Excited QCD 2011

Electron-D^0 azimuthal correlations with STAR at RHIC

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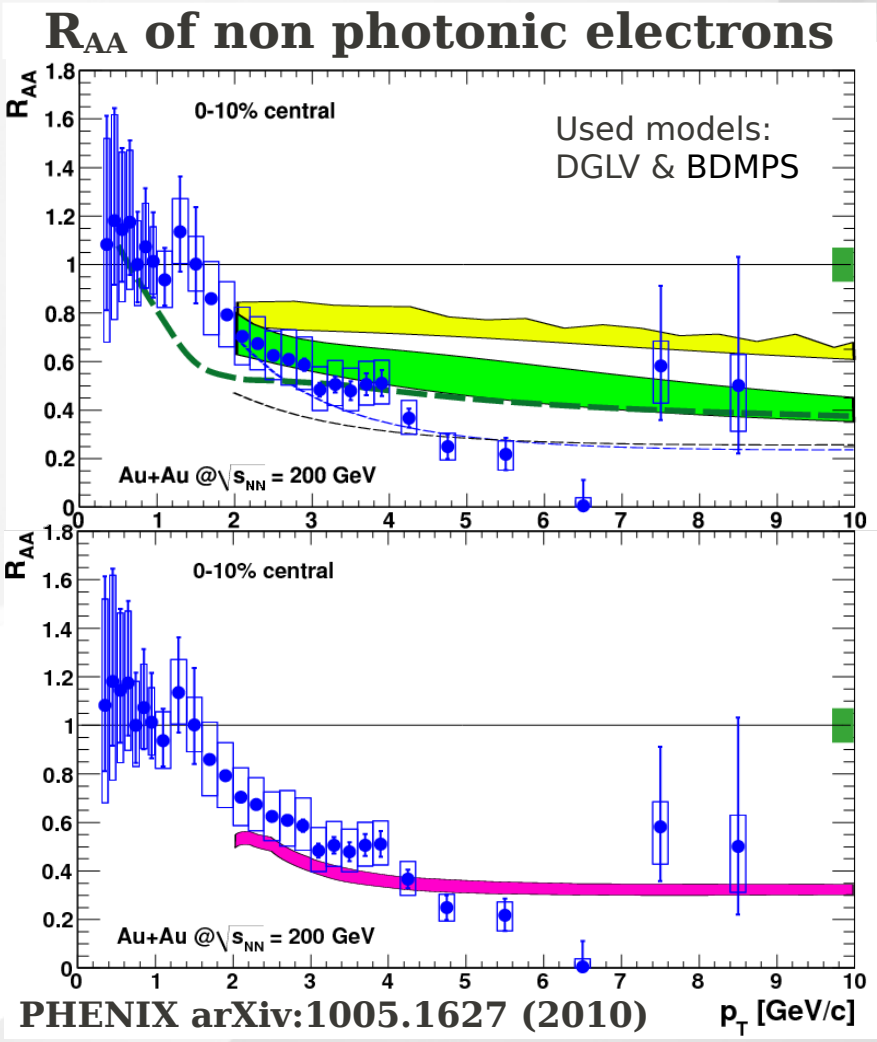
for the STAR collaboration

Motivation

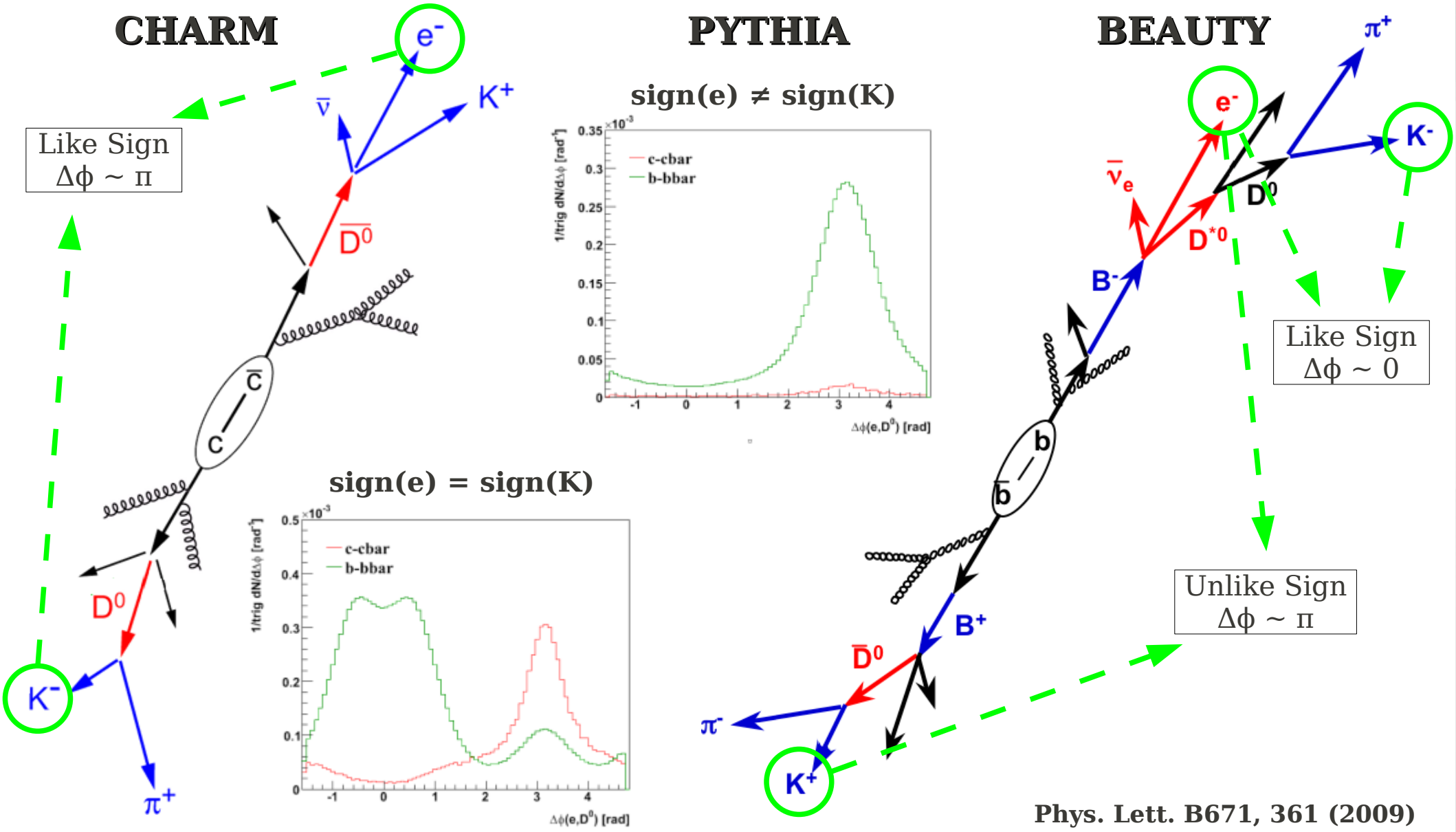
Suppression in non photonic electron yields for B and D meson decays in central AuAu collisions

$$R_{AA} = \frac{Yield^{AA} / \langle N^{AA}_{binary} \rangle}{Yield^{pp}}$$

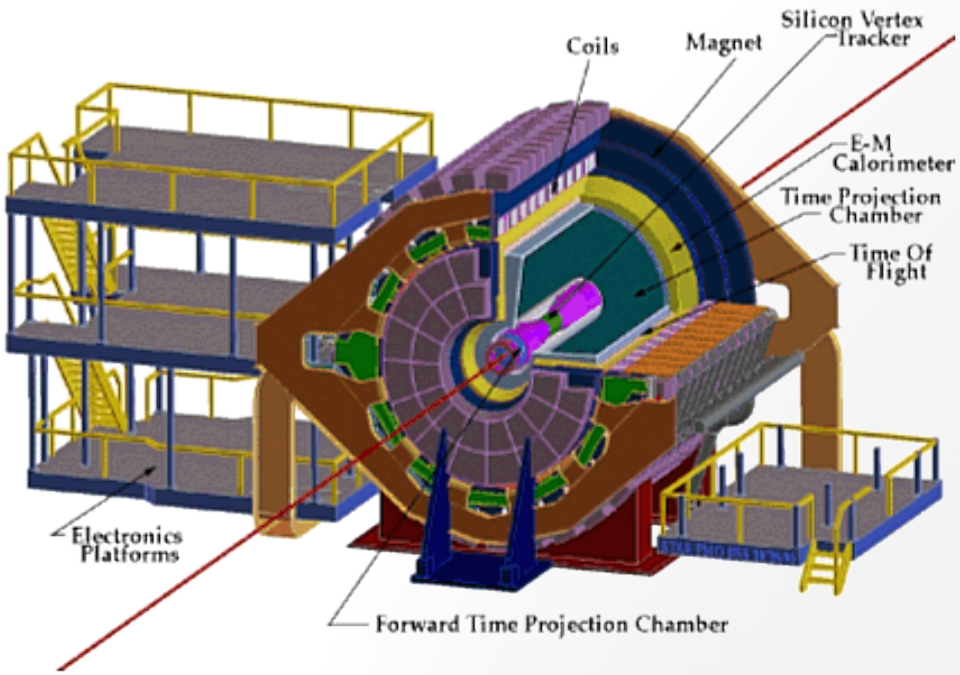
- **Similar** as observed for the **light quark hadrons**
- **Not expected** (dead cone-effect)
  D.Kharzeev et al. Phys Letter B. 519:1999
- **Theoretical Models** explaining the charm and bottom quark energy loss **are still inconclusive**
- Need for separation of D/B contributions in the spectra of non photonic electrons



Charm and beauty contributions



The STAR Detector



Solenoidal Tracker at RHIC

Magnet

B = 0.5 T

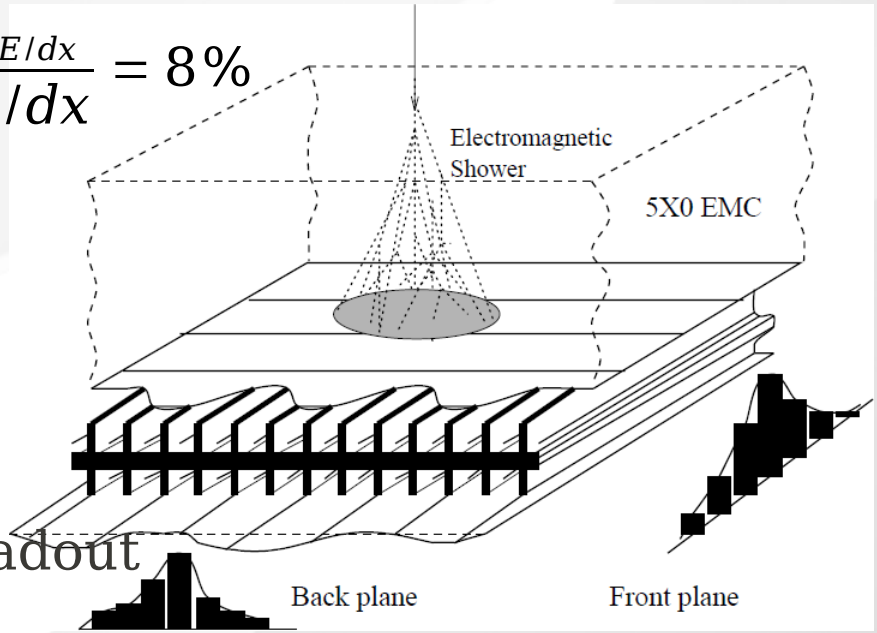
TPC

Main tracking and PID device

$|\eta| < 1.5$

$\Delta p/p = 2-4\%$

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



Barrel EMC

Electron energy measurement

Lead scintillator (21 X_0)

$|\eta| < 1.0$

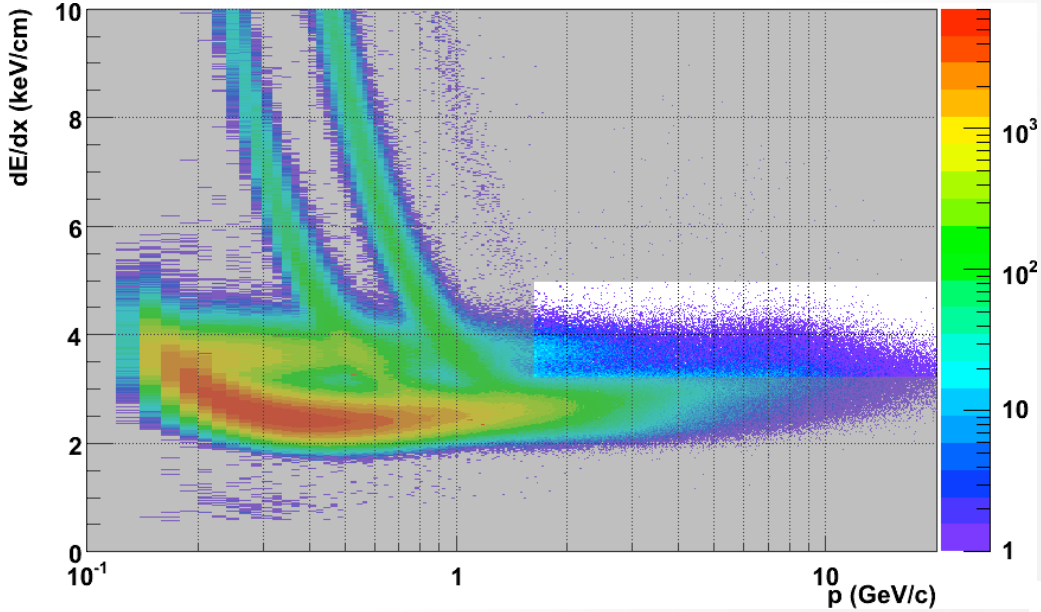
Shower Maximum Detector

Wire proportional detector with strip readout

Situated at 5 X_0

Resolution: $(\Delta\phi;\Delta\eta)=(0.007;0.007)$

Trigger particle selection



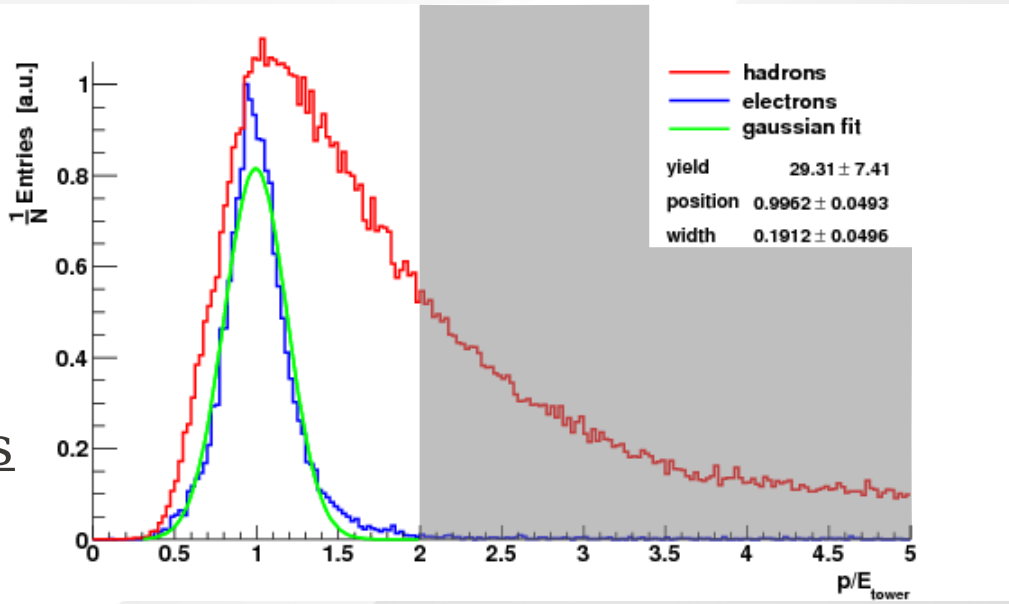
PID cuts [TPC]

- Electrons band:
  dE/dx ∈ (3.5; 5.0) [keV/cm]
- Away from overlapping region
  p > 1.5 [GeV/c]

PID cuts [EMC]

- p/*E* ∈ *(0; 2)*
  p – momentum from TPC
  E – energy of the shower

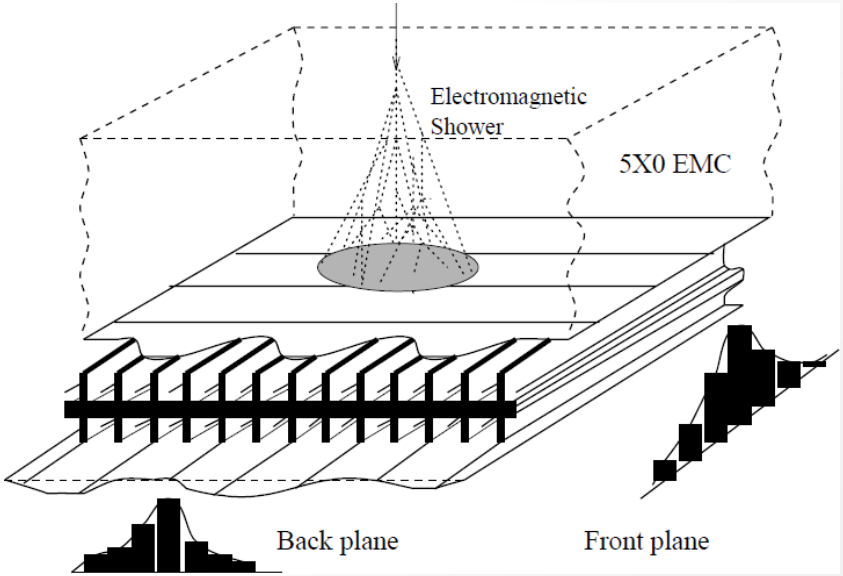
Should have a peak ~ 1 for electrons



Trigger particle selection

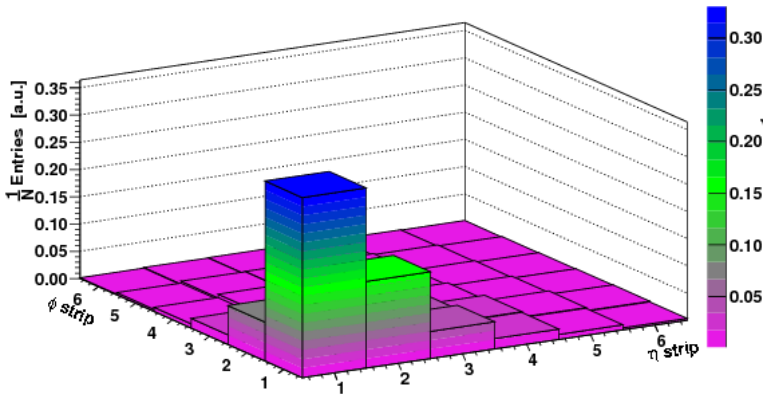
PID cuts [SMD]

Shower Maximum Detector

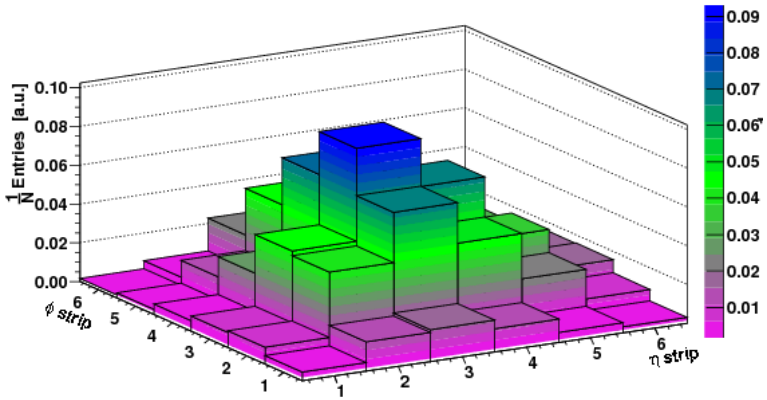


80% of the EM shower energy is being deposited in 2-3 strips

Hadron shower



Electron shower

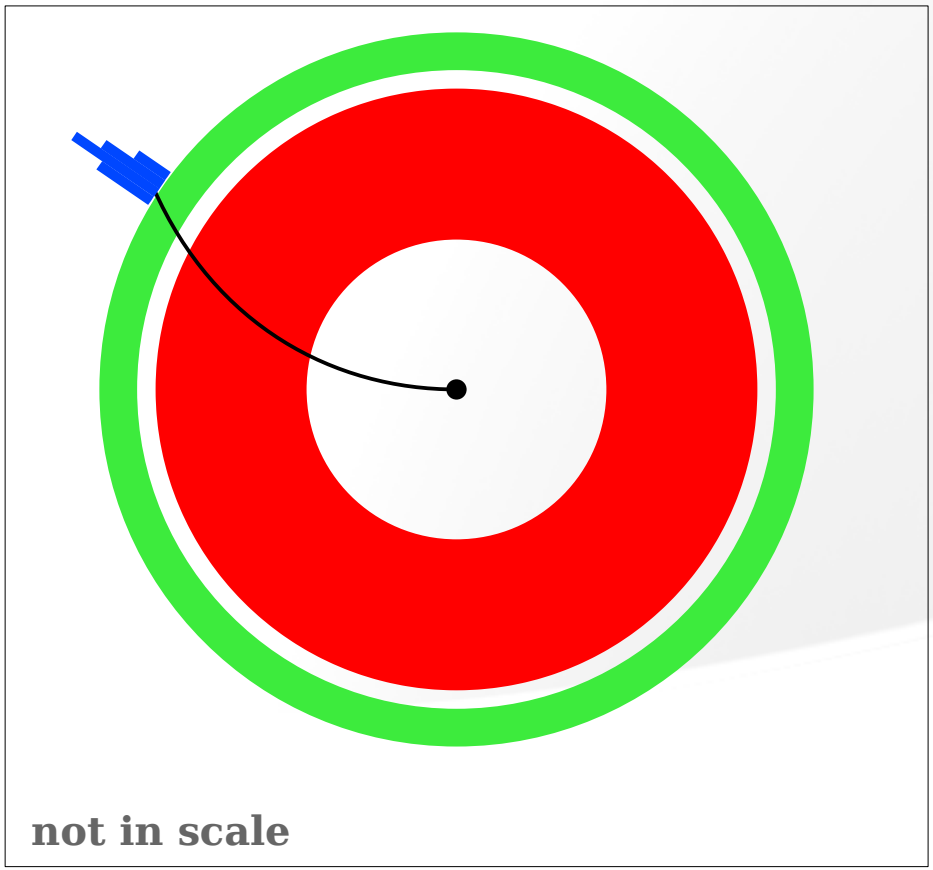


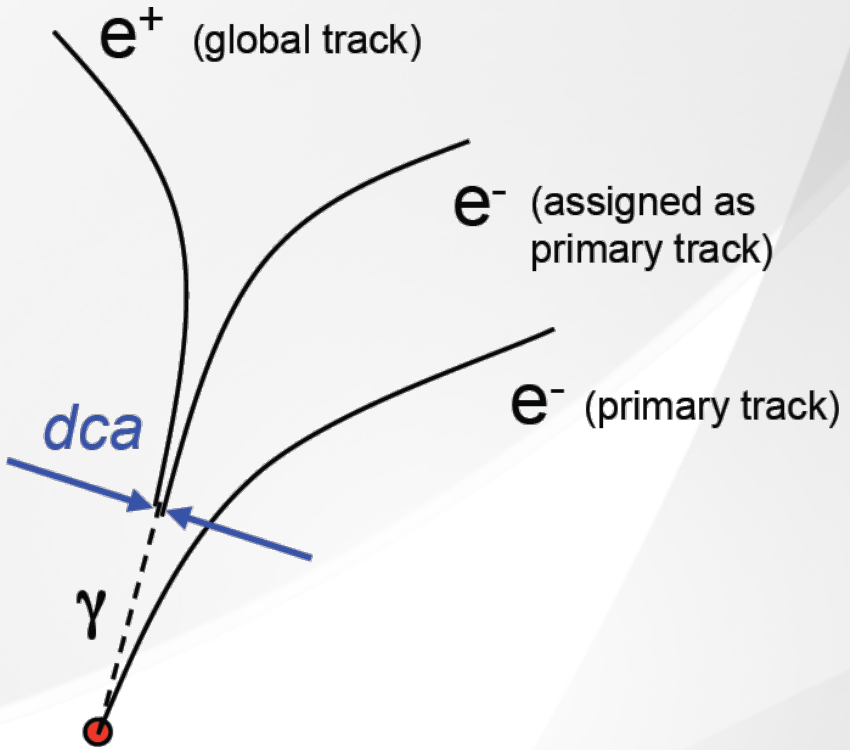
Electron shower is broader than the one that comes from hadron

$SMD_\eta > 1$
$SMD_\phi > 1$

Trigger particle selection

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





Sources of Contamination:

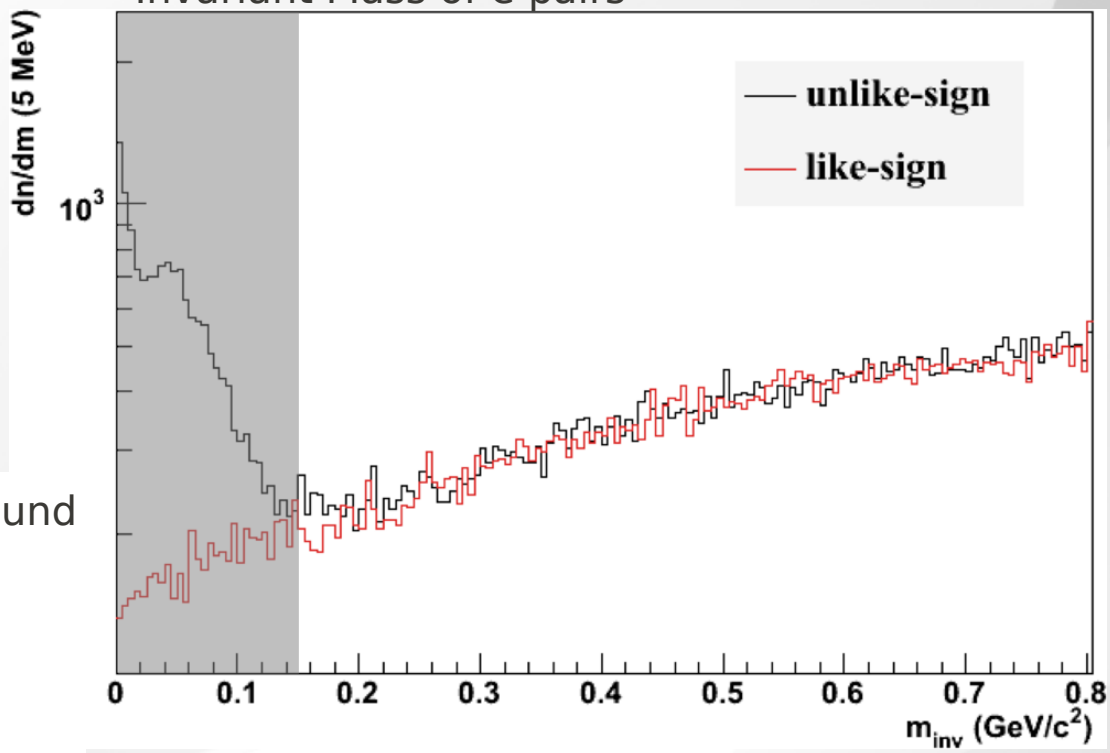
- Photon Conversion (material)
- neutral meson decays (π^0, η)

Trigger particle selection

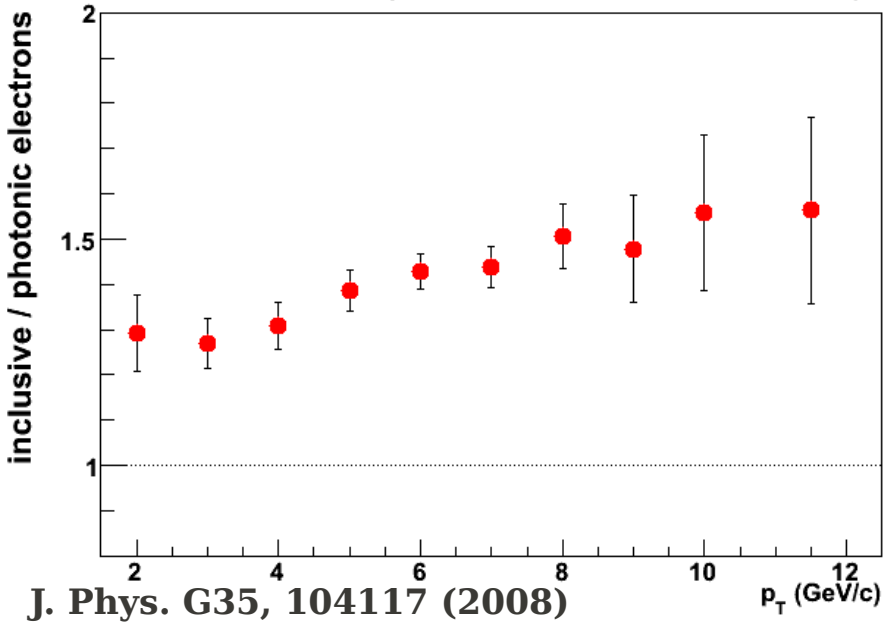
Discrimination Method:

- Calculate the invariant mass of every e^+e^- and e^+e^+/e^-e^-
- Superimposing the plots indicates the cut at 150 MeV/c^2

Invariant Mass of e pairs



Ratio of inclusive to photonic electron background

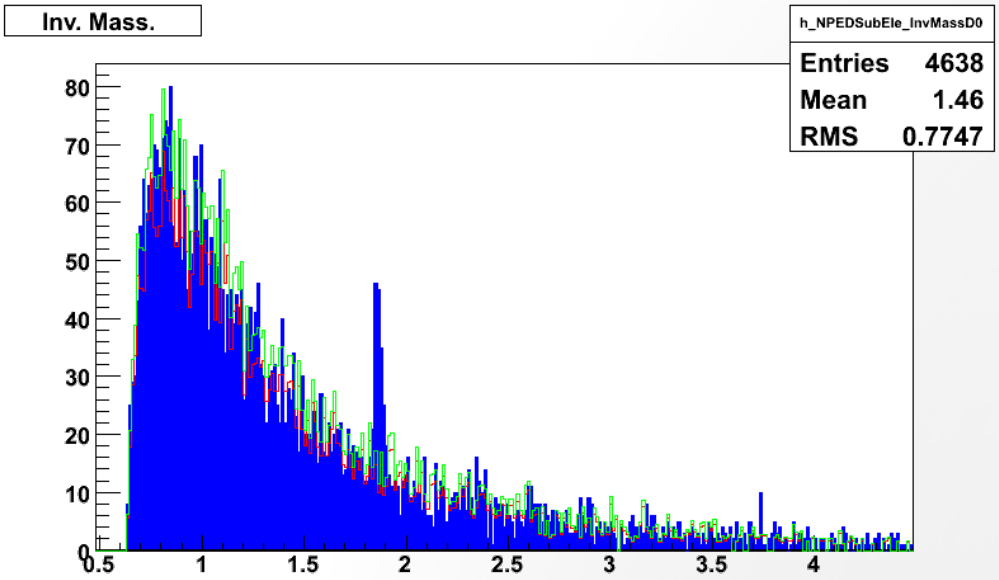


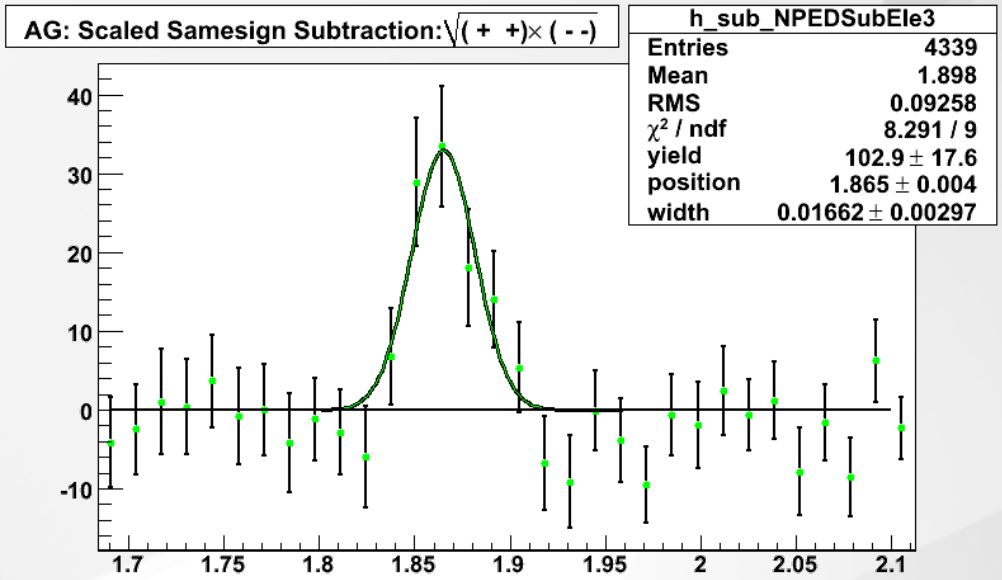
Removes up to 70% of the photonic electrons

p+p Results

p+p Results

Monte Carlo (PYTHIA+GEANT)





Fit results

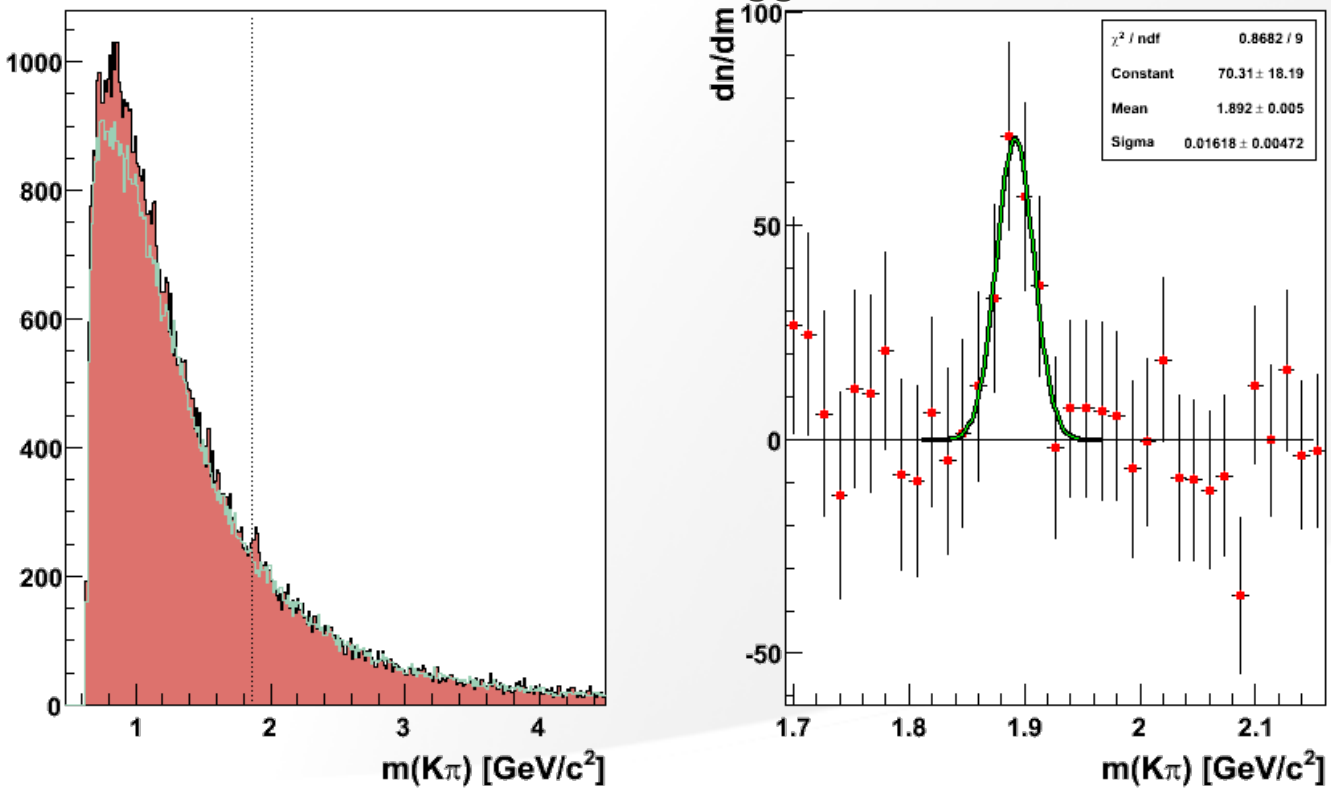
Peak position m = 1865 ± 4 MeV/c^2

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

p+p Results

Data

Invariant Mass from electron triggered events



Fit results

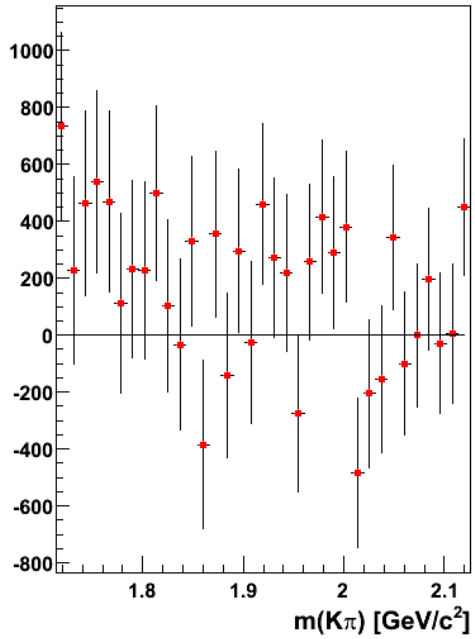
Peak position m = 1892±5 MeV/c^2

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

Signal-to-background ratio ~0.14%

Signal significance ~3.7

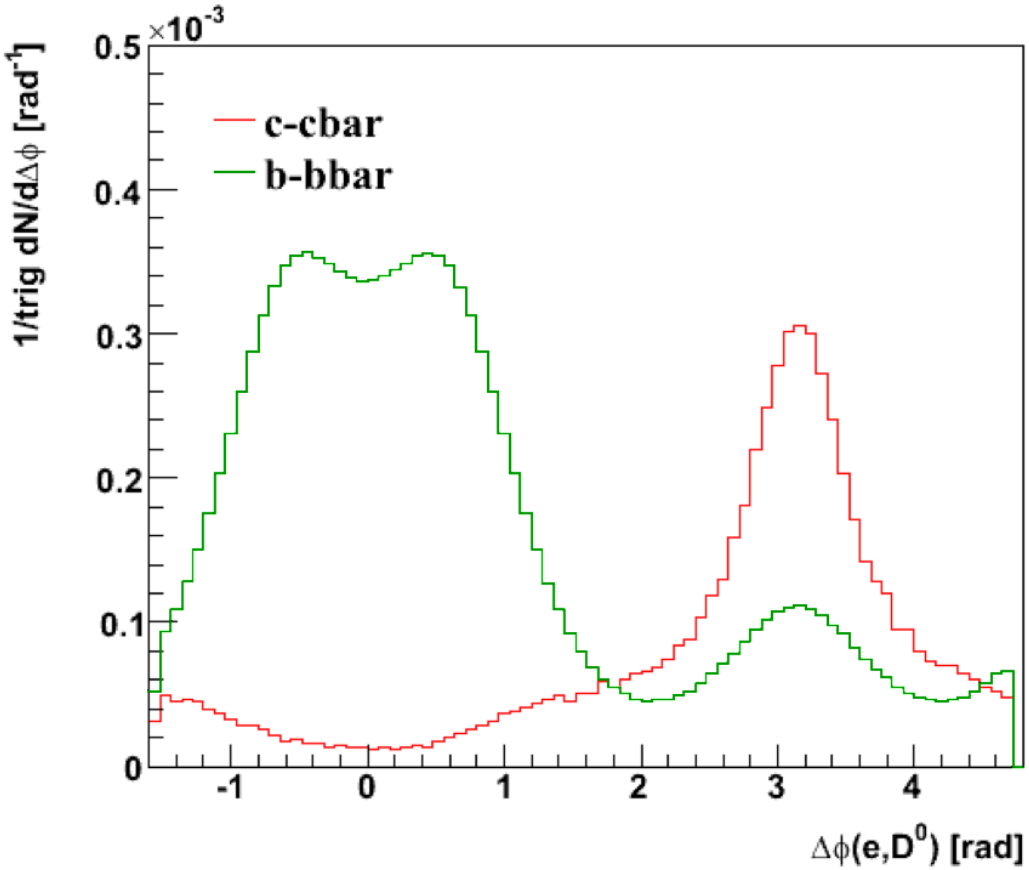
Without electron trigger

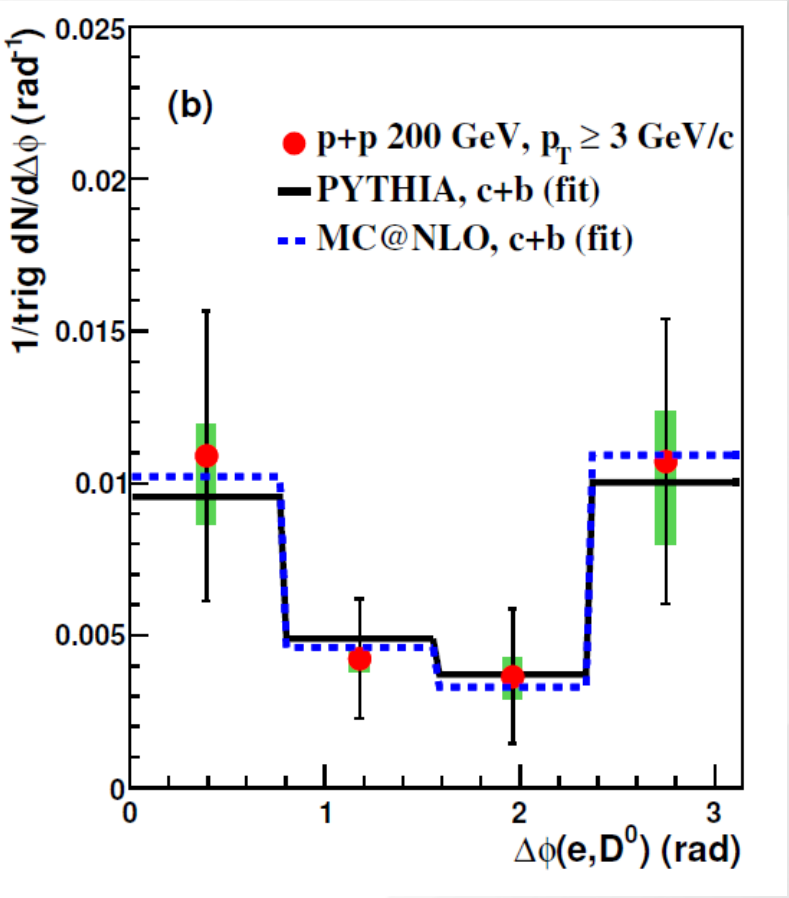


Demand on electron triggered events reduces background **by a factor of 100**

J. Phys. G35, 104117 (2008)

p+p Results



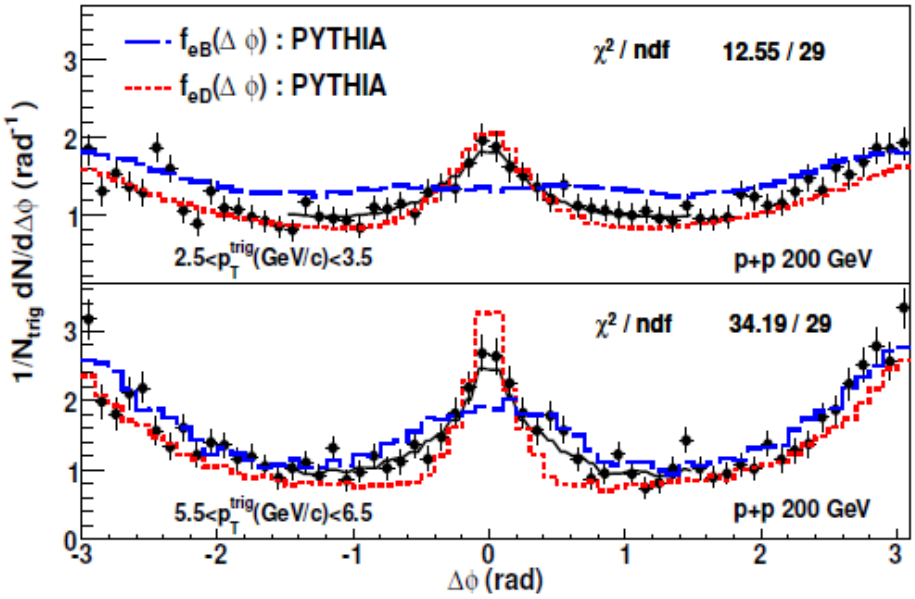


Charm to beauty ratio obtained form the real data is in agreement with PYTHIA simulations

STAR arXiv:1007.1200 (2010)

p+p Results

Heavy flavor contribution to non-photonic electrons



B much heavier than D

↓

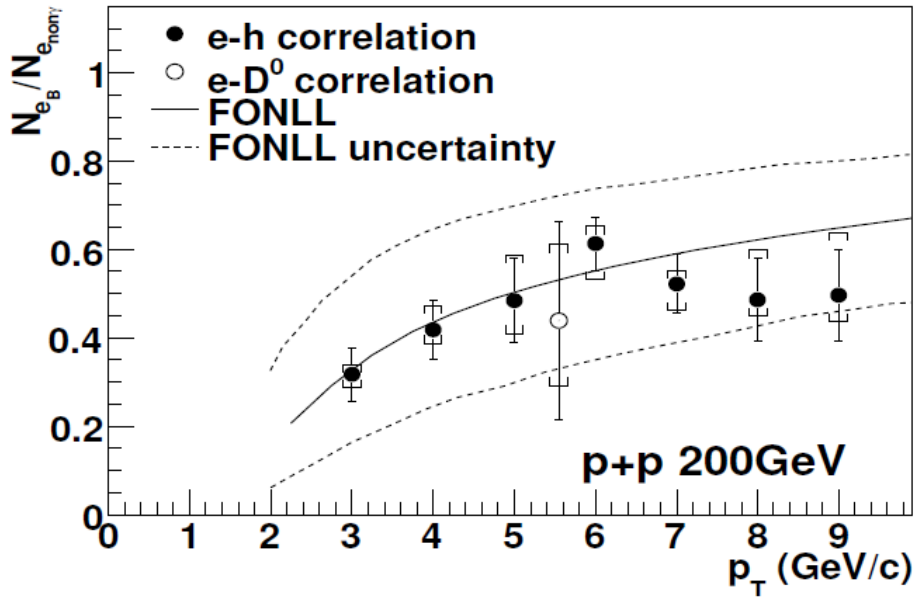
Sub leading electrons get a larger kick from B

↓

Near side e-h correlation is broadened

Conclusion from e-h and e-D correlations:

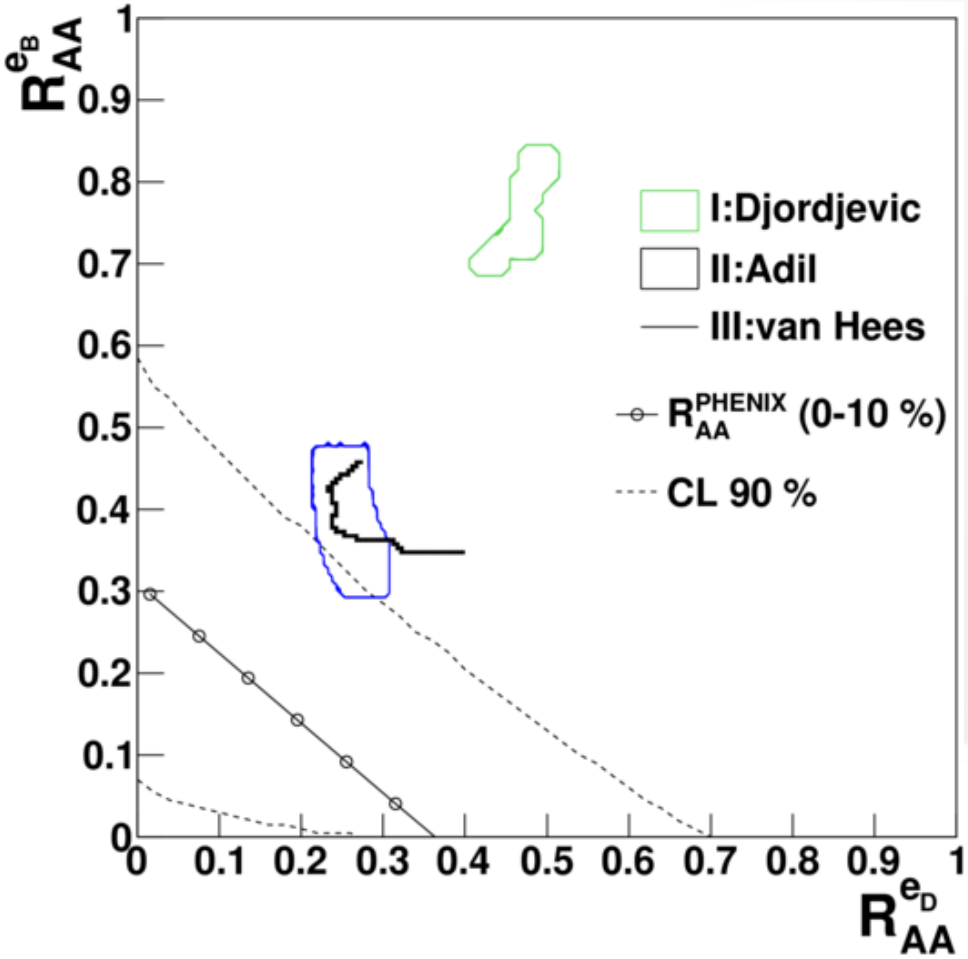
<u>B contribution to non photonic electrons is ~50% at p_T~ 5 GeV/c</u>



STAR arXiv:1007.1200 (2010)

Beauty contribution in central Au+Au

Beauty and Charm nuclear modification factors



Confidence level contours for the R_{AA} for beauty and charm are determined from:

- R_{AA} of NPE p_T>5 GeV/c (Phenix)
- B/(C+B) from e-h and e-D^0 correlations for p_T>5 GeV/c (STAR).

$$R_{AA}^{HF} = (1 - r_B) R_{AA}^{e_D} + r_B R_{AA}^{e_B}$$

$$r_B = N_{e_B} / (N_{e_B} + N_{e_D})$$

Beauty is suppressed in Au+Au collisions!

R_{AA} of e from beauty at p_T> 5 GeV is < 0.6 at CL 90% even if electrons from charm are completely suppressed.

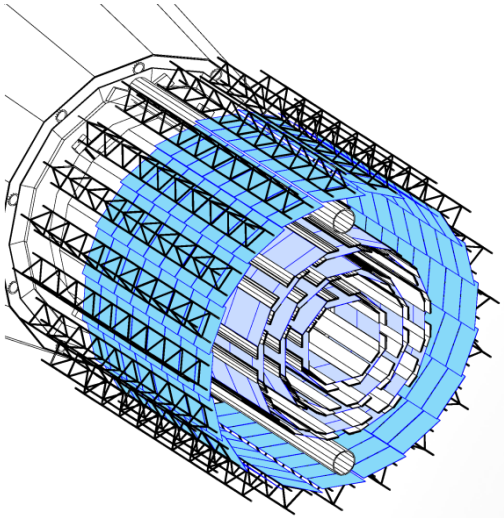
↓

Separate measurement of R_{AA} for B and C in Au+Au is crucial!

Au+Au Analysis

The STAR Detector

Silicon Tracking System



Silicon Strip Detector

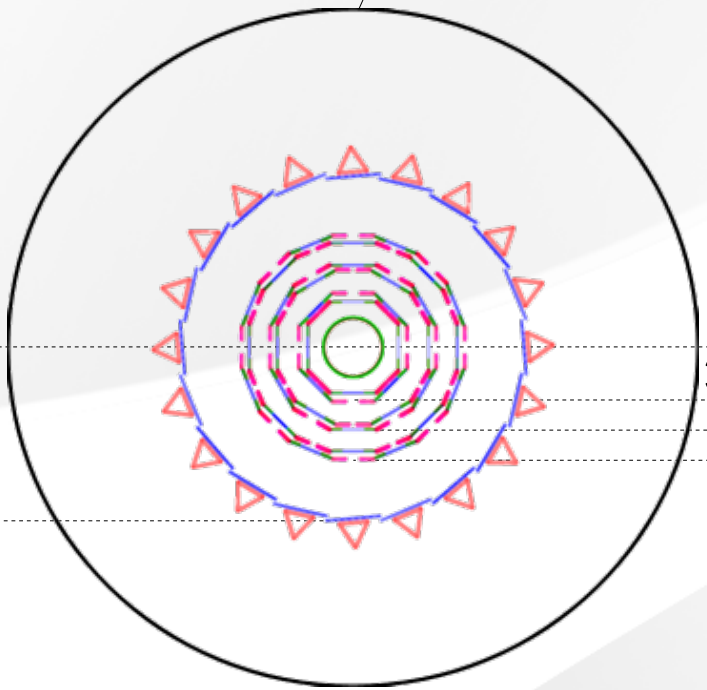
1% X_0

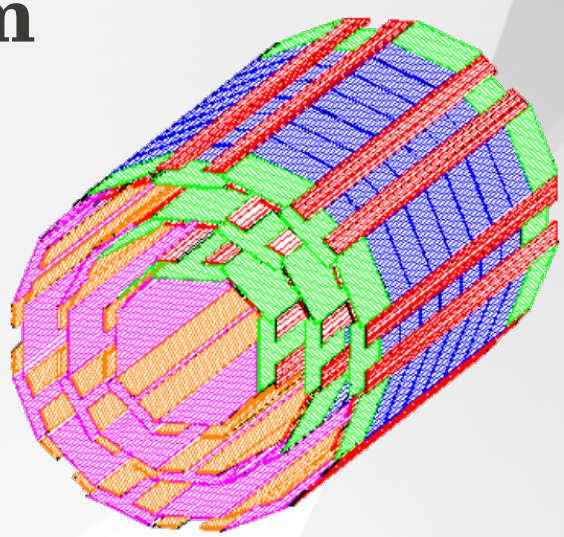
$\sigma_{r\phi}=30\,\mu m$

$\sigma_Z=742\,\mu m$

TPC

Inner Radius: 50 cm





Silicon Vertex Tracker

3 layers – 1.5% X_0 each

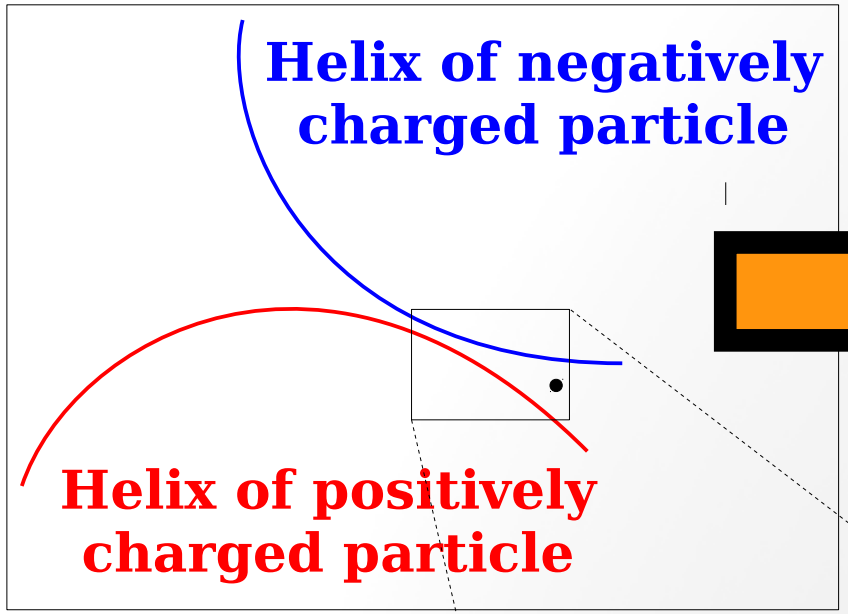
$\sigma_{r\phi}=49\,\mu m$

$\sigma_Z=30\,\mu m$

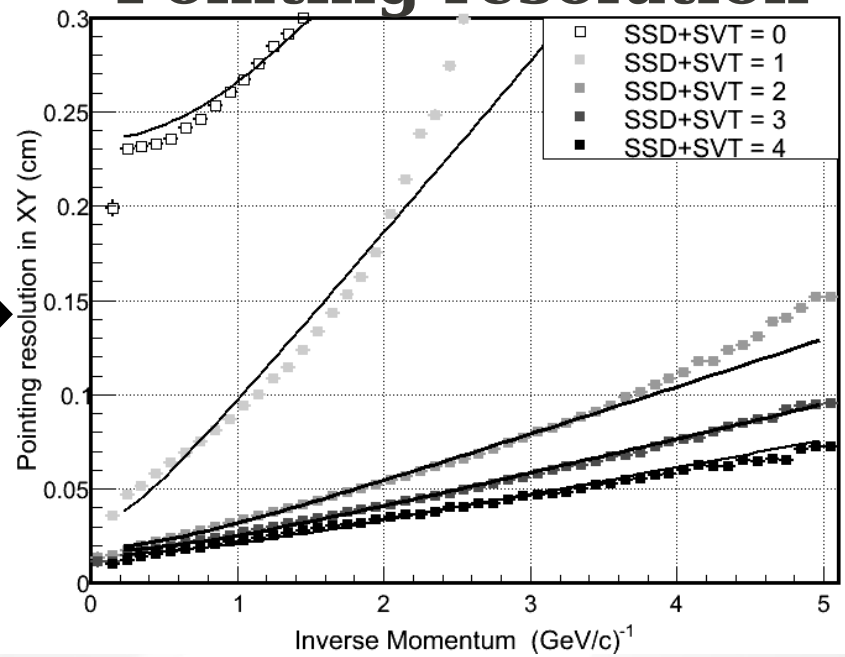
J.Phys.Conf.Ser.119:032017 (2008)

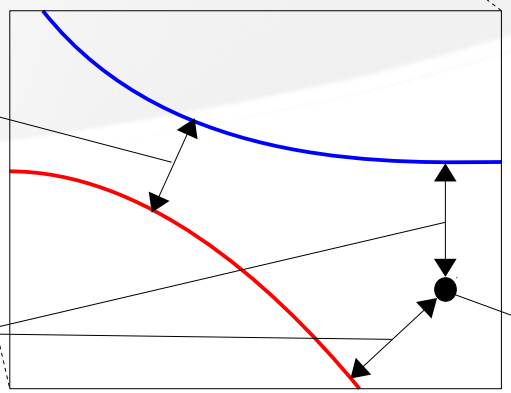
Reconstruction of the D^0 decay

Reconstructed Tracks



Pointing resolution





Distance of Closest Approach between tracks

Distance of Closest Approach (DCA) to PV

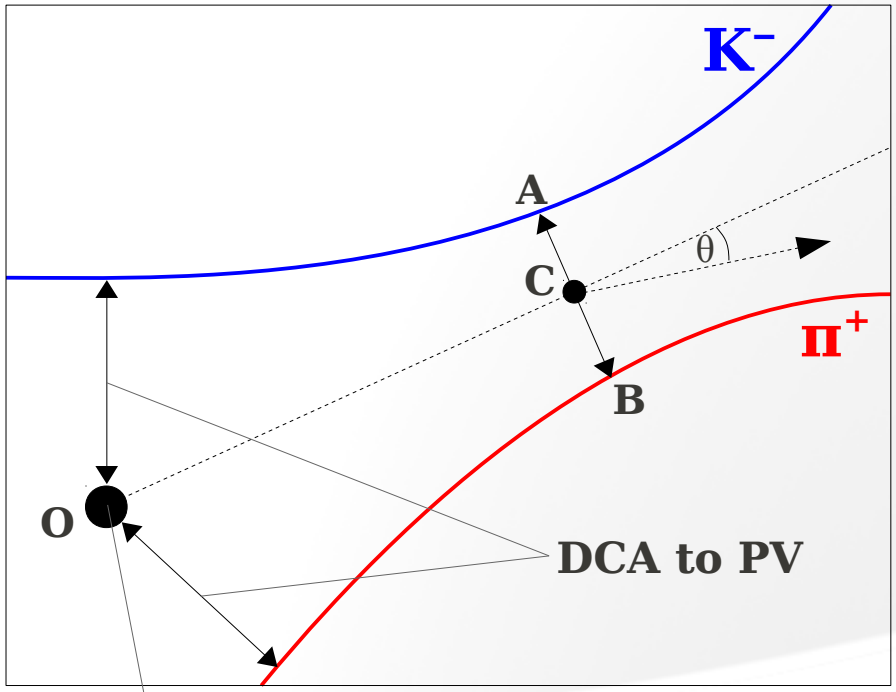
Primary Vertex

At 1 GeV/c the DCA resolution improves by a factor of 10

Reconstruction of the D^0 decay

$D^0 \rightarrow K^-\pi^+$ BR: 3.89%

$c_\tau = 123\ \mu m$



θ* – angle between p of the K in the rest frame of the parent and p of the D0 in the lab frame

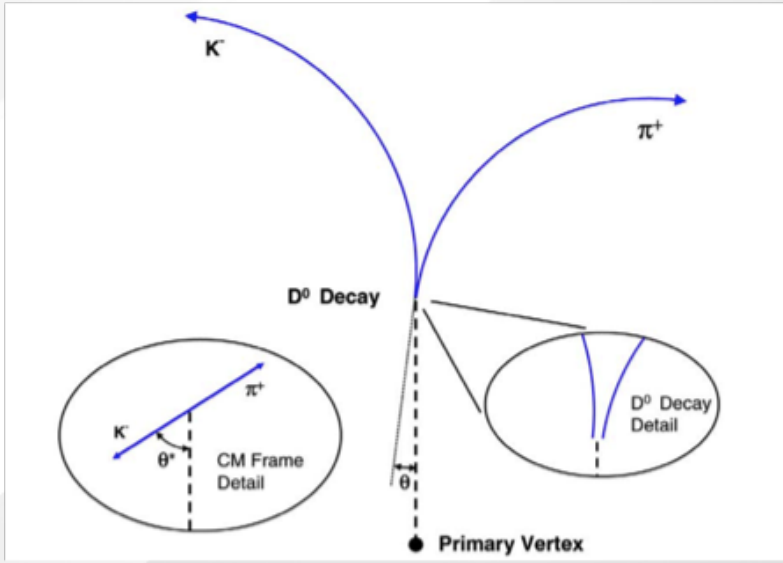
μVertexing in AuAu

|AB| – Distance of Closest Approach (DCA) between two tracks

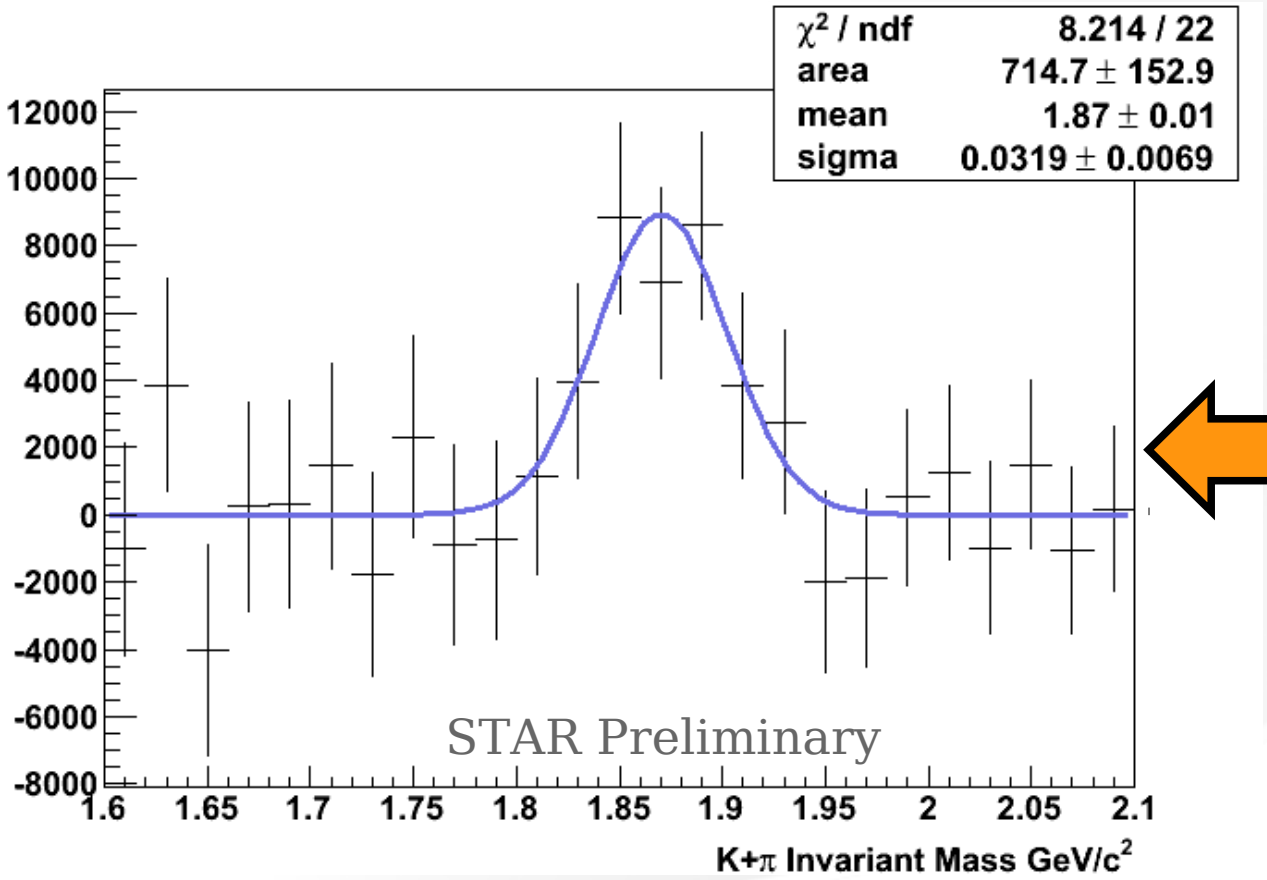
C – Possible D0 decay point

|OC| – Decay length

θ – pointing angle



Au+Au 2007



Min Bias

Peak significance ~5σ

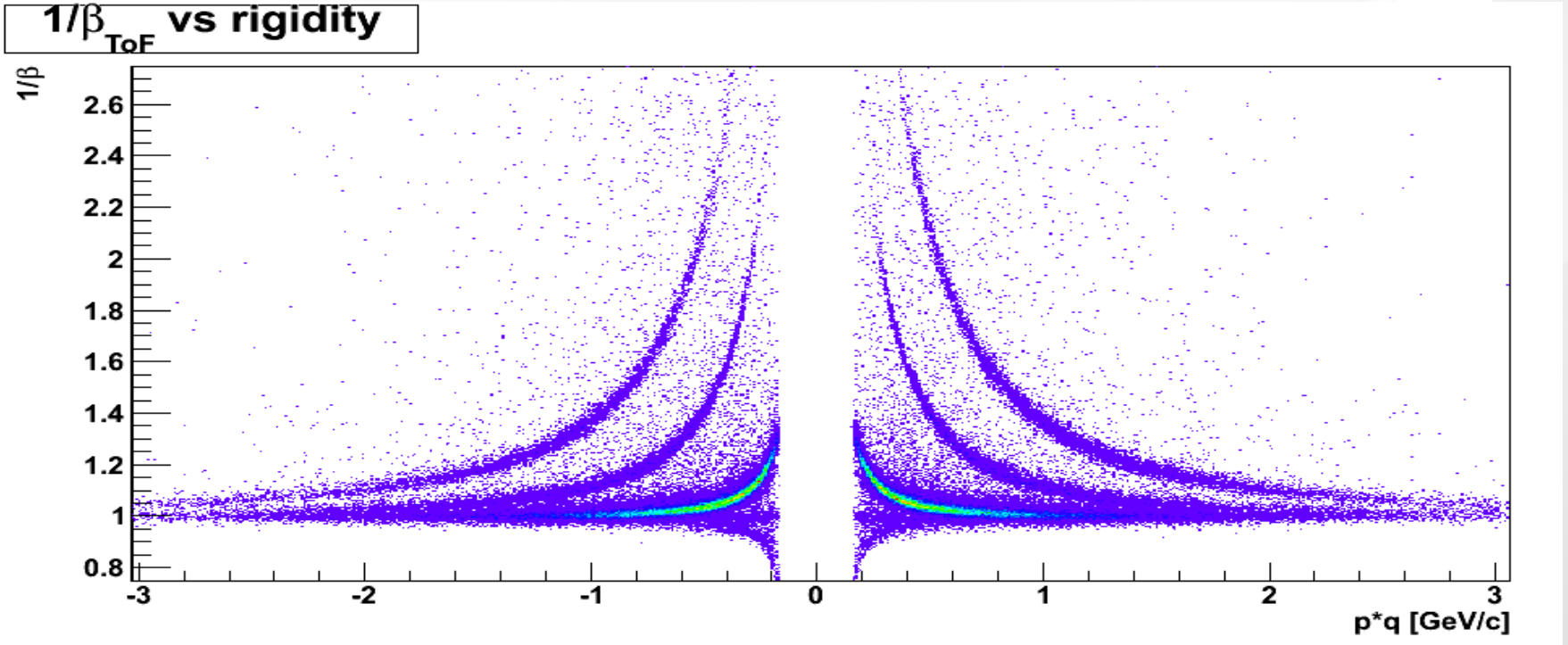
Analysis of e-D^0 azimuthal angular correlations

Are on the way!

J. Phys.: Conf. Ser. 270:012030 (2010)

Au+Au 2010

+ Over 10x more statistics than in 2007
+ Lower material budget → less photonic electrons
+ Particle identification with ToF
– No Si detector inside → worse pointing resolution



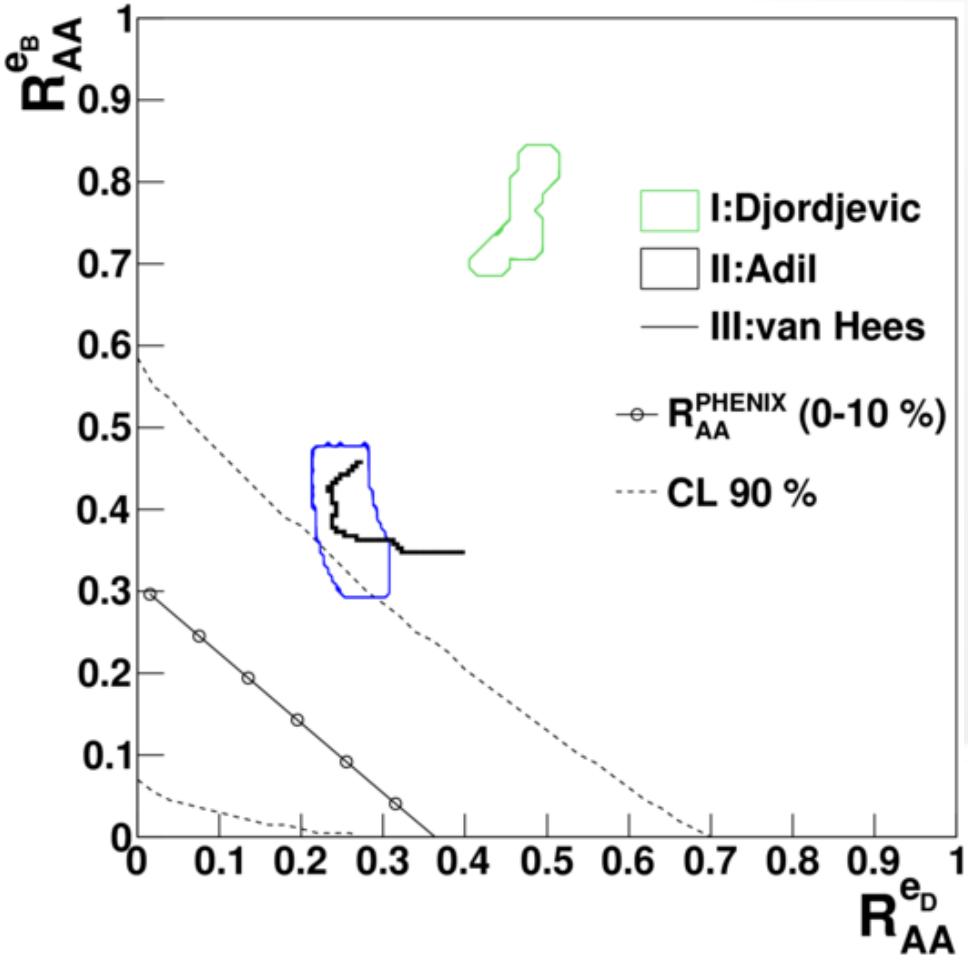
Summary & Outlook

- Studies on e-D0 correlation in p+p collisions have been presented
  - Observed results agrees with the FONLL within the errors
  - B contribution to non photonic electrons is ~50% at p_T~ 5 GeV/c
  - e-h and e-D0 correlations are consistent with each other
- Ongoing studies on e-D0 correlation in Au+Au
  - MicroVertexing techniques have been developed and successfully applied to the data
  - A peak of D0 with significance of 5σ has been observed
  - Further analysis are still needed to optimize the cuts
  - A comparison with models is on the way
  - New high statistic data from run 10 is available

Backup

p+p Results

Beauty and Charm nuclear modification factors



Models

I: (Djordjevic) radiative energy loss with initial g density dN/dy(g)=1000. This model is excluded by the data.

II: (Adil) collisional dissociation of D and B mesons in the QGP causes suppression of R_{AA}.

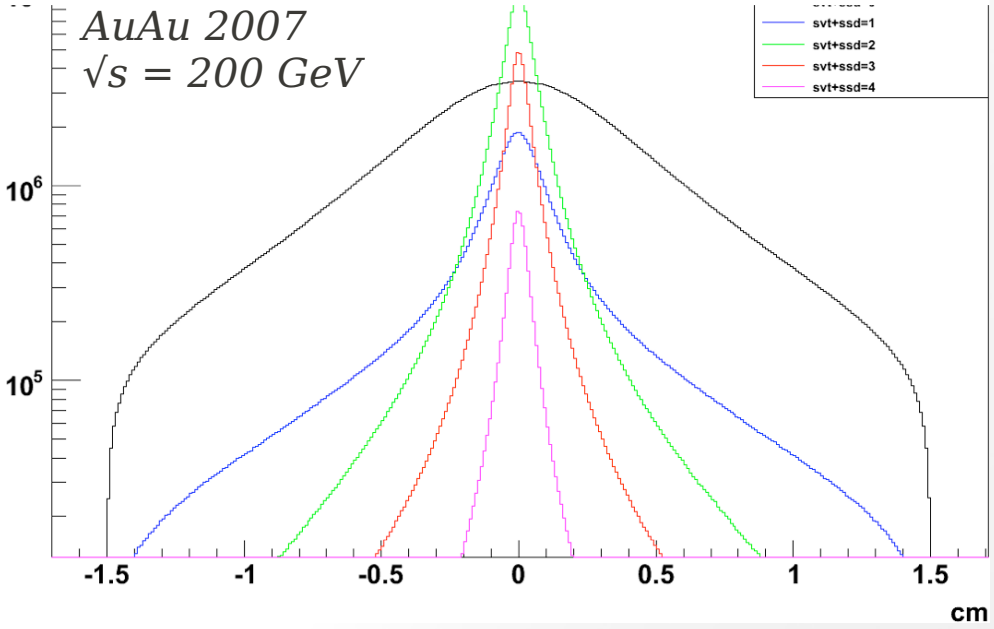
III: (van Hees) Large elastic scattering cross section associated with resonance states of D and B mesons in the QGP.

STAR arXiv:1007.1200 (2010)

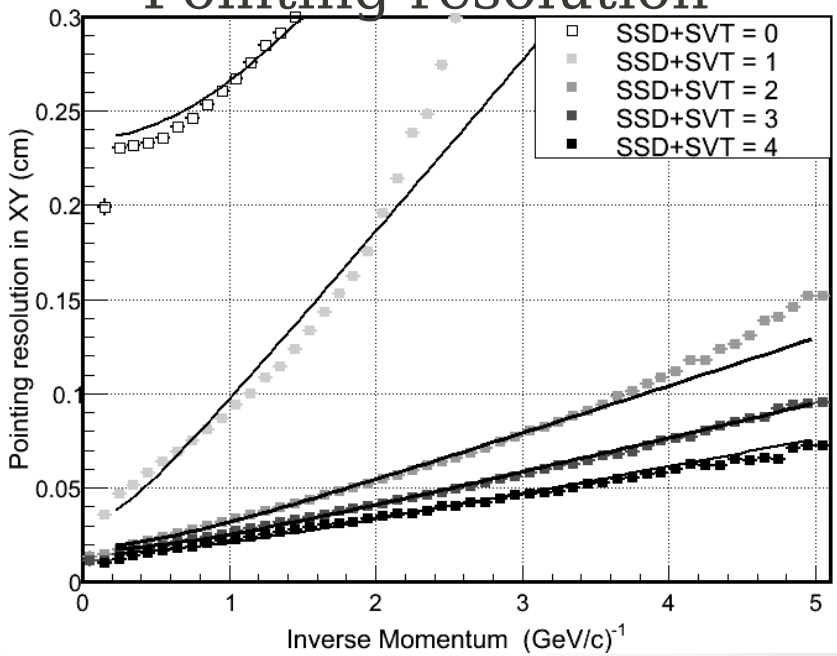
Reconstruction of the D^0 decay

DCA resolution

Transverse DCA



Pointing resolution



$$\sigma_{r\phi} = \sqrt{a^2 + (b/p)^2}$$

DCA resolution improves with the number of hits in SVT and SSD detectors!

At p = 1 GeV/c the DCA resolution improves by a factor of 10