中国科学技术大学
University of Science and Technology of China

Isobar hypernuclei

2022/8/30

- Isobar pico:

  /star/u/suyuann/pwg/Isobar.Blind/isobar_ana/picoRaw_phy_20220807.list

- QA code:

  based on /star/u/suyuann/pwg/Isobar.Blind/isobar_QA/isobar_QA/

  in /star/u/dsli/Isobar_hypernuclei/Isobar_QA/

  ~0.36M pico in list, run 5/9 (2 x 10^9 event)

- Ana:

  based on /star/u/xli/pwg/gpc_CSB/02_kfparticle/H4L

  in /star/u/dsli/pwg/Isobarhypernuclei/02_kfparticle/H3L

Cuts:

Trigger: 600031

Badrun: 19130085, 19131009, 19131010, 19131012, 19132063, 19133009, 19133010, 19133012, 19133013, 19133014, 19133018, 19134010, 19134011, 19135011, 19135013, 19135014, 19136016, 19137003, 19137022, 19137047, 19137050, 19137051, 19137052, 19137053, 19137056, 19137057, 19138008, 19138009, 19138014, 19139022, 19139023, 19139024, 19139026, 19139027, 19139028, 19139032, 19139033, 19139034, 19139037, 19140009, 19140014, 19141008, 19142005, 19142048, 19143008, 19143009, 19143010, 19143011, 19143012, 19143013, 19143014, 19143015, 19143016, 19143017, 19146016, 19147007, 19147008, 19147009, 19147010, 19147014, 19147015, 19147016, 19156002, 19156032, 19156044, 19156045, 19156046, 19157013, 19158003, 19158007, 19158009, 19158010, 19158011, 19158013, 19158014, 19158015, 19158017, 19158018, 19158019, 19160018, 19162002, 19162005, 19165015, 19165020, 19165021, 19167042

86 badruns in total

Good event:

-35 < Vz < 25

|Vx| > 1.e-5

|Vy| > 1.e-5

|Vz-VpdVz| <= 1000

|Vr| < 2.0

Good track:

nHitsFit >= 15

nHitsDedx >= 15

0.52<nHitsFit/nHitsMax*1.0<1.02

|eta| < 1.5

pt > 0.2

Dca < 200 (Dca<3 for run by run QA)

Check badrun list:

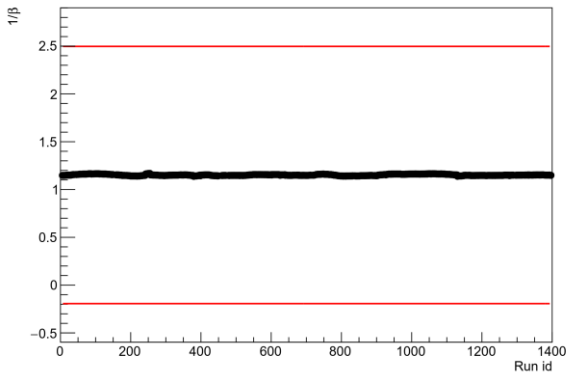
<Y>$\pm$5*σ

<Y> by TProfile::GetMean()

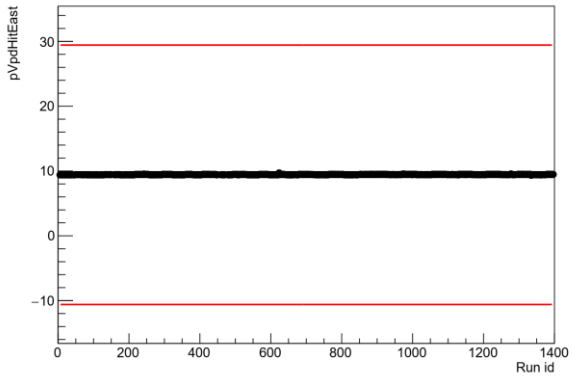
σ by TProfile::GetStdDev()

run by run QA

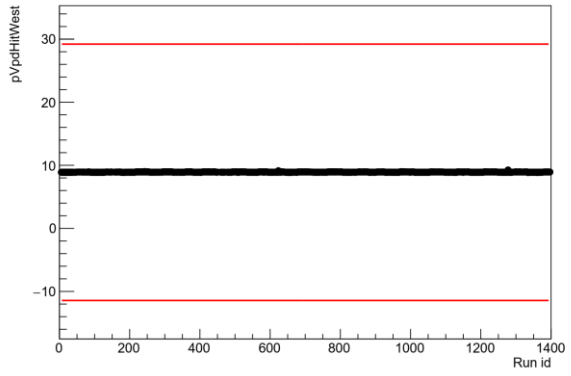
pTof



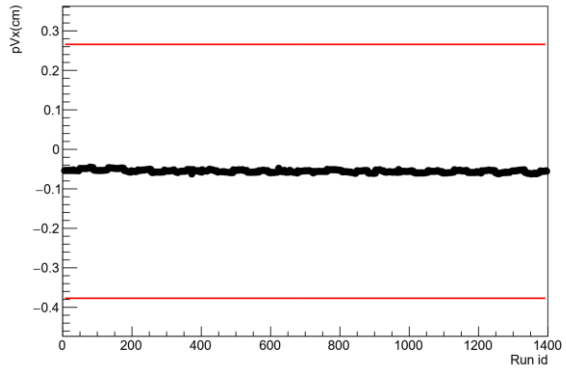
pVpdHitEast



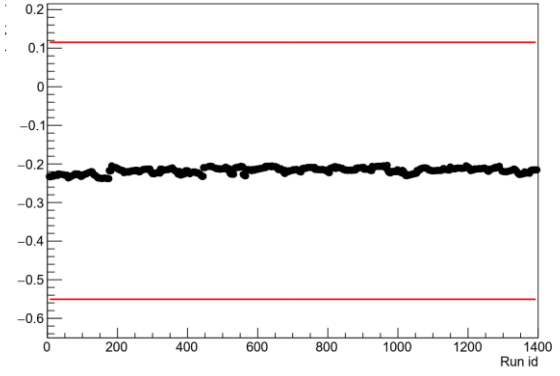
pVpdHitWest



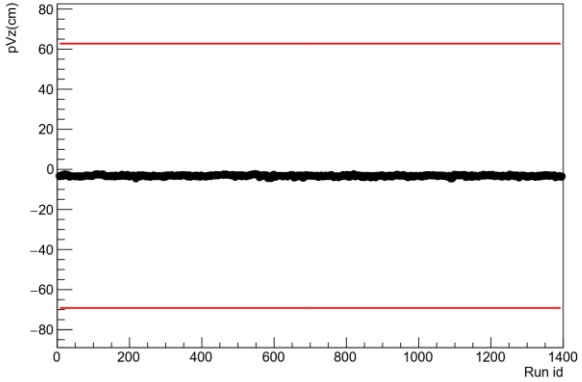
pVx



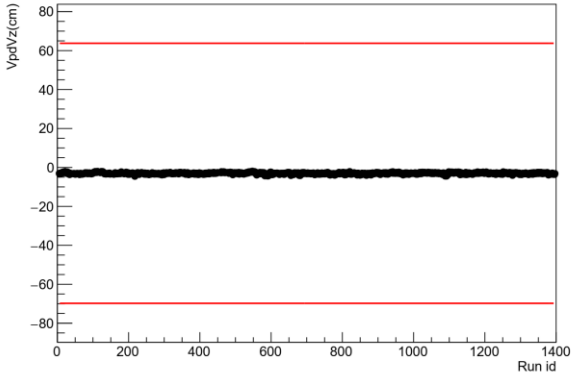
pVy



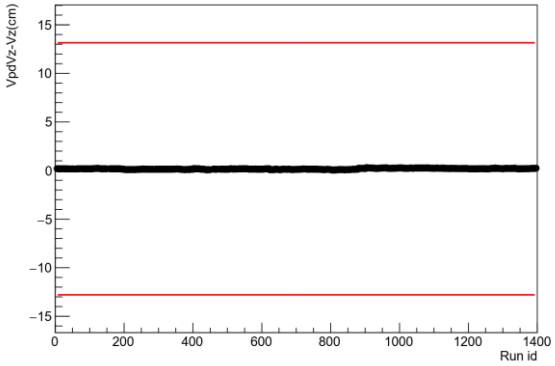
pVz



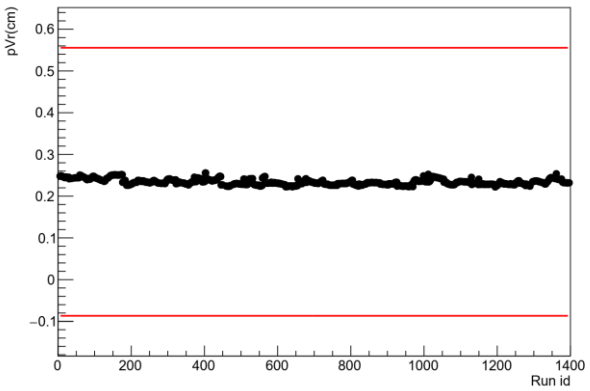
pVpdVz



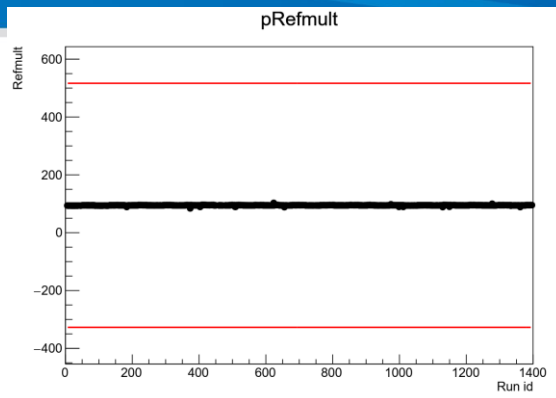
pVzVpdVz

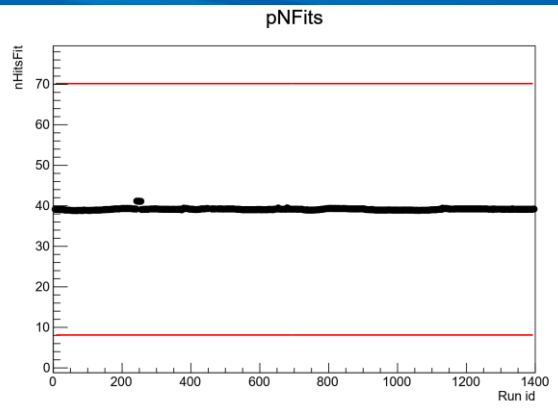


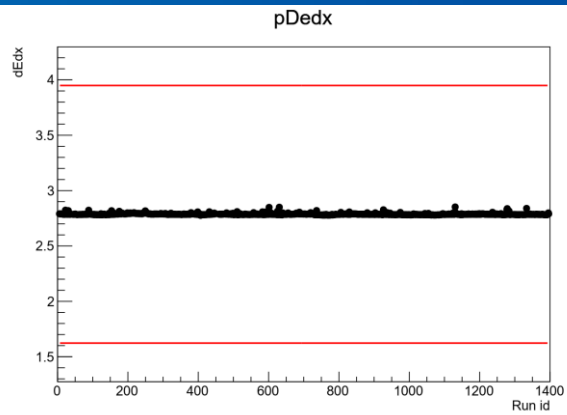
pVr

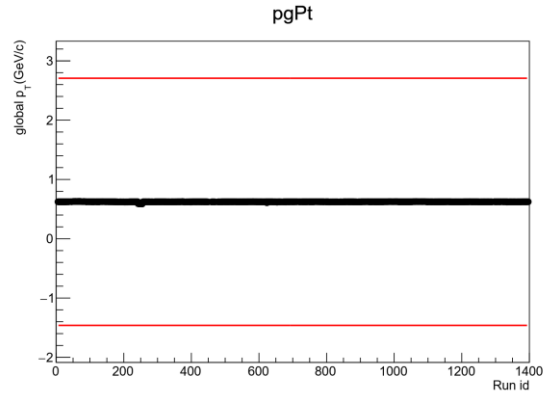


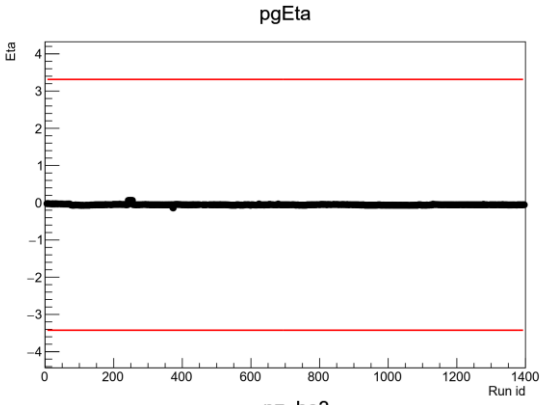
run by run QA

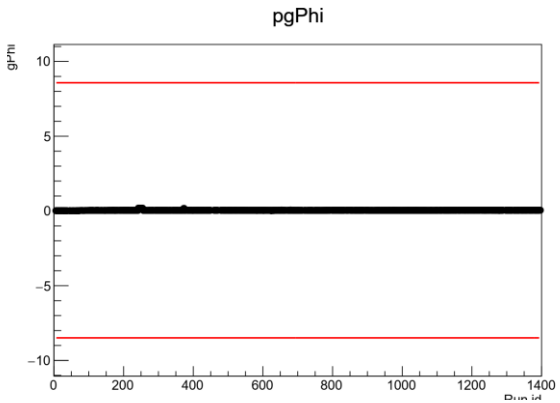

pRefmult
Refmult
Run id

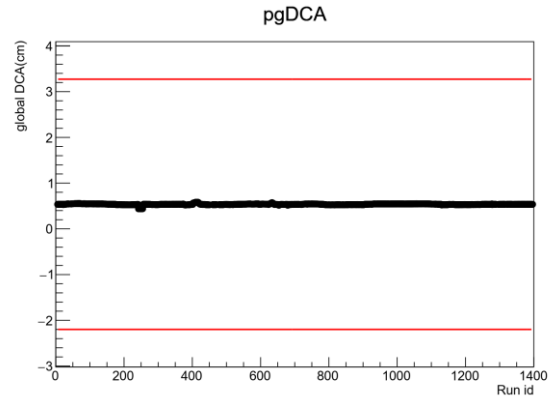

pNFits
nHitsFit
Run id

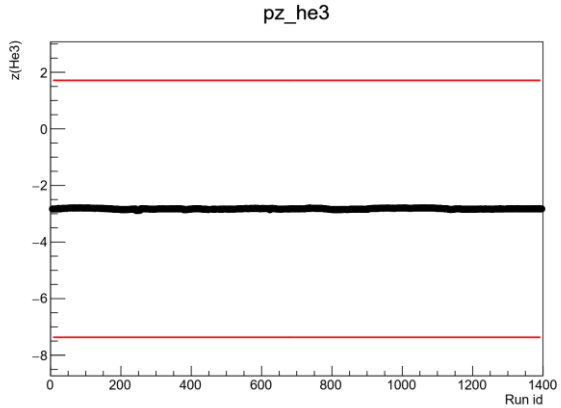

pDedx
dEdx
Run id

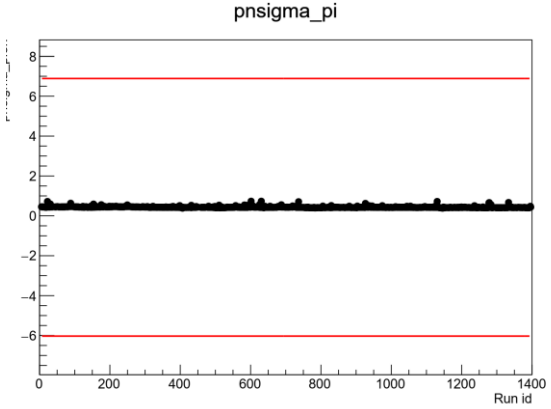

pgPt
global p_T (GeV/c)
Run id


pgEta
Eta
Run id

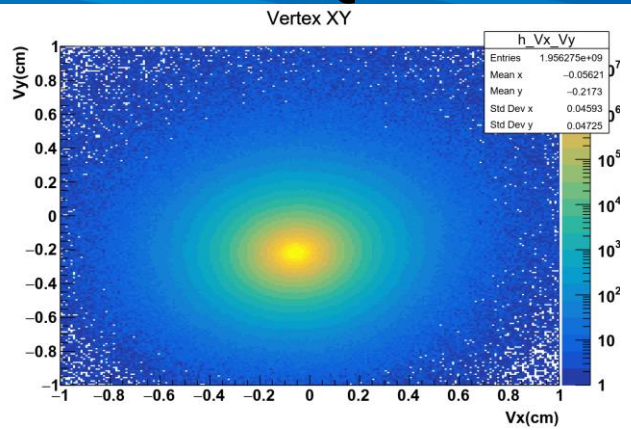

pgPhi
gPhi

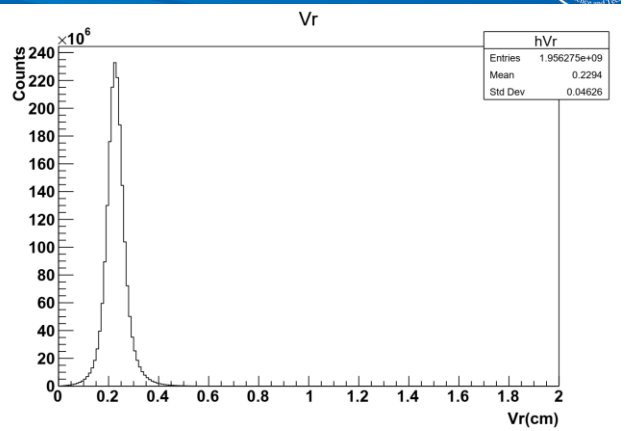

pgDCA
global DCA(cm)
Run id

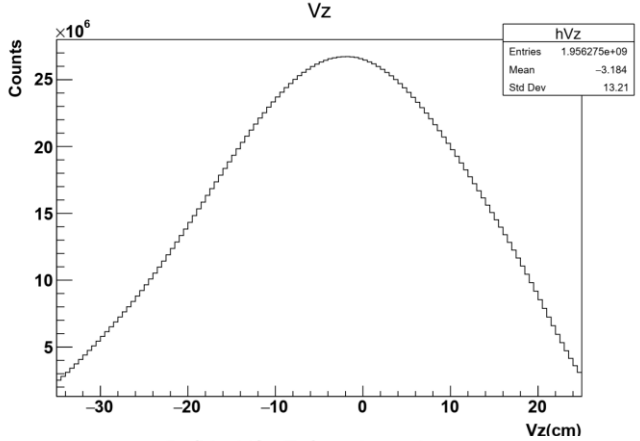

pz_he3
z(He3)
Run id

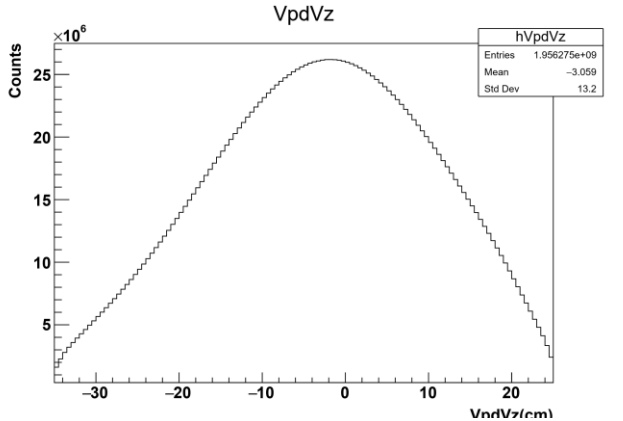

pnsigma_pi
Run id

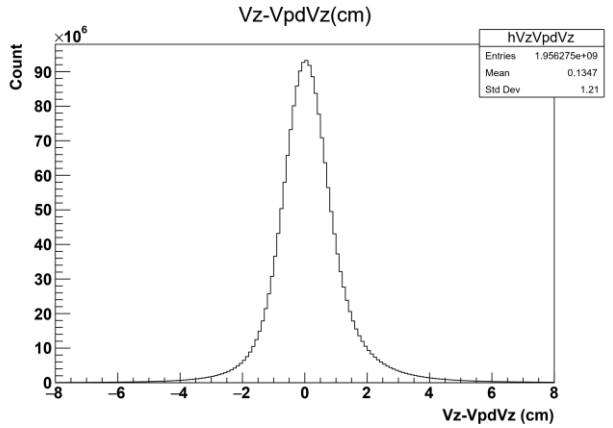
Event QA

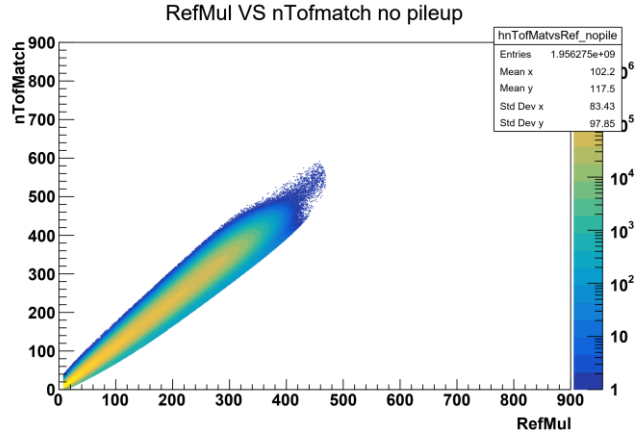

Vertex XY
h_Vx_Vy
Entries 1.956275e+09
Mean x −0.05621
Mean y −0.2173
Std Dev x 0.04593
Std Dev y 0.04725
Vy(cm)
Vx(cm)

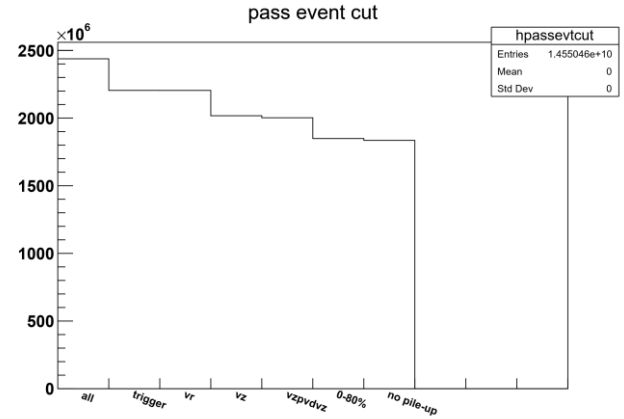

Vr
hVr
Entries 1.956275e+09
Mean 0.2294
Std Dev 0.04626
Counts
Vr(cm)


Vz
hVz
Entries 1.956275e+09
Mean −3.184
Std Dev 13.21
Counts
Vz(cm)

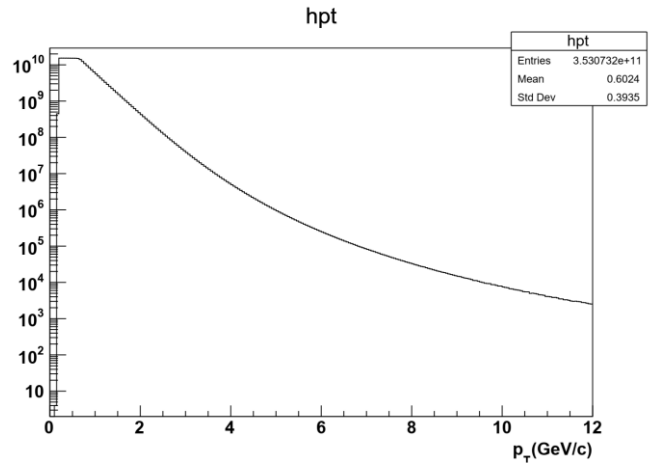

VpdVz
hVpdVz
Entries 1.956275e+09
Mean −3.059
Std Dev 13.2
Counts
VpdVz(cm)

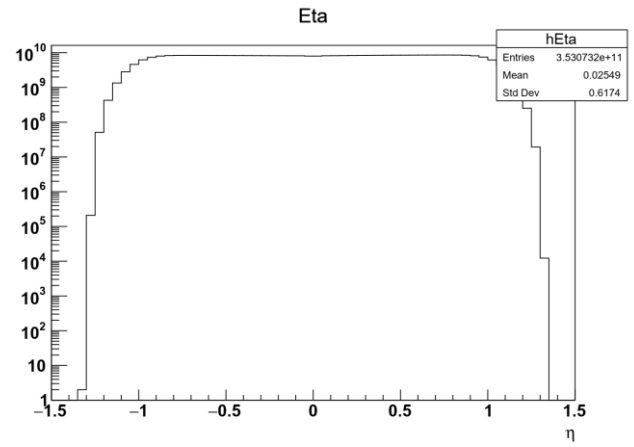

Vz-VpdVz(cm)
hVzVpdVz
Entries 1.956275e+09
Mean 0.1347
Std Dev 1.21
Count
Vz-VpdVz (cm)

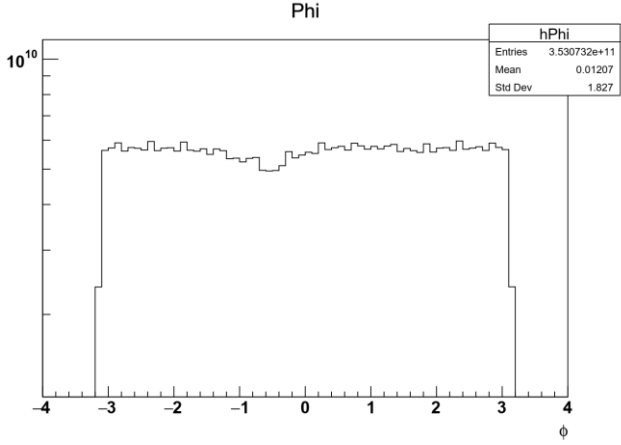

RefMul VS nTofmatch no pileup
hnTofMatvsRef_nopile
Entries 1.956275e+09
Mean x 102.2
Mean y 117.5
Std Dev x 83.43
Std Dev y 97.85
nTofMatch
RefMul

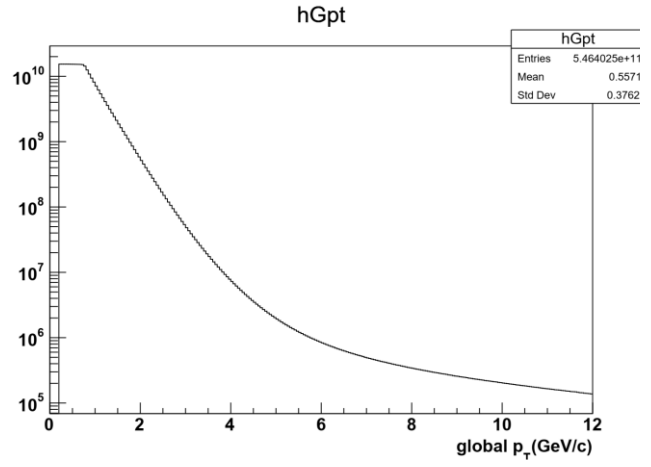

pass event cut
hpassevtcut
Entries 1.455046e+10
Mean 0
Std Dev 0
all
trigger
vr
vz
vzpvdvz
0-80%
no pile-up

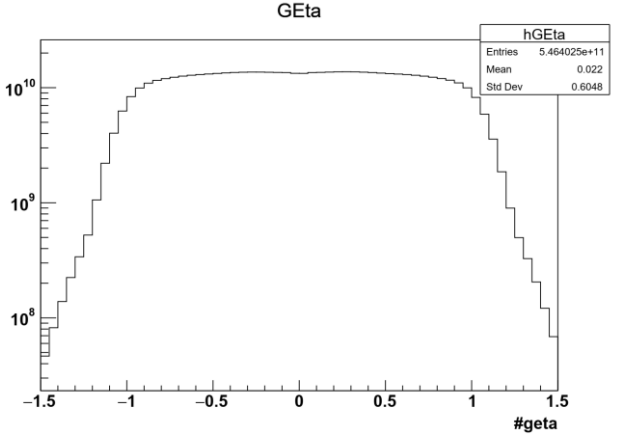
Track QA

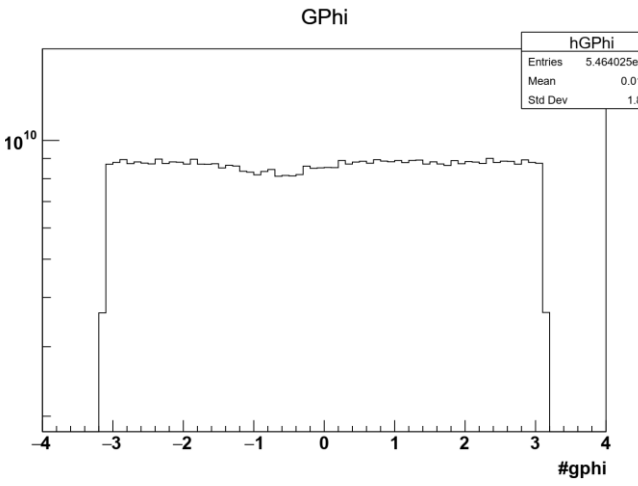






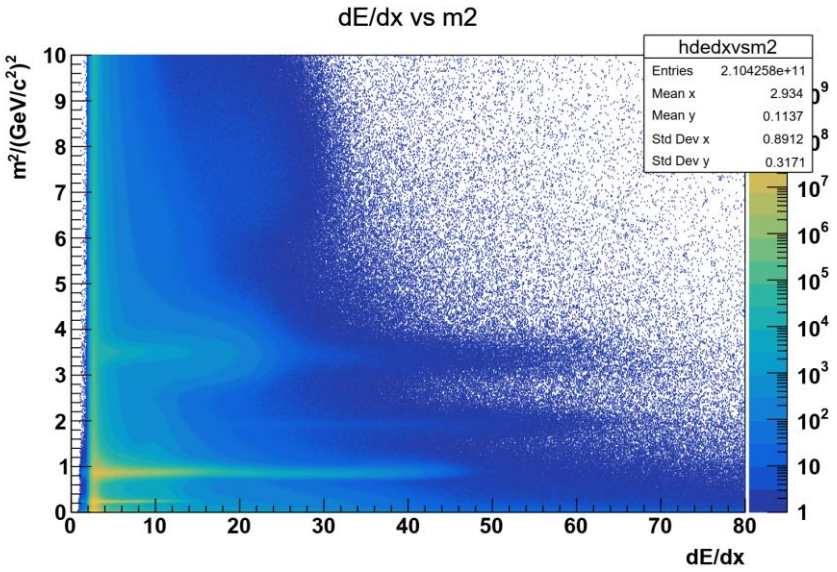


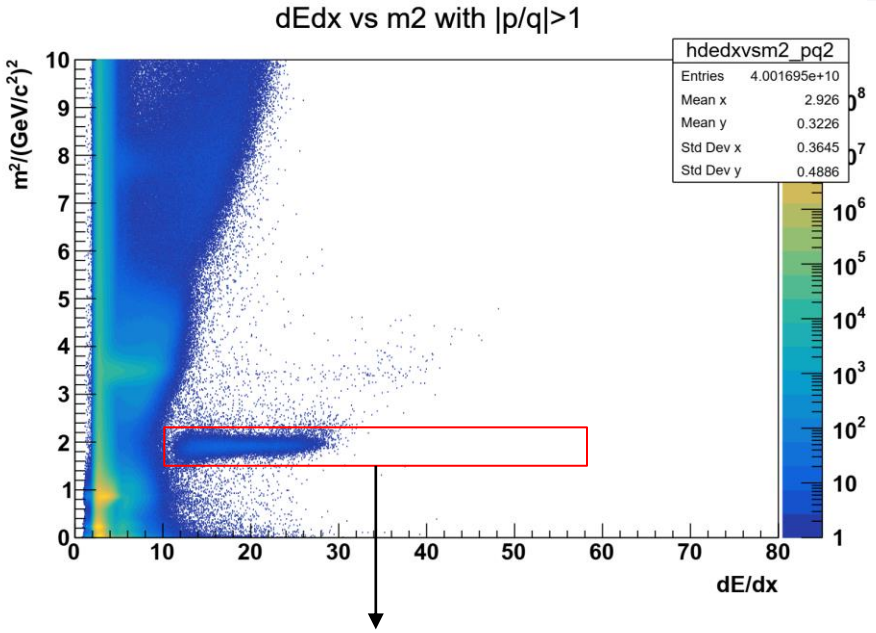




With 0.52<nHitsFit/nHitsMax*1.0<1.02 cut
A smooth shape of eta/phi now

Pid





After event/track cut:

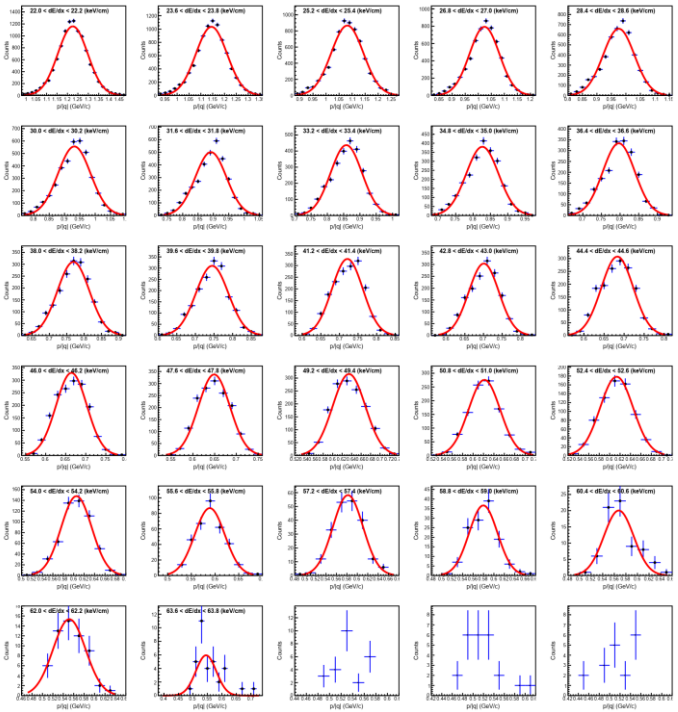
1.7<m2<2.3 && dE/dx > 10
Tofm2 cut is only used to get a pid

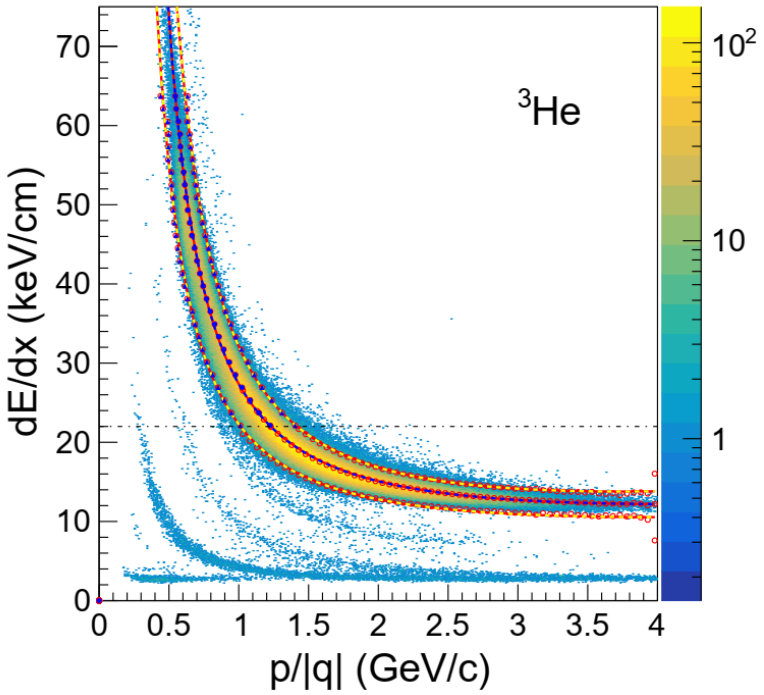
```
hdEdx->Fill(mom.Mag() / trk->charge() * 1.0, trk->dEdx());



if(tofmatch){
…
if(fabs(mom.Mag() / trk->charge() * 1.0)>1)
hdedxvsm2->Fill(trk->dEdx(), mom.Mag2() * (1. / beta / beta - 1.));
…
}
```

Pid

https://drupal.star.bnl.gov/STAR/system/files/Chenlu_analysisnotes_v6_1.pdf

For ^{3}He PID, we obtain a 2-D plot of energy loss (dE/dx) and the rigidity (p/|q|, q=1) distribution shown in Fig. 12(left) with a TOF mass cut in a range of $1.7 < (\frac{m}{q})^2 < 2.4$, where m^2 is given by STAR TOF detector. We make a projection on the X axis every 1.6 keV/cm and each projection covers 0.2 keV/cm when dE/dx is from 22 to 70 keV/cm, if dE/dx is smaller than 22 keV/cm, we make a projection on the Y axis every 0.05 GeV/c and each projection covers 0.05 GeV/c. Since we applied the TOF mass cut of ^{3}He, we use a Gaussian function to fit every projection plot and get the corresponding mean and σ value. The projections and





Pid

1.Fold dEdx_vs_p/q to dEdx_vs_|p/q| (0 < dEdx < 80, 0 < |p/q| < 5)

2.Rebin and cut slices:

when dEdx > 22, projection to X, dEdx width = 0.8

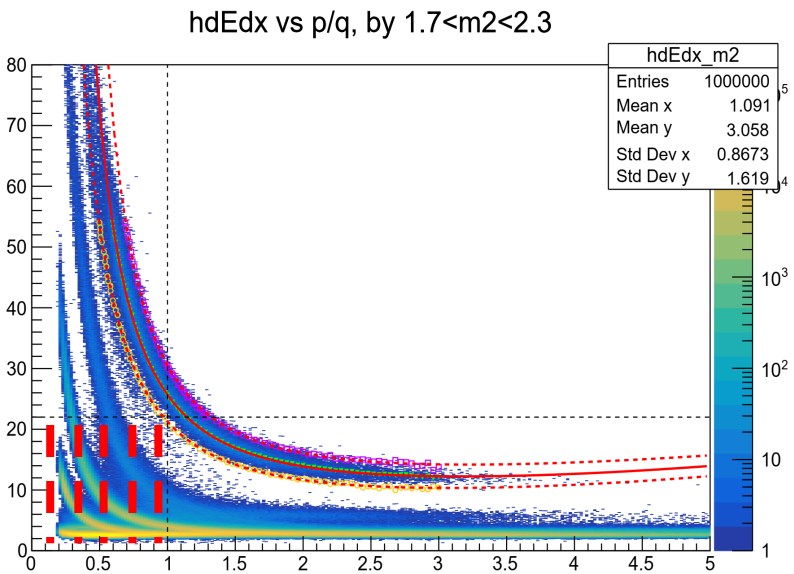
when |p/q| > 1, projection to Y, |p/q| width = 0.04

we must project to different axes in different regions, otherwise we can't avoid touching |p/q| > 3 and dEdx > 60, where we have poor statistics.

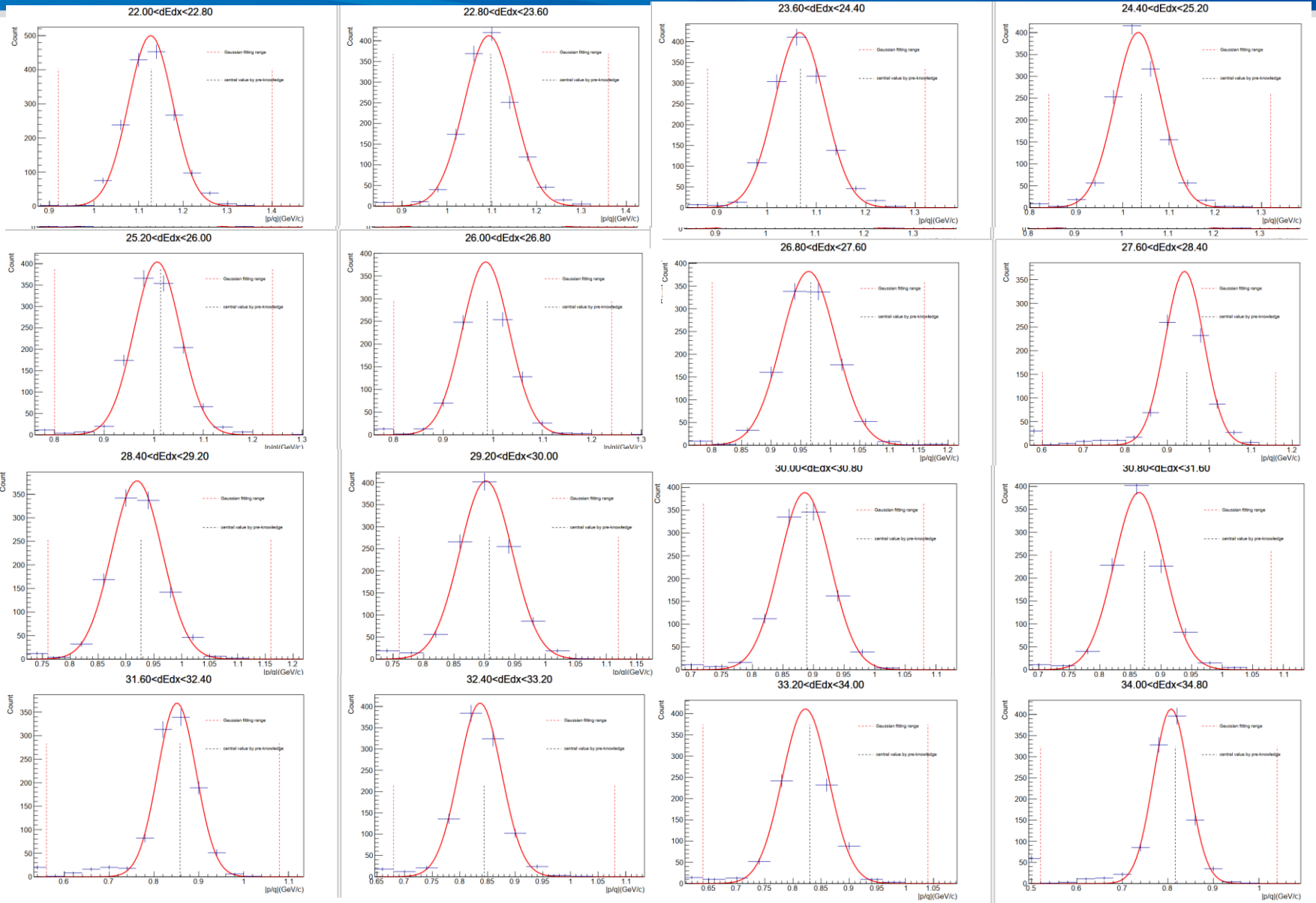
3.Fit with gaussian:

automatically find the position of He3 peak and fit with gaussian

```
hproj2x[i]->Fit(g, "IENOR", "", p2x_low[i], p2x_high[i]);
```

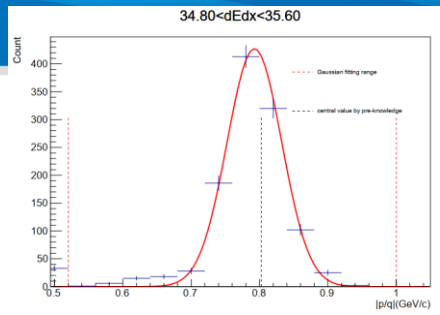


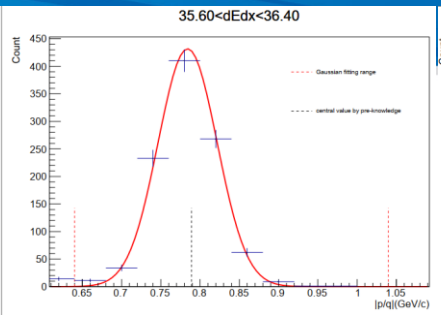
Pid

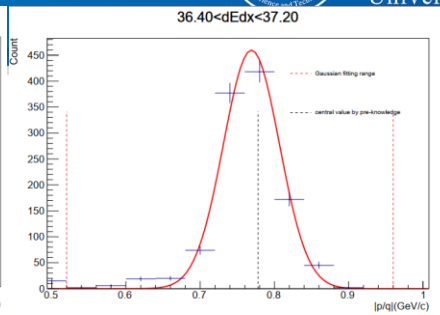


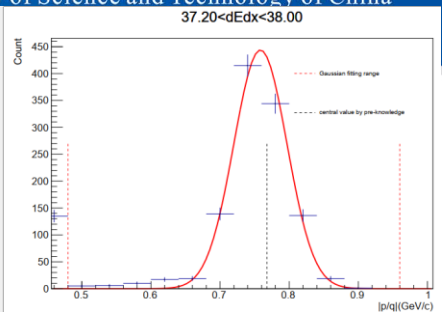
Only dEdx slices Are shown here

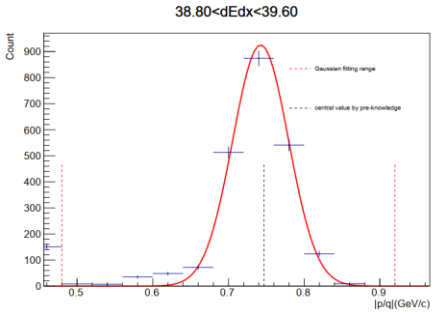
Pid

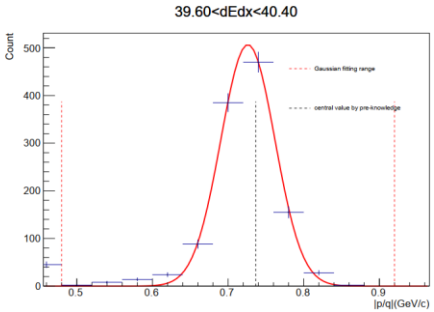

34.80<dEdx<35.60
Count
|p/q|(GeV/c)
Gaussian fitting range
central value by pre-knowledge

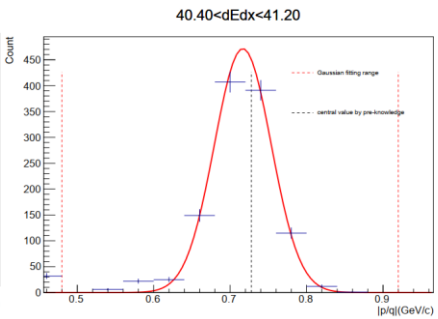

35.60<dEdx<36.40
Count
|p/q|(GeV/c)
Gaussian fitting range
central value by pre-knowledge

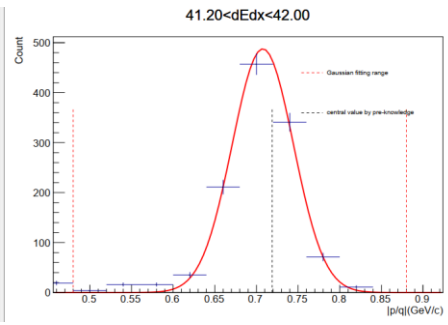

36.40<dEdx<37.20
Count
|p/q|(GeV/c)
Gaussian fitting range
central value by pre-knowledge

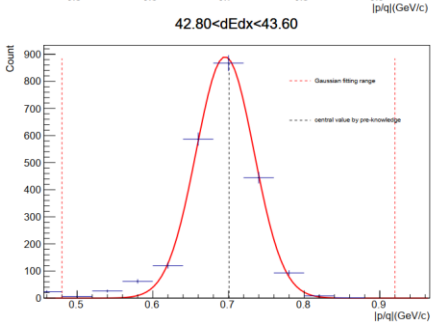

37.20<dEdx<38.00
Count
|p/q|(GeV/c)
Gaussian fitting range
central value by pre-knowledge

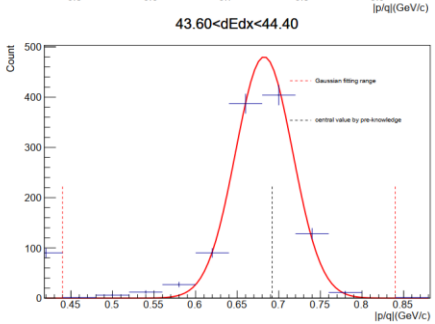

38.80<dEdx<39.60
Count
|p/q|(GeV/c)
Gaussian fitting range
central value by pre-knowledge

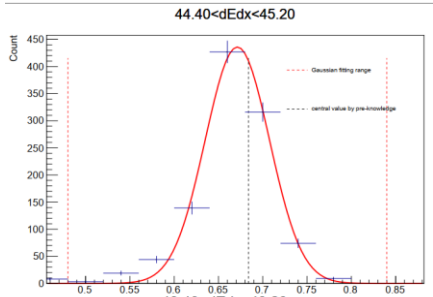

39.60<dEdx<40.40
Count
|p/q|(GeV/c)
Gaussian fitting range
central value by pre-knowledge

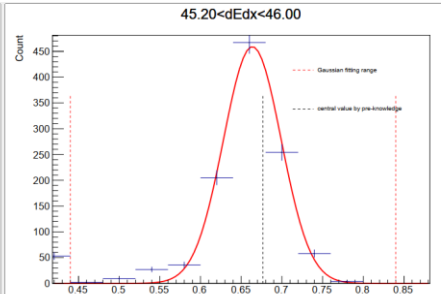

40.40<dEdx<41.20
Count
|p/q|(GeV/c)
Gaussian fitting range
central value by pre-knowledge

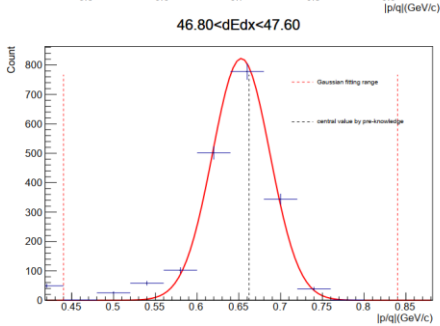

41.20<dEdx<42.00
Count
|p/q|(GeV/c)
Gaussian fitting range
central value by pre-knowledge

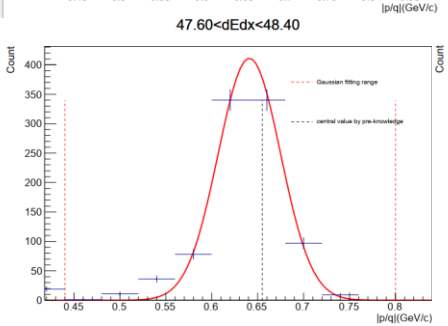

42.80<dEdx<43.60
Count
|p/q|(GeV/c)
Gaussian fitting range
central value by pre-knowledge

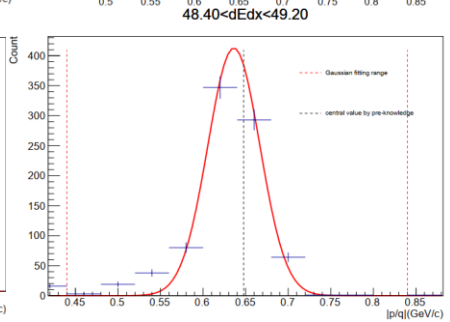

43.60<dEdx<44.40
Count
|p/q|(GeV/c)
Gaussian fitting range
central value by pre-knowledge

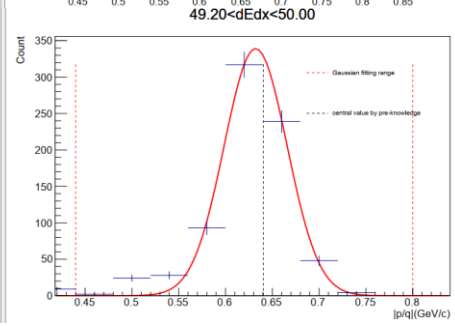

44.40<dEdx<45.20
Count
|p/q|(GeV/c)
Gaussian fitting range
central value by pre-knowledge


45.20<dEdx<46.00
Count
|p/q|(GeV/c)
Gaussian fitting range
central value by pre-knowledge

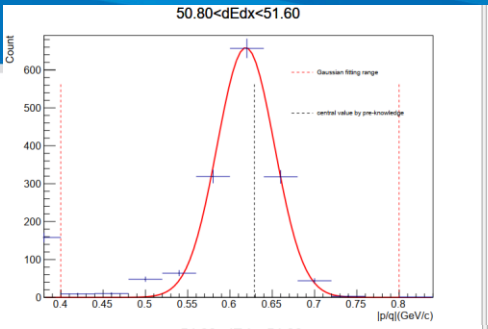

46.80<dEdx<47.60
Count
|p/q|(GeV/c)
Gaussian fitting range
central value by pre-knowledge

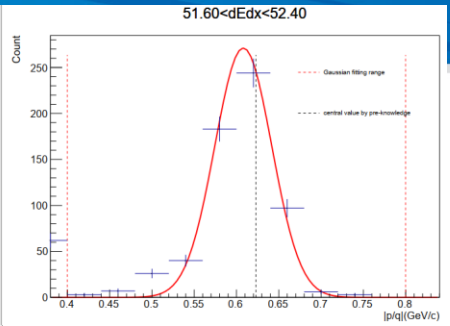

47.60<dEdx<48.40
Count
|p/q|(GeV/c)
Gaussian fitting range
central value by pre-knowledge

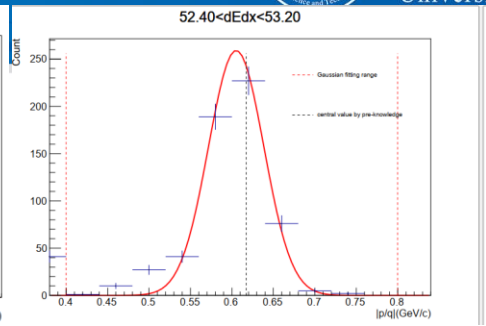

48.40<dEdx<49.20
Count
|p/q|(GeV/c)
Gaussian fitting range
central value by pre-knowledge

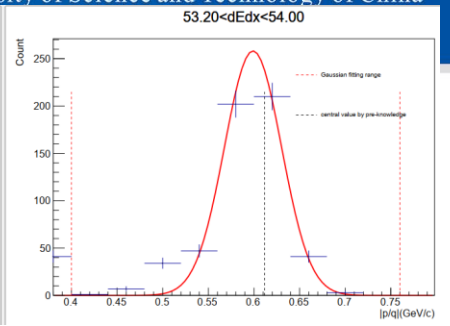

49.20<dEdx<50.00
Count
|p/q|(GeV/c)
Gaussian fitting range
central value by pre-knowledge

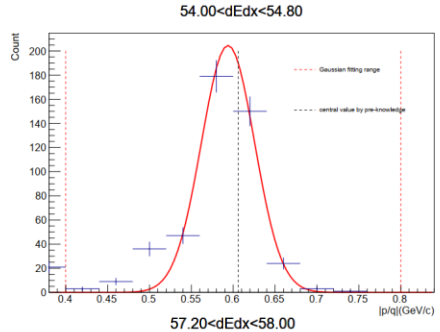
Pid

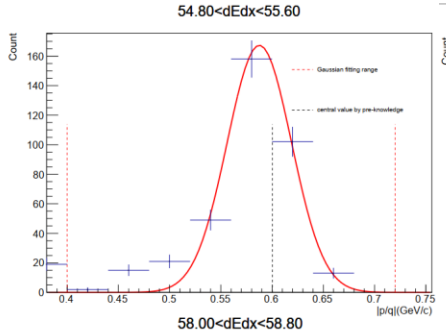

50.80<dEdx<51.60
Count
|p/q|(GeV/c)
Gaussian fitting range
central value by pre-knowledge

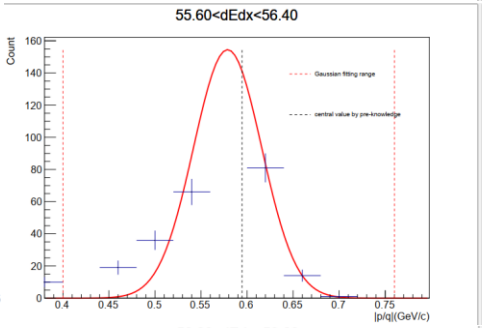

51.60<dEdx<52.40
Count
|p/q|(GeV/c)
Gaussian fitting range
central value by pre-knowledge

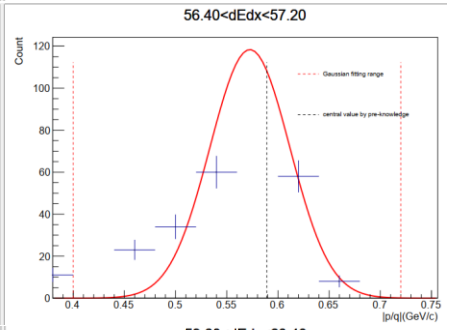

52.40<dEdx<53.20
Count
|p/q|(GeV/c)
Gaussian fitting range
central value by pre-knowledge

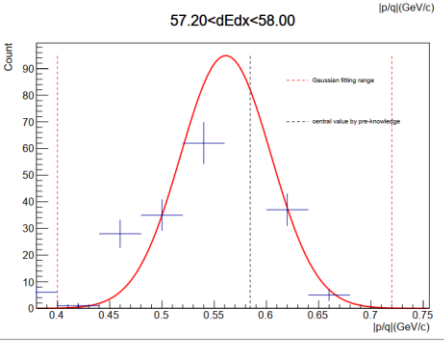

53.20<dEdx<54.00
Count
|p/q|(GeV/c)
Gaussian fitting range
central value by pre-knowledge

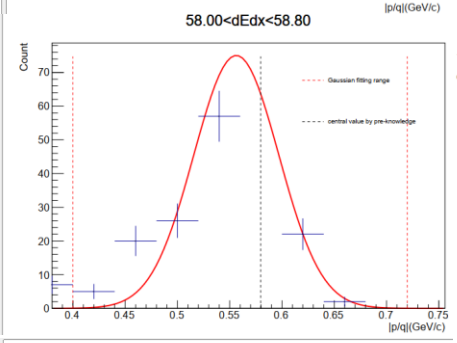

54.00<dEdx<54.80
Count
|p/q|(GeV/c)
Gaussian fitting range
central value by pre-knowledge

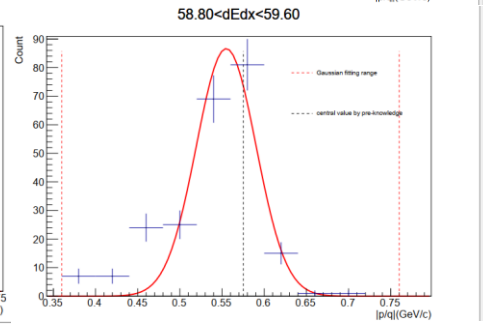

54.80<dEdx<55.60
Count
|p/q|(GeV/c)
Gaussian fitting range
central value by pre-knowledge

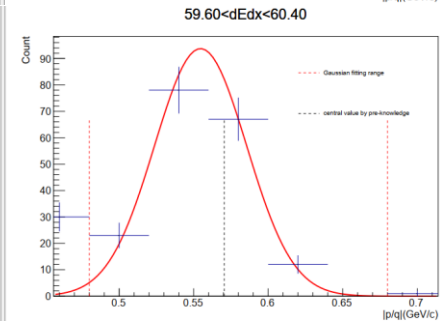

55.60<dEdx<56.40
Count
|p/q|(GeV/c)
Gaussian fitting range
central value by pre-knowledge

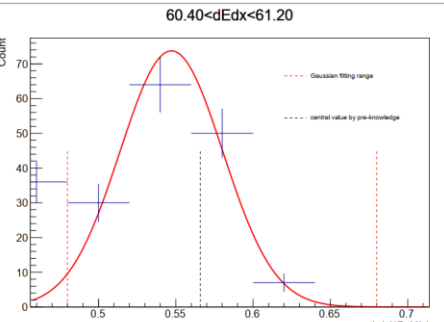

56.40<dEdx<57.20
Count
|p/q|(GeV/c)
Gaussian fitting range
central value by pre-knowledge

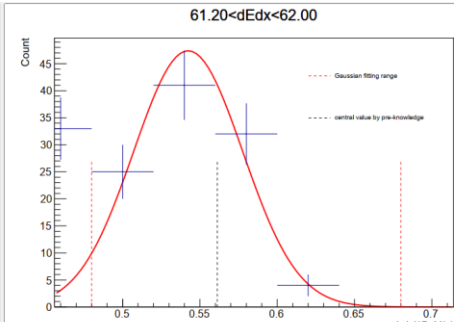

57.20<dEdx<58.00
Count
|p/q|(GeV/c)
Gaussian fitting range
central value by pre-knowledge

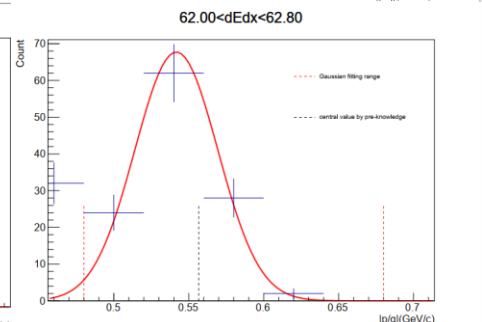

58.00<dEdx<58.80
Count
|p/q|(GeV/c)
Gaussian fitting range
central value by pre-knowledge

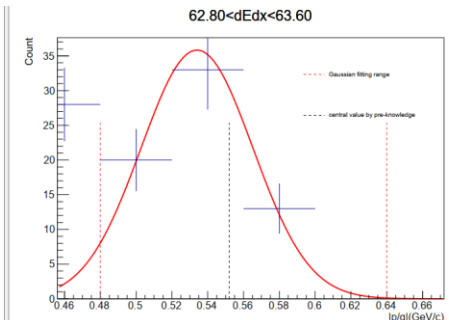

58.80<dEdx<59.60
Count
|p/q|(GeV/c)
Gaussian fitting range
central value by pre-knowledge


59.60<dEdx<60.40
Count
|p/q|(GeV/c)
Gaussian fitting range
central value by pre-knowledge


60.40<dEdx<61.20
Count
Gaussian fitting range
central value by pre-knowledge

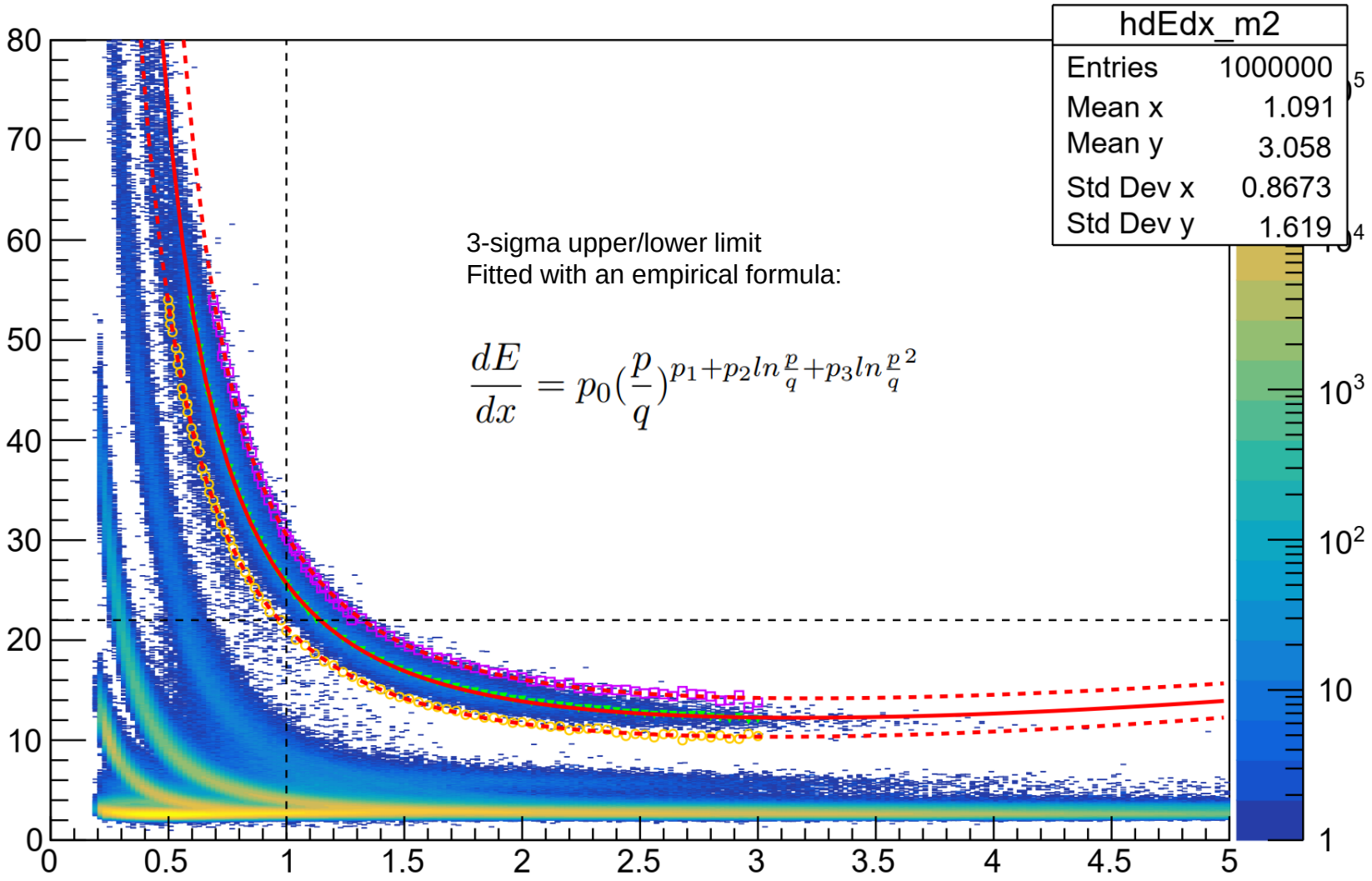

61.20<dEdx<62.00
Count
Gaussian fitting range
central value by pre-knowledge


62.00<dEdx<62.80
Count
Gaussian fitting range
central value by pre-knowledge


62.80<dEdx<63.60
Count
Gaussian fitting range
central value by pre-knowledge

Pid

hdEdx vs p/q, by 1.7<m2<2.3



Pid

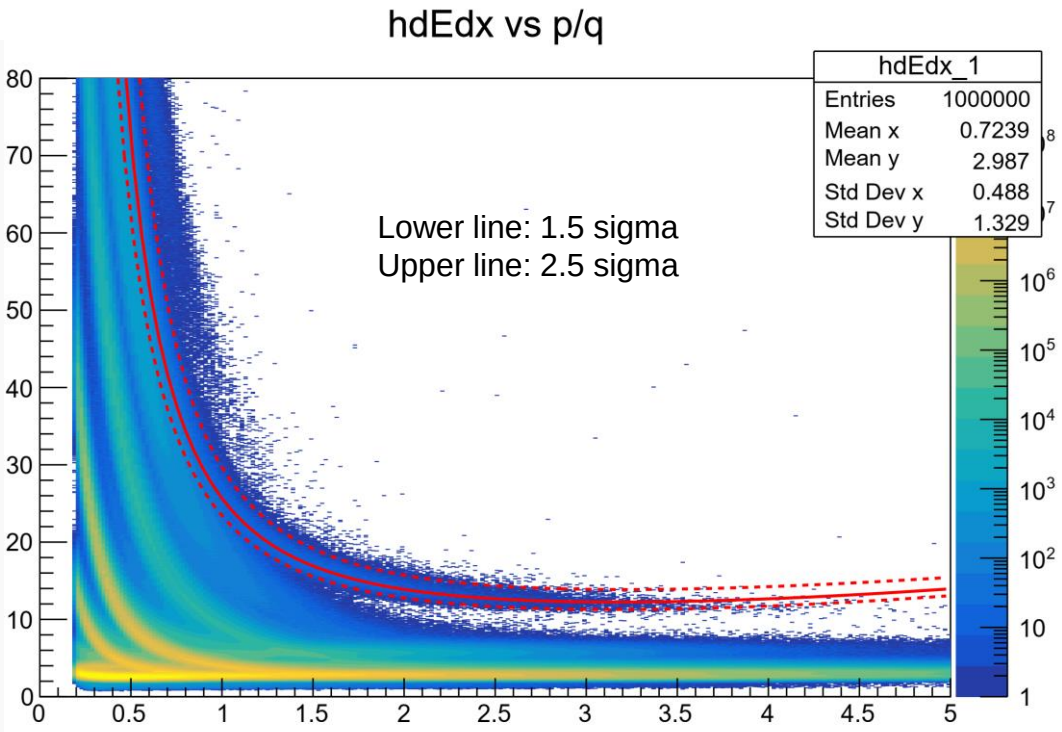
sigma = 1.
fl 24.1588, -1.18784, 0.400274, 0.0678065
fm 25.6723, -1.21547, 0.439636, 0.0499675
fh 27.23, -1.24832, 0.484846, 0.0306433

sigma = 1.5
fl 23.4162, -1.17593, 0.382587, 0.0763662
fm 25.6723, -1.21547, 0.439636, 0.0499675
fh 28.028, -1.2668, 0.509963, 0.0201415

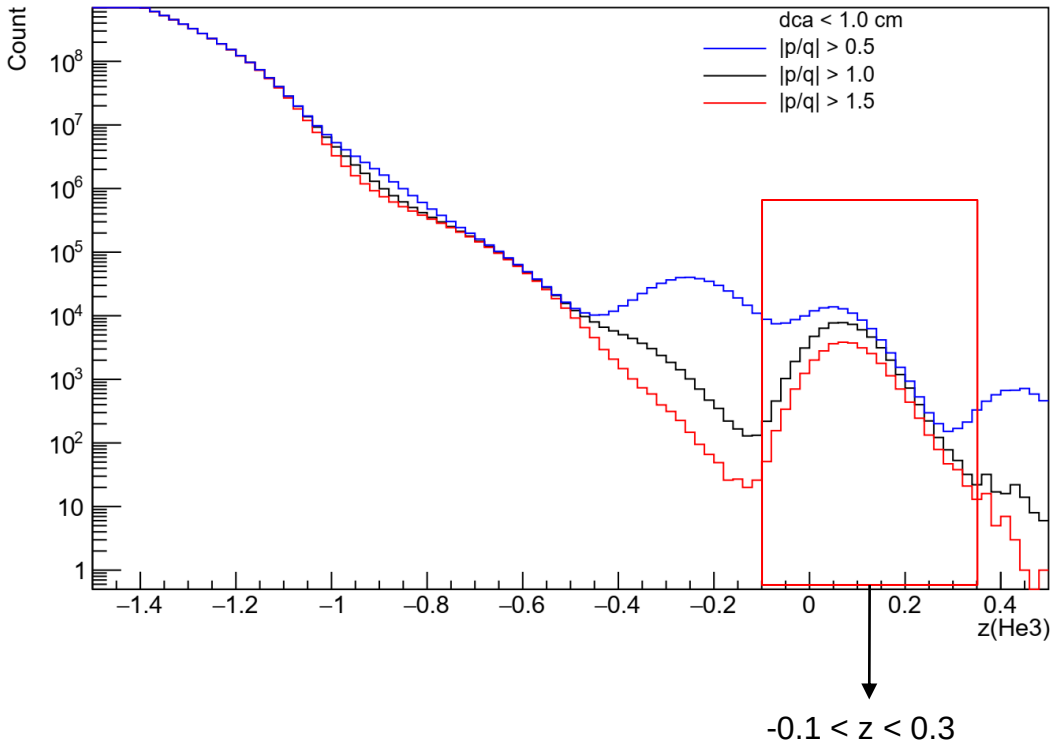
sigma = 2.0
fl 22.6818, -1.16524, 0.366166, 0.0847473
fm 25.6723, -1.21547, 0.439636, 0.0499675
fh 28.8402, -1.28672, 0.537006, 0.00886793

sigma = 2.5
fl 21.9547, -1.15577, 0.350995, 0.0929808
fm 25.6723, -1.21547, 0.439636, 0.0499675
fh 29.6677, -1.30816, 0.566214, -0.00336088

sigma = 3.0
fl 21.2389, -1.14855, 0.335103, 0.104148
fm 25.6723, -1.21547, 0.439636, 0.0499675
fh 30.5117, -1.3312, 0.597879, -0.0167671

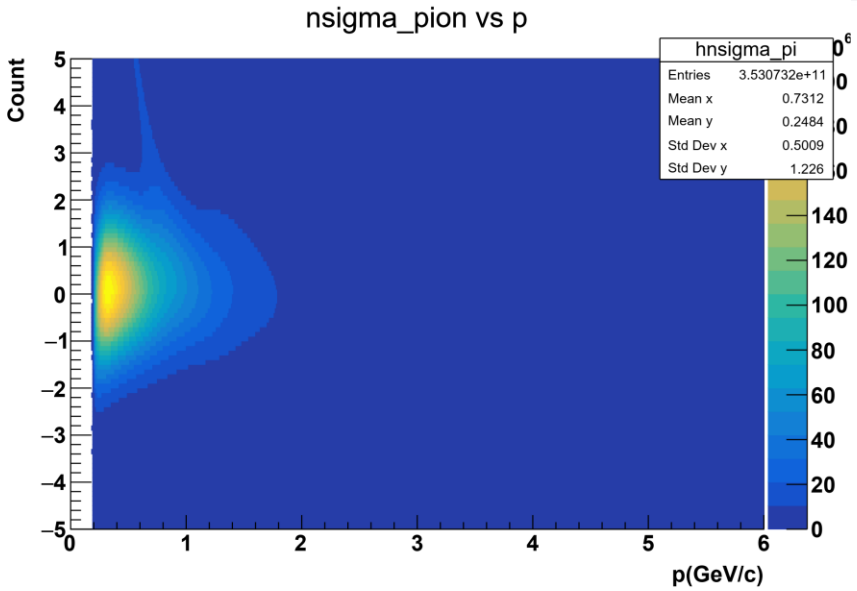


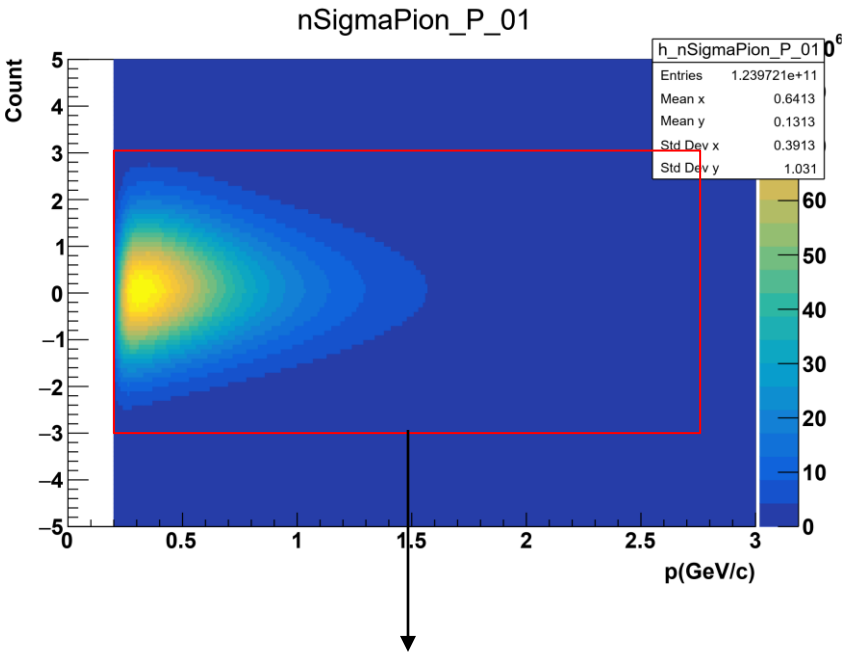
Pid



Z values are saved in mini-tree
If we need this cut, we can add it with a simple macro

Pid





|nsigma_pi| < 3

After event/track cut:

```
…
hnsigma_pi->Fill(mom.Mag(),trk->nSigmaPion());
…


if(tofmatch)
…
if(fabs(1.0/beta - sqrt(pow(M_pion,2)+pow(mom.Mag(),2))*1.0/mom.Mag()) < 0.01)
        {
          h_nSigmaPion_P_01->Fill(mom.Mag(),trk->nSigmaPion());
        }
…
```

Pid

$^{3}_{\Lambda}\mathrm{H} \rightarrow {}^{3}\mathrm{He} + \pi^{-}$ (2-body decay)

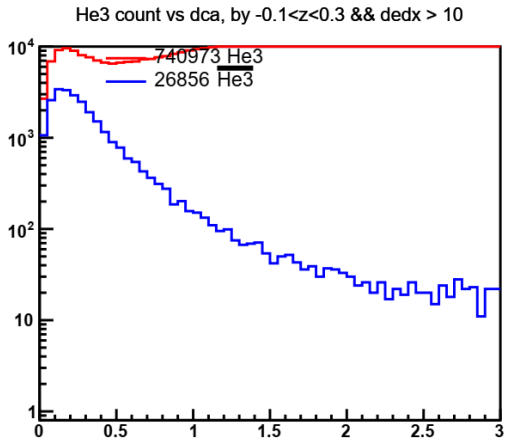
He3:

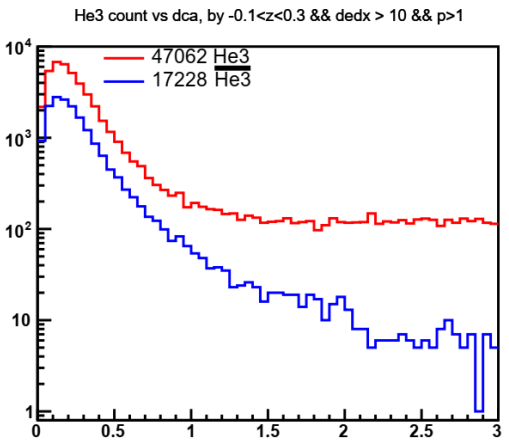
dEdx cut
Z cut (saved in mini-tree, easy to add if needed)

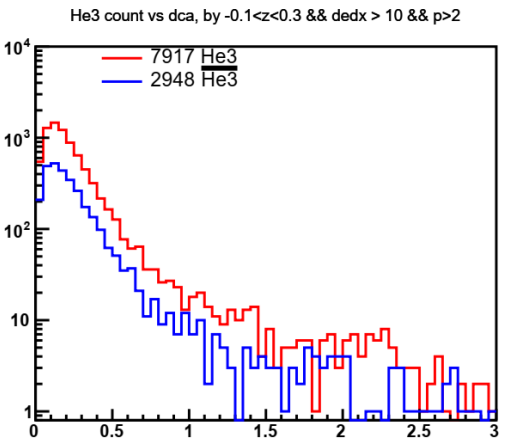
Pion:

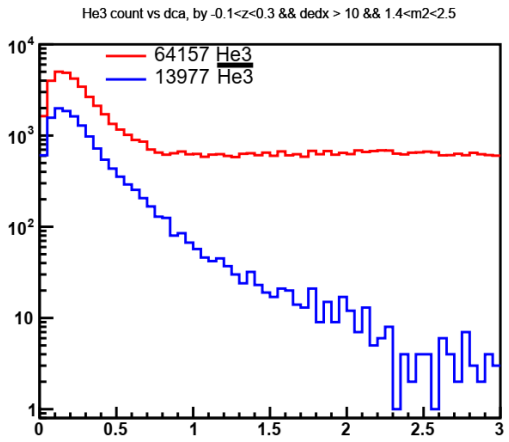
|nsigma_pi| < 3

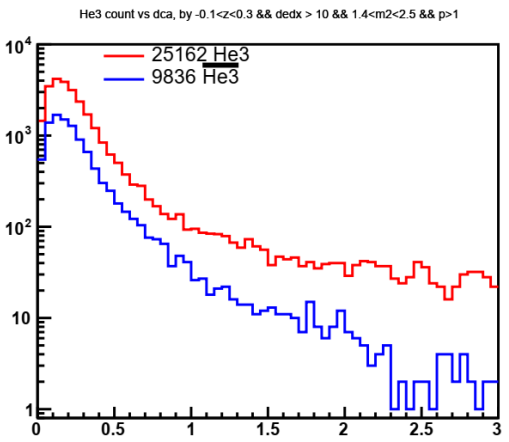
He3 distribution

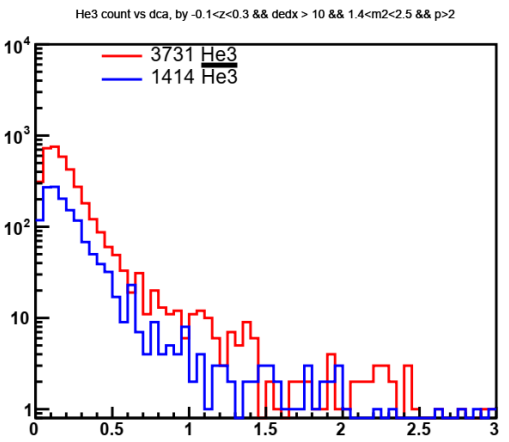




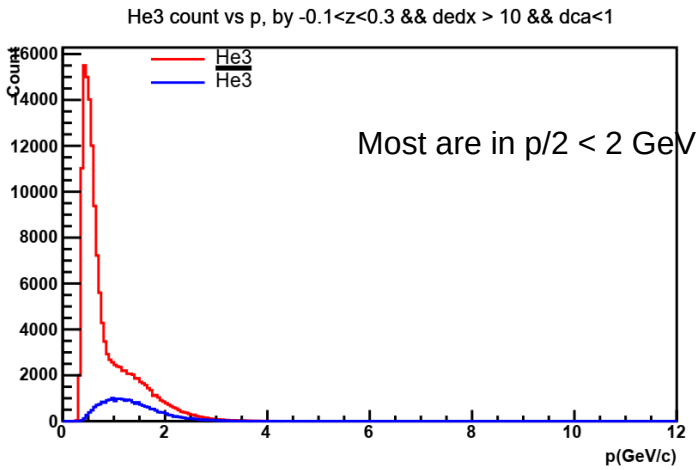


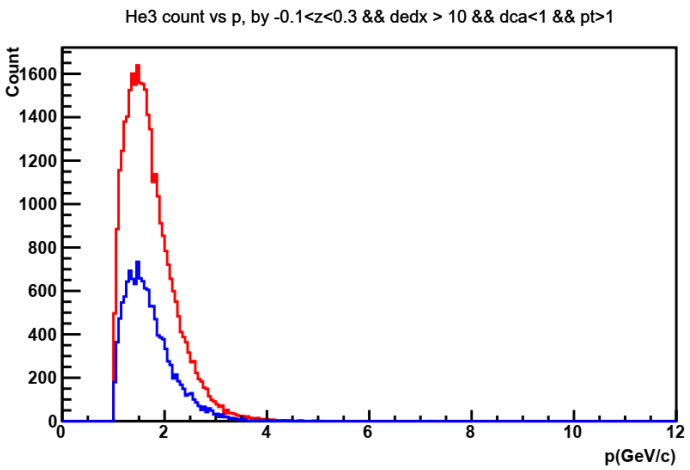


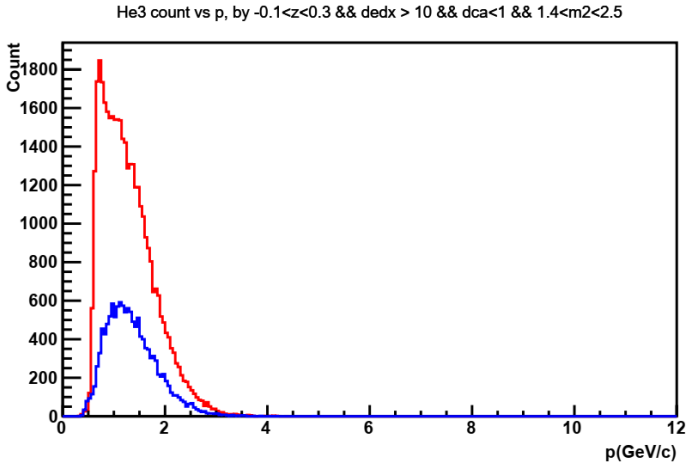


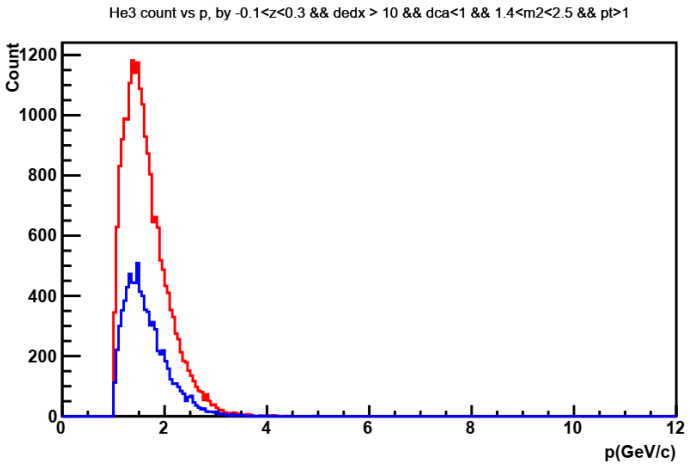


He3 distribution

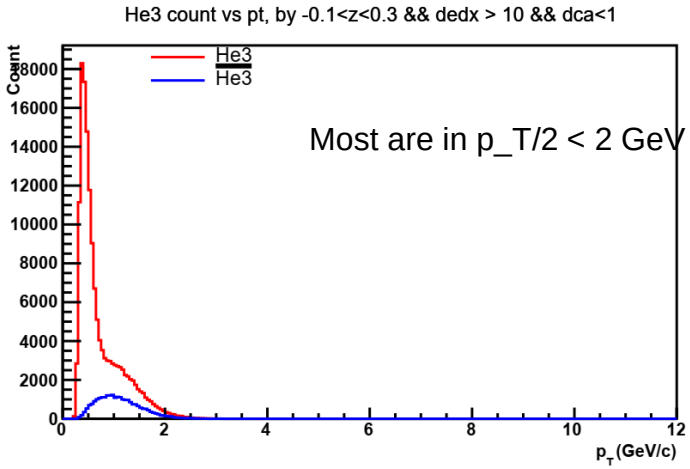


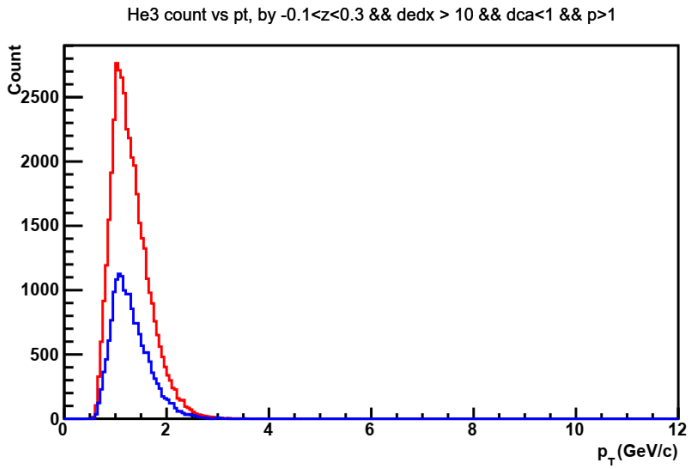


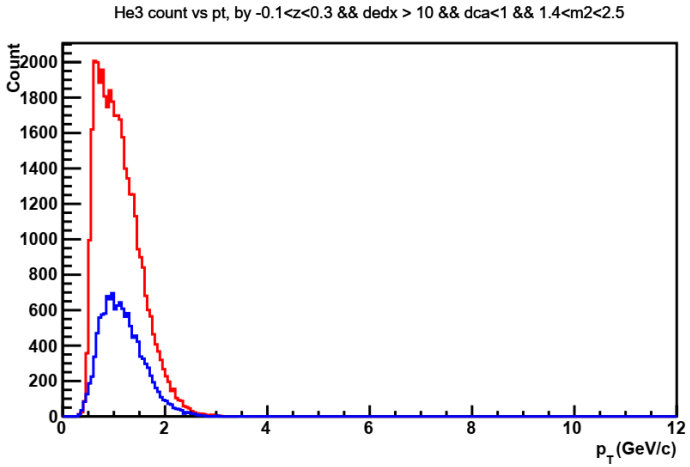


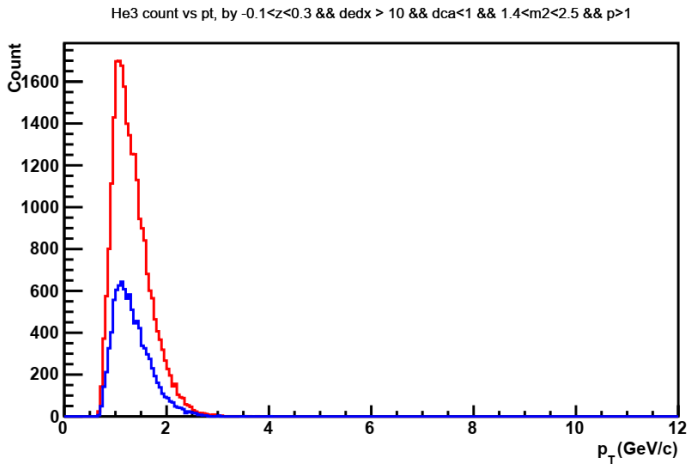


He3 distribution



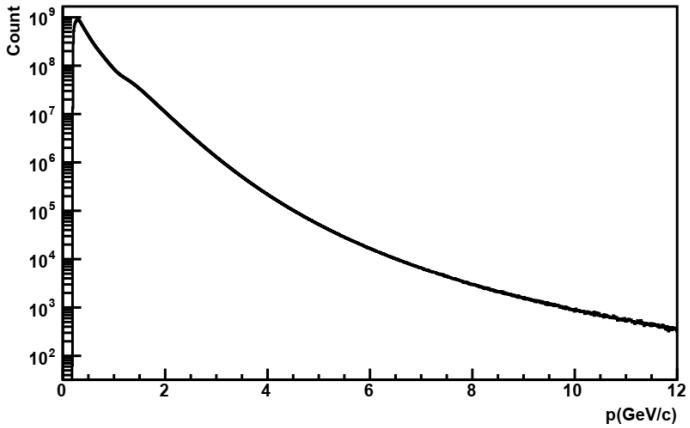




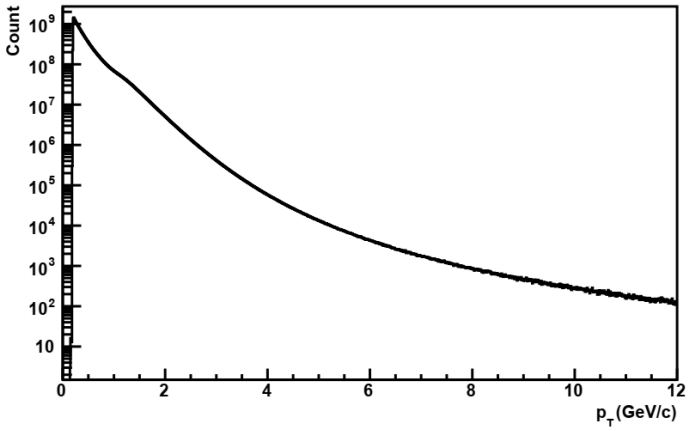


pion distribution

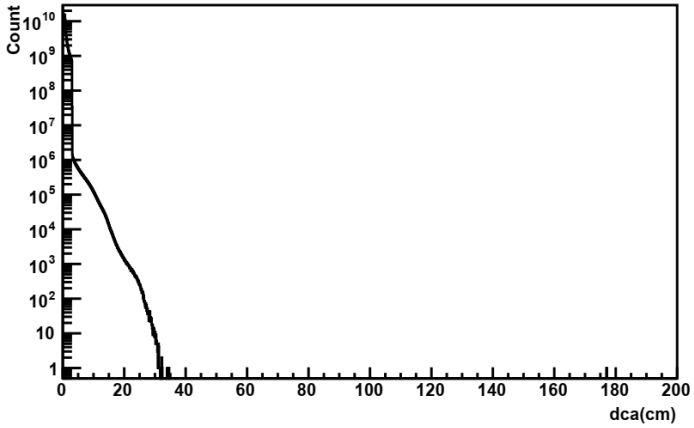
pion count vs p, by |nsigma_pi| < 3. && dca>1.



pion count vs pt, by |nsigma_pi| < 3. && dca>1.



pion Count vs dca, by |nsigma|<3



Kfparticle reconstruction

With old z-value pid

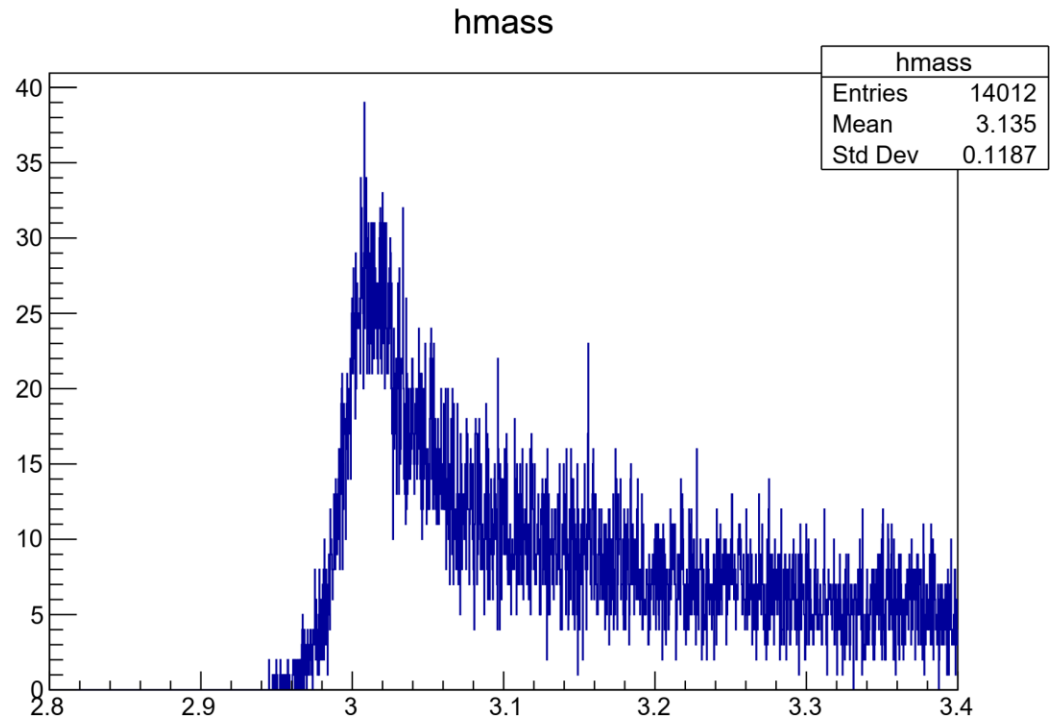
1.No momentum correction
2.Applied an old-fashioned dca cut on daughters when fiilling the mini-tree, rather than a chi2primary cut

Table 14: Topological cuts for ${}^{4}_{\Lambda}\mathrm{H}$ two-body decay reconstruction with KFParticle.

Cuts
$\lvert n\sigma_{\pi}\rvert < 3.0$
$2.5 < m^2(He4) < 4.5$
Chi2primary He4 > 3
Chi2primary pi > 25
H4L chi2topo < 2.5
H4L chi2ndf < 3
${}^{4}_{\Lambda}H$ decay length > 8.0 cm

Cuts	Value	
$\lvert Vz\rvert$	<6.0cm	
$\lvert Vz(TPC) - Vz(VPD)\rvert$	<3.0cm	
Sqrt(Vx^2+Vy^2)	<2.0cm	
Global Tracks	Yes	
HFT Tracks	Yes	
NHitsFit(TPC)	>16	
Pt(^{3}He/anti-^{3}He)	>1.0GeV	✓
Pt(π-/π+)	>0.16GeV	✓
fabs(Nsigma_pion)	<3.0	
fabs(Z_He3)	<0.3 && >-0.1	
Dca from pion to primary vertex	>0.01cm&&<3.0cm	✓
Dca from ^{3}He to primary vertex	>0.01cm&&<3.0cm	✓
Dca_pion > Dca_He3	Yes	✓
Dca from pion to He3	<0.02cm	
$\vec{R} \bullet \vec{P}$ of V0 candidate	>0.0	
Dca from V0 candidate to the Primary vertex	<0.017cm	
V0 decay length	>0.4cm	✓

Kfparticle reconstruction




```
for (int i = 0; i < N; i++) {
tr->GetEntry(i);
if (dca_he < dca_pi) continue;
if (ht_1 < 0.4) continue;
Float_t pt_he = sqrt(px_he * px_he + py_he * py_he);
Float_t pt_pi = sqrt(px_pi * px_pi + py_pi * py_pi);
if (pt_he < 1) continue;
if (pt_pi < 0.16)continue;
if (mass > 3.4 || mass < 2.8) continue;
hchi2primary_pi->Fill(chi2primary_pi);
hchi2primary_he->Fill(chi2primary_he);
hchi2ndf->Fill(chi2ndf);
hchi2topo->Fill(chi2topo);
if (chi2ndf > 3) continue;
if (chi2topo > 2.5) continue;
hmass->Fill(mass);
}
```

Position of the peak is slightly larger than m(3H_Lambda)~2.99, due to lack of momentum correction

Kfparticle reconstruction