HOT QUARKS 2010

Charm and beauty searches using electron-D^0 azimuthal correlations and microvertexing techniques in STAR experiment at RHIC

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for the STAR collaboration

Subatech

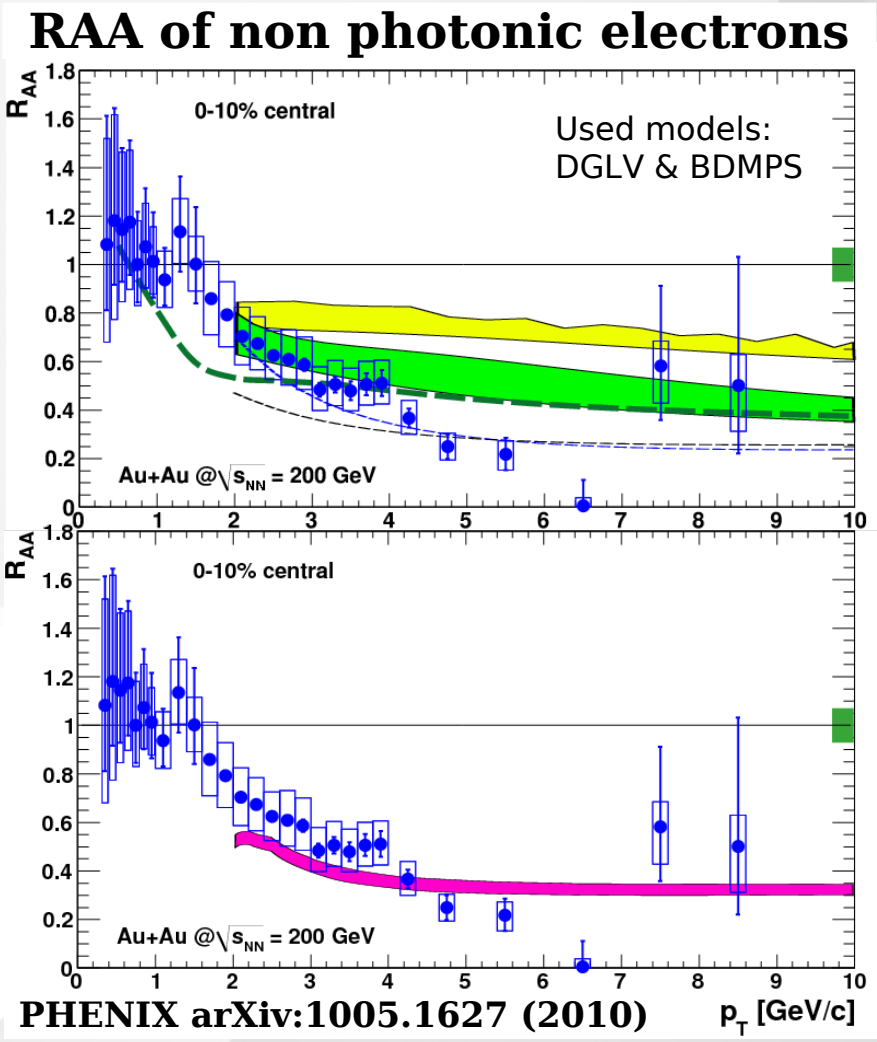
STAR

Motivation

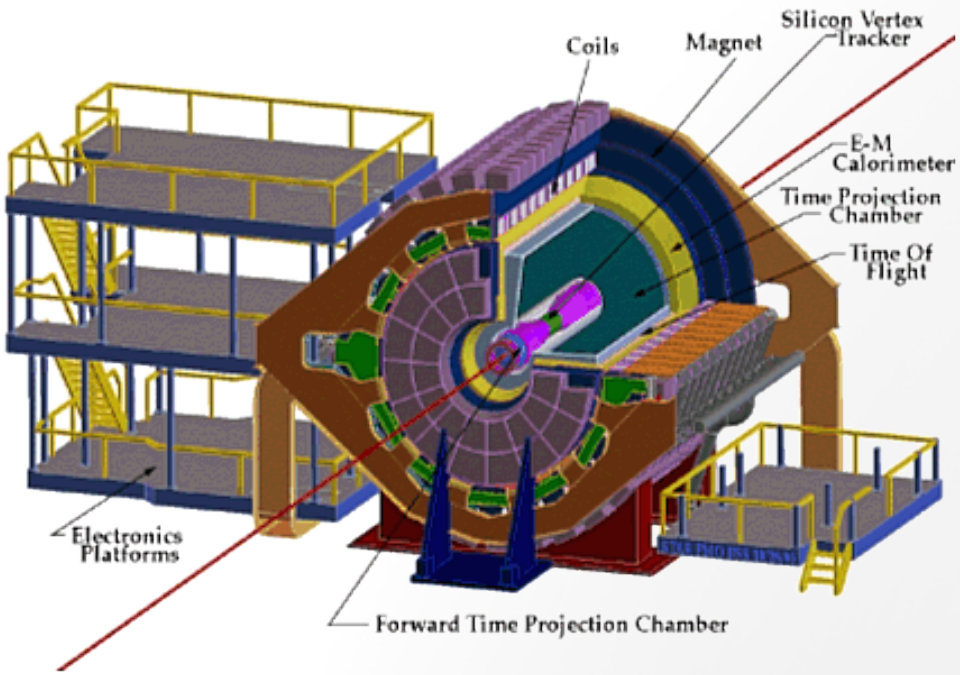
Suppression in non photonic electron yields for B and D mesons decays in central AuAu collision

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

- **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



The STAR Detector



Solenoidal Tracker at RHIC

Magnet

B = 0.5 T

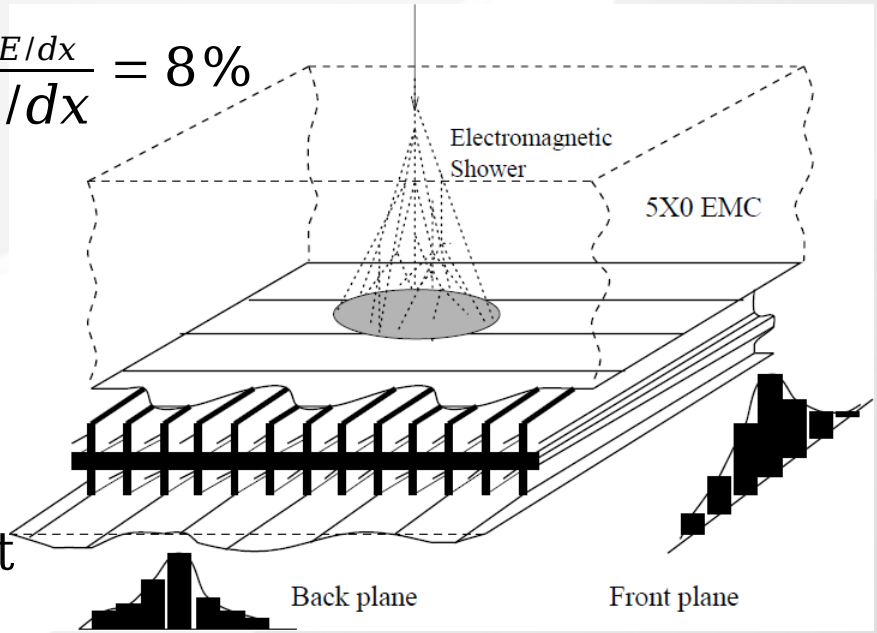
TPC

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

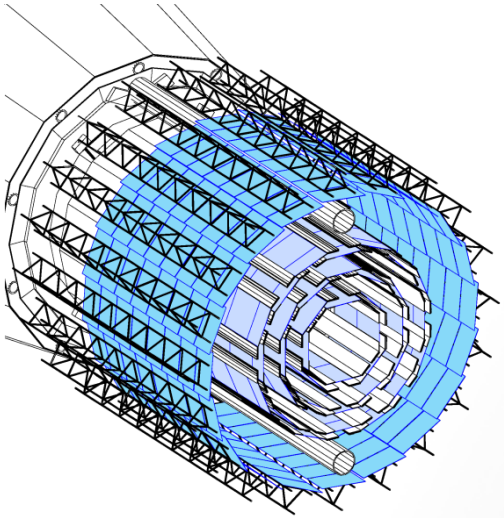
Wire proportional detector with strip readout

Situated at 5 X_0

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

The STAR Detector

Silicon Tracking System



Silicon Strip Detector

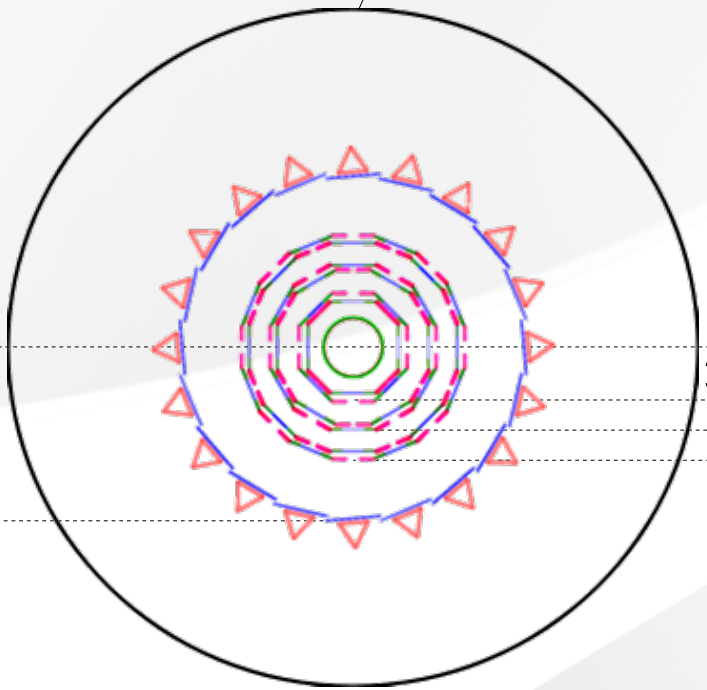
1% X_0

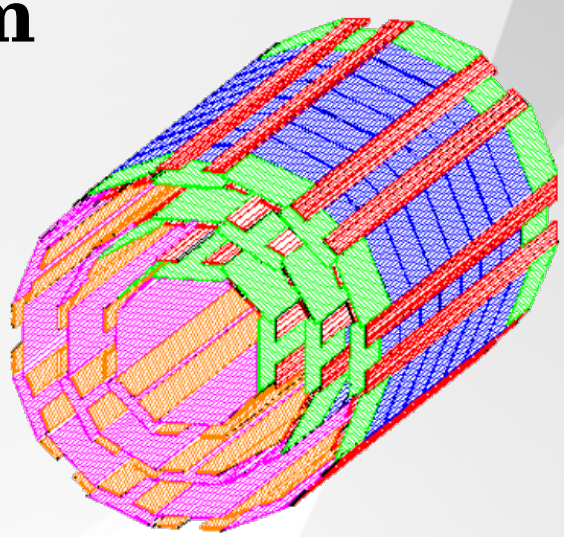
$\sigma_{r\phi}=30\,\mu m$

$\sigma_Z=742\,\mu m$

TPC

Inner Radius: 50 cm





Silicon Vertex Tracker

3 layers – 1.5% X_0 each

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

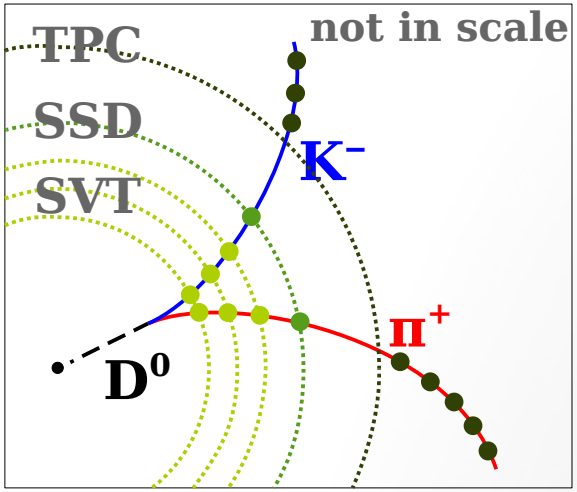
$\sigma_Z=30\,\mu m$

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

Reconstruction of the D^0 decay

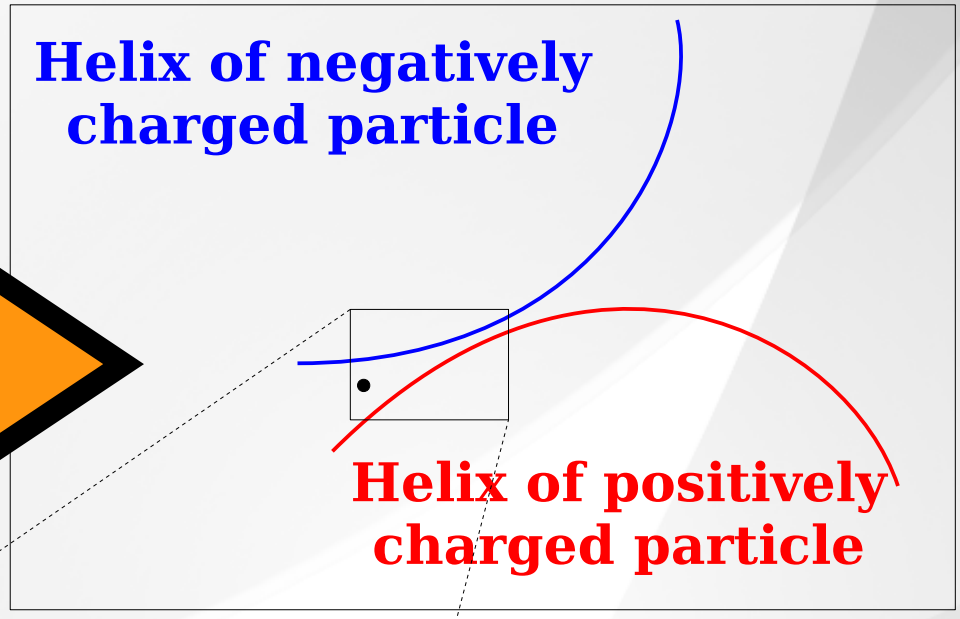
$D^0 \rightarrow K^-\pi^+$ BR: 3.89%

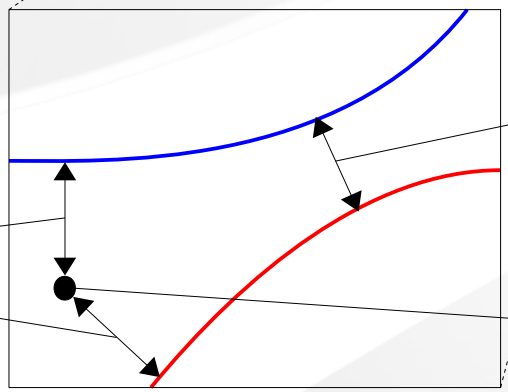
$c\tau = 123\ \mu m$



D^0 decay

Reconstructed Tracks





Distance of Closest Approach between tracks

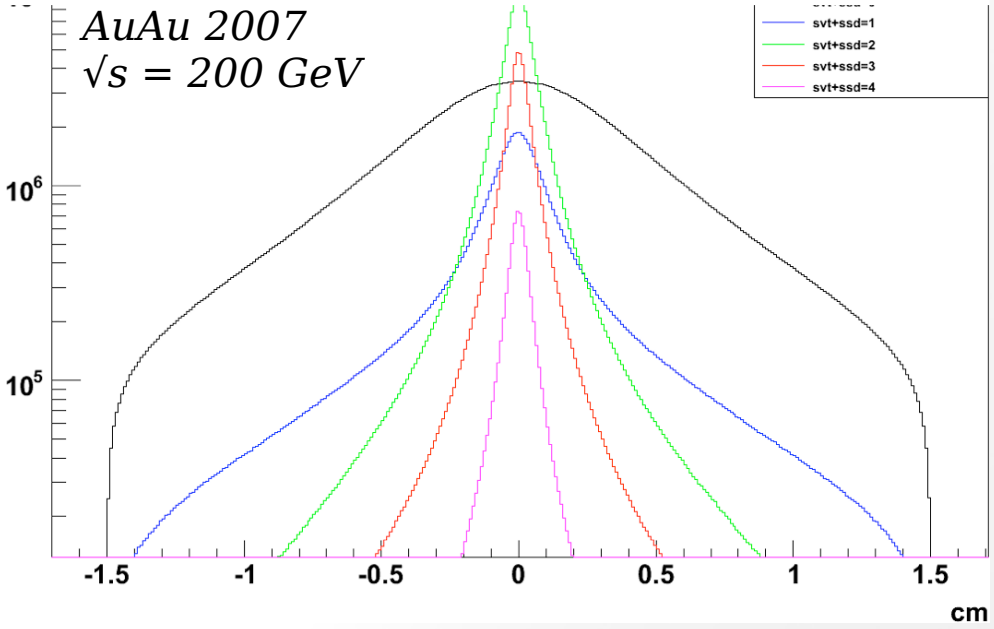
Distance of Closest Approach (DCA) to PV

Primary Vertex

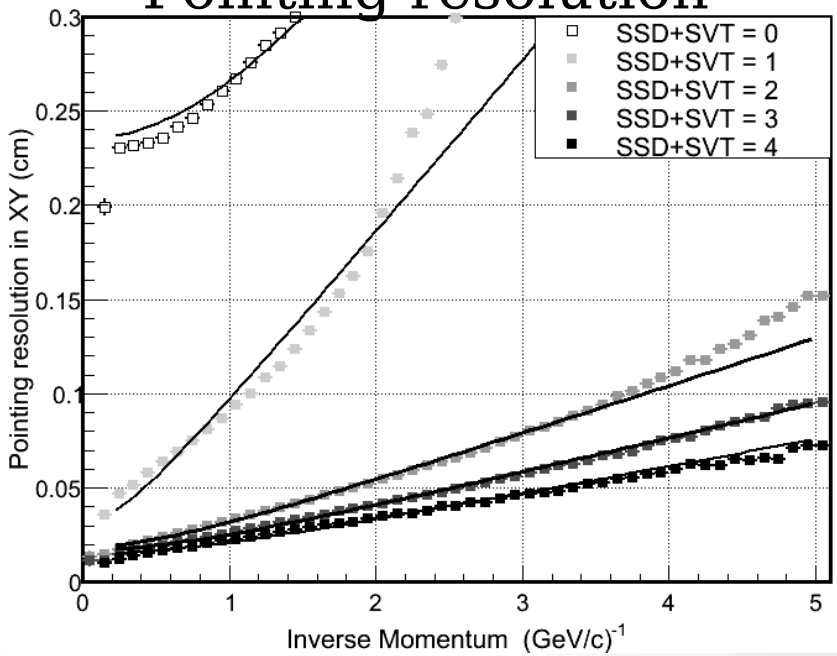
Reconstruction of the D^0 decay

DCA resolution

Transverse DCA



Pointing resolution



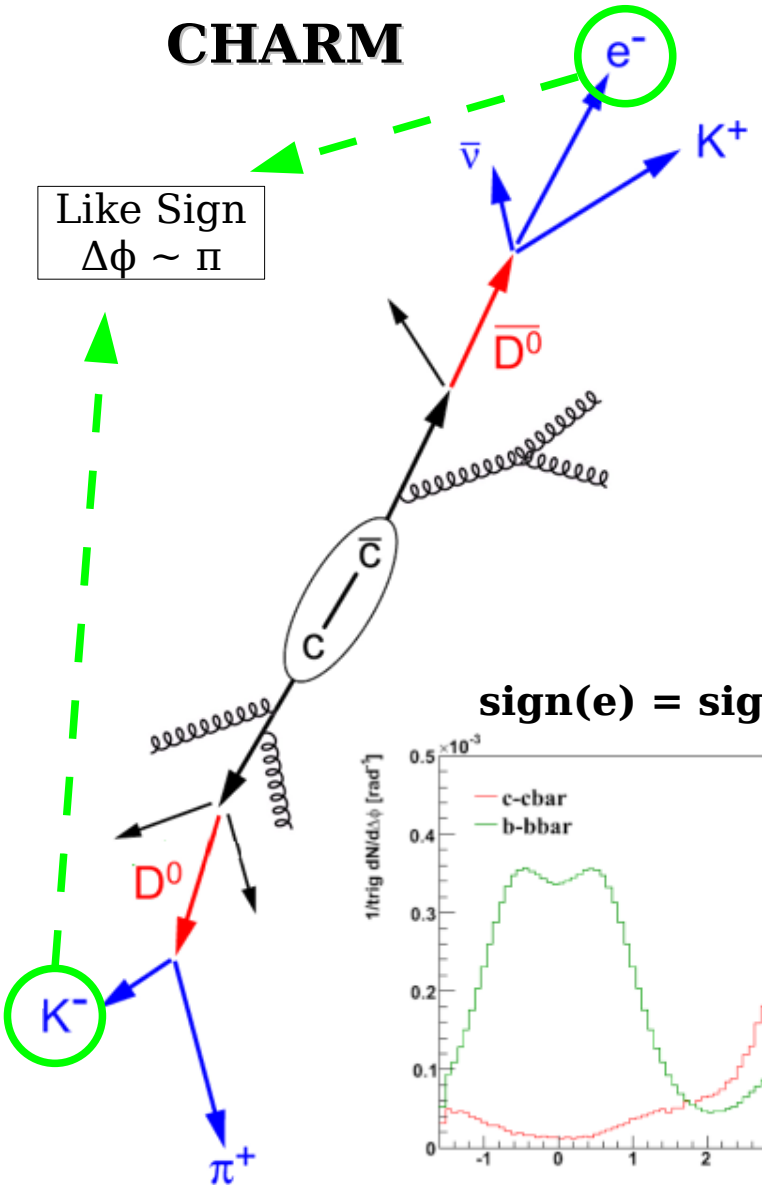
$$\sigma_{r\phi} = \sqrt{a^2 + (b/p)^2}$$

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

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

Charm and beauty contributions

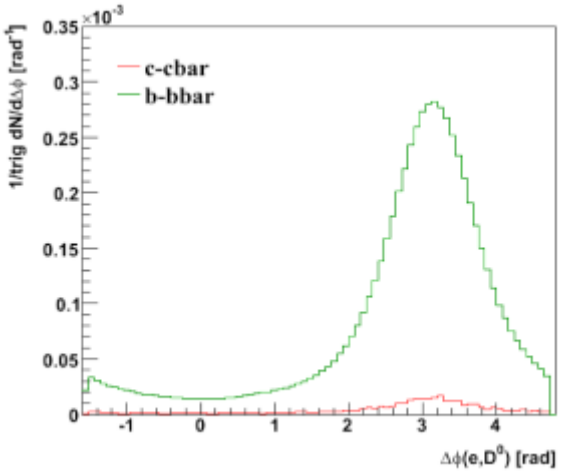
CHARM



Like Sign
Δφ ~ π

PYTHIA

sign(e) ≠ sign(K)



sign(e) = sign(K)

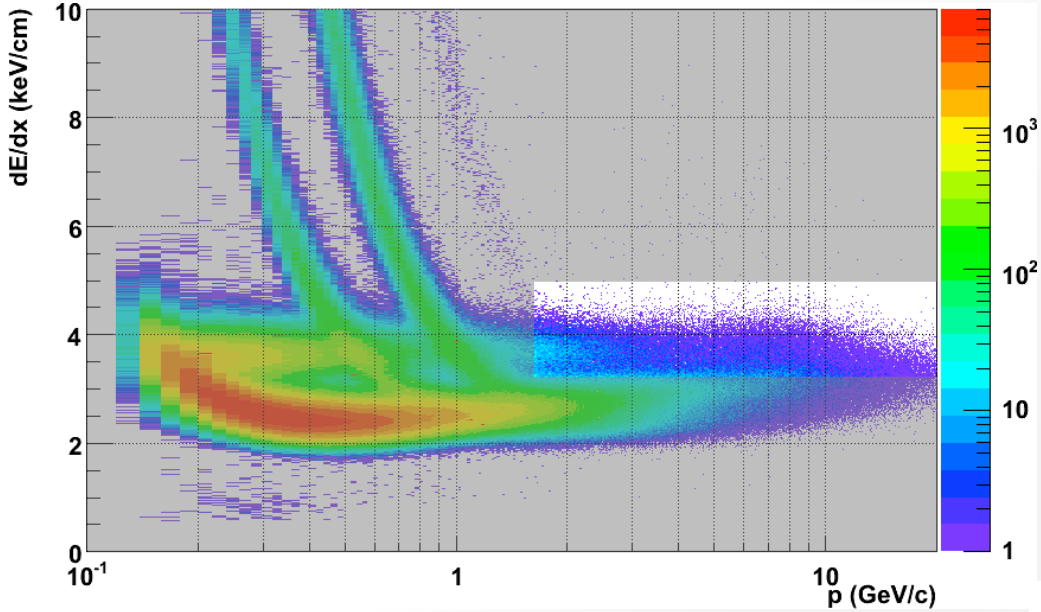
BEAUTY

Like Sign
Δφ ~ 0

Unlike Sign
Δφ ~ π

Phys. Lett. B671, 361 (2009)

Trigger particle selection



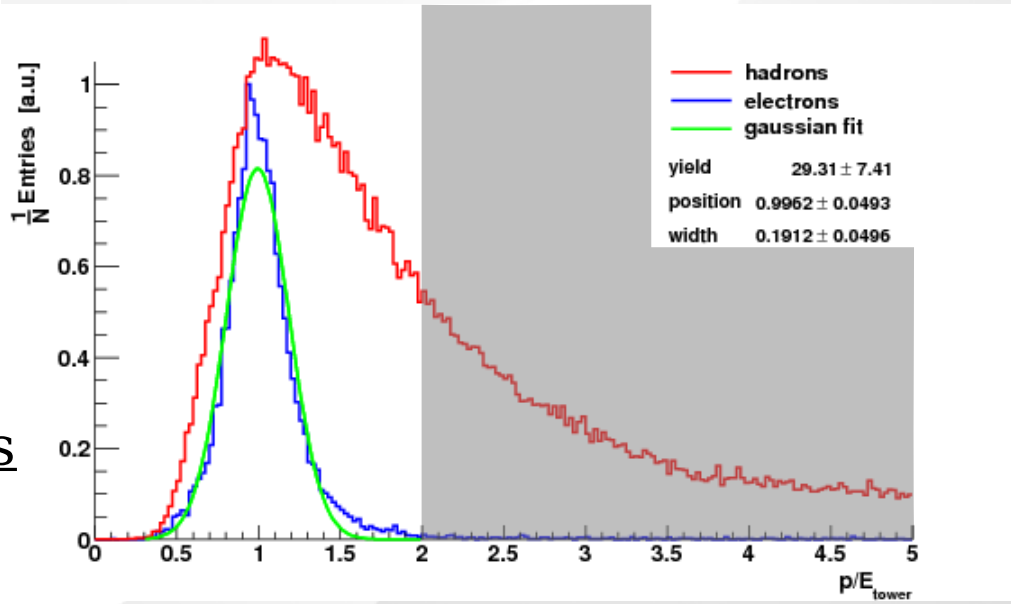
PID cuts [TPC]

- 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

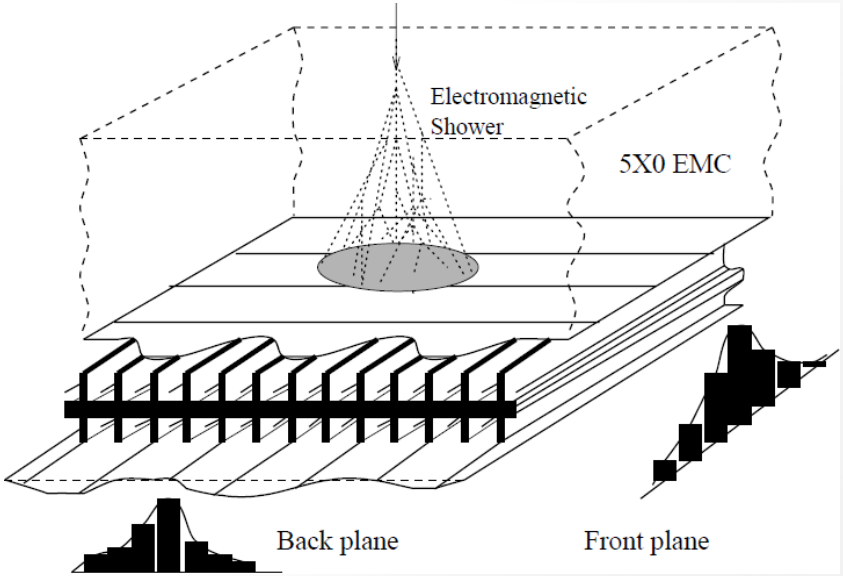
Should have a peak ~ 1 for electrons



Trigger particle selection

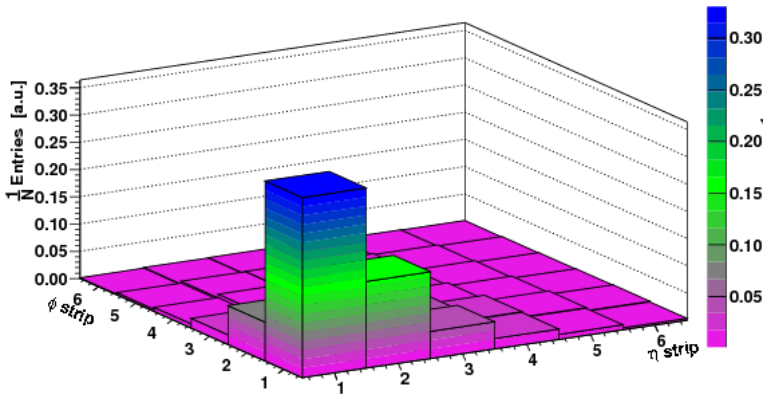
PID cuts [SMD]

Shower Maximum Detector

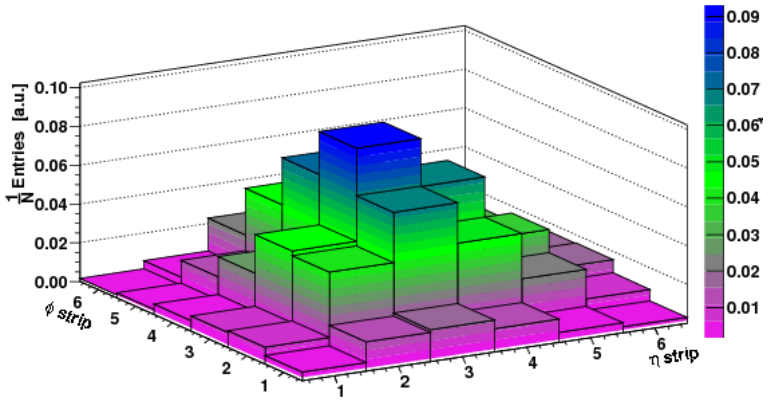


80% of the EM shower energy
is being deposited in 2-3 strips

Hadron shower



Electron shower

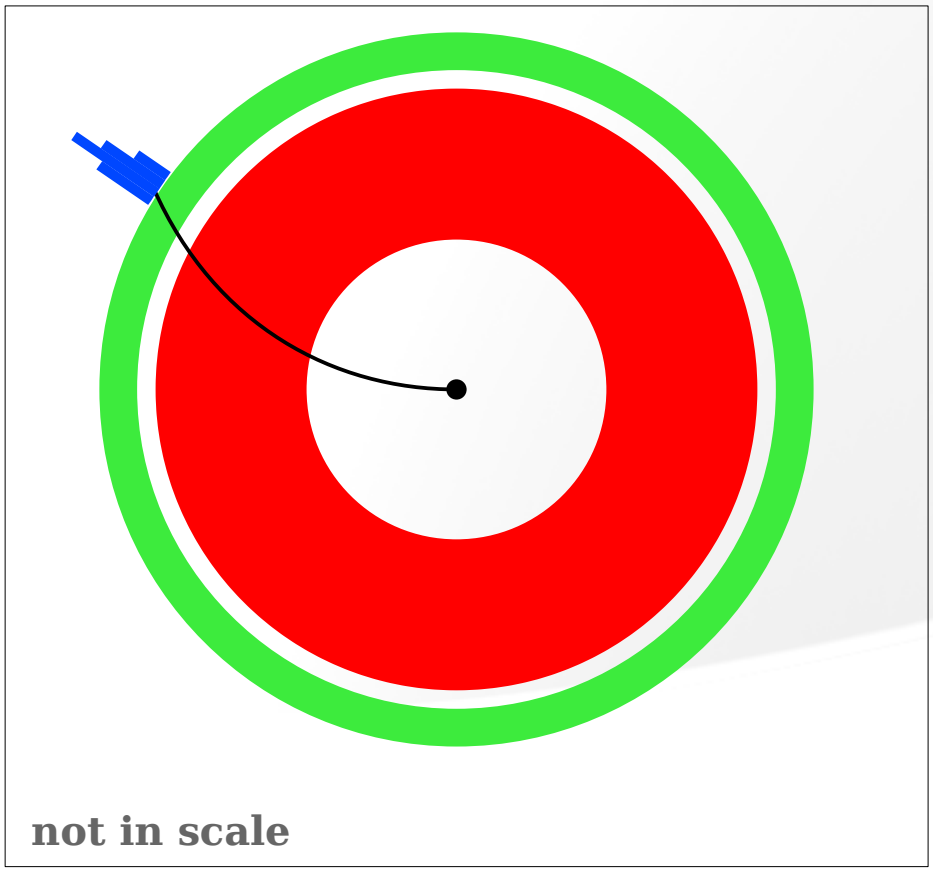


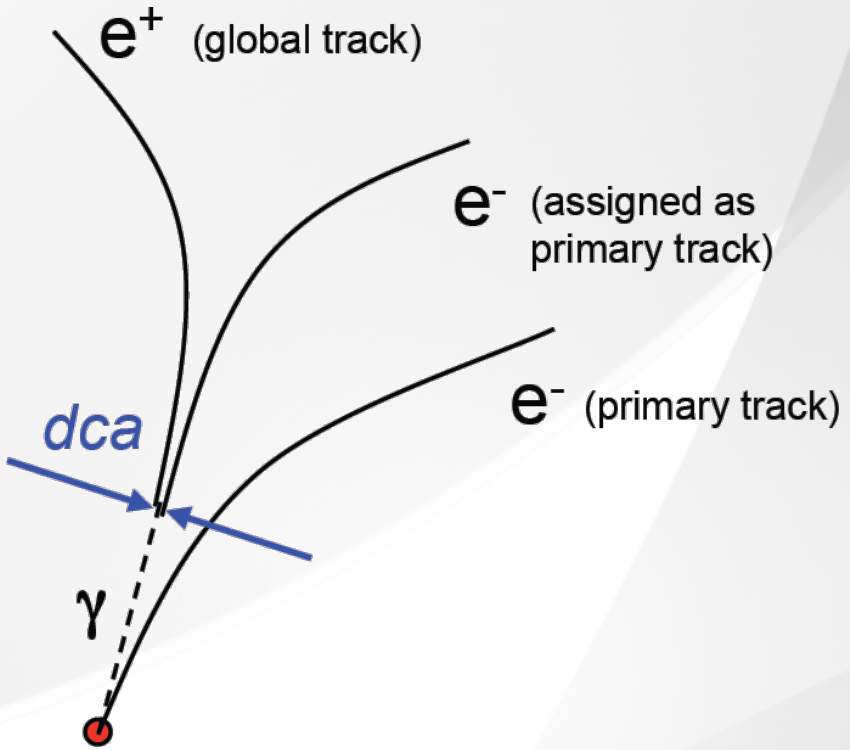
Electron shower
is broader than the one
that comes from hadron

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

Trigger particle selection

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





Sources of Contamination:

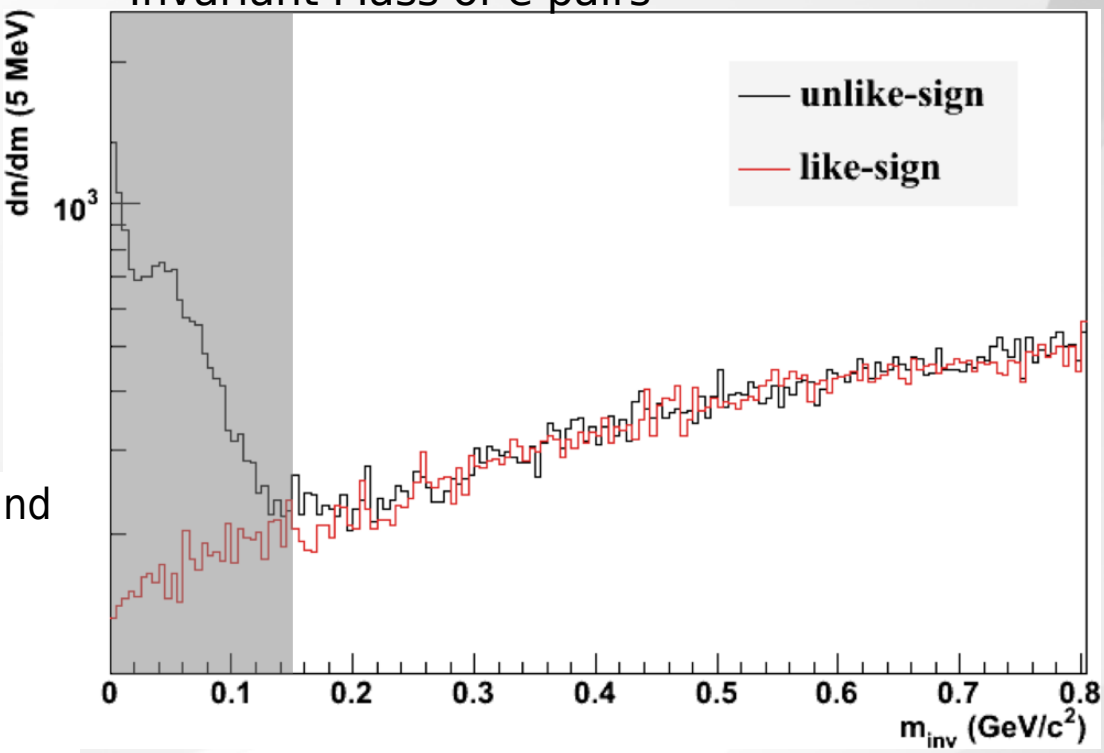
- Photon Conversion (material)
- neutral meson decays (π^0, η)

Trigger particle selection

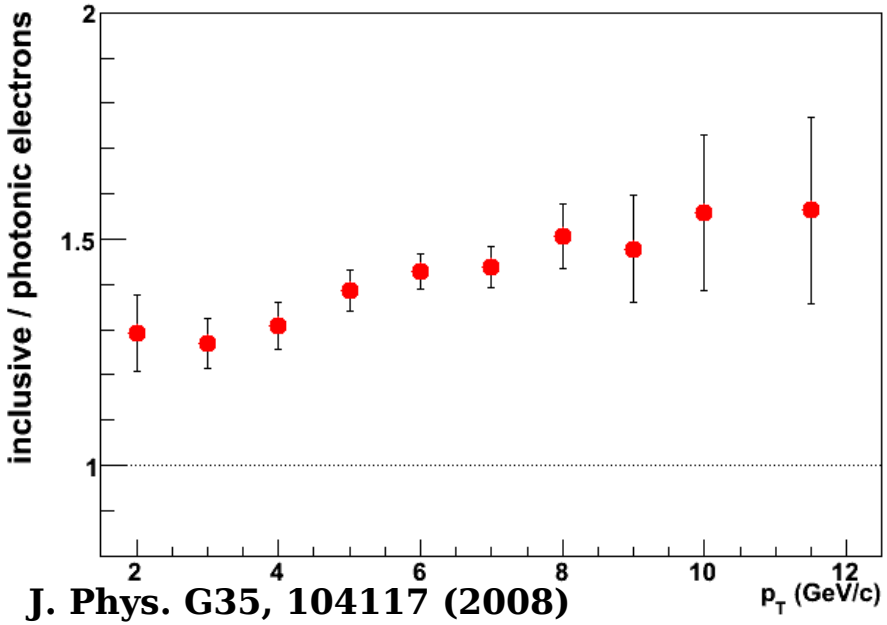
Discrimination Method:

- 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



J. Phys. G35, 104117 (2008)

Removes up to 70% of the photonic electrons

Analysis Methodology

p+p 2006

Event Cuts

Vertex-Z ∈ (-30; 30) [cm]

Trigger electron E_t > 5.4 [GeV]

Au+Au 2007

Event Cuts

Vertex-Z ∈ (-20; 20) [cm]

Trigger electron E_t > 4.2 [GeV]

Track Cuts

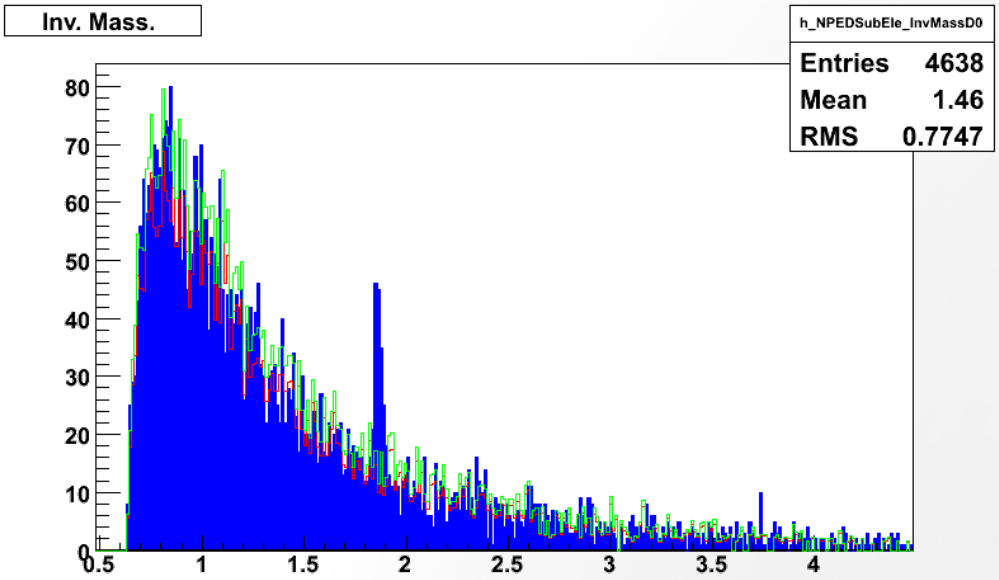
DCA to Primary Vertex < 1.5 [cm]

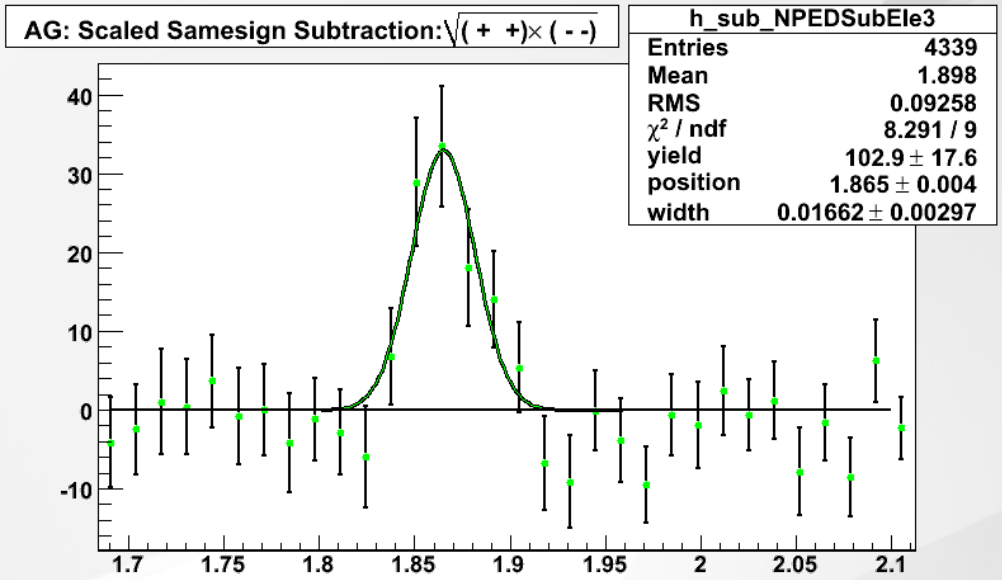
TPC hits > 25 (of max. 45 possible)

|η| < 1.0

p+p 2006 Results

Monte Carlo (PYTHIA+GEANT)





Fit results

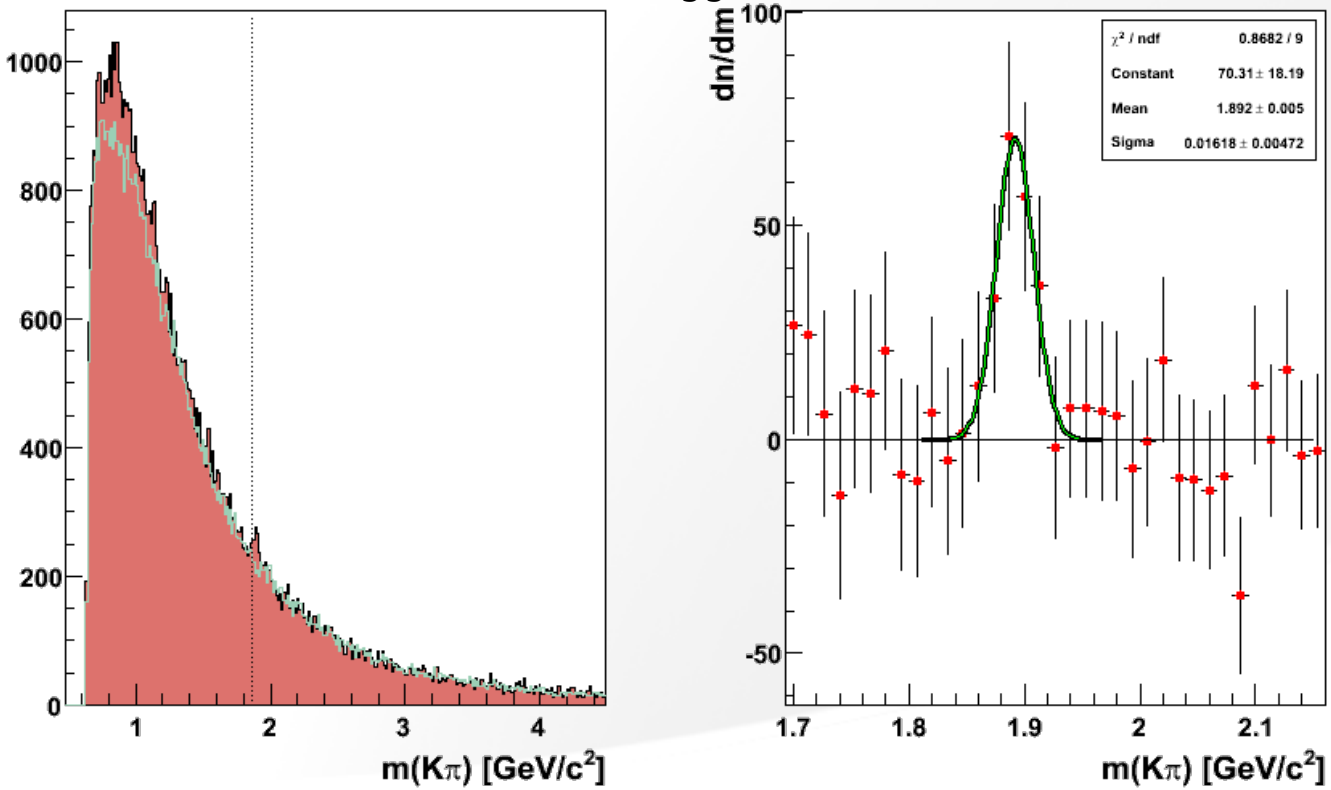
Peak position m = 1865 ± 4 MeV/c^2

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

p+p 2006 Results

Data

Invariant Mass from electron triggered events



Fit results

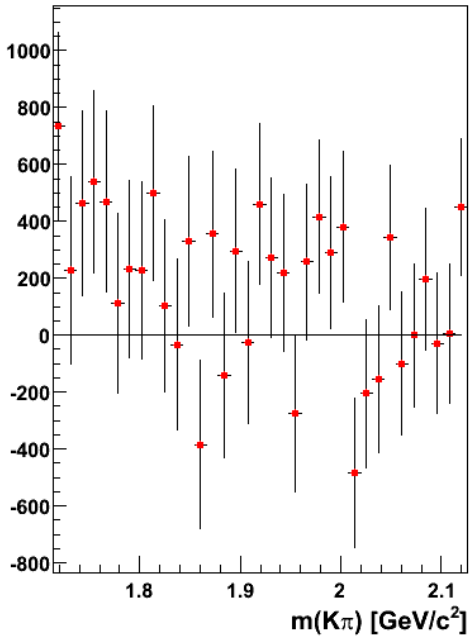
Peak position m = 1892±5 MeV/c^2

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

Signal-to-background ratio ~0.14%

Signal significance ~3.7

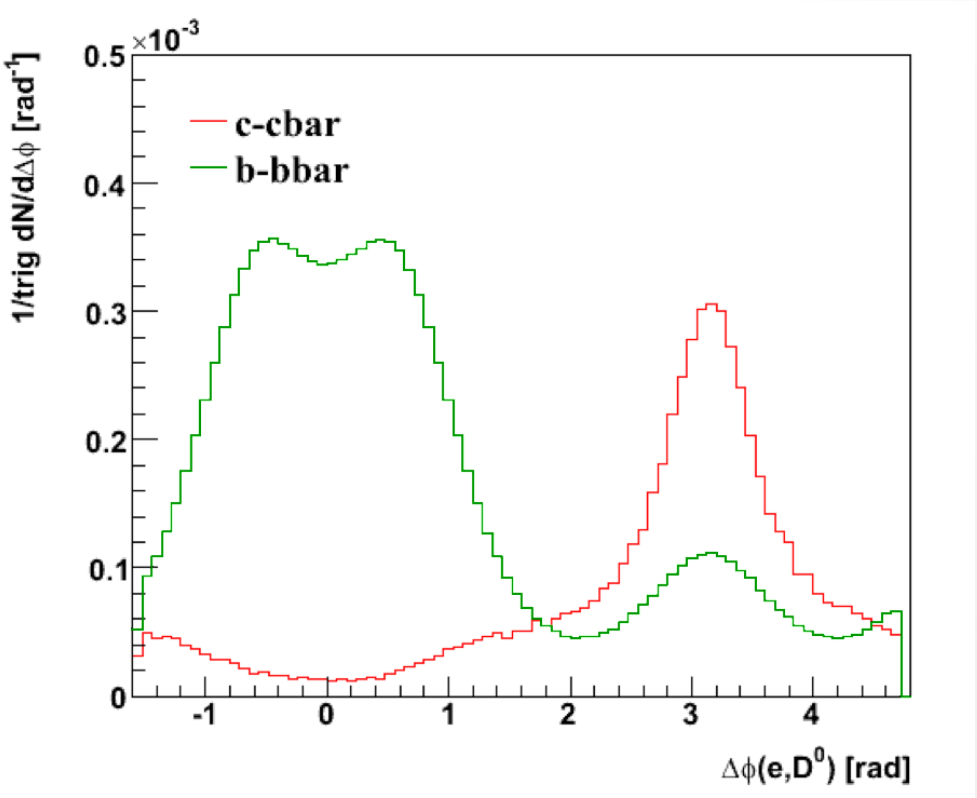
Without electron trigger

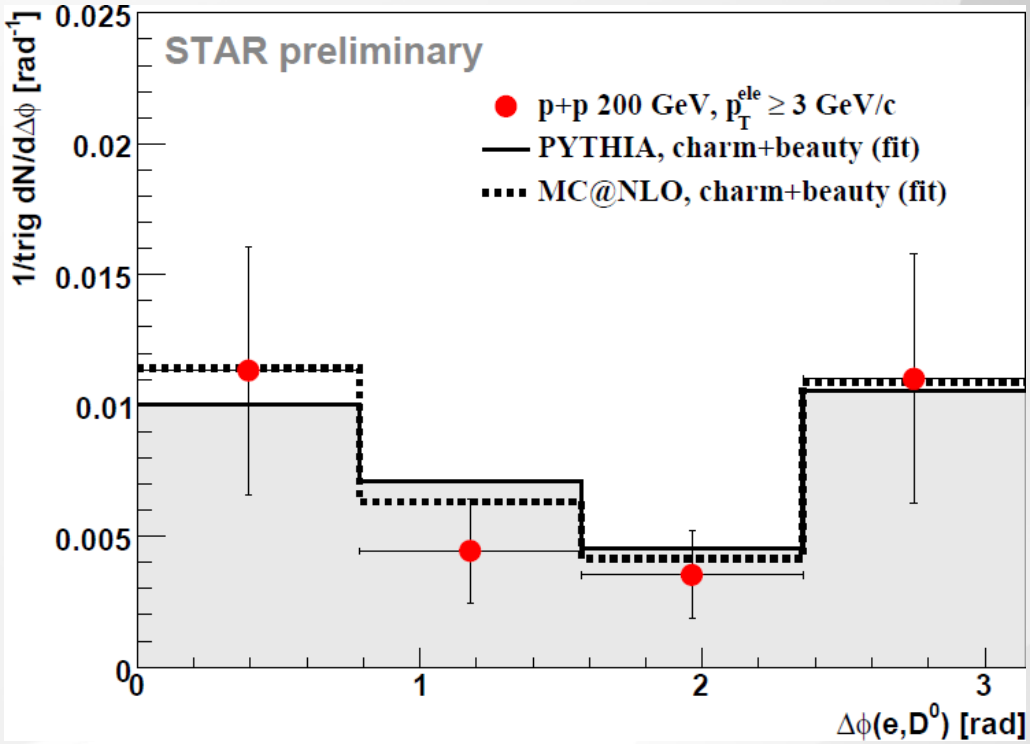


Demand on electron triggered events reduces background **by a factor of 100**

J. Phys. G35, 104117 (2008)

p+p 2006 Results

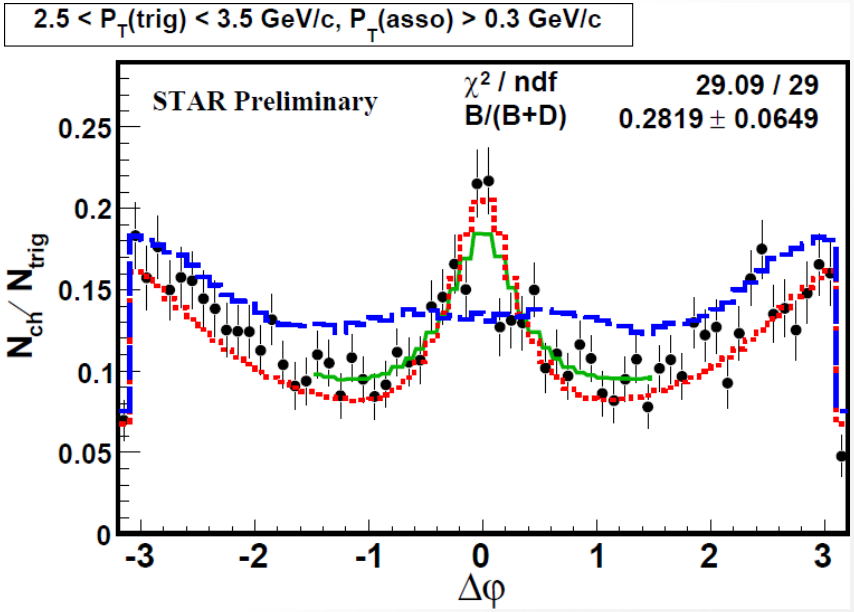




Charm to beauty ratio obtained form the real data is in agreement with PYTHIA simulations

p+p 2006 Results

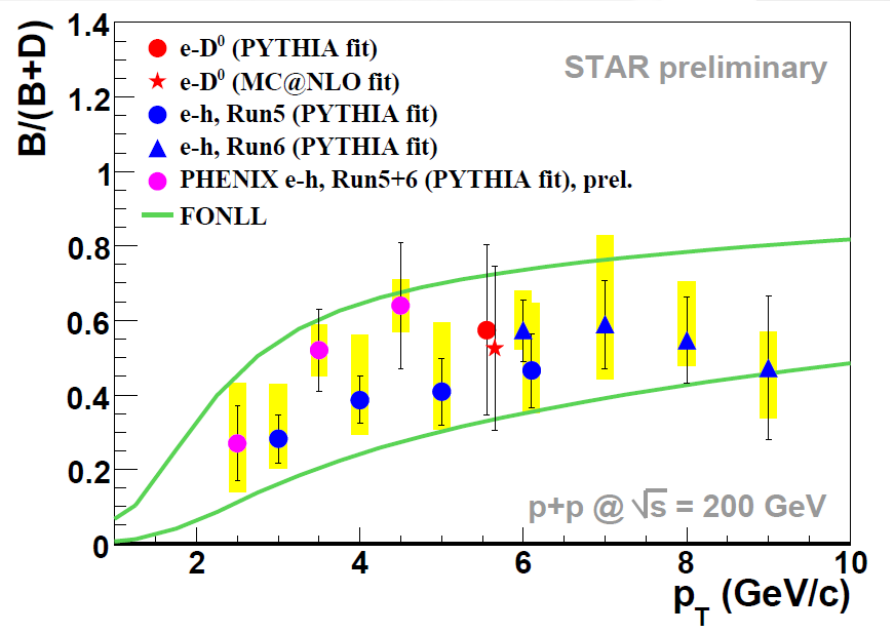
Heavy flavor contribution to non-photonic electrons



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>



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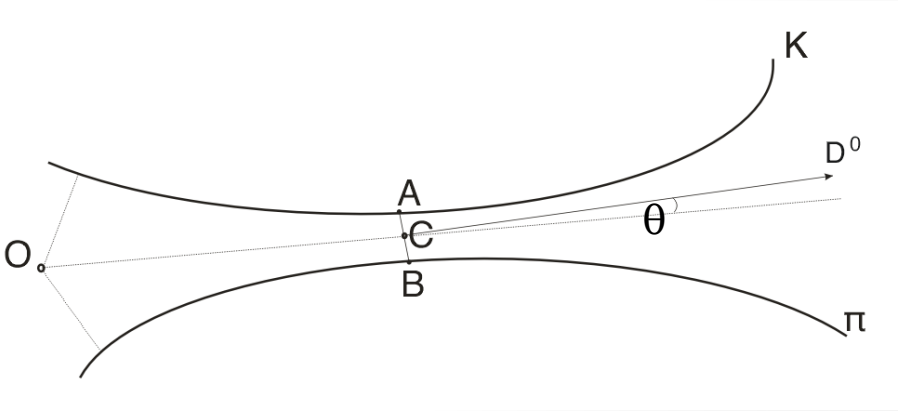
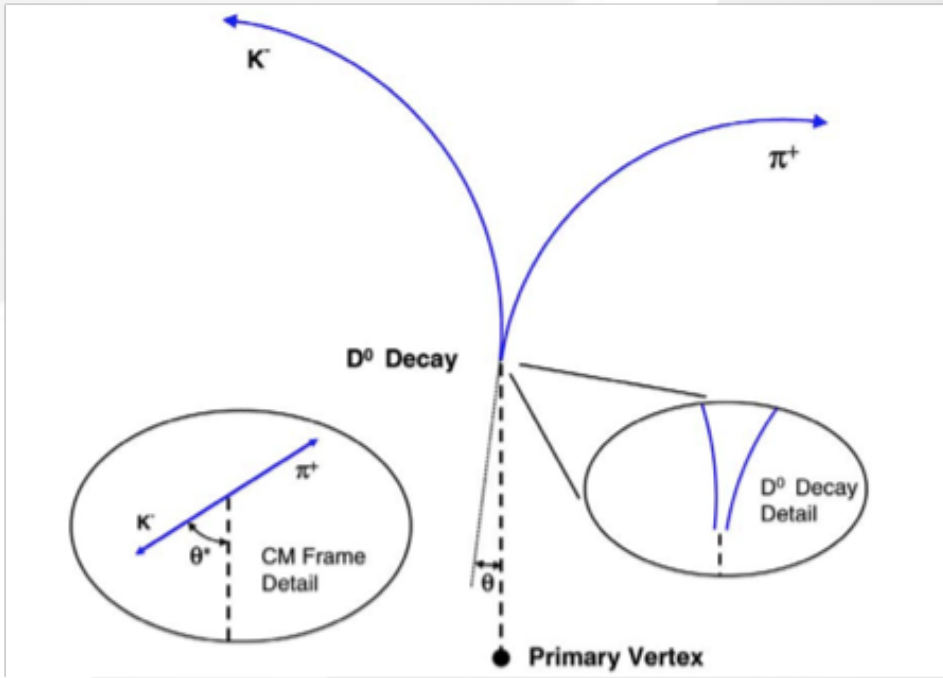
μVertexing

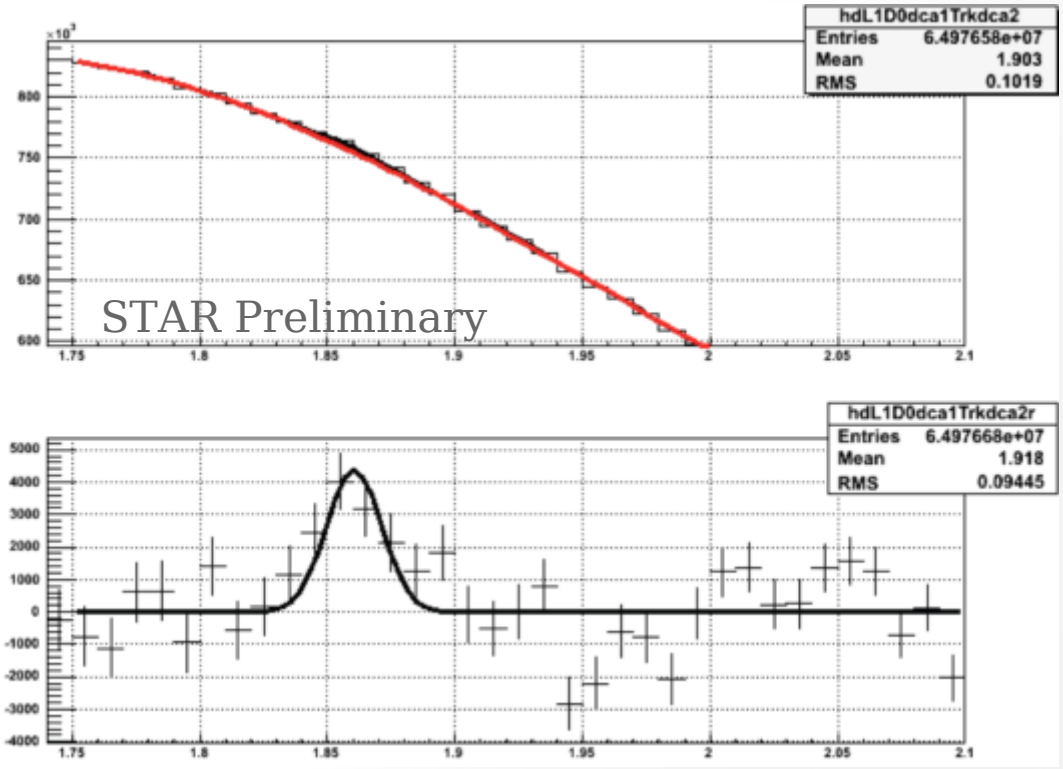


θ^* – *angle between K and direction of D0 in the rest frame of the parent*

O – Primary vertex
C – Possible D0 decay point
$|AB|$ – DCA between tracks
$|OC|$ – Decay length
θ – pointing angle



Au+Au 2007



Min Bias

Statistics ~35M
Peak significance ~5.16

Significance

$\int$signal/$\sqrt{\int(S+2B)}$ [mass ± 2·σ]

More in the talk of Sarah LaPointe

Summary & Outlook

- Studies on e-D0 correlation in p+p collisions have been presented
  - Observed results agrees with the simulation 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 has been observed
  - Further analysis are still needed to optimize the cuts
  - A comparison with models is on the way