EMCal for eID

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EIC-YR-Detector-Calorimetry Group

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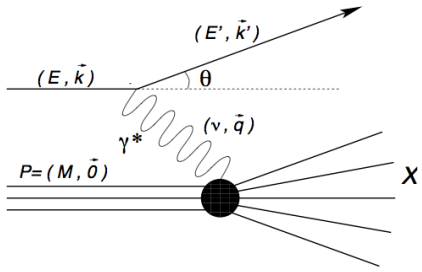
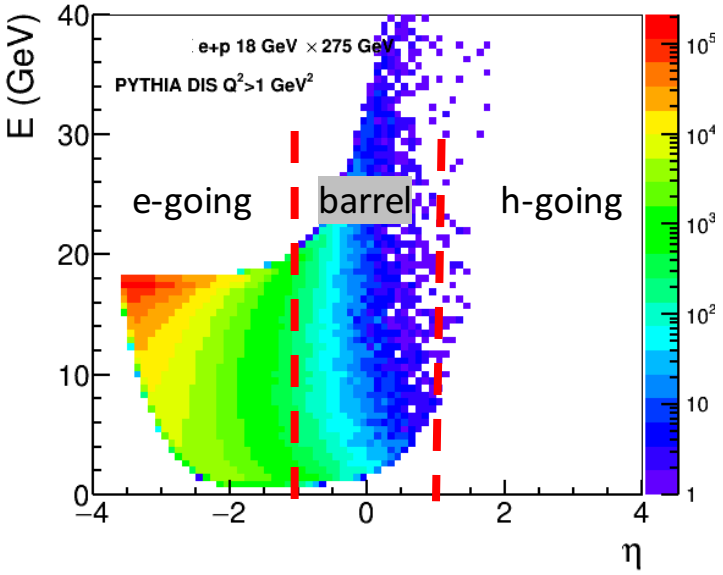
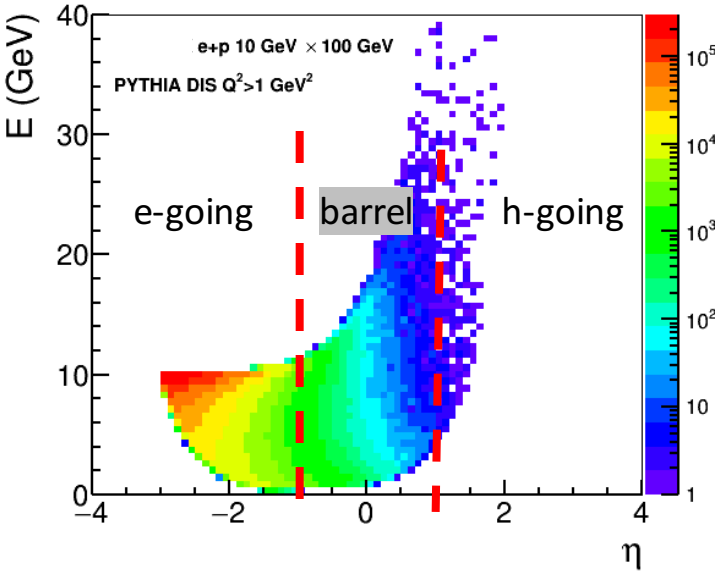
Inclusive DIS: scattered electron



e+p 18x275 GeV

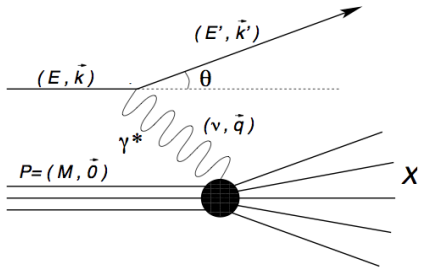


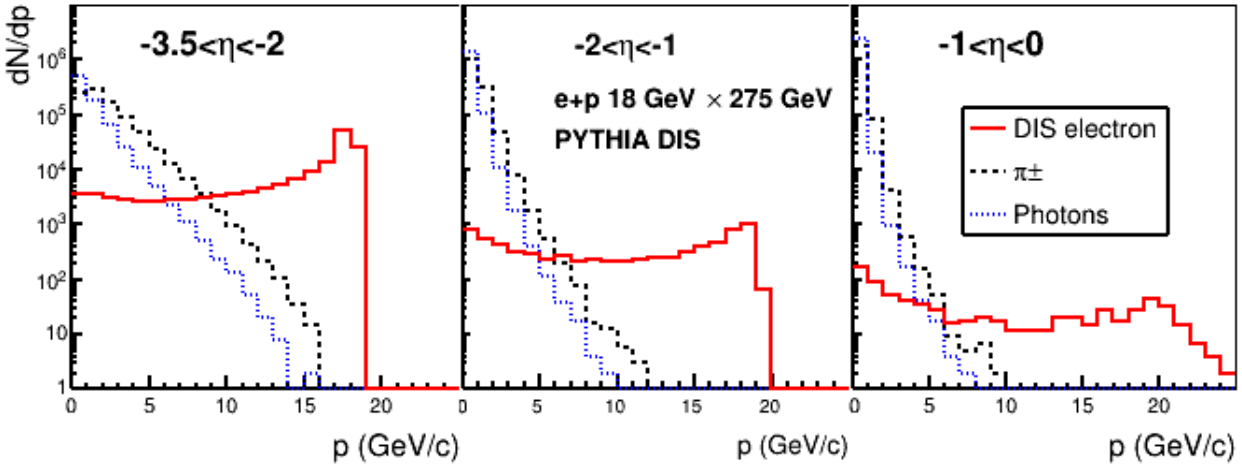
e+p 10x100 GeV



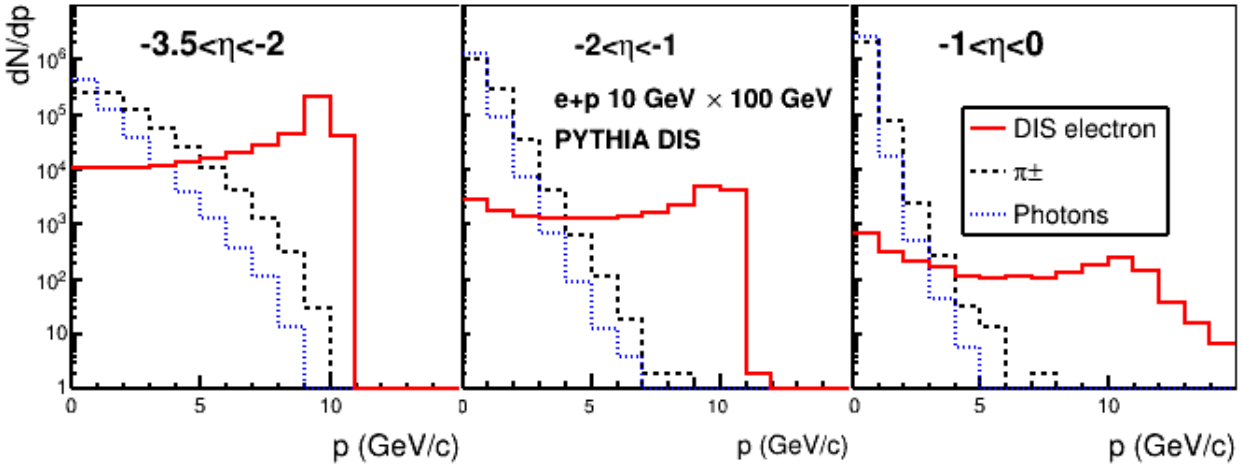
Mostly scattered in backward (e-going) and barrel
Electron energy varies from 0 to e-beam energy in backward (e-going)
And to higher energy in barrel and h-going region

Inclusive DIS: background





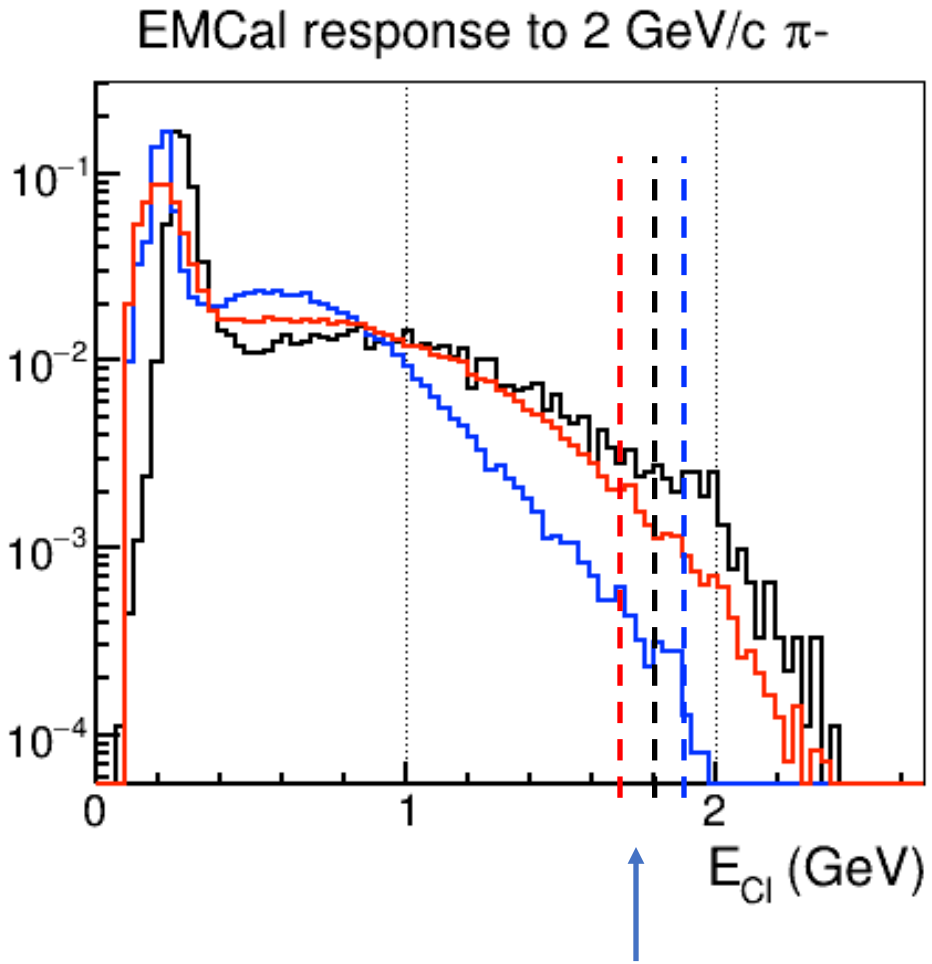
18x275 GeV



10x100 GeV

Clean measurements at higher momenta
Huge background at lower momenta

h± response in EMCal



E/p > 1 - 1.6 · σ_{EMC} to keep $\boldsymbol{\varepsilon}_e$=95%

$PbWO_4$ Crystal (GEANT)

$$\frac{\sigma_E}{E} = \frac{2.5\%}{\sqrt{E}} \oplus 1\%$$

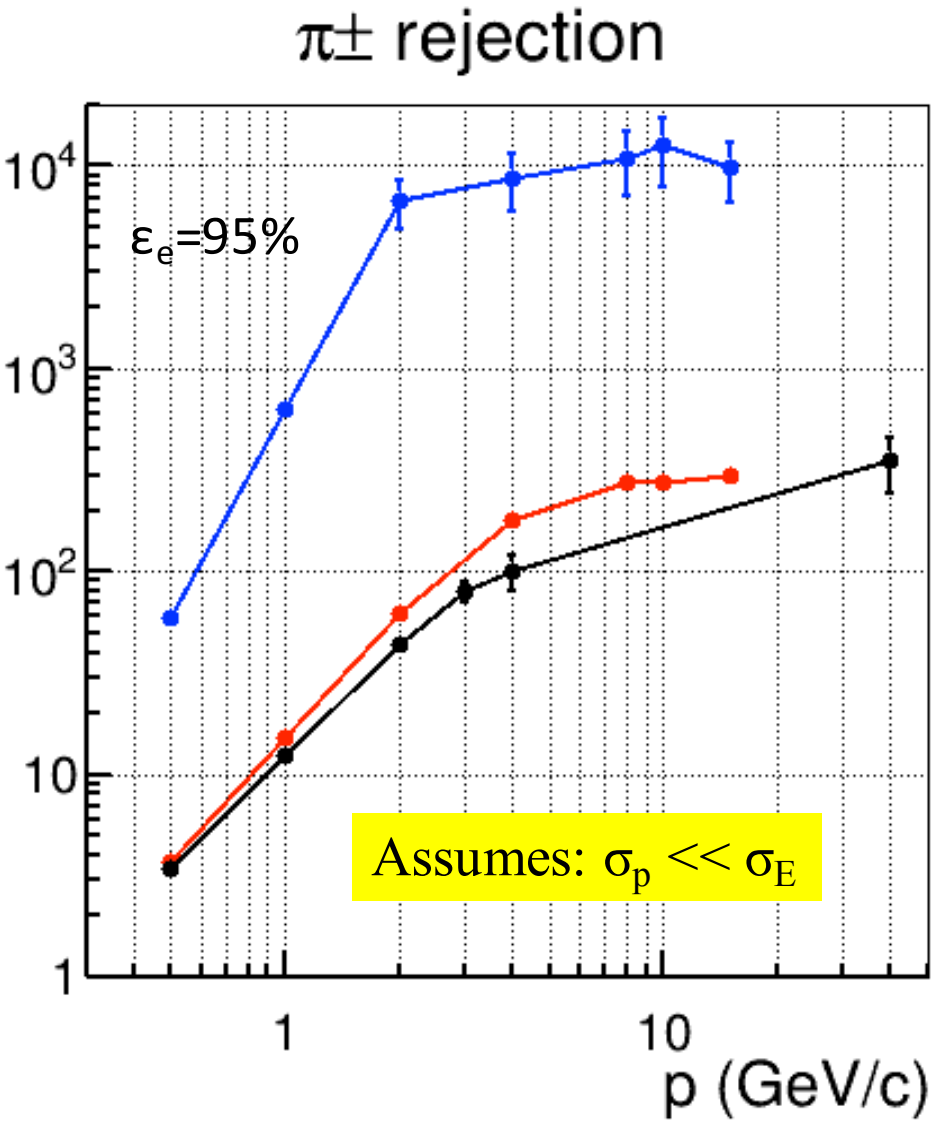
sPHENIX W/SciFi (GEANT)

$$\frac{\sigma_E}{E} = \frac{13\%}{\sqrt{E}} \oplus 3\%$$

PHENIX PbSc (data):

$$\frac{\sigma_E}{E} = \frac{8\%}{\sqrt{E}} \oplus 2\%$$

π± rejection with E/p cut



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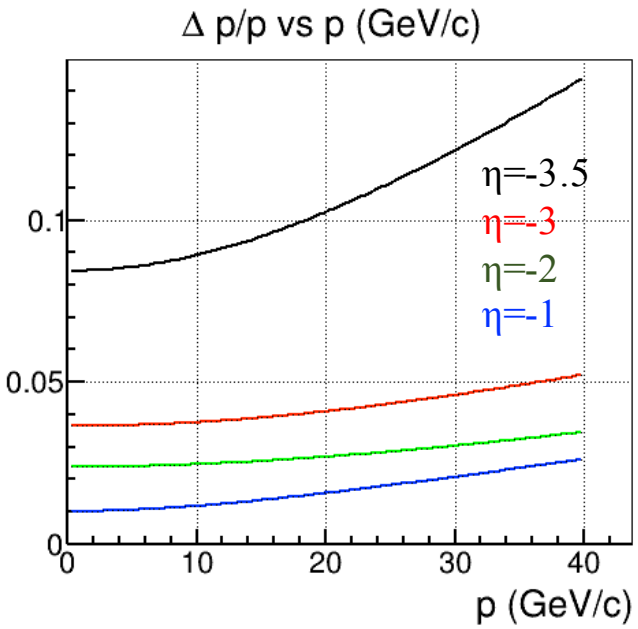
Including momentum resolution

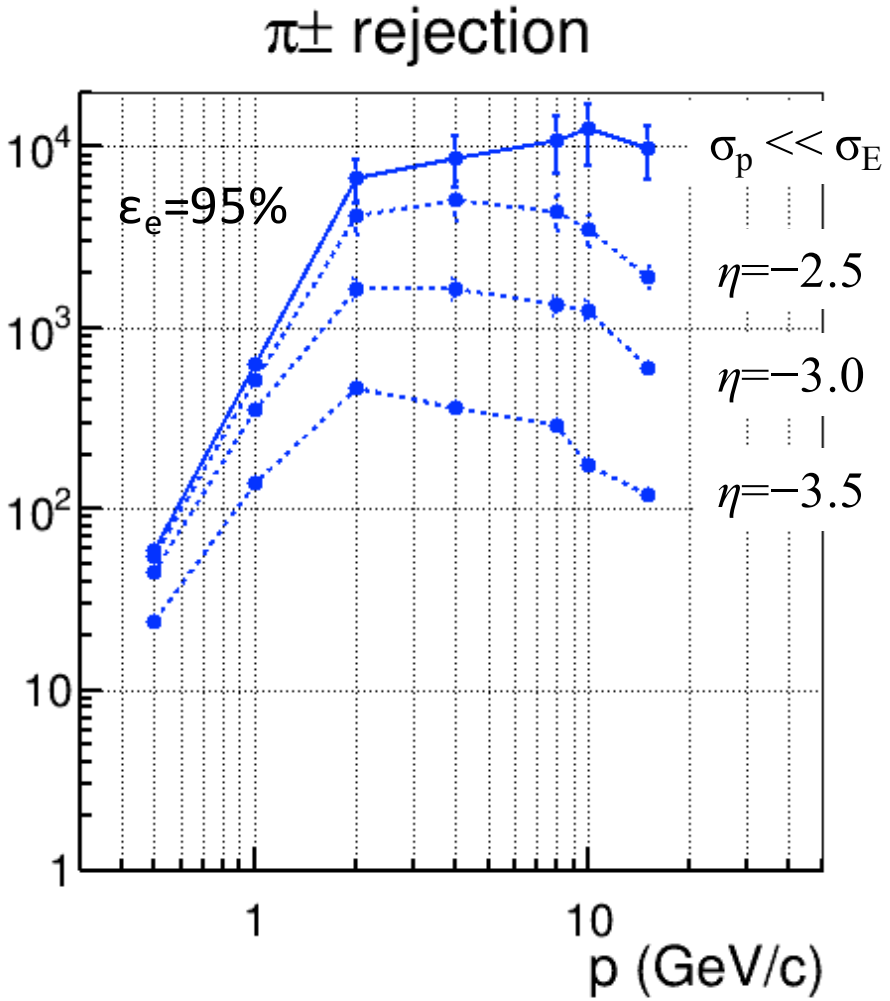
$PbWO_4$ Crystal (GEANT)

$$\frac{\sigma_E}{E} = \frac{2.5\%}{\sqrt{E}} \oplus 1\%$$

BaBar-based Tracking model:
TPC (barrel), Si +GEM (forw)
(Fun4All-GEANT4 simulation)



E/p > 1 - 1.6 · $\sqrt{\sigma_{EMC}^2 + \sigma_p^2}$ to keep ε_e=95%

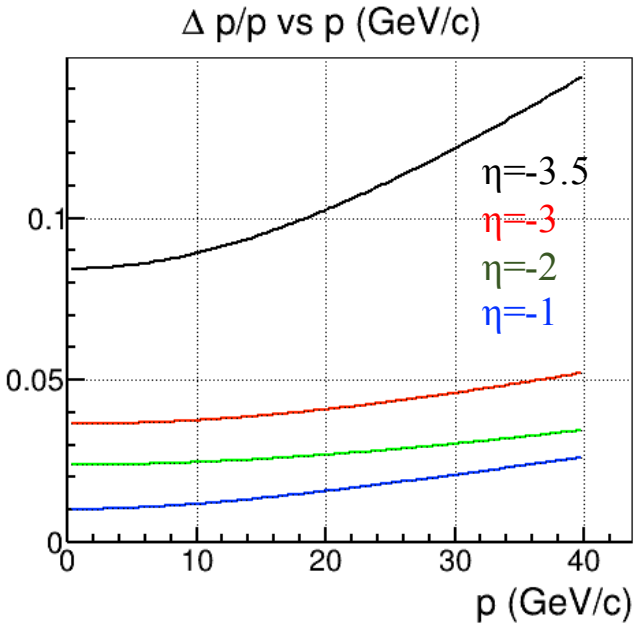


DIS: Hadronic Background Suppression

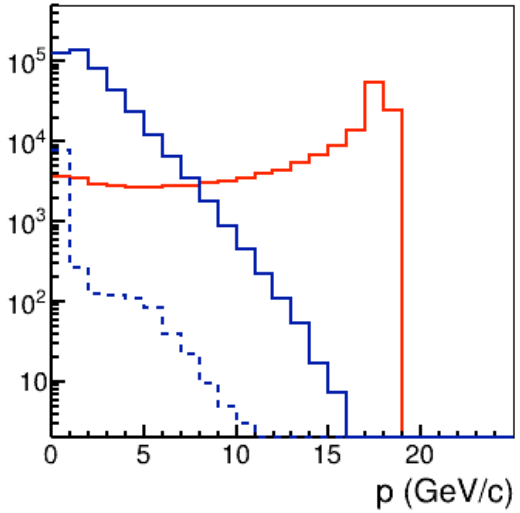
$PbWO_4$ Crystal (GEANT)

$$\frac{\sigma_E}{E} = \frac{2.5\%}{\sqrt{E}} \oplus 1\%$$

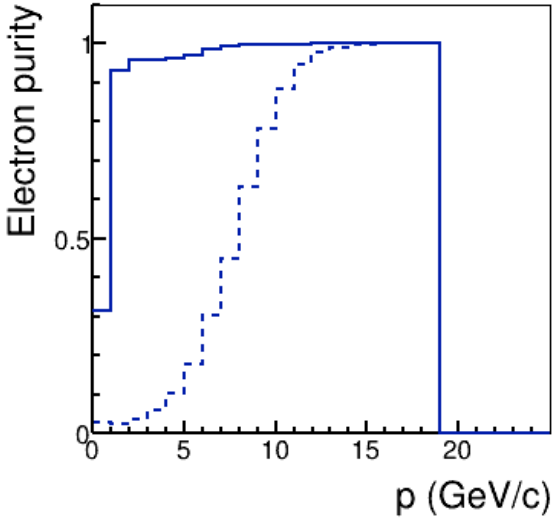
BaBar-based Tracking model:
TPC (barrel), Si +GEM (forw)
(Fun4All-GEANT4 simulation)



e+p 18x275
-3.5<η<-2



e
Solid: π-
Dashed: π-, after E/p



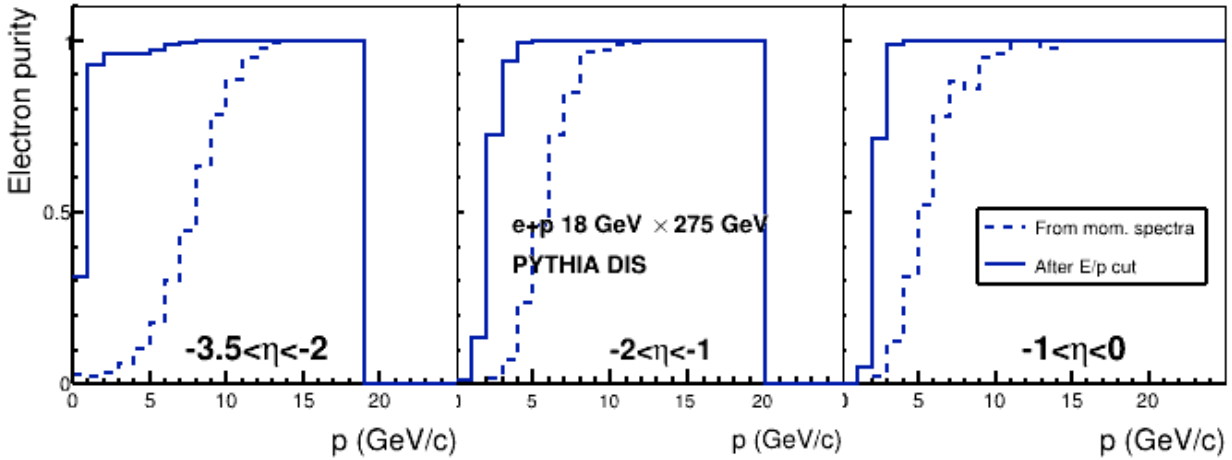
Purity = e / (e+π)

Solid: Before E/p
Dashed: After E/p

DIS scattered electron purity

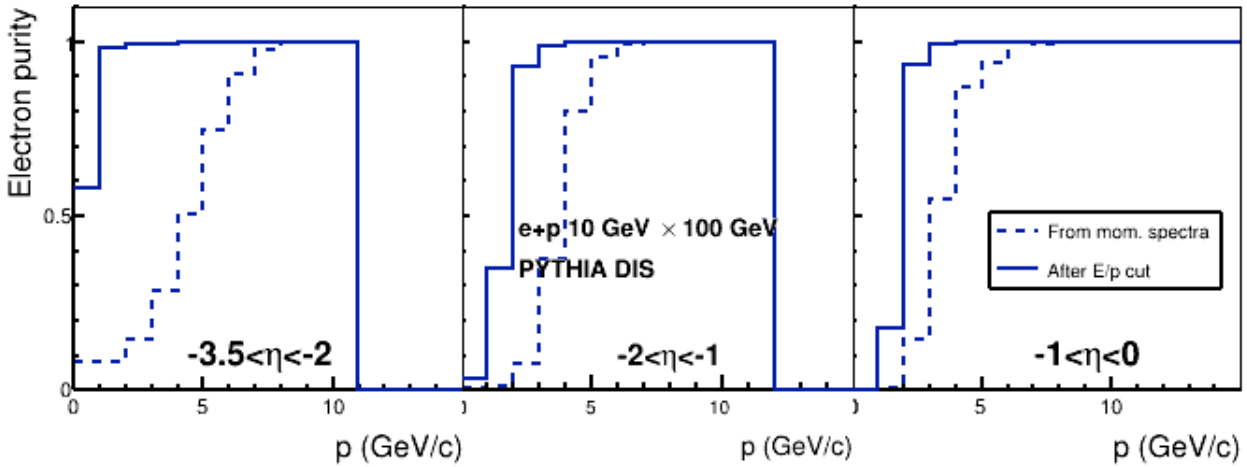
-3.5<η<-2	-2<η<-1	-1<η<1
$\frac{\sigma_E}{E} = \frac{2.5\%}{\sqrt{E}} \oplus 1\%$	$\frac{\sigma_E}{E} = \frac{7\%}{\sqrt{E}} \oplus 2\%$	$\frac{\sigma_E}{E} = \frac{12\%}{\sqrt{E}} \oplus 2\%$

Purity = e / (e+h)



18 GeV × 275 GeV:

Clean eID at >4 GeV/c



10 GeV × 100 GeV:

Clean eID at >2-3 GeV/c

Need additional eID capabilities at p<4 GeV/c

On EMCal projectivity

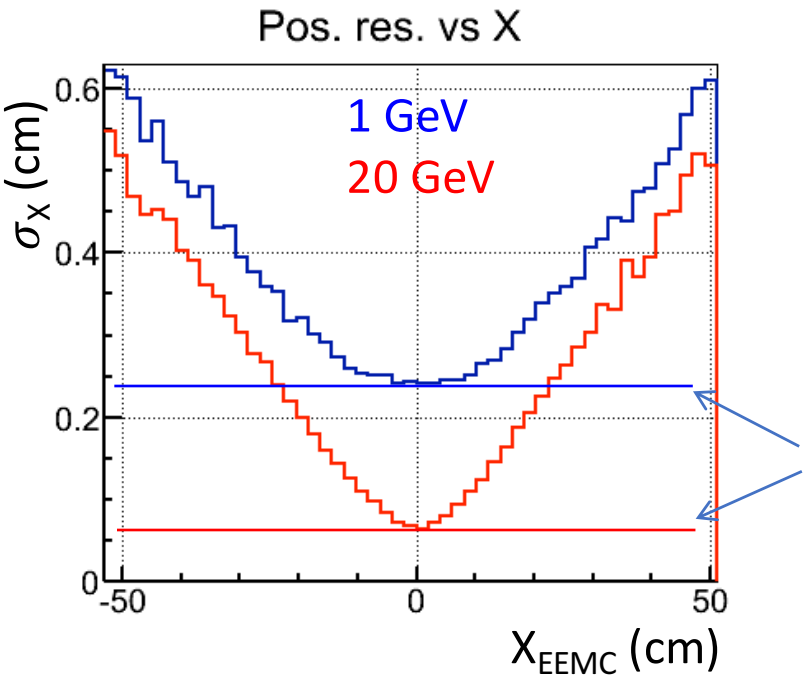
Directly affects:

Position Resolution

$\pi 0/\gamma$ discrimination

(Non)projectivity and position resolution

GEANT4: PWO endcap EMCal at z ~1.2m



For projective geometry

$$\sigma_X\left(E,\theta_X\right)=\sigma_X\left(E,0^0\right)\oplus d\sin\left(\theta_X\right)$$

For projective geometry

"Non-projectivity" term (from long. shower fluct.) $d\sim X_0$

Position resolution is dominated by "non-projectivity" term

Need to evaluate the impact on physics measurements

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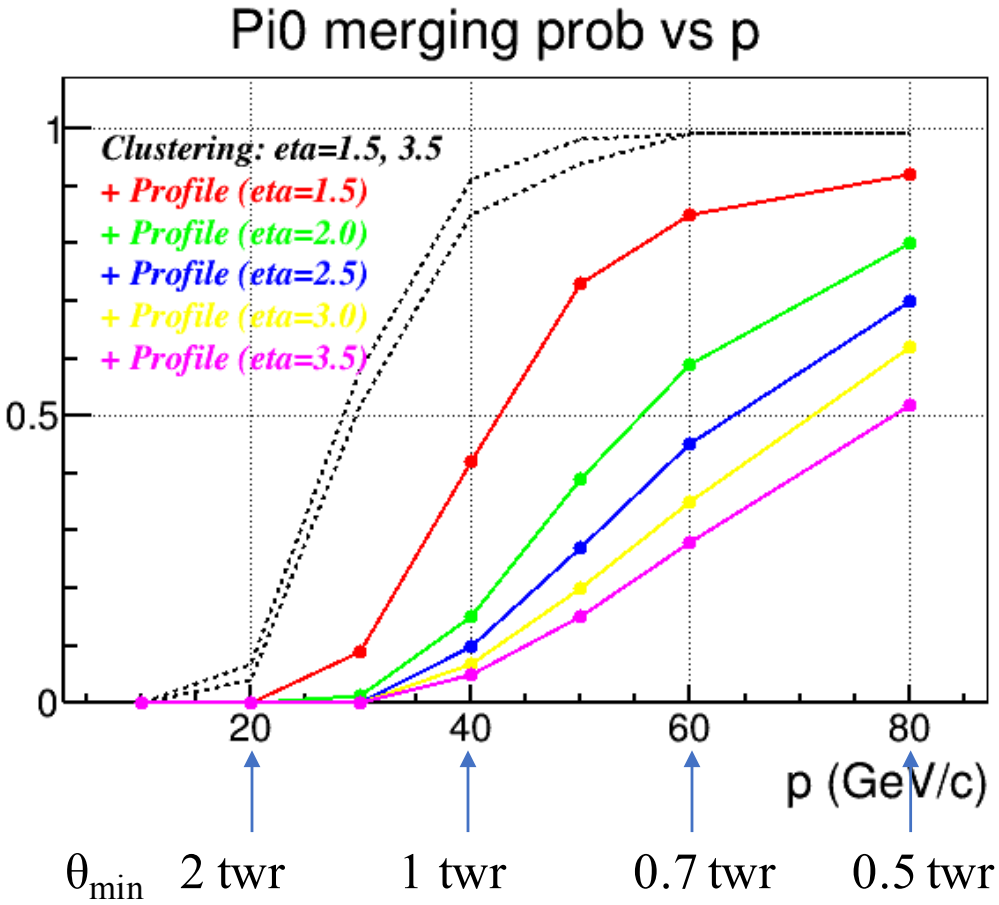
(Non)projectivity and π0/γ discrimination

$$\theta_{min} = \frac{2m_{\pi 0}}{E_{\pi 0}}$$



GEANT4:
Forward **non-projective** EMCal with granularity ~0.007 (d×d=2×2cm^2 at Z=3m)

Scalable with Z and d:

$Z \rightarrow Z \cdot k \quad p \rightarrow p \cdot k$

$d \rightarrow d \cdot k \quad p \rightarrow p/k$

For projective geometry:
All colored lines expected to be at or below the magenta one

Backup