Update on Bigbite and SBS GEM layers

SBS Weekly Meeting, August 16, 2021

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Manpower SBS and BB GEMs :

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Holly, Zeke, Evaristo, Paolo

Michael, Cameron

Andrew, Bogdan, Brad, Alexandre, Ben, Bryan

Hall A and C teams …

Weekly meeting for the commissioning of GEM every Wednesday at 10:00 am

Wiki: https://hallaweb.jlab.org/wiki/index.php/GMn_GEM_Commissioning_Meeting

Bigbite GEMs for GMn

Bigbite GEMs for GMn: INFN GEMs

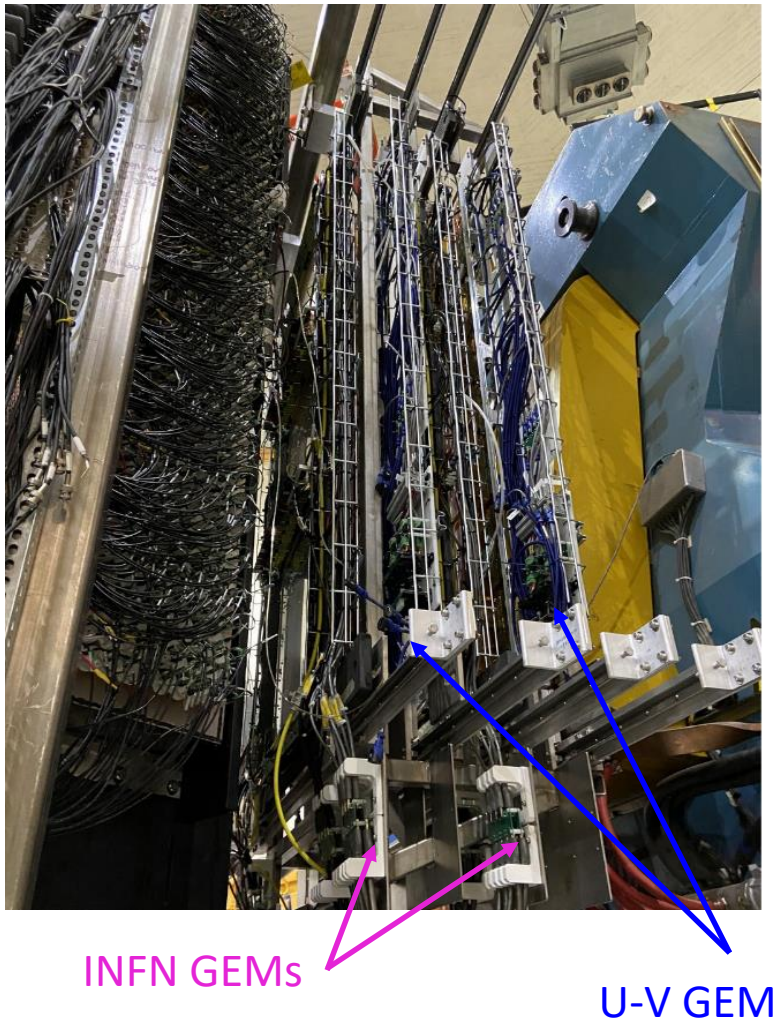
- **Timeline for the preparation of INFN GEMs in Bigbite detector package**
  - Re-cabling HDMI cables at MPDs and diagnostic checks for connections – ongoing (1-2 days)
  - Pedestal evaluation: Overall noise and check that all APV cards or backplanes are properly connected (2-3 days)
  - HV Test (1-2 days)
  - Cosmic data (till beam comes)

Installation of two INFN GEM layers in Bigbite before moving to the Hall
February 2021

Bigbite GEMs for GMn: INFN GEMs

- **Uncertainties for INFN GEMs in BigBite:**
  - Shielding INFN GEMs
    - Tests are being done with the GEMs for shielded SBS layers. Not successfully run HV on a shielded chamber.
    - Vertical installation of shielding may not be possible due to space between chambers => Will require the use of manlifts to install
  - HV for lowest module of J0 (M24)
    - Problem discovered during HV tests in TEDF.
    - Changed HV connector for module, tested short period of time and seemed fine
    - Need to test individually. For a couple of hours to be sure.
    - If still a problem, will need to evaluate source. be moved in or ESB

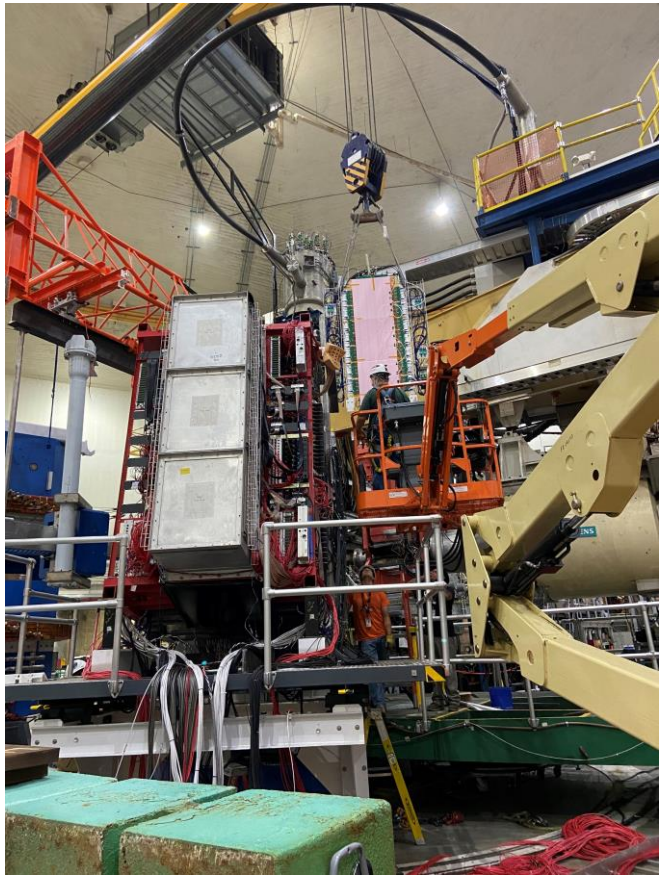
Two INFN and two UVa U-V GEM layers in Bigbite in the Hall
July 2021



Bigbite GEMs for GMn: UVa GEMs

Installation of UVa X-Y GEM behind GRINCH
May 2021

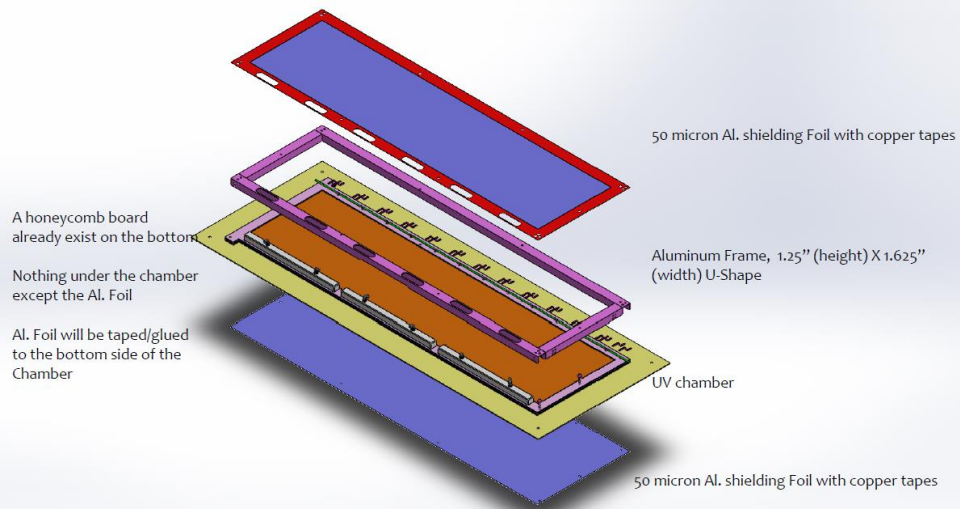
- **All 3 UVa GEM layers installed in BB spectrometer**
  - Two U-V strip GEM layers as part of the front trackers
  - One X-Y strip GEM layer behind the GRINCH (4 modules)
- **All GEM chambers RF shielded (see next slide)**
  - HV and readout tests after shielding and before installation
- **Cabling completed for the 3 layers** (HV, LV, gas, readout)
  - UVa GEM Wiener PS crate installed in main electronic hut
    - Remote control of HV setup **(thanks Steve)**
  - Low voltage PS module installed for APV25-MPD readout
  - Gas flowing through the chamber since last week
- **Getting ready for cosmic run, in coming day**
  - MPD and DAQ debugging ongoing **(Holly, Zeke, Sean)**
  - HV test of all 3 layers by end of this week **(Sean)**
  - Bar any unexpected issue, UVa GEMs are ready for cosmic and subsequently for the GMn experiment



Installation of first UVa U-V GEM in BB front tracker
July 2021

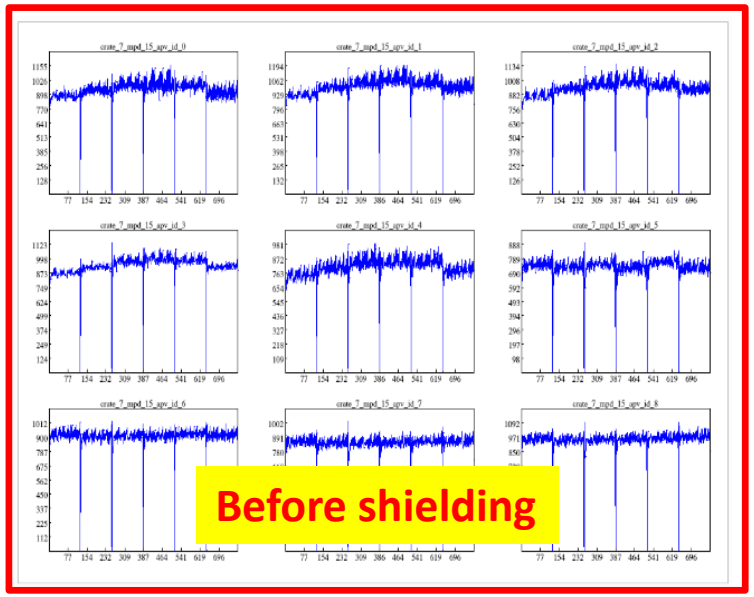
Shielding of U-V GEMs: Reduction of the common mode fluctuation

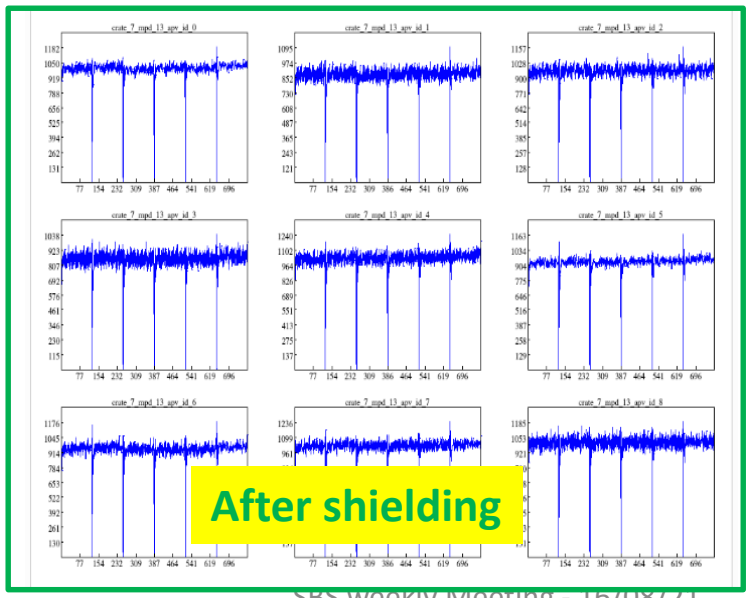
Ad hoc shielding scheme for U-V GEM layer



Similar shielding scheme is also been applied to all SBS GEM modules before assembly into layers

Impact on shielding on the common mode of APV raw data frames

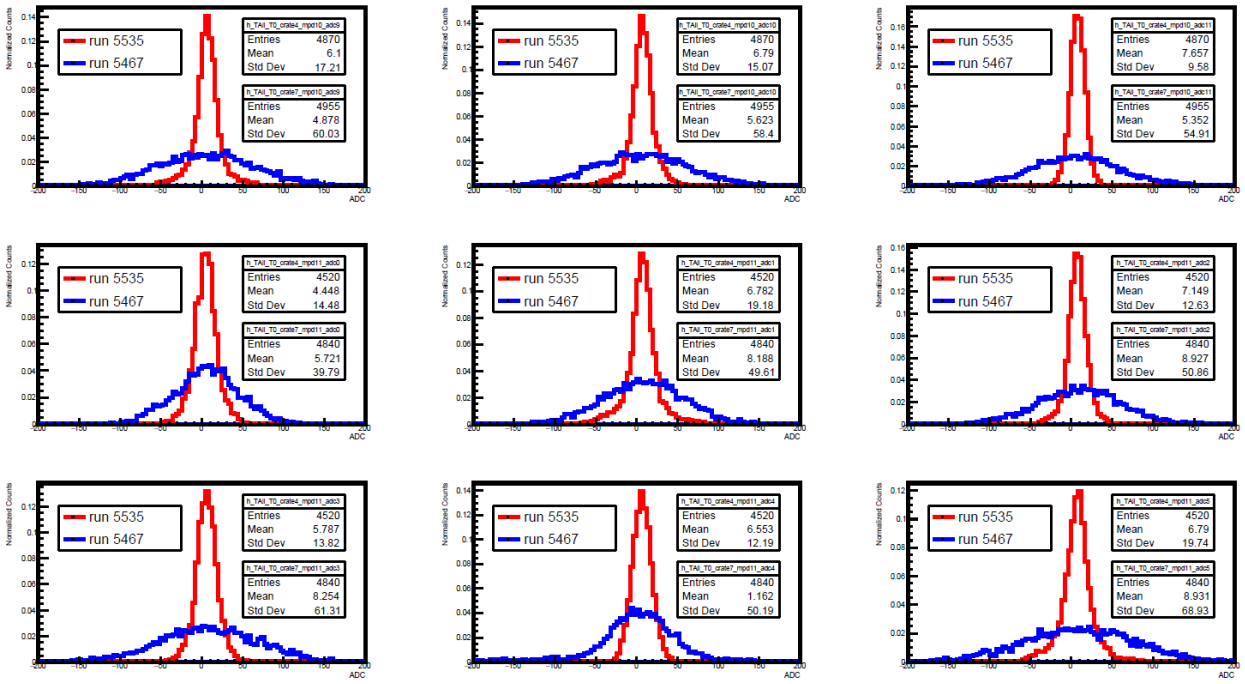




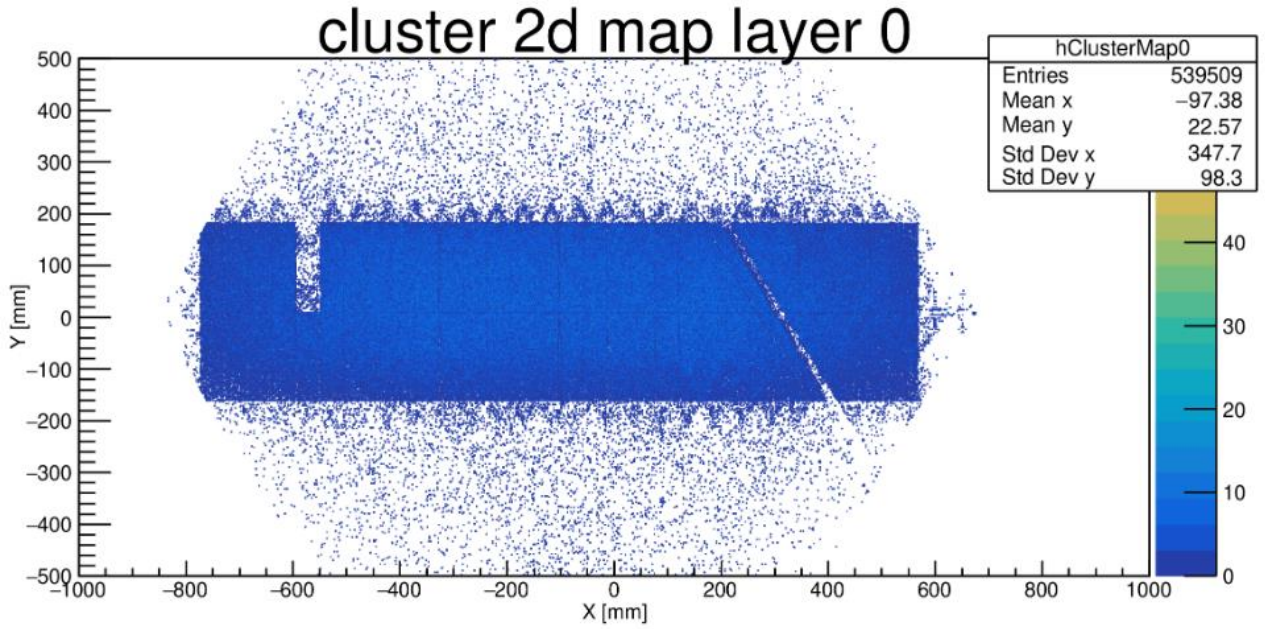
Impact of shielding on common mode fluctuation

- The improvement is dramatic and can be observed on all APV25 connected on both U-V and X-Y strip modules
- Can not completely suppress the common mode fluctuation but we are confident that the reduction is enough to safely exploit the data in high-rate environment
- The same shielding work is currently ongoing for the 40 modules of the GEn-RP GEMs
- The shielding of the GEM modules is the source of the installation delay of the GEM layers (specially for the GEn-RP GEMs) **but it is worth the effort and the delay**

Typically, ~75% reduction of the amplitude of the fluctuation



Cosmic 2D hit map reconstruction in BB U-V GEM layer #1



SBS GEMs for GEn-RP

SBS GEMs for GEn-RP: INFN GEMs

- **2 Timeline for INFN GEMs for SBS**
  - Two layers for GEn-RP inline detector currently in preparation in Testlab GEM clean room **(Holly & Zeke)**
  - Will Note: Currently expertise is focused on BB install and readout
  - Evaluating and installing shielding. Not able to successfully run HV on shielded chambers. (Unknown time, still debugging and studying)
  - Re-cabling GEM layers for DAQ. Diagnostic for cable connections **(2-3 days)**
  - Pedestal evaluation: Overall noise and check that all APV cards or backplanes are properly connected **(2-3 days)**
  - Cosmic **data (2-3 days for enough statistics)**
  - Caveat: If cosmic data reveals problem with GEM readout electronics more time will be needed to debug. Also if time is available, all of this will be done before going into the SBS inline GEM stand.
- **Uncertainties with the shielding of INFN GEMs**
  - If shielding is not compatible with HV and mitigations are not sufficient, shielding will need to be removed (1-2 days per chamber layer)
  - If there is a spark or discharge this could cause damage to the GEM modules themselves.
- **Cosmic test setup with the UVa GEMs in GEn-RP detector frame**
  - Will be installed the 2 INFN layers as well (early September)

SBS GEMs for GMn: UVa GEMs

- **10 UVa GEM layers need to be ready and installed in the 3 GEn-RP frames by August 29th (we need to vacate EEL124 clean room)**
  - Two layers fully shielded and installed on cosmic stand
  - Will add two more layers by tomorrow Tuesday 17th, flow gas for a couple days and perform HV and pedestal test by Thursday 19th
  - Not time for cosmic data, the plan is to install the 4 layers in GEn-RP inline detector frame by Friday 20th morning
    - Will coordinate with Brad for help from the Hall C technician on Friday
- **Need to vacate EEL124 clean room by August 31st**
  - Shielding of 10 layers need to be completed, pedestal data and HV test by this timeline
  - We can complete two layers a day, so bar unexpected problem and we will be able to meet the deadline
    - By Friday 20th we will have completed 4 layers
    - This include installation of the remaining GEn-RP frames also
  - Not clear if we will have time for cosmic test for any of these layers in EEL clean room
- **We are going to set up another cosmic test with the GEMs in GEn-RP detector frame**
  - This will be set up after we move away from the clean room outside on August 31st
  - Will include the 2 INFN layers as well (need coordination with **Holly and Zeke** regarding timeline)
  - Need a large space for this setup (3 large GEn-RP frames, two racks for the readout electronics, gas system etc…
  - EEL125 is a probably not a good fit in its current state, maybe EEL126 if the detector frames can be moved in or ESB

SBS GEMs for GEn-RP: Status of MPD readout

Items	Needs (10 UVa GEMs)	Needs (2 INFN GEMs)	In hands (UVa GEMs)	In hands (INFN GEMs)	Spares	Missing?	Need repair	promised	Ordered	Comments/ location
APV cards	880	108	800	All		80	15		NL: 110	EEL 124 and INFN lab
MPDs	70	8	68	8		2	7	MK: 2	NL: 15	EEL 124 and INFN lab
12-slot BP	40	N/A	38	N/A		2	6		NL: 10	EEL 124
5-slot BP	80		80		4	0	3			EEL 124
VME (St)	3	1	3	1		0				EEL 124 and INFN lab
Controller	5	2	5	2		0				EEL 124/INFN lab/Hall
VTPs	2	1	2	1		0				EEL 124/INFN lab/Hall
VXS	2	1	2	1		0				EEL 124/INFN lab/Hall
TI	2	1	2	1		0				EEL 124/INFN lab/Hall
CPU	2	1	2	1		0				EEL 124/INFN lab/Hall

- **With what in hand right now, we have enough for 9 out of the 10 GEn-RP GEM layers**
- **We will have enough for all 10 layers with the ordered pieces**

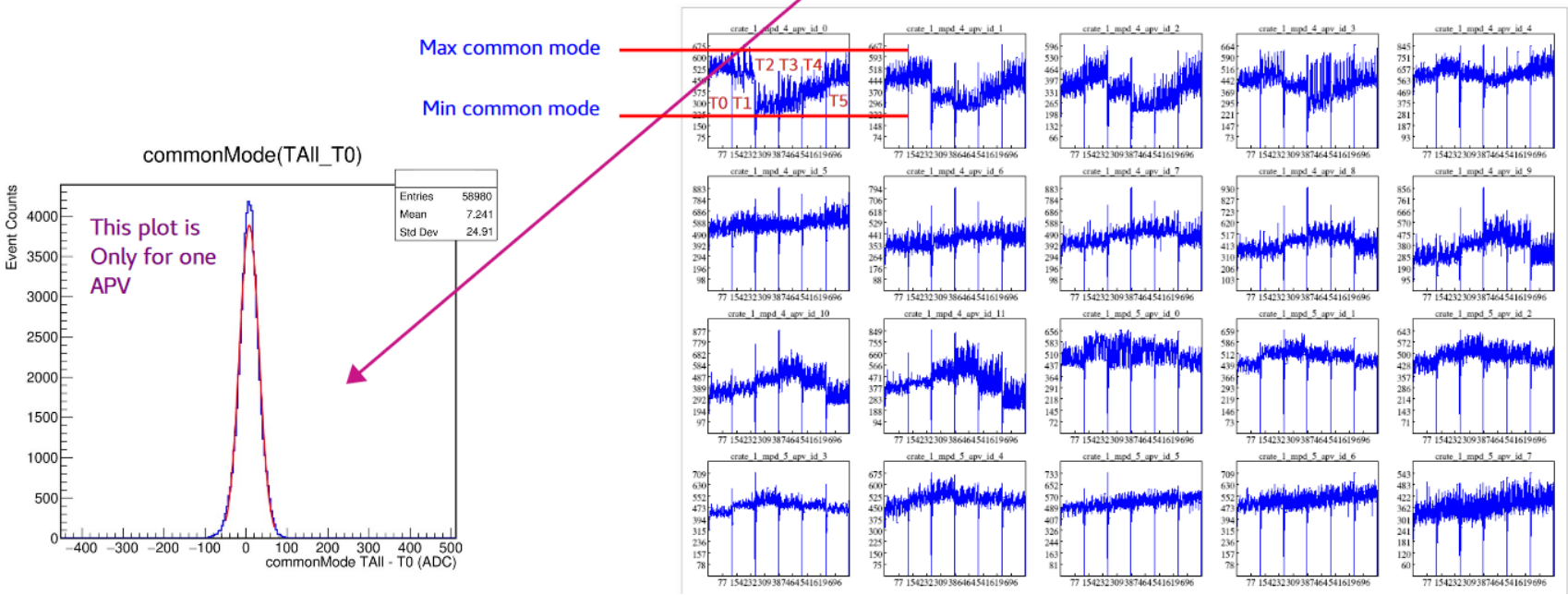
Courtesy Thir

Back up

APV25 common mode fluctuation issue

- APV pedestal baseline level vary significantly from significantly from one time sample to the other within the same event
- The effect is amplified by external conditions i.e.strips picking up RF noise from external source
- Baseline fluctuation needs to be corrected on event-by-event basis => common mode correction
  - Software algorithm have been successfully tested for the common mode correction

- To quantify the APV baseline fluctuation:
- Since plotting common mode (Max_value – Min_value) cannot avoid outliers
- So for each APV, for all 6 time samples, I calculate the ADC difference: (T1-T0, T2-T0, T3-T0, T4-T0, T5-T0 all relative to T0), and dump the 5 delta values into one histogram
- For each APV, I do this for ~ 10,000 events



- Correction likely not efficient for high-rate condition with large fluctuation
- Critical to minimize the fluctuation with good shielding of the GEMs
- Ad hoc implementation of the shielding scheme for