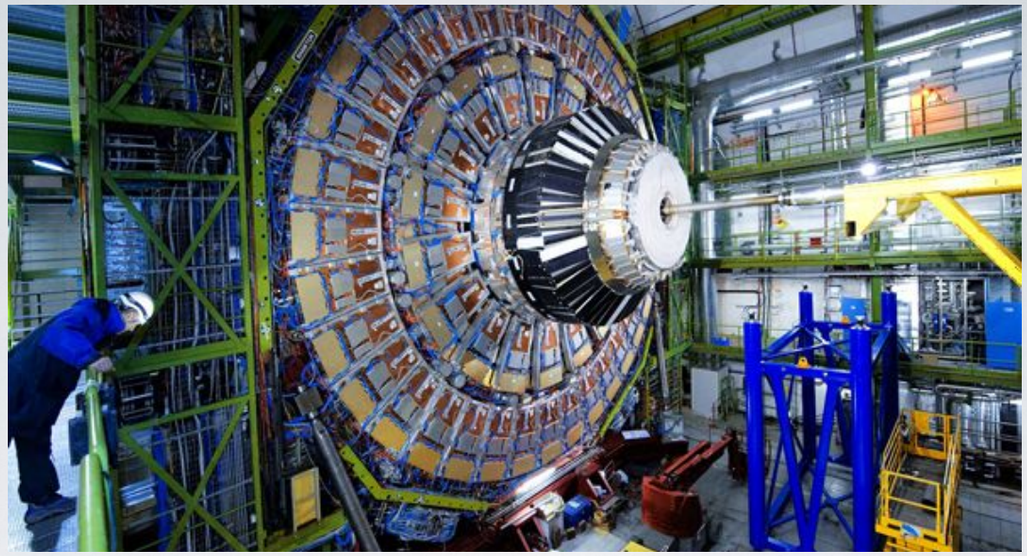

IMPROVING THE CMS ECAL TRIGGER FOR RUN 3 OF THE CERN LHC

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WEIGHTS

- Amplitude weights
  - active, uniform for whole detector in run 2
  - Current study: update weights and increase granularity by choosing different weights for different parts of the detector for run 3
- Timing weights
  - very front end readout electronics have unused capacity for second set of weights
  - Out-of-time pileup not only changes the amplitude but also the pulse shape, so timing weights may be able to reshape pulses to identify out-of-time pileup
  - Current study: optimize timing weights to identify out-of-time pileup in a signal for run 3

Reminder: VFE -very front end

Crystals in high-eta regions, like the endcaps are especially susceptible to radiation damage and may need unique weights, while weights are currently uniform for the whole detector

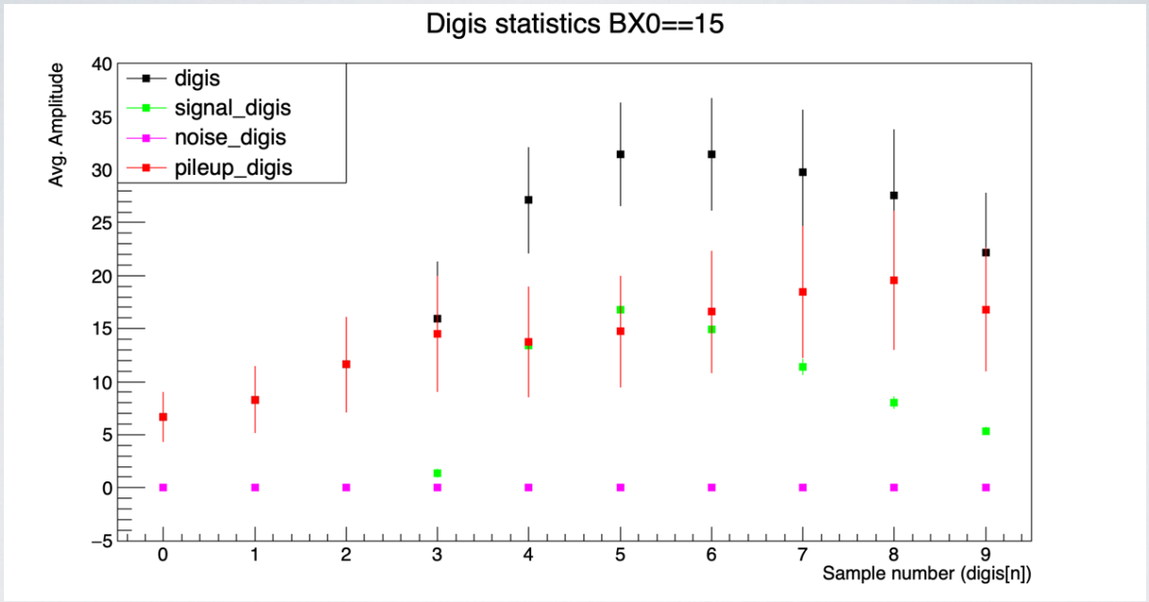
Run 2— 2015-2018

Run 3 — 2021-2024

PLOTTER

- Plotter is split into 2 layers to separate time-heavy processes for ease of use
- ROOT libraries are used for power to deal with large datasets
- First layer takes data and produces histogram objects and saves them to a file that can be accessed for the second layer
- Second layer takes histogram objects and plots them, since second layer runs quickly it can be tweaked easily
- Flexibility makes changes to cuts, studying different parameters, or repeating the same studies on different data sets easy

SIMULATED SIGNALS

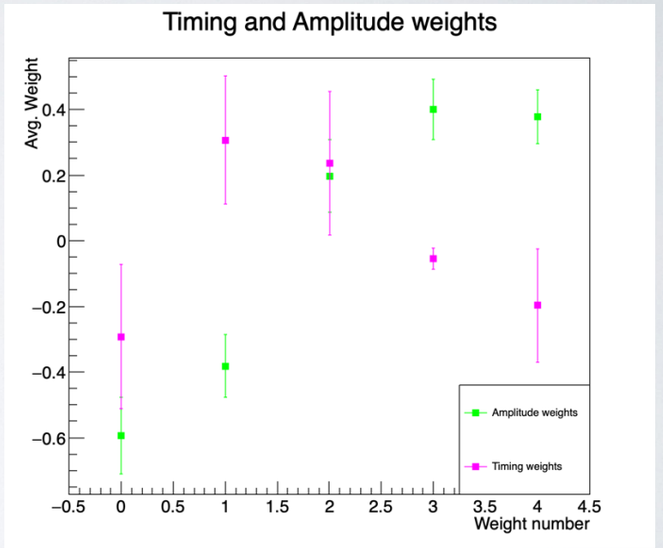


This particular simulation has low energy interactions (~2GeV transverse energy) and high pileup (50 interactions per bunch crossing)

The average signal (green)
Average electronic noise (magenta) (can be positive or negative, small amplitude, average is zero)
Pileup (red) is very variable— only 1 BX is studied, which means that different bunch crossings may have different pileup behavior (BXs with more or fewer events preceding/following it will have different distributions)
This plot is at eta ring 28, bunch crossing 15
Statistics are generated from histograms of each digis[n]

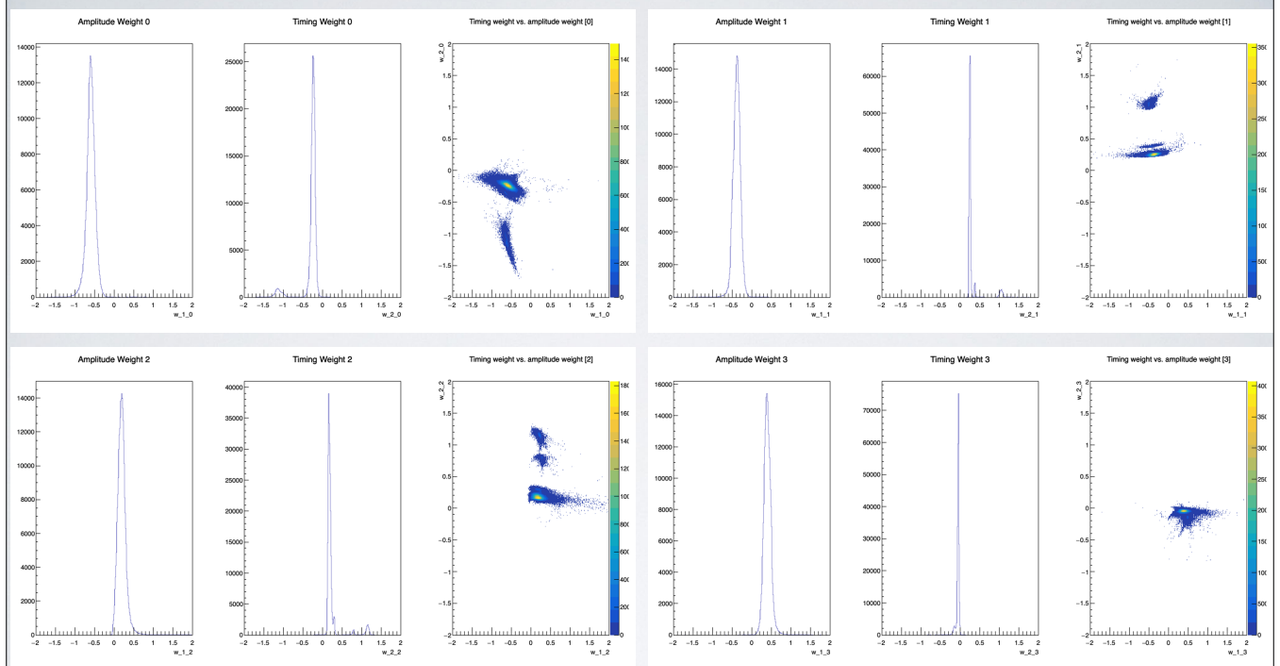
WEIGHTS

- The model uses the 'true' amplitude to choose the weights that accurately reconstruct the amplitude for each event
- The model chooses the timing weights that identify if the peak arrives sooner or later than the expected peak
- 320,000 events



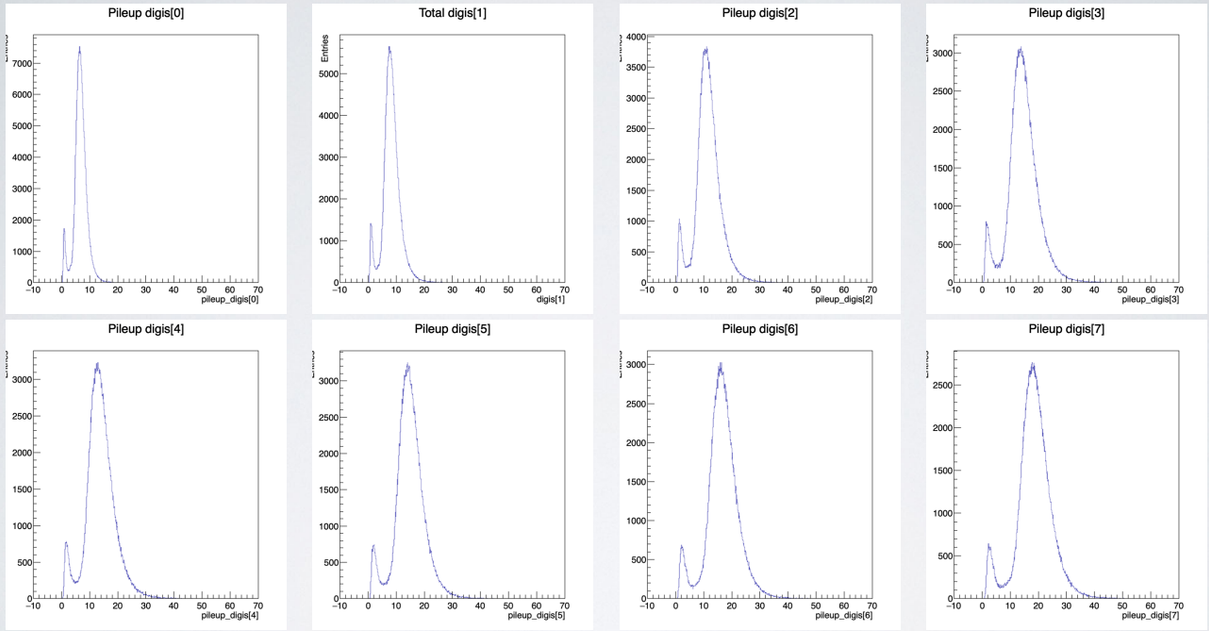
Check with Abe on how accurate description of timing weights is
peak is at w3
1st two amplitude weights are negative because they are attempting to subtract background (no signal here)
two timing weights before peak are high because they are trying to return difference between actual peak time and expected peak time

WEIGHTS



Features in the timing weights distributions suggests a probe into the populations that are reconstructed with different weights, though the correlation with the amplitude weights is weak

PILEUP DIGIS



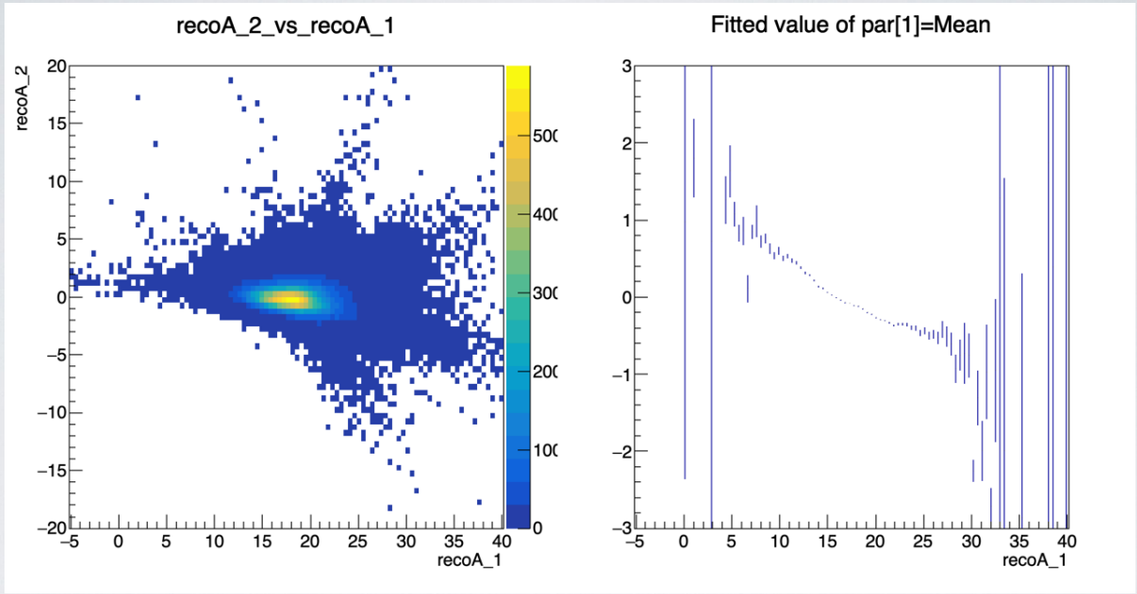
Pileup digis (single bunch crossing, pileup = 50) have a second low energy peak in the distribution which might warrant some study

FUTURE DIRECTIONS

- Better understand how selected timing weights reflect types of events
- Determine what types of events are failing to reconstruct the true amplitude, likely from pileup
- Quantify in which sample high pileup affects amplitude reconstruction the most
- Study failure modes for amplitude weight failure, specifically the pileup dependence
- Examine & quantify timing weight's ability to identify anomalous signals in the barrel region and out-of-time pileup throughout the detector

Determine which events are failing — this may require examining single events

WEIGHTS EFFECTS ON AMPLITUDE

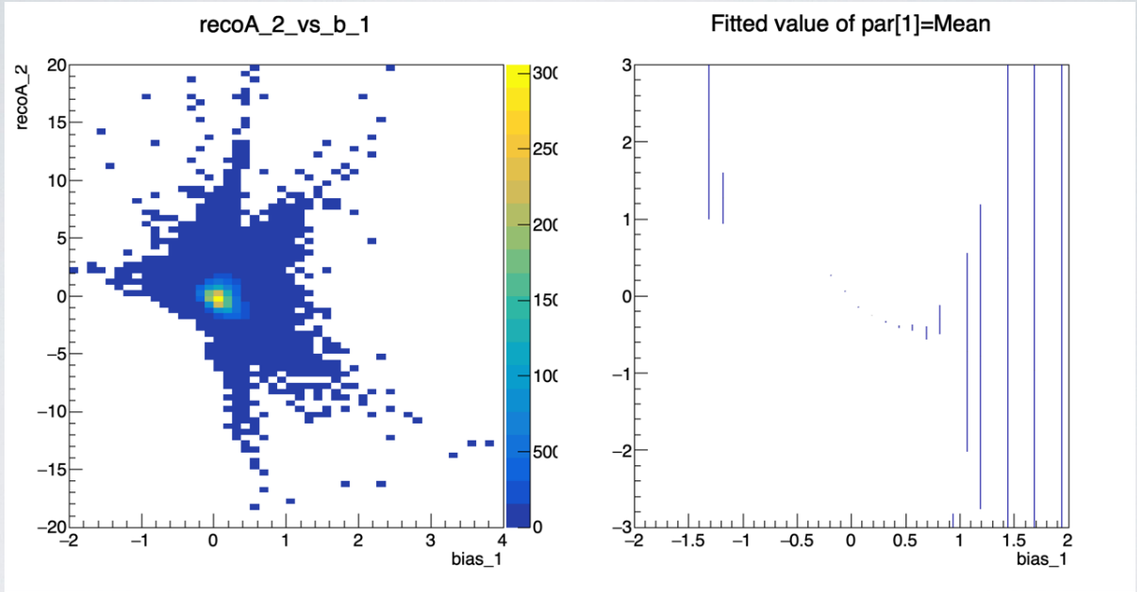


Apparent correlation of reconstruction amplitudes
Right Side uses a ROOT method for 2-D histograms that finds the average value of the y-distribution in each x bin

Examining behavior of recoA_2 vs recoA_1:
we expect the average of recoA_2 to be zero when the waveform is not shifted, and for recoA_1 and recoA_2 to be uncorrelated
recall Z is entries
on right: y is the mean from a gaussian fit of each slice

THANK YOU

WEIGHTS EFFECTS ON AMPLITUDE



bias, a metric for accuracy of energy reconstruction, shows that when recoA_1 fails, recoA_2 also doesn't behave as expected

Examining behavior of recoA_2 vs bias_1:

recoA_1 and bias_1 are correlated because the range of true energies is very small, so a high or low reconstructed energy must therefore be inaccurate, and this shows that the correlation between recoA_2 and bias_1 is preserved, and suggests that out-of time peaks are correlated with bad energy reconstruction