High p_T Spectra from STAR

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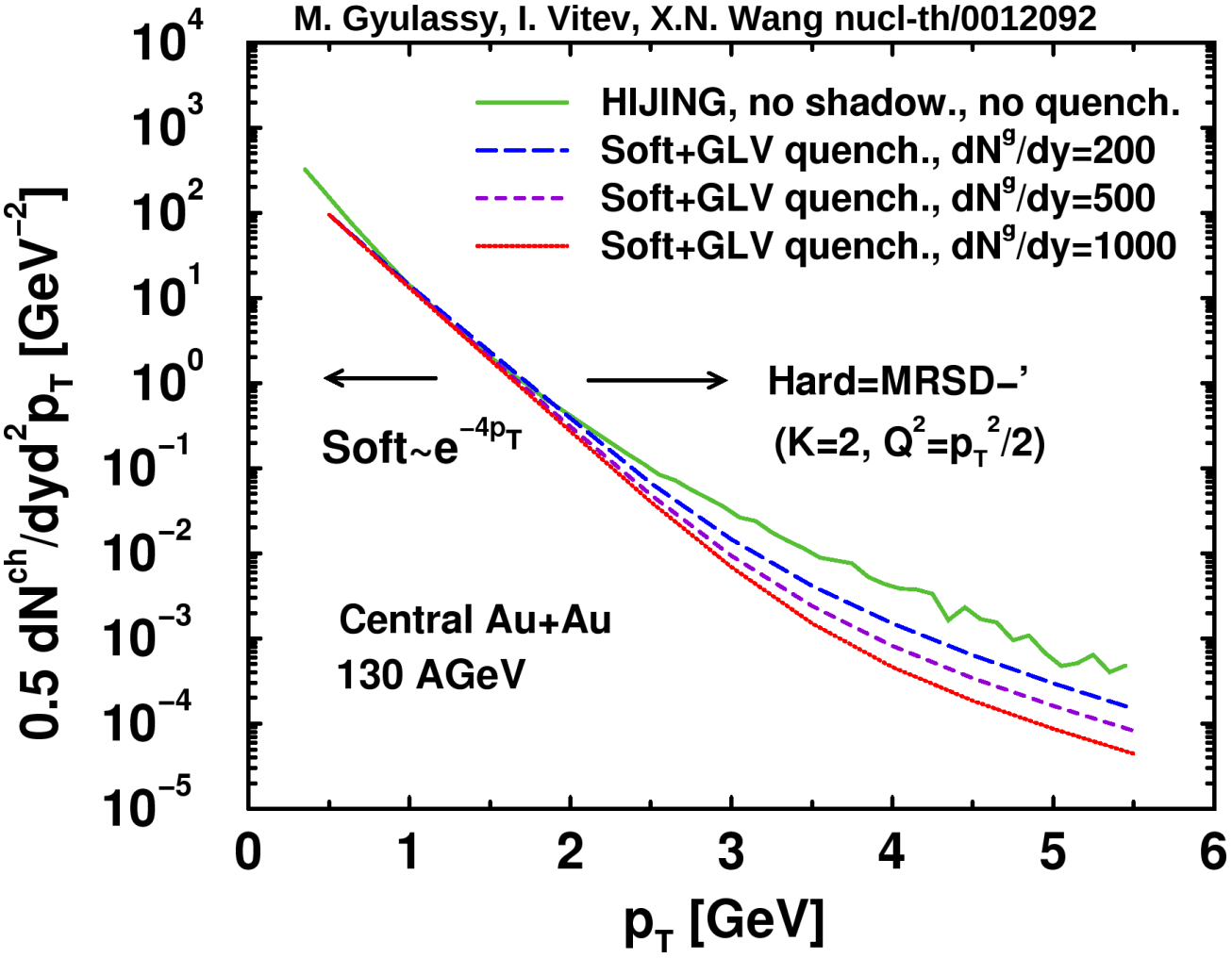
for the STAR Collaboration

High p_T at RHIC: Motivation

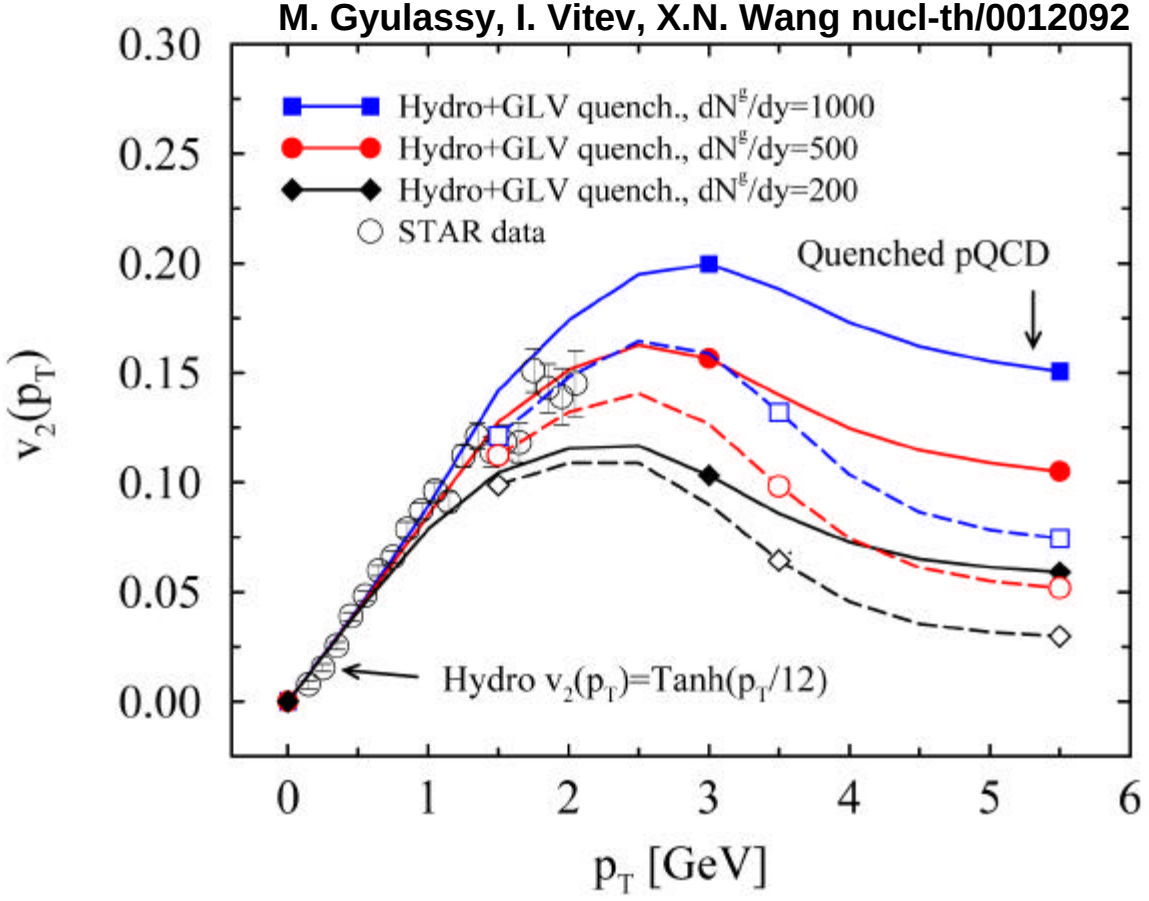
- **New opportunity at RHIC**
  - **Ös = 130 AGeV vs 17 AGeV at SPS**
- **Extend into perturbative regime**
  - **Calculations reliable**
- **Predictions based on partonic energy loss**
  - **Interaction of parton with partonic matter**
  - **Energy loss of partons**

Partonic Energy Loss Predictions: Hadron Spectrum

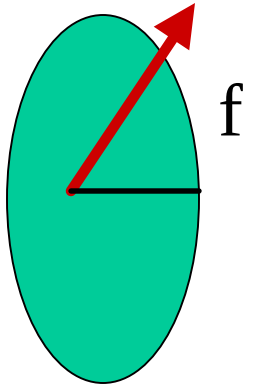


Partonic Energy Loss Predictions: Azimuthal Anisotropy

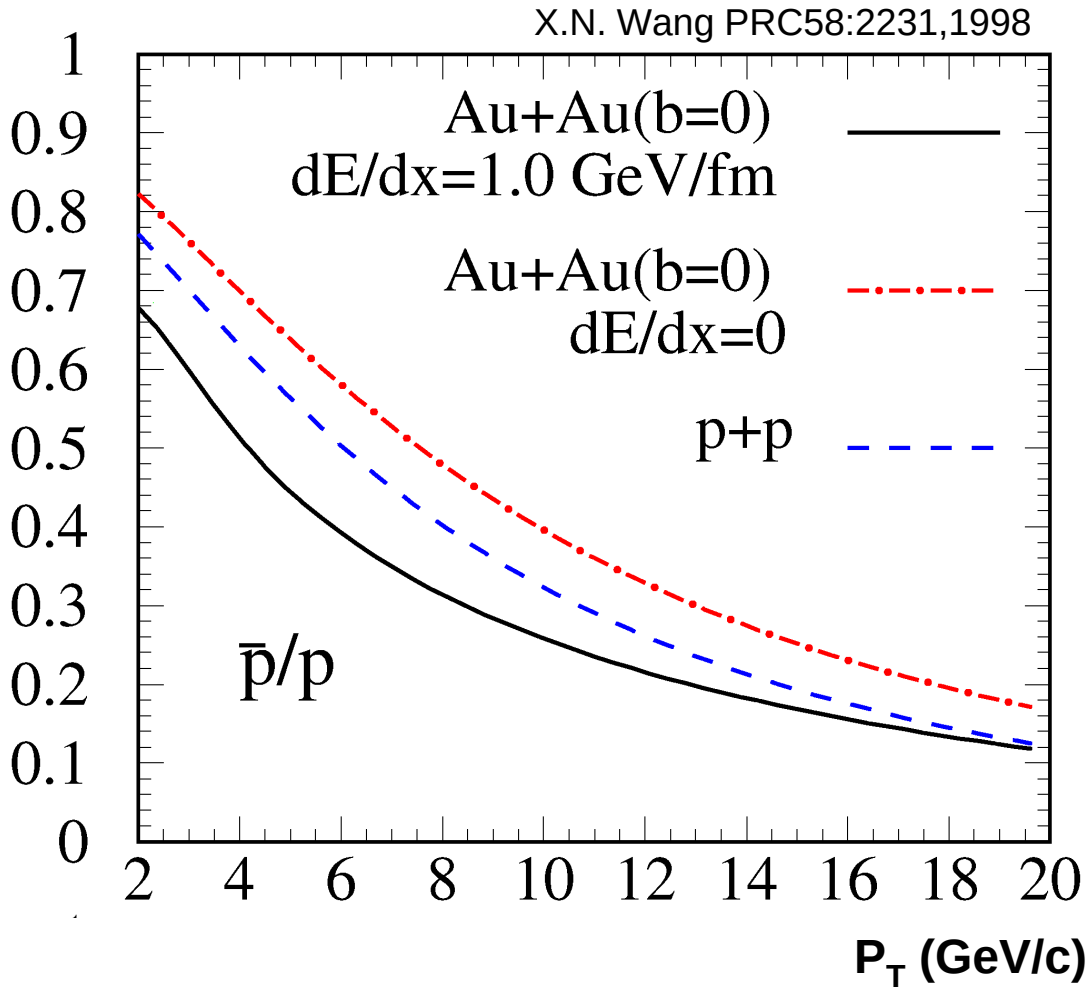
M. Gyulassy, I. Vitev, X.N. Wang nucl-th/0012092



- **Azimuthal anisotropy at low p_T provides control of geometry**
- **Different pathlength as function of ϕ leads to f anisotropy from partonic energy loss**



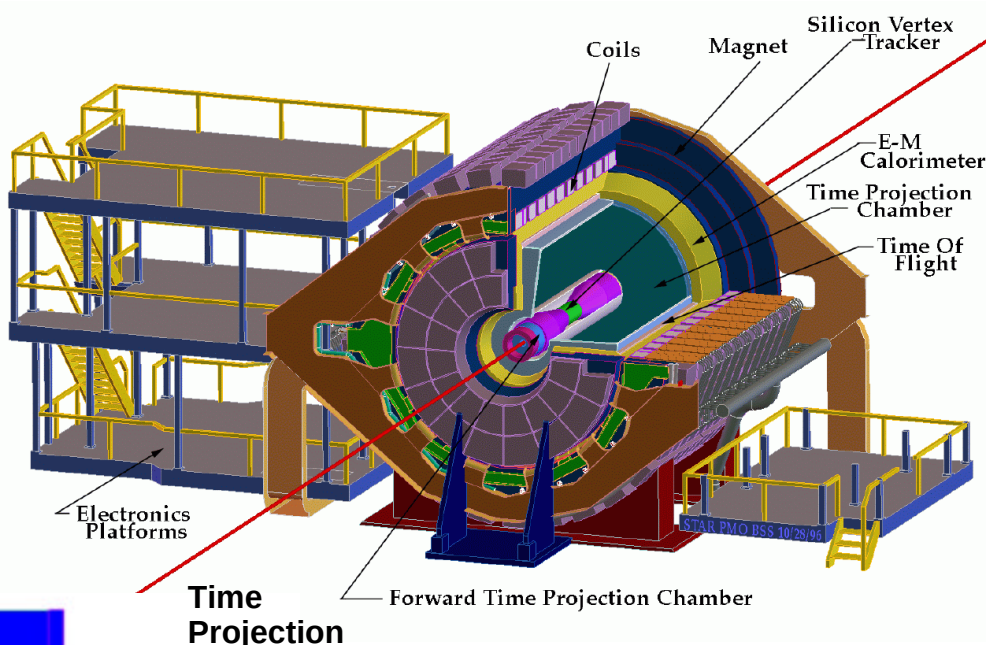
Partonic Energy Loss Predictions: Antiproton/Proton



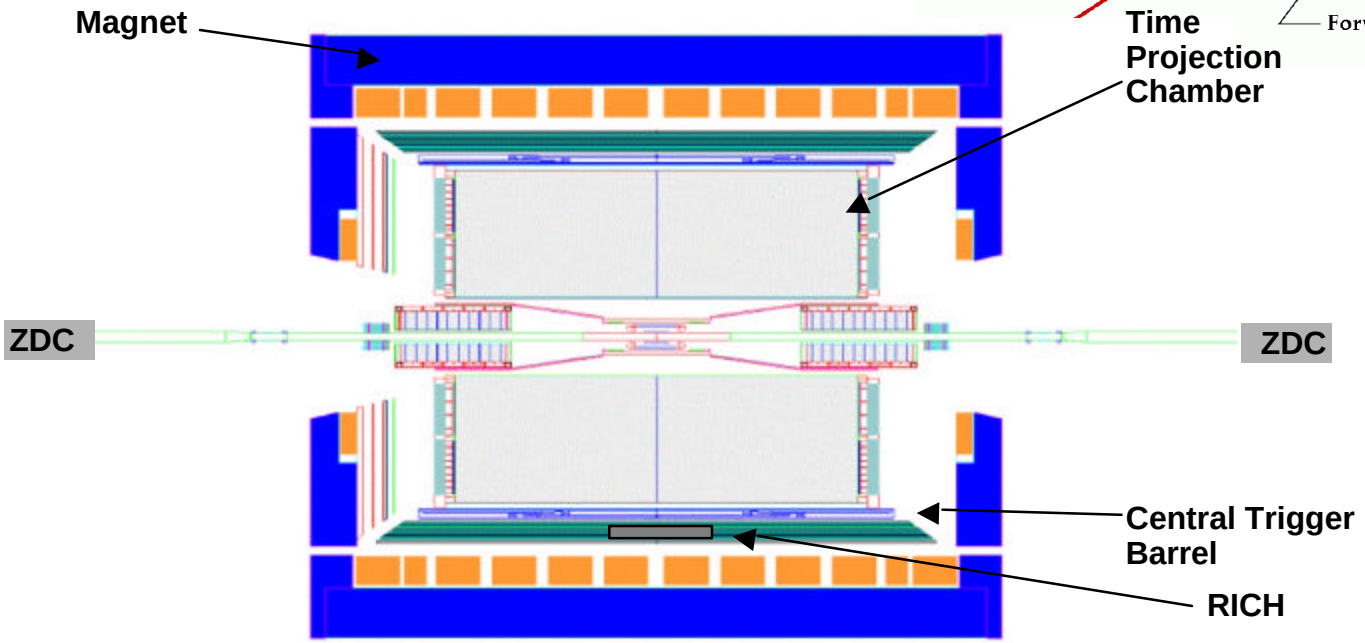
- **Gluons interact more strongly with partonic matter than quarks**
- **Fragmentation functions prefer quark ® proton**

⇒ **Antiprotons more strongly affected by partonic energy loss than protons**

STAR Experiment



Year 1: Magnet, TPC, CTB, ZDC, RICH

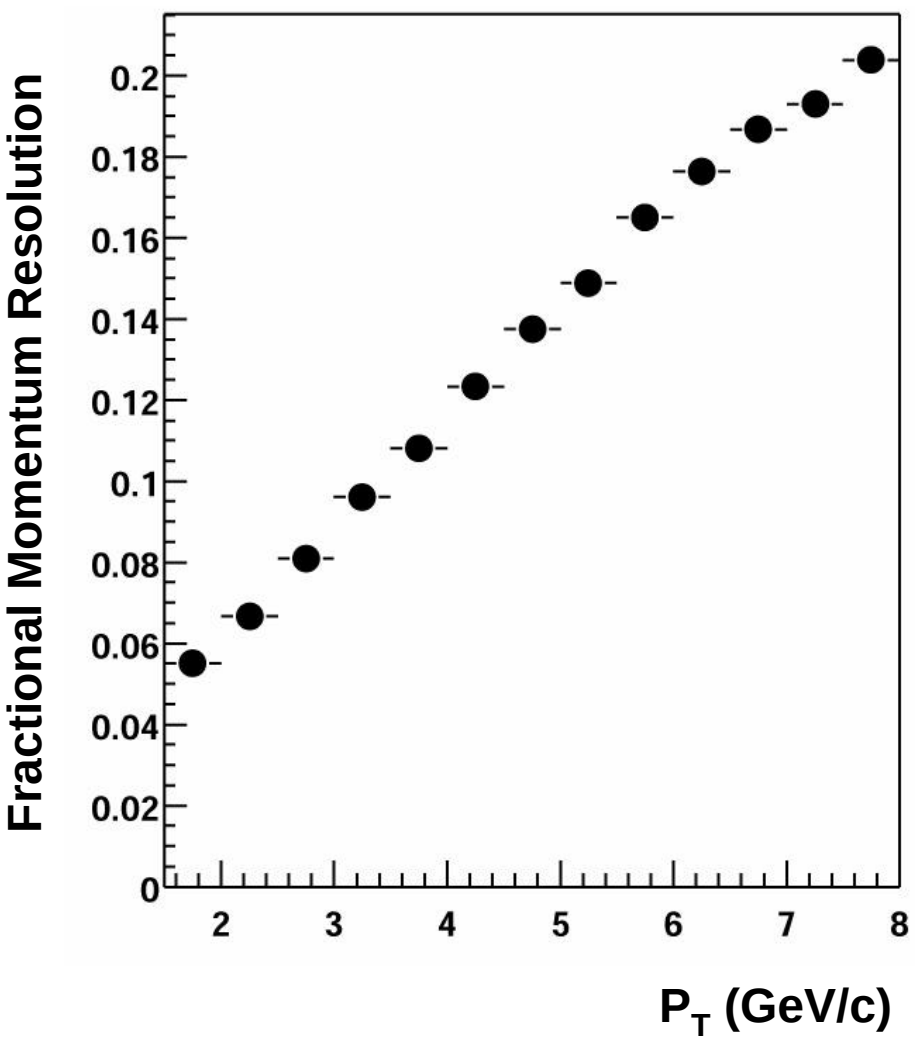


TPC: **radius=2 m**
length=4 m
|h|<1.8, 0<f<2p

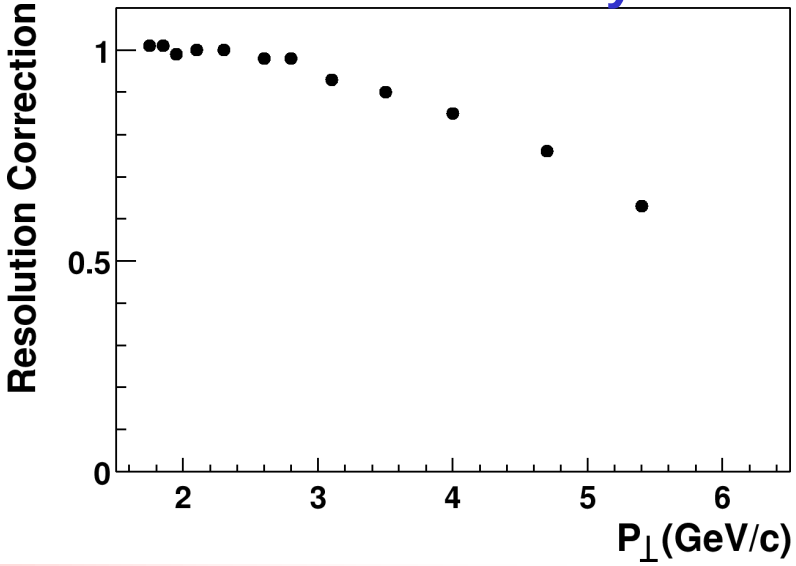
Magnet: 0.25 T Year 1
To be increased to 0.5 T

RICH: |h|<0.3, Df = 30º

TPC Momentum Resolution



- **Obtained from embedding GEANT® Data**
- **Half field (0.25 T)**
- **Steeply falling spectrum®**
  - **Flattening of spectrum**
  - **Correction necessary**

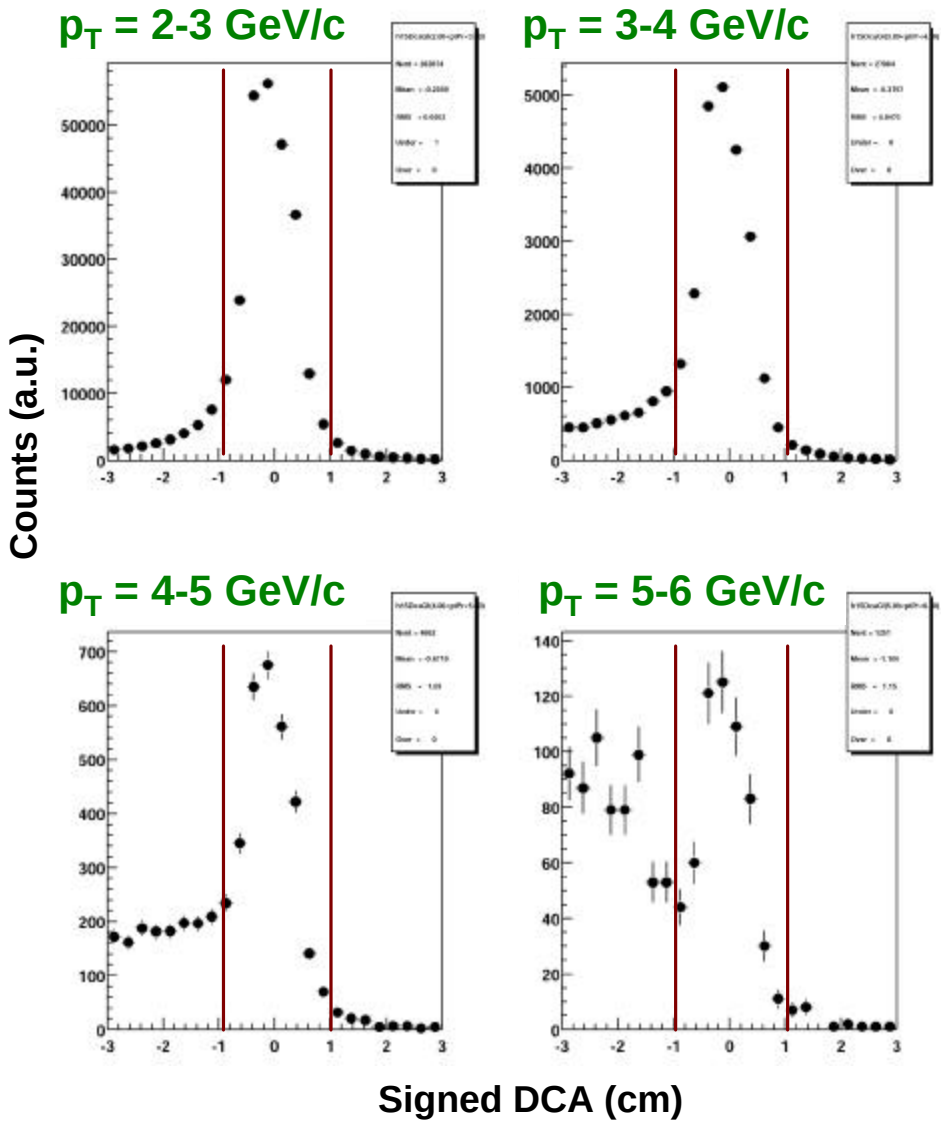


Further Experimental Considerations

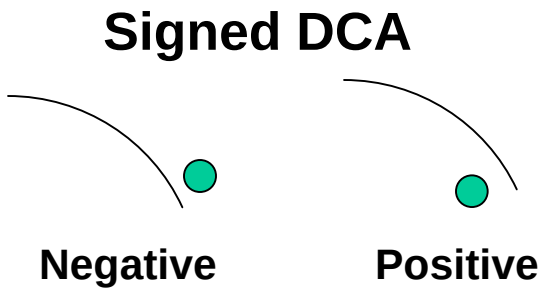
- **Efficiencies**
  - **Embed GEANT® 5% Central Au-Au Data**
  - **Tight cuts on TPC points and DCA to primary vertex**
  - **Small level of dependence on p_T and η**
    - **0.65 at p_T = 2 GeV/c to 0.70 at p_T = 6 GeV/c**
    - **0.68 at η = 0 to 0.70 at η = 0.5**

- **Backgrounds: decays and secondaries**
  - **Obtain shape in DCA from Hijing/ GEANT/ full tracking**
  - **Normalize to tails from data**
    - **7% at p_T = 2 GeV/c, 15% at p_T = 6 GeV/c**
    - **Dominates systematic error**

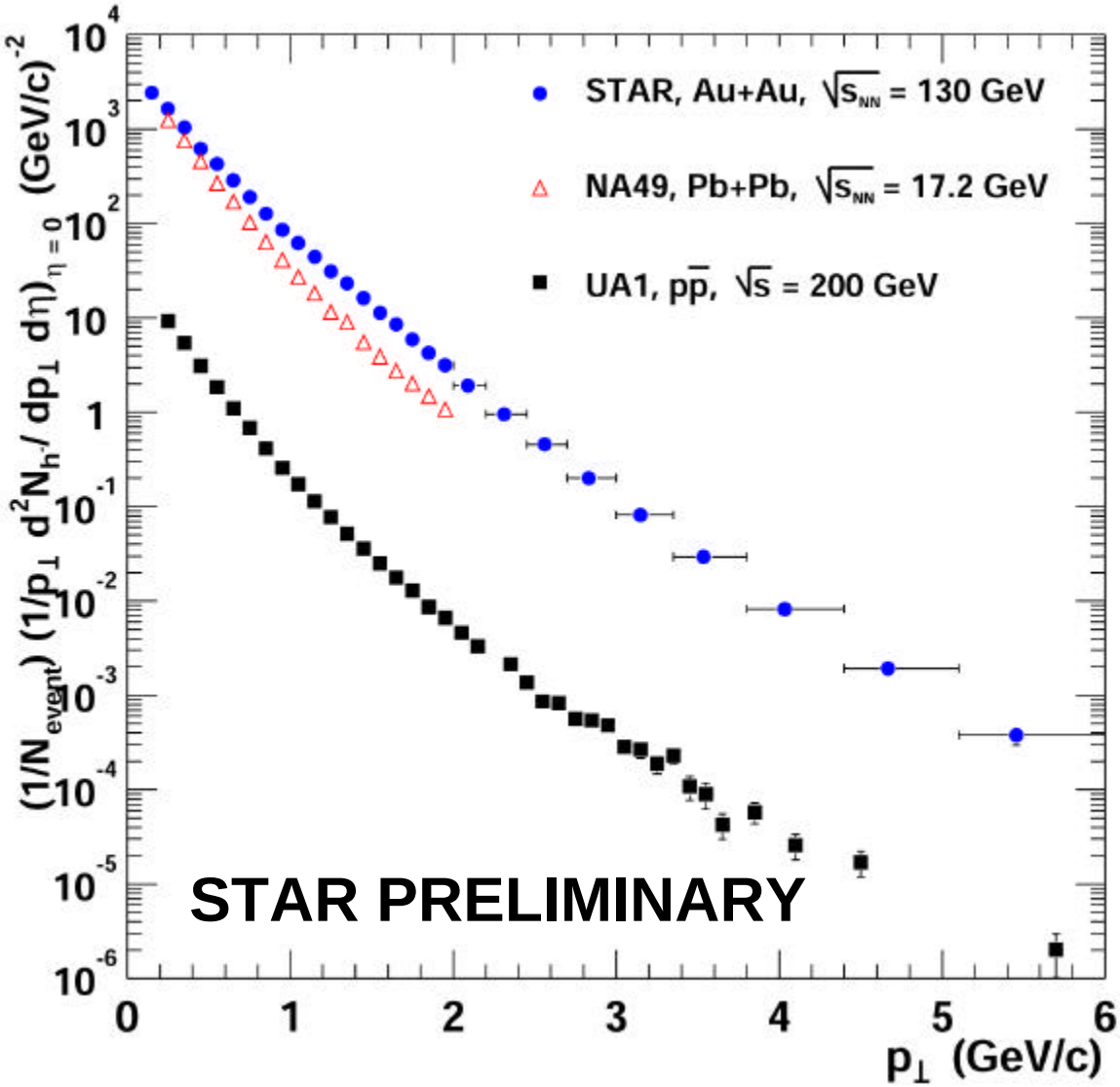
Backgrounds: “Signed” DCA



- Cut on DCA to event vertex
  |DCA| < 1 cm
- Removes much of feed-down from Λ and K^0_s
- Residual feed-down correction from simulation, normalized to tails in data

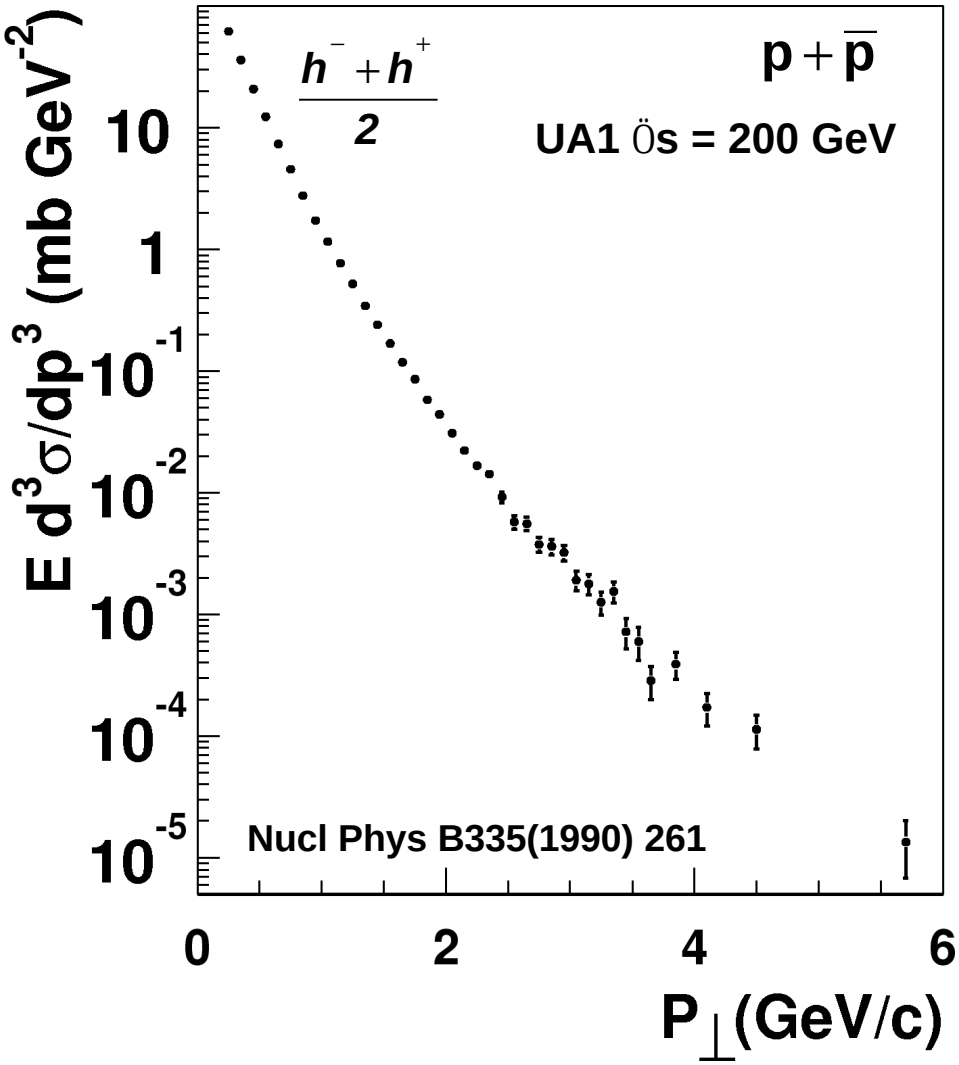


Negative Hadron Spectrum



Horizontal error bars indicate bin width

Reference for Spectrum: UA1

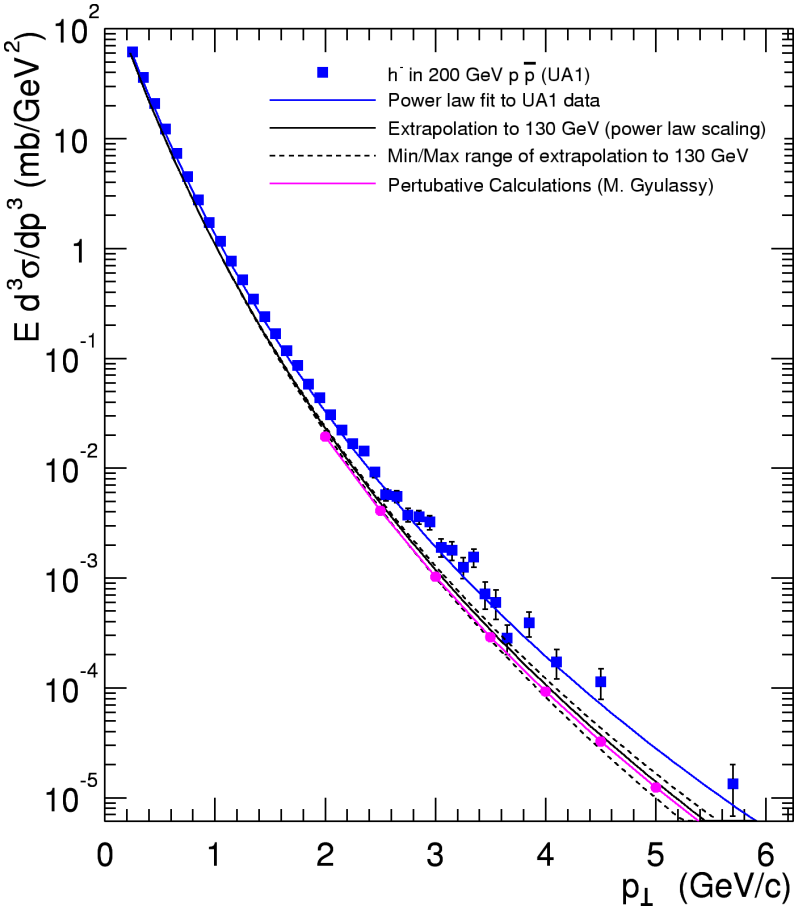


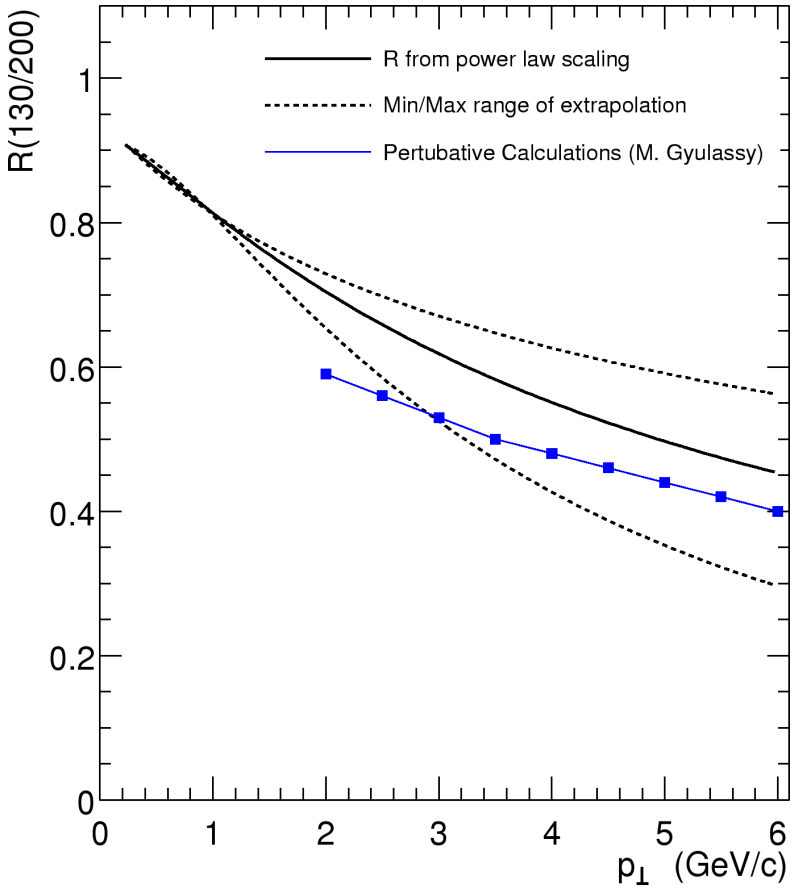
- **Simple reference system**
- **Normalization to Au+Au**
- **Hard: Binary collisions**
  - **Valid for $\sigma T_A << 1$**
  - **T_{AA}=26 ± 2 mb**
- **Soft: Wounded nucleons**
  - **Ratio soft / hard:**

$(\langle N_{part}\rangle / 2) / \langle N_{binary}\rangle$ = (344 / 2) / 1050

D. Kharzeev, M. Nardi nucl-th/0012025, 2000

UA1 Fit, Scaled to Ös=130 AGeV

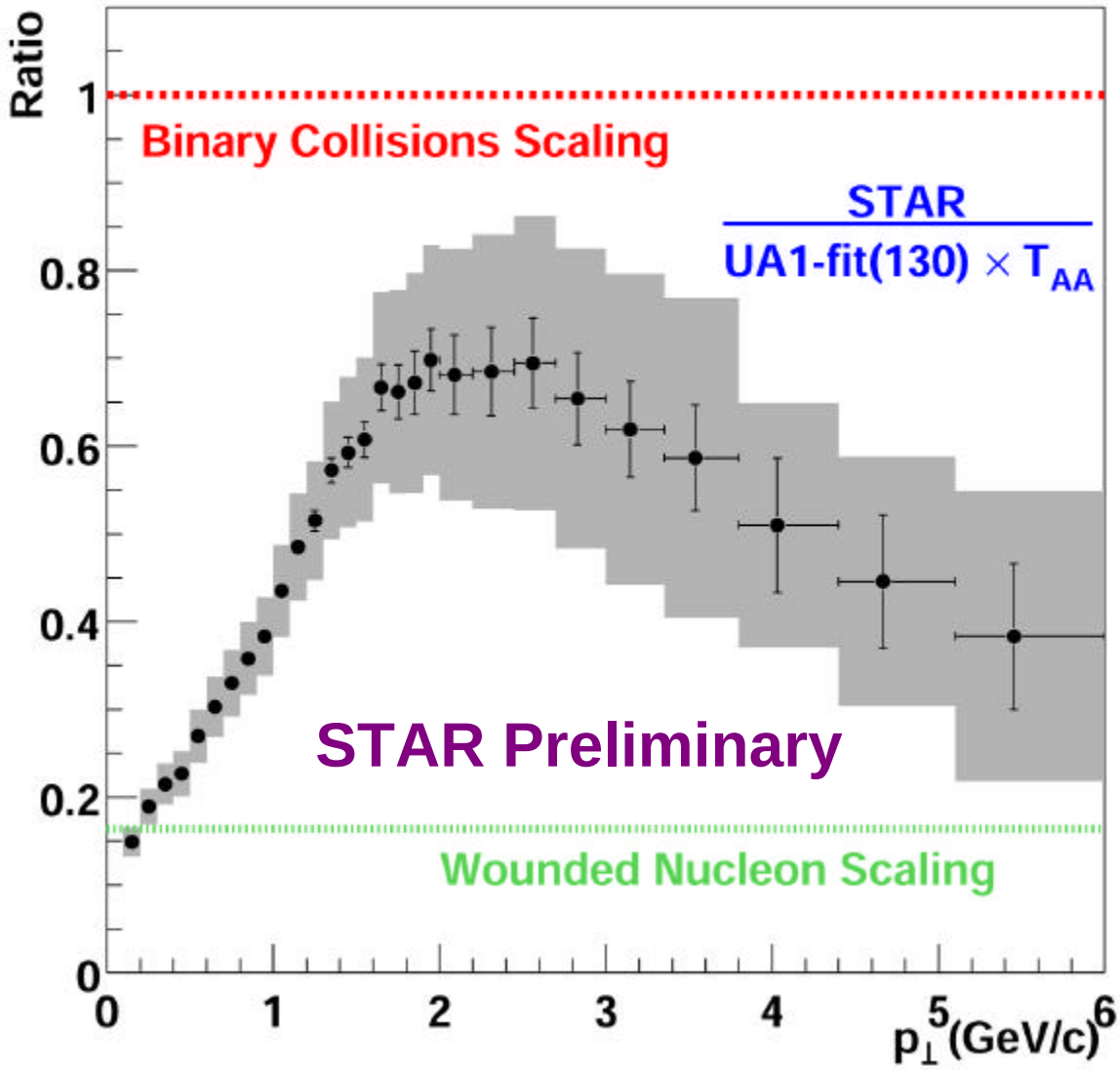




Scaling from: Established scaling laws for <p_T>, <$dN_{ch}/d\eta$> and Ös scaling of power law parameters

At high p_T agrees with perturbative calculation

h^- Spectrum: Comparison to UA1



Statistical errors negligible

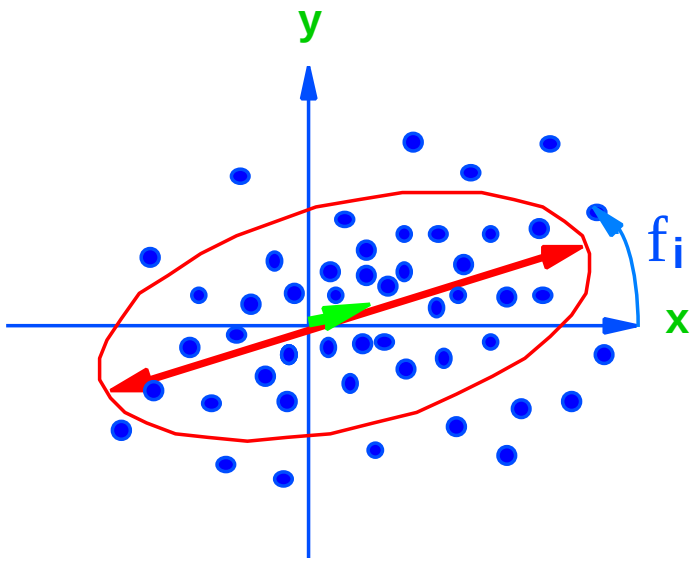
Errors on points:
systematic error
on STAR data

Gray bars: cumulative
error including UA1
scaling

Hard: Binary collisions
$T_{AA} = 26 \pm 2 \ mb^{-1}$

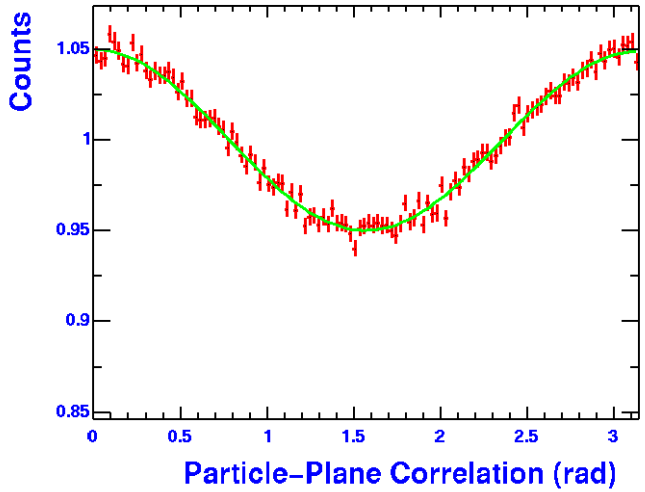
Soft: Wounded nucleon

Azimuthal Anisotropy



- **Find event plane**

$$\Psi_2 = \frac{1}{2}\tan^{-1}\left(\frac{\sum_i w_i \cdot \sin(2 f_i)}{\sum_i w_i \cdot \cos(2 f_i)}\right)$$

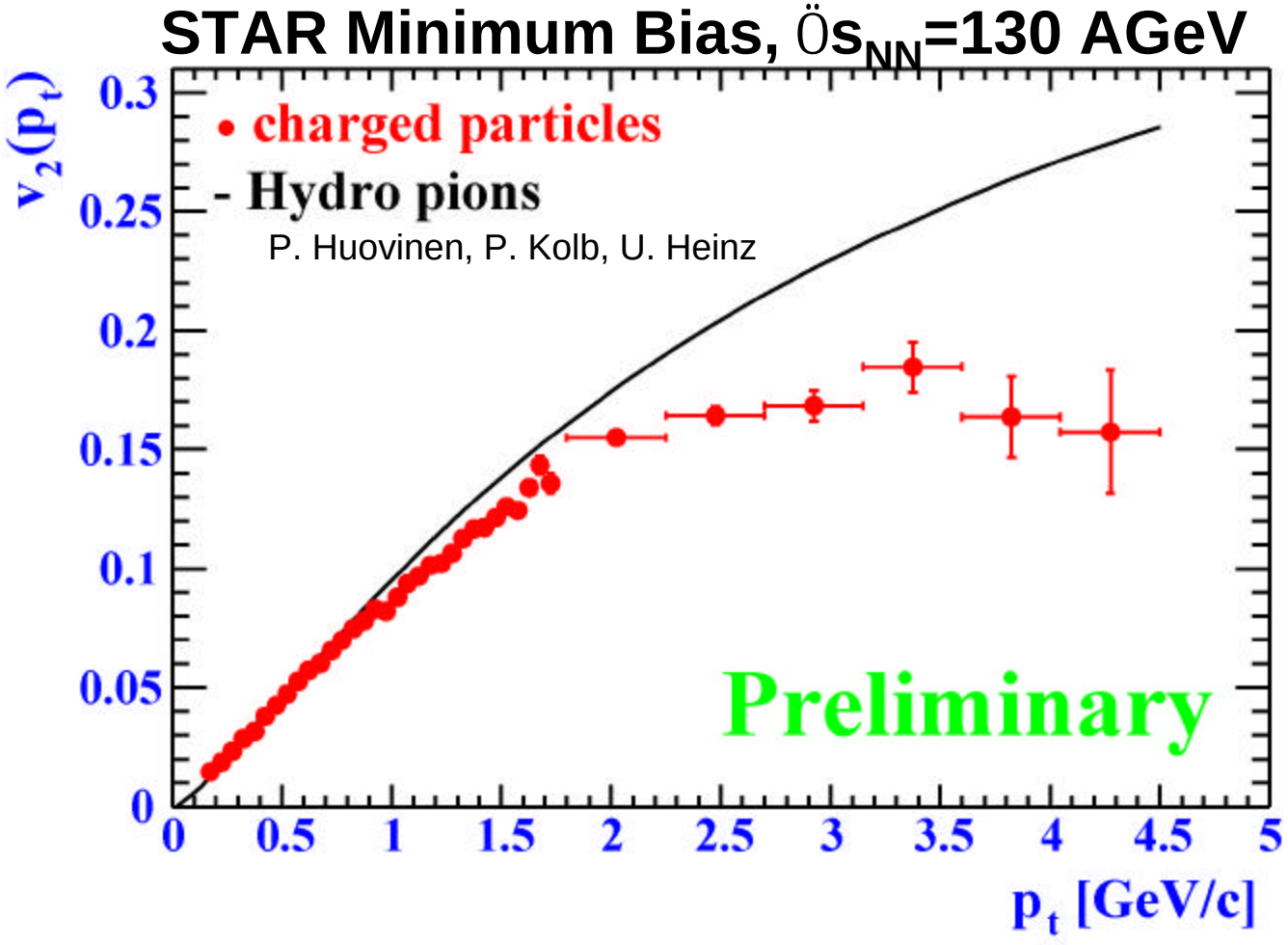


- **Correlate particles to event plane**

$$v_2 = \langle \cos(2[f - \Psi_2]) \rangle$$

•PRL 86:402, 2001

v_2 at High p_T



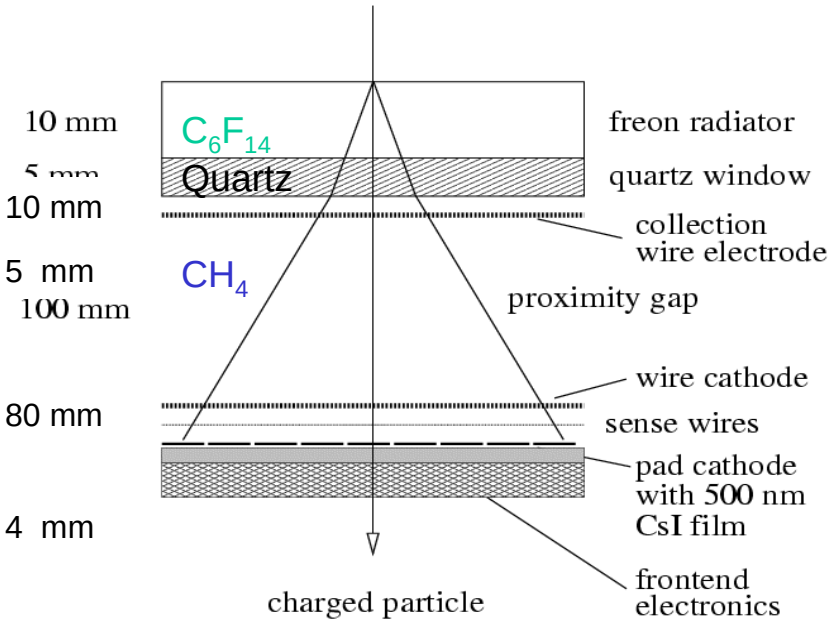
Errors statistical only

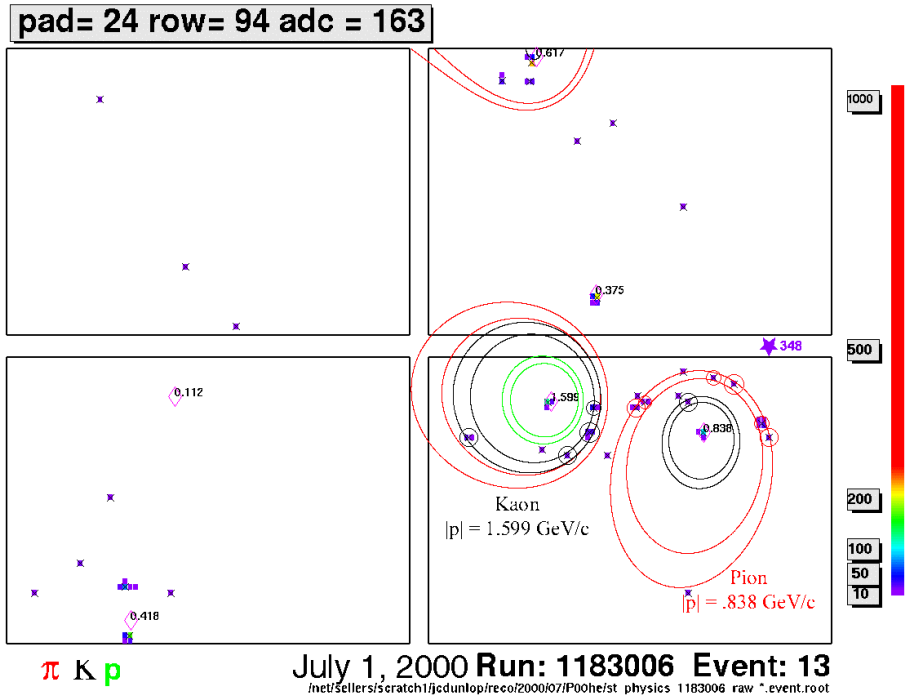
Systematic errors 10-20%p_T=2-4.5 GeV/c

STAR Ring Imaging Cherenkov Detector

Yale/CERN/Bari STAR-RICH Collaboration

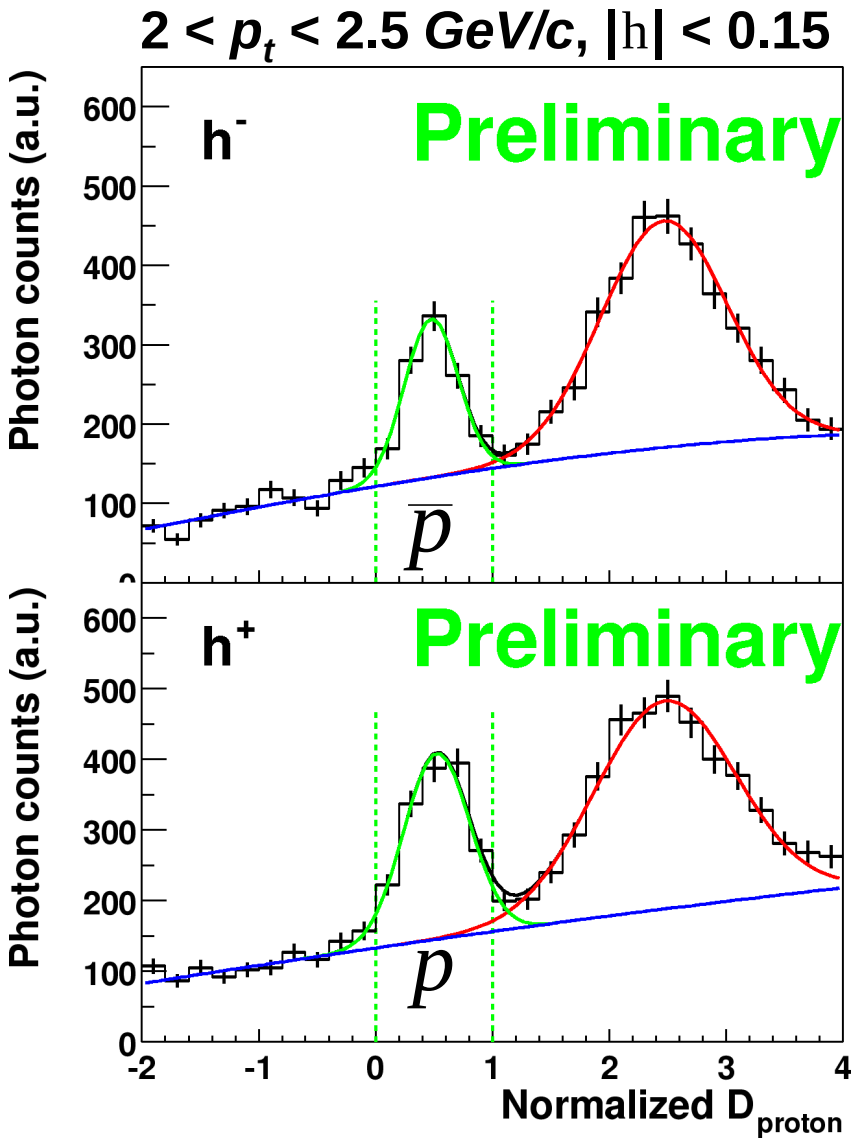
- **PID for Kaon/Pion/Proton**
- **1-3 GeV/c for K/p**
- **1.5-5 GeV/c for p/pbar**





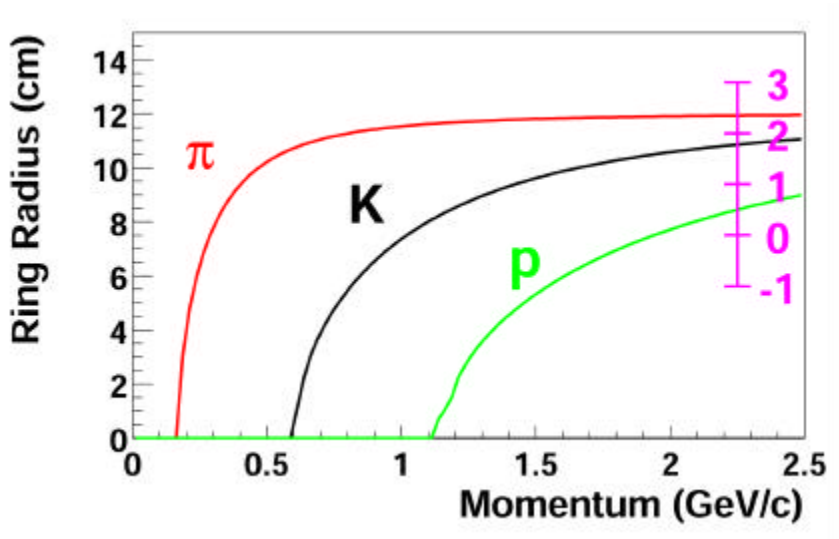
- **C_6F_{14} Liquid Radiator**
- **CsI Photo Cathode**
- **MWPC with 16,000 Pads 0.84x0.8 cm**
- **Gassiplex readout 10-bit ADC**

Proton identification in STAR-RICH

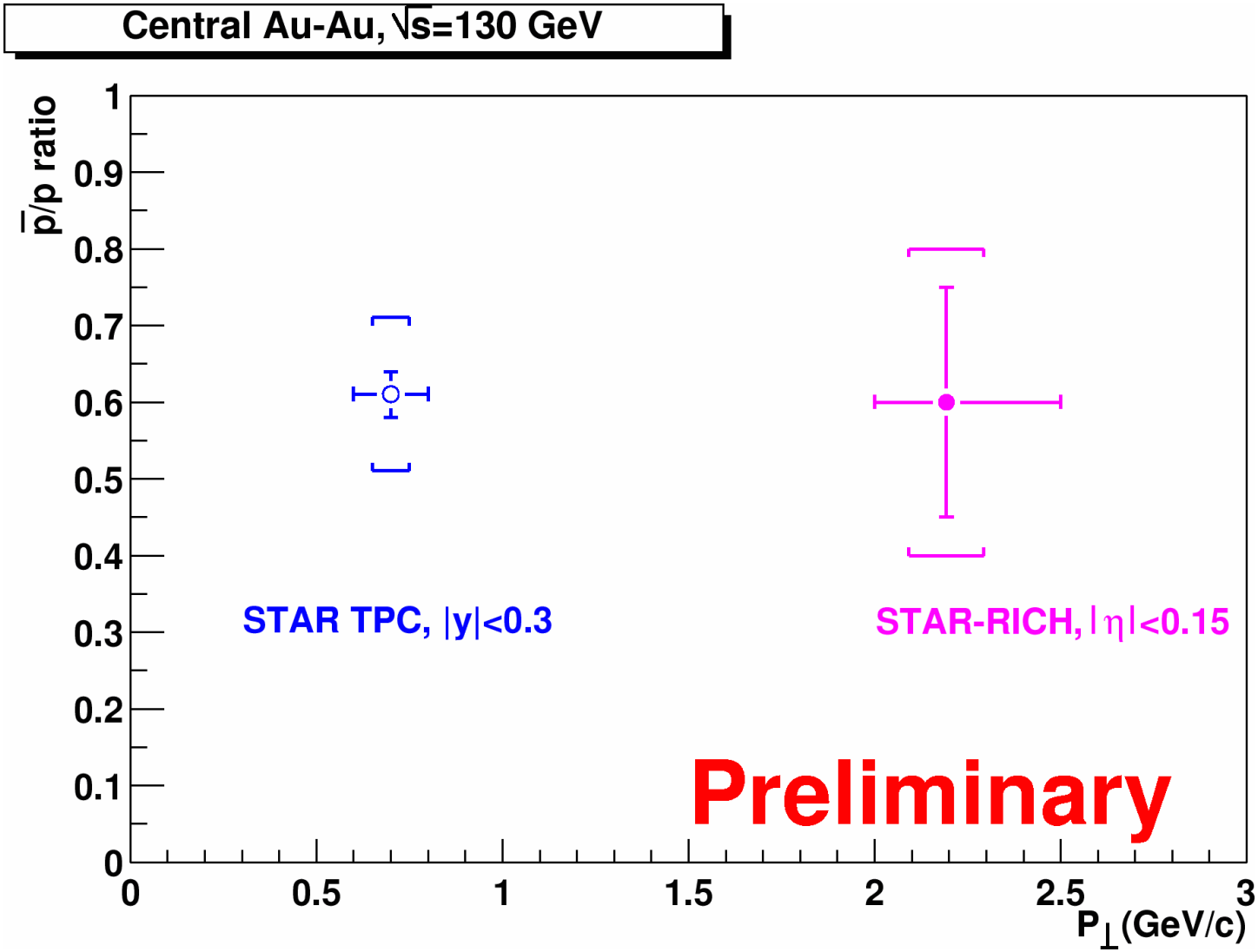


- Photon position as transformed into Cherenkov cone frame
- Assumes proton mass

$$D_{proton} = \frac{PhotonPosition_{proton} - InnerRadius_{proton}}{OuterRadius_{proton} - InnerRadius_{proton}}$$



Identified Antiproton/Proton Ratio



Conclusions

- **Negative hadrons suppressed at high p_T in central Au+Au relative to UA1 reference**
- **Azimuthal anisotropy plateaus with p_T**
- **STAR-RICH has measured $\bar{p}/p$ at p_T = 2-2.5 GeV/c**

The STAR Collaboration

Brazil: Universidade de Sao Paolo

China: IHEP - Beijing, IPP - Wuhan

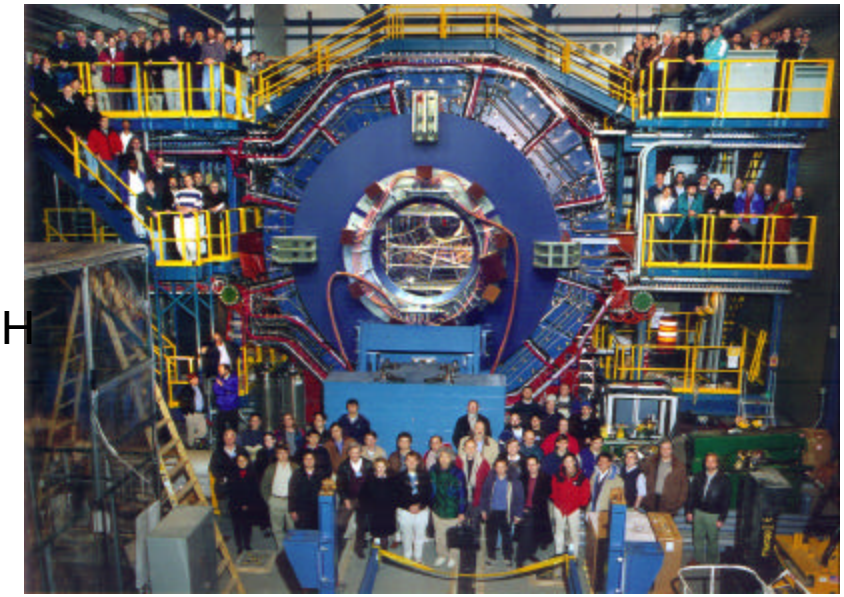
England: University of Birmingham

France: Institut de Recherches Subatomiques Strasbourg, SUBATECH - Nantes

Germany: Max Planck Institute – Munich University of Frankfurt

Poland: Warsaw University, Warsaw University of Technology

Spokesperson: John Harris



Institutions: 36
Collaborators: 415
Students: ~50

Russia: MEPHI – Moscow, LPP/LHE JINR–Dubna, IHEP-Protvino

U.S. Labs: Argonne, Berkeley, Brookhaven National Labs

U.S. Universities: Arkansas, UC Berkeley, UC Davis, UCLA, Carnegie Mellon, Creighton, Indiana, Kent State, MSU, CCNY, Ohio State, Penn State, Purdue,Rice, Texas A&M, UT Austin, Washington, Wayne State, Yale