Low p_T non-photonic electron analysis in p+p collisions at 200 GeV with reduced detector material in STAR

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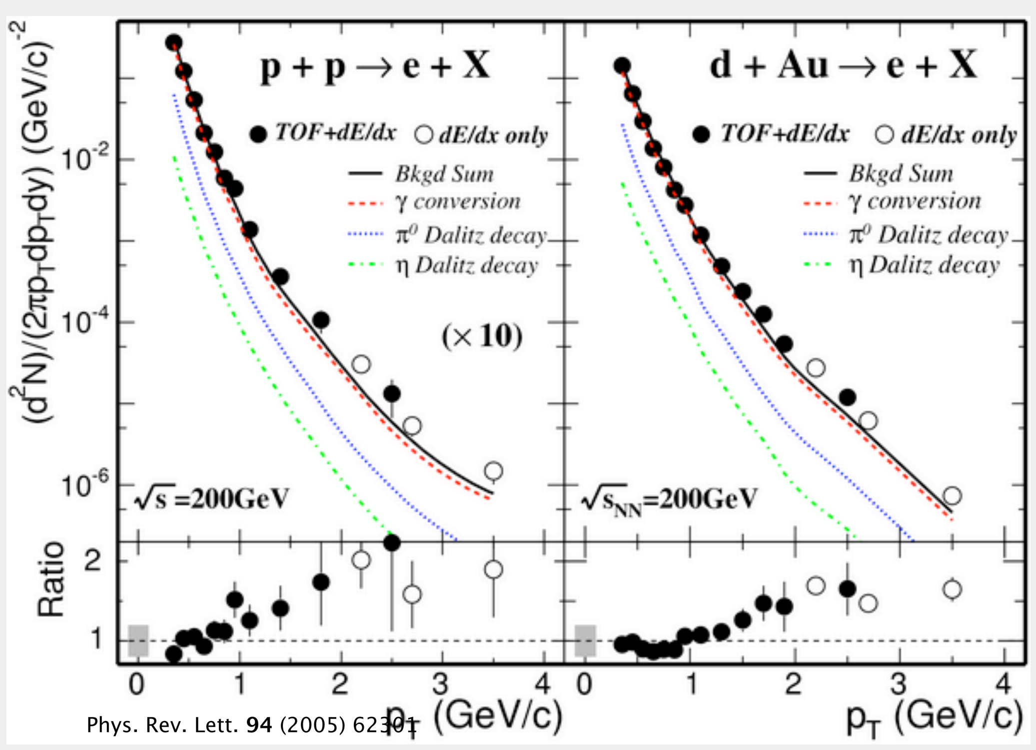
Abstract

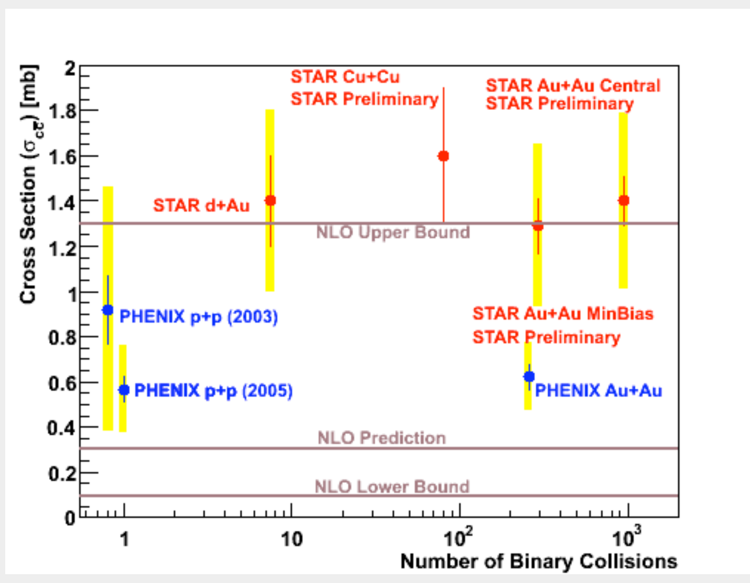
It is commonly expected that the cross section of heavy flavor production can be calculated in perturbative quantum chromodynamics (pQCD) because of its large mass. Precise measurements of charm total cross section and transverse momentum spectrum in p+p collisions will provide a baseline to understand the charm production and in-medium mechanism in heavy ion collisions.

In this poster, we will present our analysis status of mid-rapidity non-photonic electron(NPE) production at p_T>0.2 GeV/c in p+p collisions at 200 GeV. The dataset is about 78M TOF-triggered events taken from STAR year 2008 run. Due to the absence of inner tracking detectors and the supporting materials in this run, the photonic background electron(PE) from gamma-conversion at the detector material is reduced by about a factor of 10 compared with that in STAR previous runs. The dramatic increase of signal-to-background ratio will allow us to improve the precision on extracting the charm cross-section via its semi-leptonic decay to electrons.

Current status

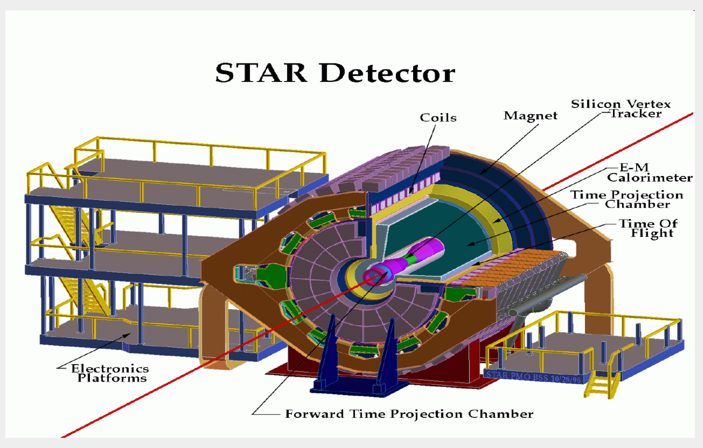


Phys. Rev. Lett. 94 (2005) 62301



1) Upper part shows electron distribution and dashed lines depict various contributing sources.
2) Lower part shows total charm cross-section. Both STAR and PHENIX are self-consistent.
3) STAR results are consistent with NLO calulation.
4) There is a factor ~2 discrepancy between STAR and PHENIX.

STAR-Detector



STAR: Larger acceptance
PHENIX: Lower material
STAR removed SVT and SSD in run 8, low material (~0.56%X_0) run to try to address the observed discrepancy between STAR and PHENIX.

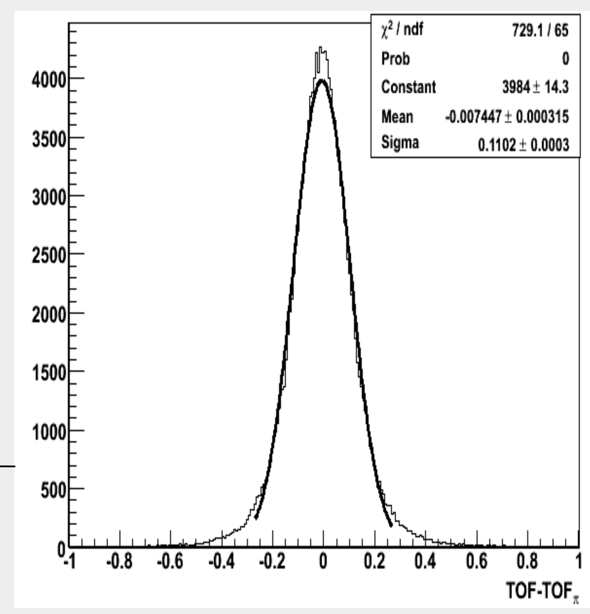
STAR-TOF (run 8)

1) 5 trays out of 120 trays

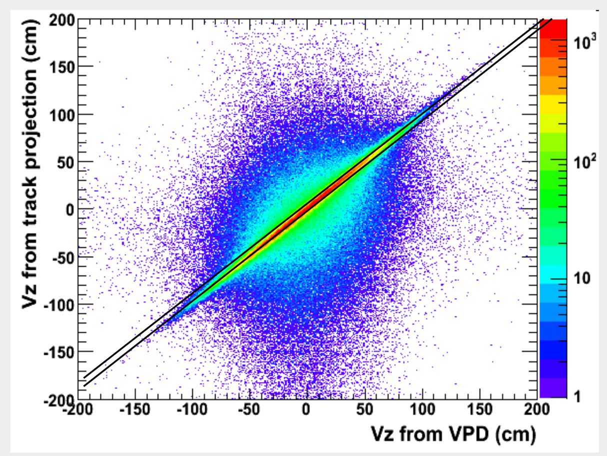
2) Coverage: $-1<\eta<0$, $\Delta\varphi<\pi/6$

3) Set behind the TPX sector (TPC with upgraded electronics DAQ1000)

4) 78M TOF triggered events, equivalent to ~400M minimum bias events.

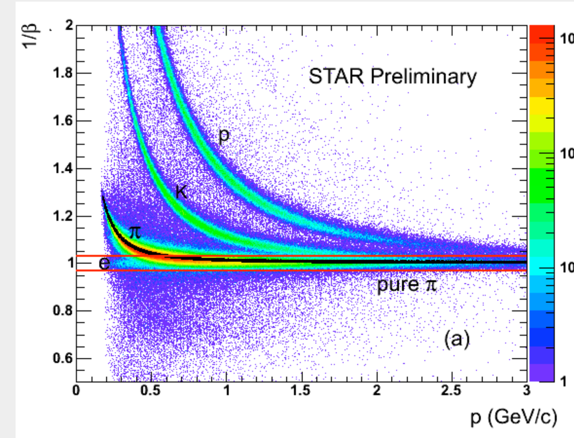


e and π Identification



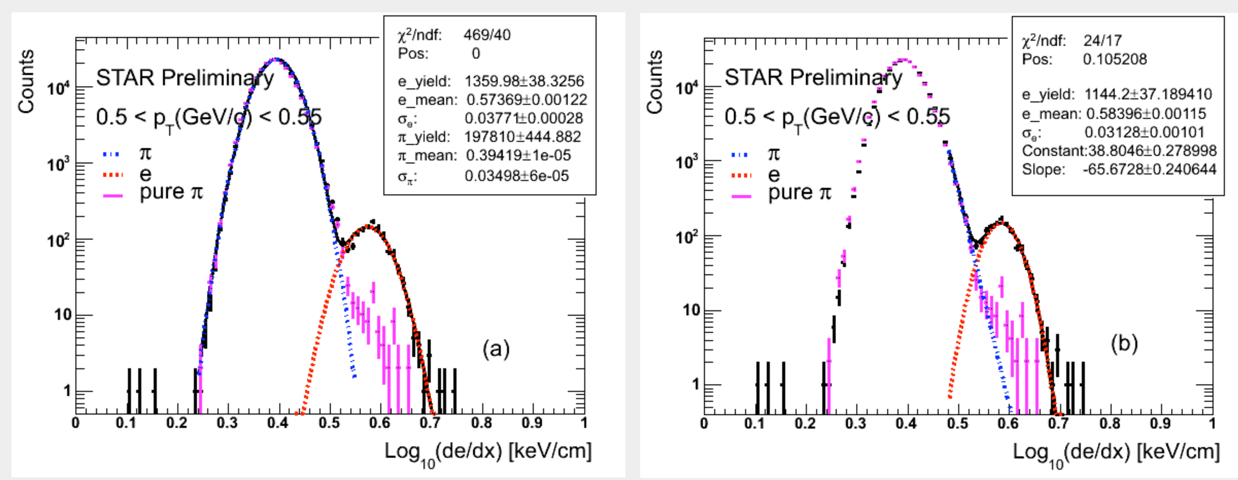
1)reject conversion background from beam pipe and its support:
|vertexZ|<40(cm)
2) Ensure good TOF hits:
|deltaY|<1.5(cm)
deltaY: distance between hits position and the center of associated TOF cell (3.15cm x 6.3cm)
3) TOF acceptance: $-1<\eta<0$
4) Ensure rapidity distribution of electron similar as that of pion
$-0.6<y<0$

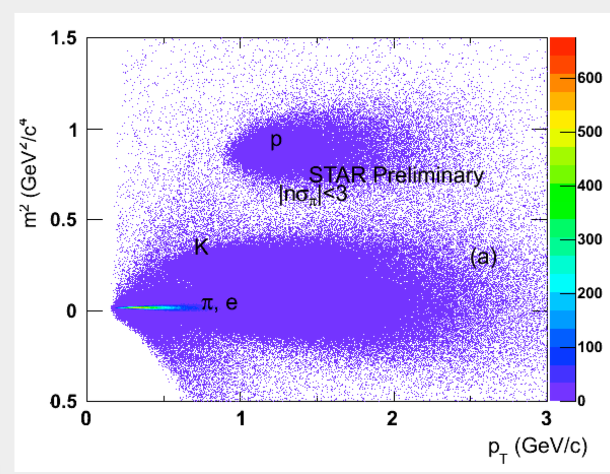
Ensure good primary track | Vz(VPD) – Vz(TPC) |<6(cm)



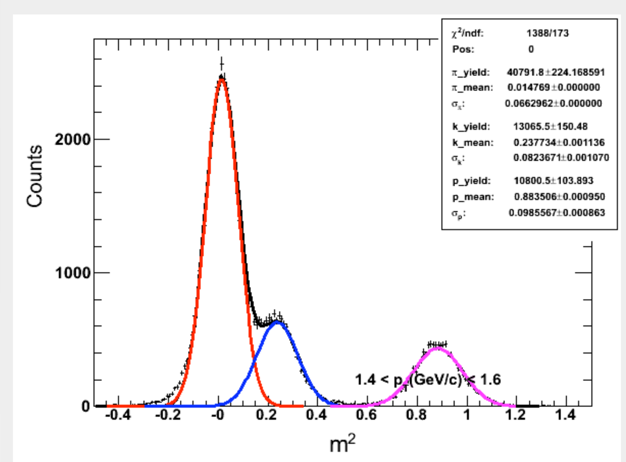
electron selection | 1/β – 1 | < 0.03 (TOF PID cut)

1) Electron identification requires TOF PID cut to reject slow hadrons.
2) Use two function to estimate the background dE/dx distribution. one is Gaussian and the other is exponential.
3) 2-Gaussian can't describe the left shoulder region below p_T<1.6GeV/c, but Gaussian+exponential can fit dE/dx well.
4) Above p_T>1.6GeV/c, 3-Gaussian fit was used, assuming one Gaussian can describe kaons and residual protons.
5) Use EMC energy to check the electron signal.





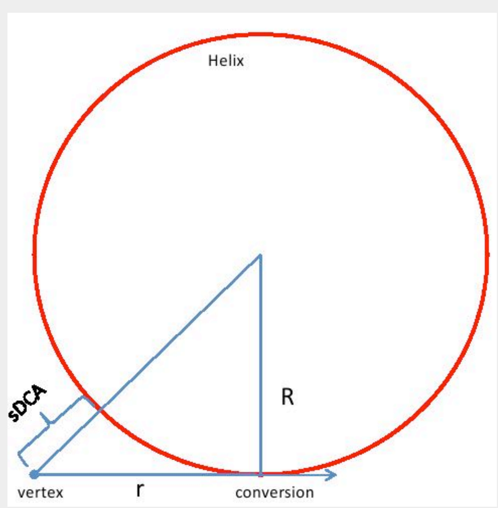
pion selection | nσ π | < 3



1) π identification was achieved with dE/dx from TPC and mass from TOF.
2) Use Gaussian function to extract pion yields.
3) Counting entries at $-0.1<m^2<0.1(GeV/c^2)^2$ are used to compare with fitting yields.
4) The difference between them was ~4% and was used as a part of systematic uncertainty.

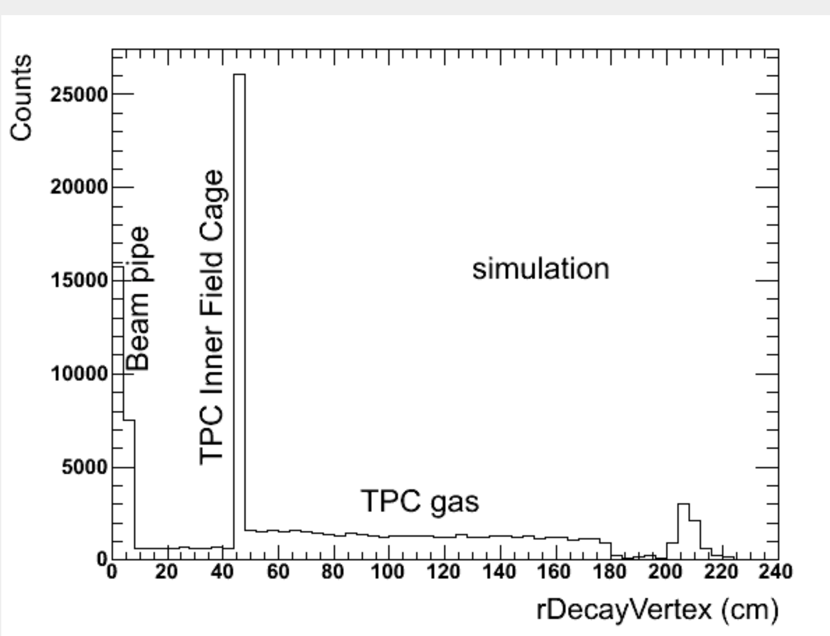
Three components of inclusive electron:

- heavy-flavor decay (c,b)
- photonic background electron (Dalitz decay of light mesons and gamma conversions)
- other background electron

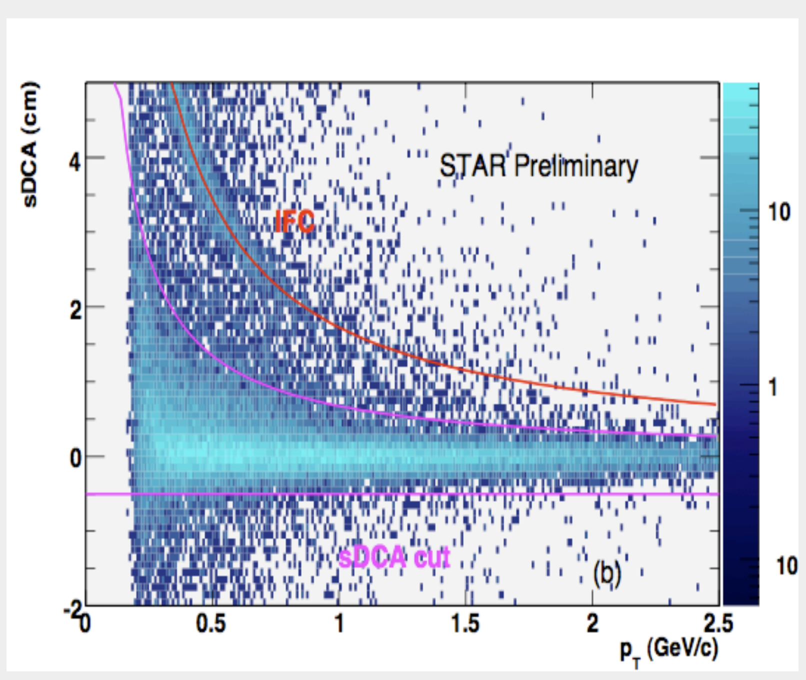


Upper part shows signed DCA definition.

1) Reject gamma converted at high radius

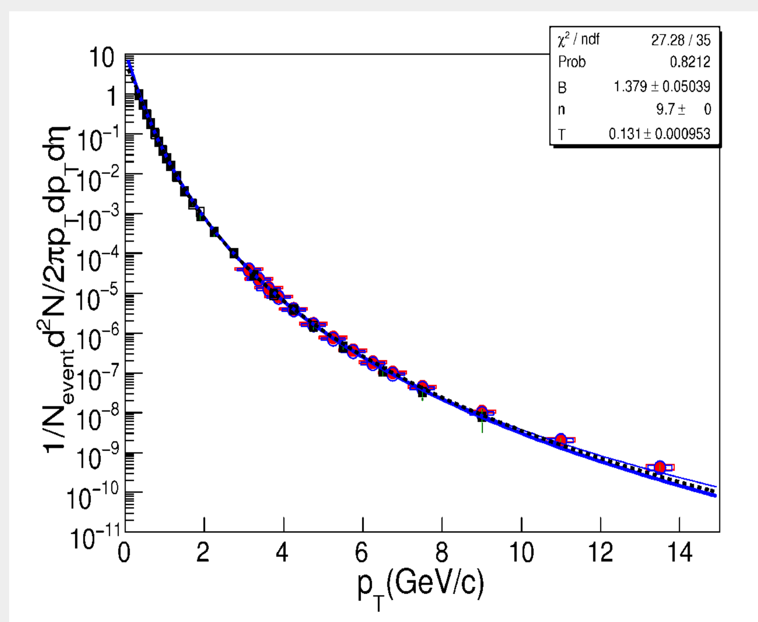


1) Upper part shows radial distance of gamma decay vertex to the primary vertex from GEANT simulation.
2) There are two major background sources of gamma conversion, material around the beam pipe and TPC inner field cage.
3) Here, we used the sDCA cut to remove gamma conversion at high radius (r<30cm)



1) Red curve shows that a hand calculation of where sDCA should be from conversions at IFC agrees with the band in data.
2) Two pink curves show the sDCA cut to reject gamma conversion at high radius, for example, IFC and TPC gas.

2) Cocktail



STAR charged pion spectra in pp NSD

1) Use cocktail method to subtract background from Dalitz decays.
2) The most important Dalitz decay background is π^0 Dalitz decays.
3) Fit to charge pion spectra in NSD pp collisions, we got one function,

$A/(1+(mt-m0)/nT)^n$ Fixed n=9.7

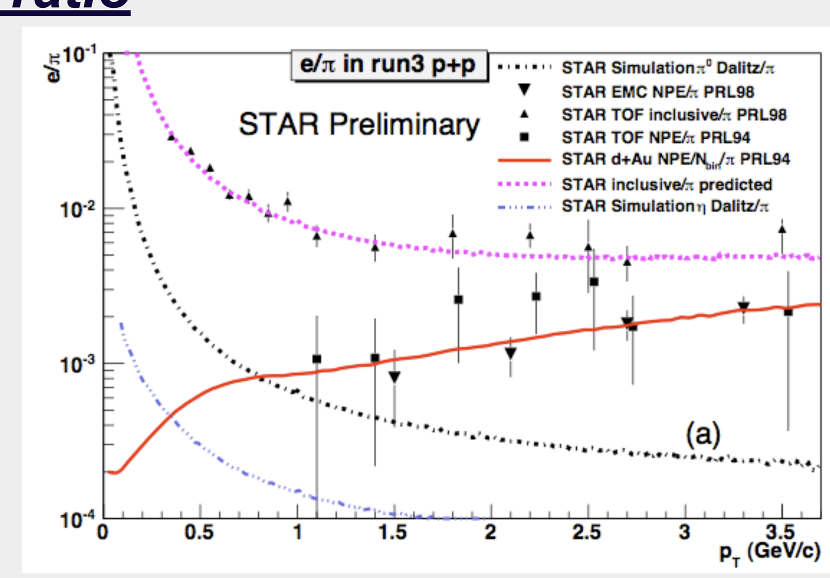
It also Fit $\pi^\pm$, $K^\pm$ (K^0_s), K^*, ρ, φ quit well.

4) Input the function to MC event generator of hadron decays to get electron backgrounds from light mesons Dalitz decays.

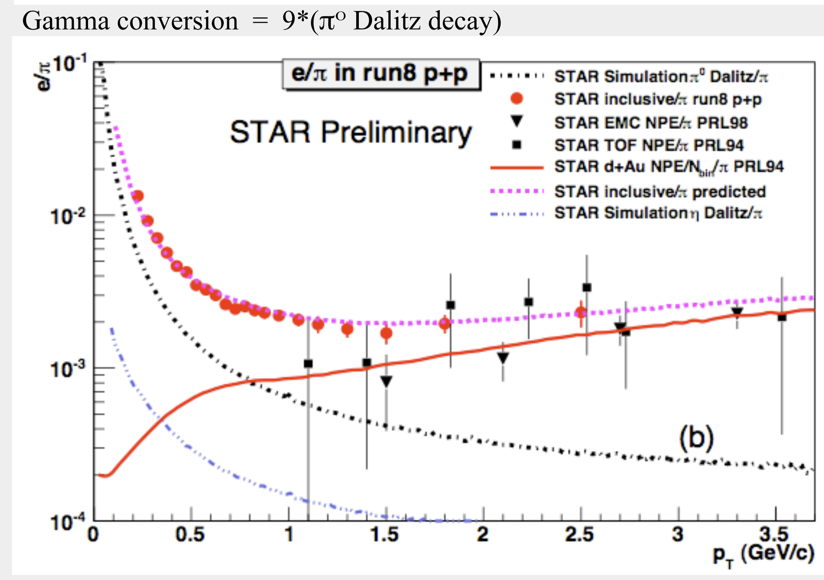
Summary

1) Due to the absence of inner tracking detectors and the supporting materials in this run, background electron from gamma conversion is reduced by a factor ~10.
2) more detailed work are in progress.

e/π ratio



Gamma conversion = 9*(π^0 Dalitz decay)



Gamma conversion = 0.9*(π^0 Dalitz decay)

We take the material budget from which gamma conversion is ~10 in run3 than that in run8 and it is equivalent to 9* π^0 Dalitz decay. We found the total sum of e/π including e/π from gamma conversion, Dalitz decays of light measons and NPE will match inclusive e/π in run8 and run3.