Azimuthal Correlations of Electrons from Heavy Flavor Decay with Hadrons at PHENIX

Anne Sickles
for the PHENIX Collaboration
Brookhaven National Lab

October 24, 2008
Division of Nuclear Physics Meeting

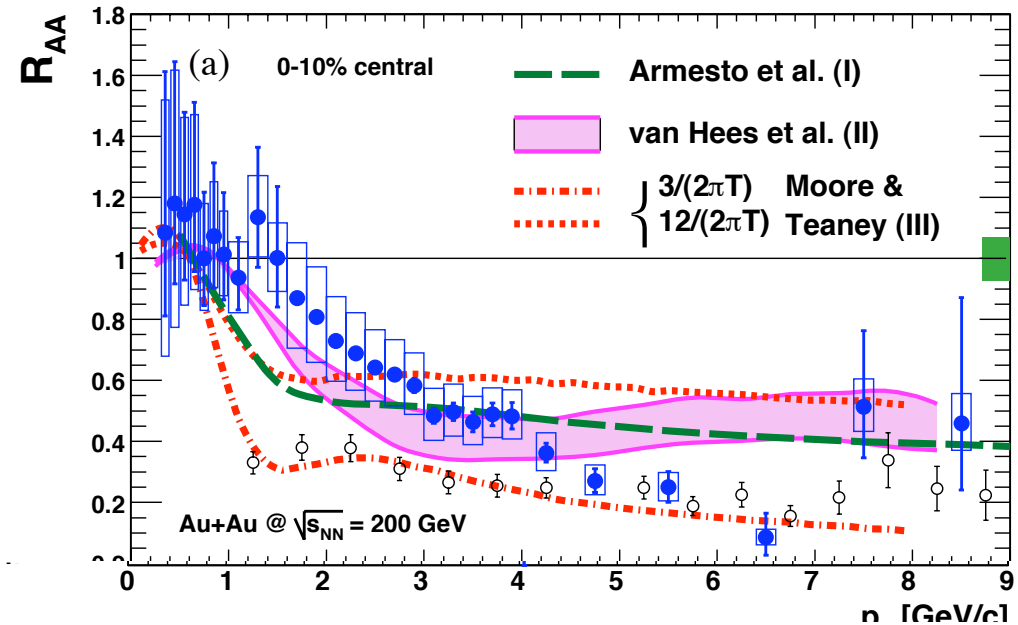
BROOKHAVEN NATIONAL LABORATORY

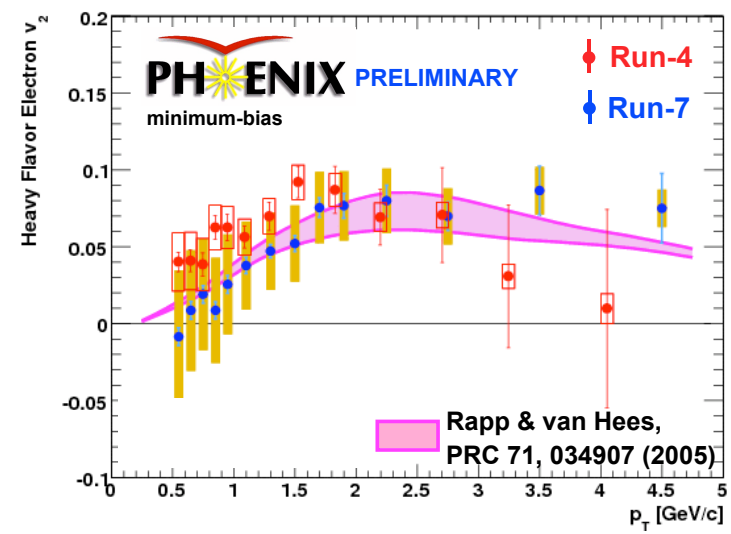
PHENIX

Motivation

- electrons from decay of heavy mesons are modified by the matter in heavy ion collisions
  - yields are suppressed
  - $v_2^{HF} > 0$

PHENIX, PRL 98 172301 (2007)

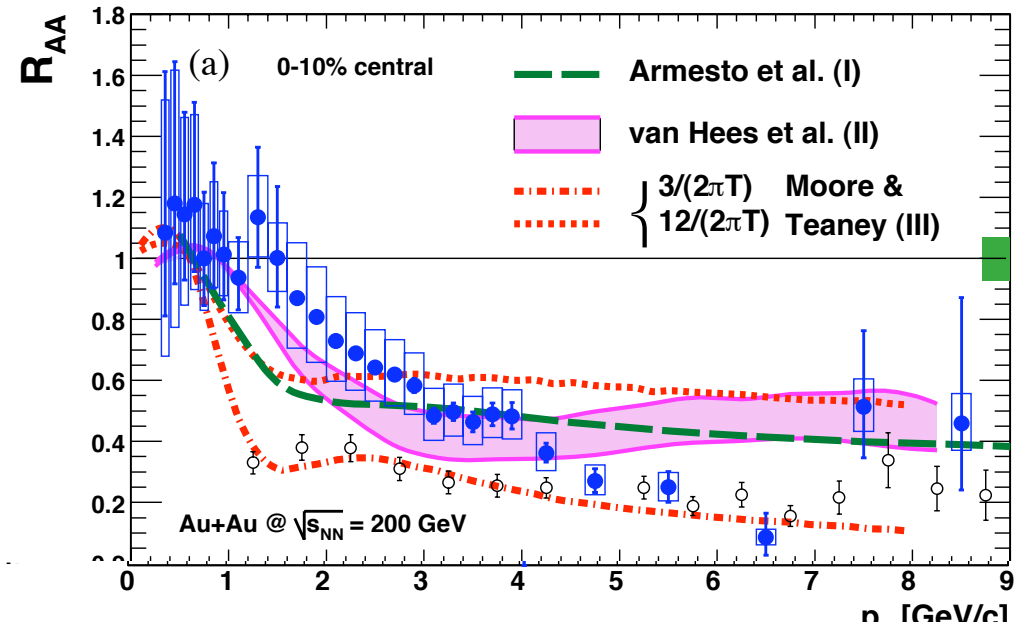




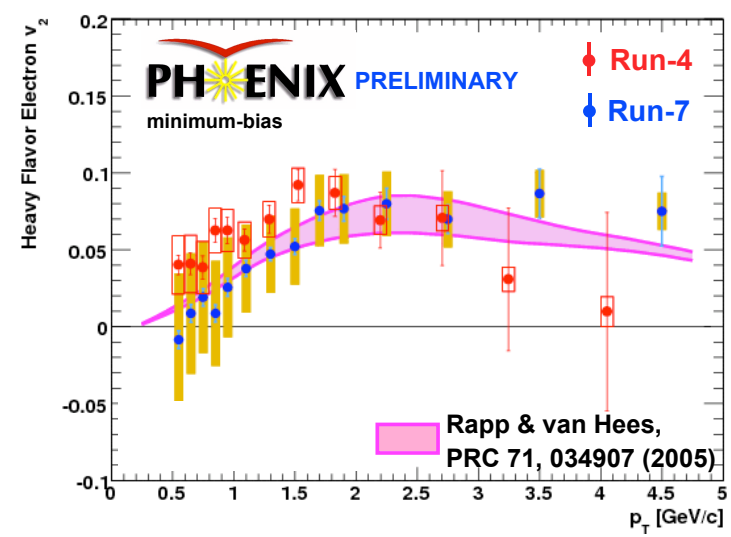
Motivation

- electrons from decay of heavy mesons are modified by the matter in heavy ion collisions
  - yields are suppressed
  - $v_2^{HF} > 0$

PHENIX, PRL 98 172301 (2007)

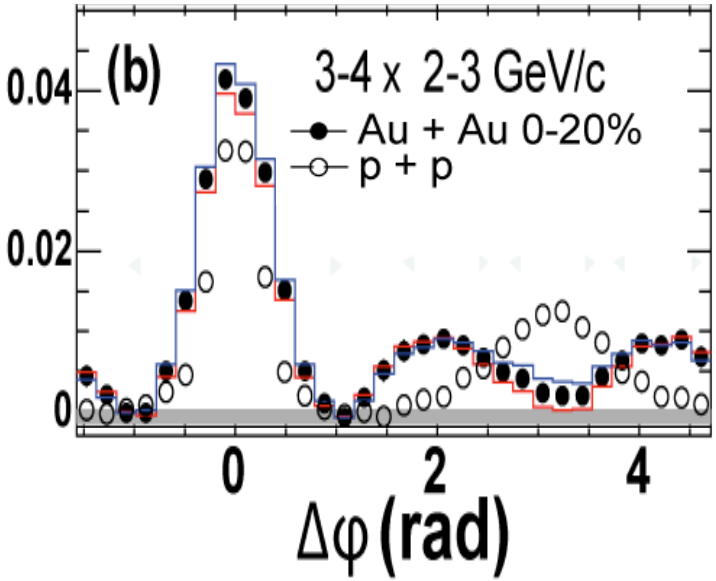


two particle correlations can provide information about how the heavy quarks interact with the matter!



Double Peak Structure

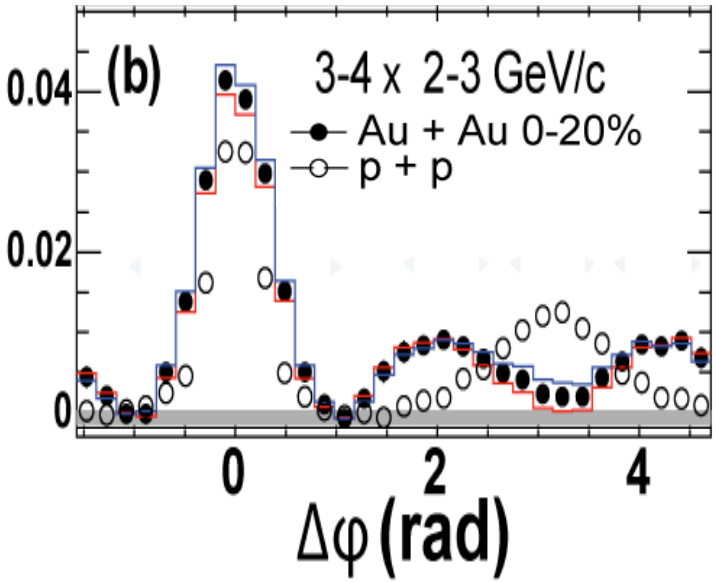
Data: Double Peak

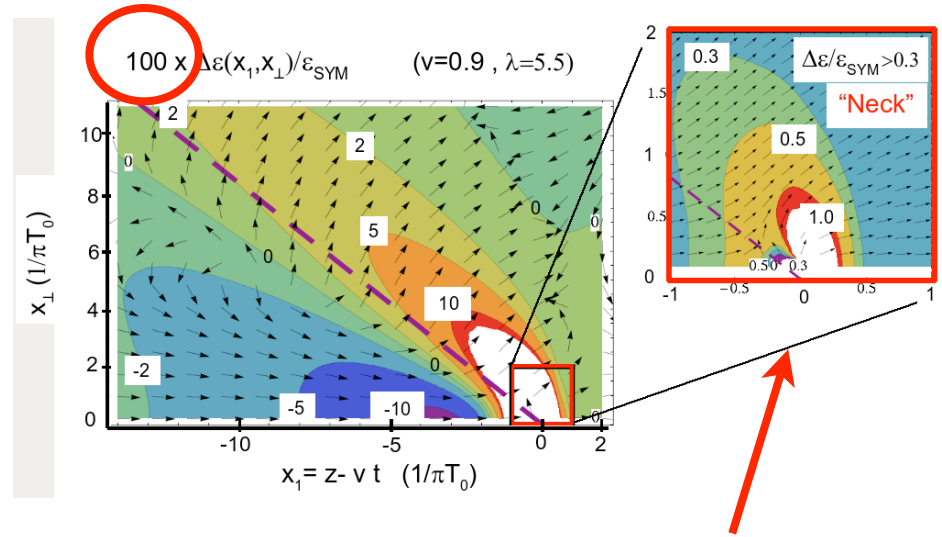


PHENIX, PRC 78 014901 (2008), Noronha et al. arXiv:0807.1038, Neufeld arXiv:0807.2996

Double Peak Structure

Data: Double Peak



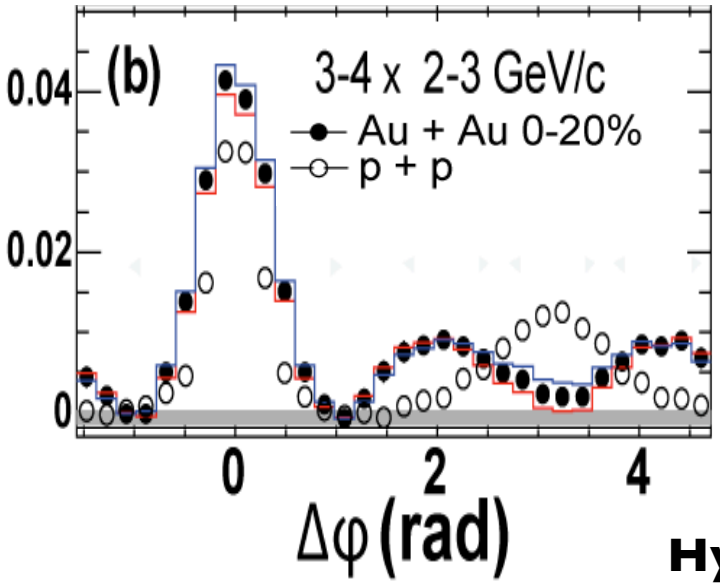


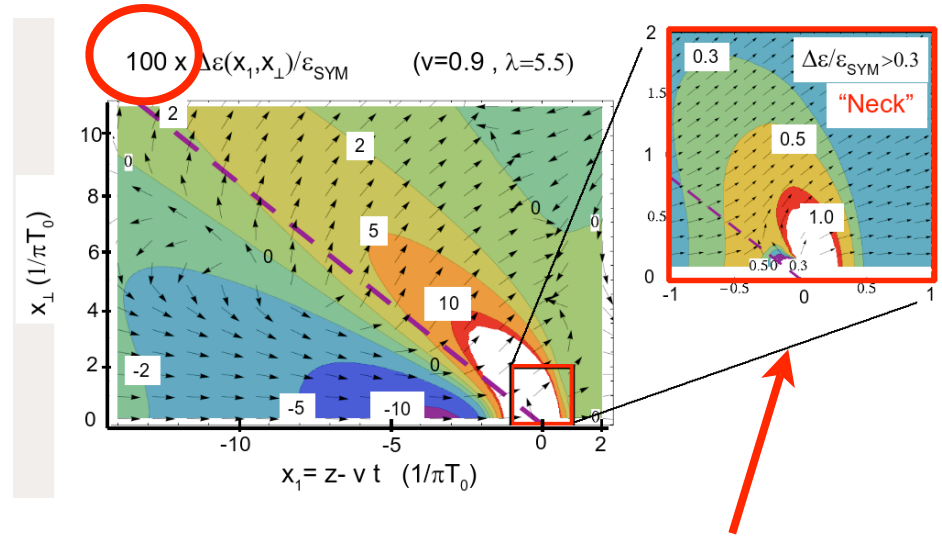
AdS/CFT: Correlations from Neck region

PHENIX, PRC 78 014901 (2008), Noronha et al. arXiv:0807.1038, Neufeld arXiv:0807.2996

Double Peak Structure

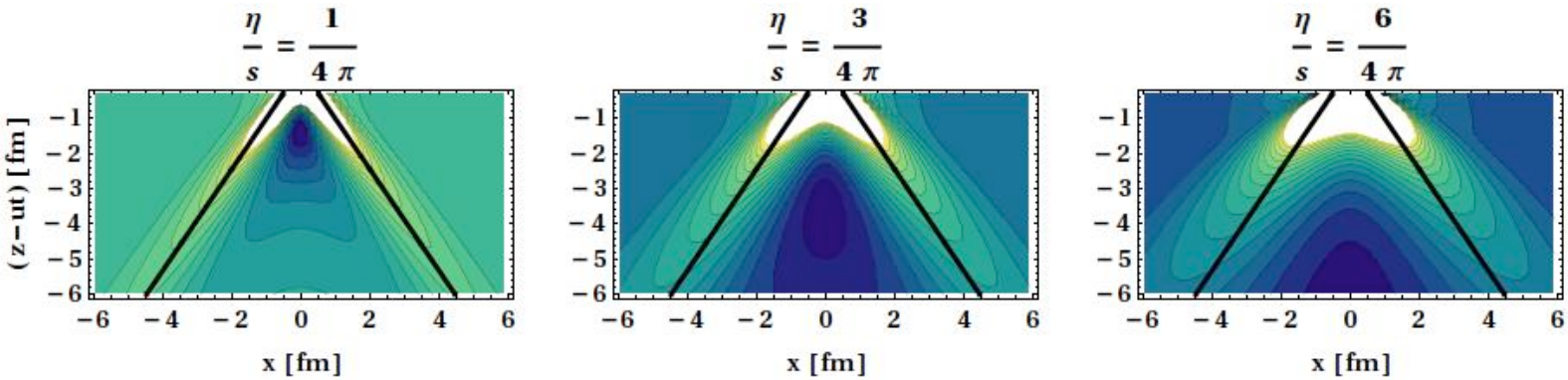
Data: Double Peak





AdS/CFT: Correlations from Neck region

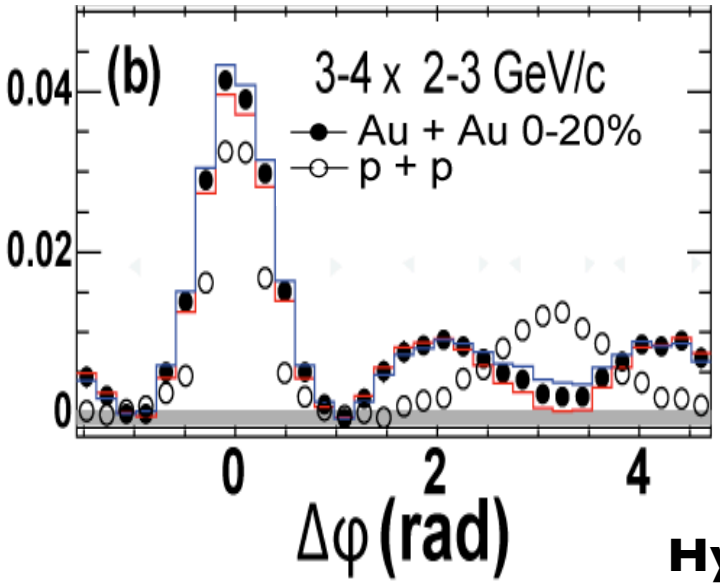
Hydro: Mach Cone width & strength sensitive to η/s

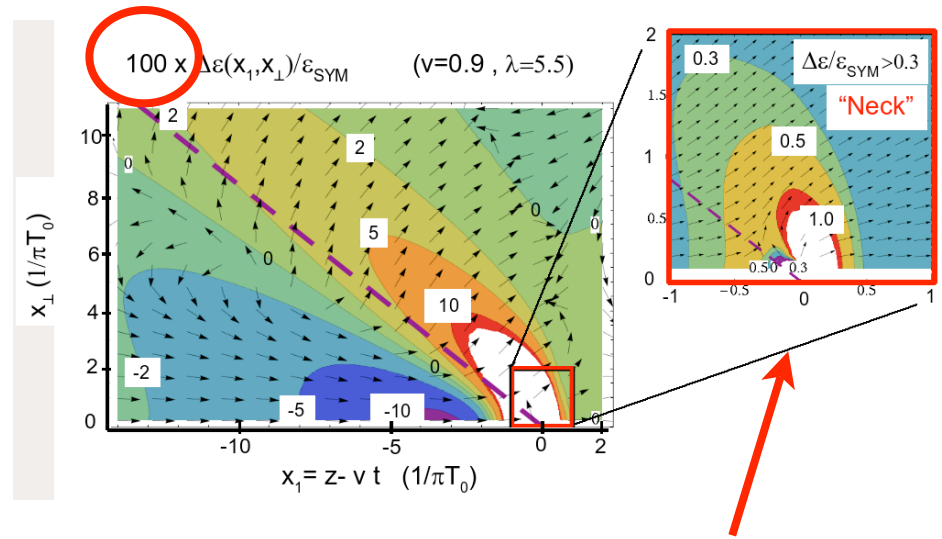


PHENIX, PRC 78 014901 (2008), Noronha et al. arXiv:0807.1038, Neufeld arXiv:0807.2996

Double Peak Structure

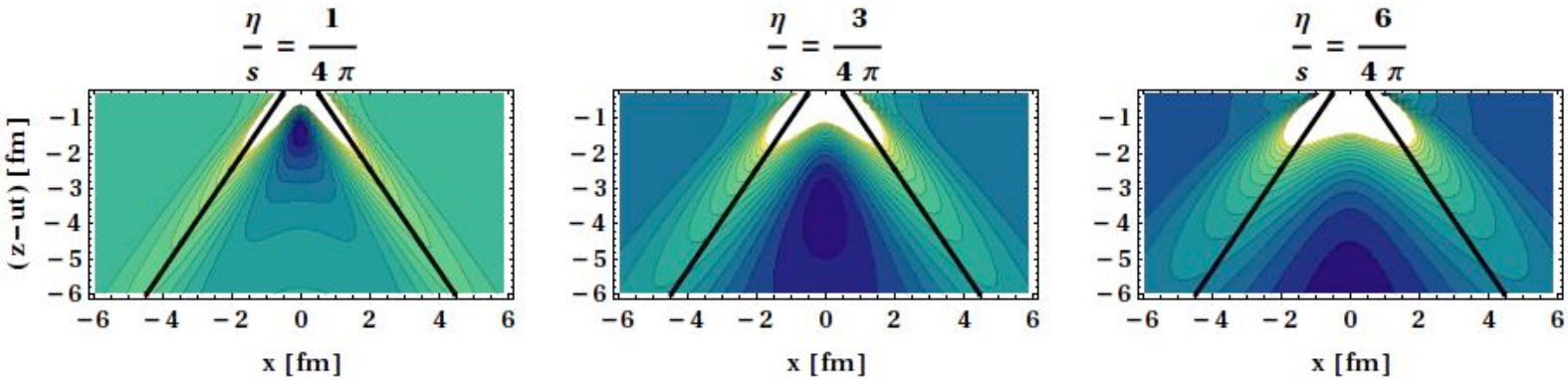
Data: Double Peak





AdS/CFT: Correlations from Neck region

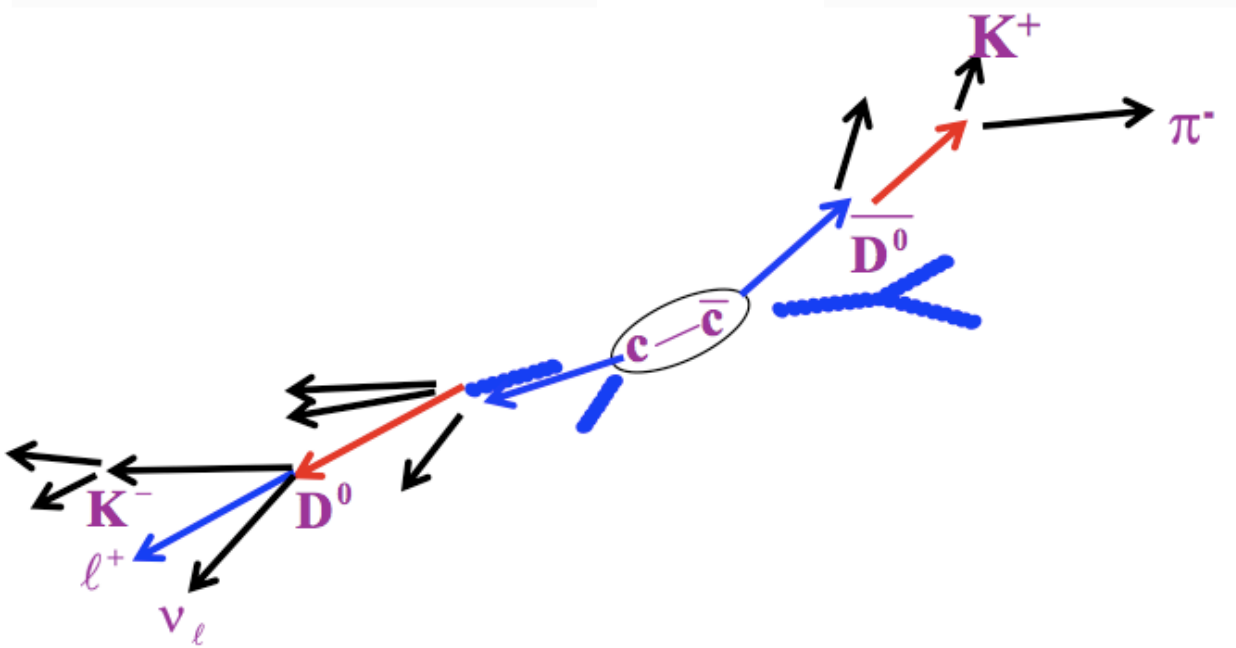
Hydro: Mach Cone width & strength sensitive to η/s



Heavy quark correlations should help discriminate!

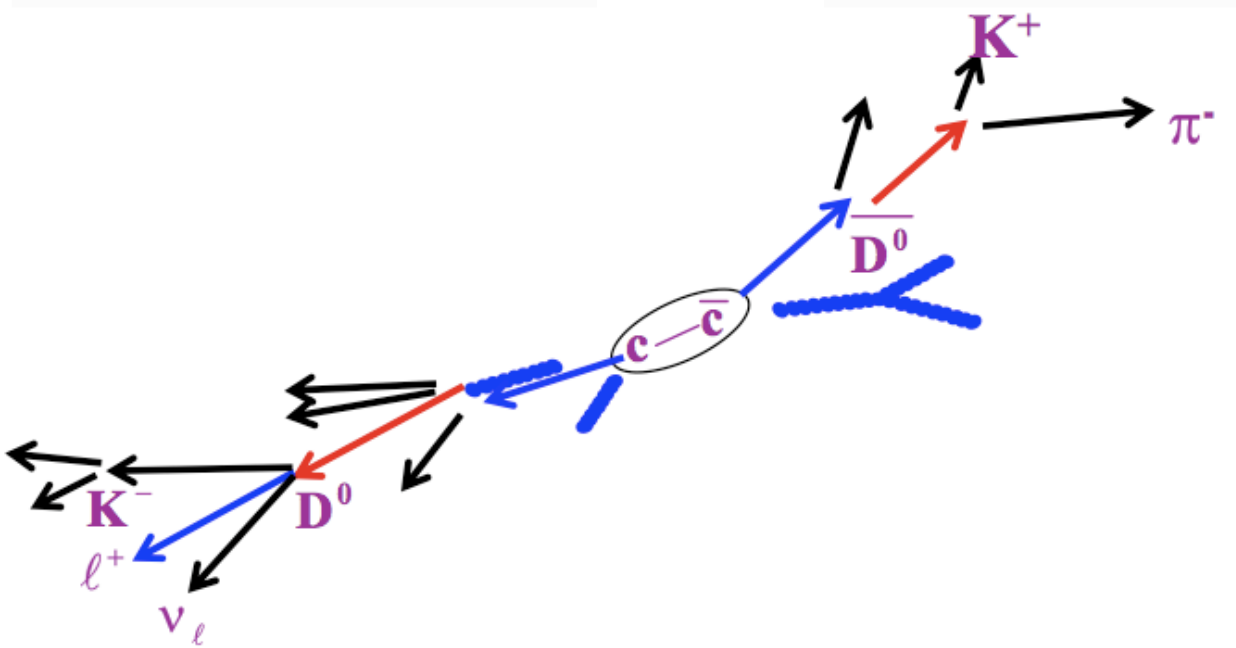
PHENIX, PRC 78 014901 (2008), Noronha et al. arXiv:0807.1038, Neufeld arXiv:0807.2996

Heavy Flavor via Semi-leptonic decays



Decay	Branching Ratio
$D^{\pm} \rightarrow e+X$	16.0%
$D^{0} \rightarrow e+X$	6.5%

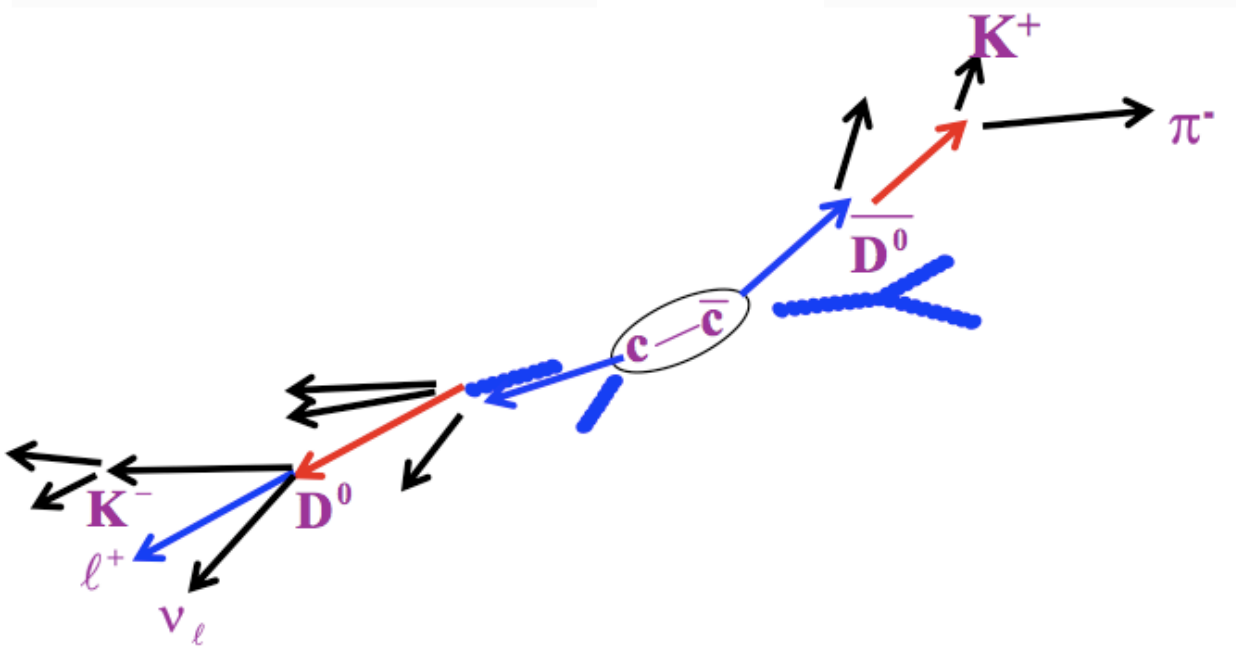
Heavy Flavor via Semi-leptonic decays



Decay	Branching Ratio
$D^{\pm} \rightarrow e+X$	16.0%
$D^{0} \rightarrow e+X$	6.5%

- single particles: measure $e^{\pm}$ from D, B decay

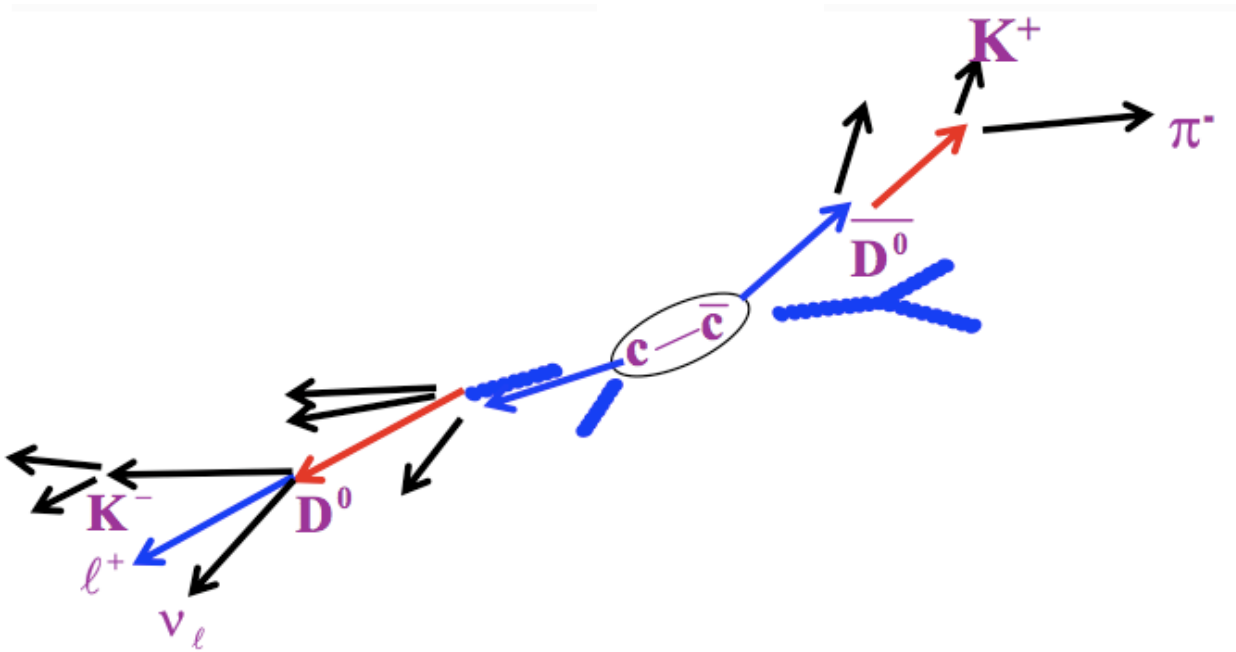
Heavy Flavor via Semi-leptonic decays



Decay	Branching Ratio
$D^{\pm} \rightarrow e+X$	16.0%
$D^{0} \rightarrow e+X$	6.5%

- single particles: measure $e^{\pm}$ from D, B decay
- near side: two particle correlations: hadrons from D, B decay + other fragmentation products

Heavy Flavor via Semi-leptonic decays

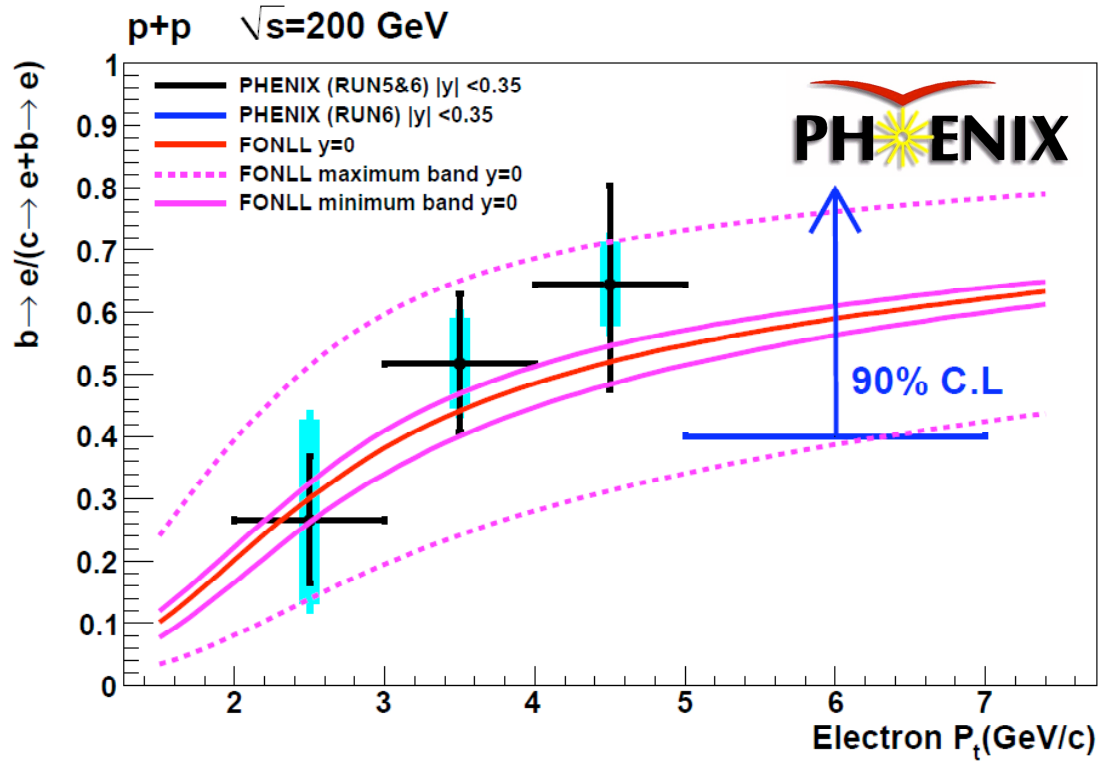


Decay	Branching Ratio
$D^{\pm} \rightarrow e+X$	16.0%
$D^{0} \rightarrow e+X$	6.5%

- single particles: measure $e^{\pm}$ from D, B decay
- near side: two particle correlations: hadrons from D, B decay + other fragmentation products
- away side: recoil heavy quark, longer medium path length

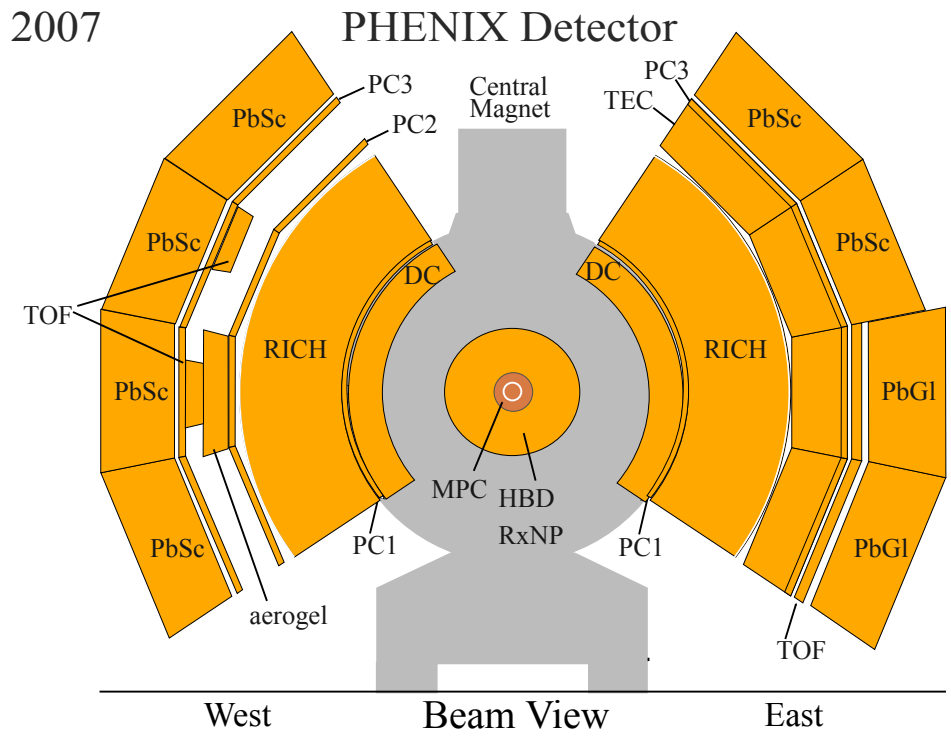
c/b Mixture: p+p

- fraction of electrons from bottom increases with p_T
- currently we cannot separate electrons from charm and bottom
  - future silicon upgrade
- currently accessible range dominated by charm, with large uncertainty



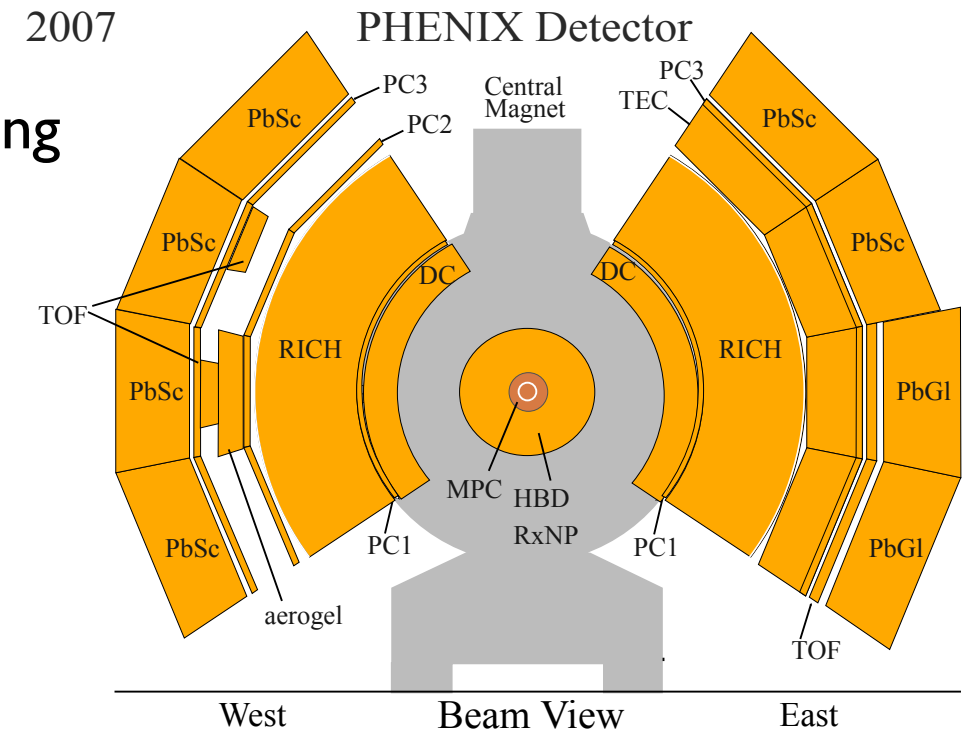
PHENIX, Y. Morino QM08

Electron Measurement in PHENIX



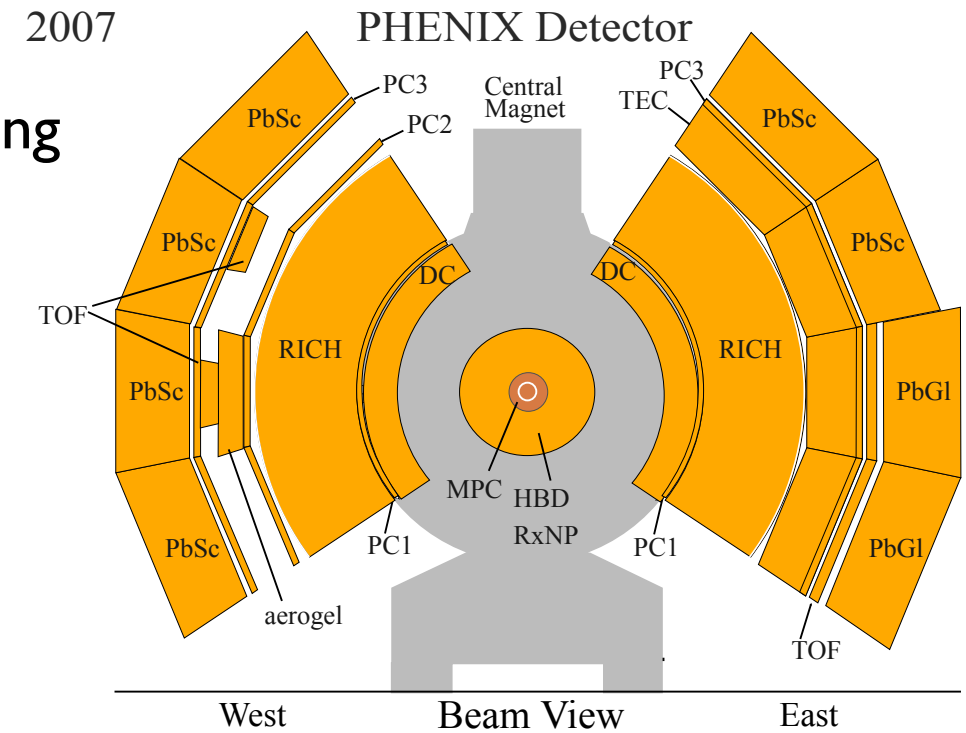
Electron Measurement in PHENIX

- electrons identification based on ring in Cherenkov detector & E/p from EMCal and drift chambers



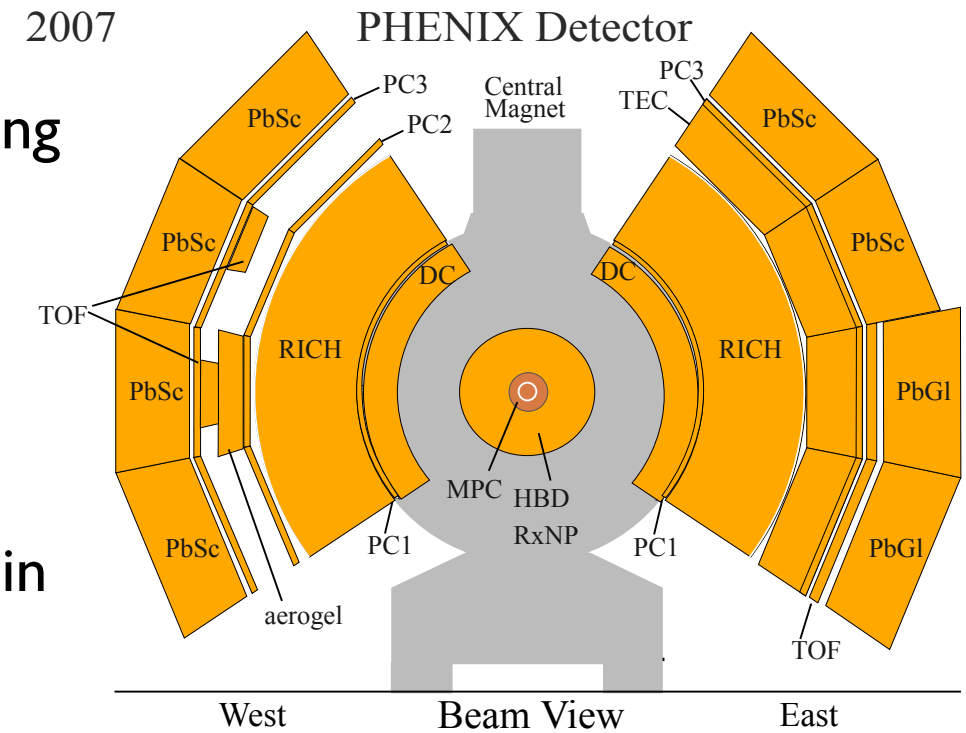
Electron Measurement in PHENIX

- electrons identification based on ring in Cherenkov detector & E/p from EMCal and drift chambers
- 3B Run 7 events w/o HBD West installed



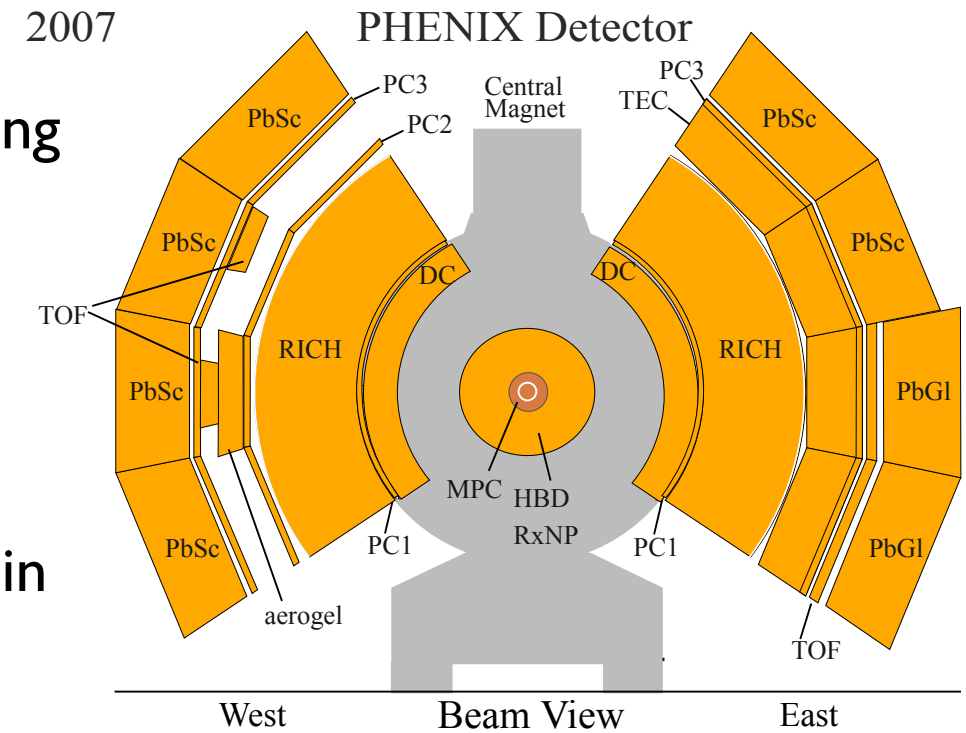
Electron Measurement in PHENIX

- electrons identification based on ring in Cherenkov detector & E/p from EMCal and drift chambers
- 3B Run 7 events w/o HBD West installed
  - HBD East added more material in acceptance



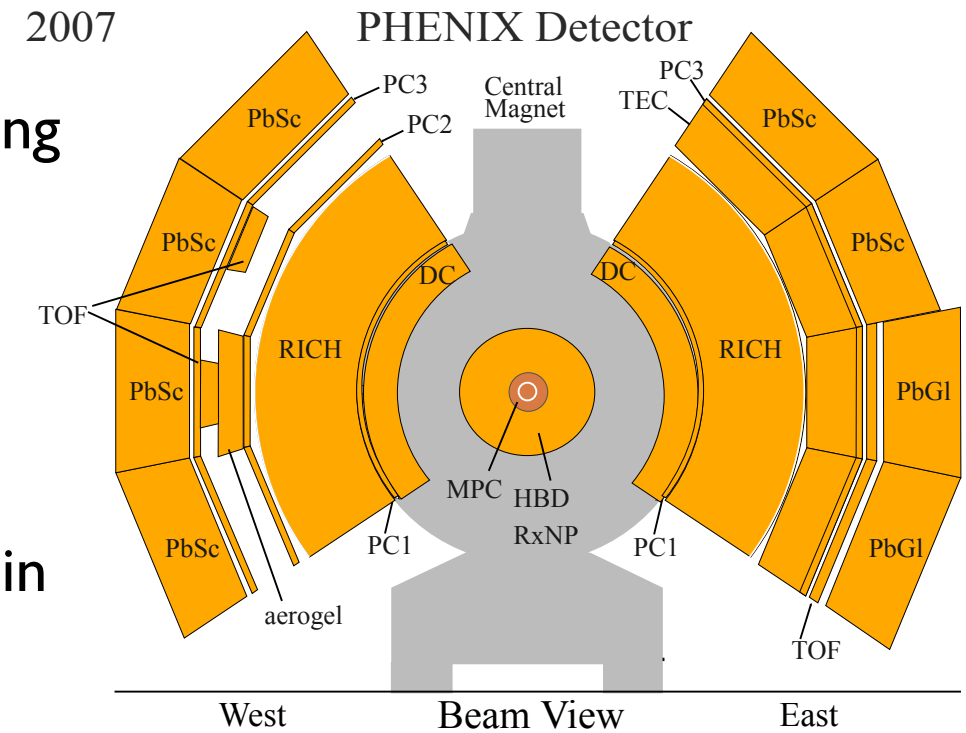
Electron Measurement in PHENIX

- electrons identification based on ring in Cherenkov detector & E/p from EMCal and drift chambers
- 3B Run 7 events w/o HBD West installed
  - HBD East added more material in acceptance
  - require electrons in west arm--conditions similar to Run 4



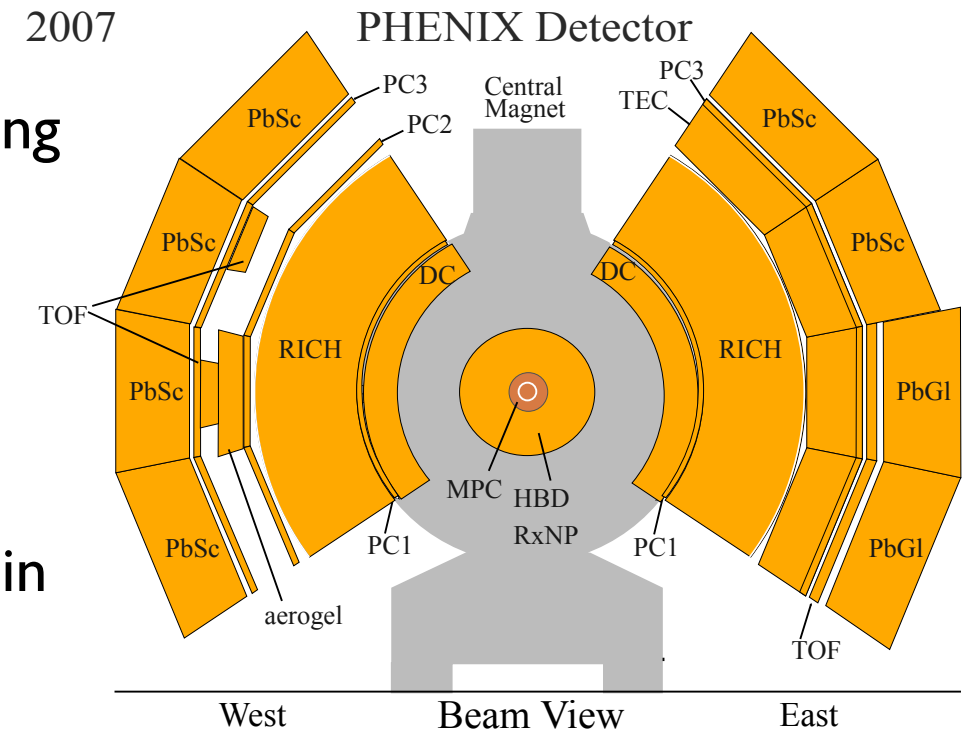
Electron Measurement in PHENIX

- electrons identification based on ring in Cherenkov detector & E/p from EMCal and drift chambers
- 3B Run 7 events w/o HBD West installed
  - HBD East added more material in acceptance
  - require electrons in west arm--conditions similar to Run 4
- hadronic background from random associations <3% in most central collisions



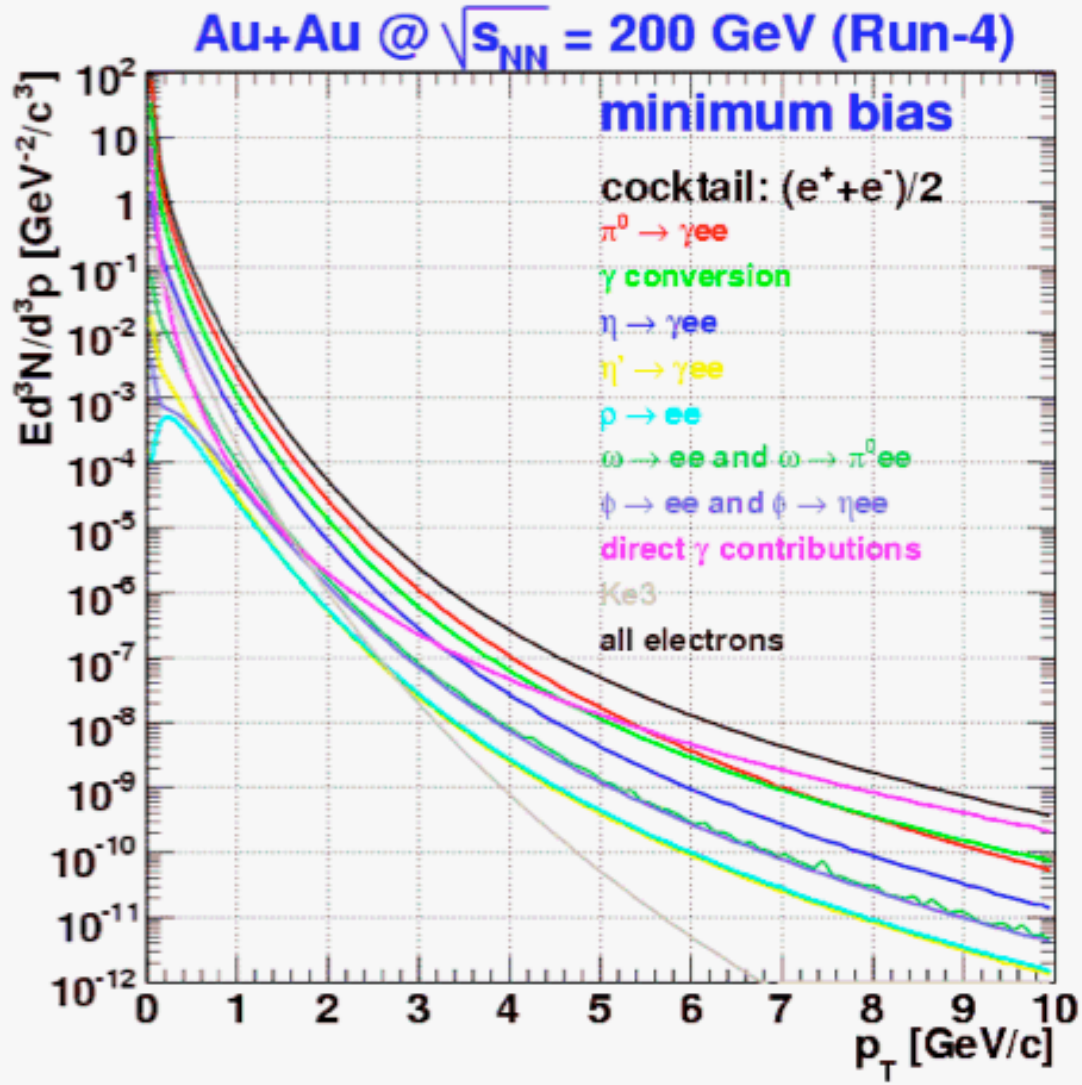
Electron Measurement in PHENIX

- electrons identification based on ring in Cherenkov detector & E/p from EMCal and drift chambers
- 3B Run 7 events w/o HBD West installed
  - HBD East added more material in acceptance
  - require electrons in west arm--conditions similar to Run 4
- hadronic background from random associations <3% in most central collisions



- hadrons measured in both arms → full Δϕ acceptance for pairs

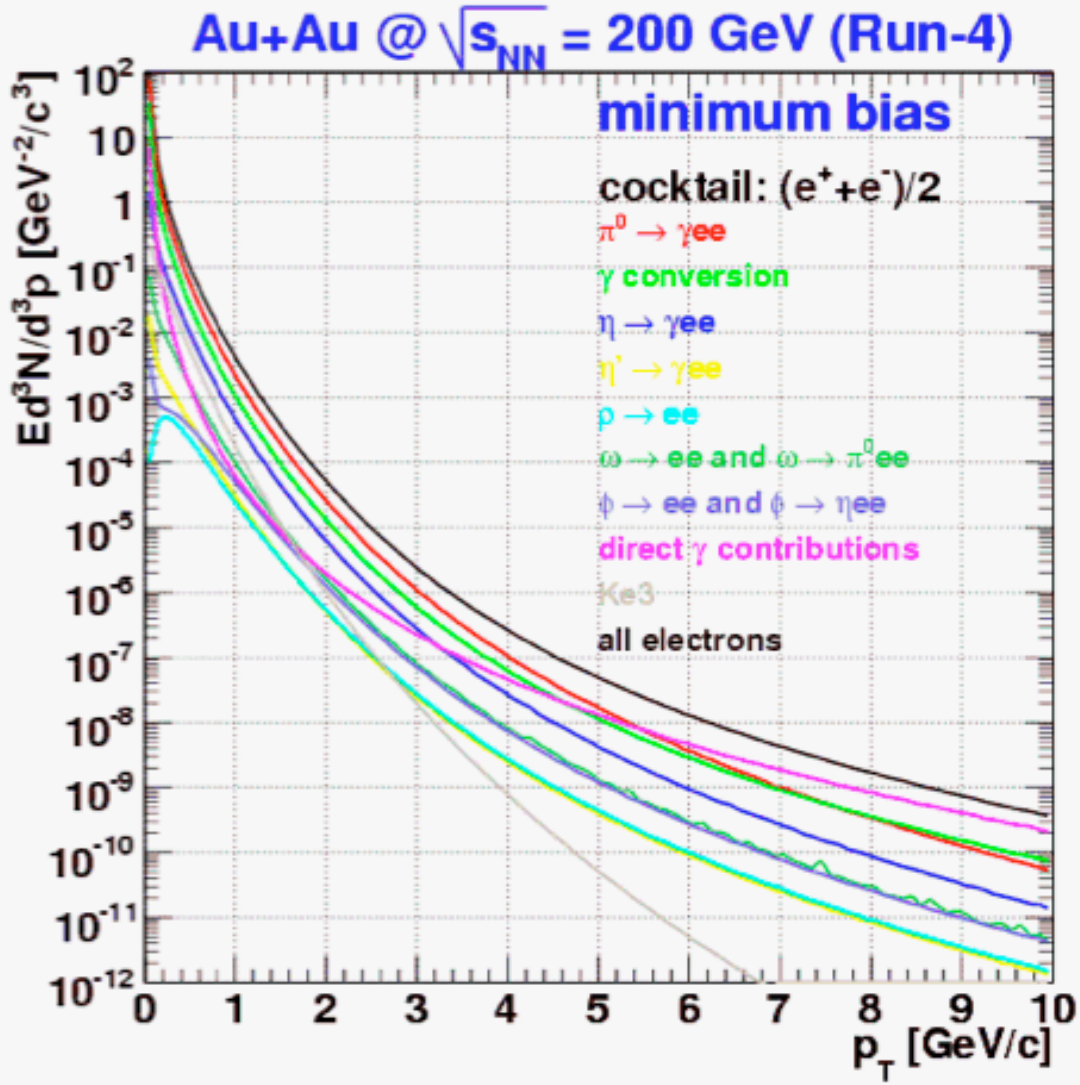
Photonic Electrons



n.b. 18% increase in photonic electrons from replacing He with air between beampipe & drift chamber in Run 7

Photonic Electrons

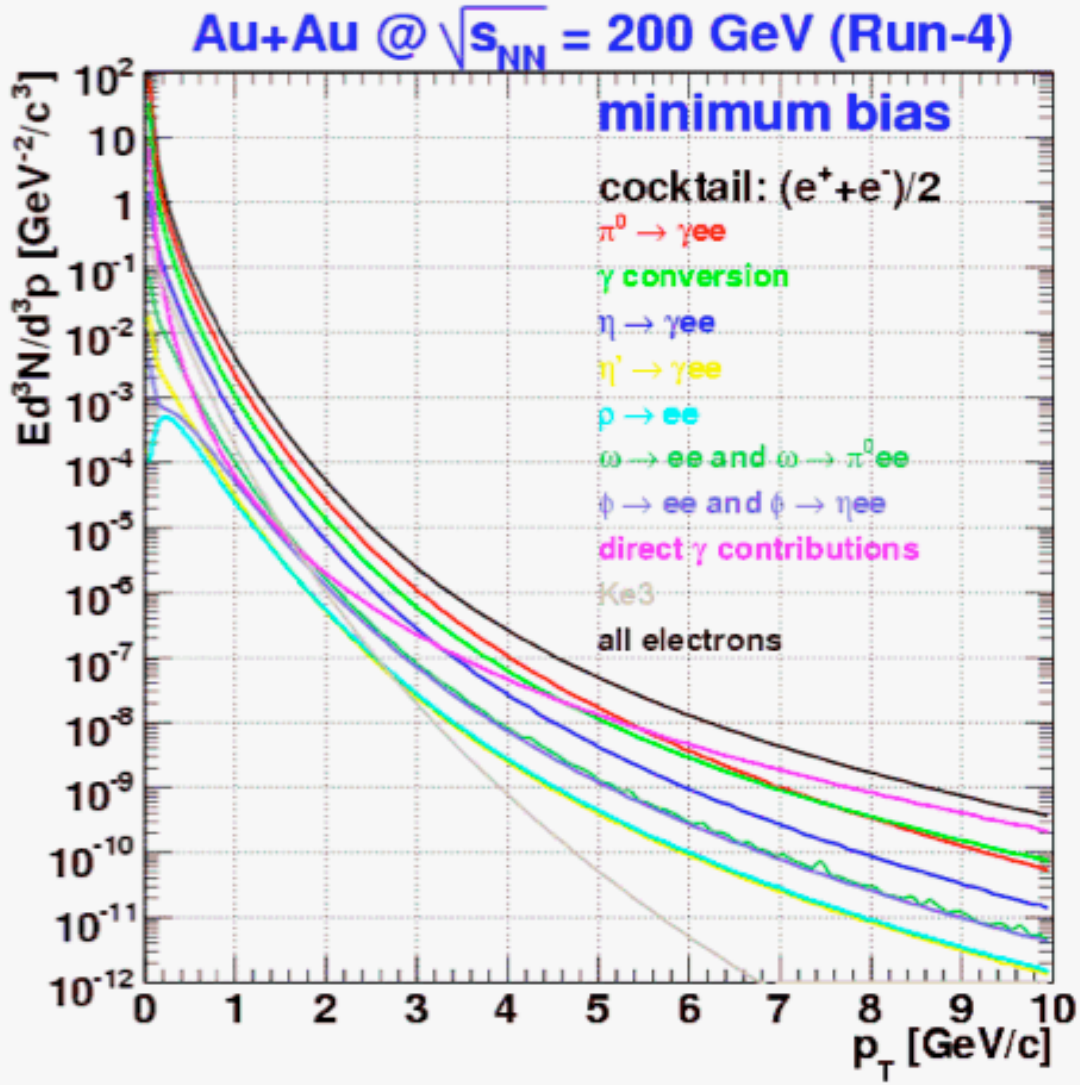
- p_T < 5GeV/c photonic electrons dominated by Dalitz decays and decay photon conversions



n.b. 18% increase in photonic electrons from replacing He with air between beampipe & drift chamber in Run 7

Photonic Electrons

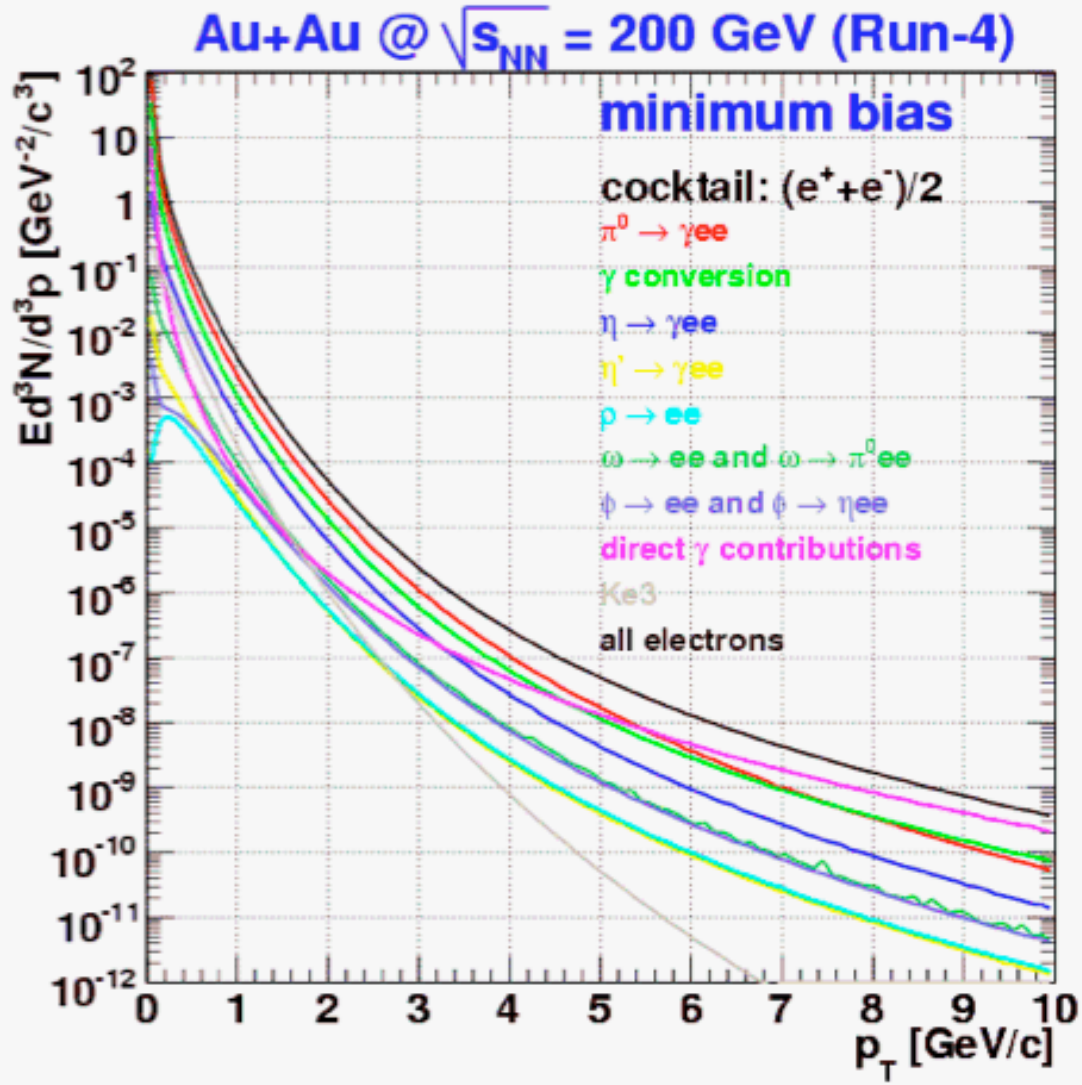
- p_T < 5GeV/c photonic electrons dominated by Dalitz decays and decay photon conversions
- approximate correlations of photonic electrons with γ-h correlations



n.b. 18% increase in photonic electrons from replacing He with air between beampipe & drift chamber in Run 7

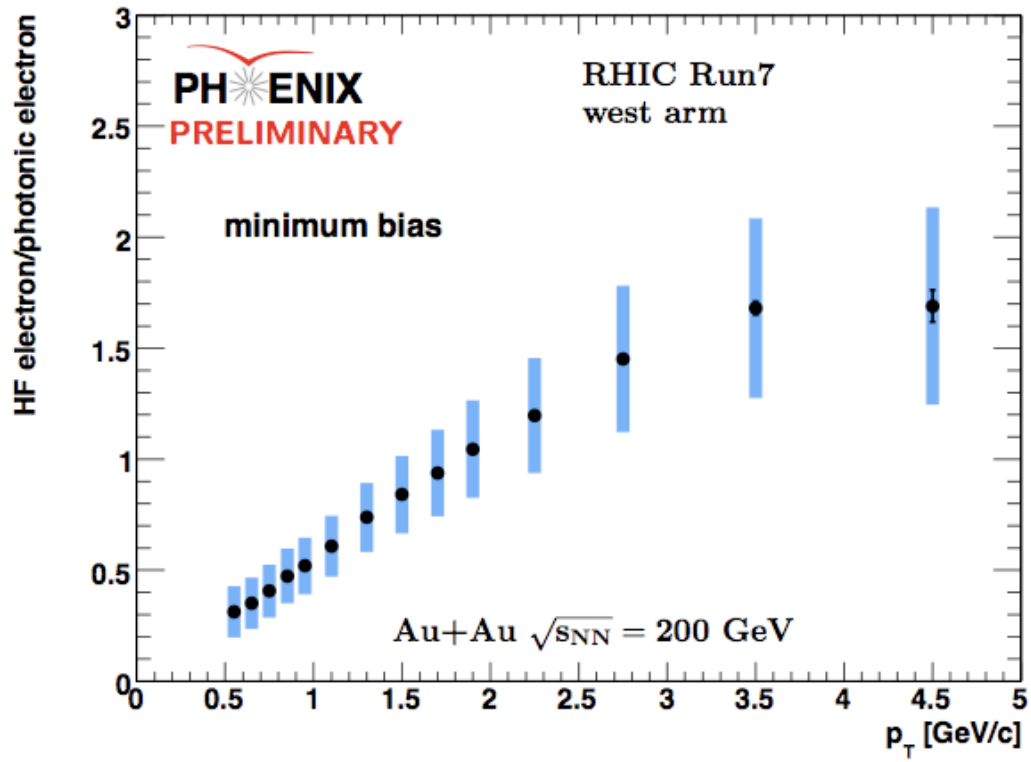
Photonic Electrons

- p_T < 5GeV/c photonic electrons dominated by Dalitz decays and decay photon conversions
- approximate correlations of photonic electrons with γ-h correlations
  - use GEANT simulations to map between $p_{T\gamma}$ & p_{Te}



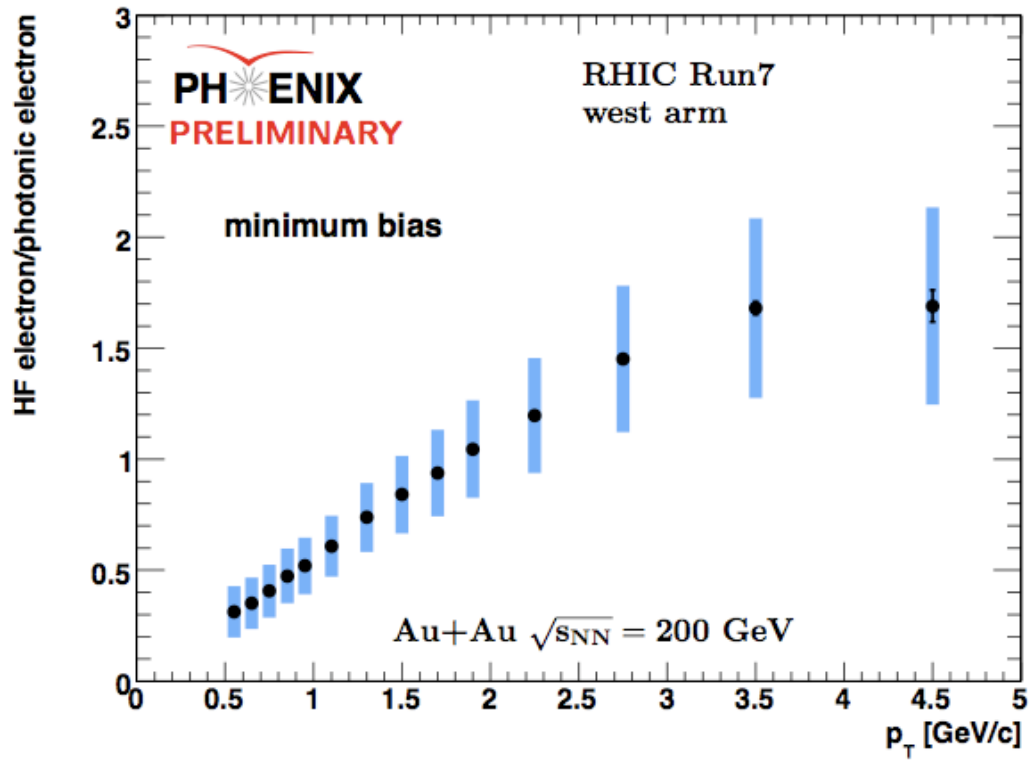
n.b. 18% increase in photonic electrons from replacing He with air between beampipe & drift chamber in Run 7

removing photonic correlations



determined by comparing total electron yields to those estimated from cocktail calculation of photonic sources

removing photonic correlations

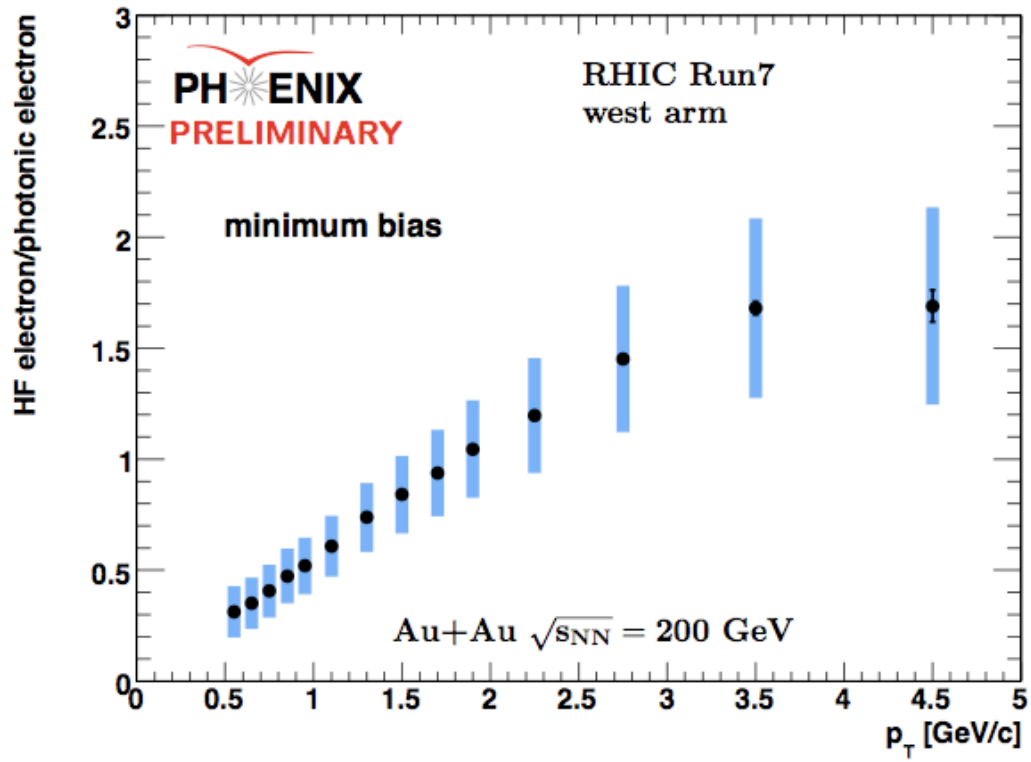


determined by comparing total electron yields to those estimated from cocktail calculation of photonic sources

statistically subtract correlations from photonic sources

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

removing photonic correlations



determined by comparing total electron yields to those estimated from cocktail calculation of photonic sources

statistically subtract correlations from photonic sources

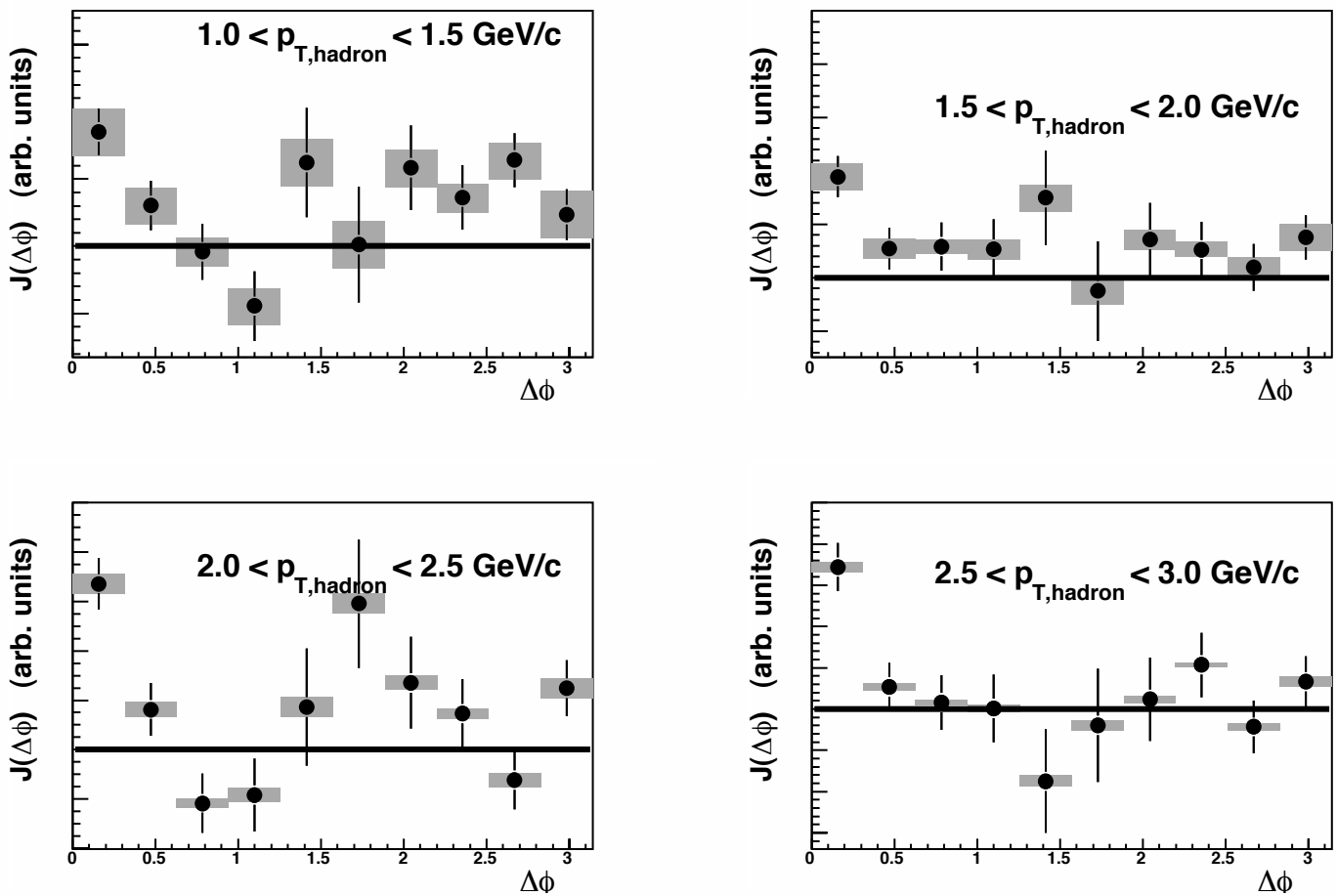
$$Y_{e_{HF}-h} = \frac{(R_{HF}+1)Y_{e_{incl}-h} - Y_{e_{phot}-h}}{R_{HF}}$$

same method PHENIX has used for γ_{dir}-hadron correlations

e_{inc}-hadron correlations

Run 7 Au+Au
0-60% centrality

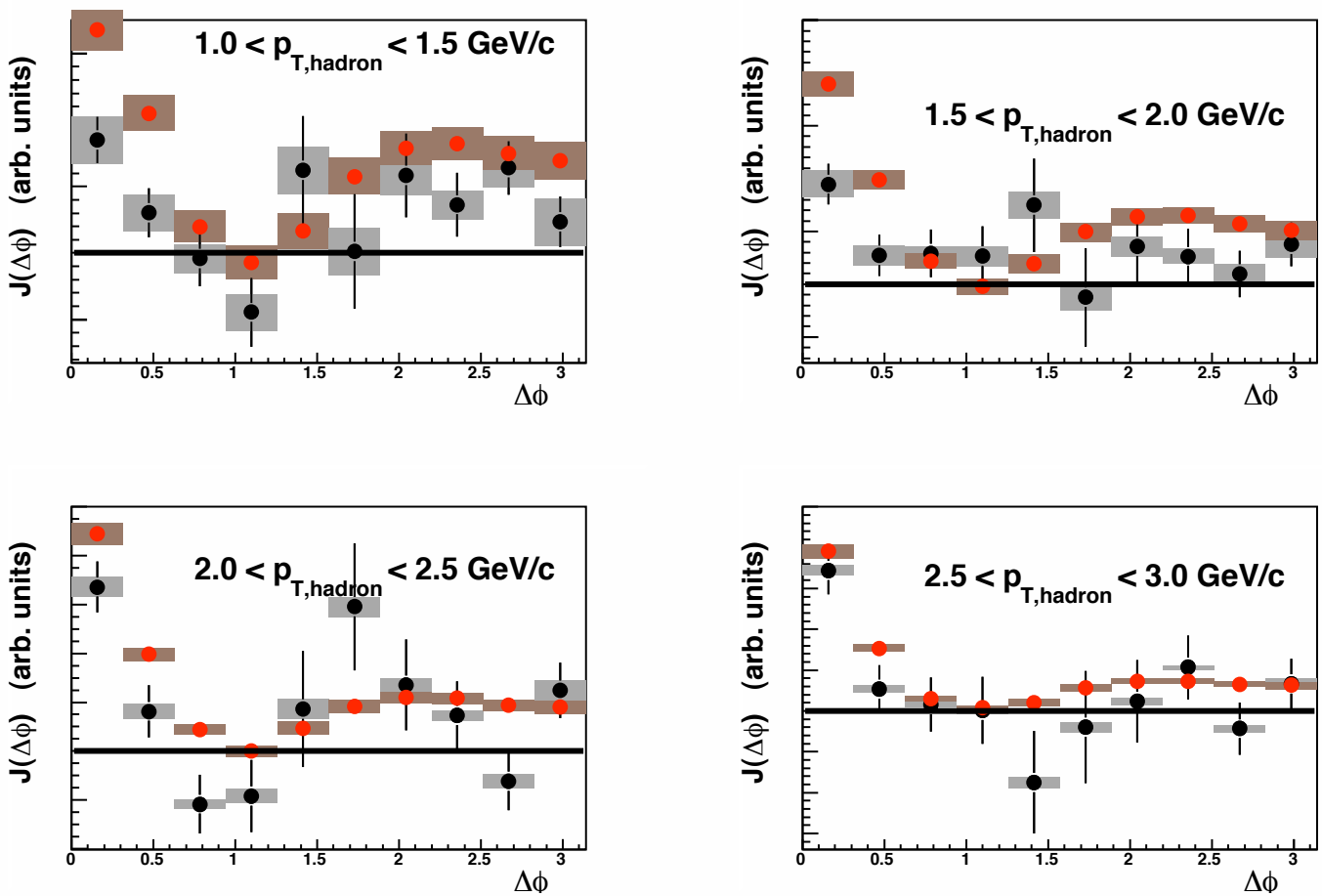
trigger: $2.0<p_T<3$GeV/c
background, v_2 subtracted
e_{inc}-h



adding e_{phot}-h correlations

trigger: $2.0<p_T<3$GeV/c
background, v_2 subtracted
e_{inc}-h
e_{phot}-h

Run 7 Au+Au
0-60% centrality

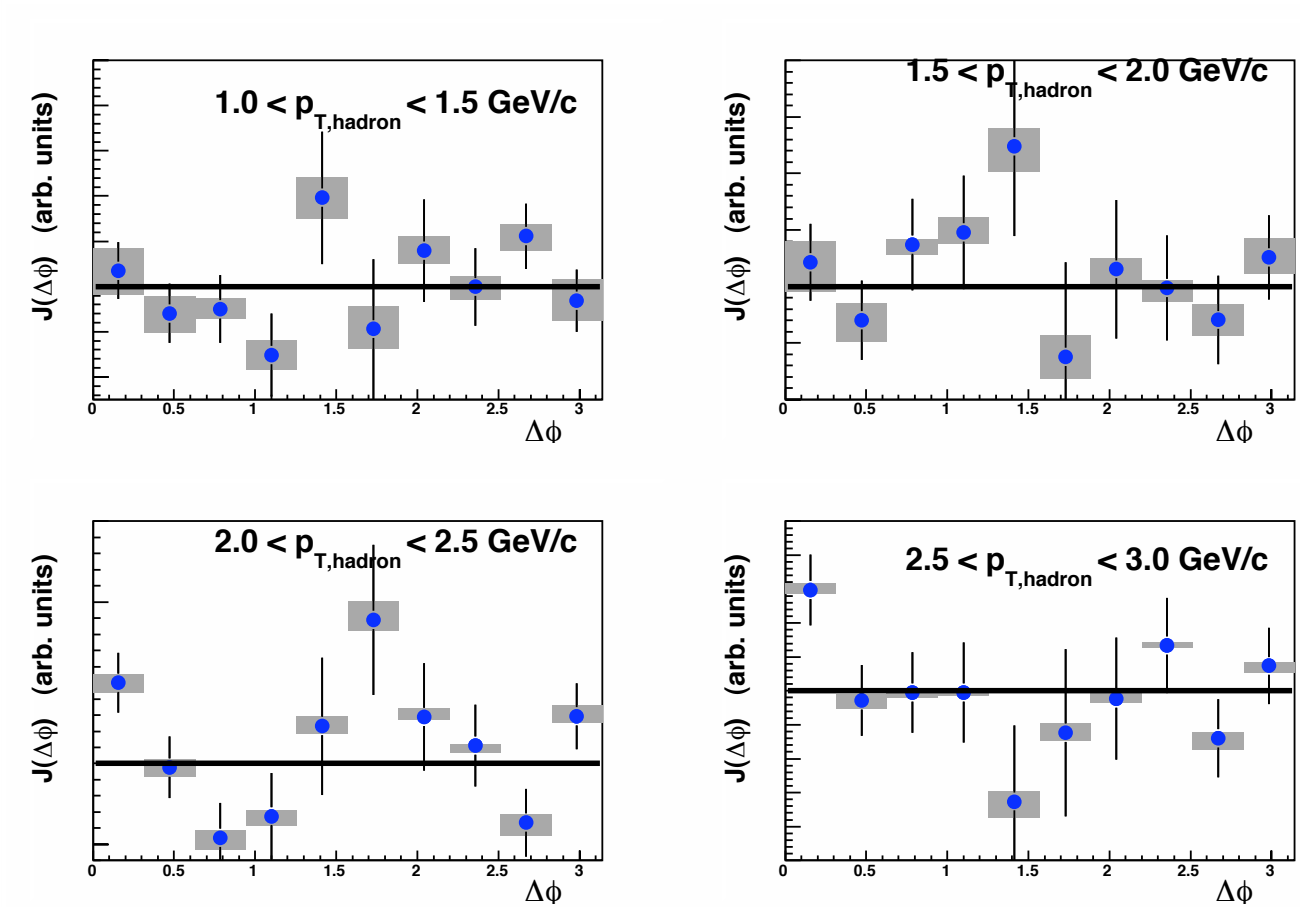


Non-photonic $e^{\pm}$-h correlations

Run 7 Au+Au
0-60% centrality

Run 7 Au+Au 200GeV
background, v_2 subtracted
trigger: $2.0<p_T<3$GeV/c
e_{NP}-h

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

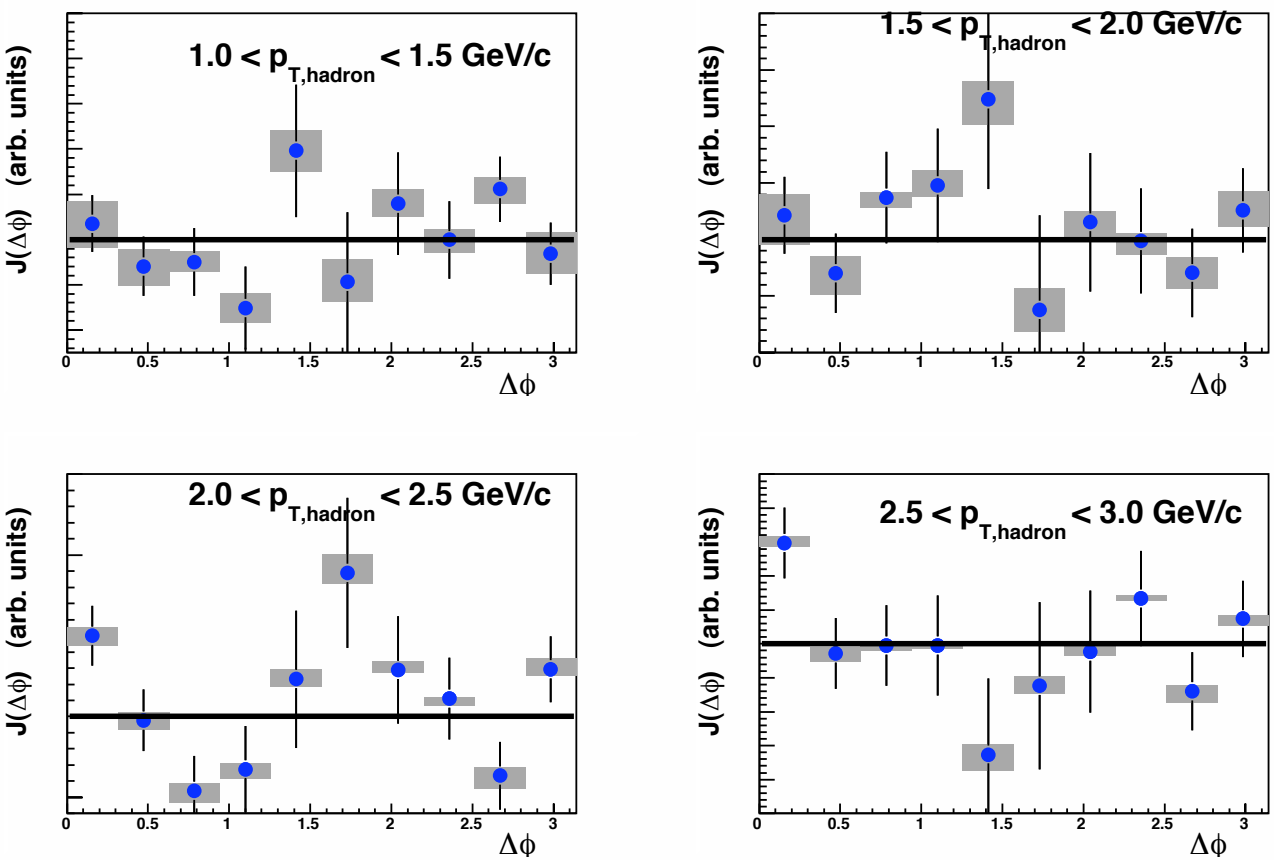


Non-photonic $e^{\pm}$-h correlations

Run 7 Au+Au
0-60% centrality

Run 7 Au+Au 200GeV
background, v_2 subtracted
trigger: $2.0<p_T<3$GeV/c
e_{NP}-h

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



p+p measurements crucial to show size of expected signal

conclusions & outlook

conclusions & outlook

- developed a method to measure correlations between electrons from heavy flavor and hadrons

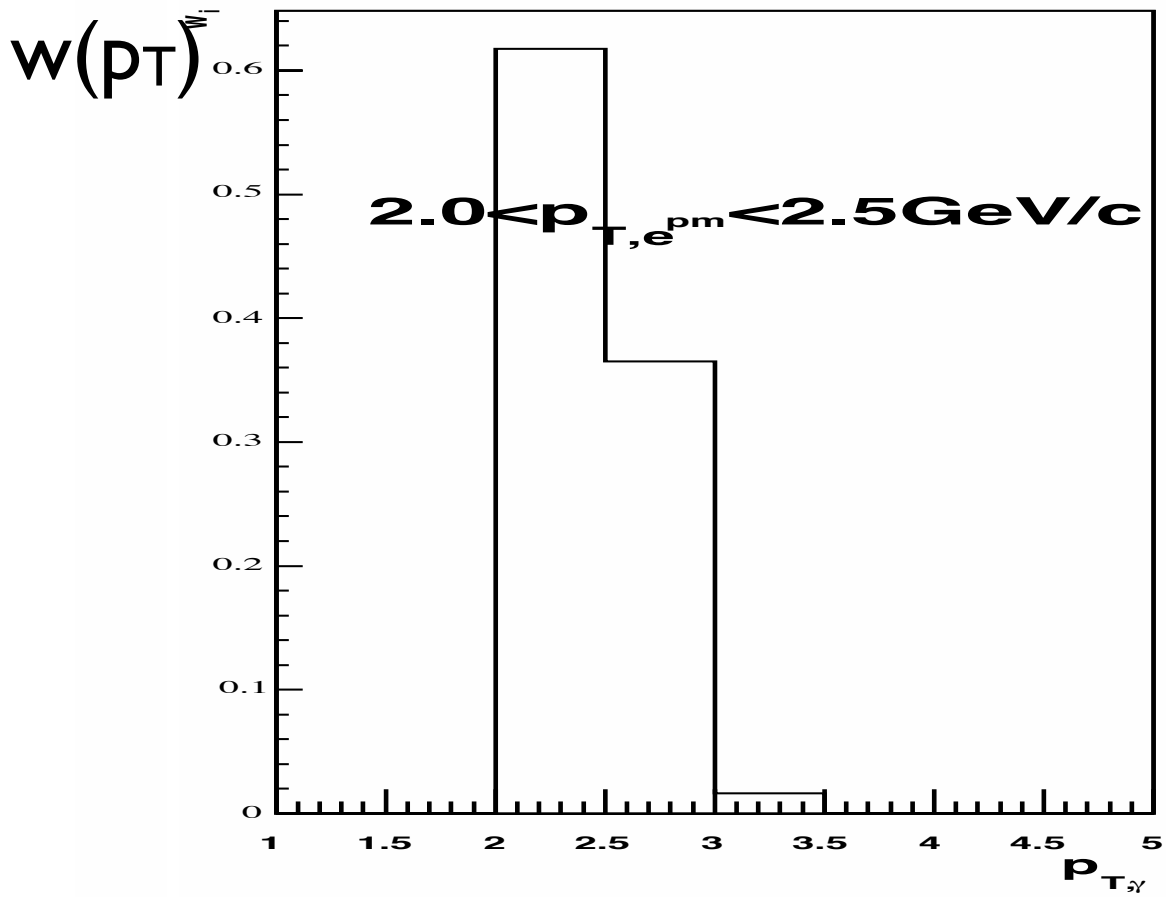
conclusions & outlook

- developed a method to measure correlations between electrons from heavy flavor and hadrons
- need p+p results as a baseline comparison → work ongoing
  - especially crucial in heavy flavor correlations because electron is a decay product

conclusions & outlook

- developed a method to measure correlations between electrons from heavy flavor and hadrons
- need p+p results as a baseline comparison → work ongoing
  - especially crucial in heavy flavor correlations because electron is a decay product
- statistical improvement in Au+Au: add Run 4 data
  - Run 7 requirement to use west arm only for electrons not needed in Run 4, significant increase in statisitics

Decay	Branching Ratio
$D^{\pm} \rightarrow e + X$	16.0%
$D^{0} \rightarrow e + X$	6.5%
$\Lambda_c \rightarrow e + X$	4.5%
$\Lambda_b \rightarrow \ell + X$	9.9%

e_{phot}-h Correlations

$$e_{phot}\text{-}h = \Sigma\, w(p_T)\, \gamma(p_T)\text{-}h$$