



Prompt identified particle spectra at RHIC-STAR

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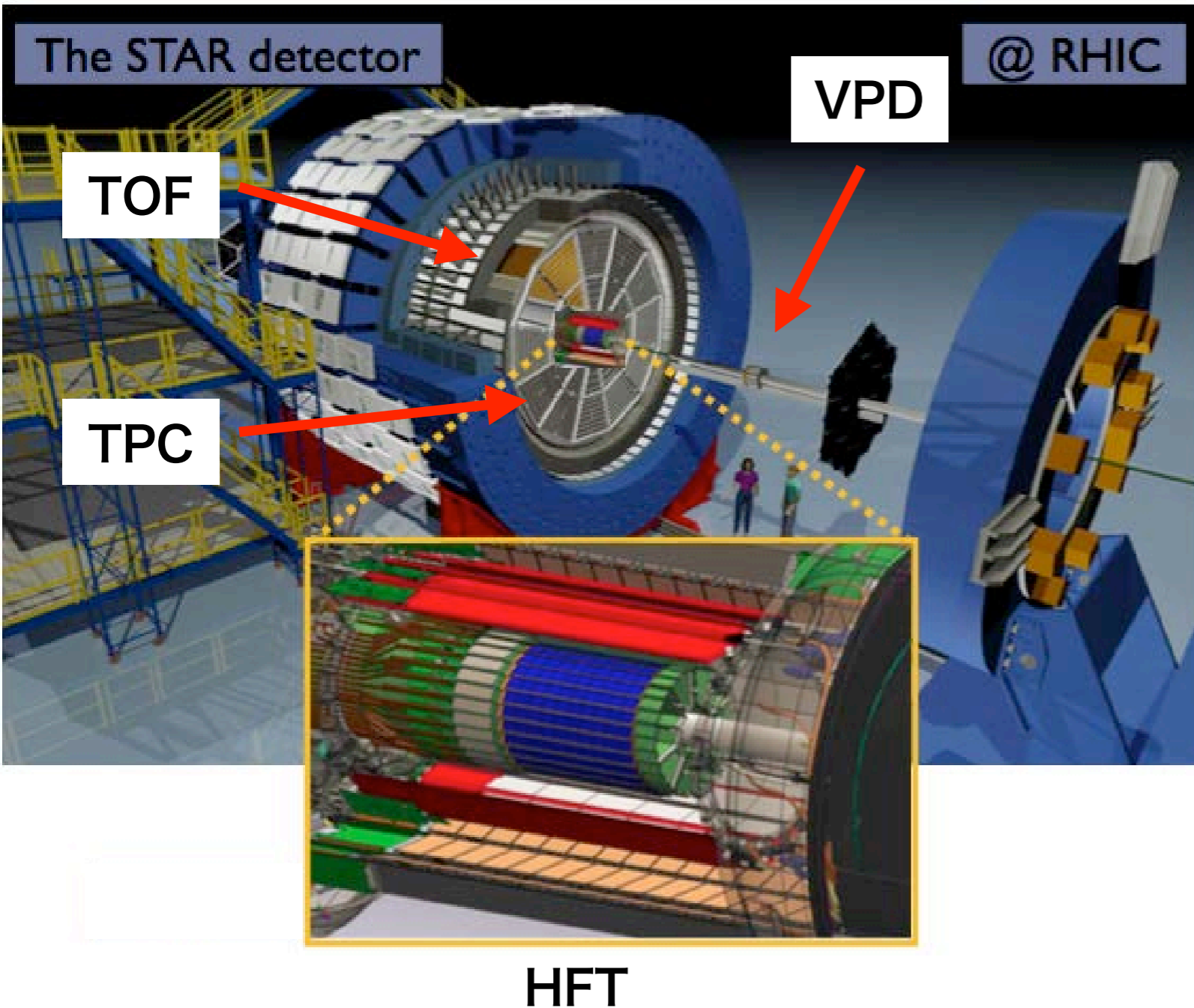
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Motivation



- Inclusive proton includes ~40% of protons from weak decay in Au+Au 200GeV.
PRL 92, 112301 (2004)
PRC 69, 034909 (2004)
- STAR - inclusive proton spectra
not corrected for weak decay feed down contribution
PHENIX - prompt proton spectra
proton coming from Λ is estimated based on model simulations
- This result will be first direct measurement of prompt proton p_T spectra with new HFT detector at RHIC.
 - Uncertainty will decrease significantly due to smaller simulation correction.

STAR detector



Vertex Position Detector

Minimum bias trigger

Time Projection Chamber

Centrality definition

Particle trajectory

Momentum

PID (dE/dx)

Time Of Flight

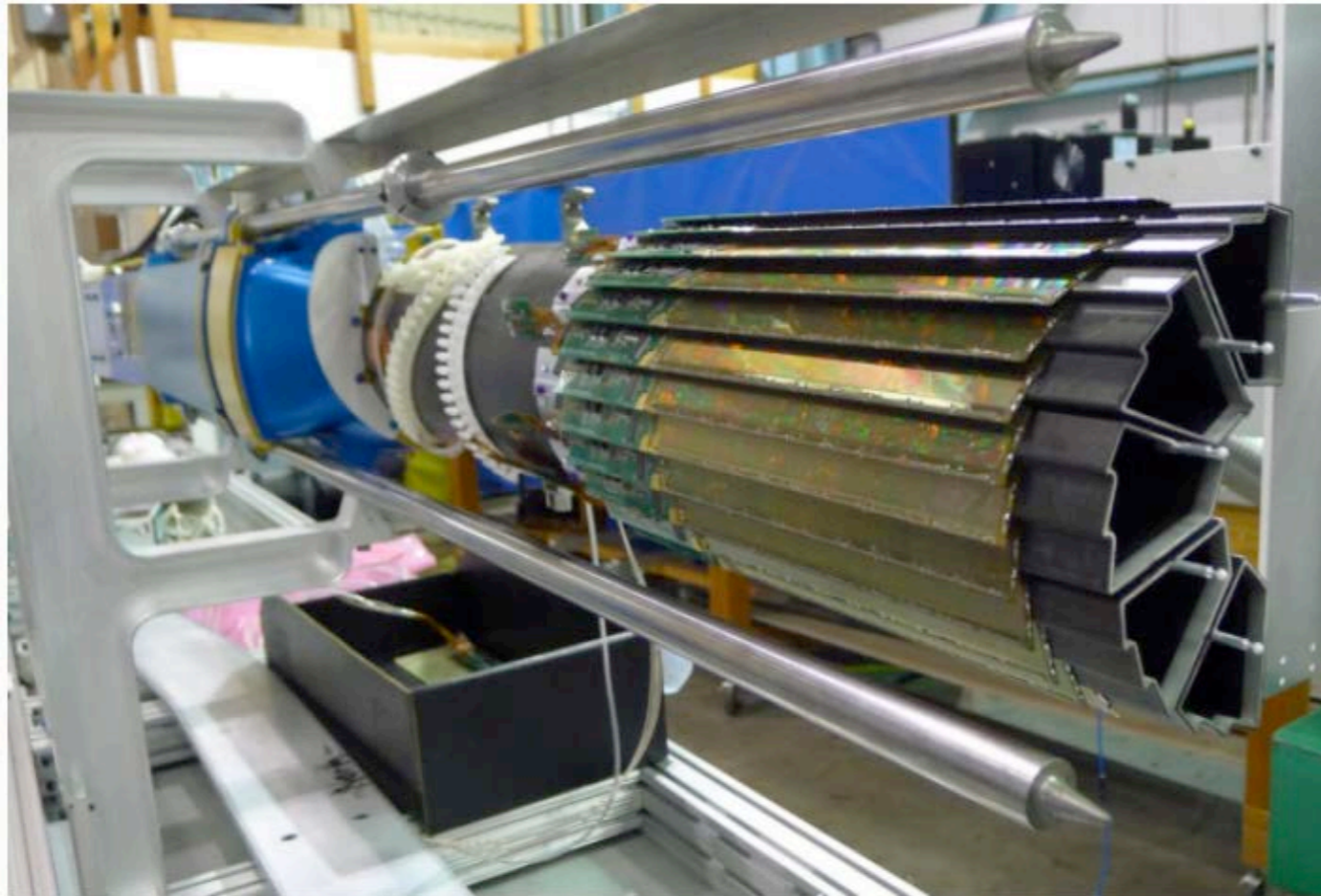
PID (flight time : $1/\beta$)

Heavy Flavor Tracker

Heavy Flavor Tracker detector



PIXEL detector



Acceptance

$$-1 < \eta < 1$$

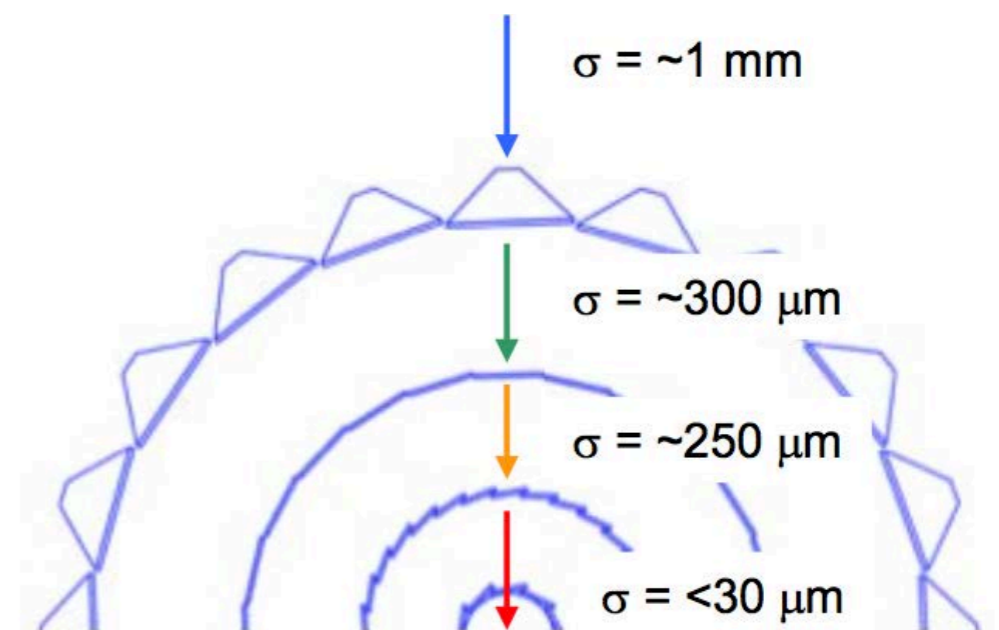
$$0 < \phi < 2\pi$$

Good resolution of DCA
(Distance of Closest Approach)
Particle track - collision point

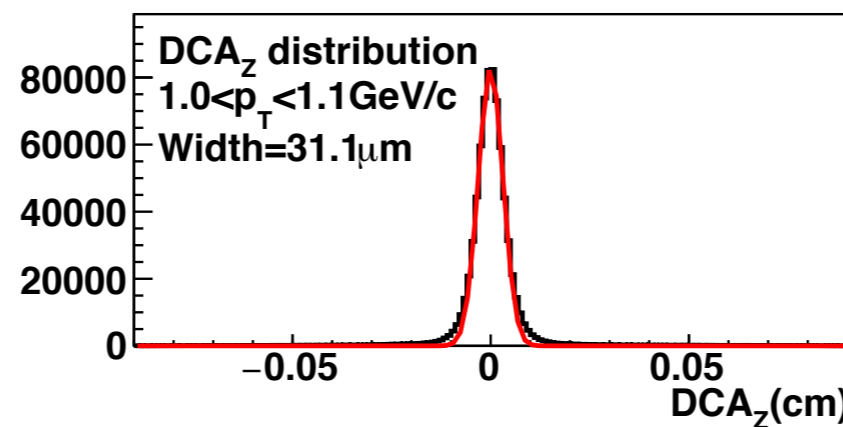
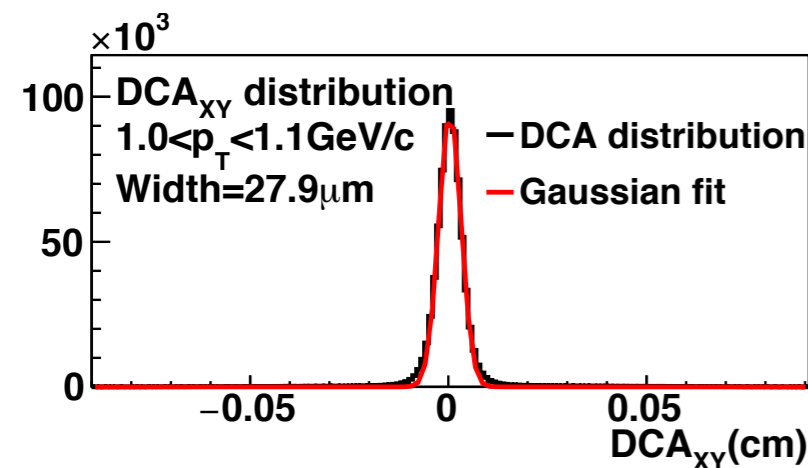
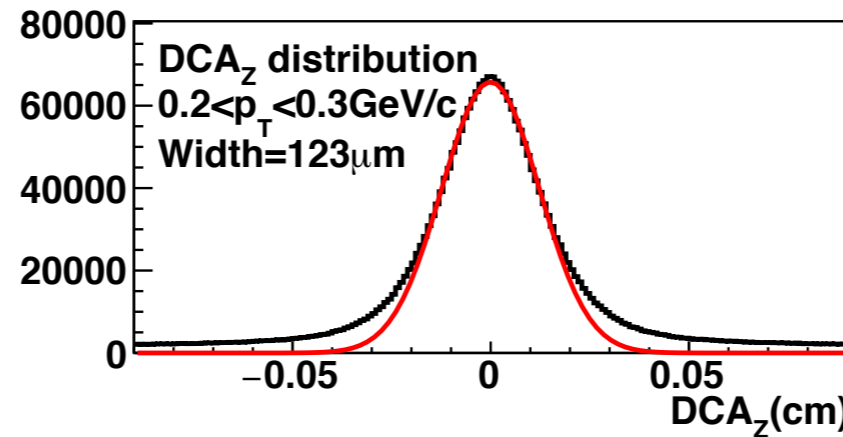
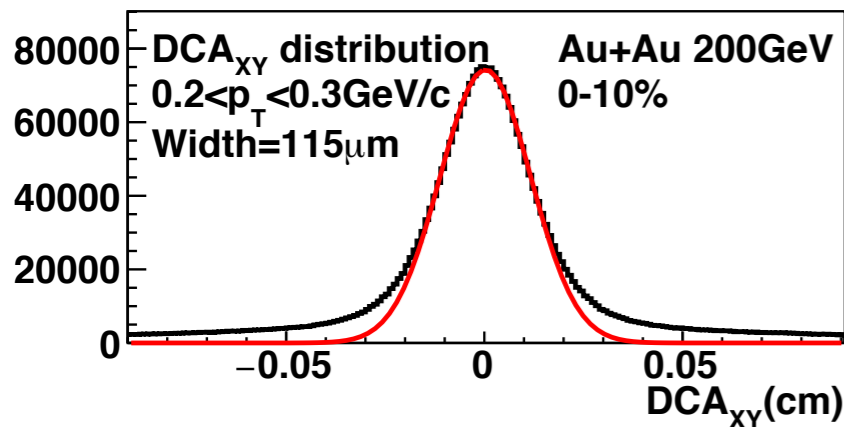
Silicon **S**trip **D**etector : $r \sim 22\text{cm}$

Intermediate **S**ilicon **T**racker : $r \sim 14\text{cm}$

PIXEL : $r \sim 2.8, 8\text{cm}$



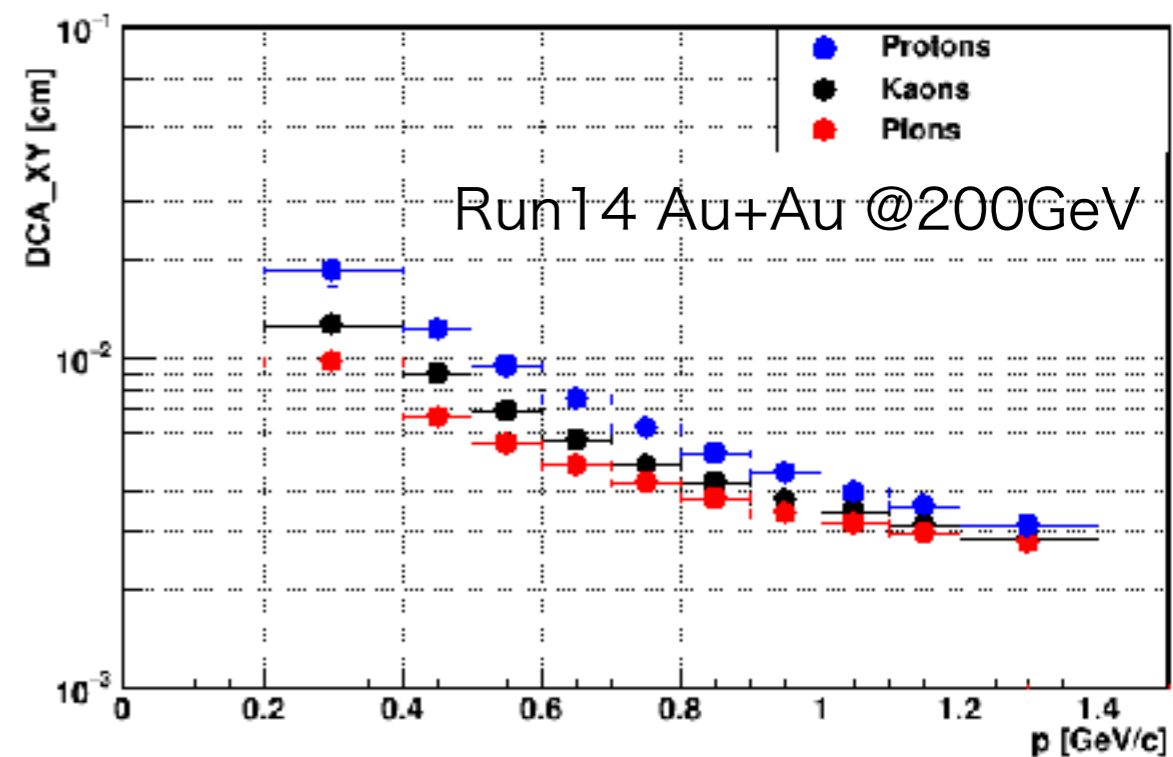
HFT performance



DCA distribution from data in AuAu 200 GeV
0-10% centrality
inclusive charged particles

DCA in XY plane and Z direction
Width : < 50 μm at p_T = 1 GeV/c

DCA Resolution



Particle Identification

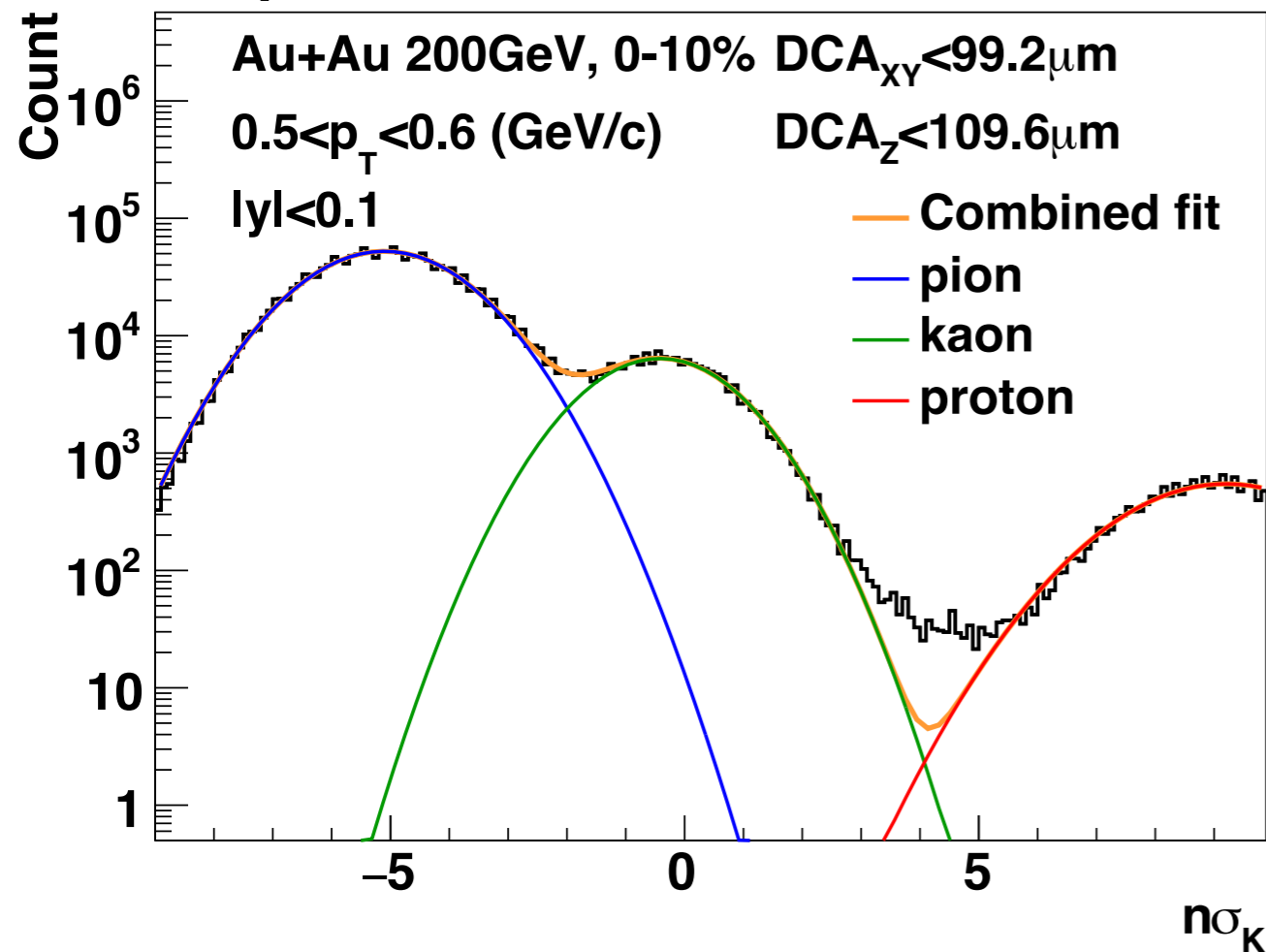


Track selection

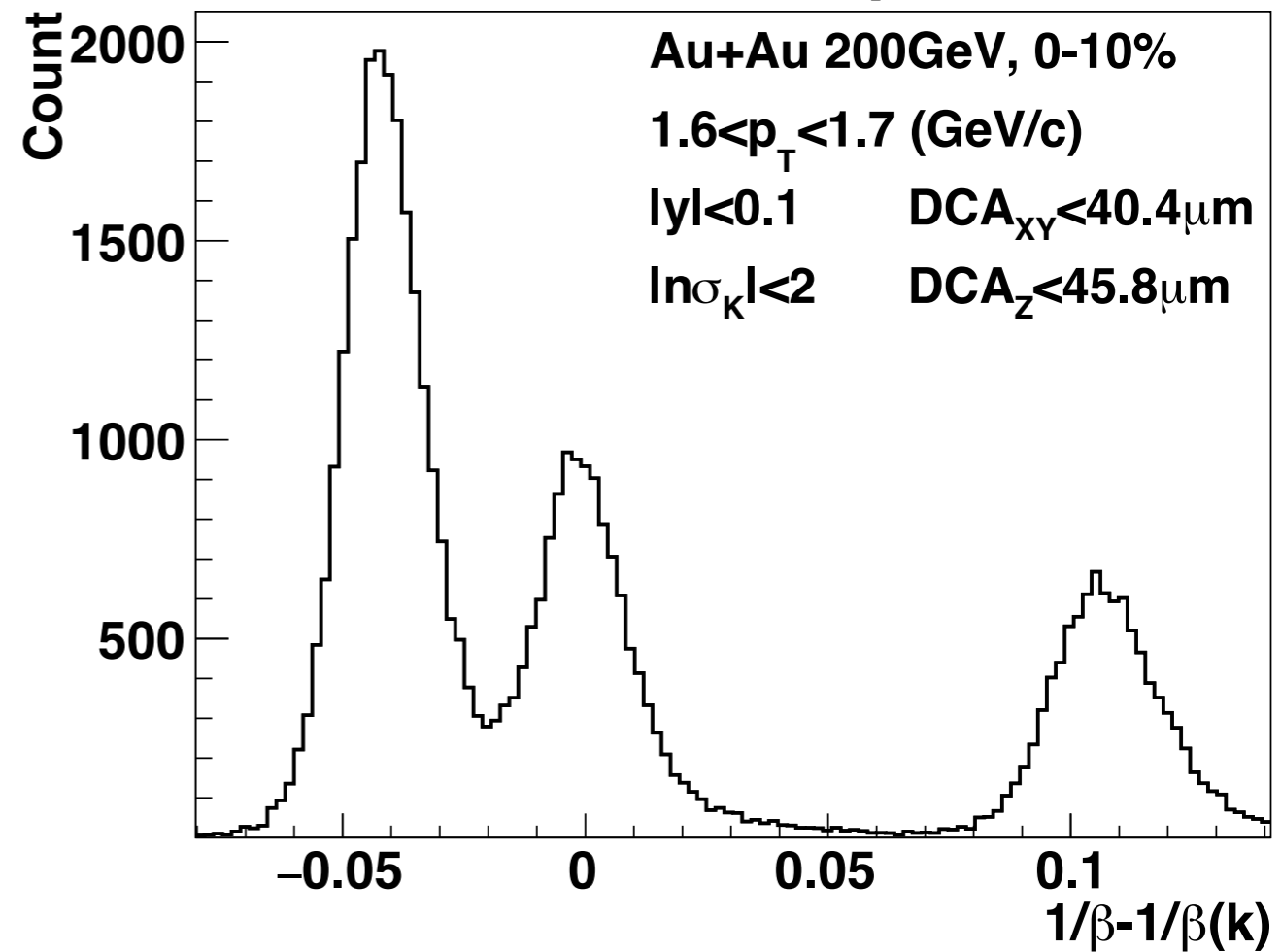
At least one hit for each HFT layer

DCA selection is determined with resolution.

dE/dx in TPC



dE/dx in TPC and β in TOF



Detector inefficiency & acceptance

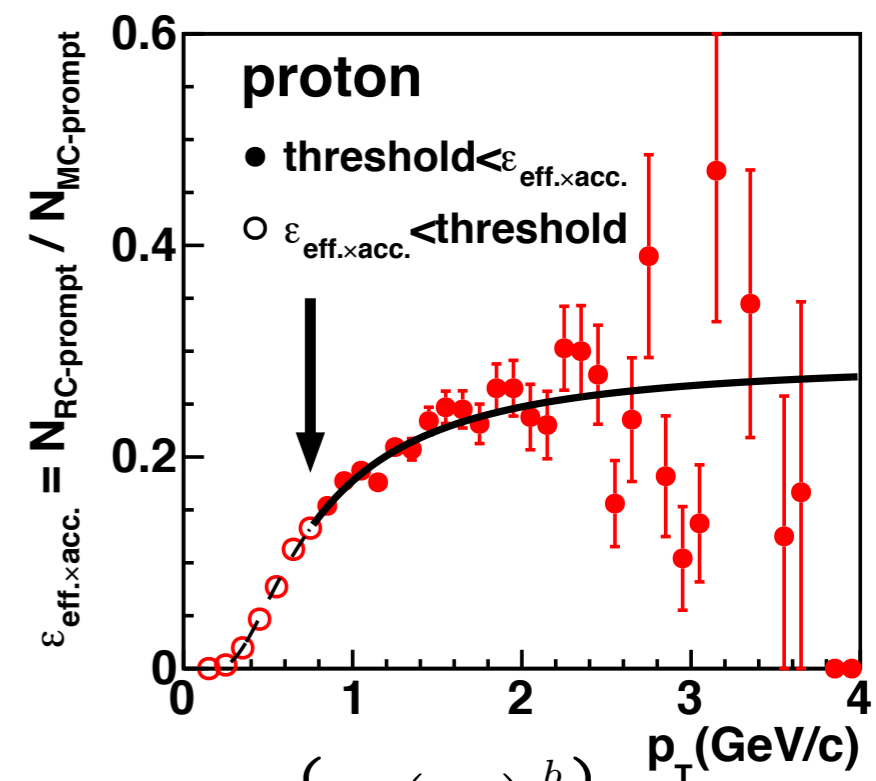
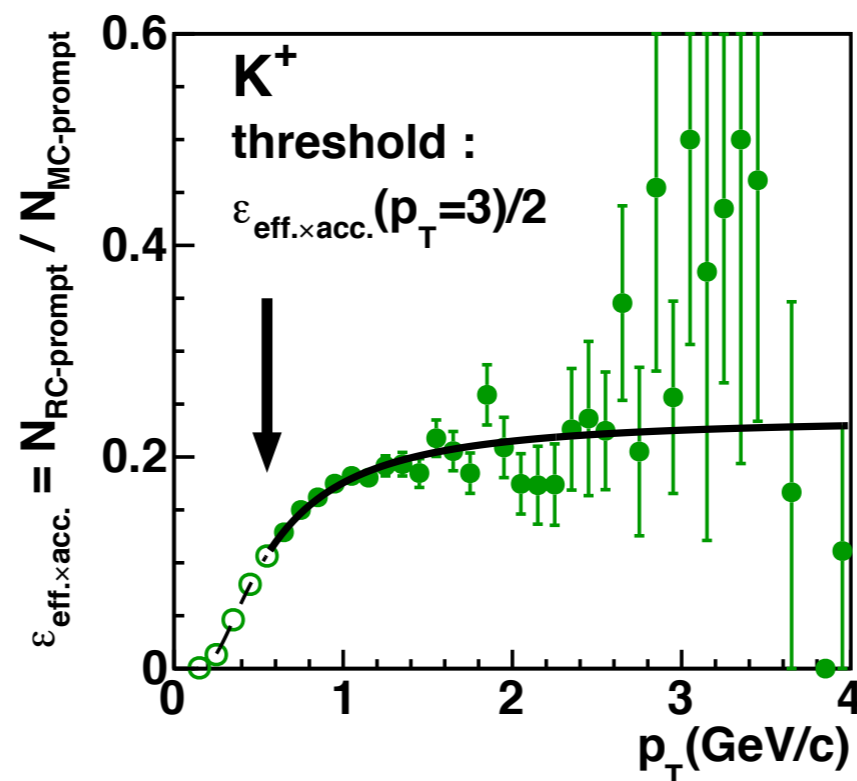
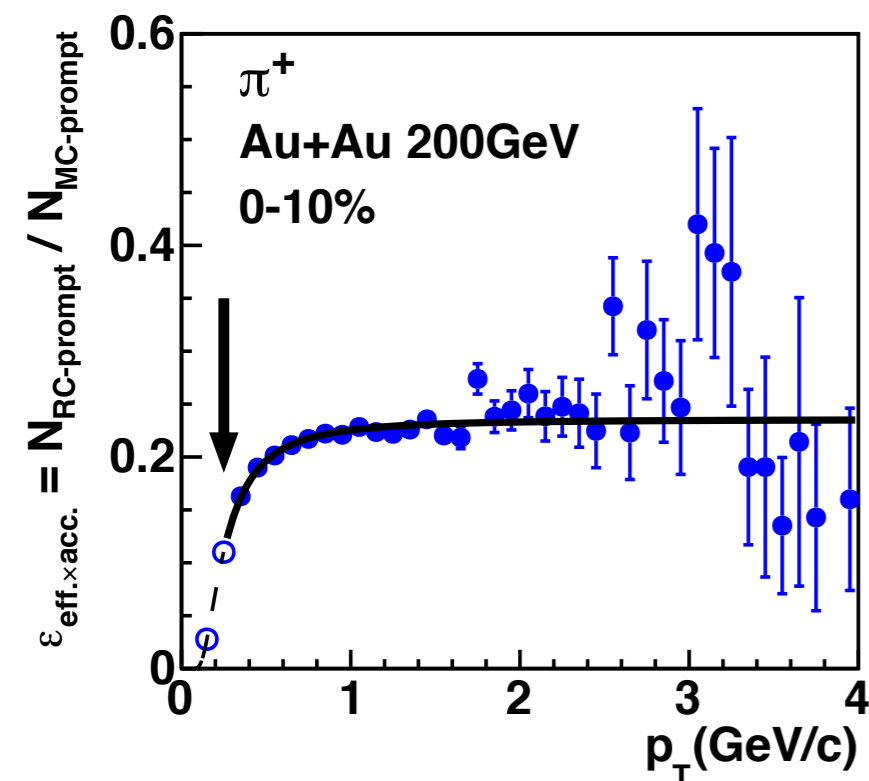
Extracted from HIJING and GEANT simulation

The combination of TPC and HFT efficiency and acceptance

$$\varepsilon_{\text{eff.} \times \text{acc.}} = \frac{N_{\text{RC-prompt particle}}}{N_{\text{MC-prompt particle}}}$$

$N_{\text{MC-prompt particle}}$: The number of created prompt particles

$N_{\text{RC-prompt particle}}$: The number of reconstructed real prompt particles



$$F = A \exp \left\{ - \left(\frac{a}{p_T} \right)^b \right\}$$

The purity of prompt particles

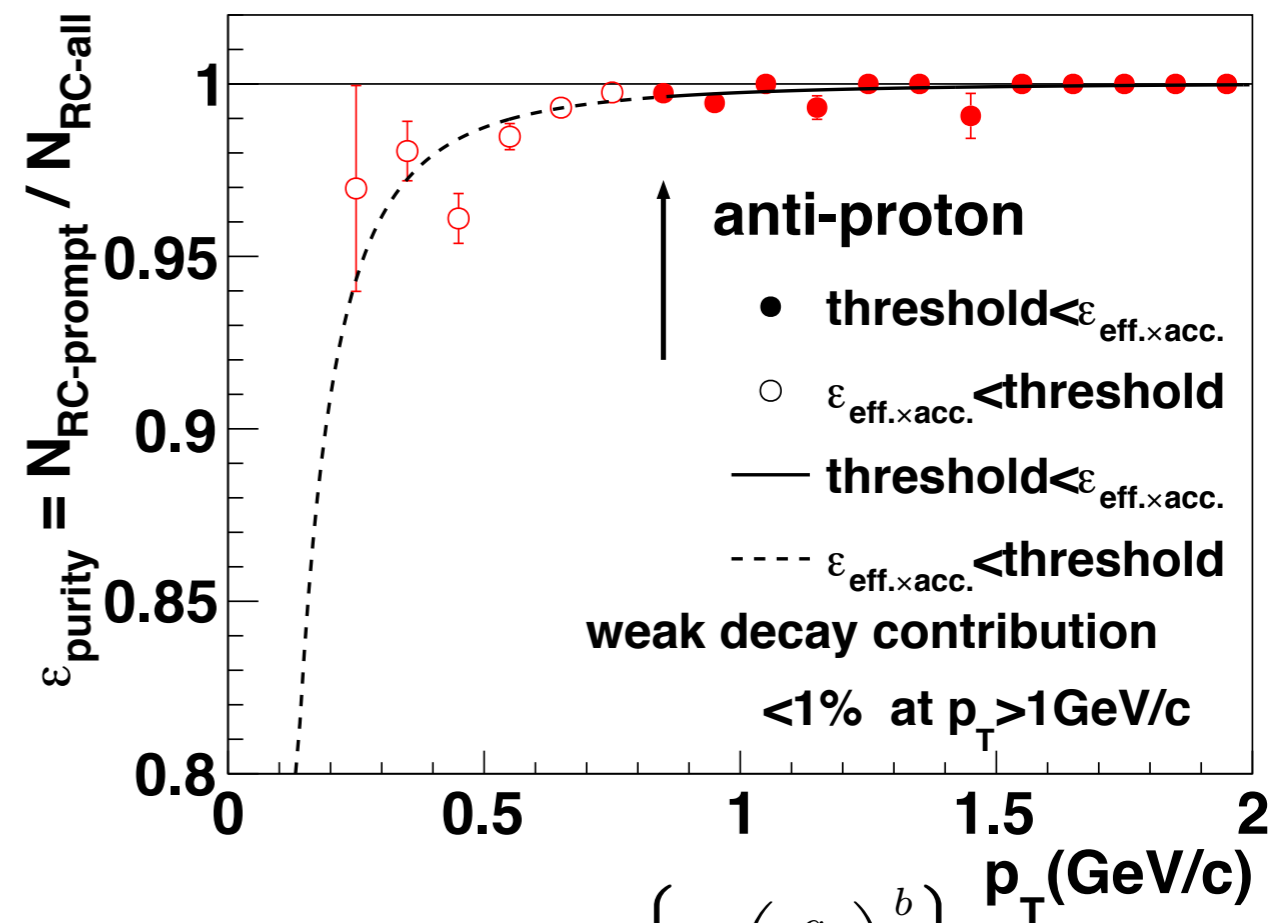
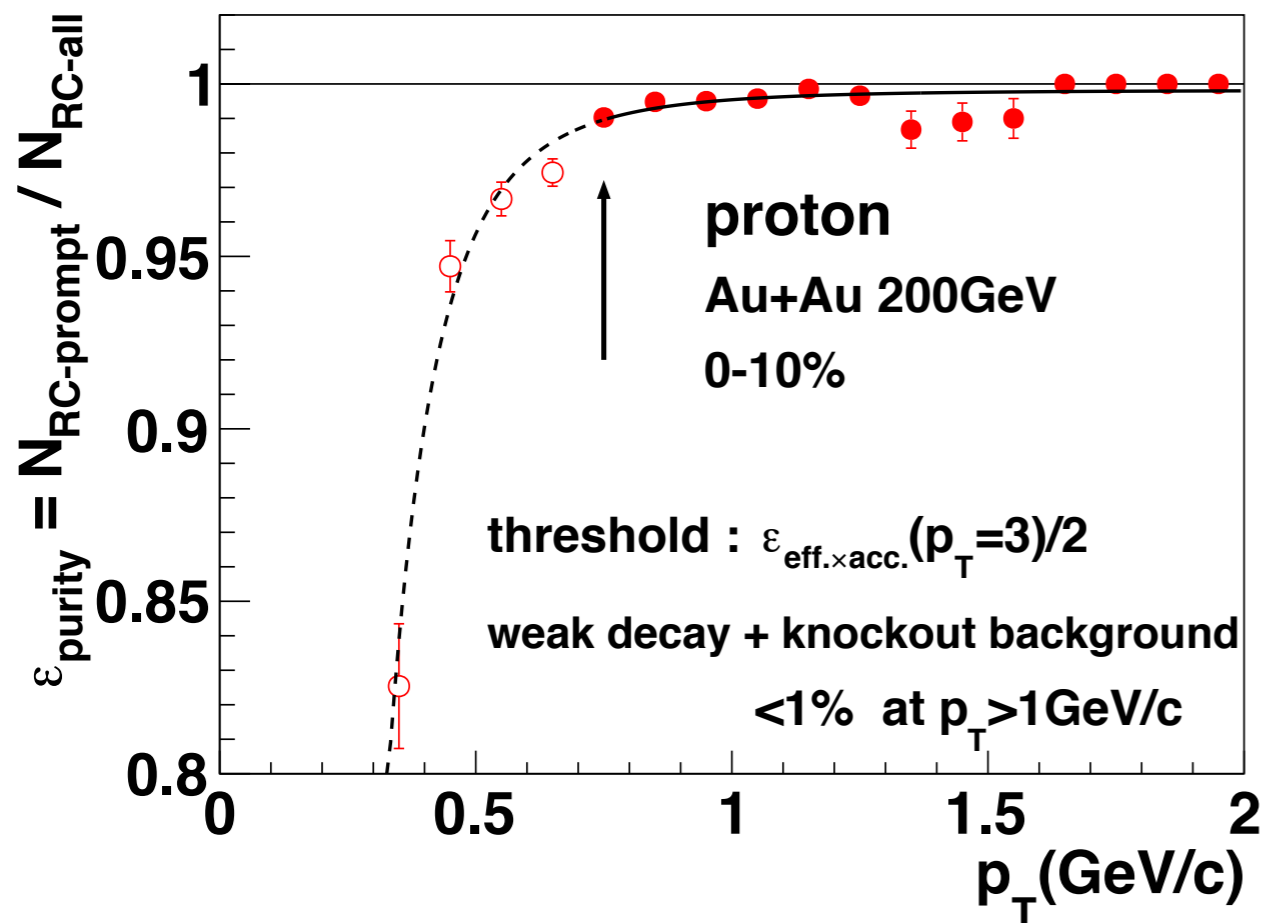


Extracted from HIJING and GEANT simulation.

$$\varepsilon_{\text{purity}} = \frac{N_{\text{RC-prompt particle}}}{N_{\text{RC-all particle}}}$$

$N_{\text{RC-all particle}}$: The number of reconstructed all of particles

$N_{\text{RC-prompt particle}}$: The number of reconstructed real prompt particles



$$F = A \exp \left\{ - \left(\frac{a}{p_T} \right)^b \right\}$$

p_T spectra correction



$$\frac{1}{2\pi p_T} \frac{d^2 N}{dp_T dy} = \frac{1}{2\pi p_T} \frac{1}{N_{evt}} \frac{\epsilon_{purity}}{\epsilon_{eff.} \times acc.} \frac{N}{\Delta p_T \Delta y}$$

Systematic uncertainty

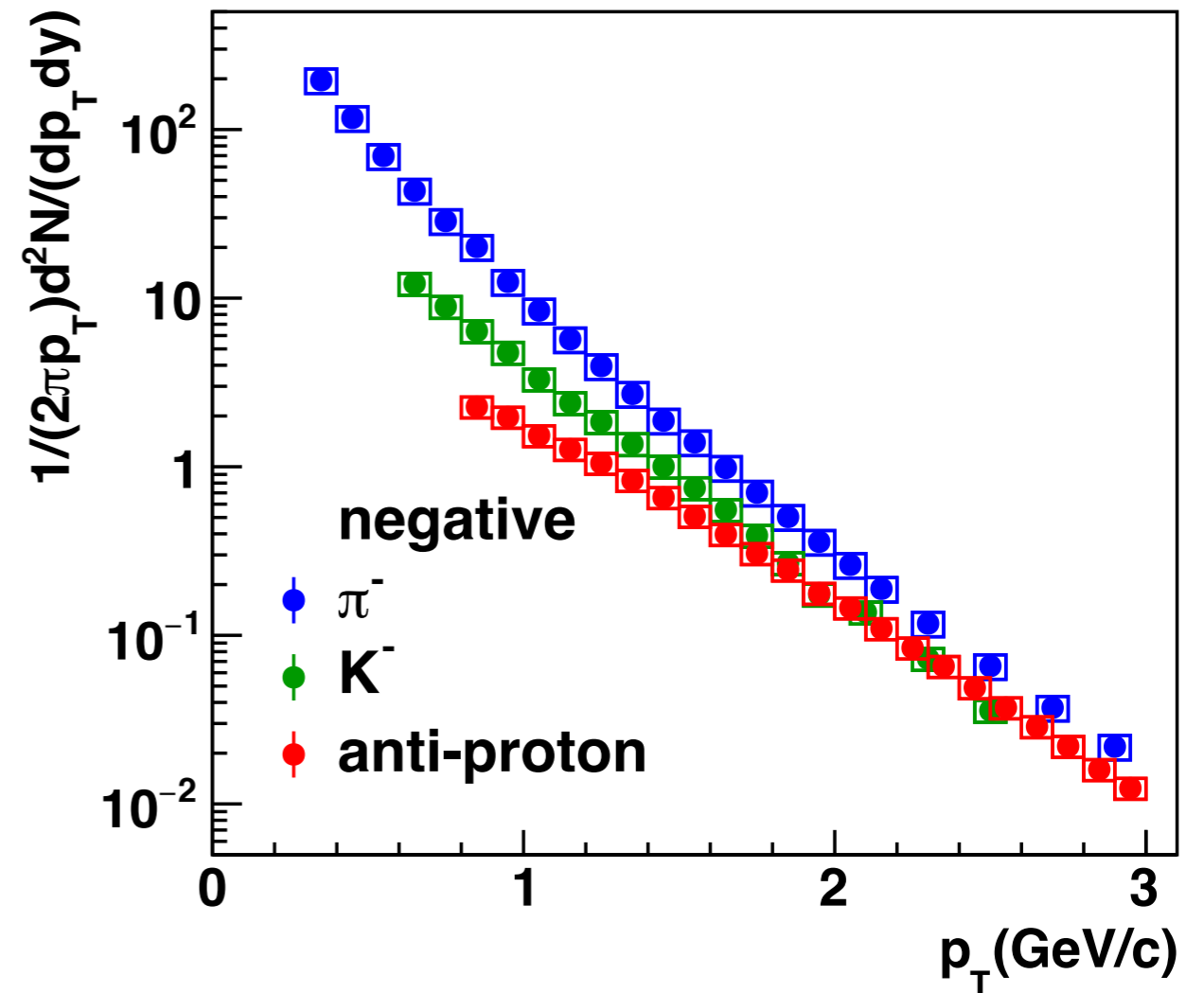
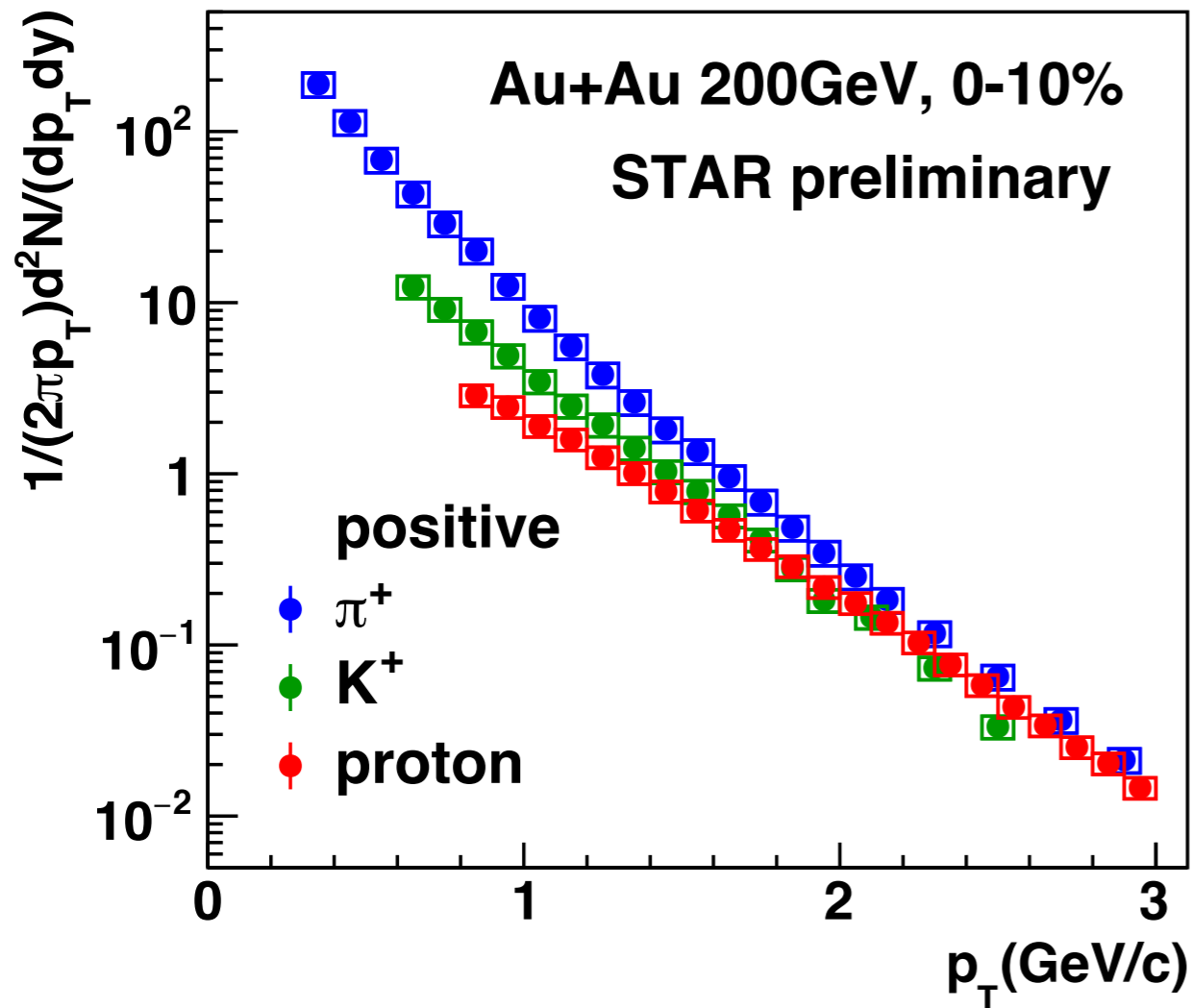
TPC efficiency : ~5%

HFT matching efficiency : <13%

The difference of HFT matching efficiency
between data and simulation

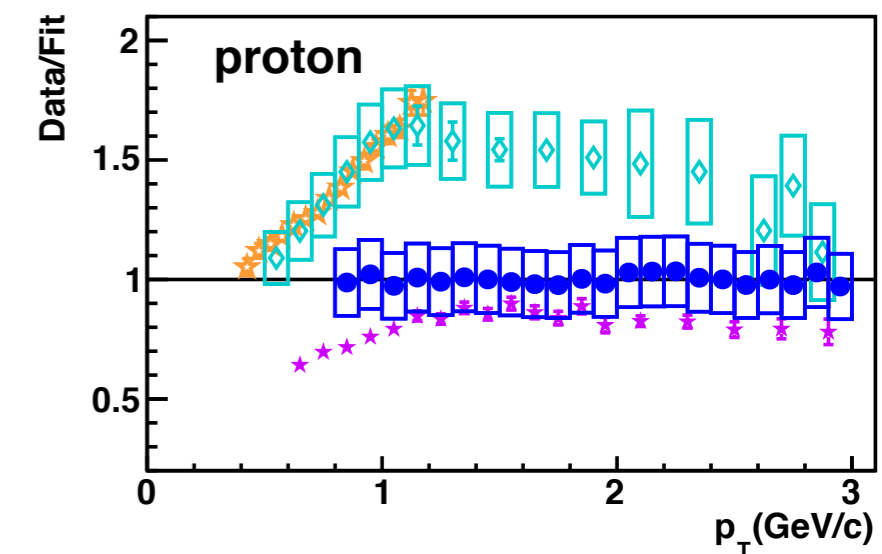
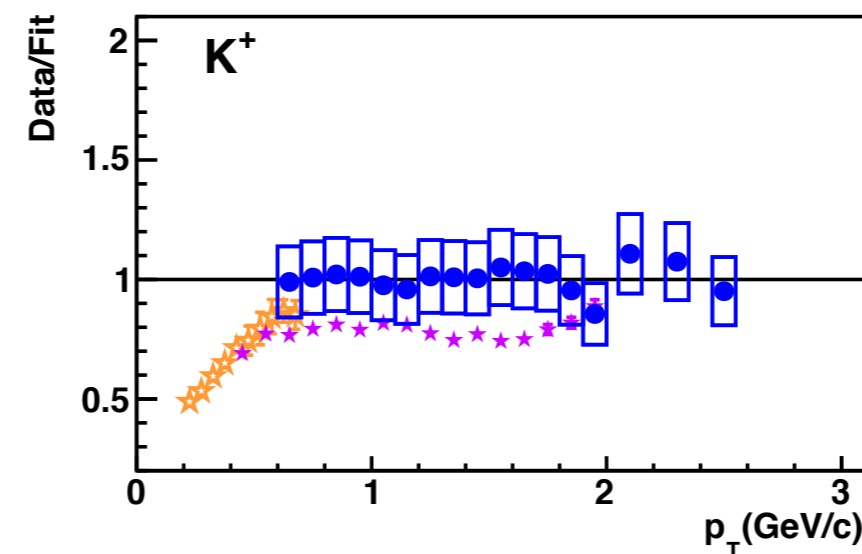
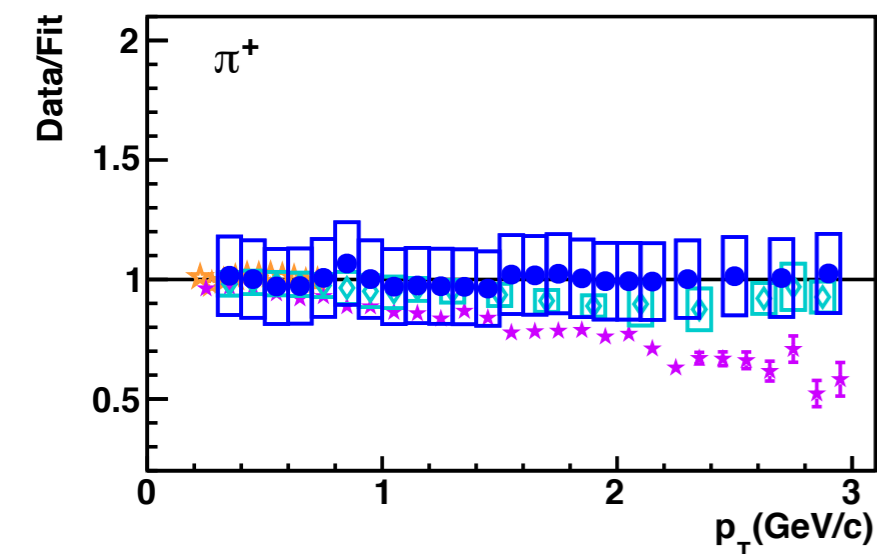
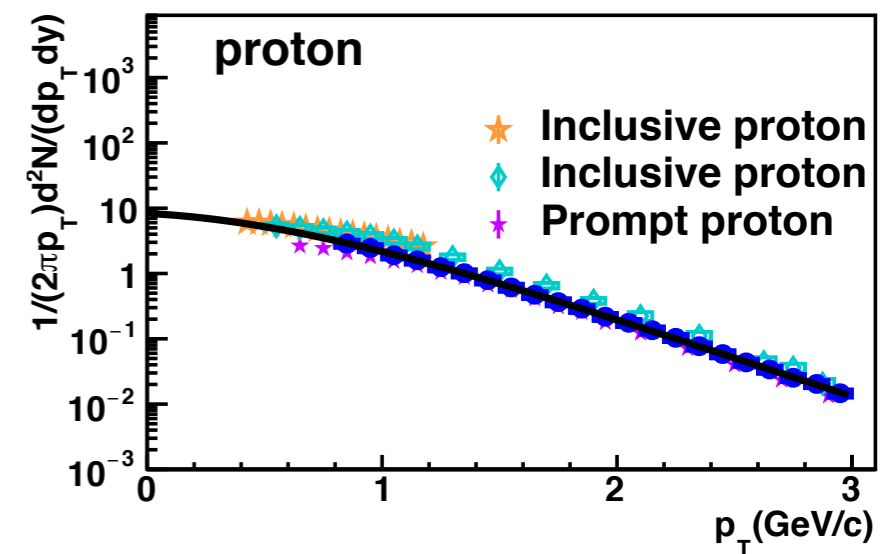
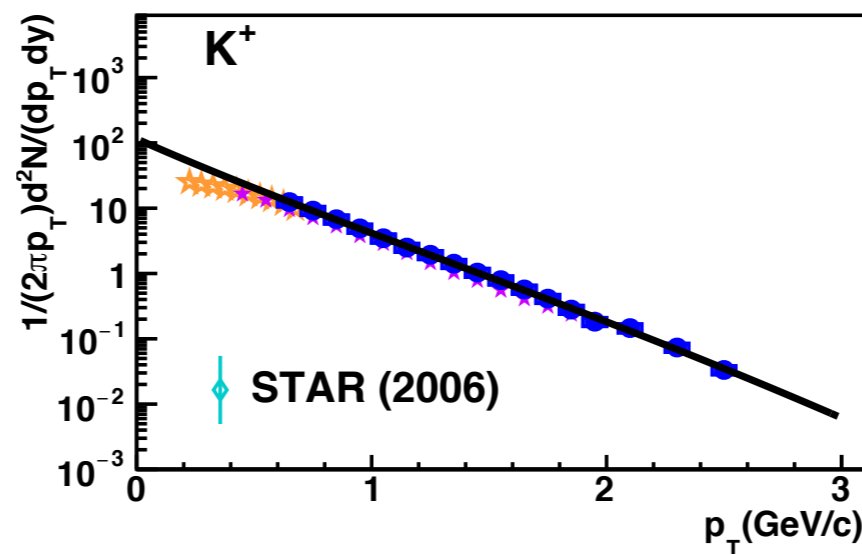
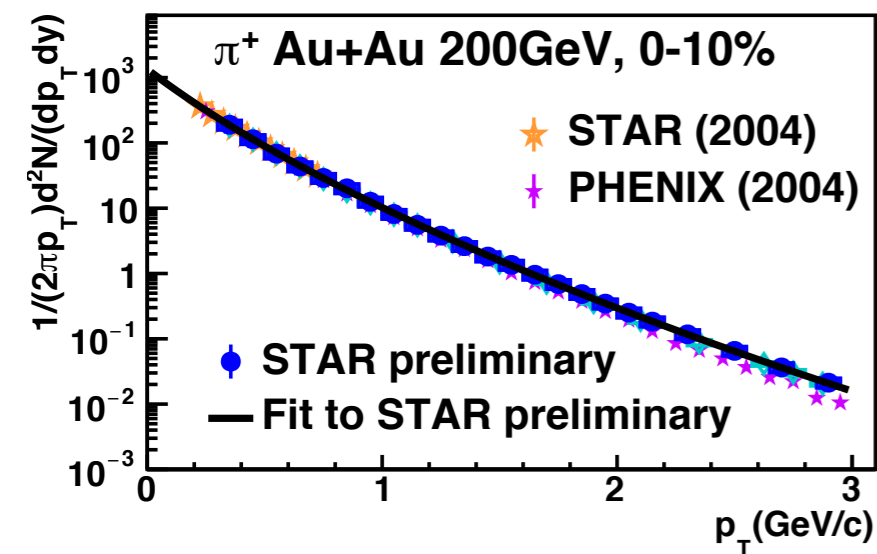
DCA selection : <10%

Particle species dependent



PID spectra with the HFT in Au-Au 200GeV
The shape depends on particle mass.

π , K , p p_T spectra



Modify Hagedorn equation

$$F = \frac{A}{\{\exp(-ap_T - bp_T^2) + p_T/p_0\}^n}$$

PRL 92, 112301 (2004)

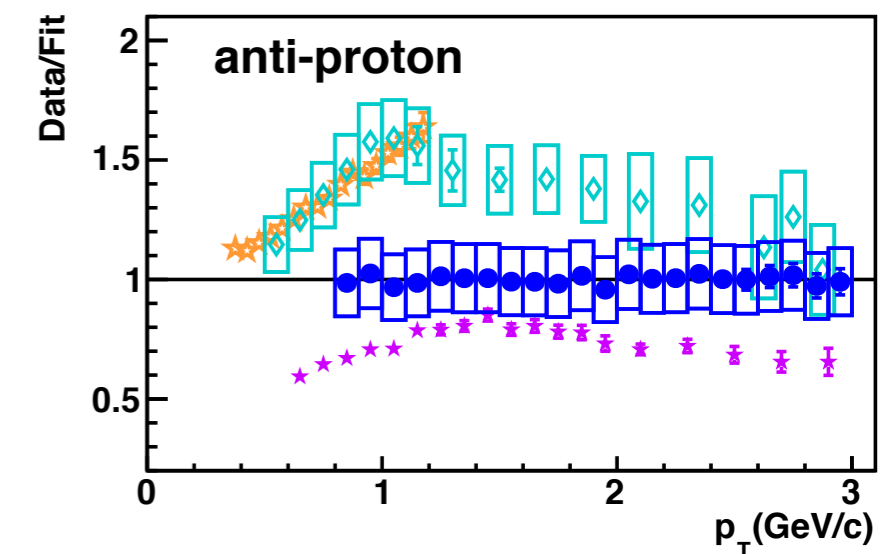
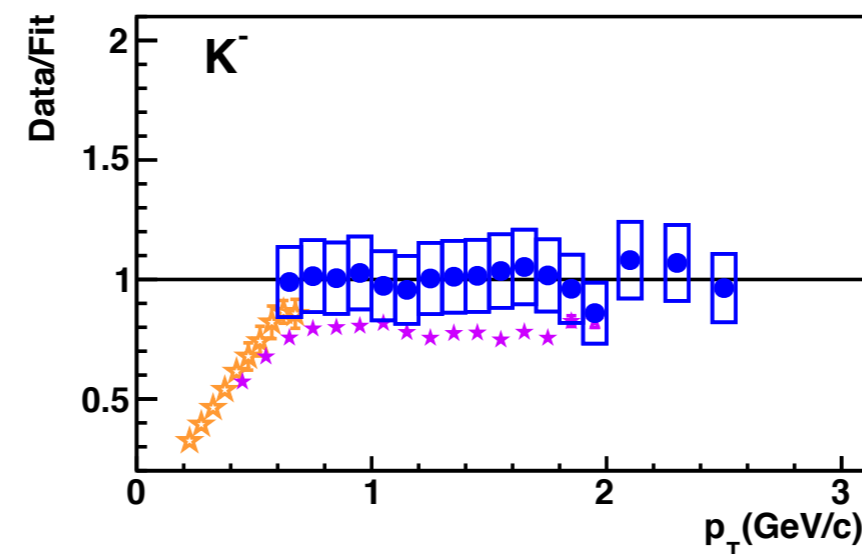
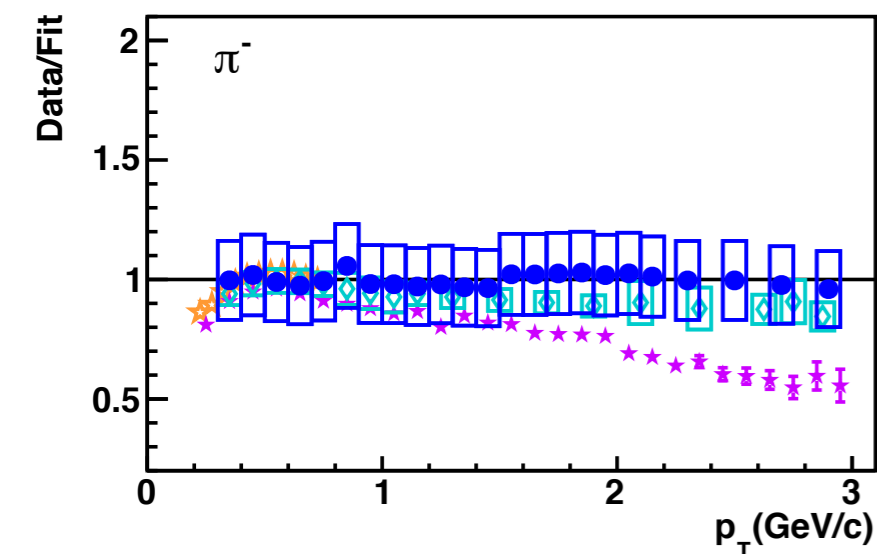
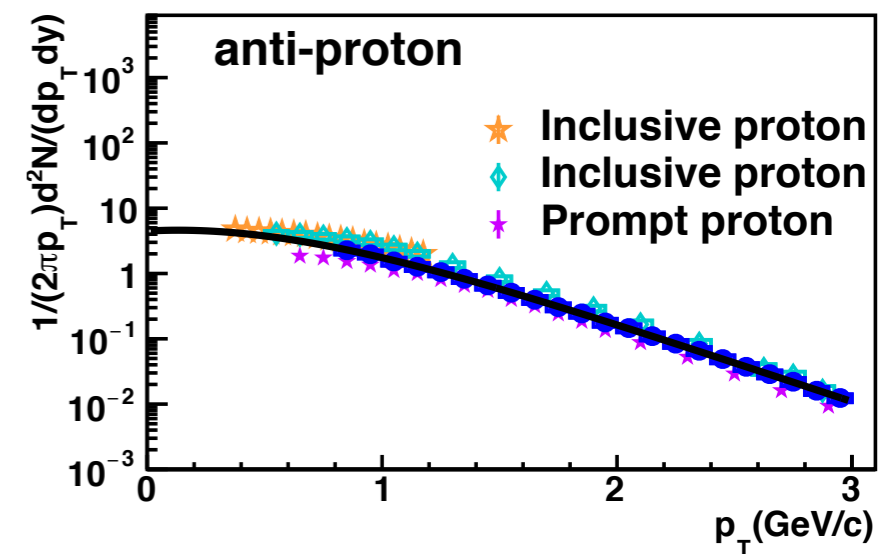
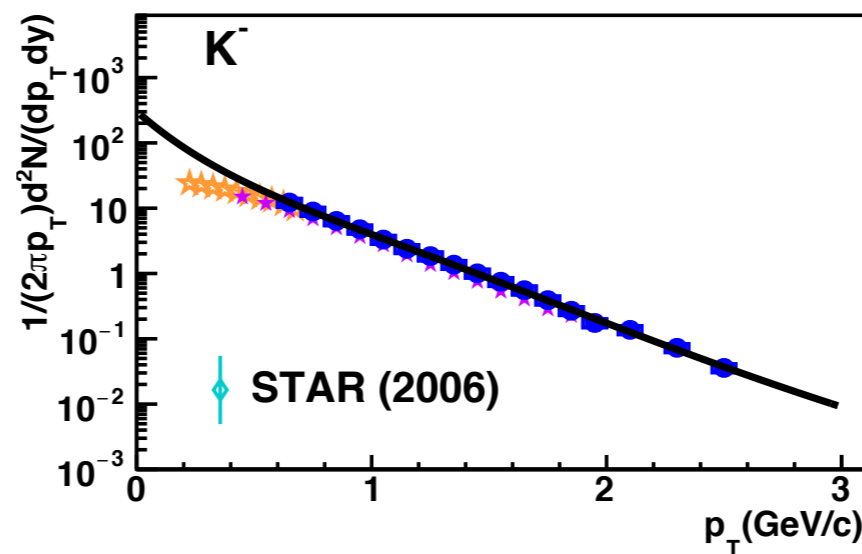
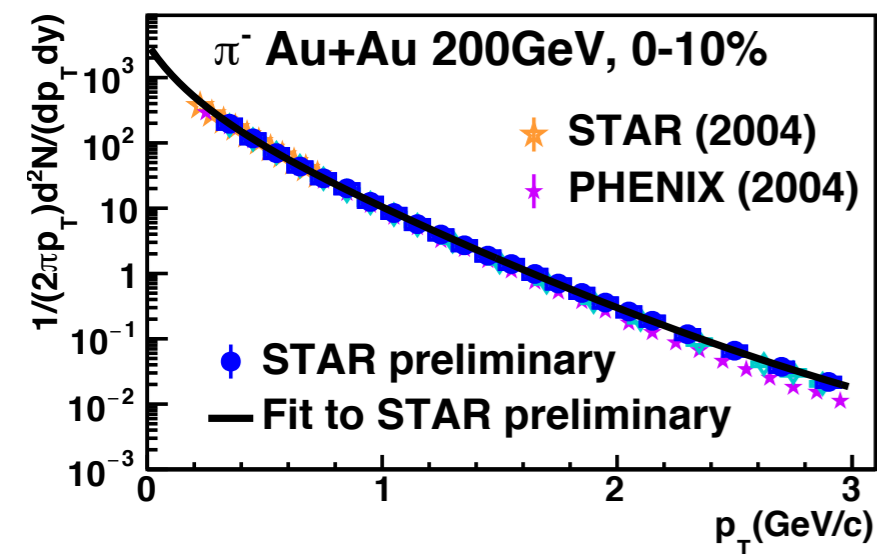
PRC 69, 034909 (2004)

PRL 97, 152301 (2006)

STAR results (orange, cyan) : inclusive proton

PHENIX results (magenta) : corrected for weak decay from Λ

π , K , p p_T spectra



Modify Hagedorn equation

$$F = \frac{A}{\{\exp(-ap_T - bp_T^2) + p_T/p_0\}^n}$$

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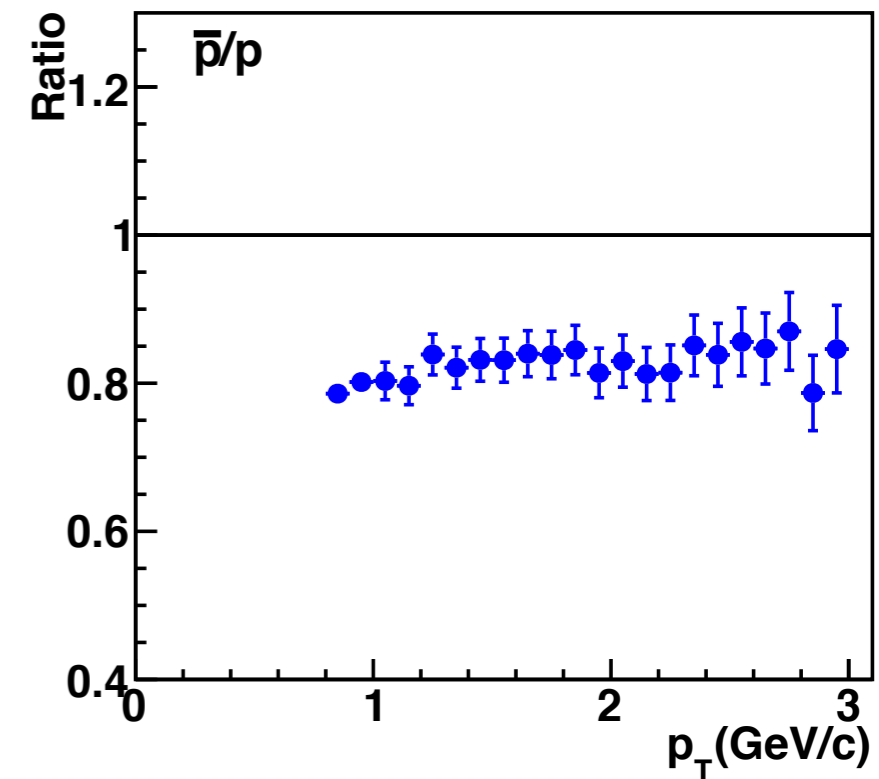
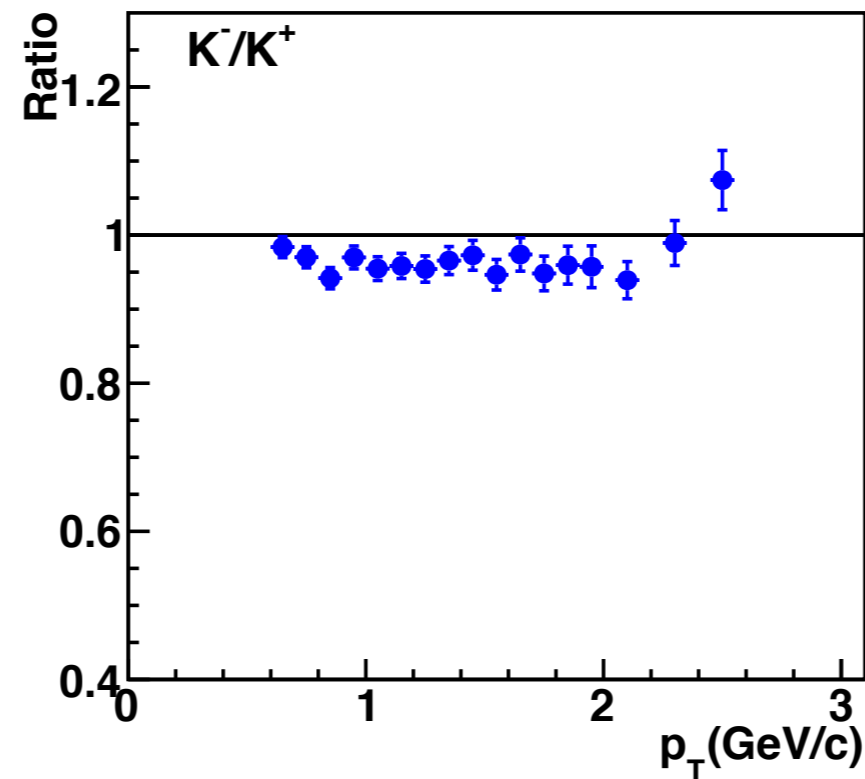
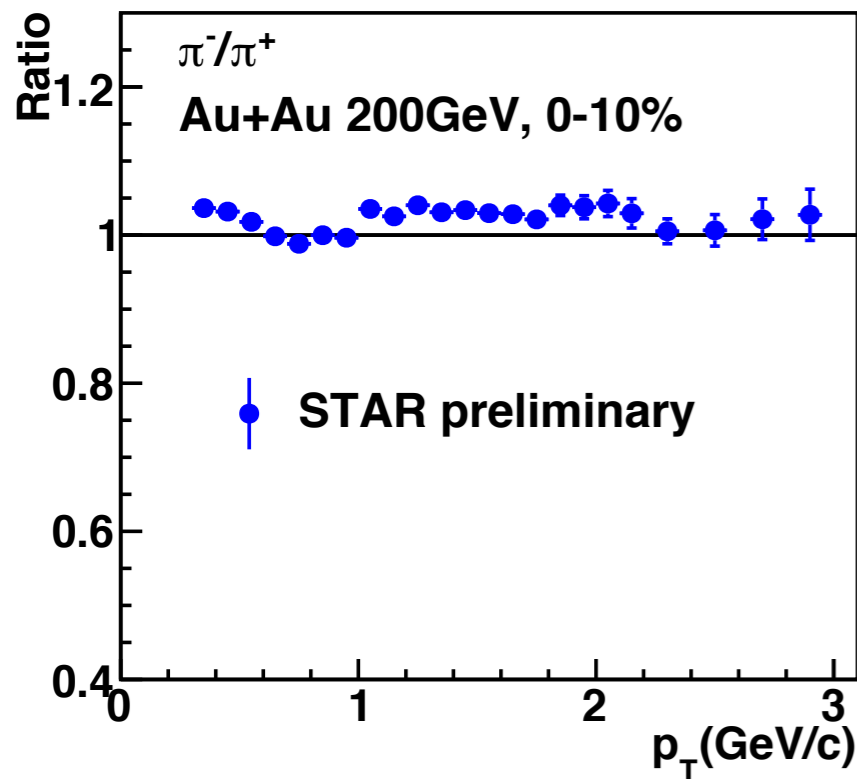
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STAR results (orange, cyan) : inclusive proton

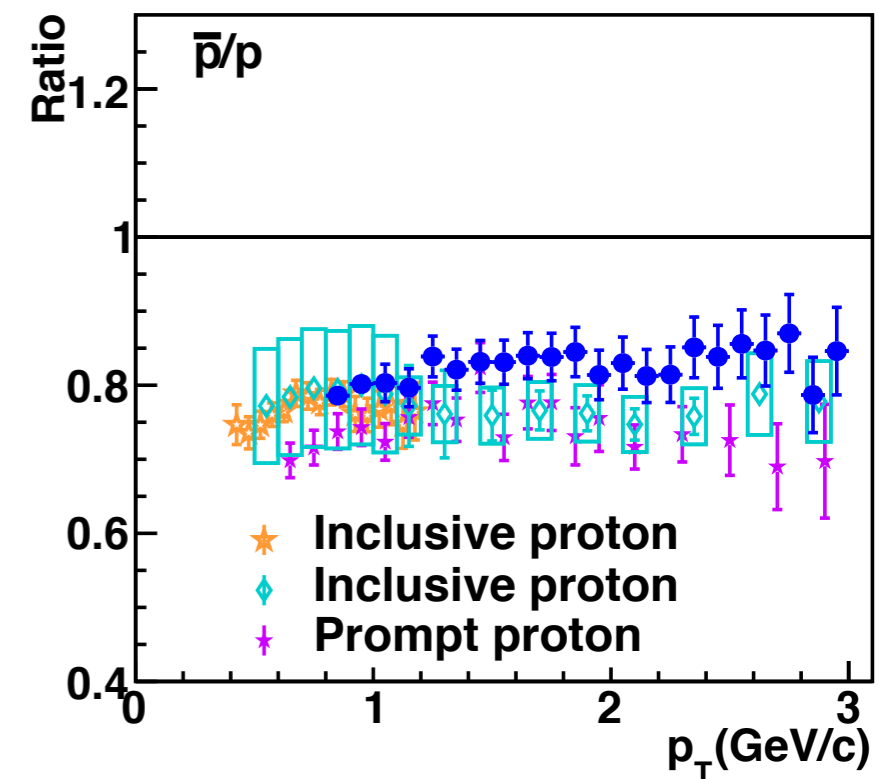
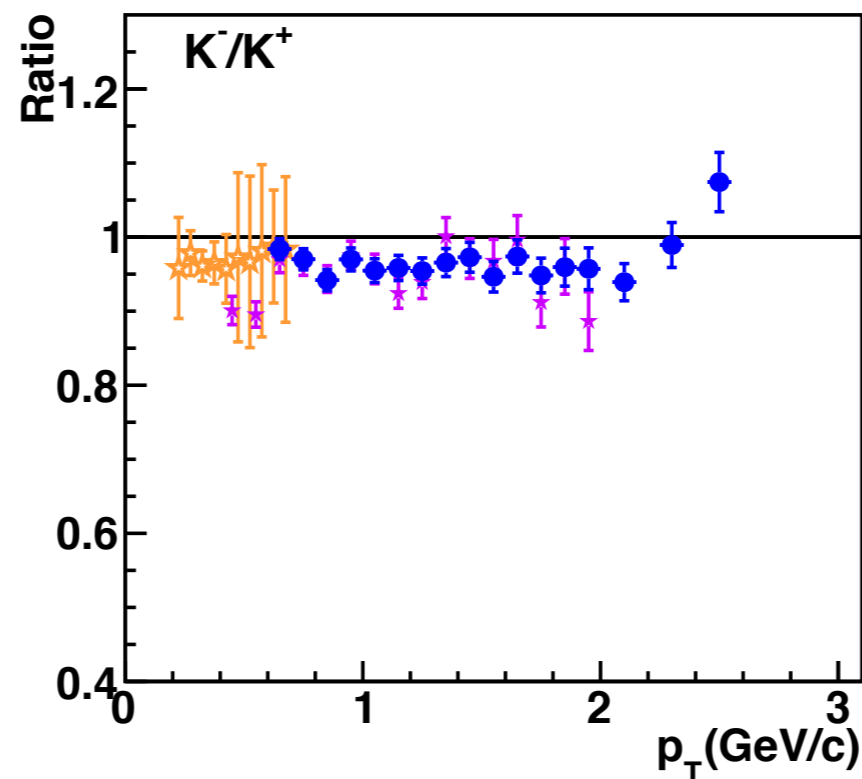
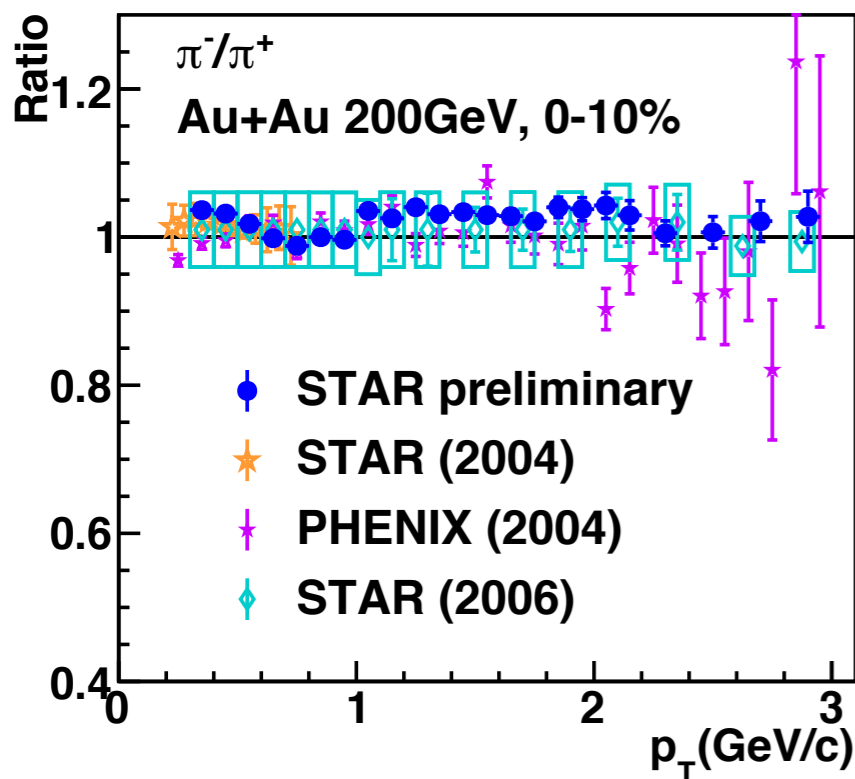
PHENIX results (magenta) : corrected for weak decay from Λ

Anti-particle to particle ratio



The ratios are about 1, 0.95, 0.8 for π , K, p at RHIC energy.

Anti-particle to particle ratio



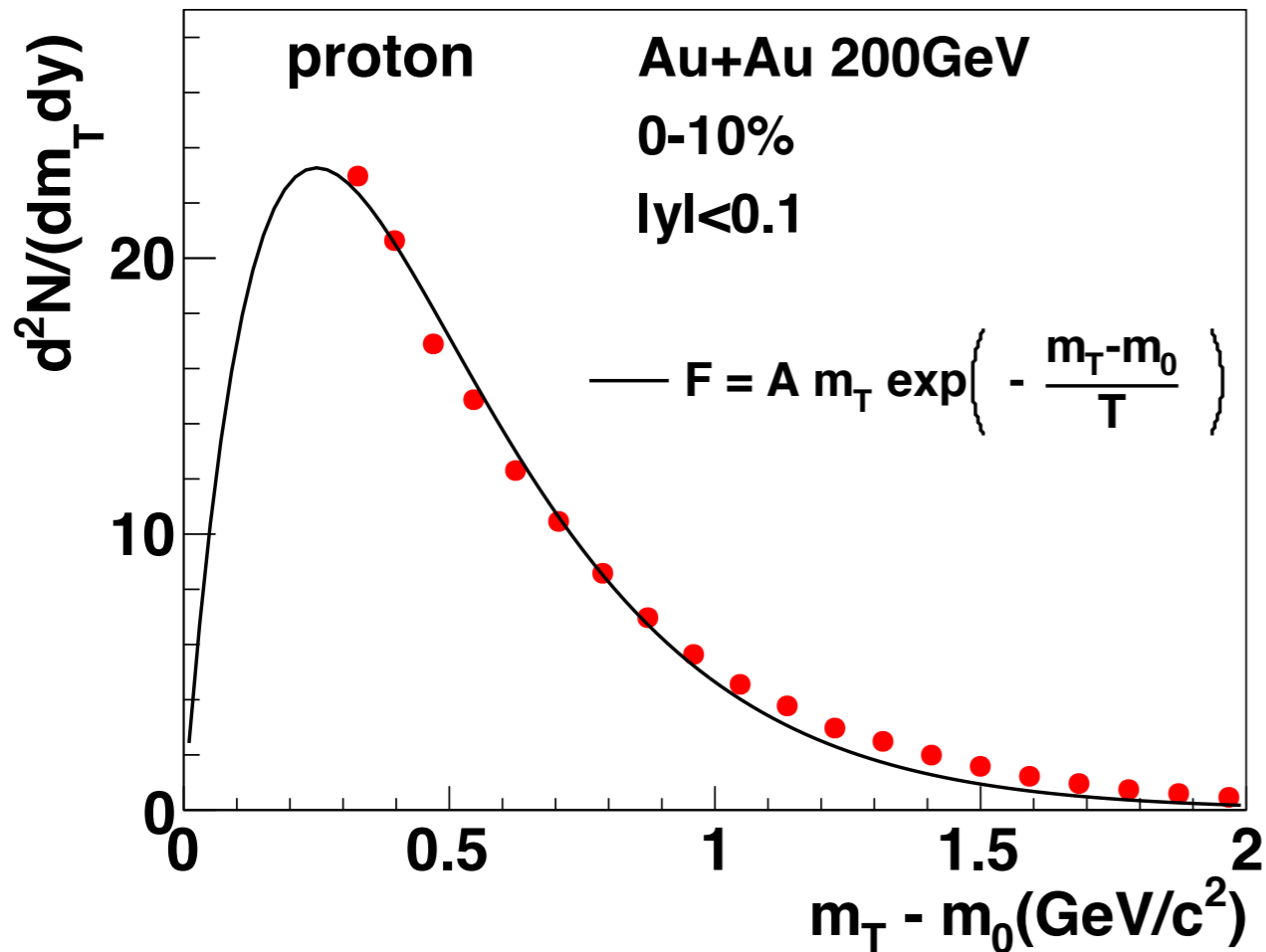
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PRL 97, 152301 (2006)

There is no significant difference between inclusive and prompt proton ratio.

Estimating dN/dy distribution



Out of range of measured spectra

Extrapolating with equations

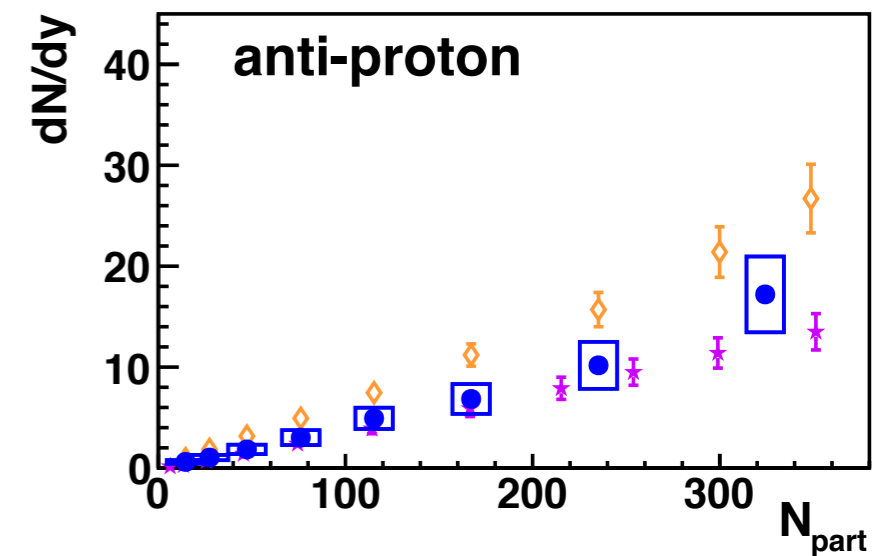
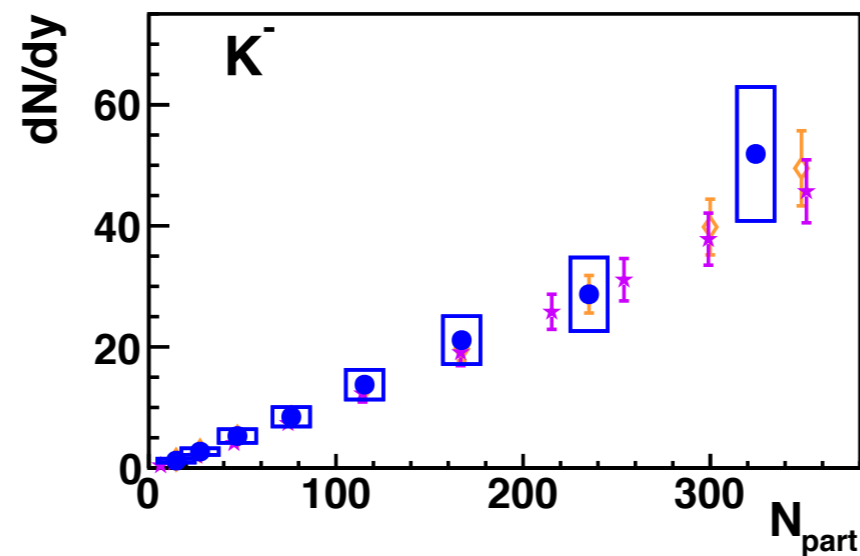
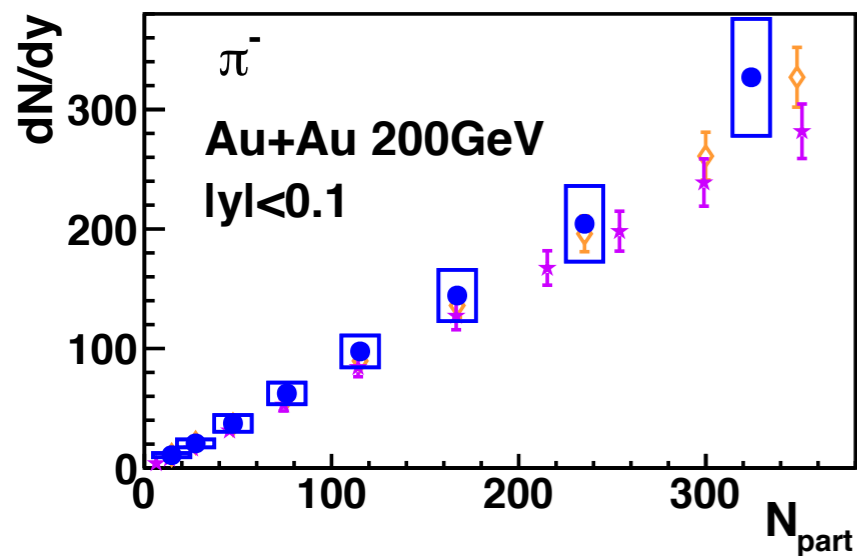
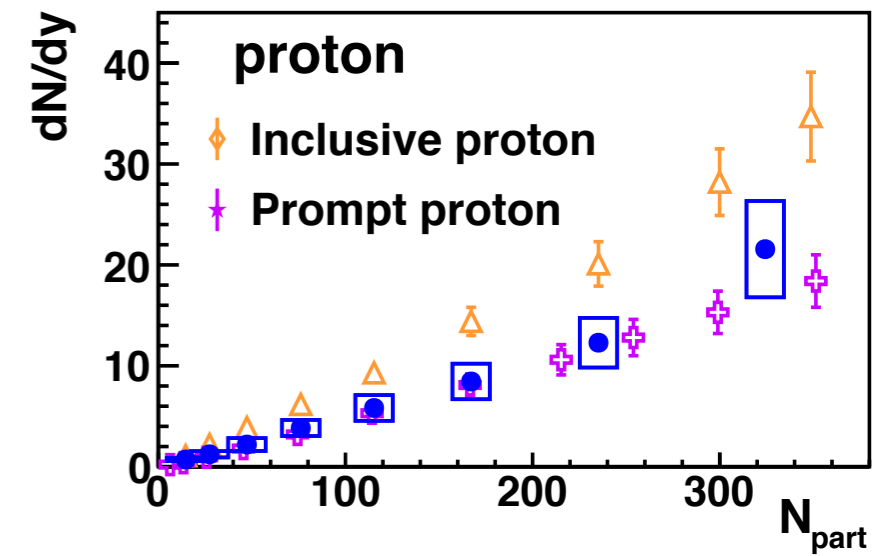
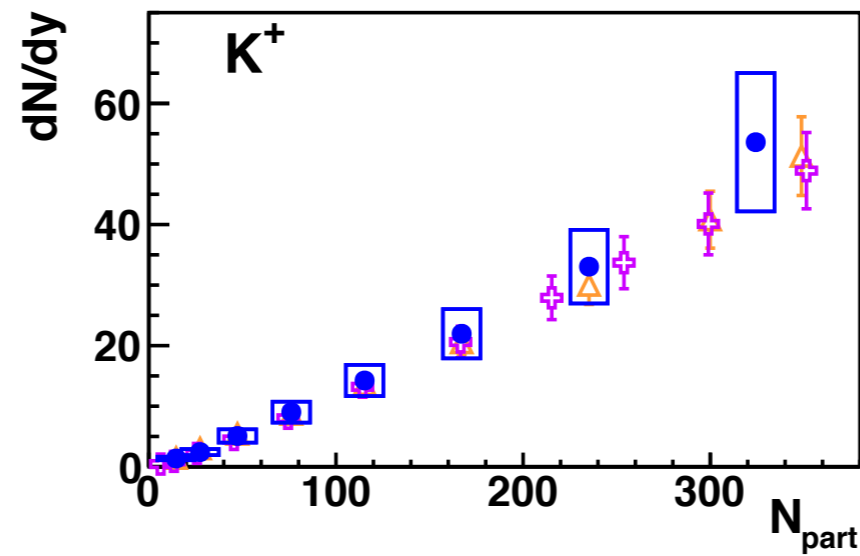
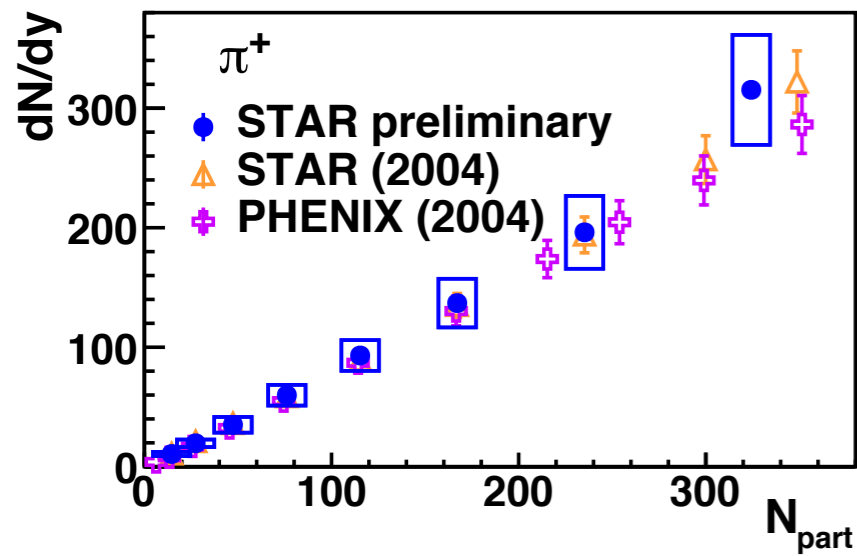
The difference of equations are defined as systematic uncertainty.

	measured dN/dy	extrapolated dN/dy low p _T	extrapolated dN/dy high p _T
π^+	168.7 (53.5%)	146.7 (46.4%)	0.14 (0.1%)
K^+	26.8 (50%)	26.7 (49%)	0.1 (1%)
proton	11.1 (51%)	10.4(48%)	0.11 (1%)

For pion, Bose-Einstein equation, m_T exponential (for estimating systematics)

For kaon and proton, p_T exponential, m_T exponential

dN/dy distribution



STAR results (orange, cyan) : inclusive proton

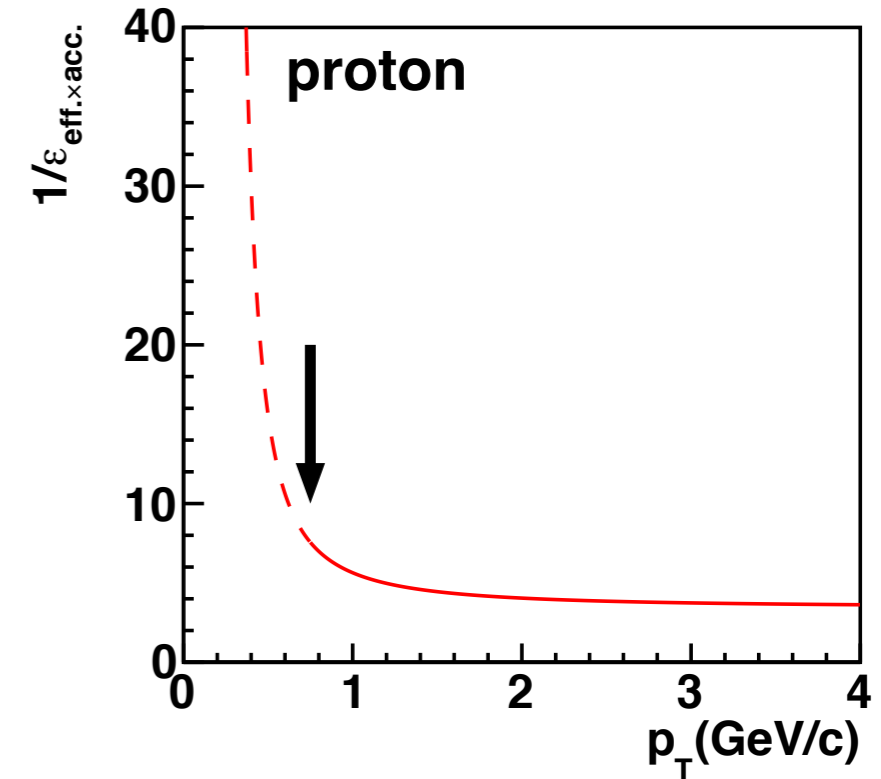
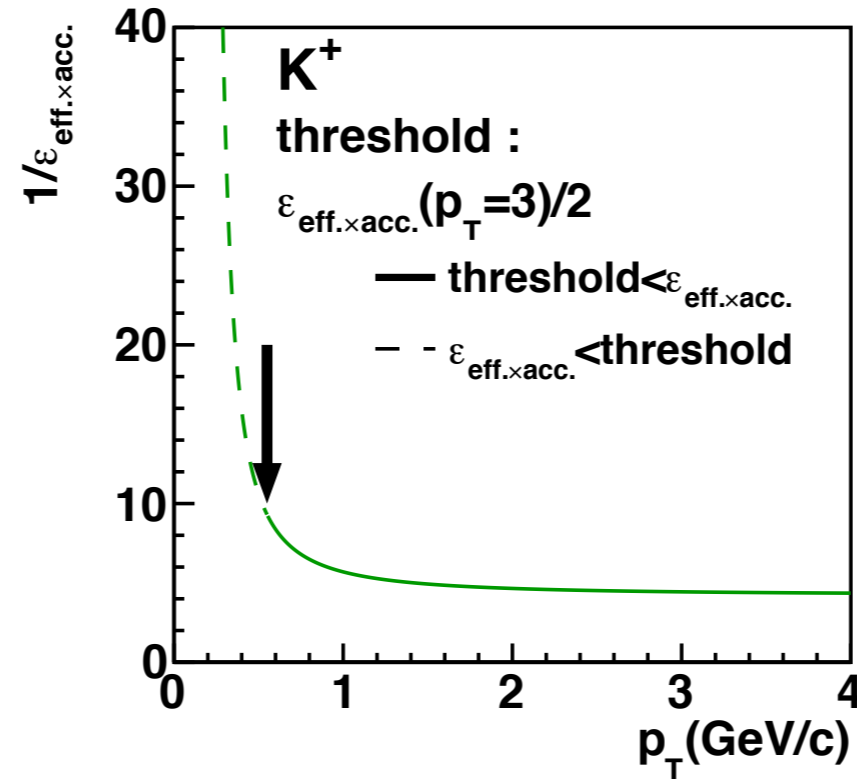
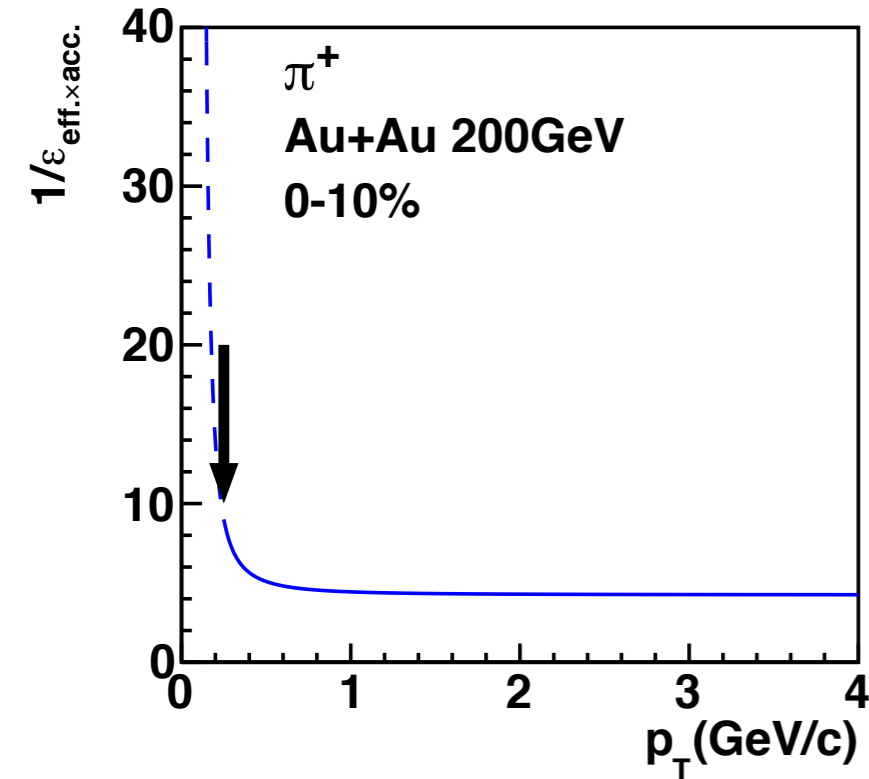
PHENIX results (magenta) : corrected for weak decay from Λ

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- The first result of prompt π , K, p p_T spectra with the HFT in Au+Au 200GeV collisions at STAR experiment
- The anti-particle to particle ratio
 - There is no significant difference between inclusive and prompt proton results.
- Prompt particle azimuthal anisotropy
 - Important for kinetic freeze-out parameters

Efficiency correction



$$\varepsilon_{\text{eff.} \times \text{acc.}} = \frac{N_{\text{RC-prompt particle}}}{N_{\text{MC-prompt particle}}}$$

Correction of detector efficiency and acceptance
Correction factor get large in low p_T region