Status of HF PMT Simulation

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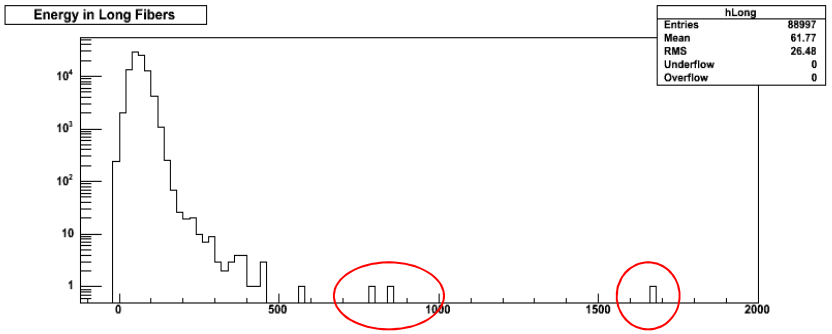
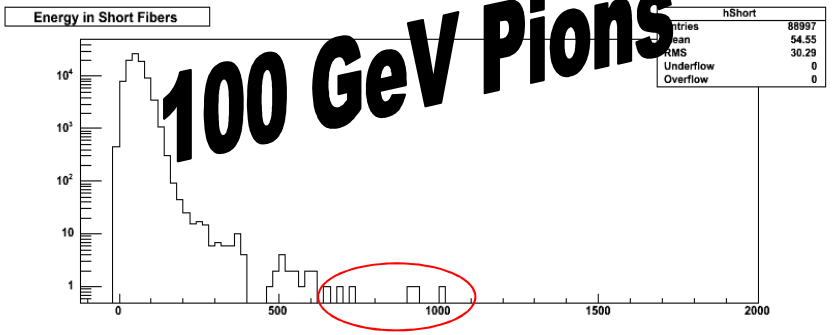
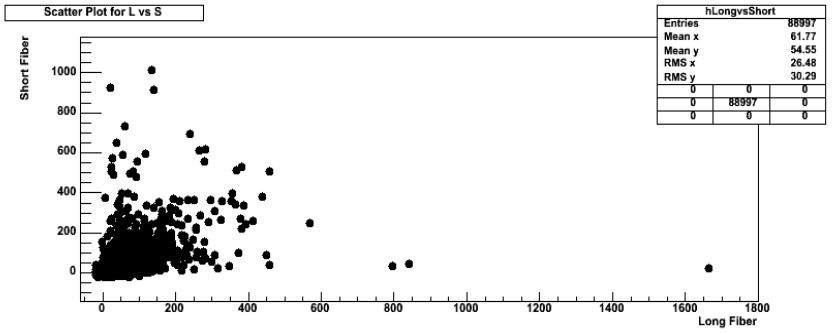
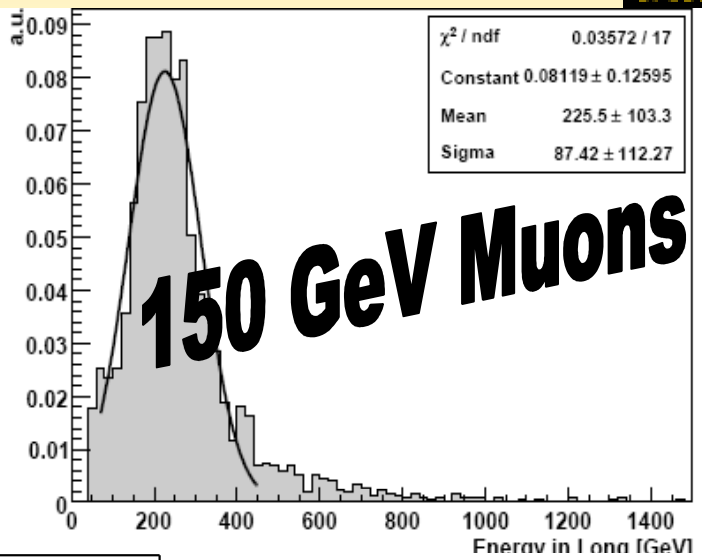
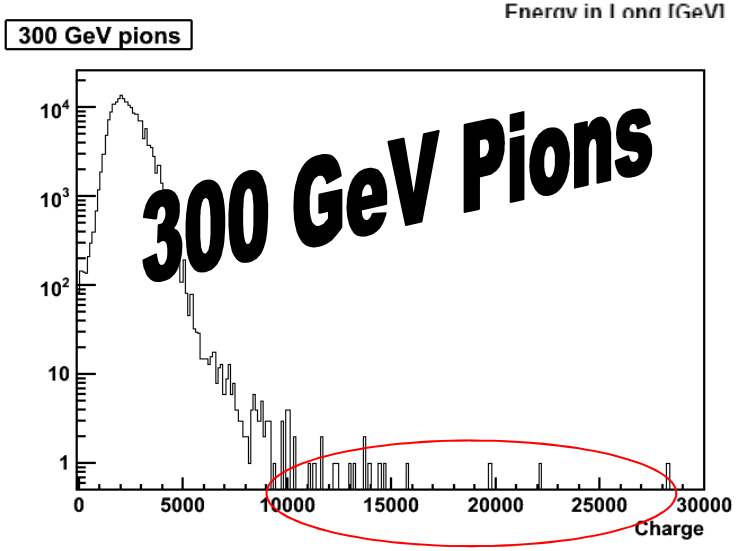
Abnormal Events Seen in TB04



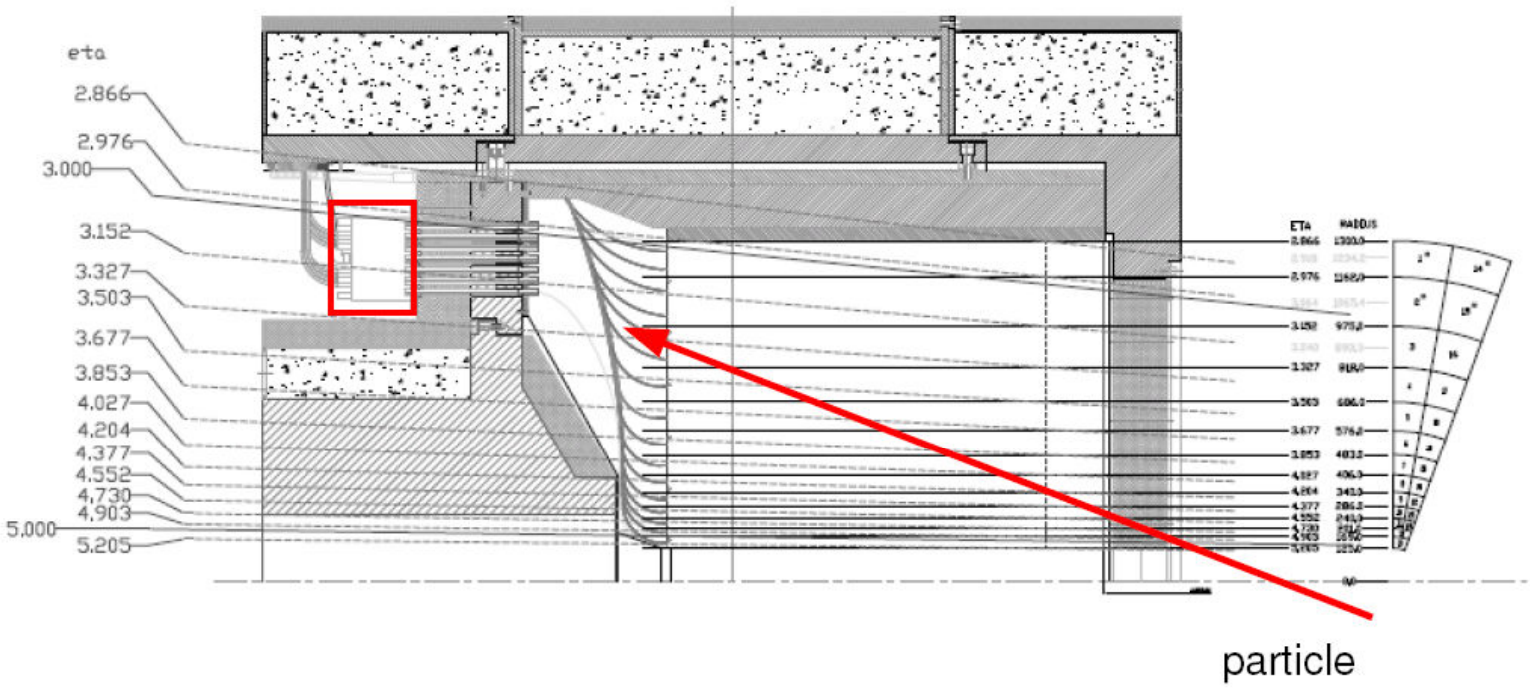








HF PMT Events



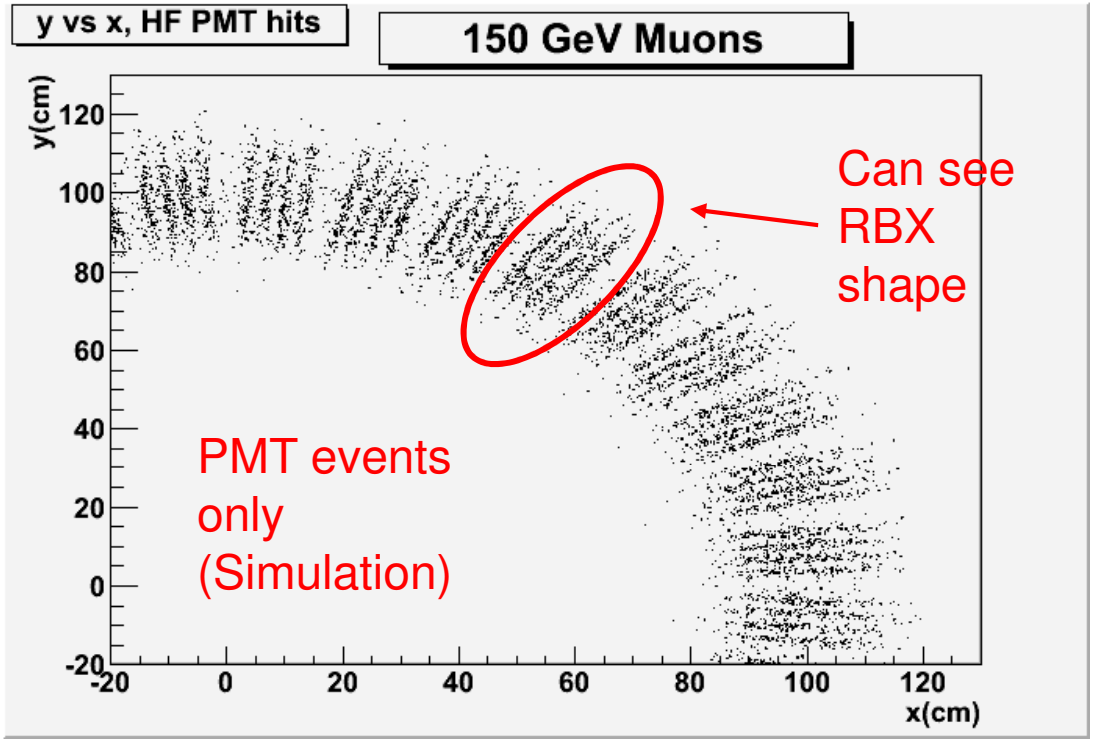
Muons or particles from late showers may hit the PMTs behind HF.

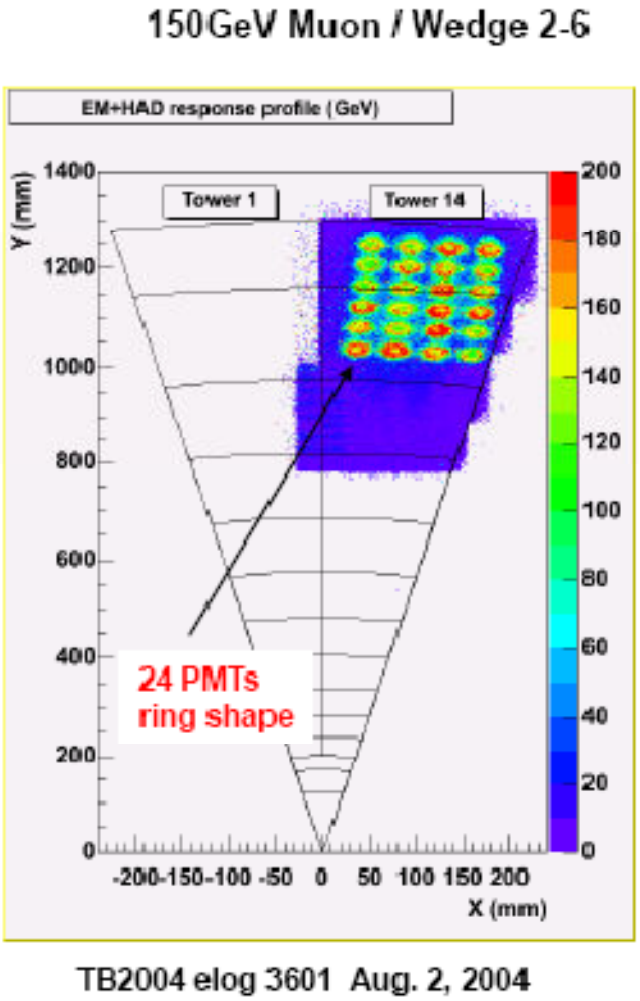
- Cerenkov radiation from particles directly hitting the PMT window create abnormally large signals.

Overall Status and Plan

- HF PMT Simulation updated to CMSSW_3_2_4
  - Parameterization for body of HF (not full HF simulation)
  - PMTs are included.
  - PMT hits exist for muons and pions, but not electrons.
  - Digitization and Reconstruction appear to work properly.
  - Timing results look like what we expect.
  - Looked at two simple methods to discriminate PMT hits:
    - Timing based, L and S fiber energy ratio based
  - Still need to add simple Pythia jets that were in the CMSSW_2_1_10 version.
    - In progress, will show a few old jet results from CMSSW_2_10.

Muons, Outline of RBX and PMTs

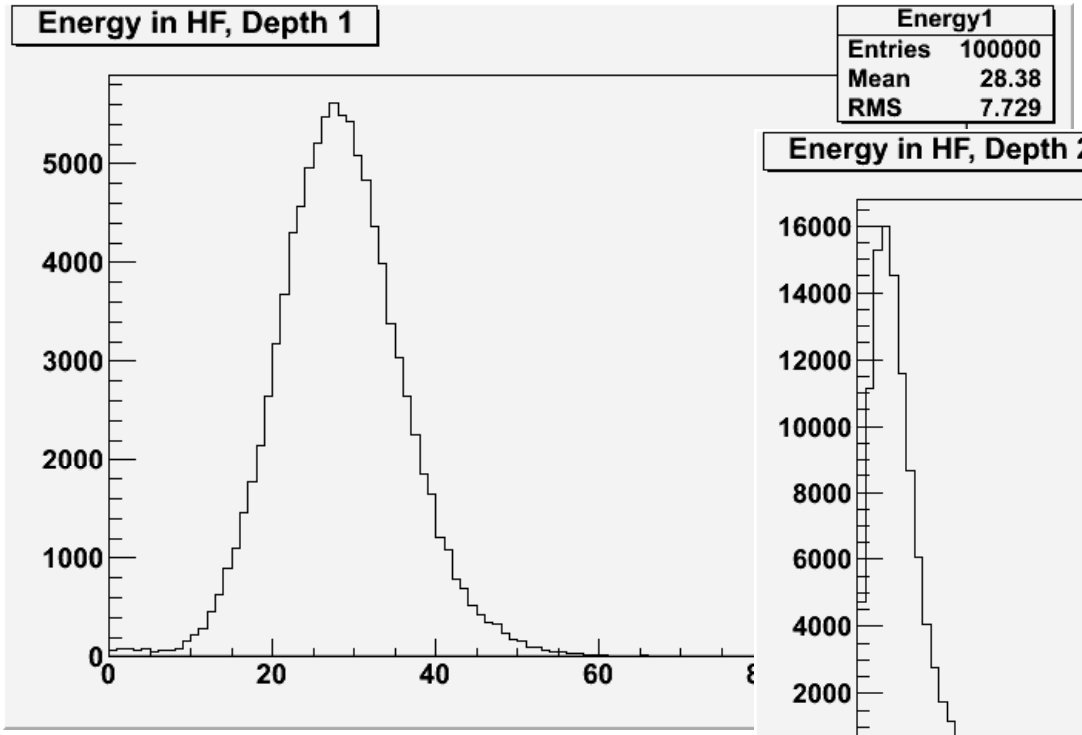


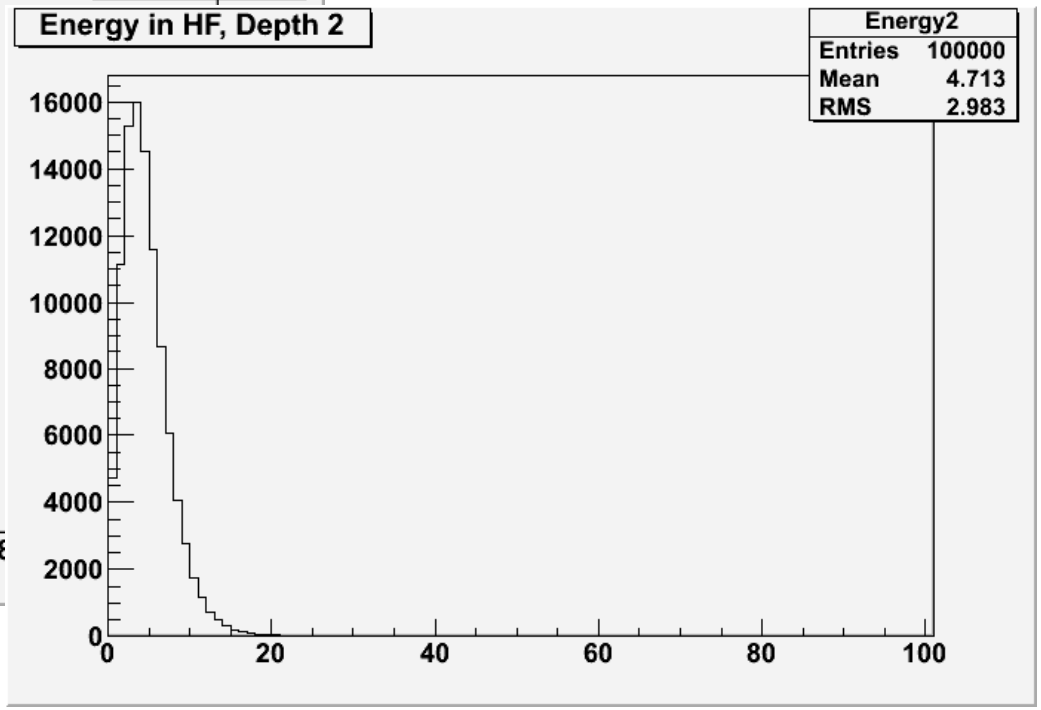


TB2004 elog 3601 Aug. 2, 2004

- Ring structure seen in testbeam is not present in simulation because PMT windows in the simulation are of uniform thickness, not plano-convex.

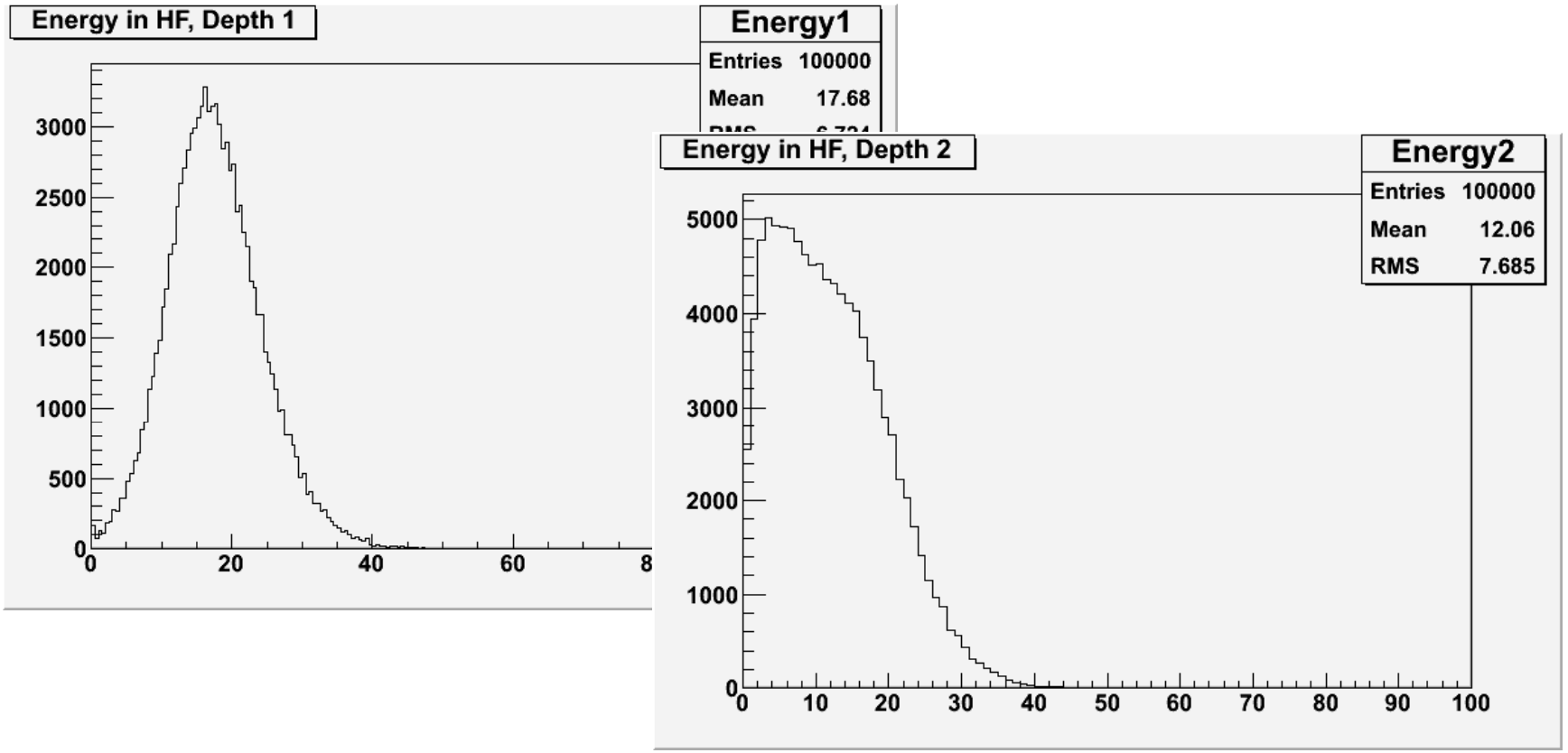
100 GeV Electrons





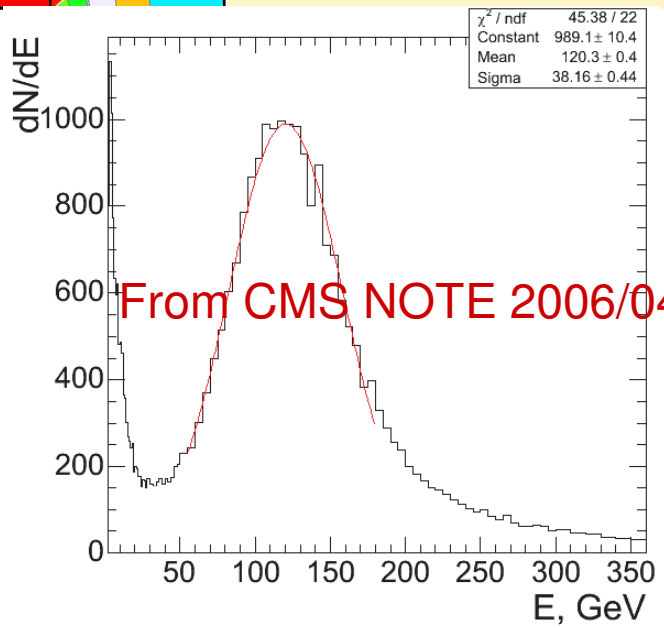
- Upgrading to CMSSW_3_2_4 made no significant effect on the long and short fiber energies. (All energies in photo electrons)
- Short fiber energies still somewhat low.

100 GeV Pions

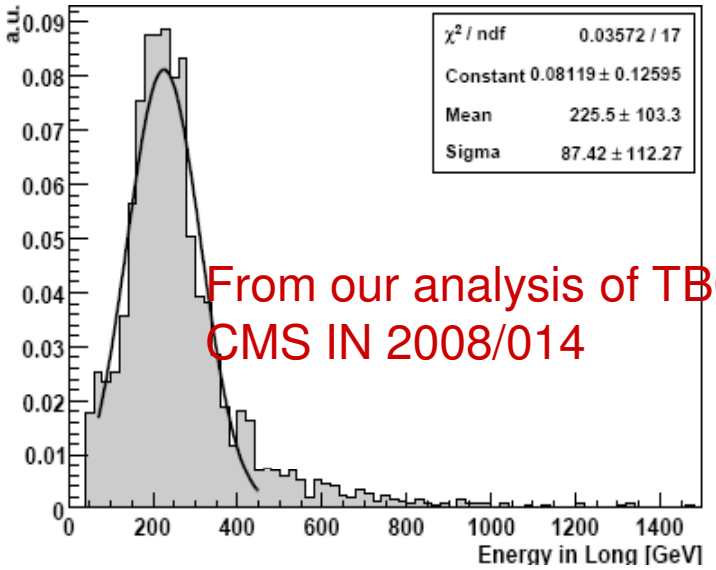


- Ratio of energy to that in the long fibers for 100 GeV e:
  - L: 0.62, S:0.43 (compare to more accepted values of roughly 0.7 and 0.5)

150 GeV Muons, TB04



From CMS NOTE 2006/044

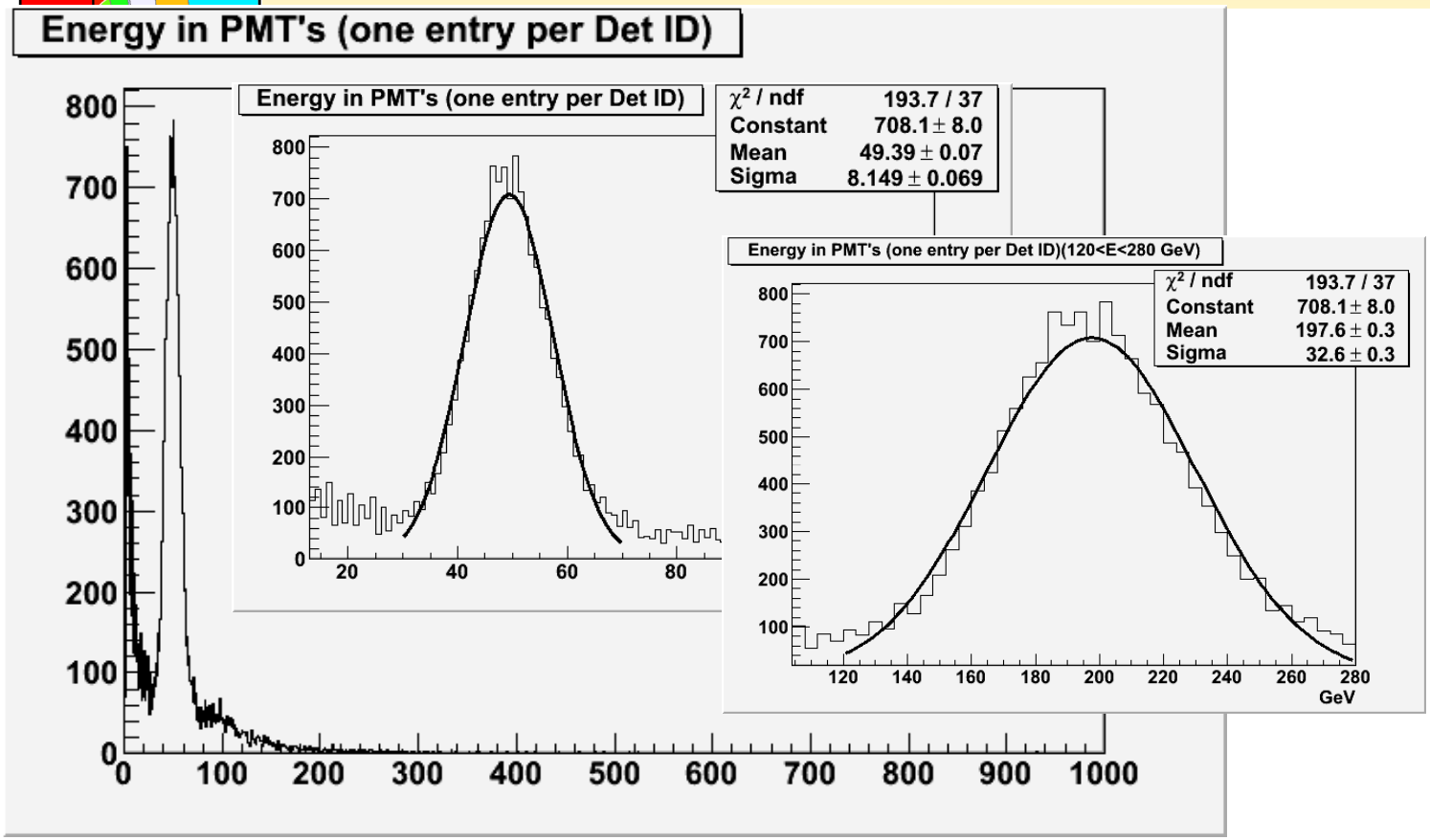


From our analysis of TB04, CMS IN 2008/014

- Mean: 120.3
- Sigma: 38.16
- Sigma/Mean:0.32

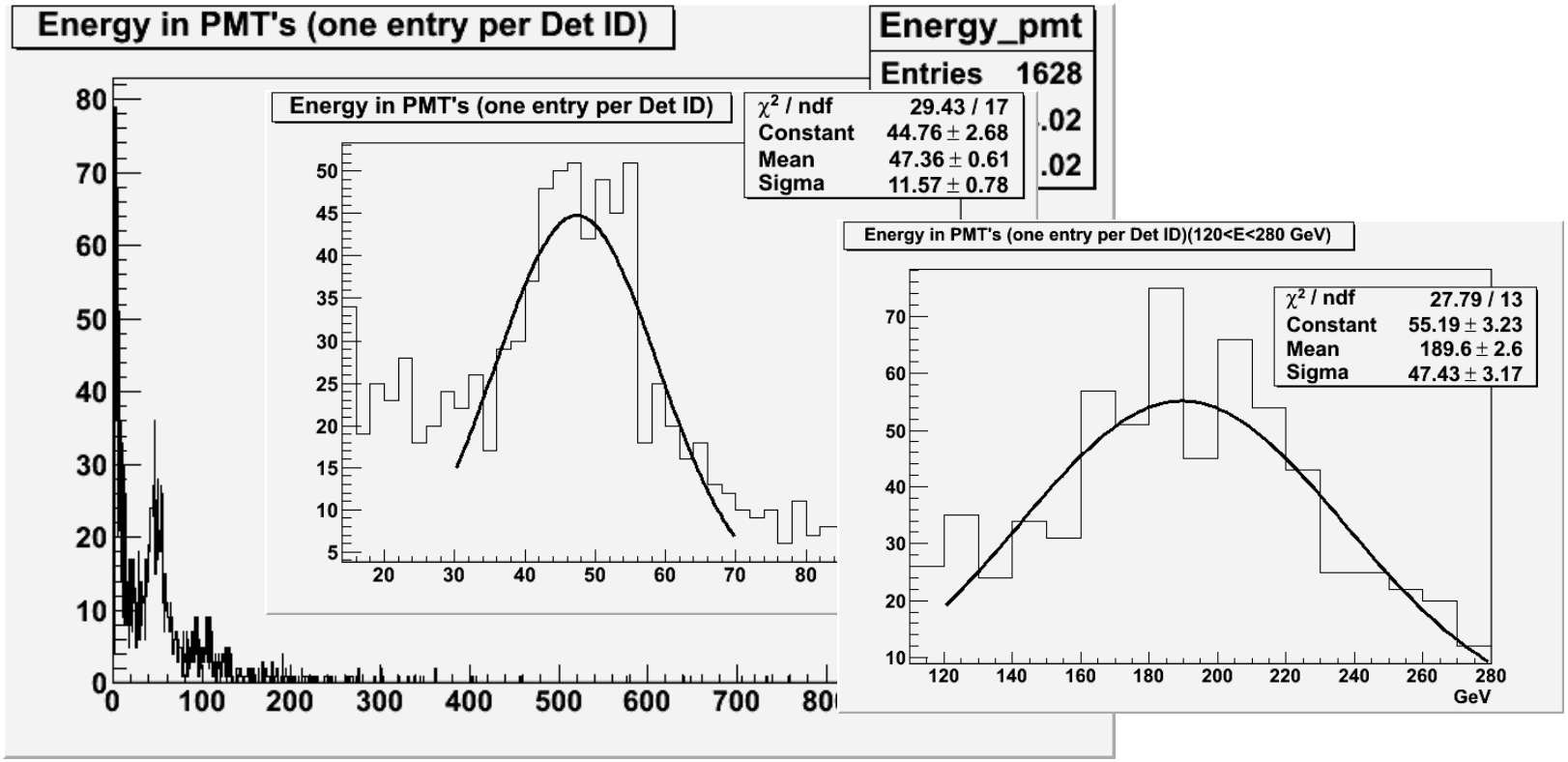
- Mean: 225.5
- Sigma: 87.42
- Sigma/Mean:0.39

150 GeV Muons, Simulation



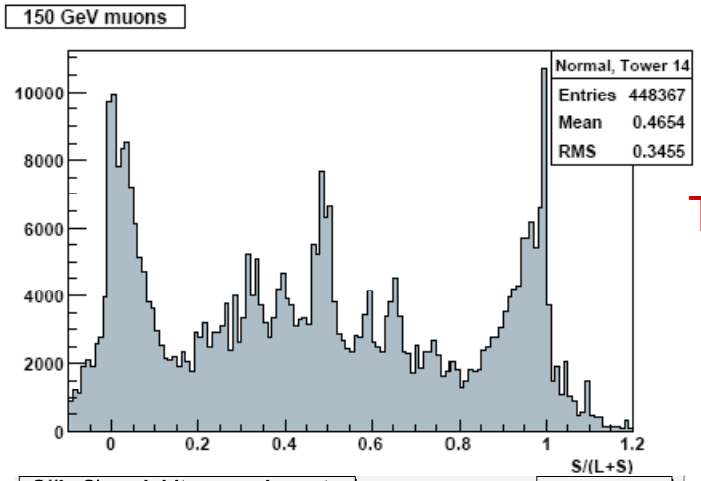
- Peak in Simulation is narrower – Sigma/Mean=0.165
- At least partially due to uniform thickness PMT window meantioned earlier
  - Have tried a different window shape, but needs work – Broadens peak, but also somewhat washes it out.

100 GeV Pions, Simulation

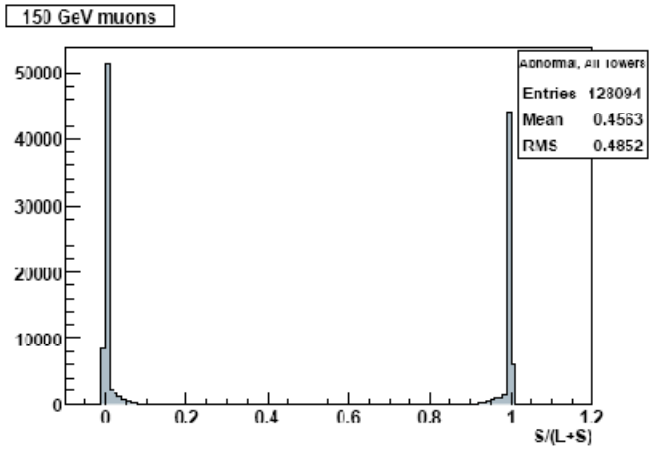


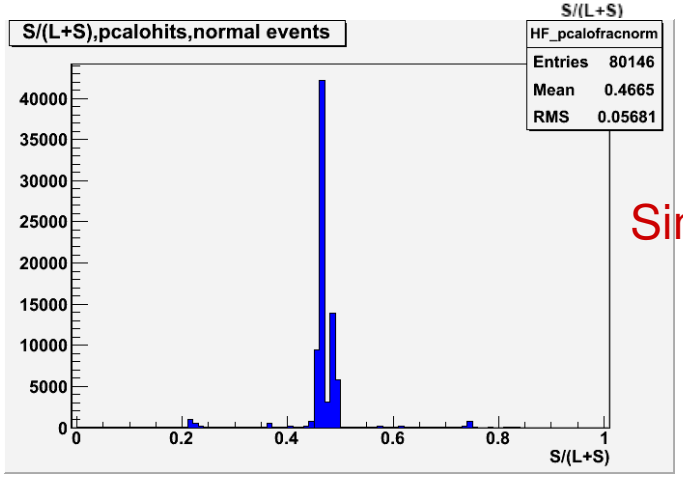
- A peak at about 50 p.e. is also seen for pions, although it is not as prominent as the muon peak.
- Sigma/Mean=0.24 (Not enough statistics for good fit)

S/L+S, Muons

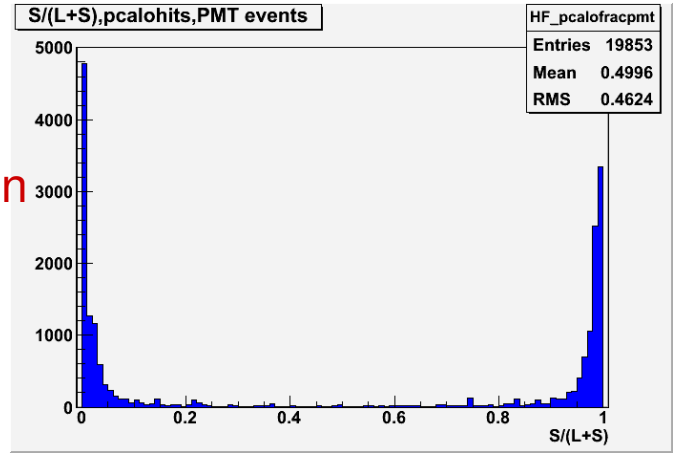


TB04



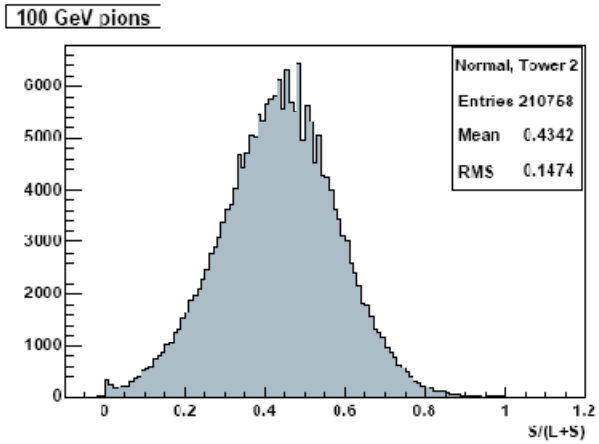


Simulation

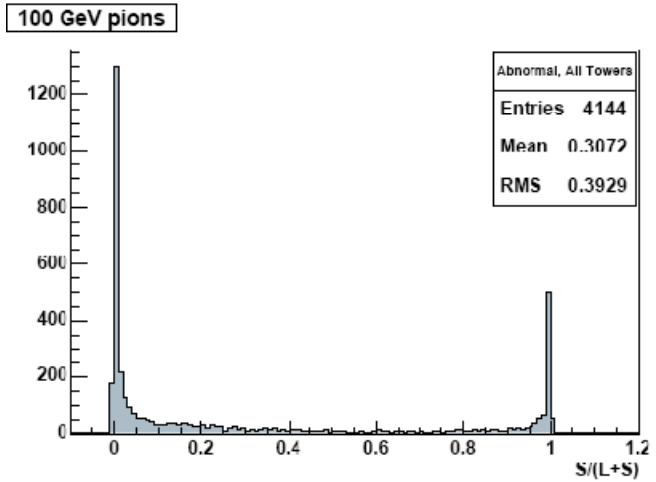


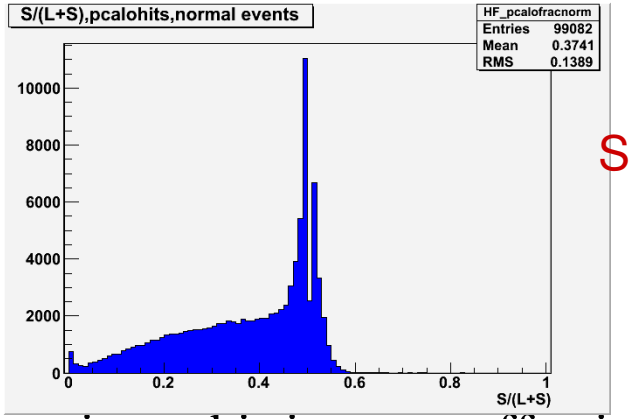
- For Muons, this can be used quite effectively:
  - Only accepting events with 0.2< S/L+S <0.8 rejects 94% of PMT events, while only rejecting 0.3% of non-PMT events (Simulation).

S/L+S, Pions

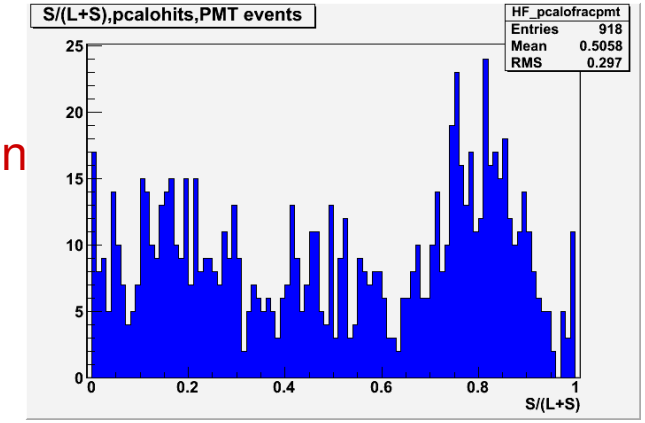


TB04



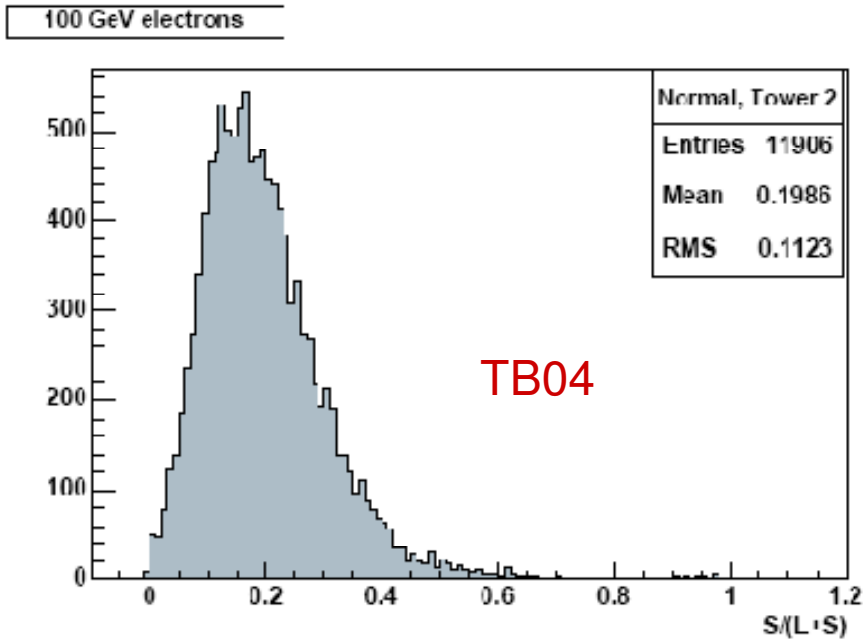


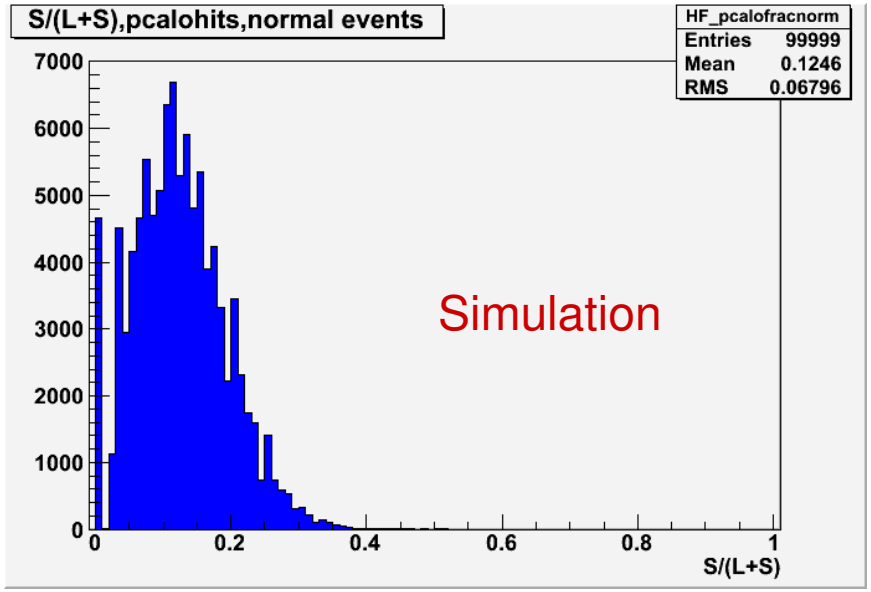
Simulation



- For pions, this is not as effective:
  - The same cuts reject only 45% of PMT events, but also reject 14% of non-PMT events (Simulation).

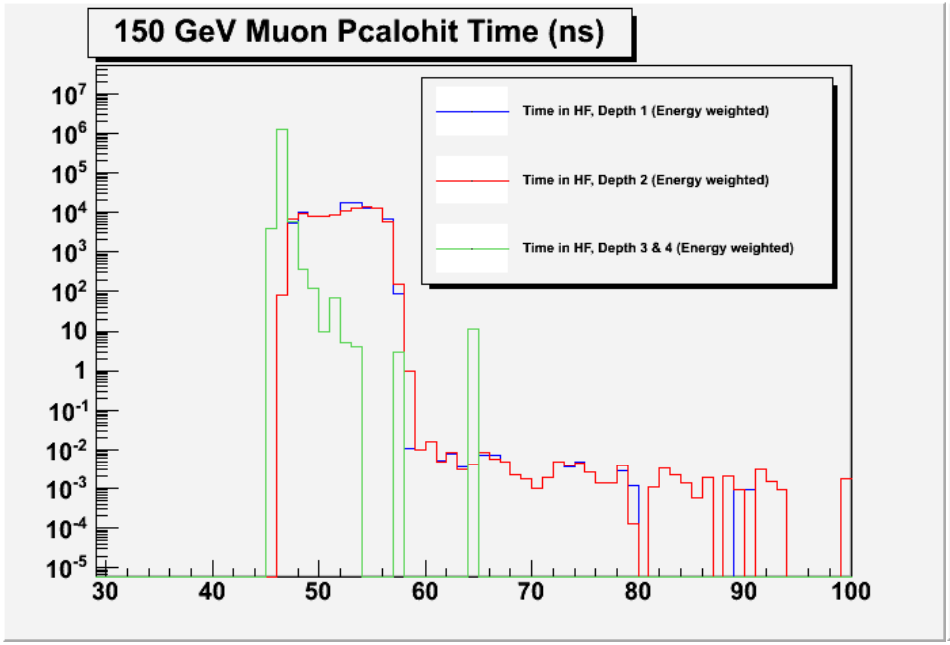
S/L+S, Electrons

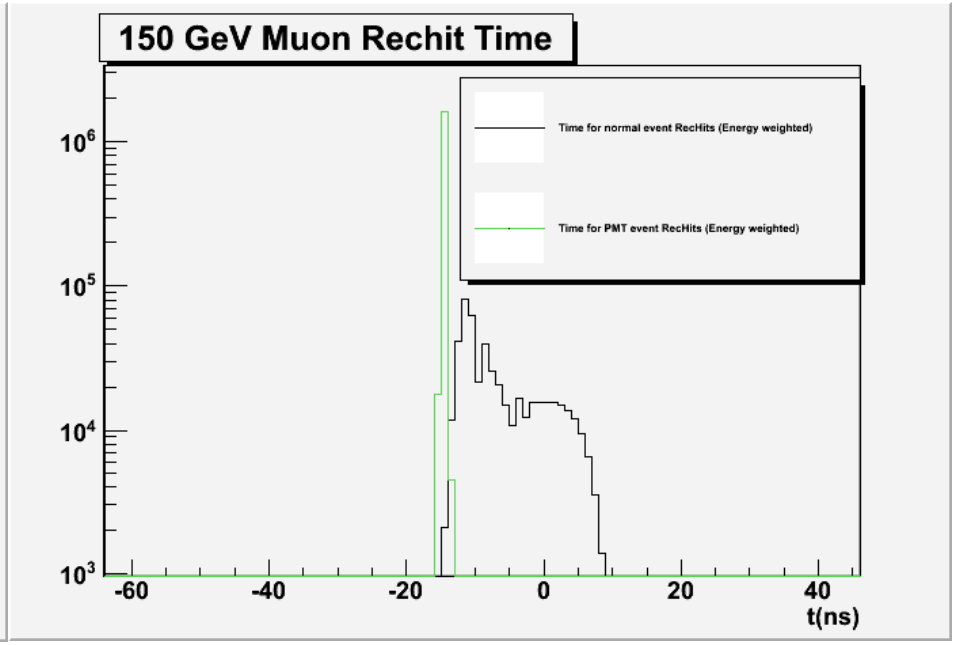




- These cuts would also not be effective at all on early showering particles such as electrons.
  - Same cuts eliminate almost 85% of electrons.
- Events with high values of S/(L+S) can very likely be rejected as PMT hits, but the same cannot necessarily be said for events with low values of S/(L+S).

Timing, 150 GeV Muons

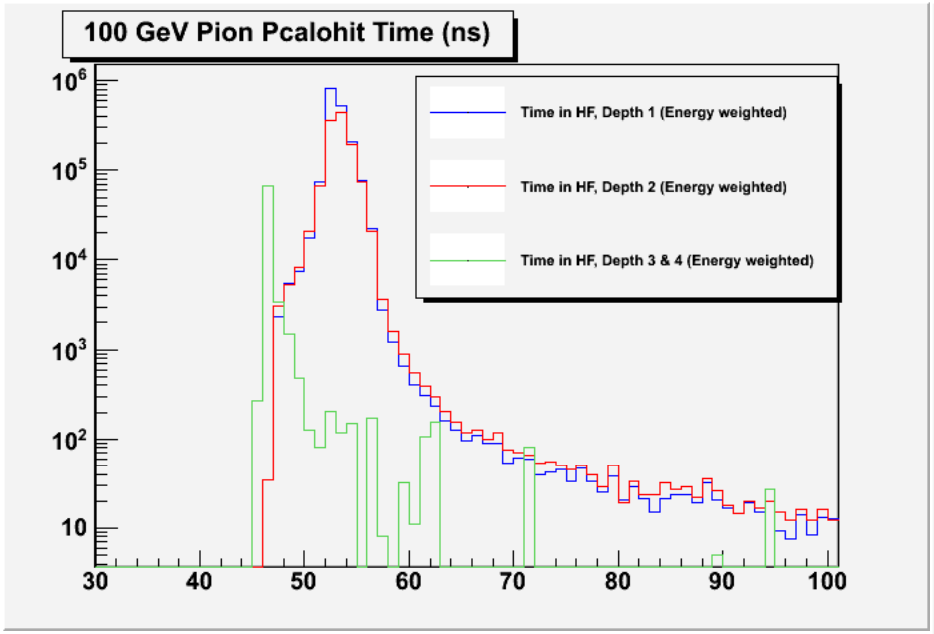


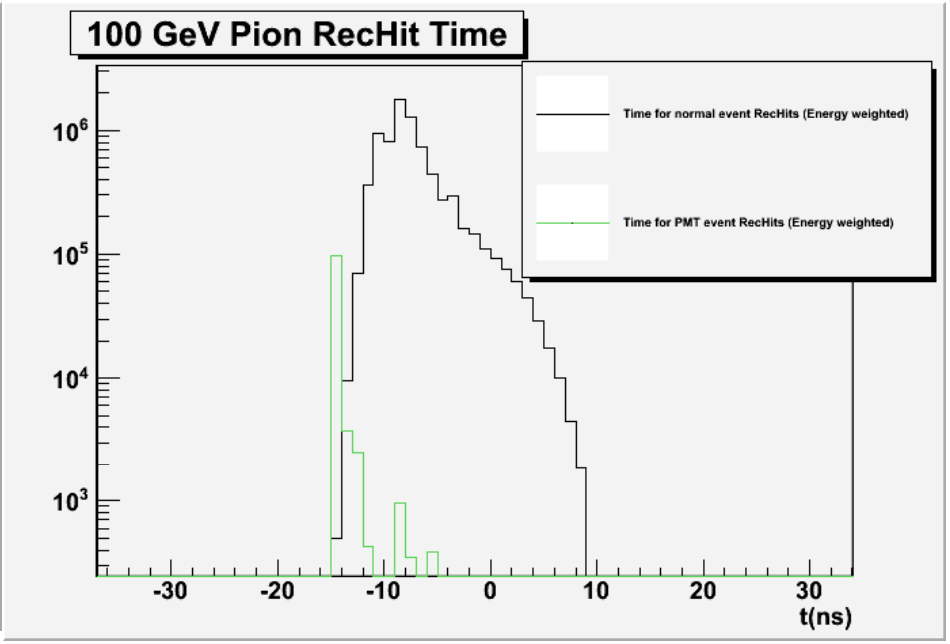


Events Eliminated by cutting those events with (Pcalohit) times less than 46, 47, 48, 49, and 50 ns.

PMTF_46= 161 (.8%)	Norm_46= 271 (0.3%)
PMTF_47= 19570 (98.6%)	Norm_47= 5229 (6.5%)
PMTF_48= 19849 (99.9%)	Norm_48= 76375 (95.3%)
PMTF_49= 19853 (100%)	Norm_49= 80146 (100%)
PMTF_50= 19853 (100%)	Norm_50= 80146 (100%)

Timing, 100 GeV Pions





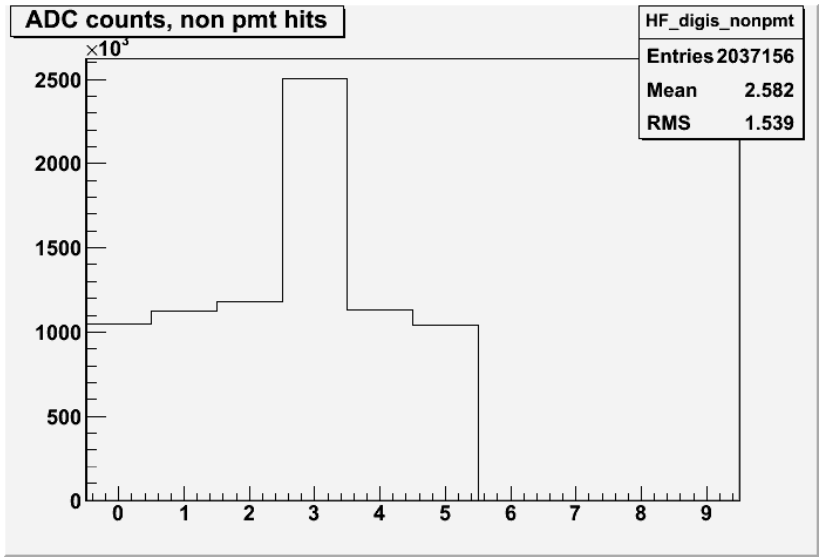
Events Eliminated by cutting those events with (Pcalohit) times less than 46, 47, 48, 49, and 50 ns.

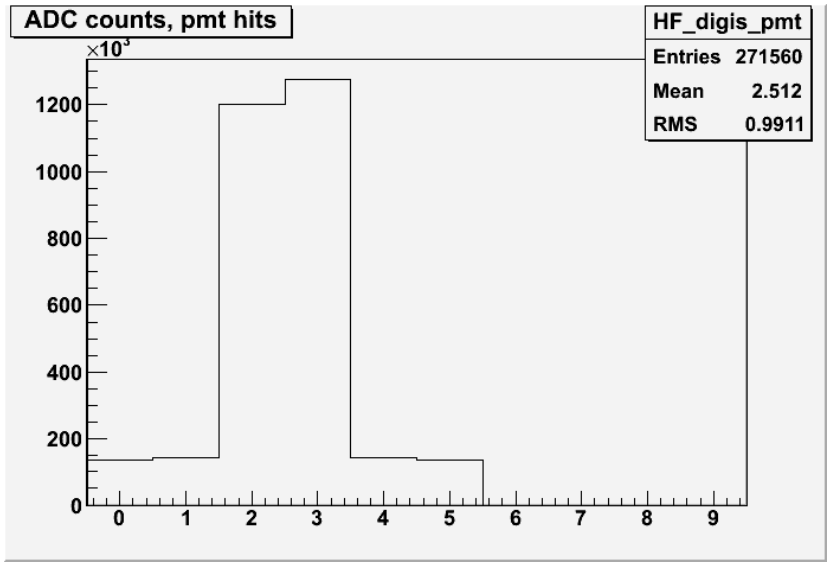
PMTF_46= 64 (7.0%)	Norm_46= 8694 (8.8%)
PMTF_47= 815 (88.8%)	Norm_47= 9214 (9.3%)
PMTF_48= 912 (99.3%)	Norm_48= 20710 (20.9%)
PMTF_49= 915 (99.7%)	Norm_49= 32104 (32.4%)
PMTF_50= 917 (99.9%)	Norm_50= 53646 (54.1%)

100 GeV Electrons

- Same cuts would eliminate some electrons as well, but the number of electrons lost isn't that sensitive to small changes in the time of the cut:
  - Norm_46= 4561 (4.6%)
  - Norm_47= 4561 (4.6%)
  - Norm_48= 4566 (4.6%)
  - Norm_49= 4572 (4.6%)
  - Norm_50= 4661 (4.7%)

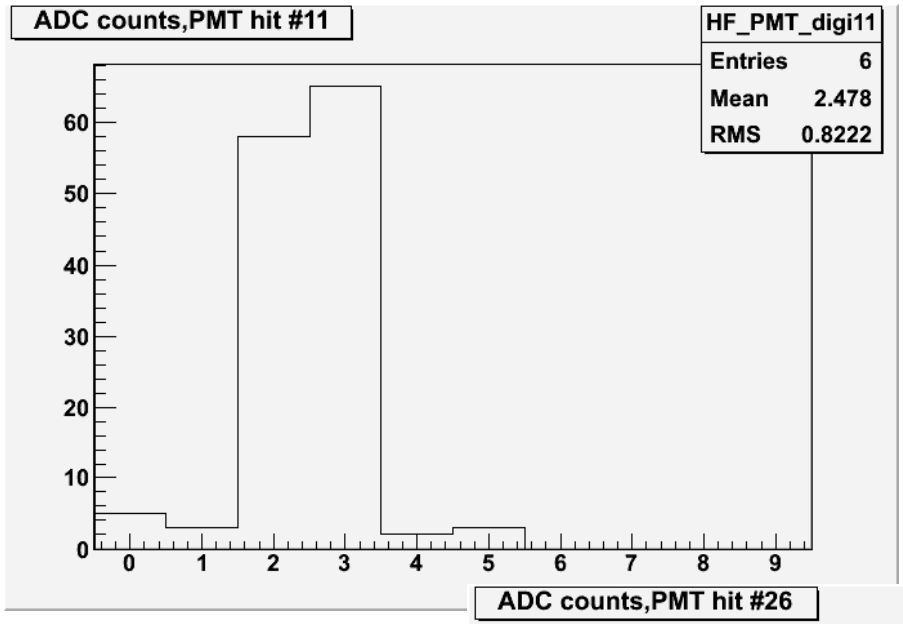
150 GeV Muons, Digis

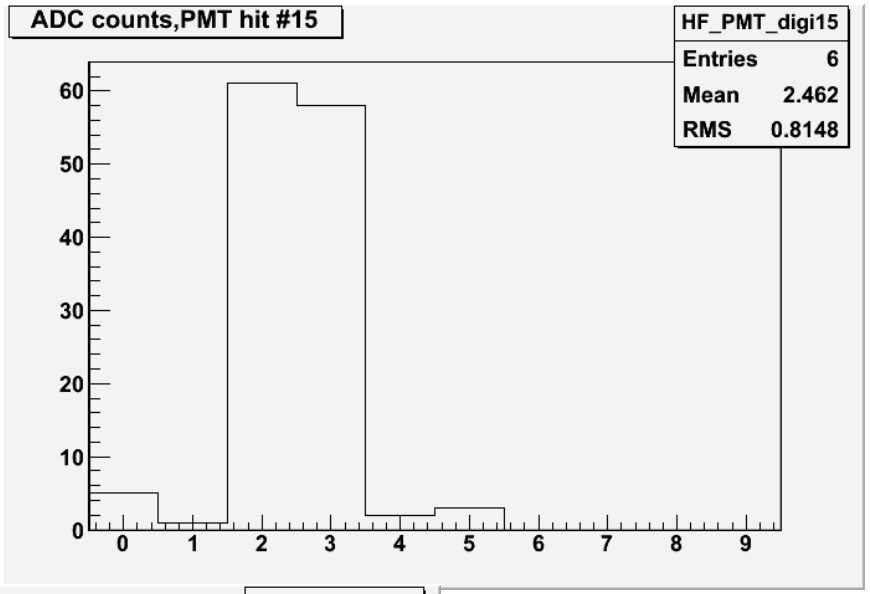


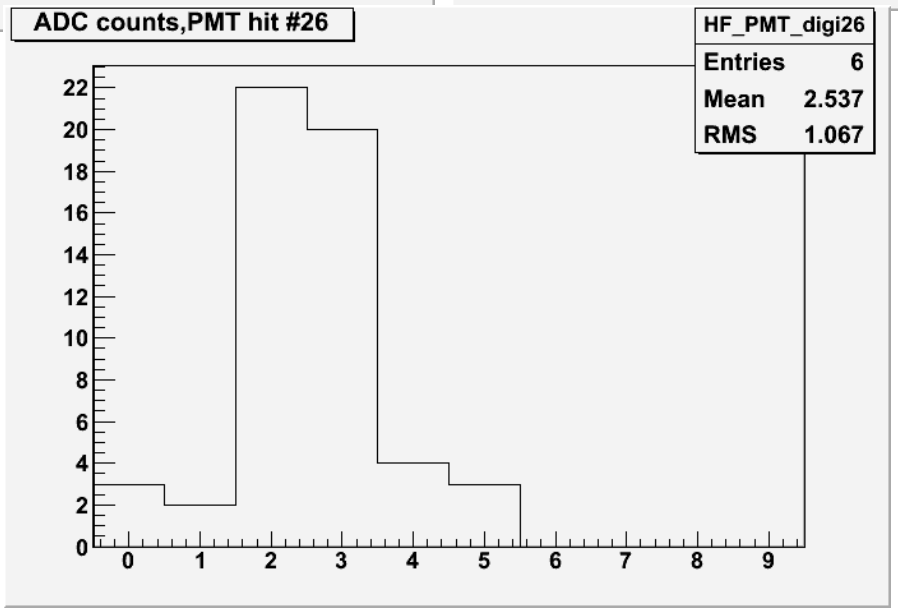


- Both histograms show ADC counts per time slice.
- Regular HF body hits have most of the signal in time slice 3, while PMT hits appear to have significant energy sharing in time slices 2 and 3.
- Both plots show total ADC count (dividing by number of digis would give an average pulse shape).
- Should look at pulse shape of a few individual PMT events to see if the average pulse shape is really indicative of the shape of individual events.

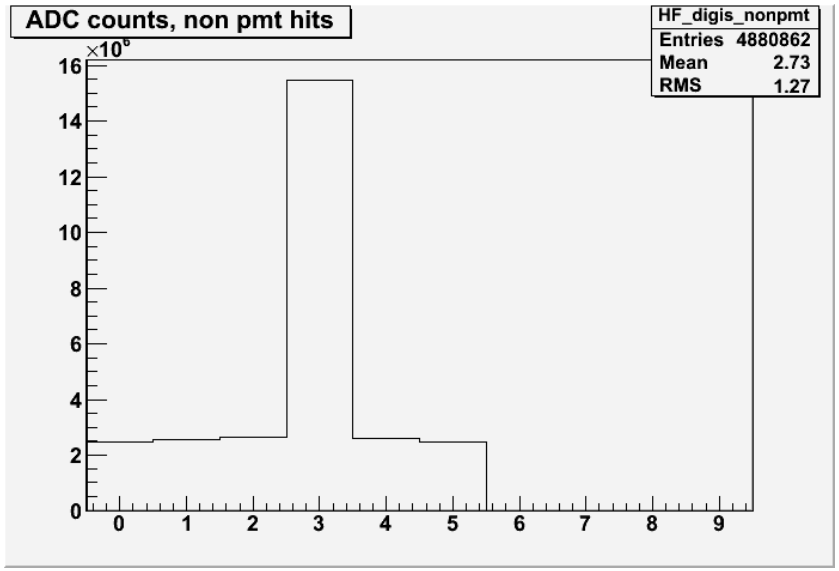
Some Representative Individual Digis

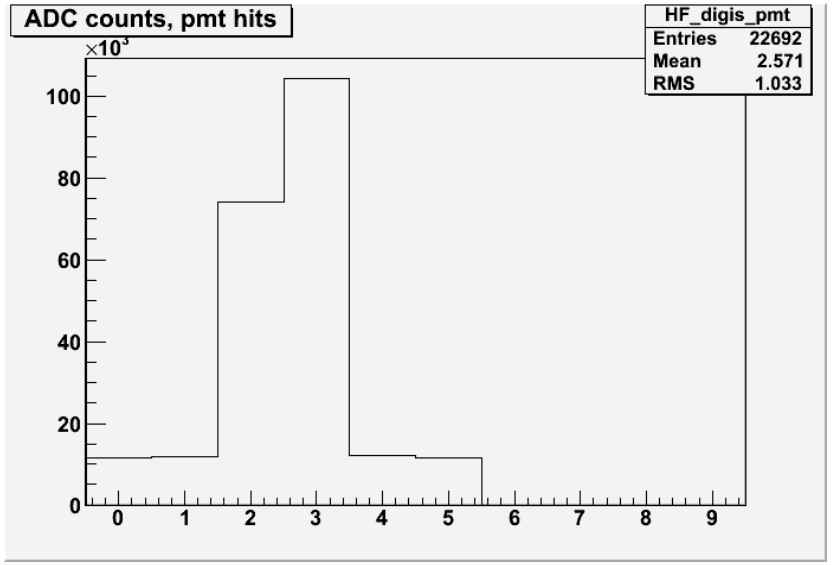






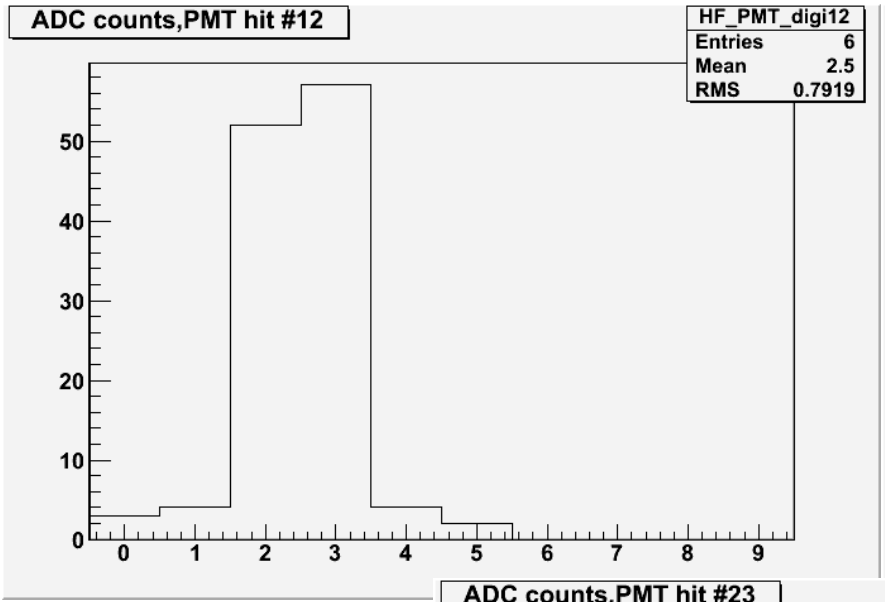
100 GeV Pions, Digis

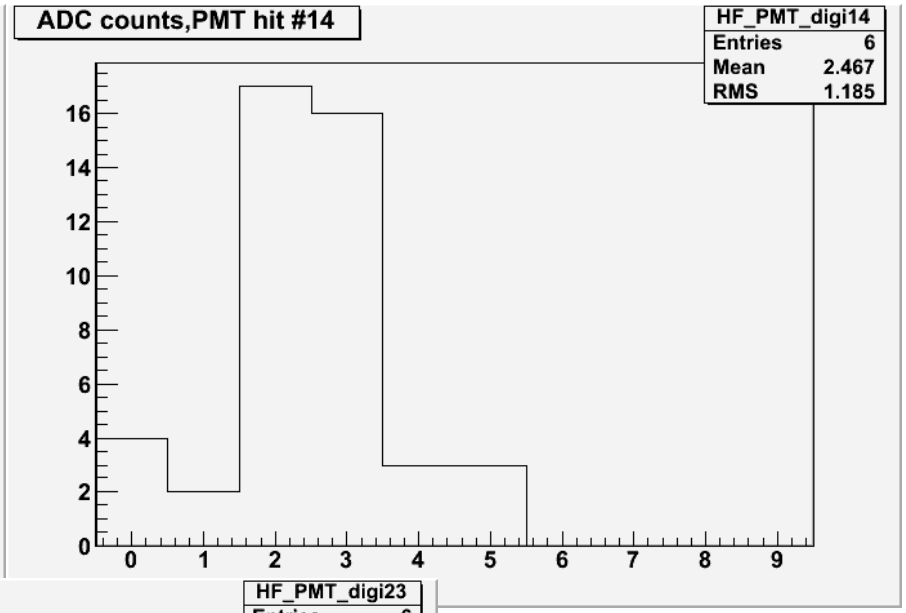


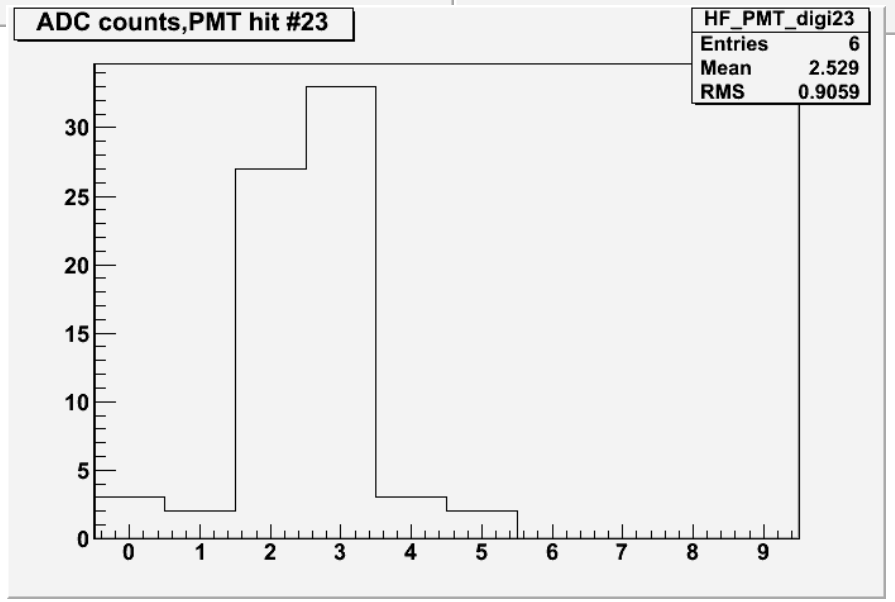


- Pions are similar to muons in that regular events have most of the signal in TS 3, but PMT hits have signal in both TS 2 and 3.

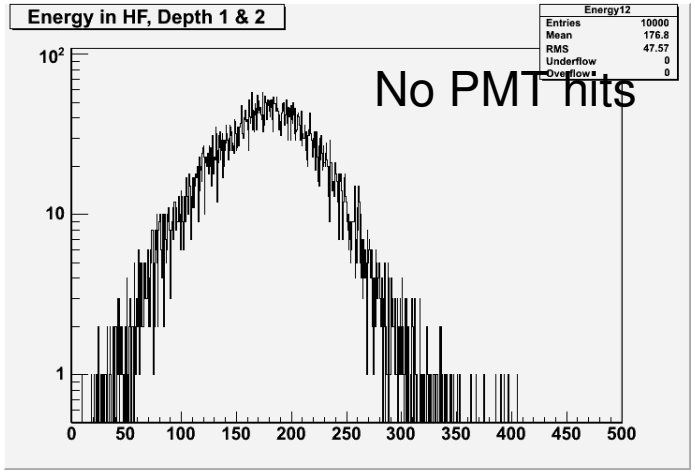
Some Representative Individual Digis

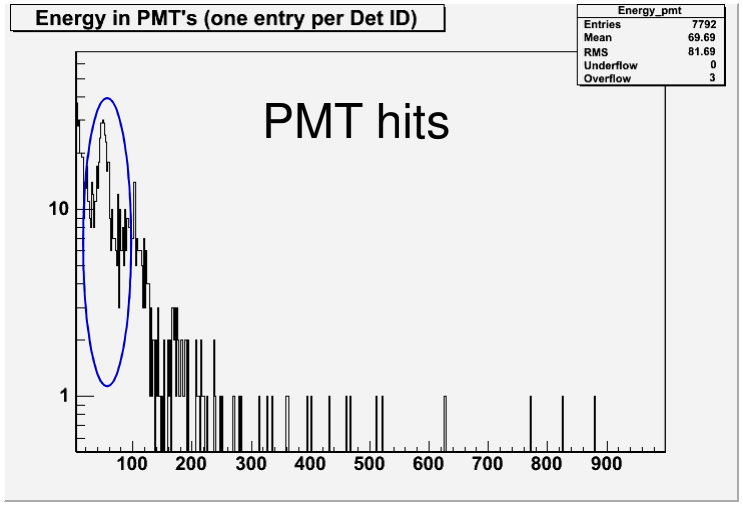


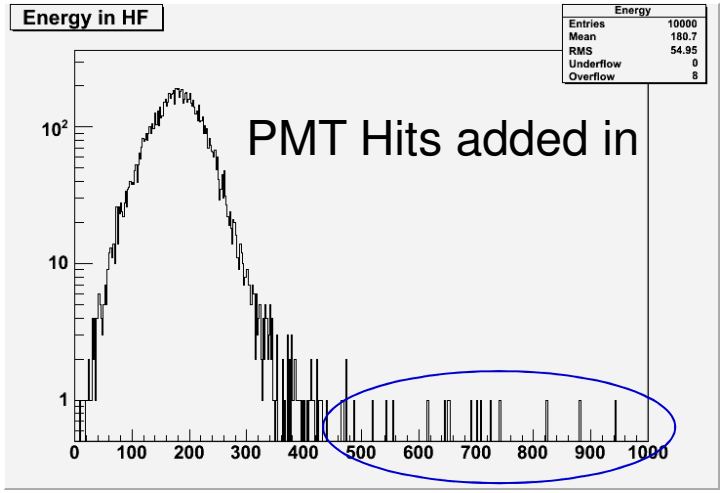




50 Pt Jets, Uniform Disk PMT Window







- Individual jets can be simulated with Pythia using a particle gun like interface.
- As with muons and pions, there is a peak in the PMT hits at about 50 GeV.
- Old Results from CMSSW_2_1_10