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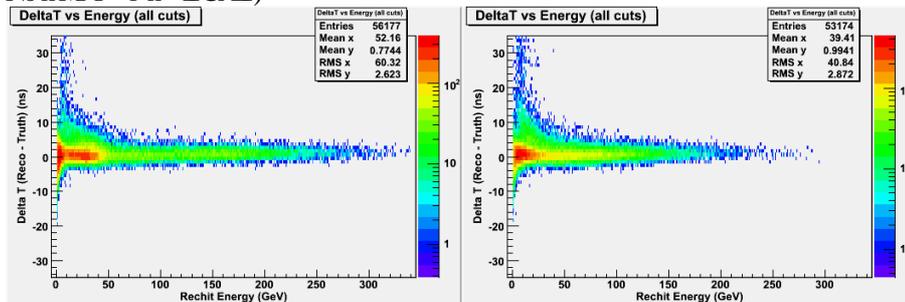
HCAL Rechi t Ti mi ng: MC vs TB06 Compar i son

Efforts were focused around comparing MC rechit times against TB06, particularly for resolution as a function of energy. MC times were expected to be "too good", such that studying timing cuts will lead to over-optimistic conclusions compared to the reality. Comparing against TB06 provides a handle for making the MC times more realistic through smearing.

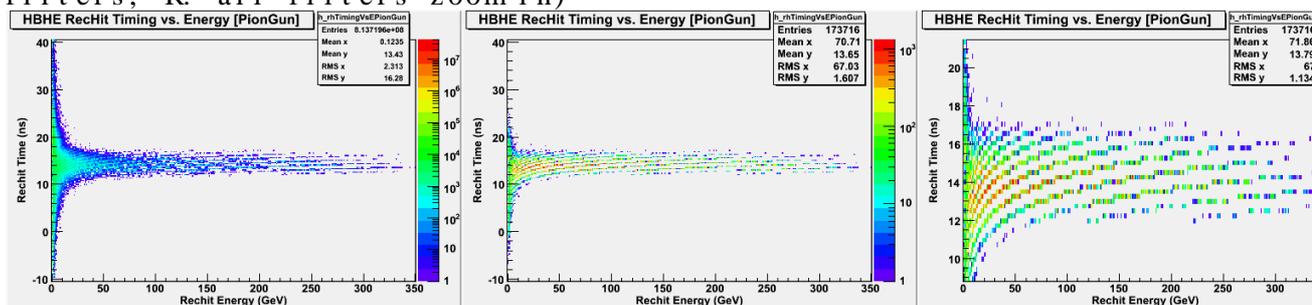
- Ran MC pion particle gun pointed at tower (1,1,1) in HB
- Discrete energy points mimic testbeam runs:
5, 10, 15, 20, 30, 50, 100, 150, 200, 300 GeV, 50k events per energy point for a total 500k events gen-sim-reco'ed.
- As in TB06, find the 68%/95% error levels in timing and plot `time_resolution(E)`.
- Compare to TB06, study relative distribution shapes and sizes and determine how to smear MC rechit times to match TB06 better.
- To get MC analysis more on an equal footing with TB06, I applied the same filters to rechits as in TB06:
 - ◆ Target tower hits only (HBieta=1, i phi=1, depth=1)
 - ◆ hit energy exceeds 1GeV threshold
 - ◆ hit energy is the max in the HBHERechit collection for that event.

Fi rst Look Ti mi ng vs Energy hit di stri but i ons:

- TB06, to show what we're shooting for (L: MP-in-ECAL, R: NonMP-in-ECAL)



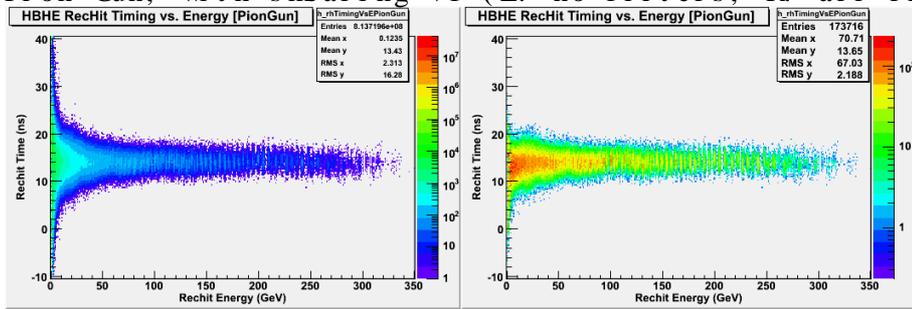
- Pion Gun, No smearing, notice the odd pattern (L: no filters, M all filters, R: all filters zoom-in)



The strange pattern in the far right plot is understood. The quantization comes from Geant; simhit times are quantized in 1ns intervals upon

digitization. The skewing indicates that the QIE time slewing is working: it is both injected in simulation and corrected for in reconstruction. When time slew correction is turned off, the quantization straightens out but the distribution itself skews to later times.

- Pion Gun, with smearing v1 (L: no filters, R: all filters)



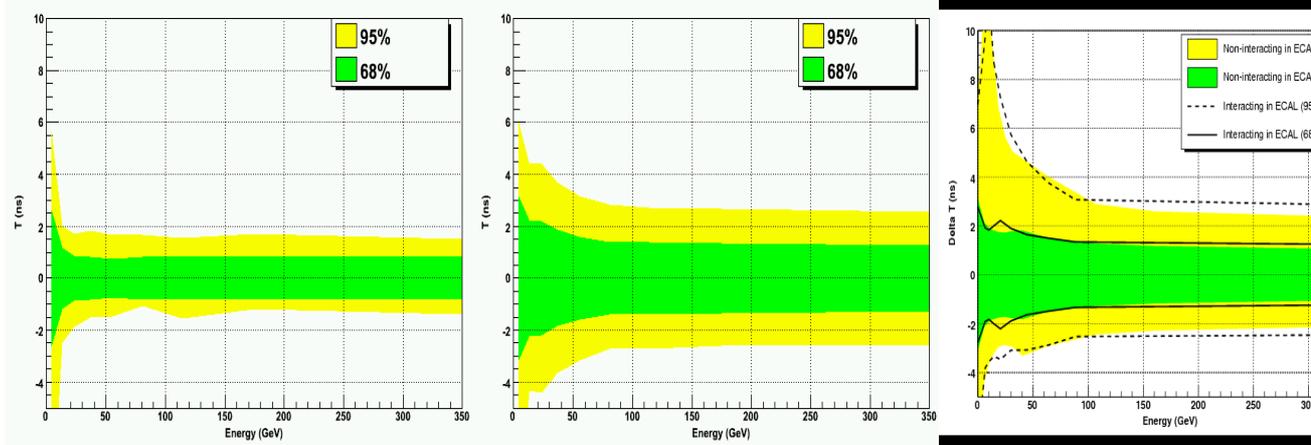
Smearing MC to look more like TB06

Assessing Smear V1 Performance

Filled Error Graphs:

These are variably binned to maintain near constant statistics. The 68% and 95% confidence intervals are found as a function of energy, with mean variations taken out.

- L: pgun before smearing, M pgun after smearing, R: tb06



From these graphs you see that the 68% levels look to be where they should, whereas the 95% levels, particularly for $E < 50 \text{ GeV}$, are still better than TB06. Confirmation to be quantified as follows:

Ratio MC/ TB06:

These next plots are graphs of the ratio MC/ TB06 timing resolution as a function of energy for the positive side envelope. These ratios are derived from the variable-bin, asymmetric error data shown above.

From that ratio a smearing sigma is calculated such that a smearing run brings the MC into conformity with TB06. However, since (for this version at least) it is only a gaussian smear, the smear cannot compensate for

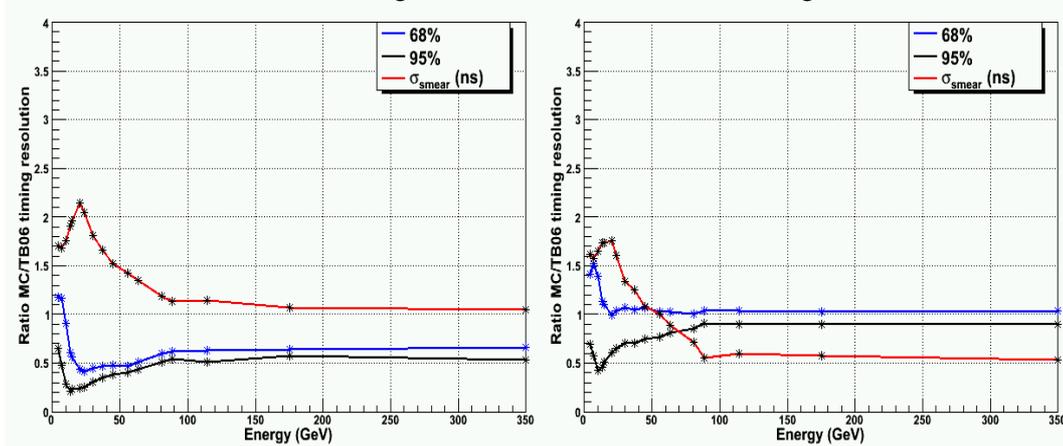
nongaussian tails at late times as seen at low energy in the TB06 data.

The smear sigma is calculated as

$$\sigma_{\text{smear}} = \text{TB06-68\%} * (1 - R_{95\%}^2)$$

where $R_{95\%}$ is the ratio of MC/TB06 using the 95% positive envelopes.

- MC/TB06 before smearing (L) and after smearing (R)



It is the smear sigma envelope in the left plot that was used to take a smearing run on the particle gun data, generate a new collection of rechits with smeared times, and then reanalyze those, the results of which are now shown on this twiki page.

The right graph was produced from the already smeared data and indicates that there is still some residual smearing to be done (smear sigma is nonzero). The reason is because the smear sigma calculation mixed both 68% and 95% levels. The 68% errors are confirmed to be ≥ 1 , but the nongaussian tails drive the remaining discrepancies.

At high energies there is still a little discrepancy, and the reason is because instead of the TB06 MP data the nonmp data was used to calculate the ratios, and the nonmp data is just a little bit worse.

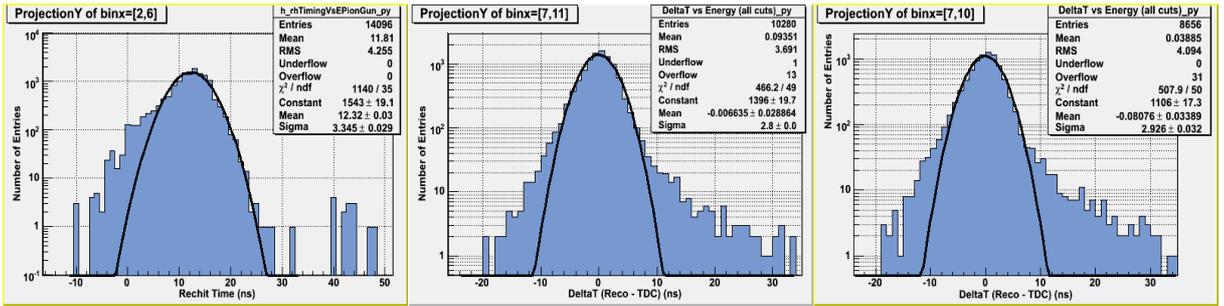
Y-Projection slice fits across energy:

These are the Y-projection plots from before. The MC plots (leftmost column) are *without* filters applied.

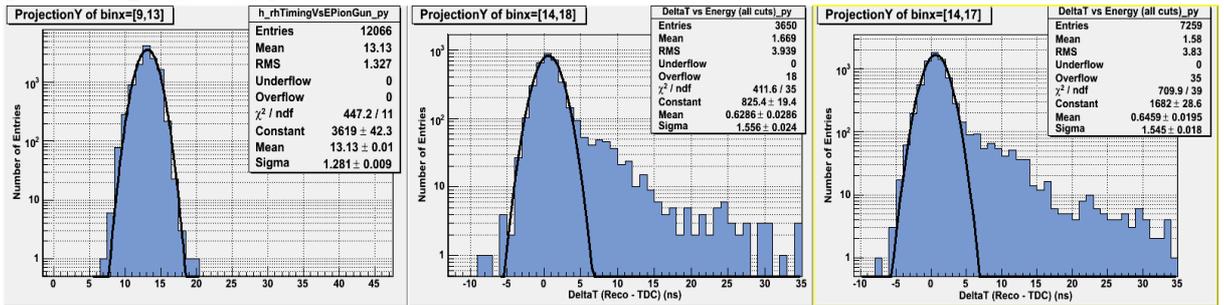
So here the order of plots is, from left to right: pgun, tb06 mip (non-interacting) in ECAL, tb06 nonmip (interacting) in ECAL.

- 1-6 GeV Slice

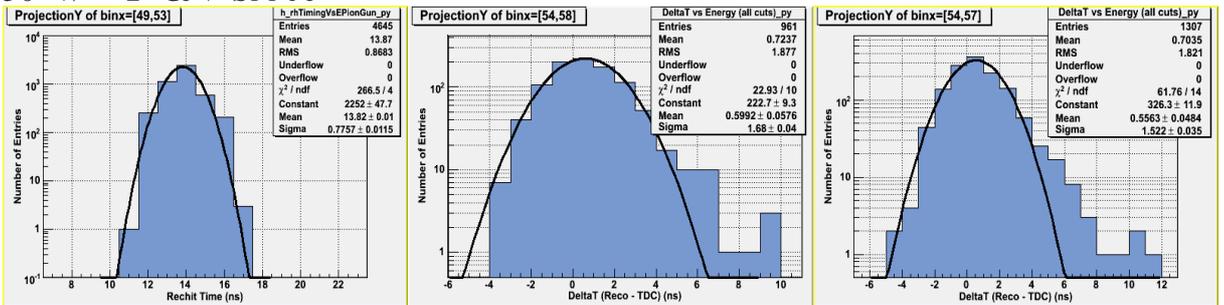
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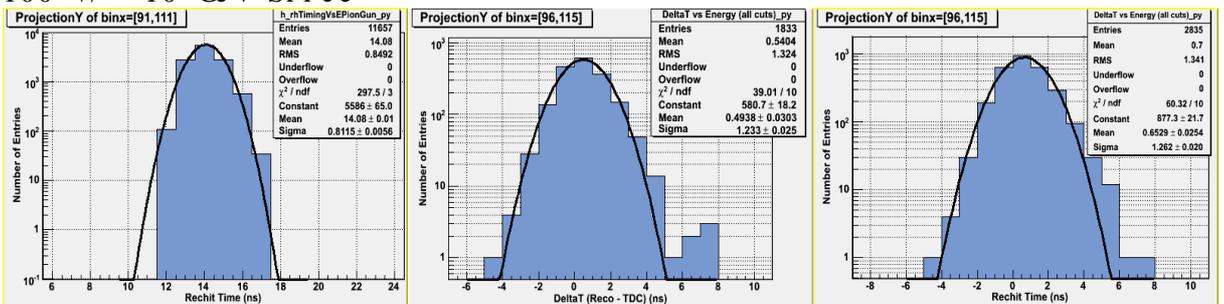
• 10 +/- 2 GeV Slice



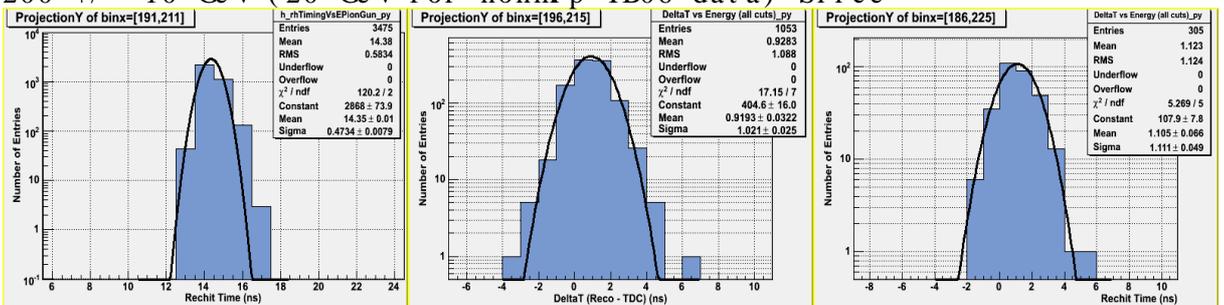
• 50 +/- 2 GeV Slice



• 100 +/- 10 GeV Slice



• 200 +/- 10 GeV (20 GeV for nonmip TB06 data) Slice



Changes in CMSSW

By release time for version 3_1_0, no study had been undertaken as to how to implement time smearing at the MC level. A study is tentatively planned. In the meantime, a new utility is planned for this release that allows a user to smear rechit times and put the smeared collection back into the event. Stay tuned.

-- PhilDudero - 15 May 2009

This topic: Main > PRDMCvsTB06

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