Light hadrons from Xe+W @ 2.5 GeV (fixed target)

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General remarks

Production 36: Xe+W, fixed target, $E_{\text{kin}} = 2.5$ GeV, UrQMD [7.5M events are presented here]
W target: $z = -85$ cm

$$\sqrt{s_{NN}} = m_N \sqrt{2\left(1 + \frac{E_{\text{Lab}}}{m_N}\right)},$$

$E_{\text{Lab}} = E_{\text{kin}} + m_N$ – energy of projectile nucleon

$$y_{\text{CM}} = y_{\text{Lab}} - \Delta y, \qquad \Delta y = \frac{1}{2}\ln\frac{1+\beta}{1-\beta}; \qquad \gamma = \frac{\sqrt{s_{NN}}}{2m_N} \Rightarrow \beta$$

$$E_{kin} = 2.5 \text{ GeV} \quad \Rightarrow \quad \sqrt{s_{NN}} = 2.87 \text{ GeV}; \quad \gamma = 1.53; \quad \beta = 0.76; \quad \Delta y = \boxed{0.986}$$

Midrapidity y_{MR}

Results are presented in lab. frame

MPDRoot setup

```
$ ls mpdroot/physics/pairKK/macros_FXT/
DCAs_FXT.root                   pPID.txt
nTr_Centr_Req35-UrQMD.root      TrackRecEff_FXT.root
pCentr.txt
```

MpdHadronSpectra wagon

No cut on Zvtx

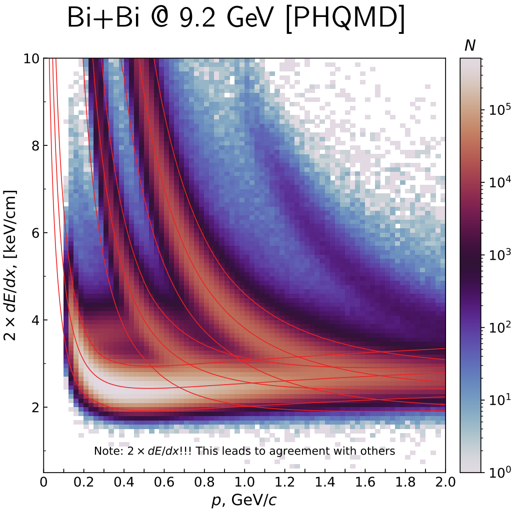
MpdPid class for PID;
both TPC and ToF information is used

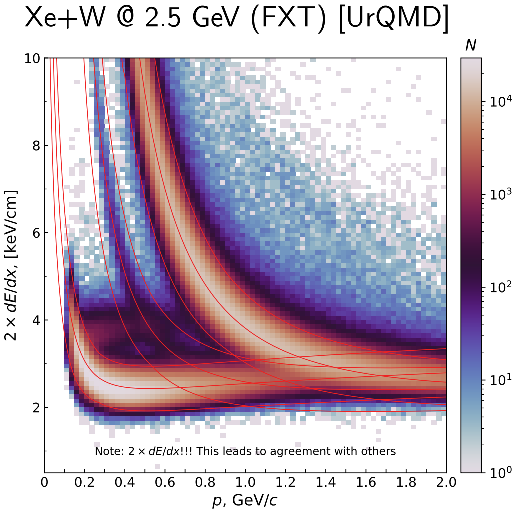
Recommendation from Cross-PWG:
apply cuts on DCA in nσ-s [not used now]

pHS.txt

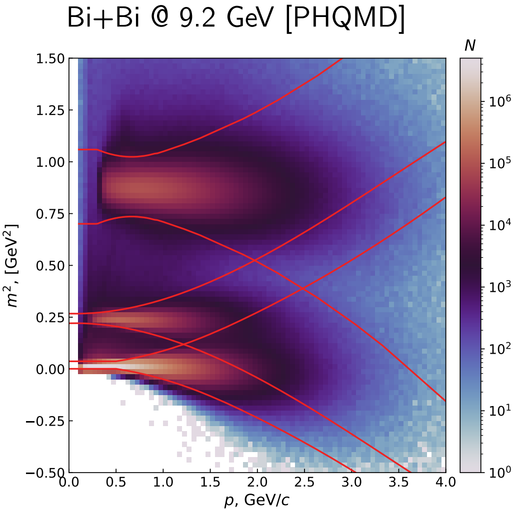
```
#-------Parameters used for analysis------
# Abs[pdg] for considered particles:
mAbsPDGs        211 321 2212
# \sqrt{s_{NN}}
mSqrtSNN       2.8652 // [GeV]
mGeneratorForPID     URQMD
# Centrality binning
mCentMin       0   10 20 30 40
mCentMax       10 20 30 40 80
# Track cuts:
mNofHitsCut    27    // minimal number of hits for a track
mDCAMax        1.0   // maximal |DCA|
#
mUseELC        true
# Pt for hists
mPtMin         0.05  // minimal pt for a track
mPtMax         3.05  // maximal pt for a track
mPtWidth       0.1   // GeV
# Rapydity for hists
mRapMin       -1.0
mRapMax        3.0
mRapWidth      0.1
# PID cuts:
mSigE          3.0   // nSigmas for dE/dx
mSigB          3.0   // nSigmas for the average beta
```

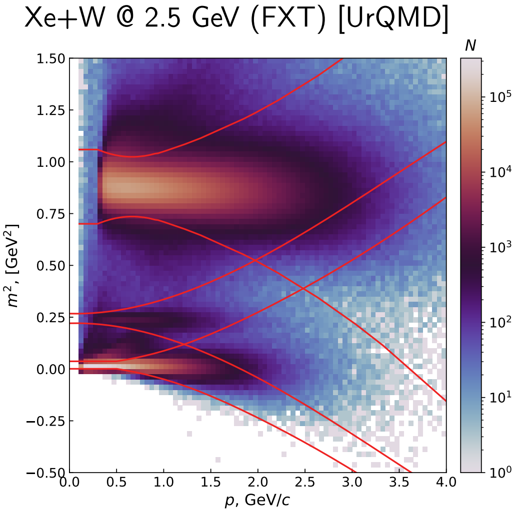
dE/dx





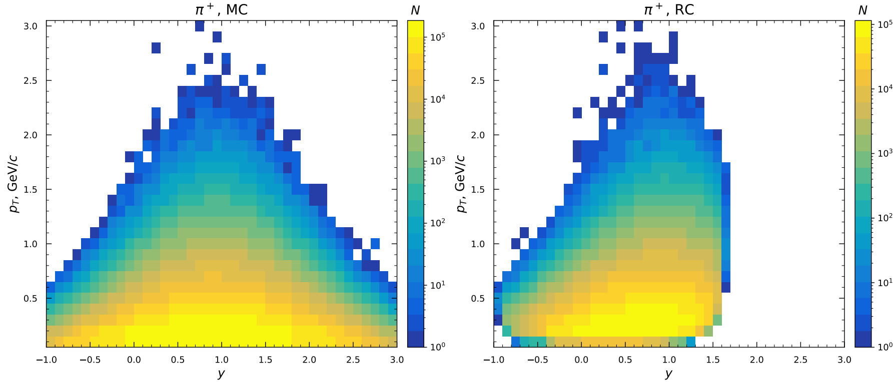
Red lines represent 3σ bands



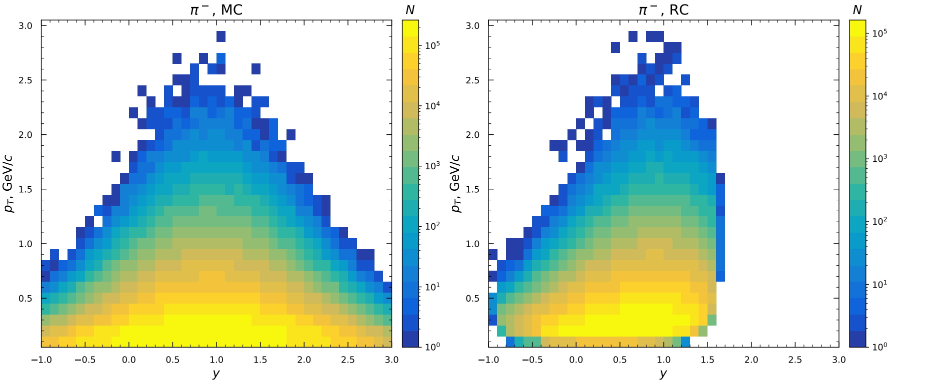


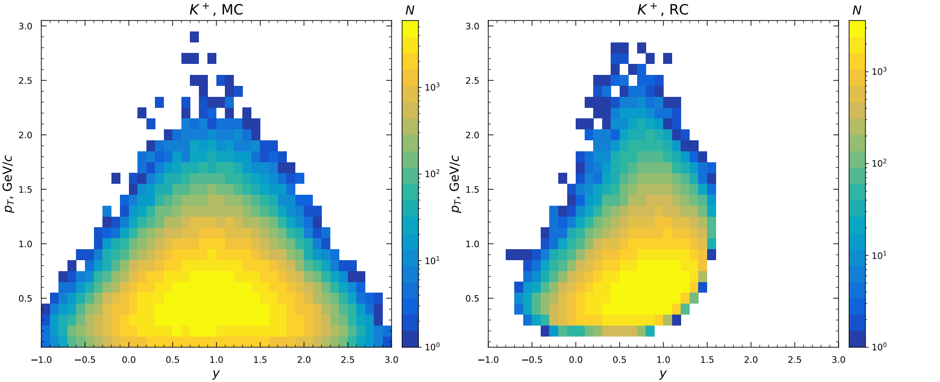
Red lines represent 3σ intervals

Phase Spaces: π^+

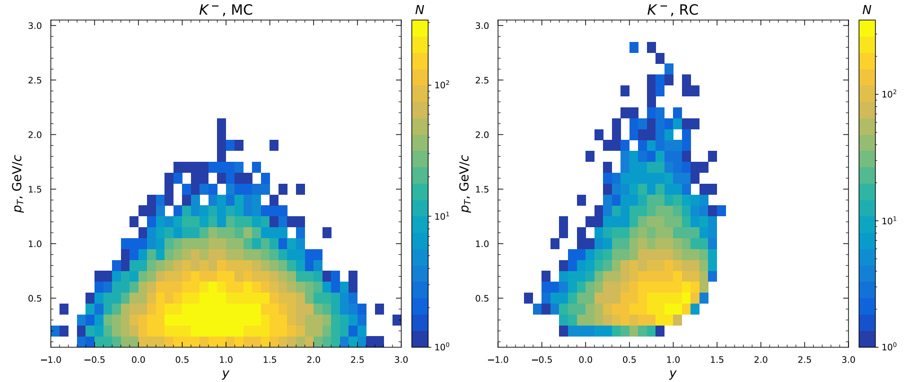


Phase Spaces: π^-

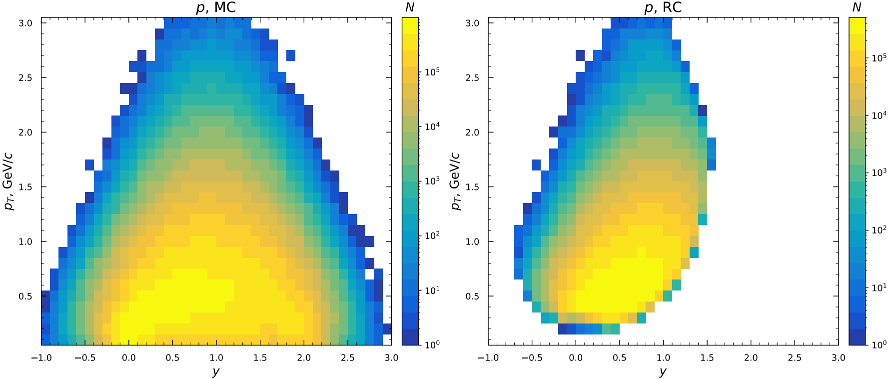



K⁺, MC
K⁺, RC
N
pT, GeV/c
y
3.0
2.5
2.0
1.5
1.0
0.5
−1.0
−0.5
0.0
0.5
1.0
1.5
2.0
2.5
3.0
10⁰
10¹
10²
10³

Phase Spaces: K^-



Phase Spaces: p



Efficiencies & Contaminations

Total correction:

$$W = \frac{\prod_i \mathrm{Eff}_i}{\prod_j (1 - \mathrm{Cont}_j)}$$

$$W = W[\mathrm{TPC},\ \mathrm{TOF},\ \mathrm{PRIM},\ \mathrm{PID},\ \mathrm{CELL}] = \frac{N_{\mathrm{RC}}[\mathrm{TOFRC},\ \mathrm{PRIMRC},\ \mathrm{PIDRC},\ \mathrm{CELLRC}]}{N_{\mathrm{MC}}[\mathrm{PRIMMC},\ \mathrm{PIDMC},\ \mathrm{CELLMC}]}$$

$$\mathrm{TPCeff} = \frac{N_{\mathrm{RC}}[\mathrm{PRIMMC},\ \mathrm{PIDMC},\ \mathrm{CELLMC}]}{N_{\mathrm{MC}}[\mathrm{PRIMMC},\ \mathrm{PIDMC},\ \mathrm{CELLMC}]}$$

$$\mathrm{TOFMCeff} = \frac{N_{\mathrm{RC}}[\mathrm{TOFMC},\ \mathrm{PRIMMC},\ \mathrm{PIDMC},\ \mathrm{CELLMC}]}{N_{\mathrm{RC}}[\mathrm{PRIMMC},\ \mathrm{PIDMC},\ \mathrm{CELLMC}]}$$

$$\mathrm{TOFeff} = \frac{N_{\mathrm{RC}}[\mathrm{TOFRC\&TOFMC},\ \mathrm{PRIMMC},\ \mathrm{PIDMC},\ \mathrm{CELLMC}]}{N_{\mathrm{RC}}[\mathrm{TOFMC},\ \mathrm{PRIMMC},\ \mathrm{PIDMC},\ \mathrm{CELLMC}]}$$

$$\mathrm{TOFcont} = \frac{N_{\mathrm{RC}}[\mathrm{TOFRC\&(!TOFMC)},\ \mathrm{PRIMMC},\ \mathrm{PIDMC},\ \mathrm{CELLMC}]}{N_{\mathrm{RC}}[\mathrm{TOFRC},\ \mathrm{PRIMMC},\ \mathrm{PIDMC},\ \mathrm{CELLMC}]}$$

$$\mathrm{PIDeff} = \frac{N_{\mathrm{RC}}[\mathrm{TOFRC},\ \mathrm{PRIMMC},\ \mathrm{PIDRC} = \mathrm{PIDMC},\ \mathrm{CELLMC}]}{N_{\mathrm{RC}}[\mathrm{TOFRC},\ \mathrm{PRIMMC},\ \mathrm{PIDMC},\ \mathrm{CELLMC}]}$$

$$\mathrm{PIDcont} = \frac{N_{\mathrm{RC}}[\mathrm{TOFRC},\ \mathrm{PRIMMC},\ \mathrm{PIDRC} \neq \mathrm{PIDMC},\ \mathrm{CELLMC}]}{N_{\mathrm{RC}}[\mathrm{TOFRC},\ \mathrm{PRIMMC},\ \mathrm{PIDRC},\ \mathrm{CELLMC}]}$$

$$\mathrm{SecEff} = \frac{N_{\mathrm{RC}}[\mathrm{TOFRC},\ \mathrm{PRIMRC\&PRIMMC},\ \mathrm{PIDRC},\ \mathrm{CELLMC}]}{N_{\mathrm{RC}}[\mathrm{TOFRC},\ \mathrm{PRIMMC},\ \mathrm{PIDRC},\ \mathrm{CELLMC}]}$$

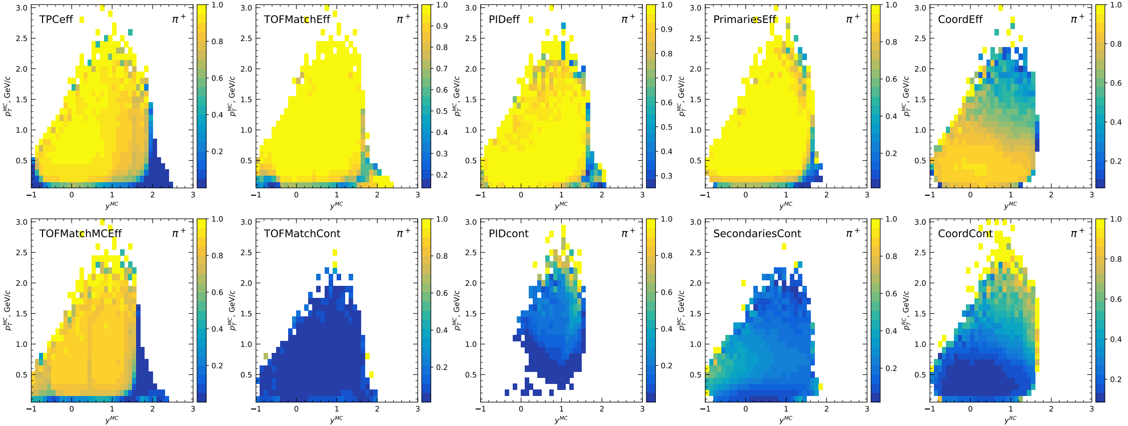
$$\mathrm{SecCont} = \frac{N_{\mathrm{RC}}[\mathrm{TOFRC},\ \mathrm{PRIMRC\&(!PRIMMC)},\ \mathrm{PIDRC},\ \mathrm{CELLMC}]}{N_{\mathrm{RC}}[\mathrm{TOFRC},\ \mathrm{PRIMRC},\ \mathrm{PIDRC},\ \mathrm{CELLMC}]}$$

$$\mathrm{CELLeff} = \frac{N_{\mathrm{RC}}[\mathrm{TOFRC},\ \mathrm{PRIMRC},\ \mathrm{PIDRC},\ \mathrm{CELLRC{=}CELLMC}]}{N_{\mathrm{RC}}[\mathrm{TOFRC},\ \mathrm{PRIMRC},\ \mathrm{PIDRC},\ \mathrm{CELLMC}]}$$

$$\mathrm{CELLcont} = \frac{N_{\mathrm{RC}}[\mathrm{TOFRC},\ \mathrm{PRIMRC},\ \mathrm{PIDRC},\ \mathrm{CELLRC{\neq}CELLMC}]}{N_{\mathrm{RC}}[\mathrm{TOFRC},\ \mathrm{PRIMRC},\ \mathrm{PIDRC},\ \mathrm{CELLRC}]}$$

Corrections: π^+

$A \cdot \varepsilon$, Purity $\Uparrow$ — Additional corrections

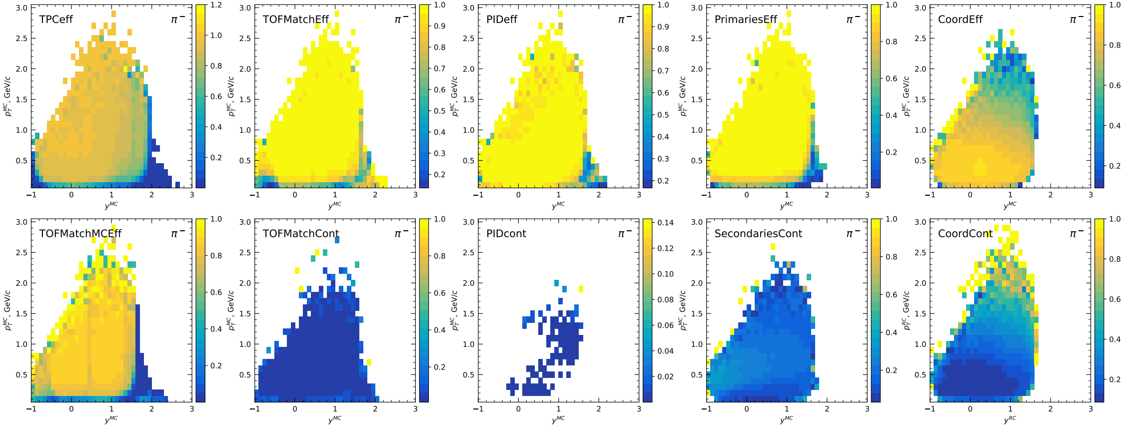


Corrections: π^-

$A \cdot \varepsilon$, Purity

$\Uparrow$

Additional corrections

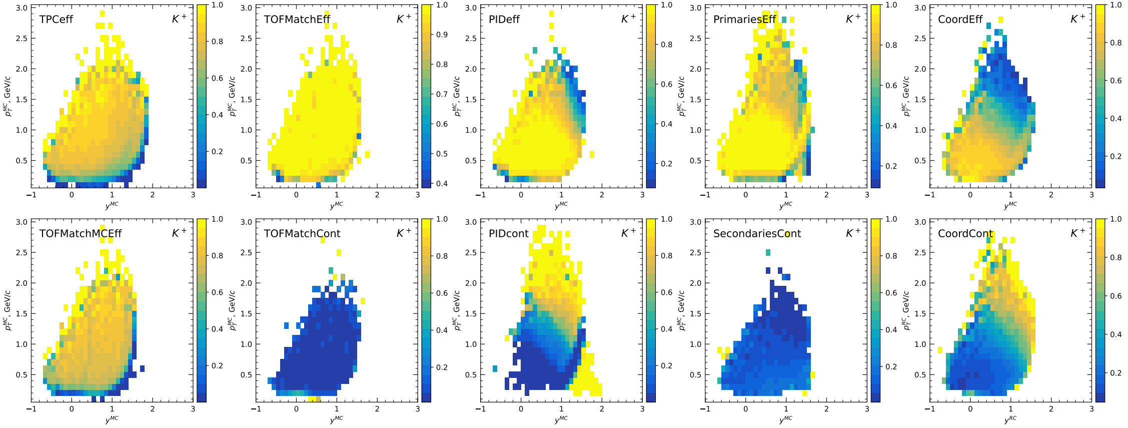


Corrections: K^+

$A \cdot \varepsilon$, Purity

$\Uparrow$

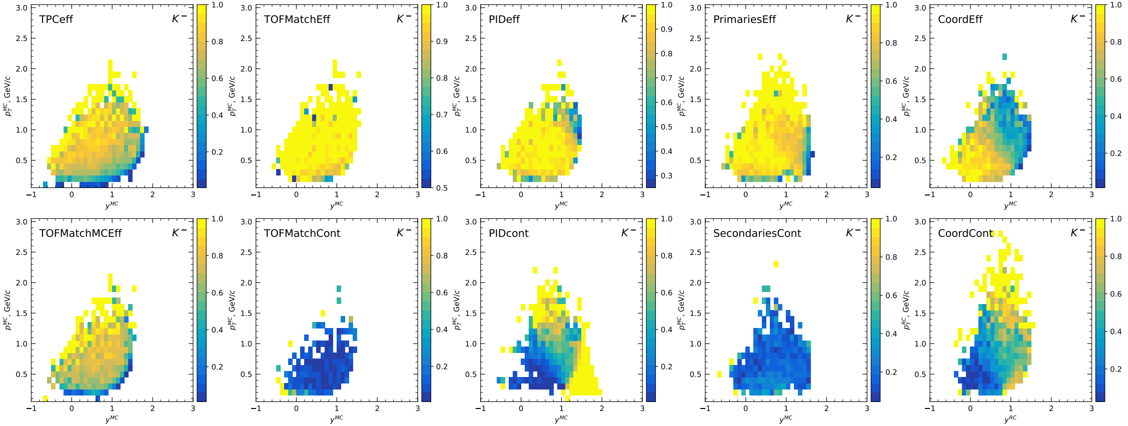
Additional corrections



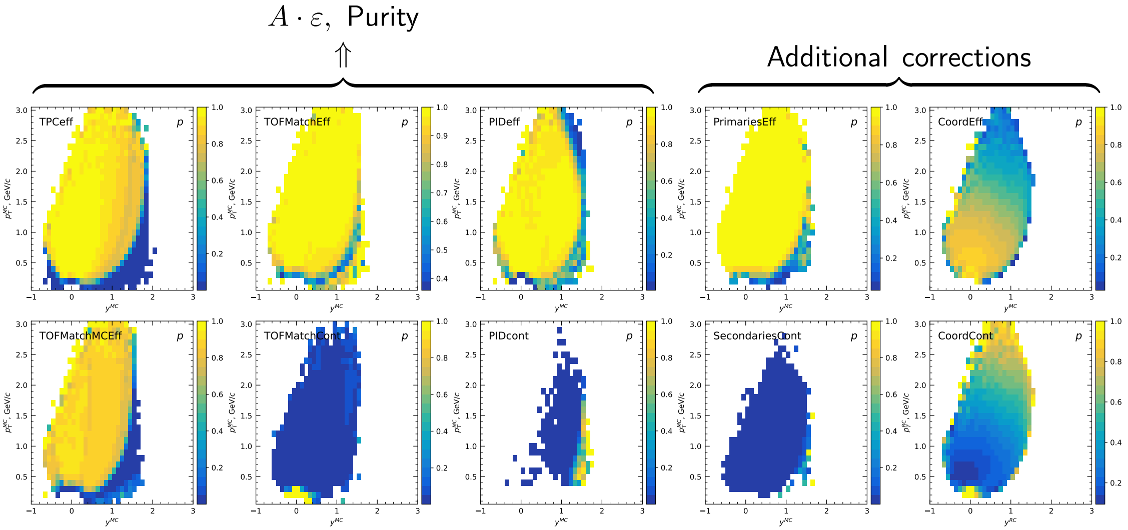
Corrections: K^-

$A \cdot \varepsilon$, Purity $\Uparrow$

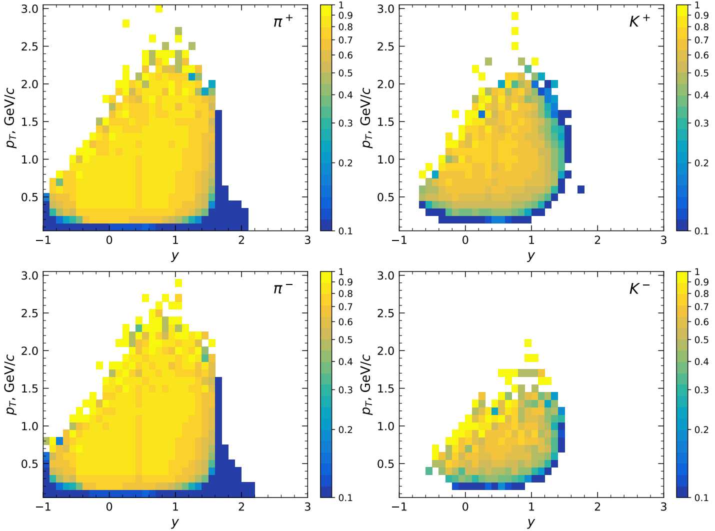
Additional corrections



Corrections: p



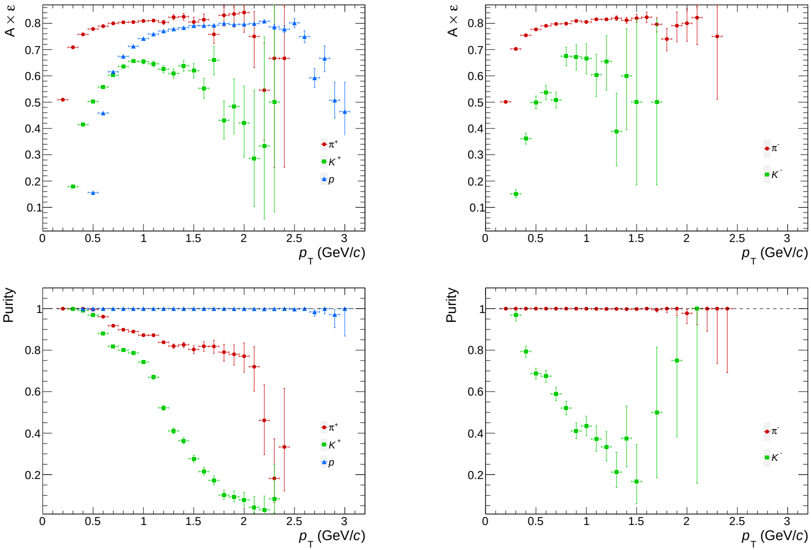
PID efficiency $(A \cdot \varepsilon)$



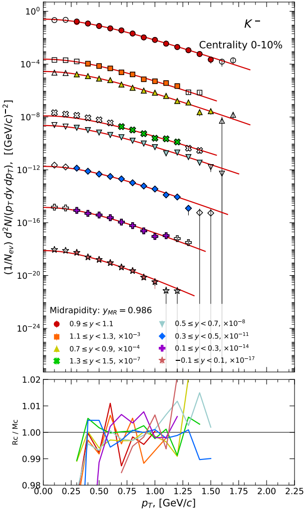
Xe+W @ $E_{kin} = 2.5$ GeV

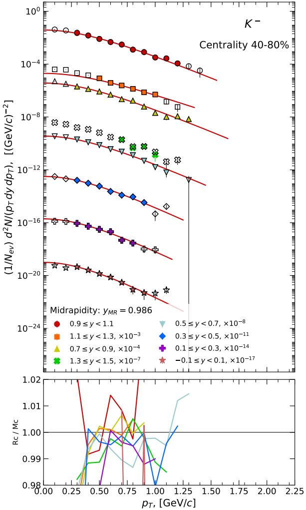
Centrality 0-10%

PID efficiency [Centr. 0-10%; $0.9 \leq y < 1.1$]

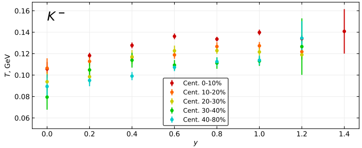


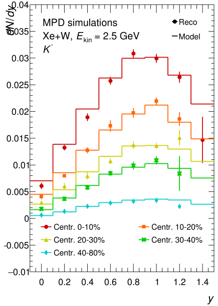
Spectra and fits: K^- [thermal exponential]



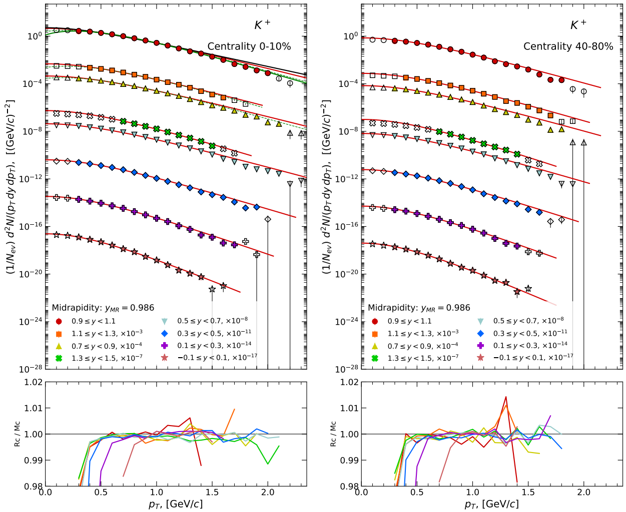


$$f(p_T) = \frac{dN/dy}{T[(m+T)^2 + T^2]} \cdot m_T \cdot \mathrm{e}^{-(m_T - m)/T}$$





Spectra and fits: K^+ [thermal exponential]



$$f(p_T) = \frac{dN/dy}{T[(m+T)^2 + T^2]} \cdot m_T \cdot \mathrm{e}^{-(m_T - m)/T}$$

Bad description at high p_T

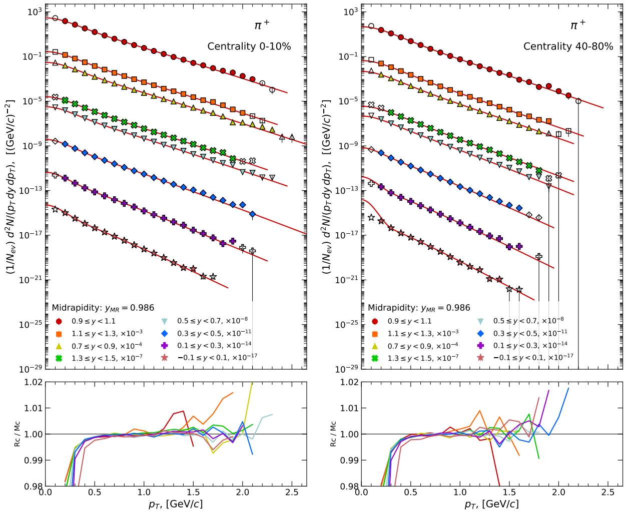
Black line:

$$f(p_T) = C \cdot \mathrm{e}^{-(m_T - m)/T}$$

Green lines:

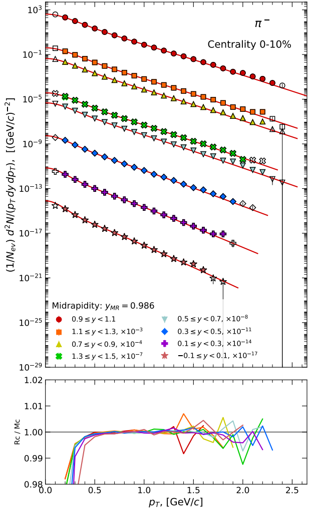
$$f(p_T) = (C_1 + C_2 p_T) m_T \cdot \mathrm{e}^{-(m_T - m)/T}$$

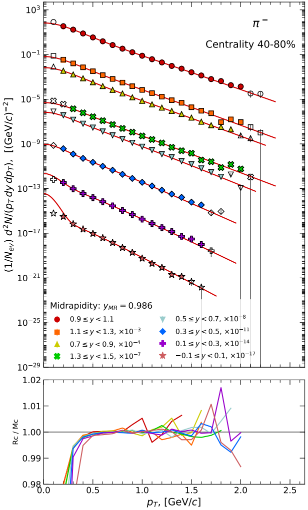
Spectra and fits: π^+ [sum of two thermal exponentials]



Problems at low p_T

Spectra and fits: π^- [sum of two thermal exponentials]

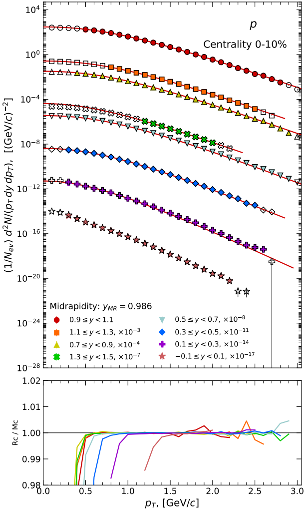


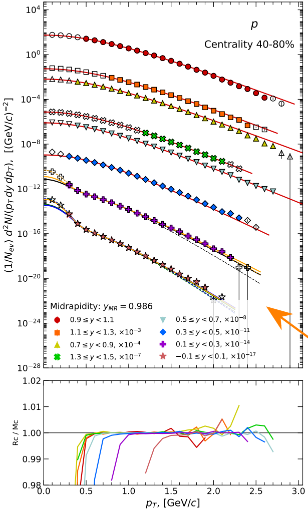


Problems at low p_T

Spectra and fits: p [Blast Wave model]

$$\frac{d^2N}{p_T dp_T\, dy} = C(y)\cdot m_T \int_0^1 \chi d\chi \exp\left[-\frac{m_T \operatorname{ch}\rho \operatorname{ch}(y-\eta)}{T}\right] I_0\left(\frac{p_T \operatorname{sh}\rho}{T}\right)$$





Boost angles: $\rho = \operatorname{arth}\beta_r$, $\eta = \operatorname{arth}\beta_z$

$$\beta_r(r) = \beta_{\max}\left(\frac{r}{R}\right)^n = \beta_{\max}\cdot\chi^n$$

$r \in [0; R]$; R is the radius of freeze-out surface.

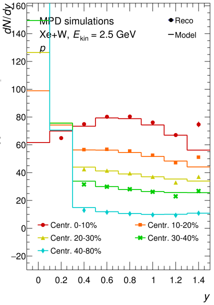
Our setup:

$$\operatorname{ch}(y-\eta) = 1;$$
$$n = 1.$$

Fit parameters: $C(y)$, T, $\beta_{\max}$

Bump:
BW+ThermExp, 2BW, 2ThermExp: the fit is not good

Orange lines:
sum of 3 therm. exps
(best fit of spectra with bump)



Based on

[1] E. Schnedermann, J. Sollfrank, U. W. Heinz, Phys. Rev. C 48, 2462 (1993) [arXiv:nucl-th/9307020 [nucl-th]].

Conclusions

- Spectra for $\pi^{\pm}$, $K^{\pm}$, and p are obtained for Xe+W @ $E_{\text{kin}} = 2.5$ GeV. The quality of reconstruction is good.
- Applicability of the parametrization by A. Mudrokh for PID has been checked. Satisfactory applicability is observed. Tuning of band widths should increase purity.
- dN/dy for K^{-} and for p around midrapidity region are obtained. Satisfactory agreement with MC data is observed.
- Issues with shape of fit functions for the rest spectra have arisen.
  One of reasons: fragmentation of target ($\Rightarrow$ low-p_T hills at low y for pions). The work is going on...

Plans for near future:

- Figure out the form of spectra fit functions
- Try to use just dE/dx for PID at low p_T ($\Rightarrow$ additional points in spectra at low p_T for $y \lesssim y_{MR}$)
- Tune band widths in PID parametrization by A. Mudrokh for Xe+W @ 2.5 GeV (?)