d_2^n BigBite

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Shower Energy Minimization

- Shower and PreShower blocks are summed and reconstructed into clusters (3x3)blocks for shower and (2x3) for preshower.
- Selects largest energy cluster for each event.
- Energy of the Clusters is then Minimized assuming the reconstructed momentum is the energy using a χ^2 linear minimization.

Shower Calibration

$$\chi^2 = \sum_{n=1}^{N} \left[\sum_{i \in M^n} C_i^{sh} \left(A_i^{sh} - P_i^{sh} \right) + \sum_{i \in M^n} C_i^{ps} \left(A_i^{ps} - P_i^{ps} \right) - E_e^n \right]^2$$

- $n = 1 - N$ Number of Events
- M^n Number of blocks in cluster
- C_i^{sh} Calibration coefficient of i^{th} shower block
- C_i^{ps} Calibration coefficient of i^{th} preshower block
- A_i^{sh} Amplitude in i^{th} shower block
- A_i^{ps} Amplitude in i^{th} preshower block
- P_i^{sh} Pedestal in i^{th} shower block
- P_i^{ps} Pedestal in i^{th} preshower block
- E_e^n Known energy of particle (momentum tracking)

Cuts used with Reconstruction Script

Electron Cuts

- One reconstructed tracks
- Require negative charge
- Momentum cut
- Preshower cut
- z-Vertex cut
- Invariant mass cut
- E/p cut

Electron Cuts (1)

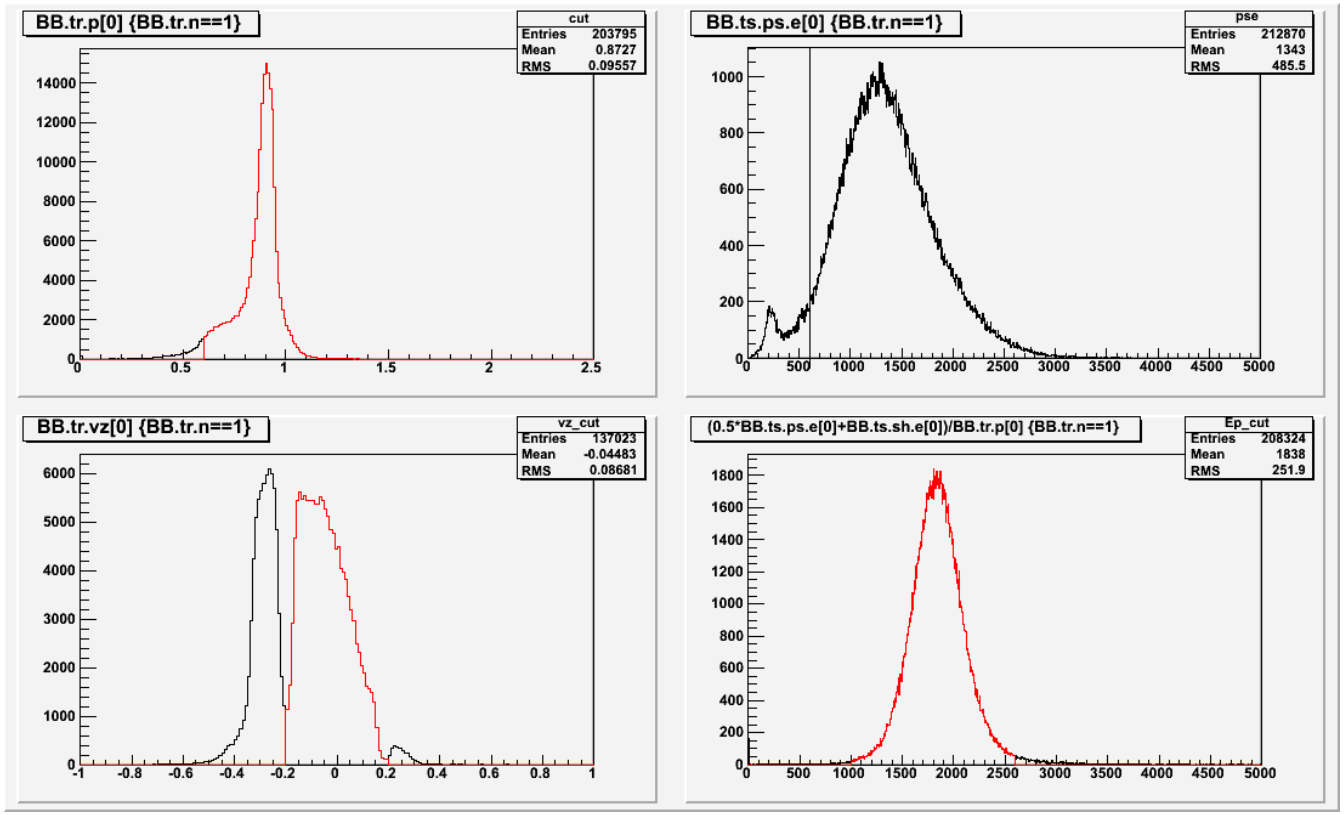


Figure 1: Electron cuts used in H2 elastic runs

Electron Cuts (2)

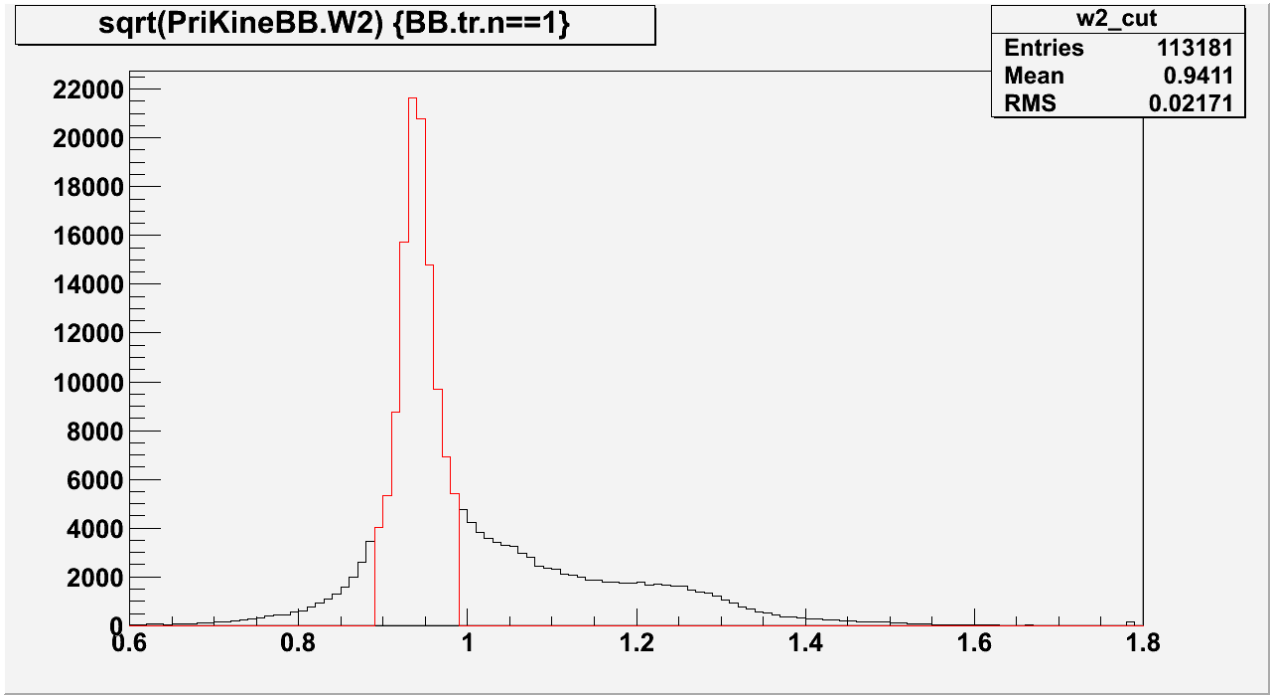
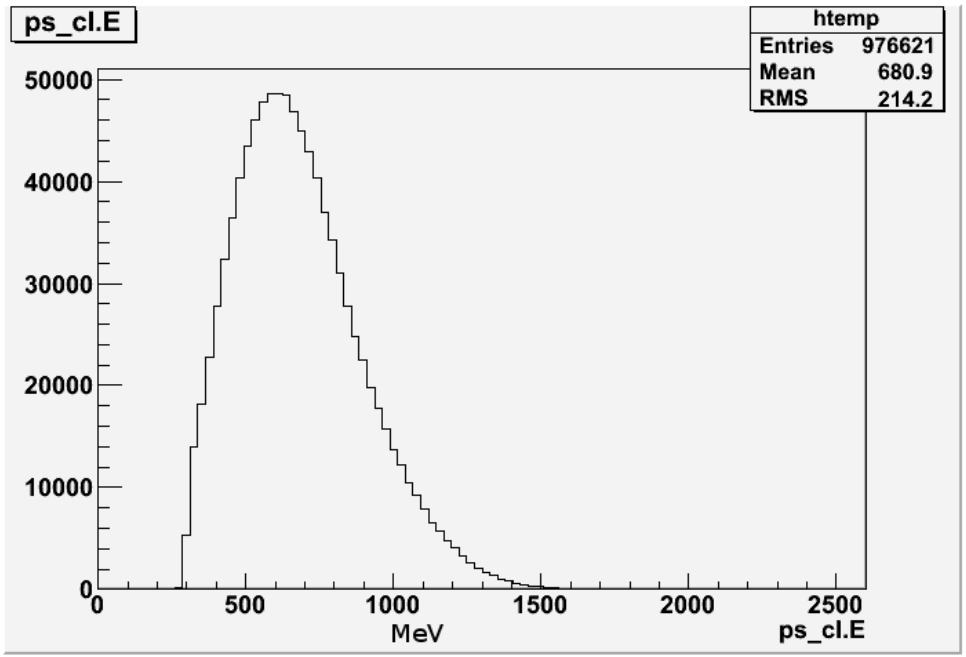


Figure 2: Electron cuts used in H2 elastic runs

Problems with Reconstruction Script

- Divide by zero error coming from $\frac{E}{p}$ solved
  - Solved by putting in momentum cut.
  - Compared the reconstructed momentum to those produced from the ROOT TTree (ROOT file from analyzing raw data file) $(T->Scan())$
  - TTree took out zero momentum.
  - TTree events now match reconstructed events for $\frac{E}{p}$
- Event mismatch for W2 cut solved
  - When using W2 cut the reconstructed events are larger than those from the ROOT TTree.
  - Some W2 values are negative and TTree automatically takes its magnitude before taking the square root.
  - The Reconstruction script takes the square root of a negative number and produces nan value that is counted as an event.
  - Solved by checking for negative W2 values and if found take the magnitude before taking the square root.
  - TTree events now match the reconstruction script events for all cuts.

Cluster Reconstruction Plots



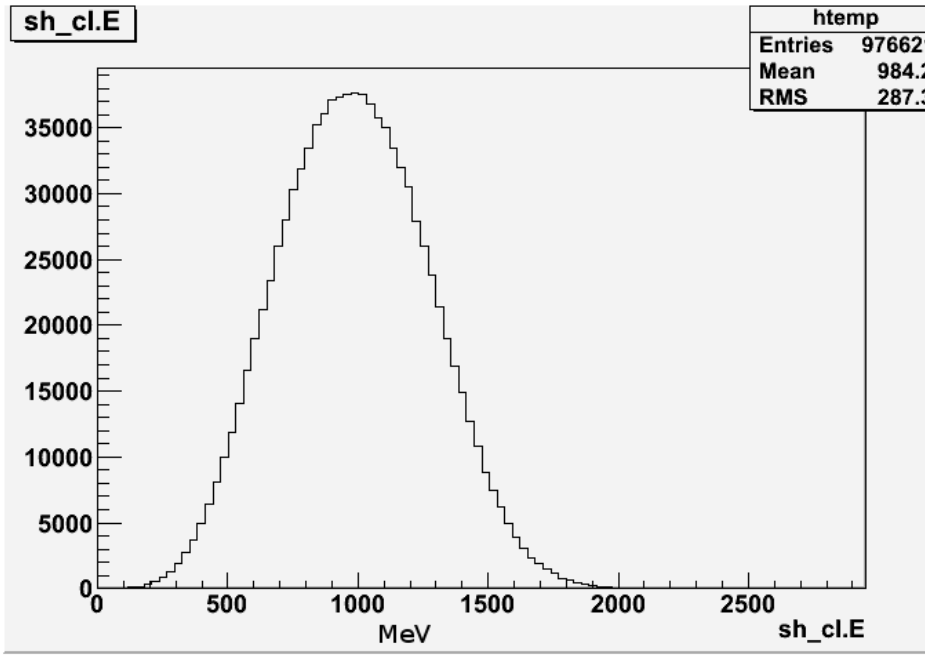


Figure 3: cluster reconstruction of shower and preshower for H2 elastic run

Cluster Reconstruction Plots

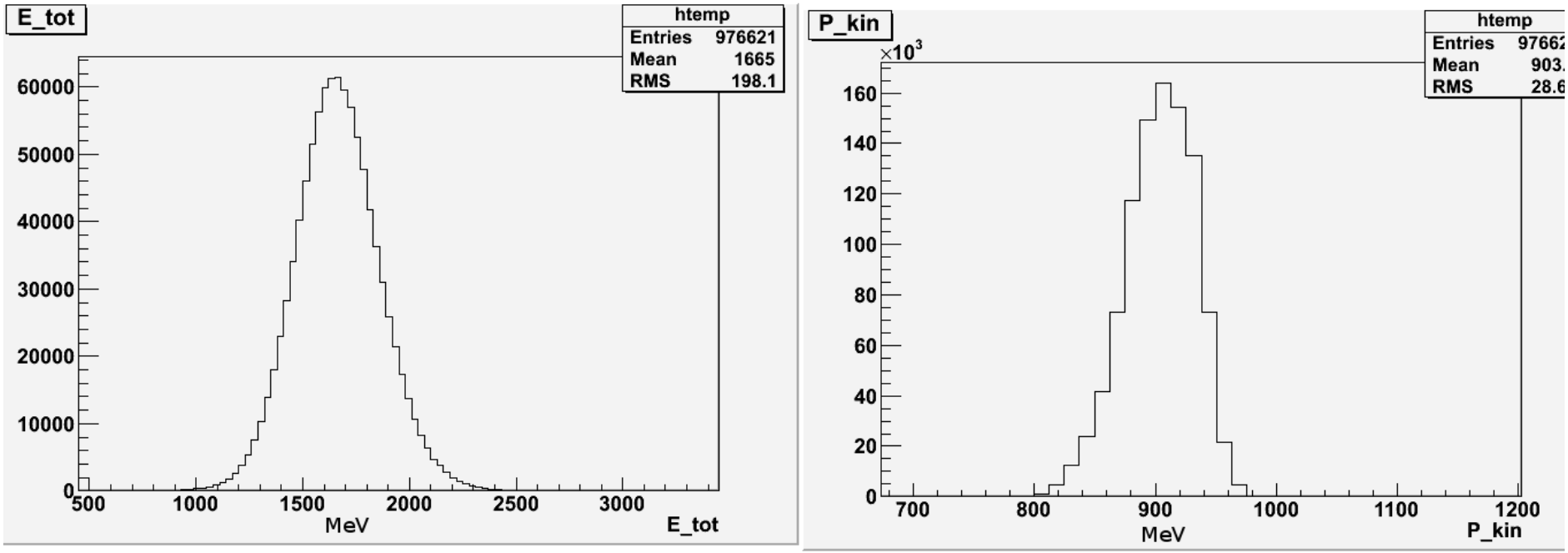


Figure 4: cluster reconstruction of total energy and momentum for H2 elastic run

Cluster Reconstruction Plots

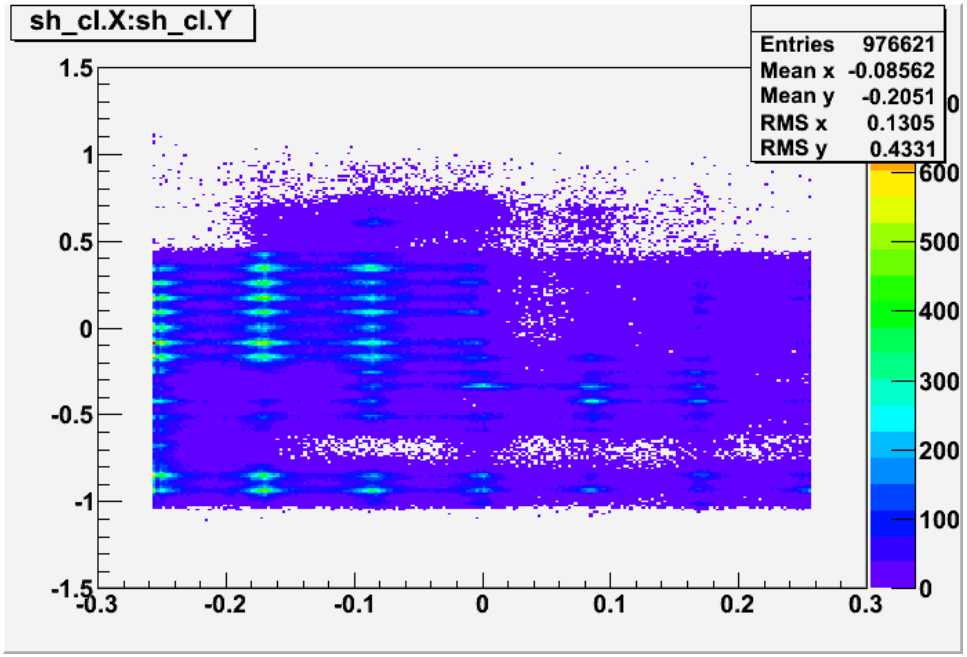


Figure 5: cluster reconstruction of shower X vs shower Y for H2 elastic run

More Issues

- Although cluster reconstruction events and plots seem good, the energy minimization script produces coefficients of order 0 to 10e10.
- The reconstruction script works with the old shower and preshower variables, the BB.ts.ps.e and BB.ts.sh.e
- The reconstruction script has more events than the TTree when using Kalyans new energy variables.
- I am Looking into how these variables are actually put together.

1 Photo Electron Calibration

- One Photo Electrons were gain matched to ADC channel 30 with LED runs
- Gain matching done by eye.
- The HV on the PMTs and calibration constants are:

PMT	HV	Coefficient	PMT	HV	Coefficient
1	1401	0.810	11	1522	0.638
2	1411	0.813	12	1750	1.150
3	981	0.680	13	1469	0.970
4	1251	0.638	14	1555	0.810
5	1150	1.000	15	1371	0.884
6	1166	1.100	16	2070	1.100
7	1390	0.900	17	1821	0.750
8	1151	0.730	18	1451	0.840
9	850	0.428	19	1403	0.430
10	1291	0.400	20	1657	0.500

1 Photo Electron Calibration

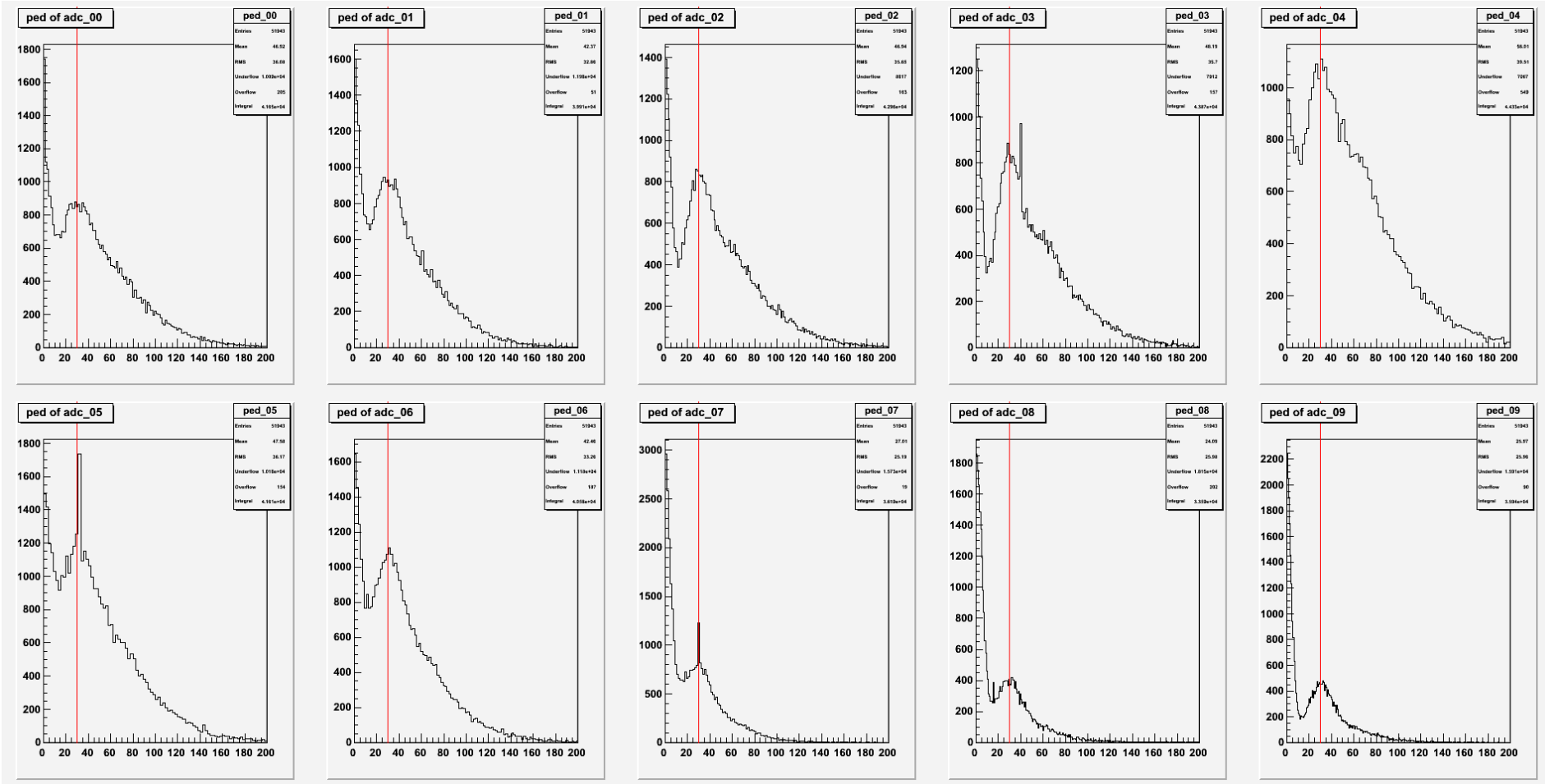


Figure 6: nearside LED ADC for run 1833

1 Photo Electron Calibration

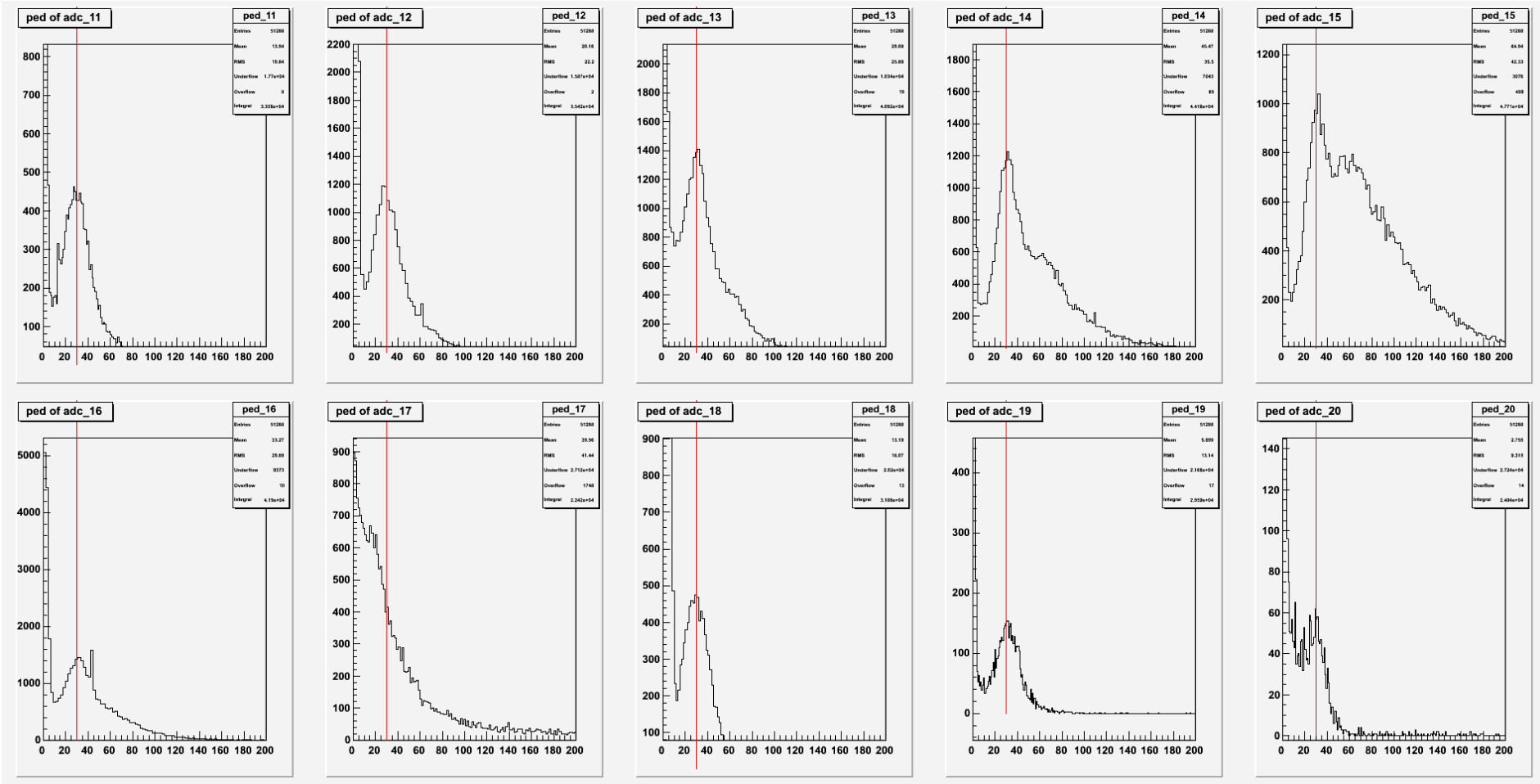


Figure 7: farside LED ADC for run 1837

General Five Pass Cuts

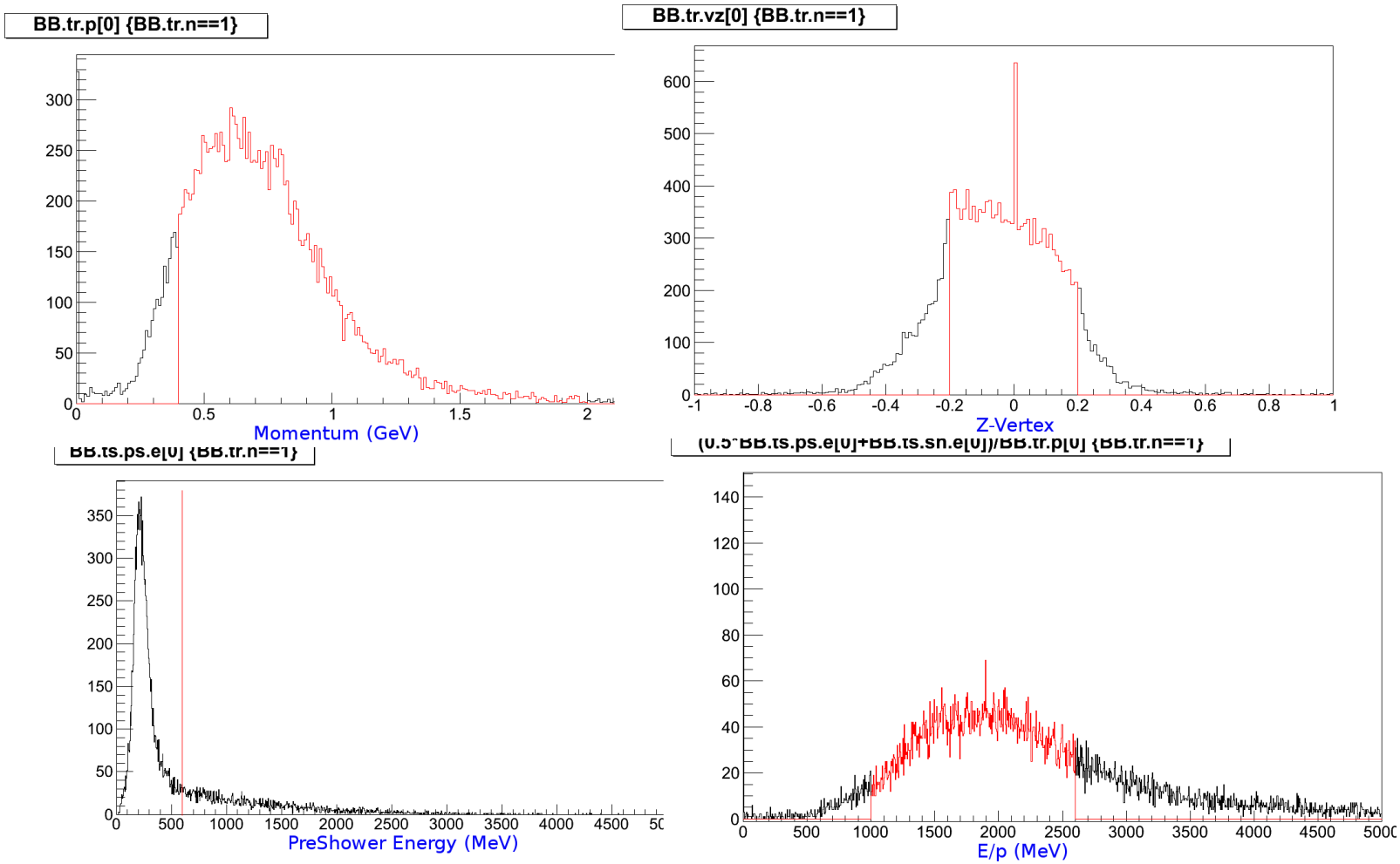


Figure 8: Cuts used for fivepass runs

TDC Cuts

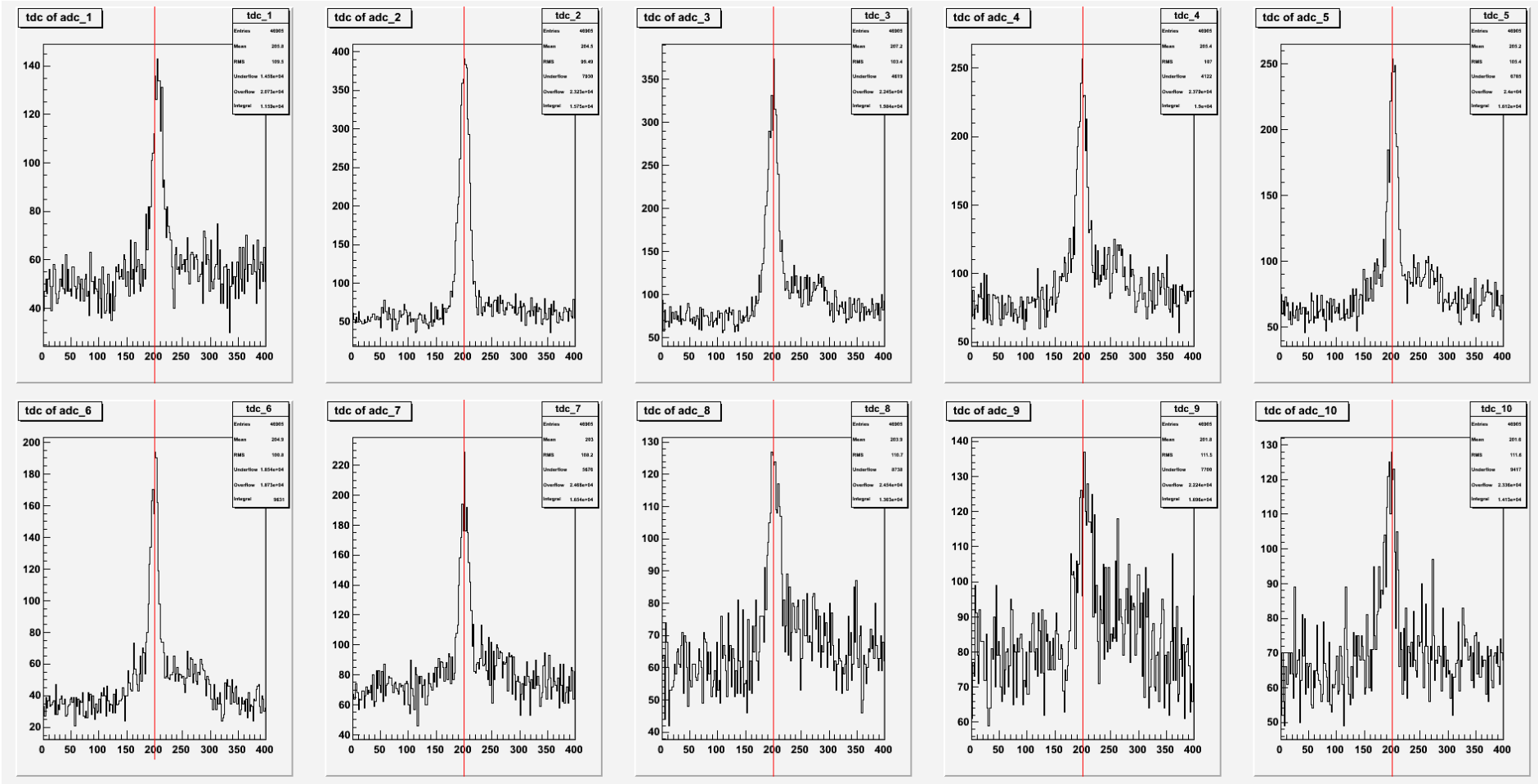


Figure 9: nearside TDC cuts for run 1848

TDC Cuts

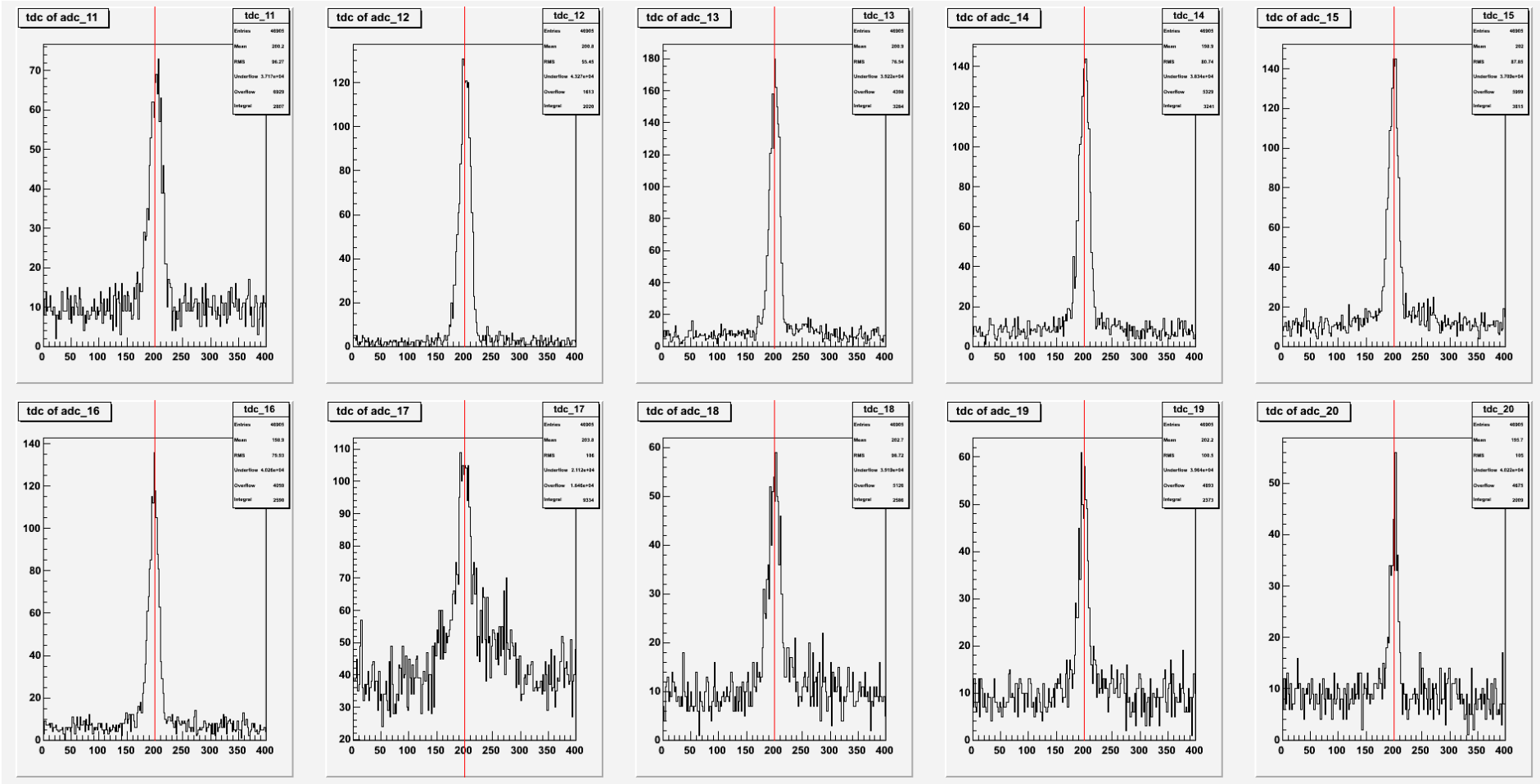


Figure 10: farside TDC cuts for run 1848

TDC Cuts

- TDC peaks are centered at channel 200.
- TDC cut is $abs(TDC - 200) < 30$

Mirror Cuts

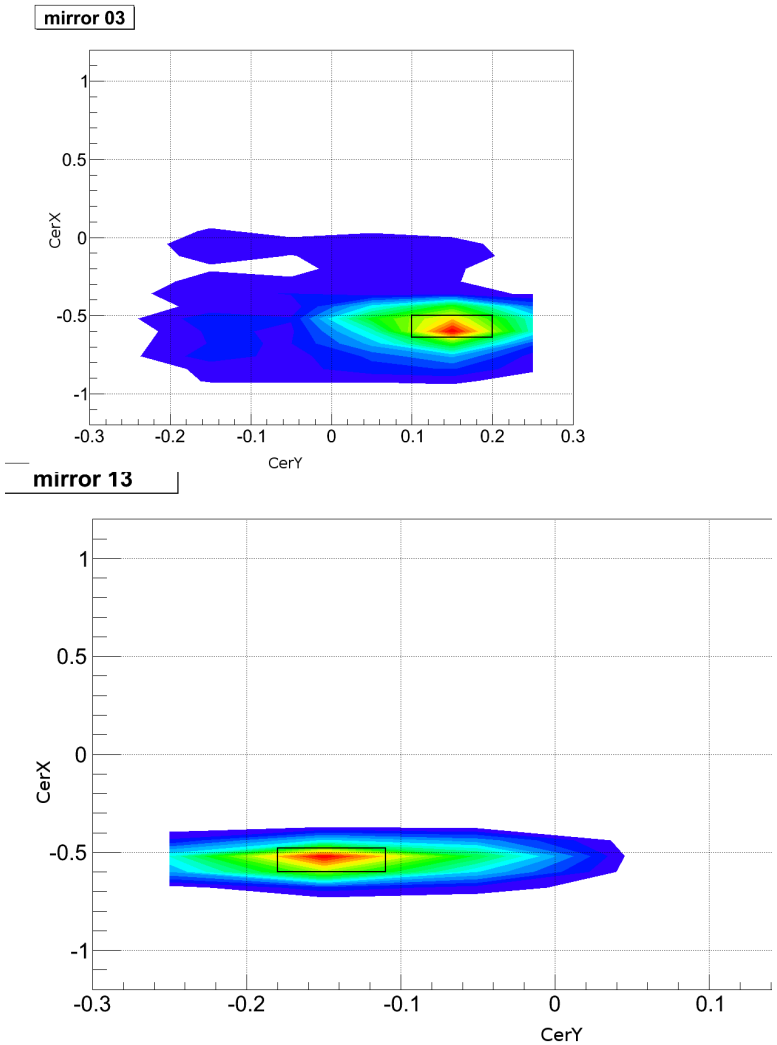


Figure 11: mirror cuts for mirror 3 and 13

ADC 3 and 13

- Green ADC has all cuts listed above but no TDC or Mirror cut.
- Red ADC has all cuts listed above and TDC and Mirror cut.
- Red ADC peaks from both mirror 3 and 13 fall near ADC chan 150.
- How to get an error on photo electron number?

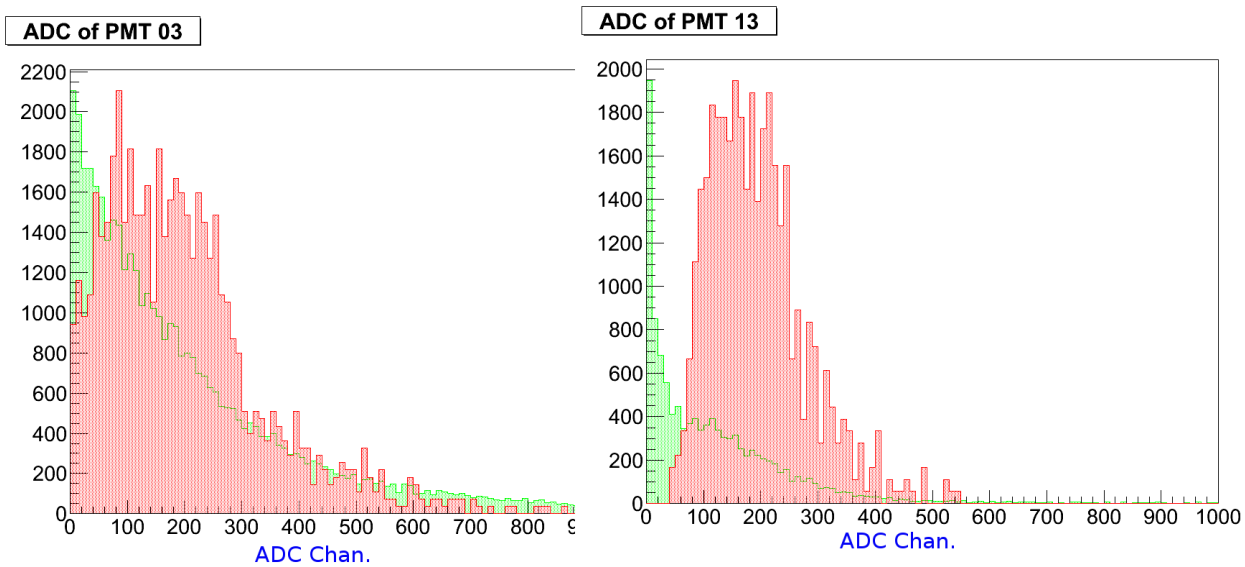


Figure 12: ADC from mirror 3 and 13 center

Contamination of ADC

- Want to look at the space between the center of mirrors 3 and 13.
- Will give an idea of what is falling outside of the selected region.
- This is done by using another mirror cut (mid mirror cut).

Mid Mirror Cut

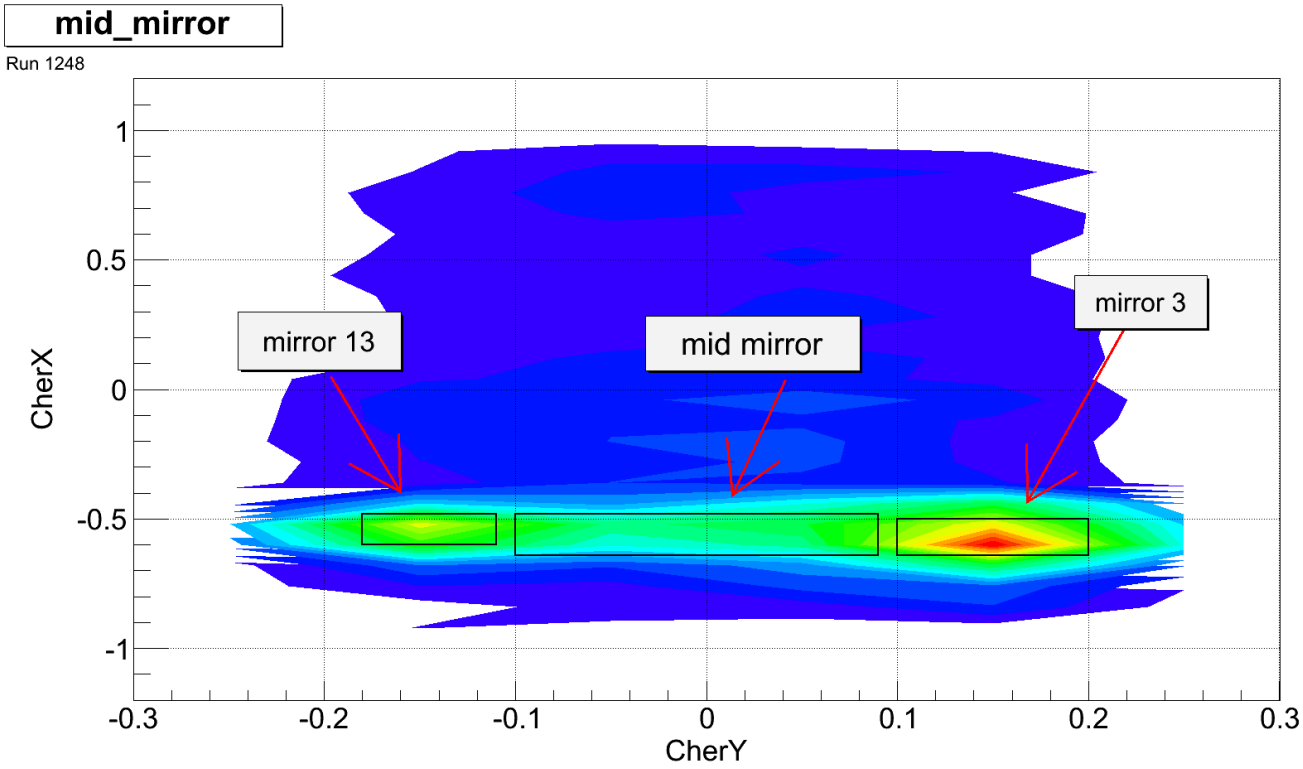
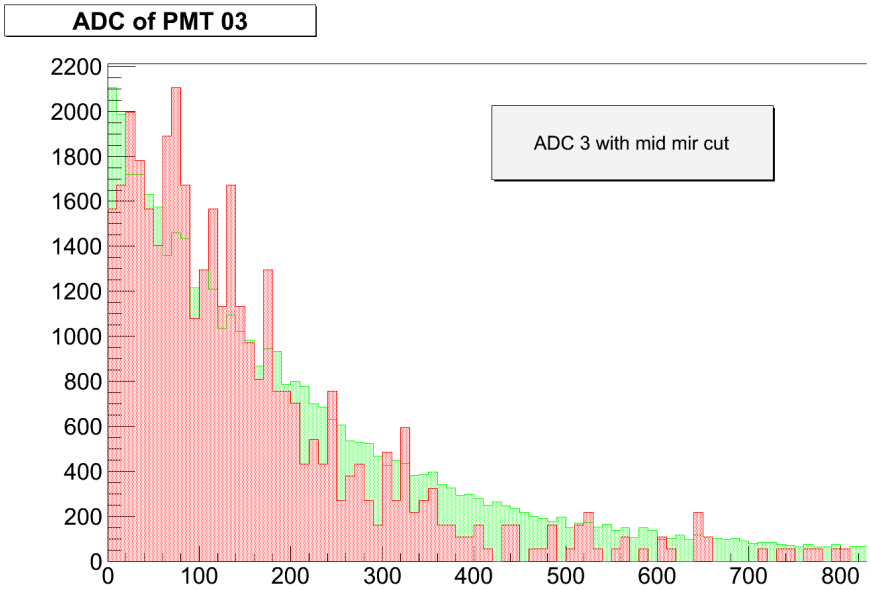
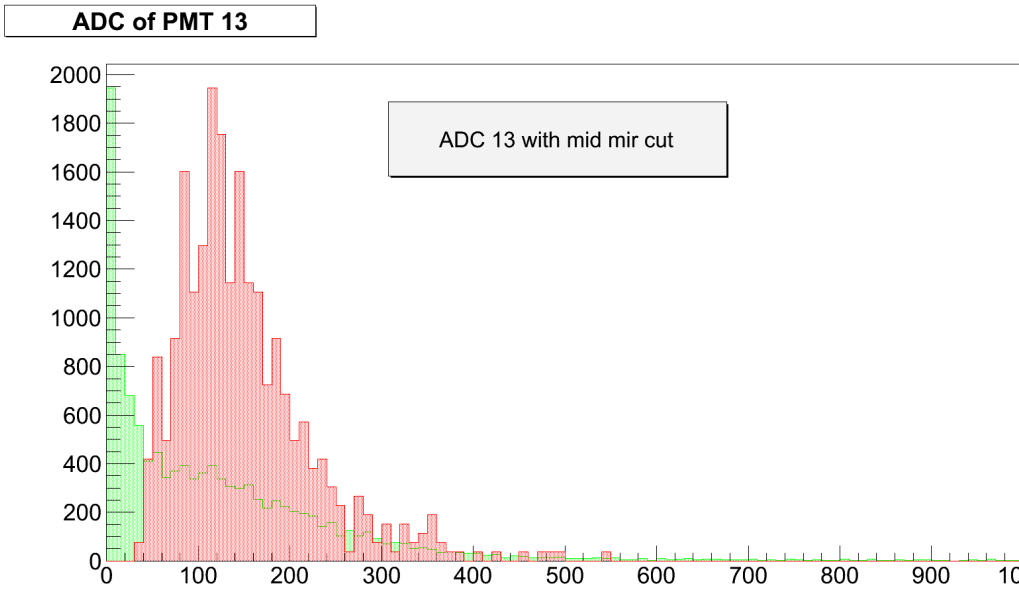


Figure 13: mirror cut between mirror 3 and 13 center

Contamination of ADC

- Using mid mirror cut we look at ADC 3 and 13
- Seems to be less signal on ADC 3 than ADC 13, could be do to higher rate on PMT 3.





Mid Mirror Cut ADC Sum

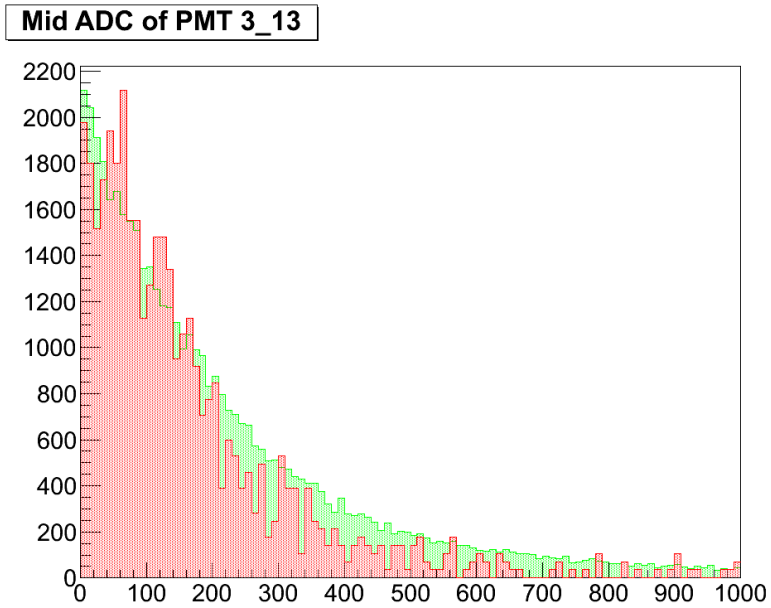


Figure 15: mid mirror cut of ADC 3 and 13 summed

To-Do

To Do

- Figure out why the energy minimization is not working
- How the new energy variables are formed
- Find Best way to form Cerenkov some
  - Just sum all ADCs together? Will loose resolution.
  - Create two separate ADC sums, near sum and far sum? Will be limited by near side photo electron cut.
  - Any suggestions?
- Start looking at pion/electron signals in Cerenkov by using shower/preshower