dE/dx PID Study

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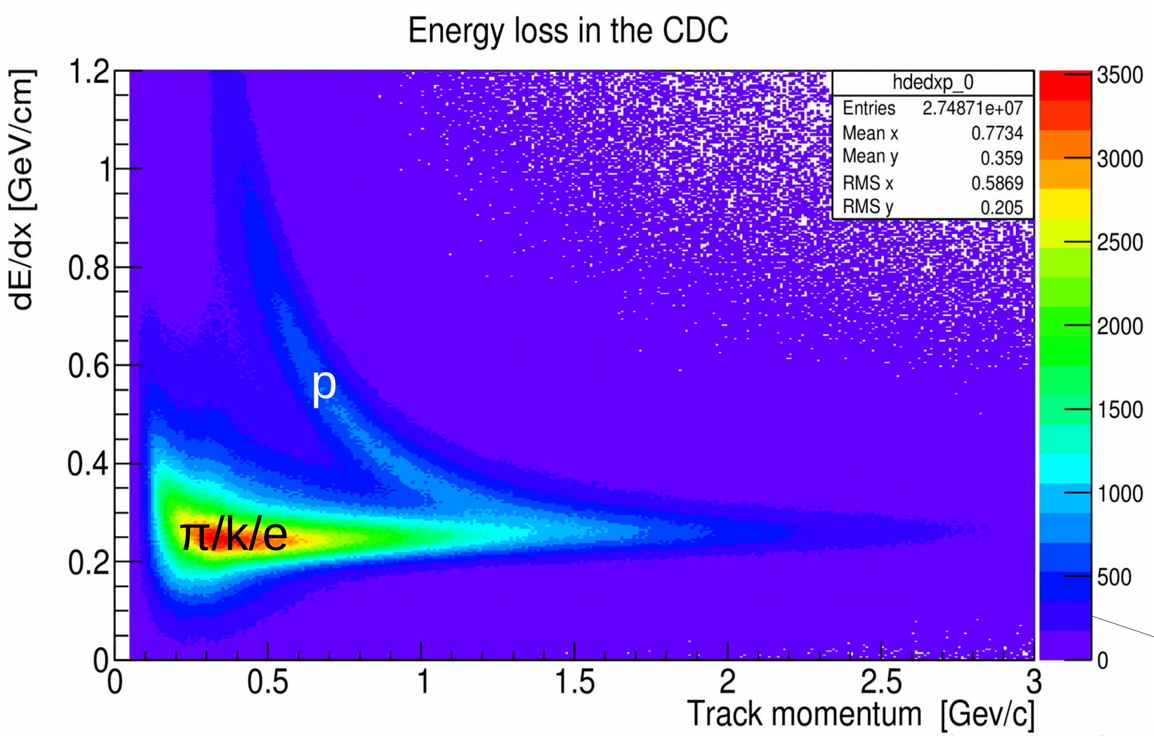
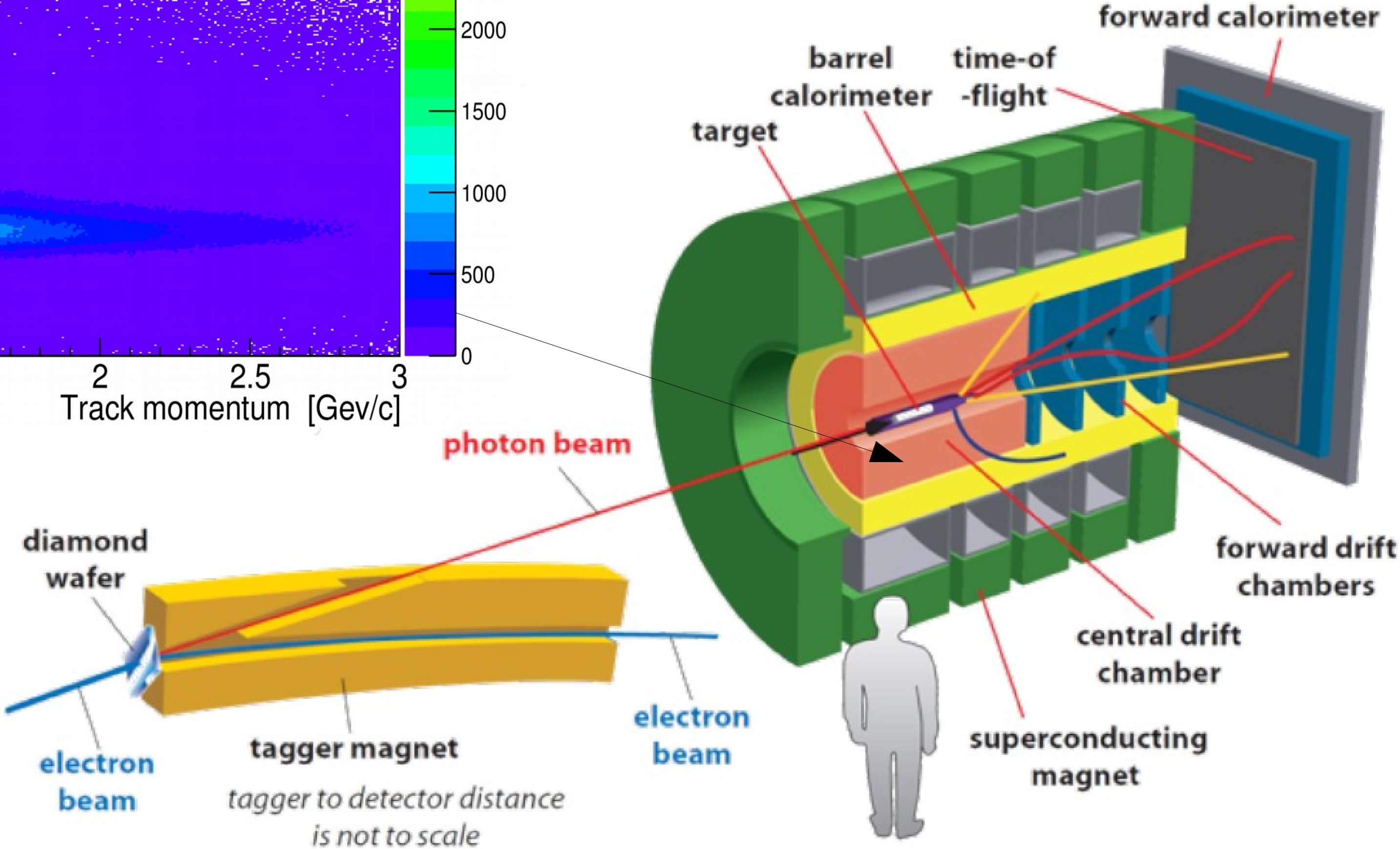
GlueX Collaboration Meeting

May 16, 2017

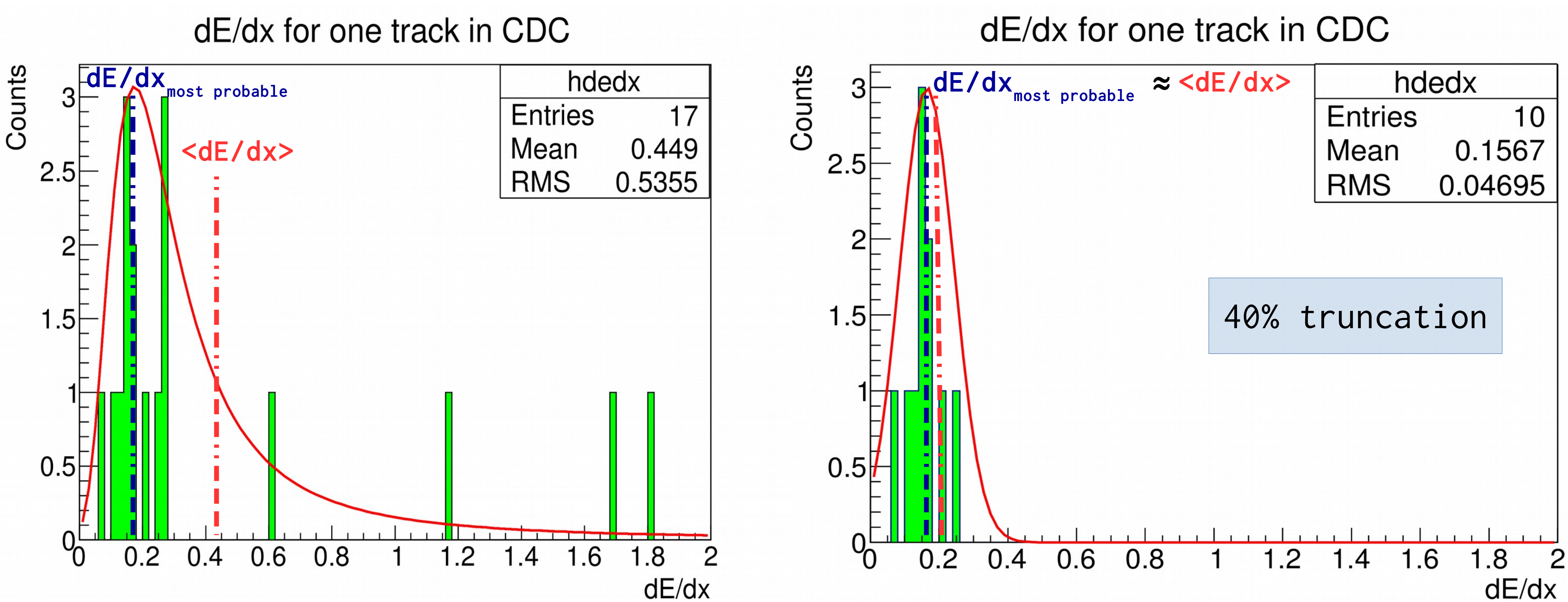
- Low Momentum charged particles will not reach outer detectors (e.g: recoiled protons)
- dE/dx measured in CDC will be the primary source for particle ID



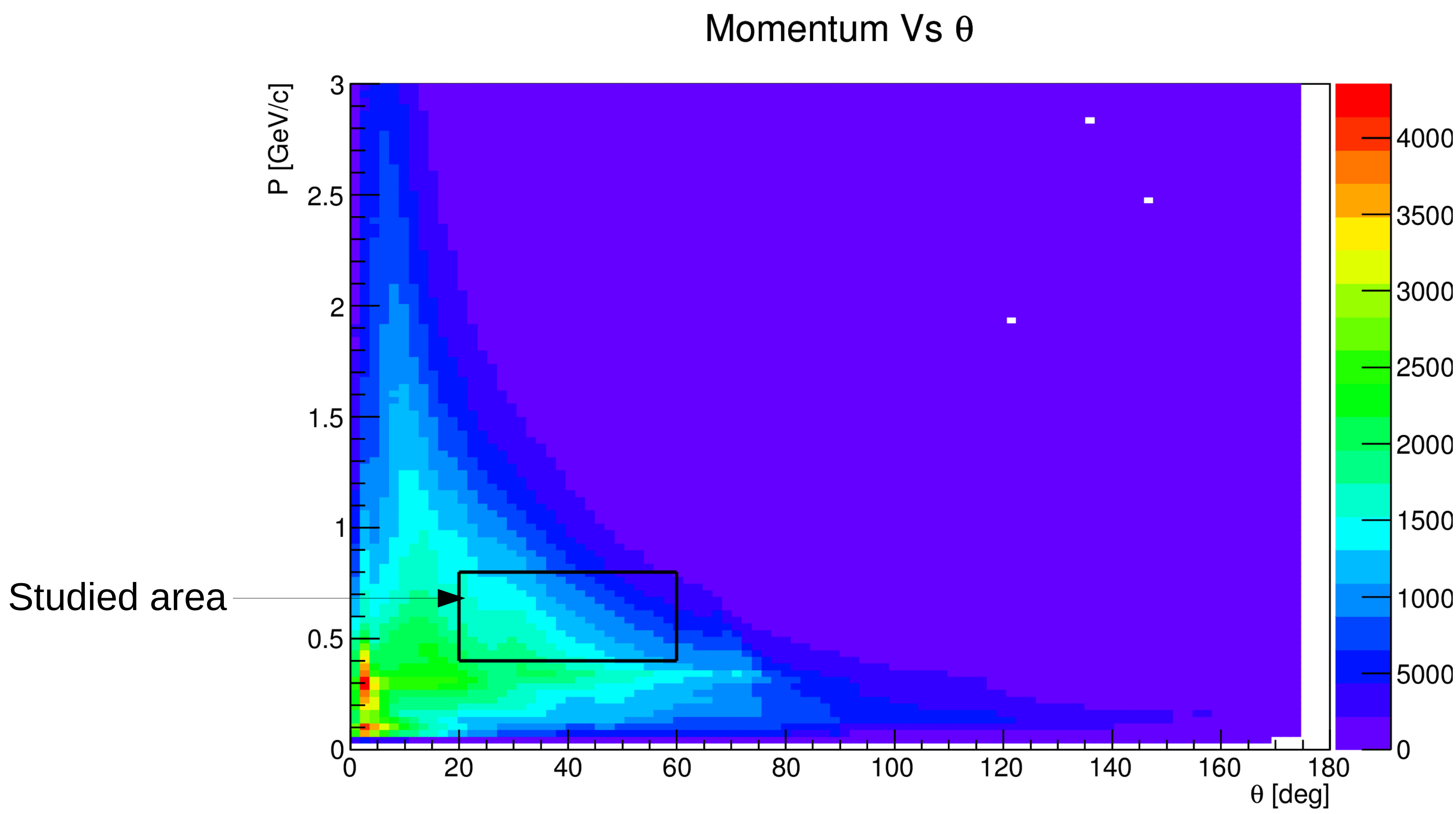


Motivation

- Goal: Achieve the optimal separation of different particle types using dE/dx
  - Estimate dE/dx mean value and eventually the width.
- Method: Truncated mean
  - Drop some hits with largest dE/dx values from the track
  - Optimize truncation by:
    - 1st method: best resolution.
    - 2nd method: Strongest separation power
    - 3rd method: lowest mis-id

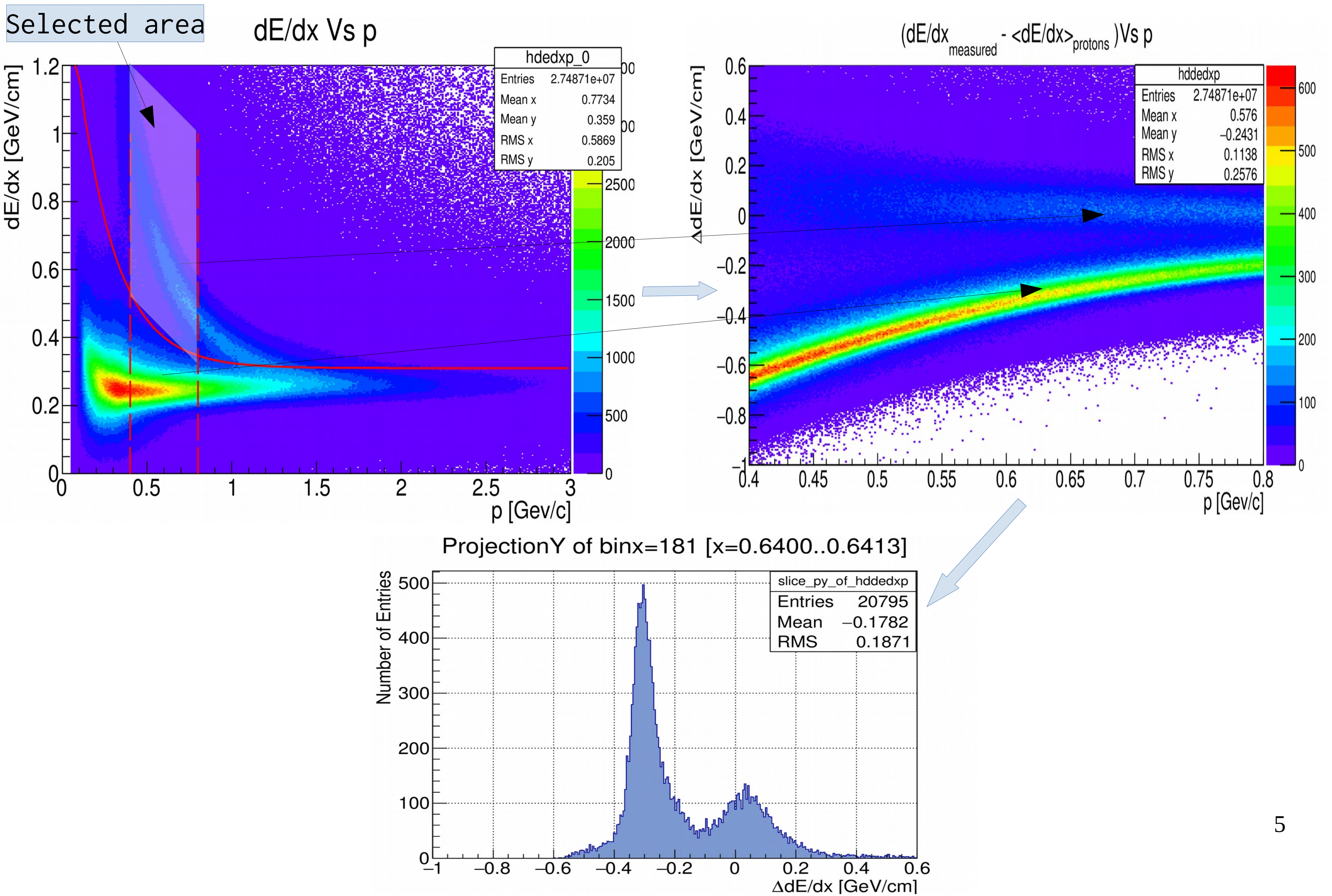


- Spring 2016 data, 10 runs.
- All the tracks in the CDC
- Truncation dependence on P(0.4 - 0.8 GeV/c) & θ (20° - 60°)



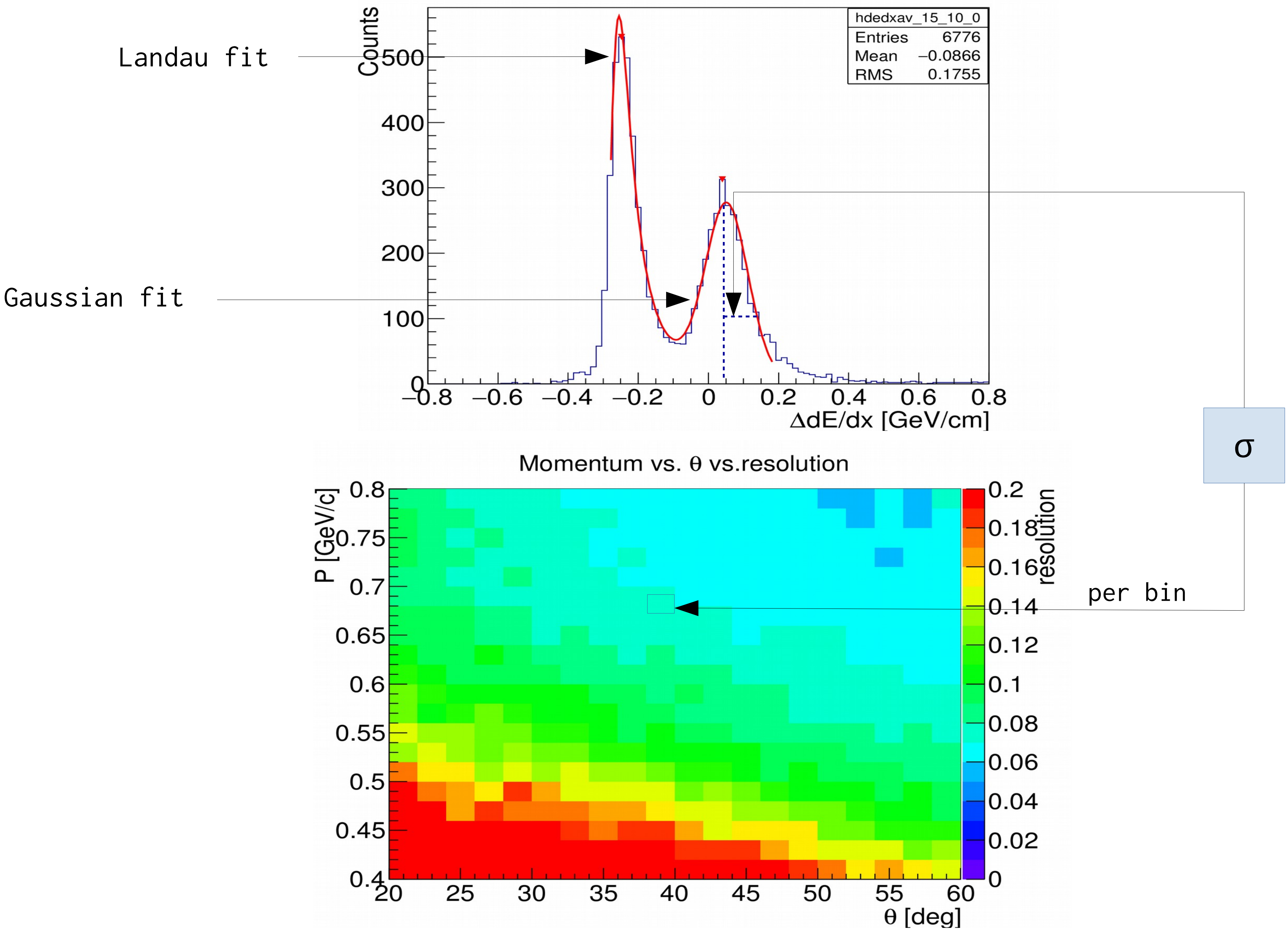
Procedure

- 1st Step: Select the protons.



Resolution

- 1st method: best resolution => optimal truncation.



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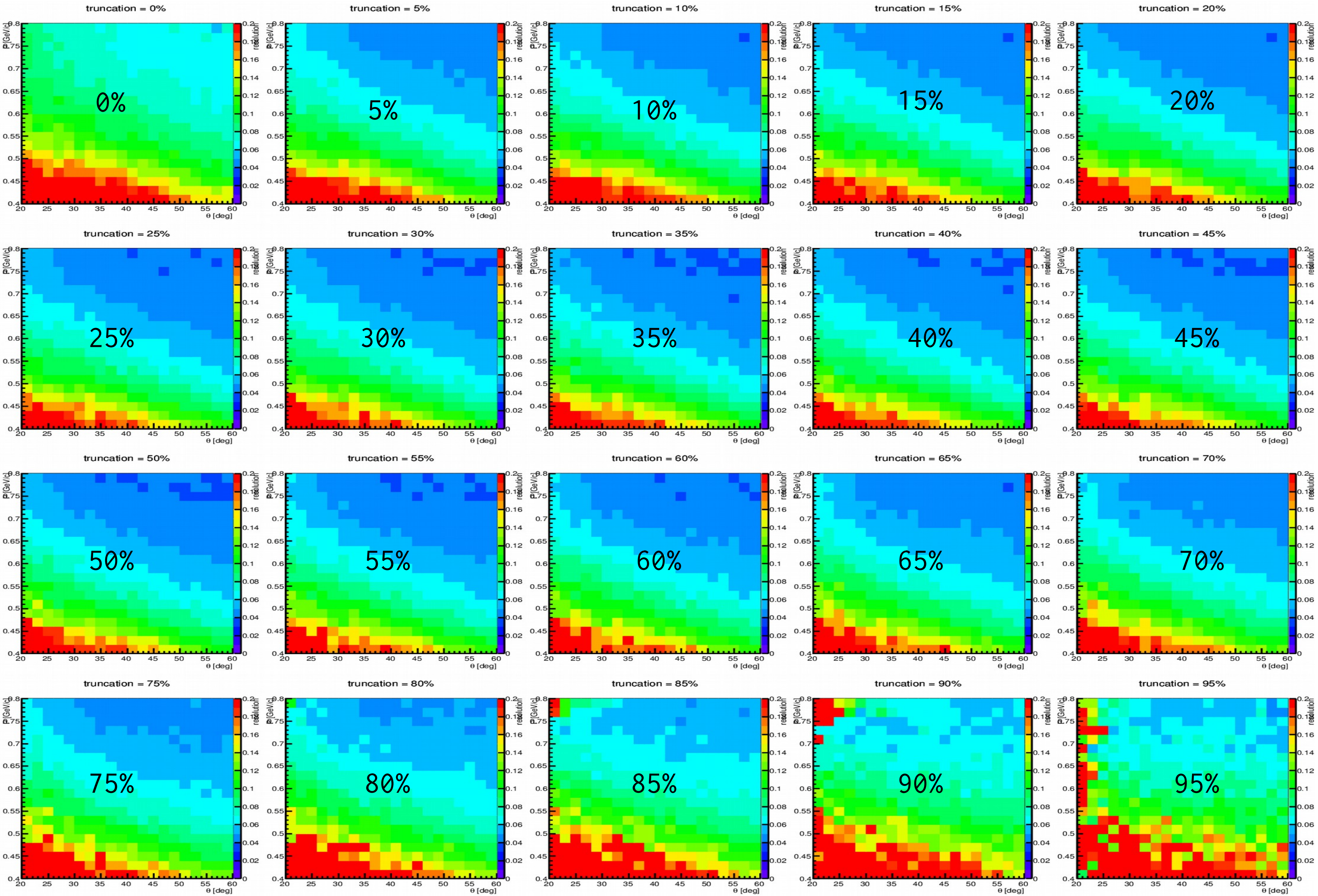
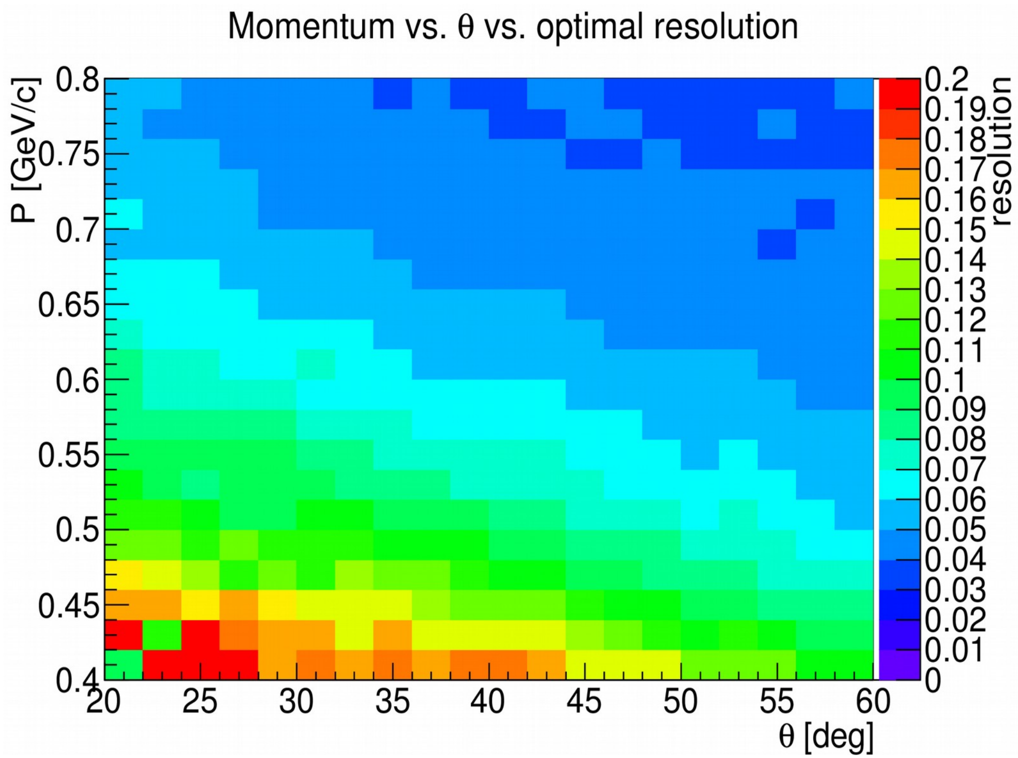
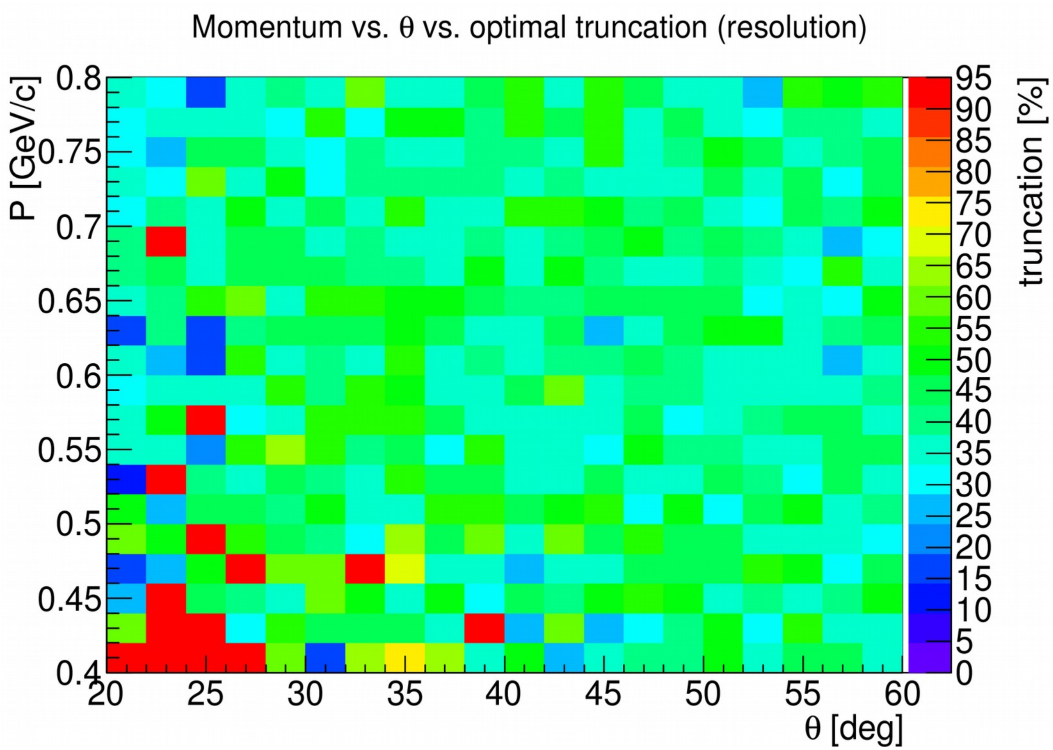
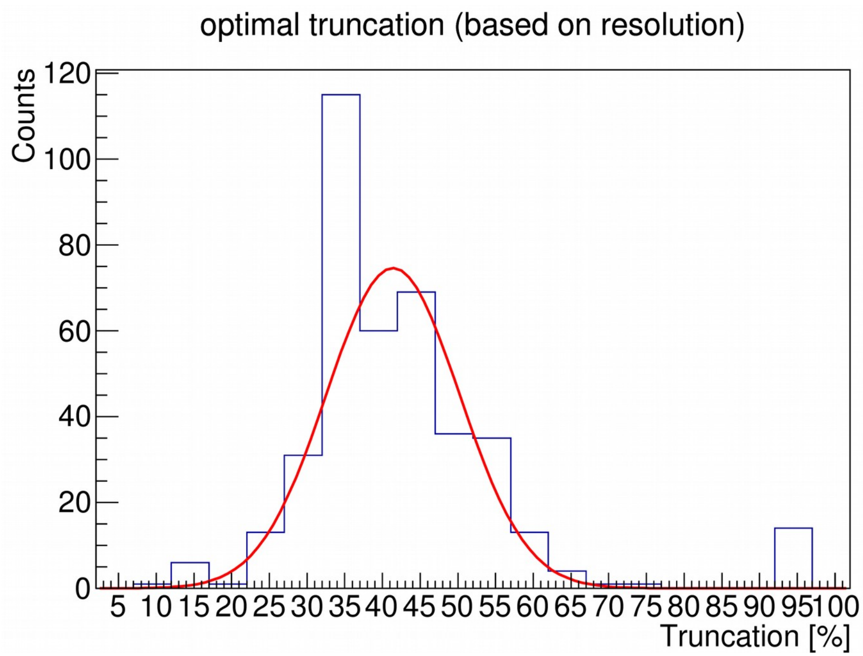


Resolution

- 1^{st} method: optimal truncation ~40%

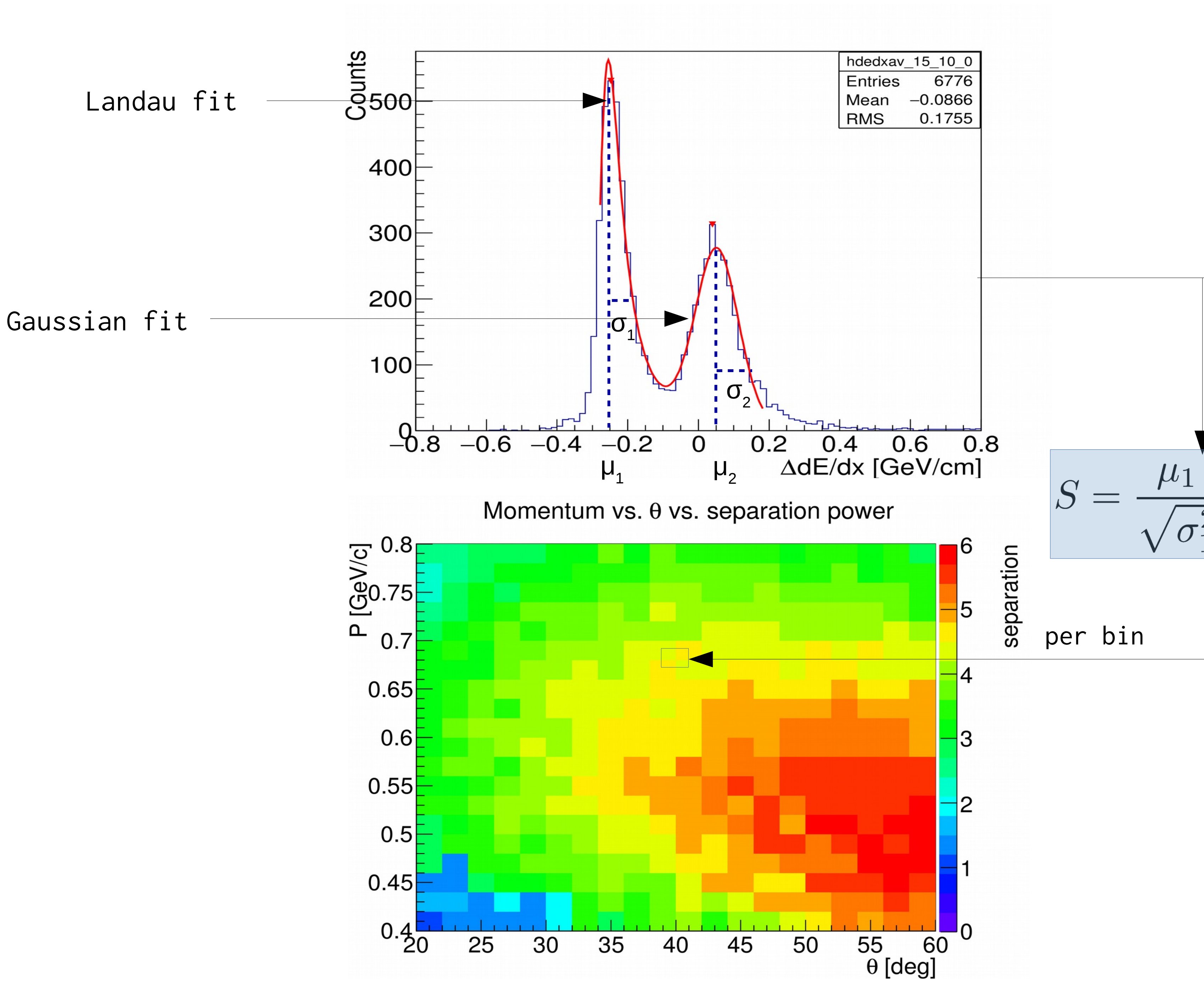






Separation Power

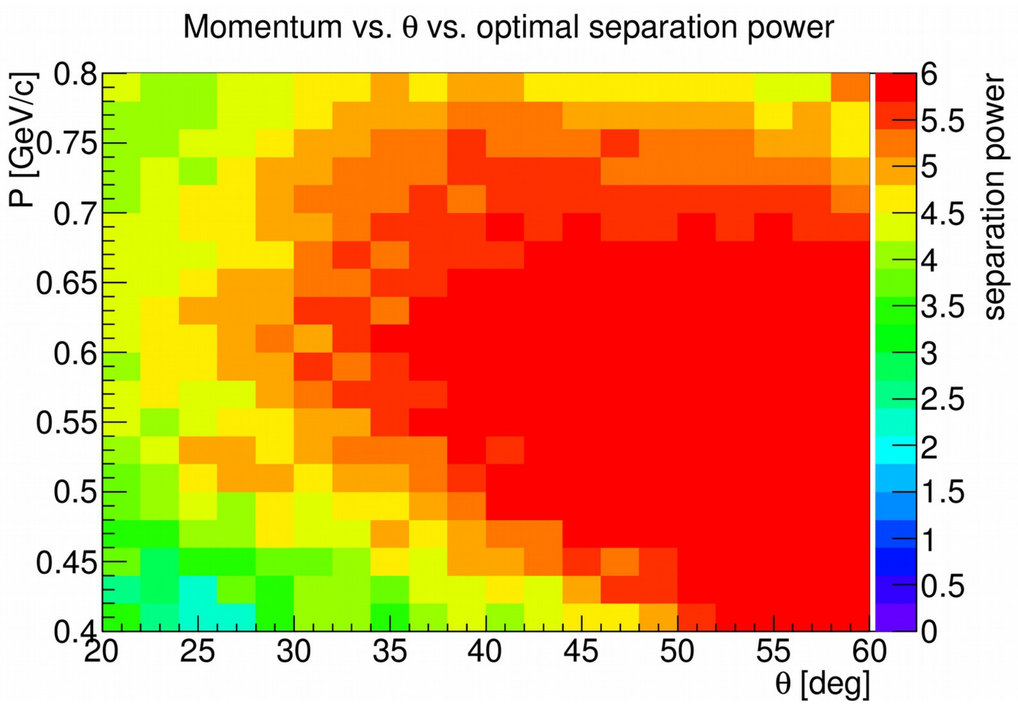
- 2nd method: strongest separation power => optimal truncation.

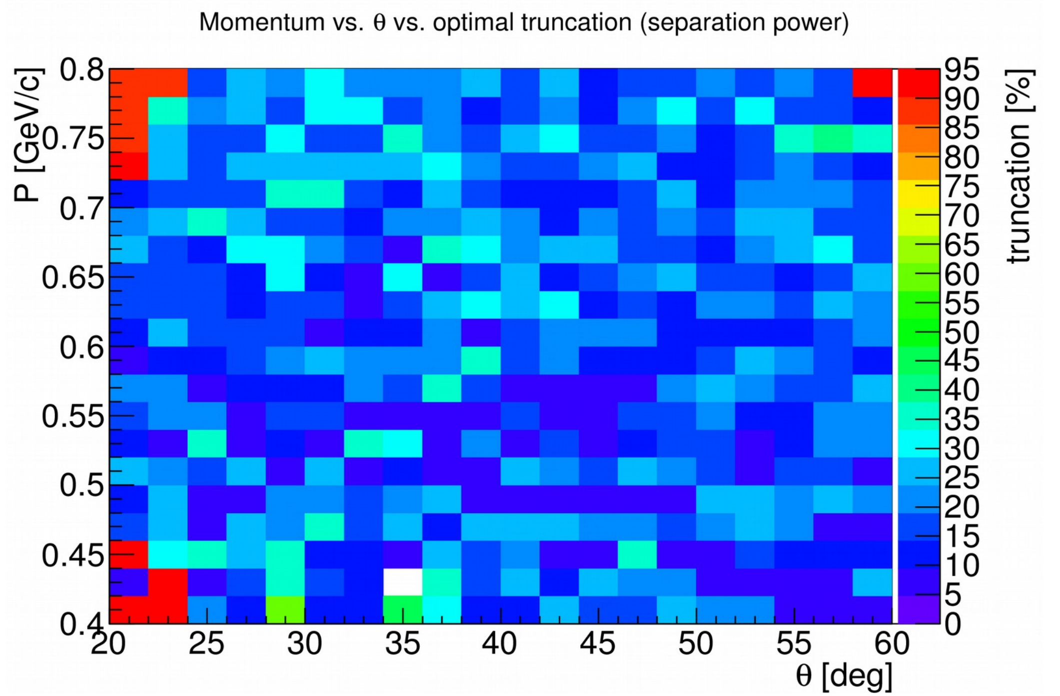


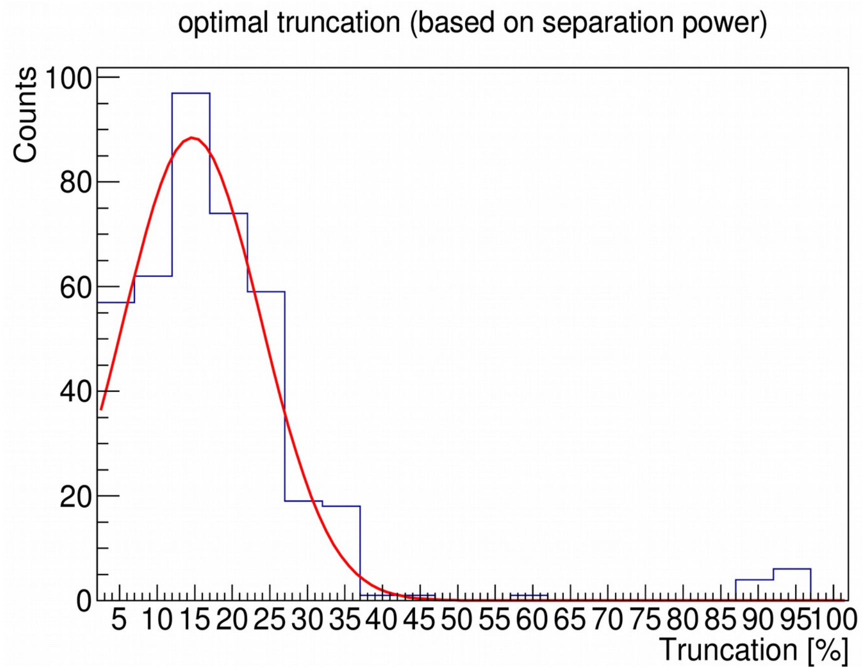
$$S = \frac{\mu_1 - \mu_2}{\sqrt{\sigma_1^2 + \sigma_2^2}}$$

Separation Power

- 2^{nd} method: optimal truncation ~15%

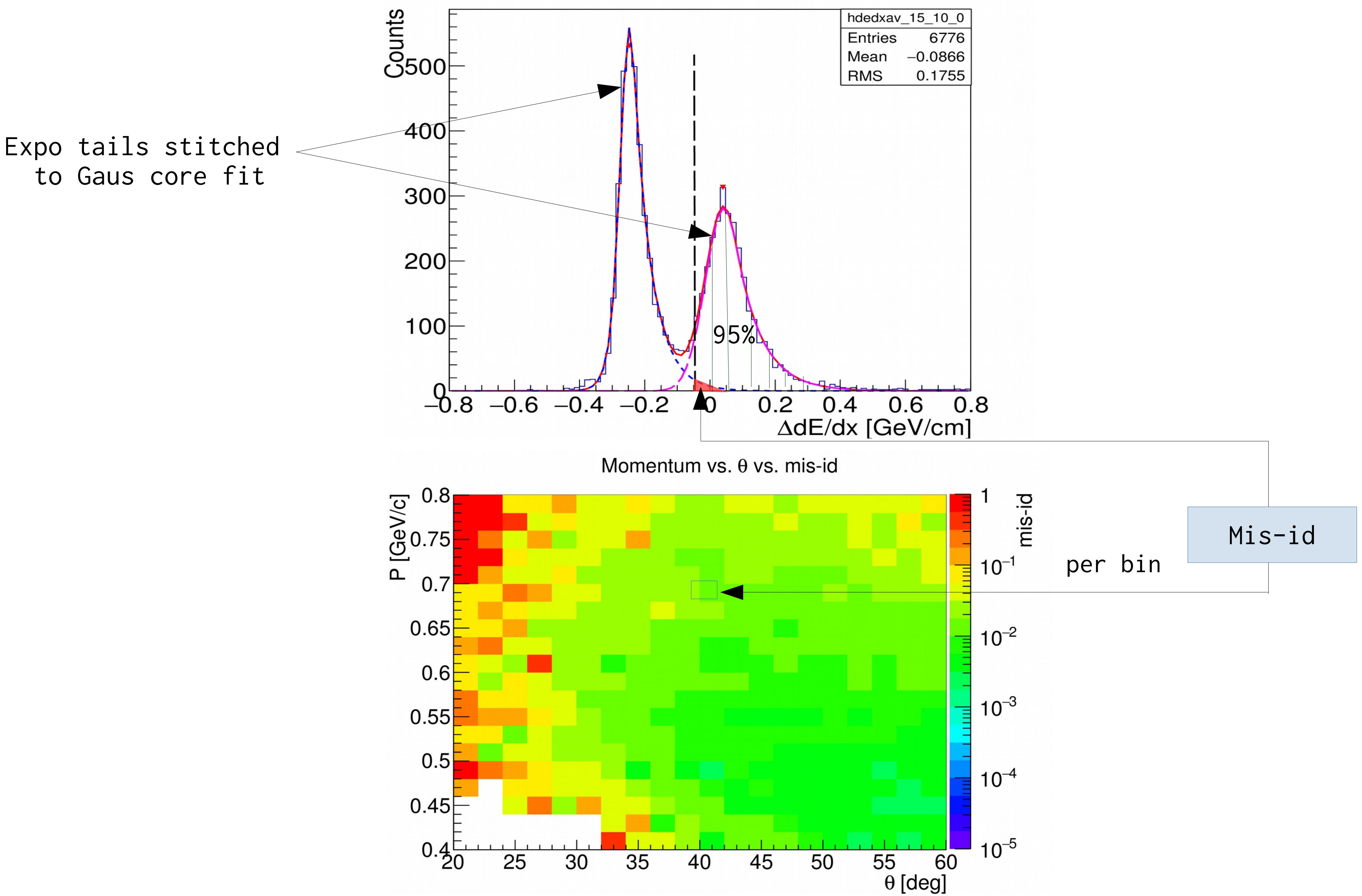






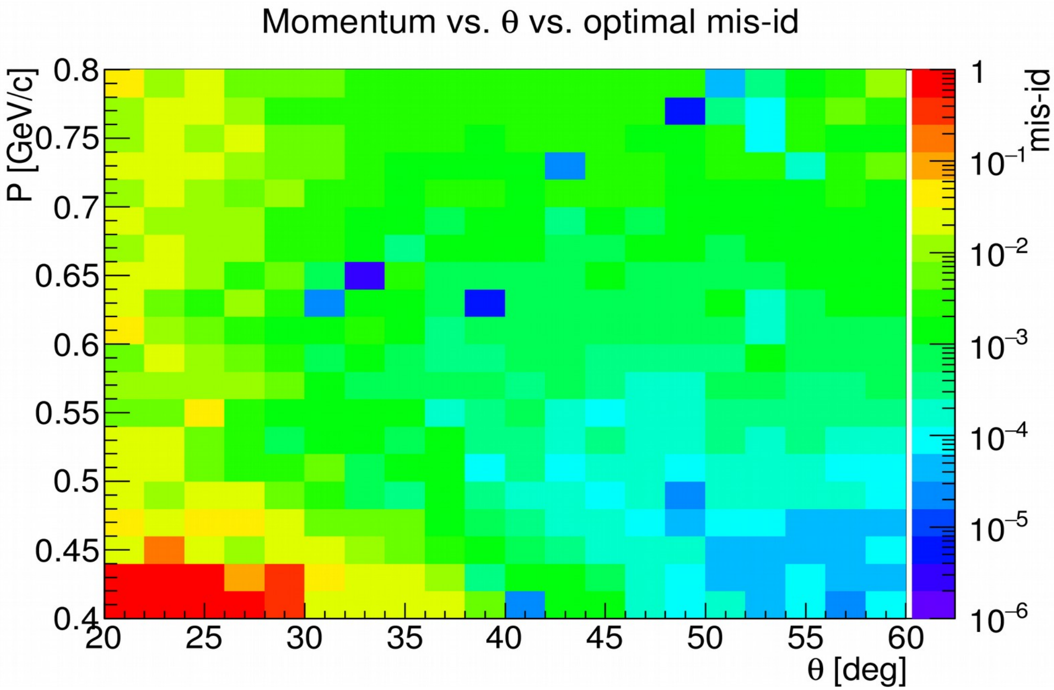
Mis-id

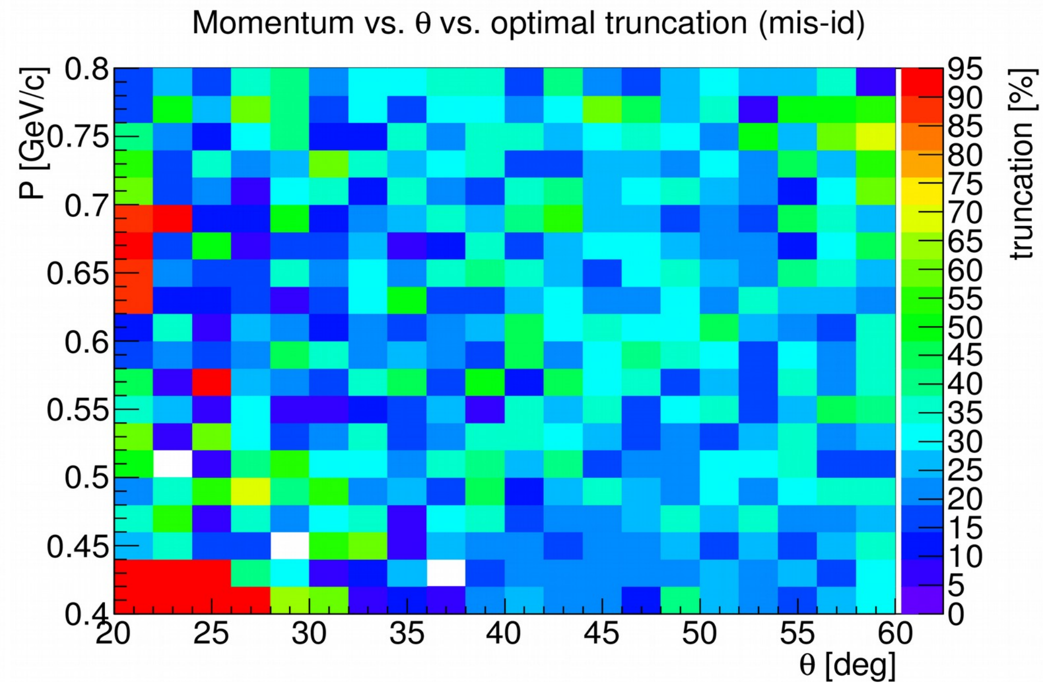
- 3rd method: lowest mis-id => optimal truncation.

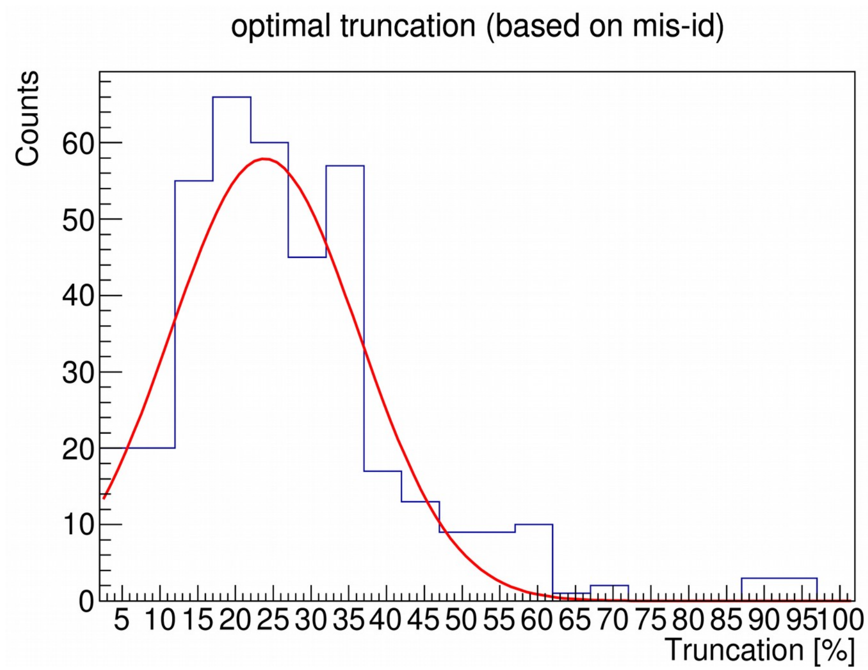


Mis-id

- 3^{rd} method: optimal truncation ~25%

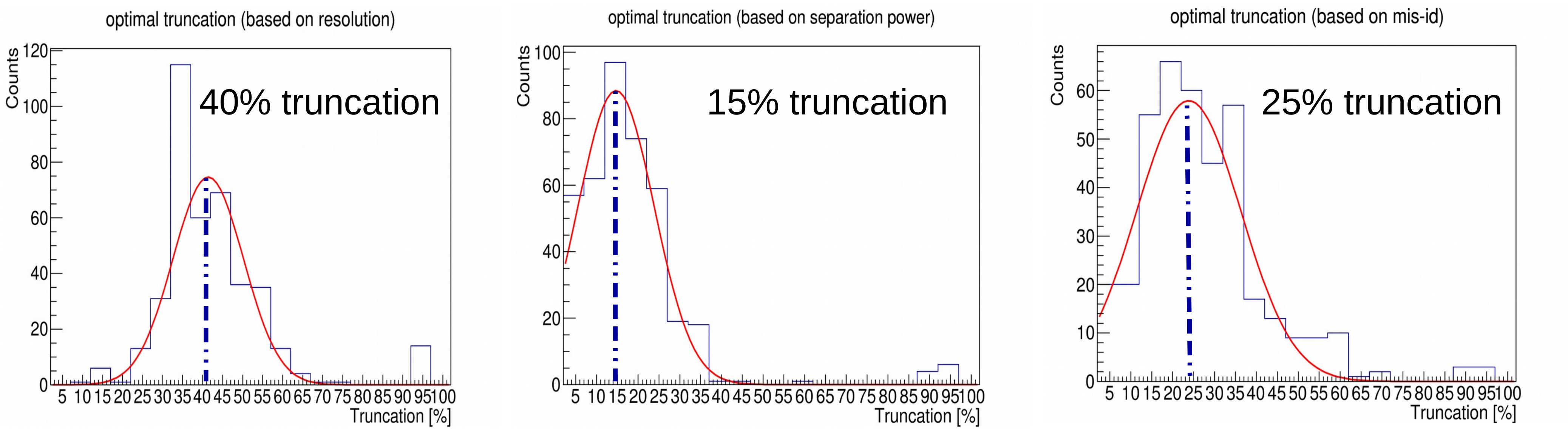






Results & perspectives

- The dE/dx optimal truncations found are different from the currently used one (50%).
- The dE/dx optimal truncation is different for each classifier.



<u>Next</u>:

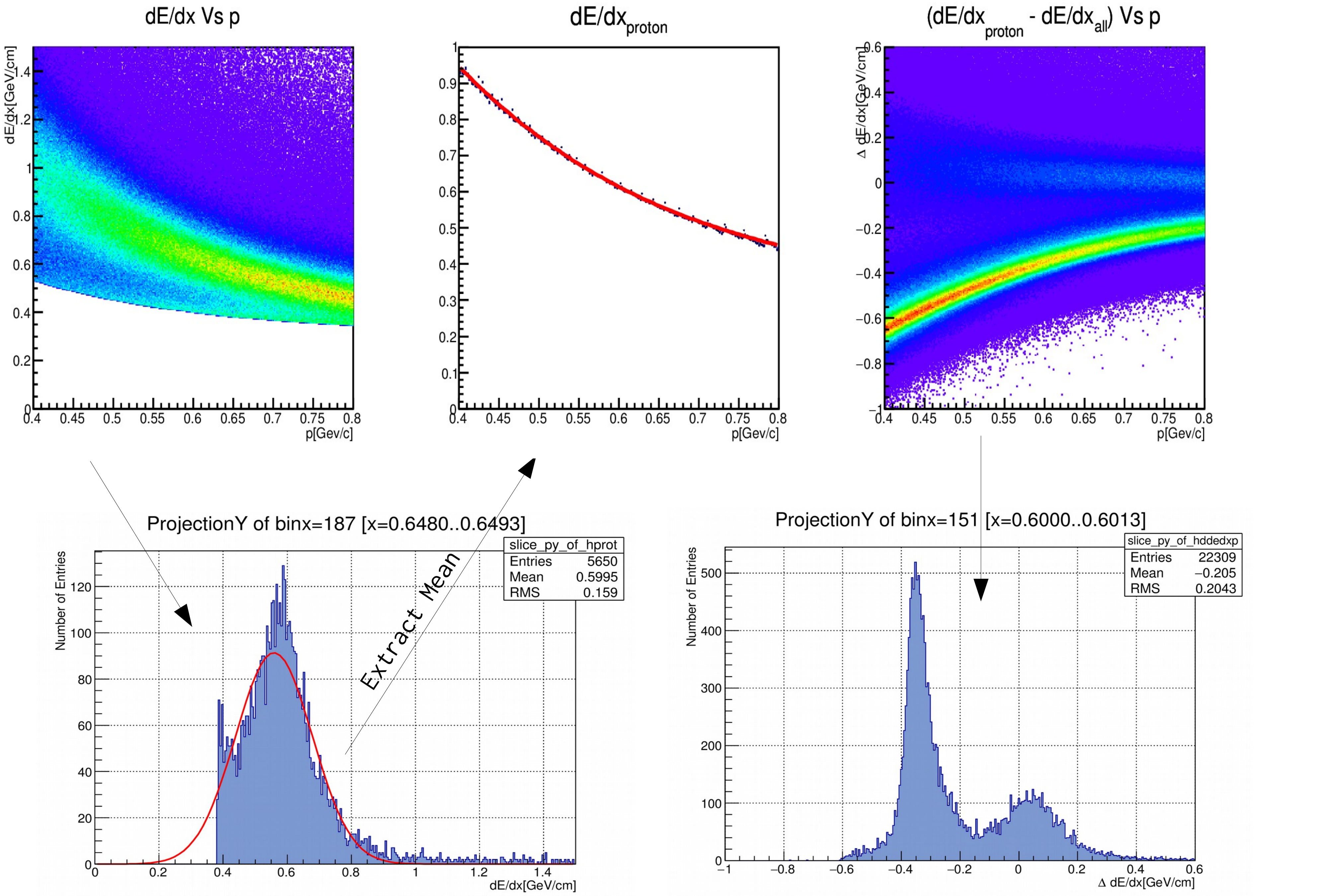
- Study the optimal truncation in exclusive channels:
  - Clean samples of different particles to improve separation power.
- Study the potential of a double truncated mean method.
- Study other possible calibration that might be needed (e.g.: entrance angle & space-charge effect).
- Determine dE/dx mean and resolution as function of particle velocity ($\beta\gamma$).

Thank you for your attention

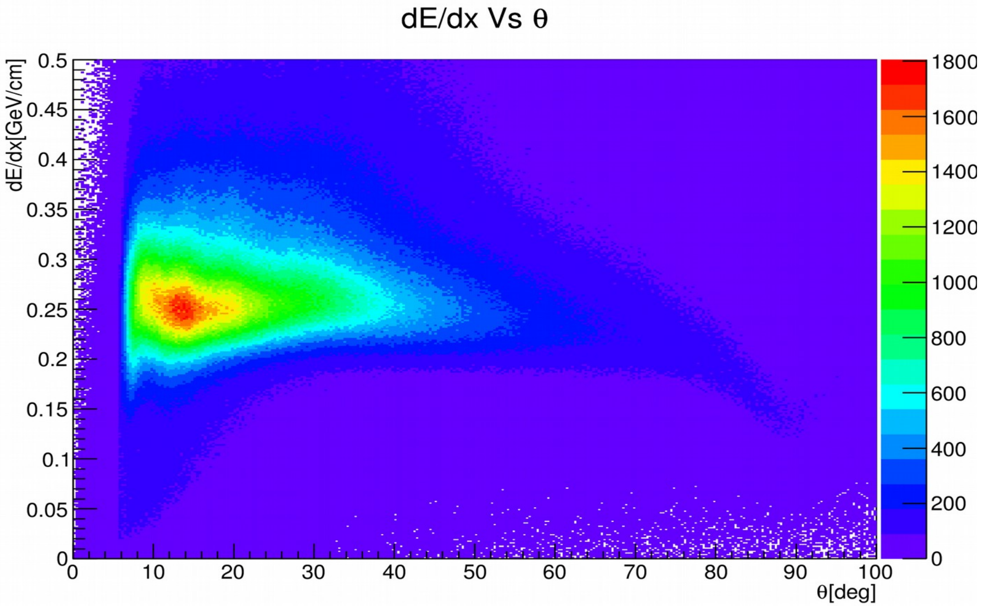
Backup

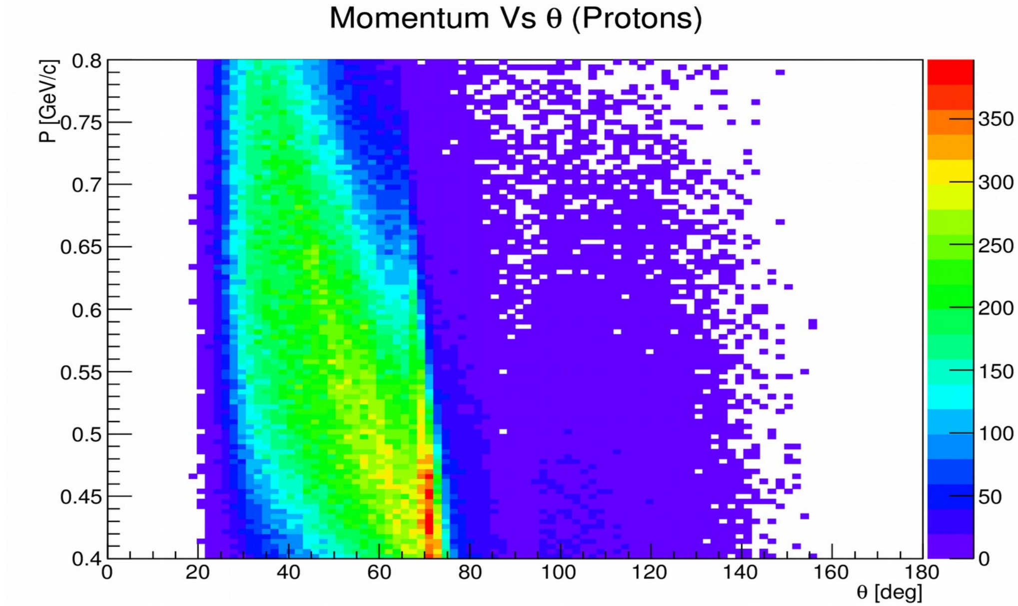
Procedure

- 2^{nd} step: extract the expected dE/dx for protons



dE/dx vs θ





GlueX TDR

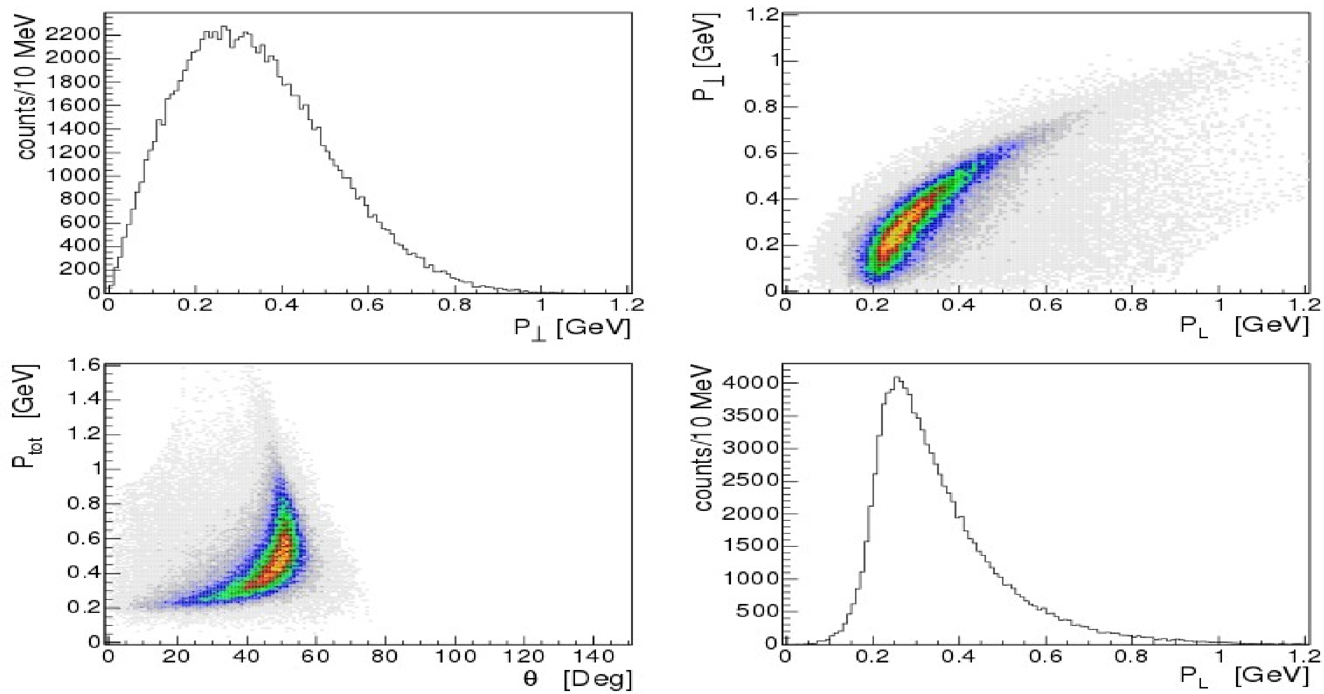


Figure 4.39: The momentum distribution of protons from the reaction $\gamma p \rightarrow \eta_1(1800)p \rightarrow 2\pi^+2\pi^-p$. The upper left-hand figure shows the momentum perpendicular to the beam direction. The upper right-hand figure shows the perpendicular versus the longitudinal momentum. The lower left-hand figure shows the total momentum versus the polar angle θ and the lower right-hand figure shows the momentum along the beam direction.

dE/dx vs θ

GlueX TDR

$$\gamma p \rightarrow K^{*}K^{*}p \rightarrow K^{+}K^{-}\pi^{+}\pi^{-}p$$

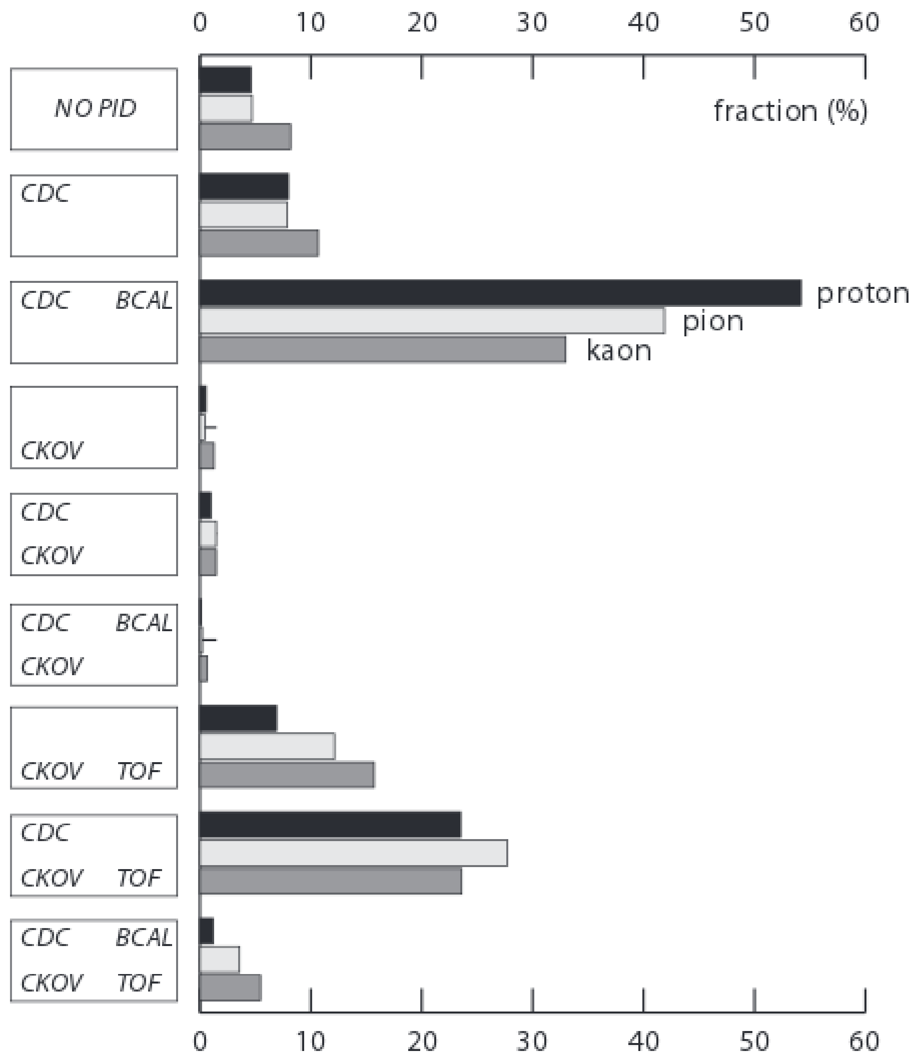
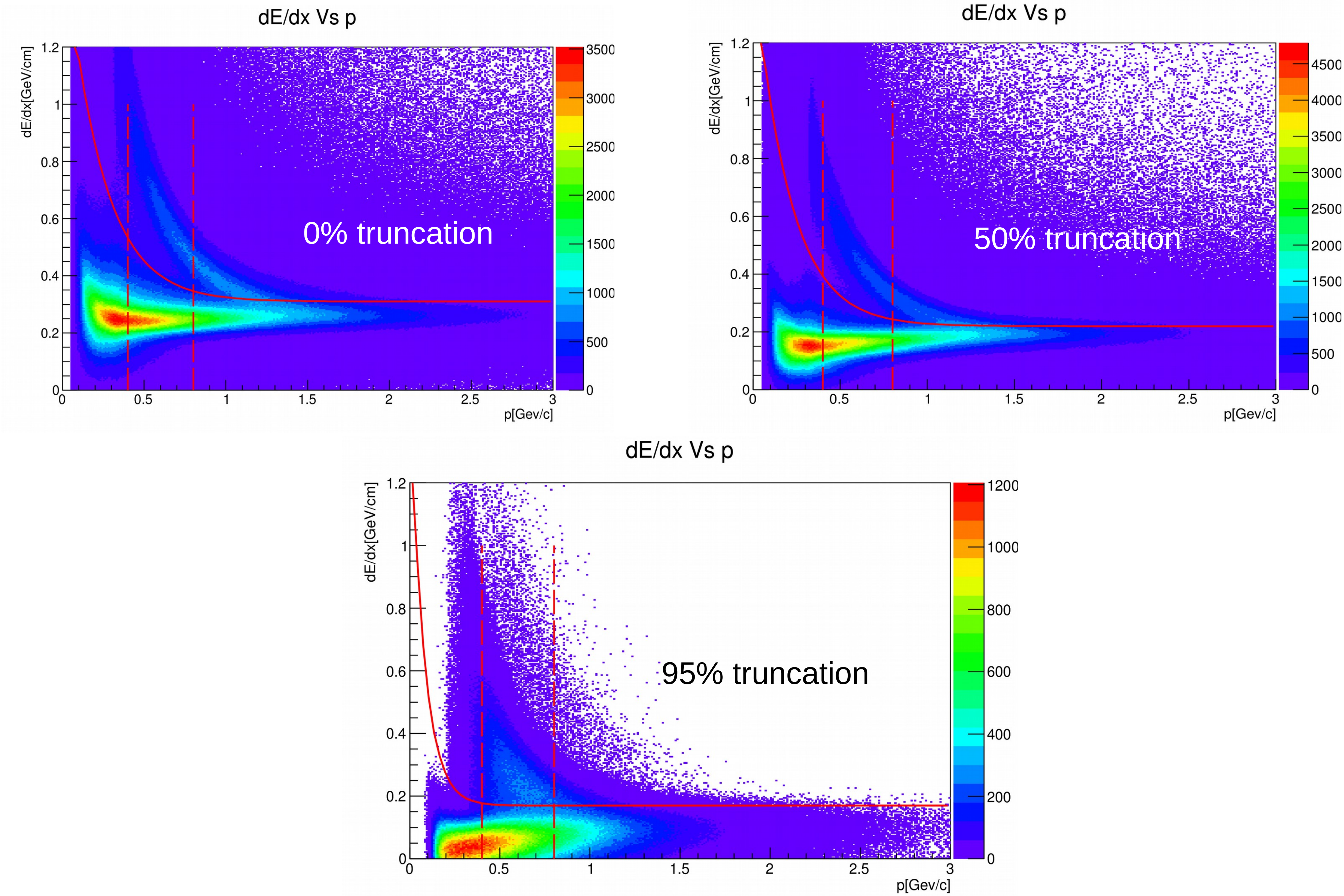


Figure 4.61: The fraction of tracks from the reaction $\gamma p \rightarrow K^{*}\bar{K}^{*}p$ detected by different combinations of particle identification elements.

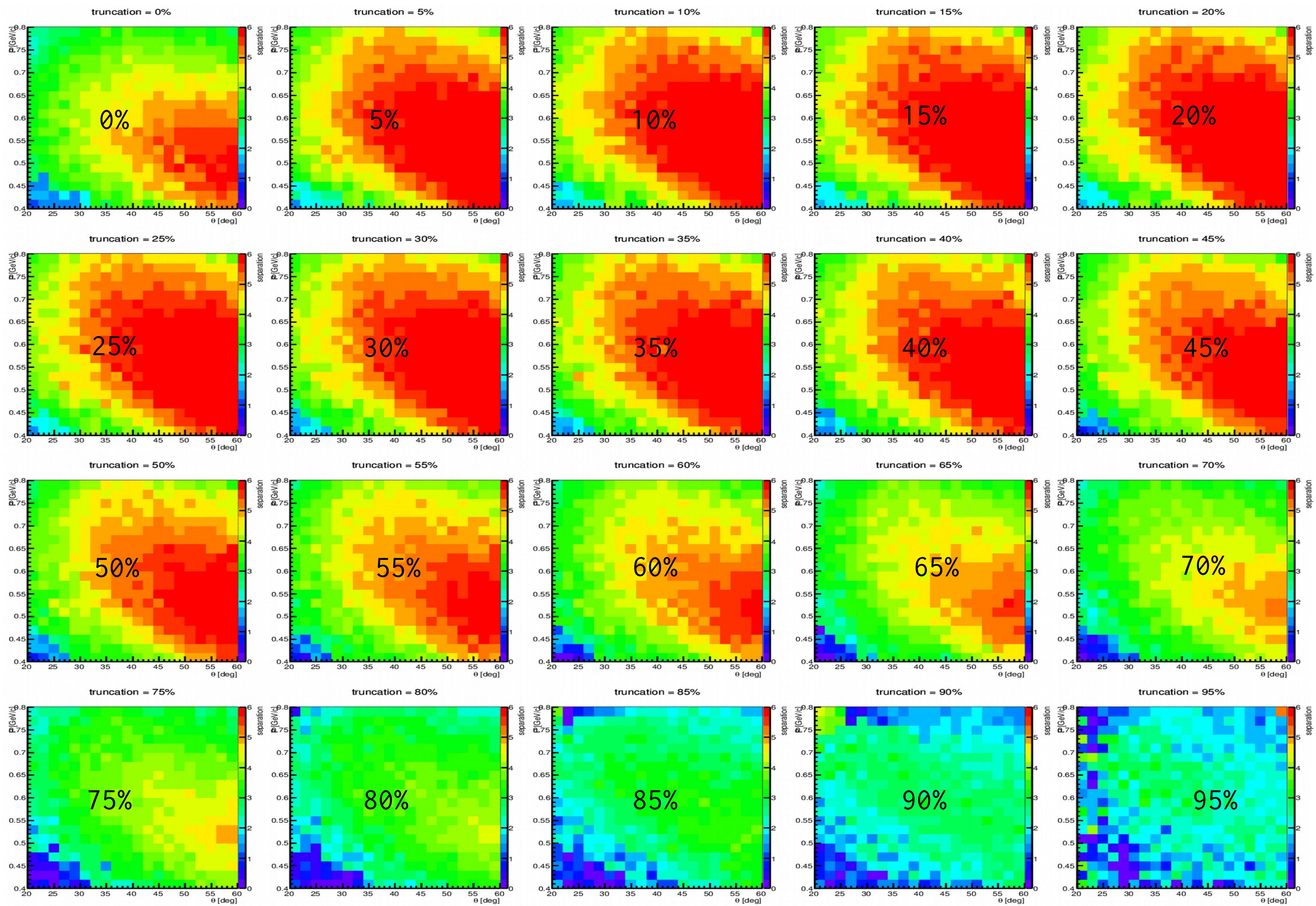
Procedure

- dE/dx dependance of truncation (different cuts)



Separation Power

- 2^{nd} method: strongest separation power => optimal truncation.



Mis-id

- 3rd method: lowest mis-id => optimal truncation.