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LFHCAL CERN Beam Preparations

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U.S. DEPARTMENT
of ENERGY

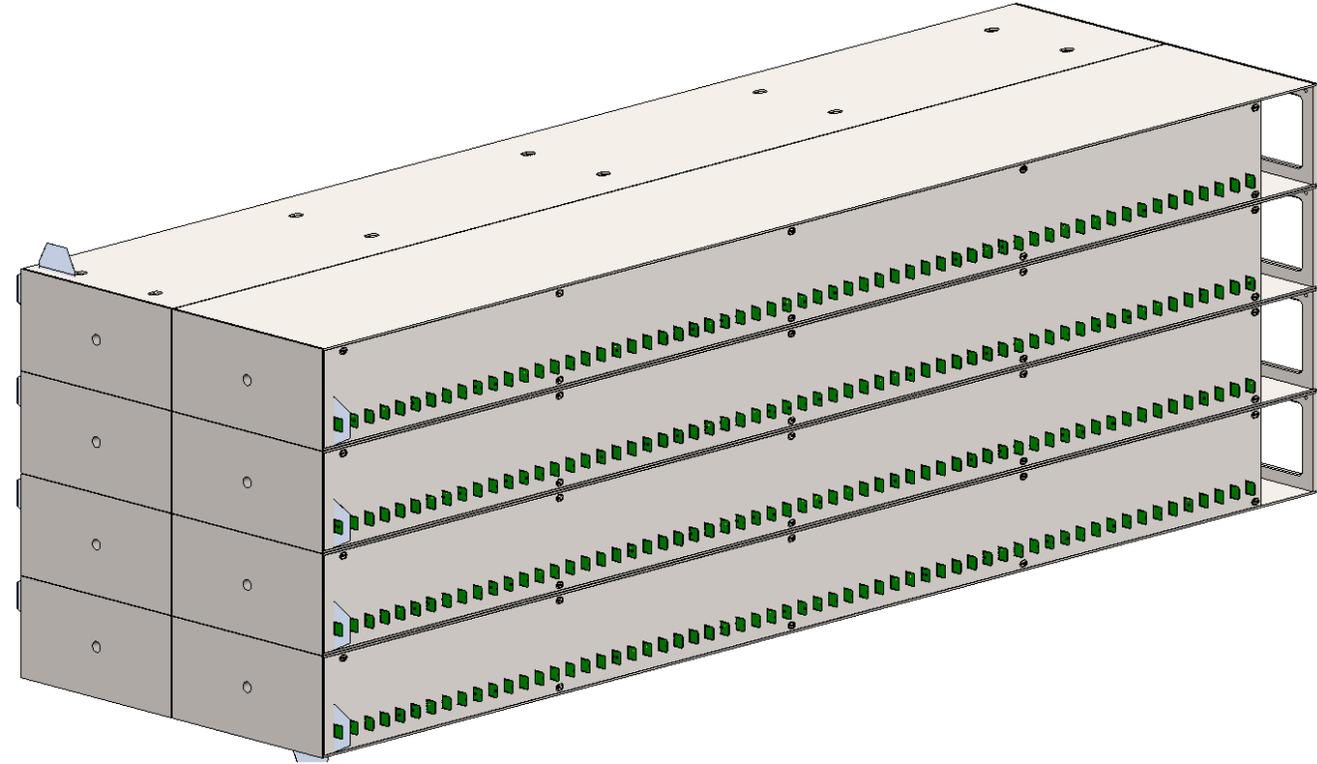
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2026 LFHCAL Beam Times at CERN

- 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)

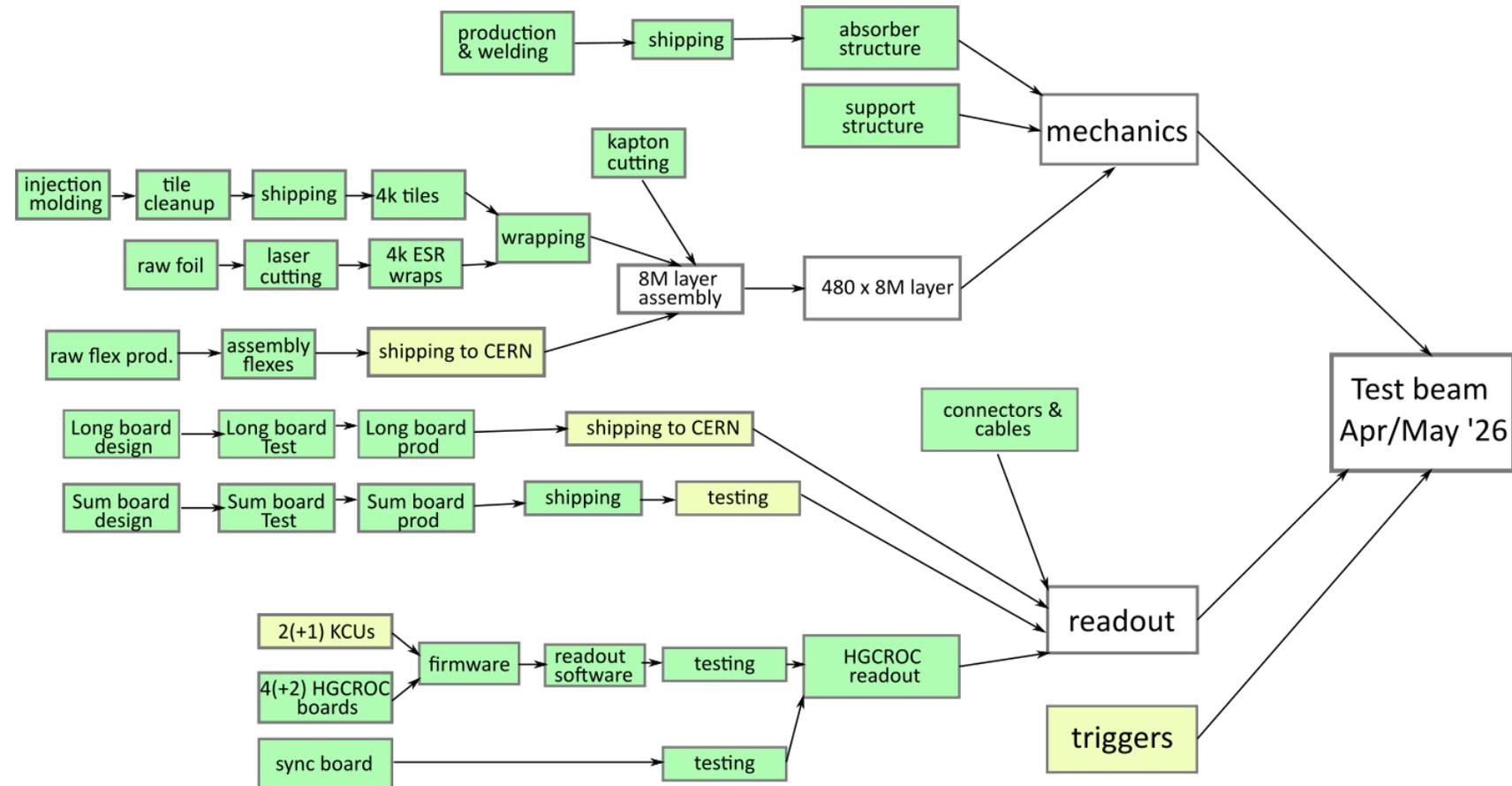
- 4x size of previous beam tests
 - Same number of readout channels due to longitudinal summing



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
- Large parts shipped to CERN
- Final assembly of active layers required at CERN:
 - Joining 2x4 scintillator modules with SiPM flex boards



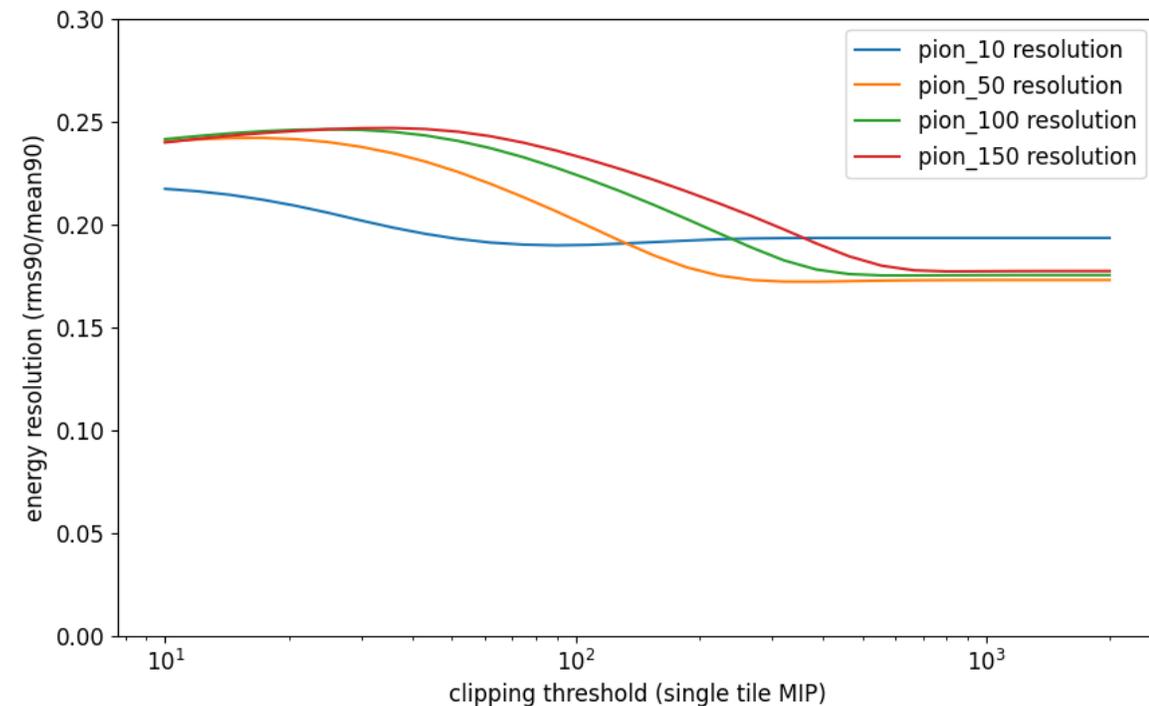
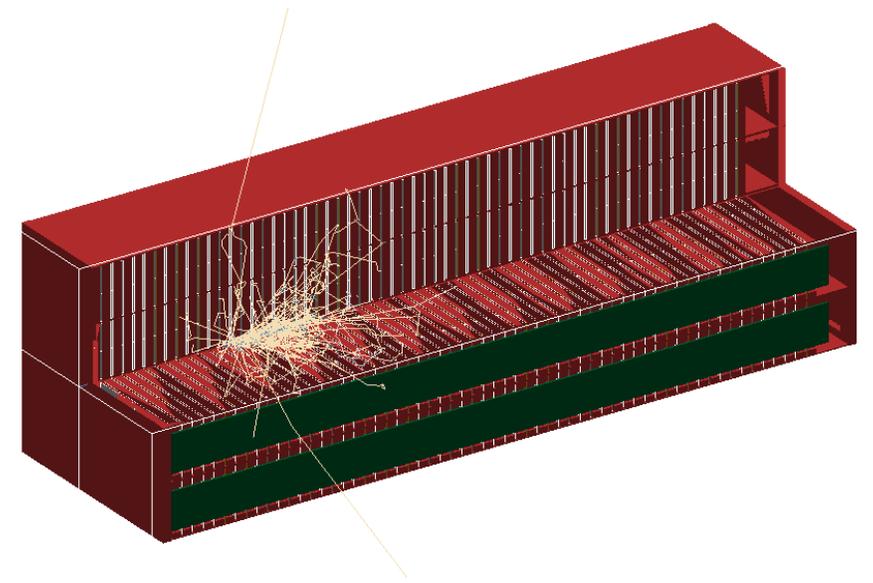
Goals & Run Plan

“Describe your scientific goals and the specific measurements and parameter scans required to fulfill it. ”

- Performance validation of full LFHCAL system with summing in longitudinal segments
 - New long transfer PCBs, summing boards
 - Summing requires modified HGCROC preamplifier settings, optimized ADC \leftrightarrow TOT turnover points
- PS: Low energy hadron response and resolution, MIP calibration
 - Validation of HGCROC preamplifier configurations for later high energy run at SPS
- SPS: High energy hadron response and resolution, MIP calibration
 - Fiducial volume of 8 module prototype will not contain high energy hadron showers

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):
 - Clipping hit energies in summed segments to few hundred single-tile MIPs barely influences overall hadron resolution
 - This is largely due to limited fiducial volume in prototype
 - We can fit this dynamic range on ADC scale!
 - TOT will cover the rest, but this operation is low risk
 - (more details on this study in LFHCAL meeting on Wednesday)



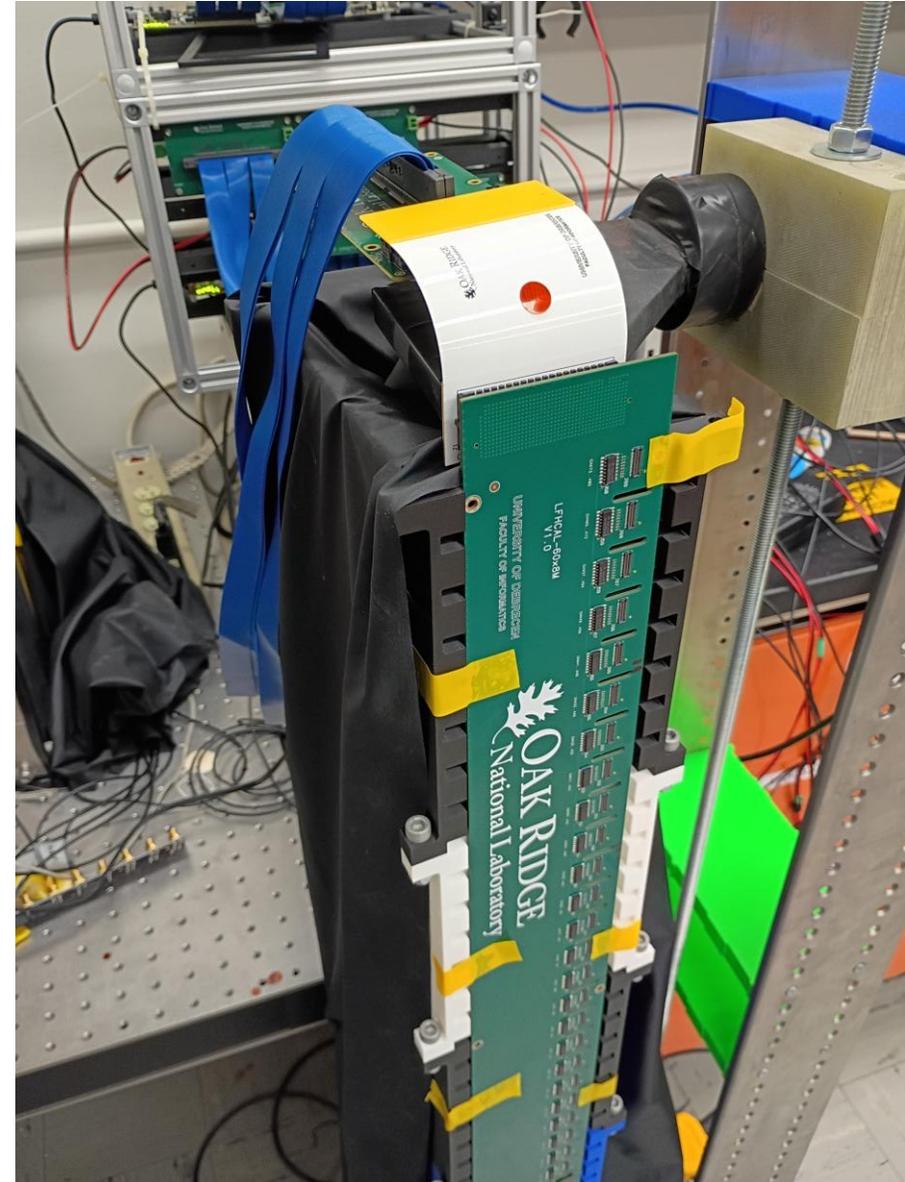
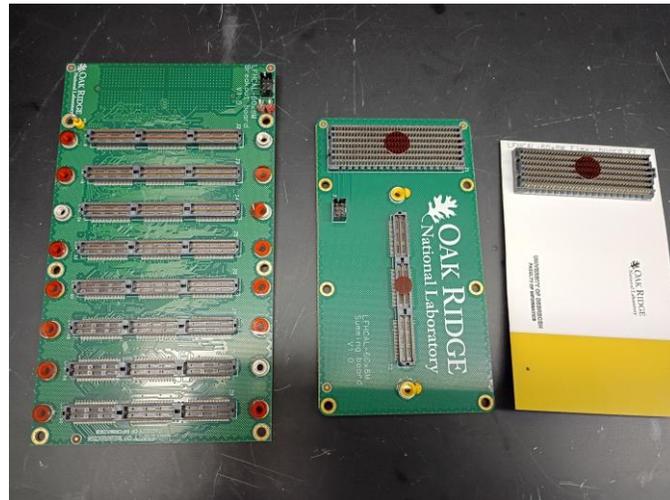
Run Plan

- PS:
 - Two preamplifier configurations predetermined in lab: “PS optimized” and “full SPS/EIC energy”
 - 1 day: validate preamp configurations with beams (muons, short hadron runs)
 - 1 day: PS optimized preamp hadron energy scan + MIP calibrations
 - 2-3 days: SPS optimized preamp hadron energy scan + SiPM bias scan
- SPS:
 - Validate SPS preamp configuration (muons, short hadrons)
 - Hadron (+electron) energy scan
 - SiPM bias scan

Run Plan

“Is the readout electronics and corresponding readout software running in the lab and thoroughly tested?”

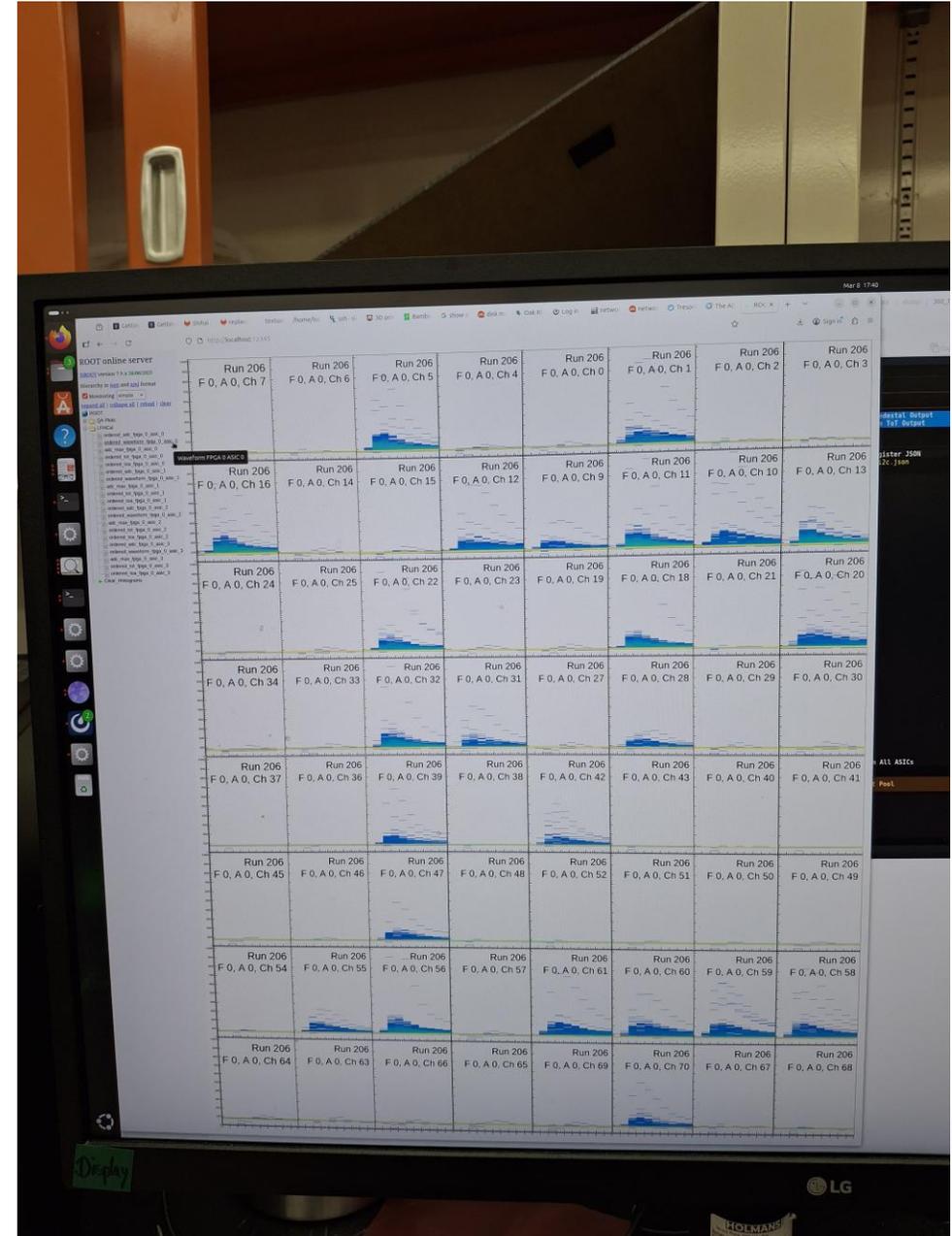
- HGCROC readout well validated in various beams by various DSCs
- Final version of summing boards just received last week
 - Running with cosmics at ORNL since weekend



Online Monitoring

“What type of "live QA" software do you have that helps you build confidence during the beam time that you are taking good data?”

- HGCROC online monitoring software developed by T. Protzmann (Lehigh) + inputs by F. Bock (ORNL) + others
 - Used in several beam tests of ePIC calorimeters, also ALICE FOCAL nowadays
 - (somewhat) seamlessly integrated in HGCROC DAQ operation
- Dedicated raw data integrity tools developed during last LFHCAL beam test



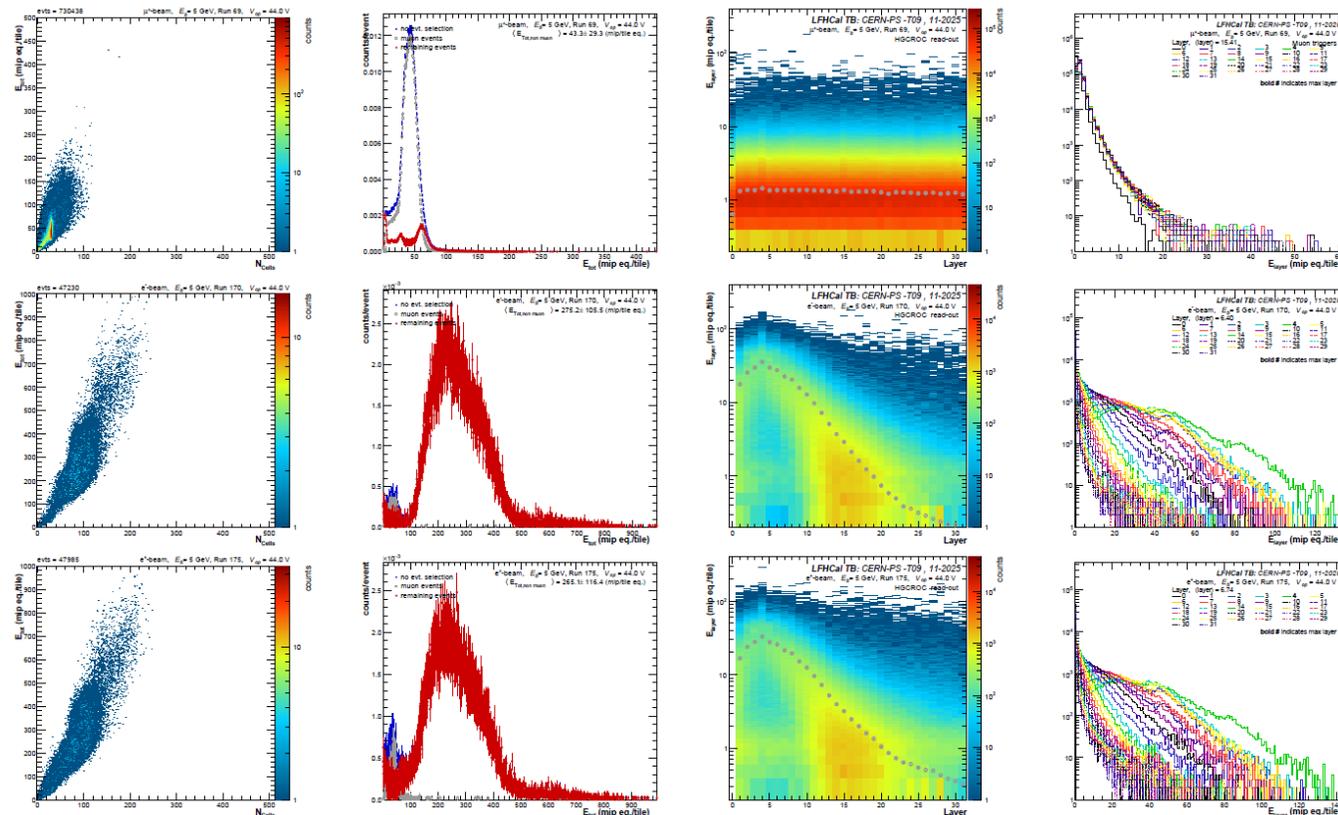
Previous Beam Test Analysis

“What is the status of data analysis of previous beam tests?
Which insights of previous beam tests are required to guarantee success of the upcoming beam test?”

- Previous beam test analysis is progressing (never fast enough)
- Analysis software is fully compatible with summed data
- Students are well trained for ad-hoc analysis of fresh data



First Look at MIP calibrated data



μ beam 5 GeV

e^- beam 5 GeV

e^+ beam 5 GeV

Similarity to Final ePIC Design

“Which components are matched to the ePIC detector design, and which ones are being used as intermediate/ad hoc solutions?”

- Setup is assembled from latest engineering test articles
 - Steel absorber modules, scintillator modules, long transfer boards, summing boards all “final” as far as we know.
- Everything but HGCROC readout board is final ePIC spec.
 - HGCROC will be replaced by CALOROC + ePIC RDO streaming
 - Readout ASIC + RDO is plug-and-play into otherwise fully assembled modules

Summary

- Biggest (and last) LFHCAL beam test campaign will start in 4 weeks
 - First beam test with summing electronics
 - As close as possible to final ePIC module specs
- Everything available and on hand
 - partial delivery directly to CERN with some local assembly required

