30/2014 15

Choice of the zero suppression cut at $5 \times \sigma$ of the strip pedestal noise

SBS1_50×50: 120 GeV proton beam

Cluster coordinate (mm) for SBSGEM1X

SBS1_50×50: Pos Scan

2.8

2.7

2.6

2.5

2.4

2.3

2.2

Ρ1

P2

P3

Ρ4

P5

Position of the beam on EIC prototype

Average nb of strips in cluster

- Uniform efficiency over the beam positions scanned
- Drop in efficiency at P5 → beam close to the spacers inside the chamber
- Relative good uniformity of the cluster size for both x-strips and y-strips
- Significant variation of the charge sharing → need to investigate why?

Efficiency @ different cuts (zero suppression)

Bottom strips

P8

P9

top strips

Cluster size