BigBite GEMs

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The image shows a diagram of a detector module with labels indicating UV GEM, XY (INFN) GEM, and 4 front tracker layers. The diagram also highlights an XY rear tracker layer.
Current install status:
- 2 INFN XY layers installed
- 1 UVa XY layer installed (cabling and checks in progress)
- 2 UV layers at UVa will be installed in May

What we have done in TEDF so far:
- Gas prototype assembly flowing N2 or Ar/CO2 to chambers
- Read out pedestals from all 3 chambers
- Verify common mode and pedestal subtraction and zero suppression
- HV and cosmics on previous UVa chamber
- HV test on INFN chamber

Troubleshoots:
- HDMI cables are not well-connected to MPDs
- Bad APV
- Develop tools for faster problem id
  (many tools thanks to Xinzhan, Evaristo, Ben, Bryan and others!)
For each event, each APV is shown in raw format:

Single time sample
128 channels

Plot courtesy of E. Wertz
Raw readout for an event. Generates **common mode** and **pedestal** values.

Left: common mode subtracted

Right: common mode and pedestal subtracted

Plots courtesy of E. Wertz
mpdLibTest: tool to verify clock phase and digital and analog connections

Fixed clock phase, good APV

Clock phase scan to determine optimim

Vertical Axis: ADC Value with range 0 - 4000

Horizontal Axis: Clock Phase Value with range 0 – 70, 1 Clock Phase value = 0.5 nanosecond

Plots courtesy of E. Wertz
Quantify the noise

INFN layer J0

Previously installed UVa layer

Xinzhan and Ben continuing studies on noise in UVa layer

Initial studies led to APV electronics at backplane

Discovered some MPD improvements along the way...

Start here to install Faraday cage on GEM plane and stand along backplane, but could not see reasonable difference

Plots courtesy of E. Wertz
Recent electronics changes:

- Install 59 ohm resistor on MPD to sink current
- Update MPD firmware to accept NIM clock sync
- Update SSP firmware for two word packing

Previous DAQ testing, able to obtain up to 2.4 kHz....we expect now to double that!
Studies of the modified and original MPDs

Comparing MPDs in slots 3&4

- Run 768, 2 Unmodified
  - Entries: 41500
  - Mean: 3.997
  - Std Dev: 28.47

- Run 847, 2 Modified
  - Entries: 37210
  - Mean: 3.934
  - Std Dev: 30.26

APV wise common mode variation distribution

<table>
<thead>
<tr>
<th></th>
<th>Entries</th>
<th>Mean x</th>
<th>Mean y</th>
<th>Std Dev x</th>
<th>Std Dev y</th>
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<tr>
<td>Run 768, 2 Unmodified</td>
<td>560250</td>
<td>13.5</td>
<td>4.001</td>
<td>7.789</td>
<td>29.96</td>
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<tr>
<td>Run 847, 2 Modified</td>
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Plots courtesy of E. Wertz
Next steps:
• Continue to verify common mode, pedestal calculations and zero suppression and verify DAQ rate studies
• Performance checks with HV
• Construct LV and grounding cables that will be used in Hall. Verify grounding scheme with testing.
• Cosmics (allows further signal checks and tracking studies)

Plan to move to Hall mid-May with BigBite stack, set up stand alone electronics, readout, and gas there to continue readout.

Manpower also needed to develop GEMs for SBS side.
Cosmic hit maps from Feb 2021

J0 and J2 efficiency is greater than 90%

Plots courtesy of E. Wertz