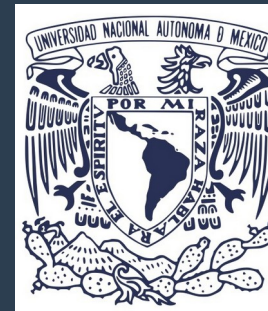# Searching for the baryon-to-meson transition region with the MPD at NICA

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Cross-PWG

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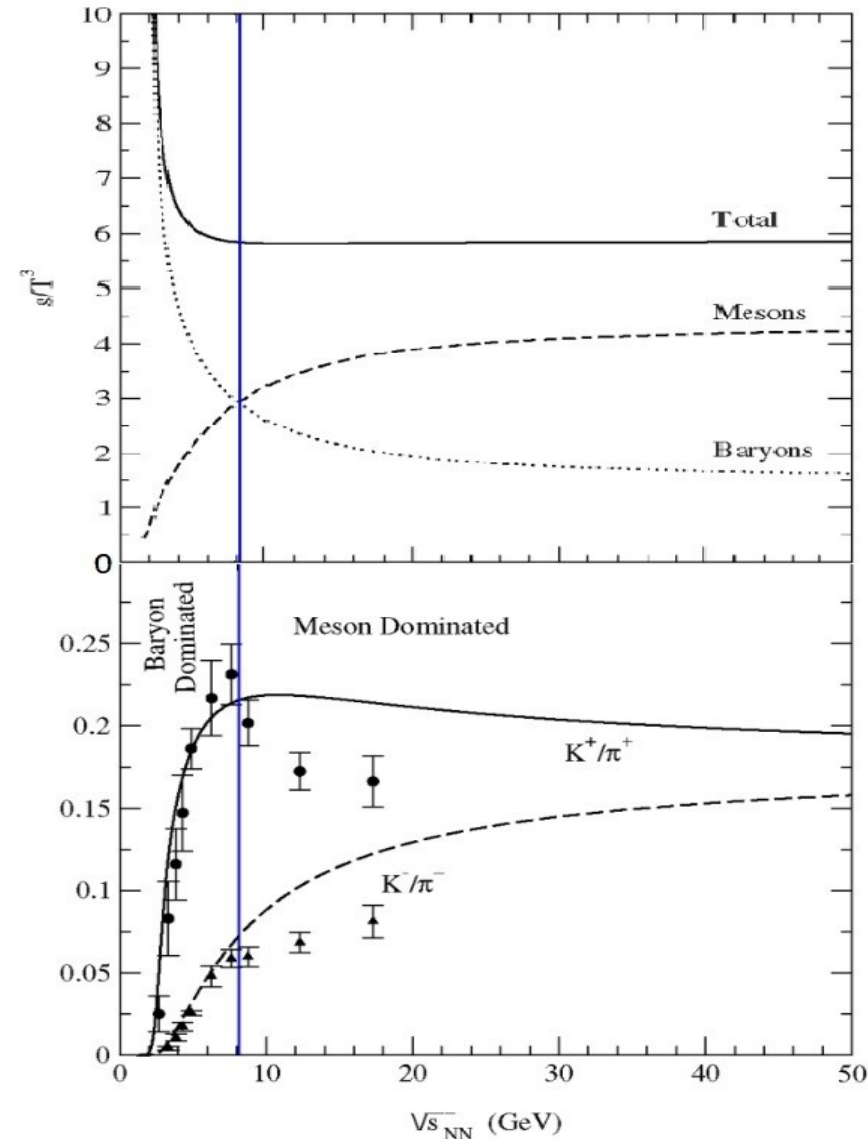 Universidad Nacional Autónoma de México
 November 14, 2022

On the previous cross PWG…

- Abstract selection is ongoing (ICPPA).

  - Slides selected (if approved). ⭐ [13 slides]

  - Comparison to data removed.

  - Centrality selection revisited.

Motivation

In the framework of the statistical model, a rapid change is expected as the hadronic gas undergoes a transition from a baryon-dominated to a meson-dominated gas.[1]

The peak in the K^+/π^+ ratio is predicted in this model which corresponds to this transition region.[1]

[1]J. Cleymans *et al.*, Phys. Lett. B **615** (2005) 50-54.

Data sample analyzed

4 data sets generated with UrQMD 3.4v:

1) Au+Au collisions at 7.7 GeV (150000 events)
Reconstruction: Geant3 & 0.5 Tesla

2) Au+Au collisions at 11.5 GeV (150000 events)
Reconstruction: Geant3 & 0.5 Tesla

3) Bi+Bi collisions at 9.2 GeV to make predictions
(125000 events from MPD request number 25)
Reconstruction: Geant4 & 0.5 Tesla

4) Bi+Bi collisions at 9.2 GeV to make predictions
(125000 events from MPD request number 28)
Reconstruction: Geant4 & 0.2 Tesla

Track selection criteria

	Au+Au 7.7 GeV	Au+Au 11.5 GeV	Request 25	Request 28
Number of events	150000	150000	125000	125000
Koef[‡]	0.89	0.89	0.073	0.073
σ_M[‡]	3	3	3	3
σ_E[‡]	2.5	2.5	2.5	2.5
Probrability cut	>0.6	>0.6	>0.6	>0.6
Primary	Mother ID	Mother ID	Mother ID	Mother ID
Number of hits (NofH)	>13	>13	>16	>16
χ^2/NofH	<8	<8	<8	<8
p_T [GeV/c]	>0.1	>0.1	>0.1	>0.1
$|\eta|$ (mult.)	<0.5	<0.5	<0.5	<0.5
$|y|$ (p_T dist.)	<0.5	<0.5	<0.5	<0.5
Centrality criteria	MPD[2]	MPD[2]	MPD[2]	MPD[2]
Events after cuts	115065 (~77%)	117350 (~78%)	91599 (~73%)	91376 (~73%)

[‡]mpdPid class (n-sigma method).
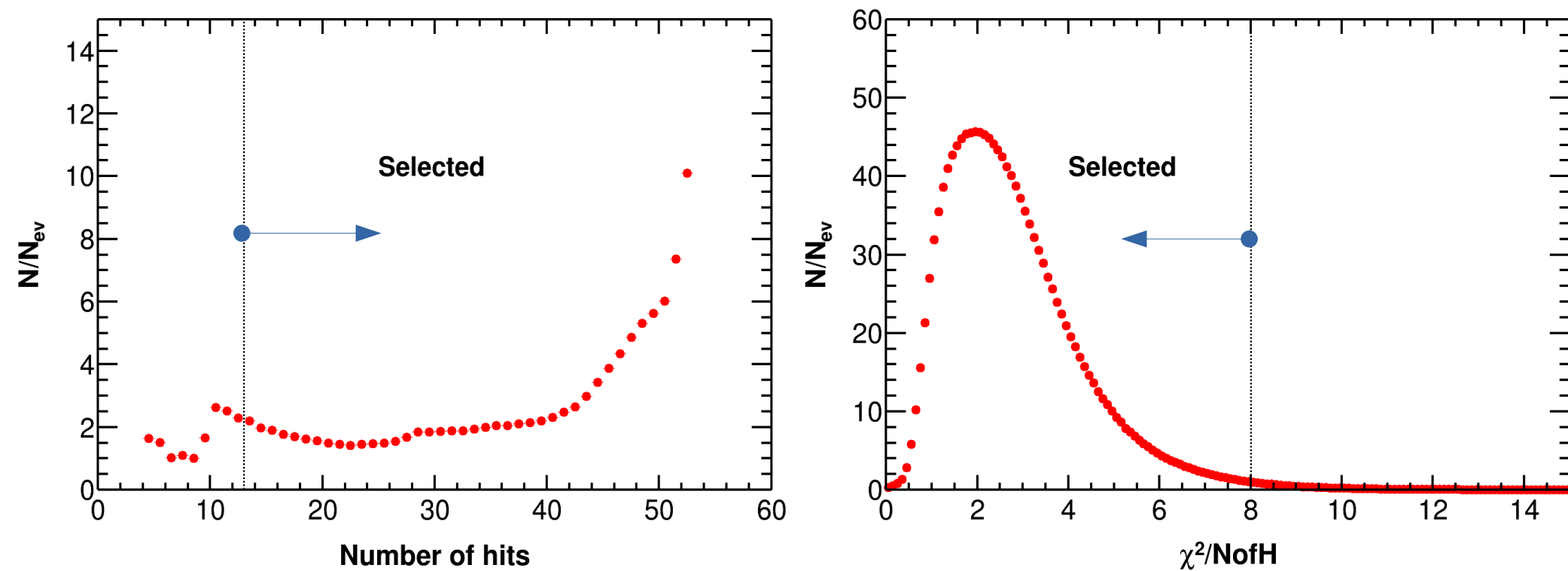[2]P. Parfenov *et al.* [MPD Collaboration], Analysis Note draft (2021).

Allison and Cobb model:

$$\left\langle \frac{dE}{dx} \right\rangle = \frac{p_1}{\beta^{p_4}} \left\{ p_2 + \beta^{p_4} - ln \left[p_3 + \left(\frac{1}{\beta\gamma} \right)^{p_5} \right] \right\}$$
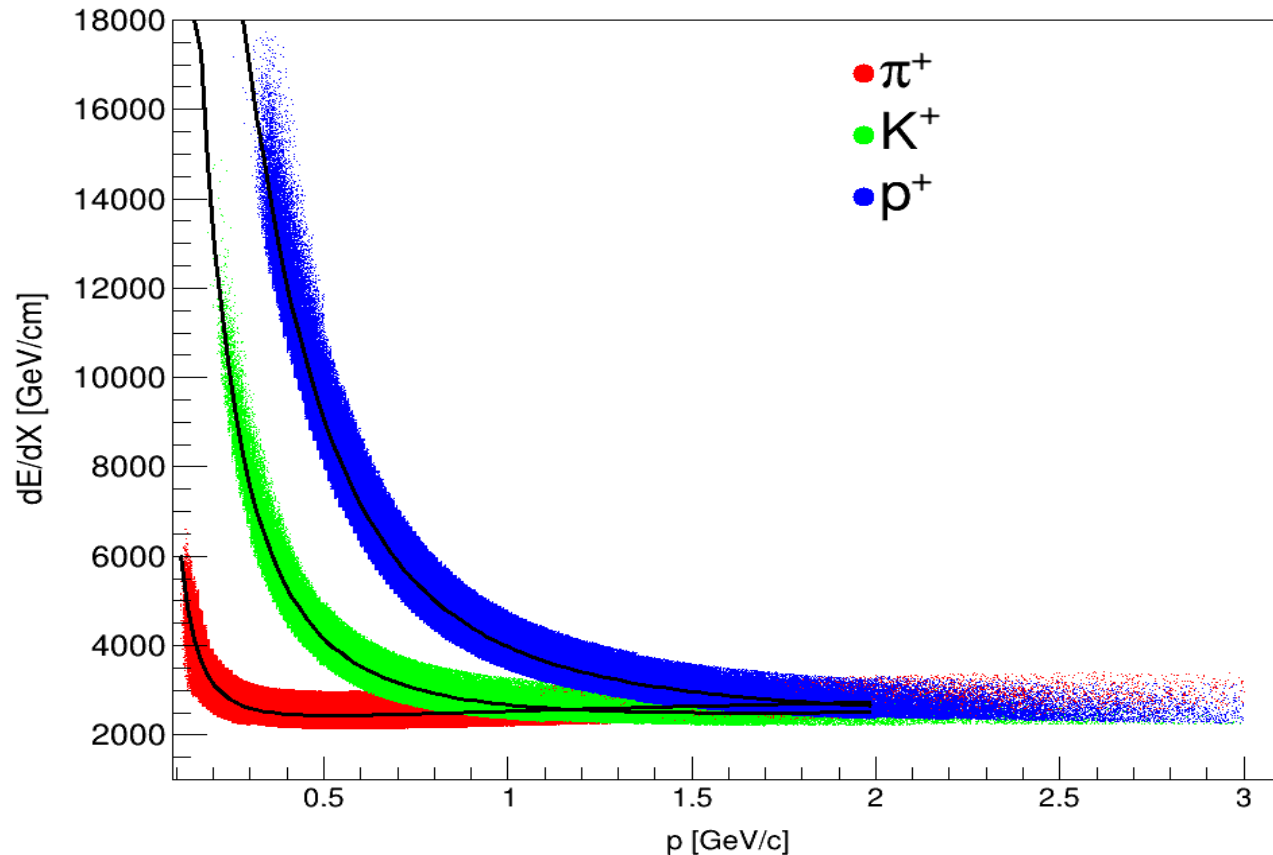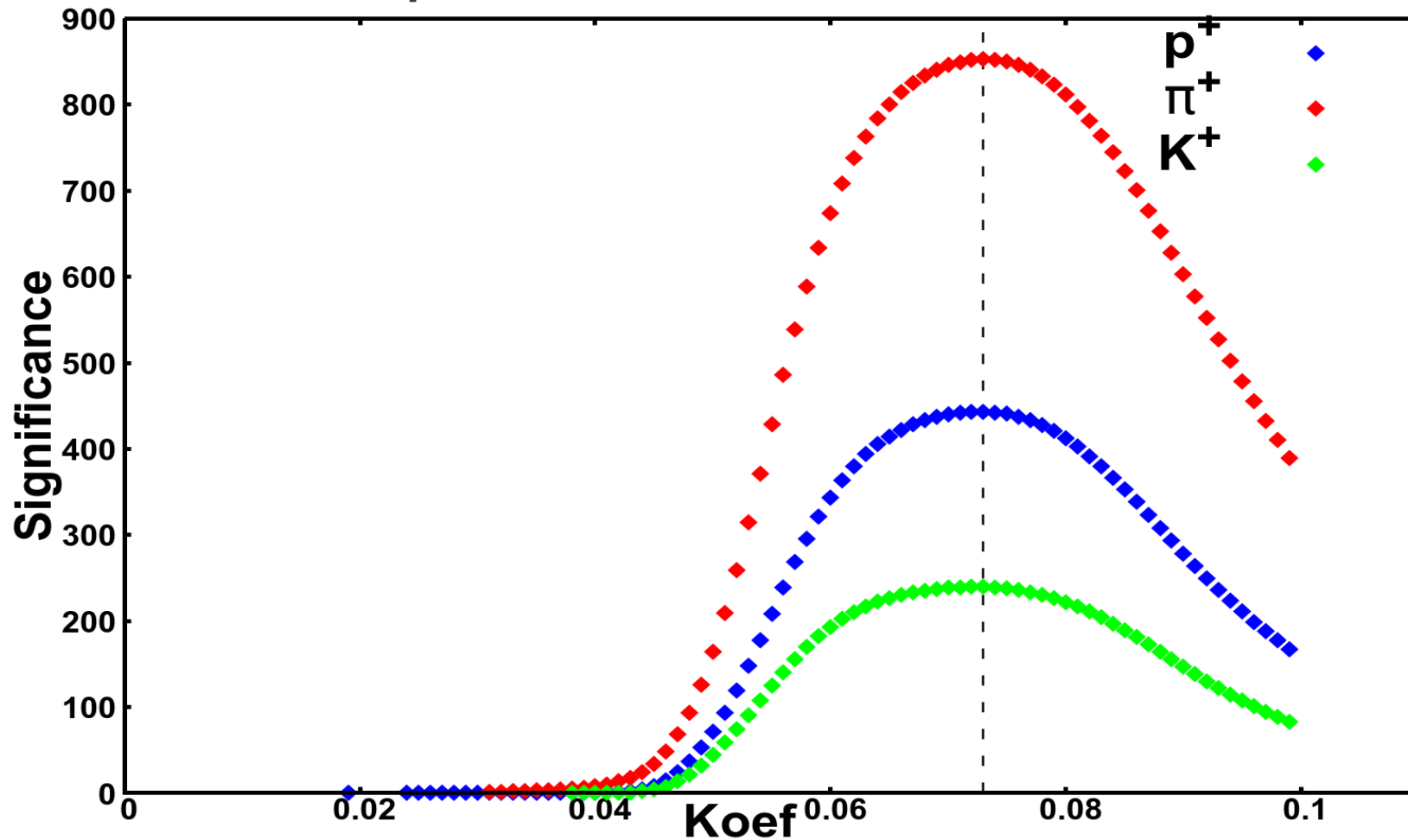
Hits and χ^2/NofH distributions

Example: Au+Au 7.7 GeV

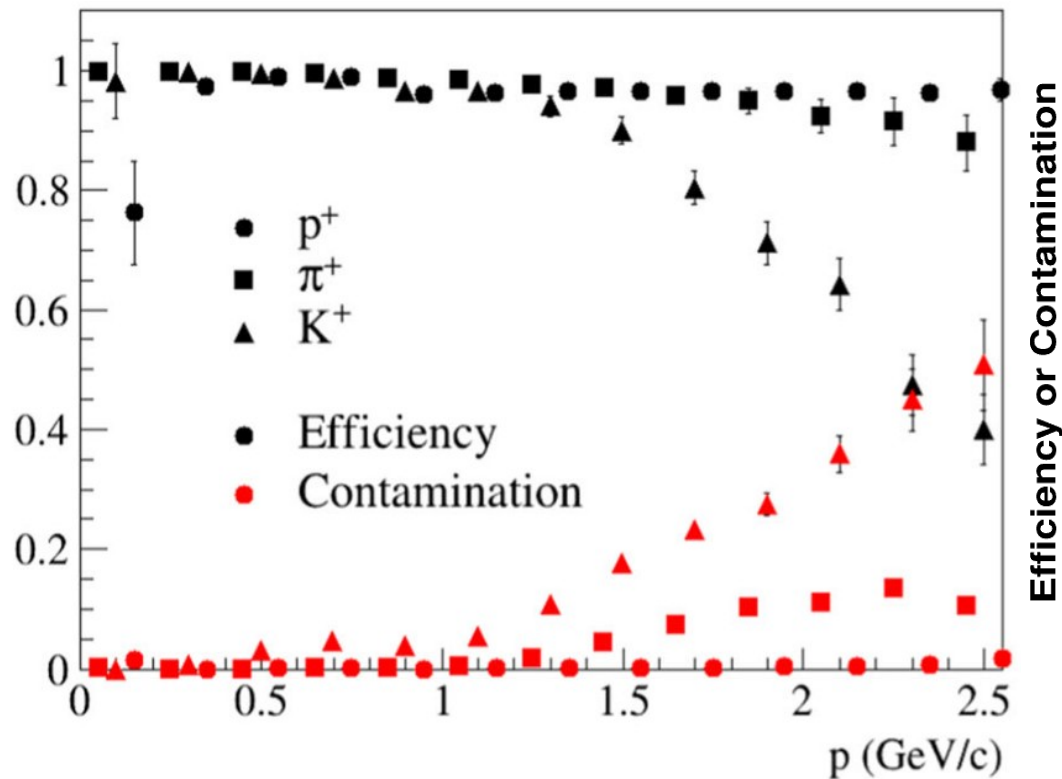# Cuts optimization process

Example: Bi+Bi 9.2 GeV (Koef)

$$Significance = \frac{signal}{\sqrt{signal+background}}$$

Au+Au collisions

- MPD collaboration[3] (9 GeV)

- Our reconstruction (7.7 GeV)
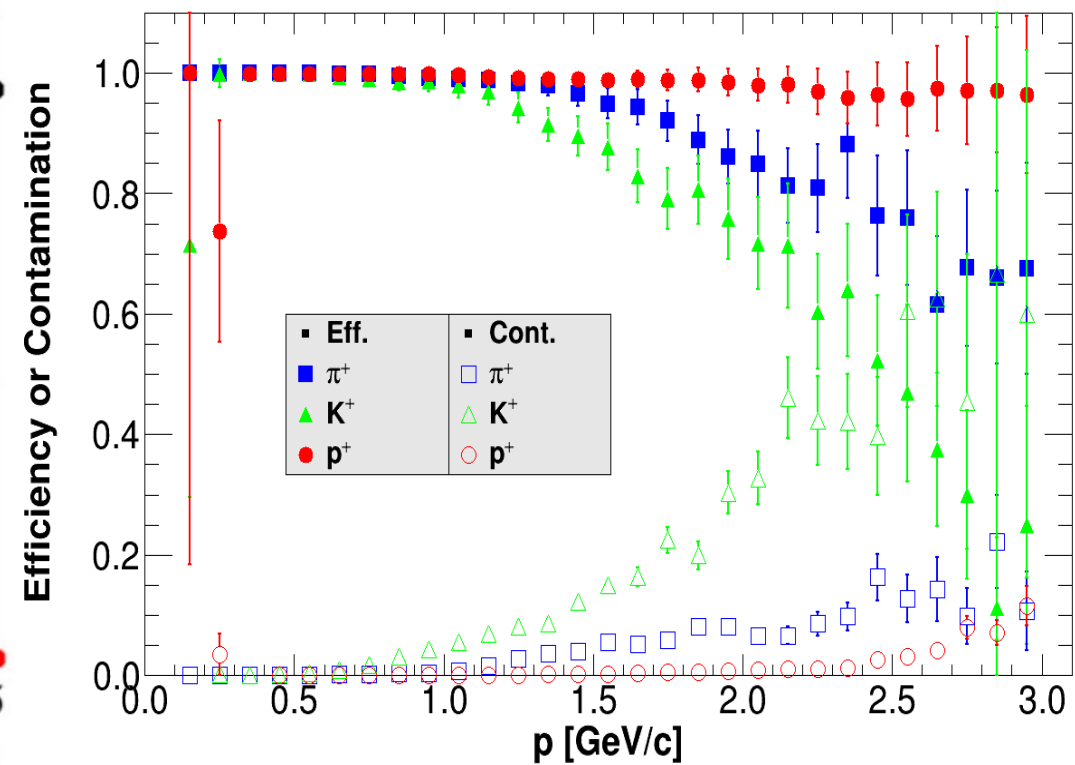
[3]V. Abgaryan *et al.* [MPD Collaboration], Eur. Phys. J. A **58**, 140 (2022).
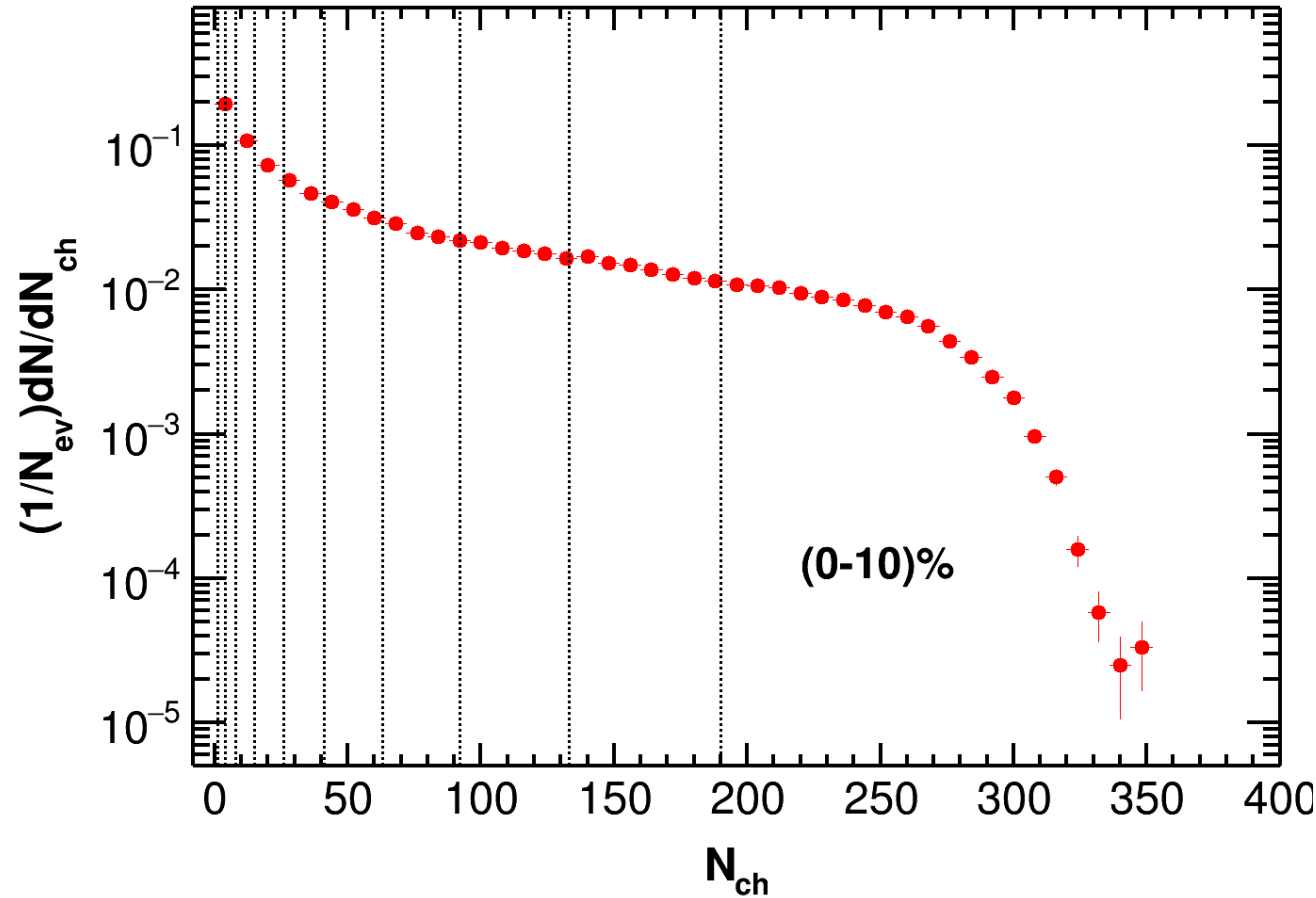
Multiplicity

Reconstructed
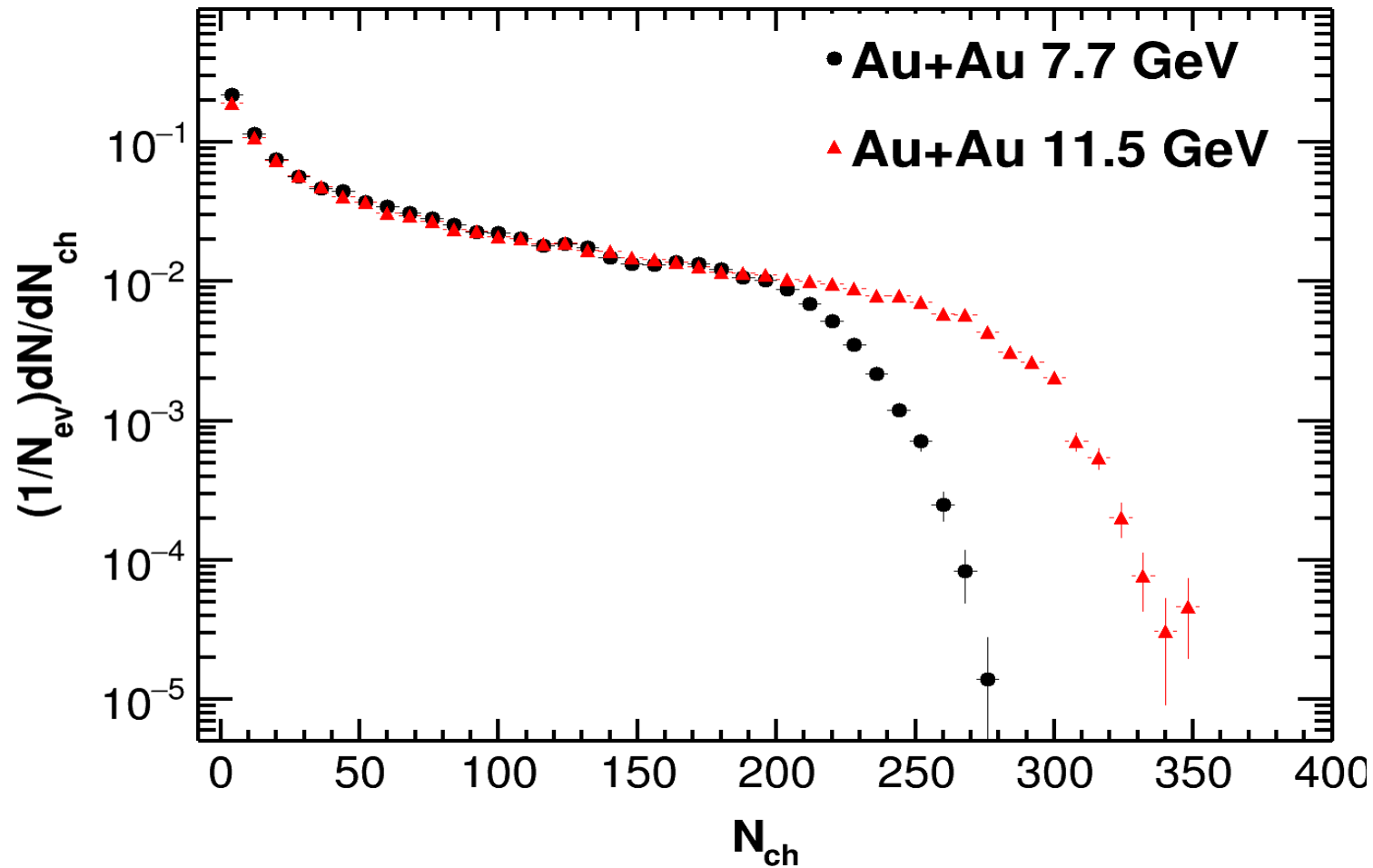
Multiplicity increases with the energy of the collision

Events per centrality (N$_{ev/c}$)

	Au+Au 11.5 GeV
(0-10)%	12295 (~10%)
(10-20)%	12080 (~10%)
(20-30)%	11833 (~10%)
(30-40)%	10991 (~9%)
(40-50)%	11924 (~10%)
(50-60)%	11246 (~10%)
(60-70)%	11882 (~10%)
(70-80)%	11696 (~10%)

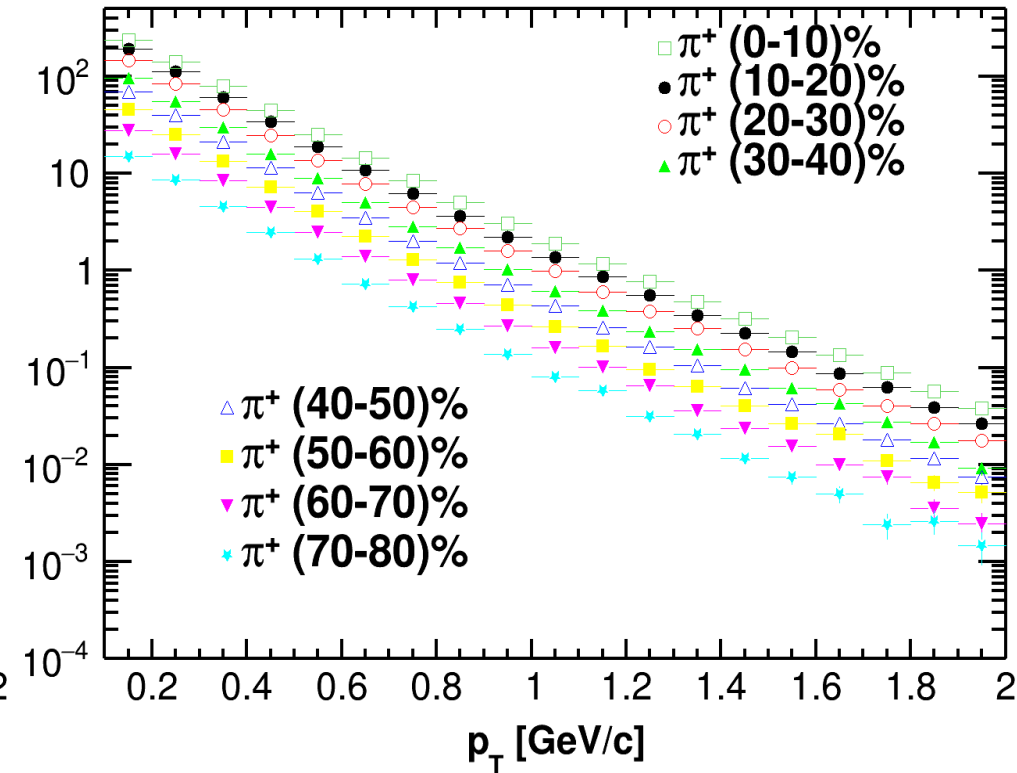# Transverse momentum distributions Monte Carlo (MC) vs. reconstruction

Au+Au

- 7.7 GeV
- 11.5 GeV

Au+Au (Reconstructed)

• 7.7 GeV

• 11.5 GeV

The distributions for the negative pions are similar
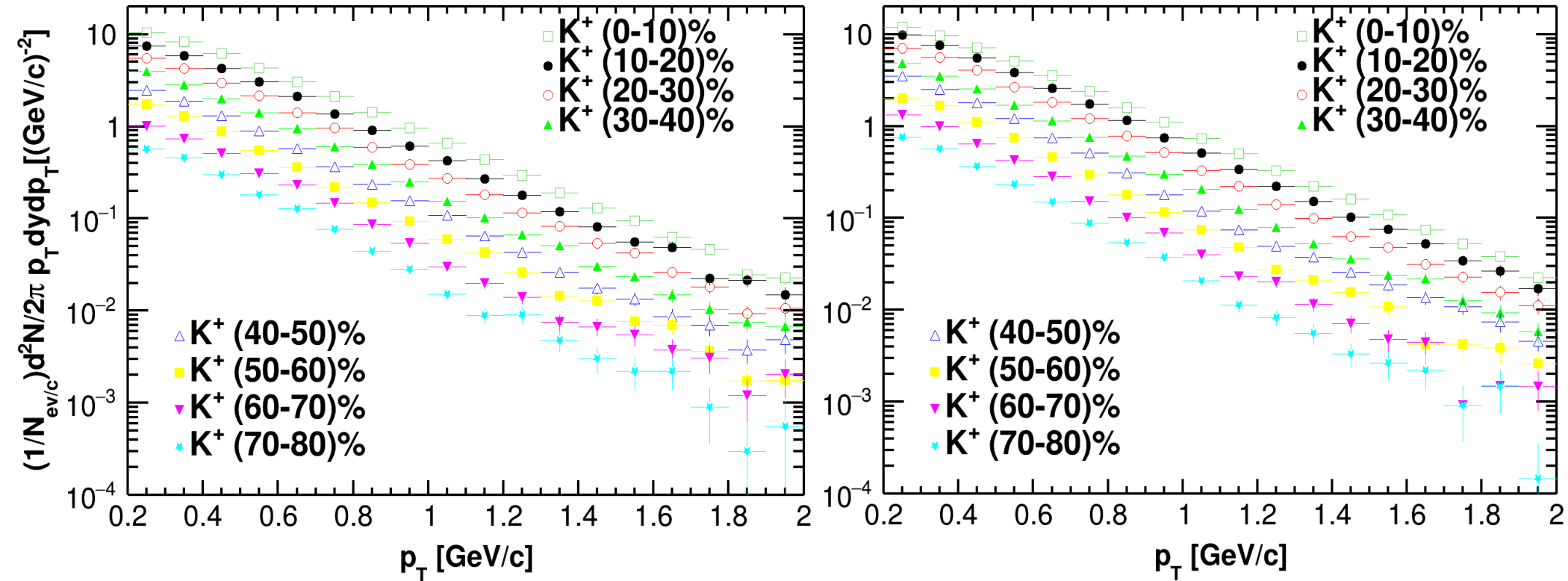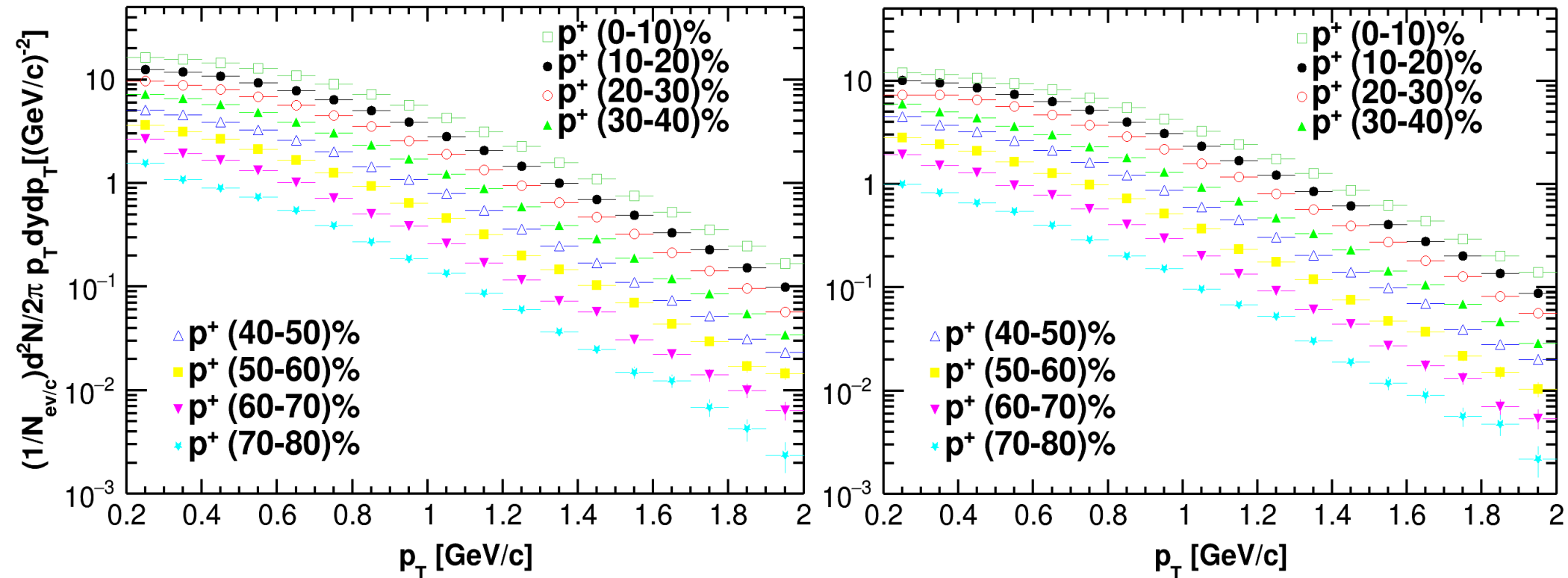
Au+Au (Reconstructed)

- 7.7 GeV

- 11.5 GeV

The distributions for the negative kaons are similar
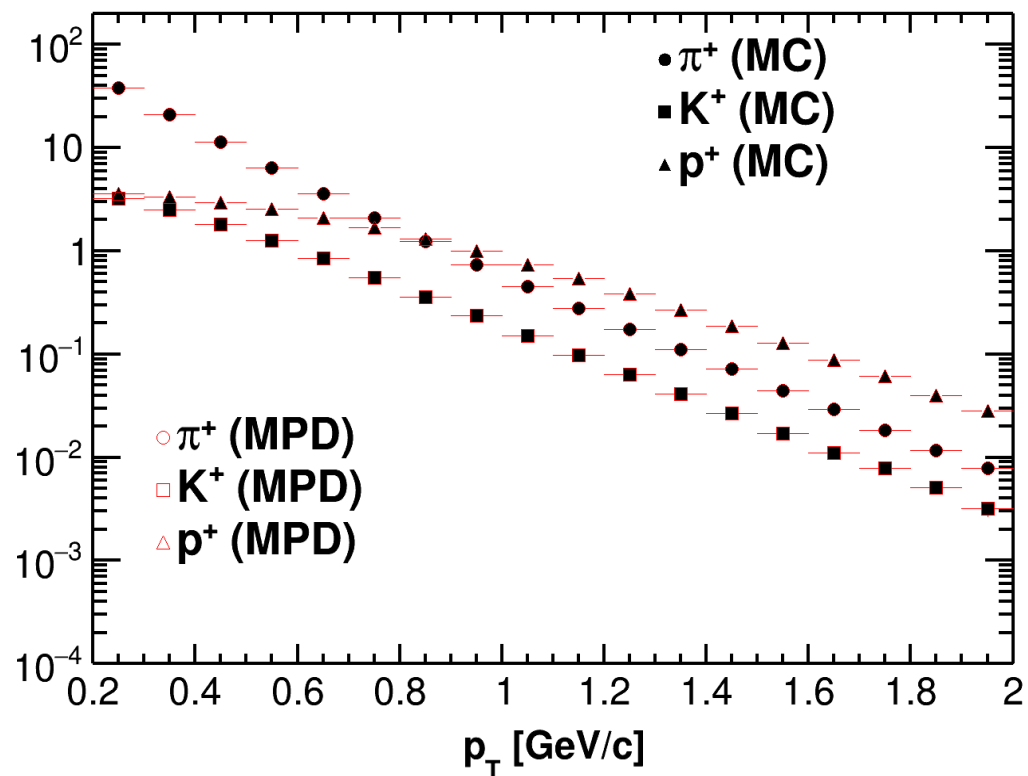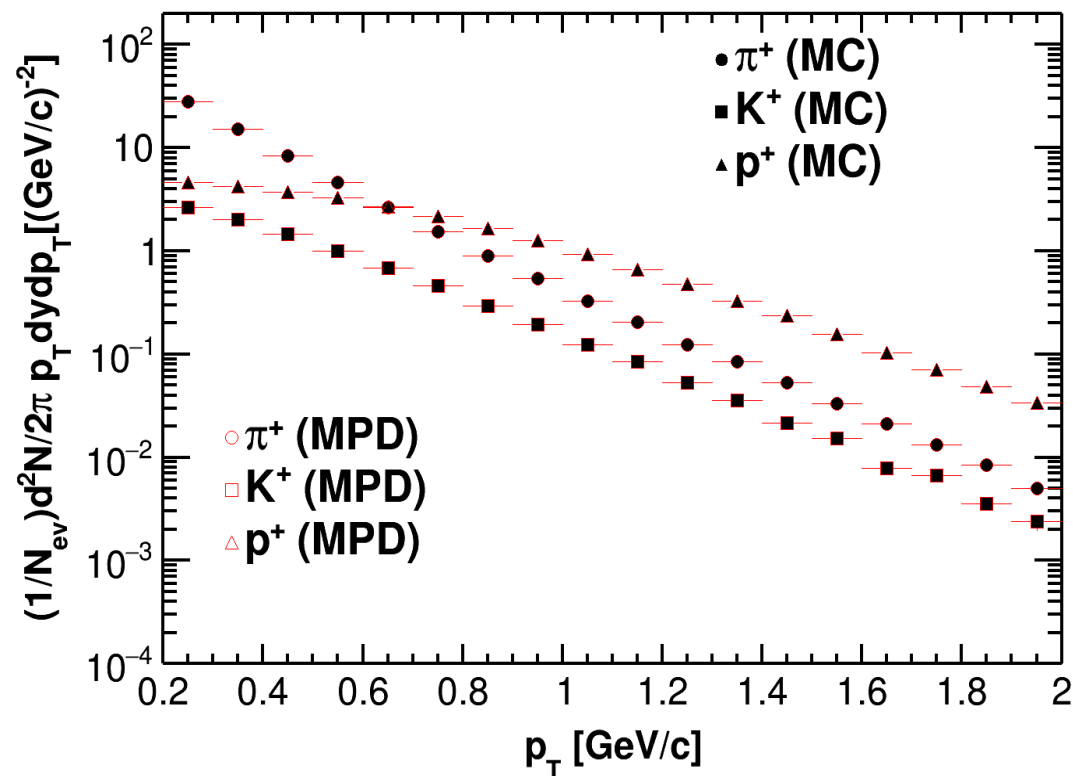
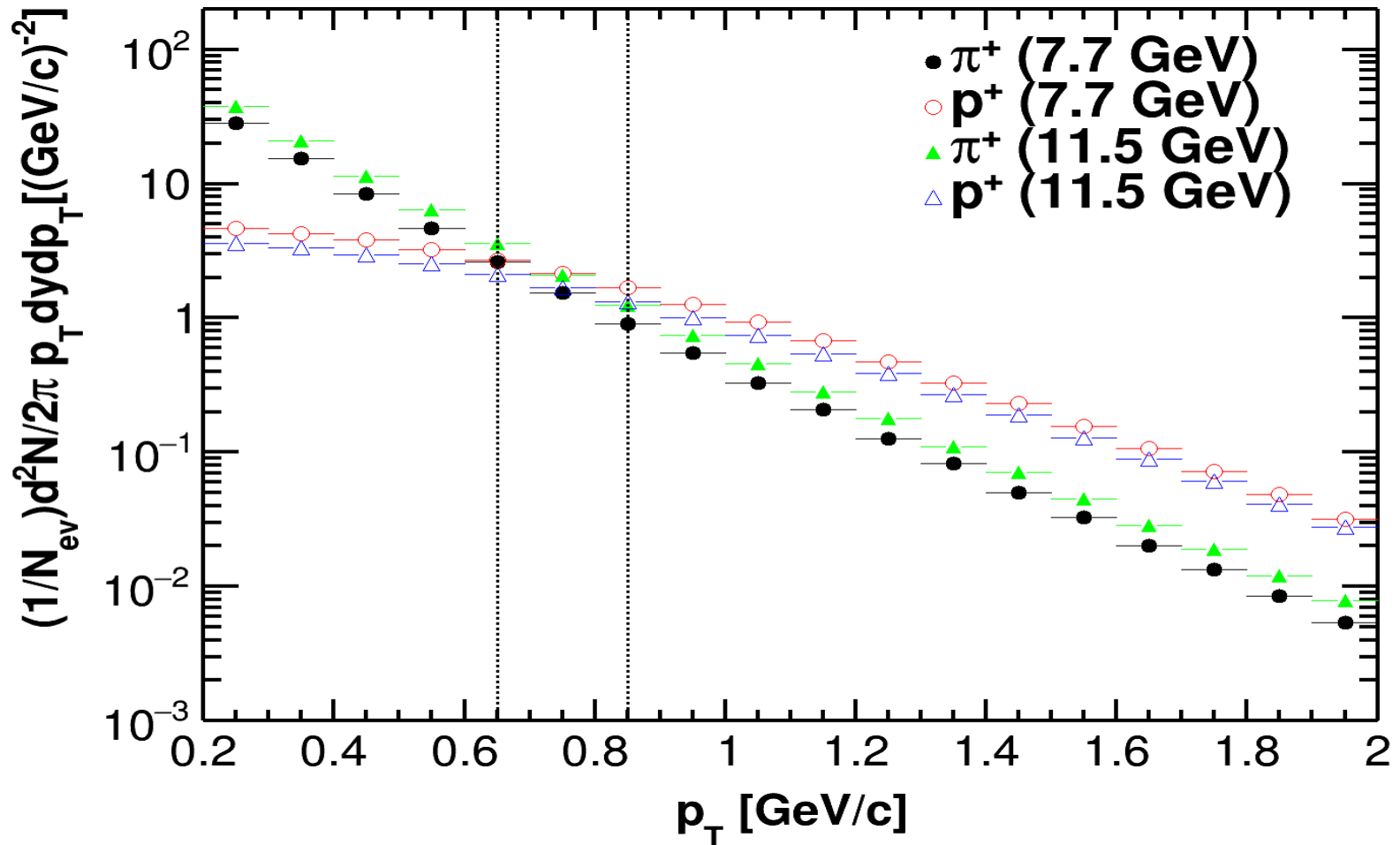# Transverse momentum per centrality

Au+Au (Reconstructed)

The distributions for the antiprotons are not as smooth due to the low statistics

Crossing point between π^+ and p^+

Au+Au ($|y|<0.5$)

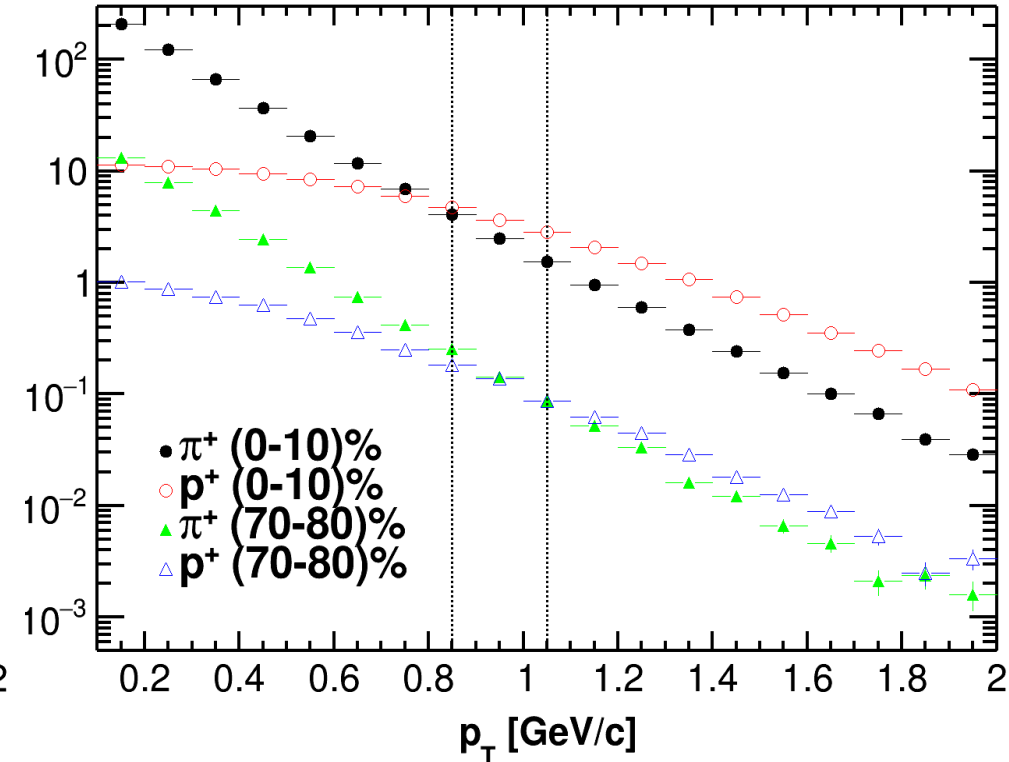Distributions cross ~0.85 GeV/c for 11.5 GeV and ~0.65 GeV/c for 7.7 GeV

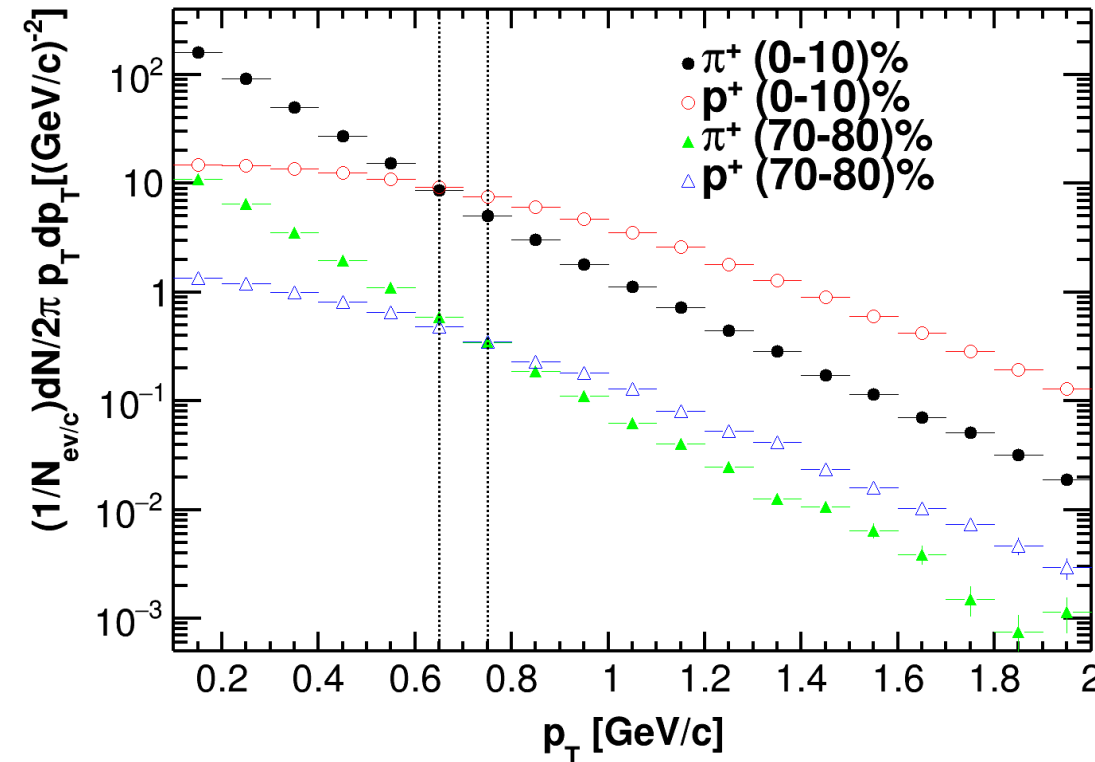# Crossing point at different centralities

Au+Au ($|y|<0.5$)
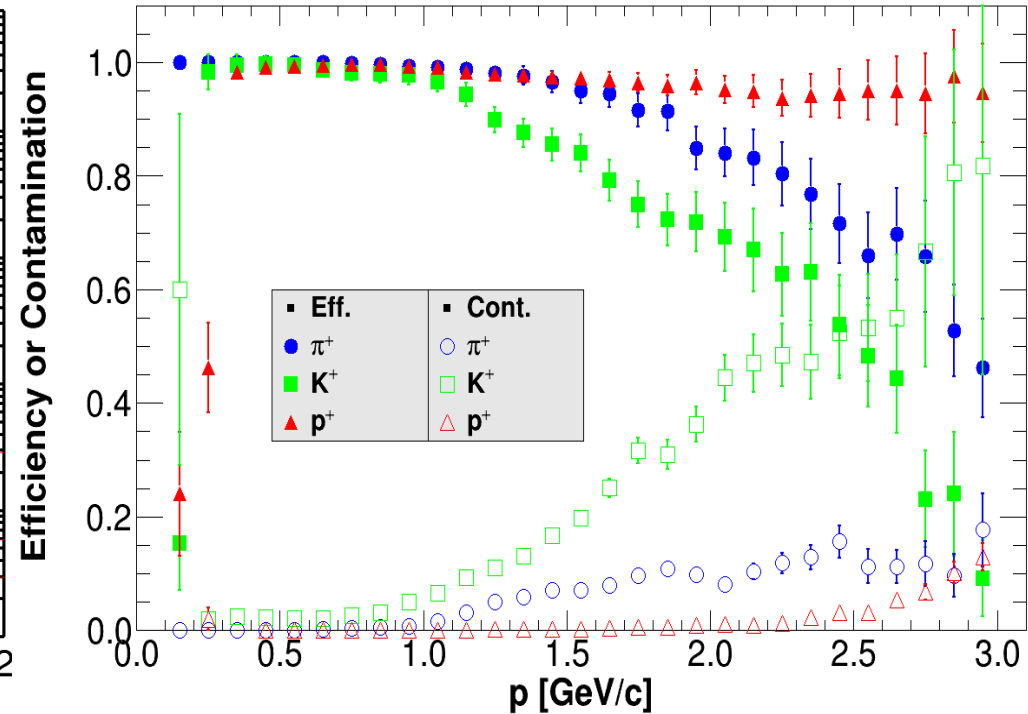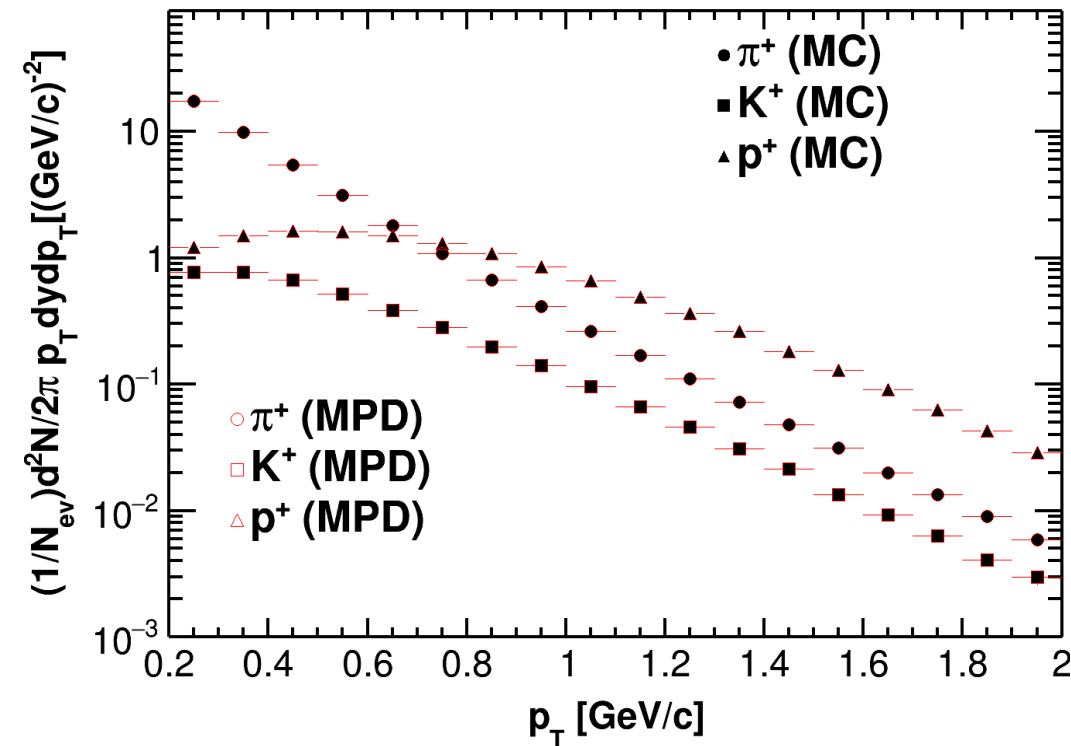

The crossing point is at ~0.65 and ~0.75 GeV/c for the most central and peripherial (7.7 GeV). Whereas ~0.85 and ~1.15 GeV/c for the most central and peripherial (11.5 GeV)

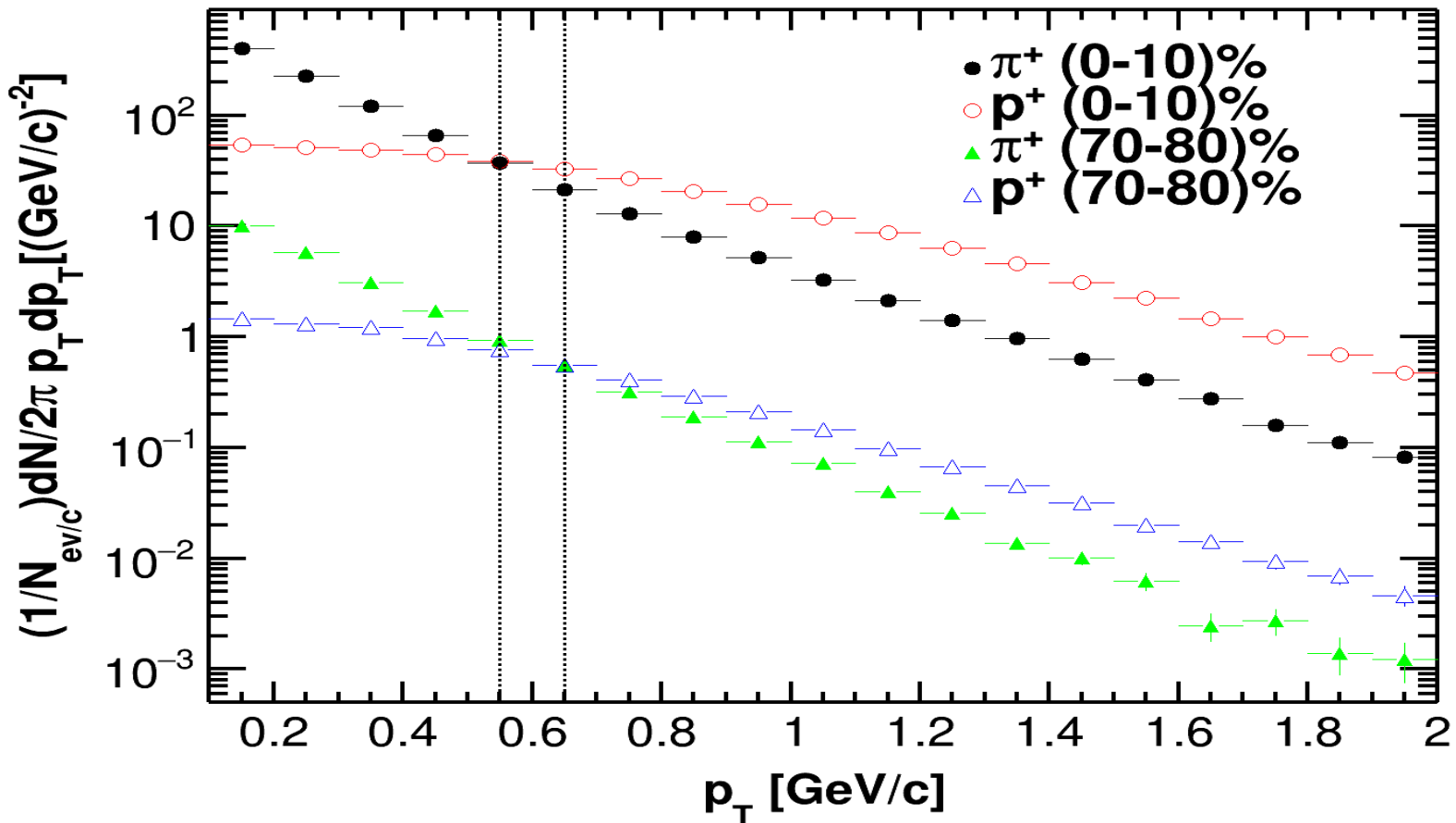# Transverse momentum and reconstruction efficiency distributions

Bi+Bi 9.2 GeV (request 28)

There seems to be a lot of contamination in the K$^+$ case
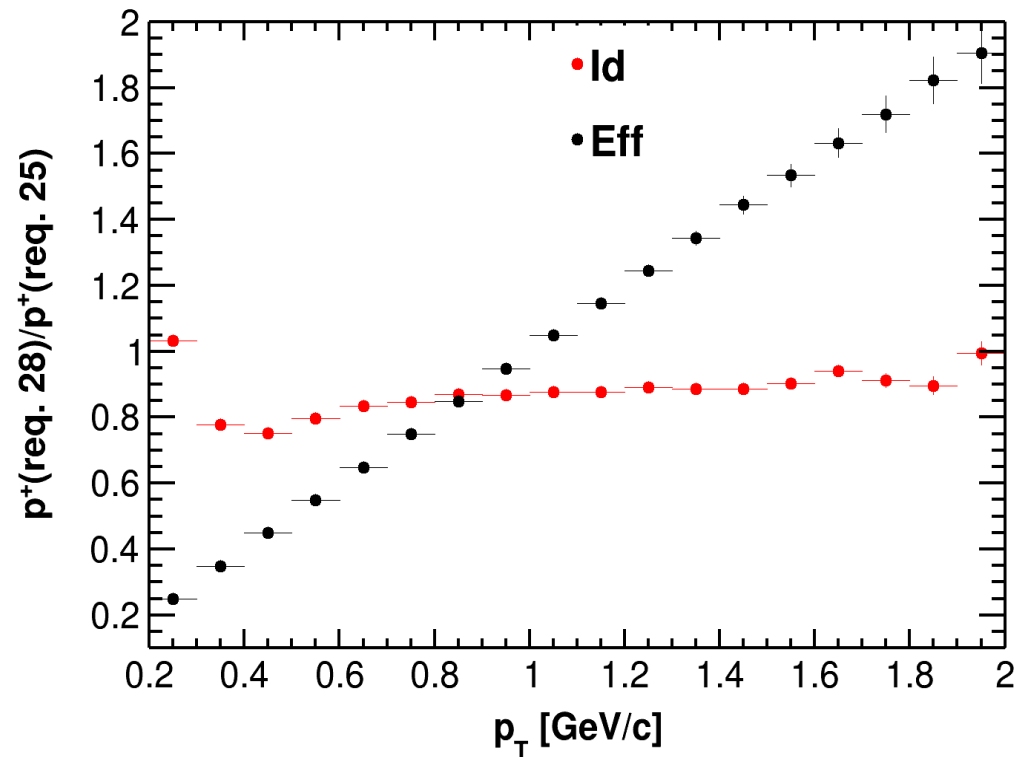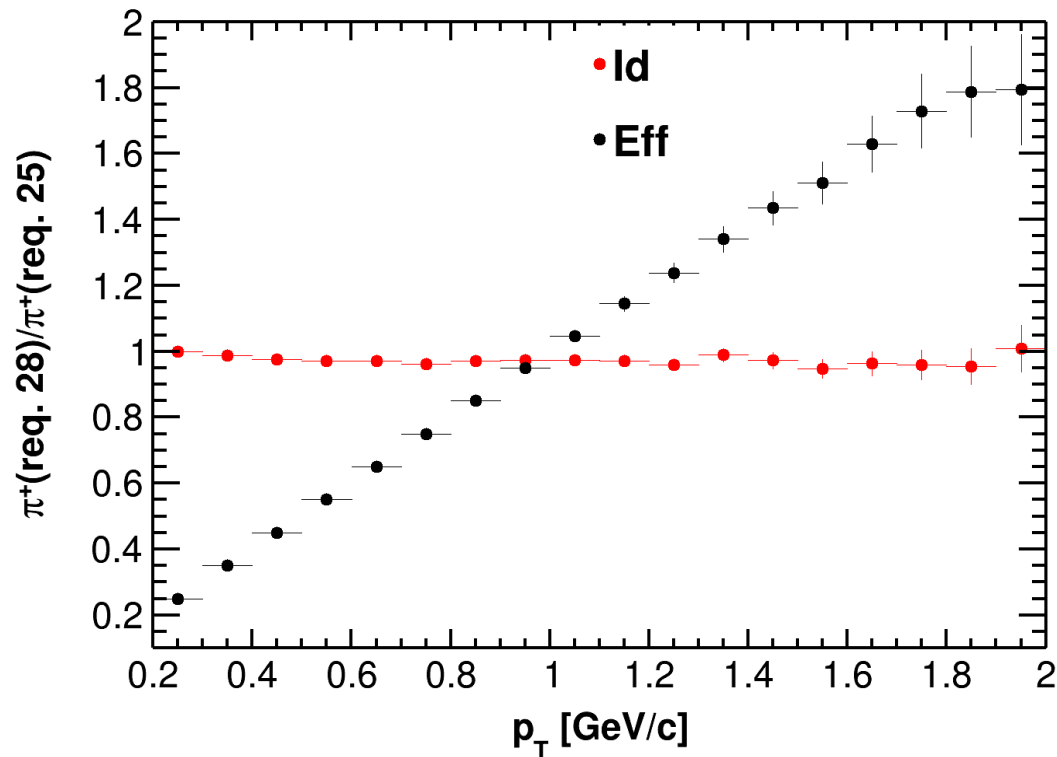
Crossing point at different centralities

Bi+Bi 9.2 GeV ($|y|<0.5$)

Distributions cross ~0.55 GeV/c for the most central and ~0.65 GeV/c for the most peripherial

Bi+Bi 9.2 GeV (B = 0.2 vs 0.5 T)

Better reconstruction efficiency at high momentum for a reduced magnetic field

Conclusions

For Au+Au at 7.7 and 11.5 GeV & Bi+Bi at 9.2 GeV, generated by UrQMD and reconstructed in the MPD framework:

a) We observed that, as we increase the energy of the collision, the crossing point between the pions and protons distributions occurs at a higher p_T.

b) The crossing point also moves to higher p_T as we decrease the centrality.

c) The same analysis was done for Bi+Bi at 9.2 GeV.

d) Details on the evolution of the crossing point of the p_T distributions are of interest. Further analysis is under investigation.

Thank you for your attention.
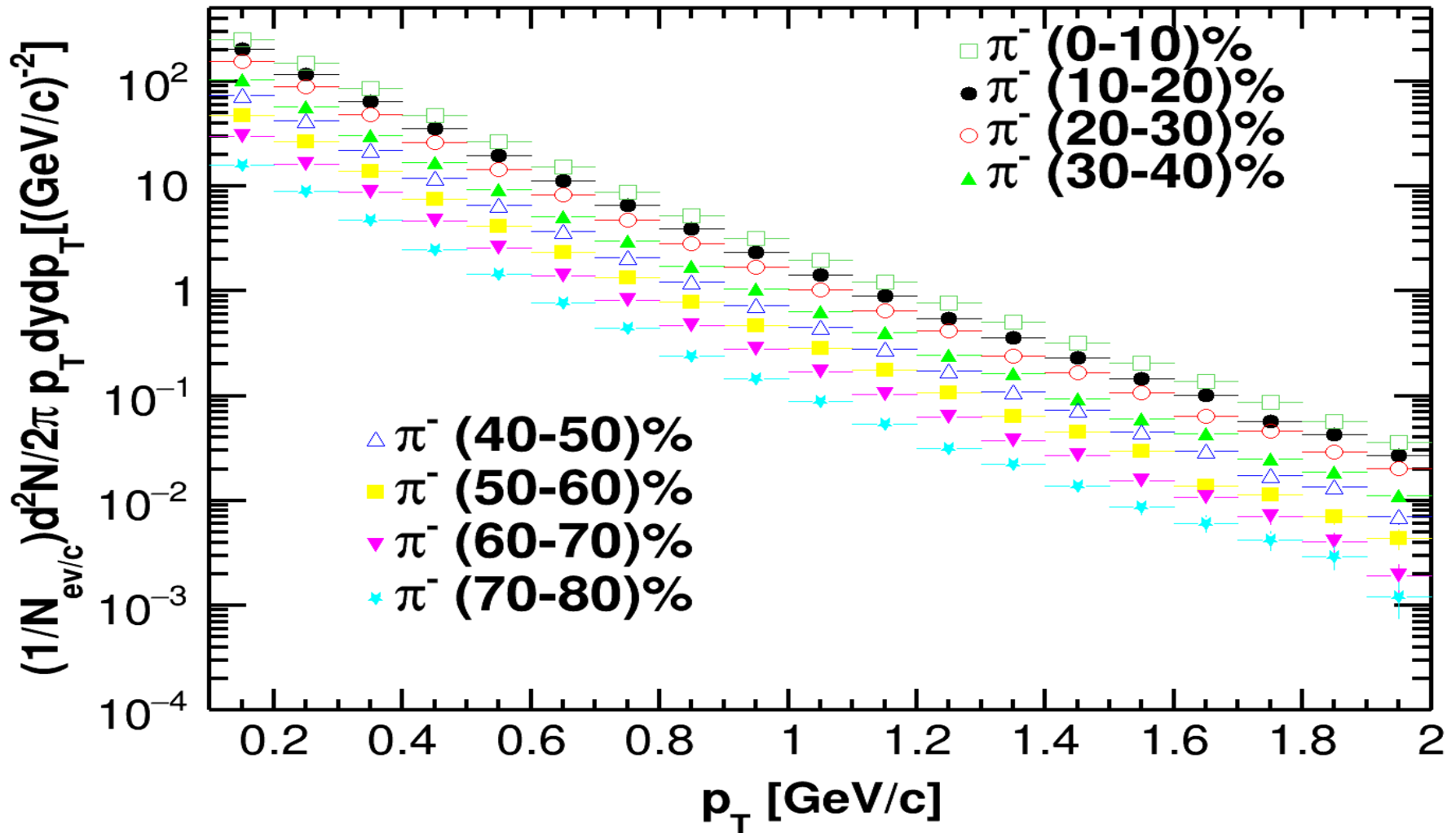**Special thanks to E. Cuautle, W. Bietenholz, A. Ayala, R. García, A. Mudrokh, V. Riabov and A. Aparin**

Backup

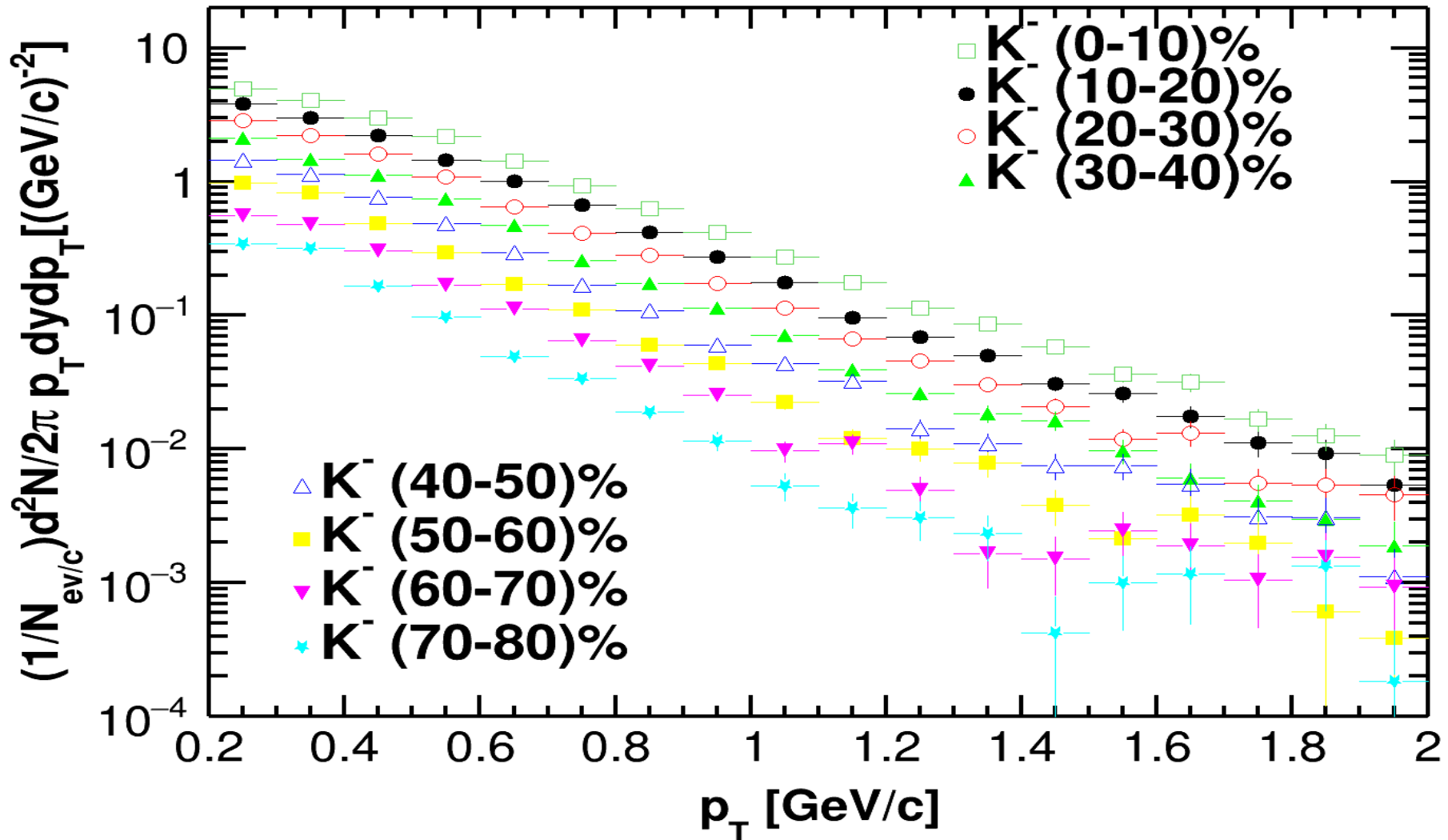# Transverse momentum for π⁻
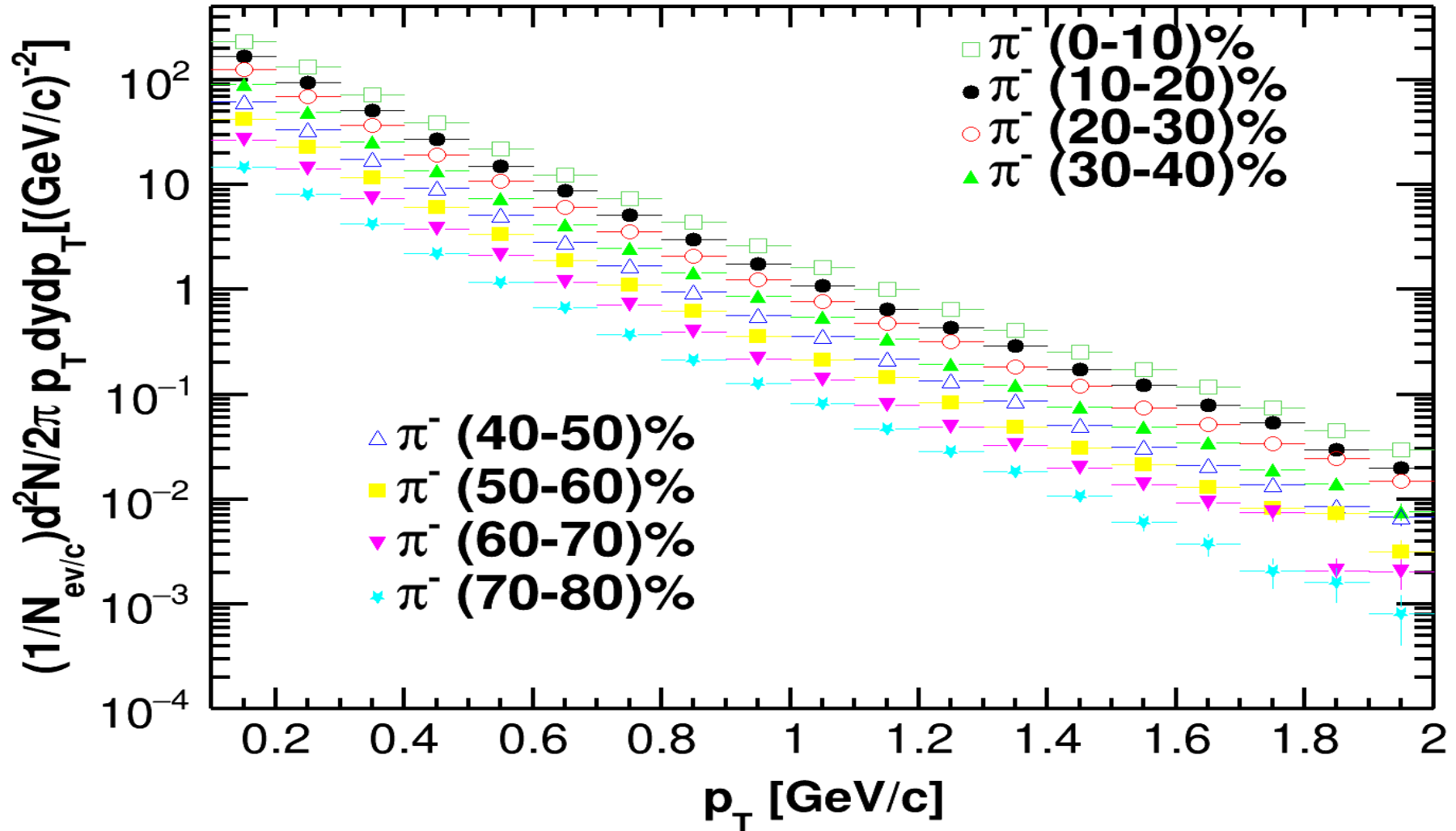
Au+Au 7.7 GeV

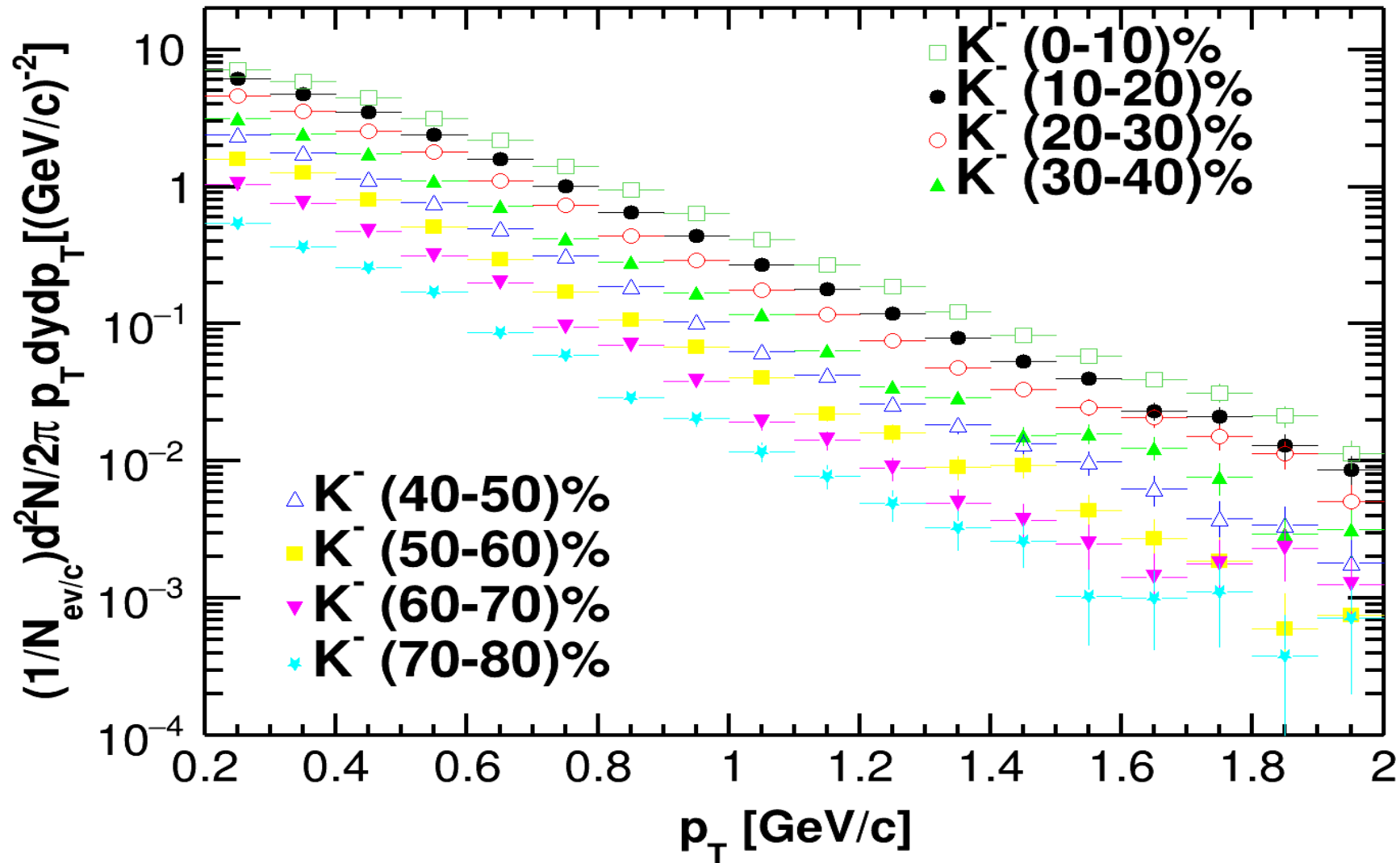# Transverse momentum for π⁻

Au+Au 11.5 GeV

Au+Au 7.7 GeV

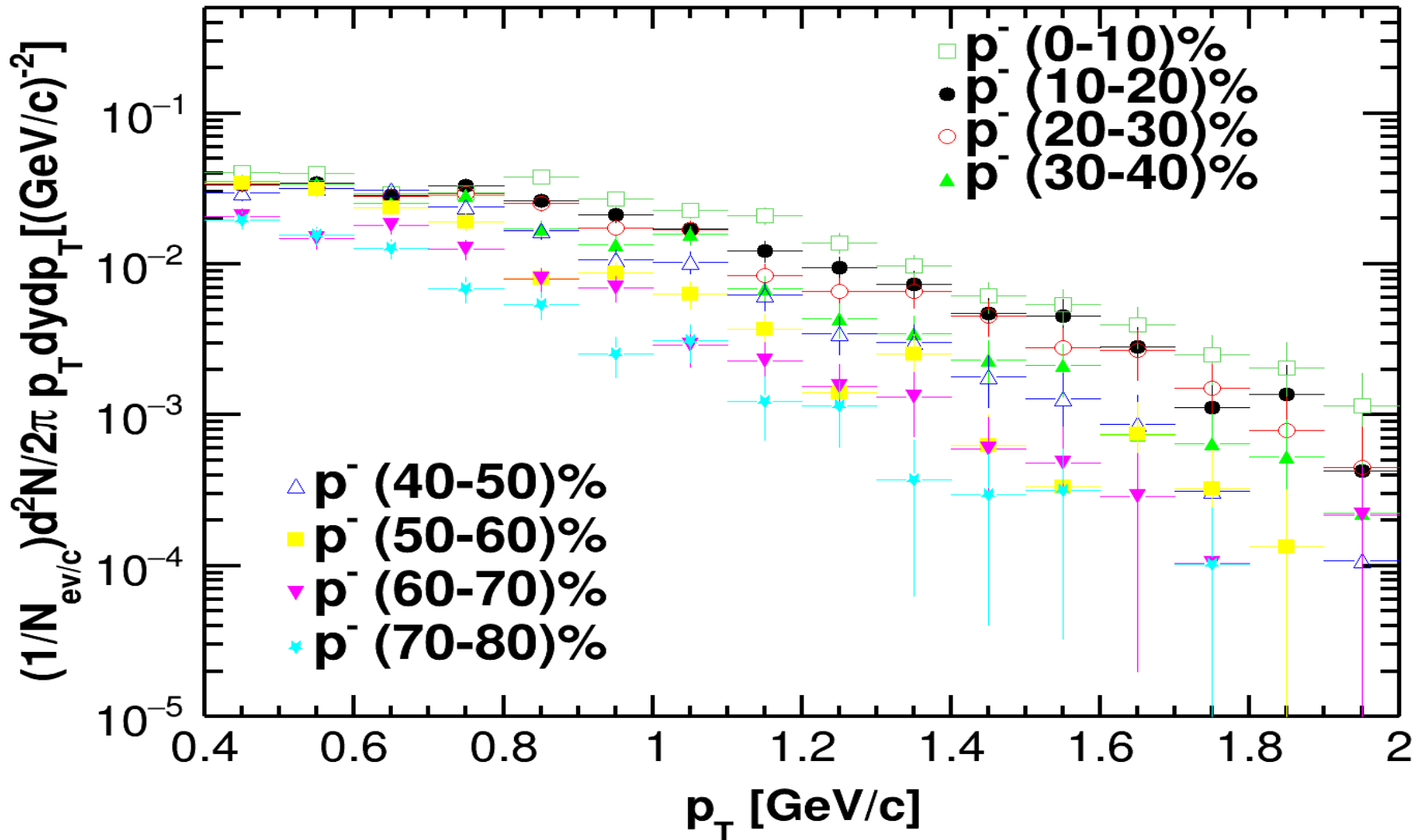## Au+Au 11.5 GeV

Transverse momentum for p⁻

Au+Au 7.7 GeV

Transverse momentum for p⁻

Au+Au 11.5 GeV