$\boldsymbol{\theta}$ Correction and PID performance of ECal in the Simulation

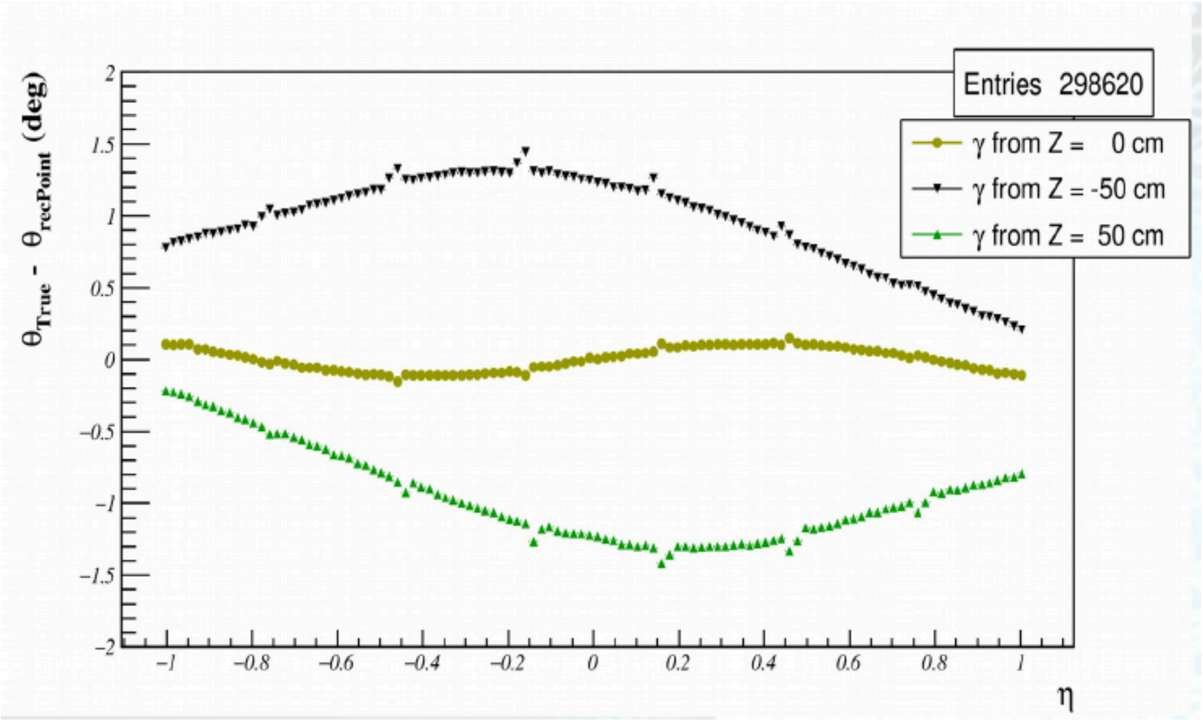
- Reconstruction of $\boldsymbol{\pi^0}$ with the Correction of $\boldsymbol{\theta}$
- Particle Identification for the Barrel Ecal
- Particle Identification for the End Cap ECal

Yan Huang, Boyana Dabrowska, Igor Tyapkin and Yi Wang

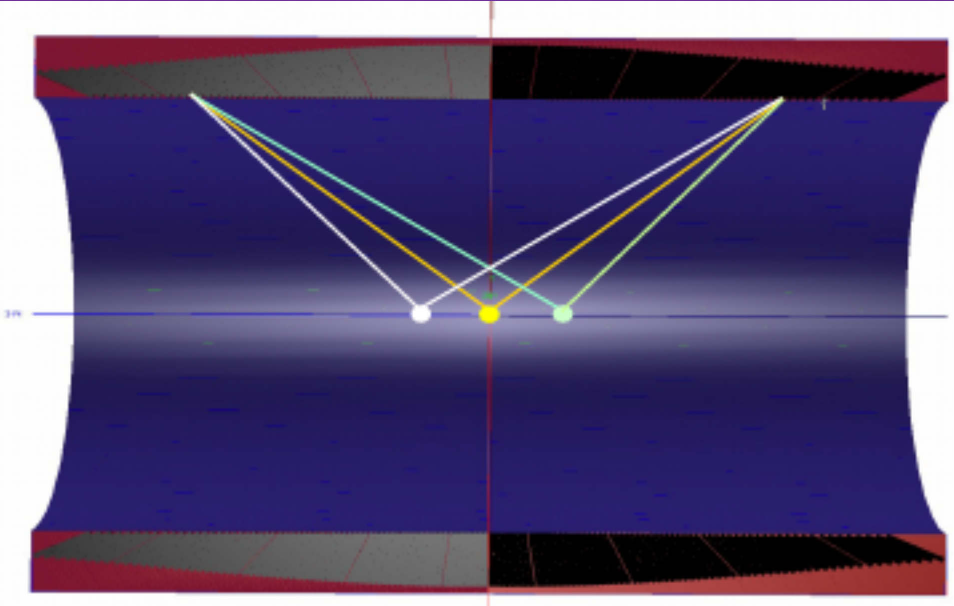
Correction of θ (from Boyana)

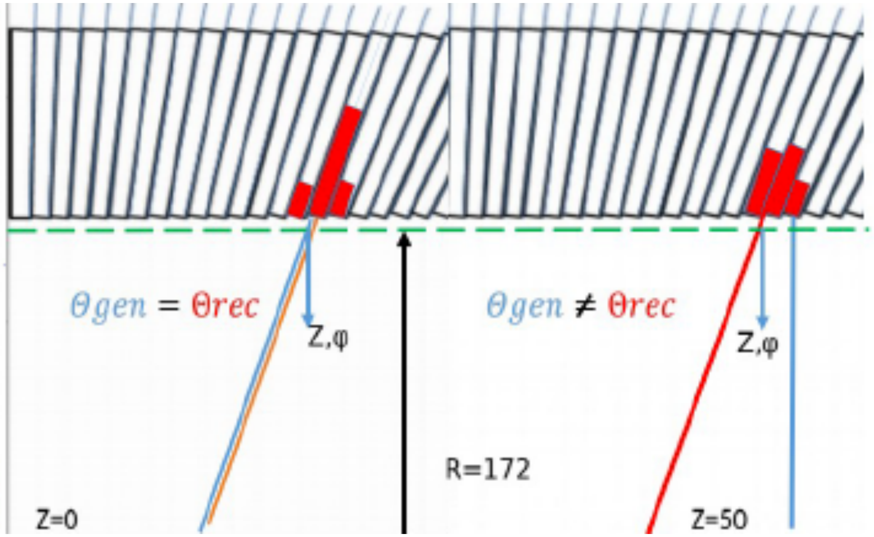
- **Box Gen**
- **Single γ**
- **Energy 500 Mev**

θ reconstructed has a bias with the true θ when the generating z position is shifted from $z = 0cm$.



Bias of the true θ and θ reconstructed by ECal as a function of pseudorapidity.





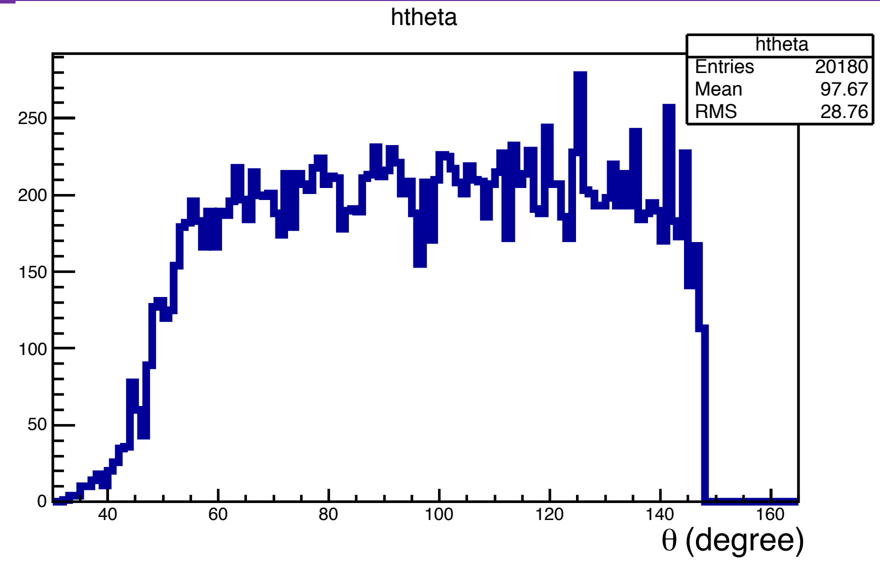
Reconstruction of π^0 with θ correction for $Z = 50cm$

- **Box Gen**
- **Single π^0**
- **EvtNum 1000**
- **Energy 1Gev**
- $48° < \theta < 148°$ $\varphi = 89.2°$

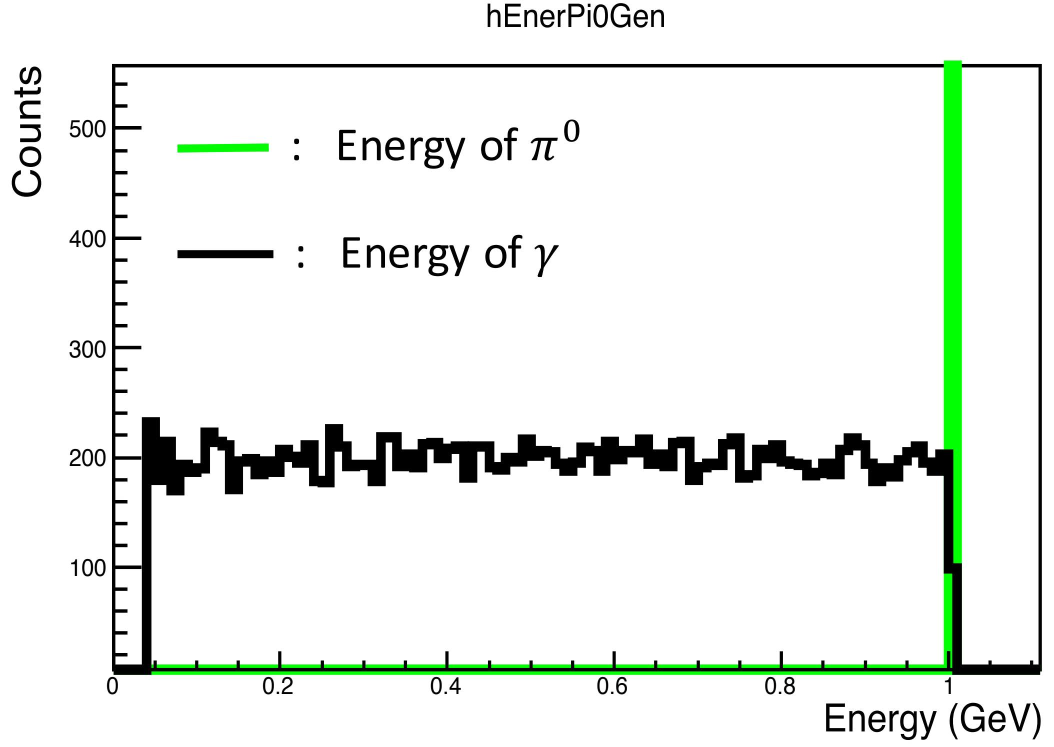
Ecal Reconstruction:

MpdEmcClusterFinderAZ.h

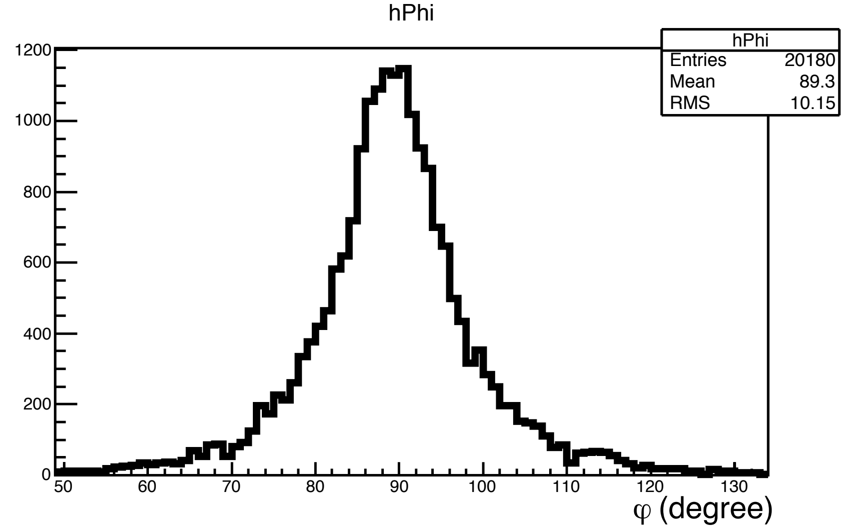
Energy Cut: 40MeV



Distribution of θ reconstructed by Ecal.



Energy of π^0 generated (in green) and γ decayed from π^0(in black).

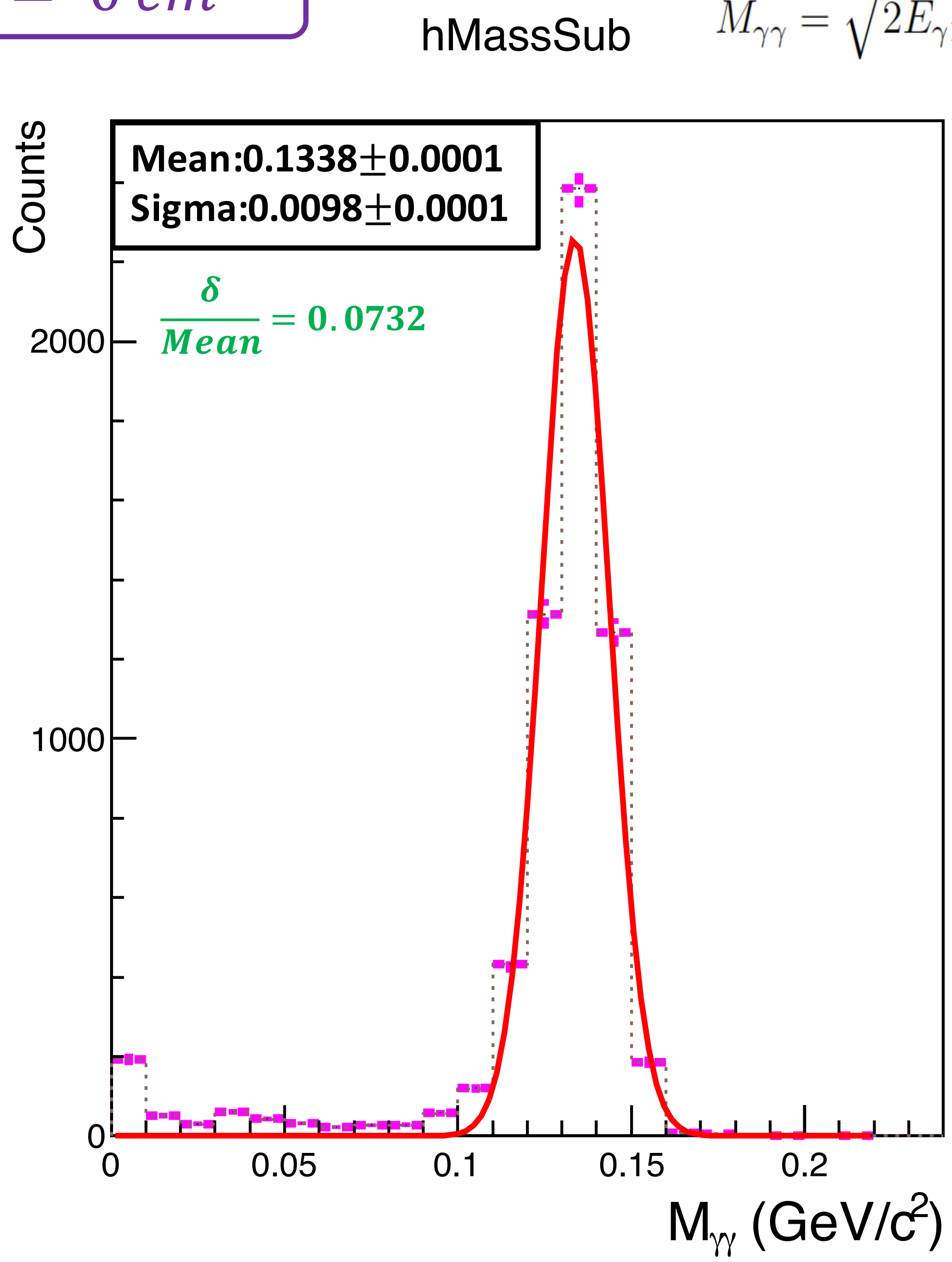


Distribution of φ reconstructed by Ecal.

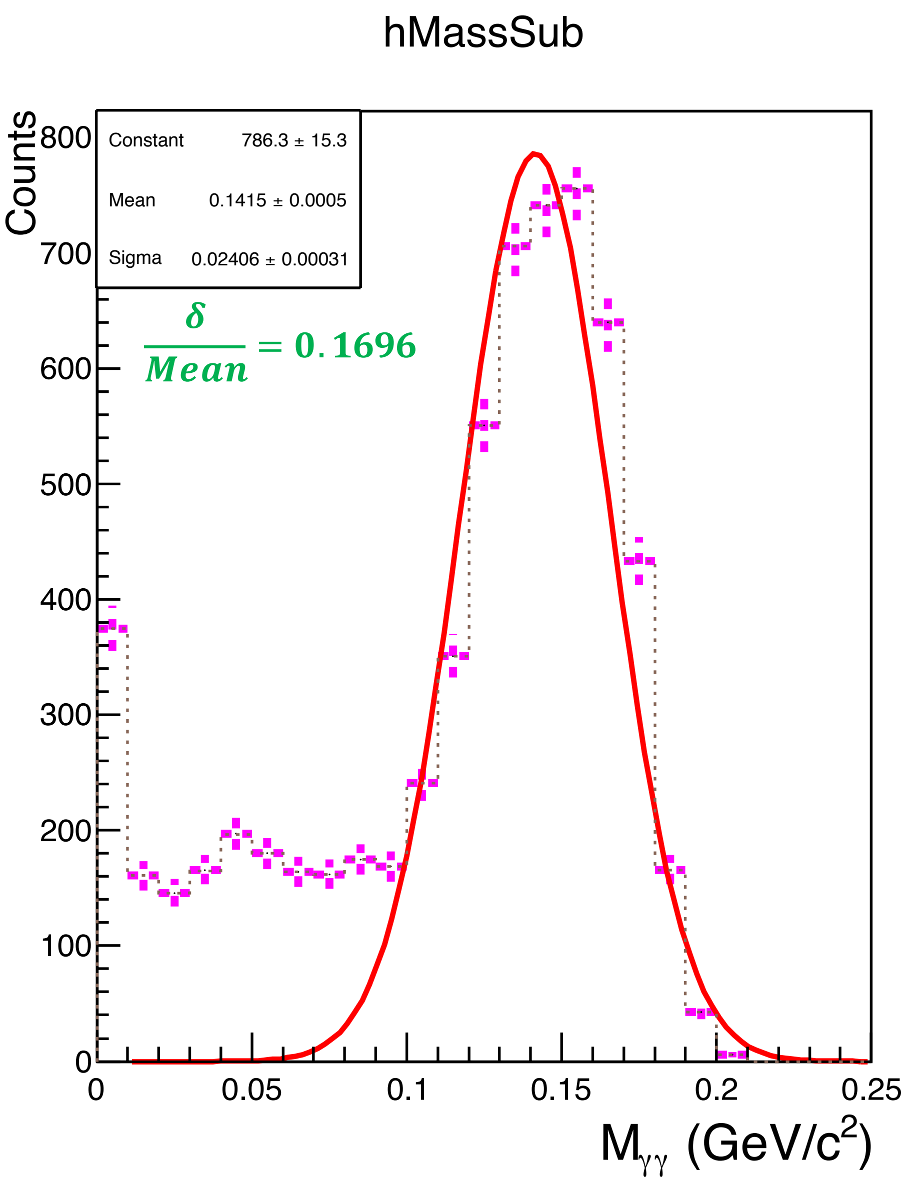
$Z = 0\ cm$

$$M_{\gamma\gamma} = \sqrt{2E_{\gamma 1}E_{\gamma 2}(1-\cos(\theta_{12}))}$$

$Z = 50\ cm$



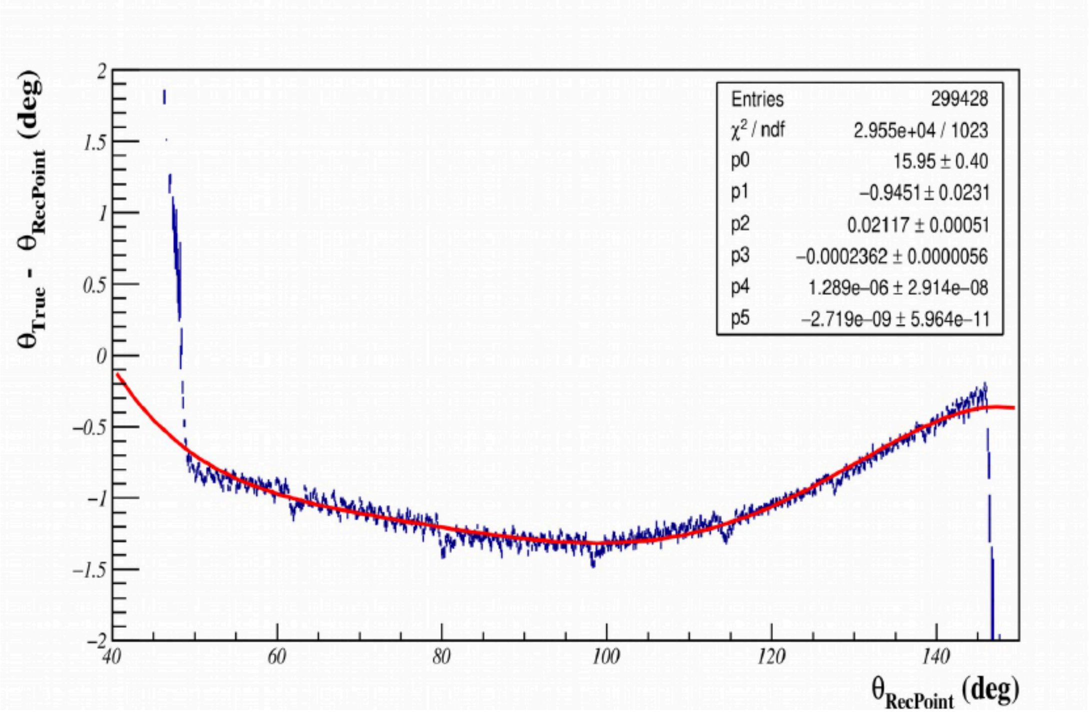
Reconstructed invariant mass of π^0 with Z = 0 cm.



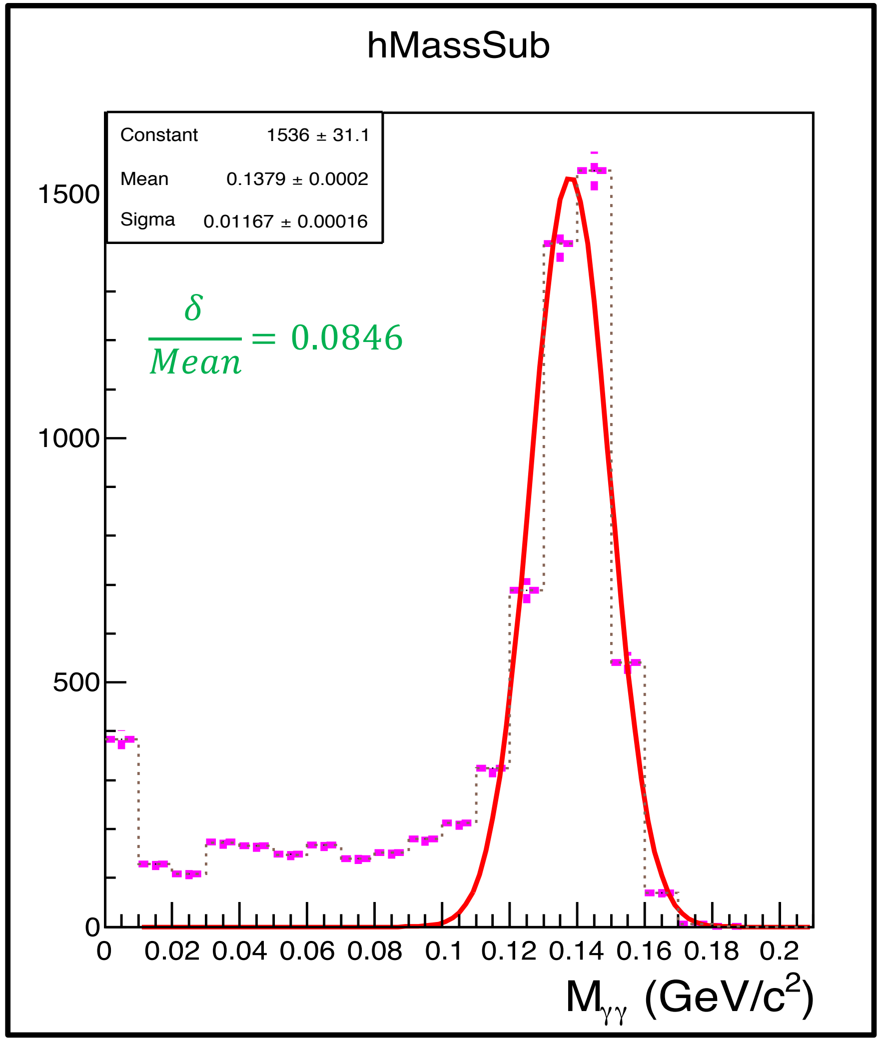
Reconstructed invariant mass of π^0 with Z = 50 cm.

$Z = 50\ cm$

$\theta_{True} = \theta_{recz} + \text{function}(\theta_{recz})$



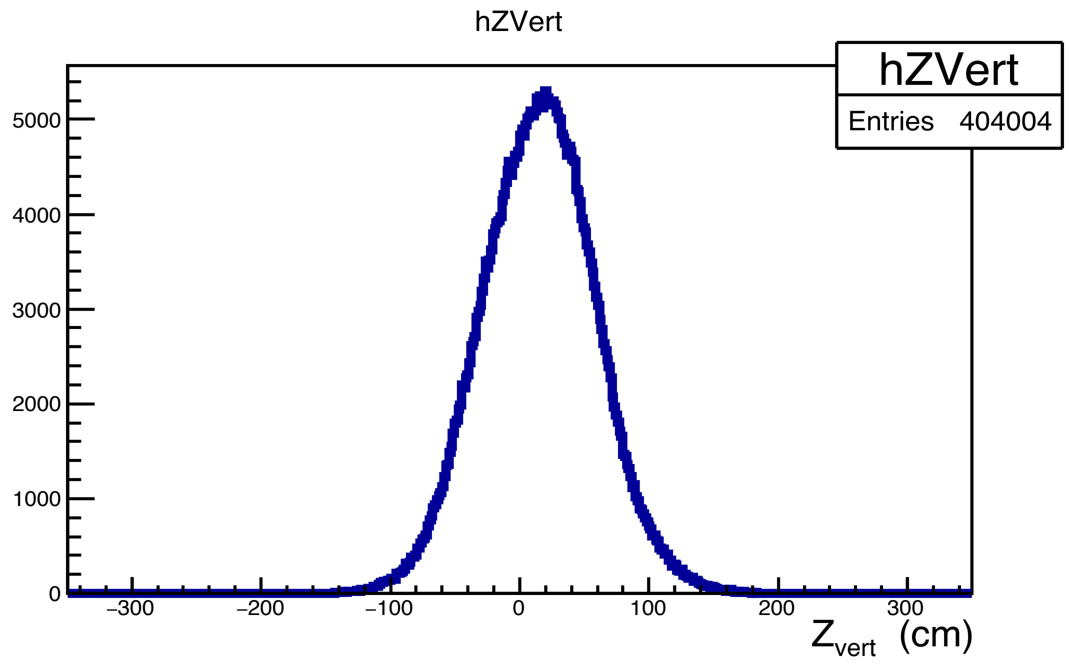
Fit function of θ for $z = 50cm$(from Boyana).



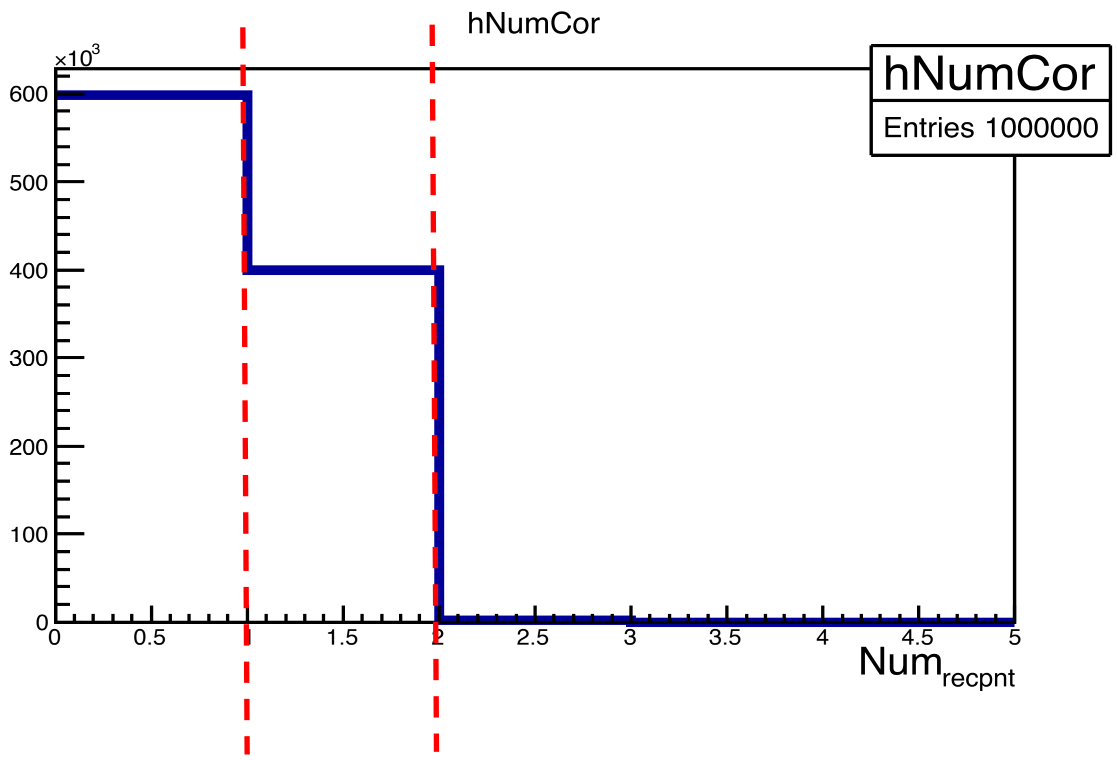
Reconstructed invariant mass of π^0 with θ correction from fit function.

θ correction for wide Z and energy distribution events

- **Box Gen Single γ**
- **EvtNum 1000k**
- **Energy: 0-2GeV**
- $0° < \theta < 180°$ $0° < \varphi < 360°$
- $Z = 20cm$ $D_Z = 50cm$



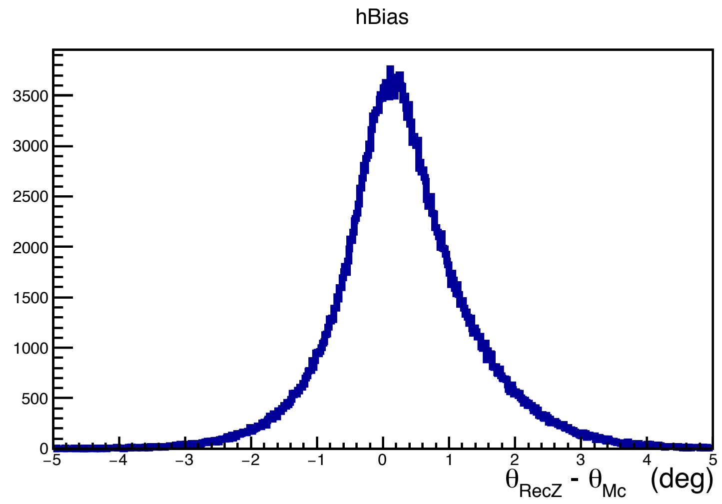
Distribution of the Z position generated



Number of hits reconstructed per event

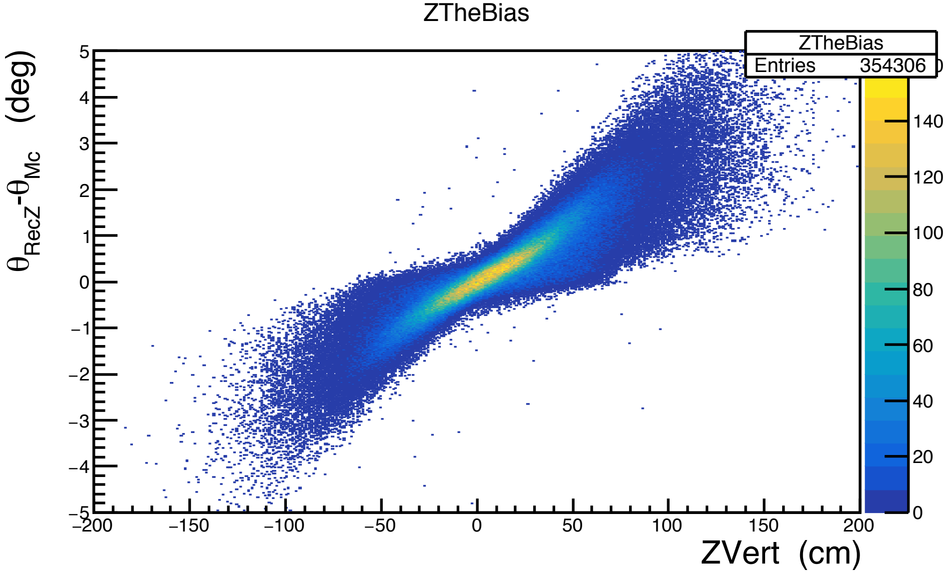
Theta Bias

$$\Delta\theta = \theta_{recZ} - \theta_{Mc}$$

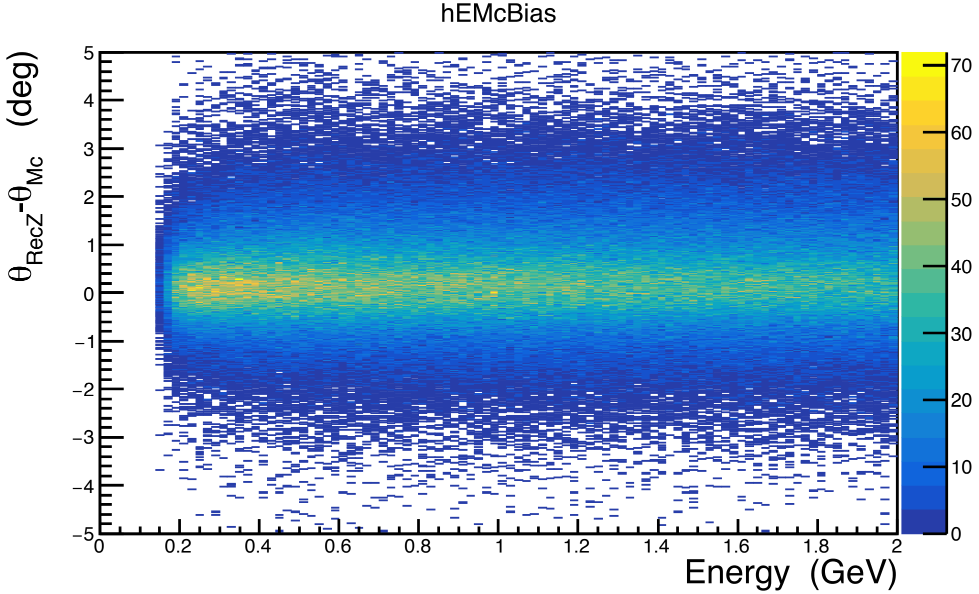


The distribution of $\Delta\theta$

θ_{recZ} is the θ angle of RecPnt with (0,0,Z) where γ is generated, not with the (0,0,0) original point.



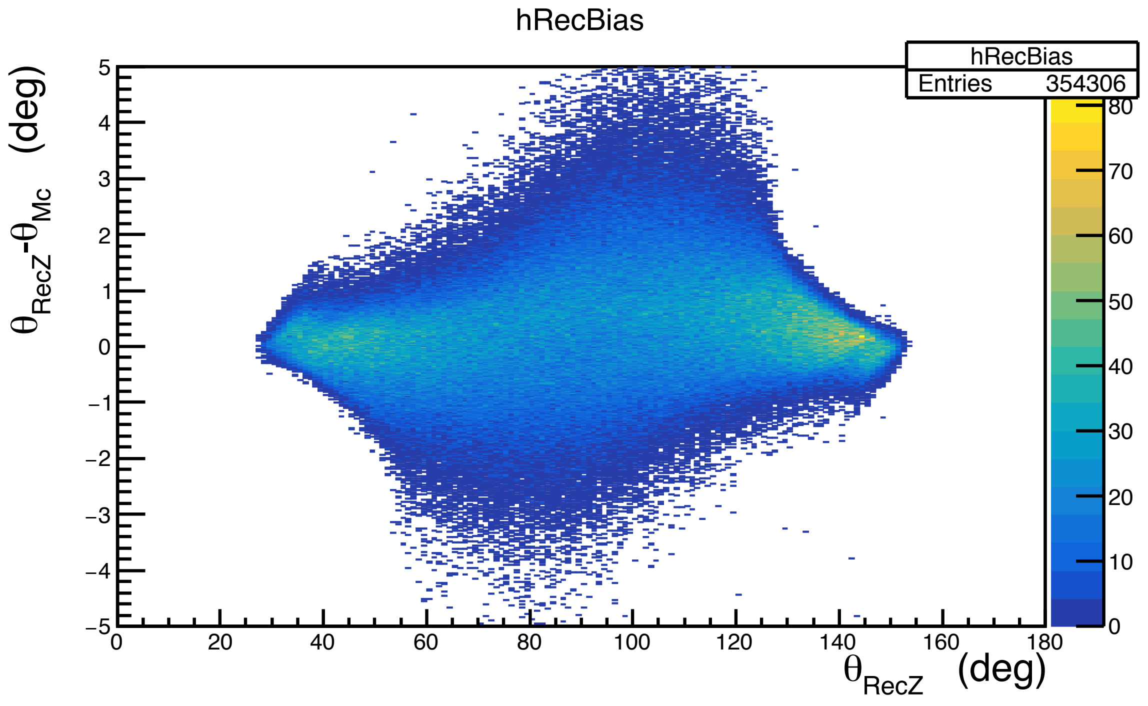
The distribution of $\Delta\theta$ with Z position where γ is generated.



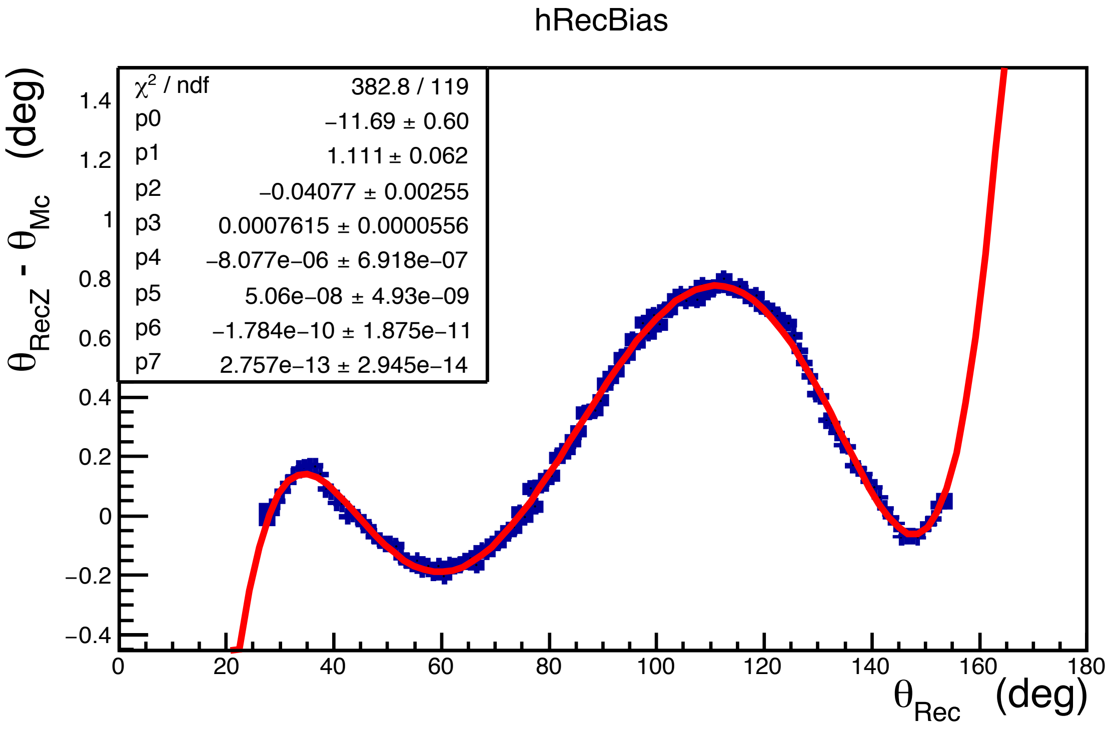
The distribution of $\Delta\theta$ with the energy of γ.

Correction of $\boldsymbol{\theta}$ reconstructed by ECal

$$N_{rec} = 1$$
$$E_{rec} > 50MeV$$
$$|E_{rec} - E_{MC}| < 200MeV$$



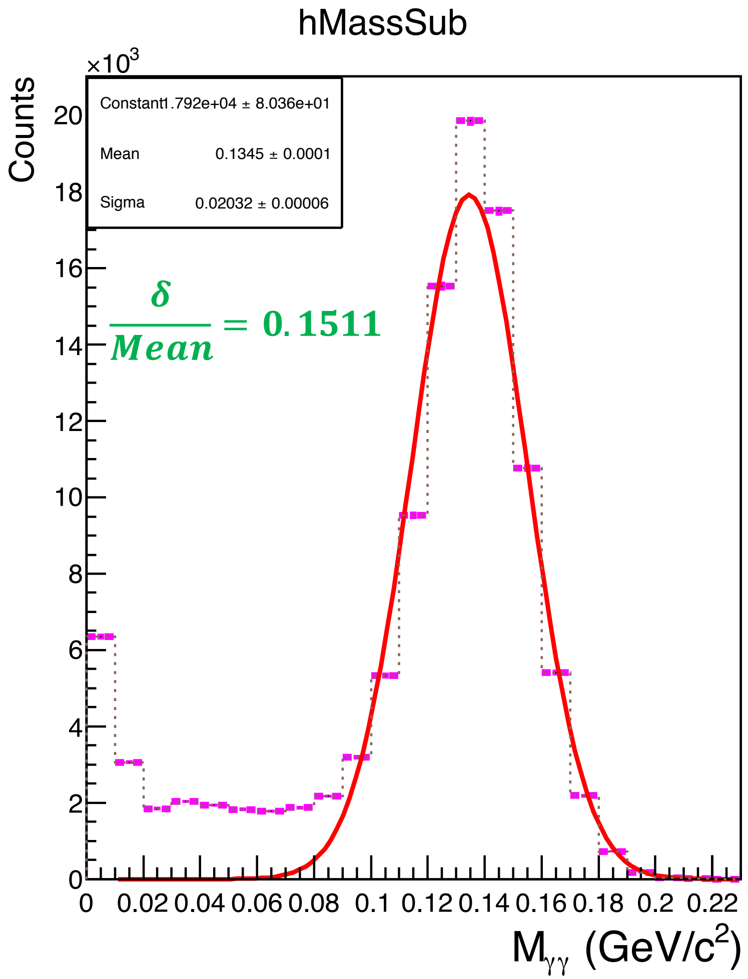
The distribution of $\Delta\theta$ with the reconstruted θ from where γ is generated.



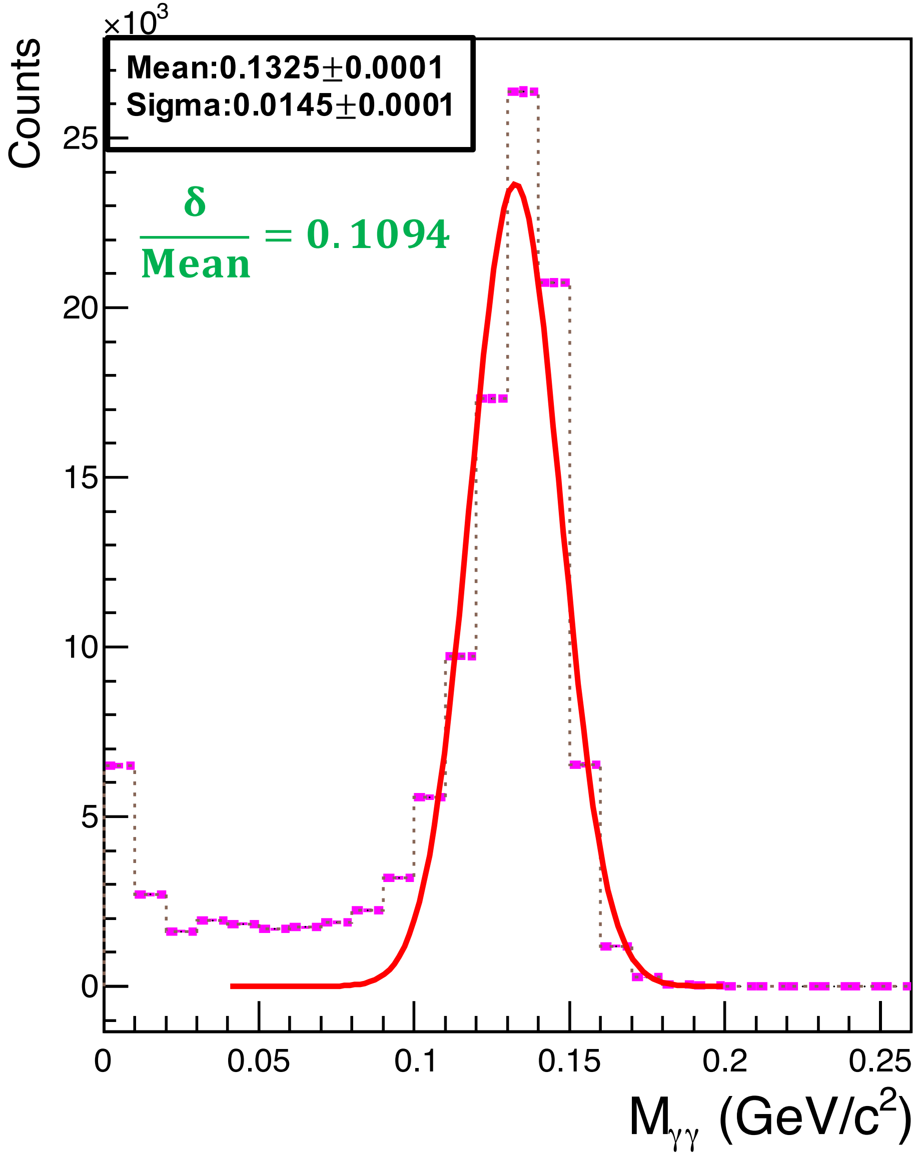
The profile along X axis of $\Delta\theta$ with $\boldsymbol{\theta_{recz}}$.

- Box Gen Single π^0
- EvtNum 350k Energy: 0-2GeV
- $0° < \theta < 180°$ $0° < \varphi < 360°$
- $Z = 20cm$ $D_Z = 50cm$

Reconstruction of π^0 with corrected θ



Reconstructed invariant mass of π^0 without any correction of θ.



Reconstructed invariant mass of π^0 with θ correction from fit function.

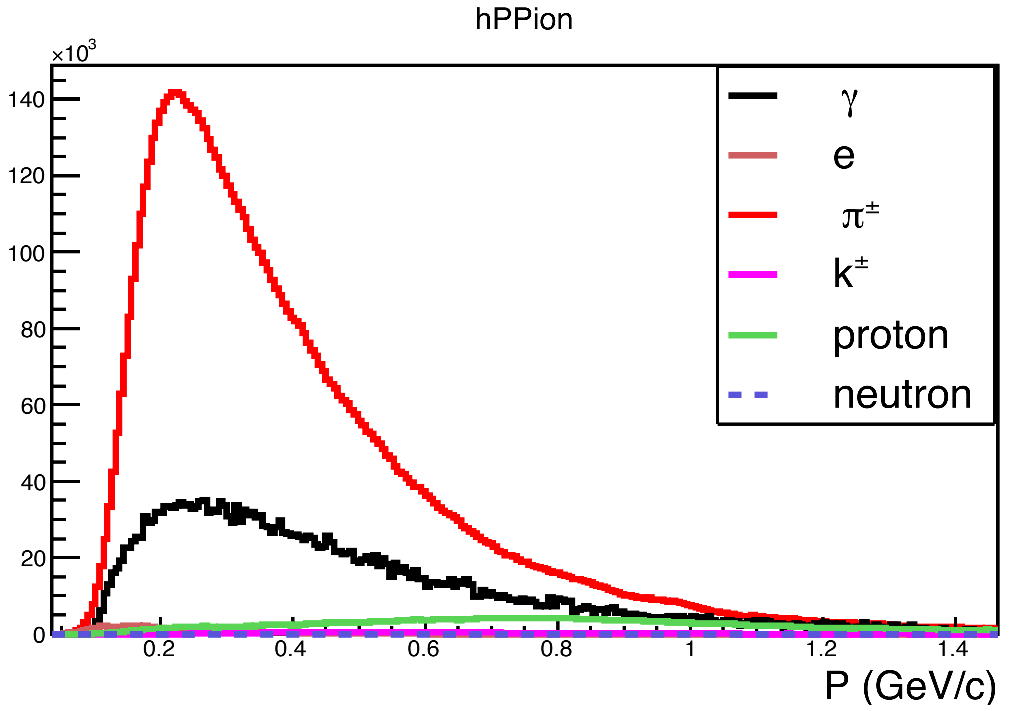
Time information of the Barrel Ecal

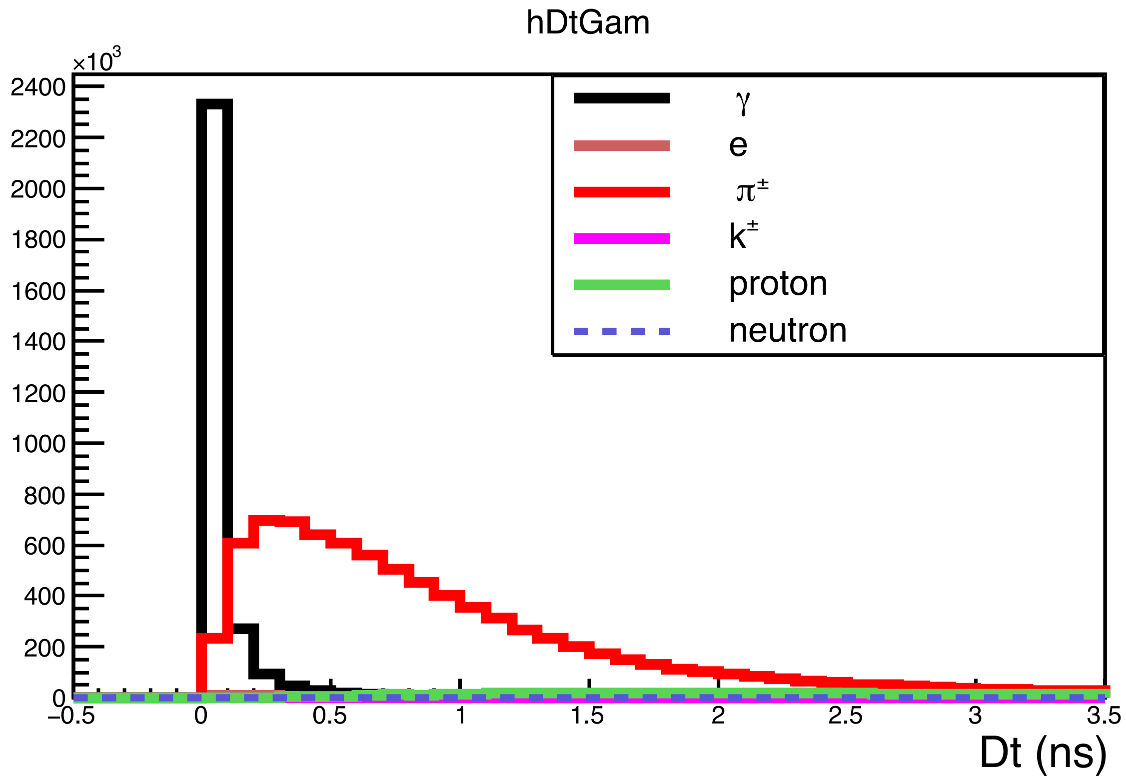
- **Urqmd Gen**
- **EvtNum 1000**
- $Au + Au \quad \sqrt{s} = 11GeV$ **central**
- **Time cut: 15ns; Energy cut: 100MeV**

$Dt = t_{point} - \frac{L}{c}$

L: distance from the point to the vertex point generated

c: velocity of light

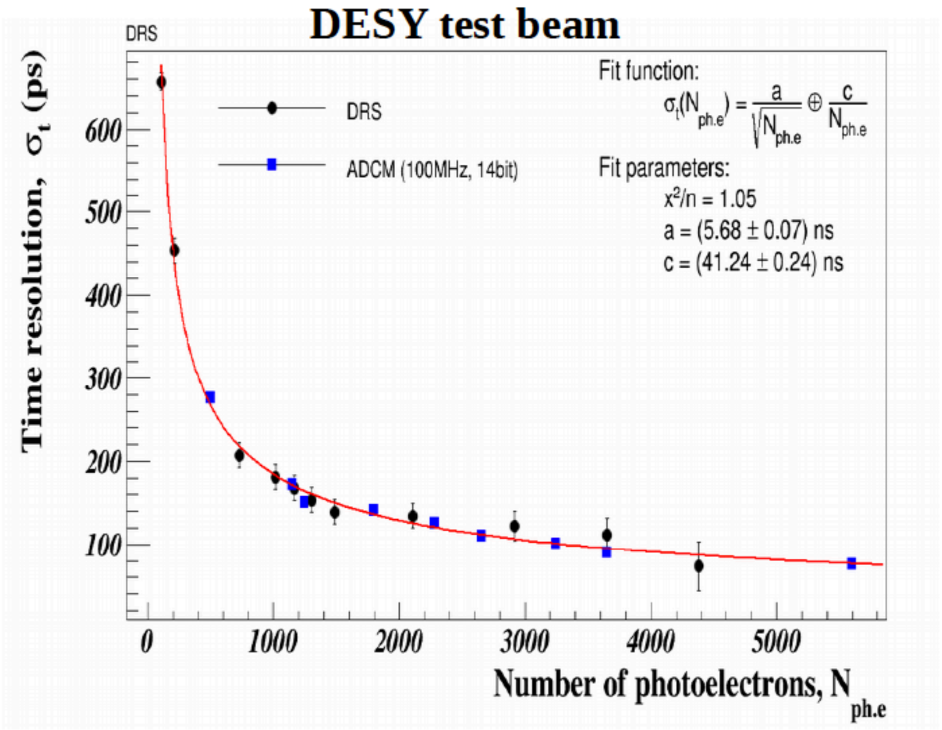


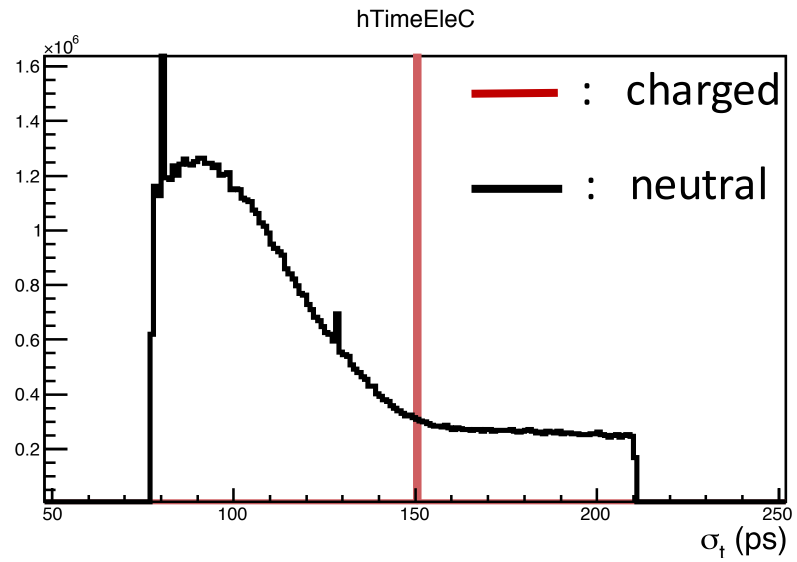


Distribution of momentum for different kind of particles.

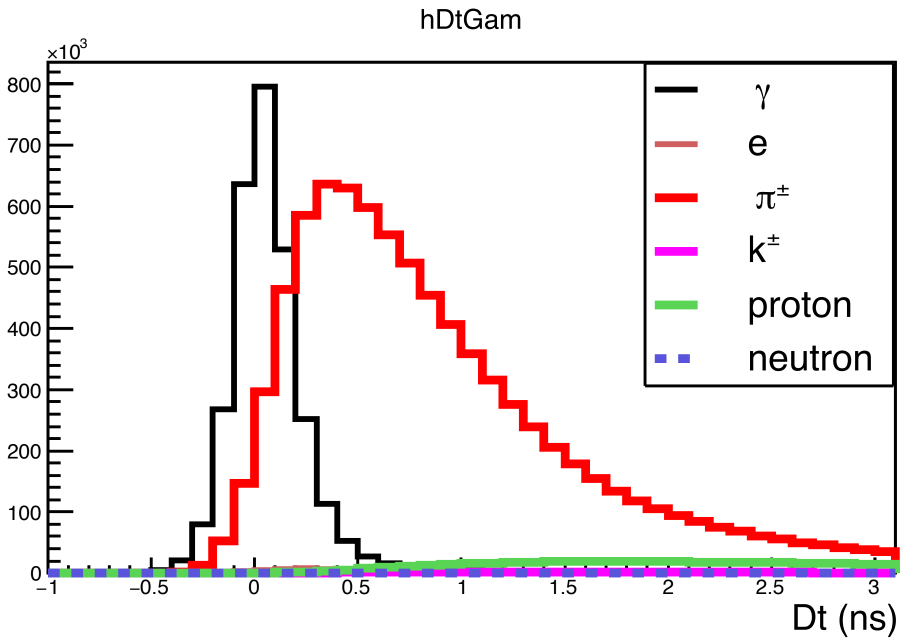
Distribution of Dt for different kind of particles.

Electronic Time Resolution for the Barrel ECal





Distribution of the time resolution



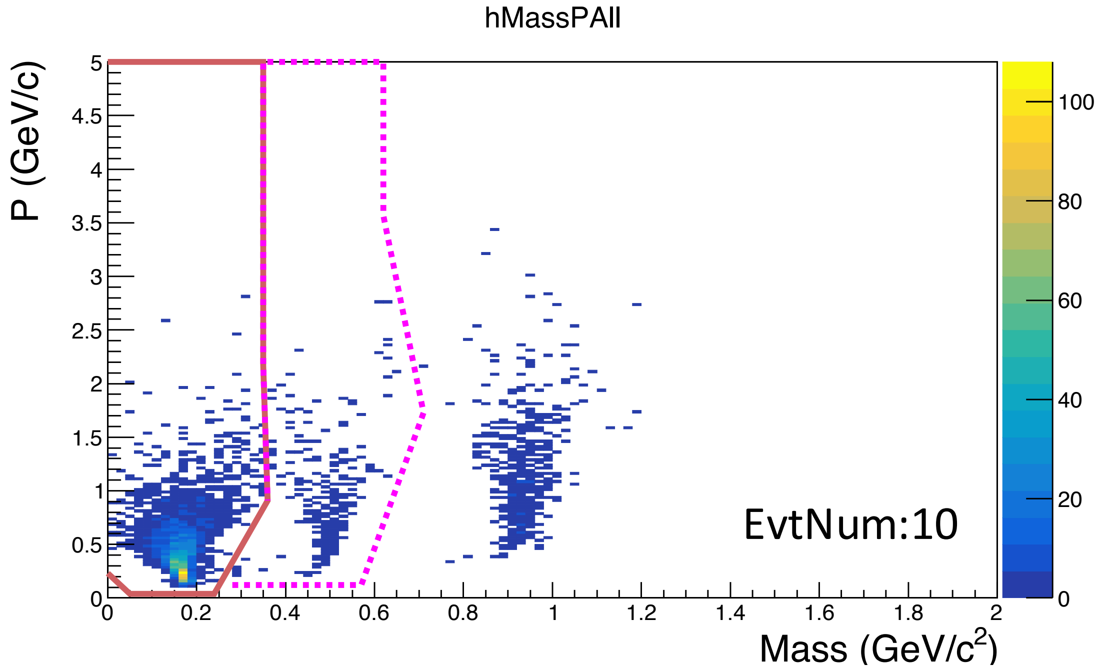
Distribution of Dt after δ_t applied

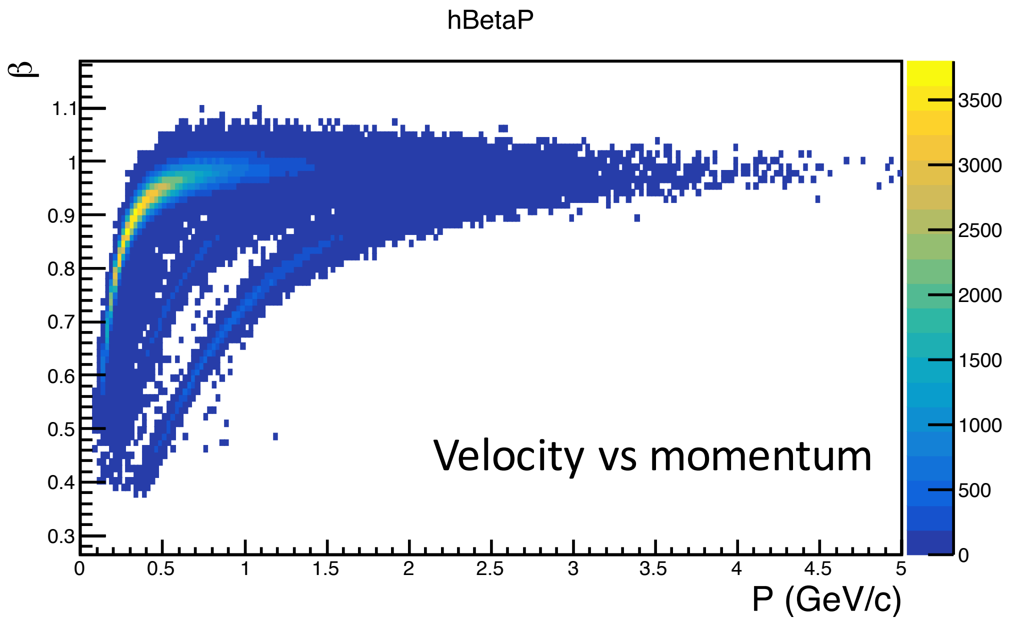
$\delta_t = 150ps$ for charged particles

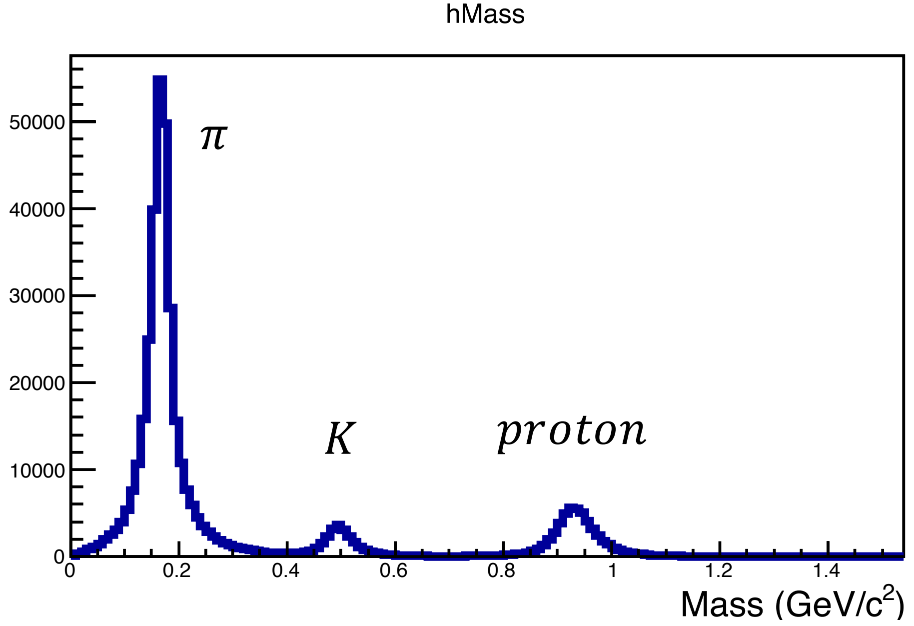
$\delta_t = 80ps$ for neutral particles with energy larger than 700MeV

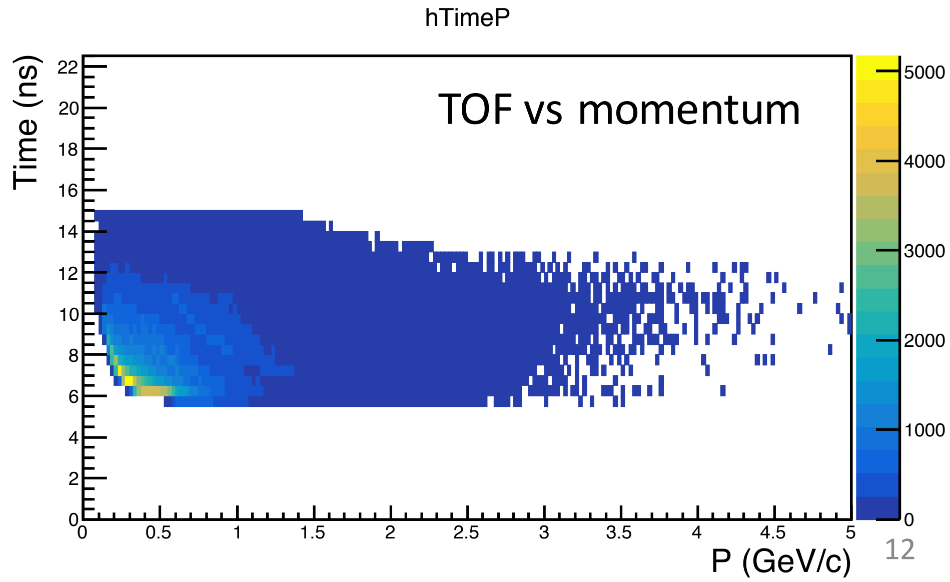
$N_{ph.e} = 7761.0 \times E(GeV)$

PID for the Barrel Ecal

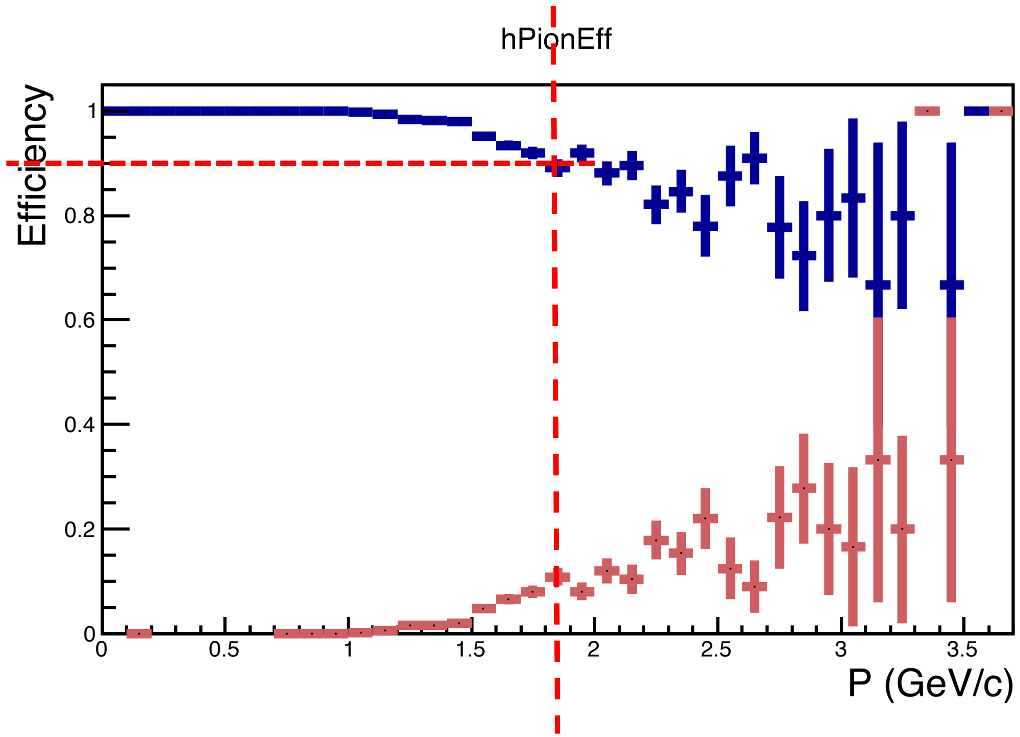






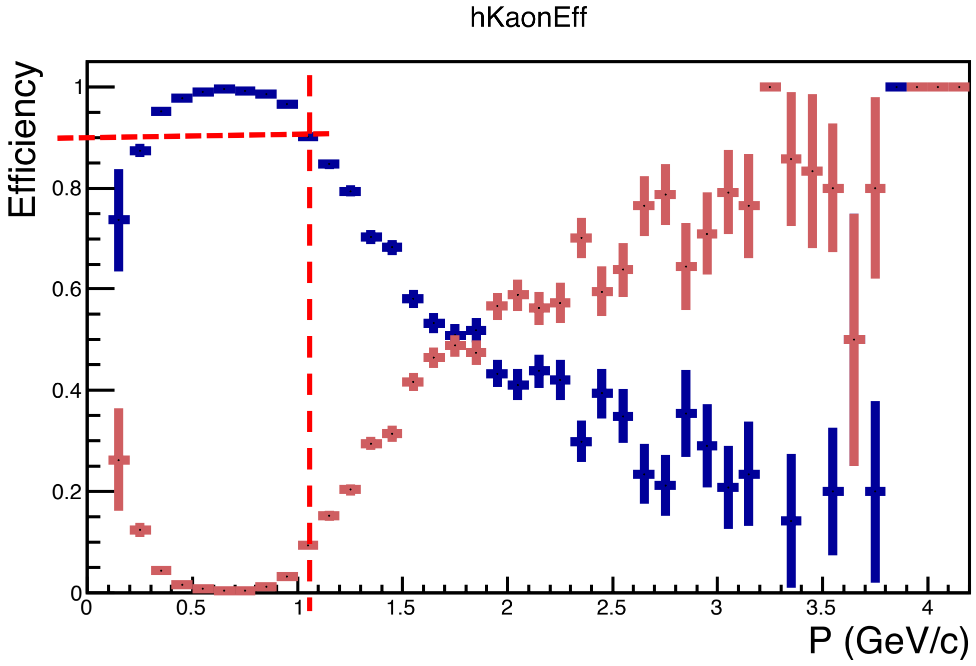


PID Efficiency for the Barrel ECal



Efficiency of separation pions from kaons and proton

π can be separated from K and p for $P < 1.9 Gev/c$ with efficiency higher than 90%

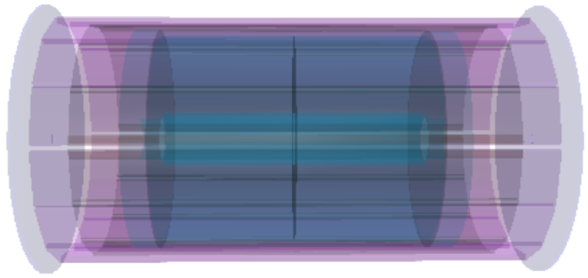


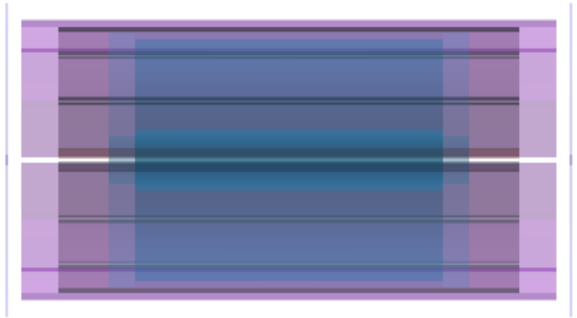
Efficiency of separation kaons from pions and proton

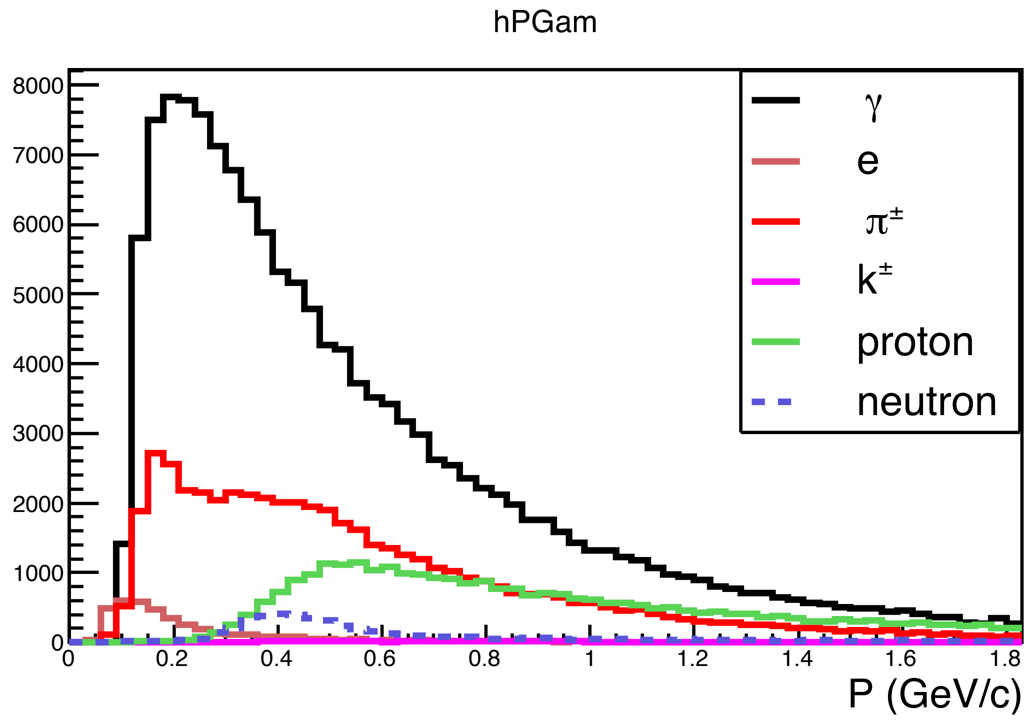
K can be separated from π and p for $P < 1.1 Gev/c$ with efficiency higher than 90%

Time information of the EndCap Ecal

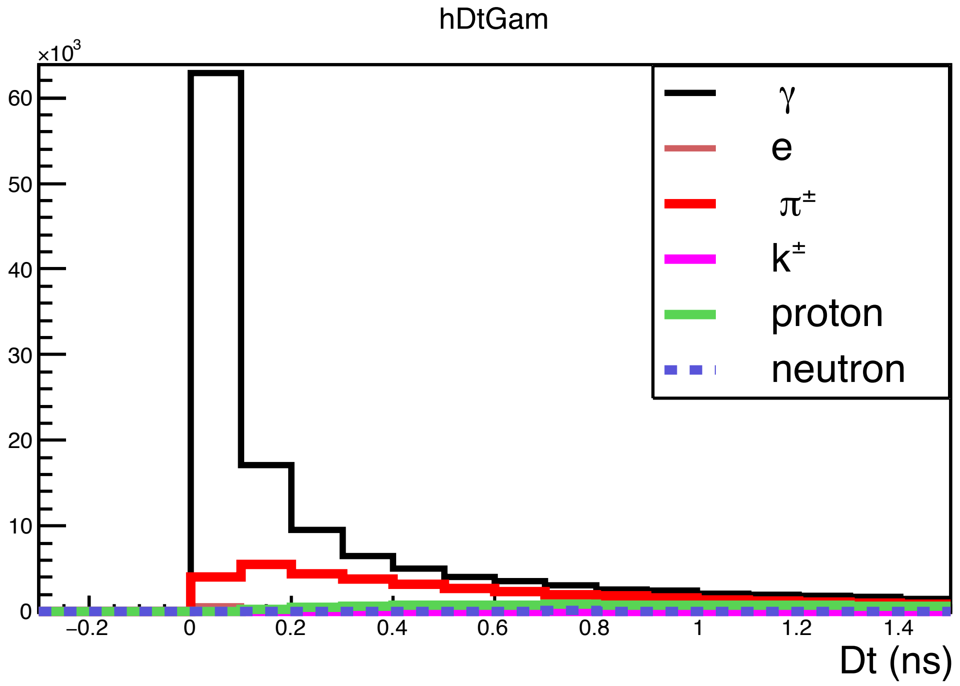
- Z: $\pm 310cm$
- Thickness: 5cm
- Outer radius: 172cm
  Inner radius: 50cm
- Material: CsI





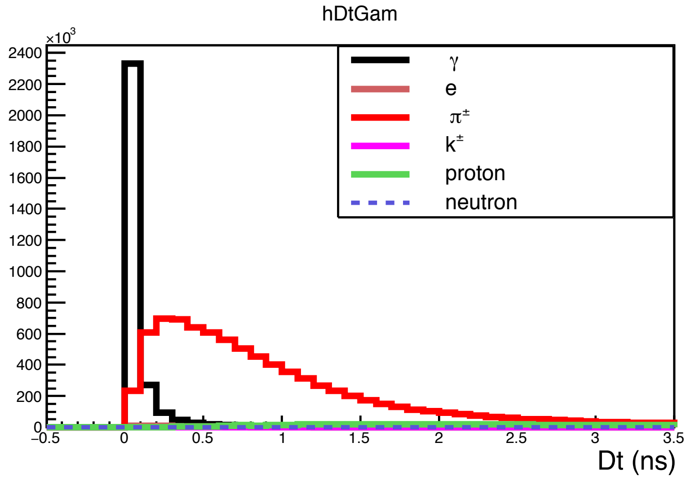


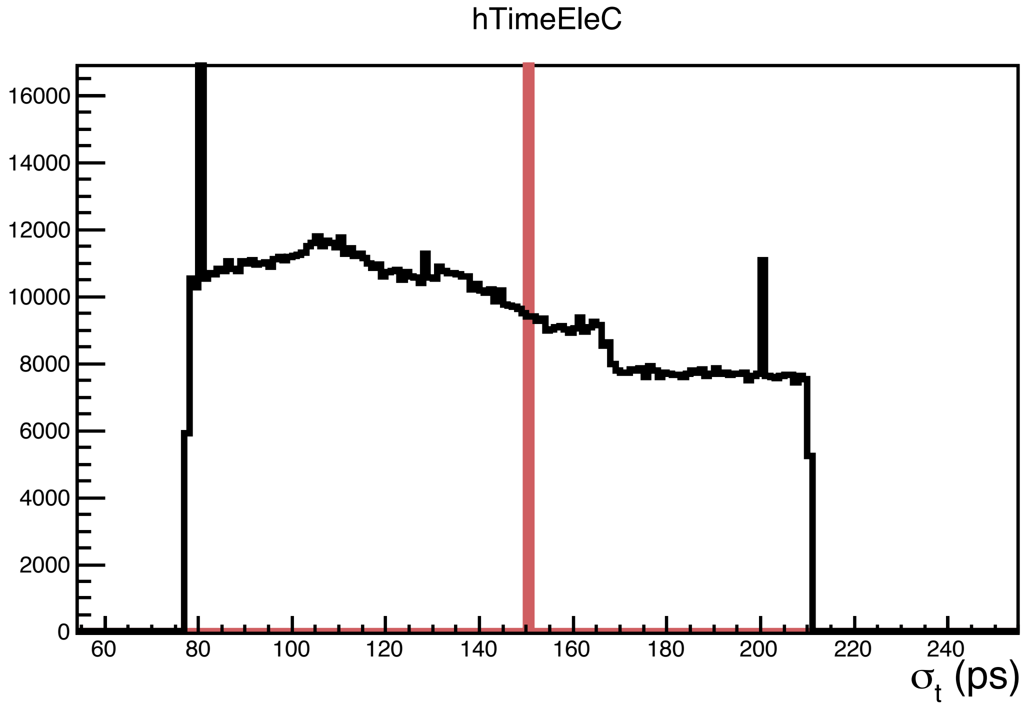
Distribution of momentum for different kind of particles.



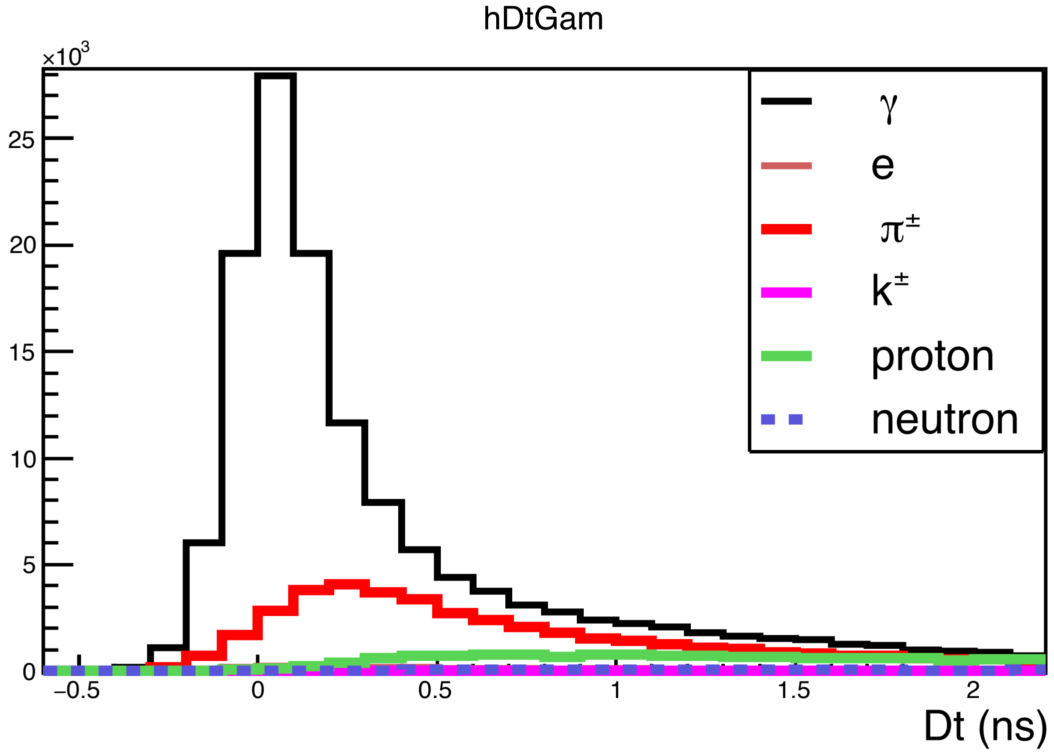
Distribution of Dt for different kind of particles.

Electronic Time Resolution for the End Cap ECal





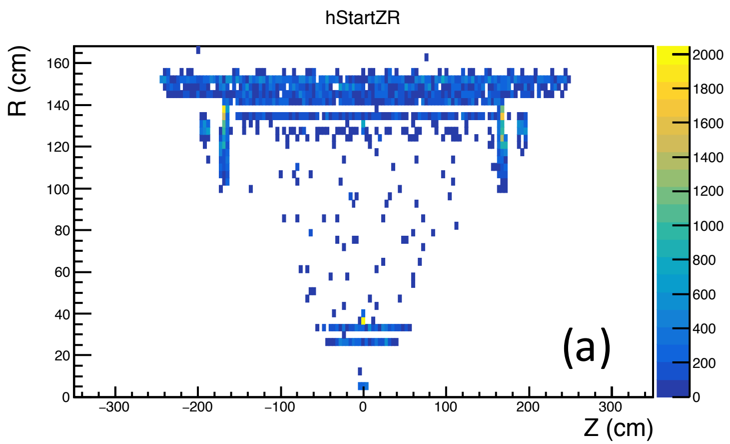
Distribution of the time resolution

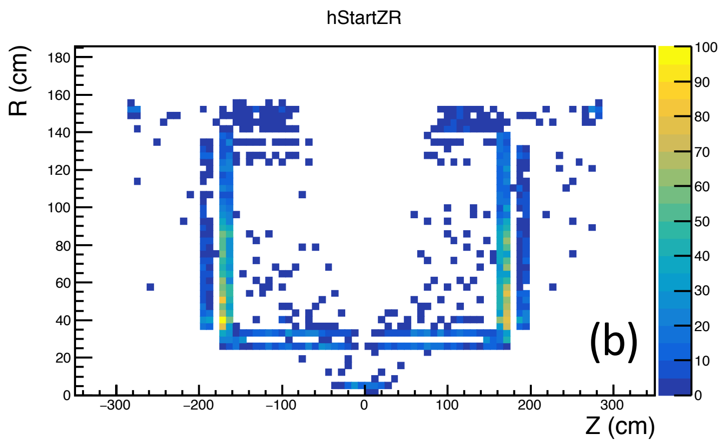


Distribution of Dt after δ_t applied

Dt Tail for γ

EvtNum:50





$$R = \sqrt{x^2 + y^2}$$

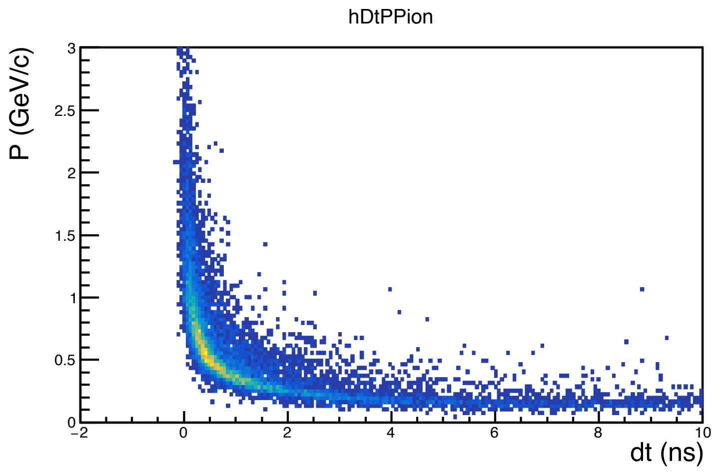
The produced position of photons hit on the Barrel (a) and end cap (b) ECal.

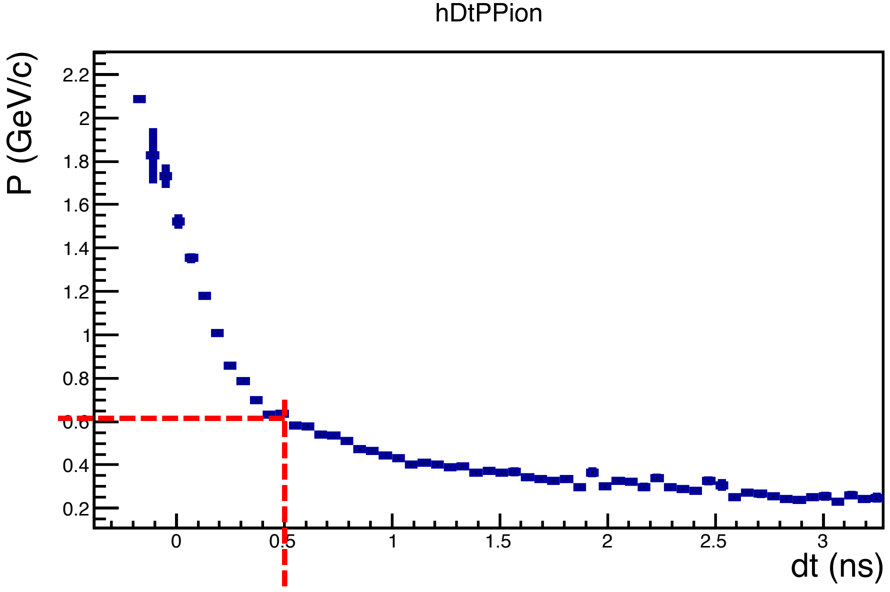
	Number of All γs	Number of direct γ	Number of secondary γ	Percent of secondary γ
Barrel	143905	130140	13765	9.6%
End Cap	7476	5721	1755	23.5%
Barrel (Dt>0.7)	2105(1.5%)	1527	578 (4.2%)	27.5%
End(Dt>0.7)	2074(27.7%)	1461	613 (35%)	30%

- **There are more secondary gammas in the end cap(23.5%) than the barrel(9.6%) Ecal.**
- **And there are more slow gammas (dt>0.7) in the end cap(35%) than the barrel(4.2%) Ecal.**

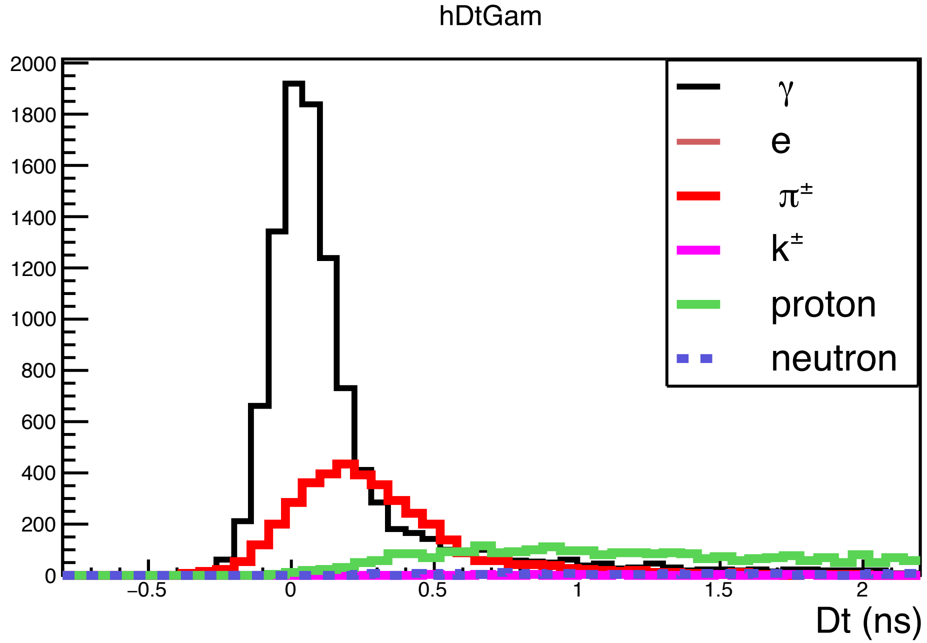
High velocity πs

Evt:200





The profile along X of the distribution of P with Dt.

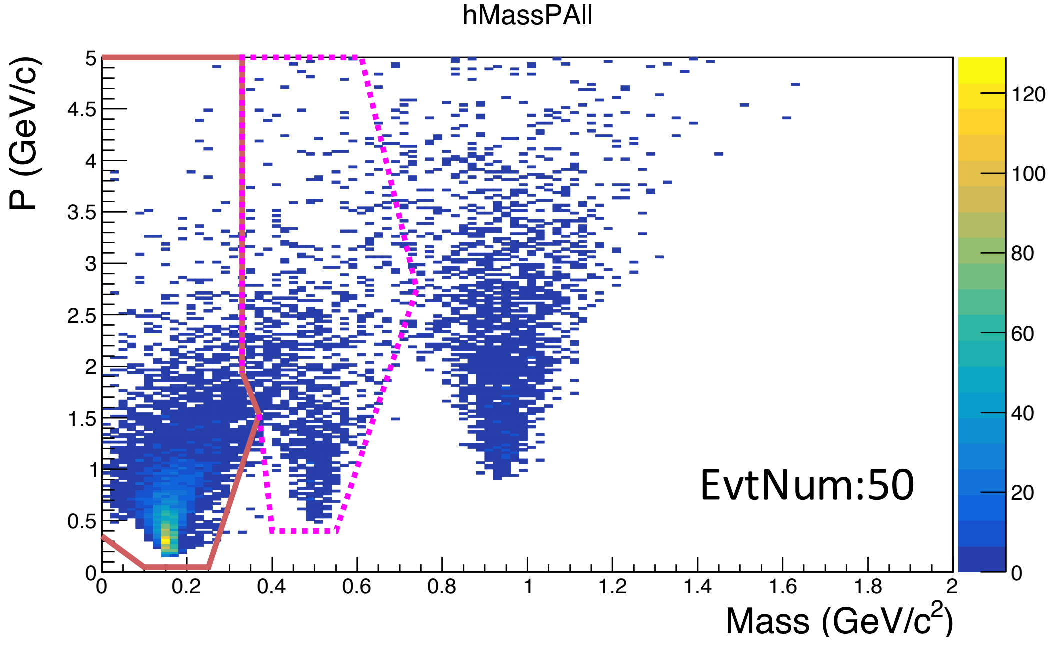


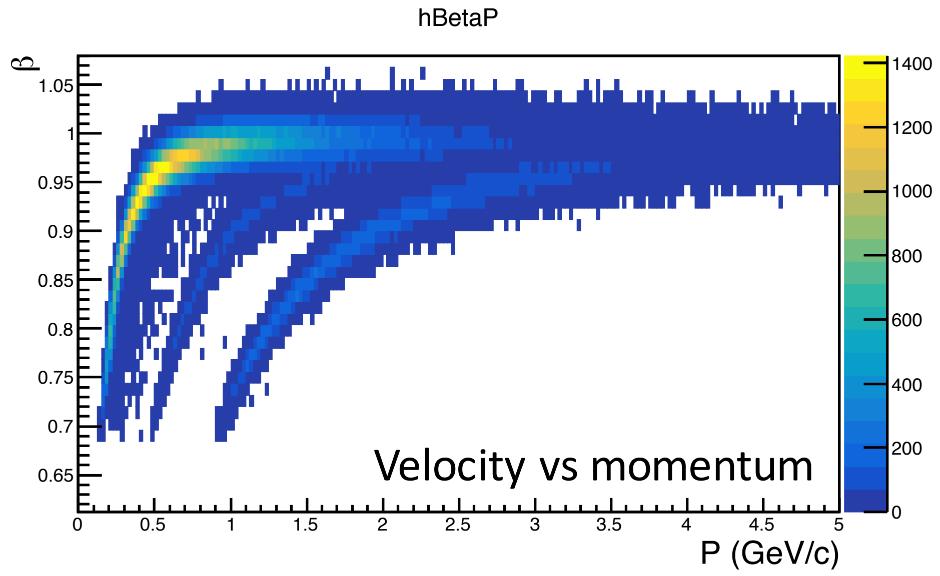
Dt distribution with $P > 0.6 GeV/c$ for the end cap Ecal.

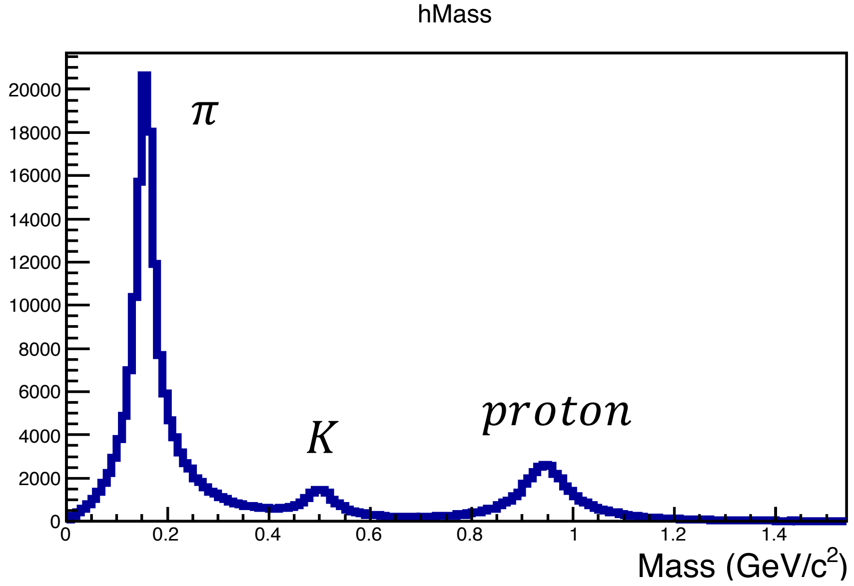
	$P > 0.6\ GeV/c$
Barrel ECal	17.4%
End Cap ECal	37.8%

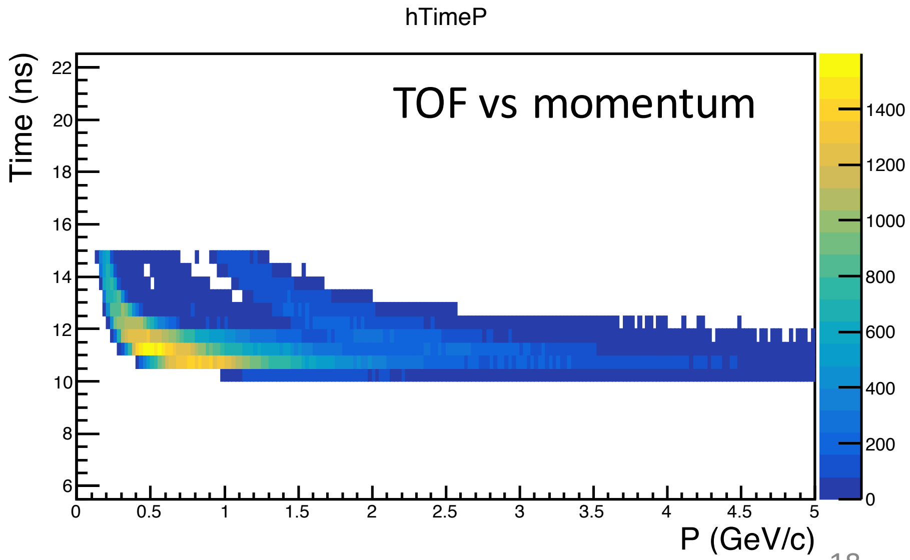
There are more high momentum pions in the end cap Ecal than the barrel Ecal.

PID of the EndCap Ecal

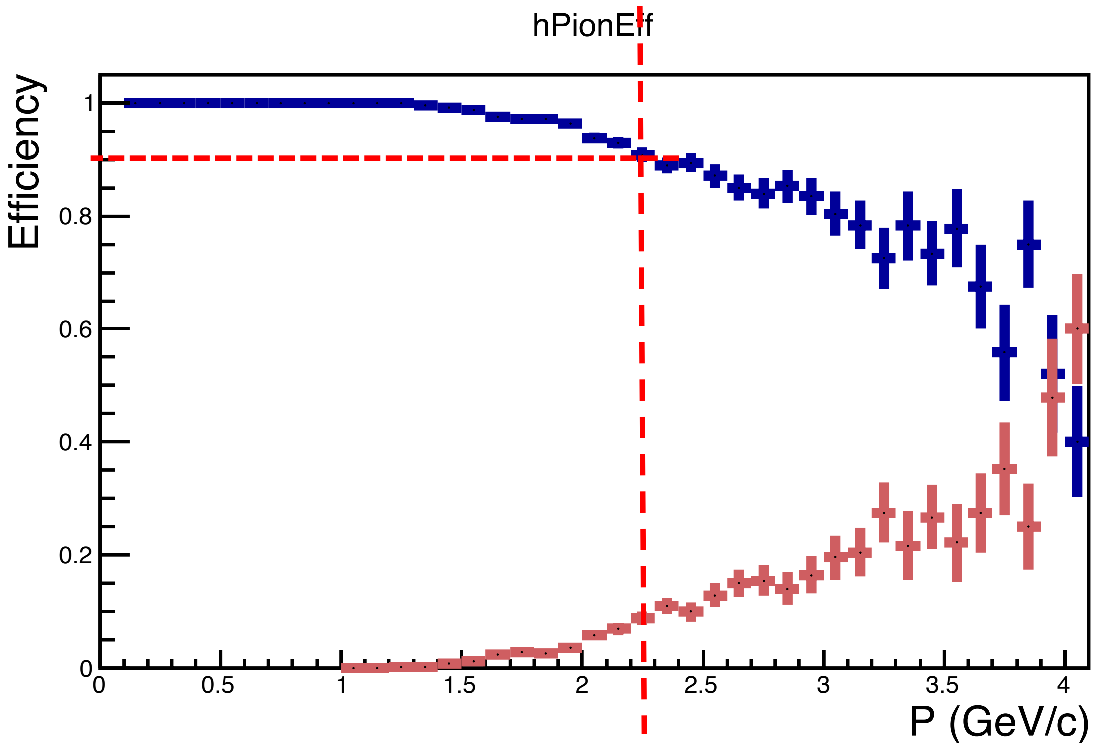




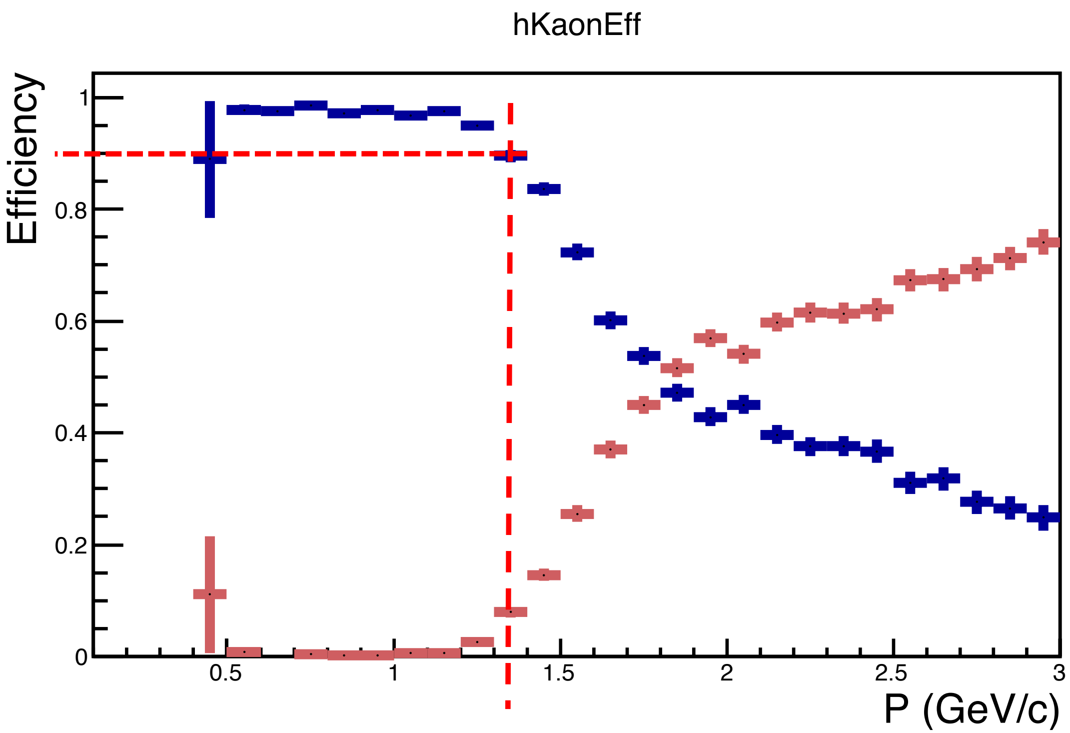




PID Efficiency for the End Cap ECal



Efficiency of separation pions from kaons and proton



Efficiency of separation kaons from pions and proton

π can be separated from K and p for $P < 2.3Gev/c$ with efficiency higher than 90%

K can be separated from π and p for $P < 1.4Gev/c$ with efficiency higher than 90%

Summary

Reconstruction of π^0 with θ correction

- ✓ There is a bias between the real θ and reconstructed θ, the bias increases when the generated z position is farther from $z = 0\ cm$.
- ✓ This theta bias can be corrected by a function fit of Δ_θ.
- ✓ Reconstruction of π^0 is affected by this theta bias, and can be improved with the correction of θ. The mean and sigma of the reconstructed invariant mass become smaller after correction.

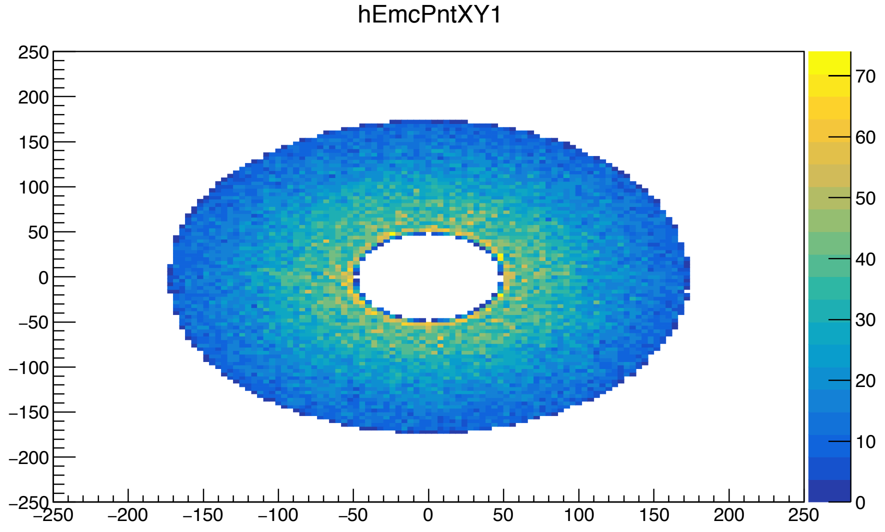
Time and PID for the barrel and end cap ECal

- ✓ The occupancy can be reduced by applying a cut on the time difference Dt for the barrel Ecal.
- ✓ Difference of Dt for different particles is small for the End cap Ecal, which can be explained by the small difference between the distance of particles and more secondary γs.
- ✓ π can be separated well from K and p for $P < 1.9Gev/c$ for the barrel and $P < 2.3Gev/c$ for the End cap ECal.
- ✓ K can be separated well from π and p for $P < 1.1Gev/c$ for the barrel and $P < 1.4Gev/c$ for the End cap Ecal.

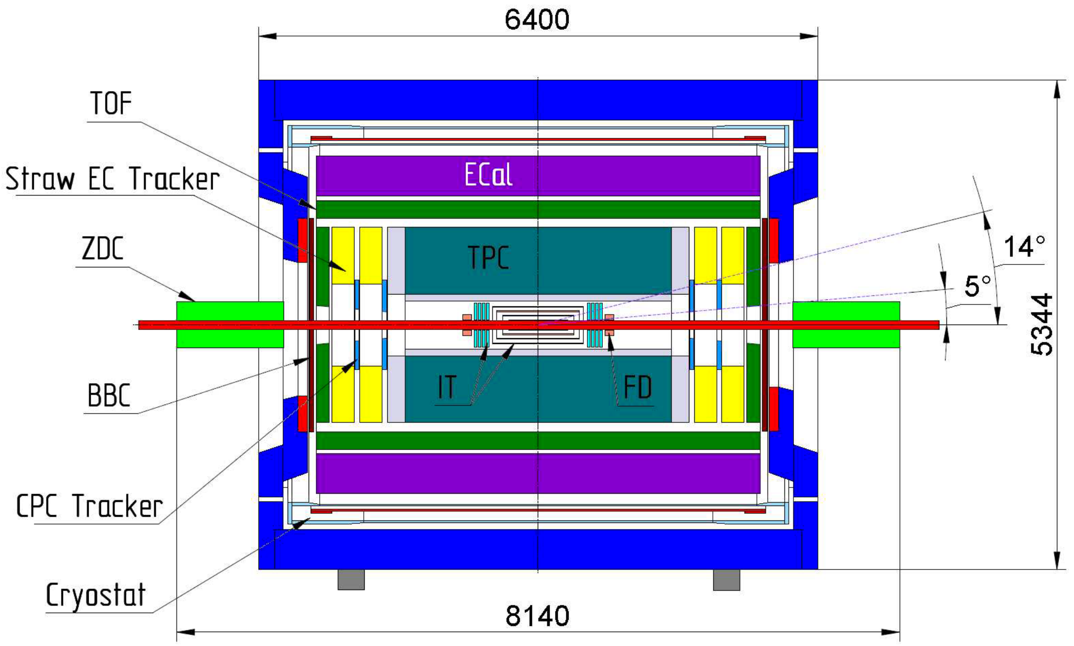
Thanks for your attention!

BackUp

Geometry

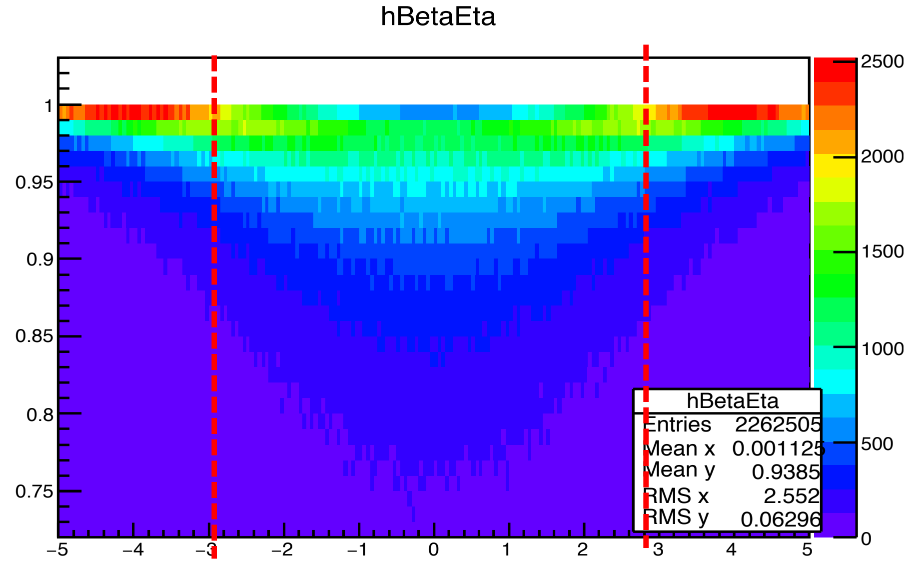


EndCap

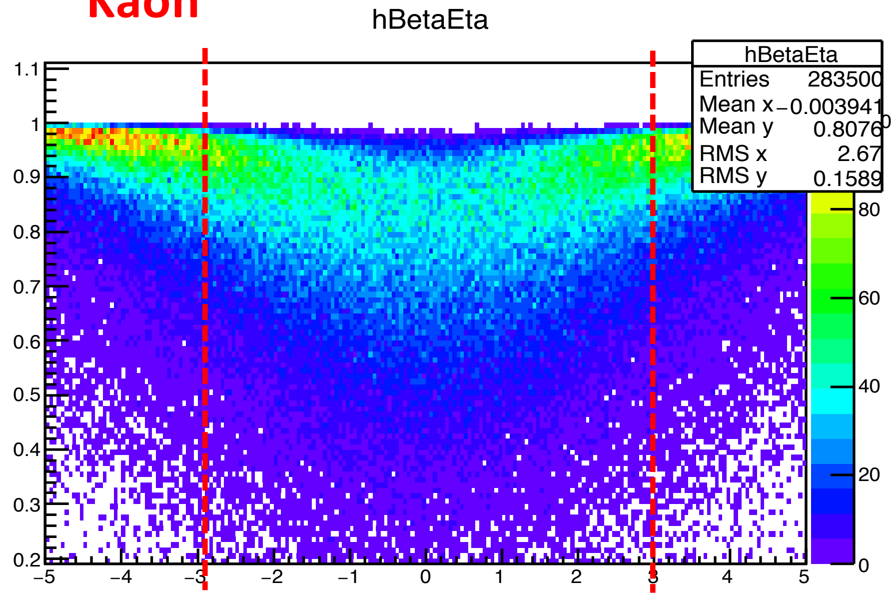


Forward particles has higher momentum and velocity.

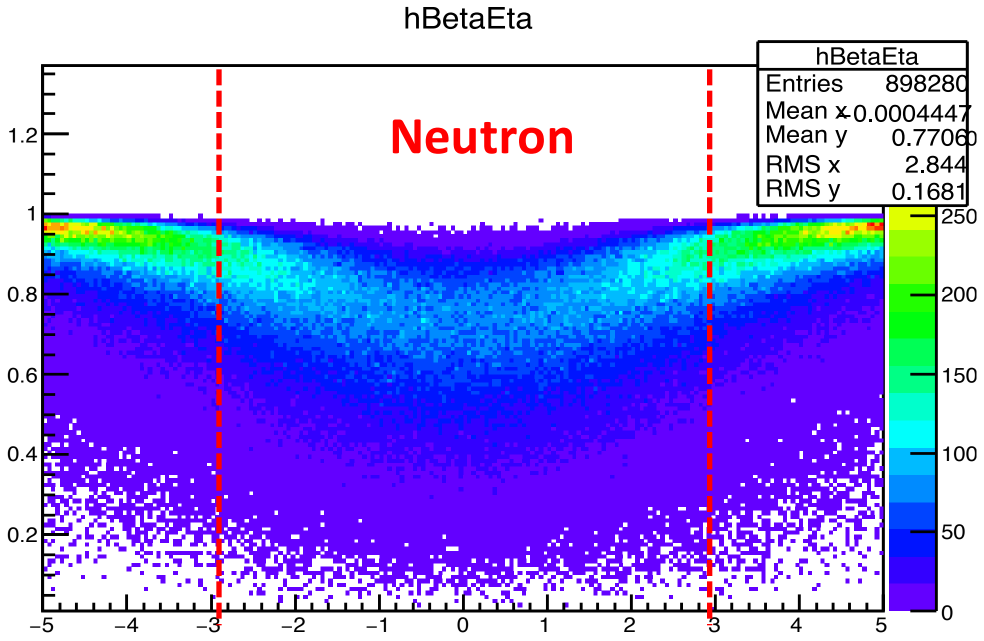
Pion



Kaon

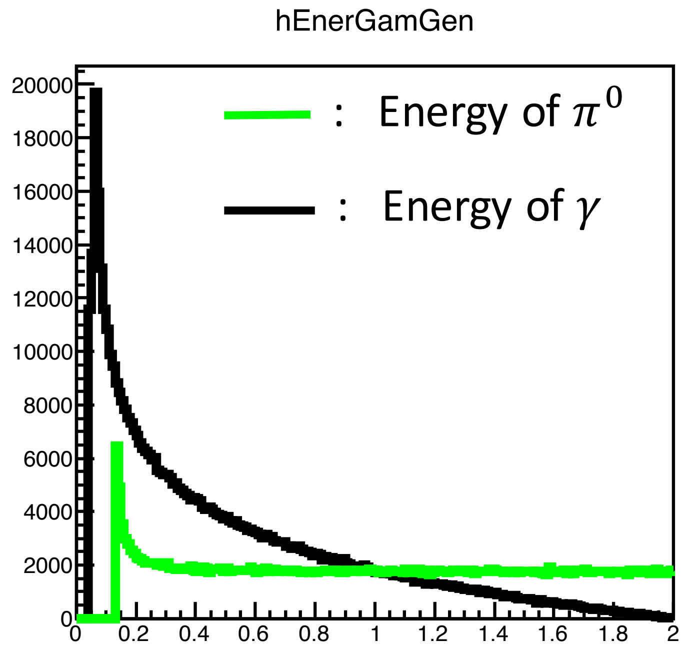


Neutron

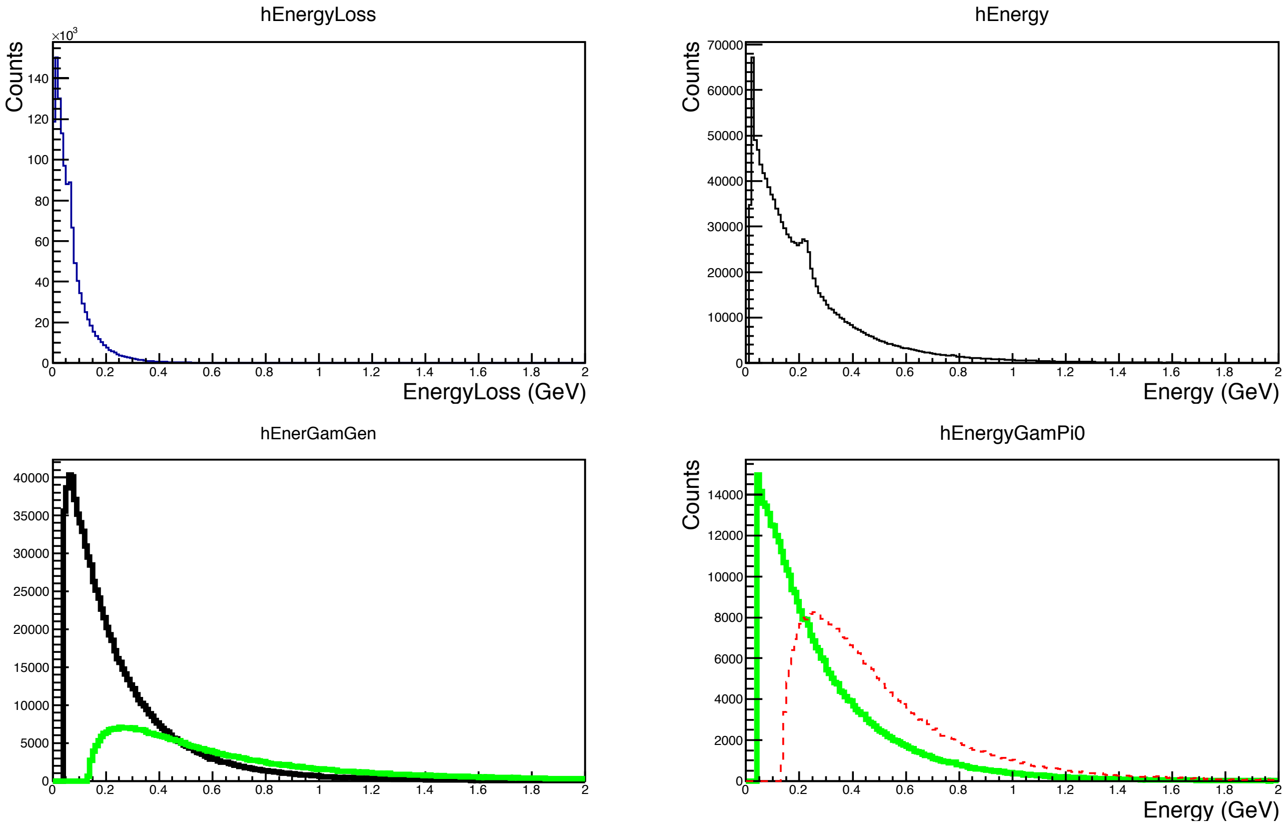


1. The speed of particle flying to EndCap is larger than to Barrel
2. The numbers of particle to barrel decreases with Mass increase

Energy distribution

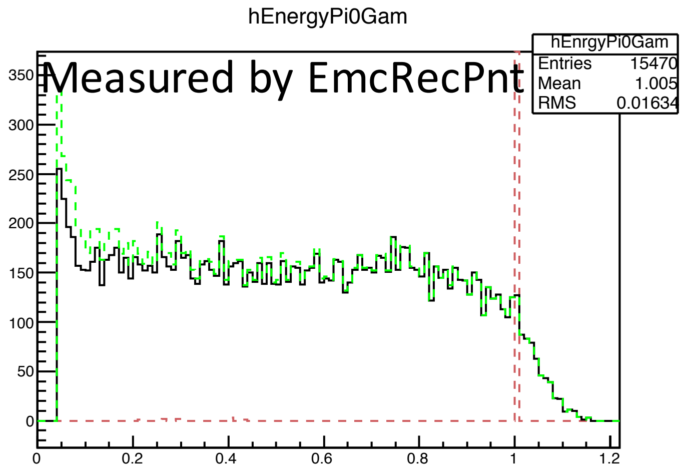


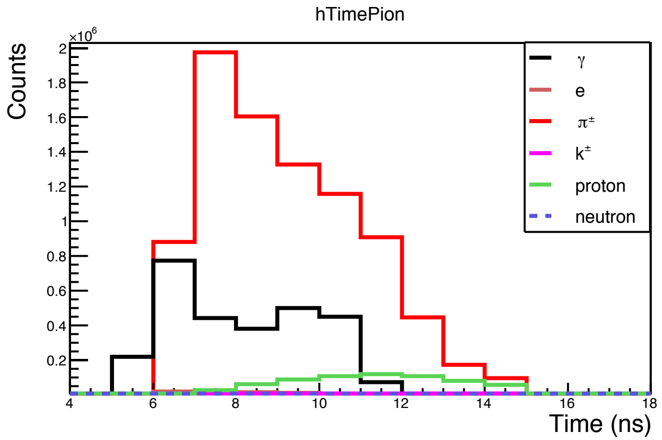
Energy distribution of π^0 generated and γ decayed from π^0 for all energy events(0-2GeV MultiZVert).



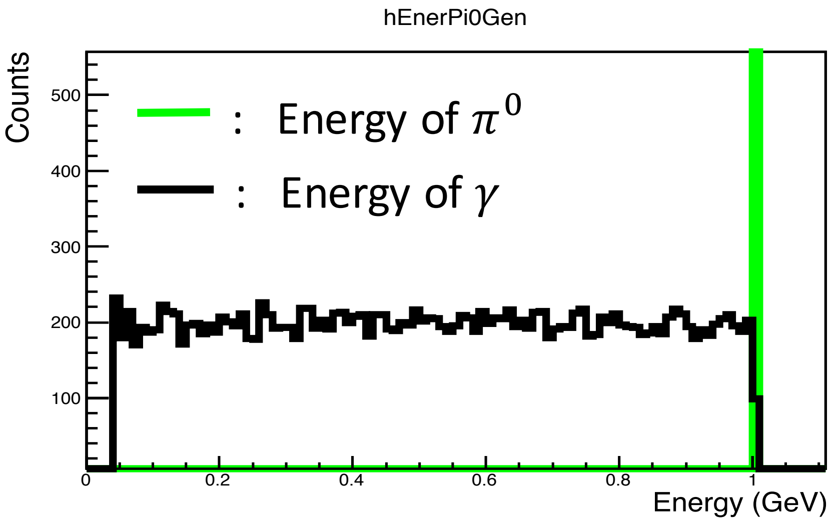
Urqmd central

Box 1GeV pion0

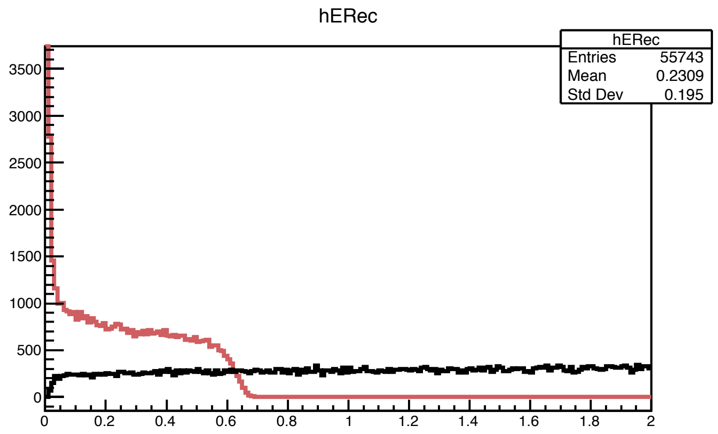


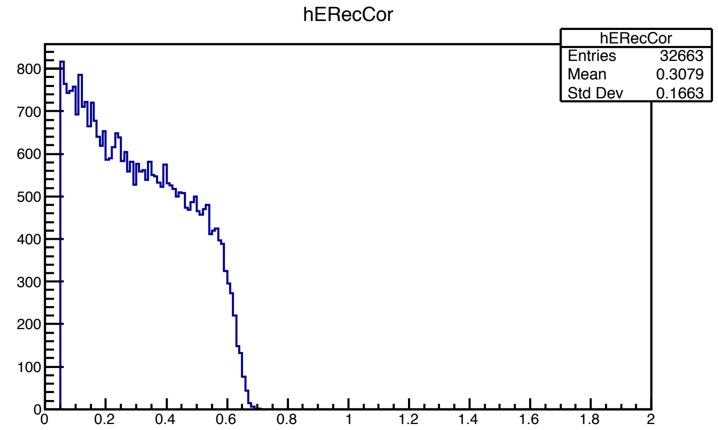


Time for the Barrel ECal

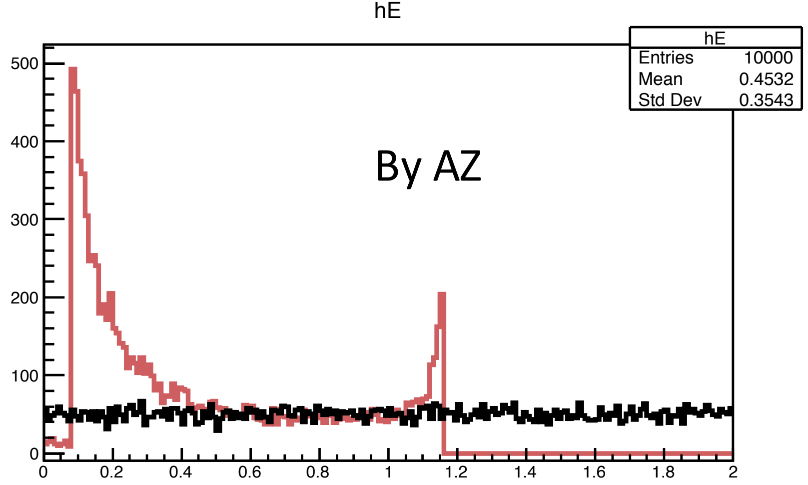


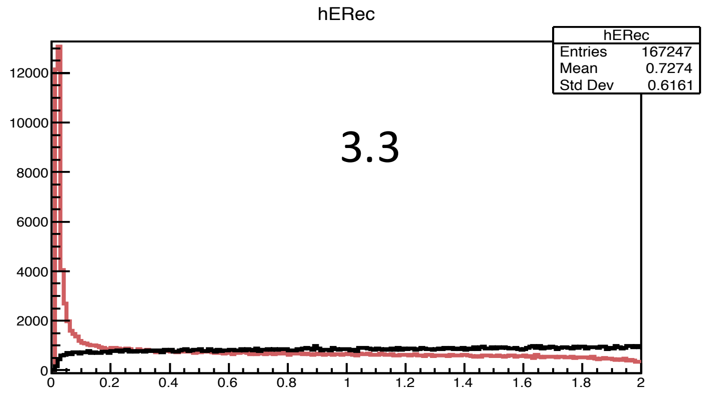
Eloss Calibration

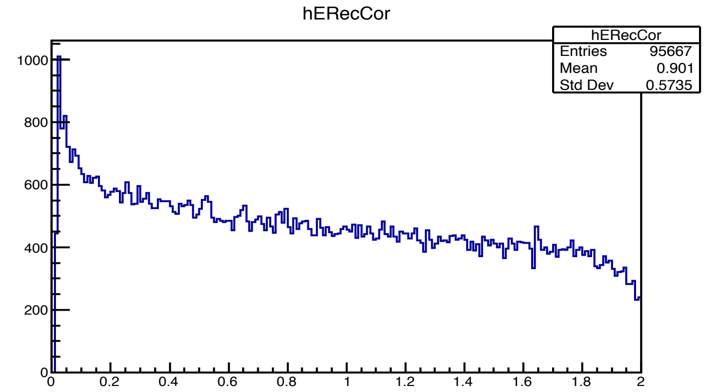


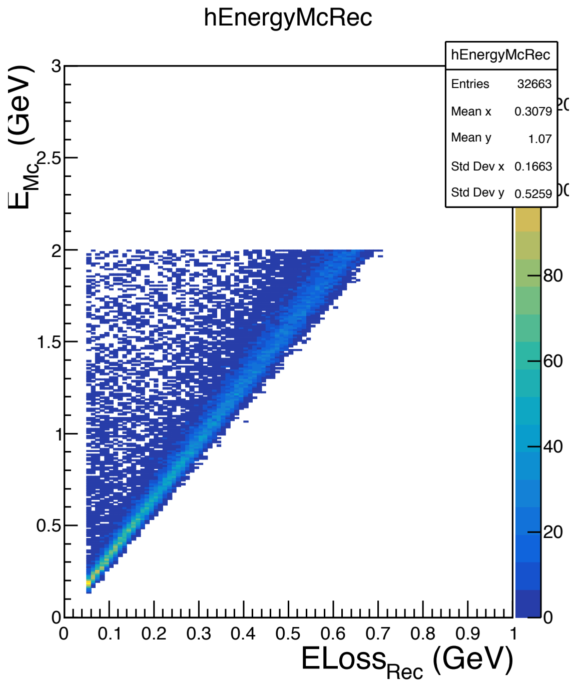


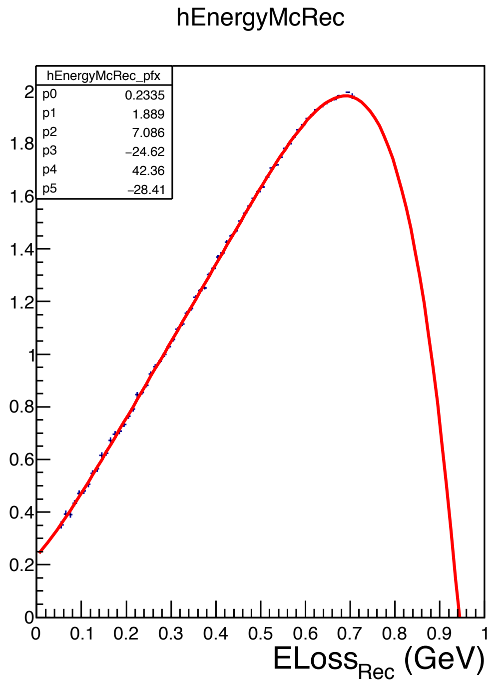
Eloss and Mc energy

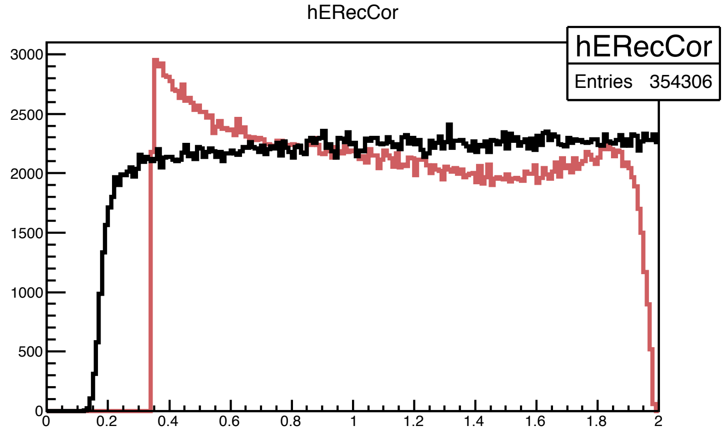







hEnergyMcRec
hEnergyMcRec
Entries 32663
Mean x 0.3079
Mean y 1.07
Std Dev x 0.1663
Std Dev y 0.5259
E_Mc (GeV)
ELoss_Rec (GeV)

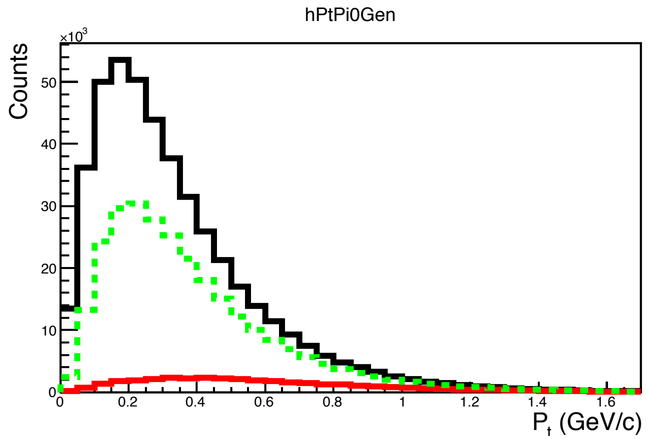

hEnergyMcRec
hEnergyMcRec_pfx
p0 0.2335
p1 1.889
p2 7.086
p3 −24.62
p4 42.36
p5 −28.41
ELoss_Rec (GeV)

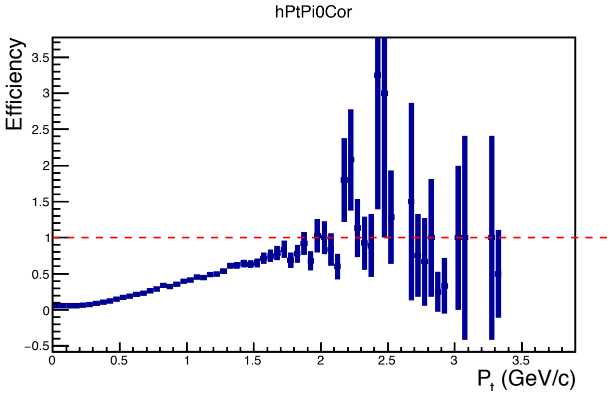

hERecCor
hERecCor
Entries 354306

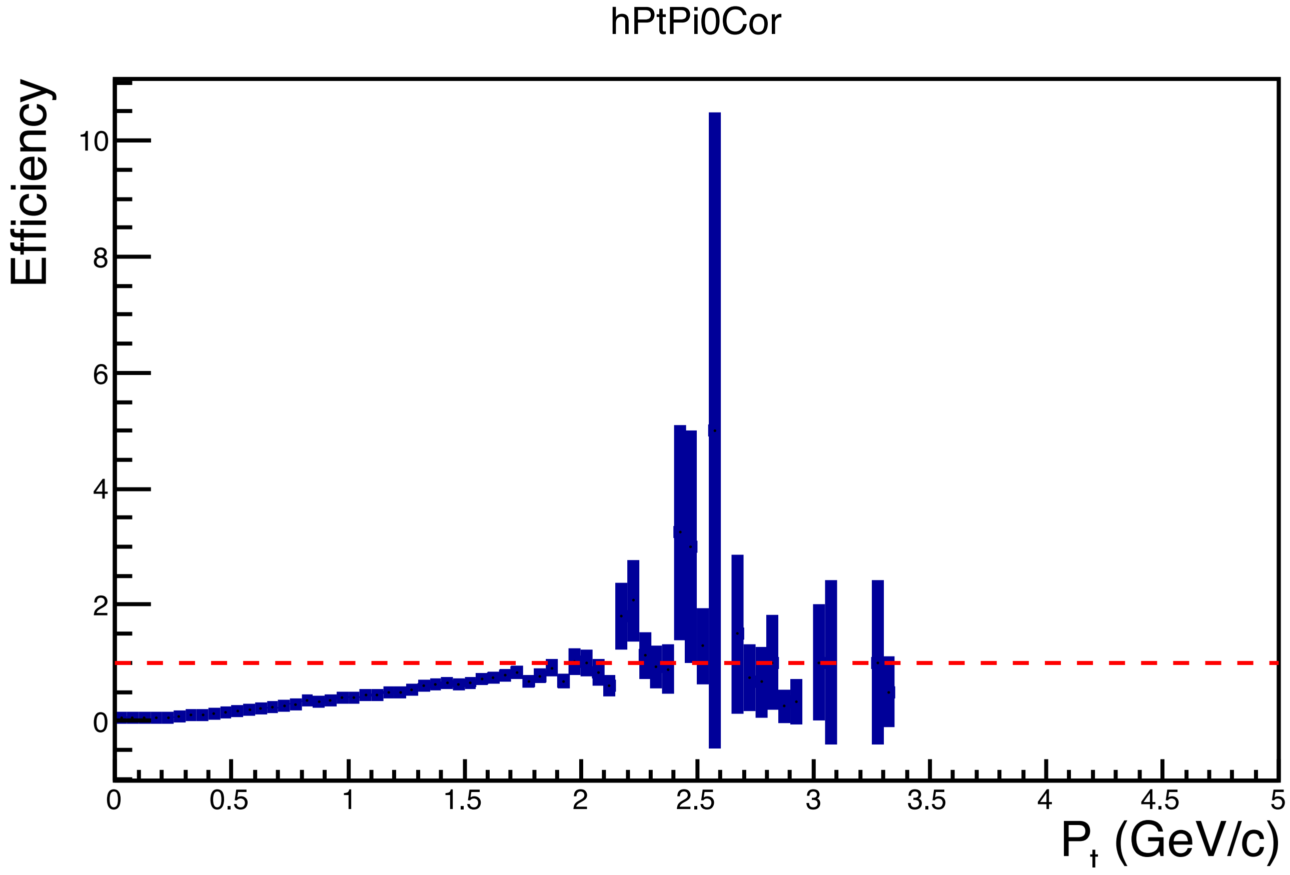
π^0 Reconstruction Efficiency

High Pt need more statistics

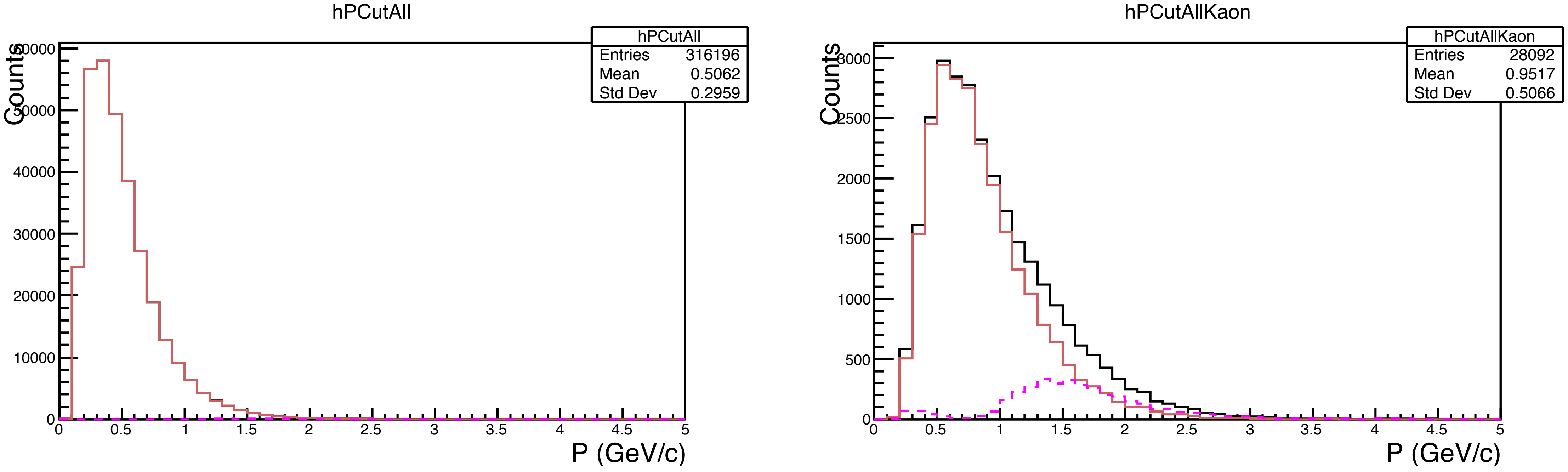
Acceptance applied: green







PID efficiency for the barrel ECal



Momentum distribution
K mass: 497Mev