Systematic Uncertainty of Electron during Low Momentum and Large Angle

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Tracking systematic uncertainty for $e^+(e^-)$

- Dataset: round11 Jpsi dataset
- MC: round11 inclusive Jpsi MC.

- Good Charged Tracks
  - $|V_z| < 10$ and $|V_{xy}| < 1$
  - $|cos\theta| < 0.93$
  - $N_{trk} \geq 3$
- PID: $1\ \pi^+, 1\ \pi^-, 1 e^-(e^+)$
- Good Photon
  - $|cos\theta| < 0.8$ and $E_{min} > 25$MeV .
  - $0.86 < |cos\theta| < 0.92$ and $E_{min} > 50$MeV .
  - 20° isolation from any charged tracks.
  - 0<T<14
- Veto $M(\pi^+, \pi^-) \in (0.4676, 0.5276)$GeV
- VertexFit for $1\ \pi^+, 1\ \pi^-, 1 e^-(e^+)$ and $\chi^2 < 10$
- After VertexFit, $M^{rec}_{\pi^+\pi^-e^-} \in (0.115, 0.15)$ GeV
- Select best $M^{rec}_{\pi^+\pi^-e^-\gamma}$ to electron mass PDG
- 1C Kinematic Fit $\pi^+\pi^-e^-\gamma$ and $\chi^2 < 10$

- Vertex Point Distance $D_{V0V1} < 1$ cm and $D_{V0V2} < 1$ cm
  - Vertex Point V0 for $\pi^+\pi^-$, V1 for $\pi^+ e^-$, V2 for $\pi^- e^-$

- Other Tracks: have the mini angle during the missing track.
- Find e^+: have another track and mini angle < 90°
- Not Find e^+: no another track or mini angle > 90°

rowNo	decay initial-final states	iDcyIFSts	nEtr	nCEtr
1	$J/\psi \dashrightarrow e^+e^-\pi^+\pi^-\gamma^F$	1	1990	1990
2	$J/\psi \dashrightarrow \pi^0\pi^+\pi^-$	0	1748	3738
3	$J/\psi \dashrightarrow \mu^+\mu^-$	4	4	3742
4	$J/\psi \dashrightarrow \pi^+\pi^-\gamma$	3	1	3743
5	$J/\psi \dashrightarrow e^+e^-\pi^+\pi^-\gamma^F\gamma$	2	1	3744
6	$J/\psi \dashrightarrow \pi^0\pi^0\pi^+\pi^-$	5	1	3745
7	$J/\psi \dashrightarrow e^+e^+e^-e^-\pi^+\pi^-$	6	1	3746
8	$J/\psi \dashrightarrow \pi^+\pi^+\pi^-\pi^-$	7	1	3747
9	$J/\psi \dashrightarrow \pi^0\pi^+\pi^-\gamma$	8	1	3748

Pure level > 99.7%

Tracking systematic uncertainty for $e^+(e^-)$

- The efficiency:

$$\epsilon = \frac{N_1}{N_1 + N_0}$$

Where N_1 is the number with two good charged tracks events, N_0 is the number with one good charged tracks events.

- The systematic error:

$$\delta = \frac{\epsilon_{data} - \epsilon_{MC}}{\epsilon_{MC}}$$

Where ϵ_{data} is the efficiency of data, ϵ_{MC} is the efficiency of MC.

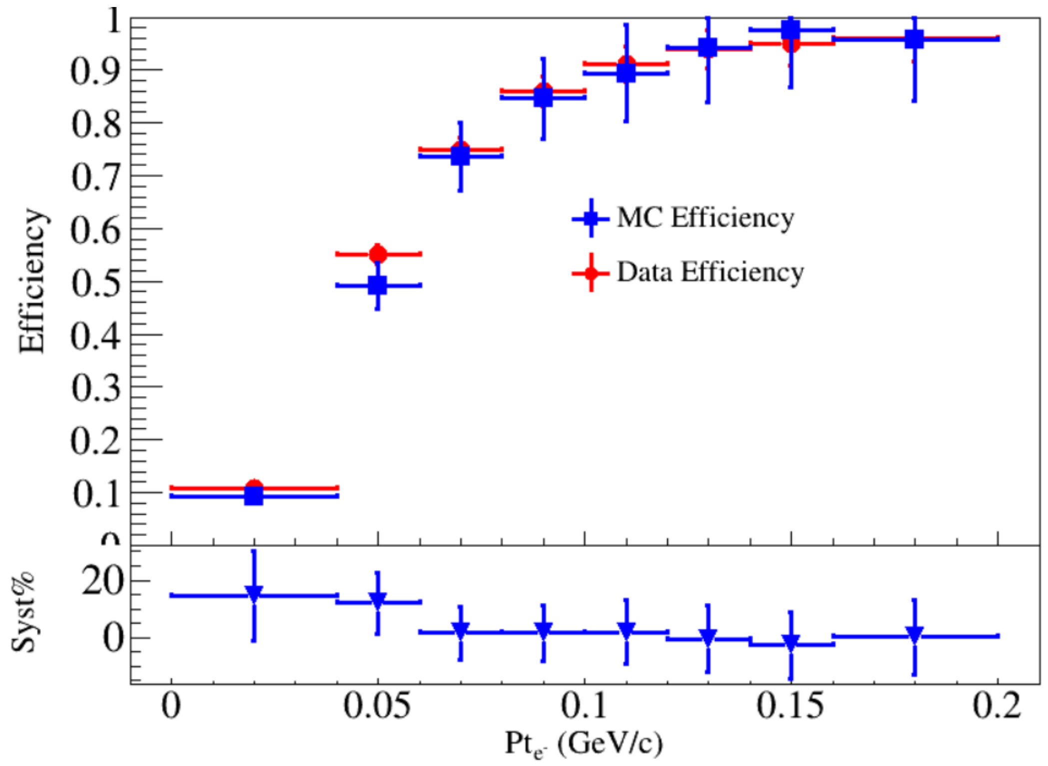
- The error of systematic error:

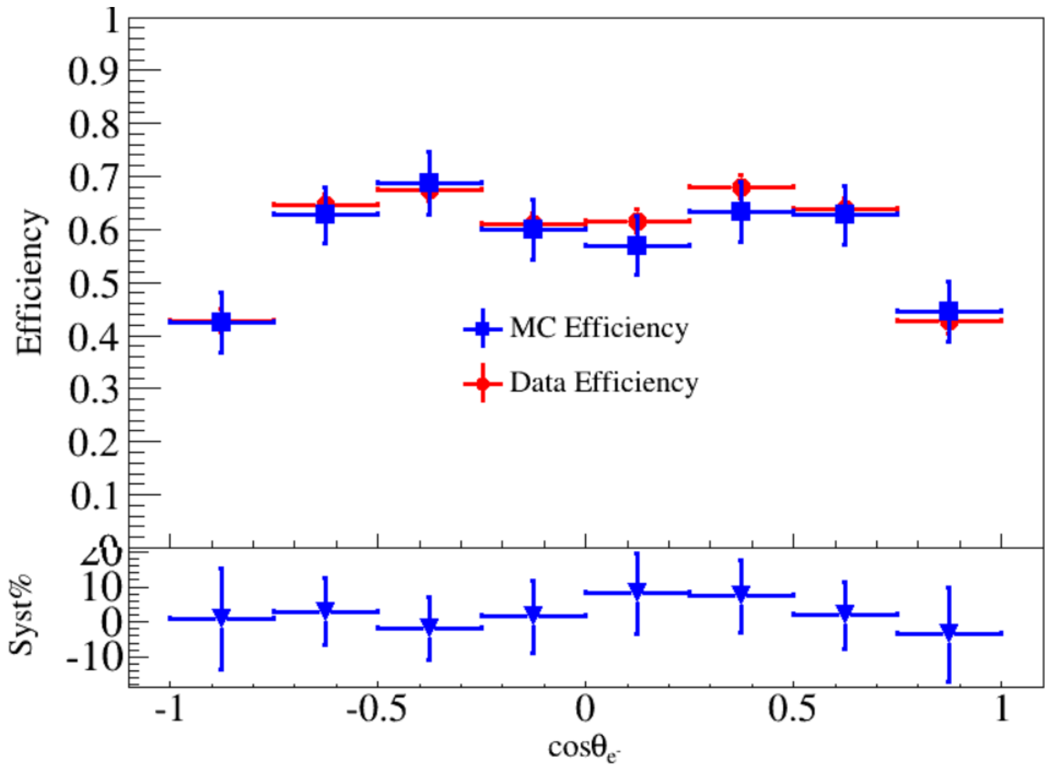
$$\Delta(\delta) = \frac{\epsilon_{data}}{\epsilon_{MC}} \times \sqrt{(\frac{\delta_{data}}{\epsilon_{data}})^2 + (\frac{\delta_{MC}}{\epsilon_{MC}})^2}$$

Where ϵ_{data} is the efficiency of data, ϵ_{MC} is the efficiency of MC, δ_{data} is the error of efficiency of data, δ_{MC} is the error of efficiency of MC.

Tracking systematic uncertainty for $e^{+}(e^{-})$

After 2D weight





PID systematic uncertainty for $e^+(e^-)$

- Dataset: round11 Jpsi dataset
- MC: round11 inclusive Jpsi MC.

- Good Charged Tracks
  - $|V_z| < 10$ and $|V_{xy}| < 1$
  - $|cos\theta| < 0.93$
  - $N_{trk} \geq 4$
- PID: $1\ \pi^+, 1\ \pi^-, 1e^-(e^+)$
- Good Photon
  - $|cos\theta| < 0.8$ and $E_{min} > 25\text{MeV}$.
  - $0.86 < |cos\theta| < 0.92$ and $E_{min} > 50\text{MeV}$.
  - 20° isolation from any charged tracks.
  - 0<T<14
- Veto $M(\pi^+, \pi^-) \in (0.4676, 0.5276)\text{GeV}$
- 4C Kinematic Fit $\pi^+\pi^-e^-\gamma$ and other tracks and select mini χ^2 and $\chi^2 < 10$
- After 4C, $M_{e^-e^+\gamma} \in (0.115, 0.15)$ GeV
- Use GammaConv Package for e^- and candidate track.
  - $R_{xy} < 1\text{cm}$

- PID e^+: the candidate track is pid to e^+
- Not PID e^+: the candidate track is not pid to e^+

Table 2: Decay initial-final states.

rowNo	decay initial-final states	iDcyIFSts	nEtr	nCEtr
1	$J/\psi \dashrightarrow e^+e^-\pi^+\pi^-\gamma^F$	0	5569	5569
2	$J/\psi \dashrightarrow \pi^0\pi^+\pi^-$	1	18	5587
3	$J/\psi \dashrightarrow e^+e^-\pi^+\pi^-\gamma^F\gamma^F$	2	1	5588

Pure level > 99.5%

PID systematic uncertainty for $e^{+}(e^{-})$

- The efficiency:

$$\epsilon = \frac{N_1}{N_1 + N_0}$$

Where N_1 is the number with the track is identified as e, N_0 is the number with the track don’t be identified as e.

- The systematic error:

$$\delta = \frac{\epsilon_{data} - \epsilon_{MC}}{\epsilon_{MC}}$$

Where ϵ_{data} is the efficiency of data, ϵ_{MC} is the efficiency of MC.

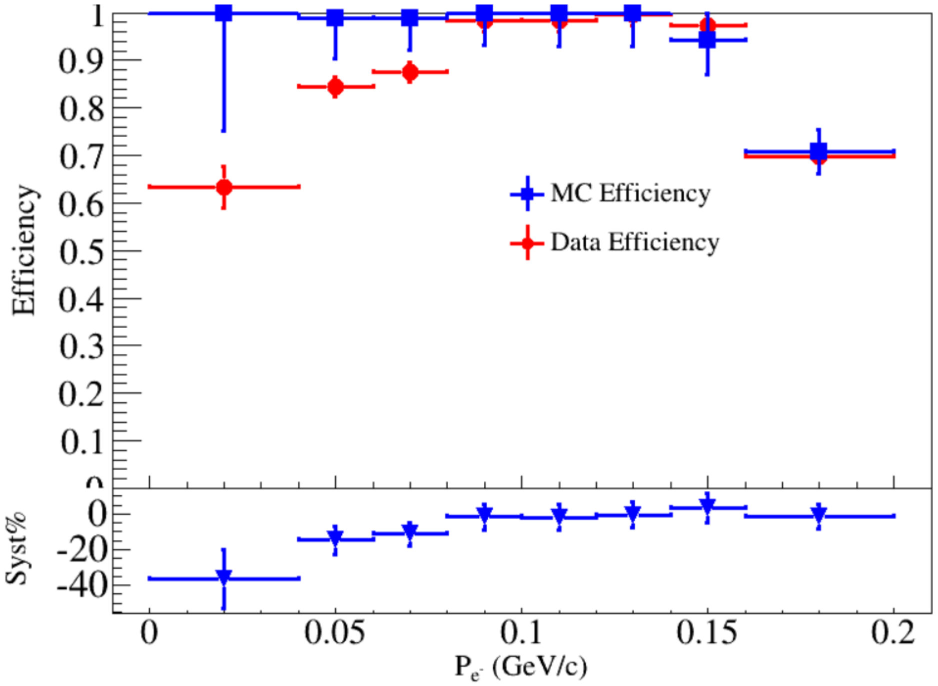
- The error of systematic error:

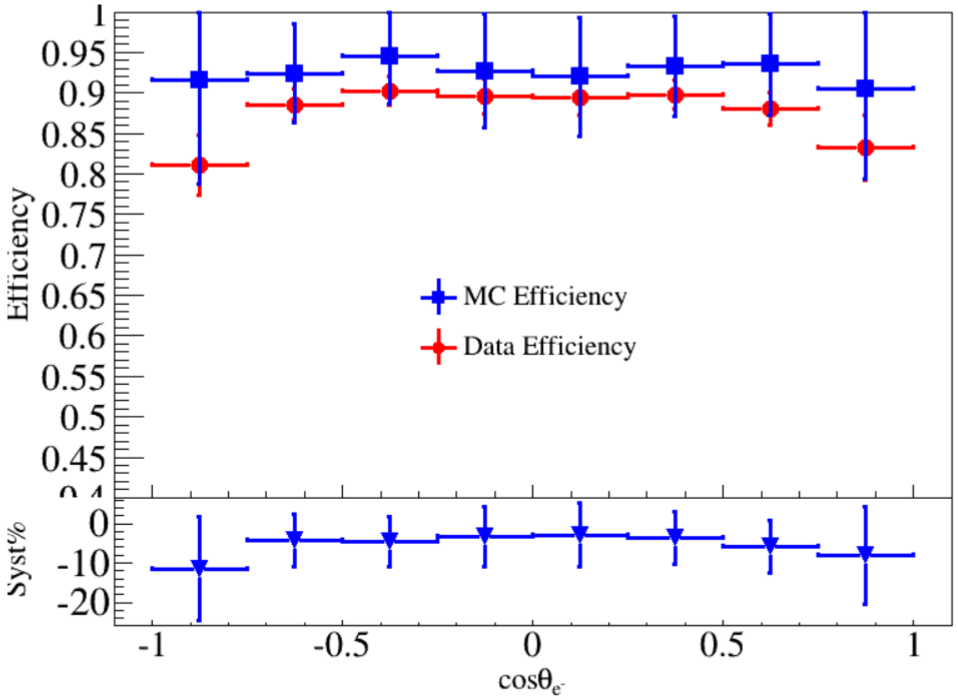
$$\Delta(\delta) = \frac{\epsilon_{data}}{\epsilon_{MC}} \times \sqrt{(\frac{\delta_{data}}{\epsilon_{data}})^2 + (\frac{\delta_{MC}}{\epsilon_{MC}})^2}$$

Where ϵ_{data} is the efficiency of data, ϵ_{MC} is the efficiency of MC, δ_{data} is the error of efficiency of data, δ_{MC} is the error of efficiency of MC.

PID systematic uncertainty for $e^+(e^-)$

After 2D weight





PID systematic uncertainty for $e^+(e^-)$

Study of electron tracking efficiency and PID efficiency

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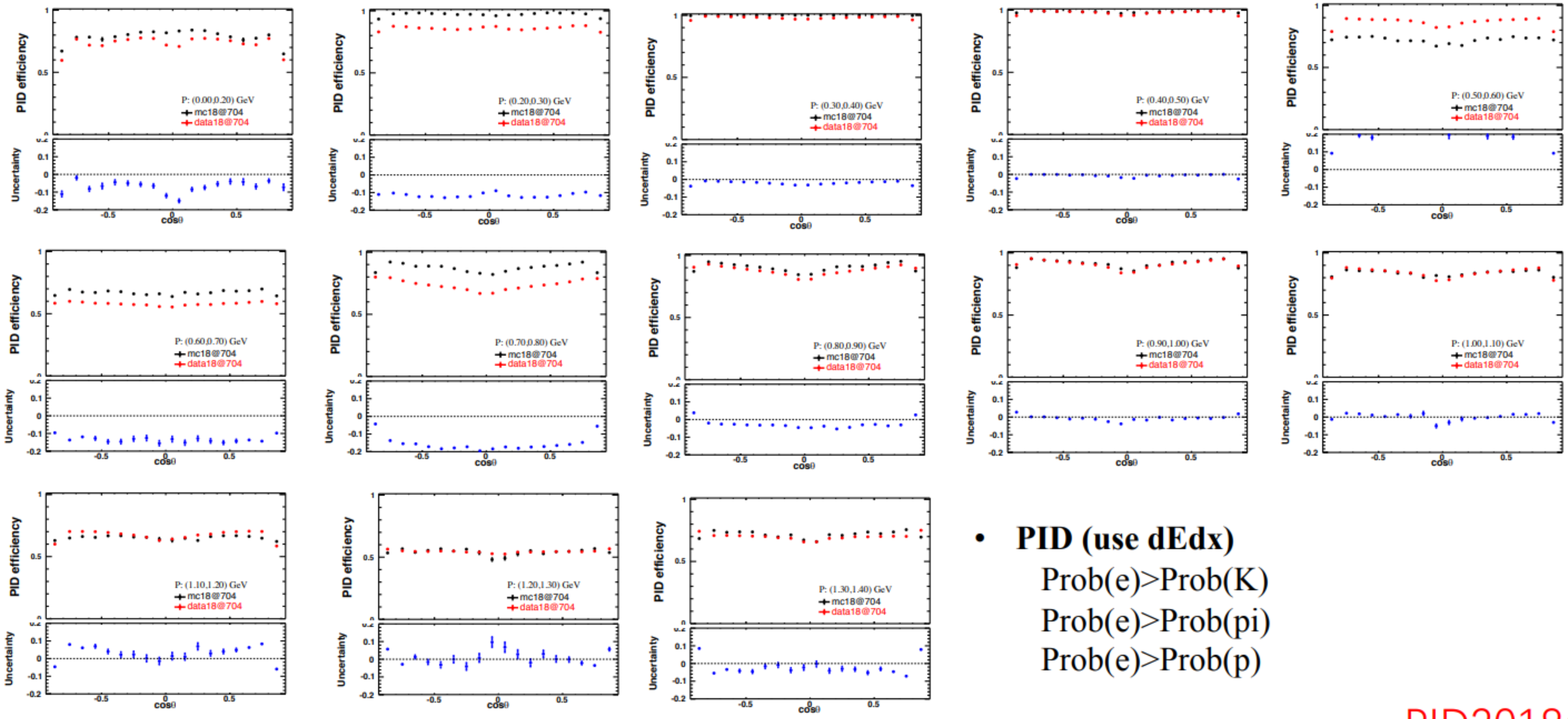
cosθ distribution in different p region



- **PID (use dEdx)**
  Prob(e)>Prob(K)
  Prob(e)>Prob(pi)
  Prob(e)>Prob(p)

PID2018@704

PID systematic uncertainty for $e^+(e^-)$

Study of electron tracking efficiency and PID efficiency

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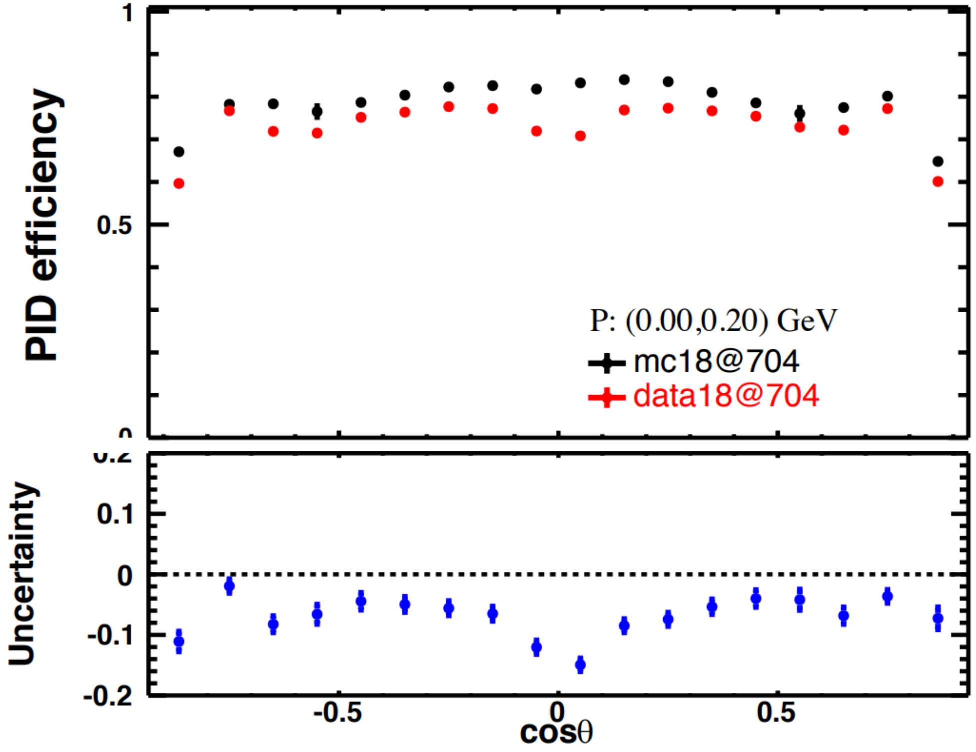


Δ_{trk}	(0.00,0.20)
(-0.93,-0.8)	99.95±0.22
(-0.8,-0.7)	99.03±0.09
(-0.7,-0.6)	99.98±0.13
(-0.6,-0.5)	100.05±0.14
(-0.5,-0.4)	99.89±0.13
(-0.4,-0.3)	99.89±0.14
(-0.3,-0.2)	100.13±0.20
(-0.2,-0.1)	100.02±0.17
(-0.1,0.0)	99.74±0.07
(0.0,0.1)	100.04±0.16
(0.1,0.2)	99.81±0.12
(0.2,0.3)	99.84±0.12
(0.3,0.4)	99.83±0.12
(0.4,0.5)	99.79±0.08
(0.5,0.6)	99.90±0.10
(0.6,0.7)	99.83±0.11
(0.7,0.8)	99.19±0.15
(0.8,0.93)	100.38±0.28

Correct efficiency

- Correct efficiency:

$$\epsilon' = \frac{\sum_{bin}(\sum_{i\in bin}\omega_i)}{N_0}$$

$$\epsilon_0 = \frac{\sum_{bin}(\sum_{i\in bin}1)}{N_0} = \frac{N_{rec}}{N_0}$$

- So

$$c = \frac{\sum_{bin}(\sum_{i\in bin}\omega_i)}{N_{rec}}$$

$$\sigma_c = \frac{\sqrt{\sum_{bin}(\sum_{i\in bin}\sigma_i)^2}}{N_{rec}}$$

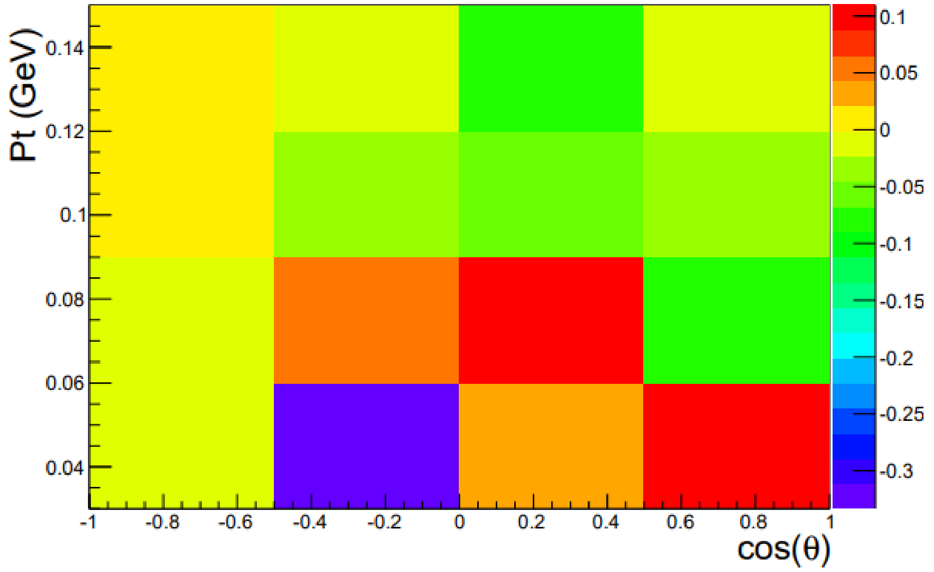
Correct efficiency

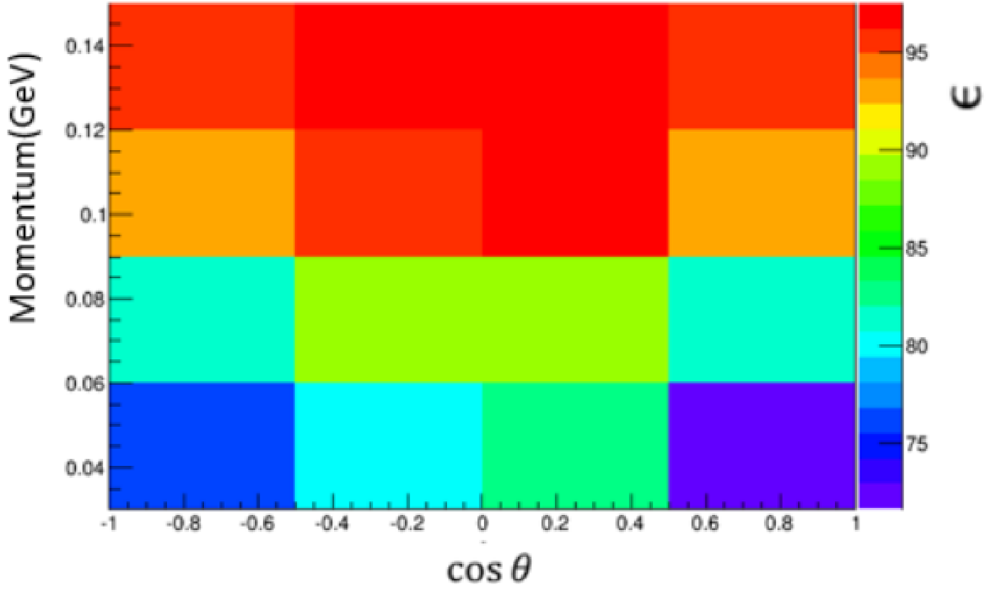
Scale Factor	Value
c_{trk}	1.227
c_{pid}	0.828
$c_{trk} \times c_{pid}$	1.016

Systematic Uncer	Value%	
Tracking	2.949	→ ~2
PID	2.311	→ ~1.5

Correct efficiency

$$e^+e^- \rightarrow \gamma e^+e^-$$





Tracking of Low momentum double $e^{\pm}$	2.9
PID of Low momentum double $e^{\pm}$	1.4