Correlations of Electrons from Heavy Flavor Decay in p+p, d+Au and Au+Au Collisions

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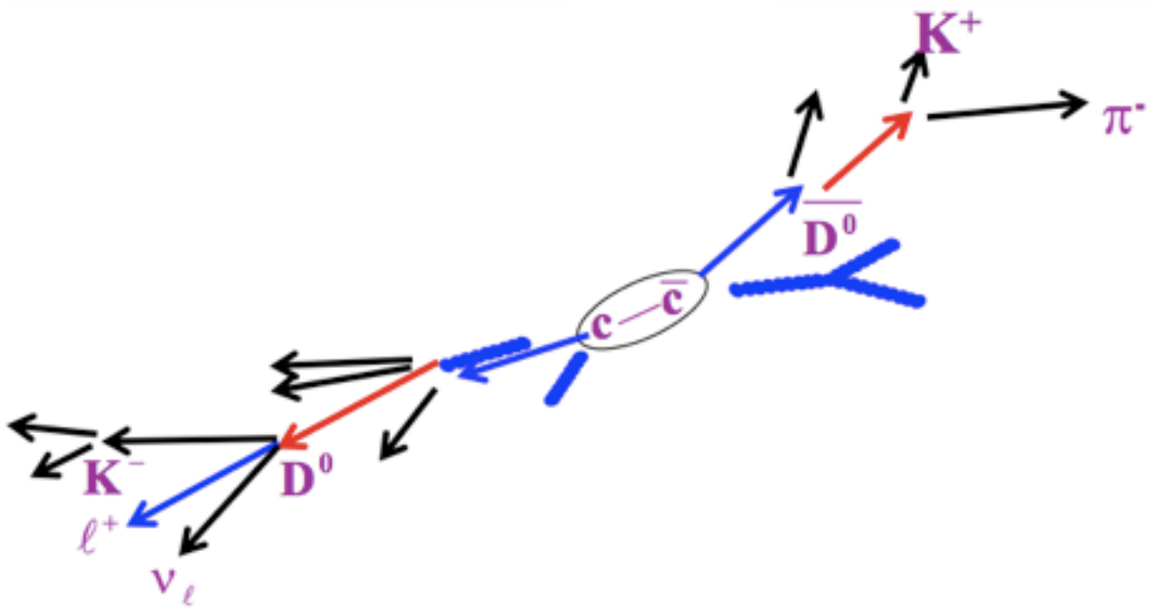
motivation

- p+p collisions:
  - understand heavy flavor production
  - baseline for Au+Au measurements
- d+Au collisions:
  - cold nuclear matter effects
  - probe nuclear gluon distribution
  - baseline for Au+Au measurements
- Au+Au collisions:
  - understand heavy quark energy loss in hot nuclear matter

identifying heavy flavor



- use leptons from semi-leptonic D & B decay
  - advantage: straightforward ways to subtract correlations from non-heavy flavor leptons
  - disadvantages:
    - no charm/bottom separation
    - broad distribution of parent meson p_T for given lepton p_T

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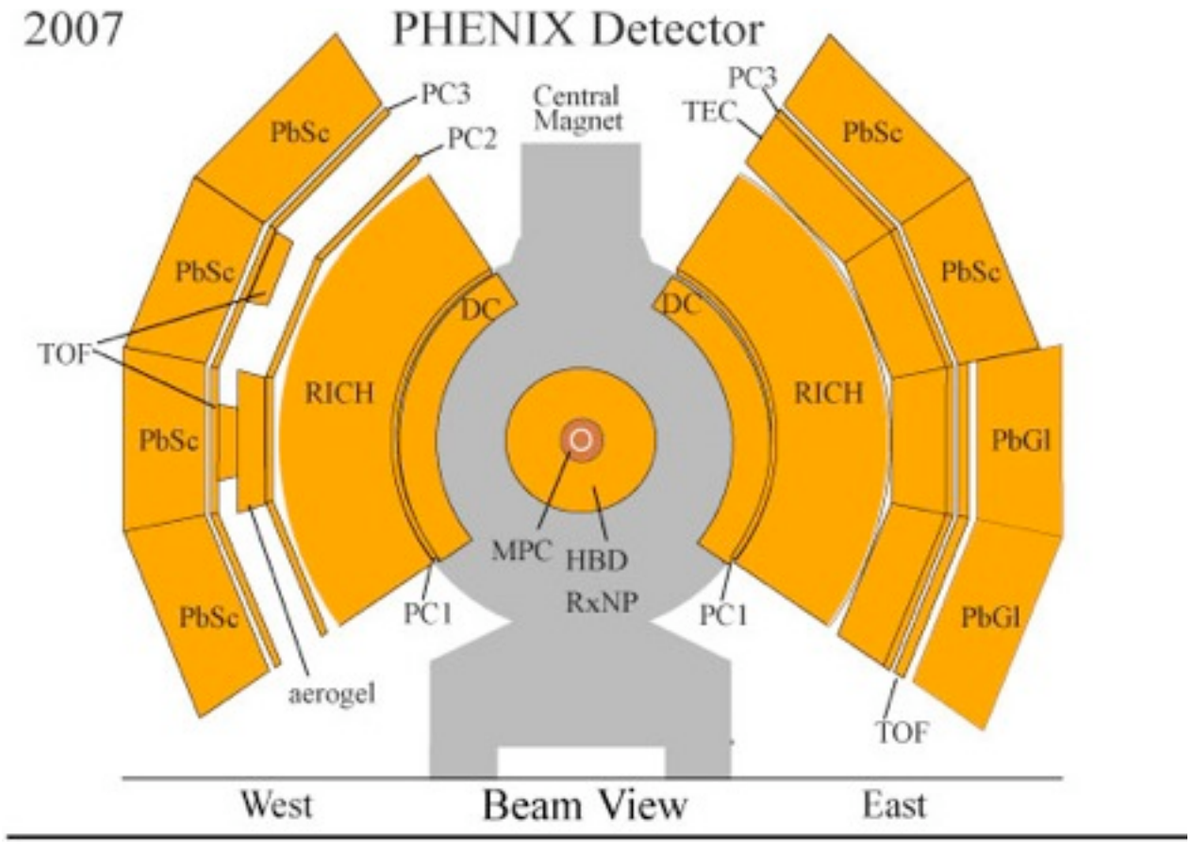
- central arms cover $|\eta| < 0.35$
- charged particle momenta measured in drift chambers
- electron identification from electromagnetic calorimeters and RICH
  - hadronic background in electron sample <3% in head on Au+Au collisions



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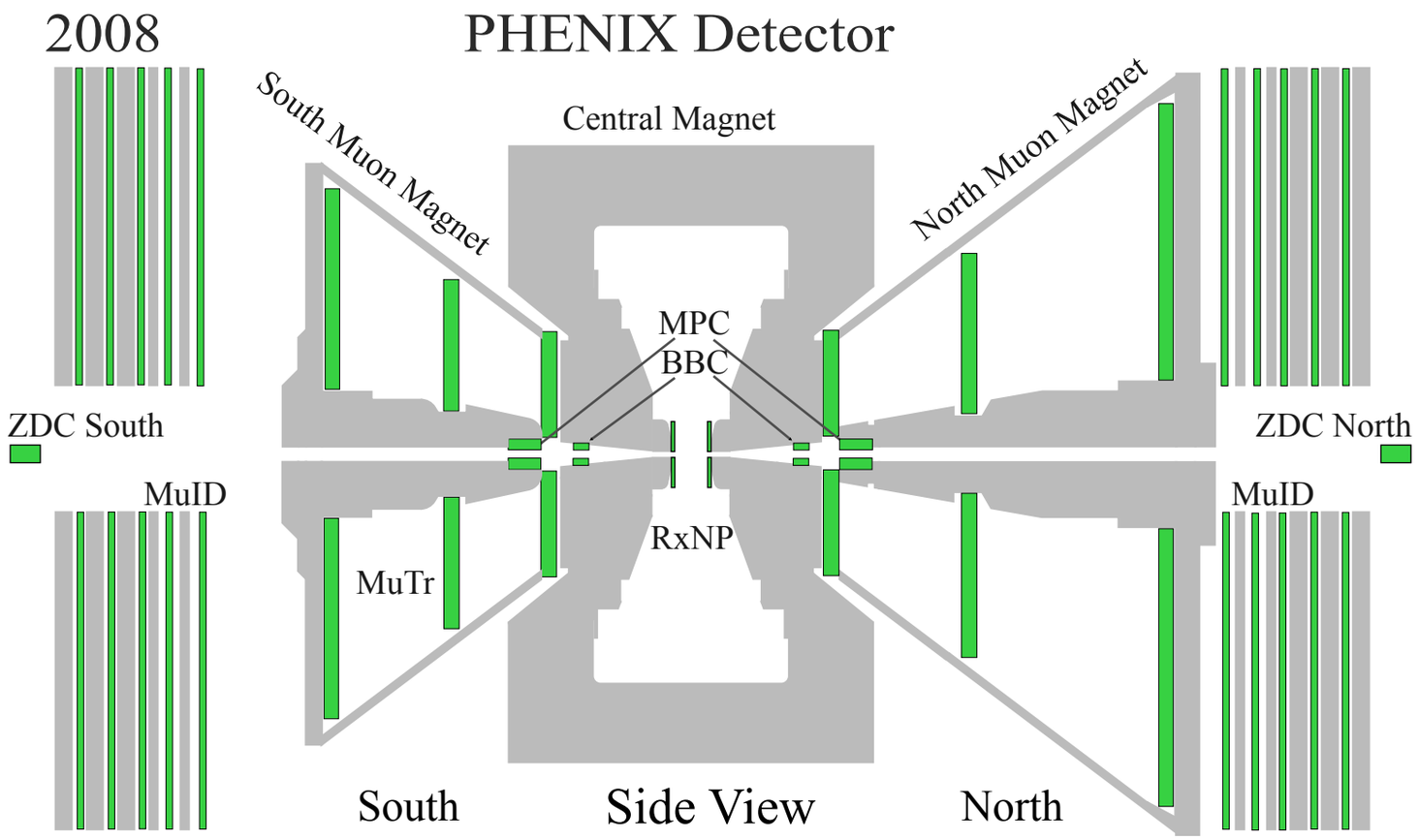
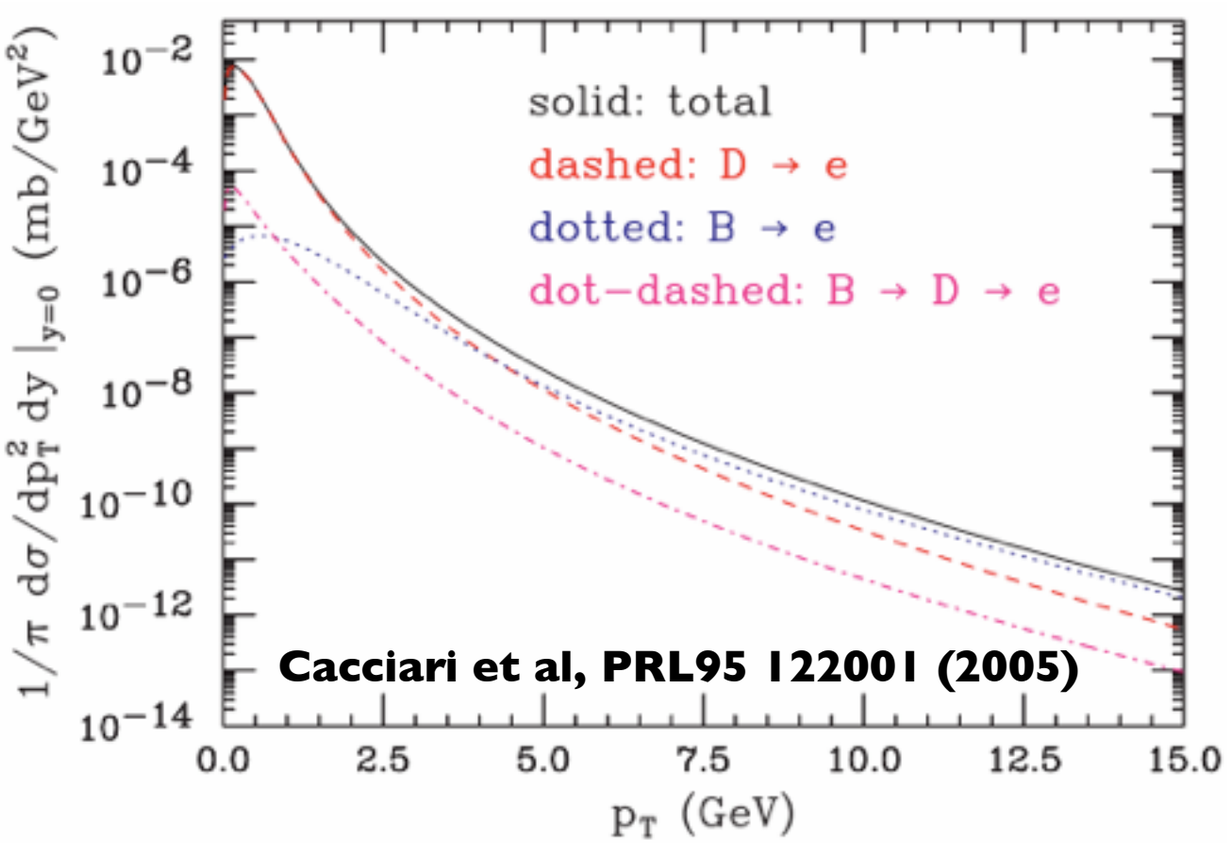


- muon arms in forward and backward rapidity
- MuTr determines momentum
- MuTr magnet and muon identifier steel stop hadrons
- muons make it to the last layer
- →pion rejection of 250:1

charm and bottom mixture

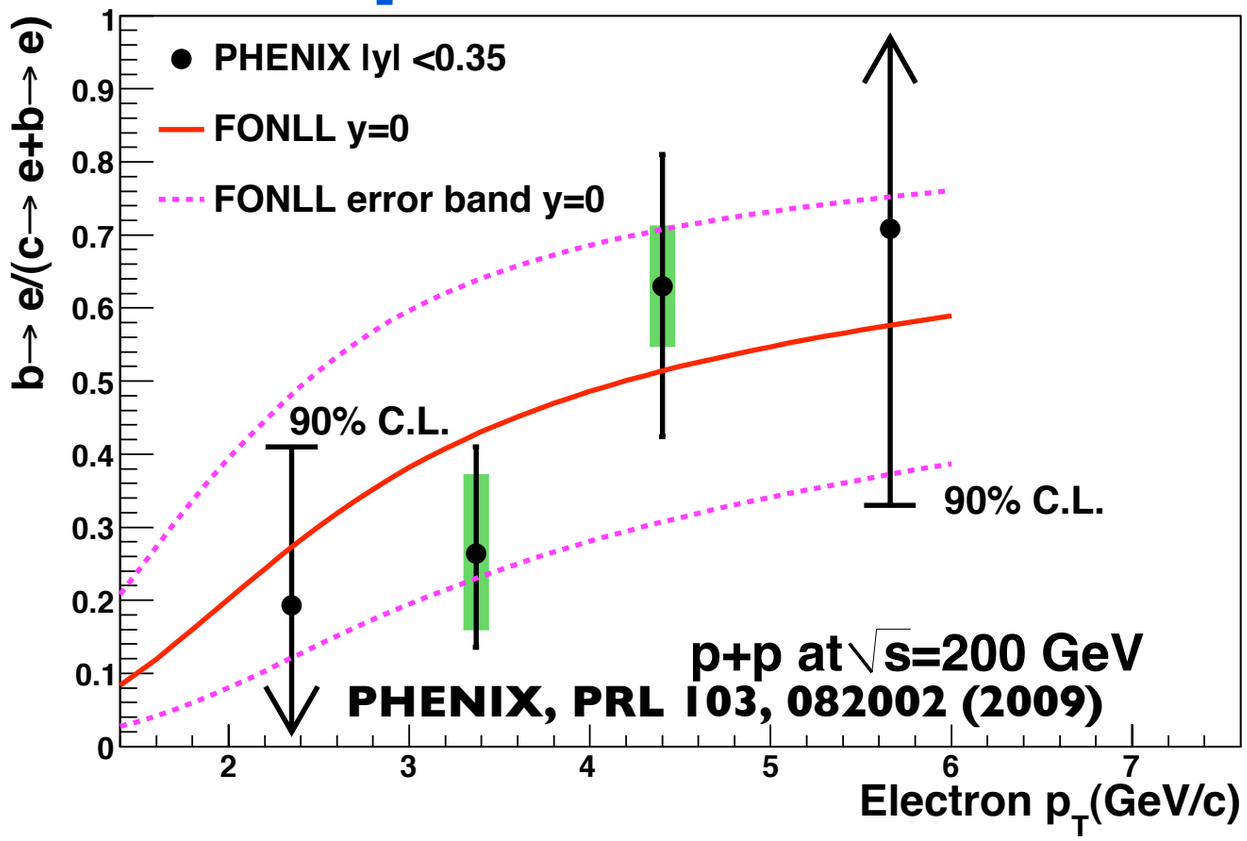
theory



Single electrons from heavy flavor

bands show theoretical uncertainty (FONLL) in components

experiment



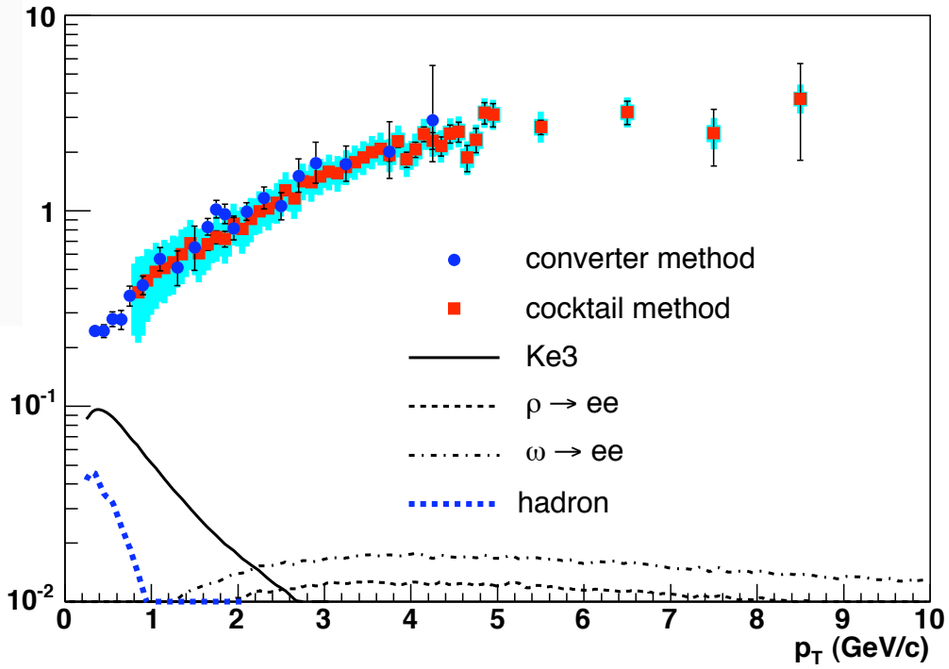
separation based on invarient mass analysis of electron-hadron pairs

theory and experiment agree well!

separating the correlations

$$Y_{e_{incl}-h} = \frac{N_{e_{HF}} Y_{e_{HF}-h} + N_{e_{phot}} Y_{e_{phot}-h}}{N_{e_{HF}} + N_{e_{phot}}}$$

$$R_{HF} = \frac{N_{e_{HF}}}{N_{e_{phot}}}$$



$$Y_{e_{HF}-h} = \frac{(R_{HF}+1) Y_{e_{incl}-h} - Y_{e_{phot}-h}}{R_{HF}}$$

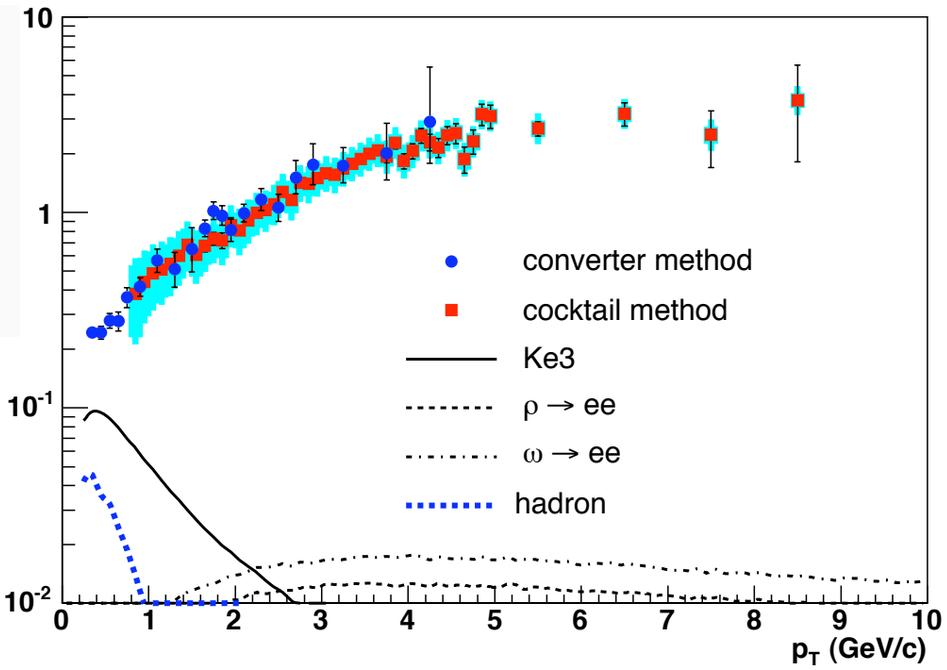
PHENIX, PRL 97 252002 (2006)

electron-hadron azimuthal correlations

- measure $\Delta\phi$ of all electron-hadron pairs
- statistically subtract correlations from non-heavy flavor (photonic) electrons
  - mainly from π^0s via Dalitz decays and photon conversions

$$R_{HF} = \frac{N_{e_{HF}}}{N_{e_{phot}}}$$

$$Y_{e_{HF}-h} = \frac{(R_{HF}+1)Y_{e_{incl}-h} - Y_{e_{phot}-h}}{R_{HF}}$$



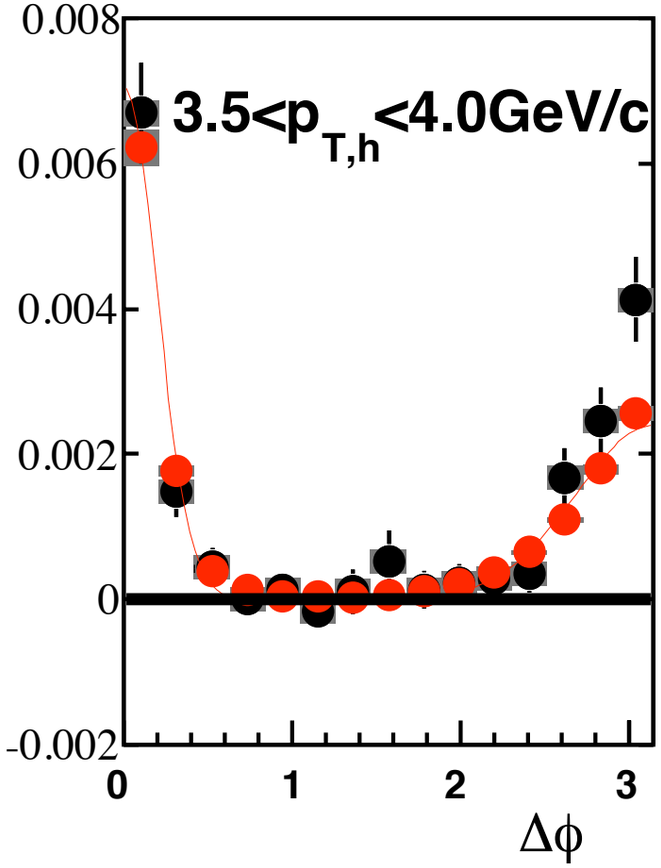
PHENIX, PRL 97 252002 (2006)

extracting HF correlations

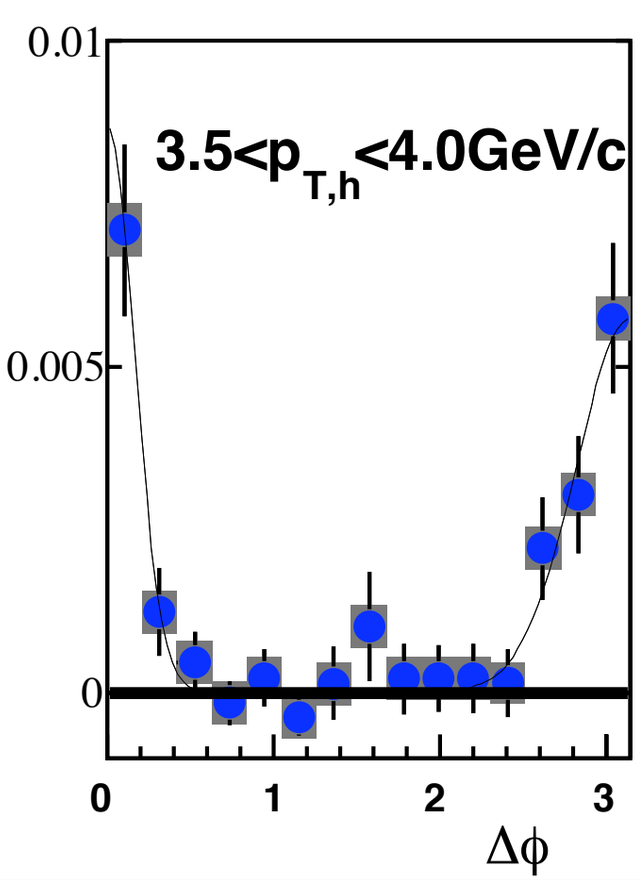
p+p Results

$$Y_{e_{HF}-h} = \frac{(R_{HF}+1)Y_{e_{incl}-h} - Y_{e_{phot}-h}}{R_{HF}}$$

inclusive e-h correlations
photonic e-h correlations

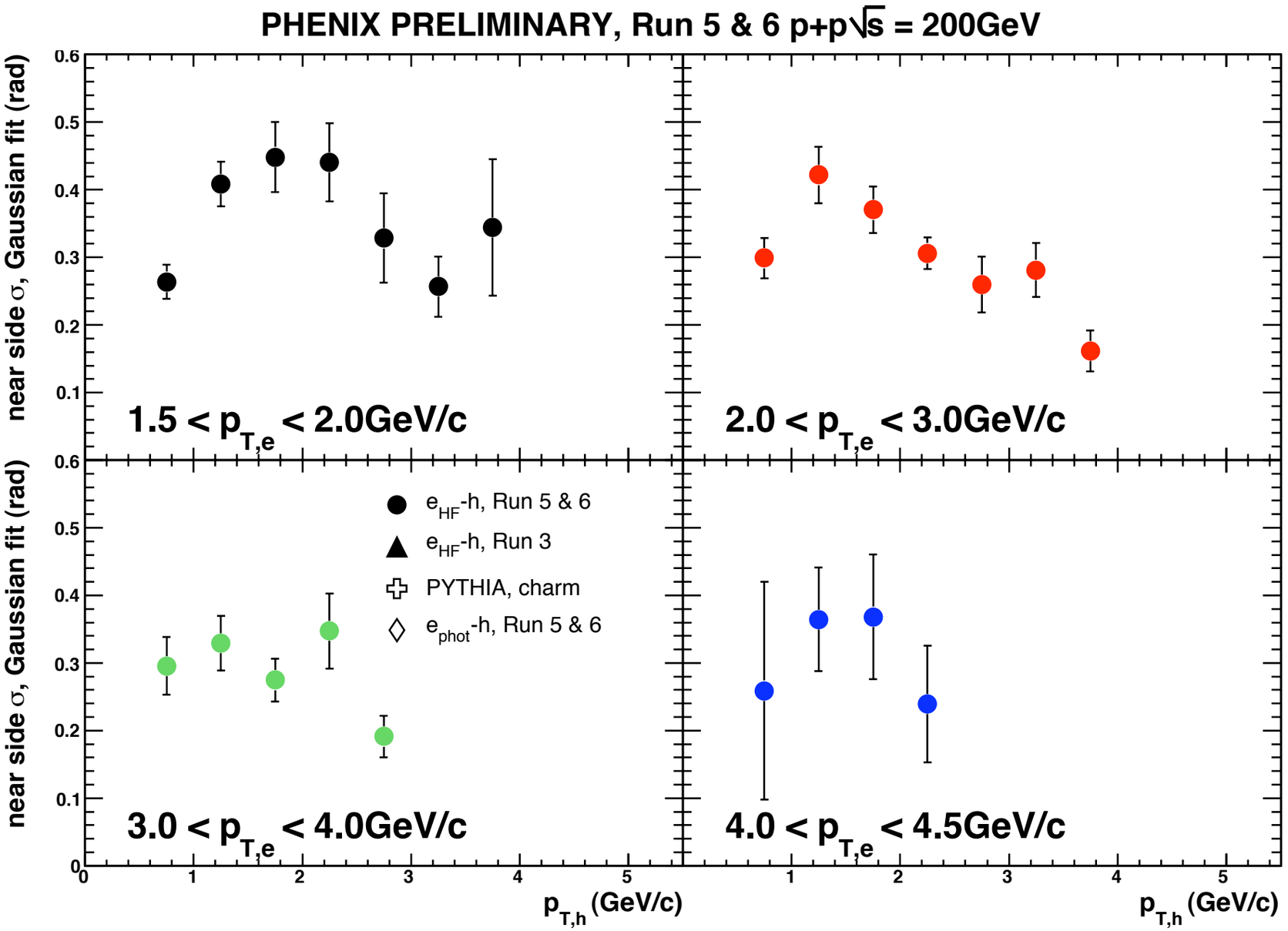


heavy flavor e-h correlations



arXiv: 0905.2112

near side widths



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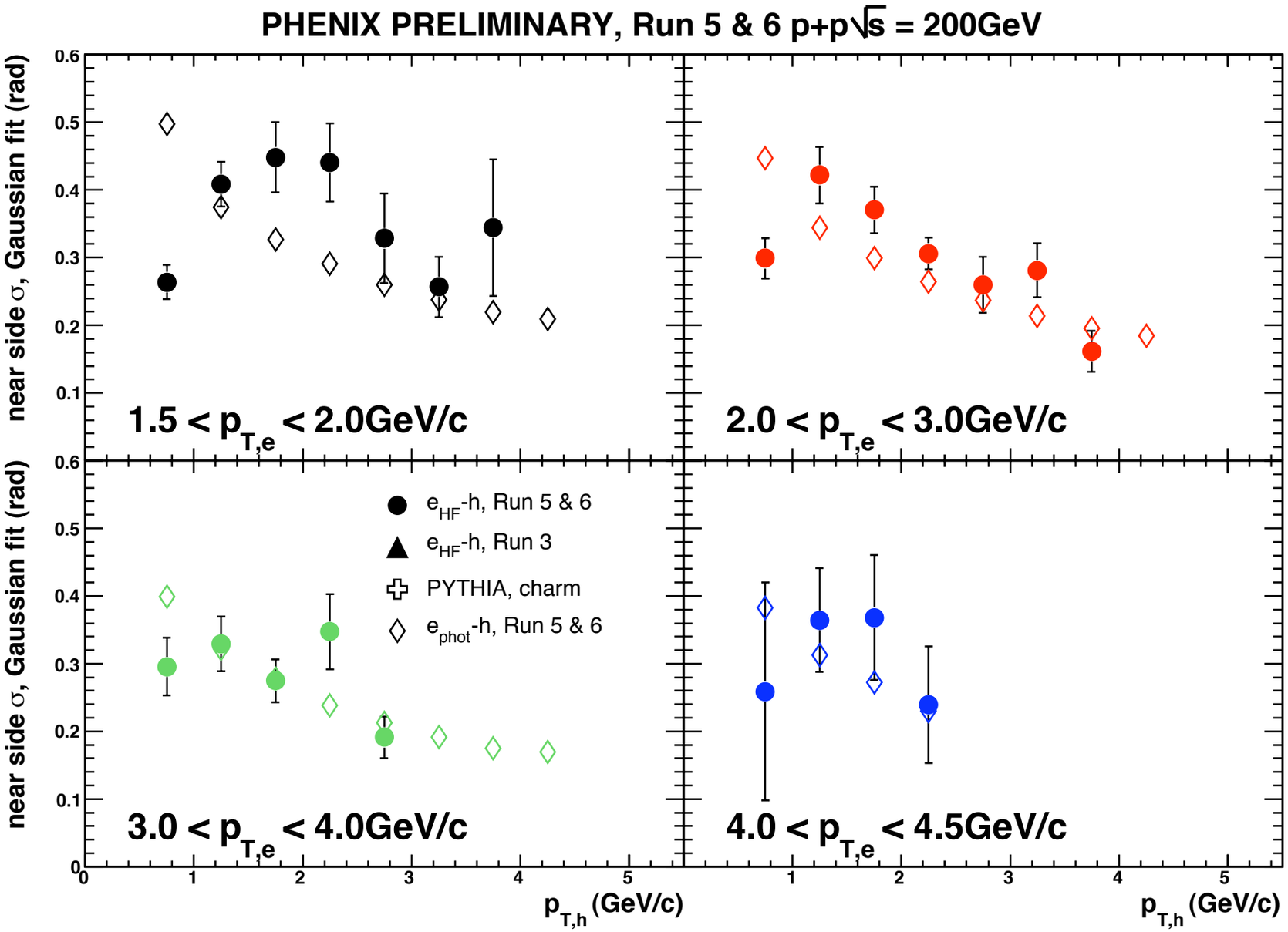

$\sigma_{HF} > \sigma_{phot}$: D/B decay kinematics

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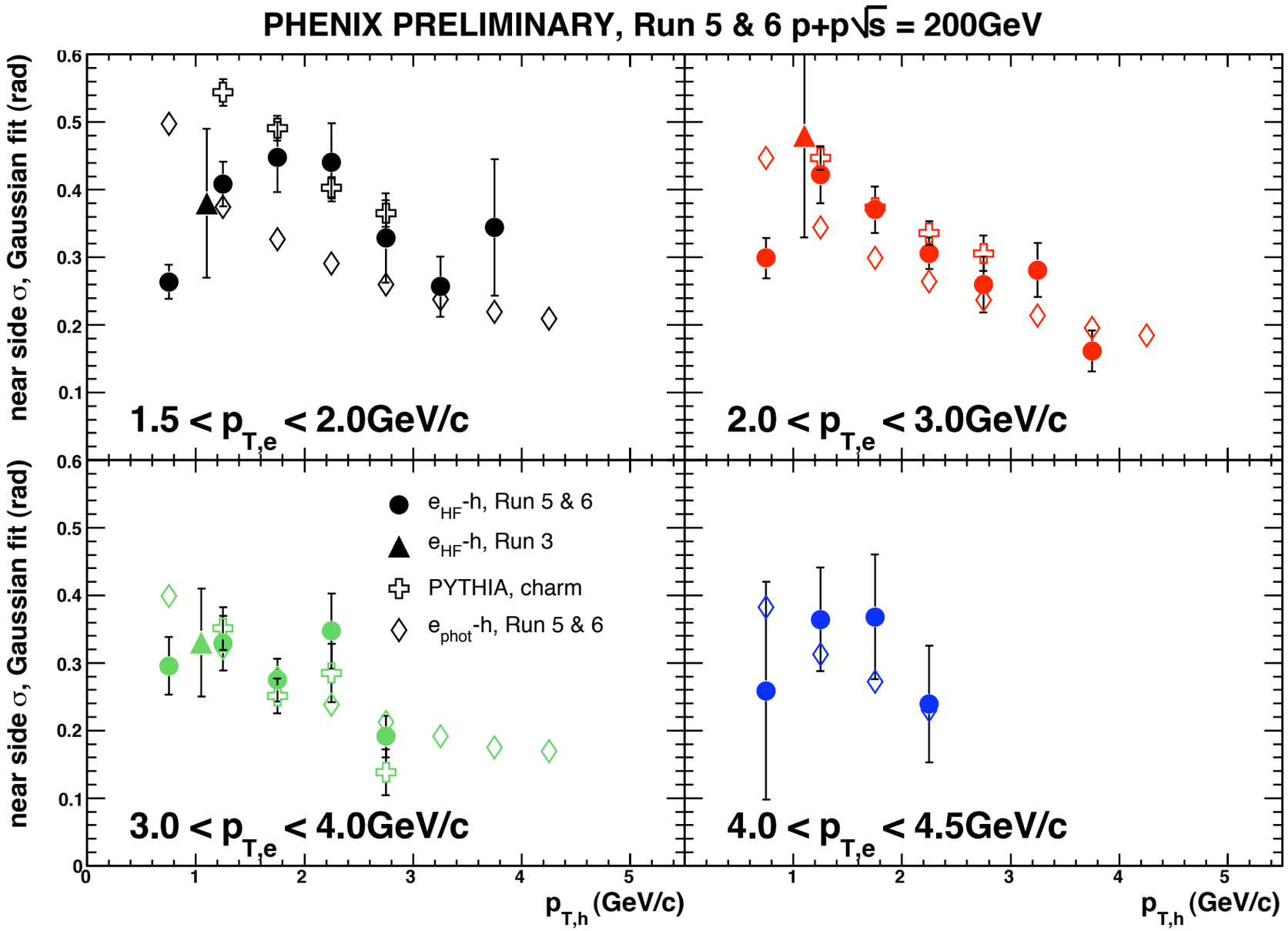
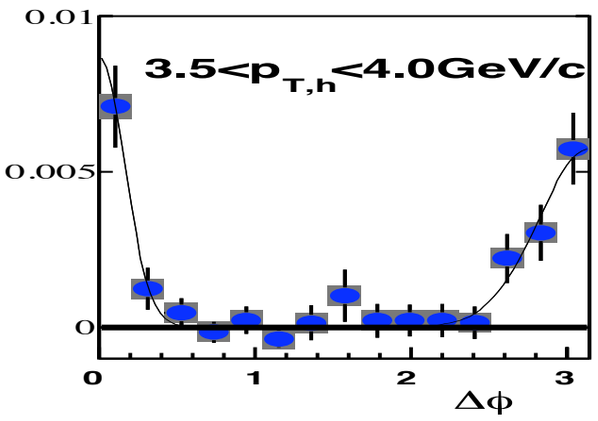


$\sigma_{HF} > \sigma_{phot}$: D/B decay kinematics

good agreement with PYTHIA (charm production)

arXiv: 0905.2112

heavy flavor e-h yields



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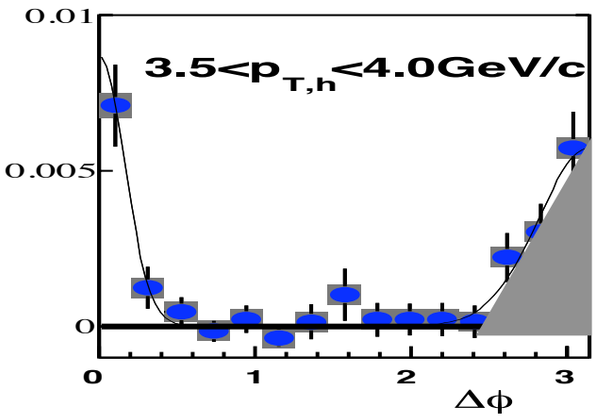

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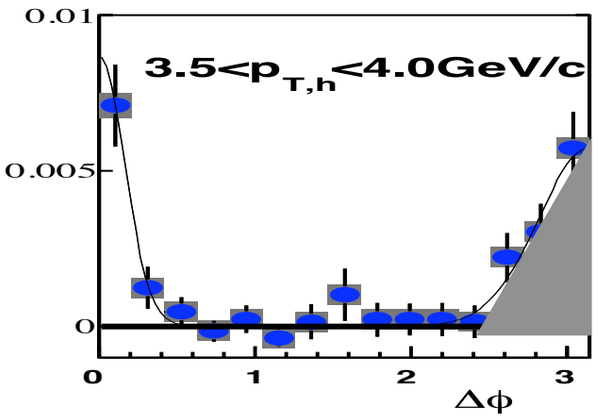
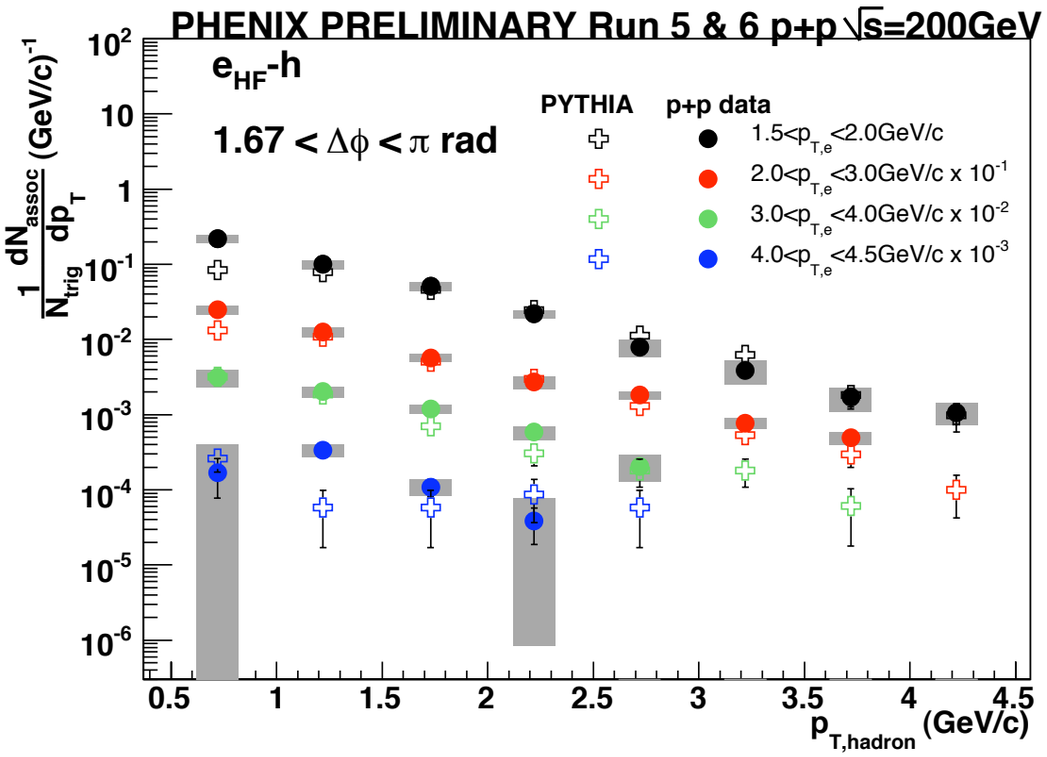
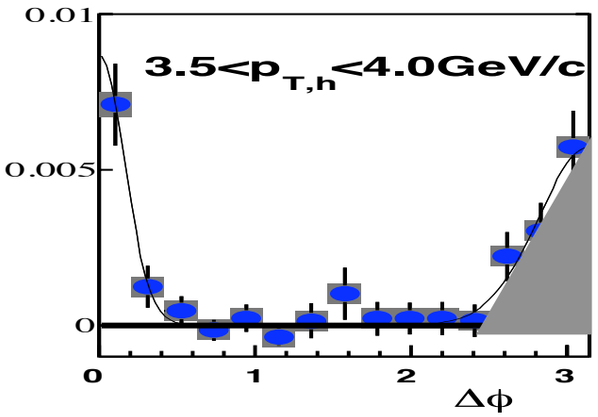




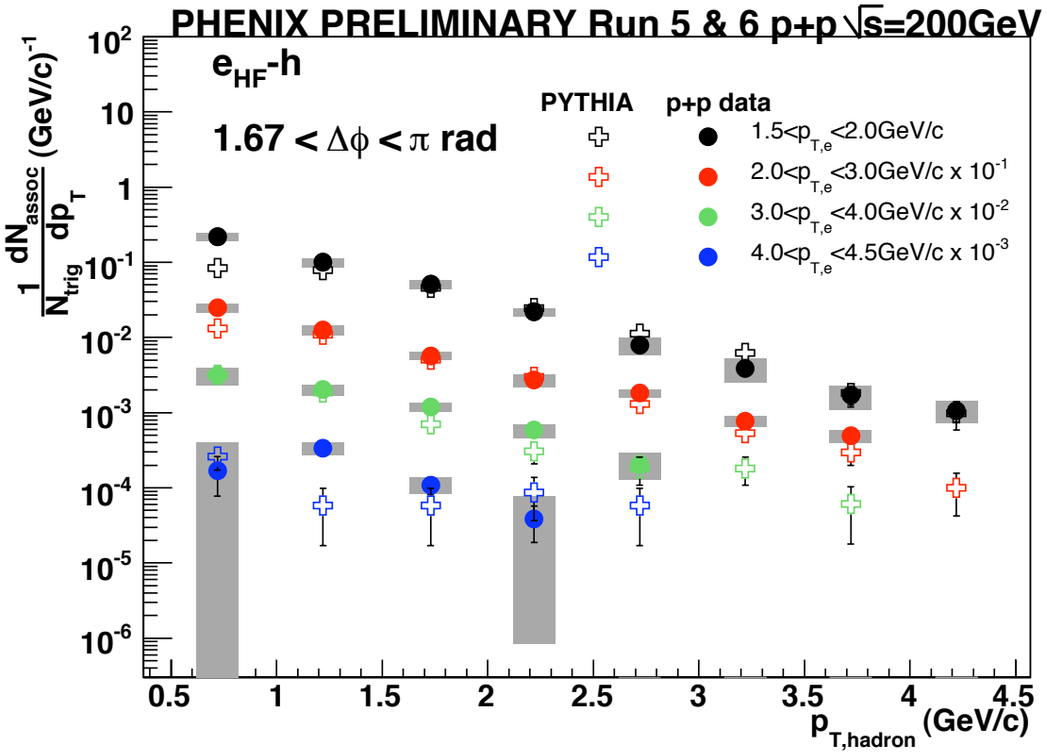
p+p measurements agree qualitatively with PYTHIA charm production

arXiv: 0905.2112, 0907.4813

heavy flavor e-h yields



$$I_{AA} = \frac{\text{conditional yield in Au+Au}}{\text{conditional yield in p+p}}$$



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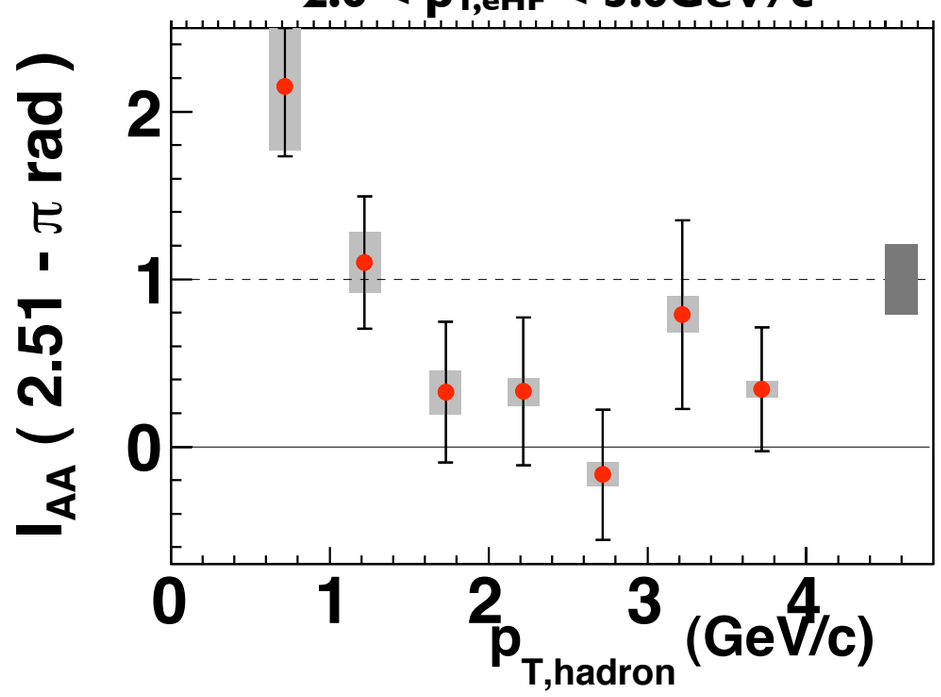


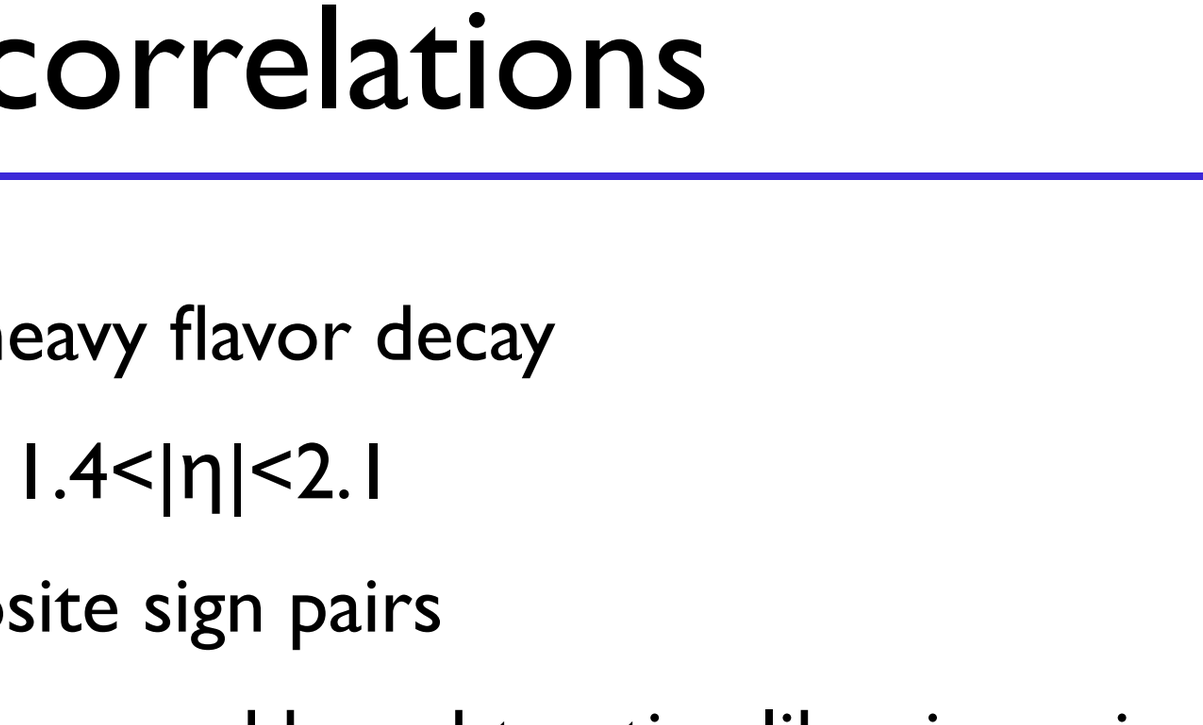
Au+Au yields are suppressed compared to p+p ($p_{T,h}$ >1.5GeV/c)

arXiv: 0905.2112, 0907.4813

e-μ correlations

- both particles from heavy flavor decay
- electron: $|\eta|<0.35$, μ: $1.4<|\eta|<2.1$
- signal produces opposite sign pairs
  - most background removed by subtracting like sign pairs
  - remaining hadrons in μ sample also subtracted

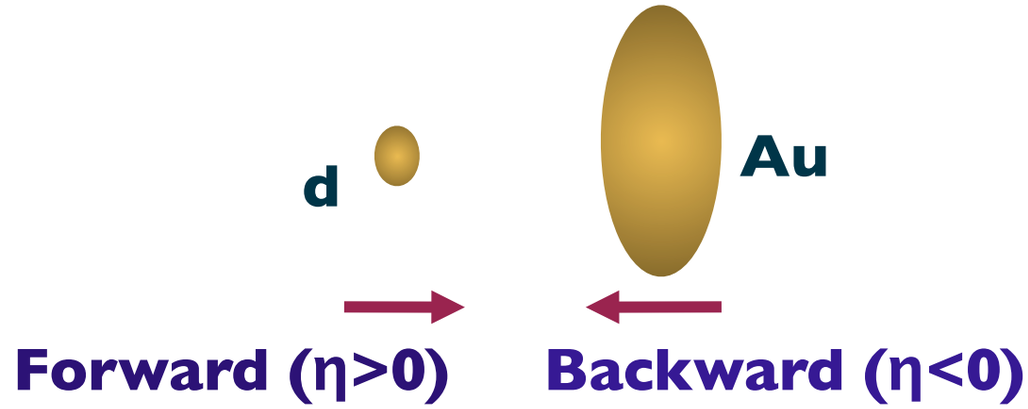
p+p result

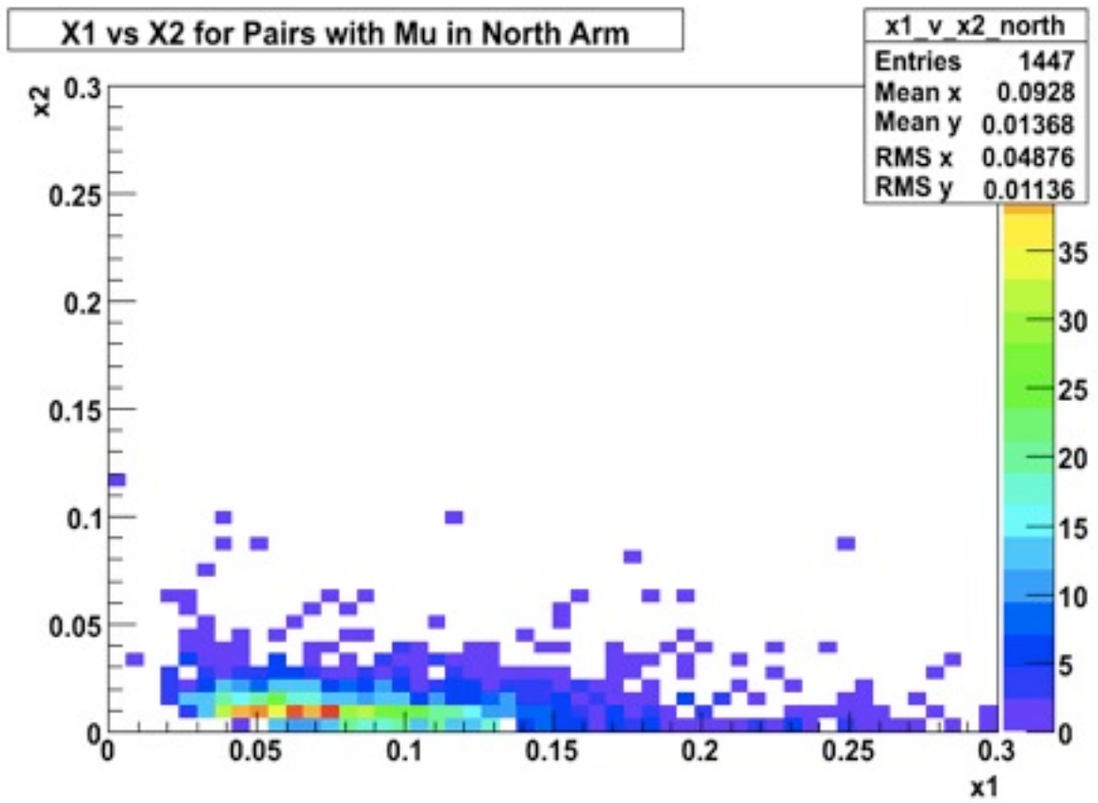


arXiv: 0907.4813

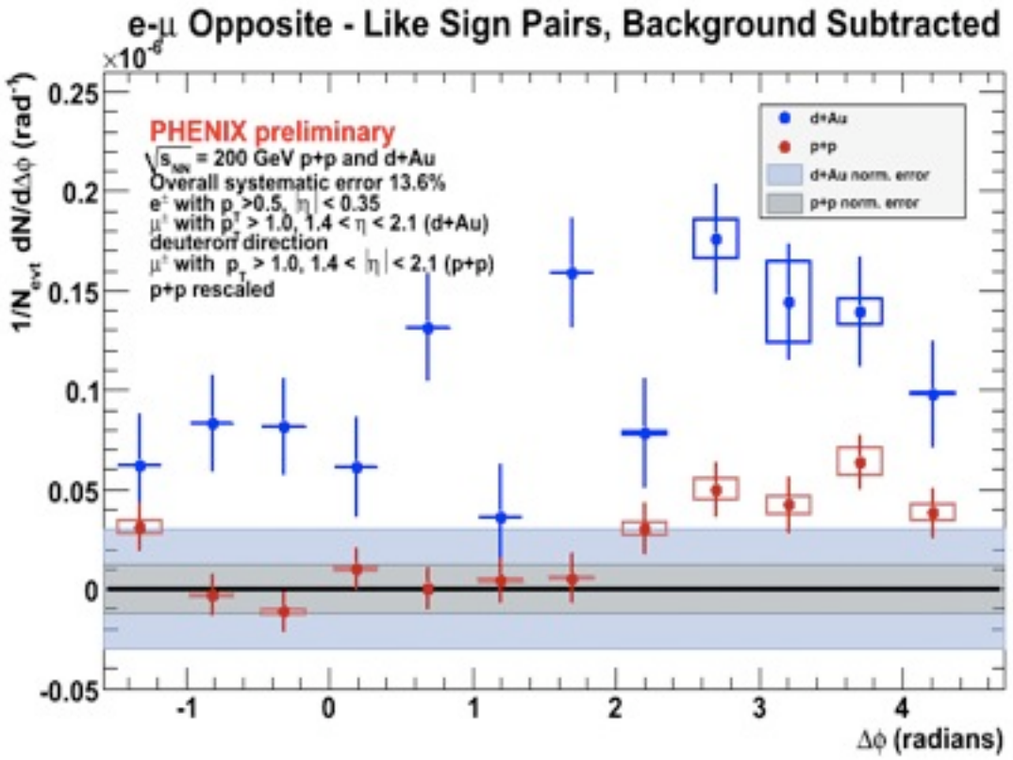
e-μ in d+Au

- forward rapidity particles sensitive to low x in the nucleus
- possible gluon saturation effects might become important around x~0.01





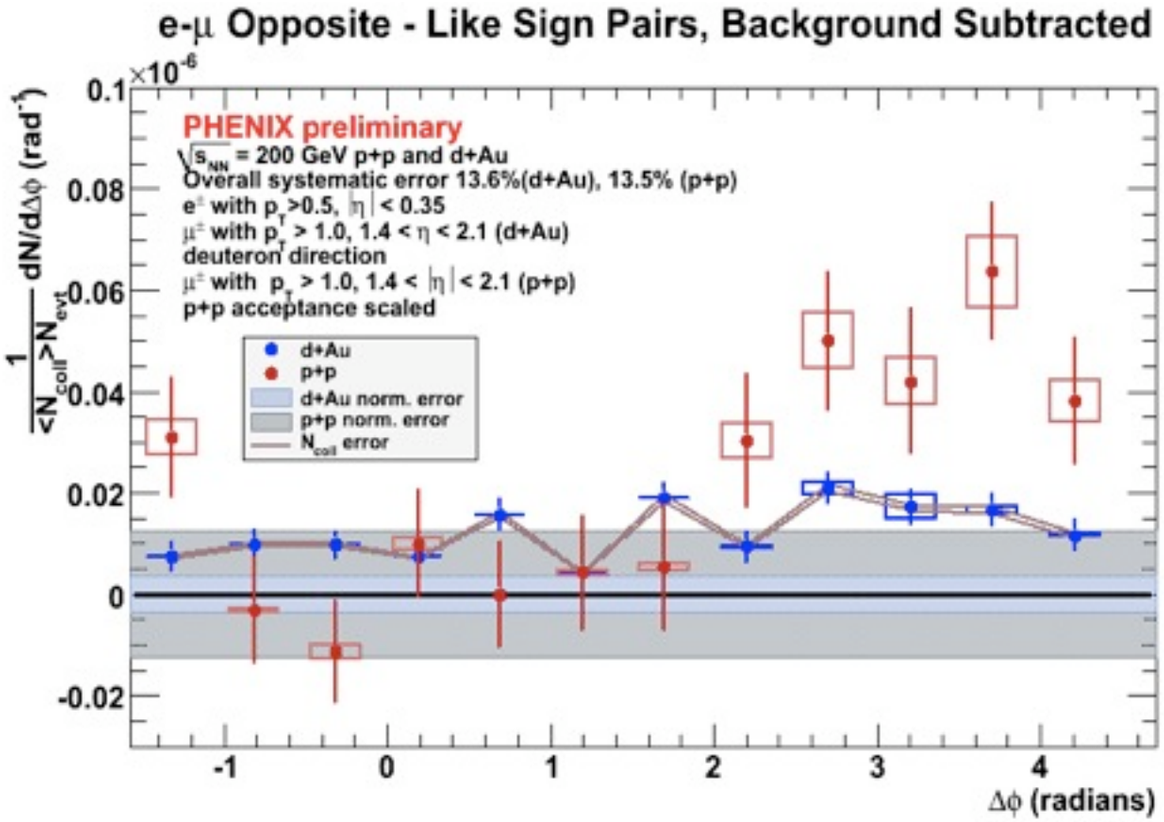
d+Au results



scaled by the number of nucleon-nucleon collisions

d+Au

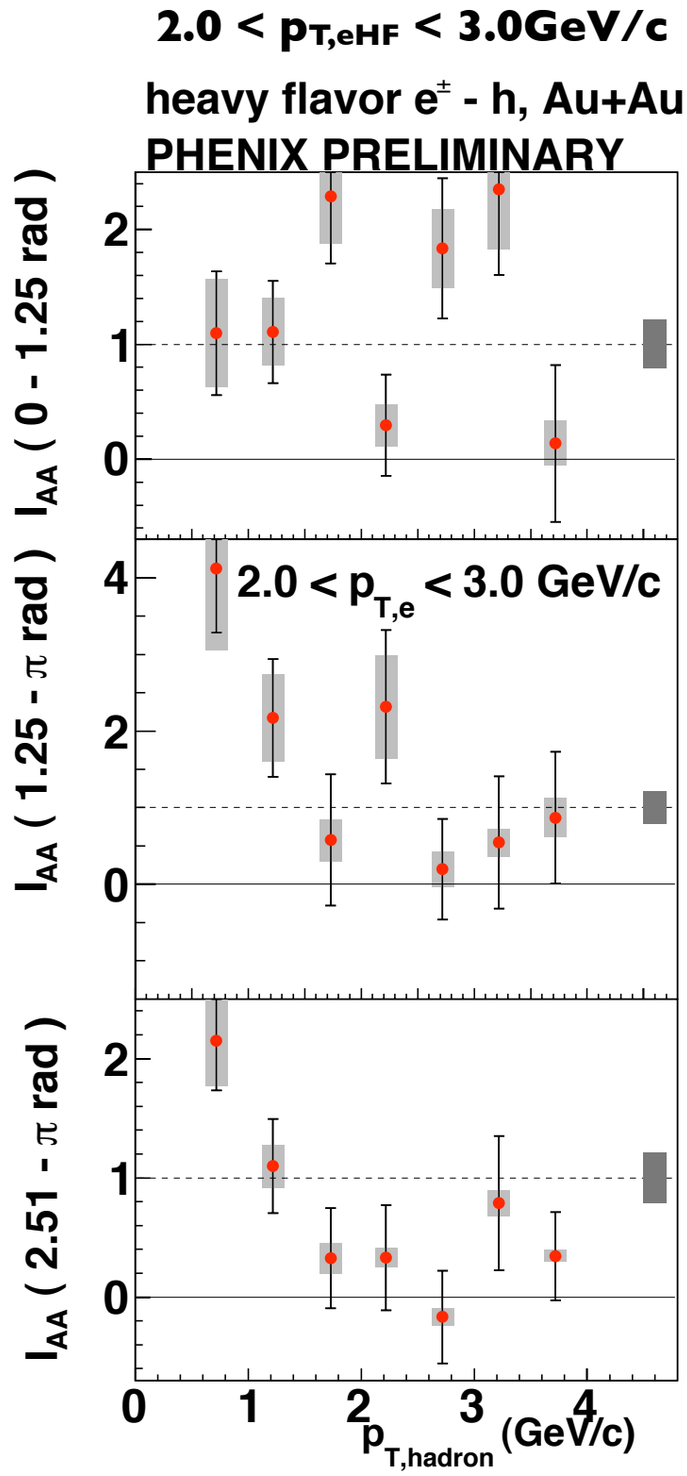
p+p



Conclusions

- electron-hadron correlations measured in p+p and Au+Au collisions
  - p+p qualitatively consistent with PYTHIA expectations
  - Au+Au consistent with suppression compared to p+p
- electron-muon correlations measured in p+p and d+Au collisions
  - suppression in d+Au seen for deuteron going muons
  - further quantification underway
- next year new silicon vertex detector will allow charm/ bottom separation leading to more precise measurements

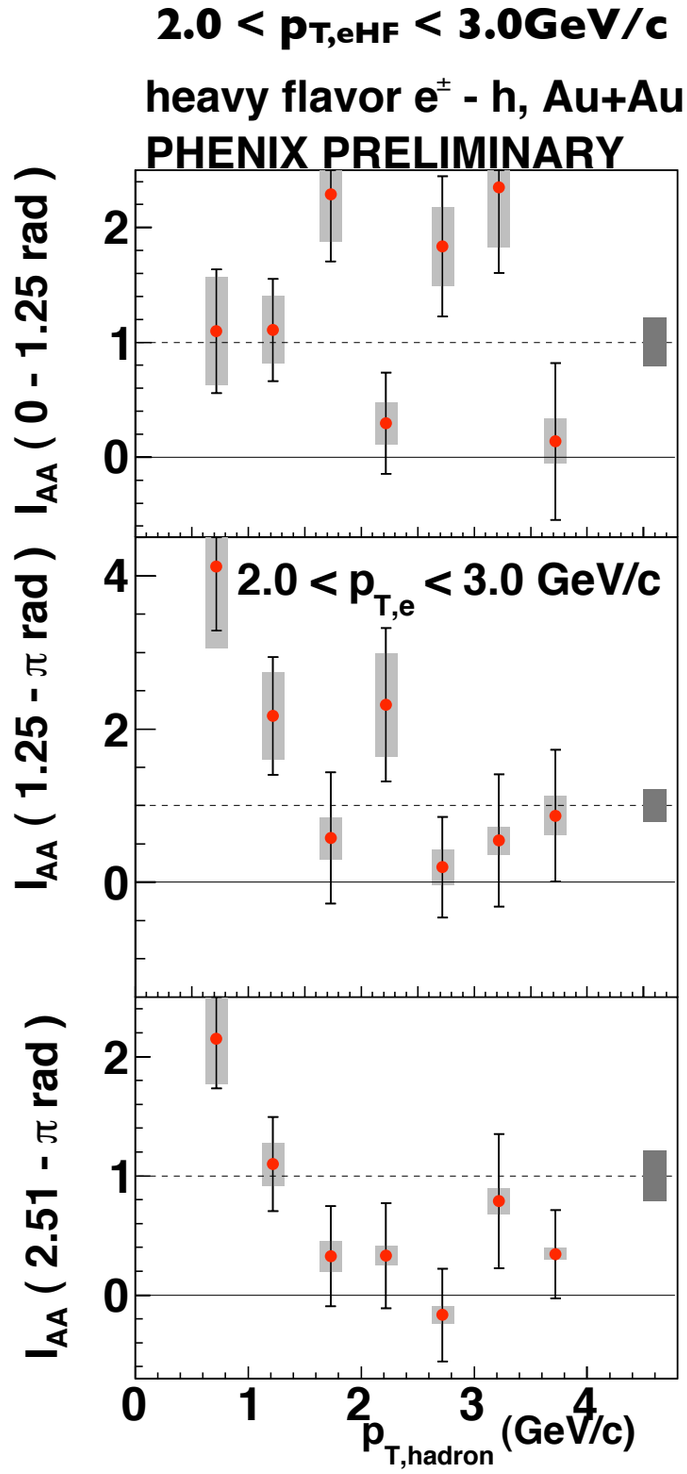
correlations: some insight



PRC 78 014901 (2008)

correlations: some insight

- near side: I_{AA}~1



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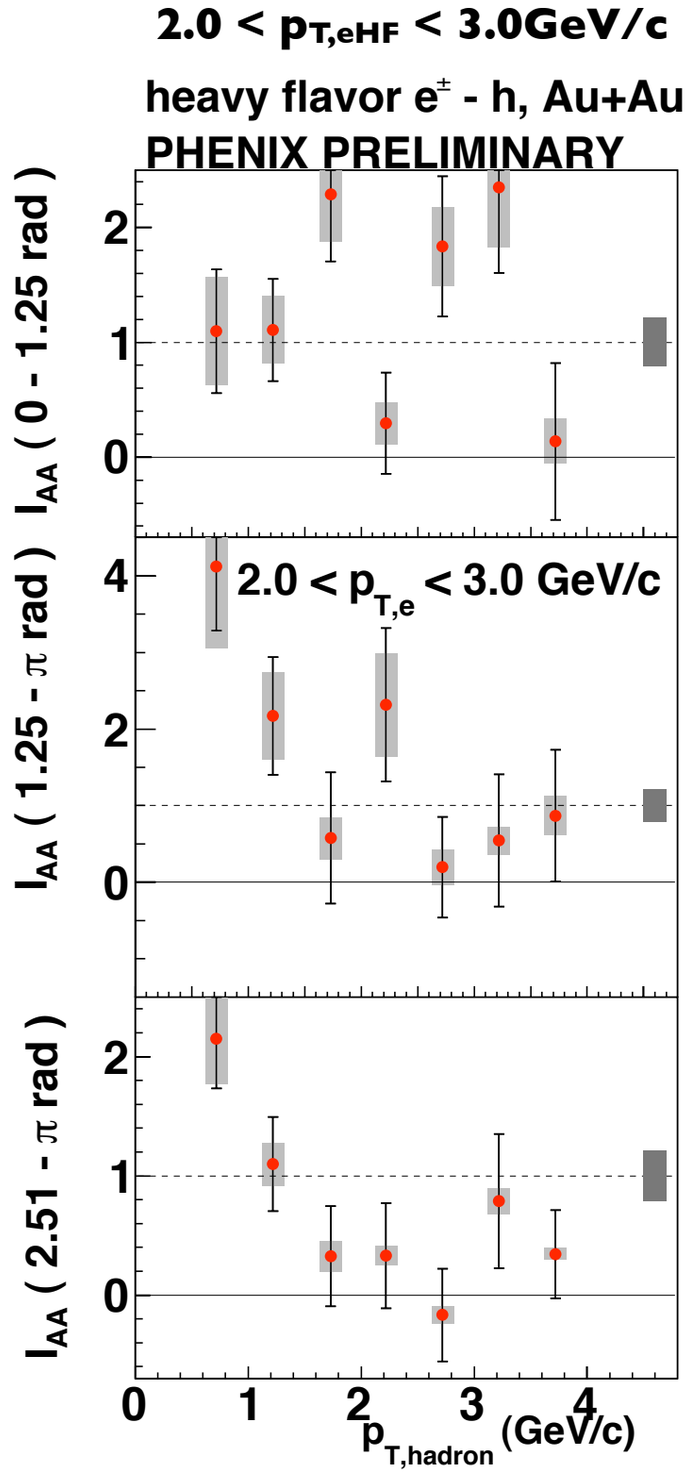
correlations: some insight

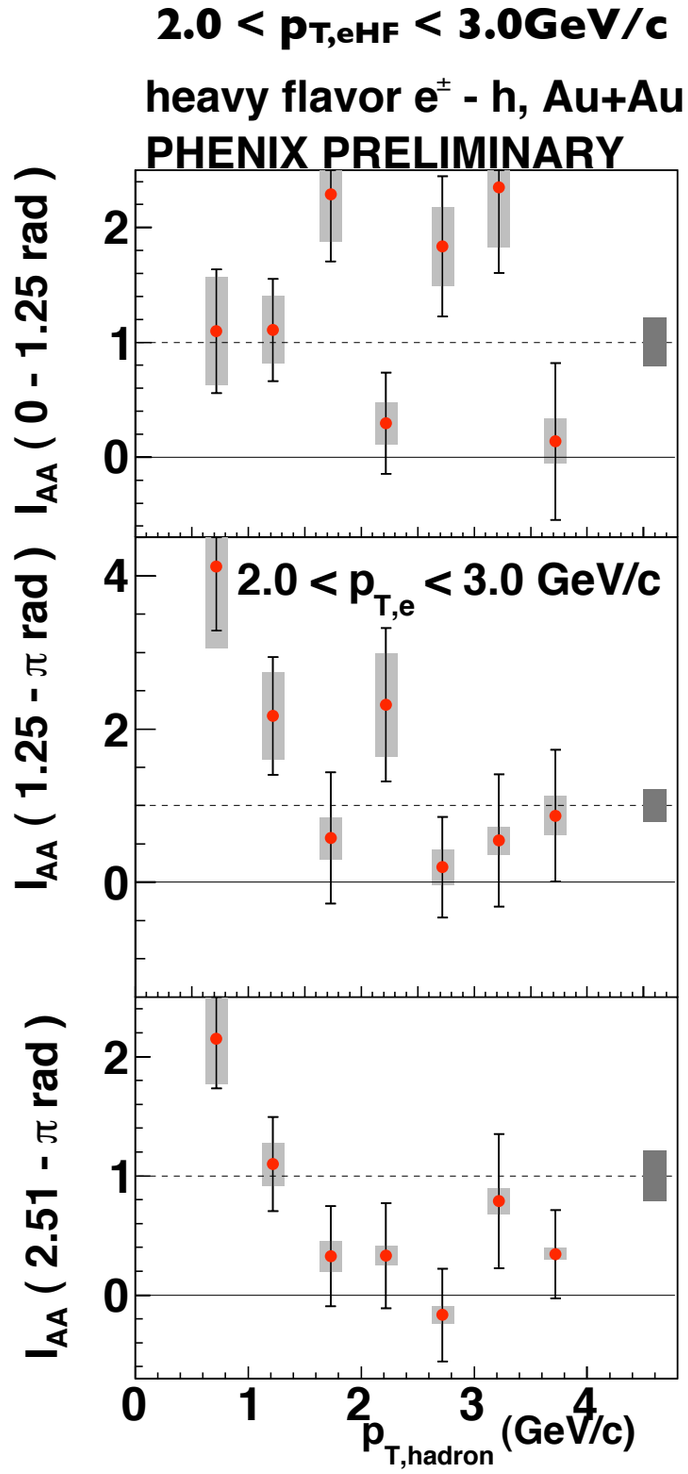
- near side: I_{AA}~1
  - consistent with electrons from Ds



PRC 78 014901 (2008)

correlations: some insight

- near side: I_{AA}~1
  - consistent with electrons from Ds
  - sanity check



PRC 78 014901 (2008)

correlations: some insight

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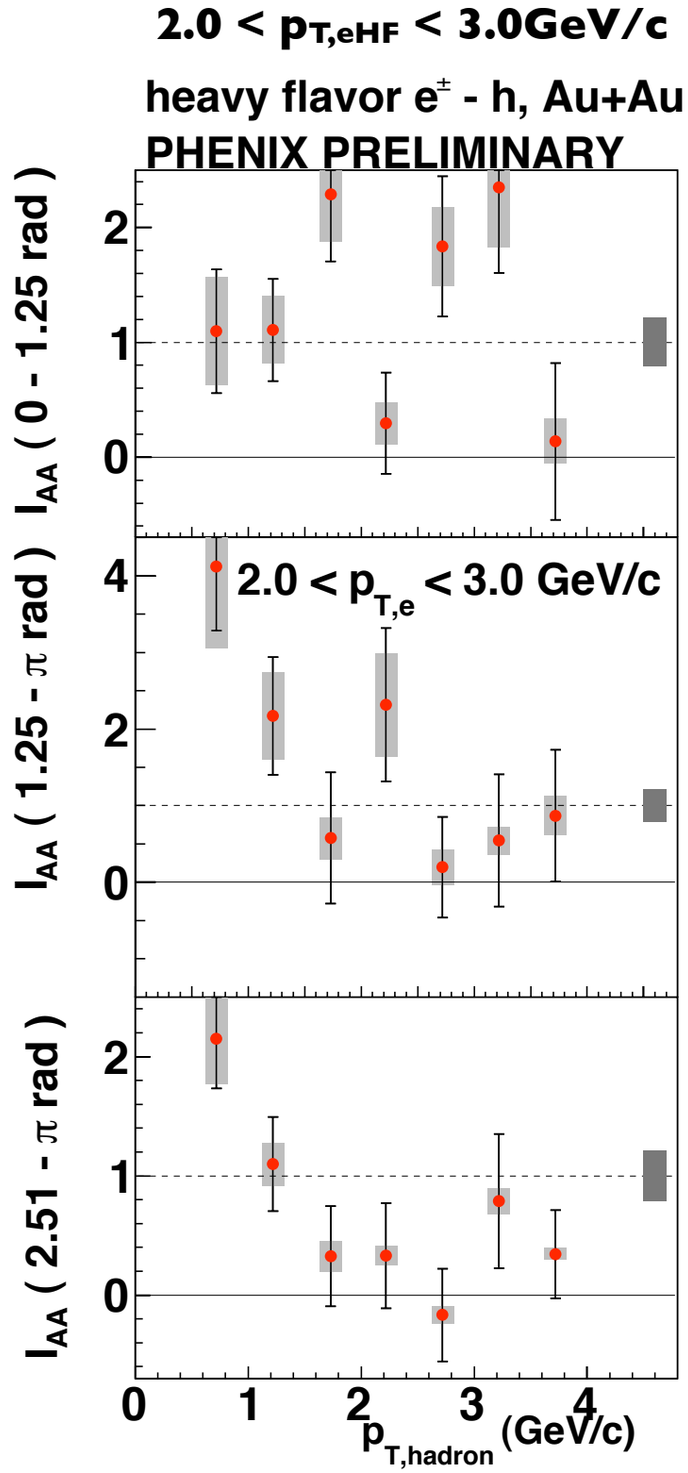
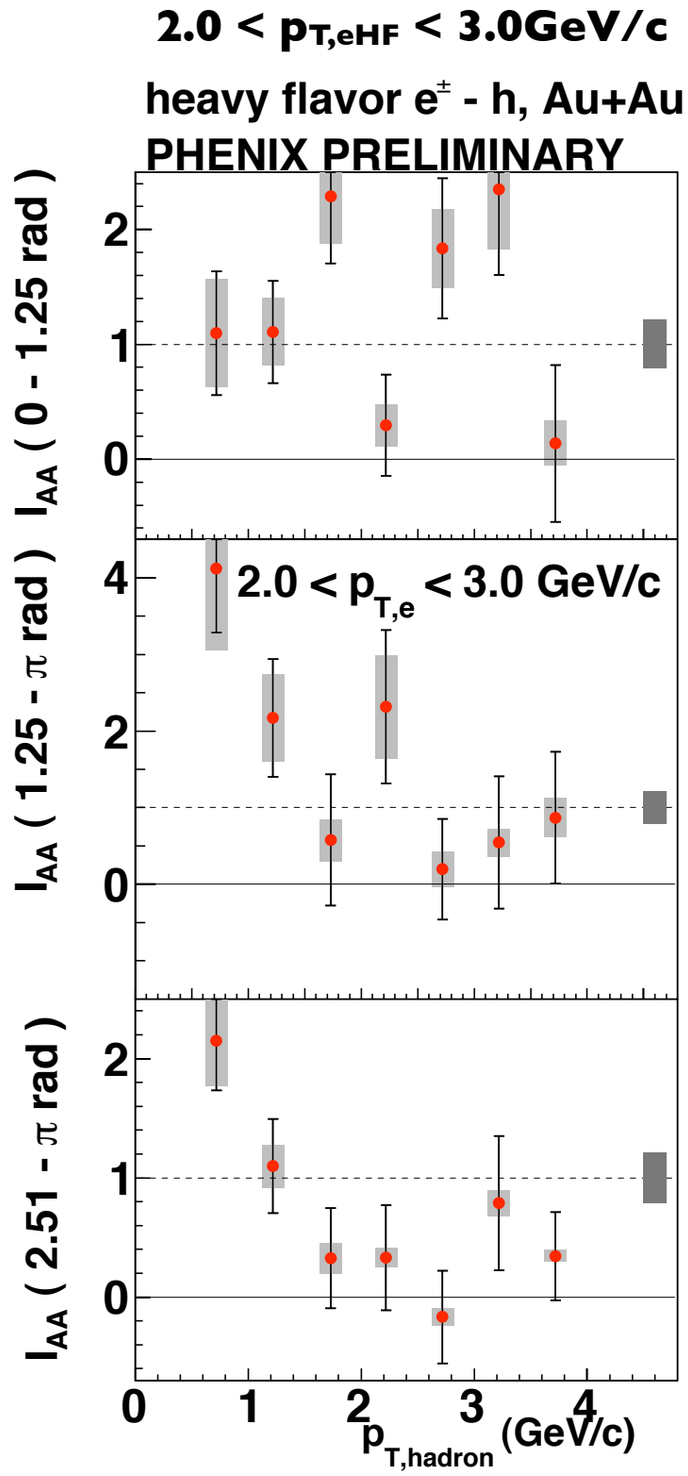
  - sanity check
- away side:



PRC 78 014901 (2008)

correlations: some insight

- near side: I_{AA}~1
  - consistent with electrons from Ds
  - sanity check
- away side:
- very similar to light hadron I_{AA}



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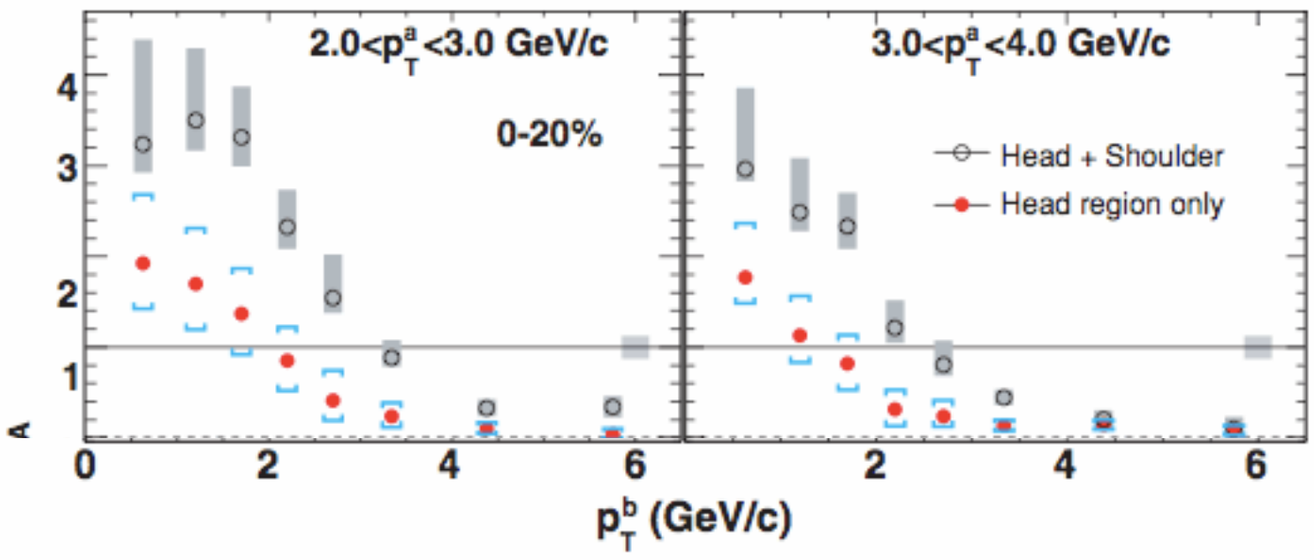

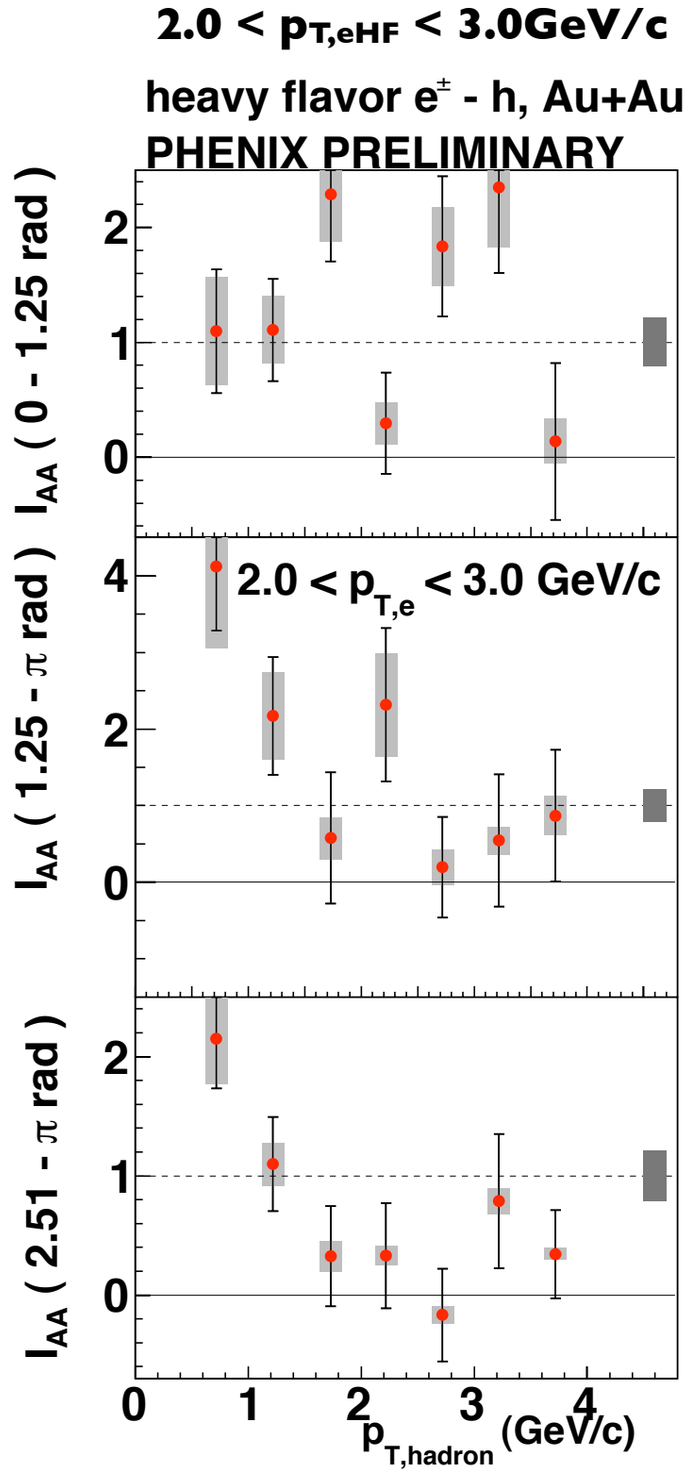

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