Charged Hadron Spectra

Preliminary results from first STAR Au+Au collisions at RHIC

- STAR Geometry and Detectors
- Event selection and triggers
- Analysis and Corrections to raw data
- Negative Hadron, π^- , K^- and $\bar{p}$ Spectra
- Conclusions

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STAR Collaboration - Spectra Working Group

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Quark Matter January 2001

Charged Hadrons

- Global observable: event characterization
  - ★Represent system at kinetic freeze-out
  - ★Constrains conditions on initial phase of the collision
  - ★Supply information on evolution of system
- Study features of collisions at RHIC energy
  - ★Comparison with $\bar{p}p$ at similar energy (UA1)
  - ★Comparison with A+A at lower energies (SPS)

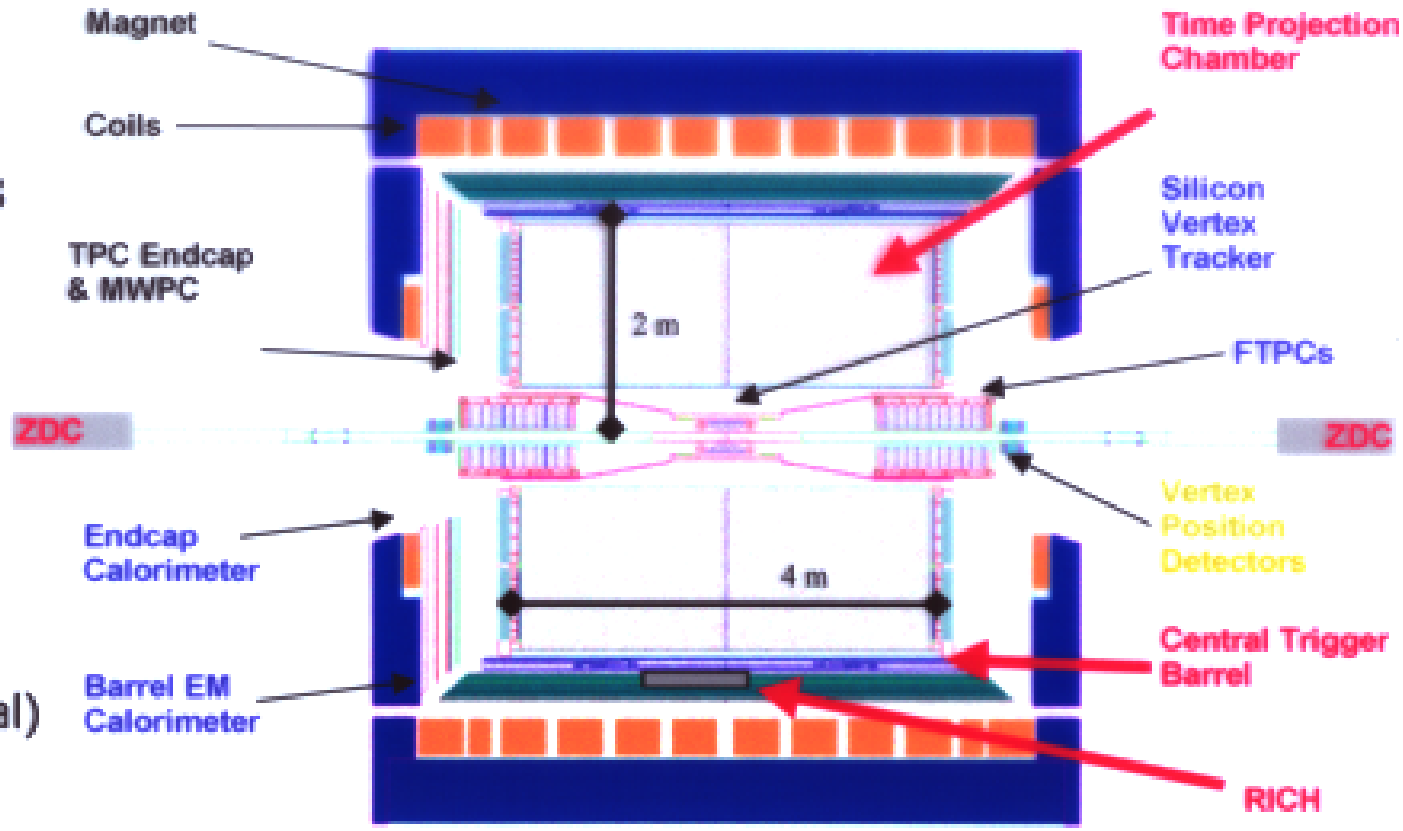
STAR Geometry

This analysis:
Tracking: TPC
Trigger ZDC + CTB
PID: dE/dx in TPC

TPC:
$|\eta| < 1.8$
$0 < \phi < 2\pi$
$p_{\perp} > 75$ MeV/c

B_{field}
0.25 T (1/2 nominal)

Trigger:
ZDC at ± 18 m
CTB $|\eta| < 1$



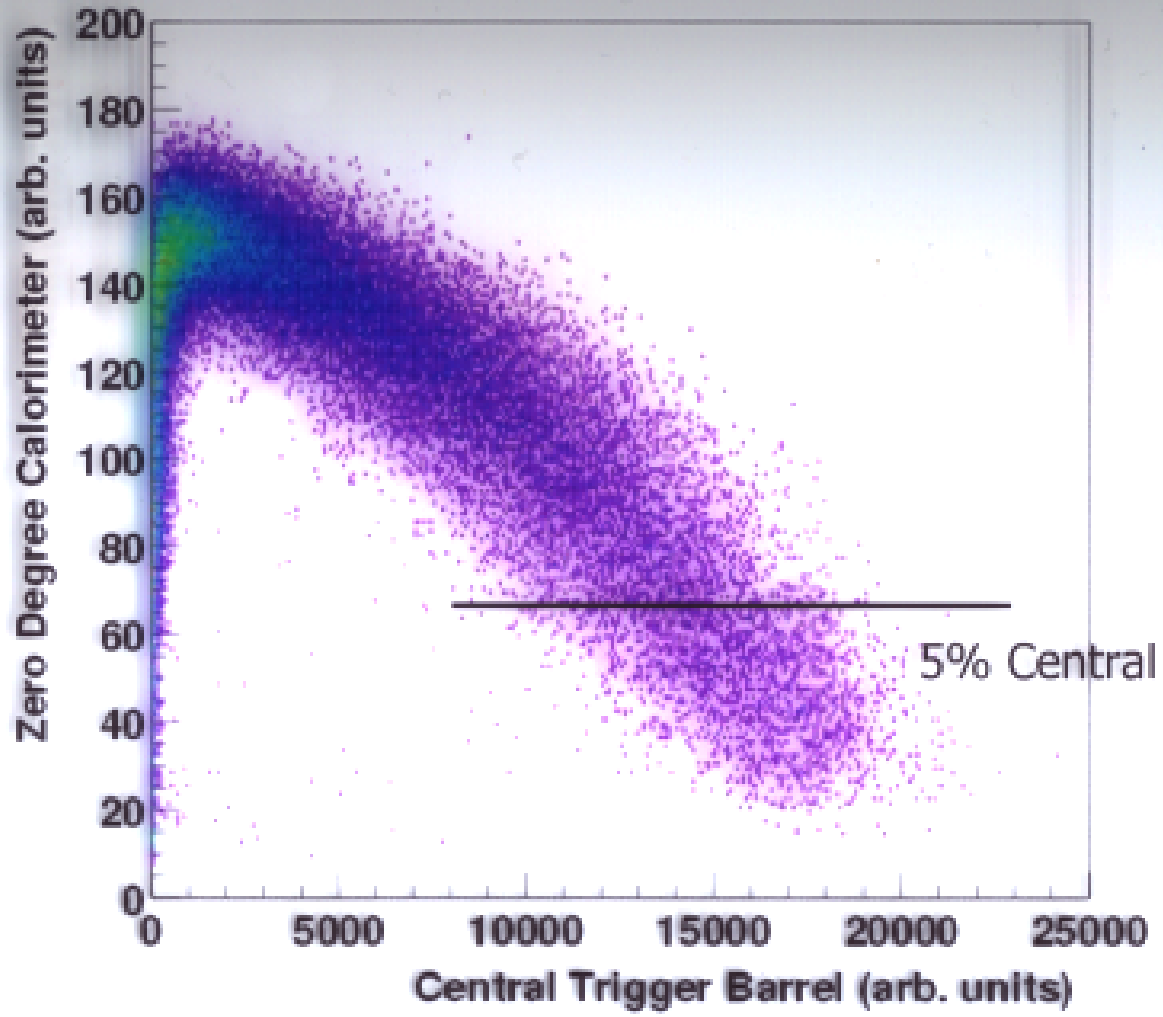
This analysis: 86 K min. bias events

Event Selections and Triggers

ZDC
Main Minimum Bias Trigger

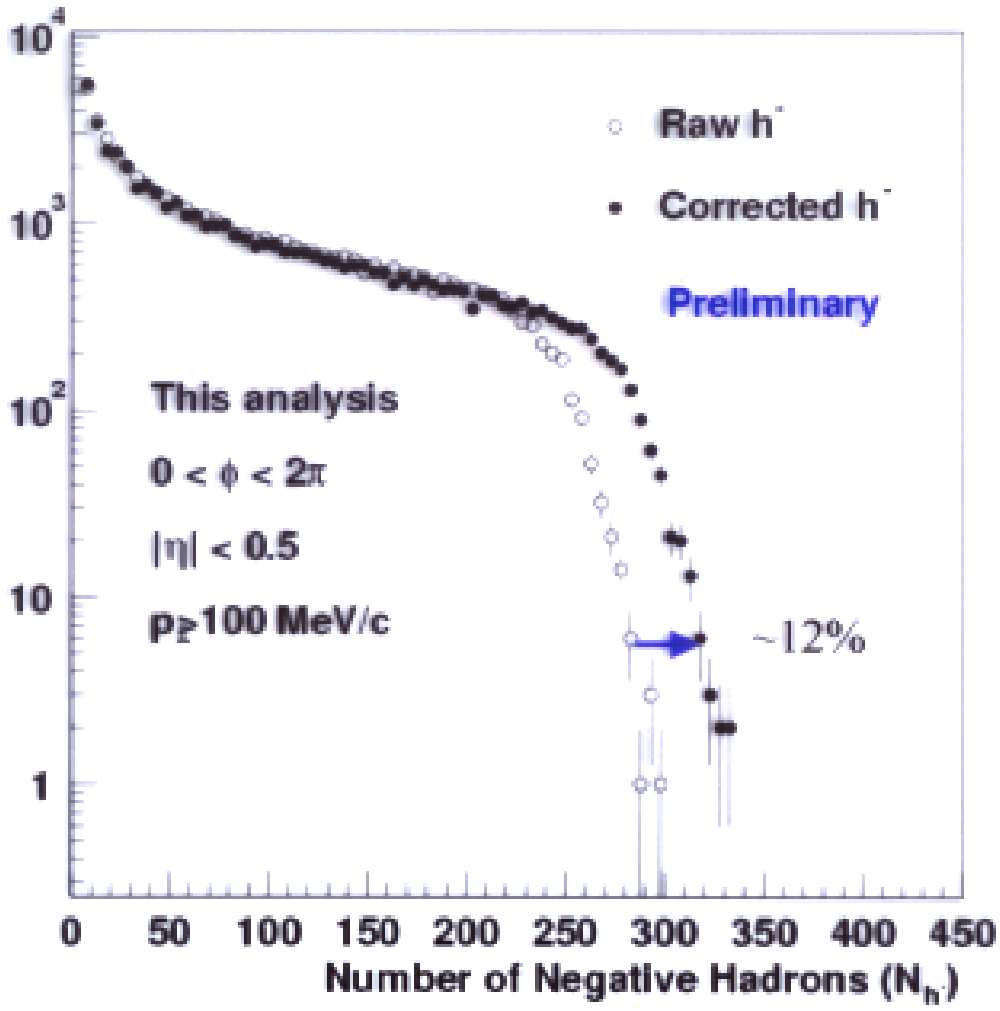
99% Efficient even at high multiplicity

Trigger
ZDC Coincidence (East and West)
OR
High CTB Signal

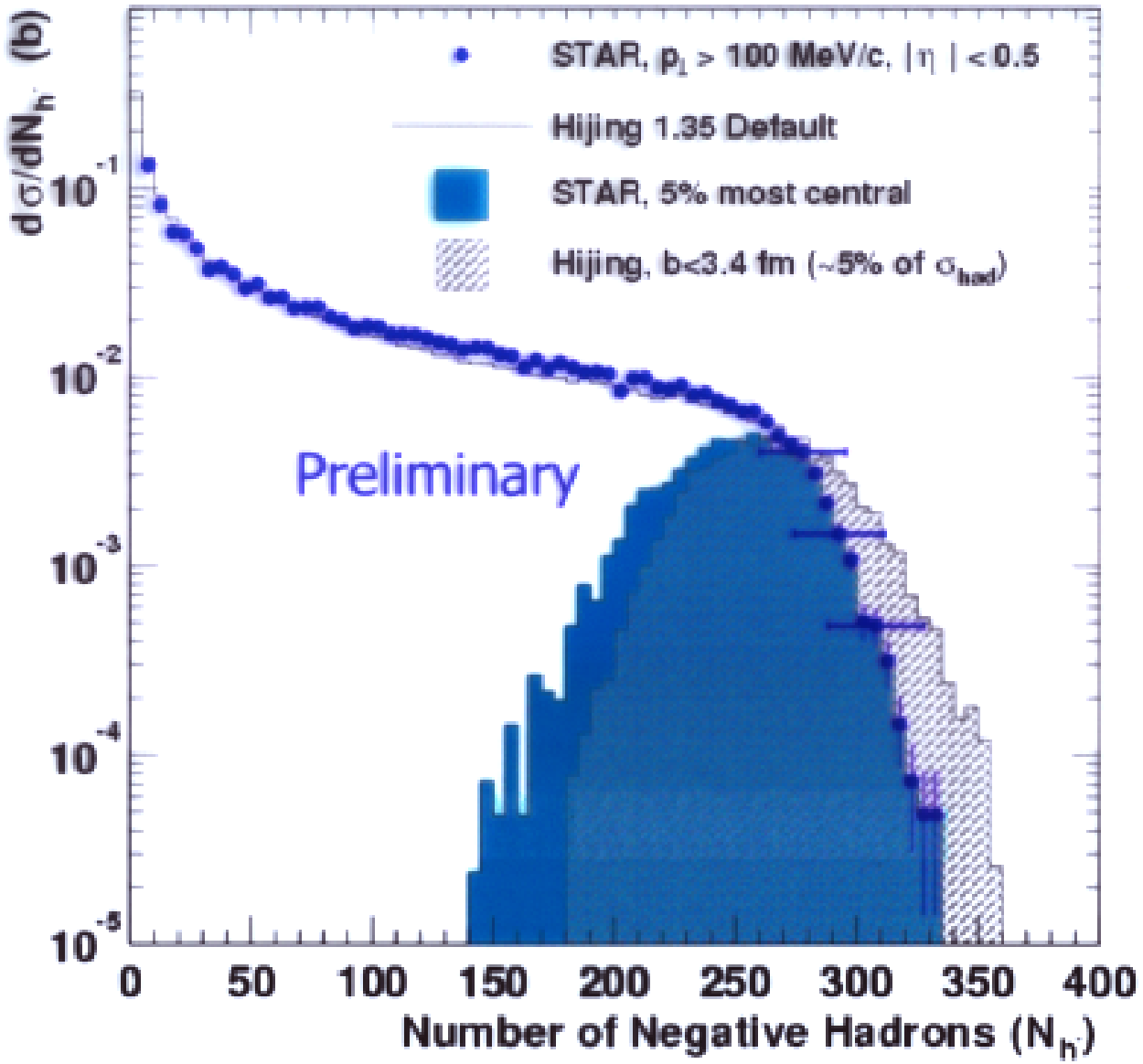


Analysis and Corrections For h^- Distributions

- TPC Tracks
  - Corrections: embedding simulated tracks in real events
- Large acceptance
  - ~95% at mid-rapidity over full azimuth
- Correction factors
  - From Tracking efficiency 8-15%
  - Secondary/Decay Background 7%
  - Other contributions
    - (merging, splitting, etc) less than 2%

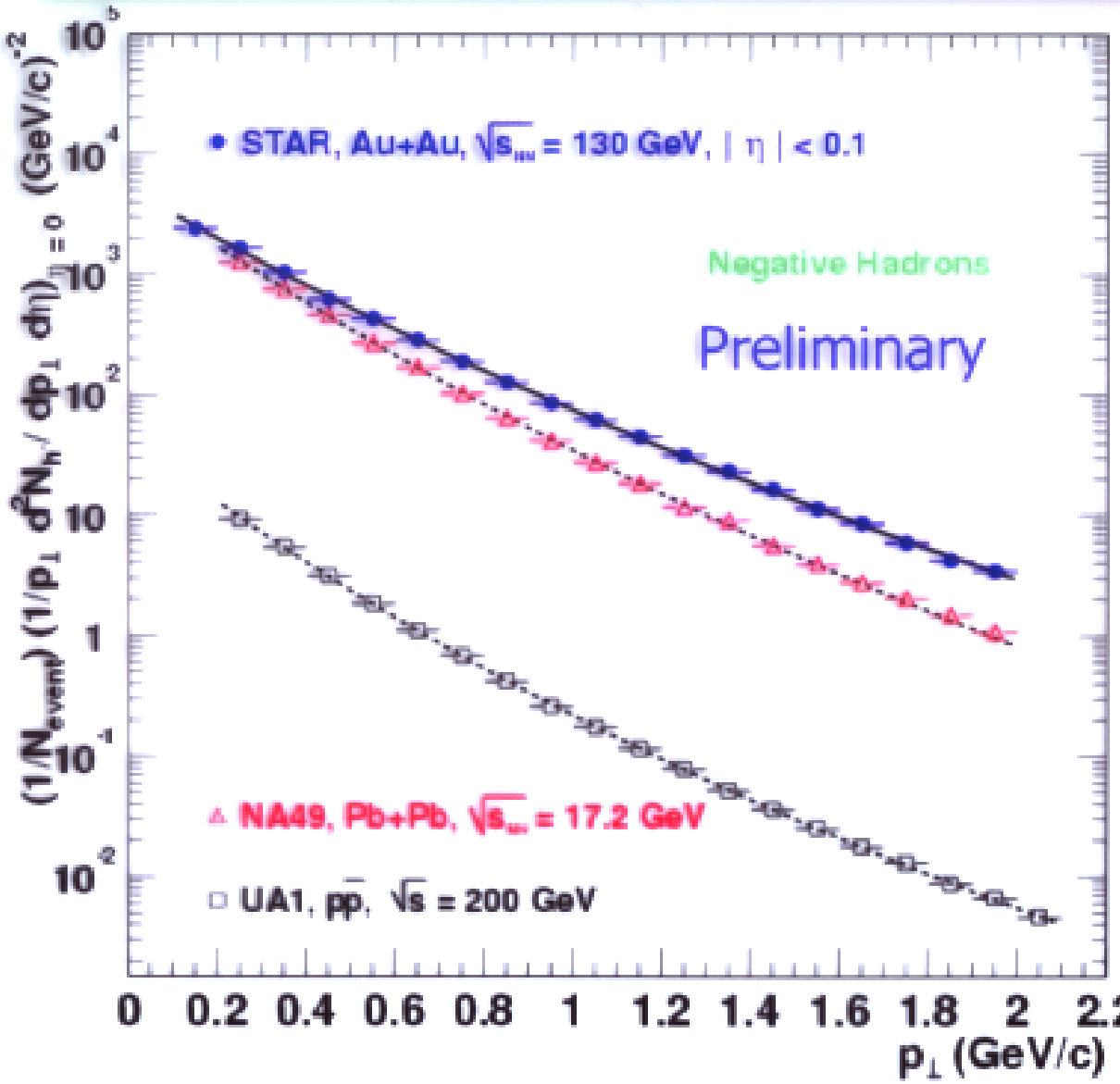


Primary h^- Multiplicity



6% sys. error shown on 3 points only

h^- $p_\perp$ Distribution



Power Law

$A\,(1+p_\perp/p_0)^{-n}$

p_0 = 2.74 ± 0.11 GeV/c

n= 13.65 ± 0.42

STAR

$\langle p_\perp \rangle$ = 0.514 ± 0.012 GeV/c

NA49

$\langle p_\perp \rangle$ = 0.414 ± 0.004 GeV/c

UA1

$\langle p_\perp \rangle$ = 0.392 ±0.003 GeV/c

Comparison to $\bar{p}p$

Compare to UA1

Problem UA1 $\sqrt{s}$ = 200

$\Rightarrow$R(130/200)

From power law scaling

R = 0.92 at 0.2 GeV/c

R = 0.70 at 2 GeV/c

"Hard" Scaling

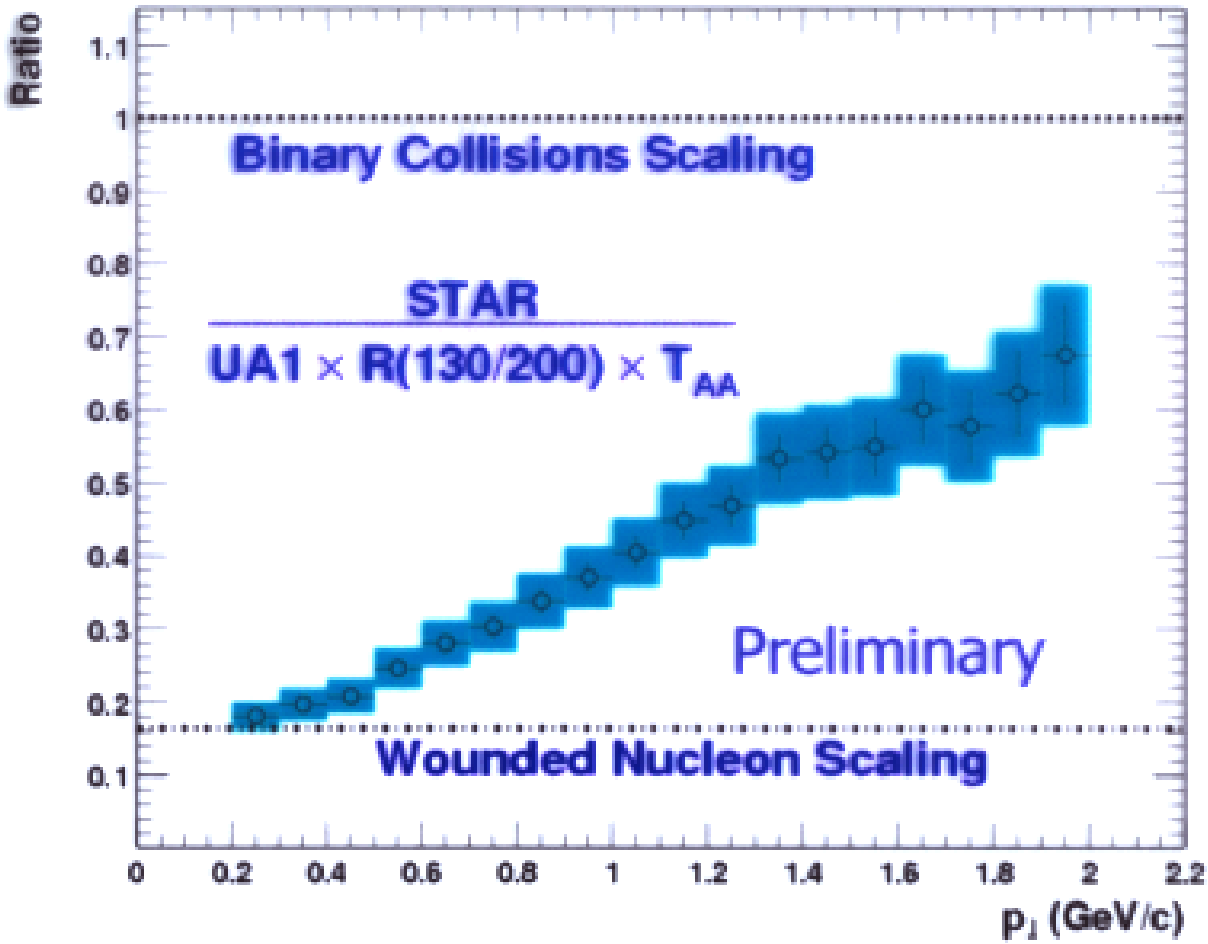
Nuclear Overlap Integral

T_{AA} = 26 mb^{-1}
for 5% most central

$N_{AA}/N_{pp} = N_{bin\ coll} = 1050$

"Soft" Scaling

$N_{AA} / N_{pp} = (344/ 2)$



Low pt $\Rightarrow$ Wounded Nucleon applies

Rising pt $\Rightarrow$ Approaching hard scaling limit?

Reach it?

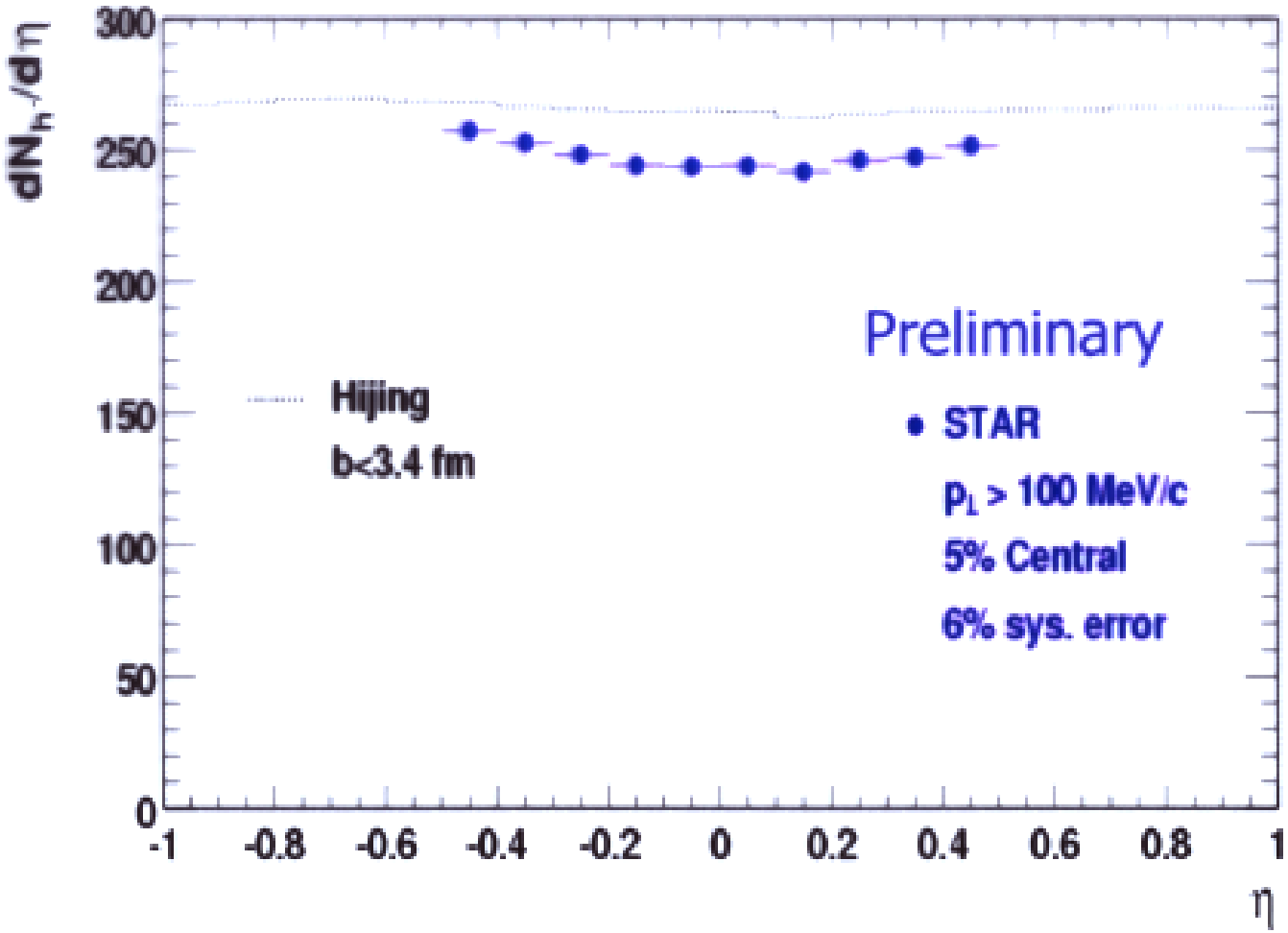
h^- η Distribution

$dN/d\eta = 244 \pm 1 \pm 16$ ($p_\perp > 100$ MeV/c)

$dN/d\eta = 264 \pm 1 \pm 18$ (Extrapolation to all $p_\perp$)

Assuming 344 participants in 5% most central collisions:

$(dN/d\eta)/(N_{part}/2) = 1.53 \pm 0.13$



Increased particle production:

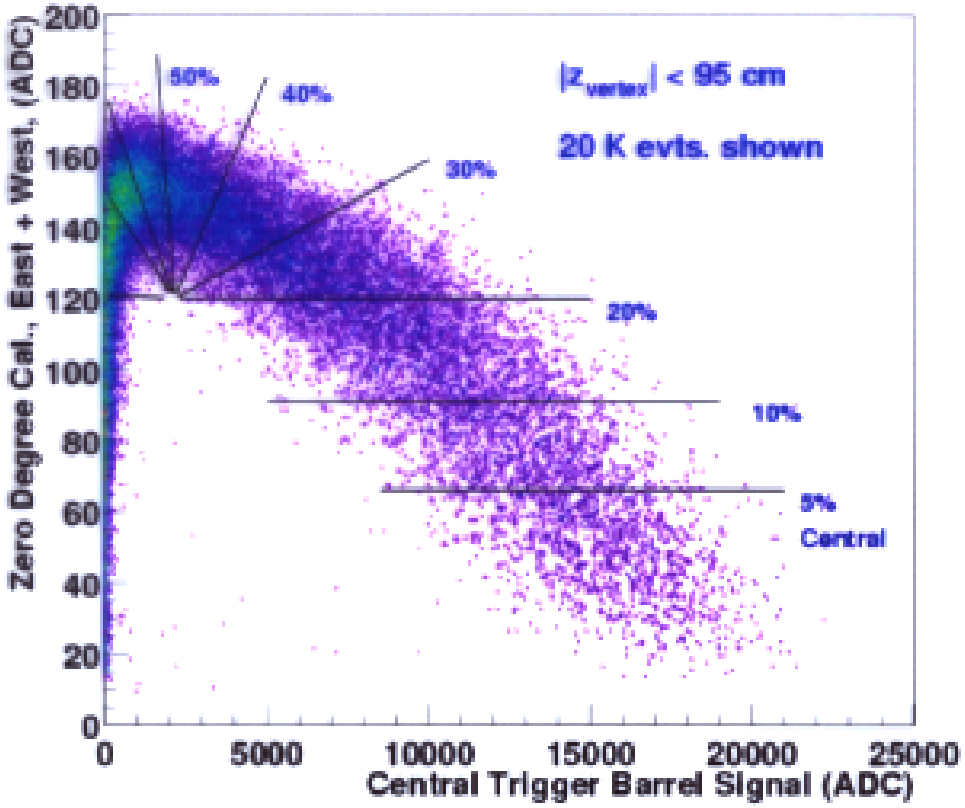
43% compared to Pb+Pb @ 17.2 GeV

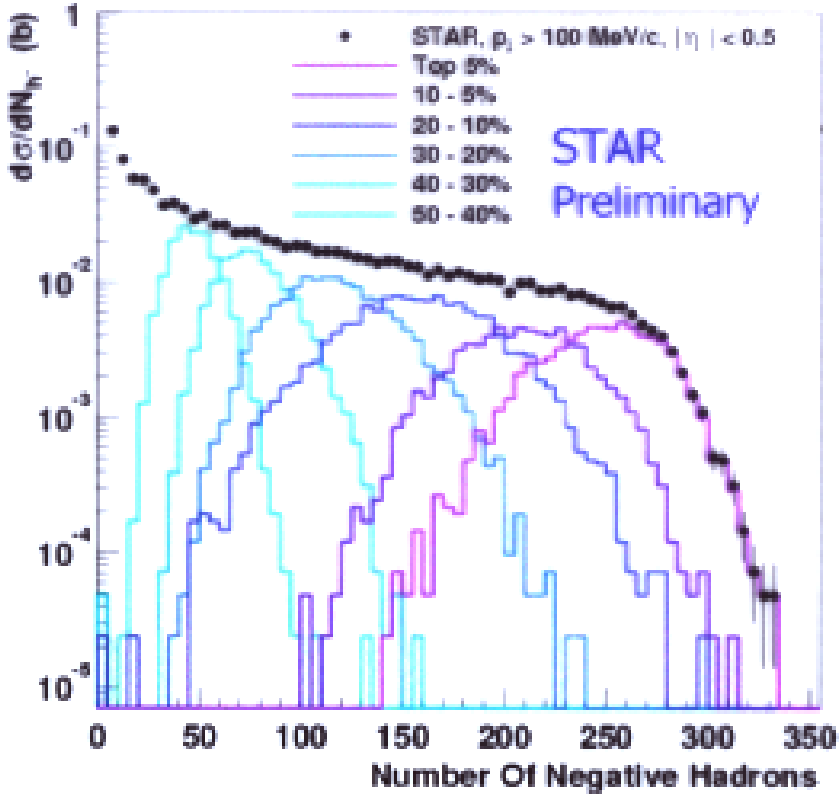
30% compared to pp @ 200 GeV

Centrality Classes

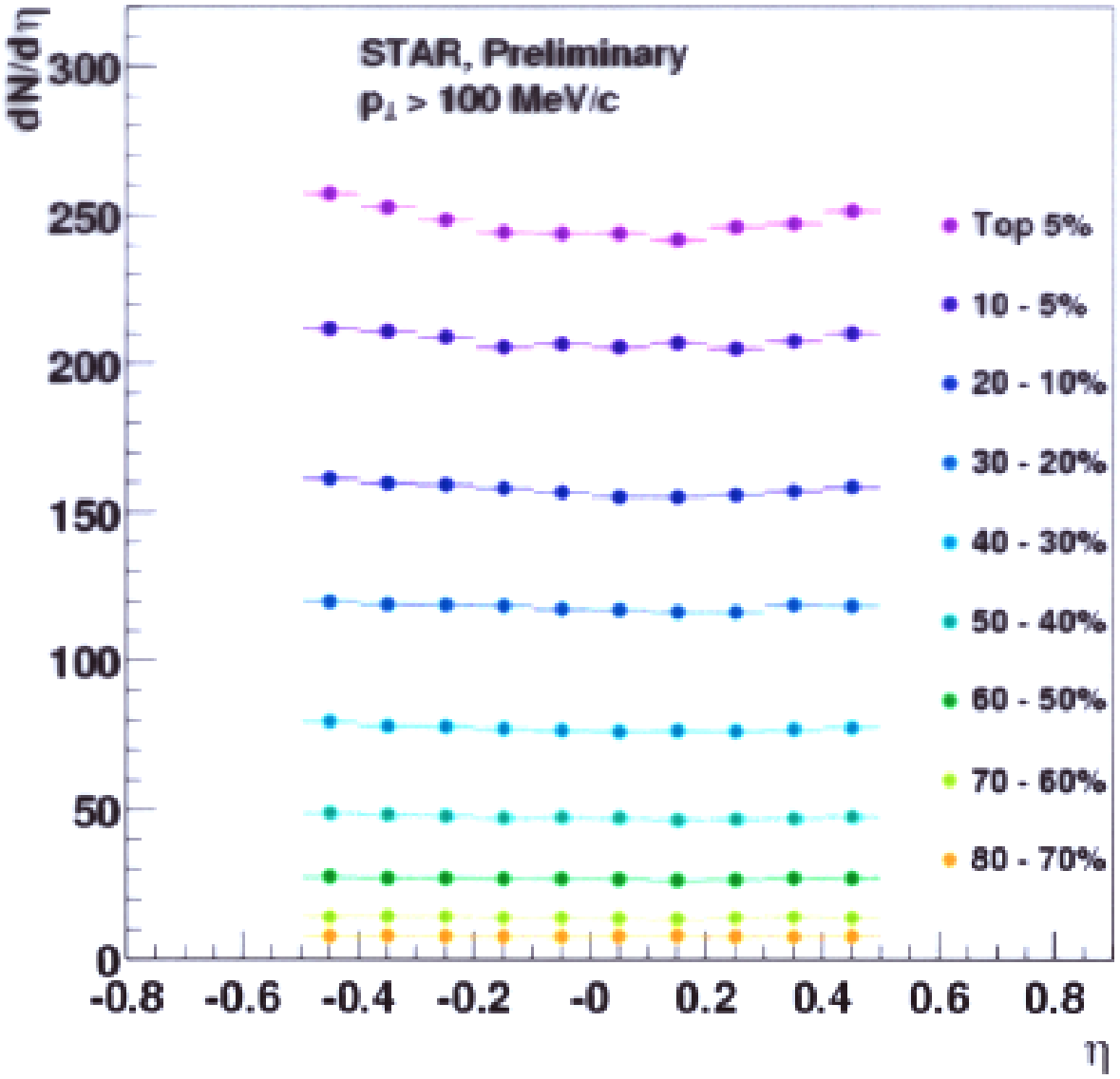
Central collisions: cut on ZDC only

Peripheral collisions: Cut in ZDC+CTB space

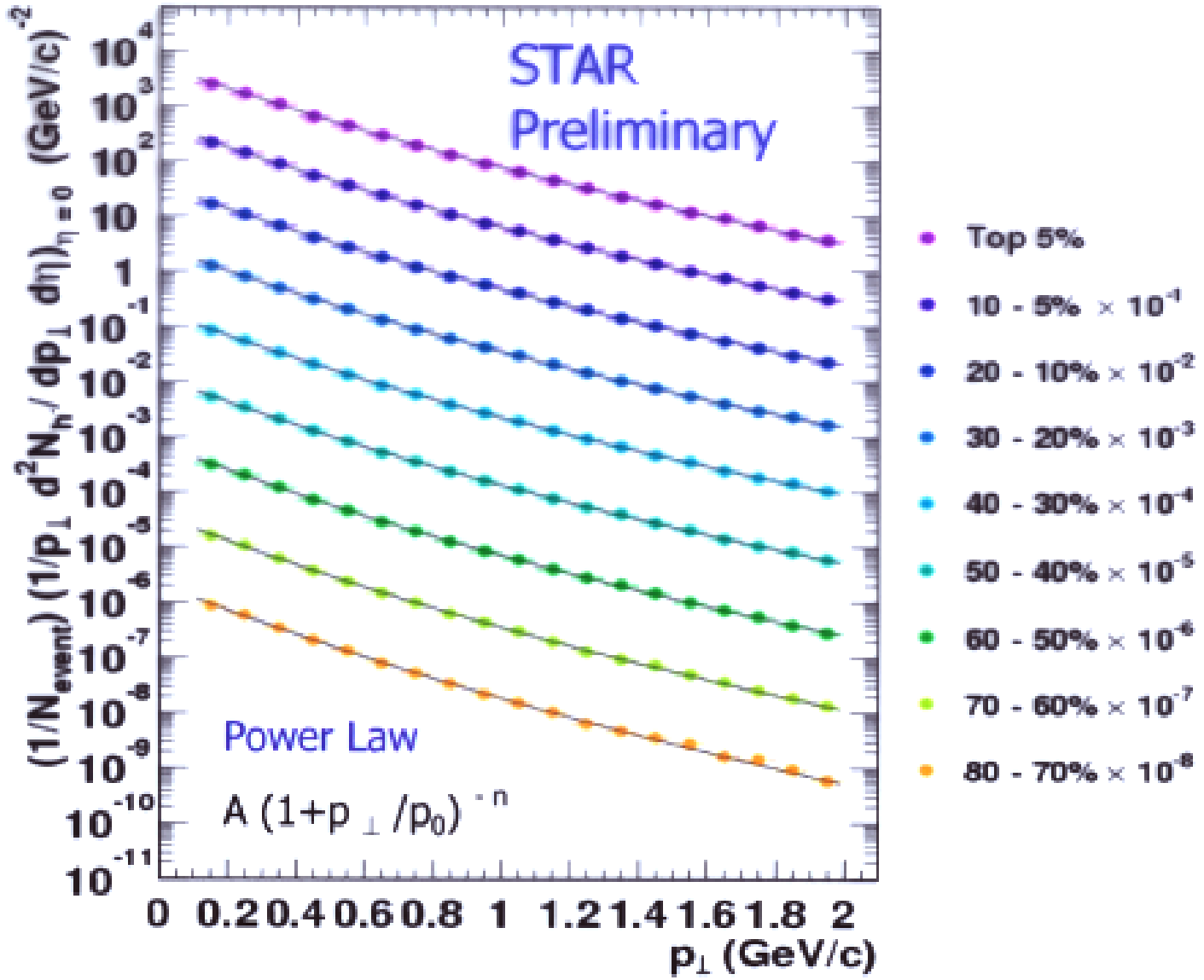




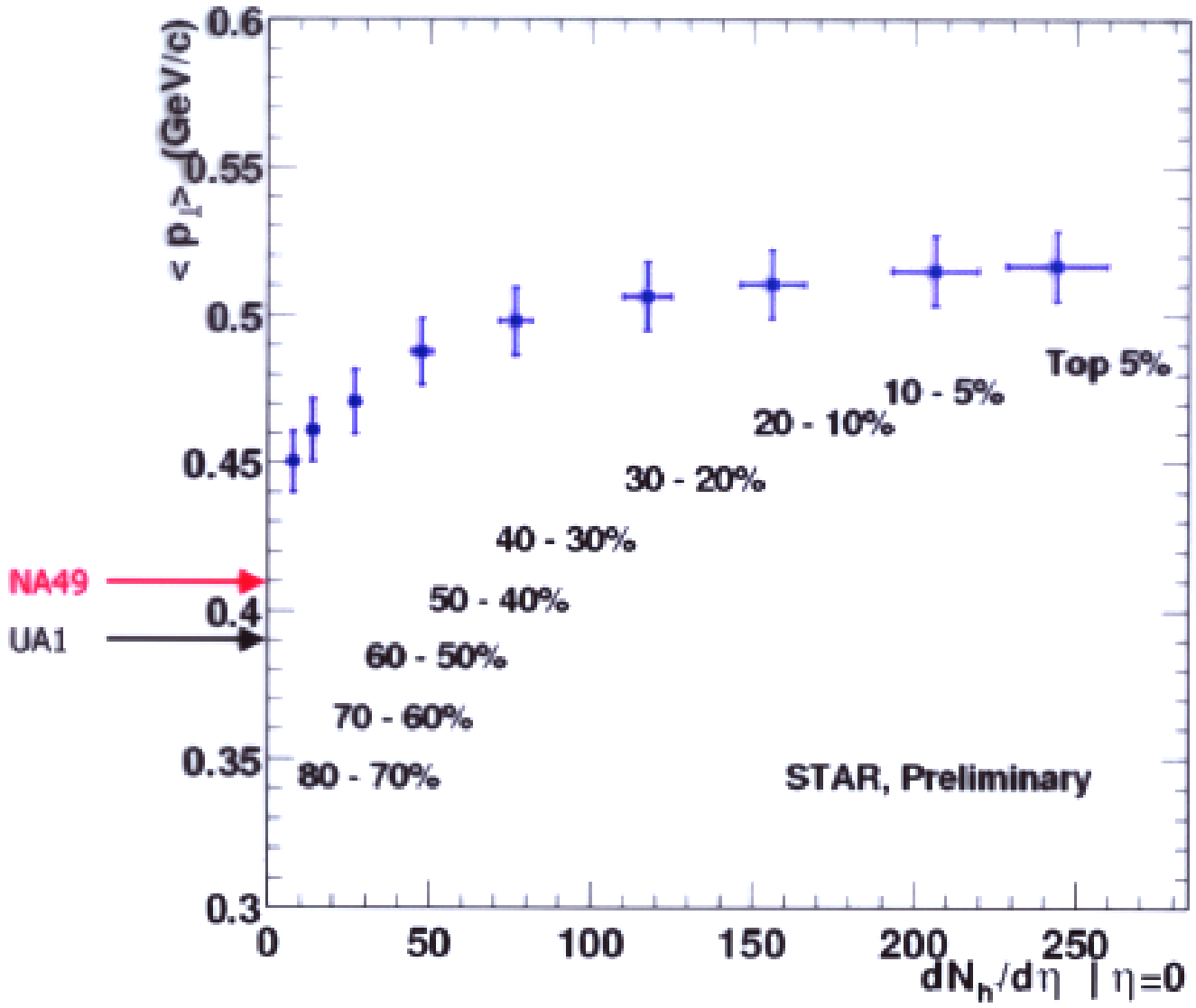
h^- η, Centrality dependence



h^- $p_\perp$, Centrality Dependence

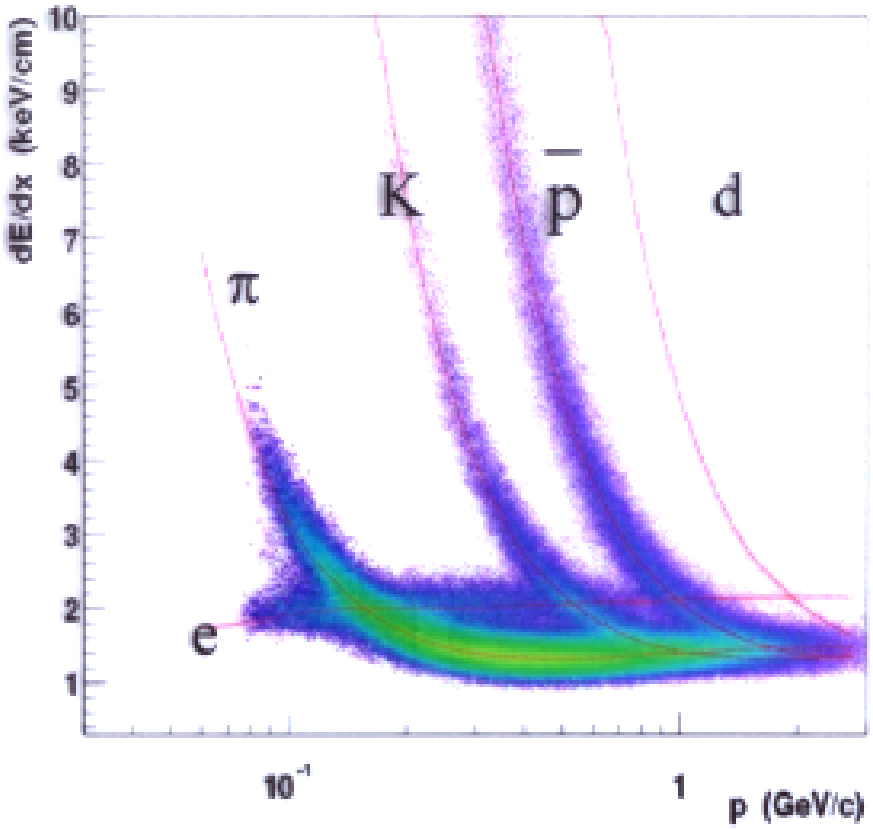


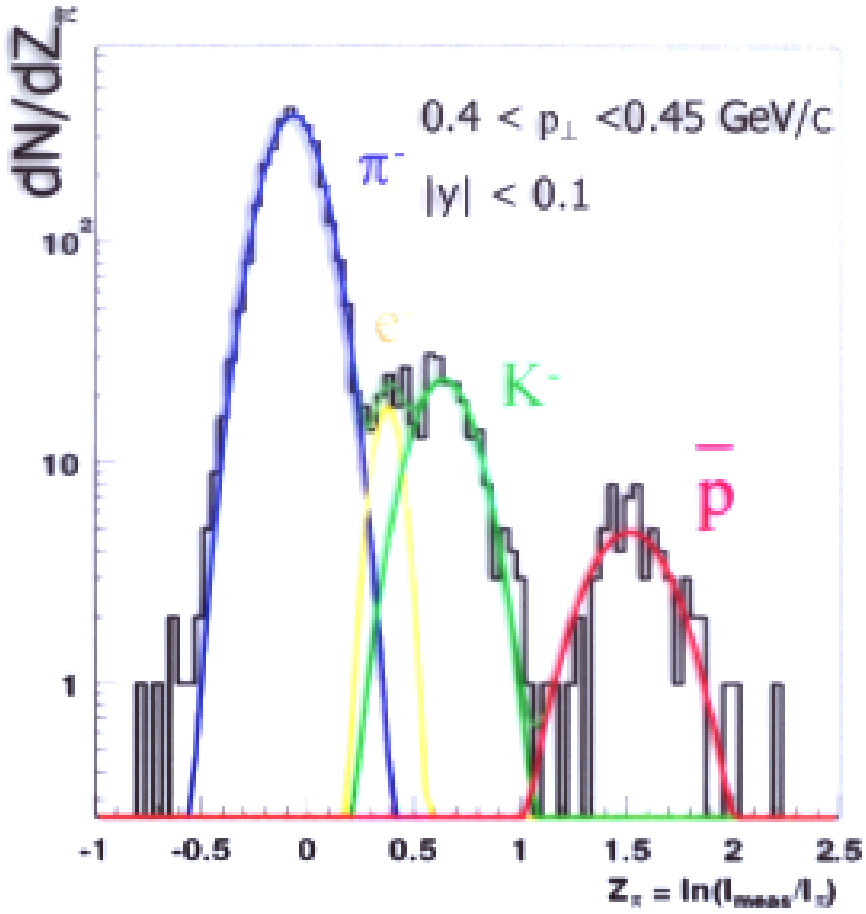
h^- $\langle p_\perp \rangle$, Centrality Dependence



15% Increase in $\langle p_\perp \rangle$ from 80% sample to 5% central

dE/dx Particle Id

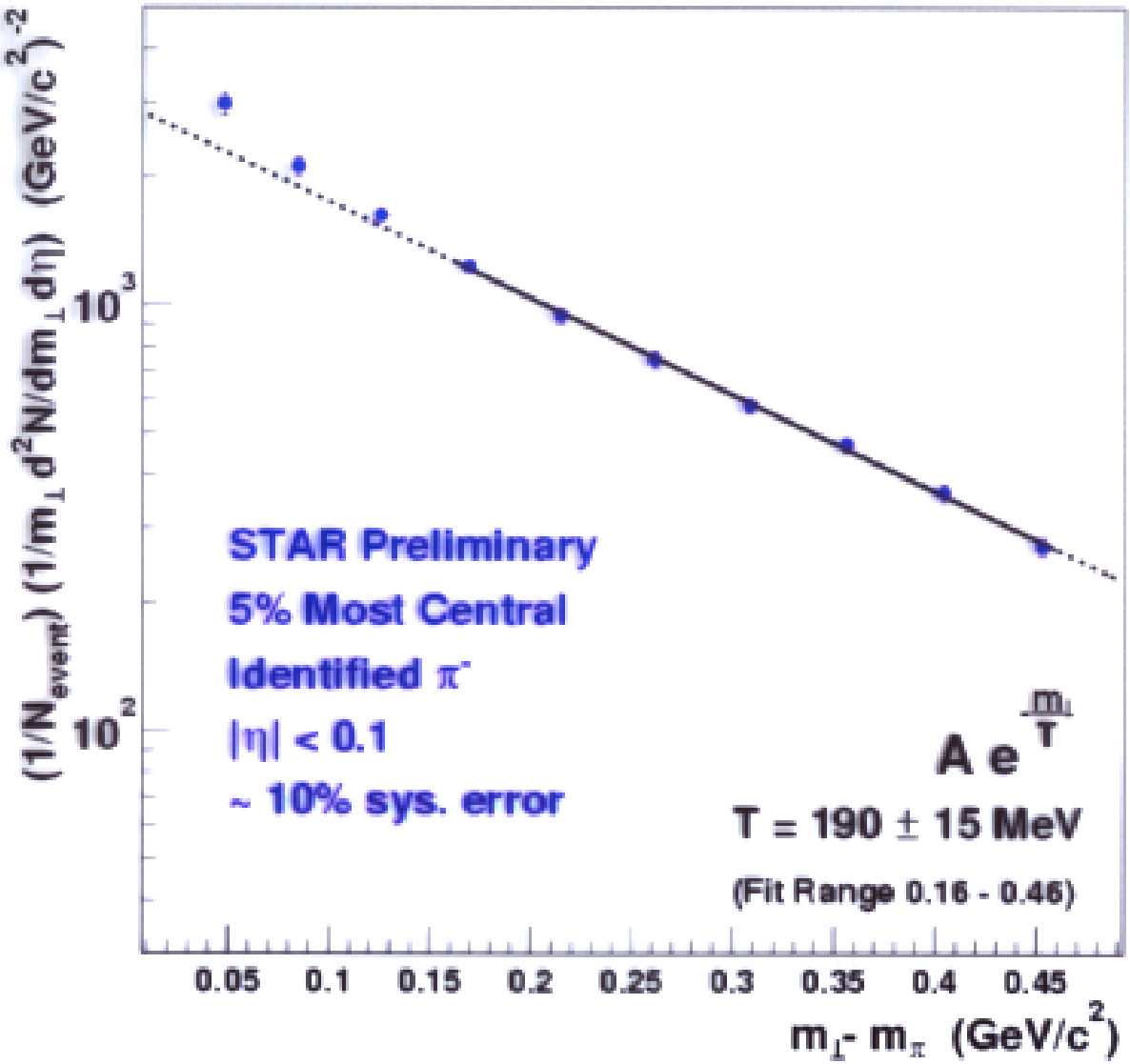




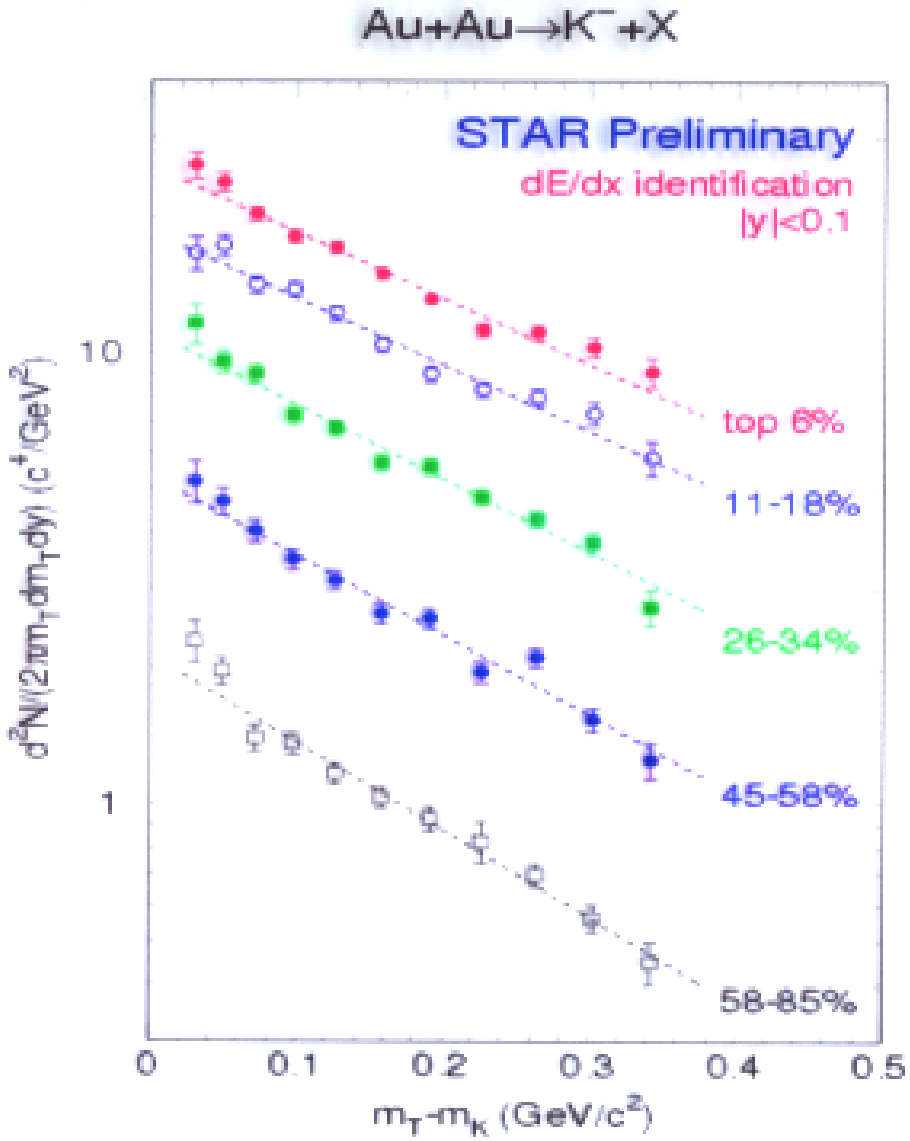
Use calibrated curves: Z variable

$$Z_\pi = \ln(I_{meas}/I_\pi)$$

π^-, $m_\perp$ Distribution



K^-, $m_\perp$ Distribution

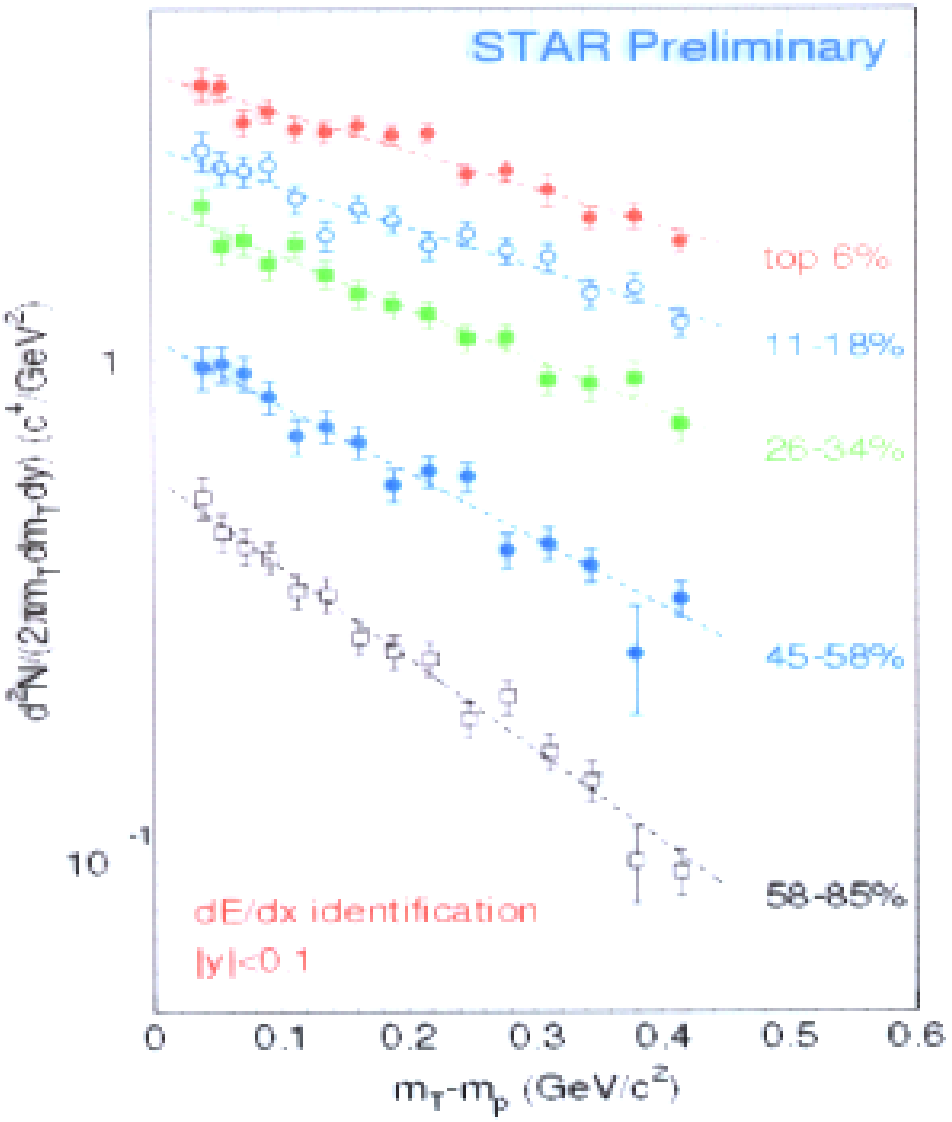


For the most central bin:
T ~ 300 ± 15 MeV.
Syst. error ~30 MeV

Slope: moderate centrality dependence

$\bar{p}$, $m_\perp$ Distribution

Au+Au→$\bar{p}$+X



Slope: stronger centrality dependence

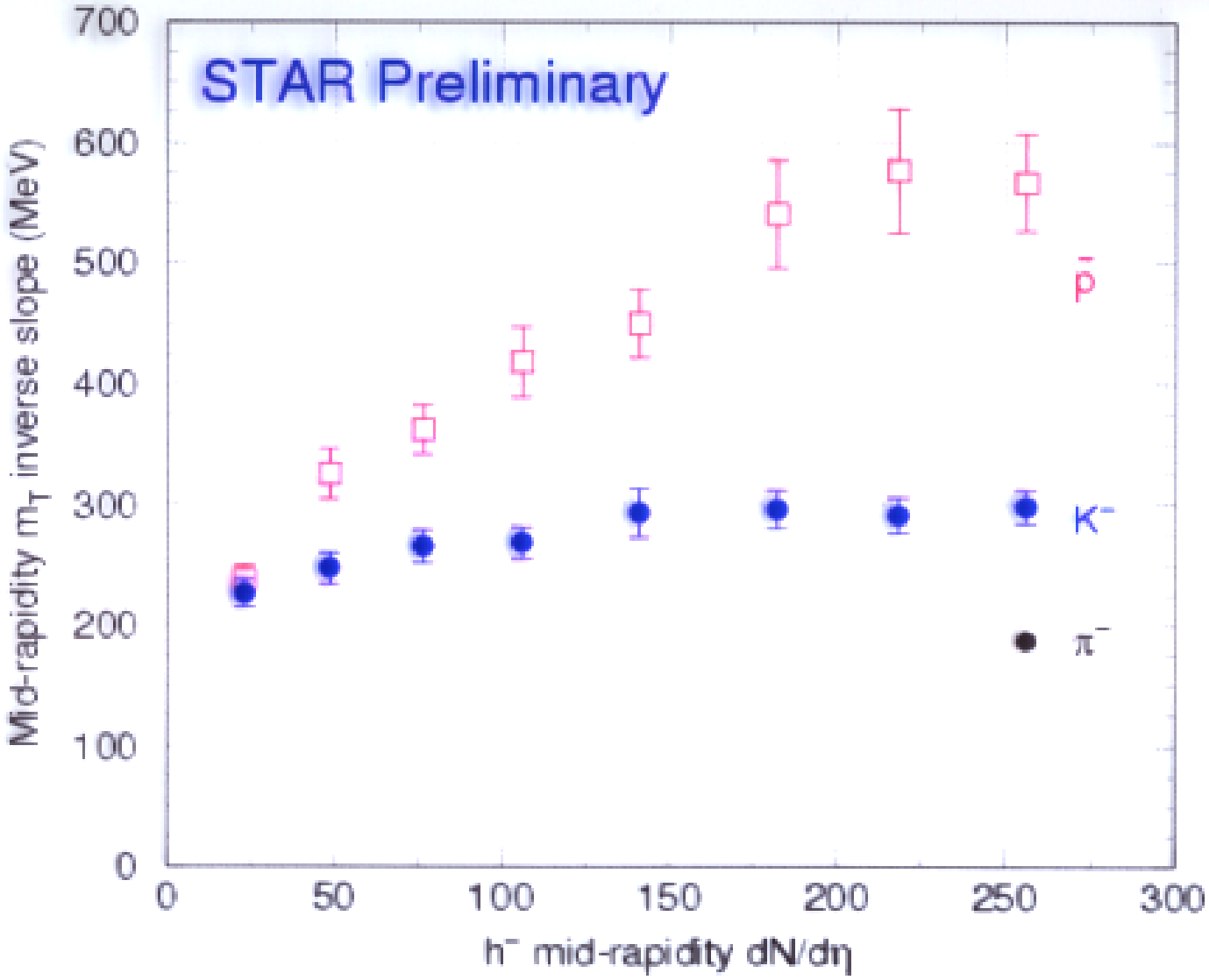
Peripheral ~200 MeV
Central ~550 MeV.

Syst. error on T ~ 50 MeV.

Current Status

- TPC is working beautifully!
- Calibrations look reasonable
- Well separated region can essentially already be used reliably
- Currently concentrating on software aspects to improve PID in overlap regions

$m_\perp$ Inverse Slopes



Report from Current Activities

- Aim to obtain a probability for PID for a given track
- Implementation of Bayes Approach (Yuri)
- Dependence of dE/dx on
  - Beta * Gamma
  - dx
  - (Hans, Aihong)

Conclusions

- Collisions dominated by geometry
- Negative hadron distributions (Central collisions)
  - **Increased particle production relative to SPS and UA1**
  - **$\langle p_\perp \rangle$ = 0.516 GeV/c (NA49 = 0.414, UA1 = 0.392)**
  - **low $p_\perp$: 'Wounded nucleon' scaling; rising $p_\perp$: 'binary collisions' scaling ?**
- Negative hadrons, centrality dependence
  - **$\langle p_\perp \rangle$ shows weak dependence**
  - **η dependence ~flat, small dependence on centrality**
- Identified pi, K, p
  - **slope parameter T increase with centrality**
    - Increase is most dramatic in anti-protons
    - Radial flow?

Efficiency Correction Function I