September Report 1:
Momentum correction to the Energy lose with momentum transfer and BigBite detecting Efficiency from Elastic runs.

I. Momentum Correction & Energy lost calculation.

Target: LH2 at T = 19 K, P = 33.36 psiA. Density 0.0723 g/cm^3.

Table 1.1 Passage of proton traveling.

	Material	Density [g/cm3]	Distance [cm]	Range= density*distance [g/cm2]
1.	LH2	0.0723	3.175/sin(exit angle) 3.424 [at 68 degree]	0.248
2.	Al sidewall	2.6989	0.0142/sin(exit angle) [from Hall A target configuation paper Jan 2011] 0.0153 [at 68 degree]	0.0413
3.	Vacuum	N/A	51.85 – target size	N/A
4.	Scattering Chamber window: Al	2.6989	2*0.038 = 0.076 or just 1*0.038??	0.205 or 0.103
5.	Air	1.20479E-03	140	

Table 1.2 sub section of energy lost through passage including momentum, Energy and dE at each state.

|q|	E_q	0.0723 g/cm3 3.175 cm 0.2296 g/cm2 * 1/sin(theta) LH2			2.6989 g/cm3 0.142 mm 0.0383 g/cm3*1/sin(theta) Al Wall			0.76 mm 0.2051 g/cm2 Al Scatter Chamber Window			1.2048E-3 g/cm3 1.4 m 0.17 g/cm2 Air		total E_loss	0.38 mm Al Scatter Chamber Window			1.2048e-3 g/cm3 1.4 m Air		total E_loss
[MeV/c]	[MeV]	|p| [MeV/c]	|E| [MeV]	dE	|p| [MeV/c]	|E| [MeV]	dE	|p| [MeV/c]	|E| [MeV]	dE	|p| [MeV/c]	|E| [MeV]	[MeV]	|p| [MeV/c]	|E| [MeV]	dE	|p| [MeV/c]	|E| [MeV]	[MeV]
250.0	32.7	212.3	23.7	9.0	209.1	23.0	0.7	191.8	19.4	3.6	170.9	15.4	17.3	200.7	21.2	1.8	182.1	17.5	15.2
260.0	35.4	226.3	26.9	8.4	223.6	26.3	0.6	209.1	23.0	3.3	192.5	19.6	15.8	216.4	24.6	1.6	201.4	21.4	14.0
270.0	38.1	239.7	30.1	7.9	237.3	29.5	0.6	224.9	26.6	3.0	211.3	23.5	14.6	231.2	28.1	1.5	218.5	25.1	13.0
280.0	40.9	252.5	33.4	7.5	250.5	32.9	0.5	239.7	30.1	2.7	228.1	27.3	13.5	245.1	31.5	1.4	234.3	28.8	12.1
290.0	43.8	265.0	36.7	7.1	263.2	36.2	0.5	253.6	33.7	2.5	243.7	31.1	12.7	258.4	34.9	1.3	249.0	32.5	11.3
300.0	46.8	277.2	40.1	6.7	275.5	39.6	0.5	267.0	37.3	2.4	258.3	34.9	11.9	271.3	38.4	1.2	262.9	36.1	10.6
320.0	53.1	300.7	47.0	6.1	299.4	46.6	0.4	292.4	44.5	2.1	285.5	42.5	10.6	295.9	45.6	1.0	289.2	43.6	9.5
340.0	59.7	323.5	54.2	5.5	322.3	53.8	0.4	316.6	52.0	1.9	310.9	50.2	9.5	319.5	52.9	0.9	313.9	51.1	8.6
360.0	66.7	345.7	61.7	5.0	344.7	61.3	0.3	339.8	59.6	1.7	335.0	58.0	8.7	342.3	60.5	0.8	337.6	58.9	7.8
380.0	74.0	367.5	69.4	4.6	366.6	69.1	0.3	362.4	67.5	1.5	358.3	66.1	7.9	364.5	68.3	0.8	360.5	66.9	7.2
400.0	81.7	388.9	77.4	4.3	388.2	77.1	0.3	384.5	75.7	1.4	380.9	74.4	7.3	386.3	76.4	0.7	382.8	75.1	6.6
450.0	102.3	441.6	98.7	3.6	441.0	98.5	0.2	438.3	97.3	1.2	435.6	96.2	6.1	439.6	97.9	0.6	437.0	96.8	5.5
500.0	124.9	493.2	121.7	3.2	492.7	121.5	0.2	490.5	120.5	1.0	488.5	119.5	5.4	491.6	121.0	0.5	489.6	120.1	4.9
550.0	149.3	544.4	146.5	2.8	544.1	146.3	0.2	542.3	145.4	0.9	540.6	144.6	4.7	543.2	145.9	0.4	541.5	145.1	4.3
600.0	175.4	595.3	172.9	2.5	595.0	172.8	0.2	593.5	172.0	0.8	592.1	171.2	4.2	594.3	172.4	0.4	592.9	171.6	3.8
650.0	203.2	646.0	200.9	2.3	645.7	200.7	0.1	644.5	200.0	0.7	643.3	199.3	3.8	645.1	200.4	0.4	643.9	199.7	3.5
700.0	232.3	696.5	230.3	2.1	696.3	230.1	0.1	695.2	229.5	0.7	694.1	228.8	3.5	695.7	229.8	0.3	694.7	229.2	3.2
750.0	262.9	746.9	261.0	1.9	746.7	260.9	0.1	745.7	260.2	0.6	744.8	259.7	3.3	746.2	260.5	0.3	745.3	260.0	2.9
800.0	294.8	797.2	292.9	1.8	797.0	292.8	0.1	796.1	292.2	0.6	795.3	291.7	3.0	796.6	292.5	0.3	795.7	292.0	2.8
850.0	327.8	847.4	326.1	1.7	847.3	325.9	0.1	846.5	325.4	0.5	845.7	324.9	2.9	846.9	325.7	0.3	846.1	325.2	2.6
900.0	361.9	897.7	360.2	1.6	897.5	360.1	0.1	896.8	359.6	0.5	896.1	359.1	2.7	897.1	359.9	0.3	896.4	359.4	2.5
950.0	397.0	947.8	395.4	1.6	947.7	395.3	0.1	947.0	394.8	0.5	946.3	394.4	2.6	947.3	395.1	0.2	946.7	394.6	2.4
1000.0	433.0	998.0	431.5	1.5	997.8	431.4	0.1	997.2	430.9	0.5	996.6	430.5	2.5	997.5	431.2	0.2	996.9	430.7	2.3

I get information from Kalyan that the bigbite scattering window is 2 times the normal thickness. 0.76 mm. So I use the energy lose from the first data set (which in the end would not really matter).

From this table, we can see how much the energy loss “rarely” depend on the scattering chamber at target momentum > 450 MeV/c. There is only 1 MeV/c momentum difference which is much below the momentum resolution in BigBite optics (resolution ~ 8-10 MeV/c).

Momentum correction

Now to correct for the momentum in Analytical model for BigBite, I check the MWDC_momentum vs the expected momentum calculated from |q|- (Eloss though passage).

The correction can either be linear or second order polynomial.

The linear fit has problem at high momentum so I pick the second order polynomial.

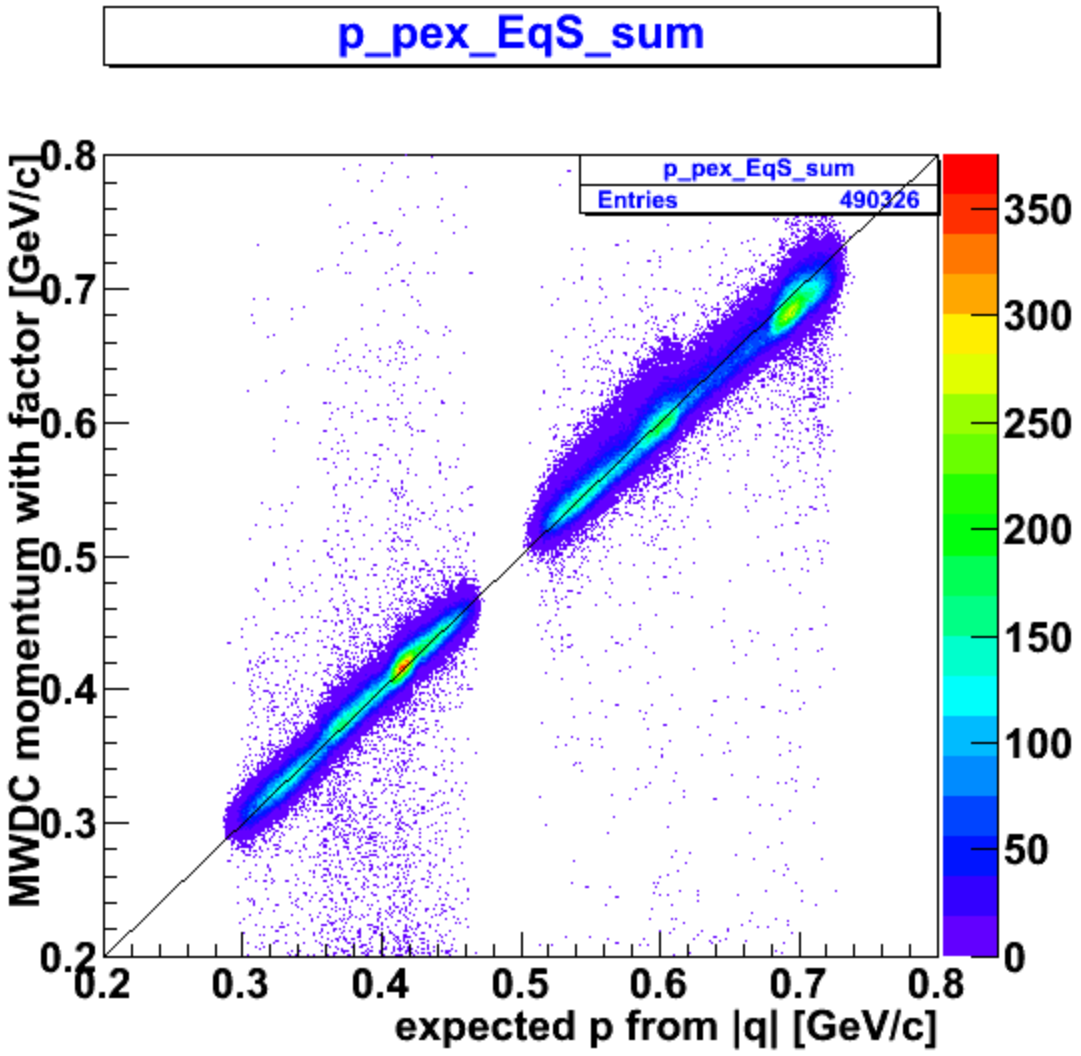


Figure 1. After linear correction with (p0 = 0.0808 GeV/c and p1 = 1.085). Black line is x=y.

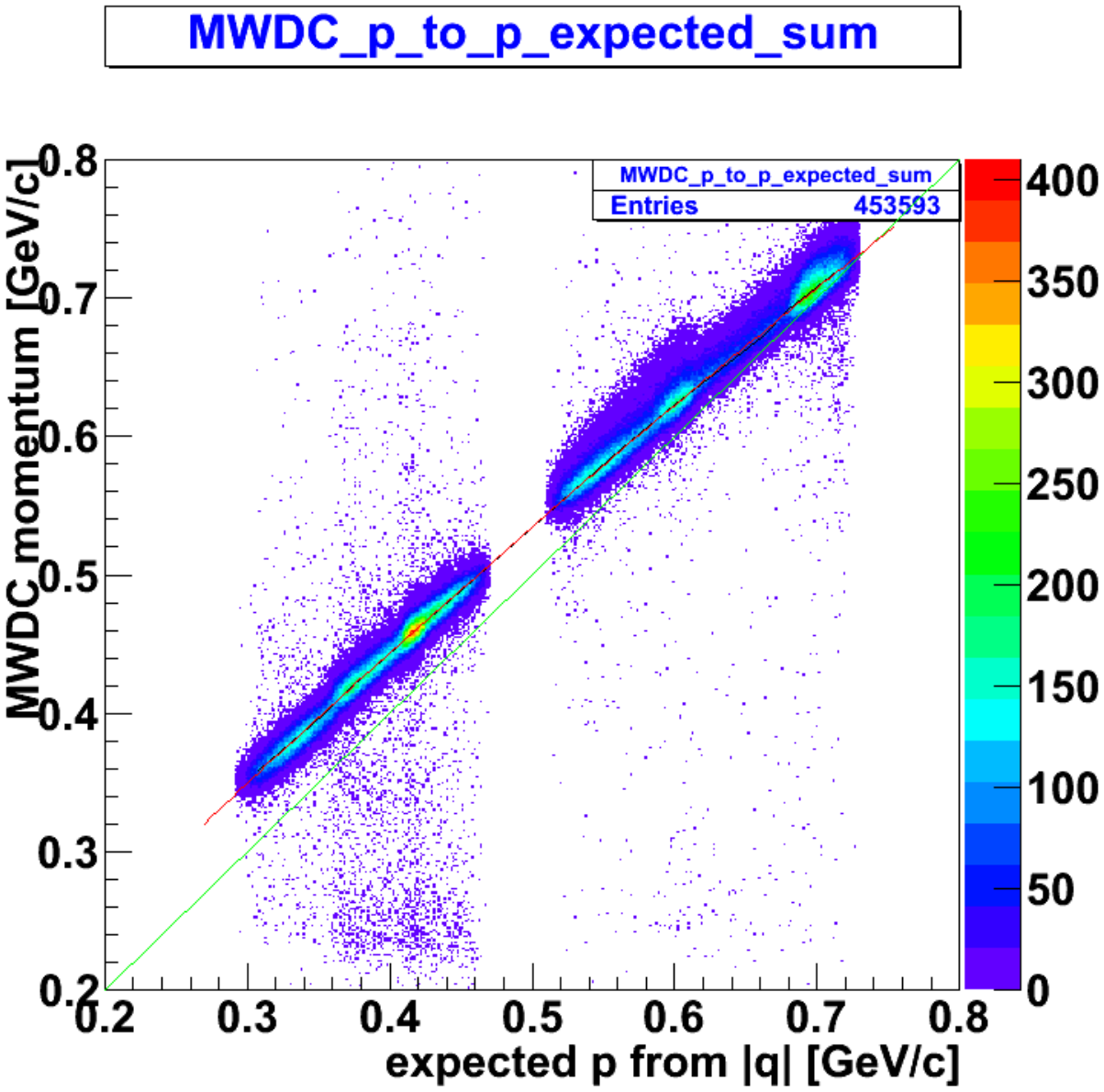


Figure 2.1: 2nd order polynomial fit in red line where green line is x= y line.

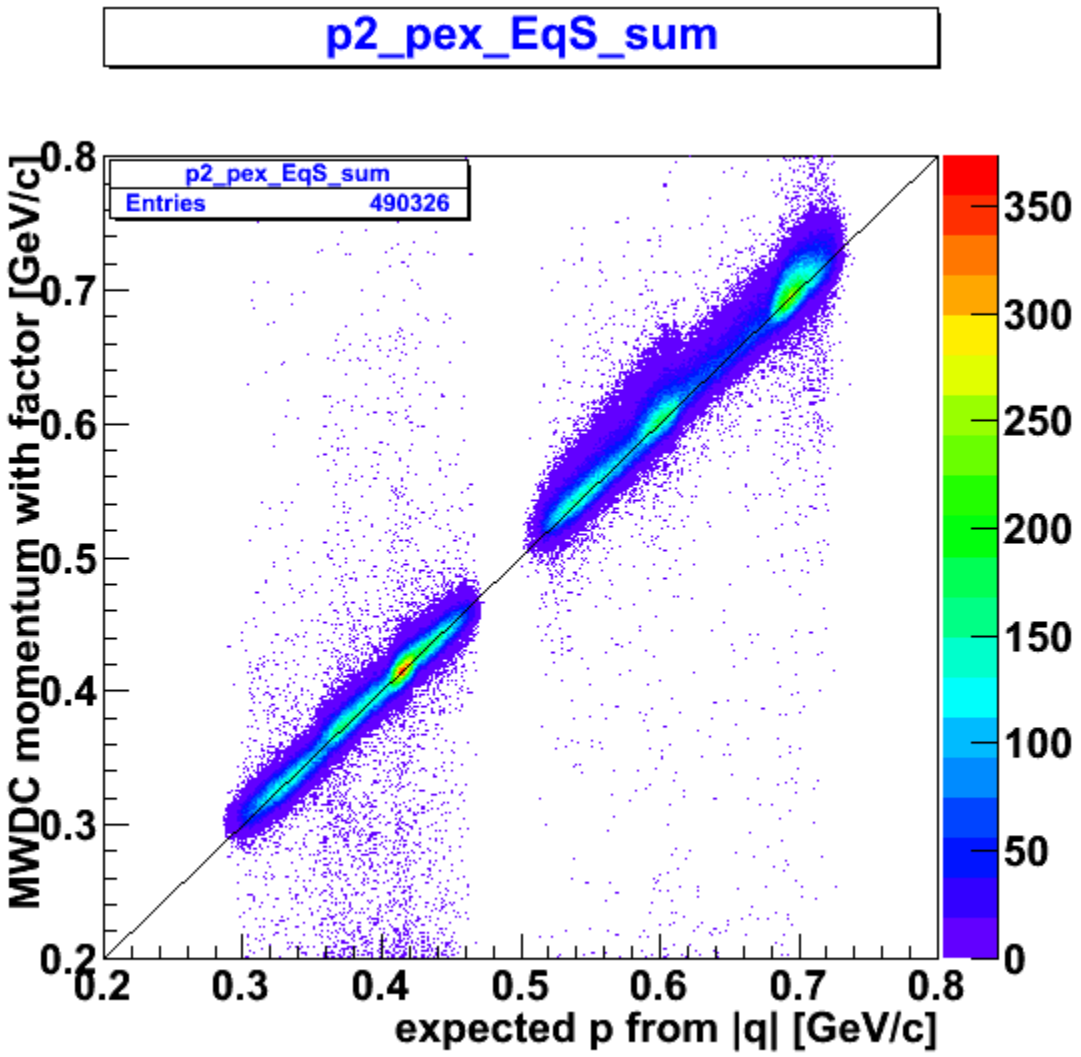


Figure 2.2: After 2nd order polynomial correction with (p0 =-0.034 GeV/c,p1 = 0.877,p2 = 0.226). black line is x=y.

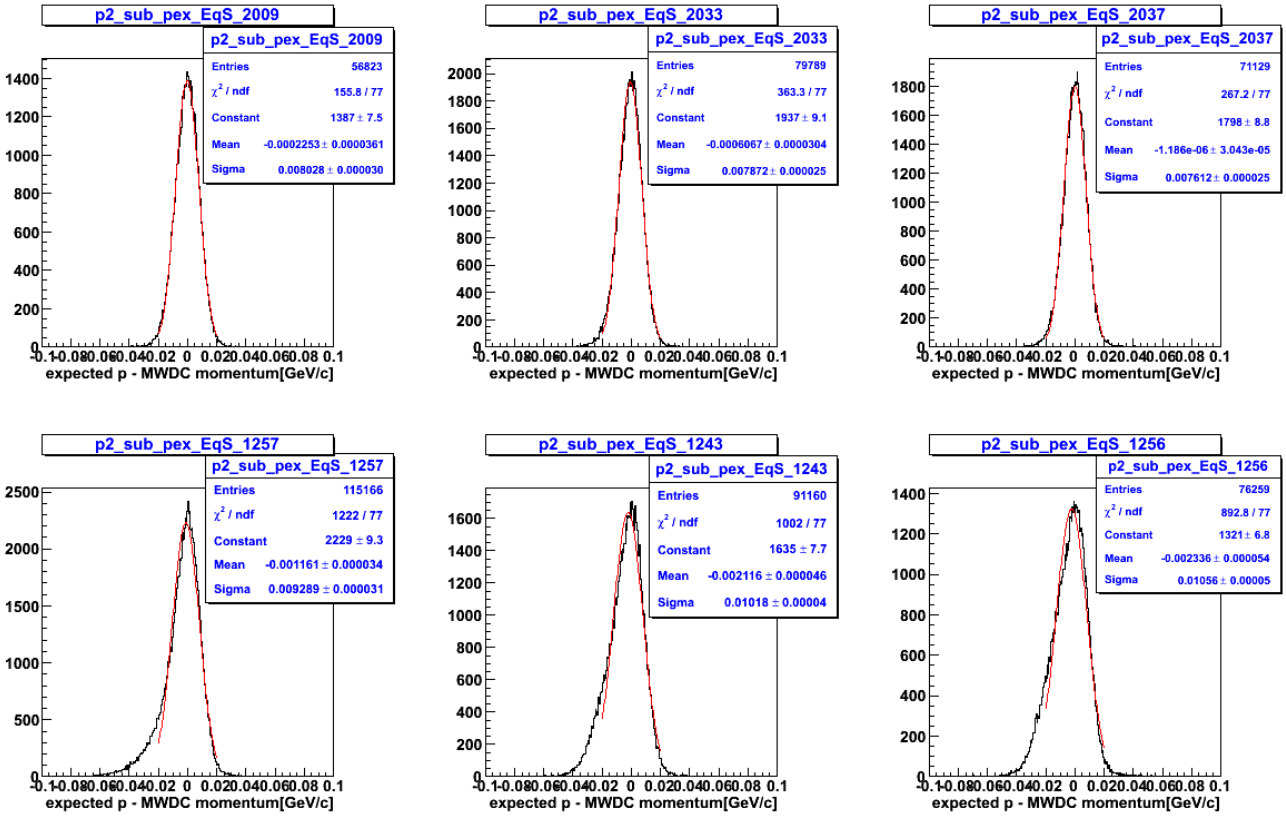


Figure 2.3: resolution per each run start from lowest momentum to highest momentum in BigBite. Resolution (sigma) are (8.0, 7.8, 7.6, 0.2,10.1,10.6) MeV/c respectively.

BB Efficiency
Run 2009, 2033, 2037, 1243, 1256, 1257

Electron Elastic Cut:

1. T3 no edtm
2. theta and phi acceptance |theta|<= 60 mrad |phi|<= 30 mrad.
3. single track
4. W = proton mass (938.3 MeV/c2)<=4.49 MeV/c2
5. Vertex (target is 4 cm LH2) (none)
6. Using T3 recorded in BigBite roc 10 as time for Left HRS reference. As in run 12xx, portion of code was missing and the timing in the HRS was not exist.

Proton Elastic Cut:

1. Graphic cut of E vs q
2. Track Matching in both (x,y) direction from MWDC to E (bar, time difference between left/right pmt).
    1. | track x – 0.65*Ebar + offset|<= 0.15 (m)
    2. | track y – 0.1*E_tdiff+offset| <= 0.045 (m)
3. Calibrated momentum from MWDC to expected momentum from |q| after energy lost.
    1. |MWDC_p-p_expected|<=30 MeV/c.

Table 1.1

run	2009	2033	2037	1257	1243	1256
|q|: transfer momentum [GeV/c]	0.32 to 0.38	0.375 to 0.44	0.42 to 0.48	0.52 to 0.62		
|q| theta angle [degree]	69.5 to 72	66.5 to 69.25	64.5 to 67	65.25 to 68.5	62 to 65.8	61.25 to 62.5
DBB.t3 cut	296 to 320	288 to 307	287 to 304	875 to 892	868 to 888	870 to 888

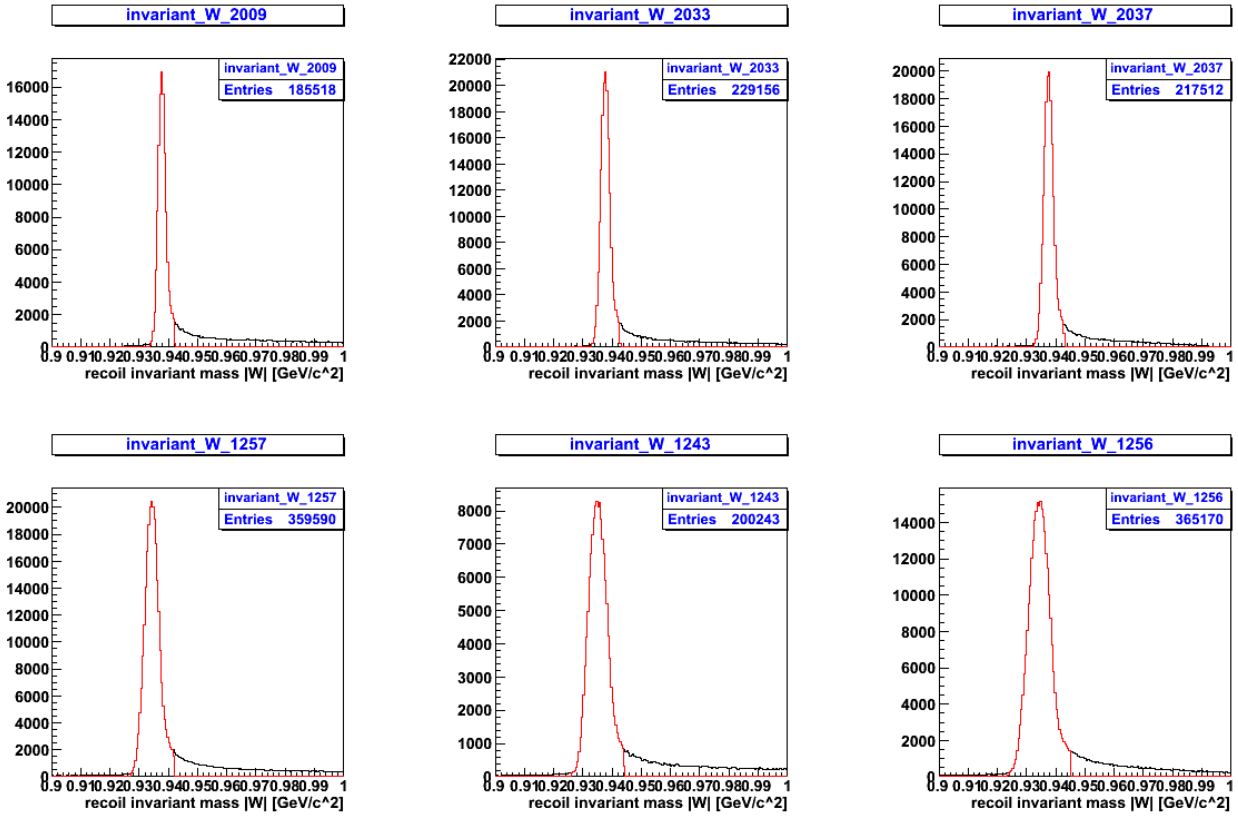


Figure 3. recoil invariant mass W cut for each run.
The red line represent the cut around proton mass +/- 4.49 MeV/c2.
Note that the last three runs have worse resolution plus offset by 3.9 MeV/c2. The cut are made base on 3* sigma fitting for each run.

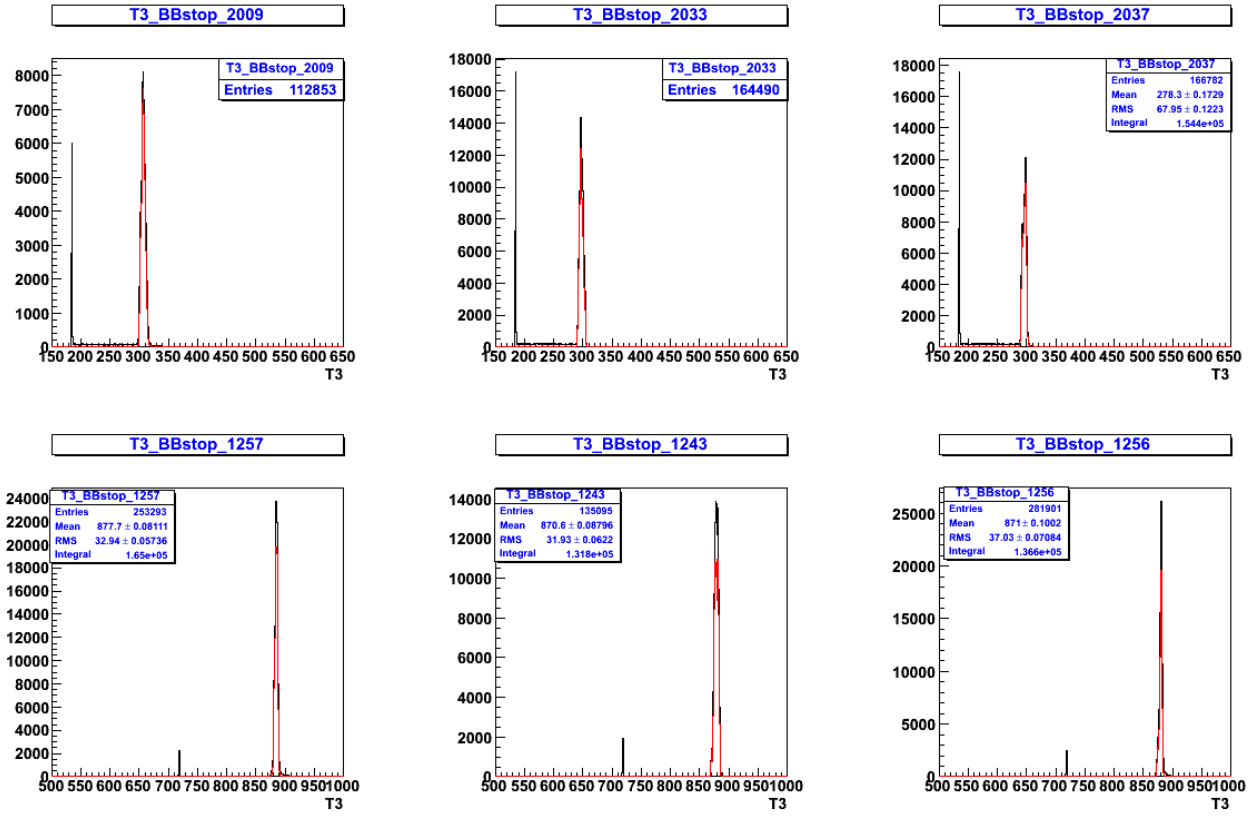


Figure 4.: DBB.t3 cut: T3 that recorded in BigBite roc10 using as the timing information for the Left HRS as for last three runs do not have timing information in S2 plane. The red line represent both T3 cut and the min-max of the theta and phi of the q vector that would show up in the BigBite center acceptance. Detail in table 1.1

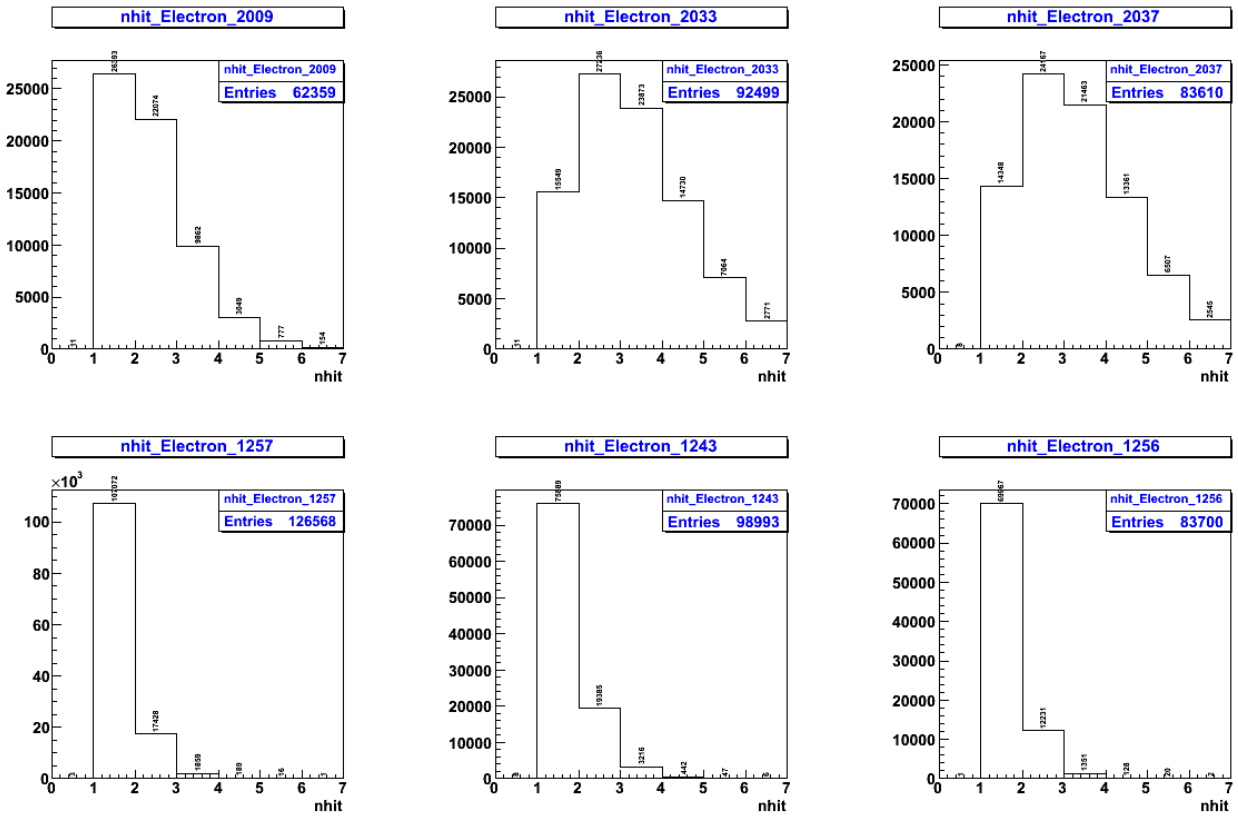


Figure 5. hit distribution for the event that pass the Elastic electron cut.
The period of 20xx run has more multi-hit data which result in higher impact on chosen the right hit.

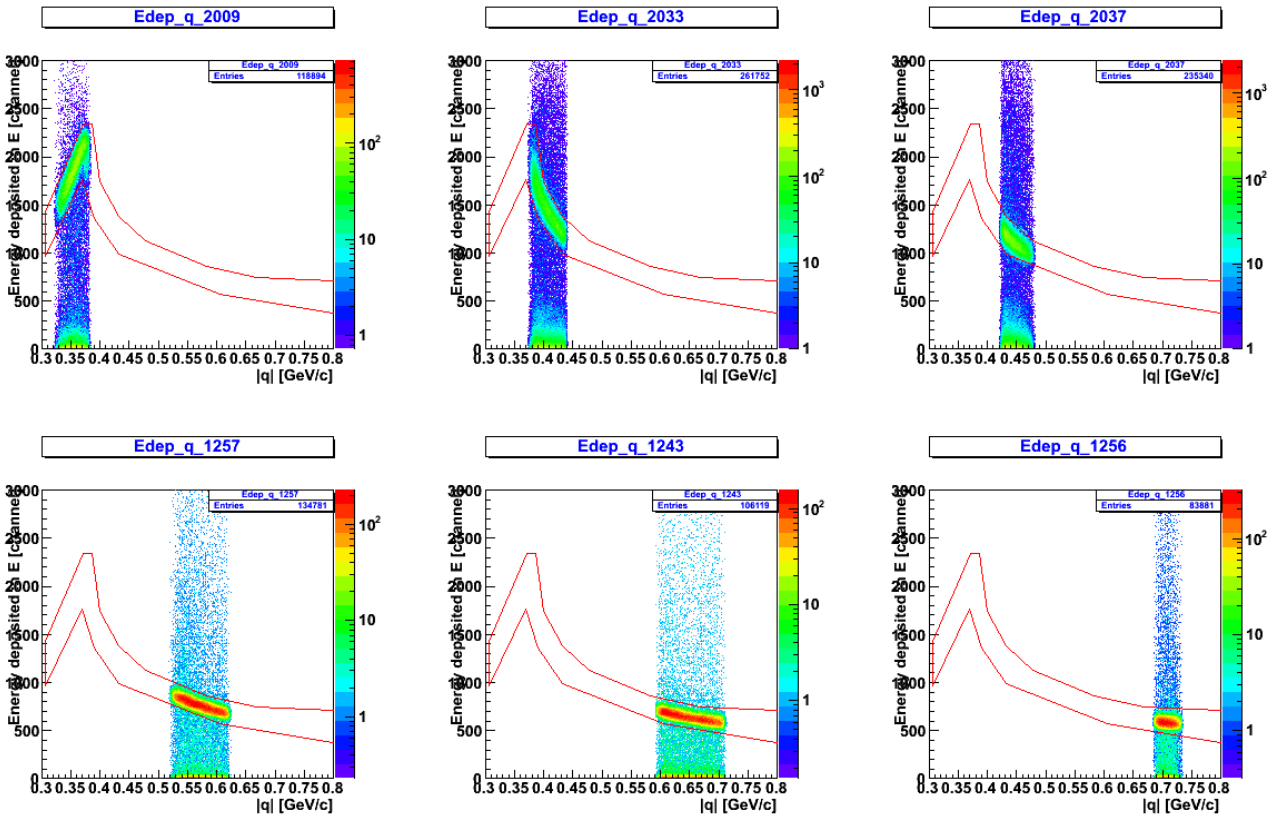


Figure 6.1 Proton PID in E-plane with graphical cut E vs q.

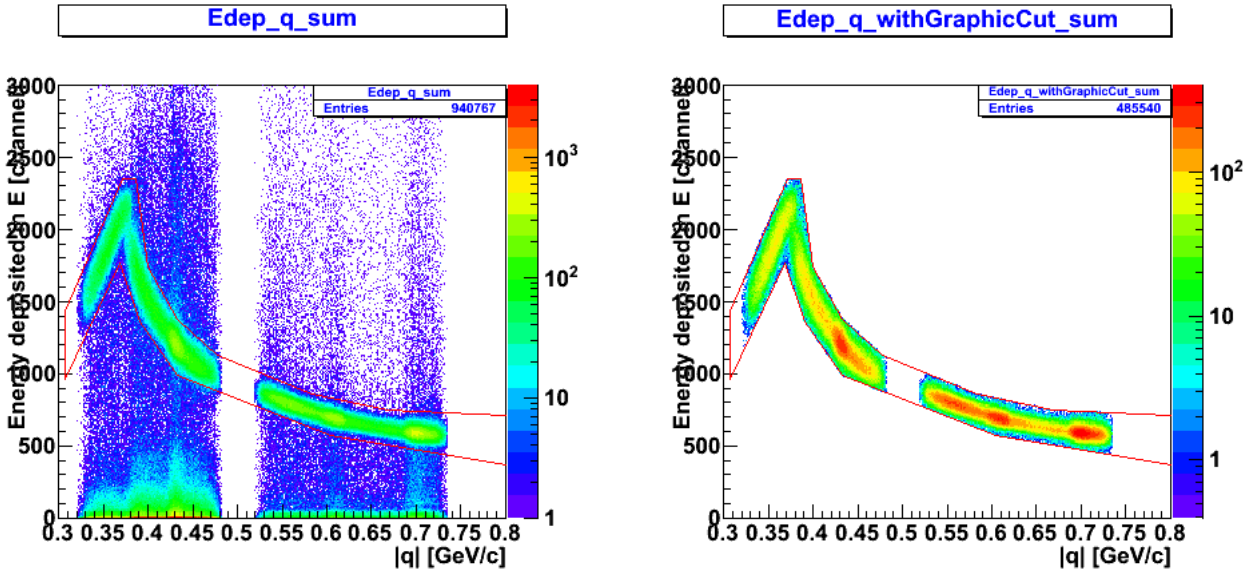


Figure 6.2 Combine all runs, Proton PID in E plane using E vs q graphic cut shown in red. (include all hits).

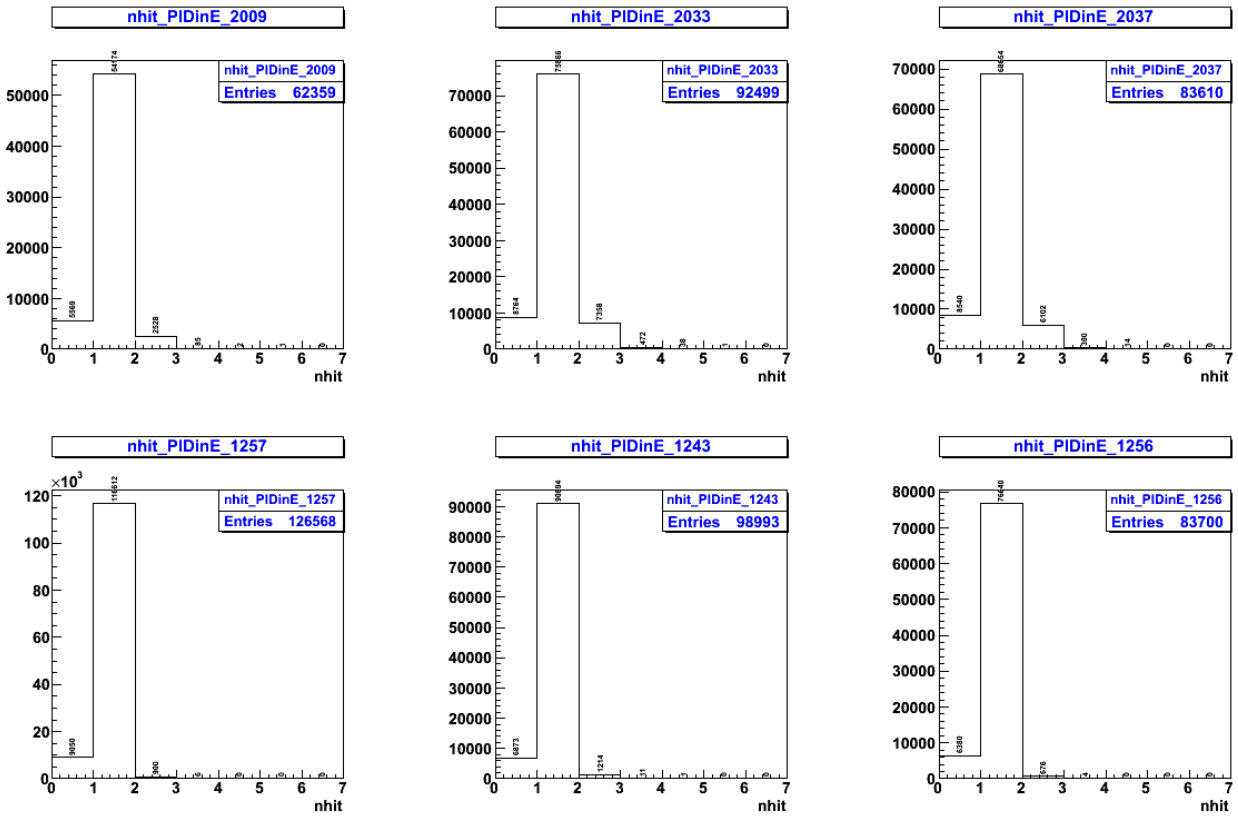


Figure 7.1 number of hit per event that pass graphical cut E_vs_q for each run. There are some events that have multi-hit passing cut.

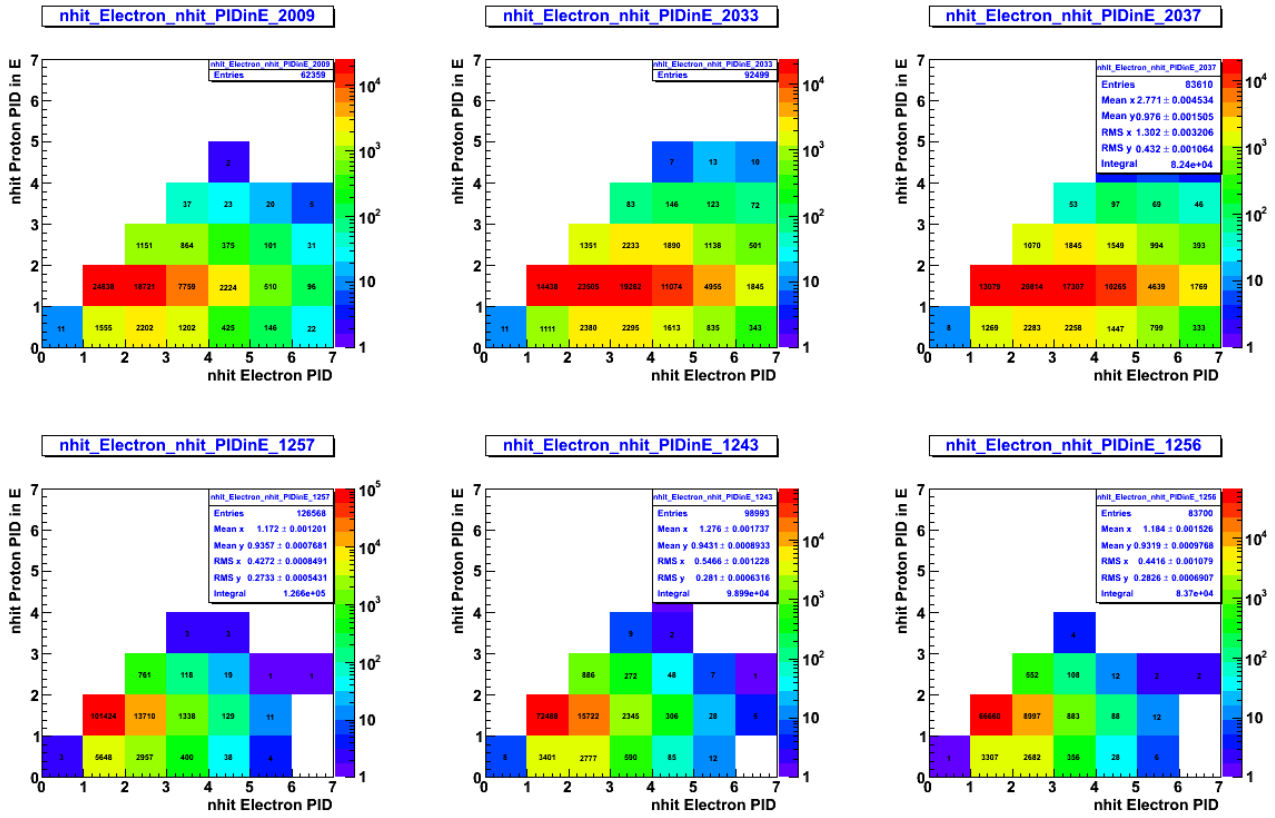
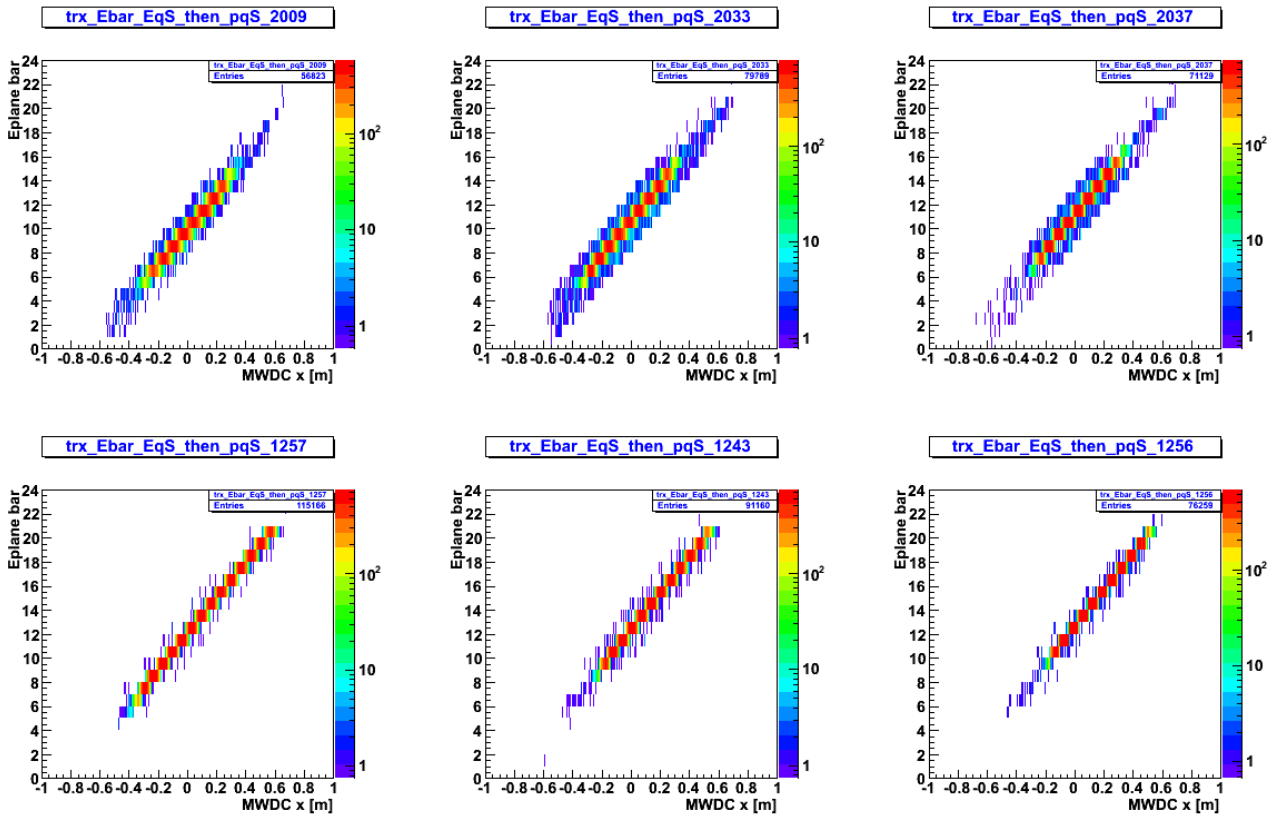
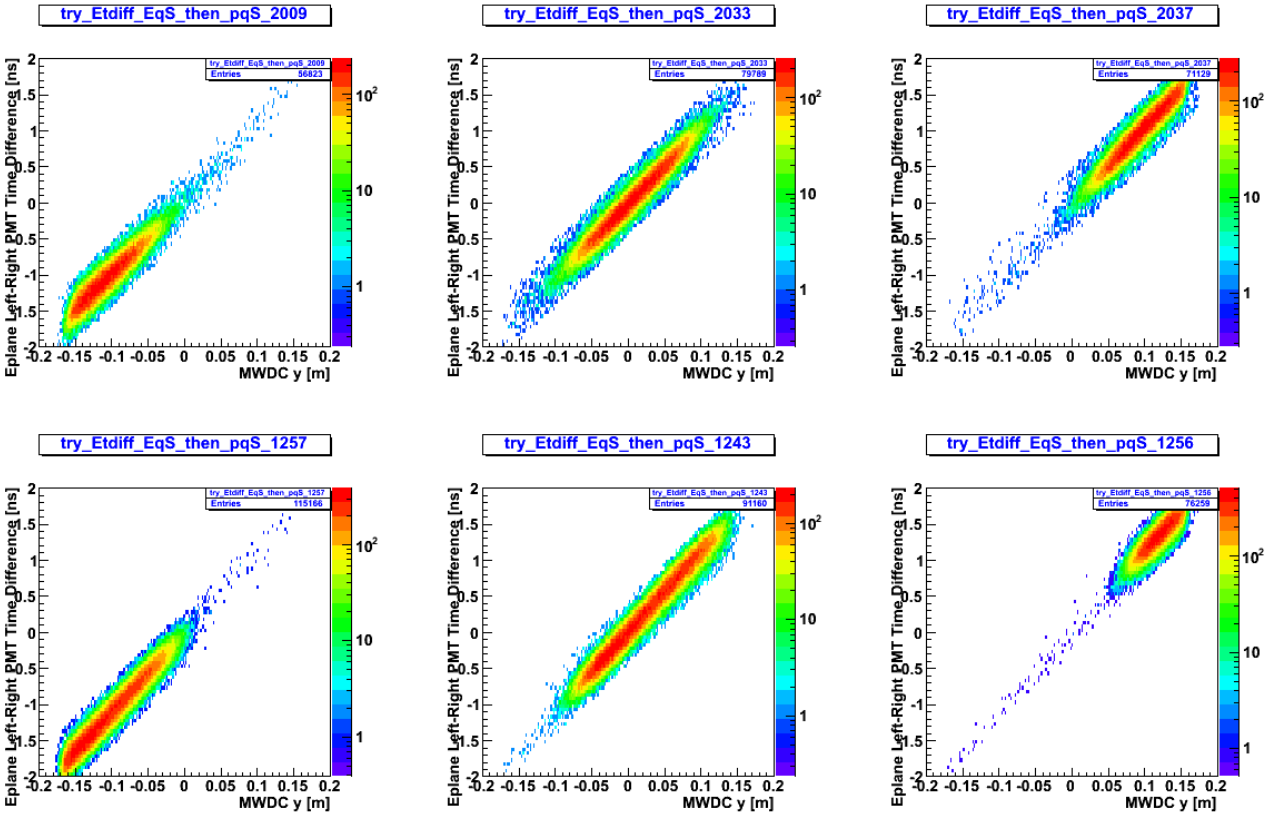


Figure 7.2: number of hit per event that pass graphical cut E_vs_q vs the number of all hit before graphical cut.



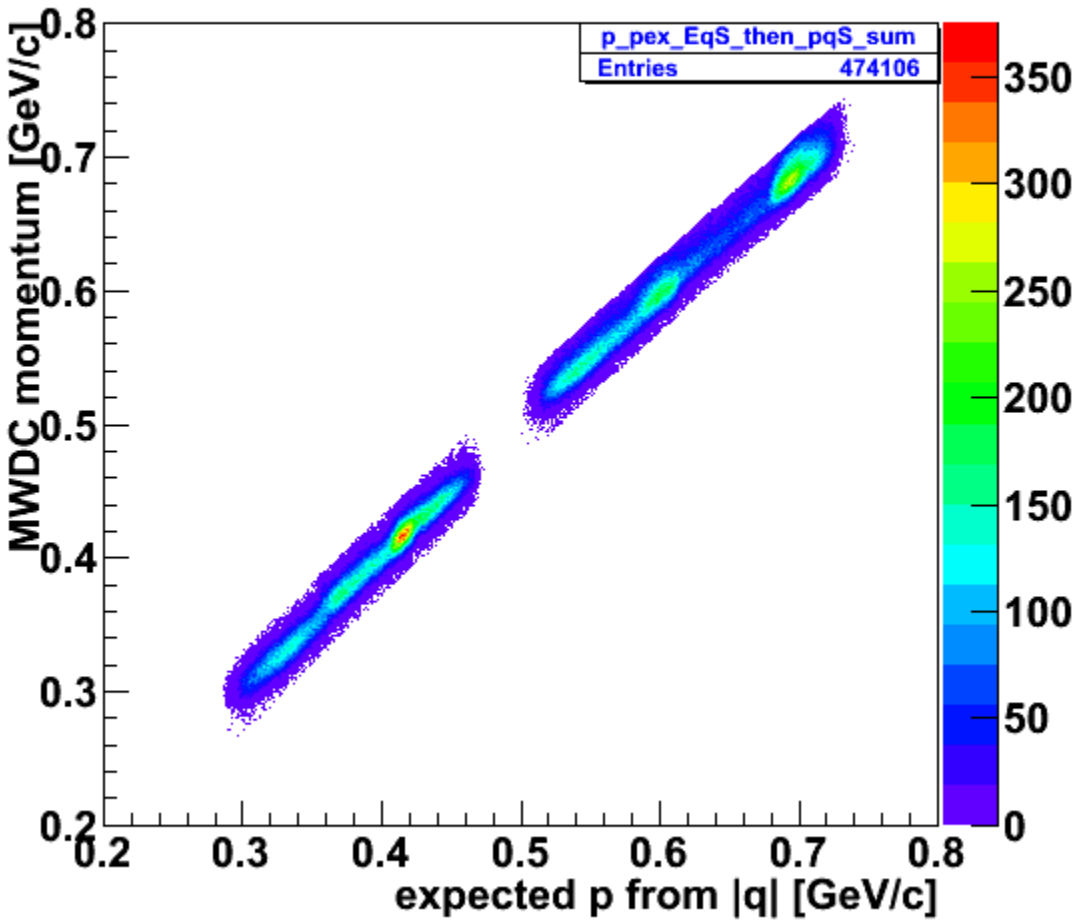
Track matching between track_x and E_bar.



Track matching between track_y and E_time difference Left/Right PMT.

Momentum selection

p_pex_EqS_then_pqS_sum



	2009	eff	2033	eff	2037	eff	1257	eff	1243	eff	1256	eff
n Electron	62348	n/a	92488	n/a	83602	n/a	126565	n/a	98985	n/a	83699	n/a
n Pid in E	56790	91.09	83735	90.54	75070	89.79	117518	92.85	92120	93.06	77320	92.38
n PID in MWDC	55652	89.26	76038	82.21	68293	81.69	109429	86.46	87691	88.59	73227	87.49