



March 11th, 2026

LFHCAL Summing Tests and Studies

Friederike Bock, Oskar Hartbrich

ORNL



U.S. DEPARTMENT
of **ENERGY**

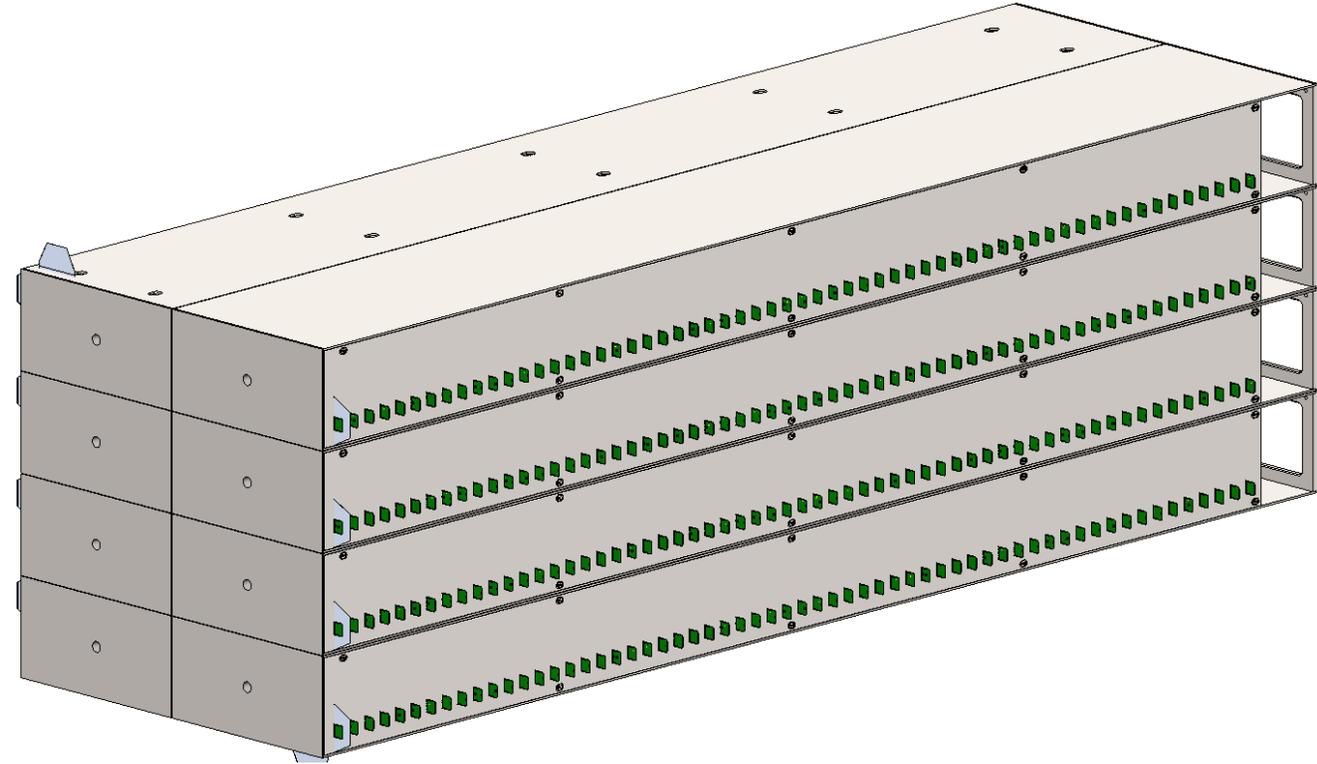
ORNL IS MANAGED BY UT-BATTELLE LLC
FOR THE US DEPARTMENT OF ENERGY



2026 LFHCAL Beam Times at CERN

- 8 full LFHCAL “8M” modules, fully equipped
 - 40cm * 40 cm * 130cm
 - 60 layers of scintillator, segmented 5cm x 5cm
 - Longitudinal summing of segments
 - Full HGCROC readout
- 1 week of CERN PS: Wk15 (April 8th – 15th)
- 1 week of CERN SPS: Wk20 (May 13th – 20th)

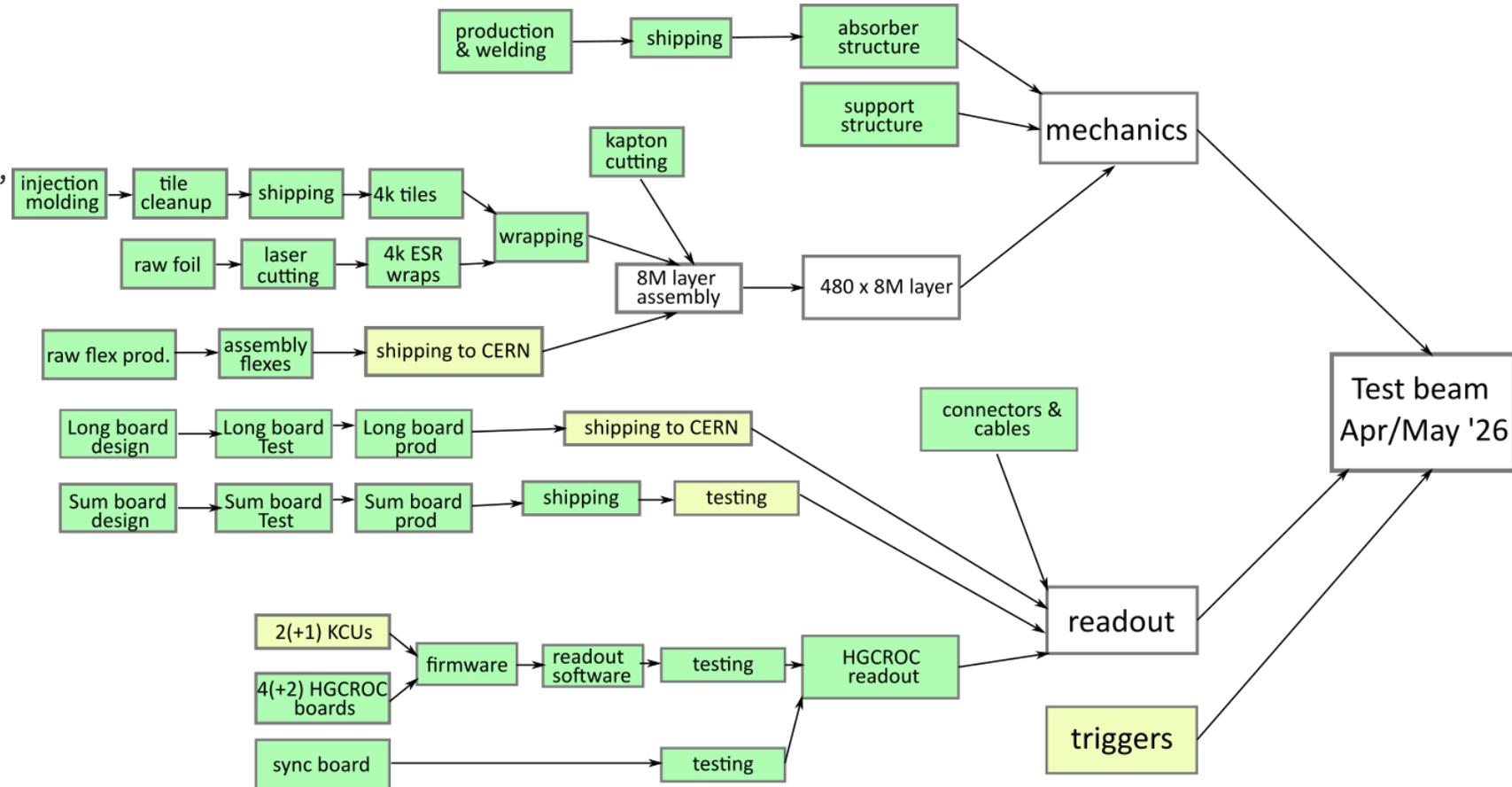
- 4x size of previous beam tests
 - Same number of readout channels due to longitudinal summing



Component availability

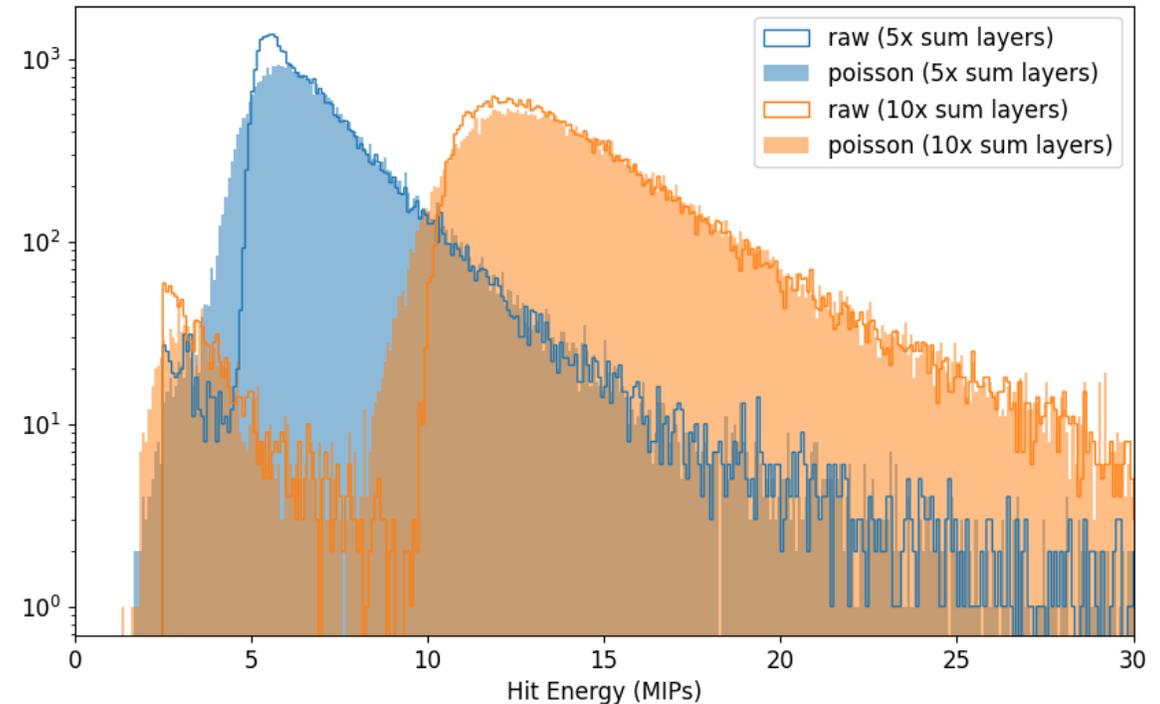
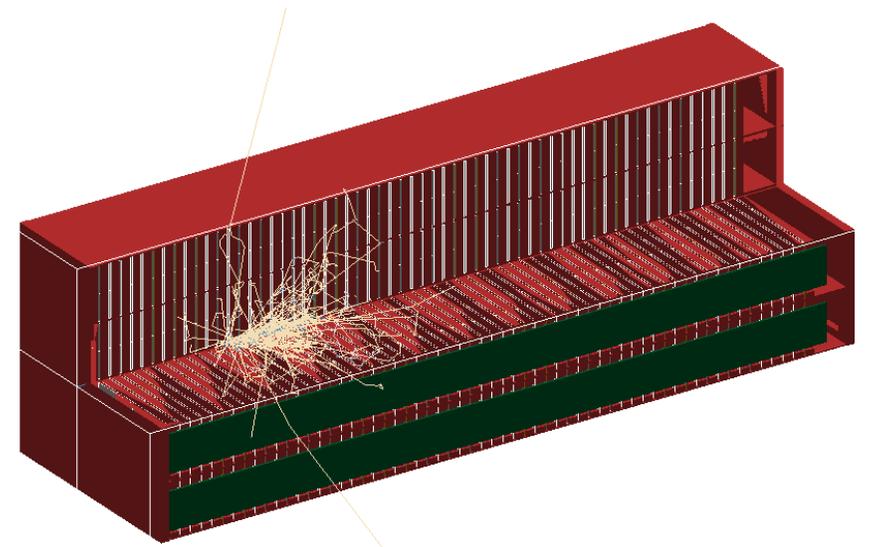
“Do you have all necessary hardware (components) available, and if not what is the timeline to receive them?”

- All parts now in hand (*)
 - Longboards direct-to-CERN, ETA 3 wks
- Large parts shipped to CERN
- Final assembly of active layers required at CERN:
 - Joining 2x4 scintillator modules with SiPM flex boards



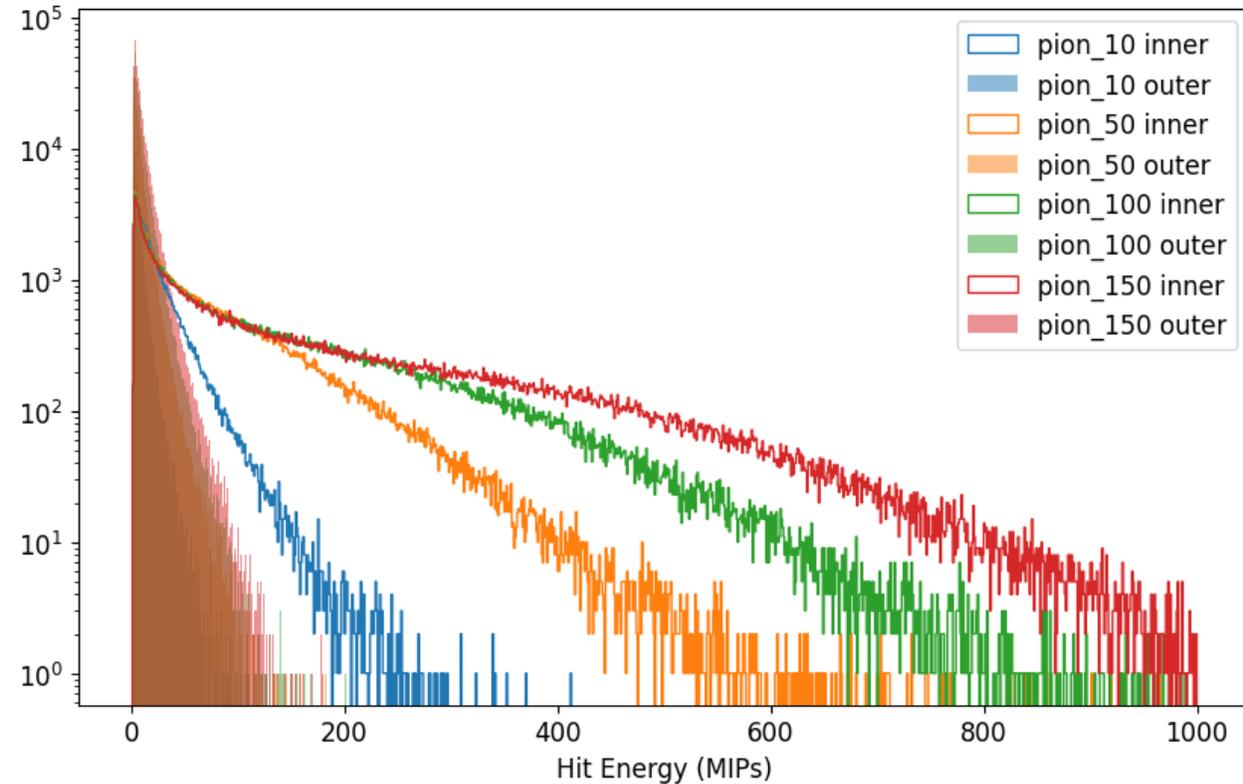
Preamplifier Setup Preparation

- Summing 5/10 layer segments (depending on depth)
 - Minimum signal is MIP in 5 layers
maximum is 10 layer sum in shower maximum
- MC Study (minimal digitization, deposition energies only):
 - Poisson smearing for photon statistics does not influence much
- Hit energies in “single layer MIPs”
- Single MIP in 5x sum layers is ~5.5 “single layer MIPs”
- Single MIP in 10x sum layers is ~12 “single layer MIPs”



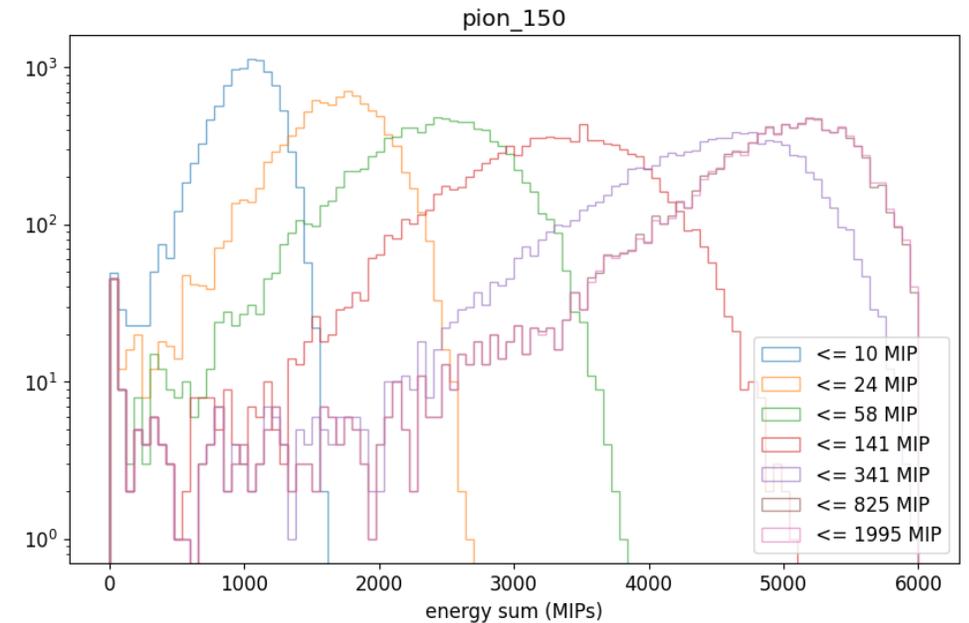
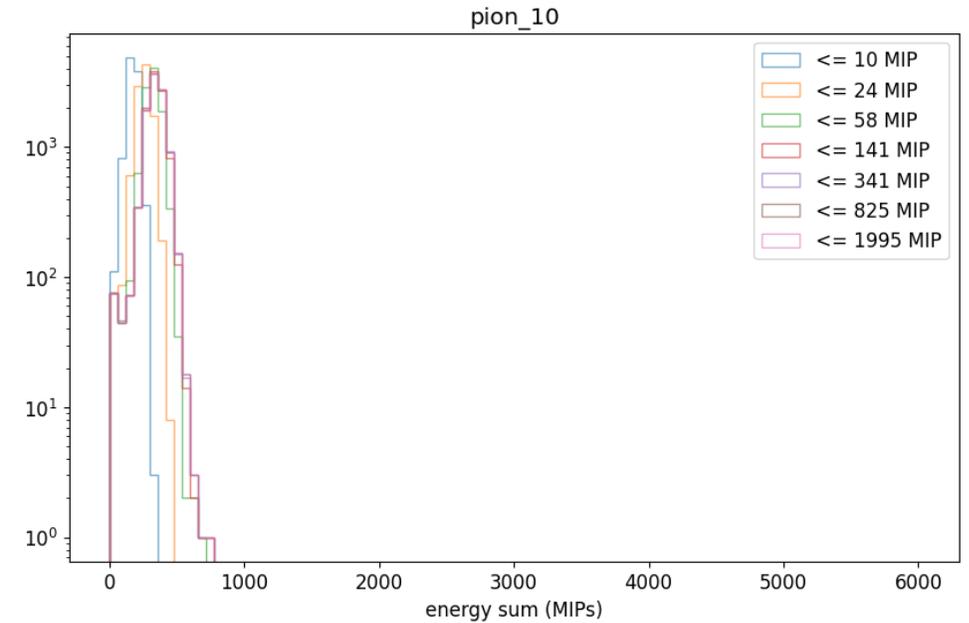
Preamplifier Setup Preparation

- 10-150GeV pions
- Hit energies have long tail up to 1000(ish) MIPs
 - Dominated by central tiles/towers
- How do we set the HGCROC input preamp to cover as much as possible on ADC?
 - What is the influence of ADC cutoff?
- HGCROC ADC is 10bit (1024)
 - Set 5x layer single MIP signal to ~ 30 ADC \rightarrow roughly 200MIP ADC coverage

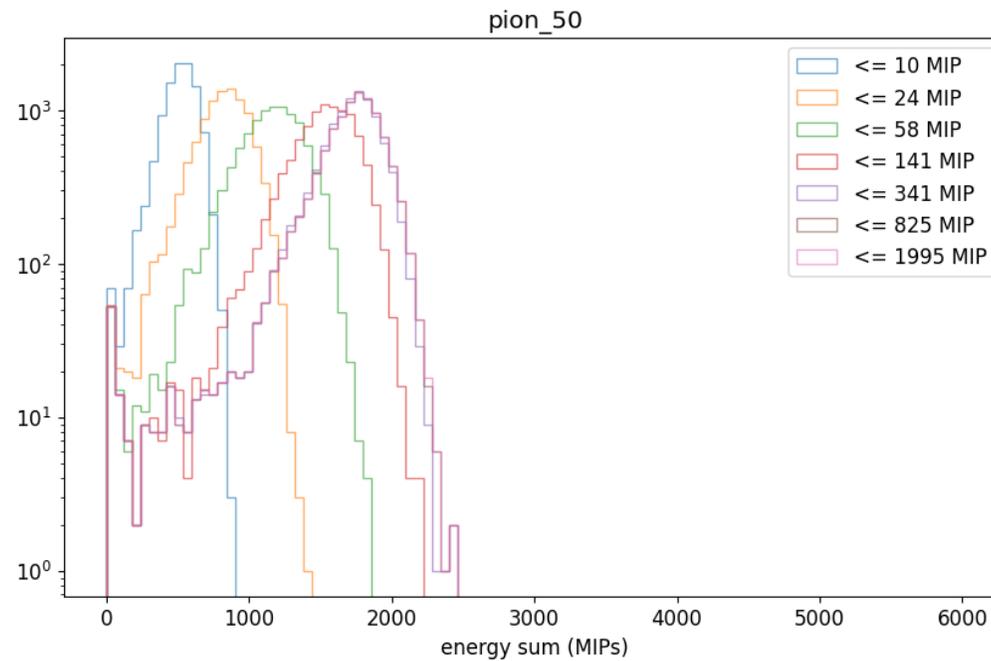
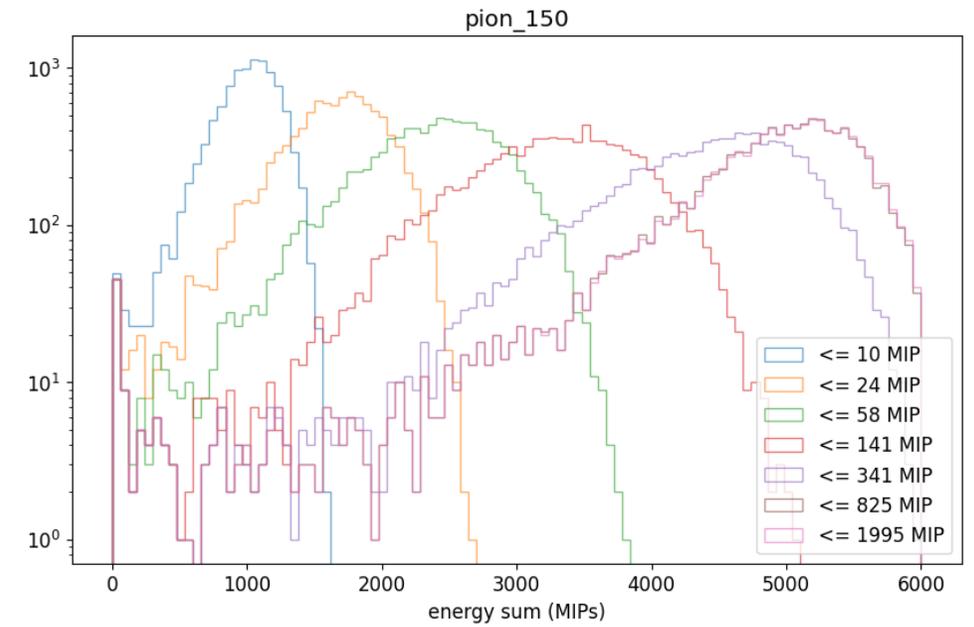
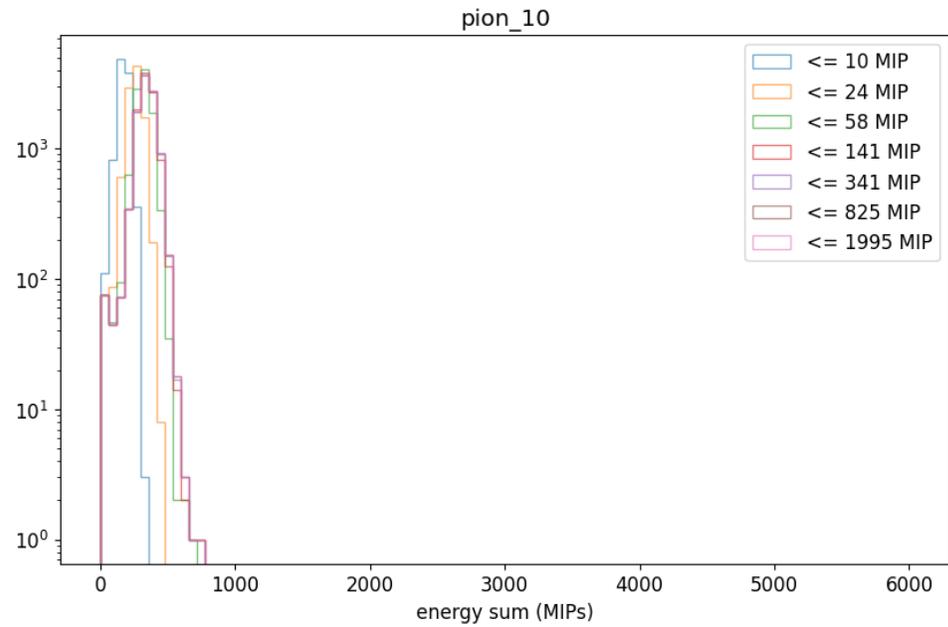


Preamplifier Setup Preparation

- 10-150GeV pions
- Hit energies have long tail up to 1000(ish) MIPs
 - Dominated by central tiles/towers
- How do we set the HGCROC input preamp to cover as much as possible on ADC?
 - What is the influence of ADC cutoff?

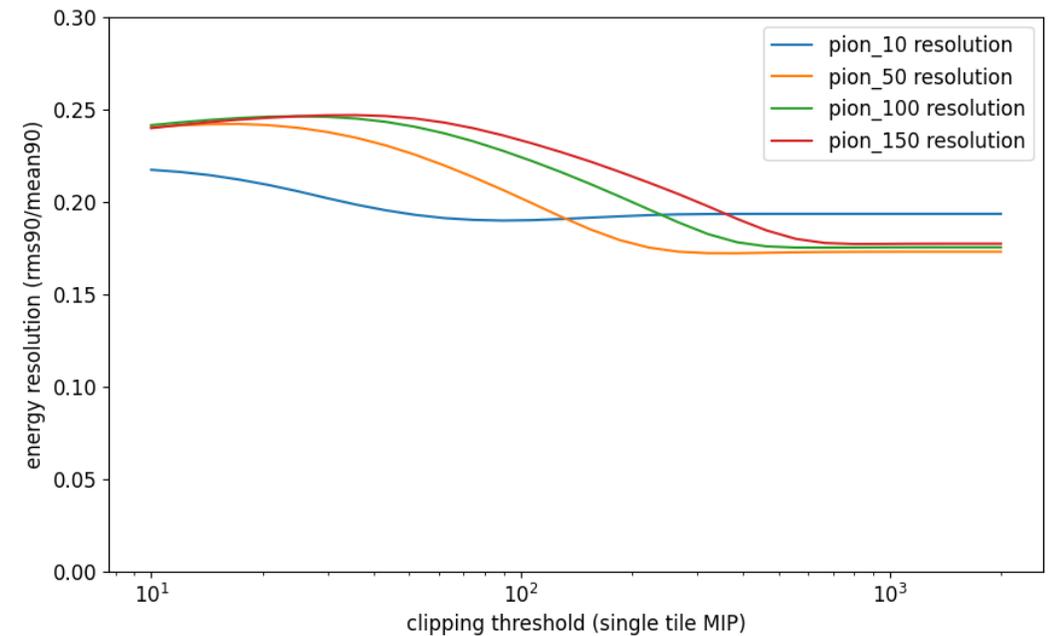
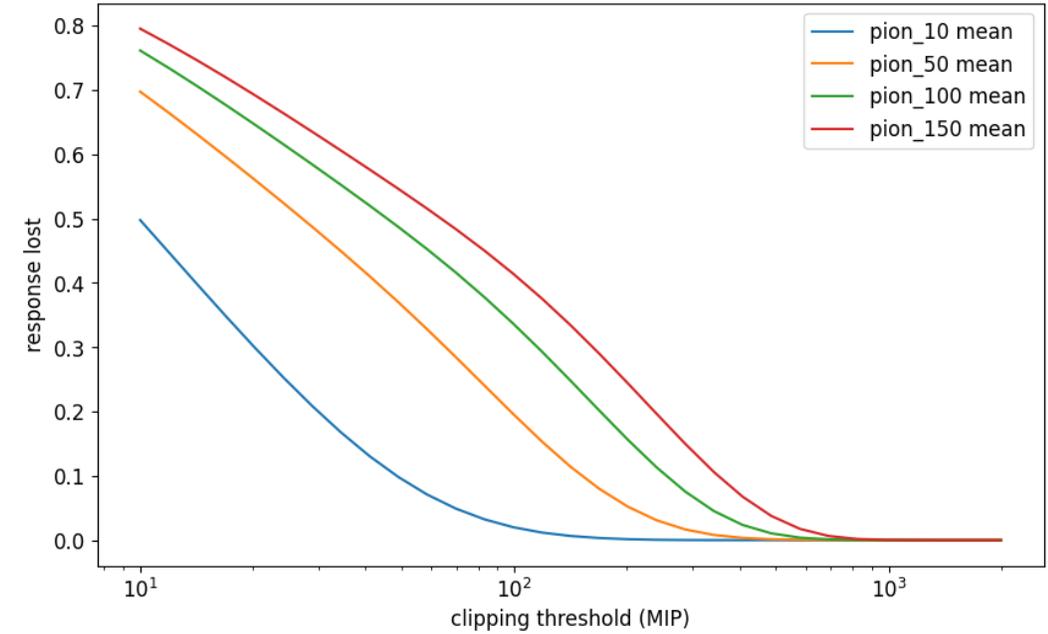


Preamplifier Setup Preparation



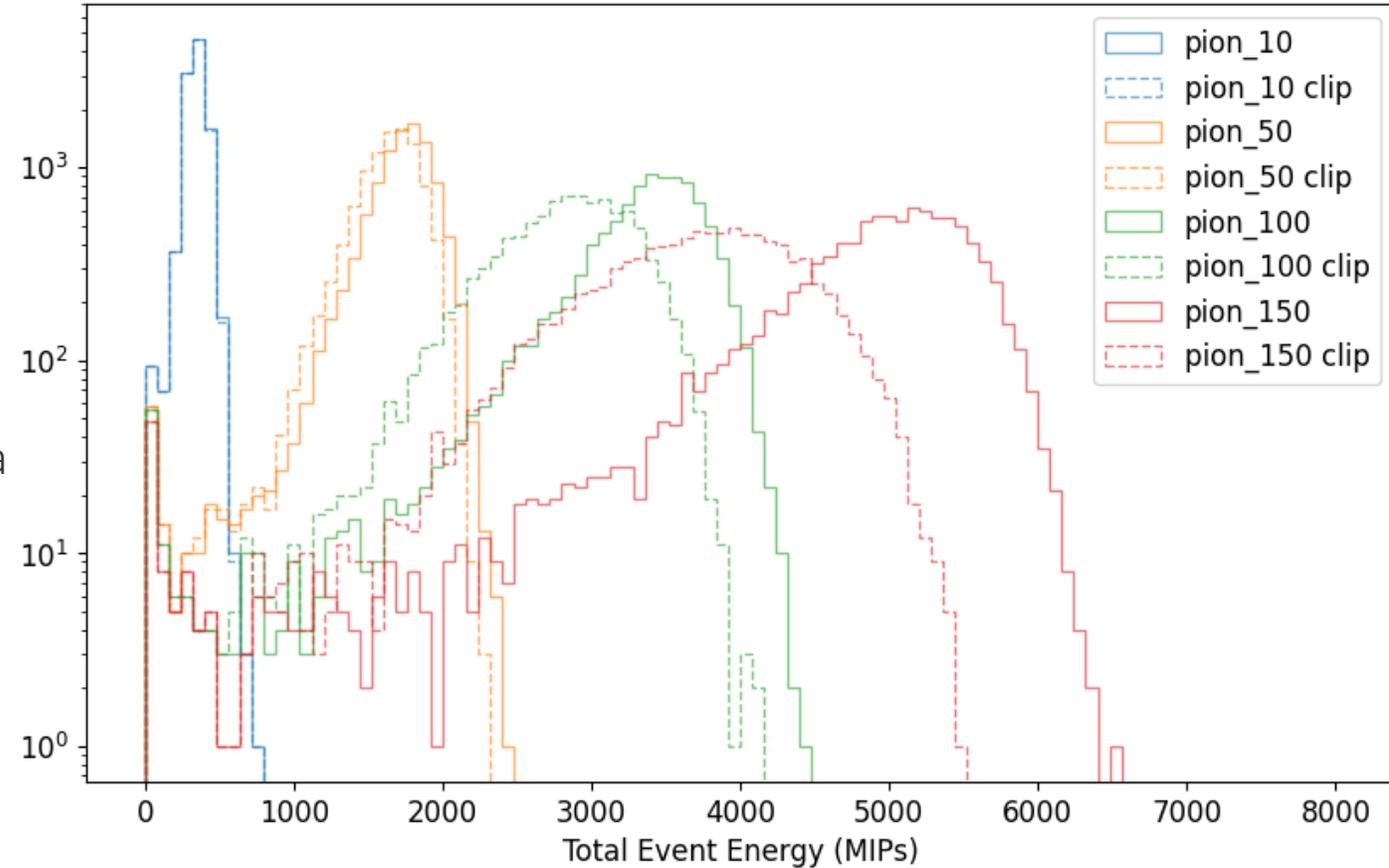
Preamplifier Setup Preparation

- HGCROC ADC is 10bit (1024)
 - Set 5x layer single MIP signal to ~ 25 ADC
-> roughly 200MIP ADC coverage
- Lose significant response at large hadron momenta
 - Loss of resolution is relative minor



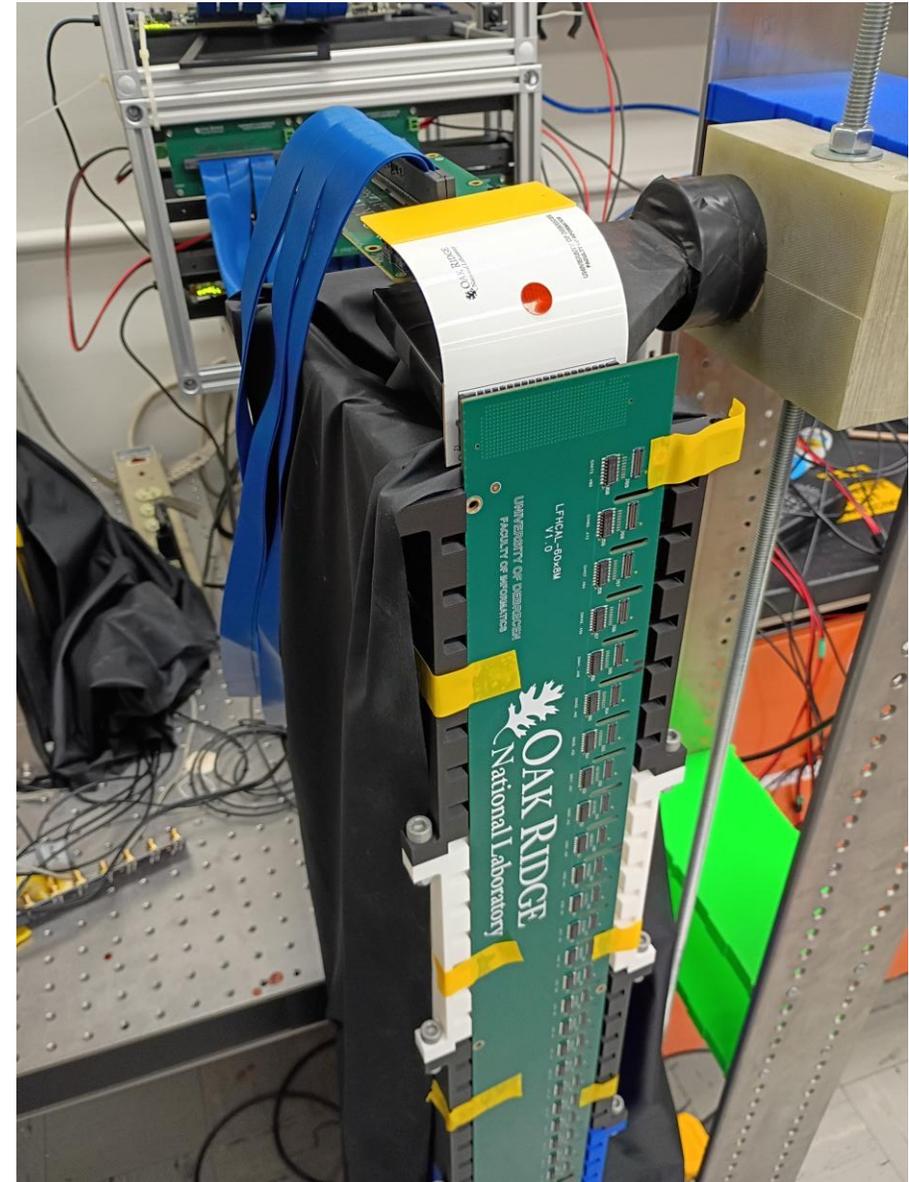
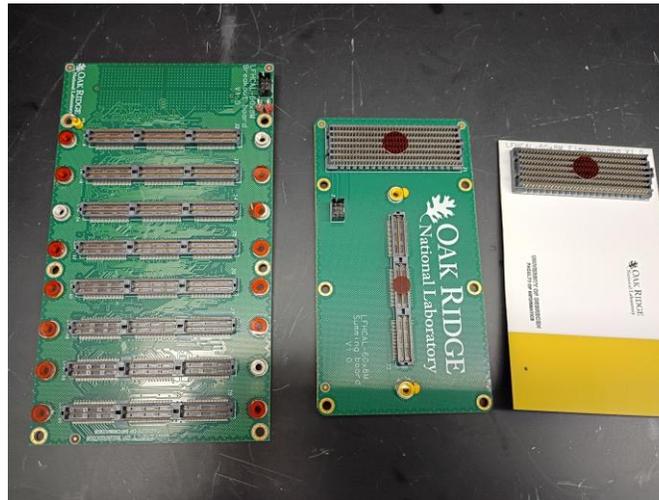
Preamplifier Setup Preparation

- HGCROC ADC is 10bit (1024)
 - Set 5x layer single MIP signal to ~ 25 ADC
-> roughly 200MIP ADC coverage
- Lose significant response at large hadron momenta
 - Loss of resolution is relative minor



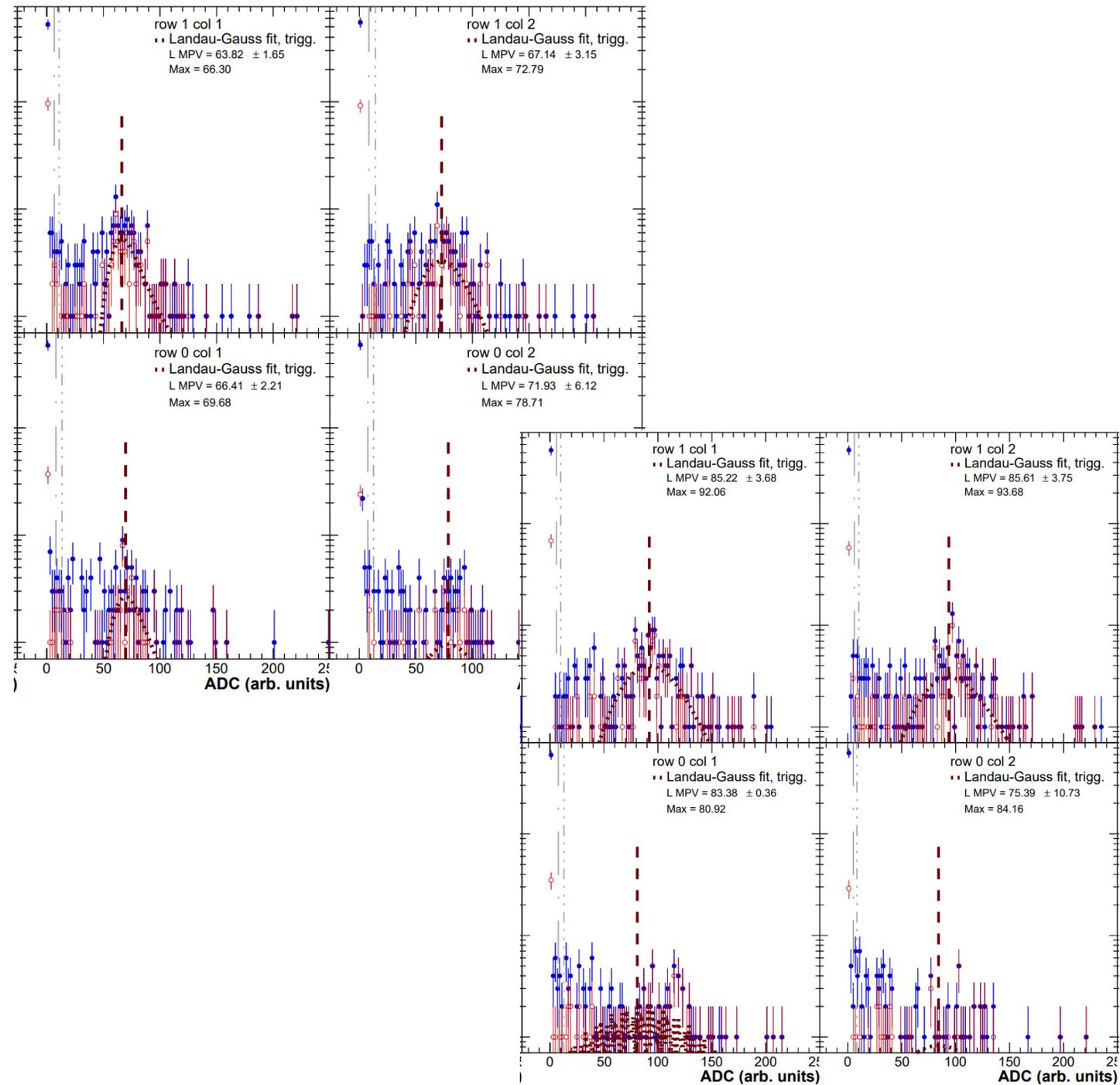
Summing Board in Practice

- Summing board + flex adapter at ORNL
 - Both [5, 5, 10, 10, 10, 10, 5, 5] and [5, 5, 5, 5, 10, 10, 10, 10] summing boards available
- Tested with vertical cosmics
 - (Before our KCU blew up, unfortunately)



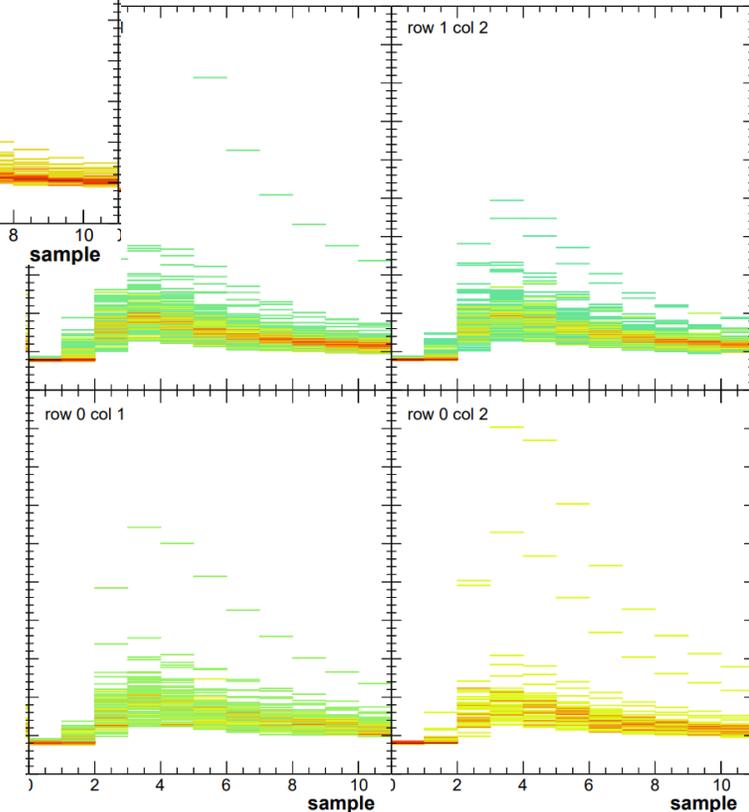
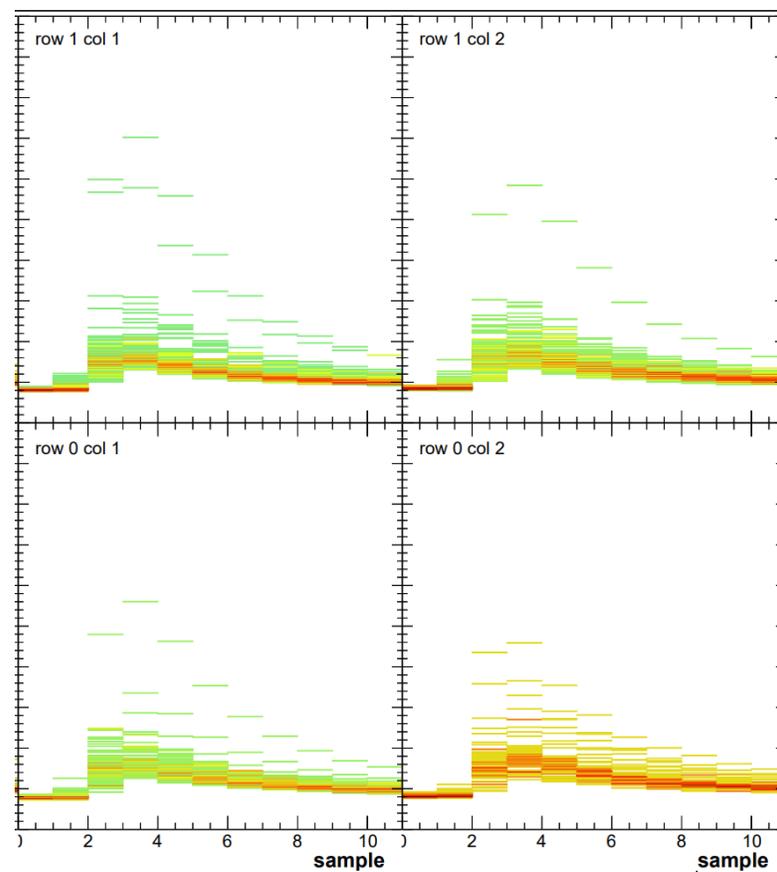
MIPs with Summing Board

- 5x summed layers MIP @ ~60
- 10x summed layers MIP @ ~80
- Why is 10x sum MIP not ~2x 5x sum MIP?



MIPs with Summing Board

- 5x summed layers MIP @ ~60
- 10x summed layers MIP @ ~80
- Why is 10x sum MIP not ~2x 5x sum MIP?
 - 10x sum has high capacitance than 5x sum, should slow signal a bit
 - Do we see that? Not sure.



Next Step

- Fix ORNL KCU
 - Supply voltage does not come up, working on it...
- Change preamplifier settings to move 5x sum MIP peak to ~25ADC
 - Alternatively, reduce bias voltage to same working point

