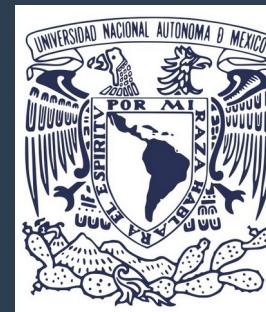


# Transverse momentum distributions for identified particles with the MPD: comparison with STAR data and predictions for Bi+Bi

Rodrigo Guzmán Castro<sup>†</sup>  
October 18, 2022

Cross-PWG meeting

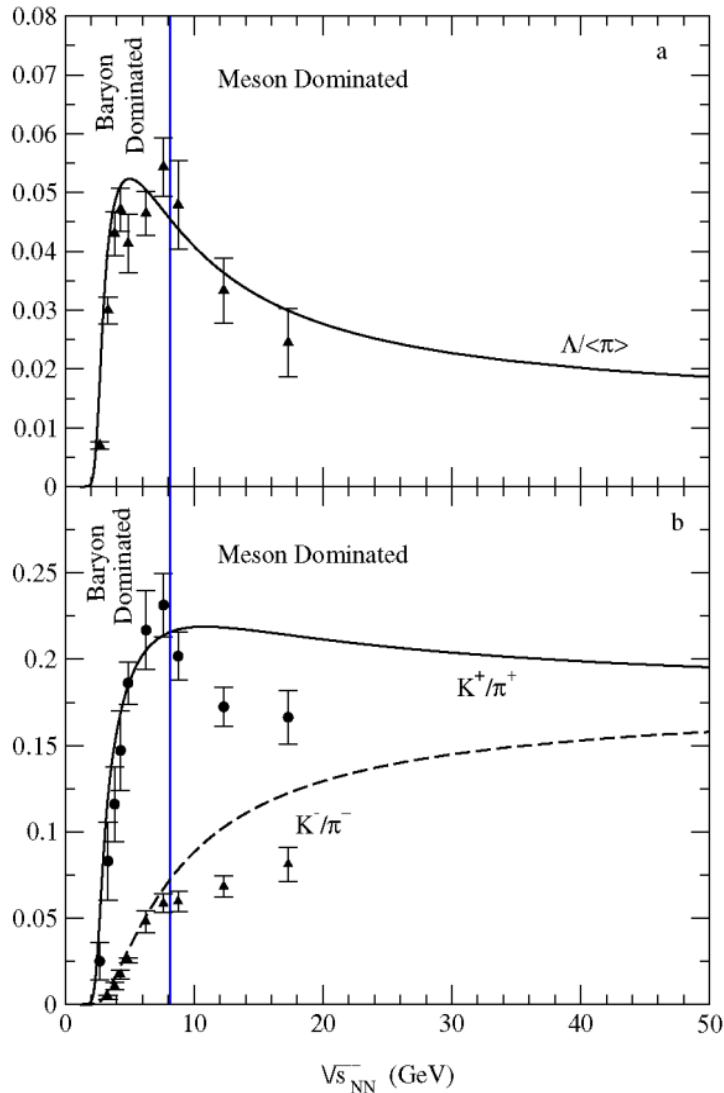
<sup>†</sup>Instituto de Ciencias Nucleares,  
Universidad Nacional Autónoma de México  
MexNICA Collaboration



Instituto de  
Ciencias  
Nucleares  
UNAM



# Motivation



The recently discovered sharp peak in the  $K^+/\pi^+$  ratio in relativistic heavy-ion collisions is discussed in the framework of the statistical model. In this model a rapid change is expected as the hadronic gas undergoes a transition from a baryon-dominated to a meson-dominated gas.<sup>1</sup>

We conclude that the measured particle ratios with 20-30% deviations agree with a hadronic freeze-out scenario. These deviations seem to occur just in the transition from baryon-dominated to meson-dominated freeze-out.<sup>1</sup>

<sup>1</sup>J. Cleymans *et al.*, Physics Letters B **615** (2005) 50-54.

# Data sample analyzed

## 3 data sets generated with UrQMD 3.4v:

- 1) Au+Au collisions at 7.7 GeV compared to real data<sup>2</sup>  
(90000 events)
- 2) Au+Au collisions at 9.2 GeV compared to real data<sup>3</sup>  
(90000 events)
- 3) Bi+Bi collisions at 9.2 GeV to make predictions  
(125000 events from MPD request number 28)

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<sup>2</sup>L. Adamczyk *et al.* [STAR], Phys. Rev. C **96**, no.4, 044904 (2017).

<sup>3</sup>B. I. Abelev *et al.* [STAR], Phys. Rev. C **81**, 024911 (2010).

# Track selection criteria

	Au+Au 7.7 GeV	Au+Au 9.2 GeV	Bi+Bi 9.2 GeV
Number of events	90000	90000	125000
Koef <sup>‡</sup>	0.89	0.89	0.073
$\sigma_M^{\ddagger}$	3	3	3
$\sigma_E^{\ddagger}$	4	4	4
Probability cut	>0.6	>0.6	>0.6
Primary	Mother ID	Mother ID	Mother ID
Number of hits (NofH)	>13	>13	>16
$\chi^2/NofH$	<8	<8	<8
$P_T$ [GeV/c]	0.1-3.0	0.1-3.0	0.1-3.0
$ \eta $	<0.5	<0.5	<0.5
$ y $	<0.1	<0.5	-
Centrality criteria	MPD <sup>4</sup>	STAR <sup>5</sup>	MPD <sup>4</sup>
Events after cuts	58600 (~65%)	68704 (~76%)	90731 (~72%)

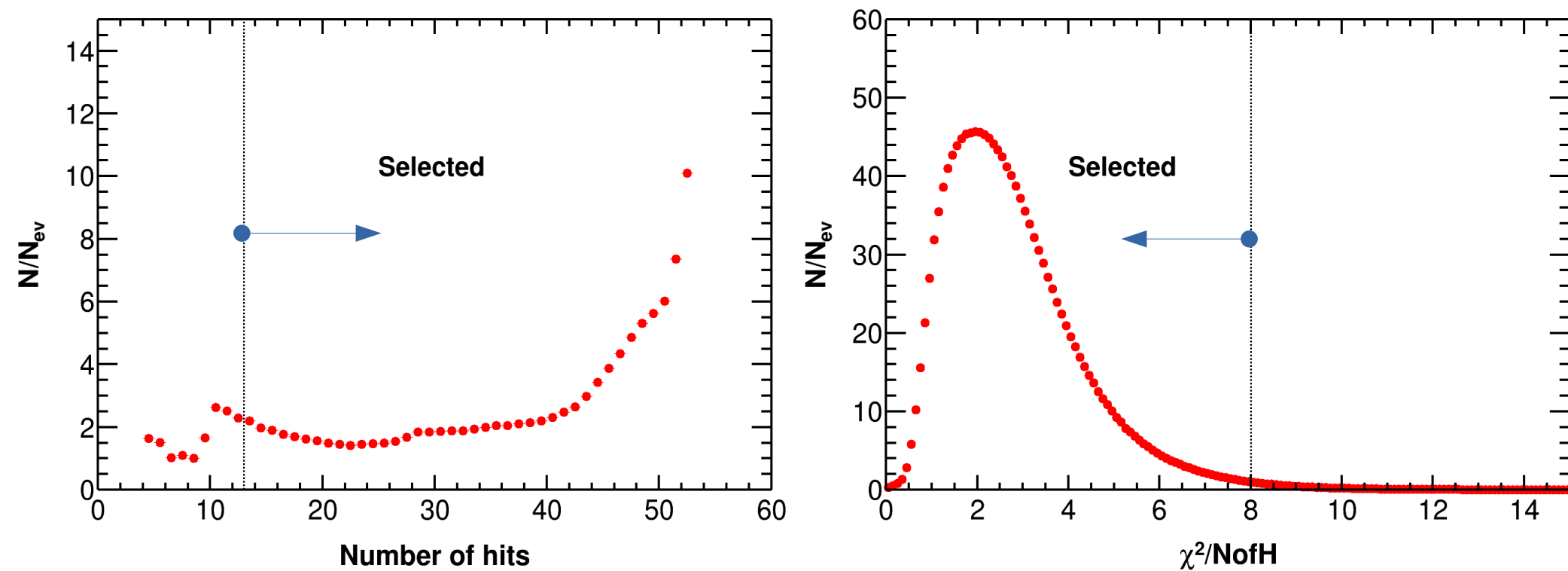
<sup>‡</sup>mpdPid class (n-sigma method).

<sup>4</sup>P. Parfenov *et al.* [MPD], Analysis Note draft (2021).

<sup>5</sup>B. I. Abelev *et al.* [STAR], Phys. Rev. C **81**, 024911 (2010).

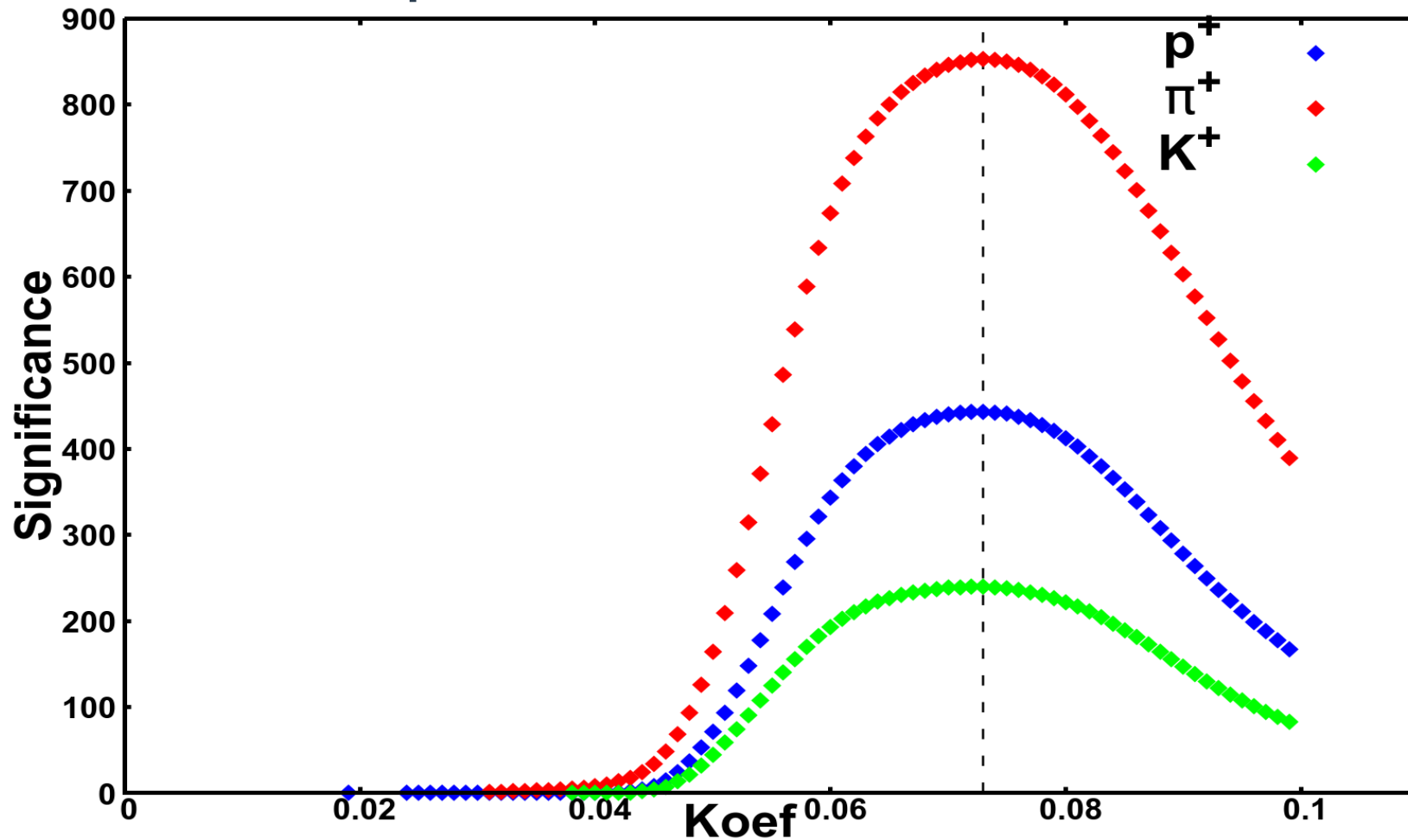
# Hits and $\chi^2/\text{NofH}$ distributions

Example: Au+Au 7.7 GeV



# Optimization

Example: Bi+Bi 9.2 GeV (Kcoef)

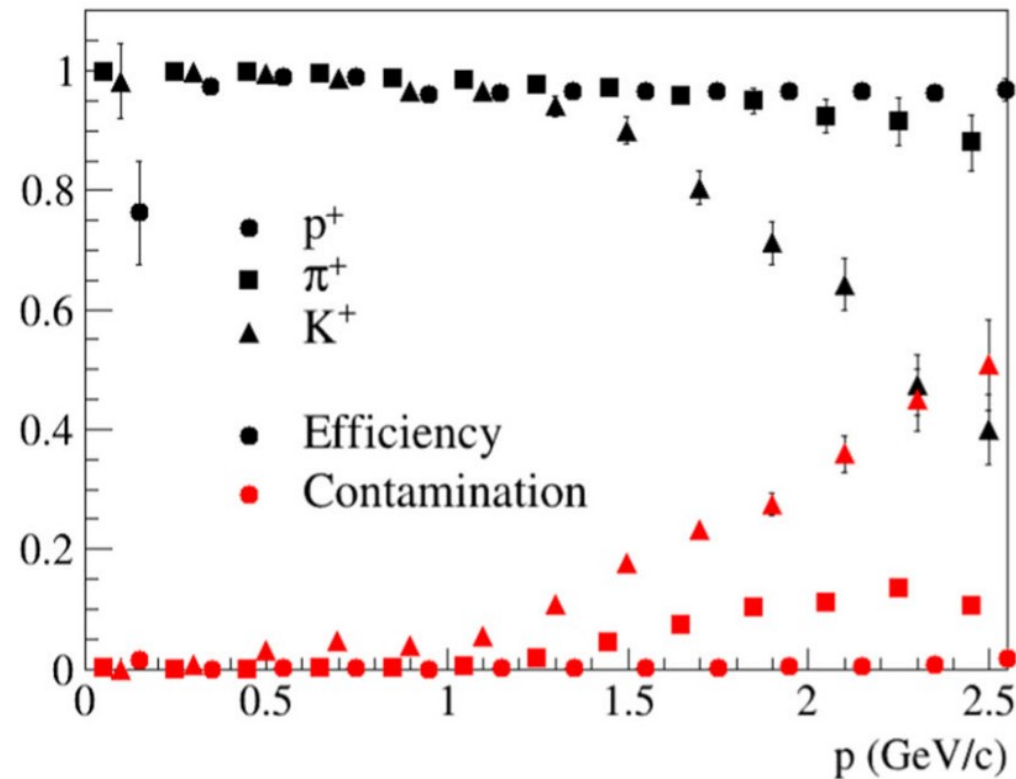


$$\text{Significance} = \frac{\text{signal}}{\sqrt{\text{signal} + \text{background}}}$$

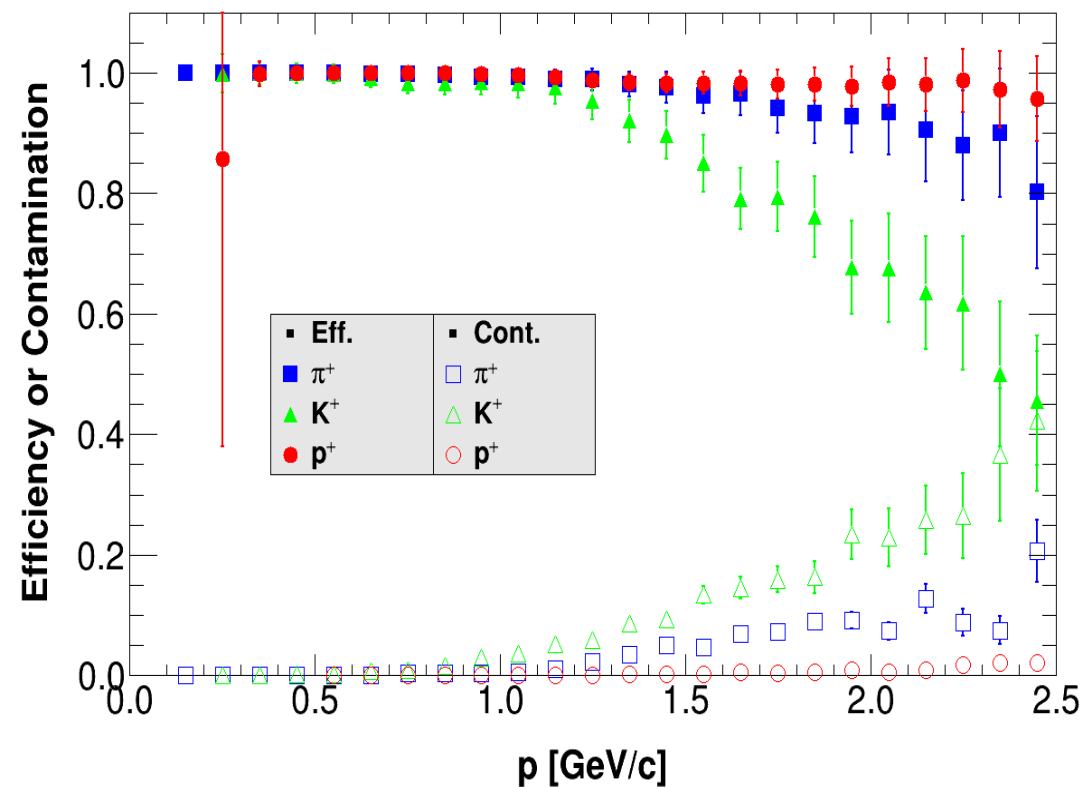
# Reconstruction efficiency

## Au+Au collisions

- MPD collaboration<sup>6</sup> (9 GeV)



- Our reconstruction (9.2 GeV)

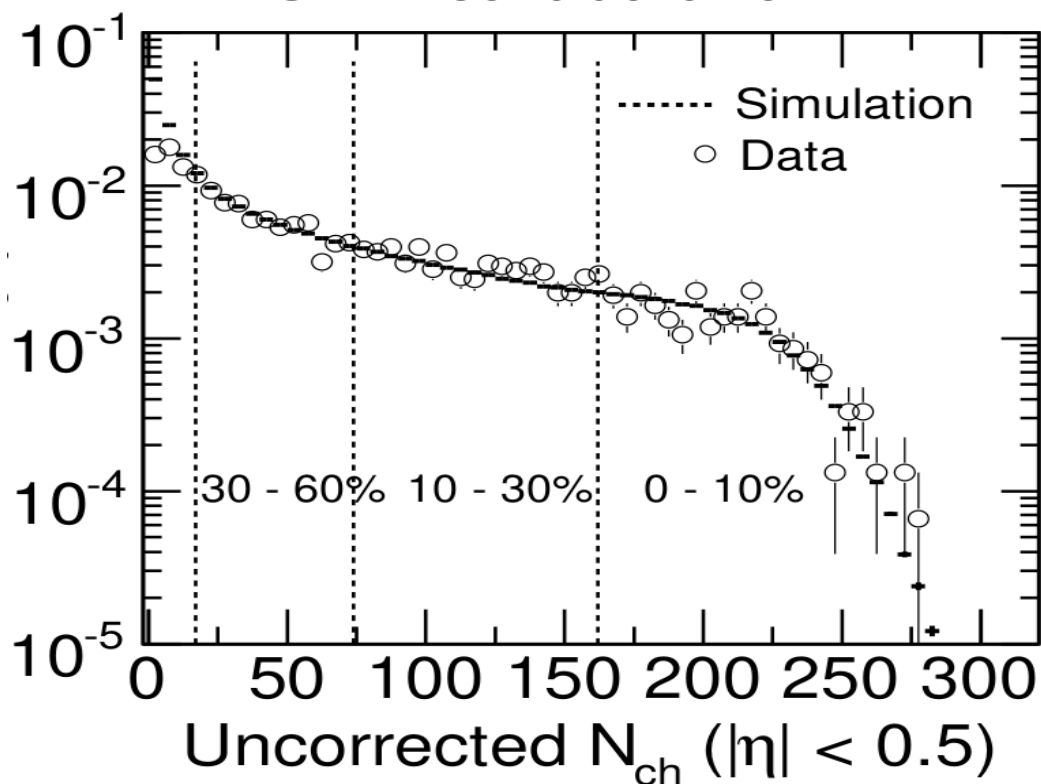


<sup>6</sup>V. Abgaryan *et al.* [MPD], Eur. Phys. J. A **58**, no.7, 140 (2022).

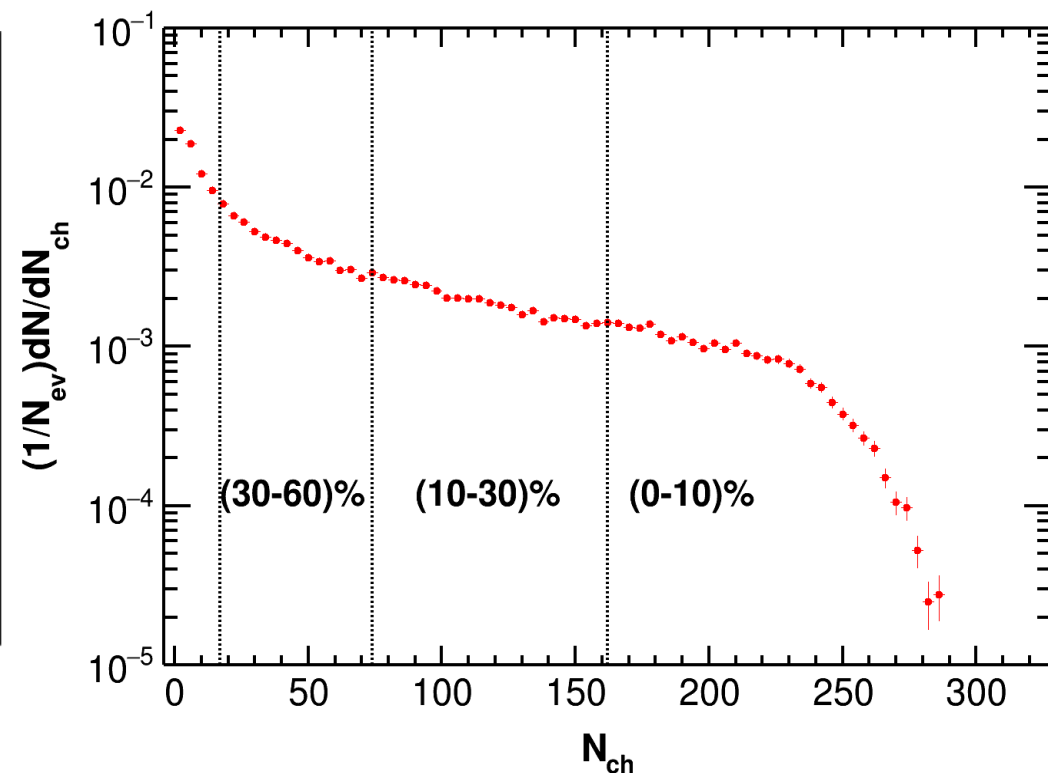
# Multiplicity and centrality selection

Example: Au+Au 9.2 GeV

• STAR collaboration<sup>7</sup>



• Our reconstruction

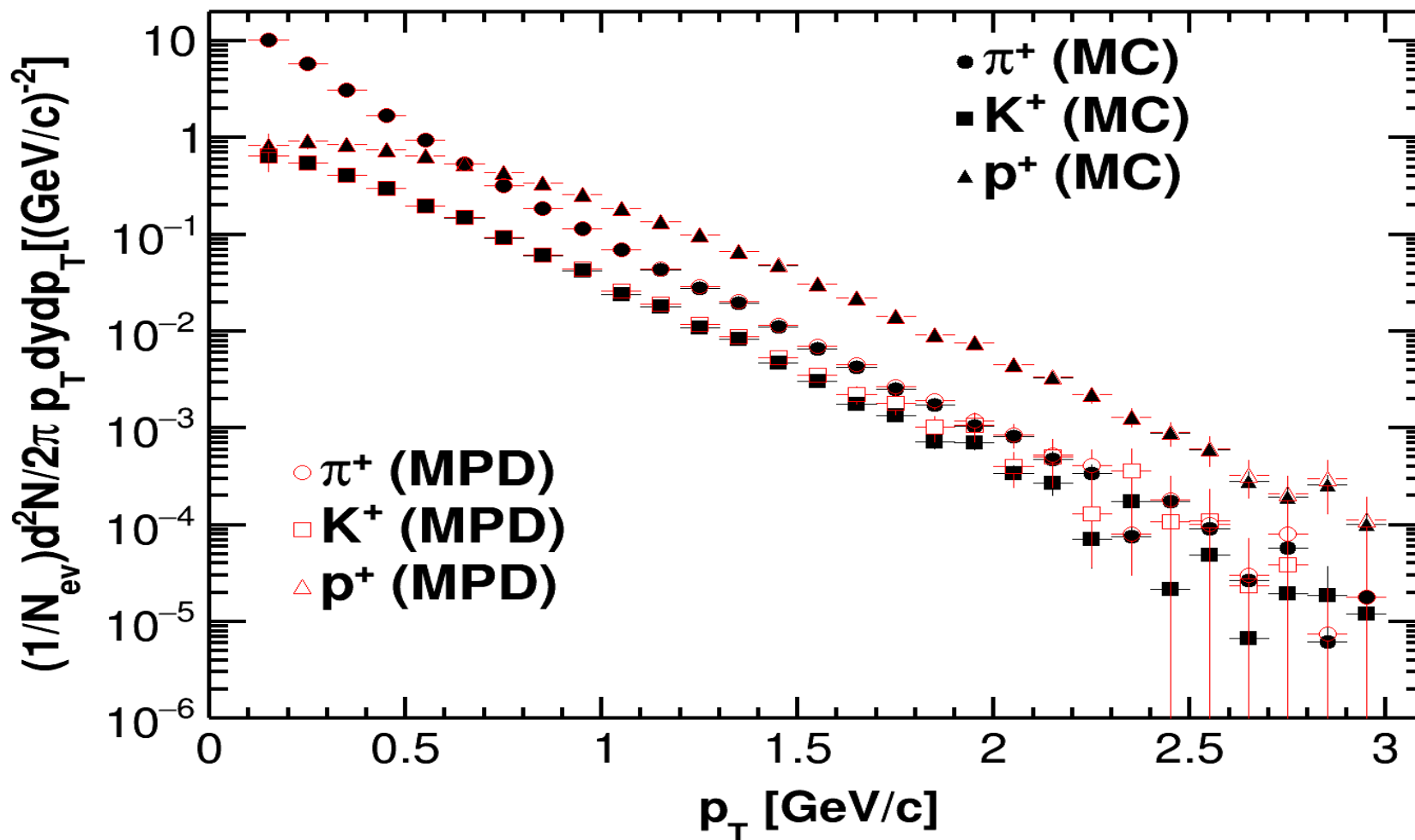


<sup>7</sup>B. I. Abelev *et al.* [STAR], Phys. Rev. C **81**, 024911 (2010).



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

Au+Au 7.7 GeV



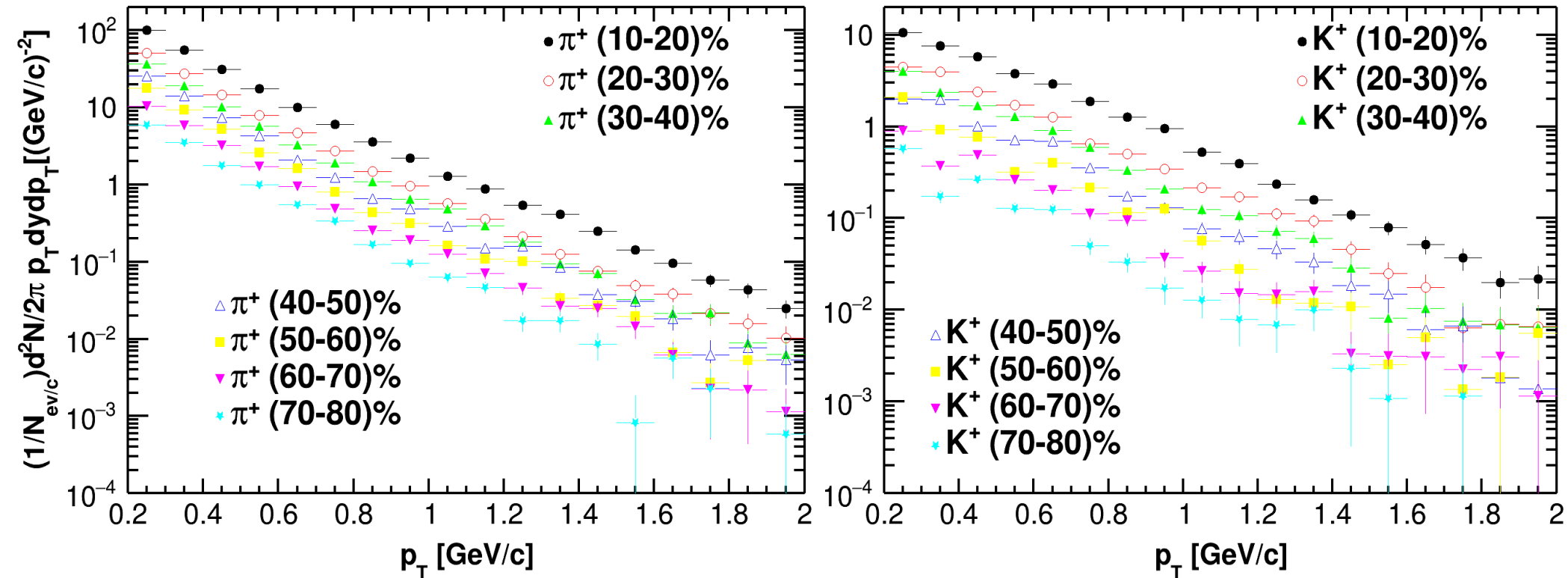
Due to the increasing contamination for  $p_T \geq 1.2$  GeV, there are differences (particularly for the  $K^+$ )

# Events per centrality ( $N_{ev/c}$ )

	Au+Au 7.7 GeV	Au+Au 9.2 GeV
(10-20)%	11451 (~13%)	-
(20-30)%	6716 (~7%)	-
(30-40)%	6869 (~8%)	-
(40-50)%	6441 (~7%)	-
(50-60)%	6338 (~7%)	-
(60-70)%	7651 (~9%)	-
(70-80)%	7441 (~8%)	-
(0-10)%	-	8252 (~9%)
(0-60)%	-	46069 (~51%)
(10-30)%	-	15290 (~17%)
(30-60)%	-	22527 (~25%)

# Transverse momentum per centrality

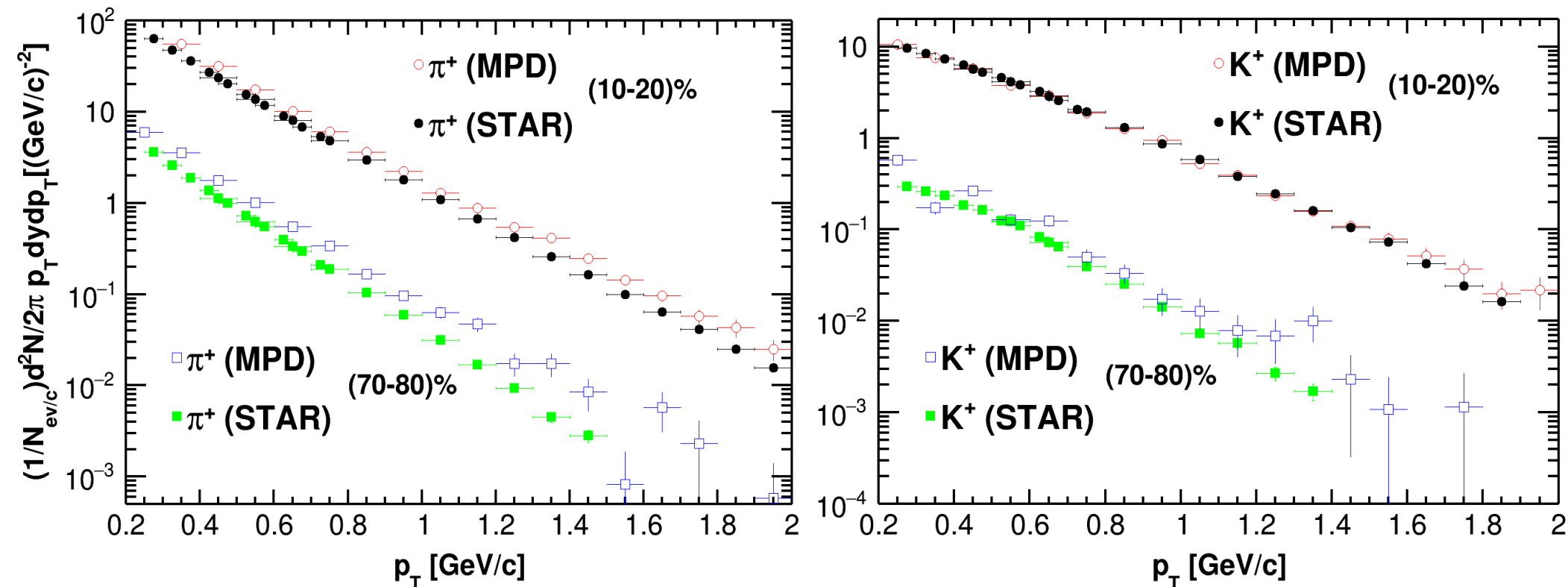
Au+Au 7.7 GeV (Our reconstruction)



Given the low statistics as well as the efficiency drop for  $p_T \geq 1.2$  GeV/c, the fluctuations are considerable

# STAR vs. MPD $p_T$ distributions

Au+Au 7.7 GeV



The agreement is good for the most central collisions.

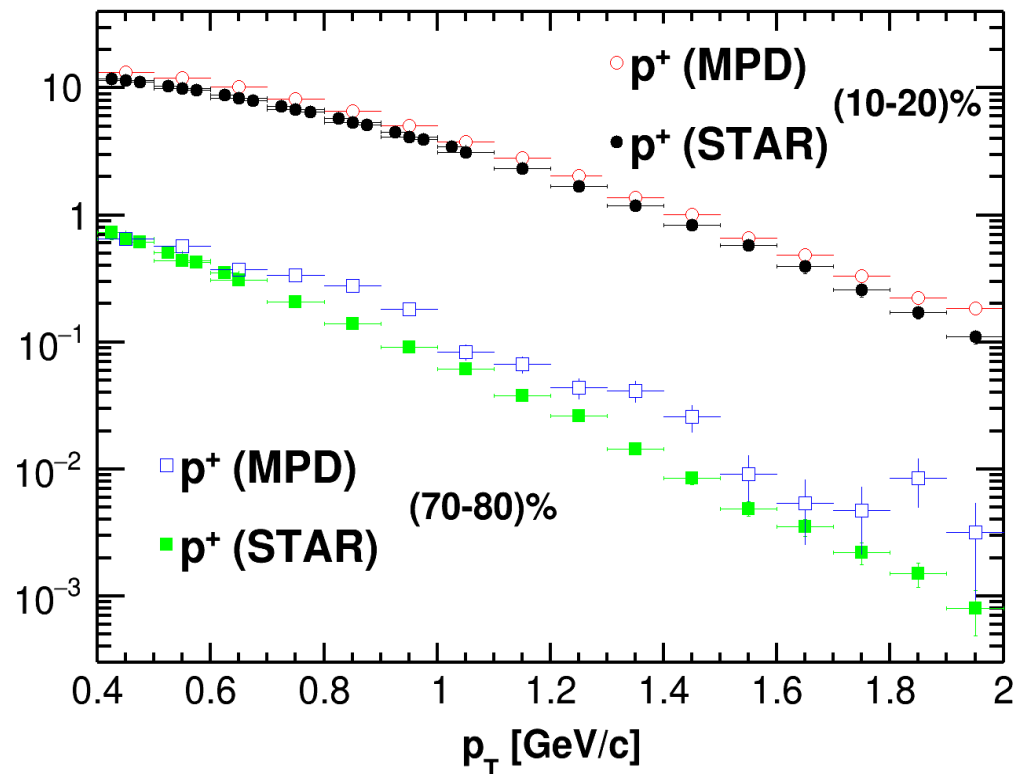
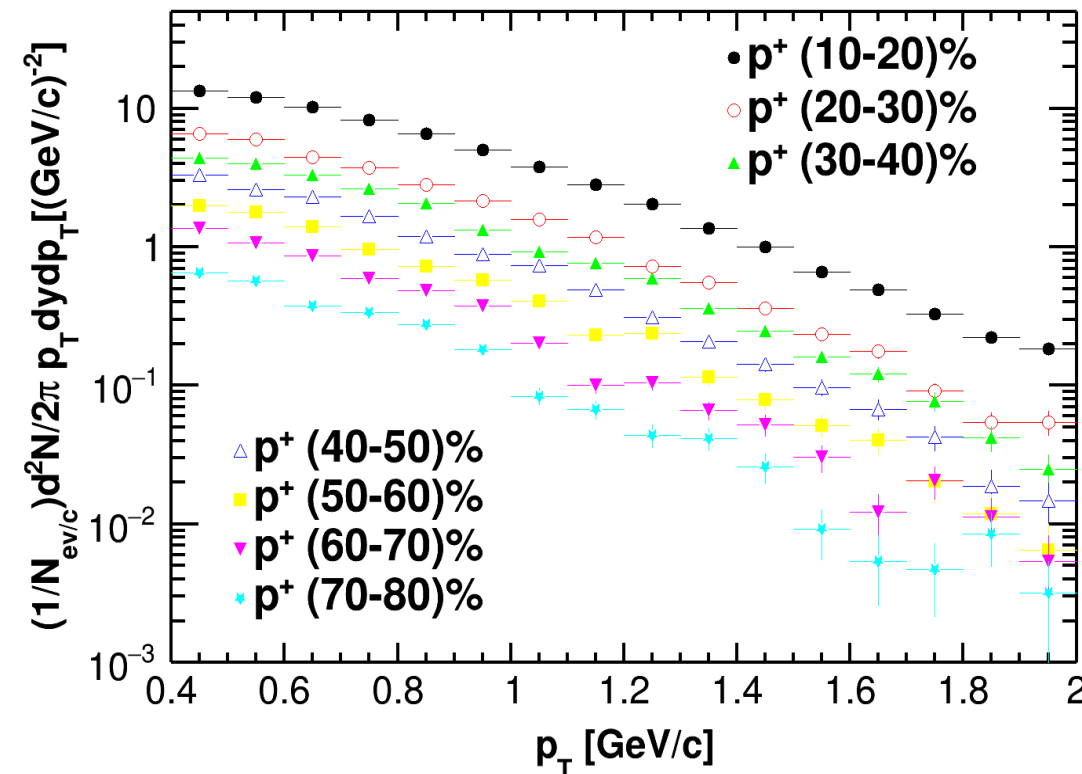
Similar results are obtained for the negative charged particles.

# Transverse momentum distributions for $p^+$

Au+Au 7.7 GeV

• Our reconstruction

• Comparison

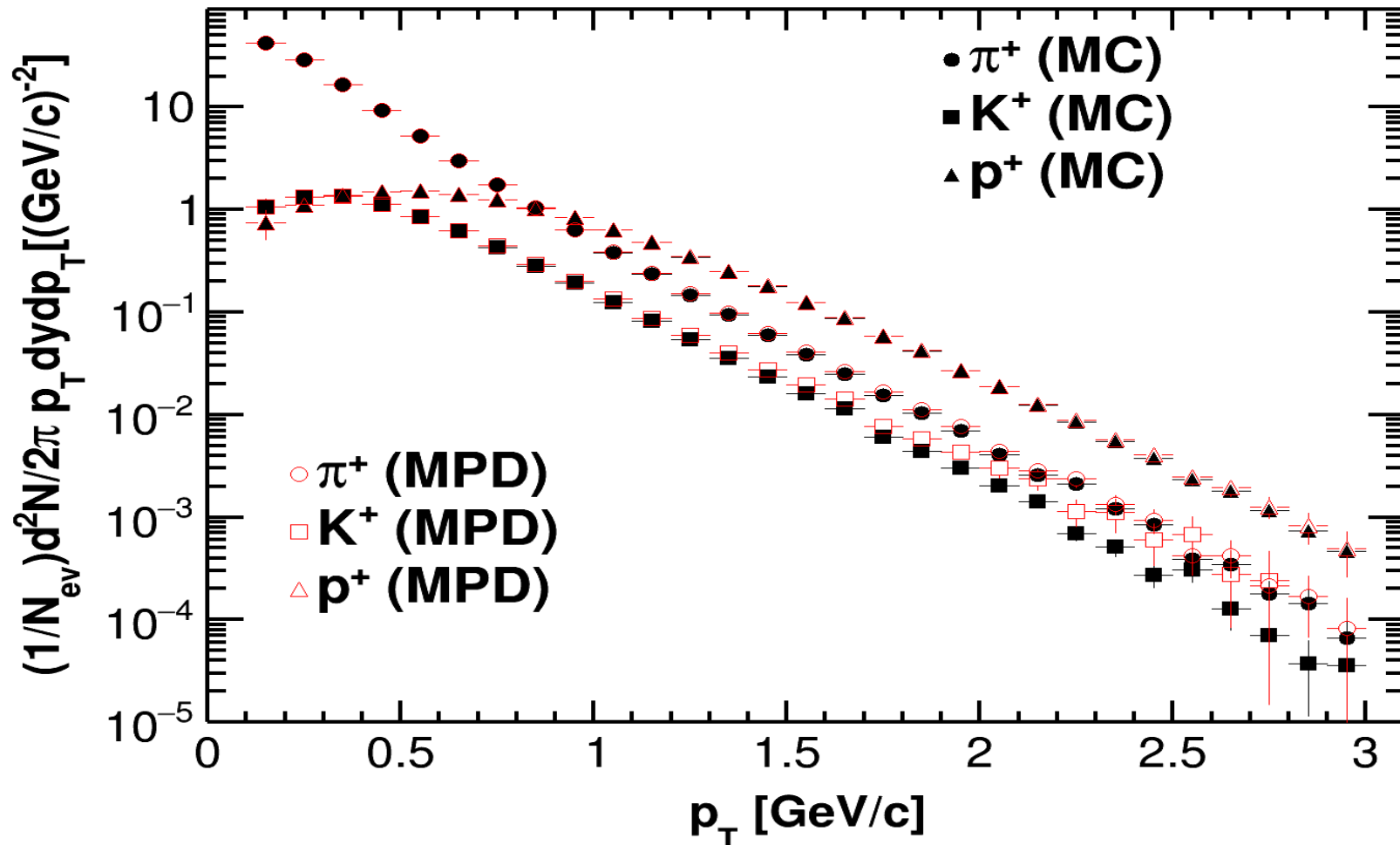


Similar behaviour for protons

The agreement worsens for the antiprotons

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

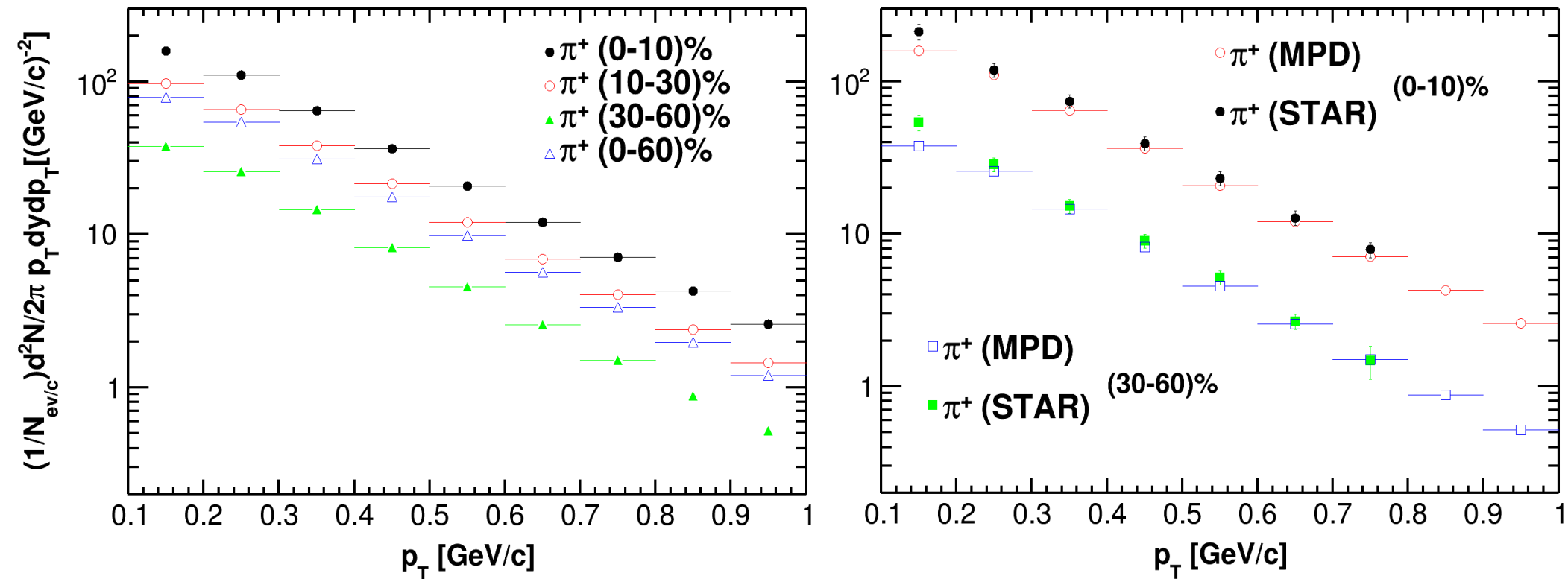
Au+Au 9.2 GeV



Similar to the 7.7 GeV case, due to the increasing contamination for  $p_T \geq 1.2$  GeV/c, there are differences (especially for the  $K^+$ )

# Transverse momentum distributions for $\pi^+$

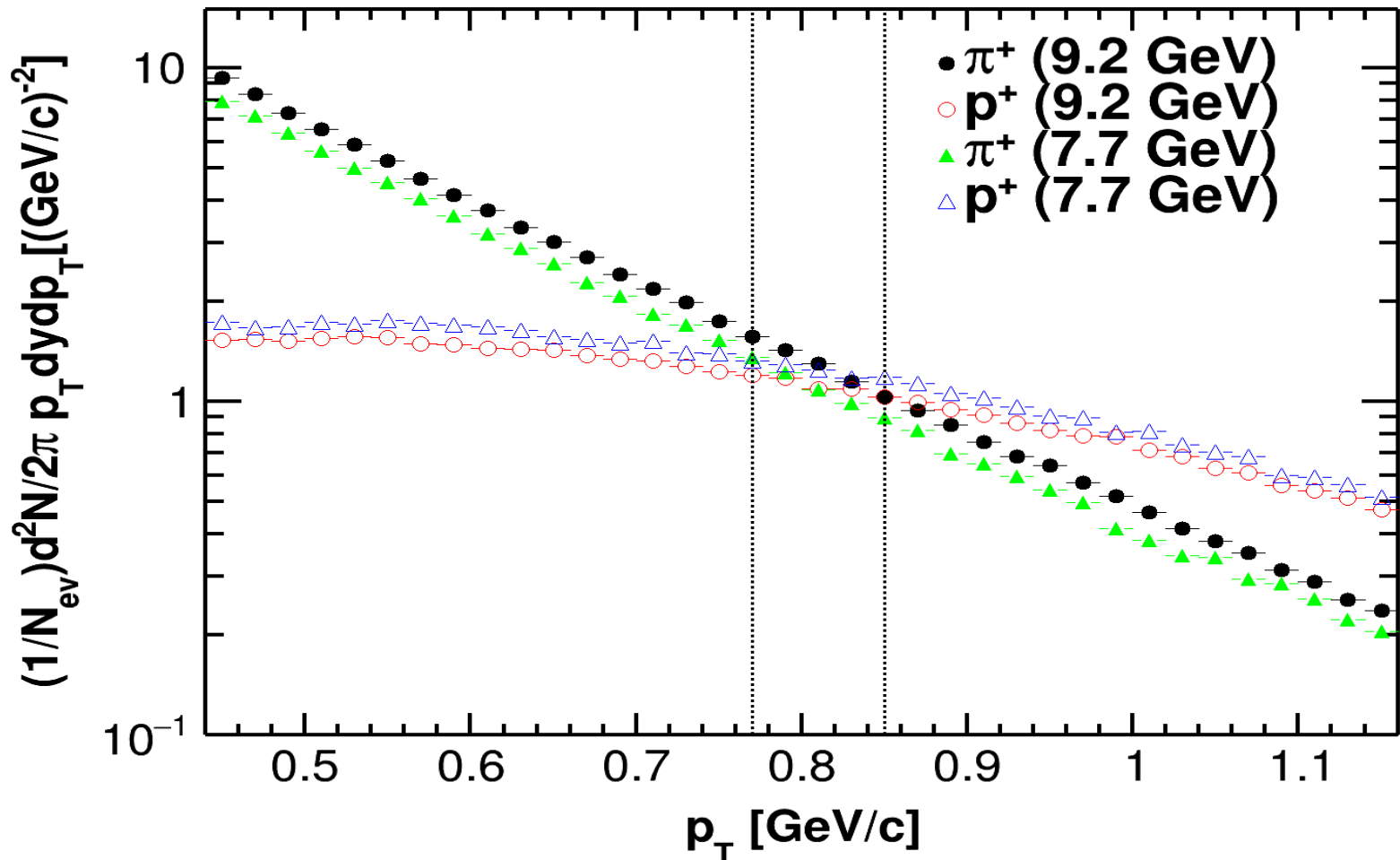
Au+Au 9.2 GeV



The agreement is good both for the most central and peripheral collisions

# Crossing point between $\pi^+$ and $p^+$

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



Distributions cross around  $p_T = 0.85$  GeV/c for collisions at 9.2 GeV  
and around  $p_T = 0.77$  GeV/c for collisions at 7.7 GeV

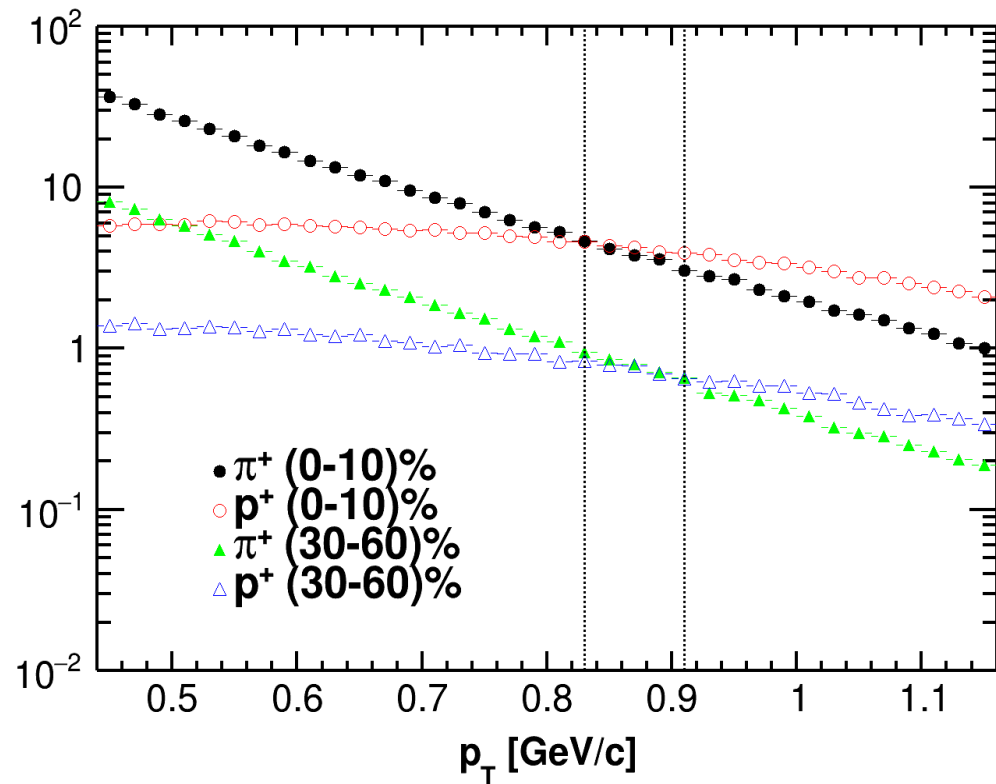
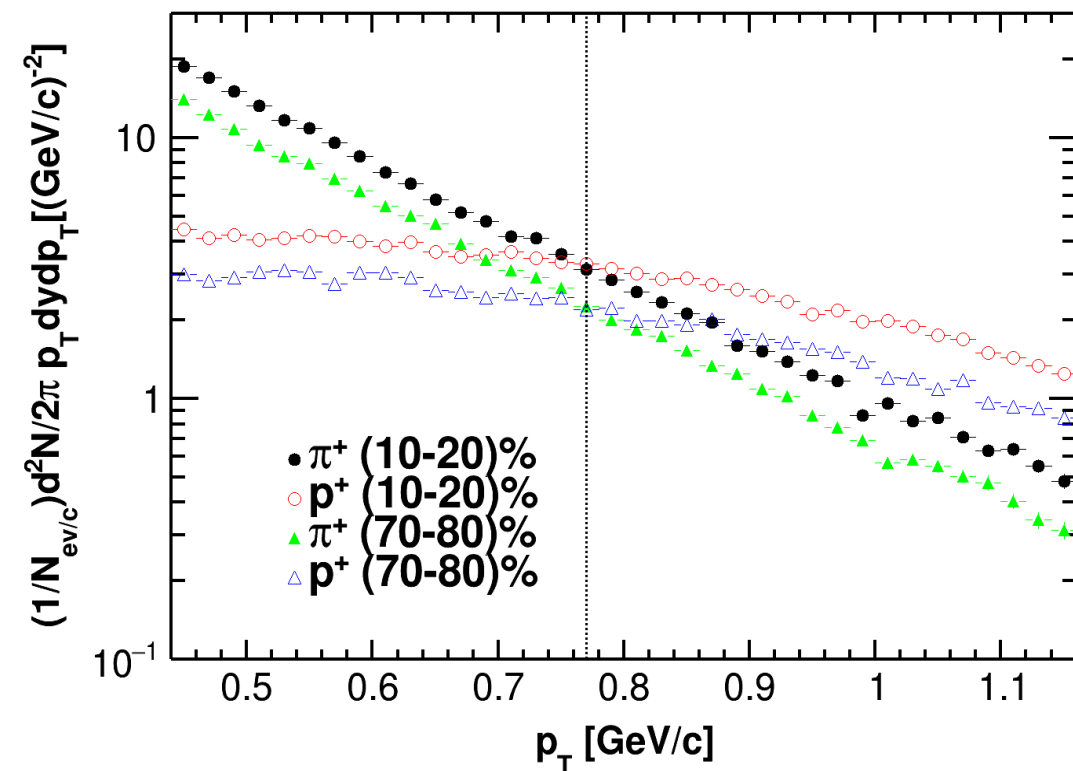


# Crossing point at different centralities

Reconstructed Au+Au  $|y| < 0.5$

• 7.7 GeV

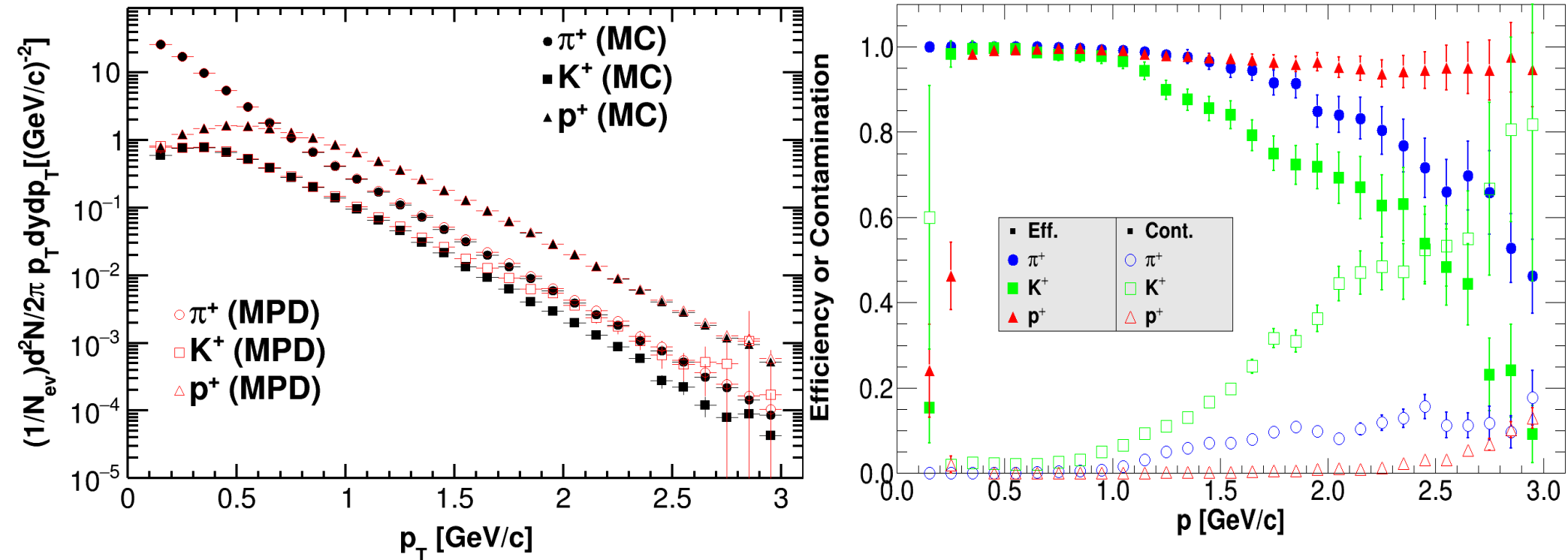
• 9.2 GeV



The crossing point appears to be at 0.77 GeV/c for both centralities for the 7.7 GeV case, while the crossing point depends on the centrality for the 9.2 GeV case (at 0.83 and 0.91 GeV/c)

# Transverse momentum and reconstruction efficiency distributions

Bi+Bi 9.2 GeV



There seems to be a lot of contamination in the  $K^+$  case

# Conclusions

- 1) We have presented a study of the transverse momentum distributions of MPD data for Au+Au at 7.7 and 9.2 GeV, and their comparison with STAR data.
- 2) The results show qualitative agreement between STAR and MPD.
- 3) We observed different crossing points between distributions of pions and protons, and how they change with collision energy and centrality.
- 4) We made a prediction for the pion, kaon and proton transverse momentum distributions that can be obtained from MPD for Bi+Bi collisions at 9.2 GeV.
- 5) Details on the evolution of the crossing point of the  $p_T$  distributions for mesons and baryons are under investigation.

# And...

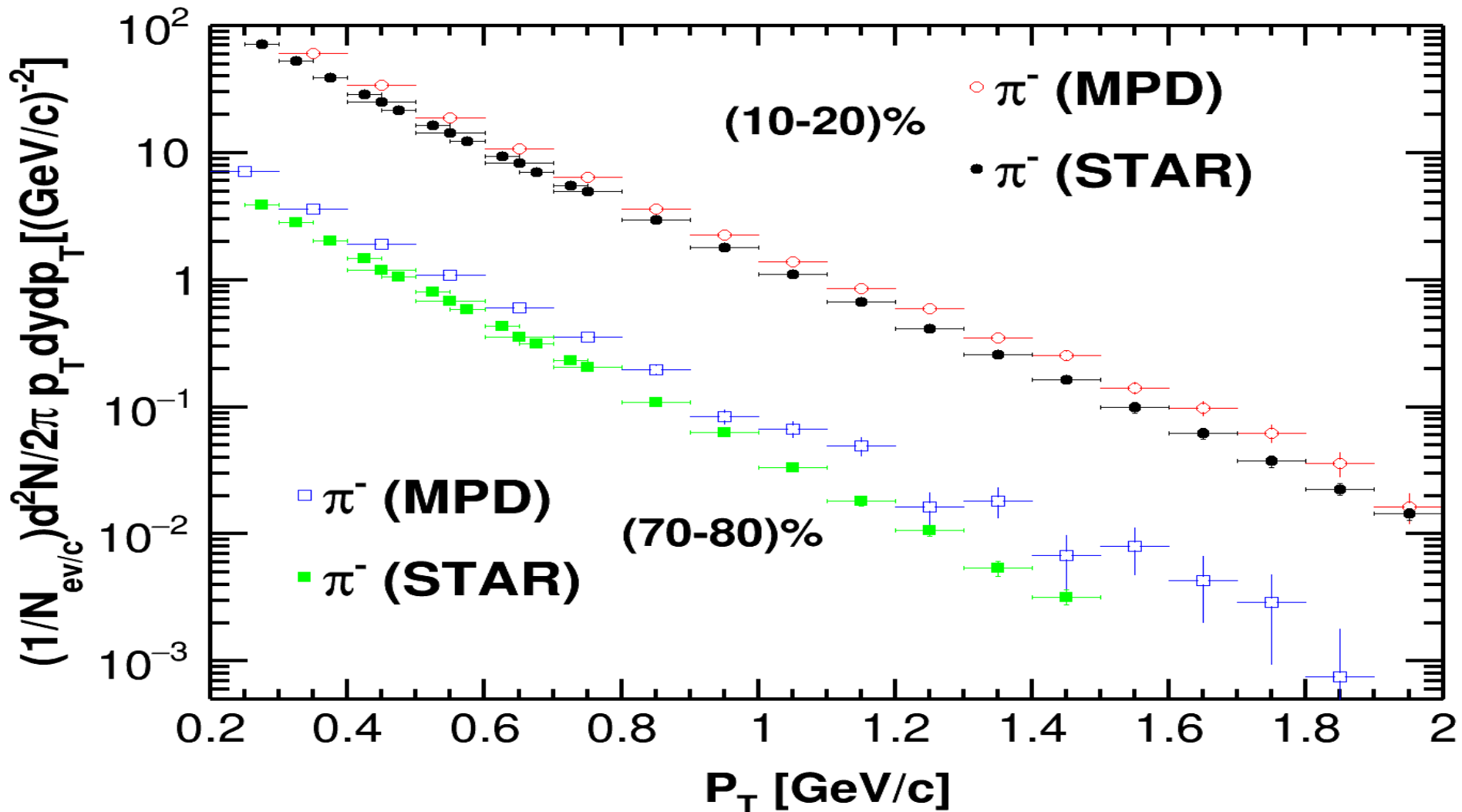
If the MPD collaboration agrees, we would also like to submit an abstract for the ICPPA-2022

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

**Backup**

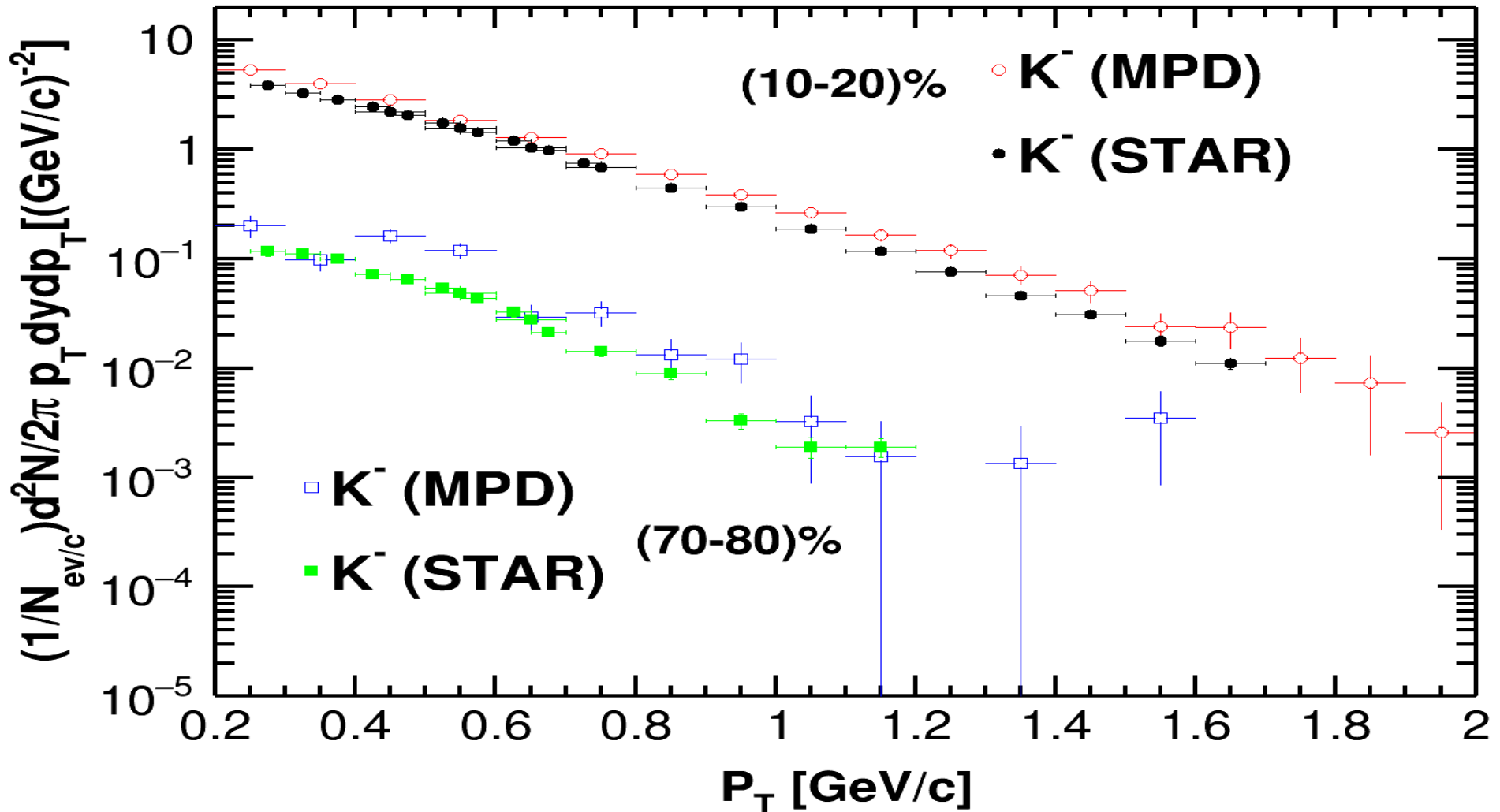
# Transverse momentum for $\pi^-$ : STAR vs MPD

Au+Au 7.7 GeV



# Transverse momentum for K<sup>-</sup>: STAR vs MPD

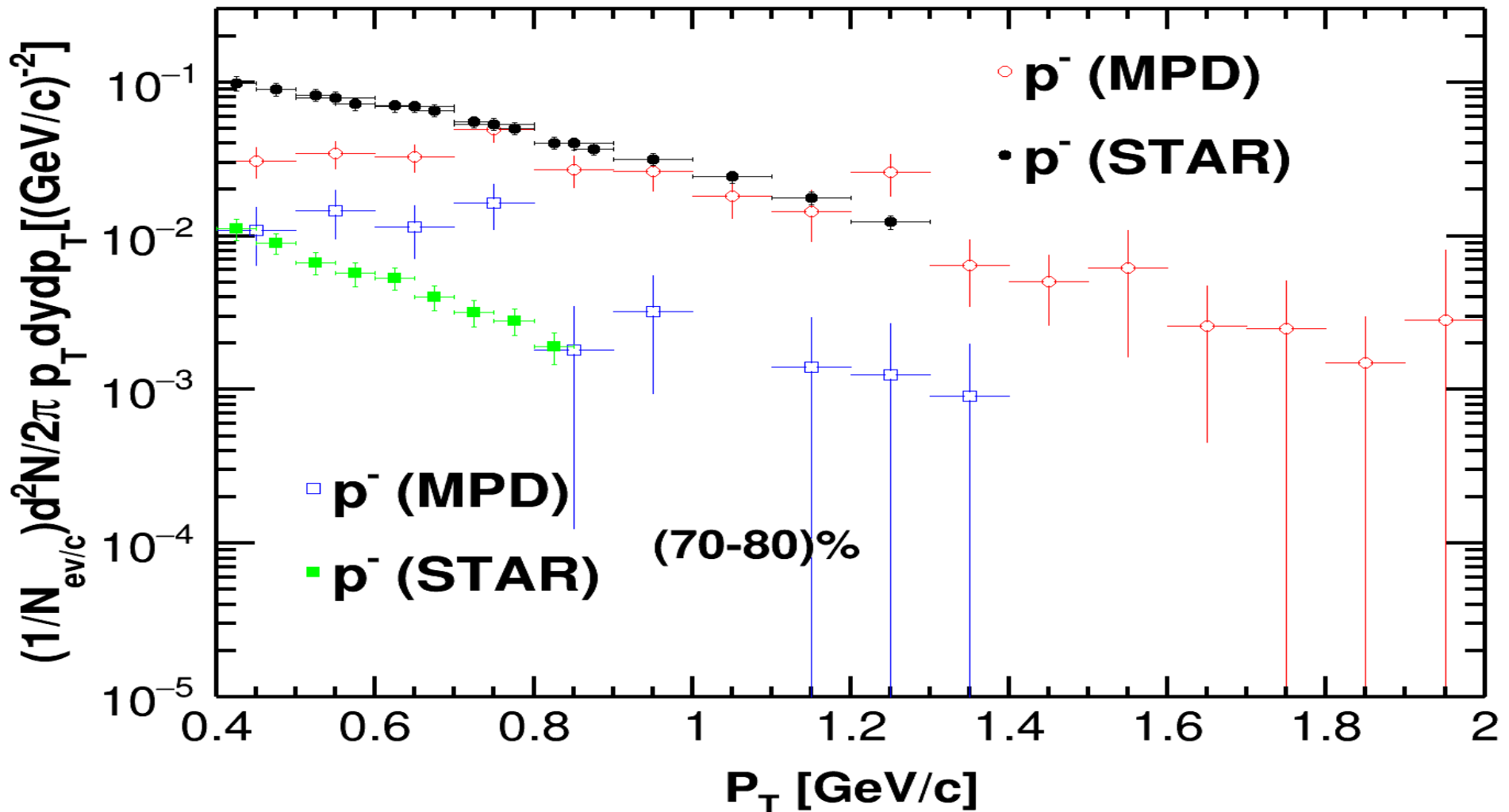
Au+Au 7.7 GeV





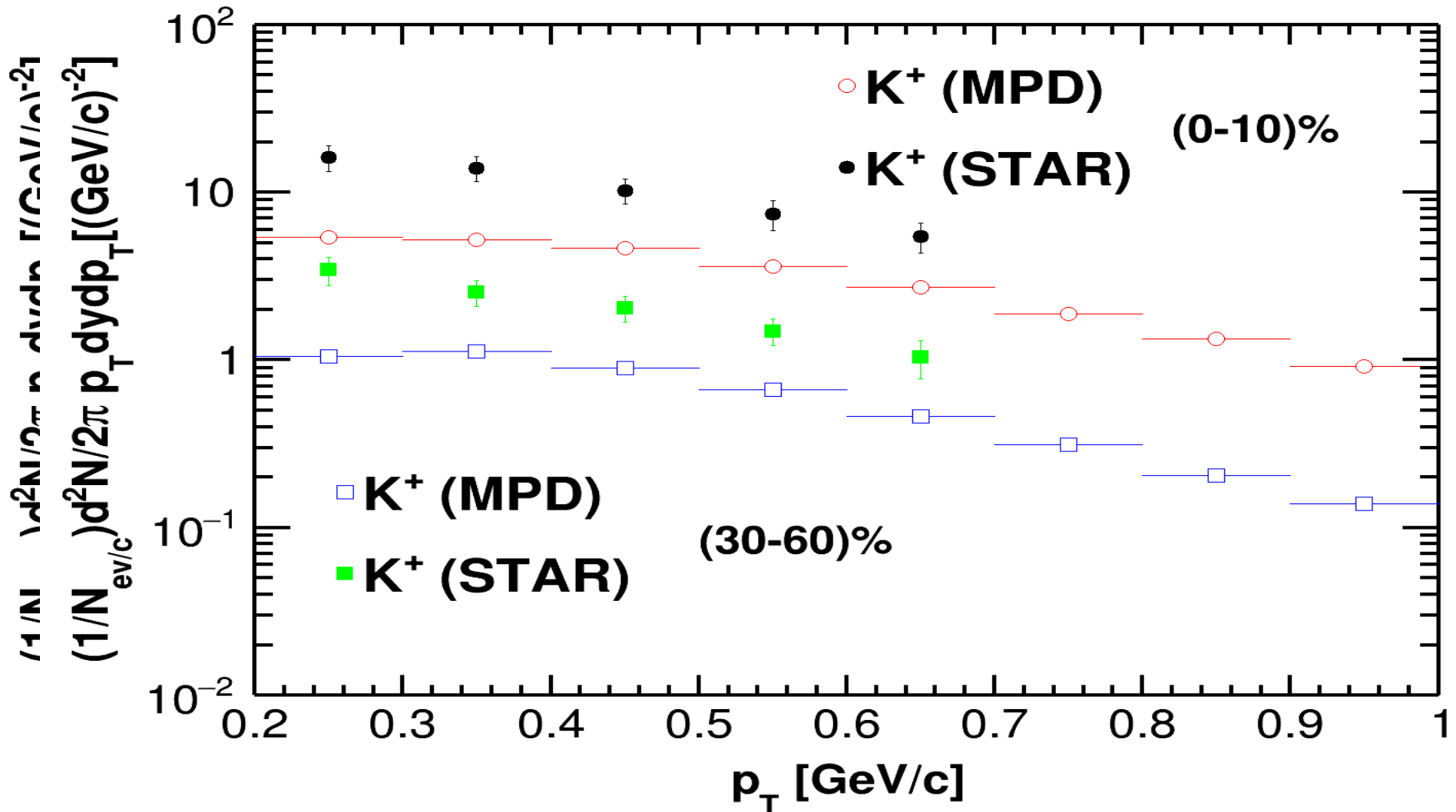
# Transverse momentum for $p^-$ : STAR vs MPD

Au+Au 7.7 GeV



# Transverse momentum for $K^+$ : STAR vs MPD

Au+Au 9.2 GeV



# Transverse momentum for p<sup>+</sup>: STAR vs MPD

Au+Au 7.7 GeV

