High speed GEM DAQ status

Ben and Danning

01/06/2020
SBS weekly meeting
SBS GEMs: large data volume and high occupancy

Signal on one of 128 channels from an APV

APV-25 FEC

Pulse peak time

GMn(GEn): 304 APVs, 23 MPDs
5GB/s raw volume at 5 kHz

GEp: 1204 APVs, 94 MPDs
20 GB/s raw volume at 5 kHz

GMn background rate from Eric

FPGA based digitizer
MPD(INFN, Paolo)

Subsystem processor (SSP)

GMn/GEN and Basic Setup

Total APVs: 310
Total raw data volume: ~0.9 MB per event

Extra 100 Hz for each set of ROC and vme crate added
GMn/GEN and SSP Setup

Total APVs: 310
Total raw data volume: ~0.9 MB per event

3 sets of SSP-ROC gives rate more than 5kHz

GMn/GEn and SSP Setup

Currently working on...
Total APVs: ~1200
Total raw data volume: ~3.6 MB per event

Extra 300 Hz for each set of SSP and ROC added

Bottole neck

VME backplane 110 MB/s

Optical fiber 300 MB/s
After reduction: 0.3 MB per event

Total APVs: ~1200
Total raw data volume: ~3.6 MB per event
Total MPDs: 94

- Reduction code on SSP is transferable to VTP
- 2 VTPs and two DAQ PC gives rate more than 5kHz

(Going further)
**Status**

- The correctness/accuracy of the online reduction code is tested under occupancy up 50% by using certain high occupancy events from 2016 Hall A GEM test data.

- Small scale SSP setup (less MPDs per SSP) has been tested with cosmic data. A direct comparison of reconstructed hits between offline mode and online reduction mode showed no distinguishable difference.

- Recently working on preparation for going to large scale SSP setup.
  - Final experiment setup, New MPD firmware, new SSP firmware, CODA3 etc.
Plan

- Testing large scale setup with Ben --- by March 2020
  - Debugging new MPD/SSP firmware
  - Testing new setup with 2 - 4 layers of UVa GEM chamber in EEL
- High occupancy test with X-ray --- by May 2020

### Small setup

<table>
<thead>
<tr>
<th>Low trigger rate</th>
<th>High occupancy</th>
<th>Low occupancy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Done</td>
<td>X-ray test May 2020</td>
<td>X-ray test May 2020</td>
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### Large setup

<table>
<thead>
<tr>
<th>Low trigger rate</th>
<th>High occupancy</th>
<th>Low occupancy</th>
</tr>
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<tbody>
<tr>
<td>EEL GEM test March 2020</td>
<td>Experiment</td>
<td>X-ray test May 2020</td>
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- Implement VTP setup?
  - GEp and GEn-RP need it.
  - SSP data reduction code transferable to VTP
  - Needs more time from Ben from DAQ group

This part can only be tested with calibration pulse on the APV chip before experiment. But a successful result of all other tests would suggest a good prediction of it.
Concerns on GEp GEM DAQ

Effective time window: ~325 ns
Average number of hits over whole active area are: 325ns*Area*Rate

<table>
<thead>
<tr>
<th></th>
<th>FPP1</th>
<th>FPP2</th>
<th>Front Tracker</th>
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</thead>
<tbody>
<tr>
<td>Avg. hits</td>
<td>240-290</td>
<td>150</td>
<td>330-520</td>
</tr>
<tr>
<td>occupancy</td>
<td>45%-55%</td>
<td>35%</td>
<td>60%-75%</td>
</tr>
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</table>

strip occupancy = \( 1 - \left( 1 - \frac{\text{clusterSize}}{\text{totalStrips}} \right)^{\text{Avg hits}} \)

APV raw data frame

Front Tracker

Cluster size: 5

Cluster size: 4

Cluster size: 3

Cluster size: 2

Cluster size: 1

75%

25%

~0%

~325 ns