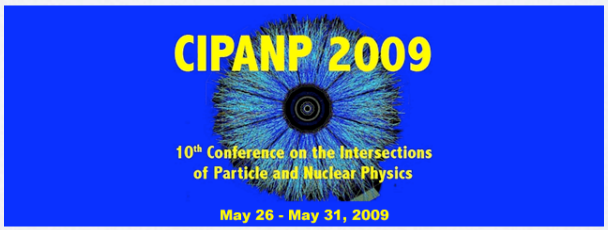
Non Photonic e-D^0 correlations in pp and AA collisions at $\sqrt{s_{NN}} = 200\ GeV$

Artemios Geromitsos
for the STAR collaboration



Overview of the Presentation

Motivation

PYTHIA Simulation

STAR Experiment

Analysis Method

Results in pp Collisions

MicroVertexing Method

Status in AuAu Collisions

Summary and Future Plans

Motivation

MOTIVATION

Heavy quarks are produced in initial state of the collision

M. Gyulassy and Z. Lin, PRC 51, 2177 (1995)

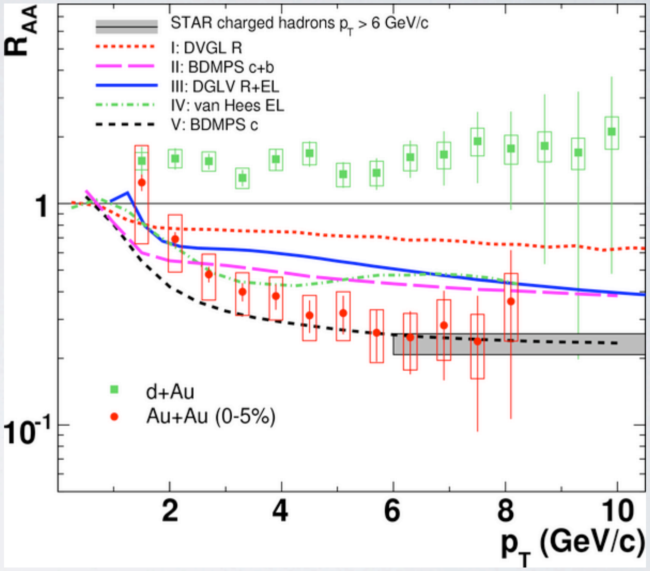
Non photonic electron yield at high pT shows a similar suppression in central AuAu colissions as observed for the light quark hadrons. Not expected according to the <u>*dead-cone effect.*</u>

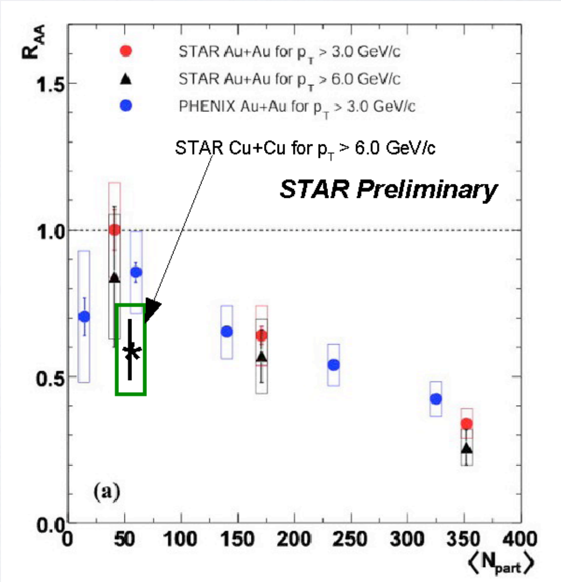
D.Kharzeev et al. Phys Letter B. 519:1999

Theoretical Models explaining the charm and bottom quark energy loss are still inconclusive

Experimentally disentagle the Charm & Bottom contribution

STAR *PRL, 98, 192301 (2007)*





nuclear modification factor

$$R_{AA} = \frac{Yield_{AuAu} / \langle N_{binary} \rangle_{AuAu}}{Yield_{pp}}$$

MOTIVATION (cont'd)

A novel Method separating Charm and Bottom Contribution

<u>Non photonic electrons</u> are used to *trigger* on C or B quark pairs.

D meson is being reconstructed by its <u>hadronic</u> decay: *probe side.*

$$D^0 \rightarrow K^- \pi^+$$

Calculate the Invariant Mass

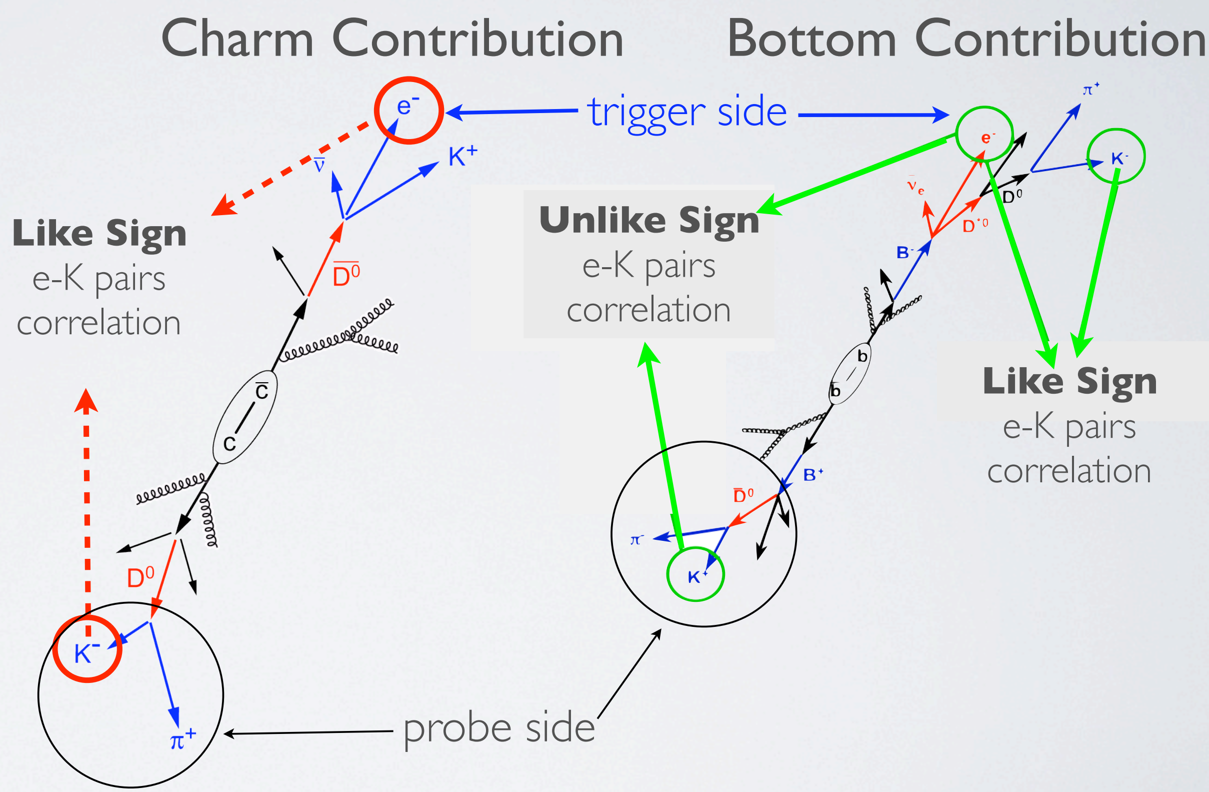
Calculate the Background:

I) Rotational Background

Kaon candidates are rotated by 180 degrees

II)Samesign Background

$$D^0 \nrightarrow K^- \pi^-$$
$$\bar{D}^0 \nrightarrow K^{\not+} \pi^+$$

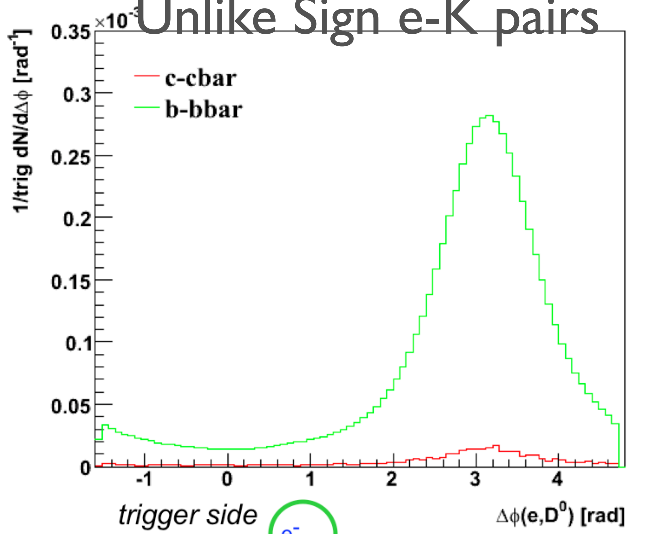


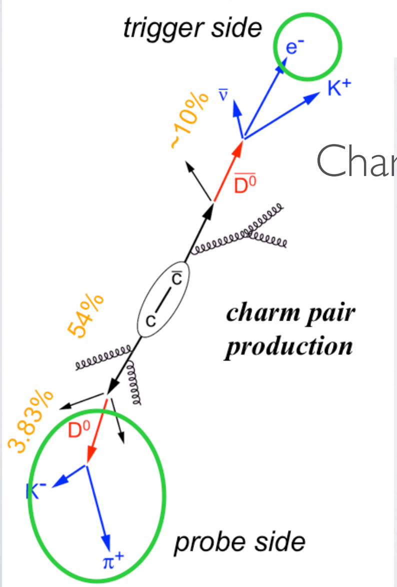
PYTHIA SIMULATION

PYTHIA SIMULATION

Leading Order

Unlike Sign e-K pairs

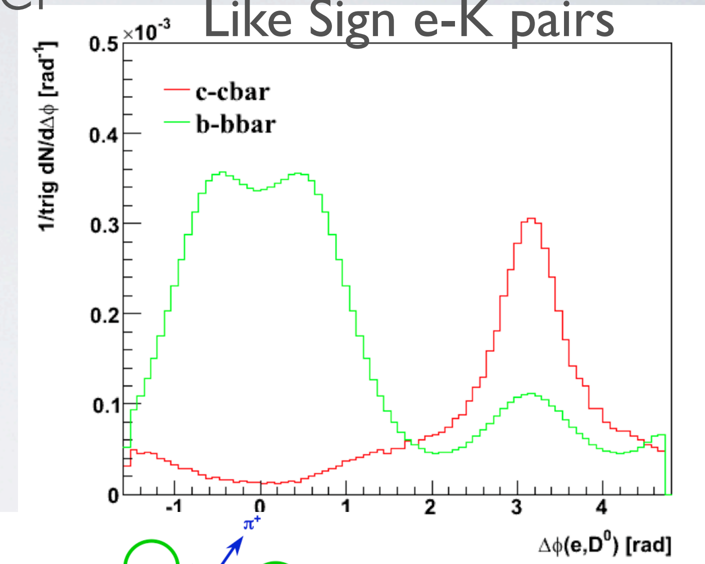


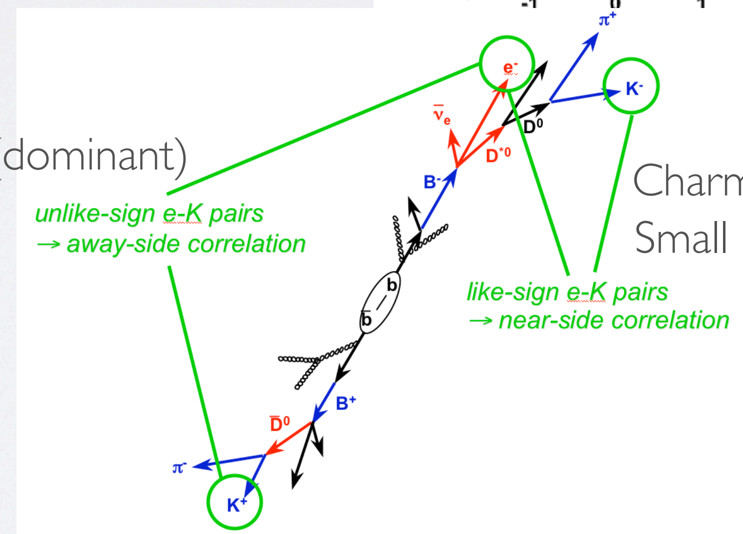


Away Side

Charm contribution(dominant)

Like Sign e-K pairs





Away Side

Charm Flavor contribution

Small Bottom contribution

Near Side

Bottom Decays

Phys. Lett. B671, 361 (2009)

STAR Experiment

STAR DETECTOR

Solenoidal Tracker at RHIC

Tracking and PID:

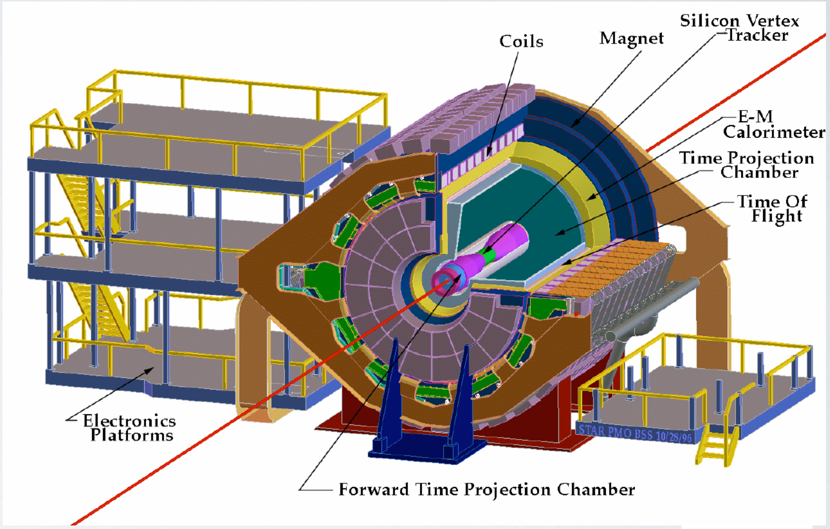
TPC

$|\eta| < 1.5$

$\Delta p/p = 2\text{-}4\%$

$$\frac{\sigma_{dE/dx}}{dE/dx} = 8\%$$

Magnet: $\mathrm{B{=}0.5\ T}$



Energy Measurement:

Barrel EMC

$|\eta| < 1.0$

Lead scintillation $(21\ X_0)$

Shower Maximum Detector

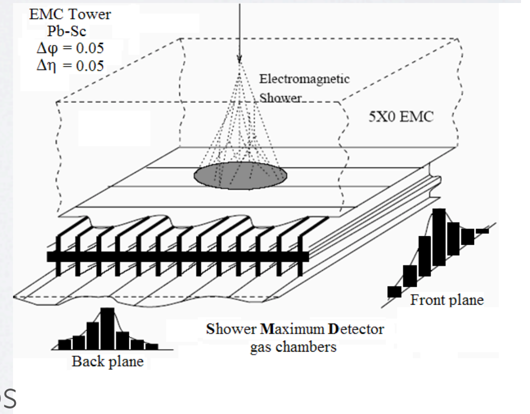
Wire proportional detector with strip readout

Situated at $5\ X_0$

Strip Resolution:

$(\Delta\phi, \Delta\eta) = (0.007, 0.007)$

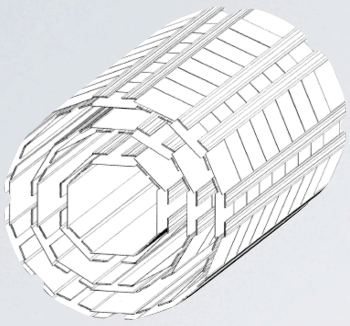
80% of the EM shower energy is being deposited in 2-3 strips



STAR DETECTOR (cont'd)

INNER SILICON DETECTORS

Silicon Vertex Tracker



Silicon Drift Detector

3 layers:

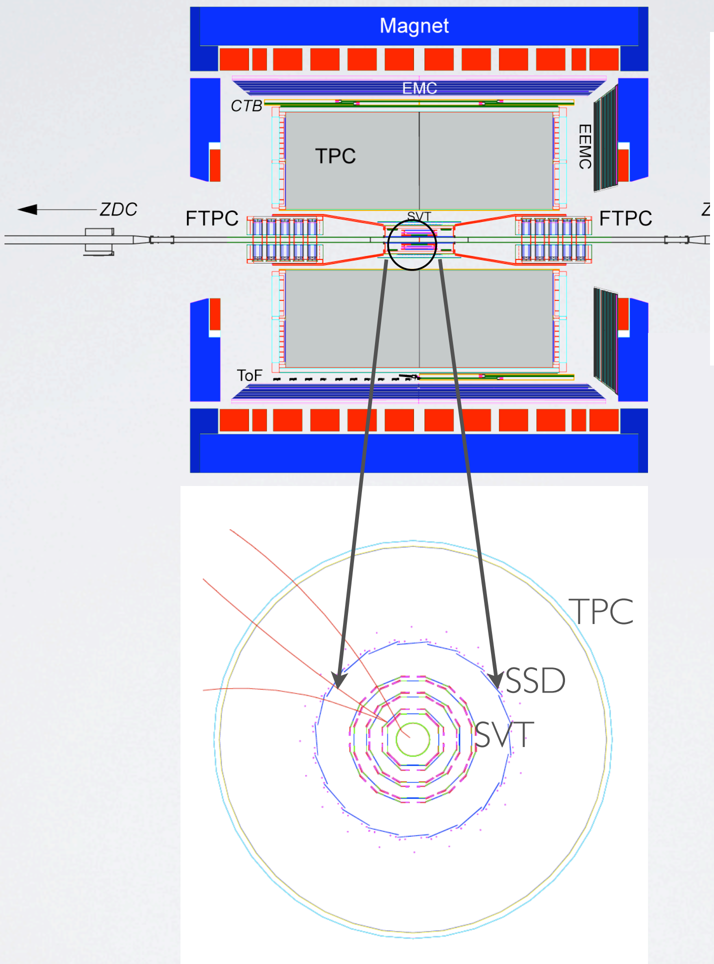
6.85 cm

10.8 cm

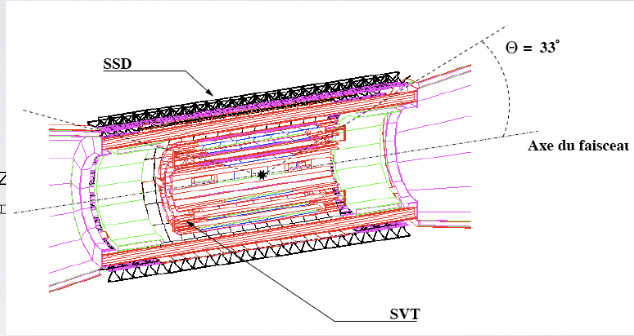
14.7 cm

$\sigma_Z = \sigma_{r\phi} = 40\ \mu m$

$1.5\%\ X_0$ per layer



Silicon Strip Detector



1 layer positioned at: 23 cm

$\sigma_{r\phi} = 30\ \mu m$

$\sigma_Z = 800\ \mu m$

$1\%\ X_0$ per layer

Analysis Methodology

METHODOLOGY

General Event Cuts

|vertex-Z |<30 cm

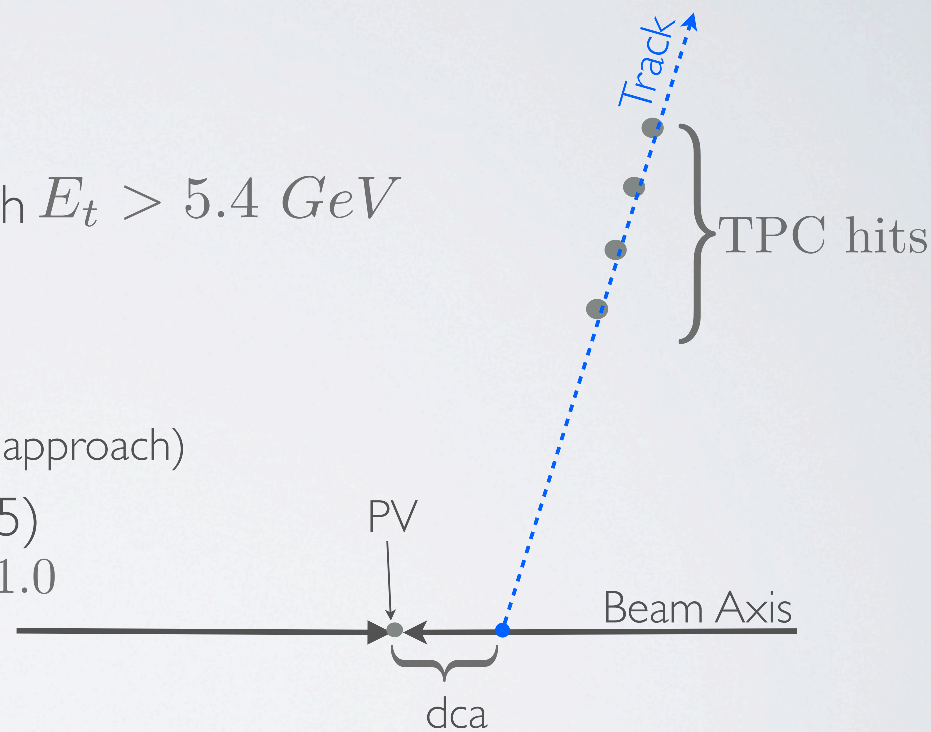
Trigger: Demanding events with $E_t > 5.4\ GeV$

Track Selection

dca <1.5 cm (distance of closest approach)

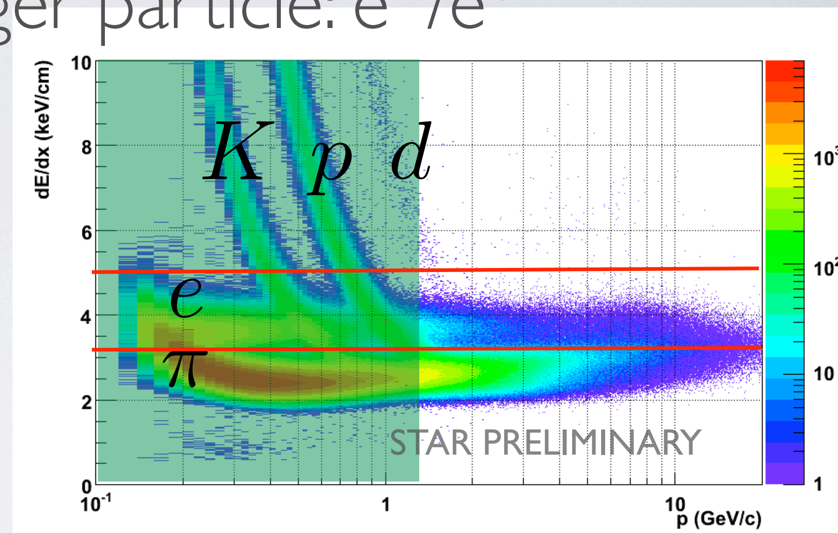
TPC hits >25 (maximum is 45)

pseudorapidity coverage: $|\eta| < 1.0$



METHODOLOGY (cont'd)

Selection of trigger particle: e^-/e^+



Applying Cuts: rejecting region

p measured by the TPC

E measured by the EMC

$$0 < \frac{p}{E} < 2$$

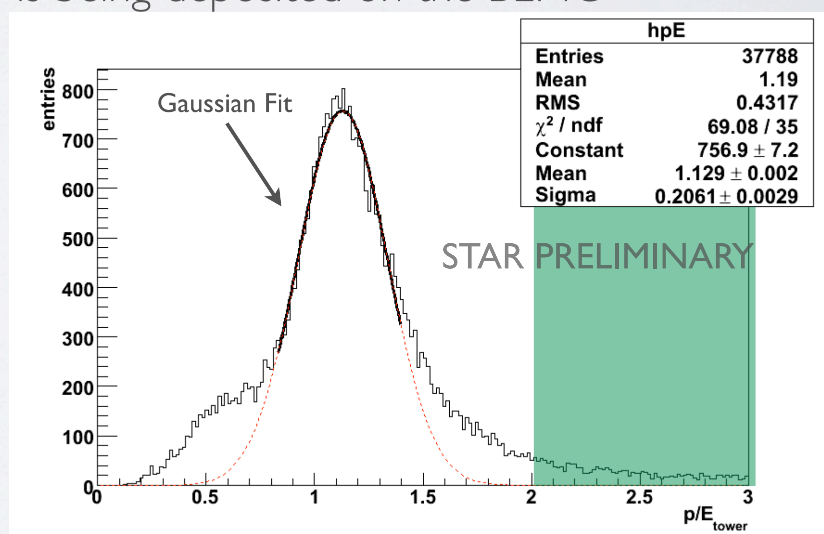
$$3.5 < \frac{dE}{dx} < 5.0 (keV/cm)$$

$$p > 1.5 GeV/c$$

EM showers:

Almost the whole amount of the particle's energy is being deposited on the BEMC

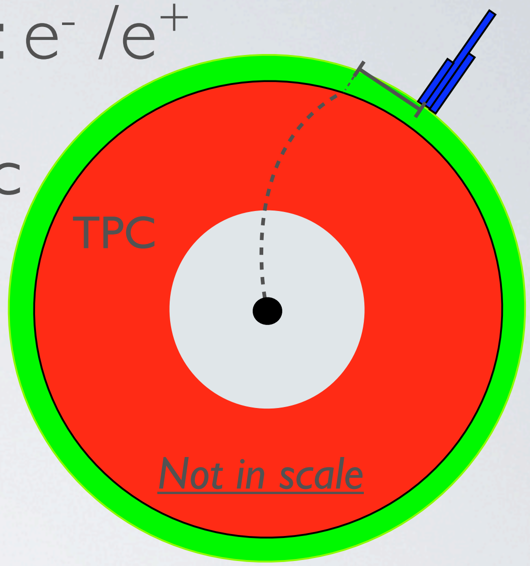
Electrons should peak for p/E=1



METHODOLOGY (cont'd)

Selection of trigger particle: e$^-$ /e$^+$

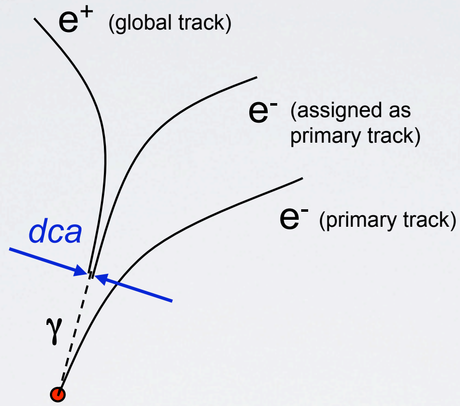
Extrapolate TPC tracks on the BEMC surface and check for nearby towers within a distance



Sources of Contamination:

Photon Conversion (material)

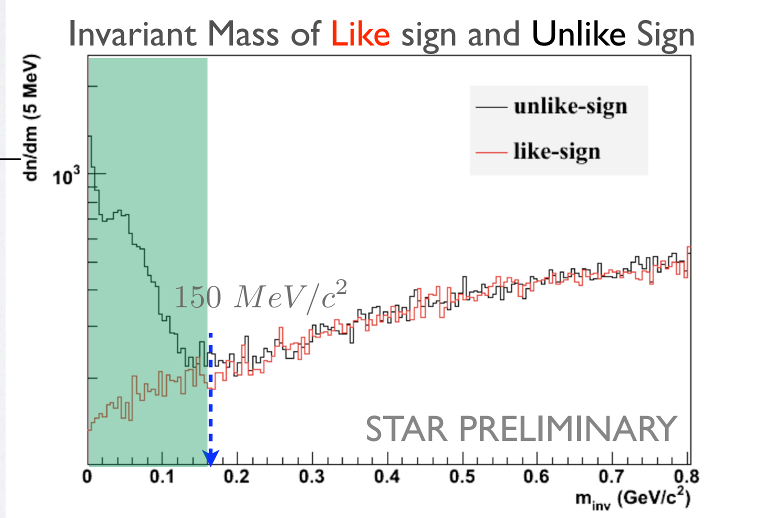
Neutral meson decays π^0, η



Discrimination Method: rejecting region

Calculate the invariant mass of every e^+e^- & e^+e^+/e^-e^-

Superimposing the plots indicates the cut at $150\ MeV/c^2$

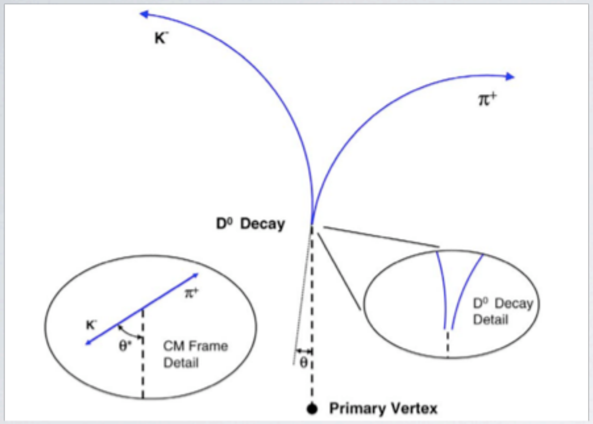


microVertexing

microVertexing

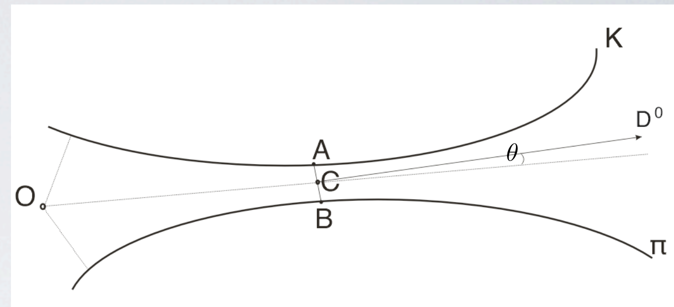
D0 decay topological reconstruction

Finding the displaced vertex of D^0

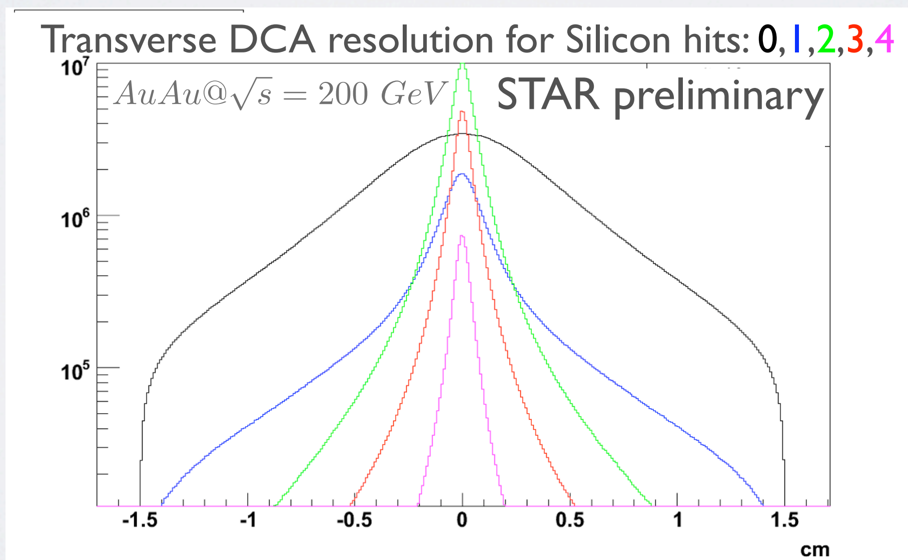


$\cos\theta^*$ in the C.M

$c\tau = 123\mu m$
$D^0 \to K^-\pi^+$



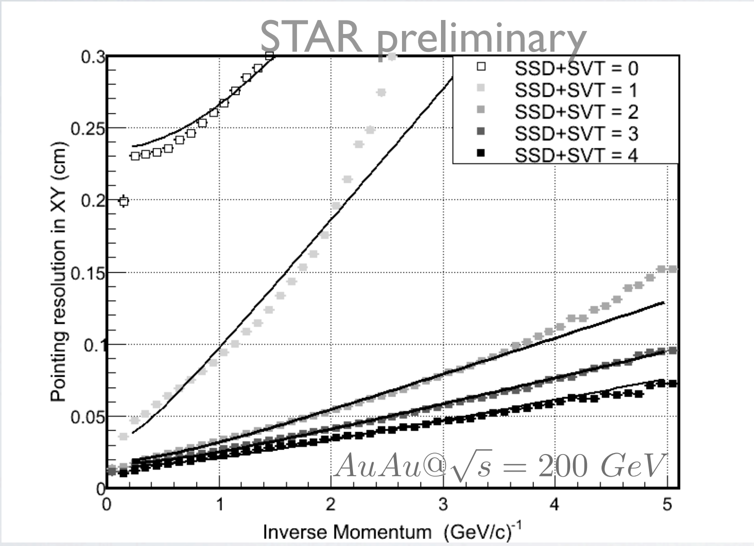
DCA between daughters: $|\vec{AB}|$
DCA of parent to PV: $|\vec{OC}|\sin\theta$
Decay Length of $K\pi$ pair: $|\vec{OC}|$

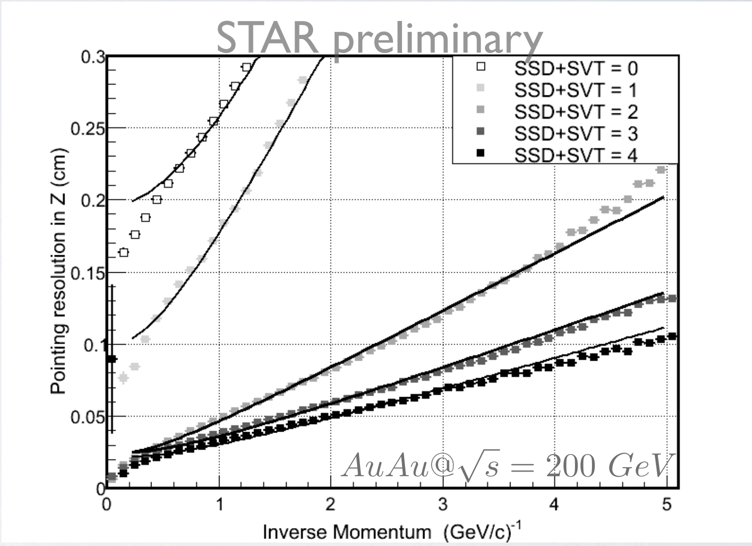


$$\cos\theta = \frac{\vec{OC}\cdot\vec{P}_{D^0}}{|\vec{OC}||\vec{P}_{D^0}|}$$

microVertexing (cont'd)

Transverse(XY) and longitudinal(Z) DCA resolution





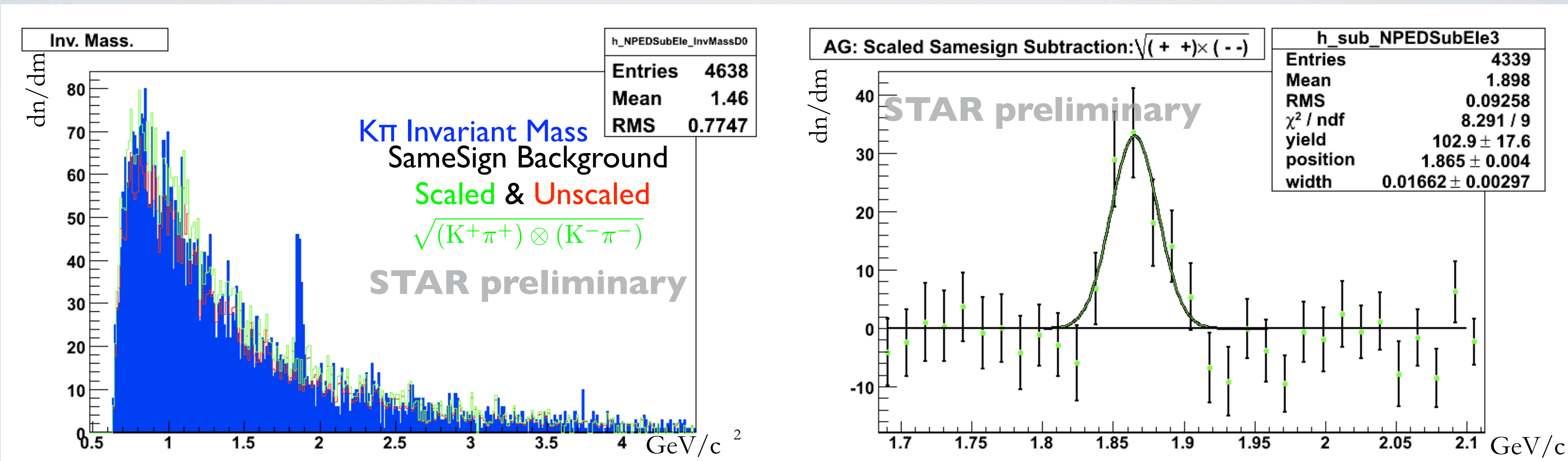
$$\sigma(p) = \sqrt{a^2 + \frac{b^2}{p^2}}$$

Improvement of resolution with the inclusion of Silicon Detectors

pp2006 results

PP2006 RESULTS

Monte Carlo(PYTHIA+GEANT)

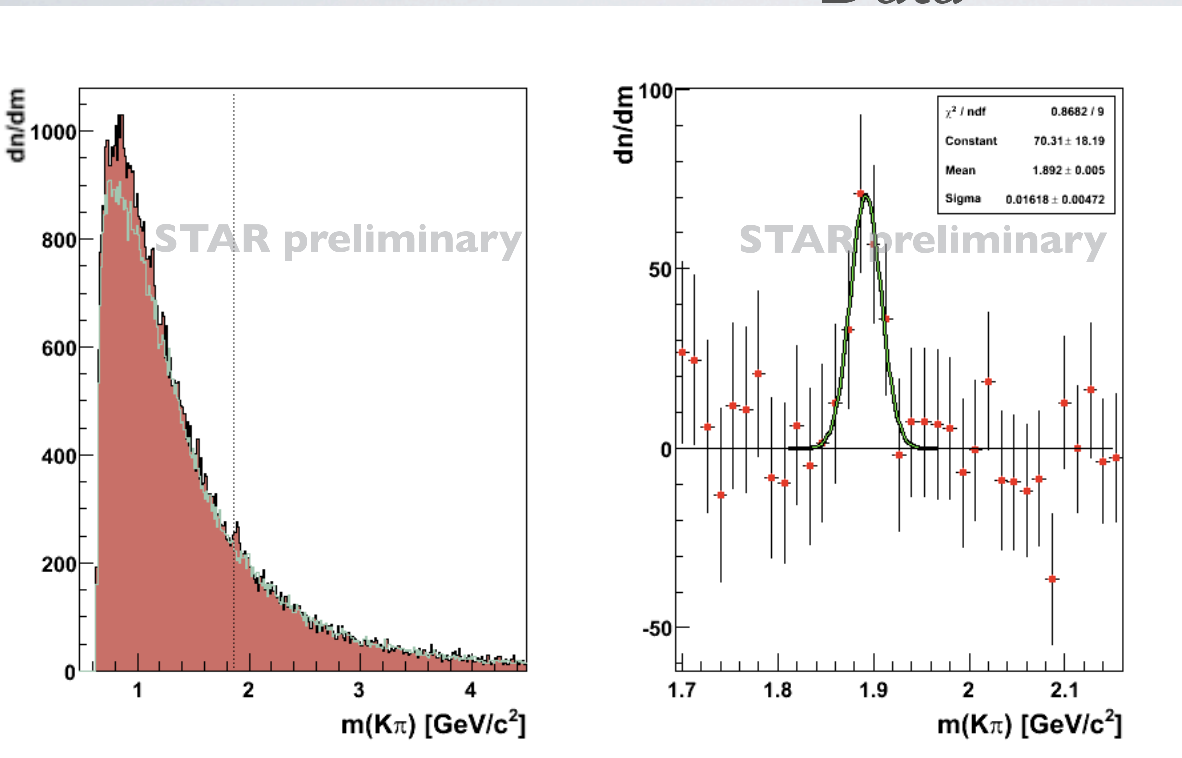


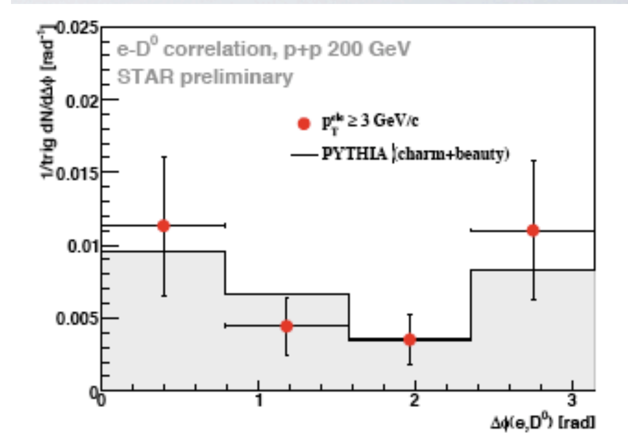
Fit results: Peak position m = 1865 ± 4 MeV/c^2

Width of the signal σ_m = 17 ± 3 MeV/c^2

PP2006 RESULTS

Data





Charm to beauty ratio is in agreement with PYTHIA simulations

J. Phys. G35, 104117 (2008)

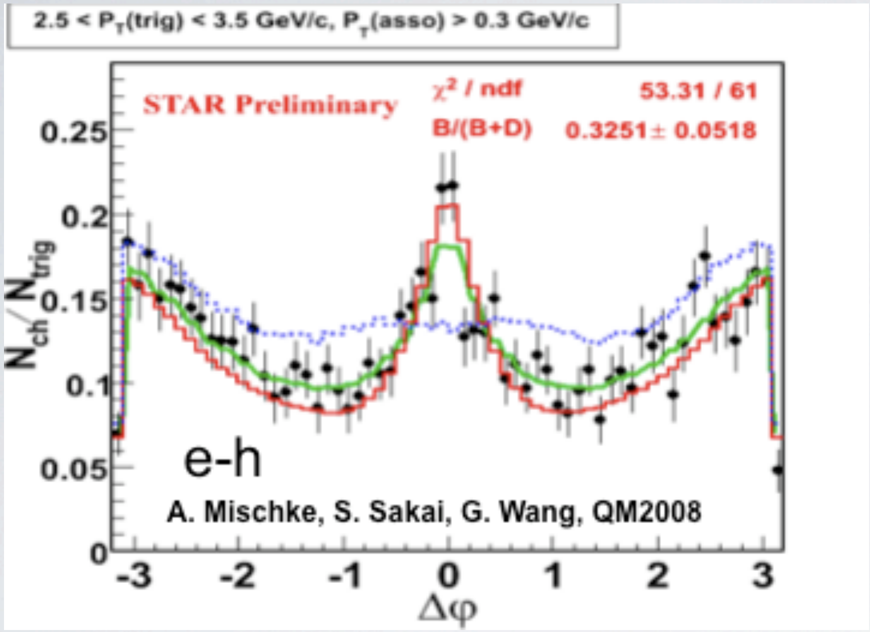
Fit results: Peak position m = 1892±5 MeV/c^2

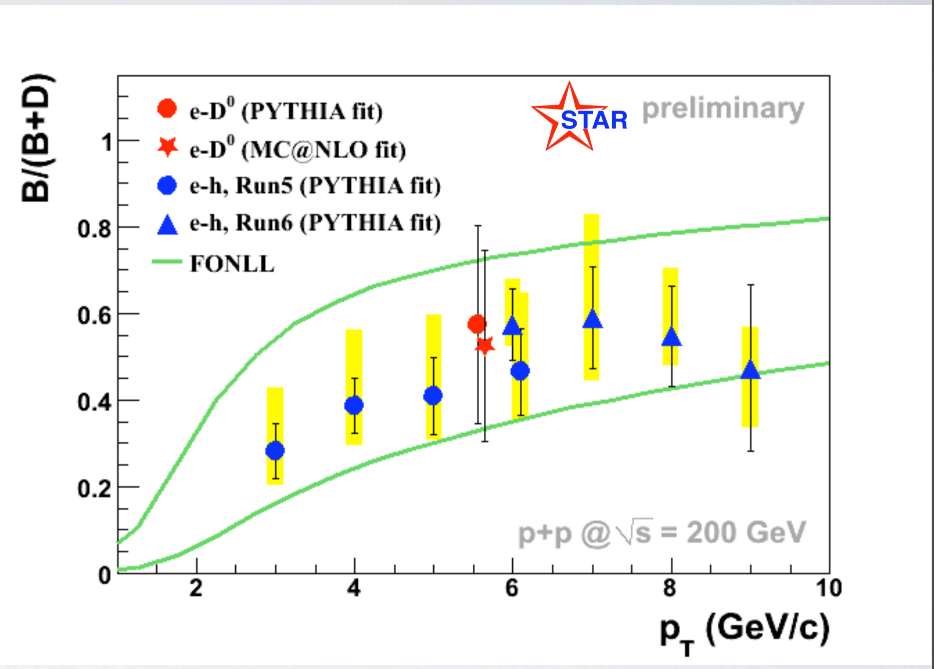
Width of the signal σ_m = 16±5 MeV/c^2

Signal-to-background ratio ~0.14%

Signal significance ~3.7

Heavy flavor contribution to non-photonic electrons in pp collisions





B much heavier than D:
Sub leading electrons get
a larger kick from B
Near side e-h correlation is broadened

B contribution to non photonic electrons
is ~50% at pT~ 5 GeV/c,
based on e-h and e-D correlations

J. Phys. G35, 104117 (2008)

$$AuAu@\sqrt{s_{NN}} = 200\ GeV$$

MinBias

$AuAu@\sqrt{s_{NN}} = 200\ GeV$ Analysis including Silicon Detectors at low multiplicity

$\text{Nr. of tracks} < 100$

$SVT + SSD > 0$

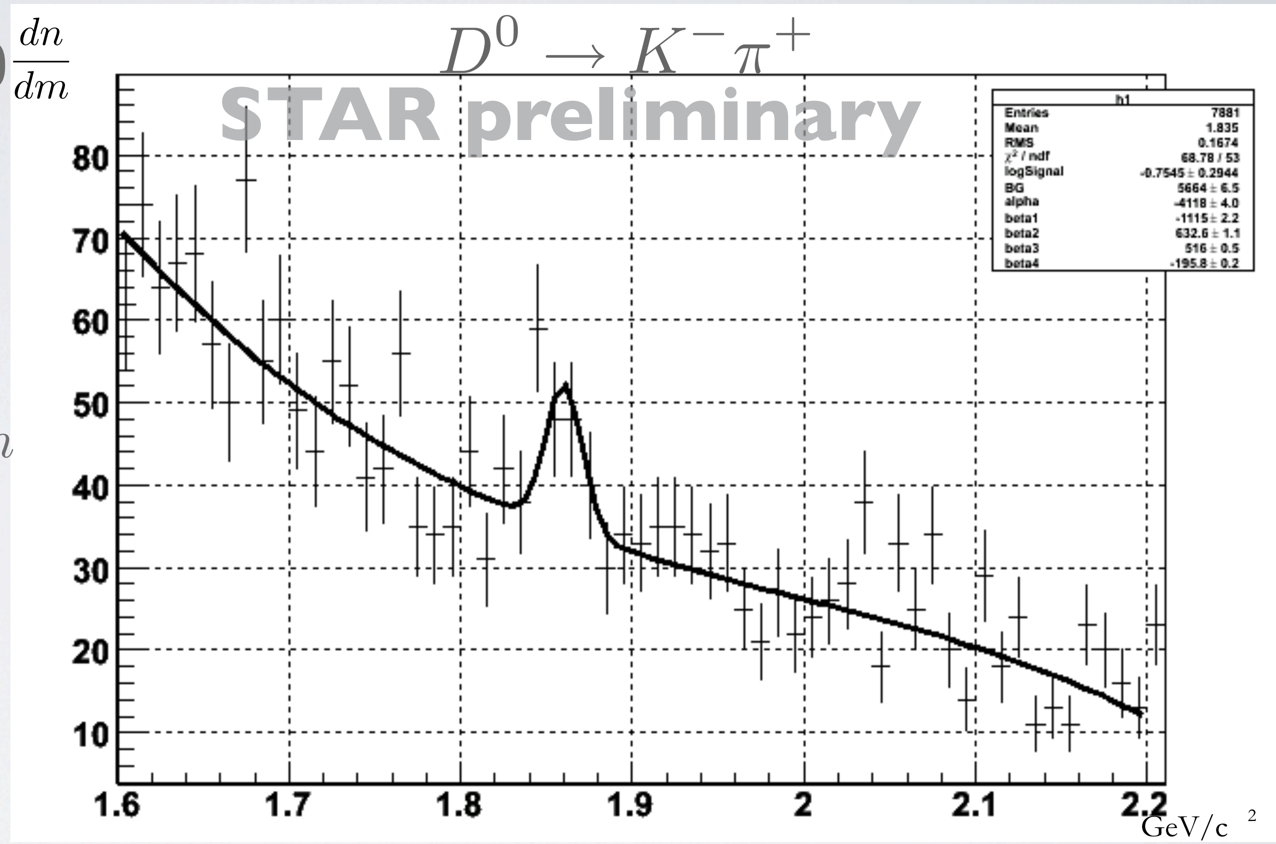
$|\eta| < 1.8$ parent

$|\eta| < 1$ daughters

$\text{Decay Length} < 700\ \mu m$

$|vtxZ| < 10\ cm$

$p_T > 0.3\ GeV/c$



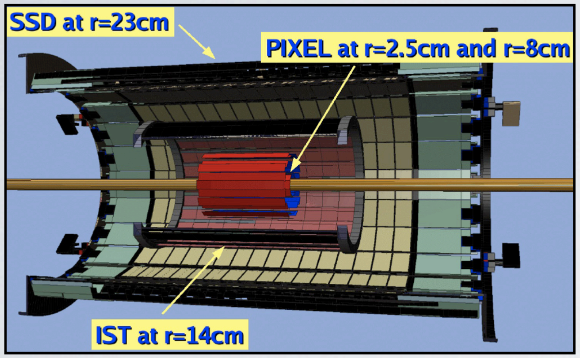
Heavy Flavor Tracker

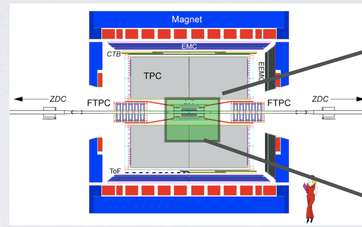
The New Silicon Detector at STAR

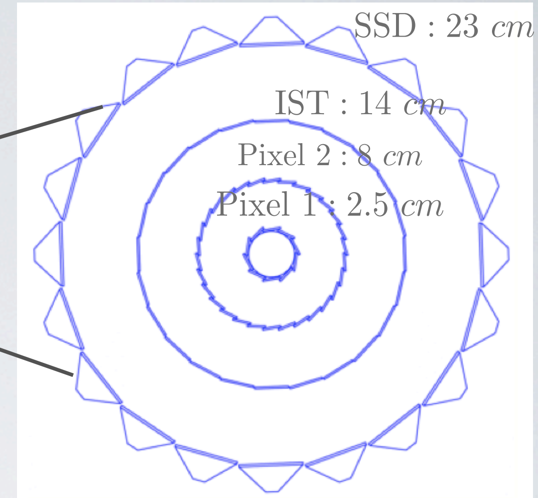
HEAVY FLAVOR TRACKER

Quark Matter 09

J.Bouchet poster: 907







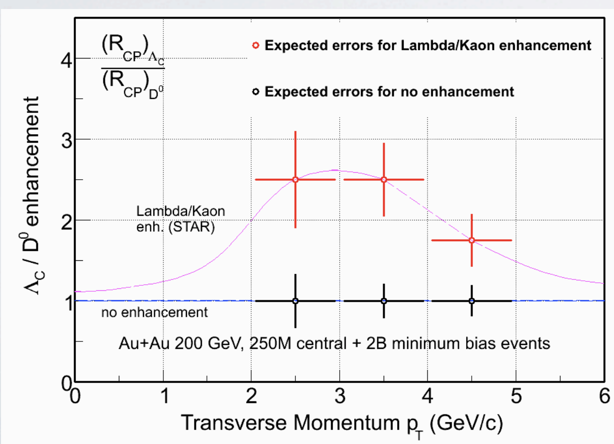
Key measurements of HFT

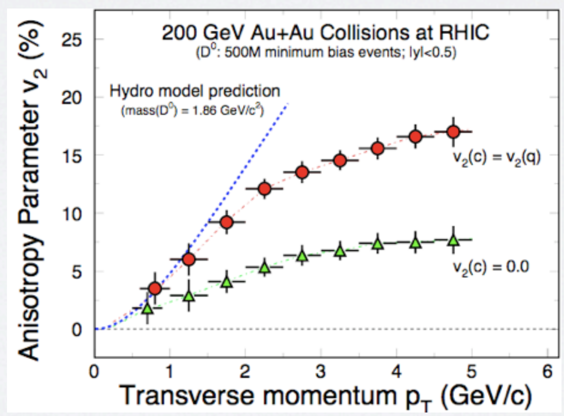
Bottom cross sections

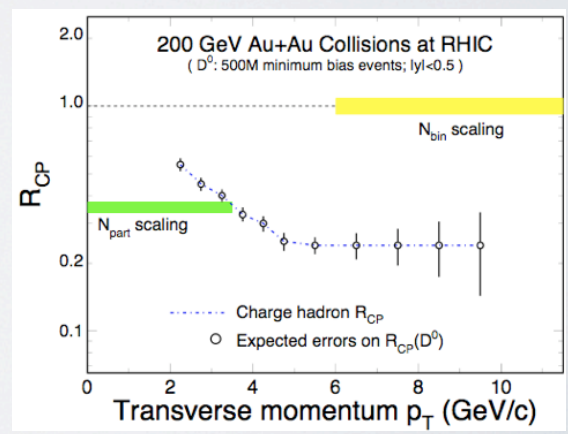
v2 and Rcp of D0

Charm baryon

	Technology	Hit resolution R-ϕ (μm - μm)	Radiation Length
SSD	double sided strips	30 - 857	1% X_0
IST	Silicon Strip Pad sensors	170 -1700	1.2% X_0
PIXEL	Active Pixels	8.6 - 8.6	0.3% X_0







Summary & Plans

Summary & Future Plans

Summary

Heavy quark decay electrons show the same suppression as the light quarks.

Importance to distinguish the contribution of charm and beauty.

e-h and e-D are the two methods to separate the signal of charm and bottom contributions due to their different decay kinematics

At $pp@\sqrt{s} = 200\ GeV$,(2006) this method was applied succesfully providing yields in agreement with PYTHIA predictions.

MicroVertexing techniques have been developed and succesfully applied in AuAu collisions.
We can see a hint of a D^0signal with the help of inner silicon detectors

We are working on understanding cuts, optimization, PID and quite a lot on silicon tracking and calibrations. So, stay tuned.

Plans

Next plan is to apply in AuAu collisions and to combine the e-D0 and microVertexing methods in. order to extract the C/B ratio.

The Heavy Flavor Tracker will be the next STAR upgrade to improve microVertexing.