INFN GEM Update:

5/5/21-5/11/21

Ezekiel Wertz (onsite), Robert Perrino(remote), Evaristo Cisbani (remote), Holly Szumila-Vance (onsite), Chuck Long (onsite),

Recent Activities:

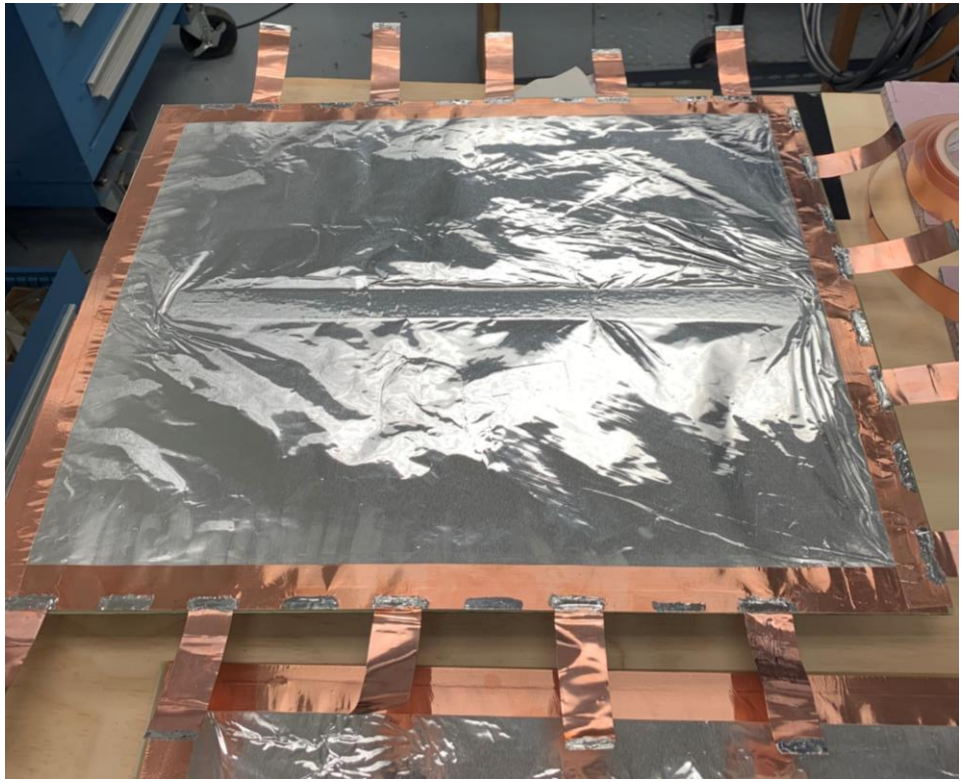
TEDF Activities (May 6-11)

- Took cosmic data and ran GEM HV over the weekend.
- DAQ would not function on Monday and this was linked to electronics connected to INFN MPD 3.
- Replaced 1st APV card on 1st backplane of MPD 3, APV closest to HV divider
- Jack and Holly witness HV arch from HV divider and spare UVa UV frame in BigBite frame. We shut off HV immediately and conclude that HV was previously arching to APV card over weekend and mid-March.
- Investigating causes and ways to prevent future HV problems.

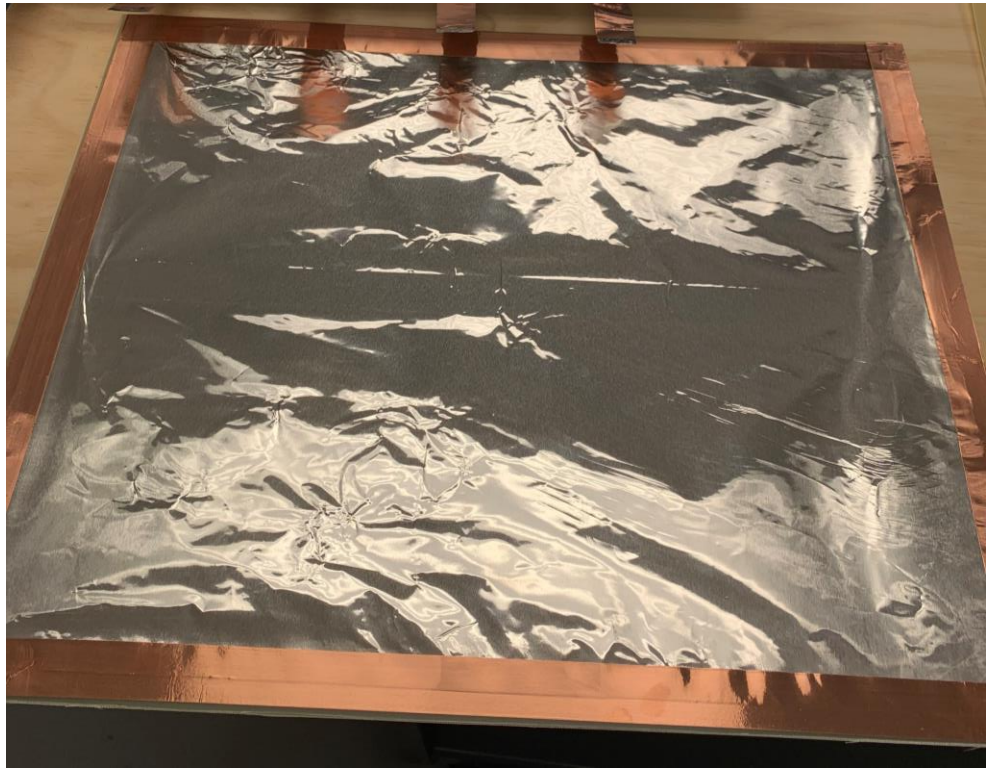
Test Lab Activities (May 6)

- Grounded the module APV cards, GEM module, and shield to the same ground.
- Inserted both layers J3 and J1 into the cosmic stand, both flushing N2.
- Reconnected layer J3 and took pedestal data to include the entire layer and just the module that is shielded.
- Optimized plot macros for comparing the common mode fluctuation.
- Plots show that shielding does improve the noise.

Aluminum Shielding Prototype for INFN Module, May 3-4



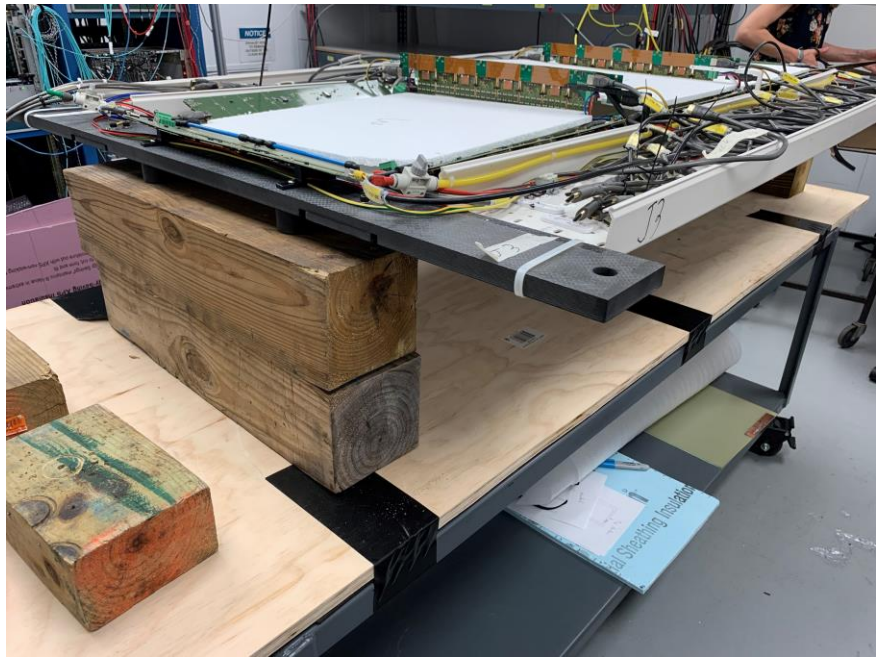
Shielding for bottom window



Shielding for Top window

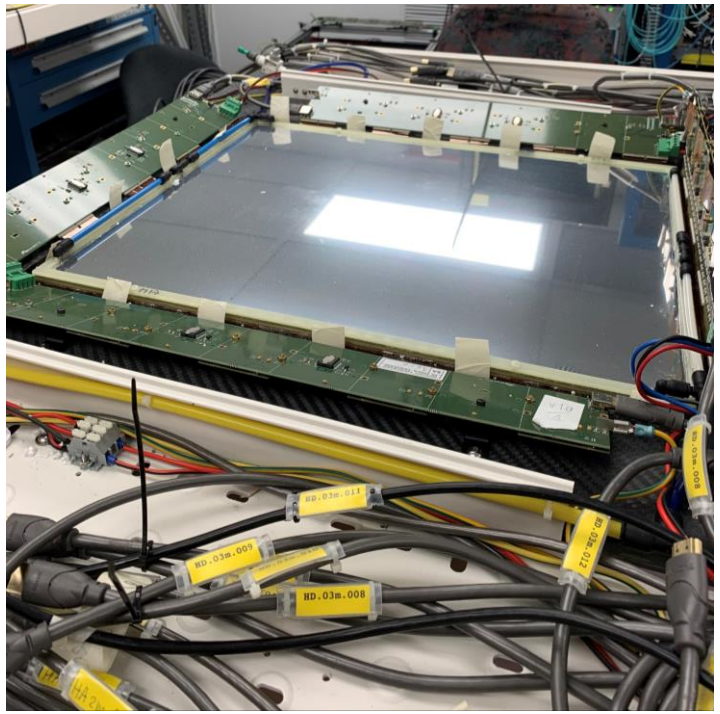
- Work done by Holly, Bogdan, and Zeke.
- Aluminum Foil is 50 microns thick
- Mounted on full g10 board
- Copper strips (~3 inches in length) are soldered to bottom to align with spaces between Kapton Fingers which connect to APV cards
- Dimensions of Shielding boards are 20.75 inches (slightly > 50 cm) by 17.5 inches (slightly > 40 cm) . This fits over module and perimeter frame of GEM module

Layer J3 setup and Modification Process, May 4



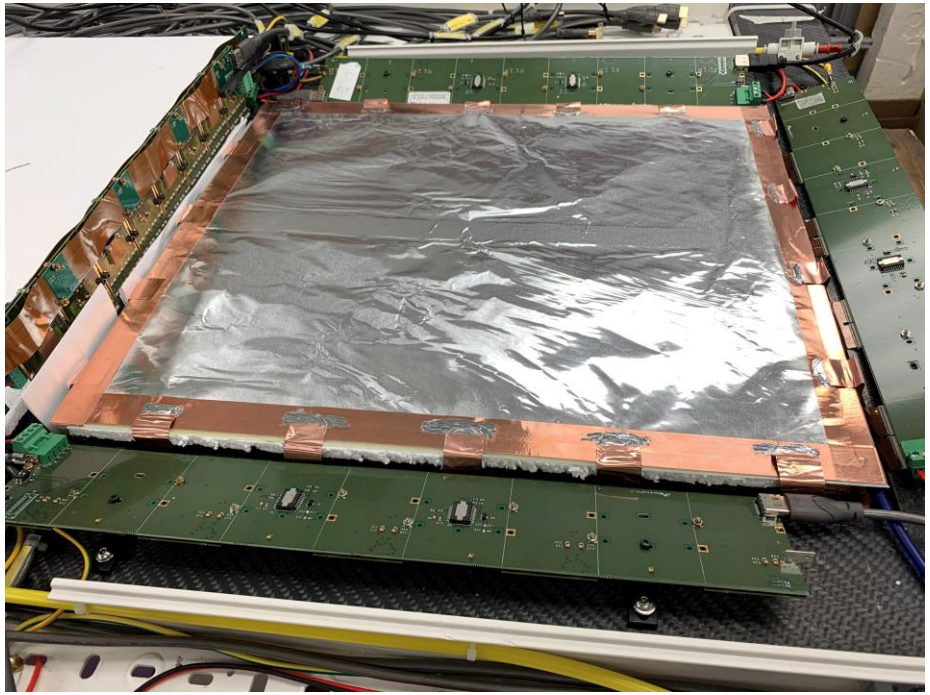
Layer J3 decabled and moved from cosmic stand and onto cart for modification. Cart is locked.

Adding the bottom layer and aligning the protected copper strips between the Kapton Fingers. Cannot damage Kapton Fingers or GEM module window!



Copper strips from above. Inserted in between APV cards.

Aluminum Shielding Prototype on INFN Module on layer J3, May 4



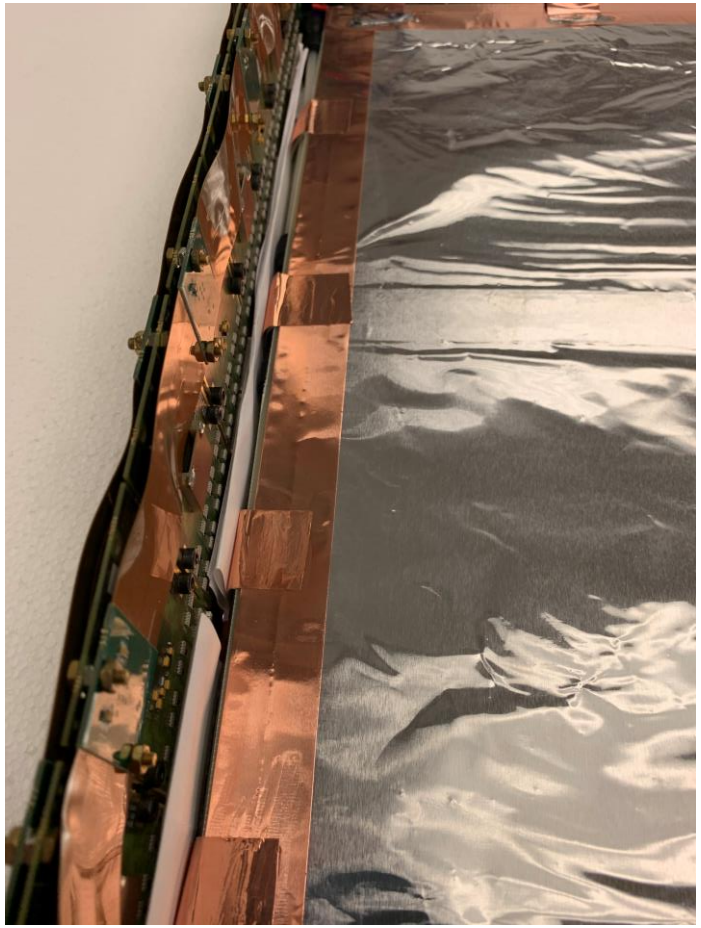
Shielding on top of GEM module

Shielding on bottom of GEM module

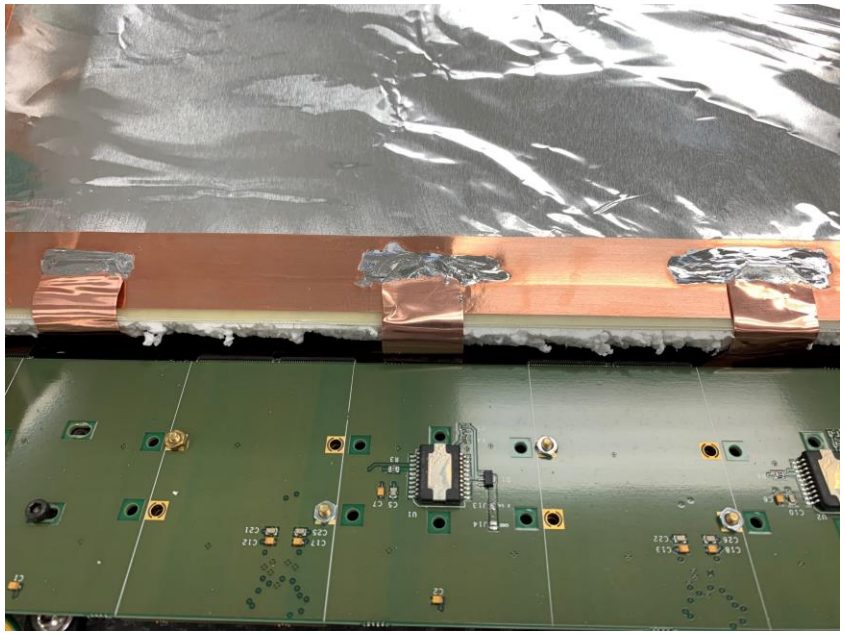
Improvements:

- Shielding can probably be connected by copper conductive tape, instead of having to solder the copper connectors.
- g10 has to be a frame and not fully cover all of the GEM module.
- Styrofoam layer between top GEM module window and aluminum shielding is not practical for HV.
- Bottom shielding has to be cut to account for HV divider connection and any other connectors.
- Copper connectors on flexible backplane side may not be practical for GEM readout or thermal contact issues with APV cards or Kapton Fingers.
- Shielding needs to be attached more to GEM module for vertical positioning of GEM modules.
- Need to understand how to make modification for middle GEM module.

Aluminum Shielding Prototype on INFN Module on layer J3, May 4



Copper connectors on flexible backplane side



Close-up of solder connections for non-flexible backplane side. Can also see the Styrofoam spacer.

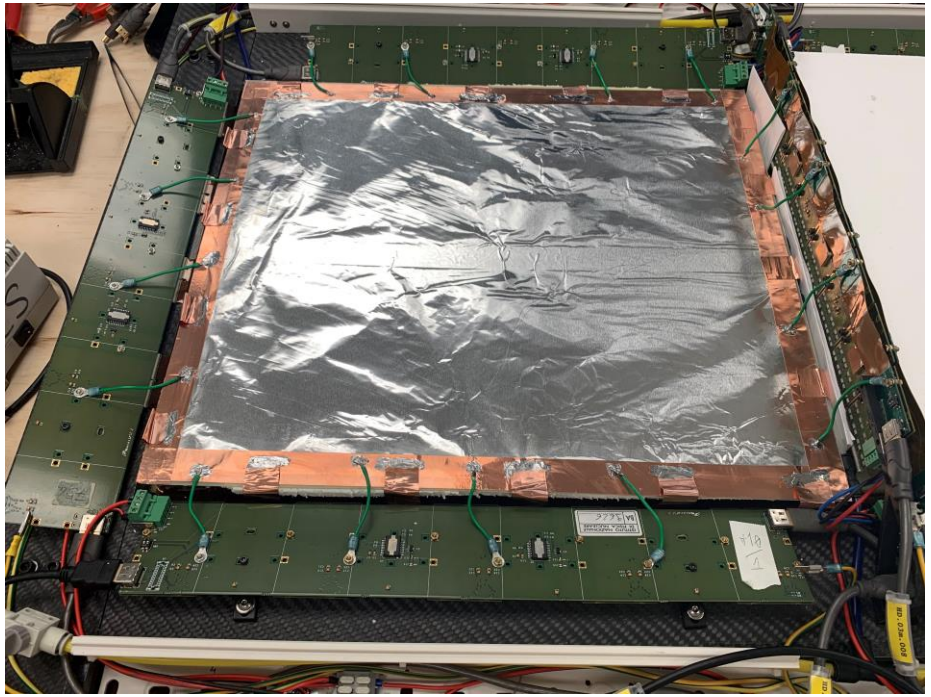
How we slowly elevate the bottom shielding. Probably want to create a more permanent apparatus if doing this shielding more.

- Need to explore copper tape vs copper strip solder.
- Copper tape is faster to use, but may not be as effective.

Aluminum Shielding Prototype on INFN Module on layer J3, May 5

Ground between top shield and ridge backplane APV cards

Ground between top shield and flexible backplane APV cards



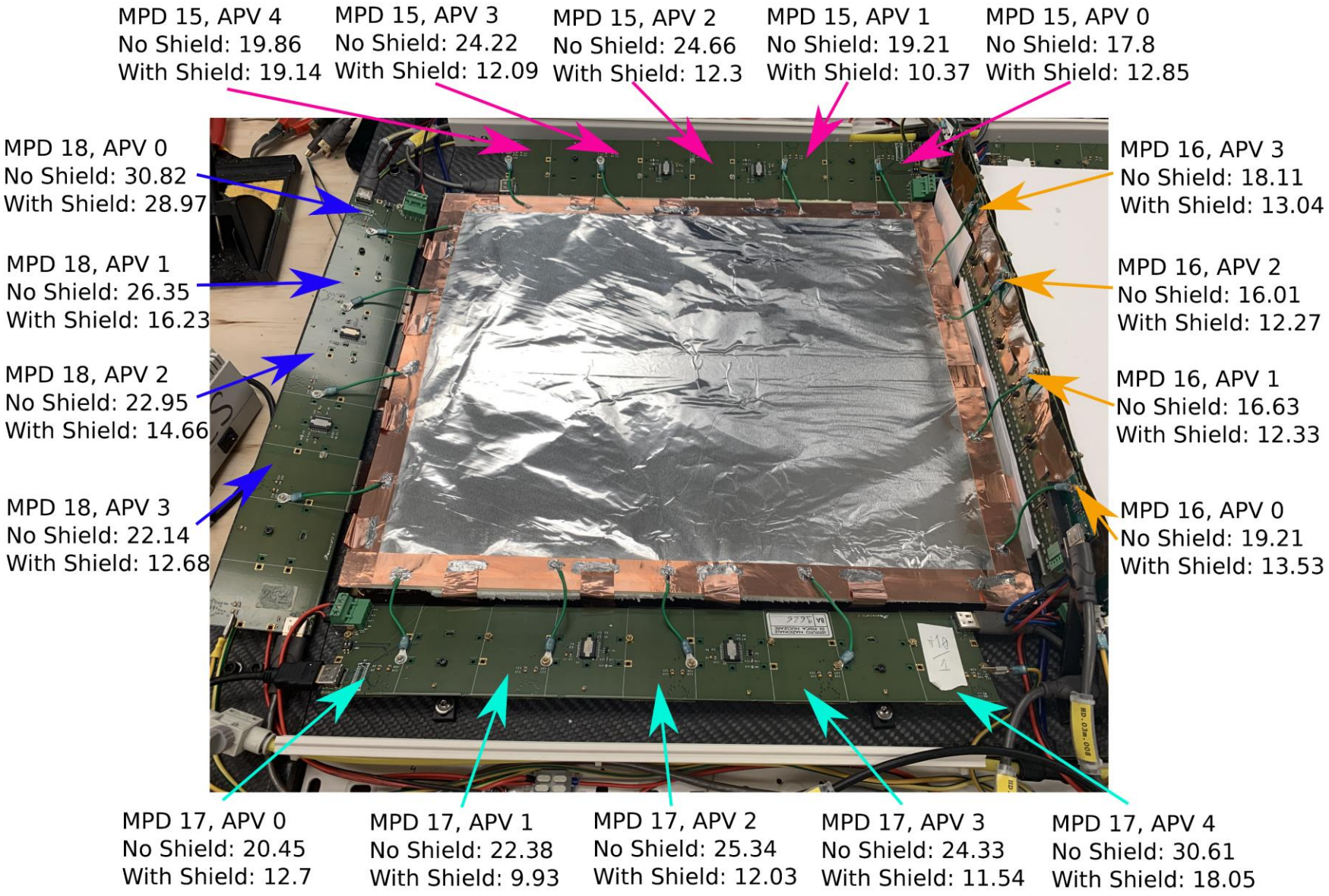
Ground between top shield and all backplanes via APVs

Cosmic Stand, May 5

Top: Layer J4
Top Middle: Layer J3
Bottom Middle: Layer J1
Bottom: extra shelf space

Common Mode Comparison: Test Lab Whole Module May 6

Run 458: Baseline pedestal of layer J3 without any shielding. Originally taken May 3
Run 488: Pedestal data for shielded module of layer J3. Values are in ADC units

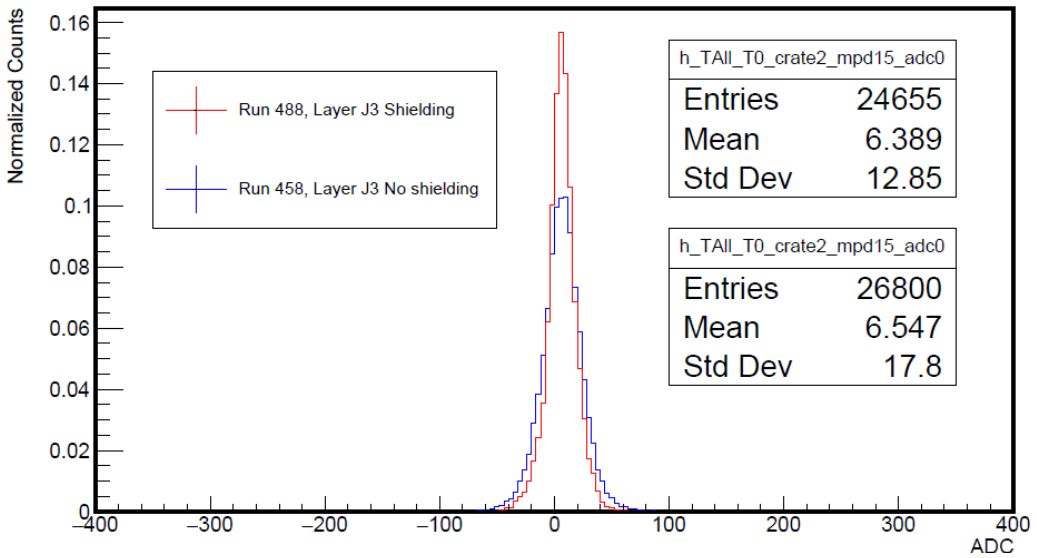


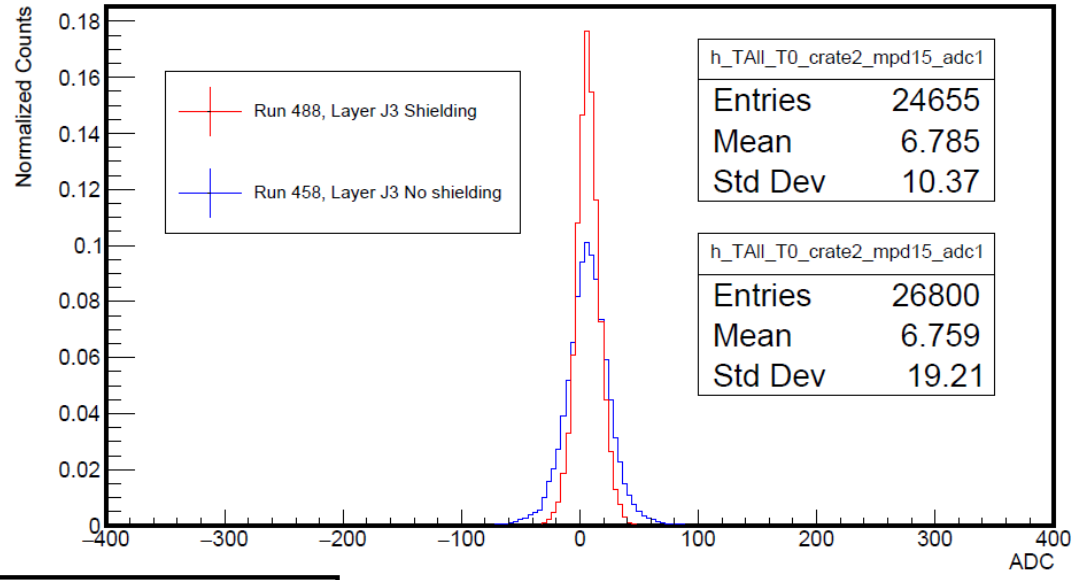
Common Mode Comparison: Test Lab MPD 15 May 6

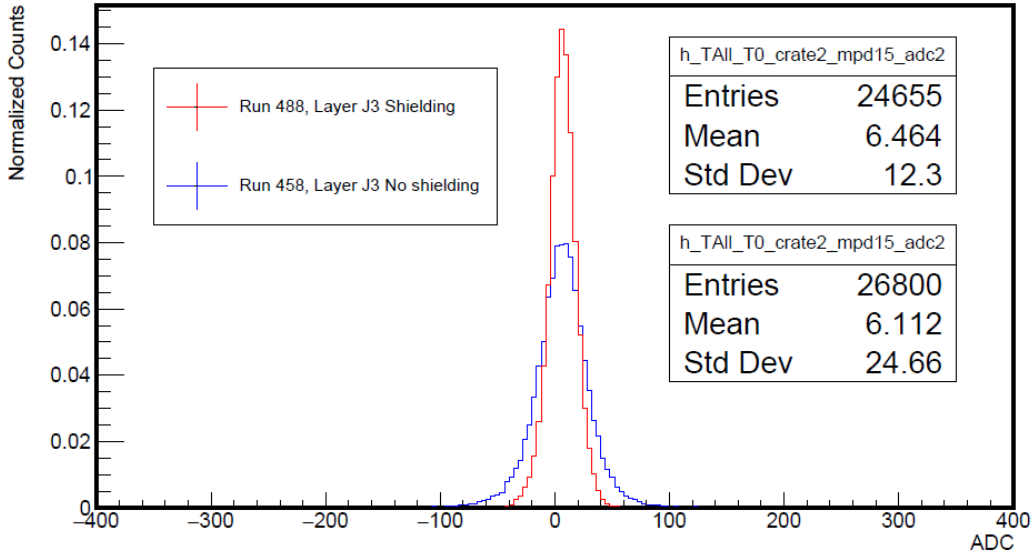
Run 458: Baseline pedestal of layer J3 without any shielding. Originally taken May 3

Run 488: Pedestal data for shielded module of layer J3.

One plot represents one APV card







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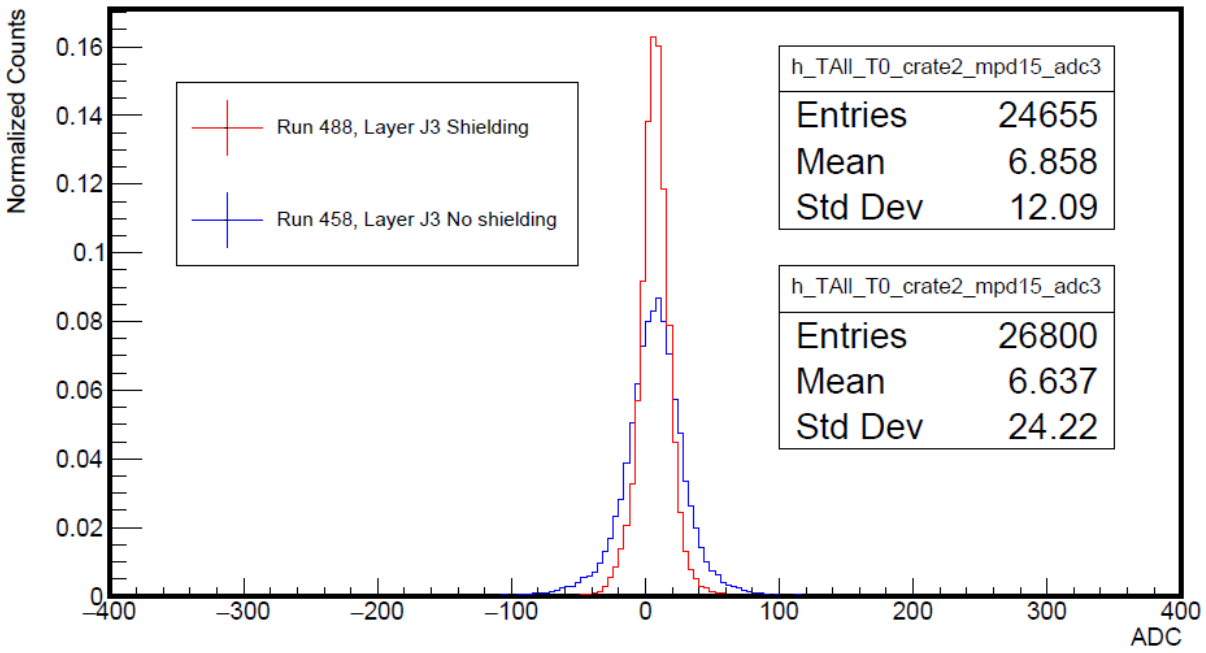

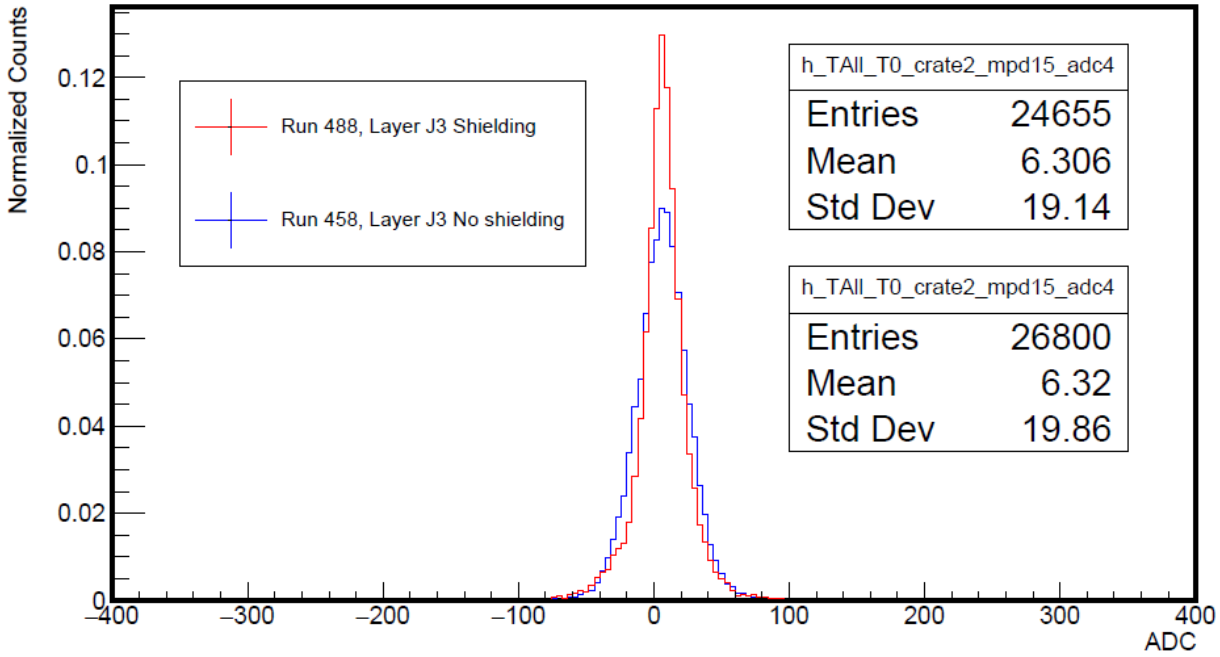

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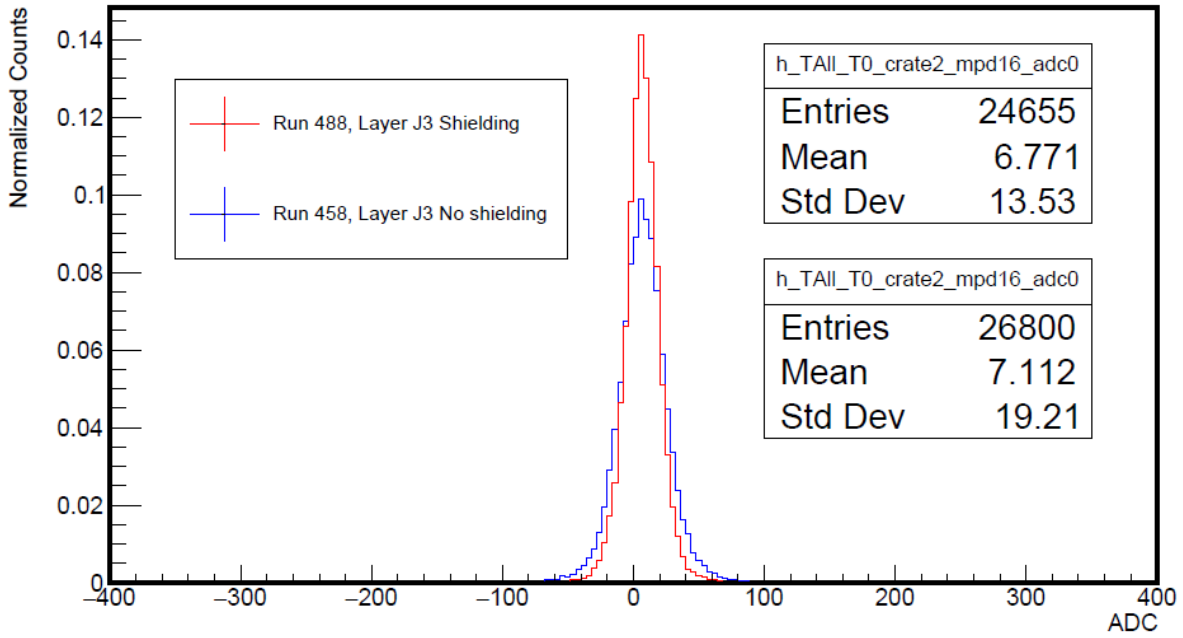

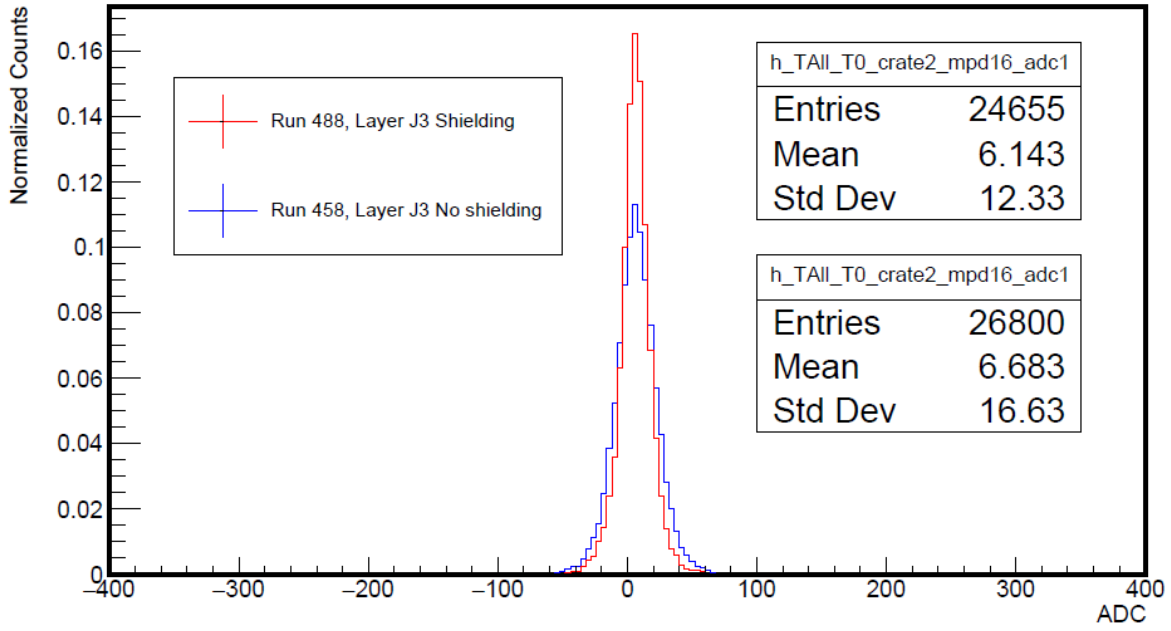

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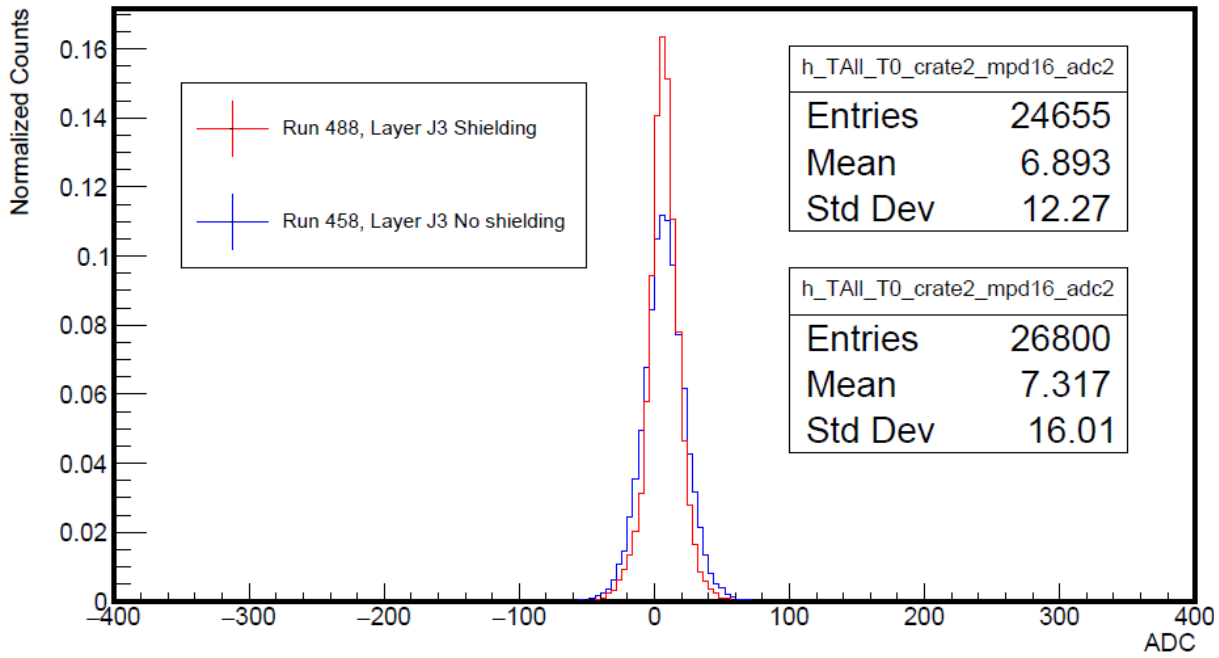

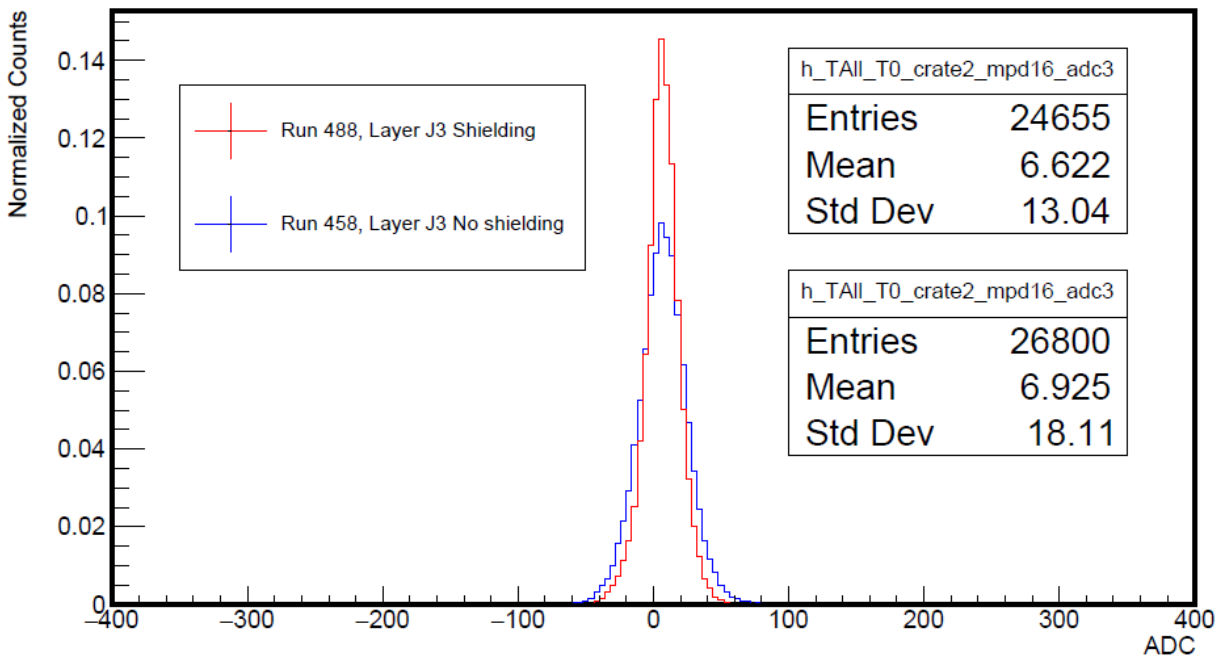

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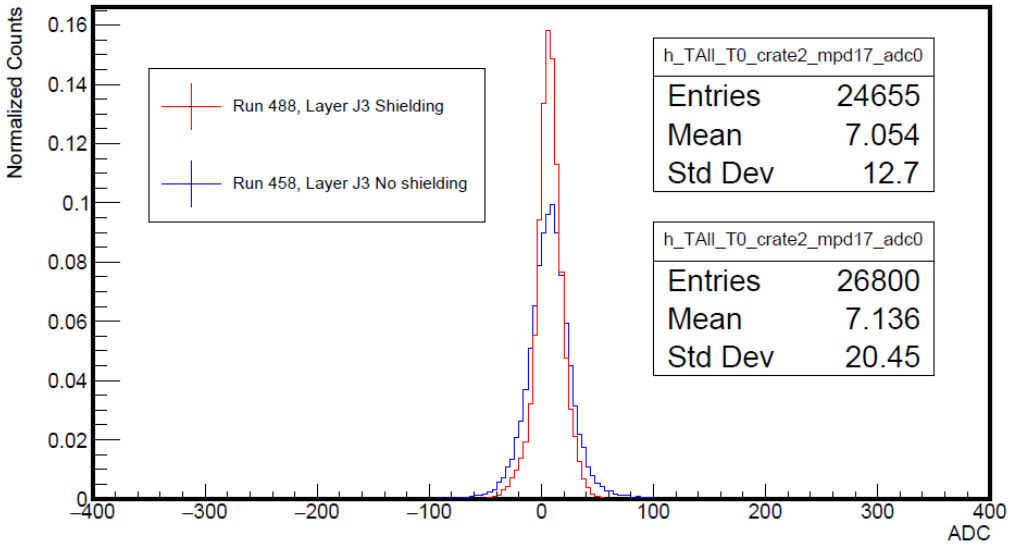

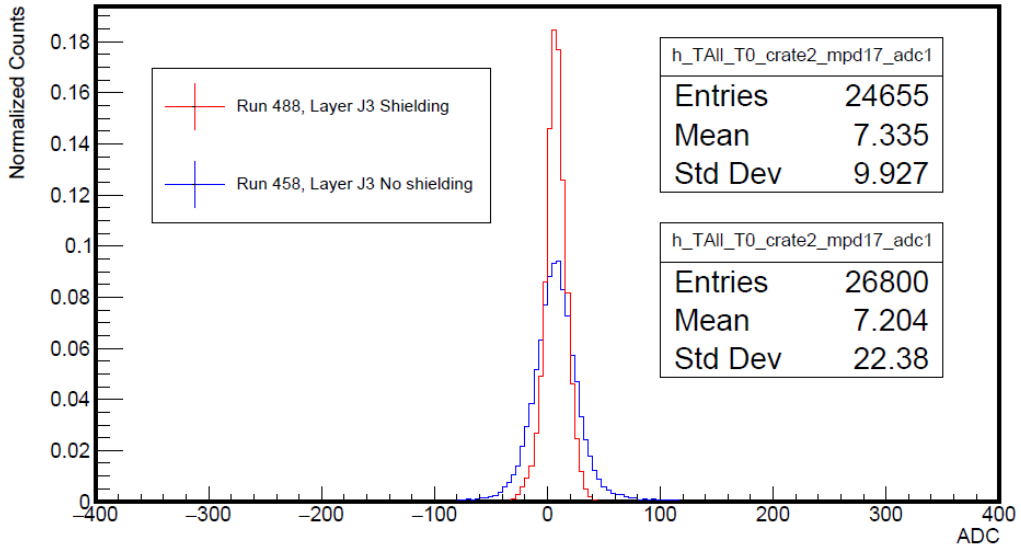

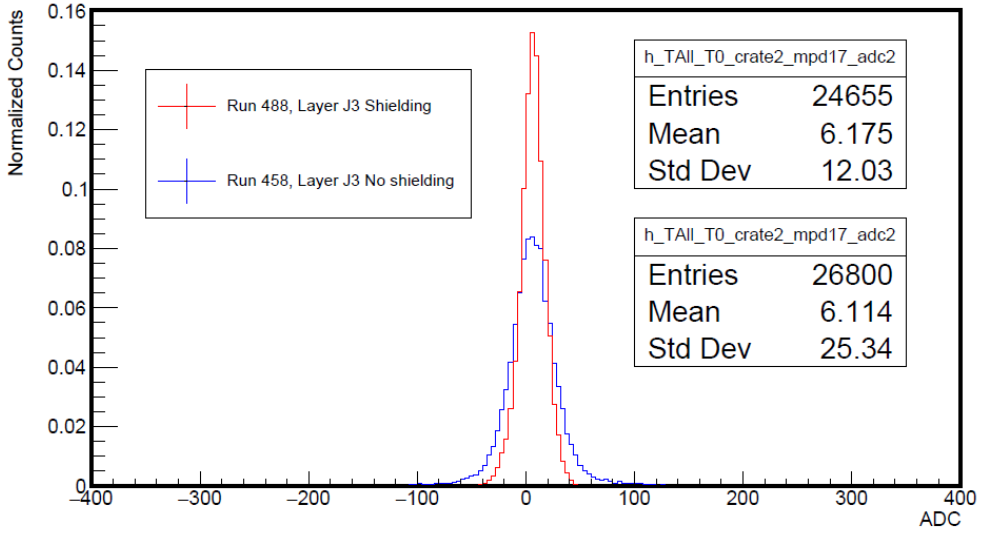

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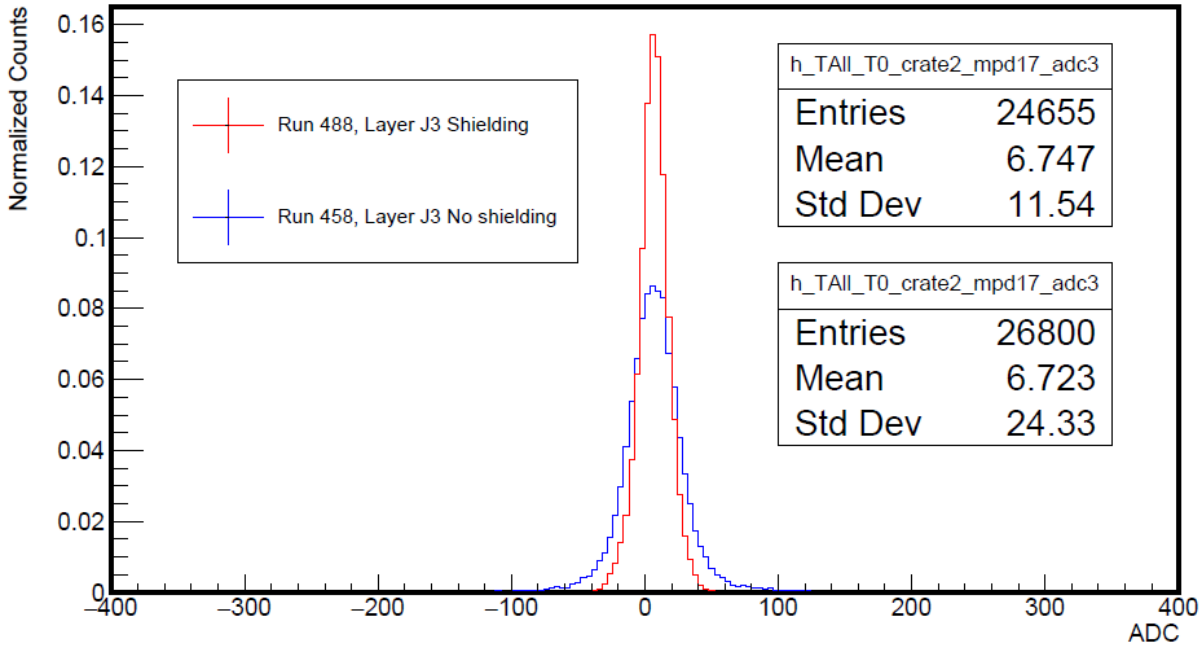

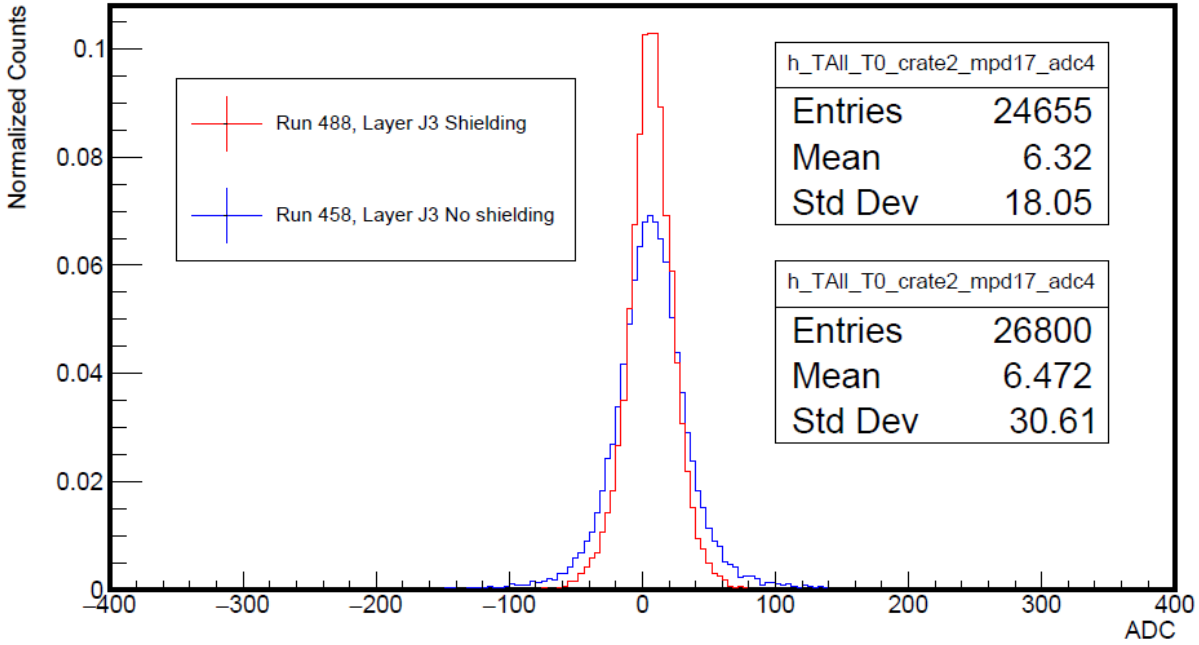

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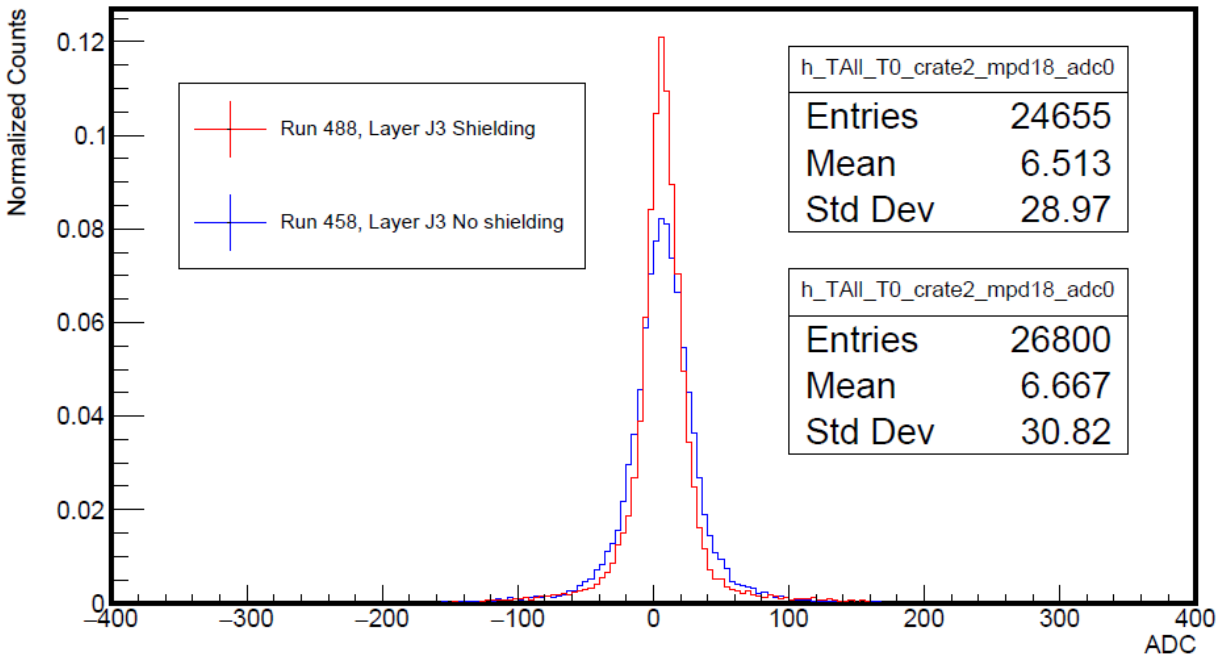

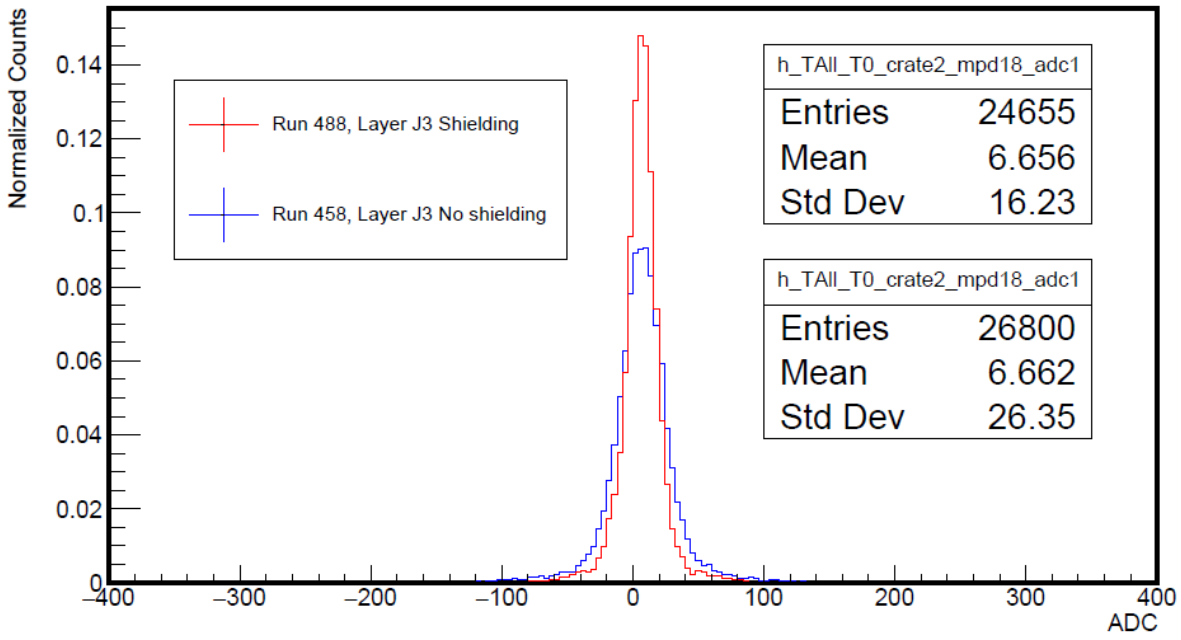

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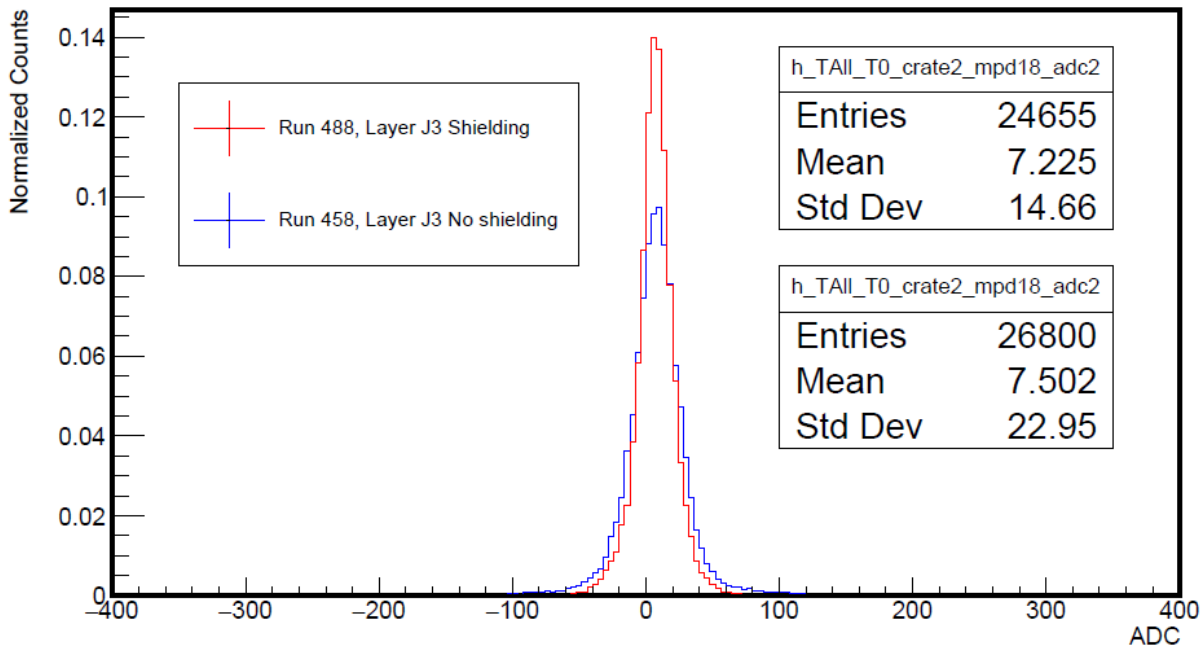
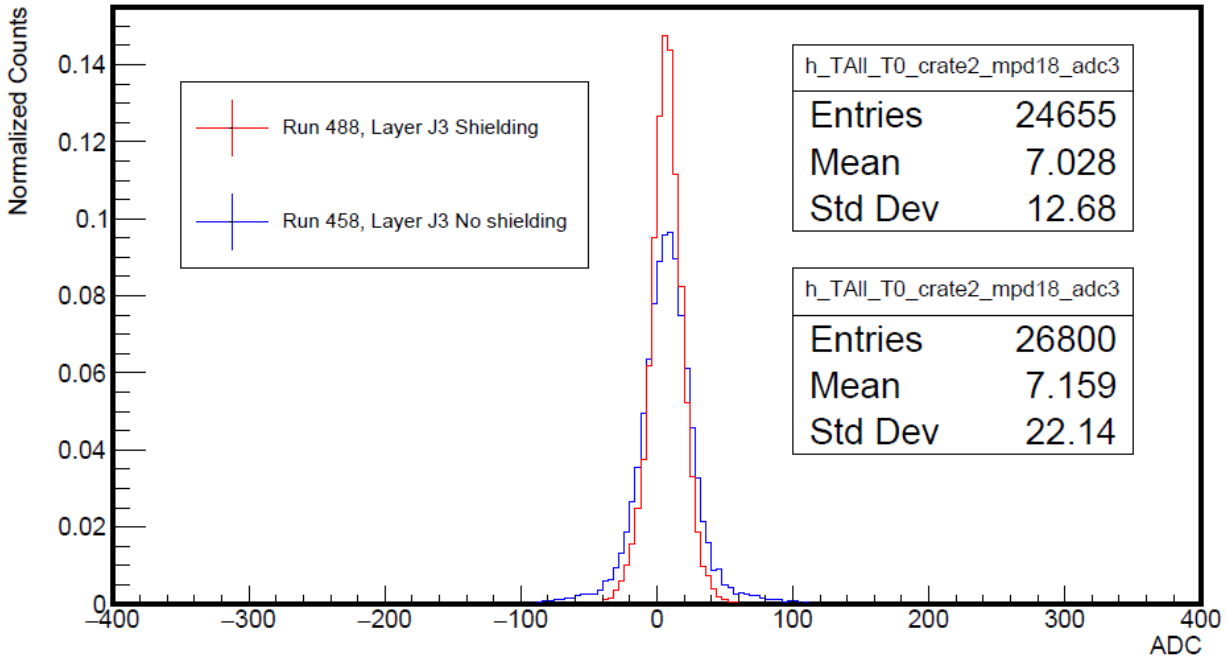




Conclusions:

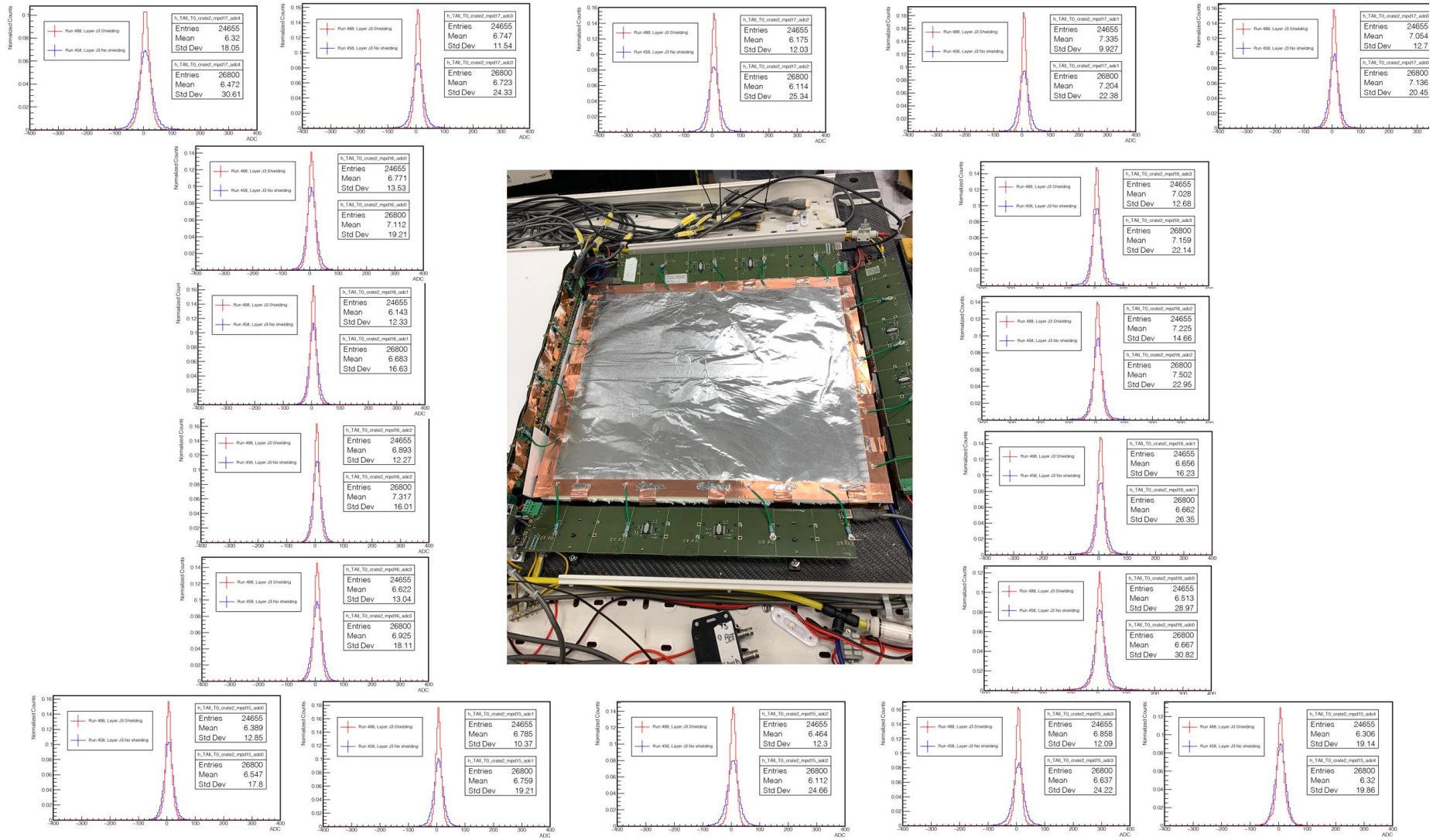
- Shielding the GEM module itself does improve the common mode fluctuation for most APV cards.
- Need to finalize the design for the INFN GEM modules
- Need to figure out modification procedure with said final design
- Process should be able to be done vertically
- Common Mode fluctuation is comparable to UVa shielded module

Common Mode Comparison: Test Lab Whole Module May 6

Run 458: Baseline pedestal of layer J3 without any shielding. Originally taken May 3

Run 488: Pedestal data for shielded module of layer J3.

One plot represents one APV card



HV Test during cosmic data Current (nanoAmp) vs Time (hour): TEDF May 7-9

- Ar/CO2 flow about 400 cc/min per layer

Bottom Module J0

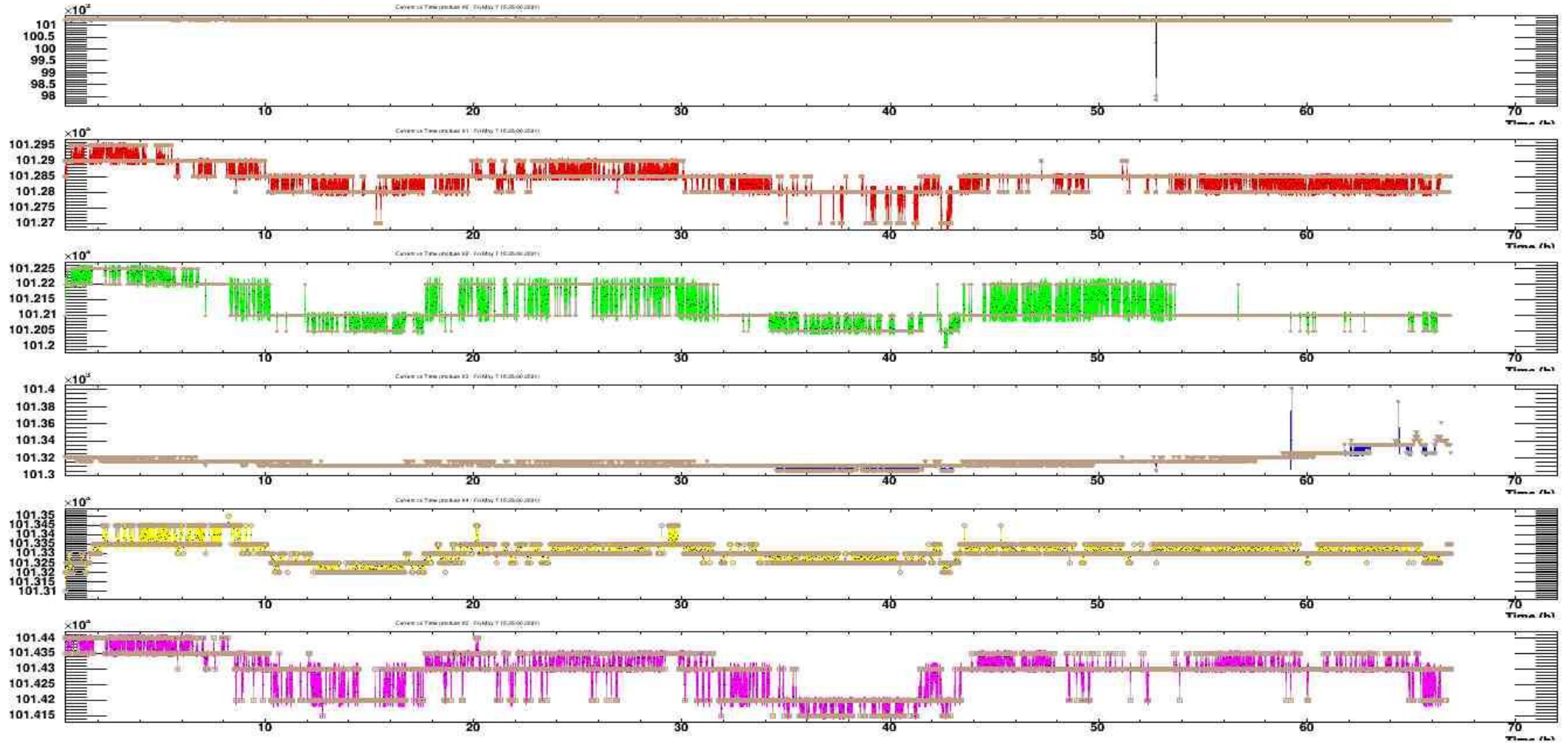
Middle Module J0

Top Module J0

Bottom Module J2

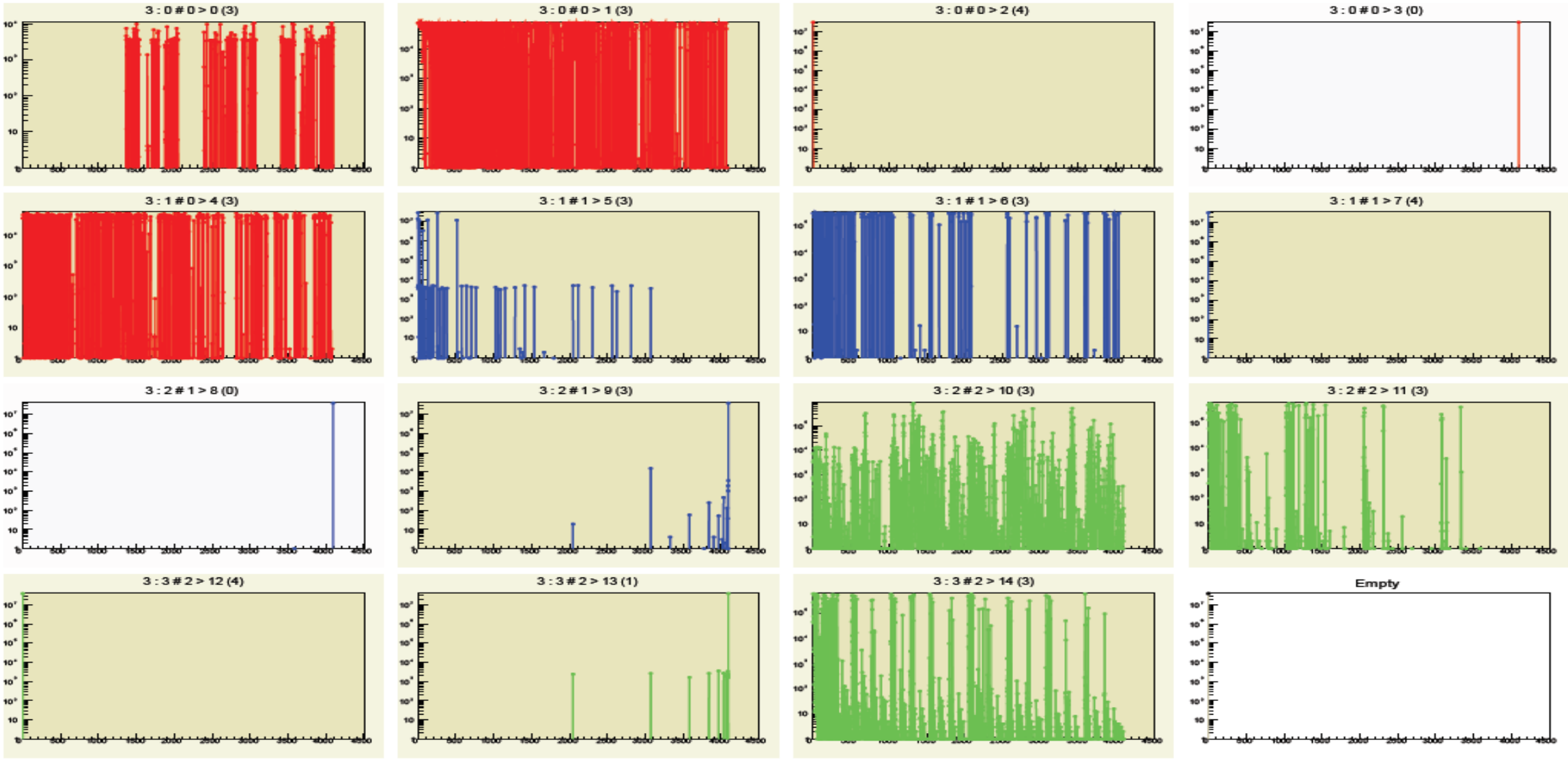
Middle Module J2

Top Module J2



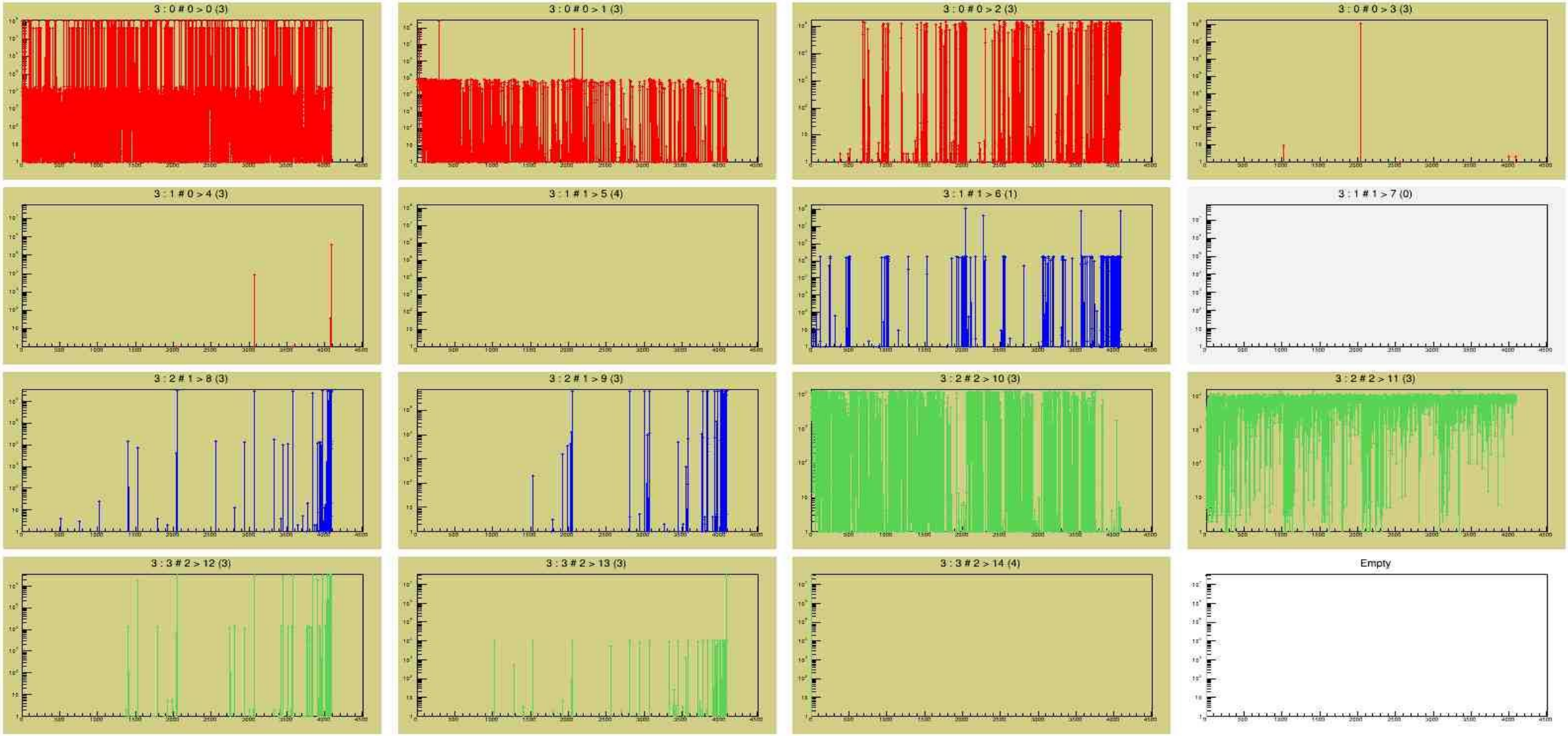
Low Level Histo Test (Amplitude vs ADC value): TEDF MPD 3 May 10

- Connected to layer J0



Low Level Histo Test (Amplitude vs ADC value): TEDF MPD 3 March 26

- Connected to layer J0



HV Test during cosmic data: TEDF May 10

- Conclude that HV divider for lowest module of J0 was arching to this APV card
- Jack and Holly witnessed the HV divider arch to Uva spare aluminum frame in BigBite
- Arch was about 2-3 inches long through humid air
- Evaluating all GEM HV dividers for features that may cause arching
- Jack ordered a silicone conformal coating, to be applied to the dividers
- This needs to be considered when shielding is being implemented
- Observed 3 APV ‘failures’ for 1st card 1st backplane of TEDF MPD 3 so far, closest HV divider

What to do next?

- Test Lab GEM Chambers
  - Make comparison between INFN Test Lab and TEDF. Data exists, just need to make plots
  - Change to metal cable trays for layers J1 and J3
  - Resolve Low Level Plots, due most likely to cable connections
  - Evaluate pedestal RMS plots and look for any noise cards, potentially altering APV cards
  - Once pedestals look good, take cosmic data and evaluate Hit Maps
  - If time permits resolve J4
- GEM Chambers in BigBite
  - **GEMs move with BigBite to Hall A on May 24th!**
  - Make progress with shielding these GEMs before move.
  - Resolve HV problems and test
  - Setup any remaining software/programs for INFN GEMs in TEDF configuration.
  - Take pedestal data and check multiple analysis forms: common mode subtraction, zero suppression, etc. for all TEDF GEMs
  - Look for any noise issues and see if we need to adjust grounding.
  - Documentation for LV, Low Level Troubleshooting, and in general. Basically manual update.

Questions?