ECal Calibration, Performance, and Simulation

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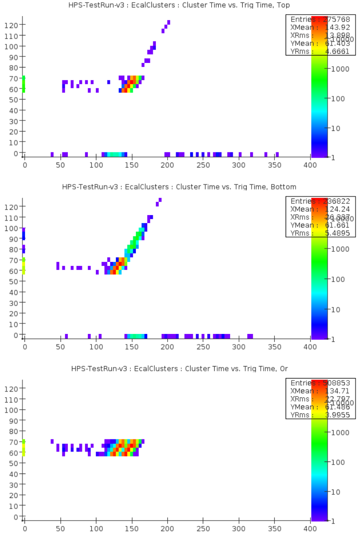
Overview

- Trigger checking: Did the trigger work as designed?
- Trigger performance: Did the trigger do what we wanted?
- ECal calibration: in progress

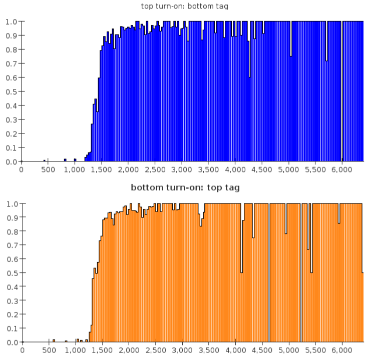
Trigger checking: decision and timing

- Take readout hits (integrated over fixed window) and estimate trigger hits (integrated over time-over-threshold); cluster using CTP algorithm, simulate trigger decision
- Actual performance of trigger matches simulation
- Actual trigger time matches trigger time predicted based on hit times



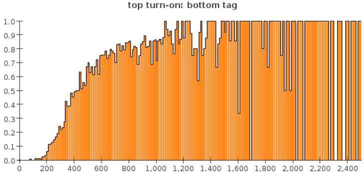
Trigger checking: tag and probe

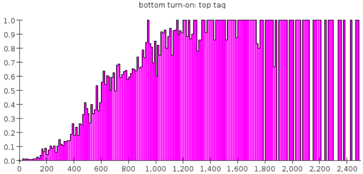
- To check trigger performance in top half:
  - Look at events where bottom trigger fires (no trigger bias) and only one probe cluster in top half
  - Calculate trigger efficiency as function of probe cluster energy
- Trigger turns on at around 1280 ADC counts on both halves, as expected

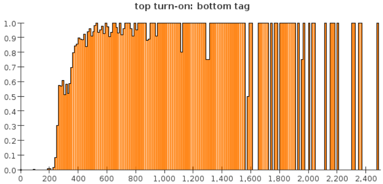


Trigger performance

- Do the same thing, but with calibrated cluster energy
- Turn-on curve is much less steep:
  - Spread in crystal gains means trigger threshold varies by position
  - Time-over-threshold integral is not linear in amplitude, so a cluster split across two crystals needs higher energy to trigger: plot below shows turn-on curve without spread in gains

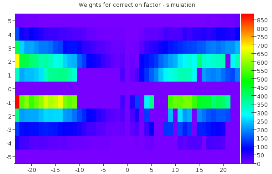


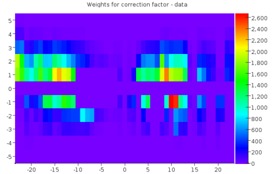


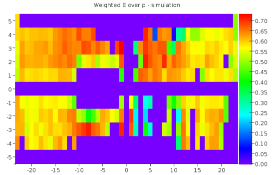


Calibration: MC and data

- Generate MC sample with same target as data
  - Needs further work on relative alignment of SVT and ECal so distribution of matched clusters is the same
  - Bad crystals (dead/noisy) are removed from both MC and data
  - Data should really be background-subtracted, but using 1.6% X_0 run (1351) minimizes effect of background
- Calculate average E/p for each crystal
  - Match ECal cluster with energy E_i to SVT track with momentum P_i
  - Each crystal j in cluster has weight $w_{j,i} = E_{j,i}/E_i$
  - Compute crystal E/p: $\dfrac{\sum_j w_{j,i}}{\sum_j \frac{P_j}{E_j} w_{j,i}}$

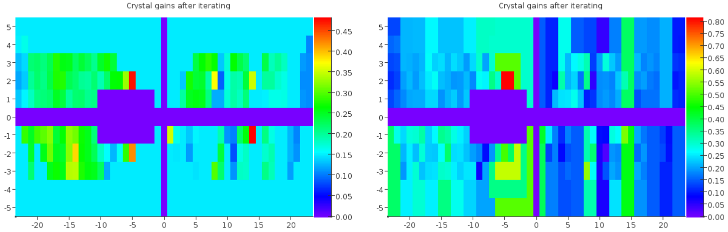






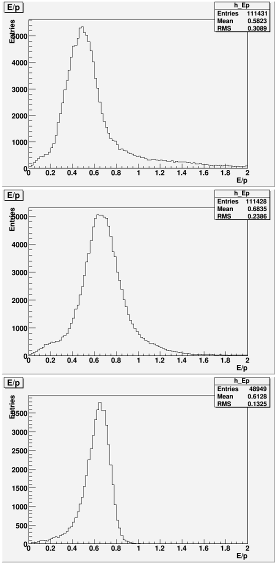
Calibration: gains

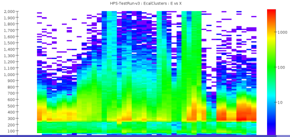
- Equalize crystal E/p between data and MC
  - Scale crystal gain by the ratio of data and MC values of E/p
  - For crystals with insufficient statistics, use the whole HV group
- Apply new gains (i.e. trigger threshold) to MC; iterate
- These gains give the correct calibration from ADC counts to energy deposited in each crystal
  - We still need to use E/p result to correct for sampling fraction—go from energy deposited and read out to incident particle energy

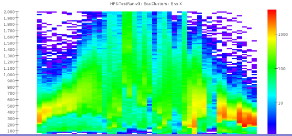


E/p distributions

- E/p distributions approach simulated distribution as expected (on right: data before cal, data after cal, simulation)
  - Clearly still not great (wider peak, clusters with E/p > 1)—mismatch between data and MC hit distributions means some crystals are not really calibrated
- E vs. X plot shows expected shape (on bottom: before and after cal.)
- Center of ECal doesn't see charged particles and can't be calibrated with tracks
- Some HV groups with very low gain don't trigger enough for the calibration to work

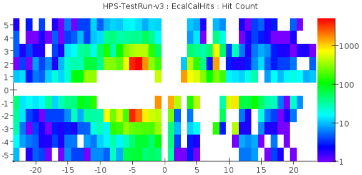


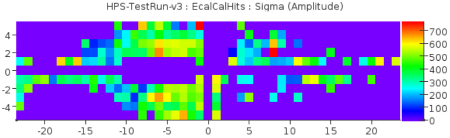


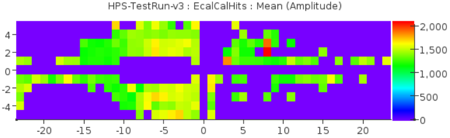


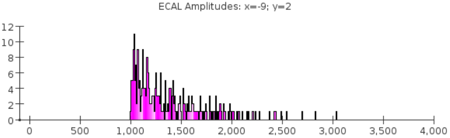
Hits in calibrated ECal

- Selecting only hits above the trigger threshold, ECal hit occupancy and hit energy distributions look smooth—remaining crystals are probably good
- So we have: 39 dead crystals, 5 noisy crystals, 13 crystals not wired to the trigger, 385 good crystals









Next

- Further work on calibration
  - Find correct detector geometry, check data vs. MC
  - Look at and subtract empty-target run
  - Calibrate remaining sections of ECal using rates, energy distributions
- Sampling fraction correction to energy
- Cluster position?
  - Already uses shower depth correction; crystal interpolation might be useful