π/K/p spectra, Au+Au for 7.7, 19.6, 27 GeV in UrQMD

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Statistics: ~2M

Track cuts:
- PDG ($\pi^{\pm} = \pm211$, $K^{\pm} = \pm321$, p (p-bar) = ±2212)
- $|y| < 0.1$

Bin width for spectra: 50 MeV/c

Centrality was calculated using multiplicity.

Simultaneous fit of the π±, K±, p, and p̄ spectra across all the BES energies.

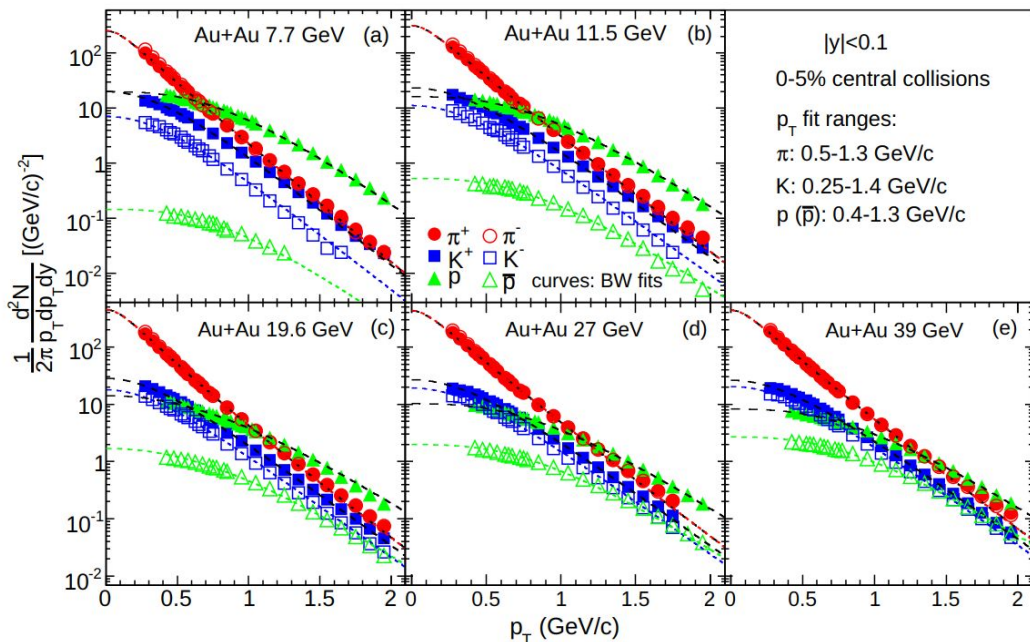Experimental results from: <u>Phys. Rev. C 96, 044904 (2017)</u>

FIG. 37: (Color online) Variation of T_{kin} with $\langle\beta\rangle$ for different energies and centralities. The centrality increases from left to right for a given energy. The data points other than BES energies are taken from Refs. [43, 66]. Uncertainties represent systematic uncertainties.

FIG. 36: (Color online) Blast wave model fits of $\pi^{\pm}$, $K^{\pm}$, p and $\bar{p}$ p_T spectra in 0–5% central Au+Au collisions at $\sqrt{s_{NN}}$ = (a) 7.7 GeV, (b) 11.5 GeV, (c) 19.6 GeV, (d) 27 GeV, and (e) 39 GeV. Uncertainties on experimental data represent statistical and systematic uncertainties added in quadrature. Here, the uncertainties are smaller than the symbol size.
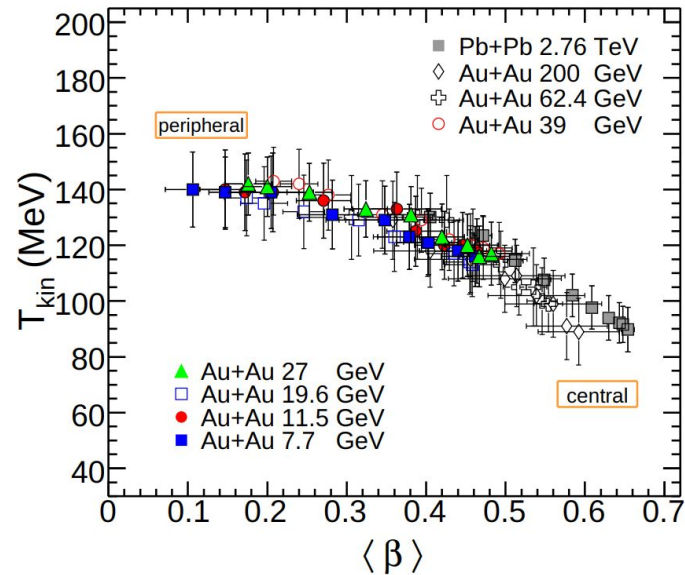
Blast wave fit

$$\frac{dN}{p_T \, dp_T} \propto \int_0^R r \, dr \, m_T I_0 \left(\frac{p_T \sinh \rho(r)}{T_{\text{kin}}} \right)$$

$$\times K_1 \left(\frac{m_T \cosh \rho(r)}{T_{\text{kin}}} \right),$$

m_T - transverse mass
$\rho\,(r) = \tanh^{-1}(\beta)$
I_0, K_1 - Bessel functions
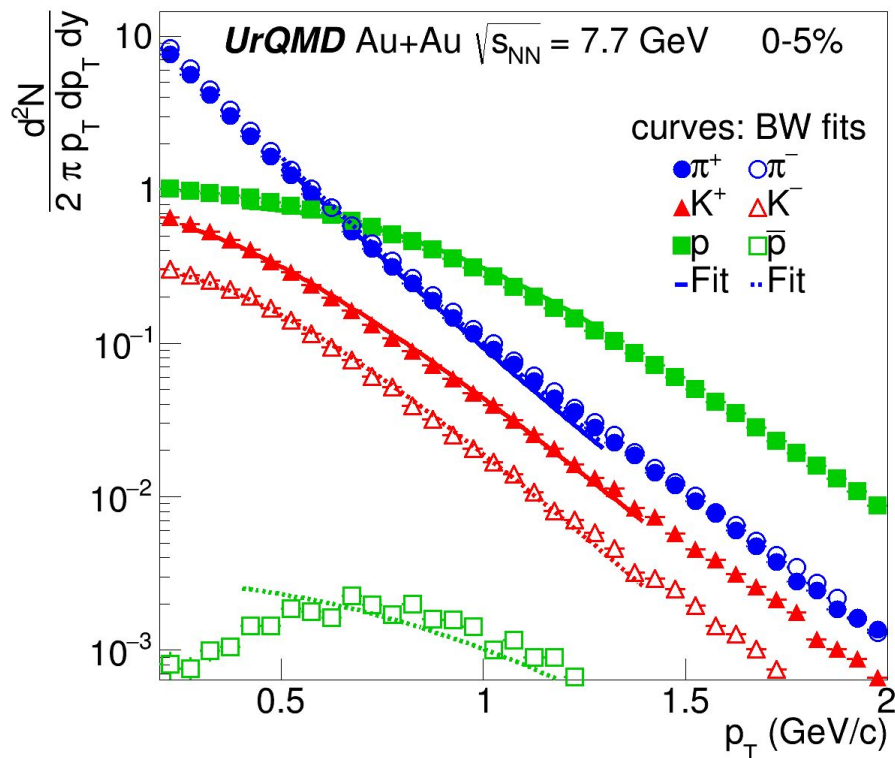$\beta = 2 * \beta_S / (2+n)$
β_S - surface velocity
n - exponent of flow velocity profile
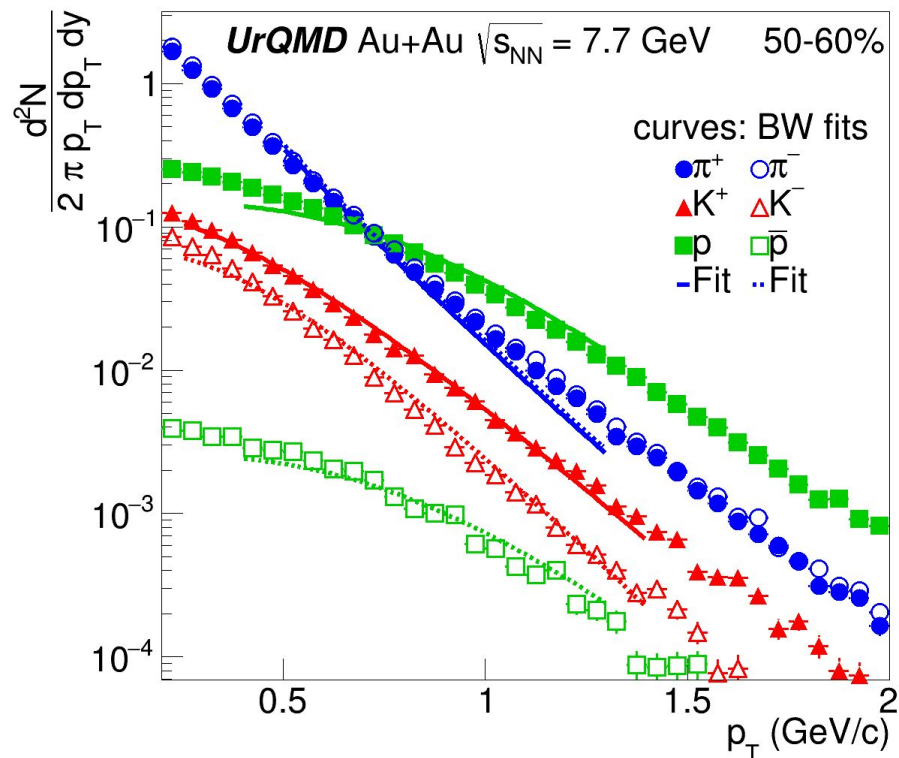
Fit parameters: T_{kin}, β

Blastwave fits of π±, K±, p and pBar pT spectra for 7.7 GeV

|y| < 0.1   pT fit ranges: **π [0.5-1.3]**, **K [0.25-1.4]**, **p (p bar) [0.4-1.3]** GeV/c

Tkin ≈ 74 MeV
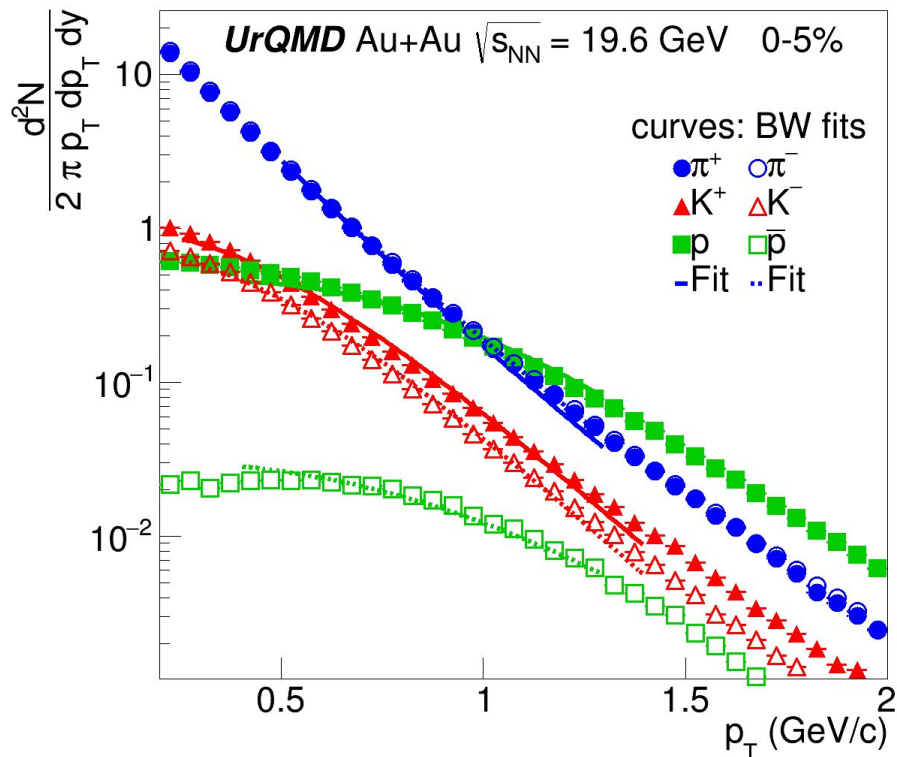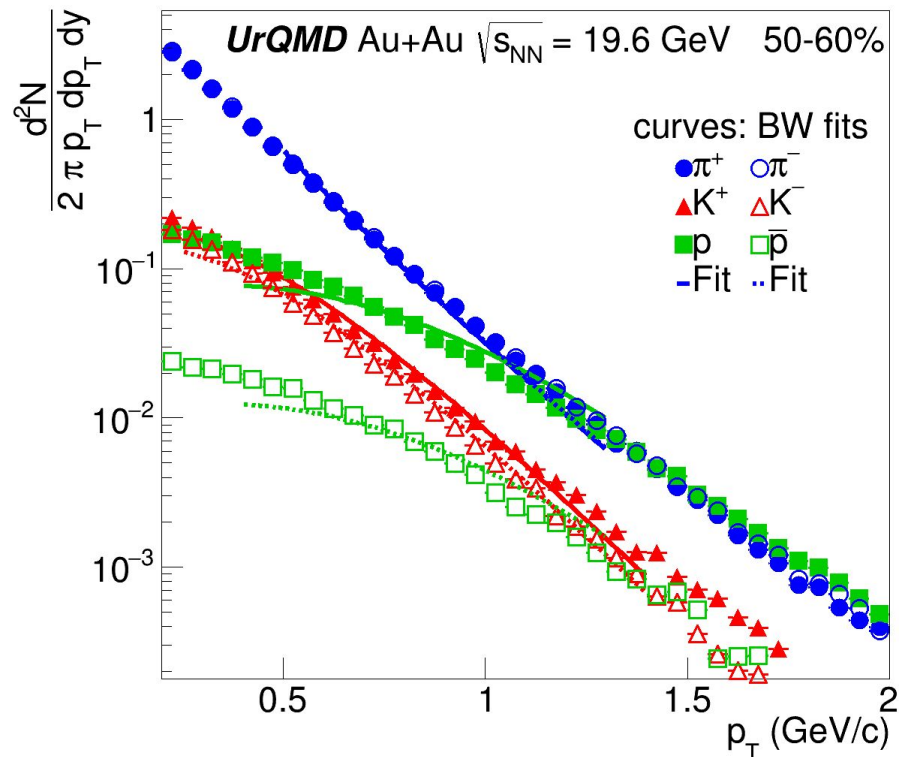
Tkin ≈ 72 MeV

Blastwave fits of π⁺, K⁺, p and pBar p$_T$ spectra for 19.6 GeV

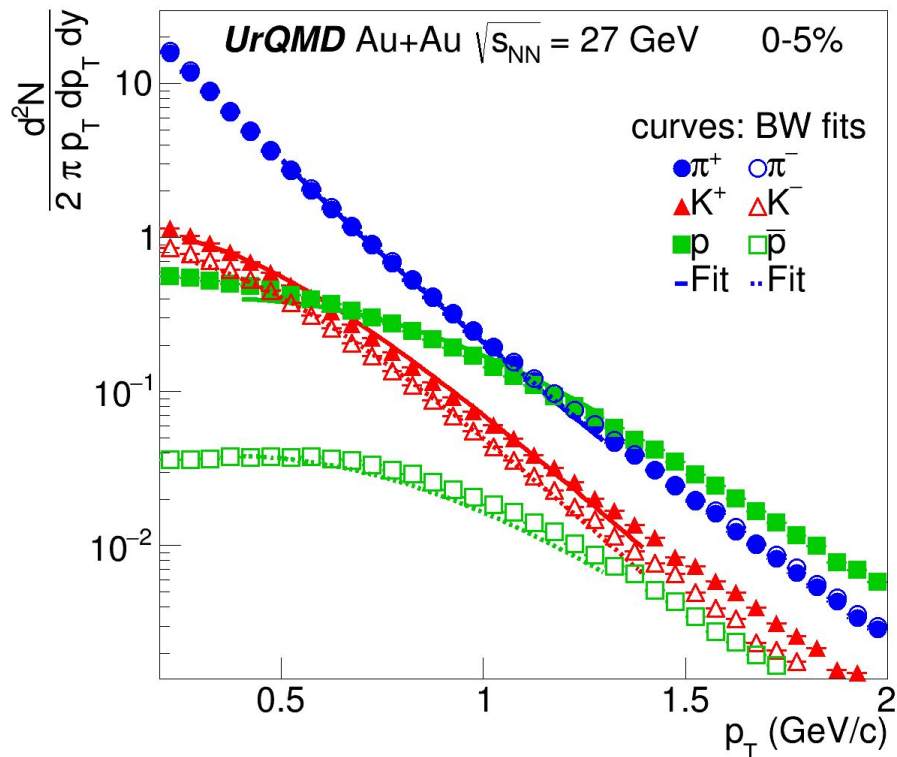|y| < 0.1   p$_T$ fit ranges: π [0.5-1.3], K [0.25-1.4], p (p bar) [0.4-1.3] GeV/c
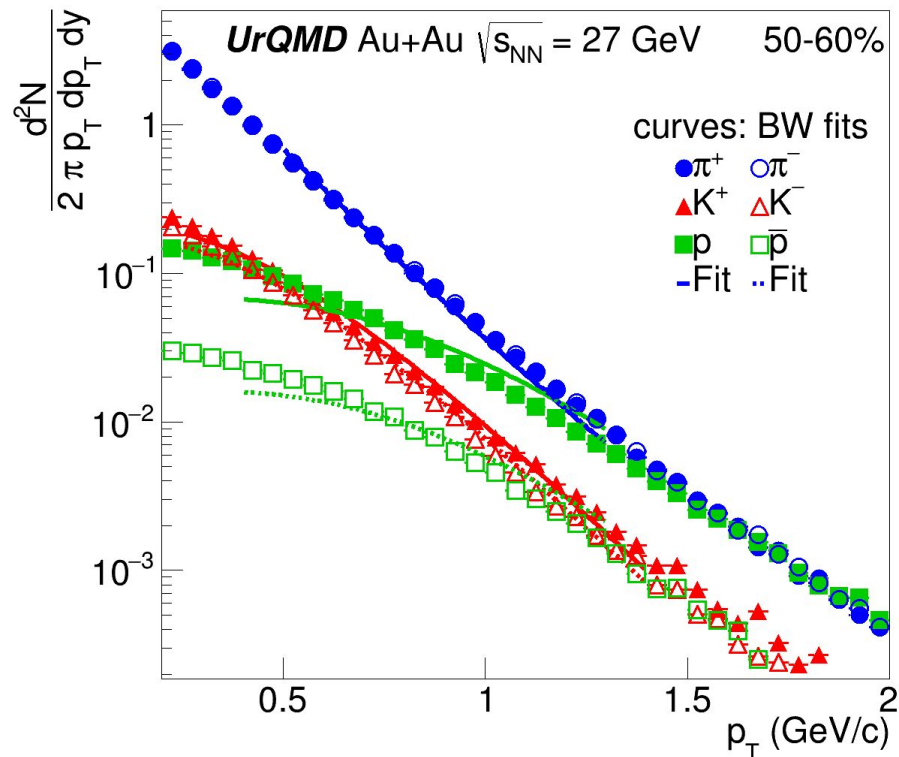

Tkin ≈ 74 MeV

Tkin ≈ 71 MeV

Blastwave fits of π±, K±, p and pBar pT spectra for 27 GeV

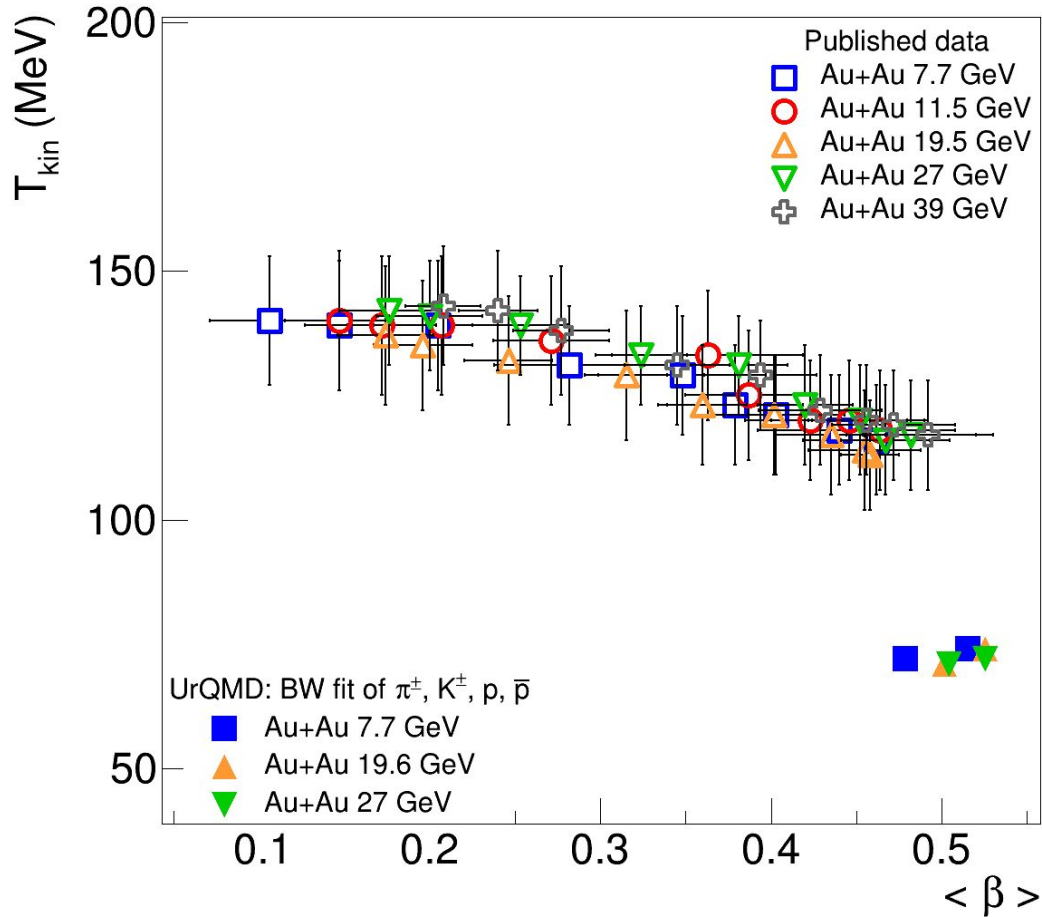|y| < 0.1 p_T fit ranges: π [0.5-1.3], K [0.25-1.4], p (p bar) [0.4-1.3] GeV/c

Tkin ≈ 72 MeV

Tkin ≈ 71 MeV

Comparison of UrQMD and Publish results: $T_{kin}(\langle\beta\rangle)$

Plot legend (top right of plot):
Published data
- Au+Au 7.7 GeV (blue square)
- Au+Au 11.5 GeV (red circle)
- Au+Au 19.5 GeV (orange triangle)
- Au+Au 27 GeV (green inverted triangle)
- Au+Au 39 GeV (grey cross)

Plot legend (bottom left of plot):
UrQMD: BW fit of $\pi^{\pm}$, $K^{\pm}$, p, $\bar{p}$
- Au+Au 7.7 GeV (blue square)
- Au+Au 19.6 GeV (orange triangle)
- Au+Au 27 GeV (green inverted triangle)

Axis labels: T_{kin} (MeV) vs $\langle\beta\rangle$

Right side text:

$|y| < 0.1$
p_T fit ranges:
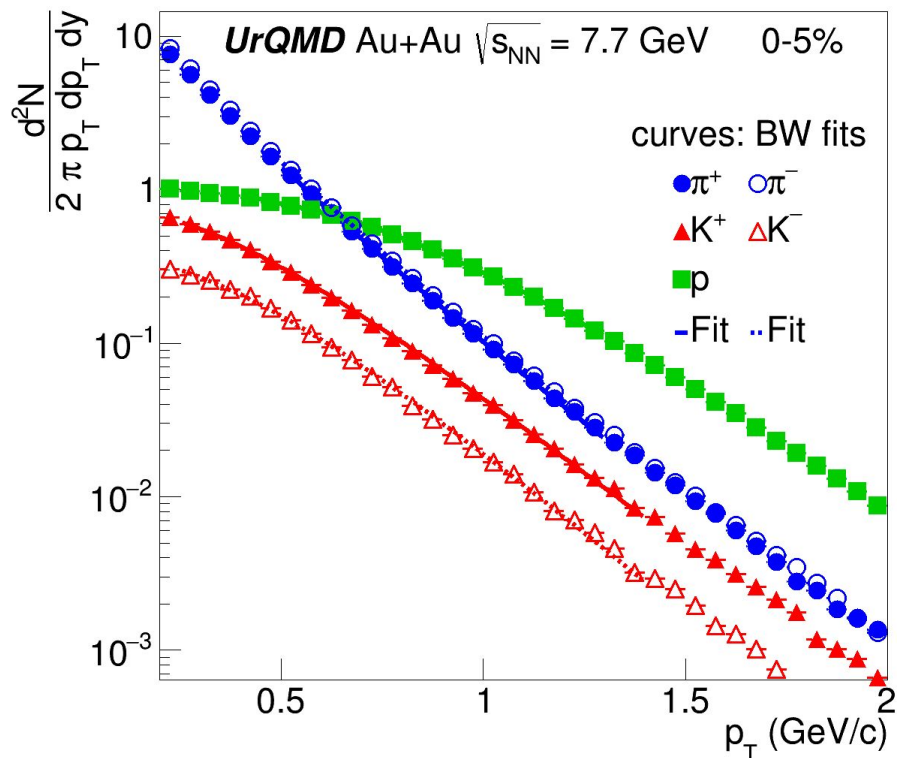π [0.5-1.3], K [0.25-1.4], p (p bar) [0.4-1.3]
GeV/c

T_{kin} and $\langle\beta\rangle$ **underestimated** after BW fit
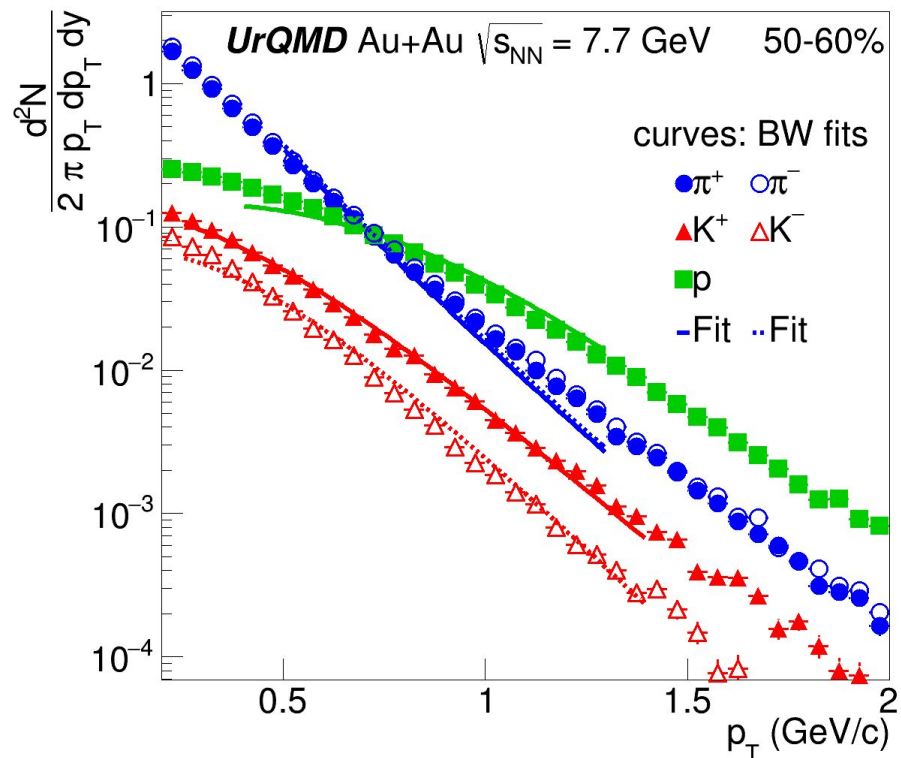for $\pi^{\pm}$, $K^{\pm}$, p and pBar p_T spectra

Blastwave fits of π±, K±, p pₜ spectra for 7.7 GeV

|y| < 0.1   pₜ fit ranges: **π [0.5-1.3]**, **K [0.25-1.4]**, **p (p bar) [0.4-1.3]** GeV/c
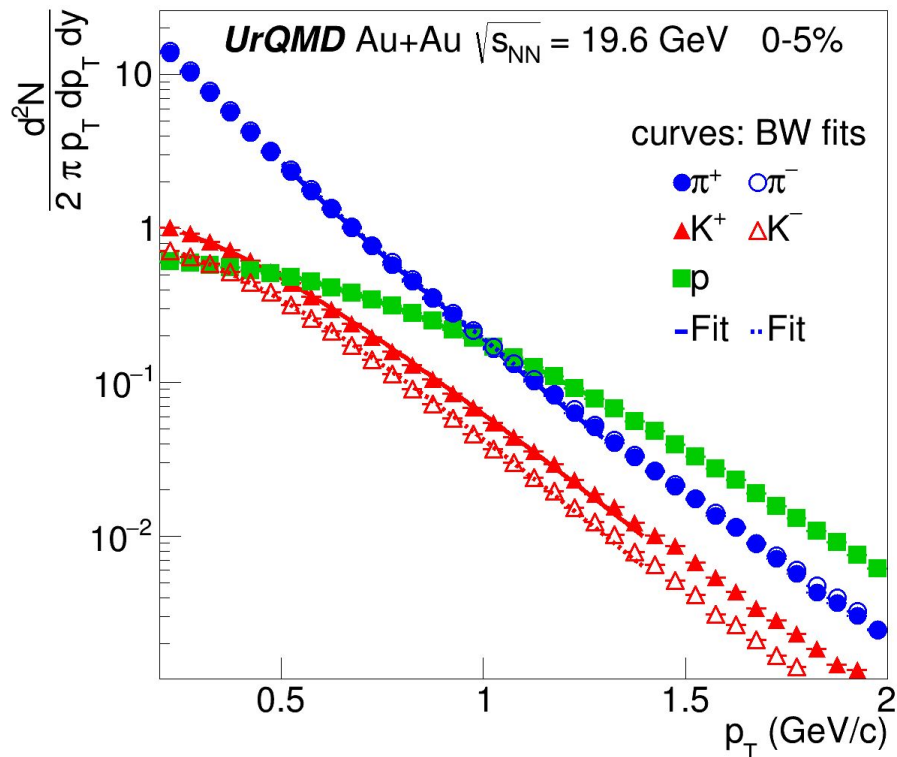

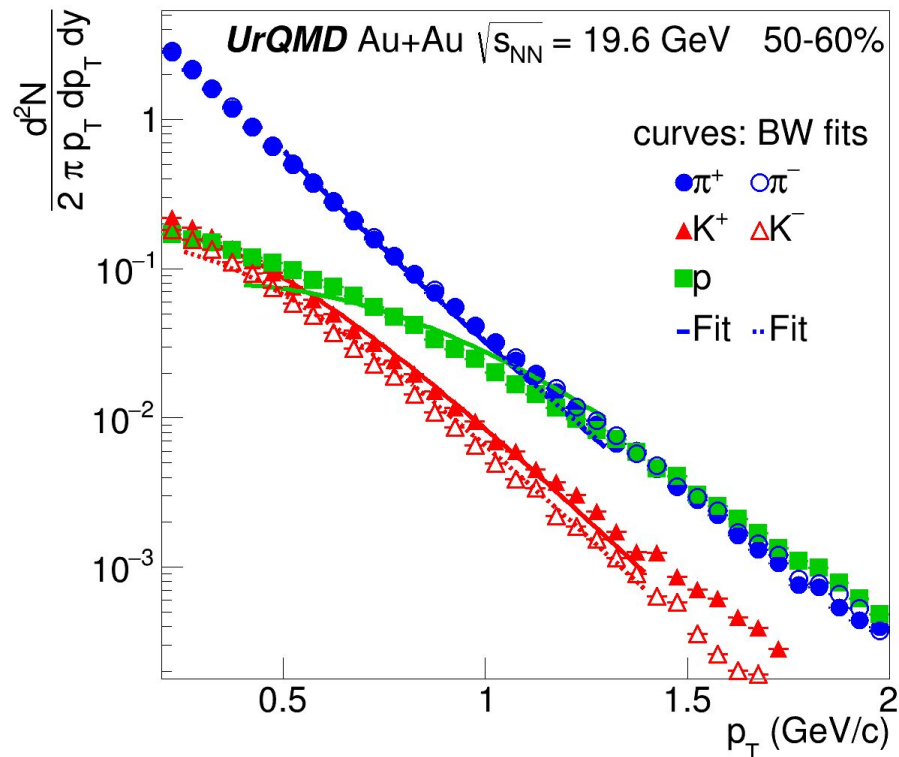Tkin ≈ 97 MeV   Tkin ≈ 73 MeV

Blastwave fits of $\pi^{\pm}$, $K^{\pm}$, p p_T spectra for 19.6 GeV

$|y| < 0.1$ p_T fit ranges: **π [0.5-1.3], K [0.25-1.4], p (p bar) [0.4-1.3]** GeV/c

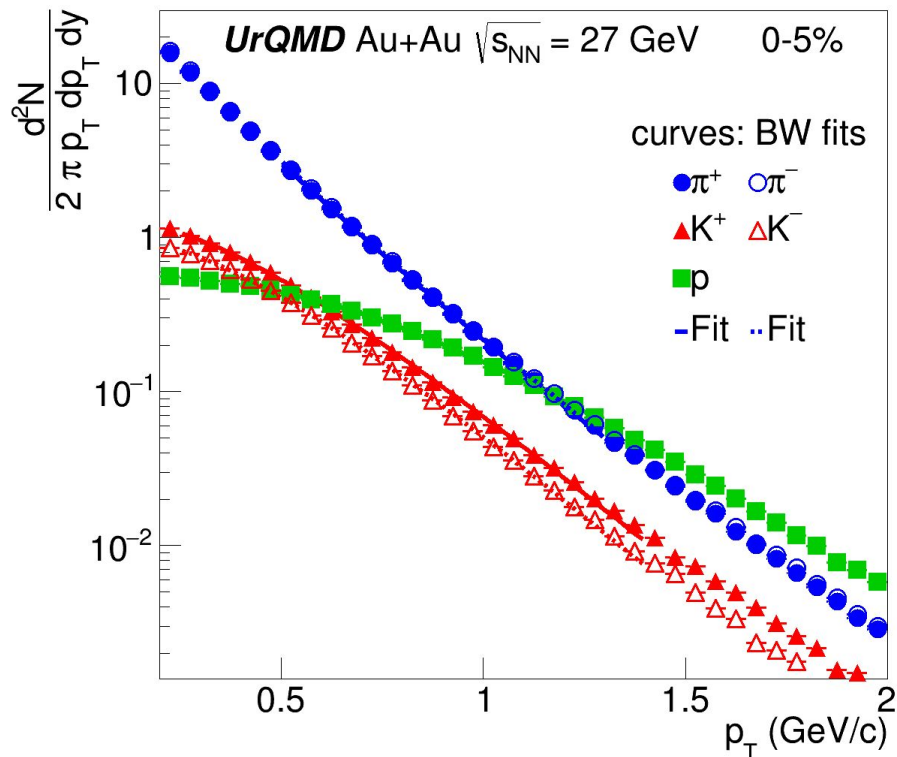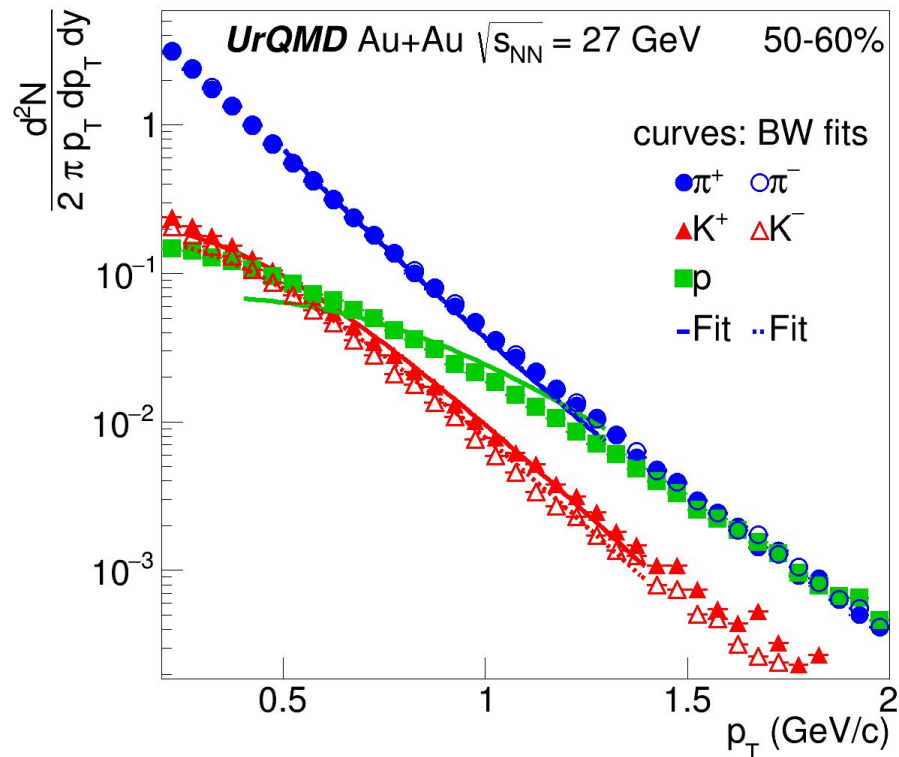Tkin ≈ 97 MeV   Tkin ≈ 73 MeV

Blastwave fits of π±, K±, p p_T spectra for 27 GeV

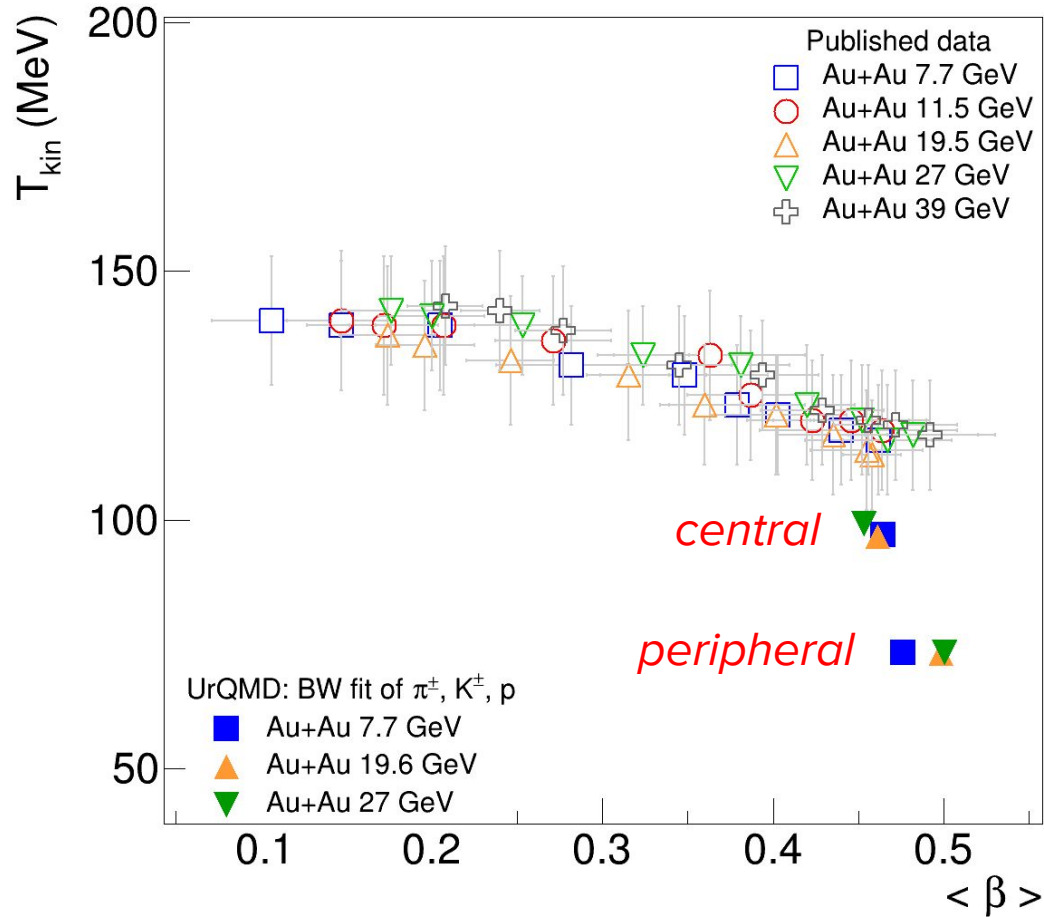|y| < 0.1   p_T fit ranges: **π [0.5-1.3], K [0.25-1.4], p (p bar) [0.4-1.3]** GeV/c

Tkin ≈ 99 MeV

Tkin ≈ 73 MeV

Comparison of UrQMD and Publish results: $T_{kin}(\langle\beta\rangle)$

|y| < 0.1
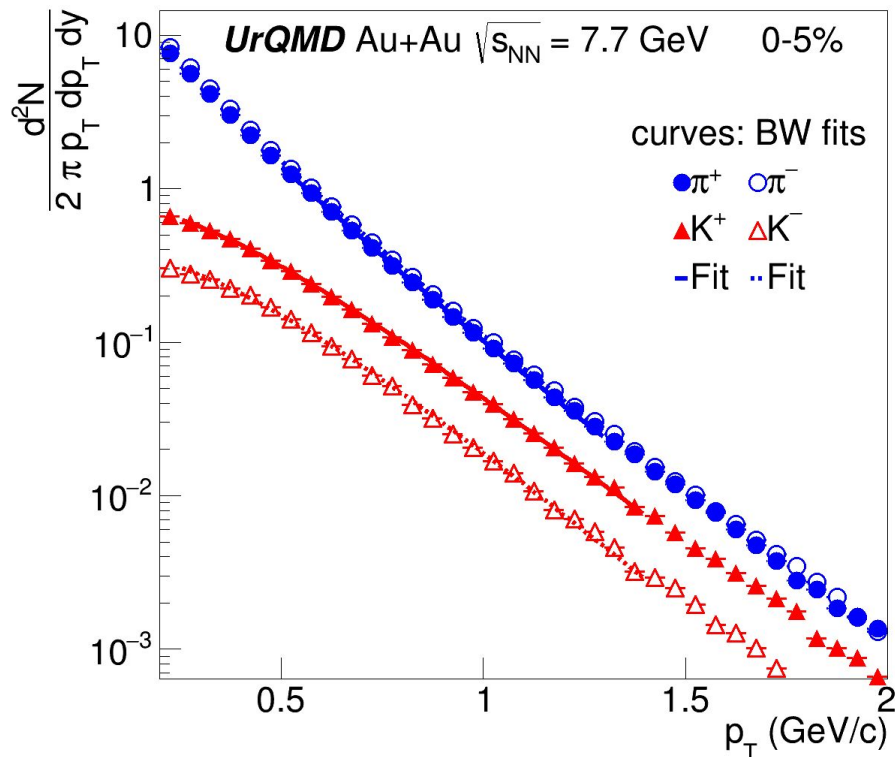p_T fit ranges:
π [0.5-1.3], K [0.25-1.4], p (p bar) [0.4-1.3]
GeV/c

T_{kin} and $\langle\beta\rangle$ **underestimated for peripheral collisions** after BW fit for **π±, K±, p** p_T spectra
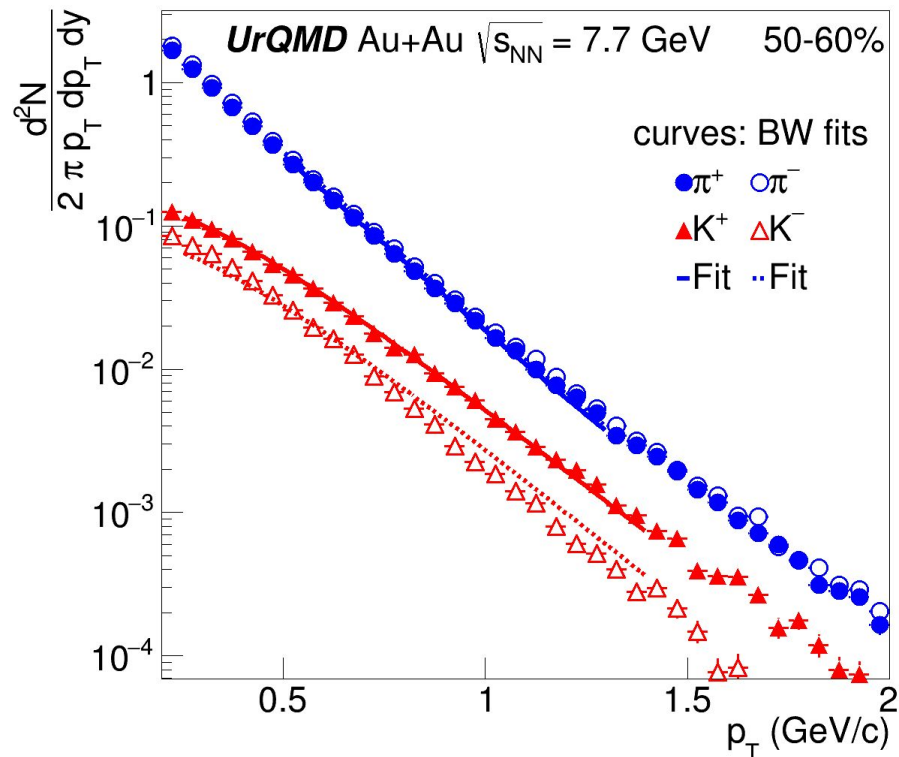
Blastwave fits of $\pi^{\pm}$, $K^{\pm}$ p_T spectra for 7.7 GeV

$|y| < 0.1$ p_T fit ranges: **π [0.5-1.3], K [0.25-1.4], p (p bar) [0.4-1.3]** GeV/c

Tkin ≈ 104 MeV   Tkin ≈ 131 MeV
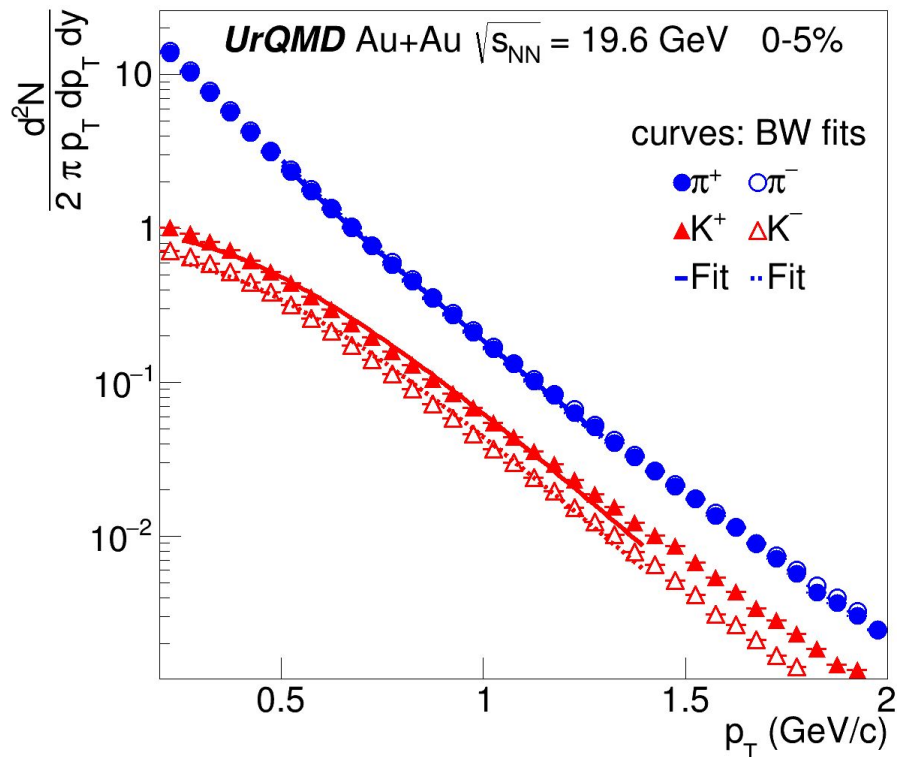
Blastwave fits of π±, K± p_T spectra for 7.7 GeV

$|y| < 0.1$ p_T fit ranges: **π [0.5-1.3], K [0.25-1.4], p (p bar) [0.4-1.3]** GeV/c

Tkin ≈ 75 MeV

Tkin ≈ 133 MeV

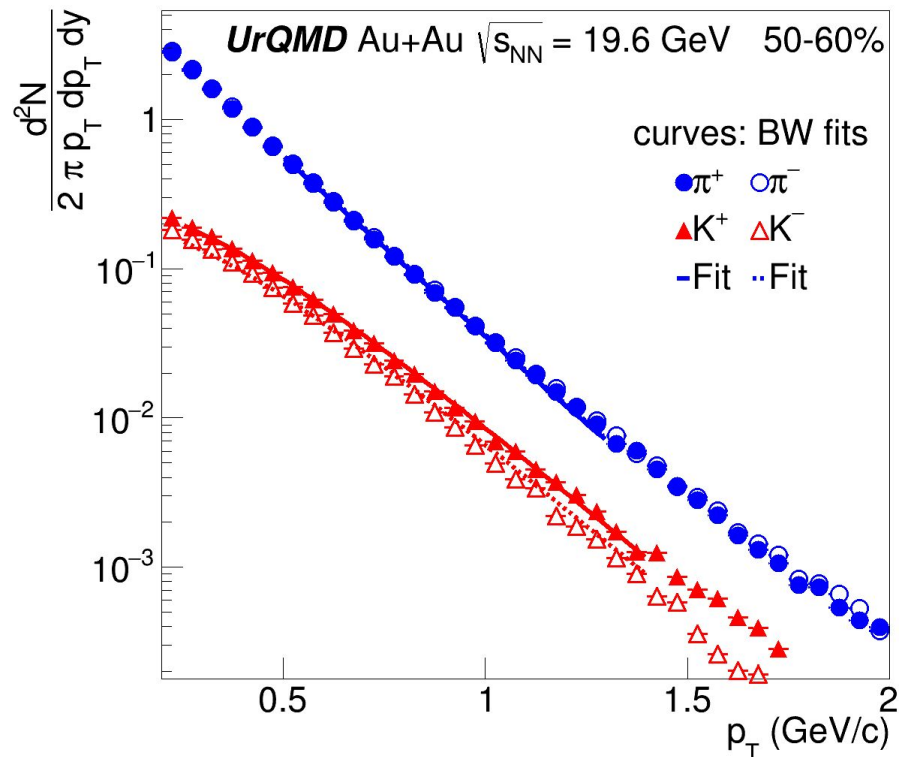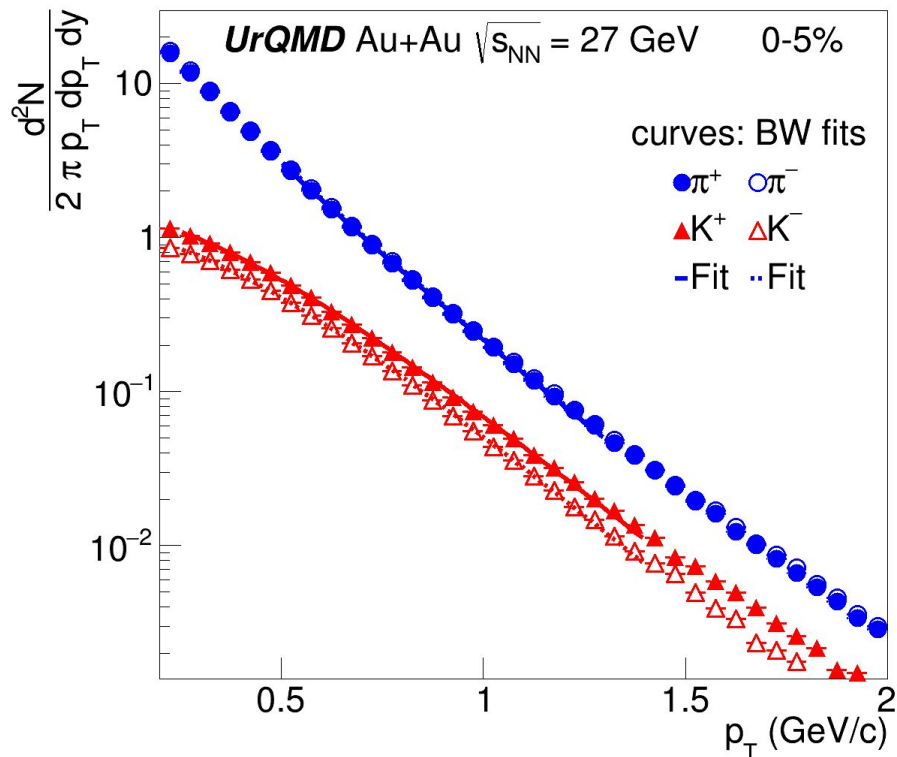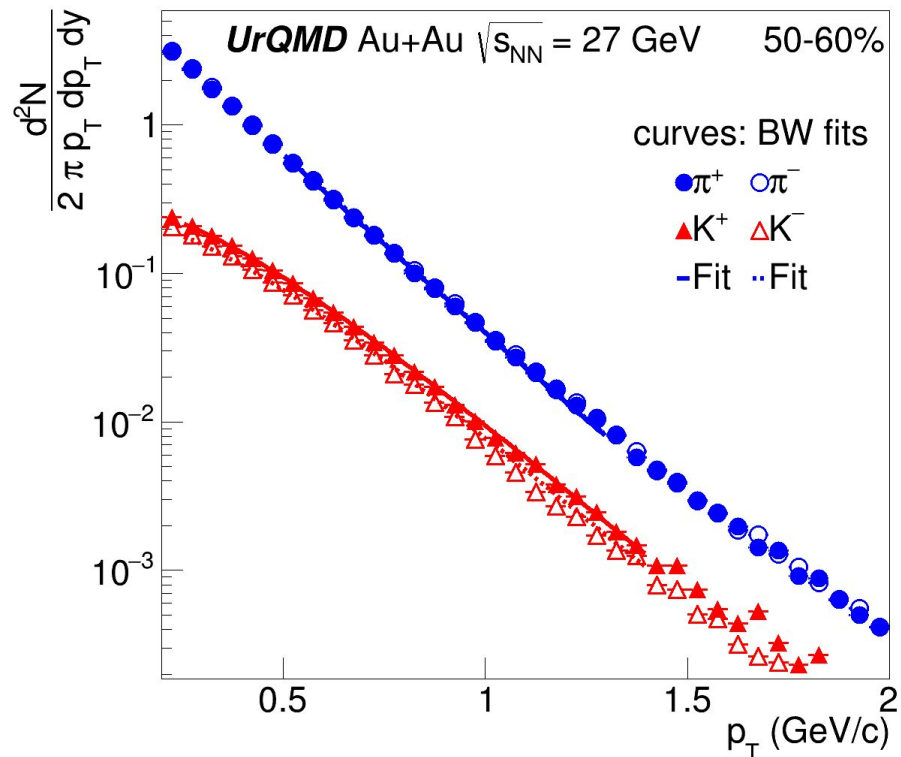# Blastwave fits of π±, K± p_T spectra for 7.7 GeV

$|y| < 0.1$ p_T fit ranges: **π [0.5-1.3], K [0.25-1.4], p (p bar) [0.4-1.3]** GeV/c
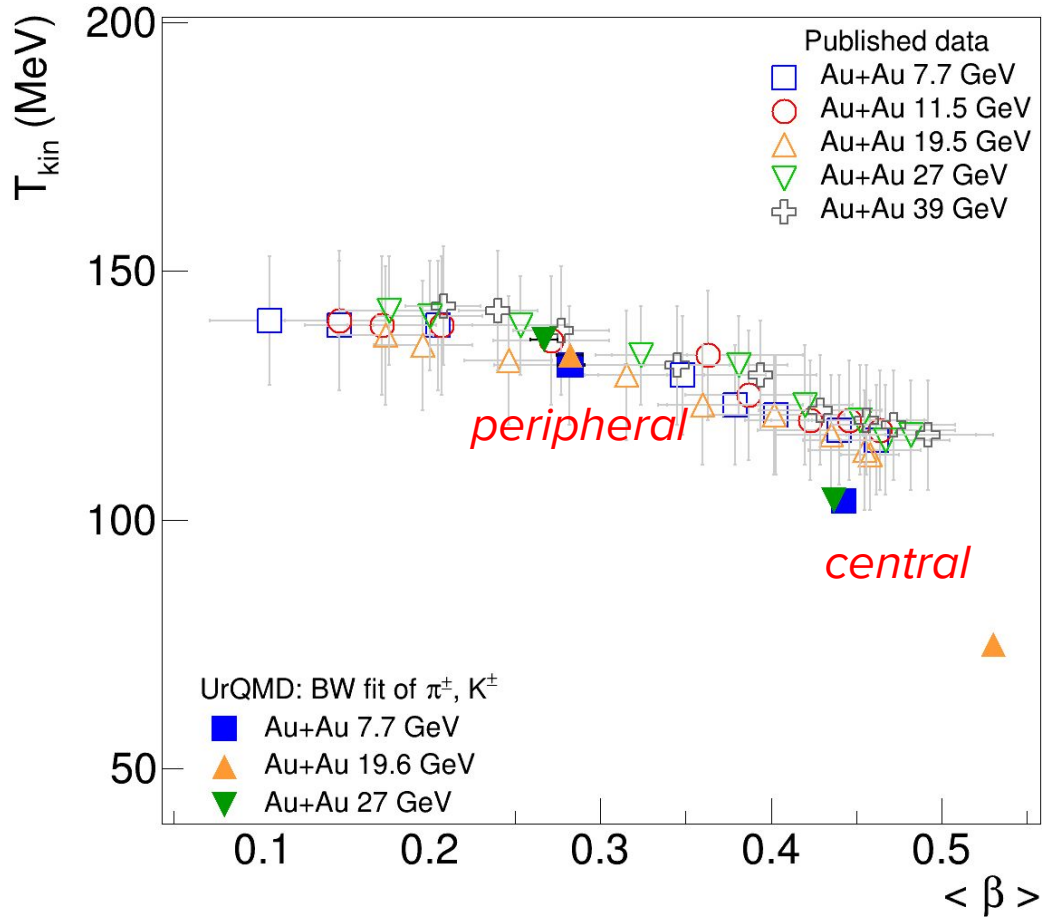

Tkin ≈ 104 MeV

Tkin ≈ 136 MeV

Comparison of UrQMD and Publish results: $T_{kin}(<\beta>)$

$|y| < 0.1$

p_T fit ranges:

π [0.5-1.3], K [0.25-1.4], p (p bar) [0.4-1.3]

GeV/c

T_{kin} and $<\beta>$ **underestimated for central collisions for 19.6 GeV** after BW fit for **π±, K±** p_T spectra

Conclusion

- Spectra for the $\pi^\pm$, $K^\pm$, p and pBar were constructed using UrQMD
  - The spectra were fitted using the BlastWave (BW) model
  - Extracted fit parameters T_{kin} and $<\beta>$ compared with published data from STAR:
    - BW fit for **$\pi^\pm$, $K^\pm$, p and pBar** underestimated T_{kin} and $<\beta>$
    - BW fit for **$\pi^\pm$, $K^\pm$, p** underestimated T_{kin} and $<\beta>$ for peripheral collisions
    - BW fit for **$\pi^\pm$, $K^\pm$** underestimated T_{kin} and $<\beta>$ for 19.6 GeV in central collisions

To do:
- BW fit of experimental data
- BW fit of UrQMD data: Ar+Ar, O+O, Kr+Kr...