Anisotropic flow in MPD-FXT: first look at the production 36

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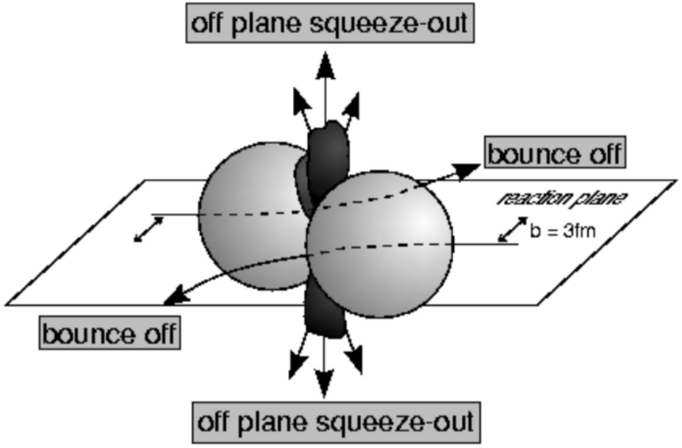
Anisotropic flow & spectators



The azimuthal angle distribution is decomposed in a Fourier series relative to reaction plane angle:

$$\rho(\varphi - \Psi_{RP}) = \frac{1}{2\pi}(1 + 2\sum_{n=1}^{\infty} v_n \cos n(\varphi - \Psi_{RP}))$$

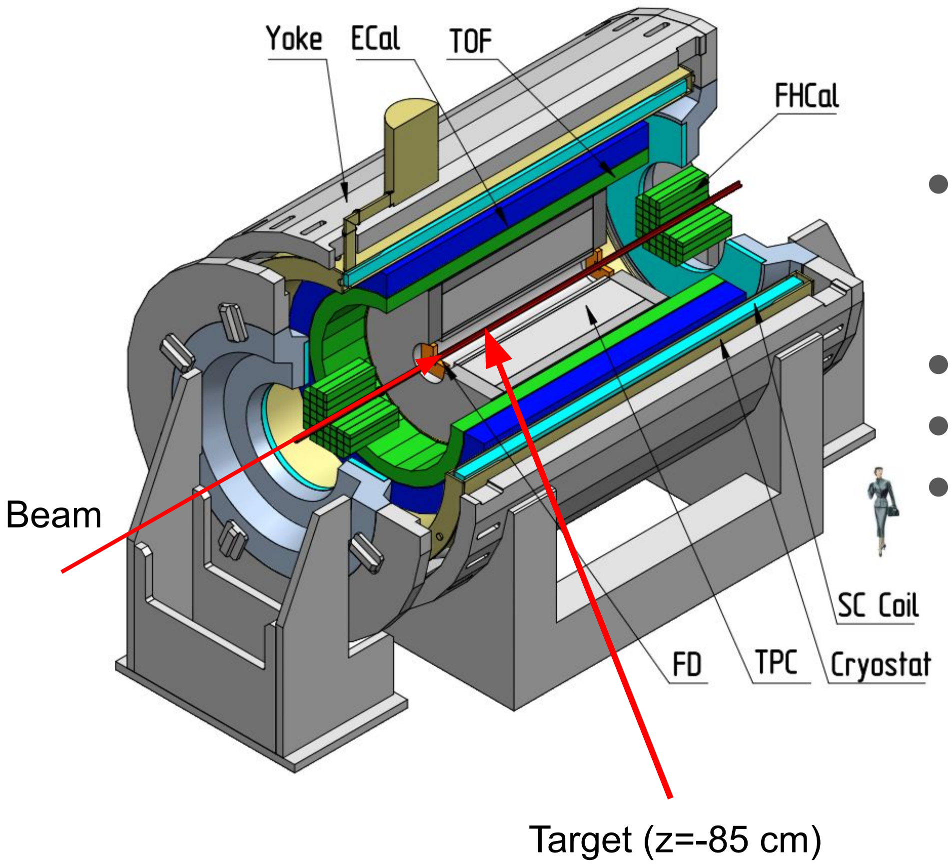
Anisotropic flow:

$$v_n = \langle \cos\left[n(\varphi - \Psi_{RP})\right] \rangle$$

Anisotropic flow is sensitive to:

- Time of the interaction between overlap region and spectators
- Compressibility of the created matter

MPD in Fixed-Target Mode (FXT)



- Model used: UrQMD mean-field
  - Xe+Xe, E_{kin}=2.5 AGeV ($\sqrt{s_{NN}}$ =2.87 GeV)
  - Xe+W, E_{kin}=2.5 AGeV ($\sqrt{s_{NN}}$ =2.87 GeV)
- Point-like target
- GEANT4 transport
- Particle species selection via TPC and TOF

Flow vectors

From momentum of each measured particle define a u_n-vector in transverse plane:

$$u_n = e^{in\phi}$$

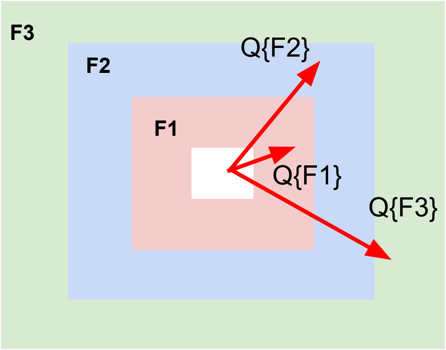
where φ is the azimuthal angle

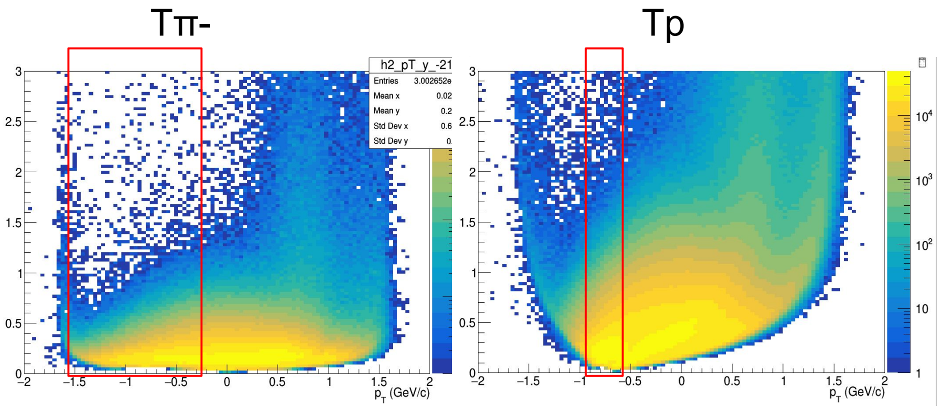
Sum over a group of u_n-vectors in one event forms Q_n-vector:

$$Q_n = \frac{\sum_{k=1}^{N} w_n^k u_n^k}{\sum_{k=1}^{N} w_n^k} = |Q_n| e^{in\Psi_n^{EP}}$$

Ψ_n^{EP} is the event plane angle

Modules of FHCal divided into 3 groups





Additional subevents from tracks not pointing at FHCal:
Tp: p; -1.0<y<-0.6;
Tπ: π-; -1.5<y<-0.2;

Flow methods for v_n calculation

Tested in HADES:
M Mamaev et al 2020 PPNuclei 53, 277–281
M Mamaev et al 2020 J. Phys.: Conf. Ser. 1690 012122

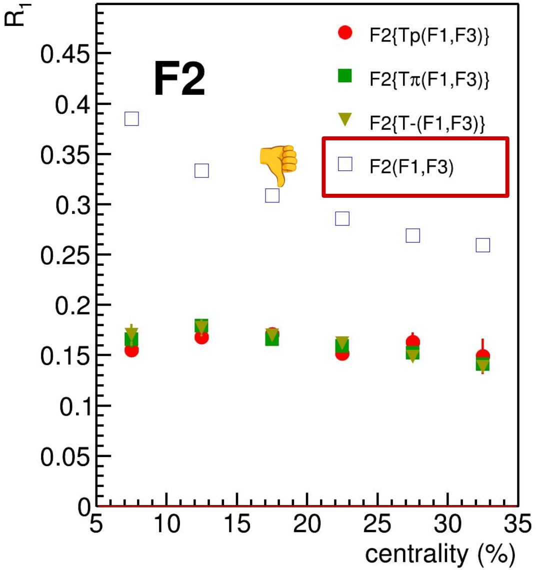
Scalar product (SP) method:

$$v_1 = \frac{\langle u_1 Q_1^{F1} \rangle}{R_1^{F1}} \qquad v_2 = \frac{\langle u_2 Q_1^{F1} Q_1^{F3} \rangle}{R_1^{F1} R_1^{F3}}$$

Where R_1 is the resolution correction factor

$$R_1^{F1} = \langle \cos(\Psi_1^{F1} - \Psi_1^{RP}) \rangle$$

Method helps to eliminate non-flow
Using 2-subevents doesn't



Symbol "F2(F1,F3)" means R_1 calculated via (3S resolution):

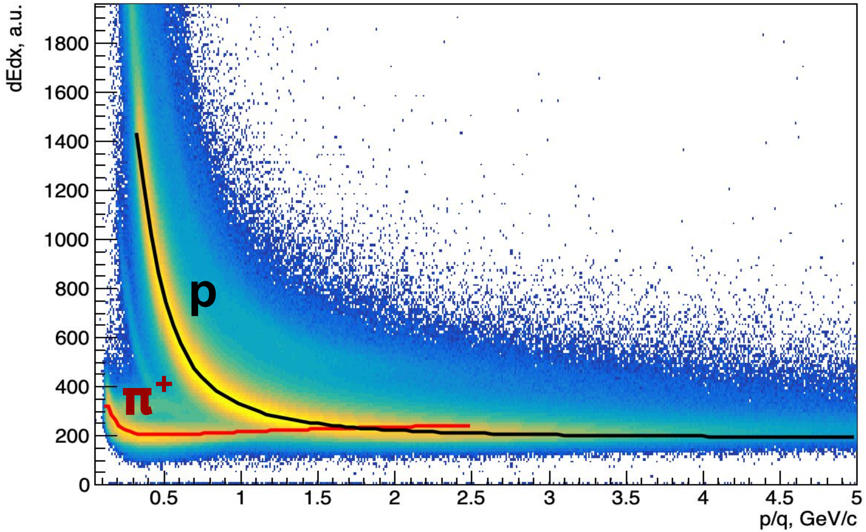
$$R_1^{F2(F1,F3)} = \frac{\sqrt{\langle Q_1^{F2} Q_1^{F1} \rangle \langle Q_1^{F2} Q_1^{F3} \rangle}}{\sqrt{\langle Q_1^{F1} Q_1^{F3} \rangle}}$$

Symbol "F2{Tp}(F1,F3)" means R_1 calculated via (4S resolution):

$$R_1^{F2\{Tp\}(F1,F3)} = \langle Q_1^{F2} Q_1^{Tp} \rangle \frac{\sqrt{\langle Q_1^{F1} Q_1^{F3} \rangle}}{\sqrt{\langle Q_1^{Tp} Q_1^{F1} \rangle \langle Q_1^{Tp} Q_1^{F3} \rangle}}$$

PID procedure

W. Blum, W. Riegler, L. Rolandi, Particle Detection with Drift Chambers (2nd ed.), Springer, Verlag (2008)

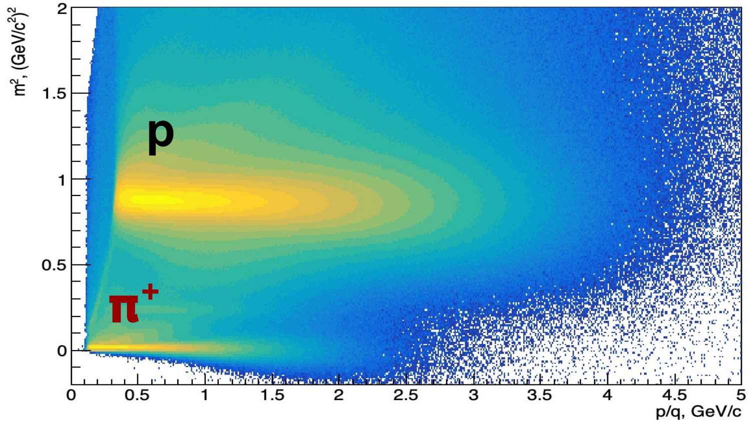


Fit dE/dx distributions with Bethe-Bloch parametrization:

$$f(\beta\gamma) = \frac{p_1}{\beta^{p_4}}\left(p_2 - \beta^{p_4} - \ln\left(p_3 + \frac{1}{(\beta\gamma)^{p_5}}\right)\right)$$

$$\beta^2 = \frac{p^2}{m^2 + p^2}, \beta\gamma = \frac{p}{m}$$ p_i - fit parameters

Fit *(dE/dx - f(βγ))/f(βγ)* with gaus in the slices of p/q and get σ_p(dE/dx)

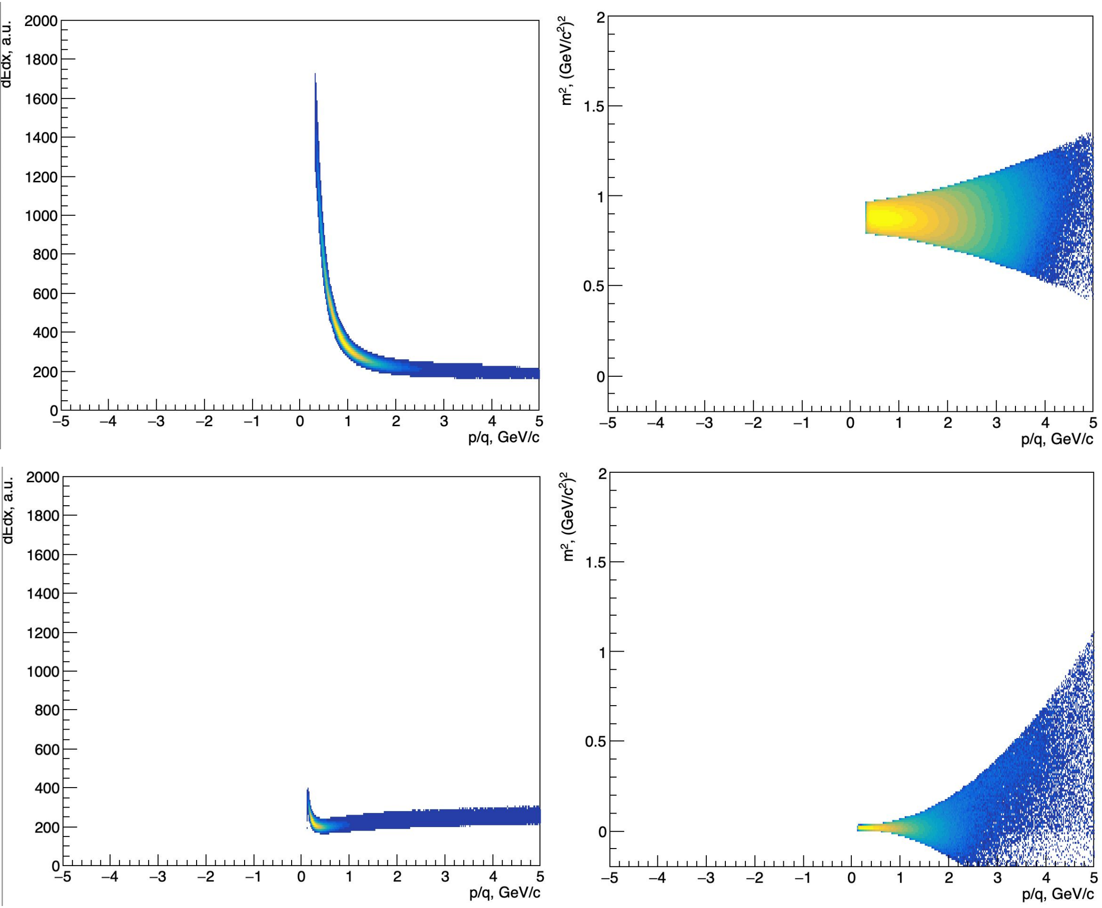


Fit m^2 with gaus in the slices of p/q and get $\sigma_p(m^2)$

(dE/dx,m)→(x,y) coordinates for PID:

$$x_p = \frac{(dE/dx)^{meas} - (dE/dx)_p^{fit}}{(dE/dx)_p^{fit}\sigma_p^{dE/dx}}, \; y_p = \frac{m^2 - m_p^2}{\sigma_p^{m^2}}$$

PID procedure: Results



$$x_p = \frac{(dE/dx)^{meas} - (dE/dx)_p^{fit}}{(dE/dx)_p^{fit}\sigma_p^{dE/dx}}$$

$$y_p = \frac{m^2 - m_p^2}{\sigma_p^{m^2}}$$

Protons:

$$\sqrt{x_p^2 + y_p^2} < 2, \sqrt{x_\pi^2 + y_\pi^2} > 3$$

Pions (π^+):

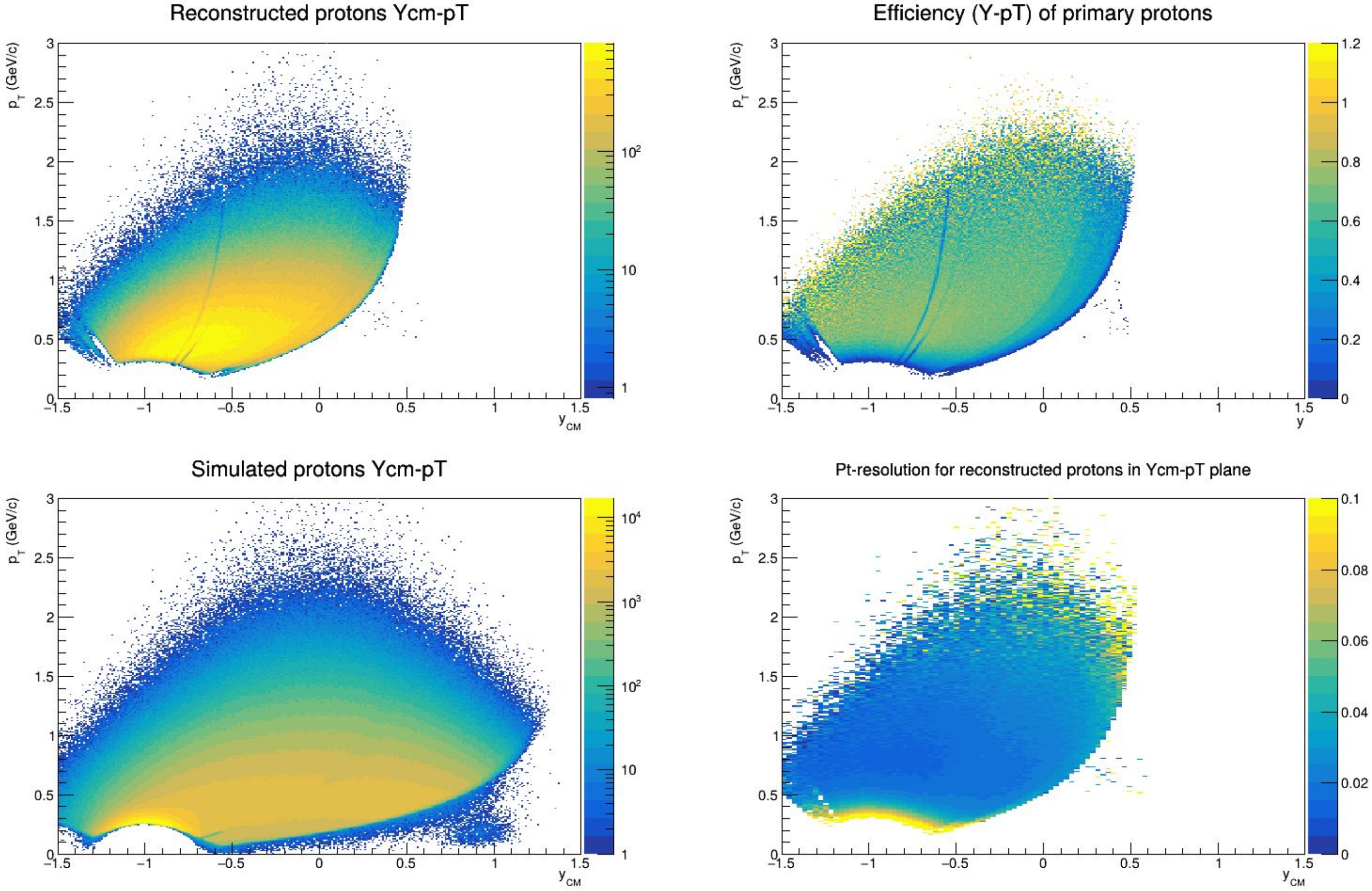
$$\sqrt{x_\pi^2 + y_\pi^2} < 2, \sqrt{x_p^2 + y_p^2} > 3$$

Pions (π^-):

charge<0

(y-pt) distribution, efficiency and δpt (Xe+Xe)

$$\text{eff} = \frac{\frac{dN}{dydp_T}(\text{reco})}{\frac{dN}{dydp_T}(\text{sim})}$$



$$\Delta p_T = \frac{|p_T^{\text{reco}} - p_T^{\text{mc}}|}{p_T^{\text{mc}}}$$

protons

<u>Xe+Xe</u> T=2.5A GeV

Cuts for reco tracks:

- Nhits>27
- DCA< 1 cm
- PID (dEdx+TOF)

Cuts for sim particles:

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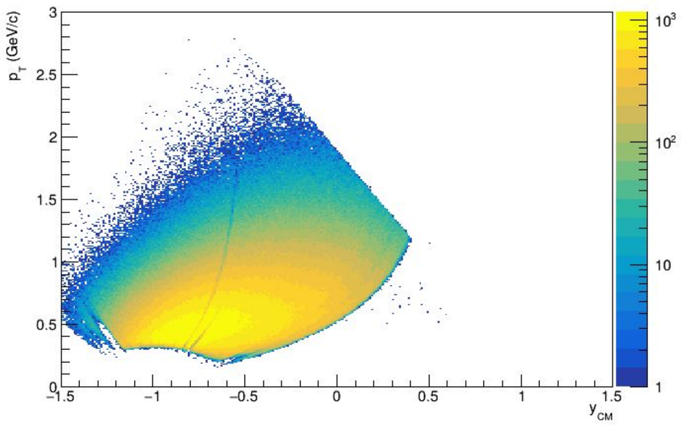
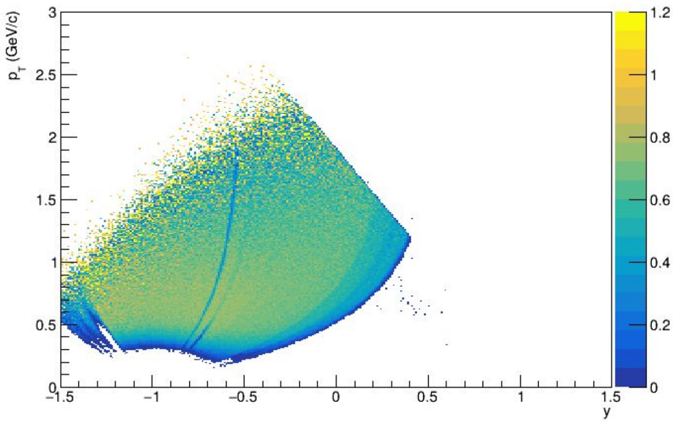
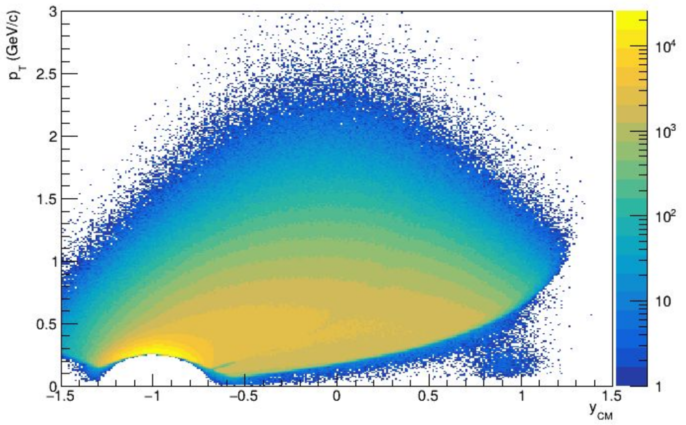
Reconstructed protons Ycm-pT



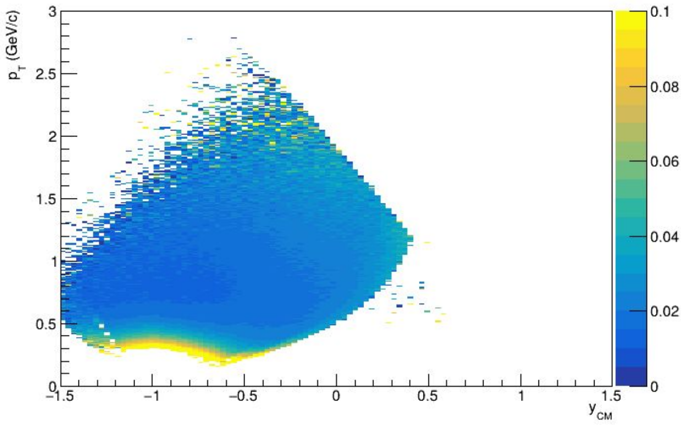
Efficiency (Y-pT) of primary protons



Simulated protons Ycm-pT



Pt-resolution for reconstructed protons in Ycm-pT plane



protons

Xe+W T=2.5A GeV

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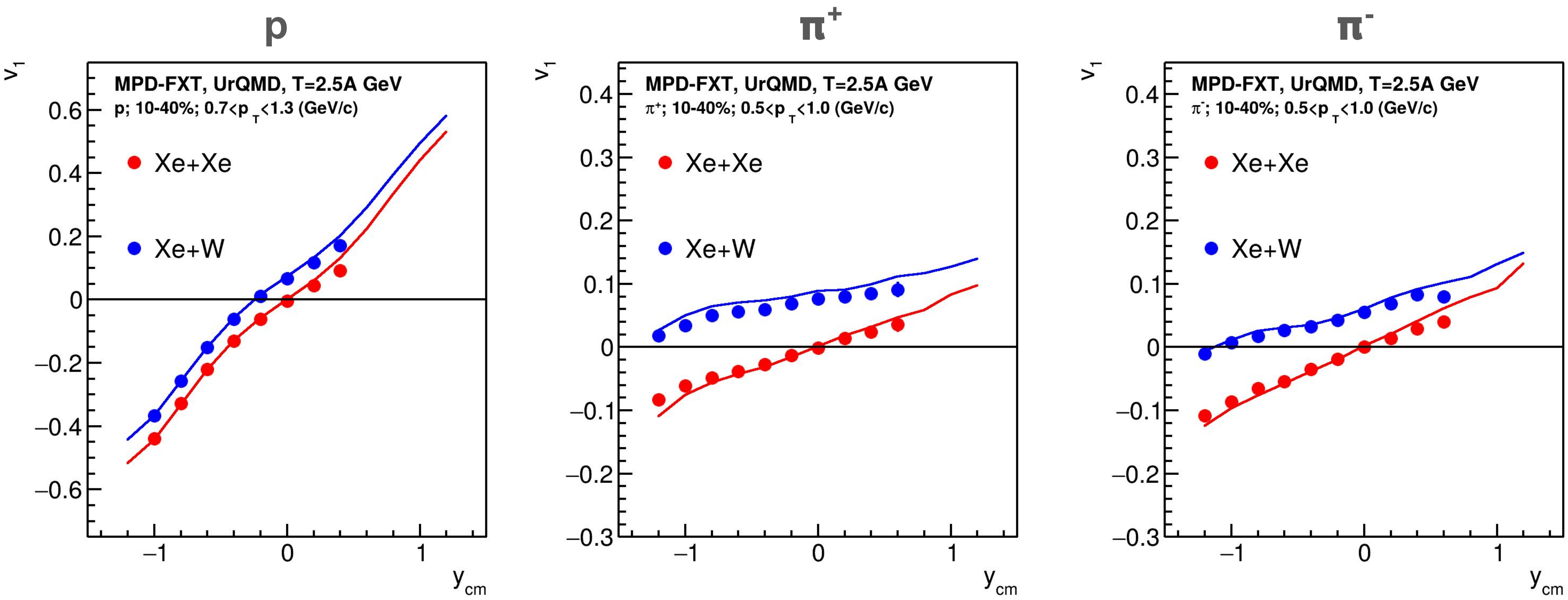
Results: $v_1(y)$

Systematics: xx, yy, F1, F2, F3

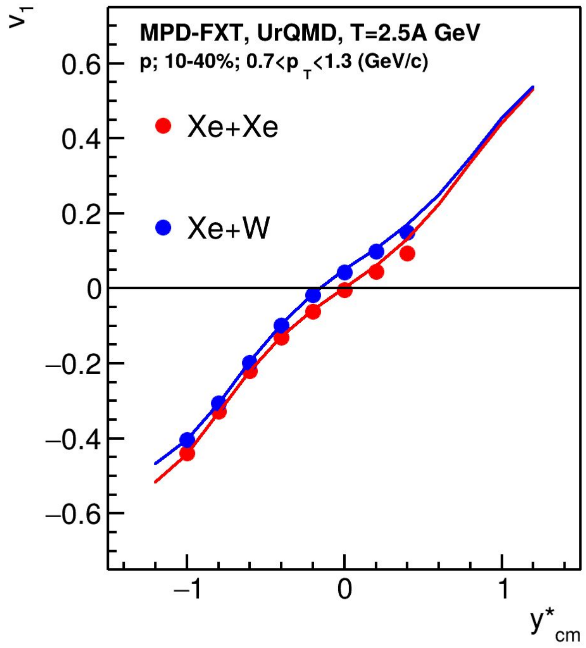


Protons - good. Discrepancy for pions: maybe we need a stricter PID/DCA cut?

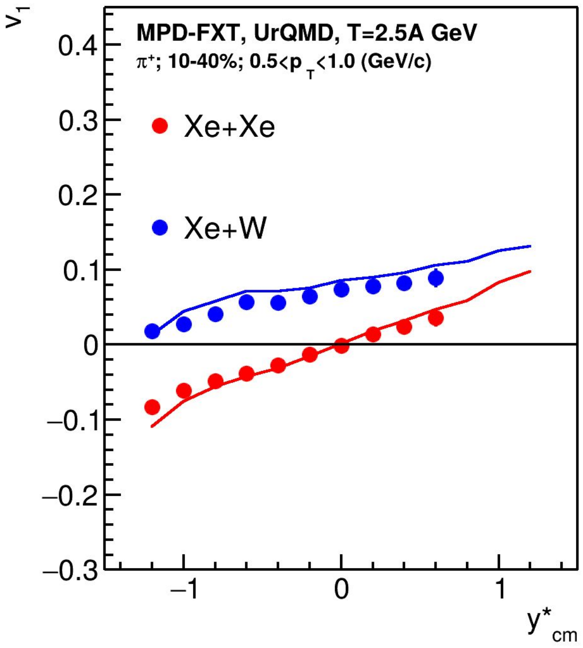
Results: $v_1(y^*)$

Systematics: xx, yy, F1, F2, F3

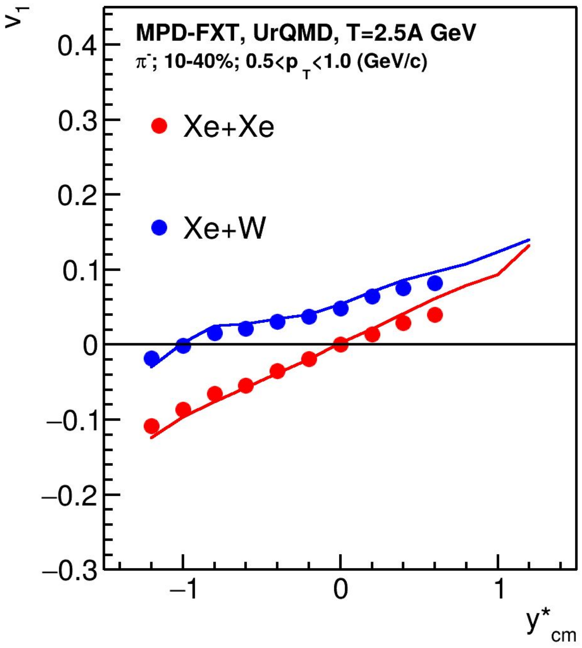
p



π^+



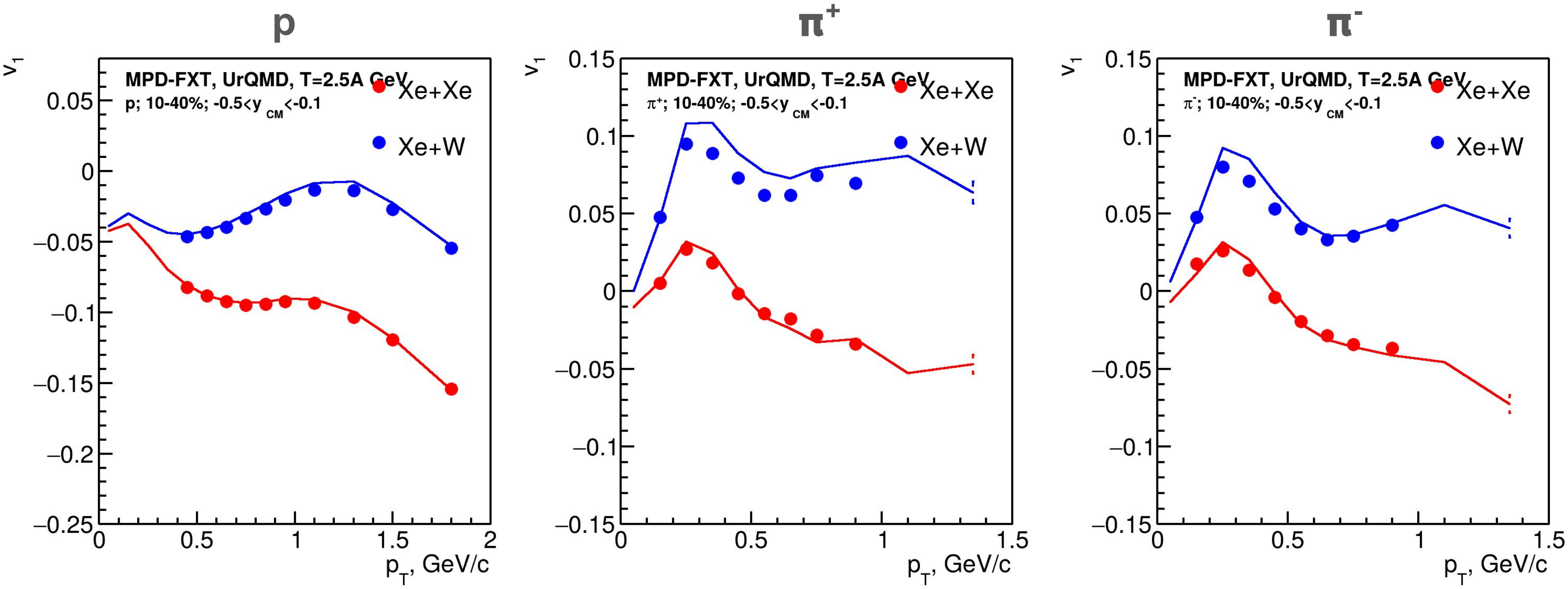
π^-



$y^*_{cm}=y_{lab}-A_{proj}/(A_{proj}+A_{targ})*0.5*\log((E_{lab}+P_{lab})/(E_{lab}-P_{lab}))$; $y^*_{cm}=y_{cm}$ for symmetric systems

Results: $v_1(p_T)$

Systematics: xx, yy, F1, F2, F3



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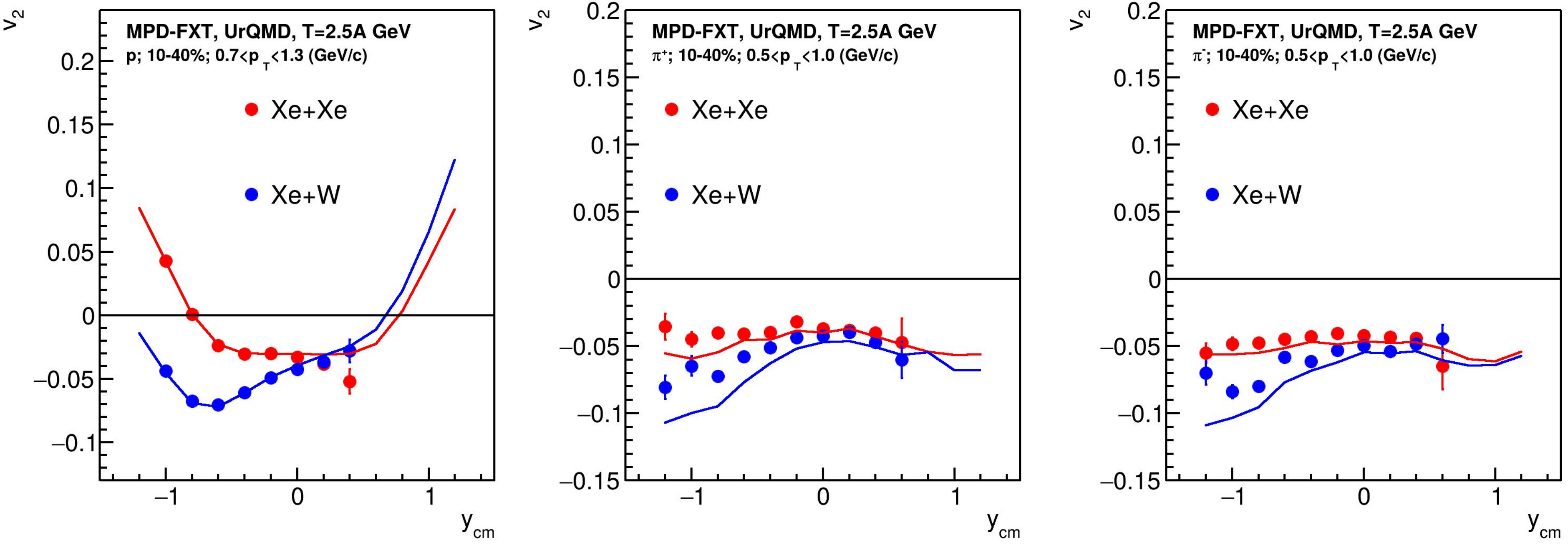
Results: $v_2(y)$

Systematics: xxx, xyy

p **π^+** **π^-**



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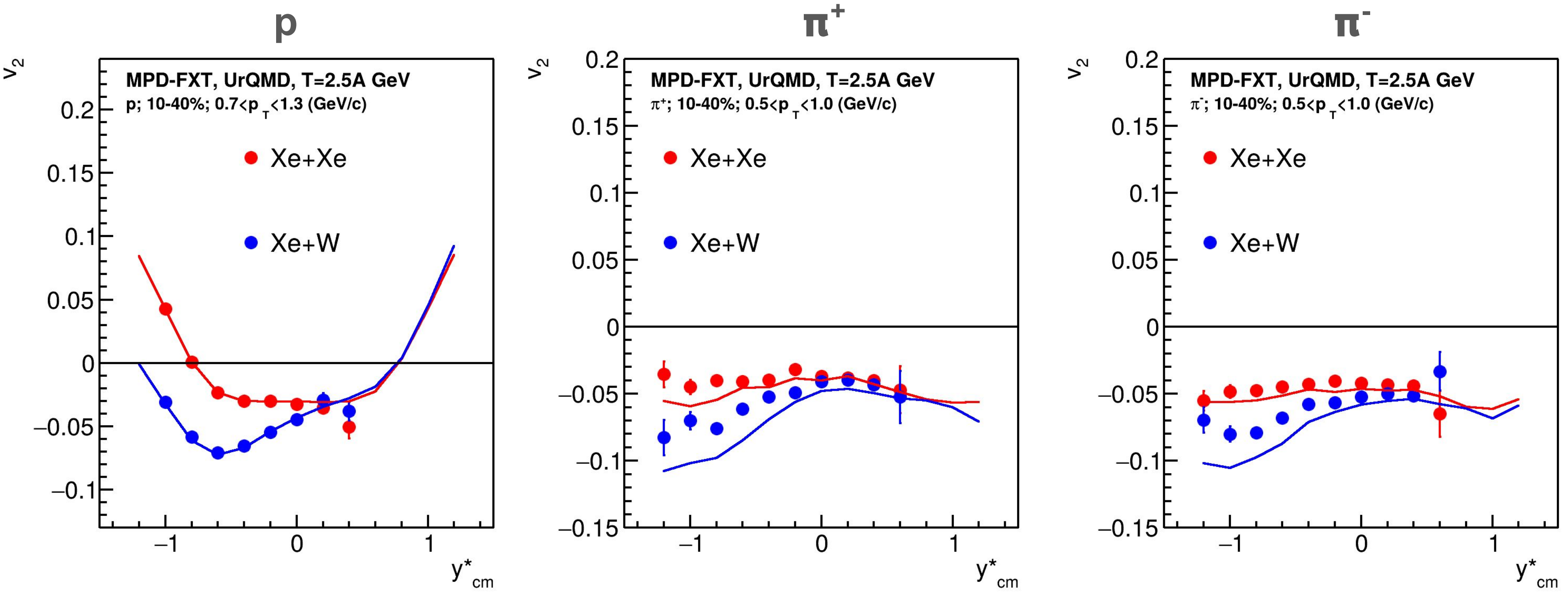

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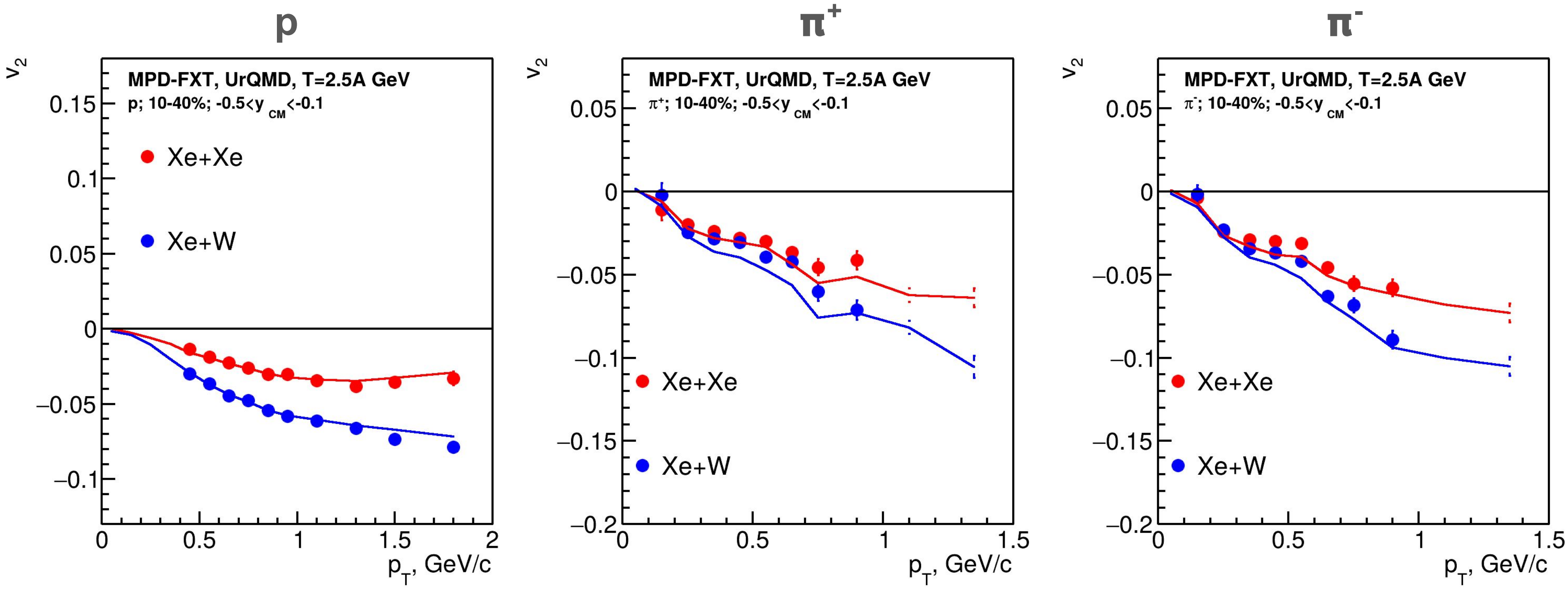

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Summary

- Realistic procedures for centrality determination, primary track selection and PID were used
    - Multiplicity-based centrality determination using MC-Glauber was used
- Basic PID was performed using dE/dx from TPC and m^2 from TOF
- Good agreement between “reco” and “mc” within corresponding acceptance window for protons, discrepancy for pions

Backup

(y-pt) distribution, efficiency and δpt (Xe+Xe)

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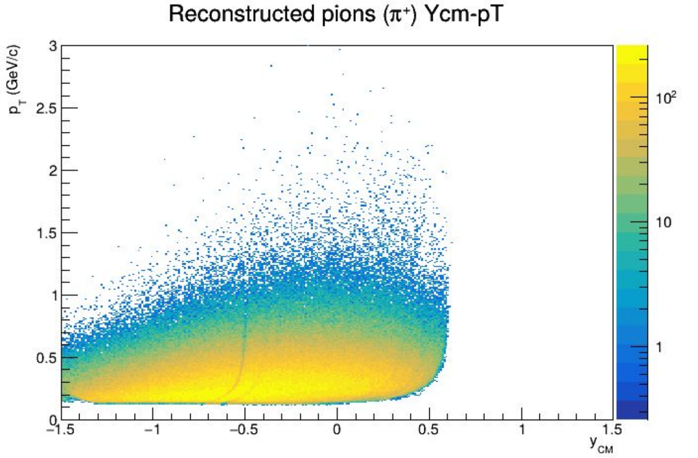

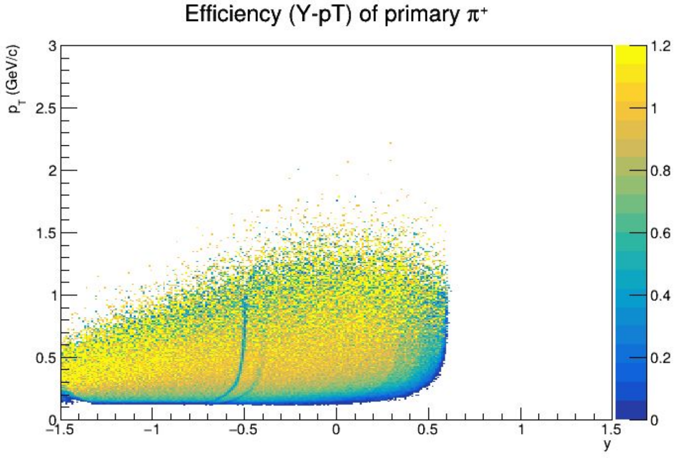

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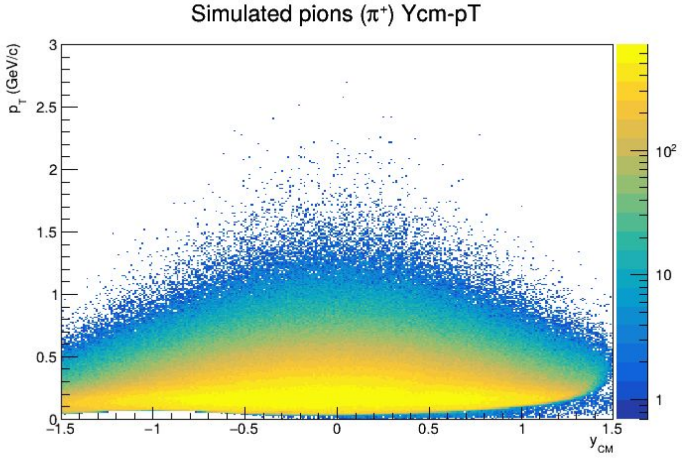

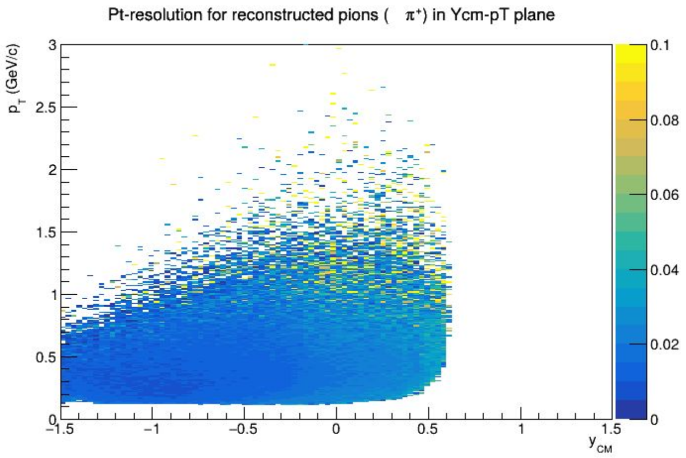

π^+

<u>Xe+Xe</u> T=2.5A GeV

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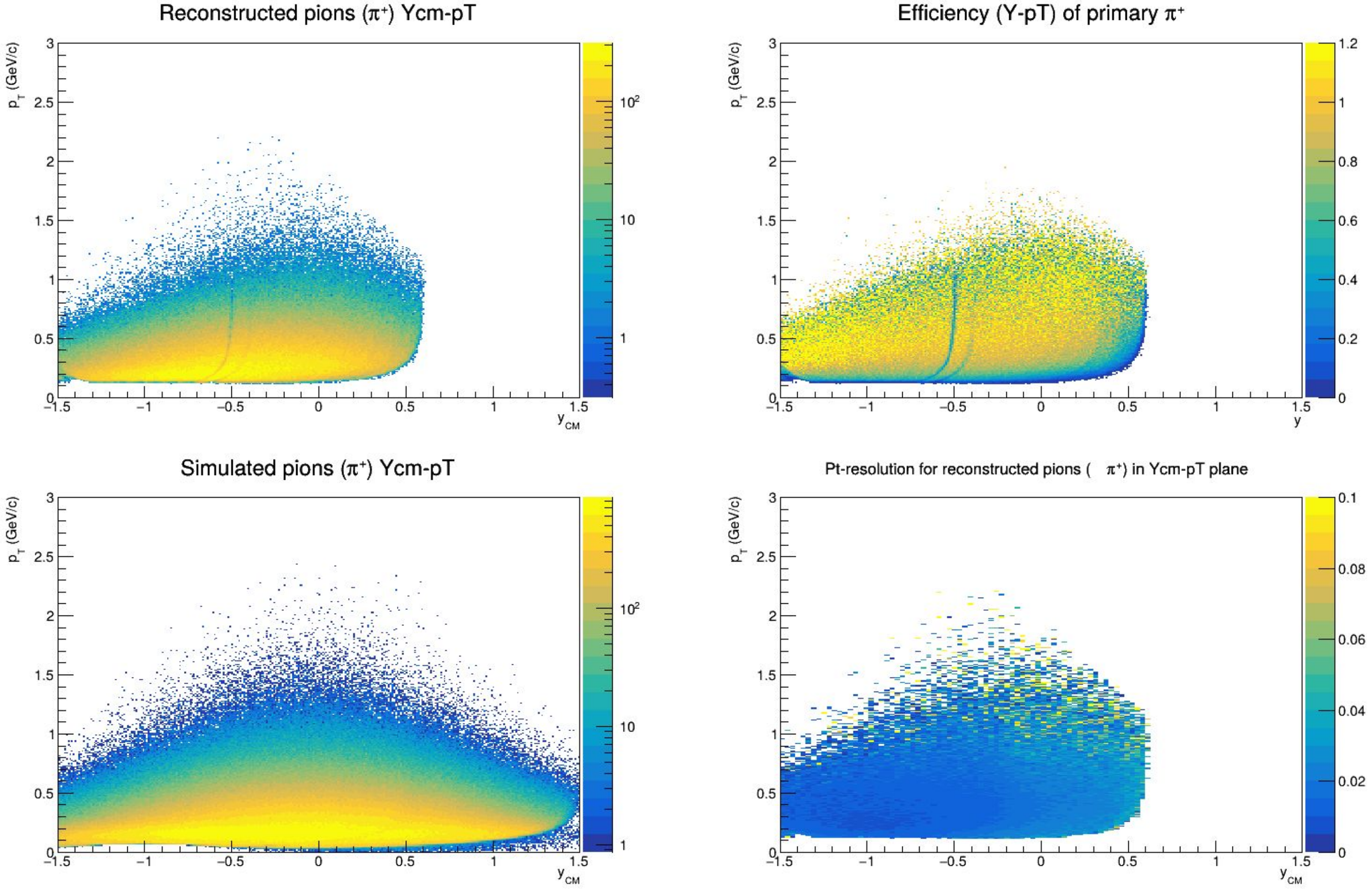

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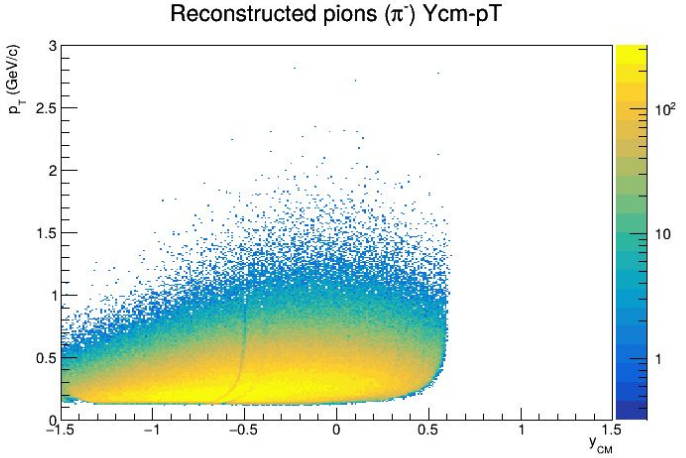

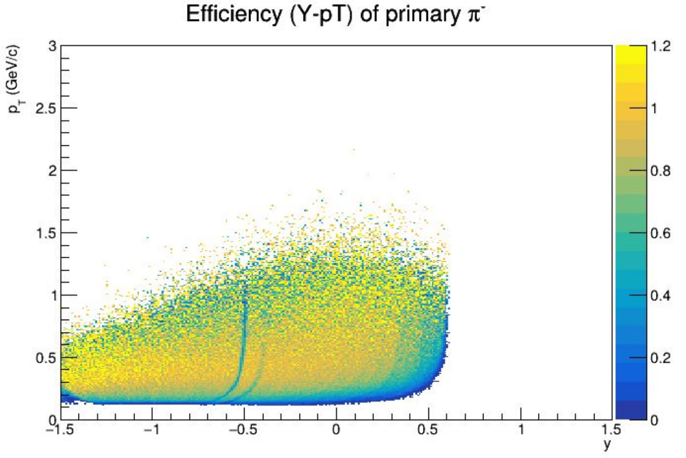

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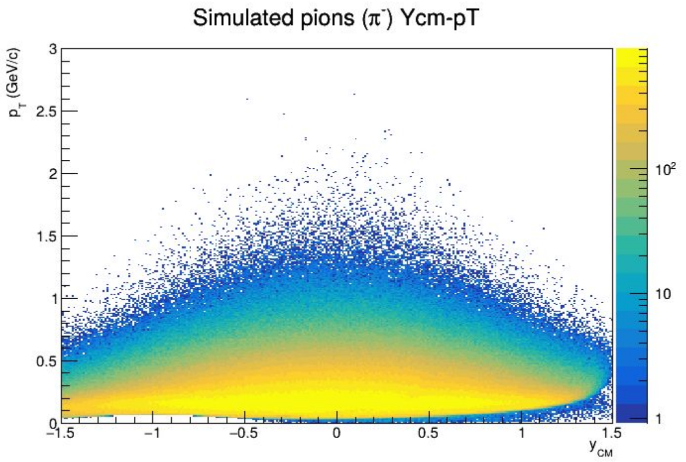
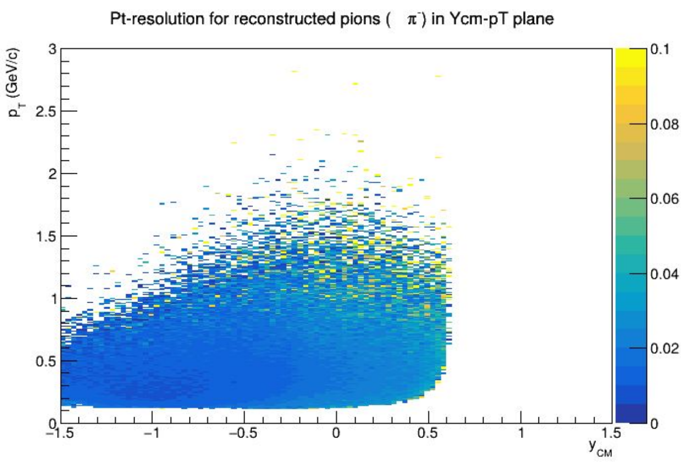
π⁻





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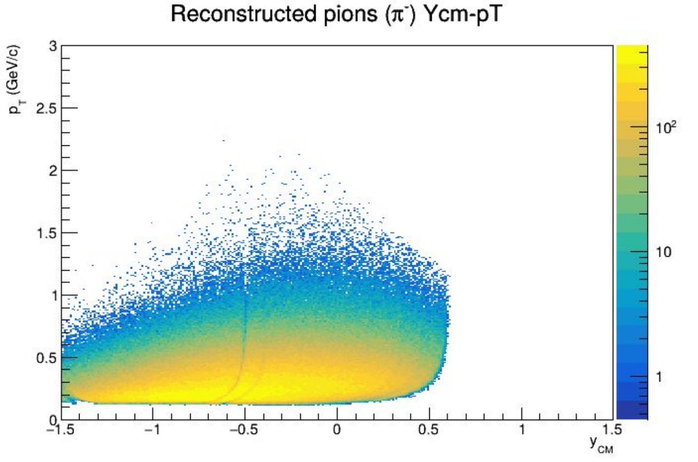

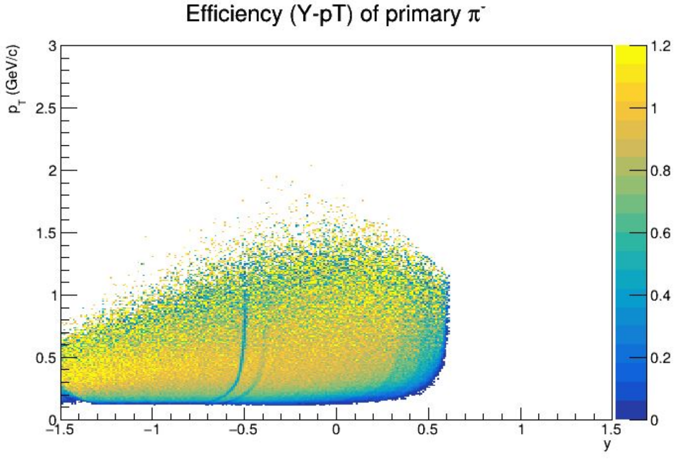

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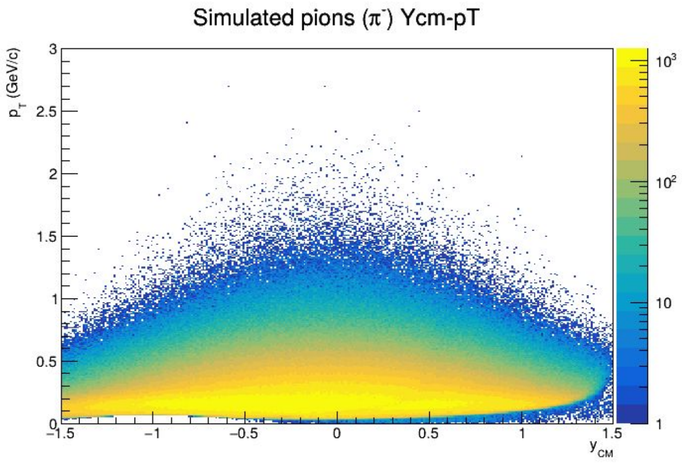

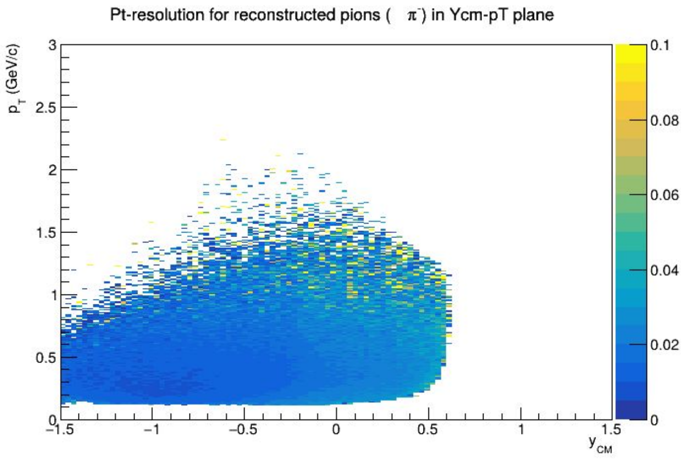

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