Cross Section He4(e,e'p_backward)X

6-fold: (d2\Omega_e) * (d\E'_e) (d2\Omega_p)*(d\p_p)

All cuts:

1.with T3, no edtm and l1a overflow 120<=l1a<=570

(id as cut_gen)

2. electron selection: at prl_sum_E/p>0.7 & single track
3. r-function >=0 (replace theta and phi cut)
4. target endcaps cut L- vertex: |rpl.z|<=0.075 m
5. track match with Trigger in BB

:BB.fh_id==1 ||

: (BB.Eph_id==1 && BB.tp.allhit_Edep>=1000.-1000*BB.tr.Bbmom_Ana)

6. With proton PID: (graphic cut E vs p) && BB.tr.tg_th>-0.3 (polarity cut)
7. Add coincidence vertex: abs(rpl.z-BB.tr.tg_y*1.12+0.007)<=0.04 m
8. Add coincidence time cut: at +/- 3.5 ns

	Correction due to cut
Single track in LHRS	Reduce data to 99.4% from all track

Only one ¼ of the data

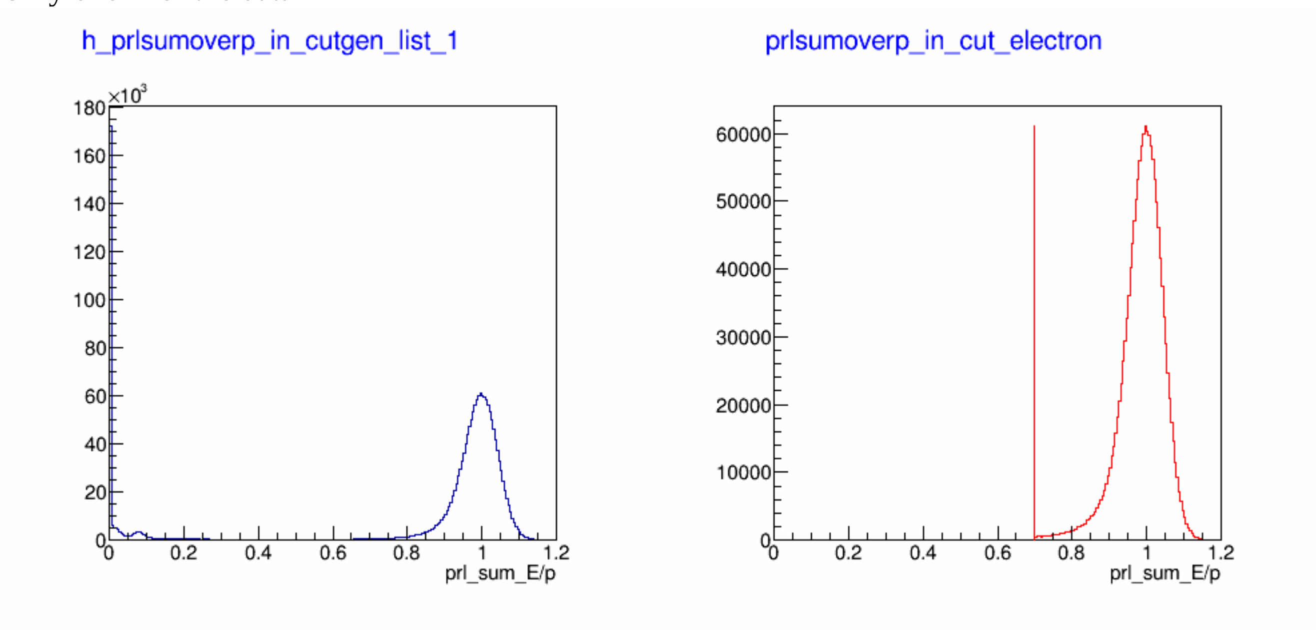


Figure C_1: before/after Electron PID (cut_2: prl_sum_E/p >=0.7) in cut #1

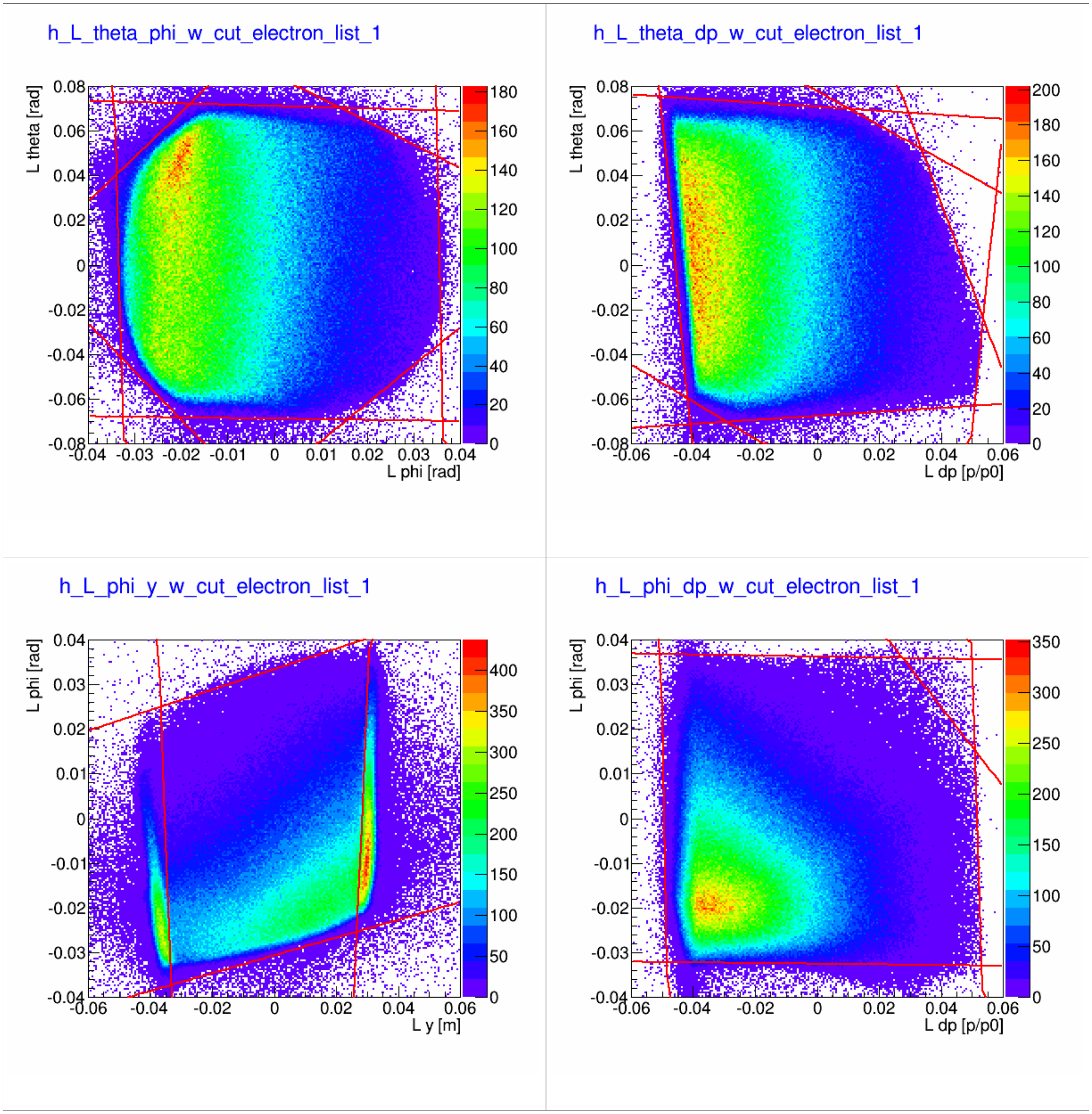


Figure C_2.1: theta,phi,dp,y parameters to obtain r-function.
r-function is >=0 when the data are within all the polygons

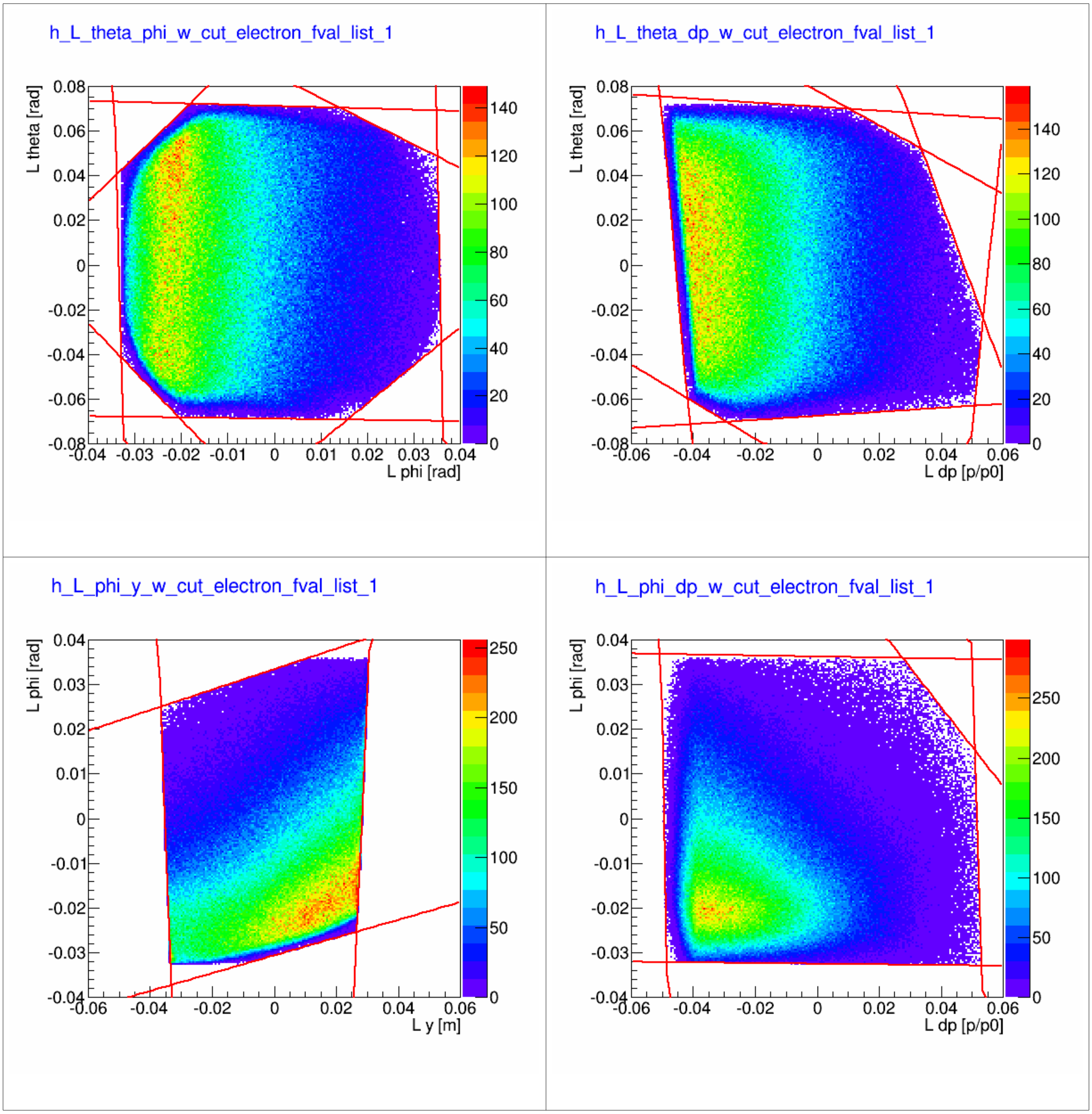
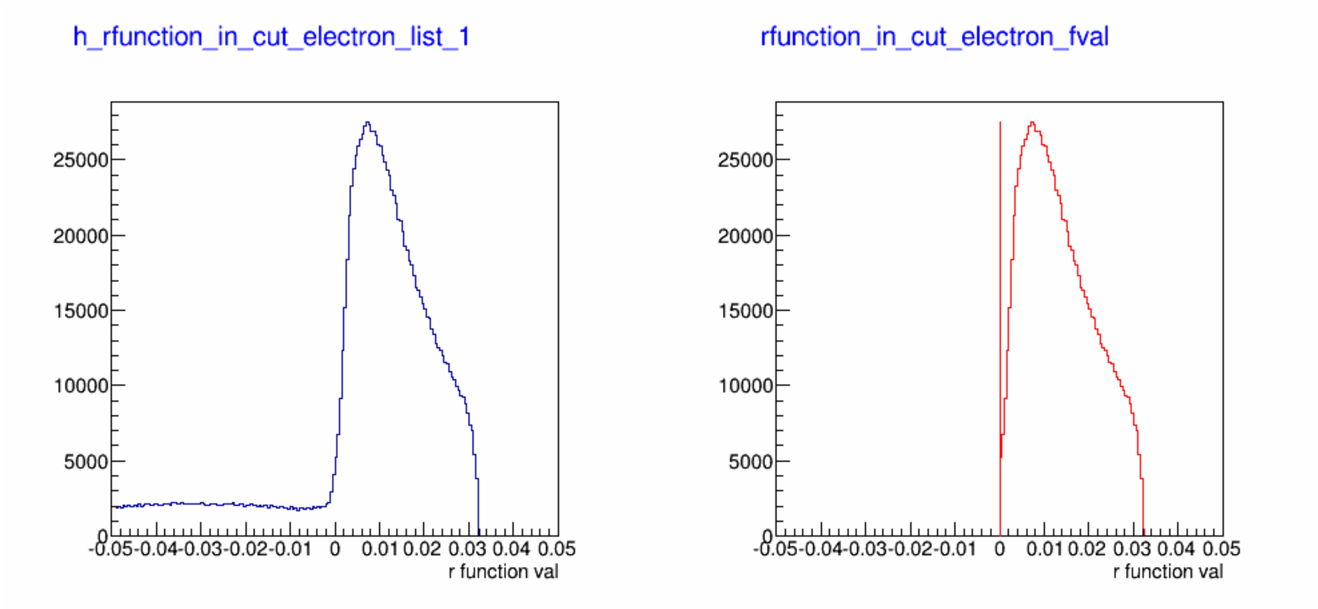


Figure C_2.2: theta,phi,dp,y with rfval>=0



Figurer C_2.3: before/after r-function cut (rfval>=0) in cut #1&#2

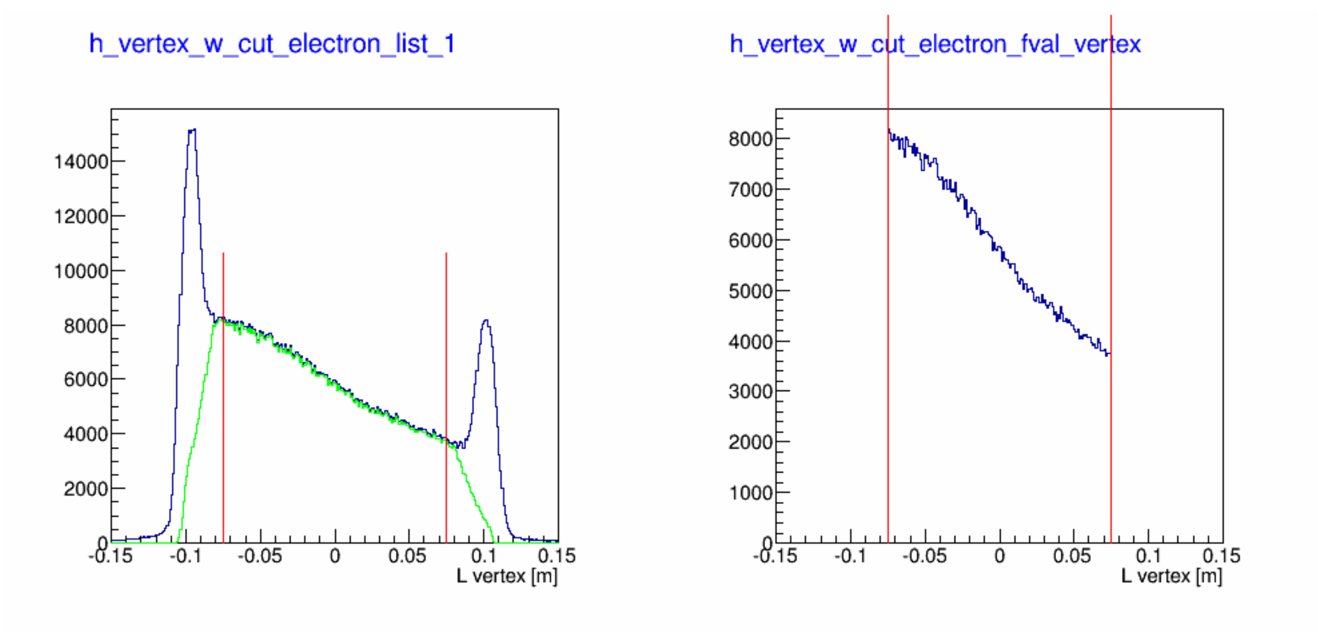


Figure C_3: before/after vertex cut (|rpl.z|<=7.5 cm) in cut #1,#2 & #3

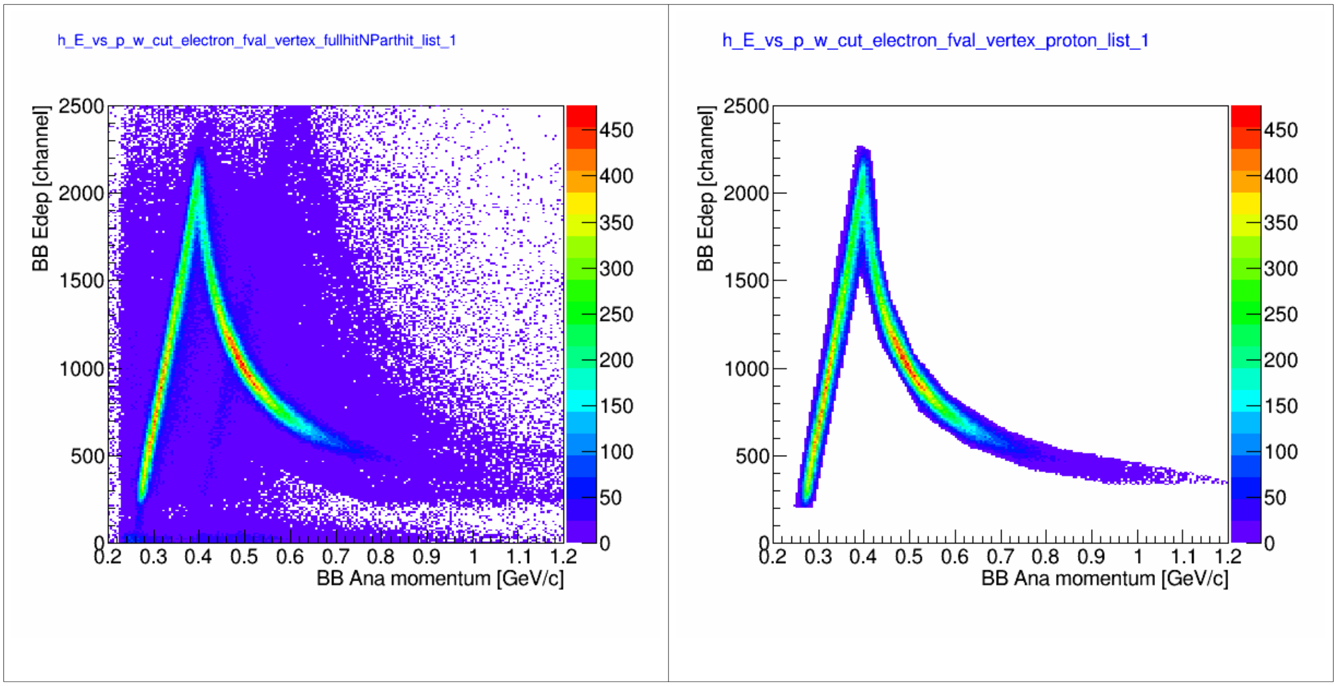


Figure C_4: before/after proton PID in cut #1,#2,#3,#4 & #5
Left: fullhit N parthit
Right: with protonPID

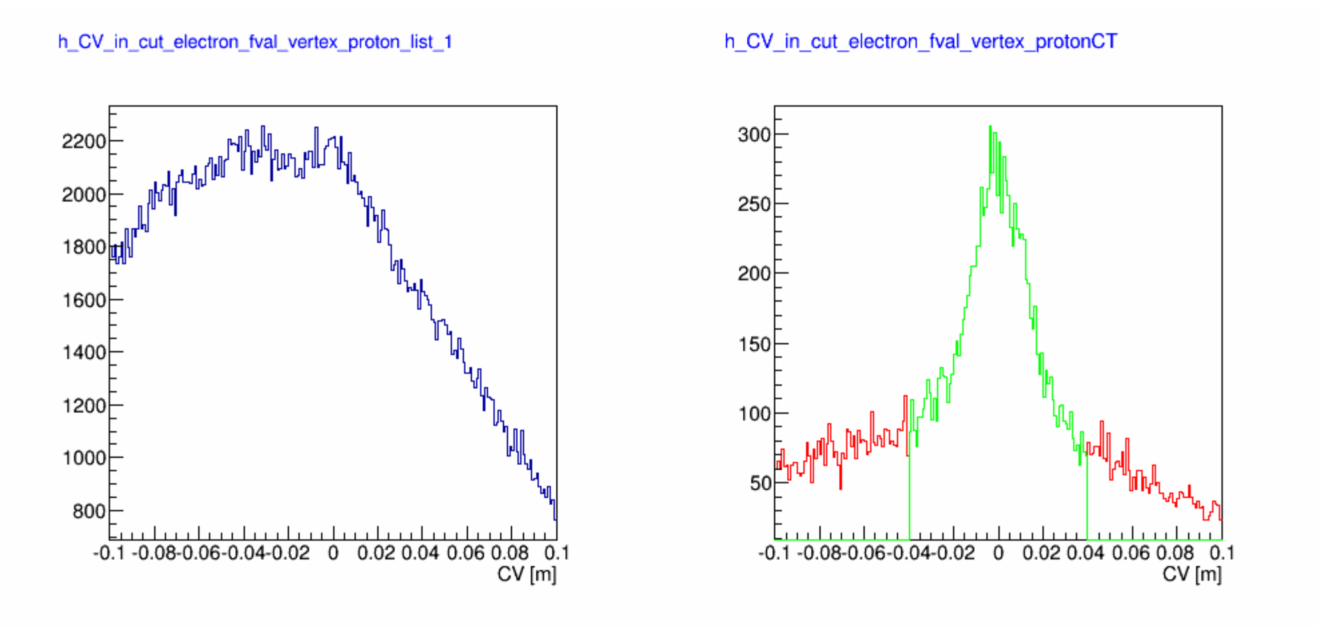


Figure C_5: coincidence vertex
Left: CV in cut #1,#2,#3,#4 & #5,&#6
Right: CV before/after in cut #1,#2,#3,#4 & #5,#6 &#8

Consider the Raw cross section

$$= \frac{N\_pass\_cut/(dOmega\_e*dE\_e*dOmega\_p*dmomentum\_p)}{N\_electron\_Target\_area\_number\_density}$$

where
Target_area_number_density = (Target density)*(target Length)*(N_A)/(A_z)
N_electron = (Total charge)/(Electron charge)

N_electron_Target_area_number_density = (Target density)*(target Length)*(N_A)/(A_z)*(Total charge)/(Electron charge)

N_A = 6.02e23 atom/mol, A_z = 4 g/mol, 1 barn = 1e-24 cm^2
electron charge :1.6e-19 C/electron

Calculation Table

	Parameter	Unit	Kin 12 value
1.	Target density d_loss at 4 uA = 1.2%	g/cm^3	33.834 * 10^-3
2.	Target Length	cm	15
3.	Total Charge	C	2.27381
4.	Target area number density= (Target density)*(target Length)*(N_A)/(A_z)	Atom/cm^2 or atom/barn	7.638e22 atom/cm^2 7.638e-2 atom/barn
5.	N_electron= (Total charge)/ (Electron charge)	electron	1.421e+19
6.	N_electron_target_area_number_density	electron*atom/barn	1.085e+18
7.	**N_pass_cut from CT (all cut are listed in the first page)**	**entries**	**(peak)-(bg) =** **42028(+/- 0.49%) -16023 (+/-0.8%)** **=26005 (+/- 0.8%) entries** with original cuts before the propose cut to get access to dOmega_e and dOmega_p (this number might got muti-count due to the multi-track in BigBie)

** using the background from the the fit and then scale the background distribution

Now to get the cross section I need to get the result with all the cuts and all data.

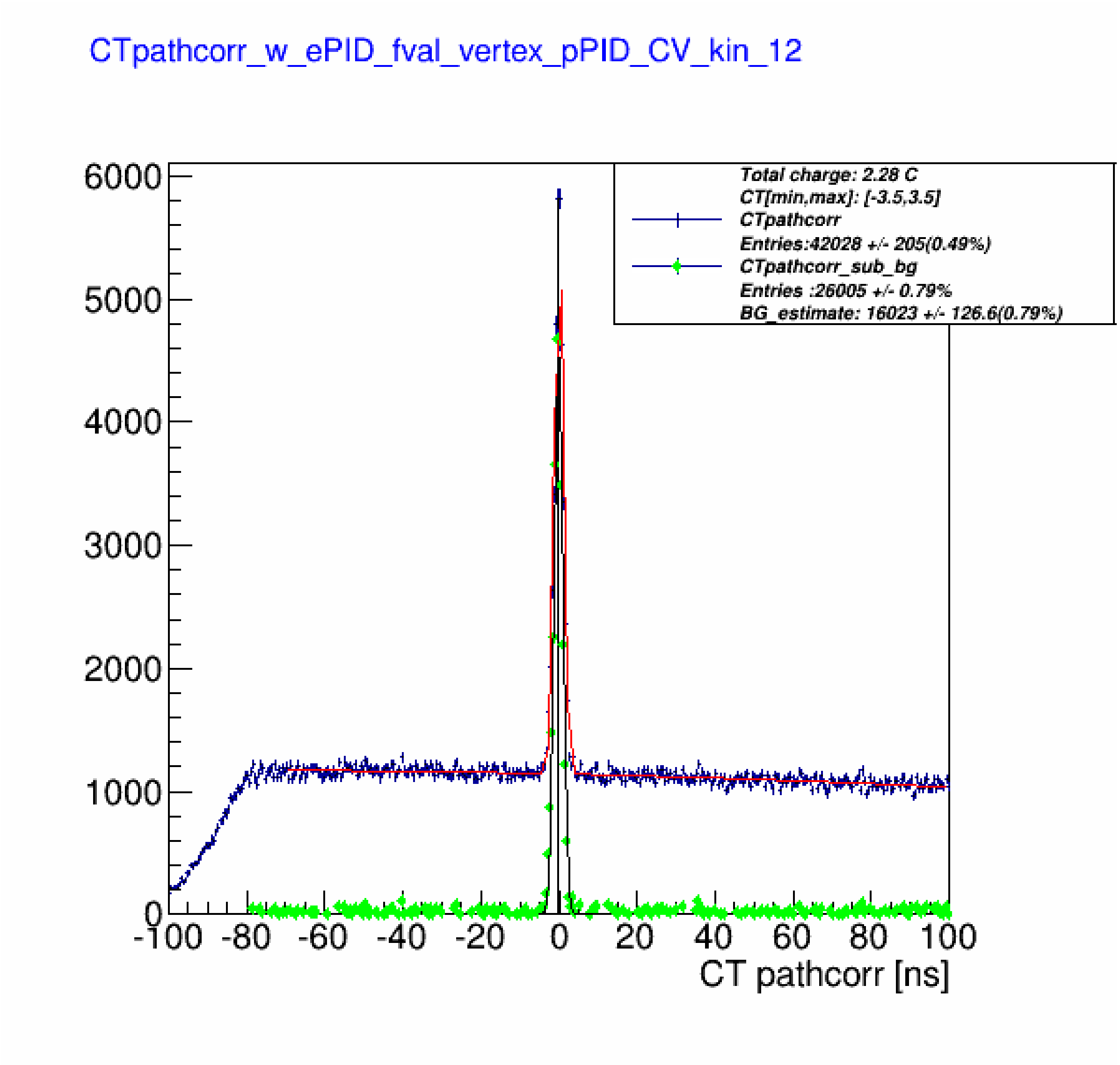


Figure B_1 : CT pathcorr with all cuts: e-pid,fval>=0,|vertex|<=7.5 cm, p-pid, coincidence vertex cut

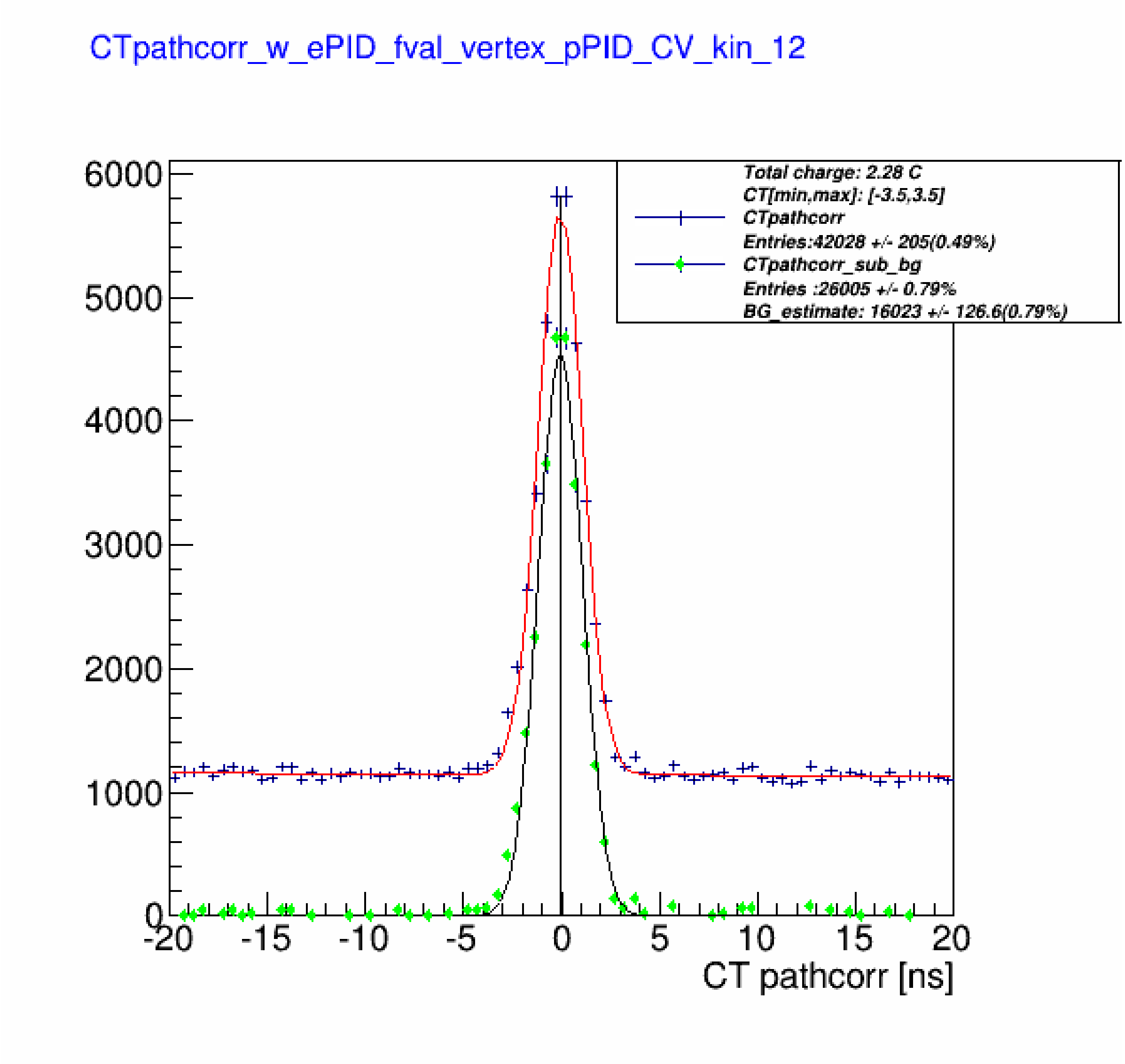


Figure B_2 :(Zoom) CT pathcorr with all cuts: e-pid,fval>=0,|vertex|<=7.5 cm, p-pid, coincidence vertex cut

8.	**N_pass_cut from CT (all cut are listed in the first page)** ***** with all track requirement in the first index*****	**entries**	**(peak)-(bg) =** **39162 +/- 198(0.51%) - 14925 +/- 122.2(0.82%)** **= 24237 +/- 0.82%** with original cuts before the propose cut to get access to dOmega_e and dOmega_p (this number is **not multi-count** due to the multi-track in BigBie)

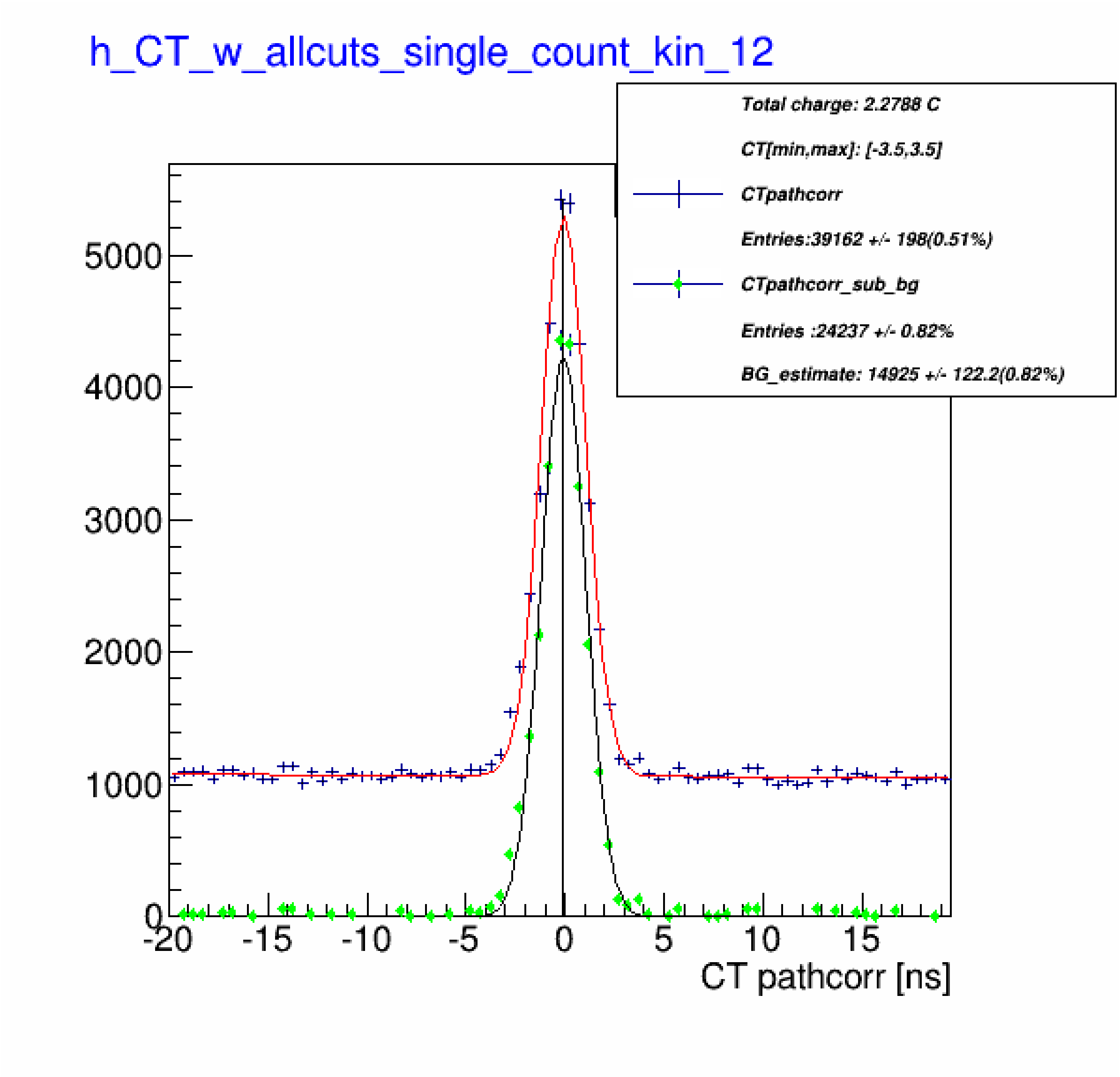


Figure B 2.2 Take out multi-count in either cut or pass-cut entries.

But the previous cut did not give a well define dOmega_e or dOmega_p.
So I do need to make additional cut in that respected.

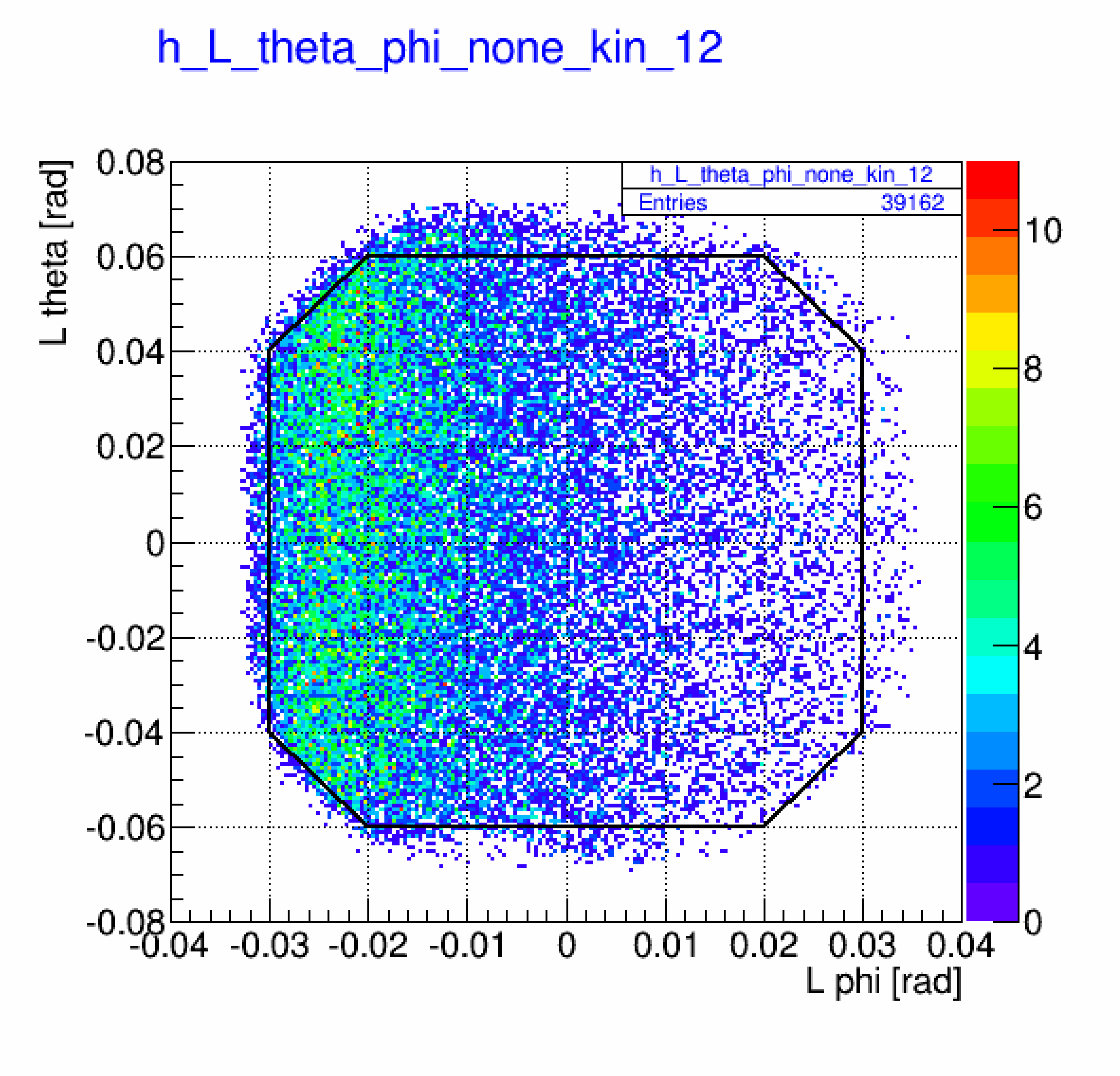


Figure A_1.1: d_theta*d_phi of electron to get dOmega_e with all the cuts
all cuts from the r-function.
The new Cut that I impose are in **black-line.**

Note: d^2 Omega_e = sin(theta_0)*d_theta*d_phi

CT:Entries: 39162 +/- 198(0.51%)
CT-bg:Entries : 24237 +/- 0.82%
BG_estimate: 14925 +/- 122.2(0.82%)
BG in width: 14624 +/- 120.9 (background that use to estimate the distribution of momentum in the same with as the CT cut on both side of the CT peak)

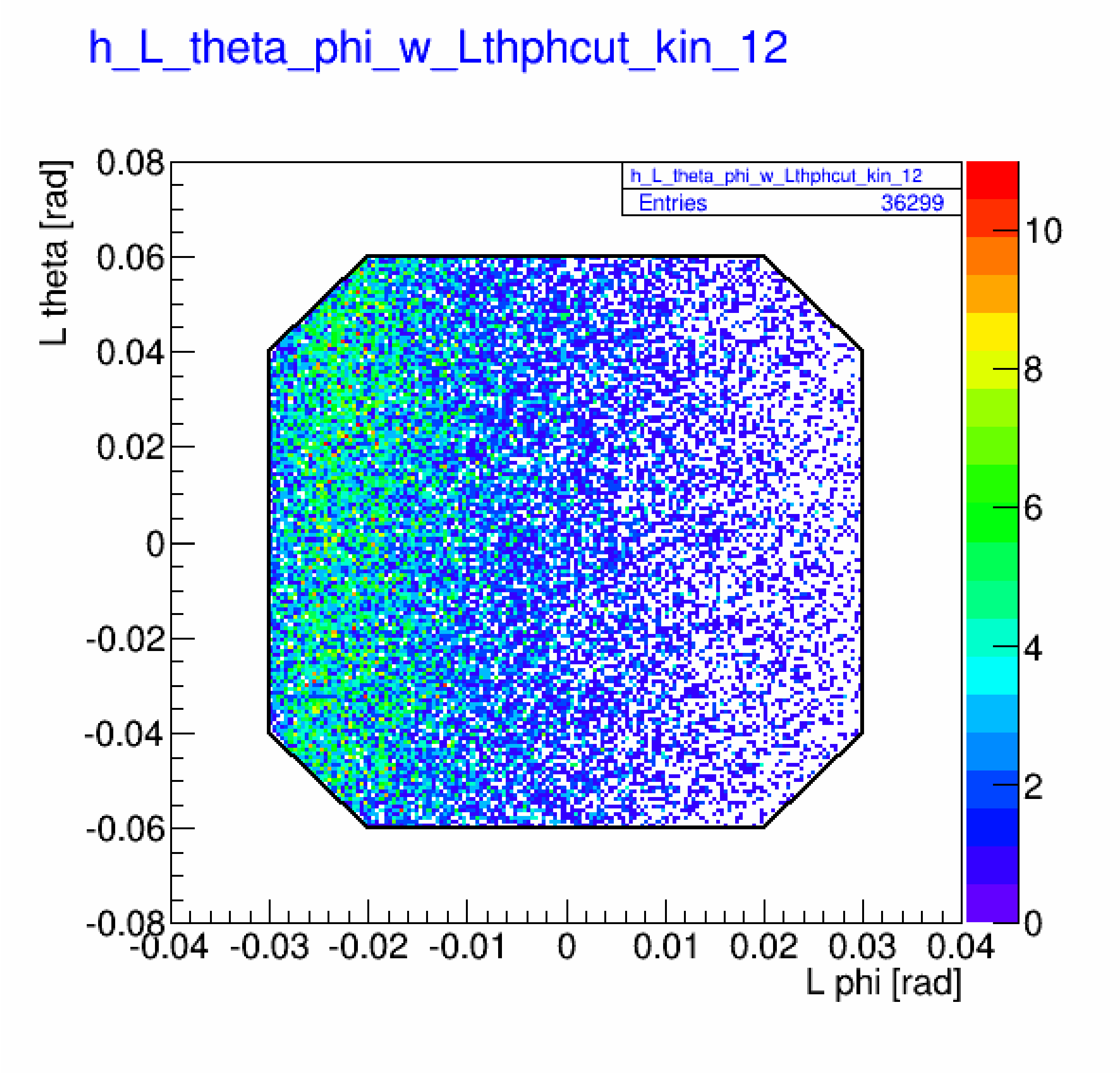


Figure A_1.2: d_theta*d_phi of electron to get dOmega_e

where

*dtheta*dphi = box-4*conner*

*=(theta: 2*0.06)*(phi:2*0.03) - 4*1/2*(theta:0.06-0.04)*(phi:0.03-0.02)*

=7.2e-3 – 0.4e-3 rad^2

=6.8e-3 rad^2

so dOmega_electron

*= sin(20.3)*dtheta*dphi*

=2.359e-3 srad.

CT: Entries: 36299 +/- 191(0.52%)
CT-BG: Entries : 22497 +/- 0.85%
BG_estimate: 13802 +/- 117.5(0.85%)
BG in width: 13515 +/- 116.3

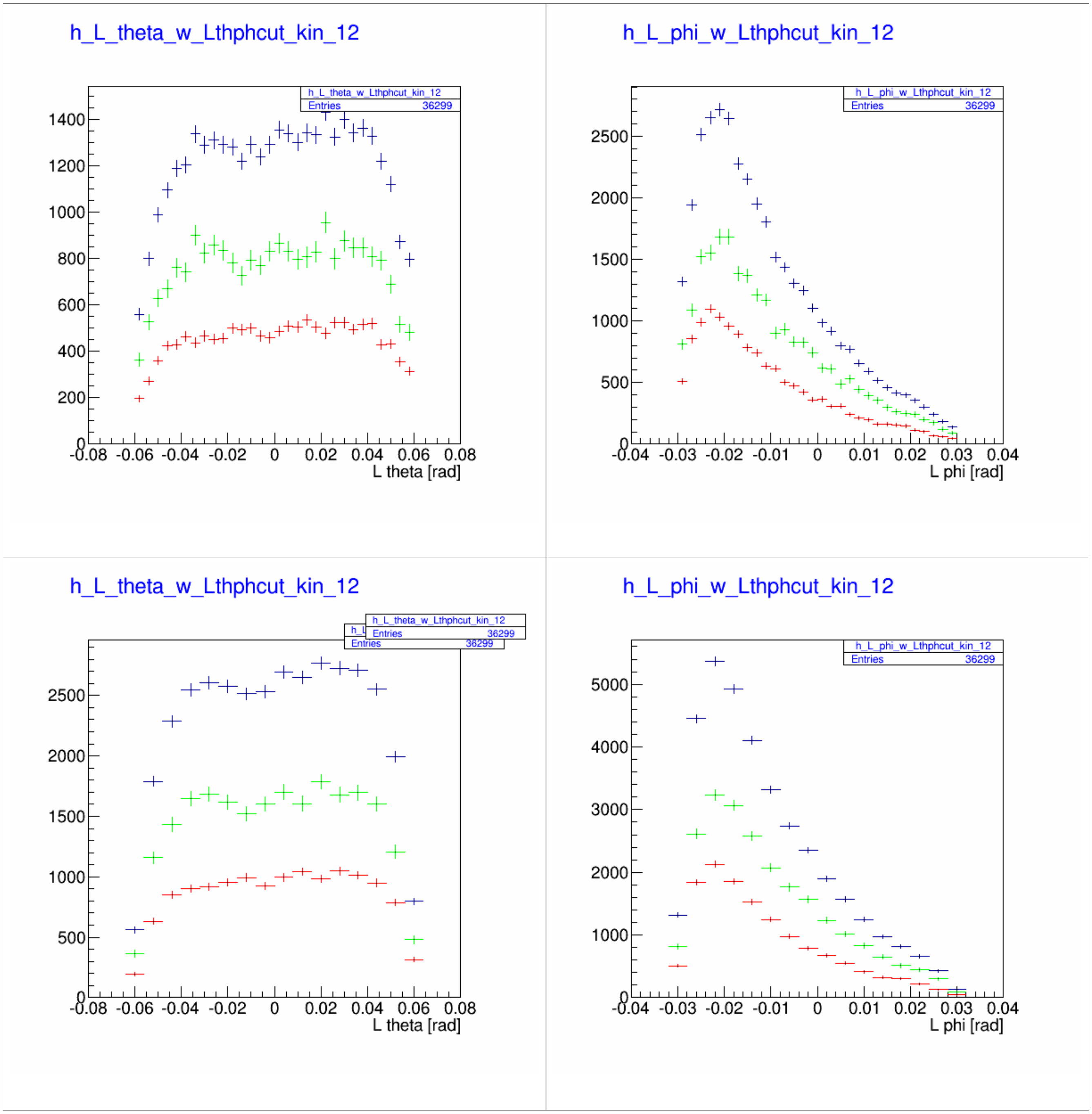


Figure A_1.3: L theta, L phi distribution with the cut in theta vs phi

the background need to be rescale by

rescale = *(BG_estimate)/ (BG in width) = 1.0212*

*** calculate the CS with this theta and phi and also with retangular at theta +/- 0.04

**check the dip of the theta

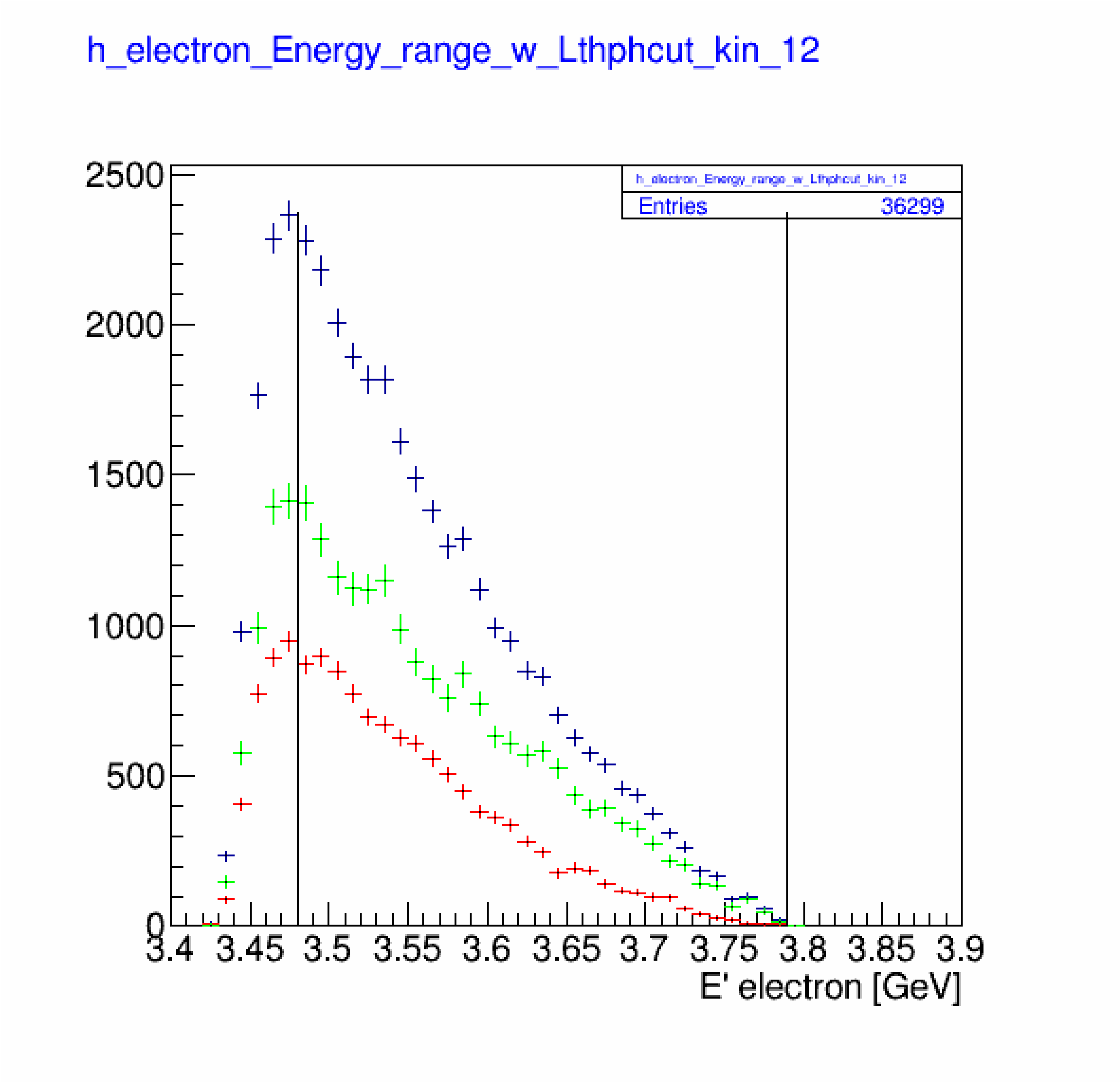


Figure A_2. dE'_e with the cut in d_theta*d_phi in previous page
10 MeV/bin

The cut on the left should cut out the acceptance dependent.: 3.48 GeV
The cut on the right side is kept as much as possible to get the high momentum tail: 3.79 GeV

dE'_e = 0.31 GeV

** look at the energy transfer = E-E'

** E' vs BBp

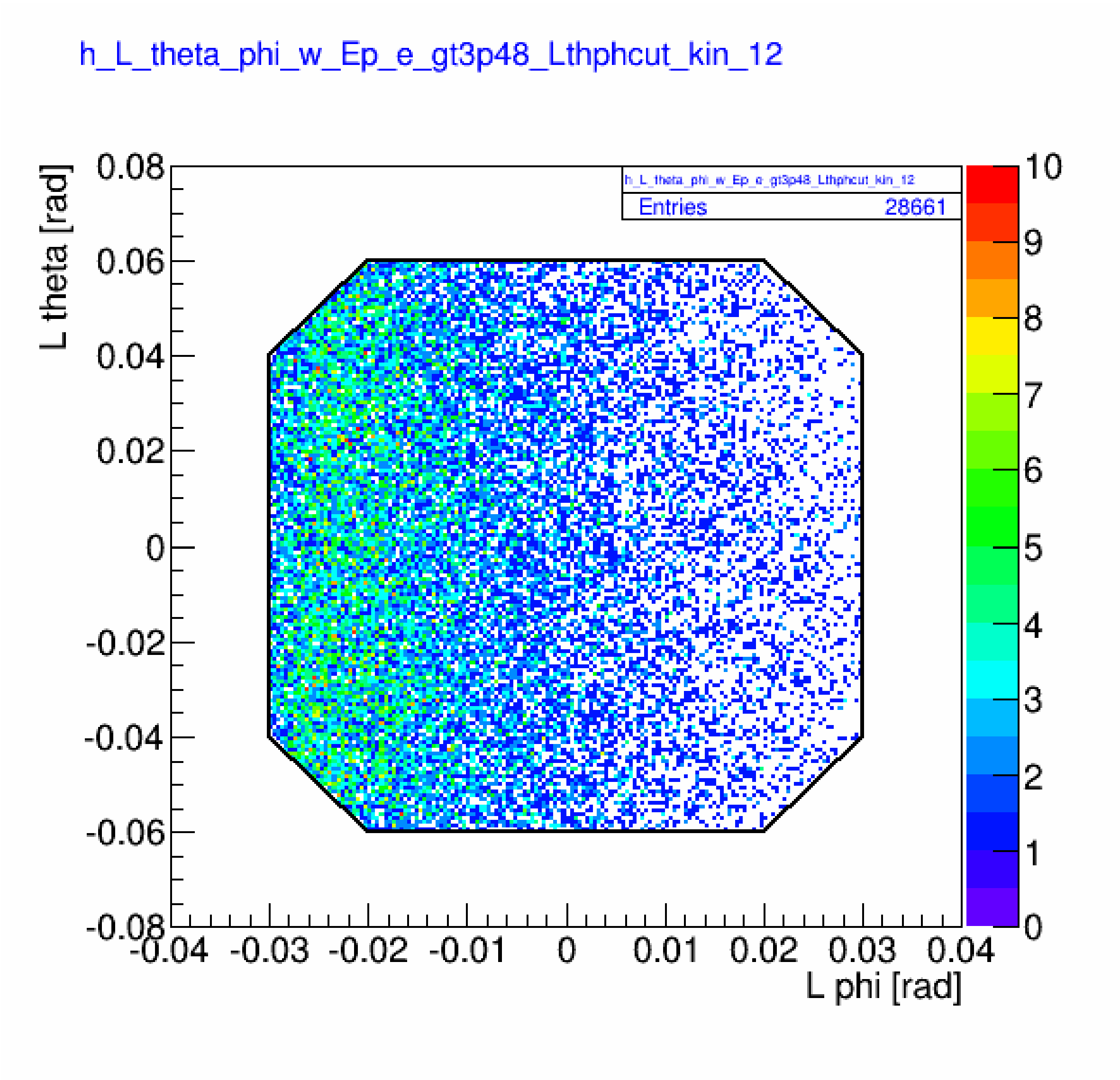


Figure A_2.2 : Theta vs phi with the cut on E'_e>=3.48 GeV the filling in Theta vs phi is still full.

CT:Entries:28661 +/- 169(0.59%)
CT-bg:Entries :18031 +/- 0.94%
BG_estimate: 10630 +/- 103.1(0.97%)
BG in width: 10402 +/- 102.0

bg_scale = 10630./10402 =1.02192

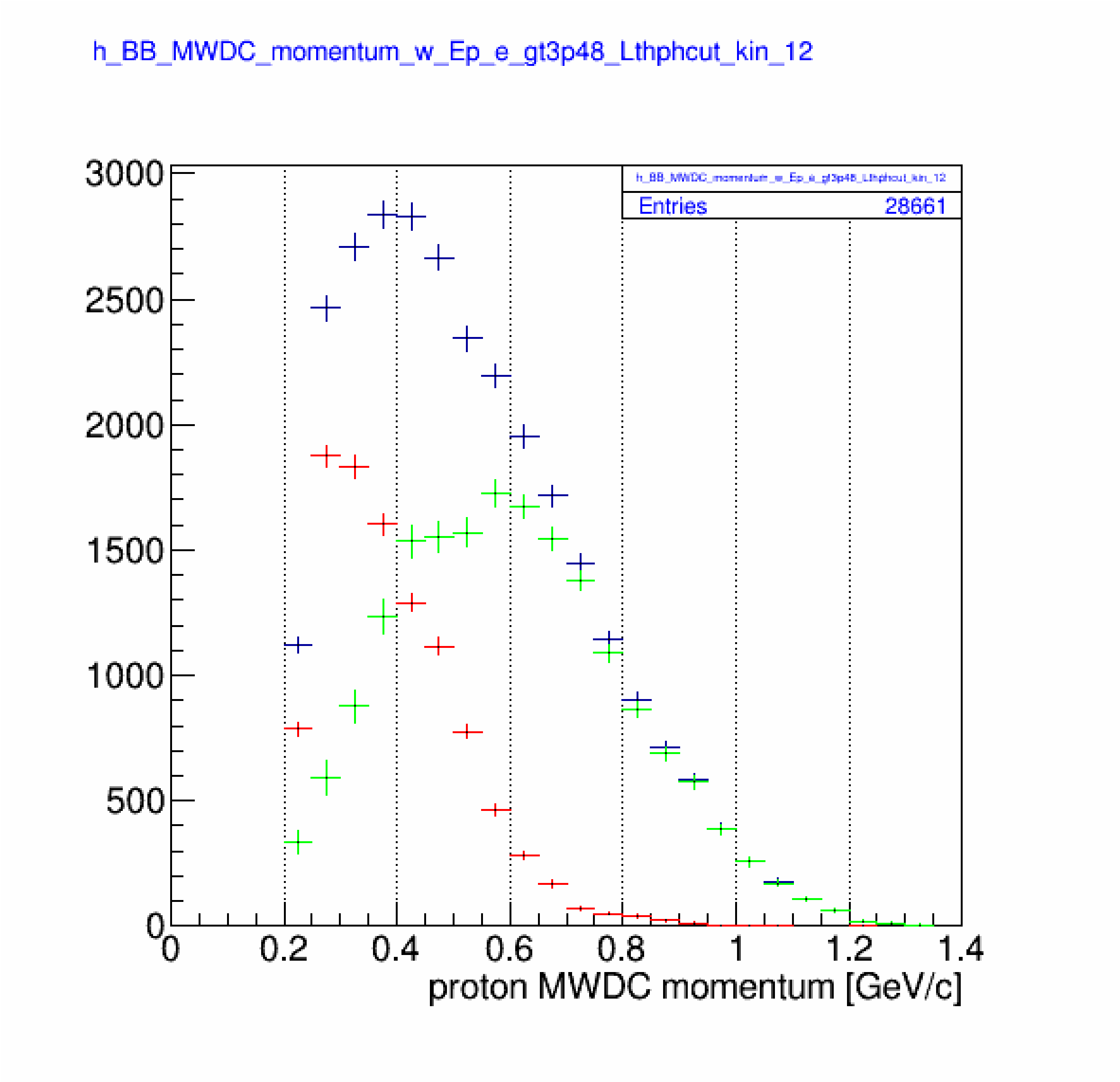


Figure A_3.1: d_momentum_p at MWDC: after d_theta*d_phi and dE'_e.
(50 MeV/bin)

CT:Entries:28661 +/- 169(0.59%)
CT-bg:Entries :18031 +/- 0.94%
BG_estimate: 10630 +/- 103.1(0.97%)
BG in width: 10402 +/- 102.0

bg_scale = 10630./10402 =1.02192

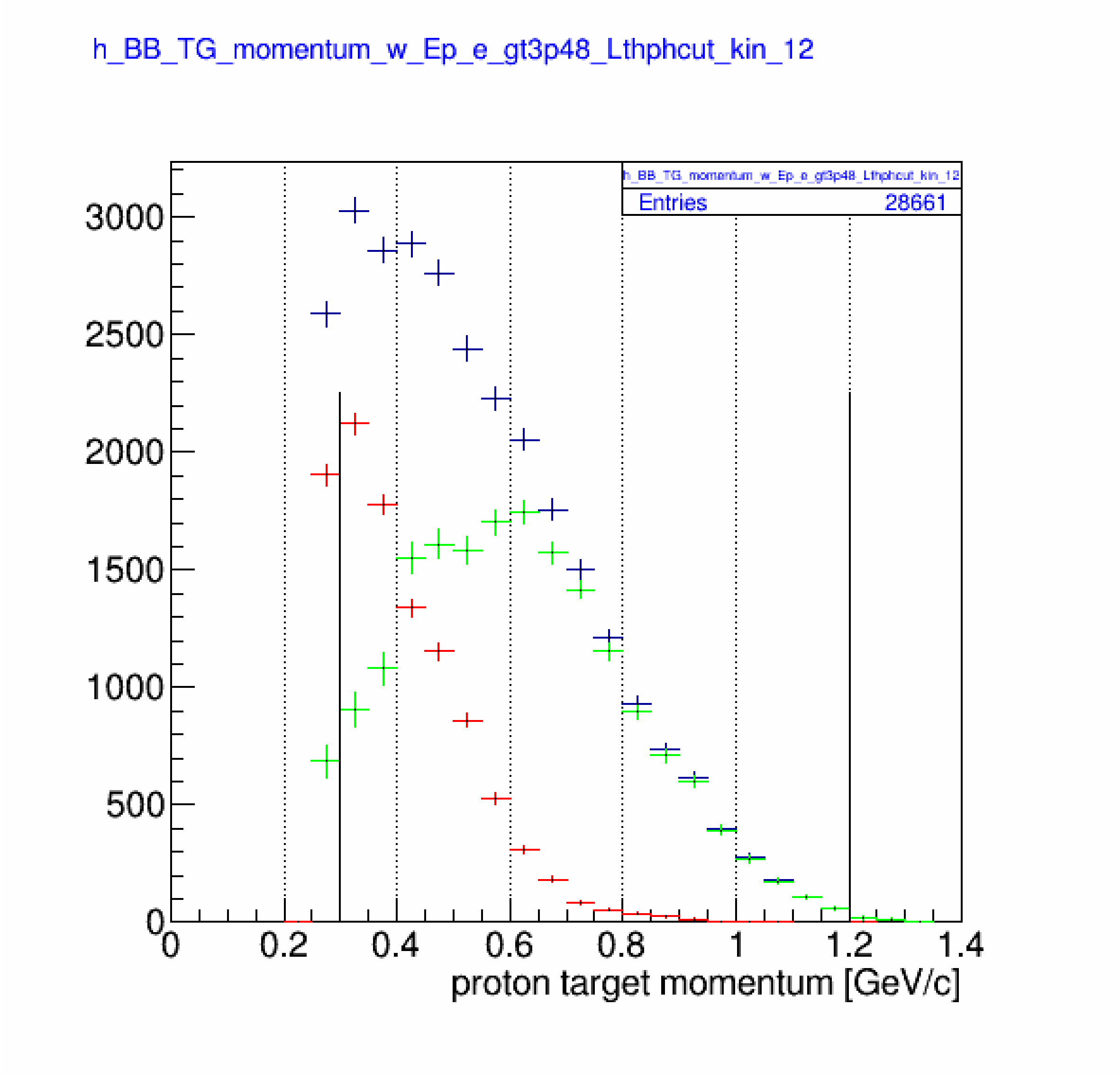


Figure A_3.2: d_momentum_p at target (with energy lose though target)
(50 MeV/bin)

The cut on the left should cut out the acceptance dependent.: 0.3 GeV/c ????
The cut on the right side is kept as much as possible to get the high momentum tail: 1.2 GeV/c
(38 entries above 1.2 GeV/c)

CT:Entries:28661 +/- 169(0.59%)
CT-bg:Entries :18031 +/- 0.94%
BG_estimate: 10630 +/- 103.1(0.97%)
BG in width: 10402 +/- 102.0

bg_scale = 10630./10402 =1.02192

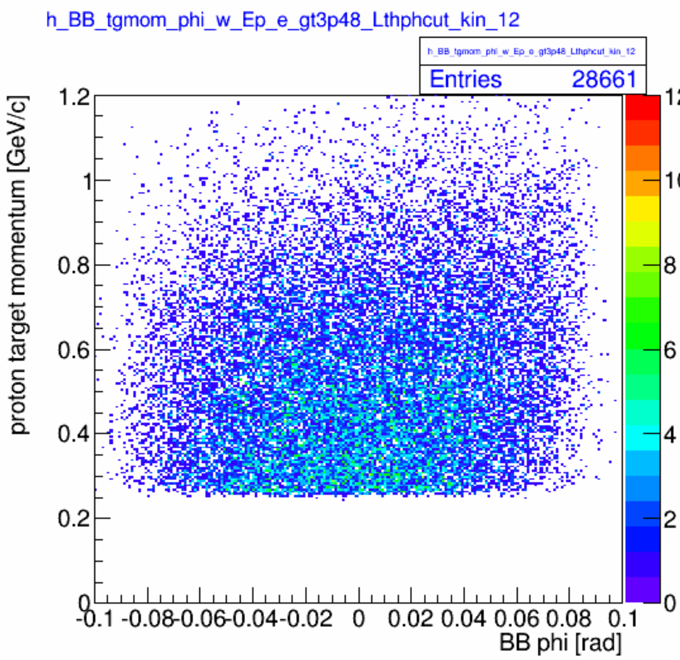


Figure A3_3: proton target momentum vs phi for data w/in CT peak

CT:Entries:28661 +/- 169(0.59%)
CT-bg:Entries :18031 +/- 0.94%
BG_estimate: 10630 +/- 103.1(0.97%)
BG in width: 10402 +/- 102.0

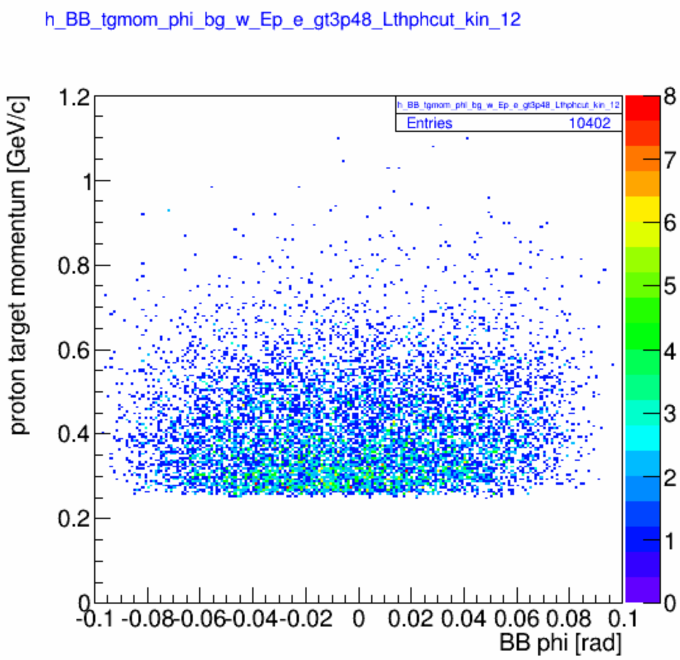


Figure A3_4: proton target momentum vs phi for data outside CT peak (BG)

Making the minimum cut at 0.3 GeV/c should not effect the phi

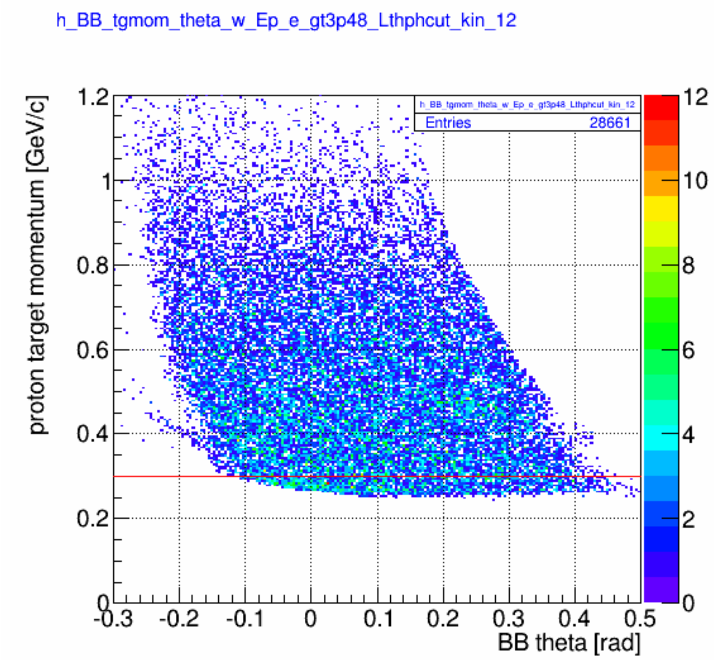


Figure A3_5: proton target momentum vs theta for data w/in CT peak

Making the minimum cut at 0.3 GeV/c will effect the theta distribution

CT:Entries:28661 +/- 169(0.59%)
CT-bg:Entries :18031 +/- 0.94%
BG_estimate: 10630 +/- 103.1(0.97%)
BG in width: 10402 +/- 102.0

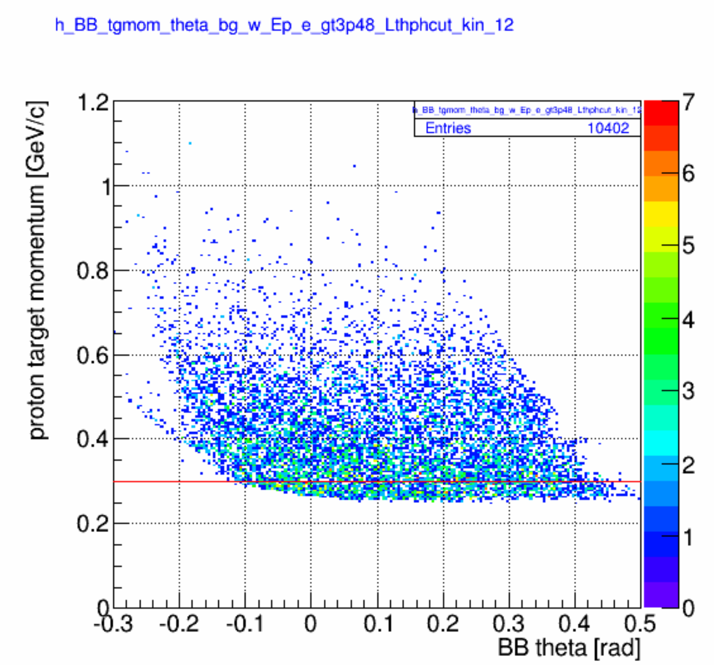
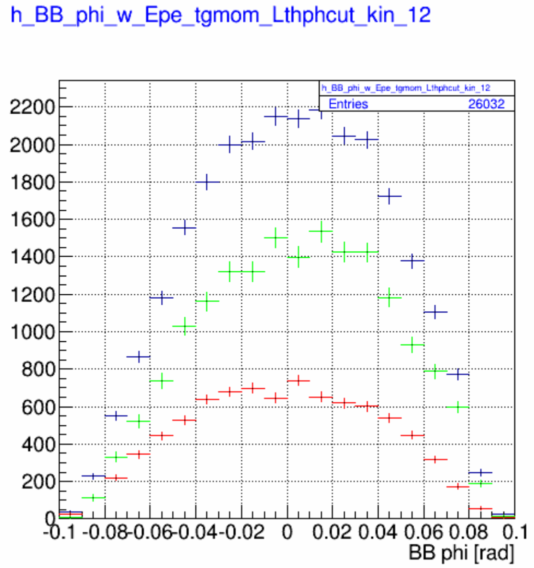
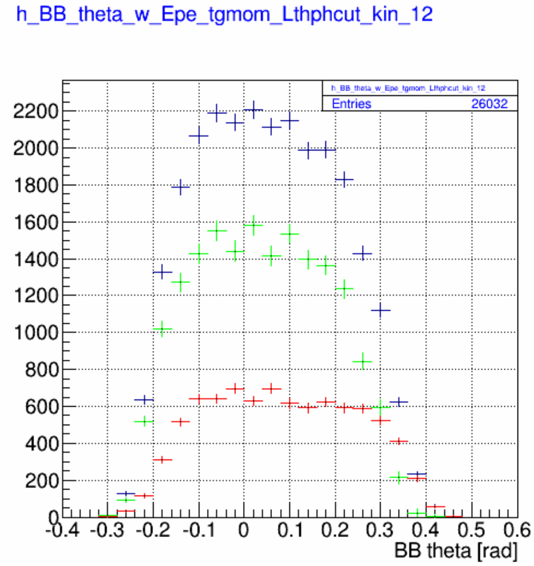


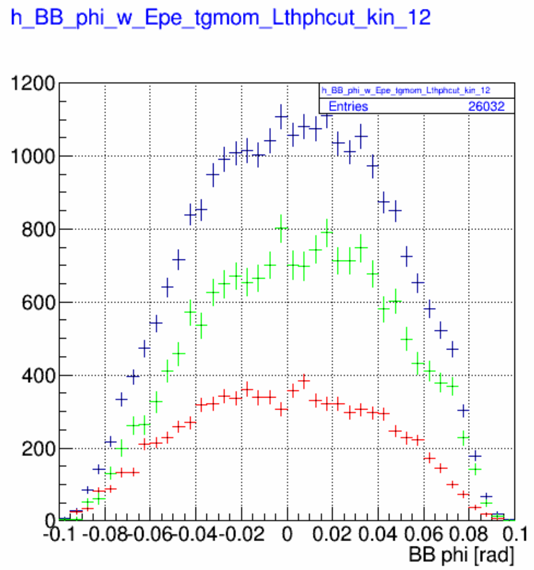
Figure A3_4: proton target momentum vs theta for data outside CT peak (BG)



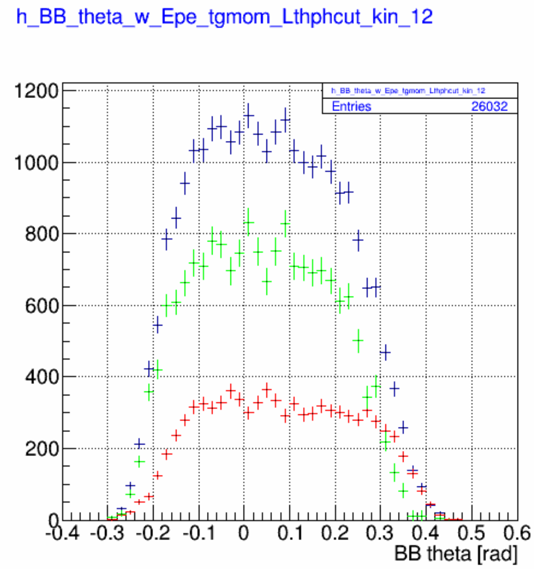
Phi



Theta



Phi



Theta

Figure A_4.1: Phi and theta distribution after LHRS: d_theta*d_phi and dE'_e and BB_tg_momentum cut [0.3,1.2]

CT:Entries:26032 +/- 161(0.62%)
CT-bg:Entries :17340 +/- 0.93%
BG_estimate: 8692 +/- 93.2(1.07%)
BG in width: 8496 +/- 92.2

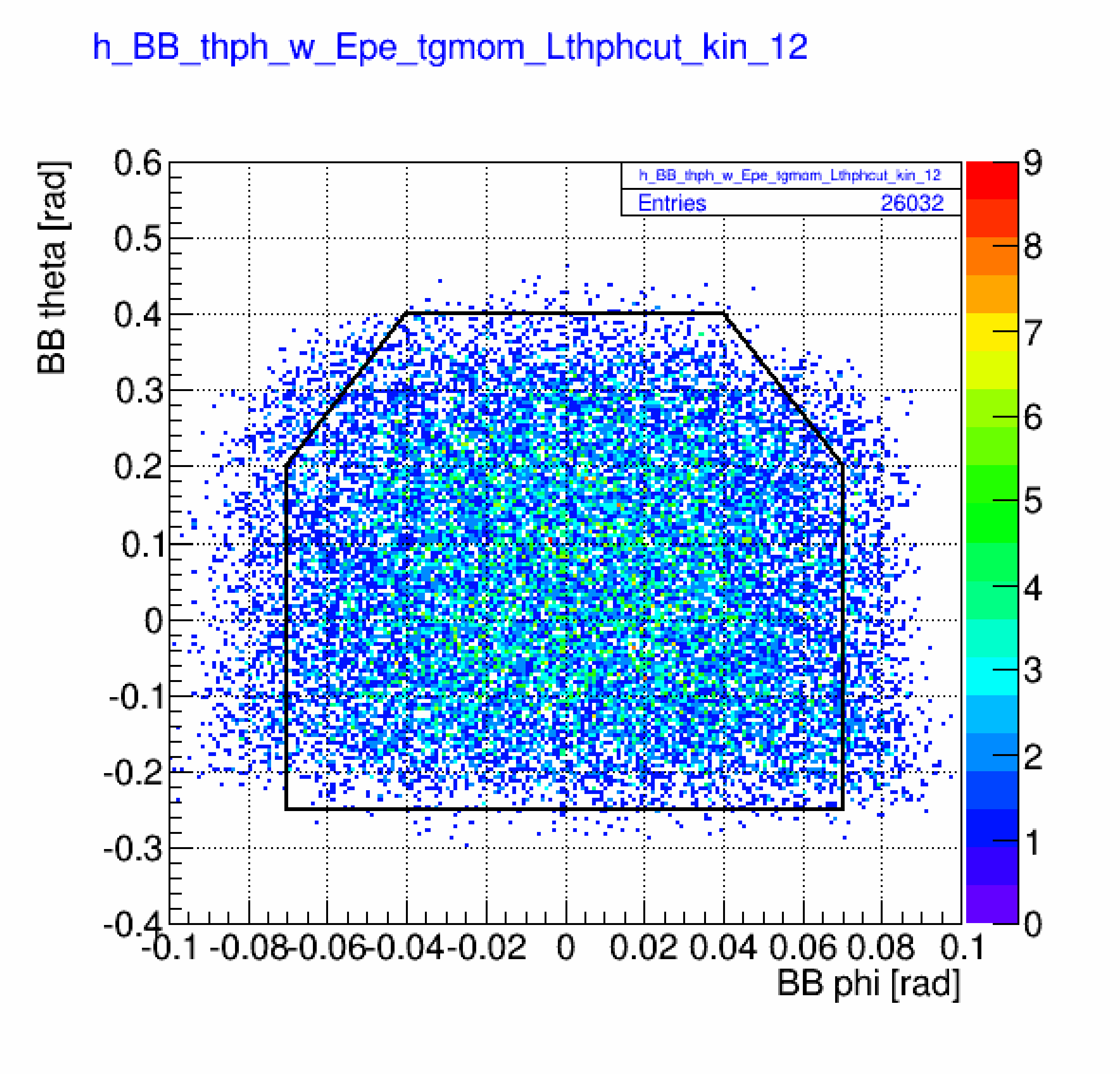


Figure A_4.2: dtheta_p*dphi_p
making additional cut to get dOmega_p

the cut on negative theta: make sure not cut the high momentum from theta

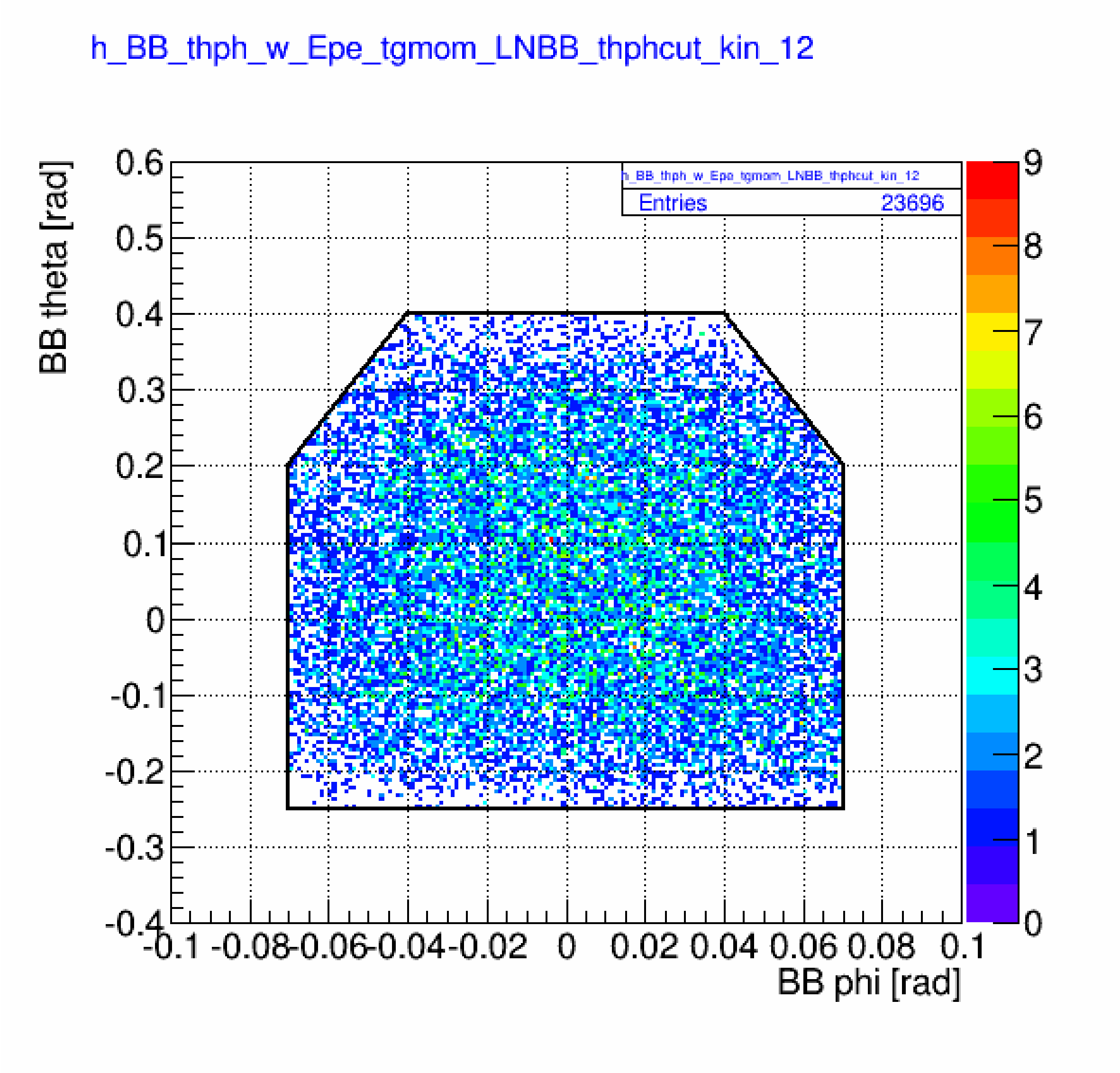


Figure A_4.2: dtheta_p*dphi_p
after cut.

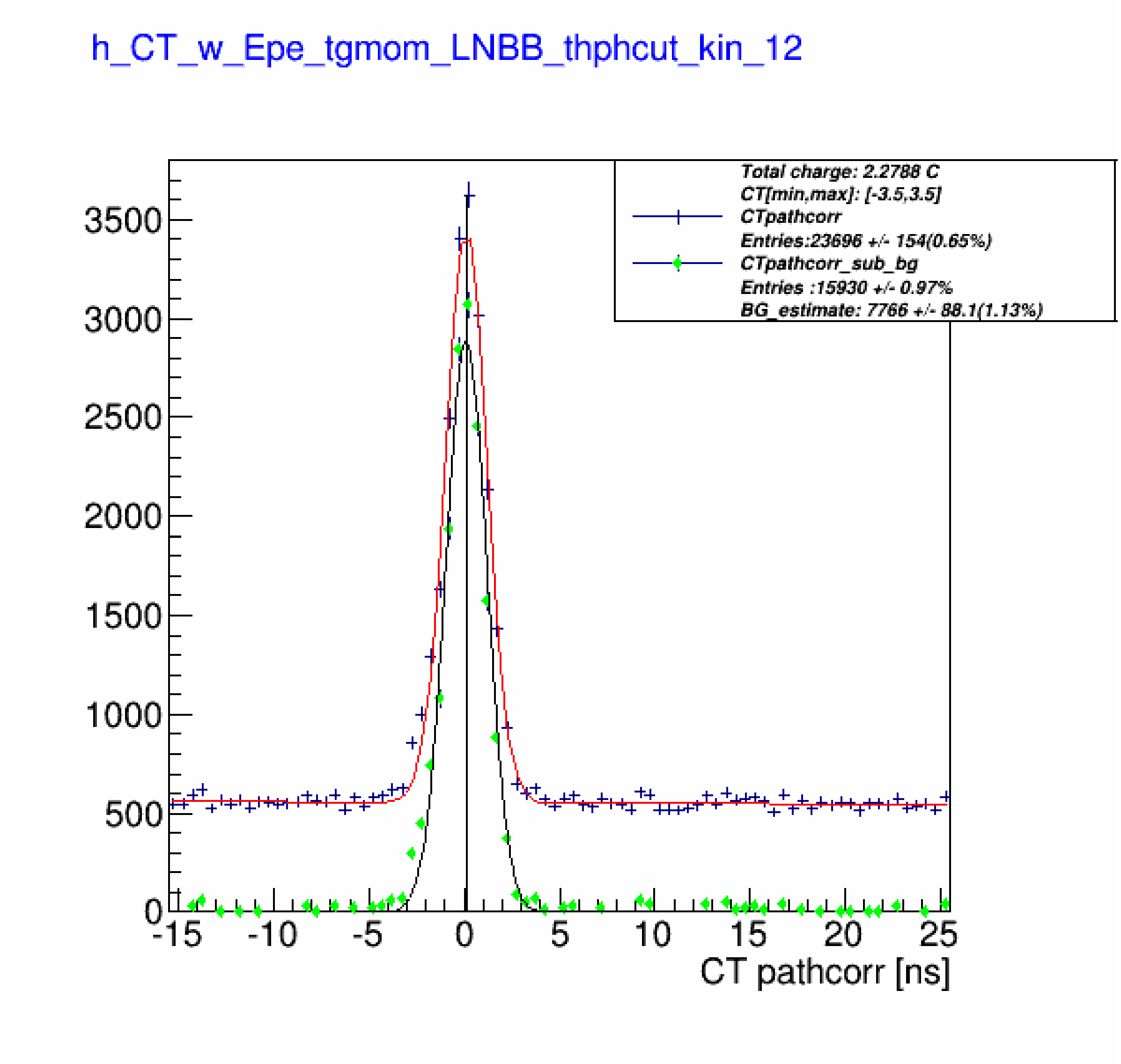


Figure A_5: CT with all acceptance cut

CT:Entries:23696 +/- 154(0.65%)
CT-bg:Entries :15930 +/- 0.97%
BG_estimate: 7766 +/- 88.1(1.13%)
BG in width: 7603 +/- 87.2

With the additional cut the number of entries does change.

8	sin(L_angle) cos(L_angle)		Sin(20.3) = 0.3469 Cos(20.3) = 0.9379
9.	**d_E'_electron**	**GeV**	**3.48to 3.79 GeV** **dE= 0.31 GeV**
10.	sin(BB_angle) |cos(BB_angle)		Sin(97) = 0.9925 |cos(97)| = 0.1219
11.	**d_momentum_proton**	**GeV/c**	**from 0.3 to 1.2 GeV/c** **dp = 0.9 GeV/c**

12	dOmega_electron =sin(L_angle)*d_theta *d_phi	srad	*Within the propose cut:* *dtheta*dphi =* *box-4*conner* *(theta: 2*0.06)*(phi:2*0.03)* *-4*1/2*(theta:0.06-0.04)*(phi:0.03-0.02)* *=7.2e-3 – 0.4e-3 rad^2* *=6.8e-3 rad^2* *dOmega_electron* *= sin(20.3)*dtheta*dphi* *=2.359e-3 srad.*
13	**dOmega_proton** **=sin(BB_angle)*d_th** **eta*d_phi**	**srad**	***Within the propose cut:*** *dtheta*dphi =* *box-2*conner* *= (0.4+0.25)*(2*0.07) – 2*0.5*(0.4-0.2)*(0.07-0.04)* *=9.1e-02 – 0.60e-02* *=8.50e-02 rad^2* ***dOmega_proton*** ***= sin(97)*dtheta*dphi*** ***= 8.436e-02 srad.***

Raw cross section

N_pass_cut/(dOmega_e*dE_e*dOmega_p*dmomentum_p)
= ---
N_electron_Target_area_number_density

N_electron_Target_area_number_density
= (Target density)(target Length)*(N_A)/(A_z)*(Total charge)/(Electron charge)*
*= (33.834 * 10^-3 g/cm^3)*(15 cm)*(6.02e23 atom/mol)/(A_z = 4 g/mol)*(2.27381 C)/(1.6e-19 C/electron)*
*=1.085e+18 electron*atom/barn*

[1 barn = 1e-24 cm^2]

Raw cross section

N_pass_cut/(dOmega_e*dE_e*dOmega_p*dmomentum_p)
= ---
*1.085e+18 electron*atom/barn*

(15930 +/- 0.97%)/(*2.359e-3 srad**0.31 GeV* *8.436e-02 srad**0.9GeV/c)
= ---
*1.085e+18 electron*atom/barn*

(15930)/(*2.359e-3**0.31* *8.436e-02**0.9)
= ---
1.085e+18

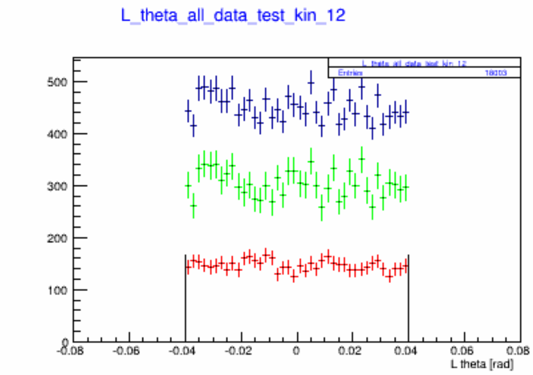
= 2.644e-10 barn/(GeV^2/c**srad^2)*

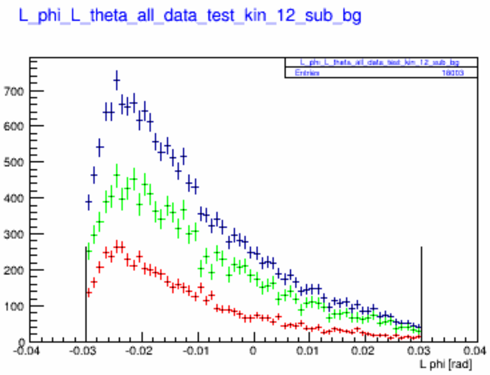
=2.644e-10 (1e2 fm^2)/(1e6 MeV^2/c**srad^2)*
= 2.644e(-14) fm^2 / MeV^2/c**srad^2*

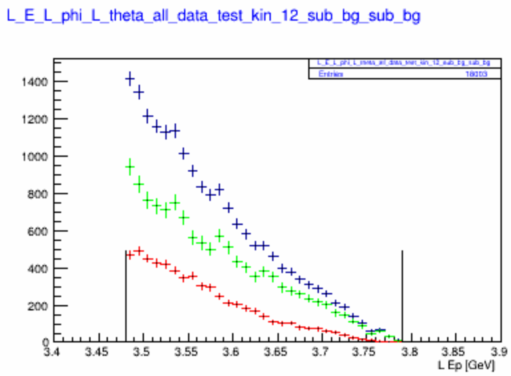
****differencial at : p_miss, p_tg*

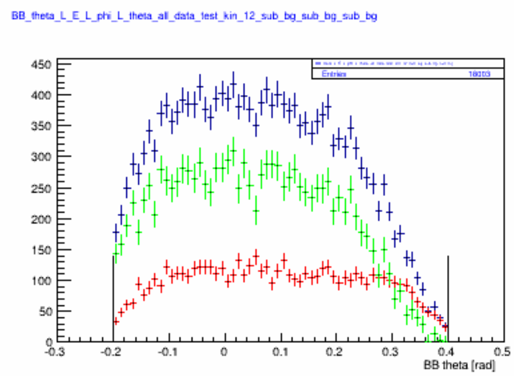
unit change:

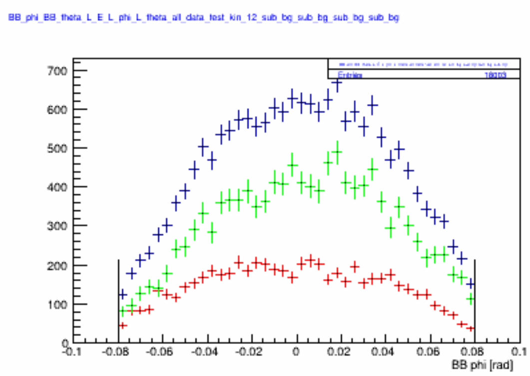
*1 barn = 1e-24 cm^2 = 1e-28 m^2 = 1e-28 *(1e15*fm)^2 = 1e2 fm^2*

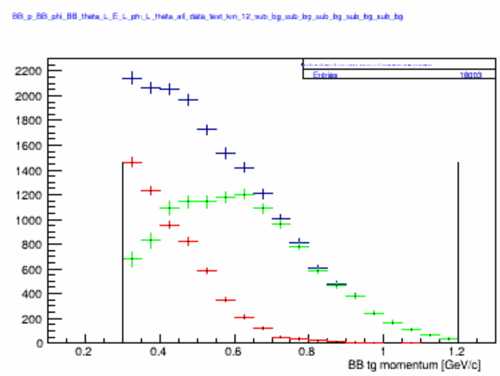






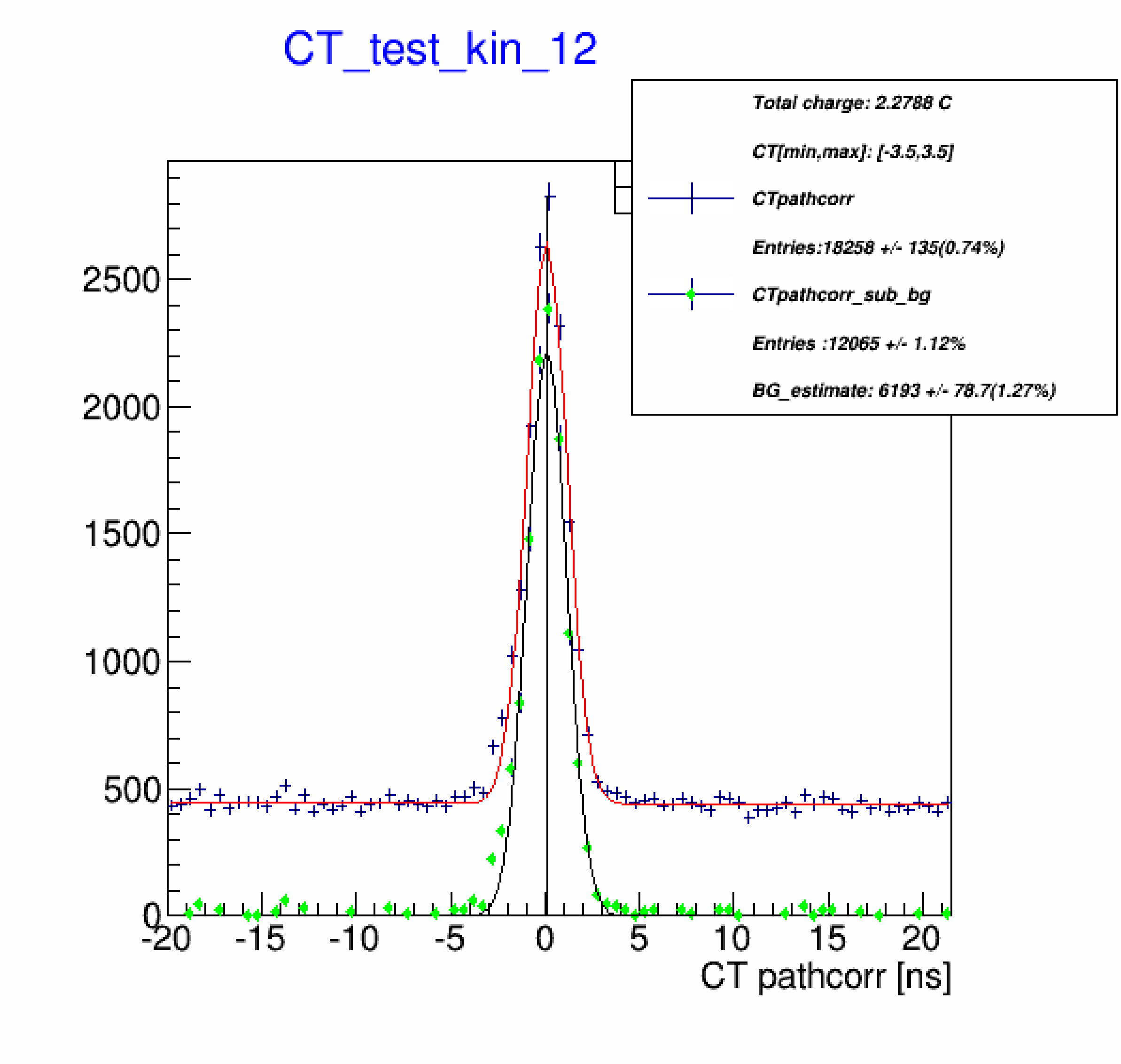






cut:
abs(exL.th)<=0.04&&abs(exL.ph)<=0.03&&abs(exL.p-3.635)<=0.155
&&abs(BB.tr.tg_ph[0])<=0.08&&abs(BB.tr.tg_th[0]-0.10)<=0.30
&&abs(BB.tr.Bbmom_tg[0]-0.75)<=0.45

Making adjustment in the cut in theta & phi and others in 1 D cut only



CT:Entries:18258 +/- 135(0.74%)
CT-bg:Entries :12065 +/- 1.12%
BG_estimate: 6193 +/- 78.7(1.27%)

Raw cross section unit:

$$= \frac{\text{N\_pass\_cut/(dOmega\_e*dE\_e*dOmega\_p*dmomentum\_p)}}{\textit{N\_electron\_Target\_area\_number\_density}}$$

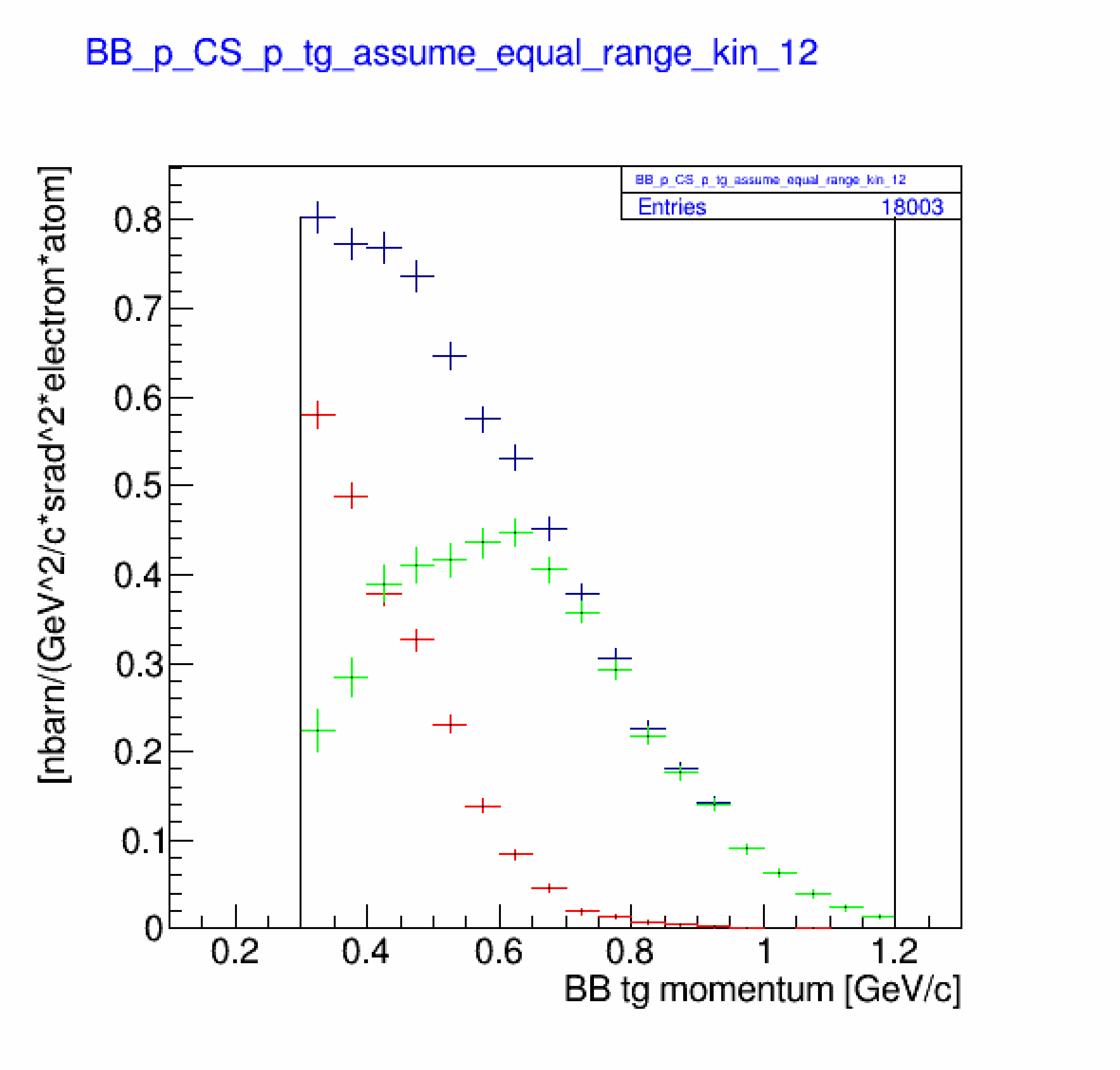
= *2.51215e-10* **[barn/(GeV^2/c*srad^2)]**

1. If assume each bin in momentum distribution does not change the coverage in other 5 parameters : L theta,phi,Ep, BB theta, phi.

Raw cross section unit:

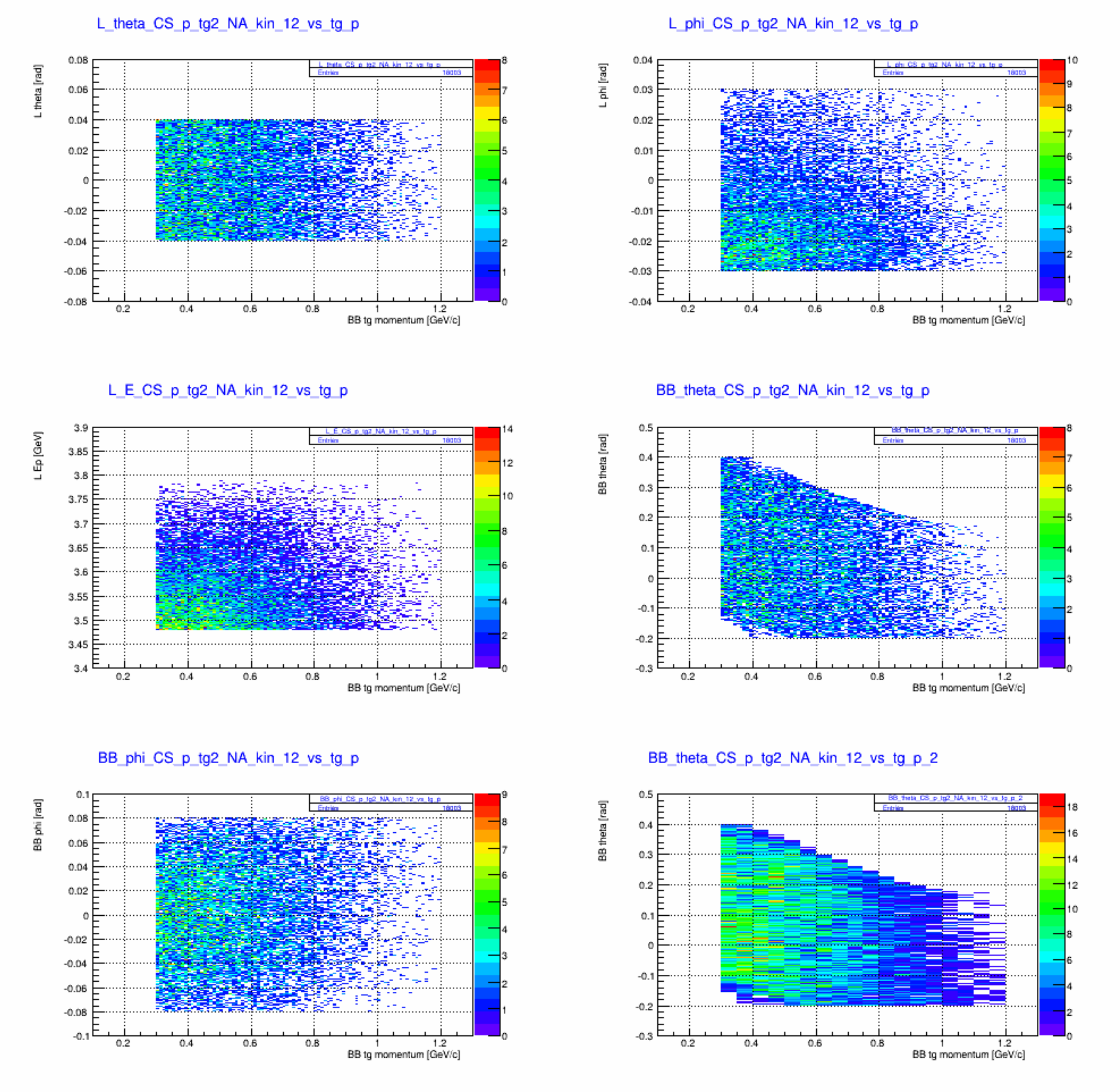
$$= \frac{\textbf{N\_pass\_cut\_in\_bin} /(\text{dOmega\_e*dE\_e*dOmega\_p*}\textbf{dmomentum\_p\_width})}{\textit{N\_electron\_Target\_area\_number\_density}}$$

= (1.87396e-14) **[barn/(GeV*srad^2*electron*atom)] *** (N_pass_cut_in_bin/ dmomentum_p_width)



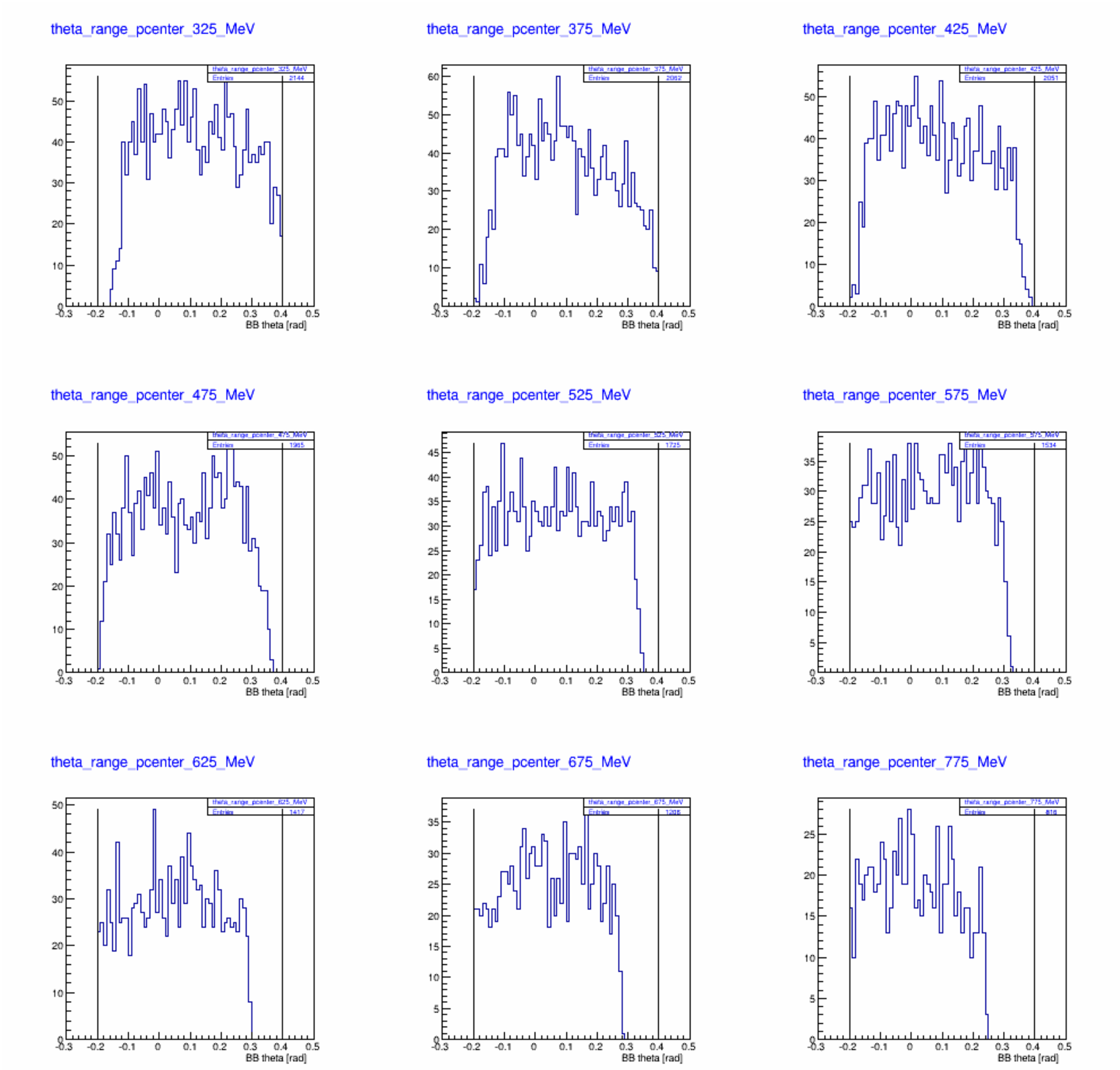
CS1: Cross Section in proton target momentum in 50 MeV/bin *assuming dOmega_e*dE_e*dOmega_p does not change due to the change in momentum range of each bin.*

Is it really true?? take a look in term of the relationship of other parameters to BB_target_momentum.



No.

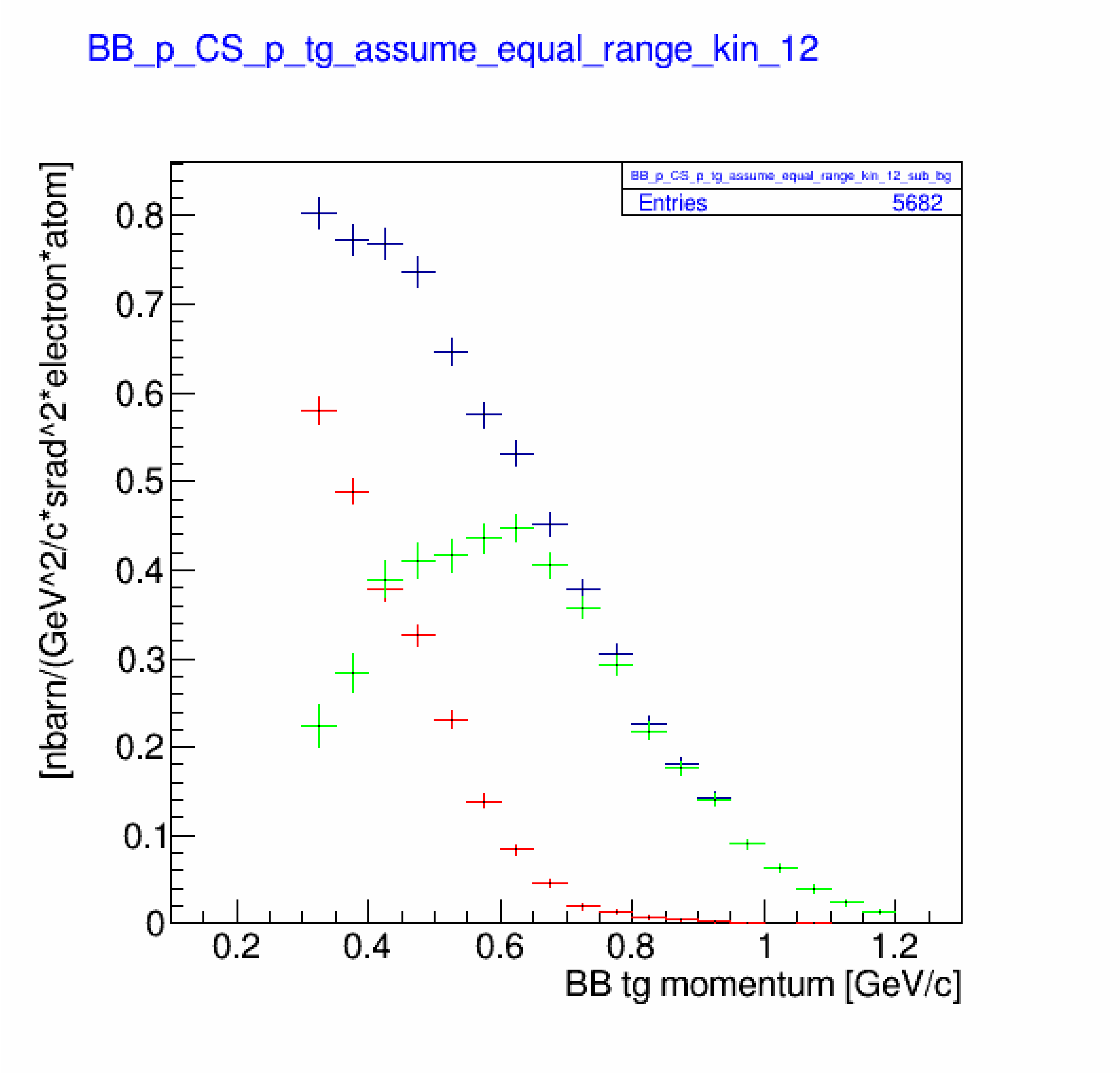
The proton momentum dose depend on theta and via. Thus, in each bin of momentum the width of BB theta change.



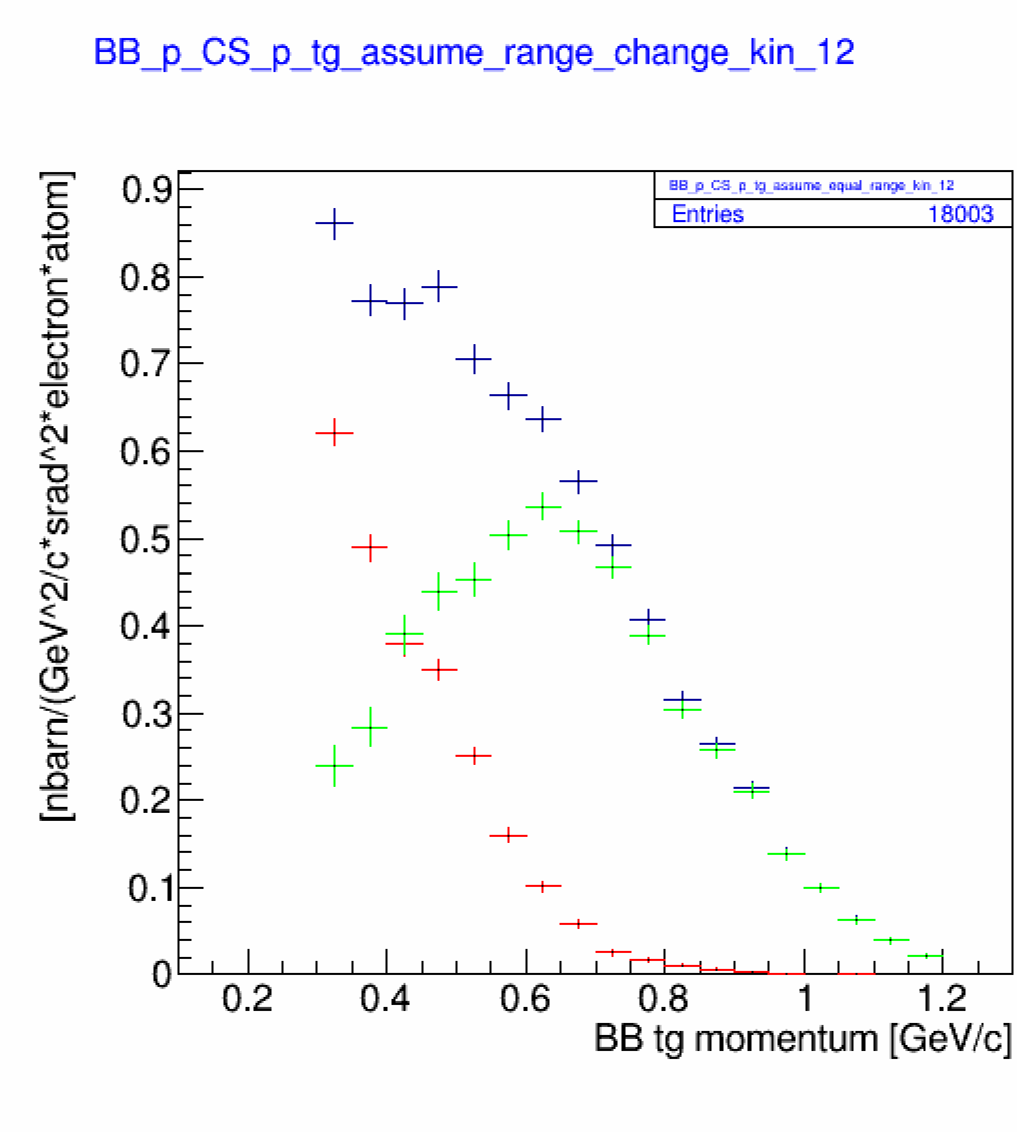
The range of Theta for each proton momentum bin (50 MeV/bin)

p_center (MeV/bin)	D theta
325	0.6 – 0.04
375	0.6
425	0.6
475	0.6 – 0.04
525	0.6 – 0.05
575	0.6 – 0.08
625	0.6 – 0.1

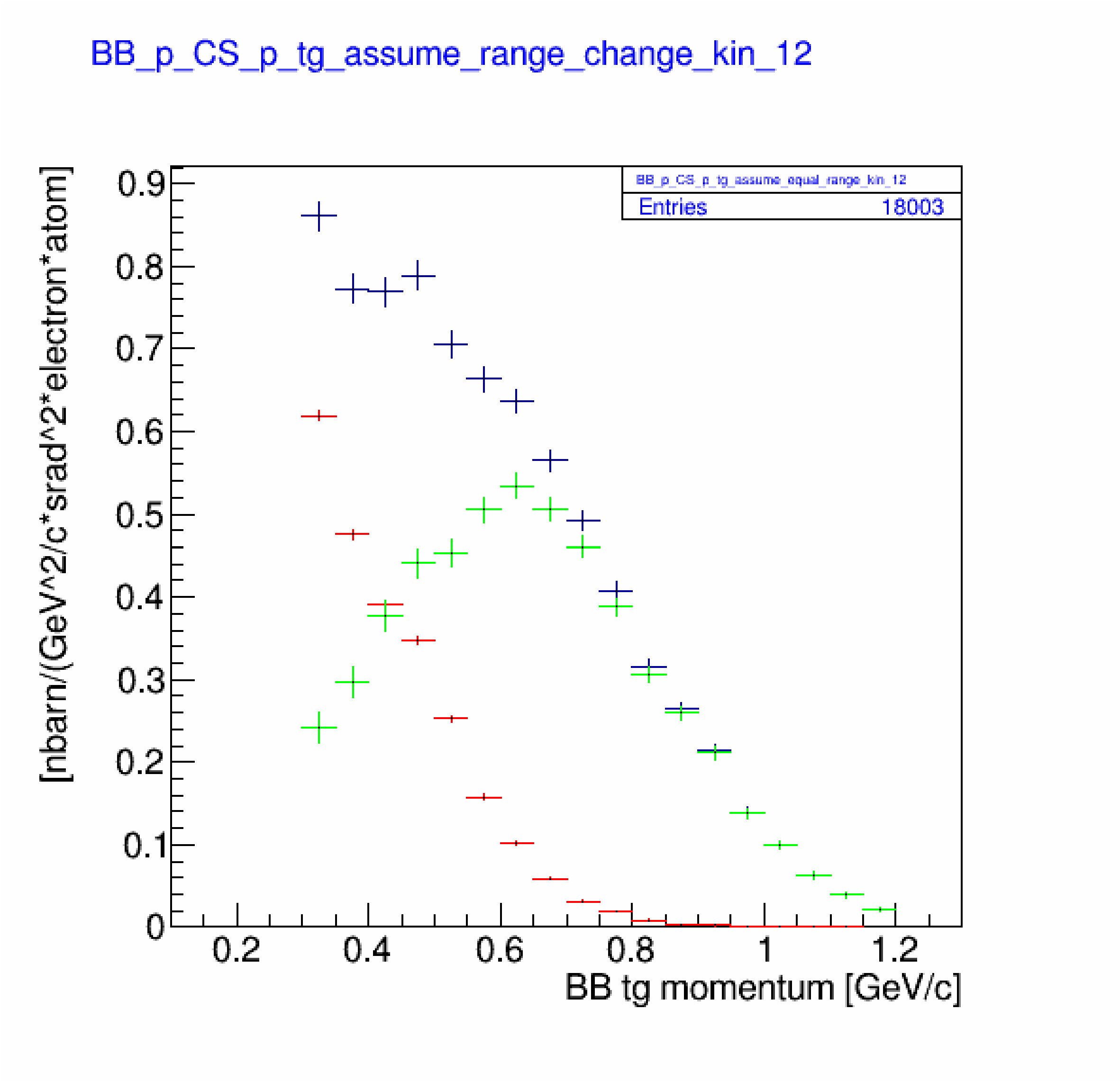
675	0.6 – 0.12
725	0.6 – 0.14
775	0.6 – 0.15
825	0.6 – 0.17
875	0.6 – 0.19
925	0.6 – 0.20
975	0.6 – 0.21
1025	0.6 – 0.22
1075	0.6 – 0.22
1125	0.6 – 0.24
1175	0.6 – 0.26



CS1: Cross Section in proton target momentum in 50 MeV/bin *assuming dOmega_e*dE_e*dOmega_p does not change due to the change in momentum range of each bin.*



CS2: Cross Section in proton target momentum in 50 MeV/bin *assuming dOmega_e*dE_e*BBsin*BBphi does not change due to the change in momentum range of each bin. But the Bbtheta does change. As given above table.*



CS3: Cross Section in proton target momentum in 50 MeV/bin *assuming dOmega_e*dE_e*BBsin*BBphi does not change due to the change in momentum range of each bin. But the Bbtheta does change. As given above table.*

With minimize the statistic uncertainty in the background by extend the width (to 6 times) of the Background estimation and then scale down.

Double check the data comparing to Peter's thesis: (page 169)
The 6-fold cross section for C12(e,e'p_forward) with P_miss in range of 575-675 MeV/c are in the range of 1e-13 to 9e-13 fm^2/(MeV^2-sr^2).

E_{miss} $[MeV]$	$\frac{d^6\sigma}{d\Omega_e d\Omega_p dE_p dE_e} \pm \delta_{stat} \pm \delta_{sys}$ $[fm^2/(MeV^2-sr^2)]$	$S_{exp}(E_m, P_m)$ $[fm^3/MeV]$	Kinematic Bin
70	4.0401e-13 $\pm$ 23.6% $\pm$ 5.0%	9.8833e-6	
90	4.9304e-13 $\pm$ 20.7% $\pm$ 5.0%	1.2481e-5	$\bar{Q}^2 = 2.139 \pm 0.104\ (GeV/c)^2$
110	5.6565e-13 $\pm$ 20.3% $\pm$ 5.0%	1.4768e-5	
130	8.8261e-13 $\pm$ 16.2% $\pm$ 4.9%	2.3564e-5	$\bar{\omega} = 883.7 \pm 56.8\ MeV$
150	1.0067e-12 $\pm$ 15.2% $\pm$ 4.9%	2.7334e-5	
170	9.0039e-13 $\pm$ 16.2% $\pm$ 5.2%	2.4628e-5	$\bar{y} =$ -0.167 $\pm$ 0.035
190	8.8911e-13 $\pm$ 16.9% $\pm$ 5.3%	2.4533e-5	
210	7.6068e-13 $\pm$ 18.0% $\pm$ 12.4%	2.0877e-5	
230	5.6667e-13 $\pm$ 24.3% $\pm$ 13.3%	1.5327e-5	

Table 6.18: Results for kinematic III: $P_{miss} = 600 \pm 25$ MeV/c

E_{miss} $[MeV]$	$\frac{d^6\sigma}{d\Omega_e d\Omega_p dE_p dE_e} \pm \delta_{stat} \pm \delta_{sys}$ $[fm^2/(MeV^2-sr^2)]$	$S_{exp}(E_m, P_m)$ $[fm^3/MeV]$	Kinematic Bin
60	7.0943e-14 $\pm$ 39.7% $\pm$ 6.6%	2.3169e-6	
100	1.4667e-13 $\pm$ 32.4% $\pm$ 5.2%	4.9356e-6	$\bar{Q}^2 = 2.249 \pm 0.075\ (GeV/c)^2$
140	1.9285e-13 $\pm$ 34.3% $\pm$ 8.7%	6.5380e-6	$\bar{\omega} = 864.1 \pm 58.5\ MeV$
180	2.3735e-13 $\pm$ 36.7% $\pm$ 8.4%	7.9443e-6	$\bar{y} =$ -0.213 $\pm$ 0.040
220	1.9601e-13 $\pm$ 43.4% $\pm$ 9.1%	6.4129e-6	

Table 6.19: Results for kinematic III: $P_{miss} = 650 \pm 25$ MeV/c

The P_miss in C12(e,e'p_forward) is comparable to, in my case, the detected momentum at the BigBite for He4(e,e'p_backward).

At p_target_BB = 500-600 MeV/c, I have the “raw” cross section at 0.4-0.5 nbarn*c/(GeV^2-srad^2) = (4 - 5) * 1e-14 fm^2*c/(MeV^2-srad^2).
(from the last two pages: CS3 figure)

The difference are in the order of 10 in magnitude. How can we explain this??

Where possibly can calculation go wrong?
1. N_pass_cut: this need the correction factor due to deadtime, cut-dependent, efficiencies.
Deadtime is at ~15%
BB tracking Efficiency is at ~ 76-79%
Single track in LHRS reduce data to 99.4%
The Coincidence vertex reduce data of CT-BG to ~90% ***need to check
combine this should give about 1.66 factor

[Not big enough to drive up ~10 factor]

what about the r-function cut?

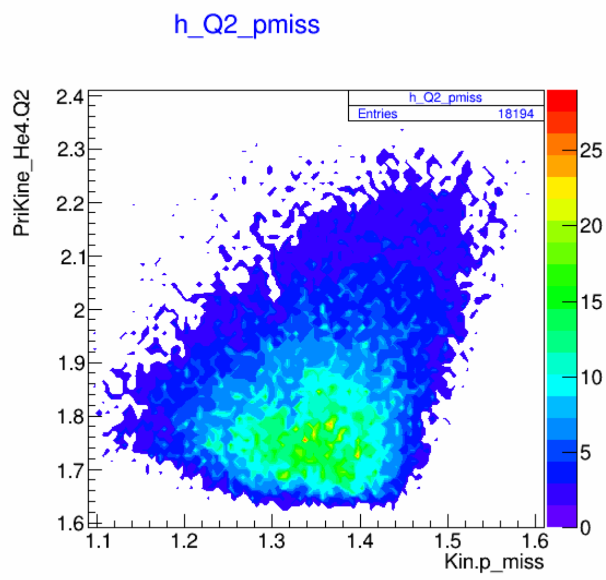
2. d2_Omega_e, and d2_Omega_p
Do I make the wrong calculation of these two parameters?
Need to check!!!
**vary the cut on both theta and phi

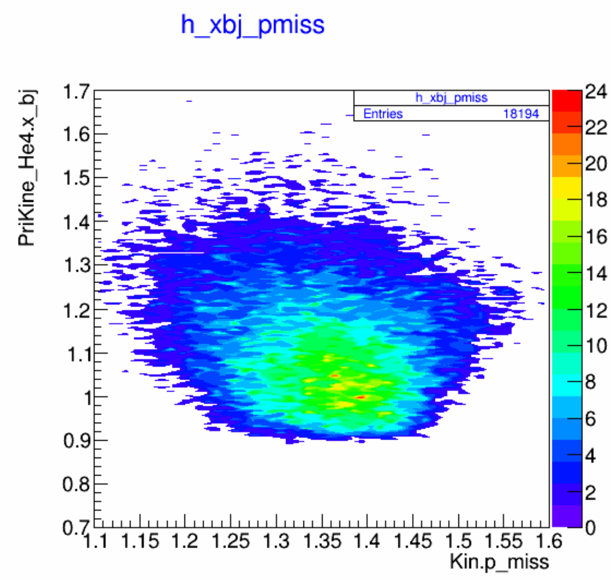
Other Reasons??

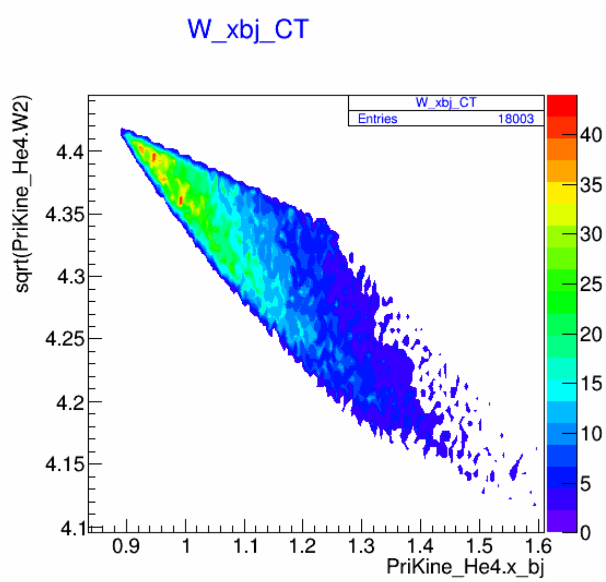
1. difference target/ difference A2
2. difference in LHRS angle setting which reduce the Mott-cross section to begin with?? (19.5 to 20.3 degree)
3. value are average over the large LHRS phi angle and the dE'_e which clearly not flat.
4. ????

To do next:

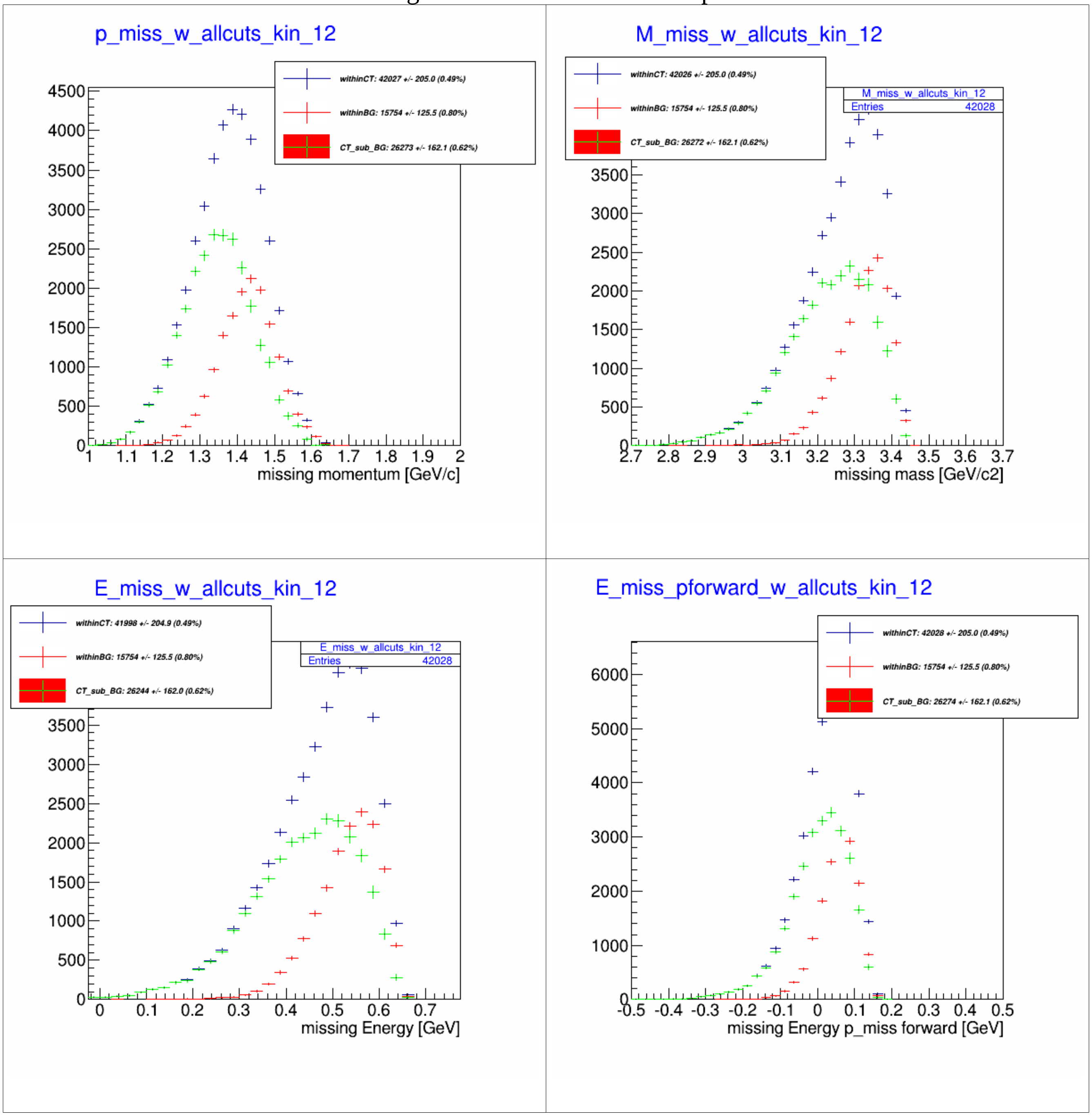
** check compare the mott cross section
** A2 difference
** missing momentum dependent


h_Q2_pmiss
h_Q2_pmiss
Entries 18194
PriKine_He4.Q2
Kin.p_miss
1.6
1.7
1.8
1.9
2
2.1
2.2
2.3
2.4
1.1
1.2
1.3
1.4
1.5
1.6
0
5
10
15
20
25


h_xbj_pmiss
h_xbj_pmiss
Entries 18194
PriKine_He4.x_bj
Kin.p_miss
0.7
0.8
0.9
1
1.1
1.2
1.3
1.4
1.5
1.6
1.7
1.1
1.15
1.2
1.25
1.3
1.35
1.4
1.45
1.5
1.55
1.6
0
2
4
6
8
10
12
14
16
18
20
22
24


W_xbj_CT
W_xbj_CT
Entries 18003
sqrt(PriKine_He4.W2)
PriKine_He4.x_bj
4.1
4.15
4.2
4.25
4.3
4.35
4.4
0.9
1
1.1
1.2
1.3
1.4
1.5
1.6
0
5
10
15
20
25
30
35
40

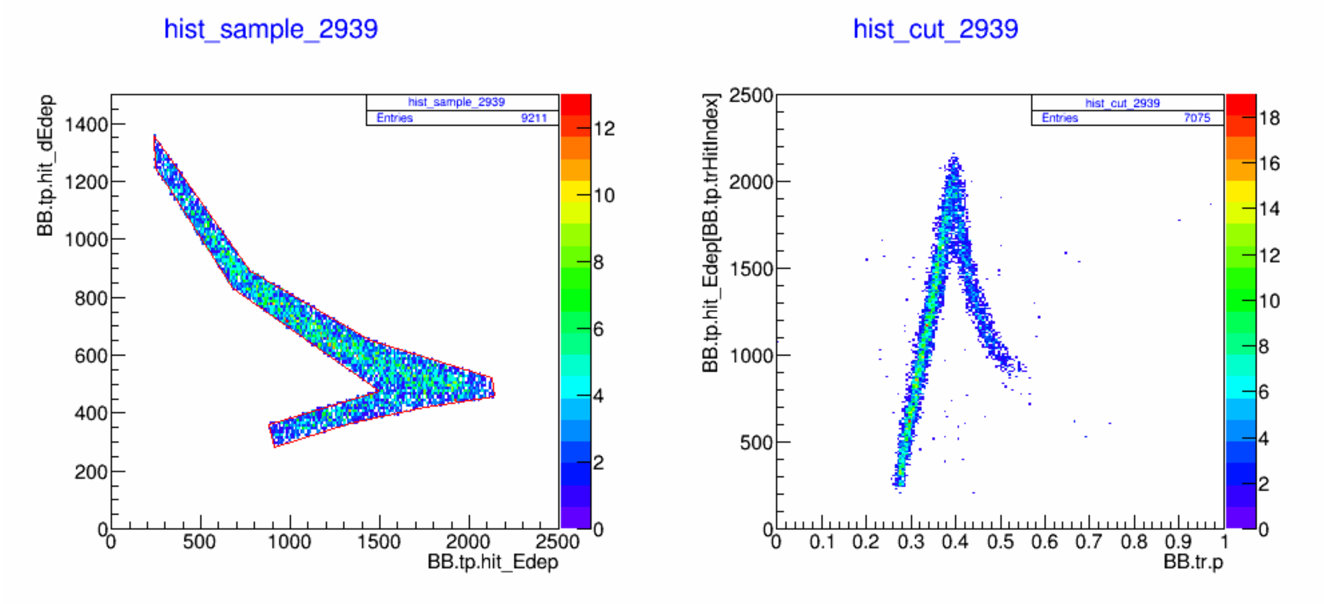
current distribution: without the dOmega cut for both electron and proton



2. other parameter needed.

2. Identify “flat” region for BB acceptance:XXXX
3. Identify “flat” region for LHRS acceptance:XXX
make sure that with all the cut the change in p-distribution not change
4. electronic dead-time factor ***
check the computer deadtime this is not much differ than the online one

3. already have:
3.1 BB tracking efficiency:
Eff: 79.2% before the turning point in dE vs E (low p)
Eff: 72.2% after the turning point in dE vs E (high p)
over all Eff: 77.8%
** can use either but then add the uncertainty to explain



The **sample data** is within the rough coincidence time **without** BB-path-length correction (better than no cut on CT at all). Scan through all the hit for which dE and E plane data matched. Only keep the data with all the hit has information within the proton PID dE_vs_E cut.

The **cut data** has additional requirement. The data must have track. The track can also be match to the fullhit data. The data also pass graphic E vs p proton PID.

Sensitivity***---> into the uncertainty not the correcting factor.
3.2 Effect/correction factor for making the electron PID??
3.2 Effect/correction factor for making the proton PID??
make sure not rejecting the proton.
3.3 correction factor for requiring a single track in LHRS
Eff: 99.4% has a single track