Heavy quark production at forward and backward rapidity in d+Au collisions at sqrt(s_{NN})=200 GeV

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for the PHENIX collaboration

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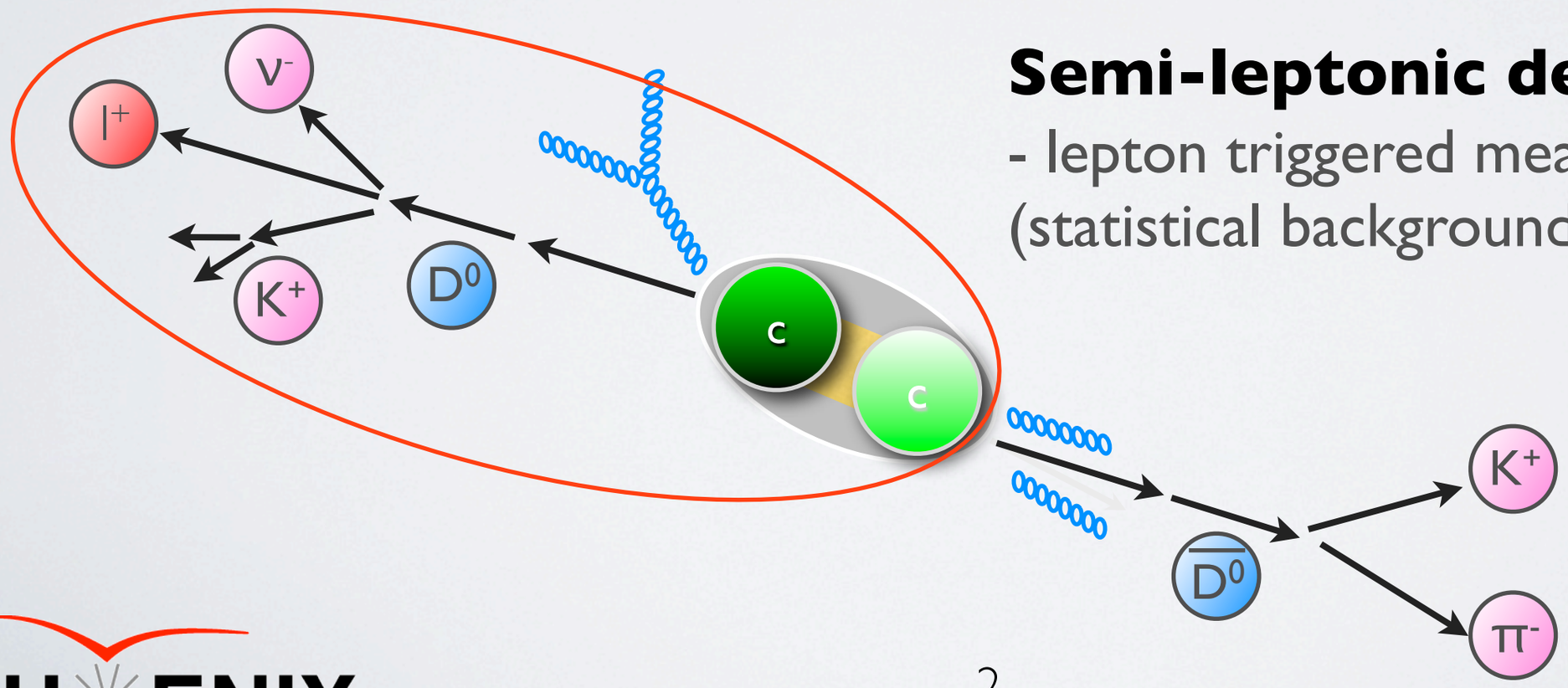
PHENIX

Single leptons from open heavy flavor

- Single lepton measurement from open heavy flavor is good channel to probe heavy quark production without hadronic medium effects
  - LO production via gluon fusion sensitive to PDF modification

- PHENIX has suitable design for single lepton measurements
  - electrons at mid-rapidity
  - muons at forward & backward rapidity

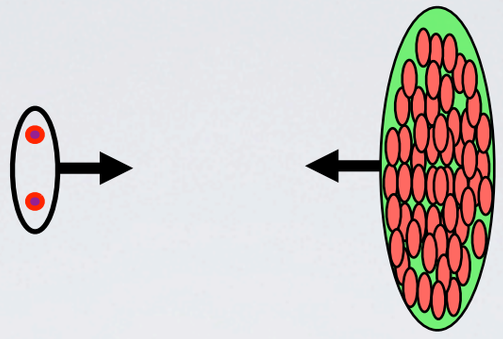


Semi-leptonic decay

- lepton triggered measurement(e, μ)
(statistical background subtraction)

Cold nuclear matter effects in d+Au collisions

Backward rapidity
*Au-going side
*$x_1 < x_2$



parton of x_1 in d

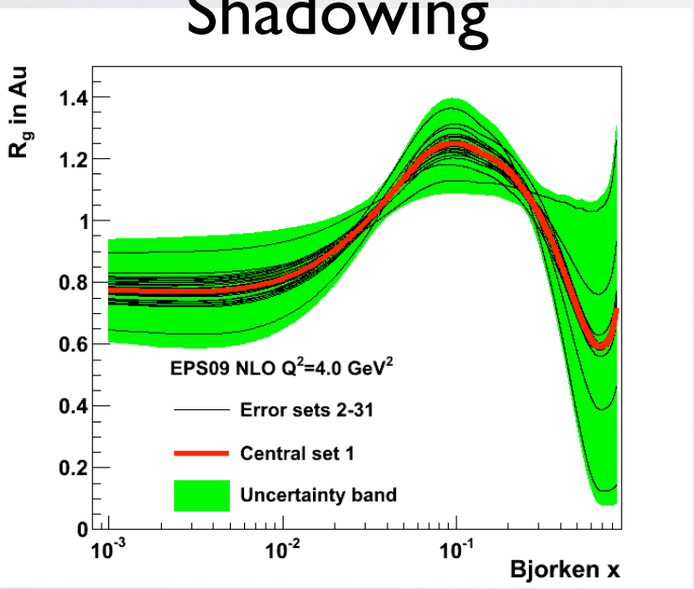
parton of x_2 in Au

Forward rapidity
*d-going side
*$x_1 > x_2$

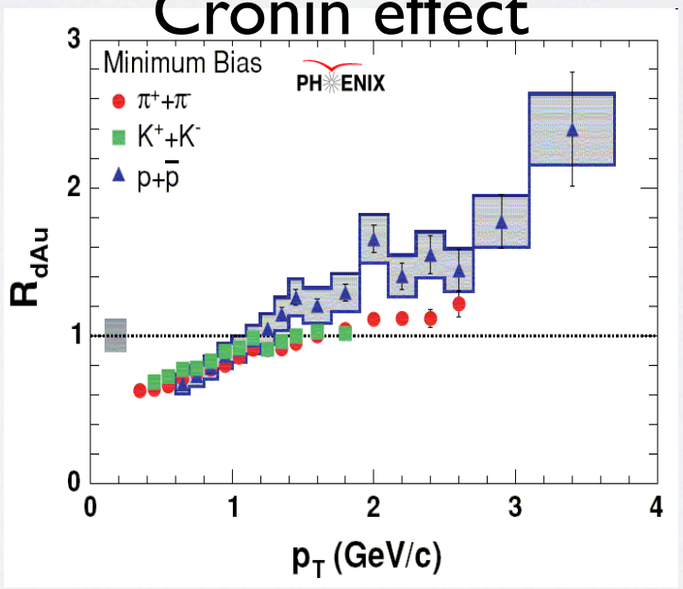
$$x_2 = \frac{Q}{\sqrt{s_{NN}}} e^{-y}$$

- d+Au collision as controlled experiment
  - In heavy ion collision, CNM & HNM effects are mixed
  - baseline measurements without hot nuclear medium in heavy ion collisions

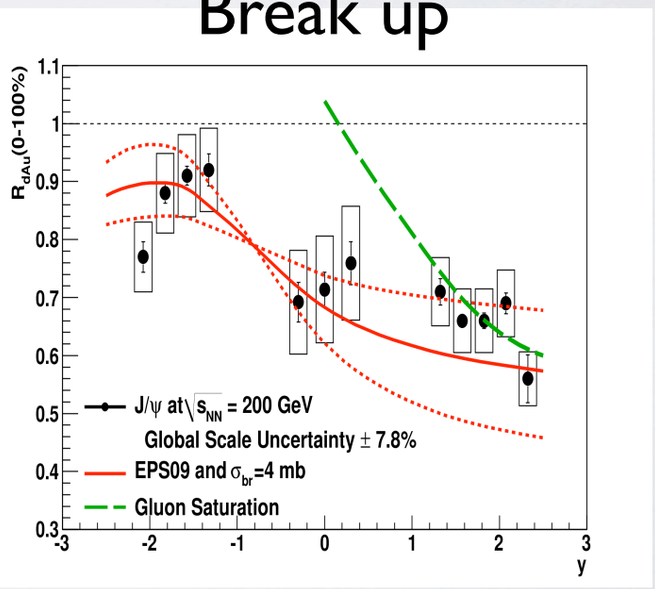
Shadowing



Cronin effect



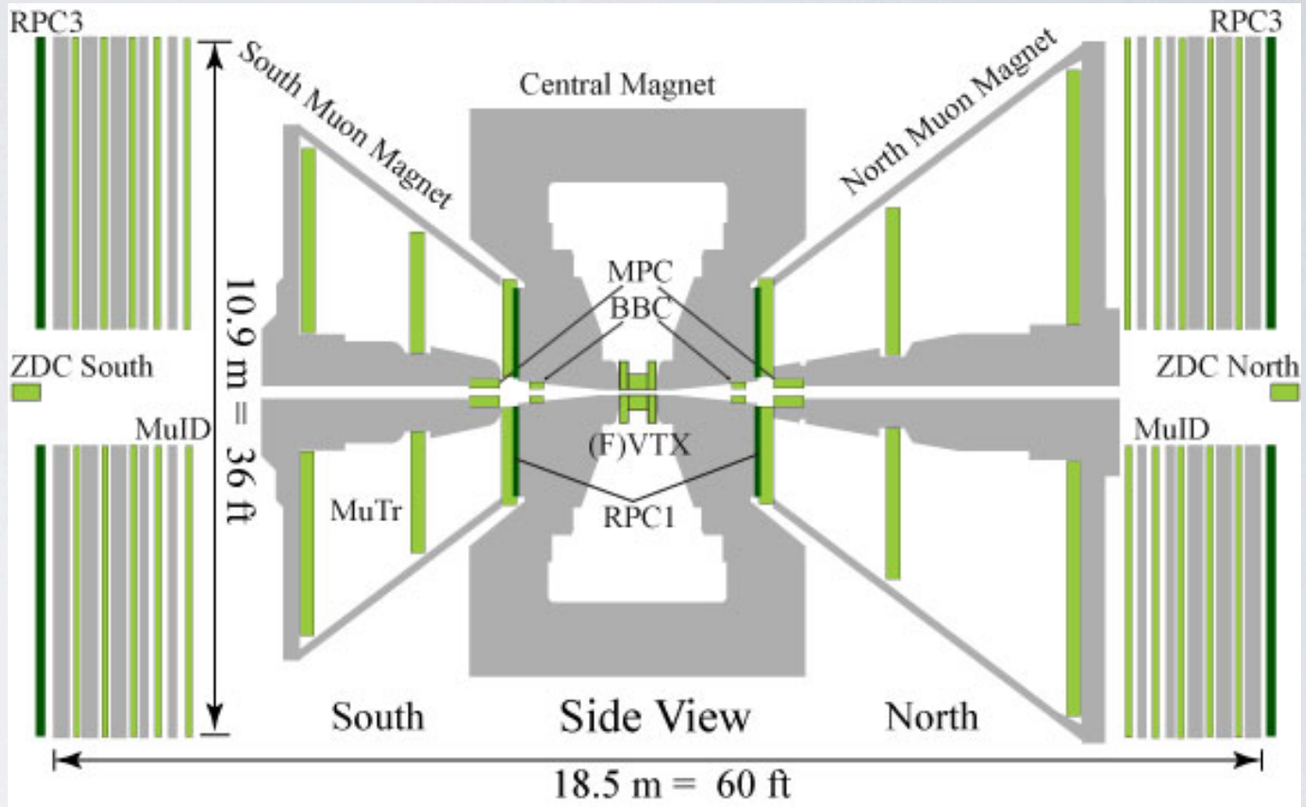
Break up

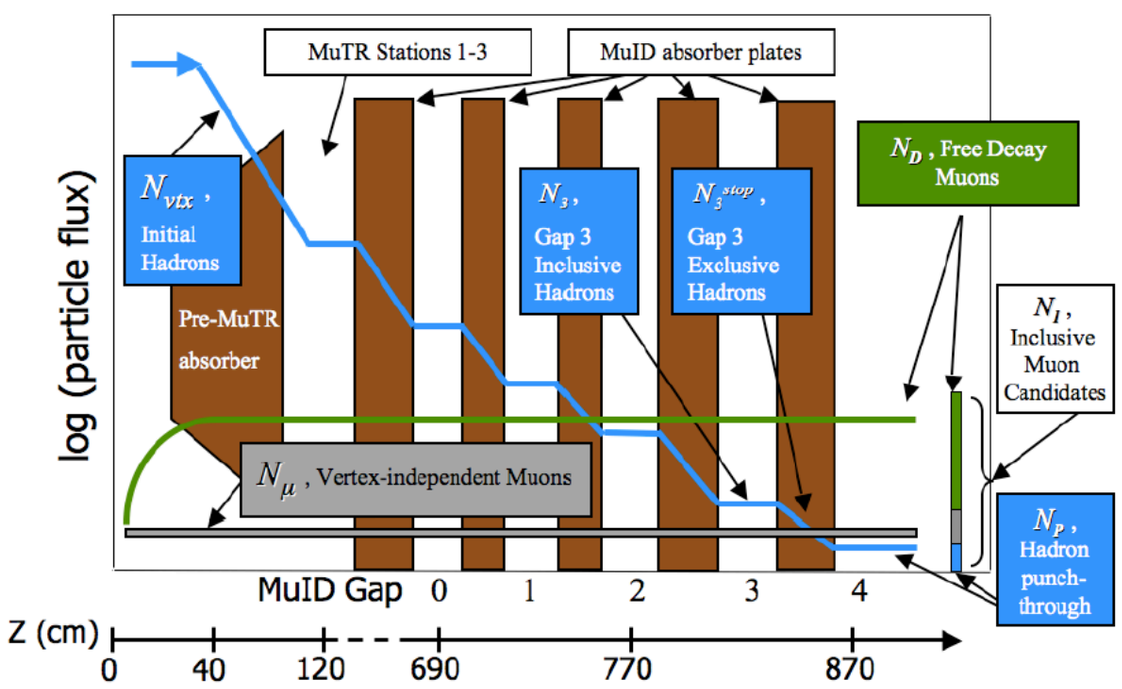


PHENIX muon spectroscopy

- kinematic range
  - 1.2 < |η| < 2.2 at forward
  - Δφ = 2π

  - ~10λ absorber to reject hadrons
  - Muon Tracker for momentum
  - Muon identifier for hadron/muon separation



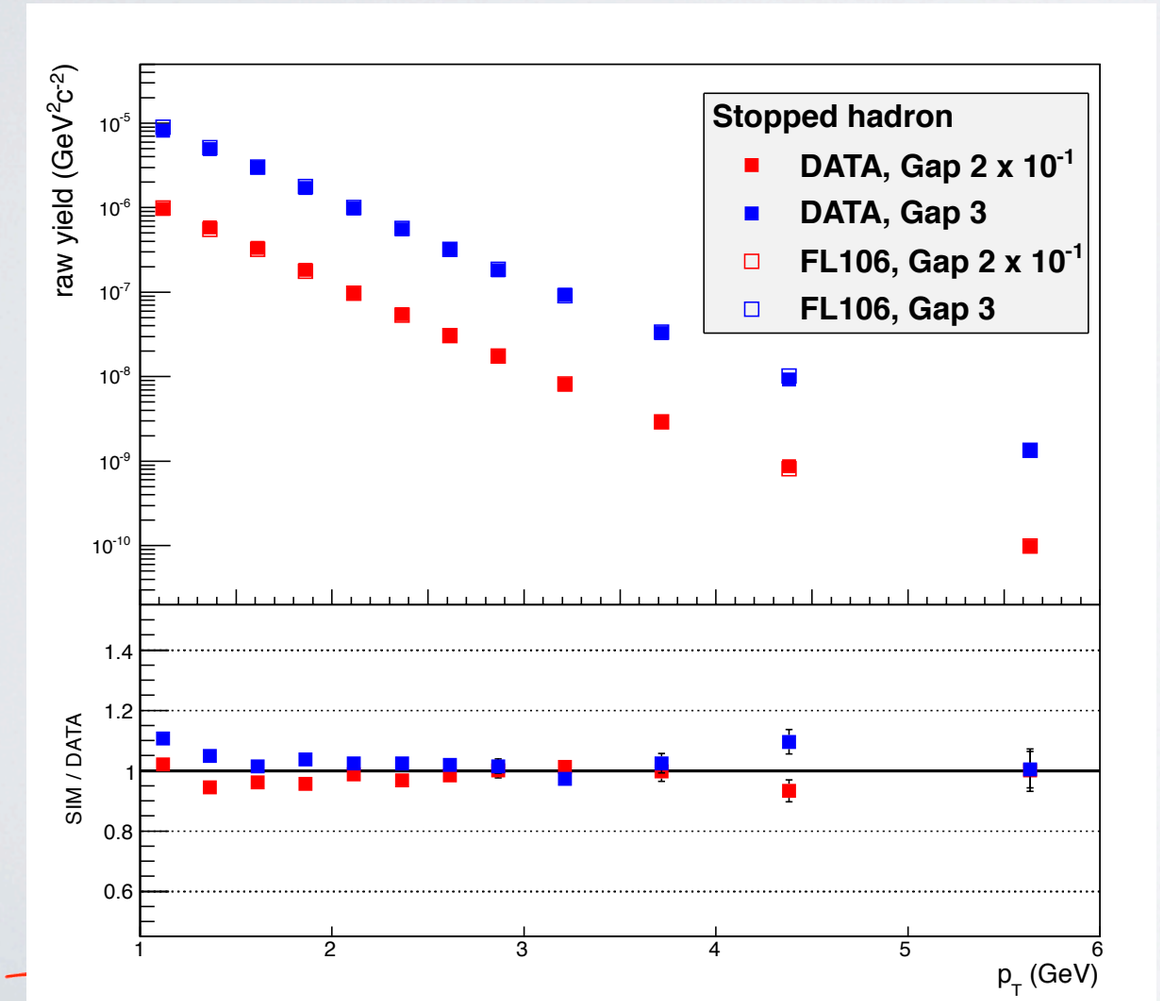


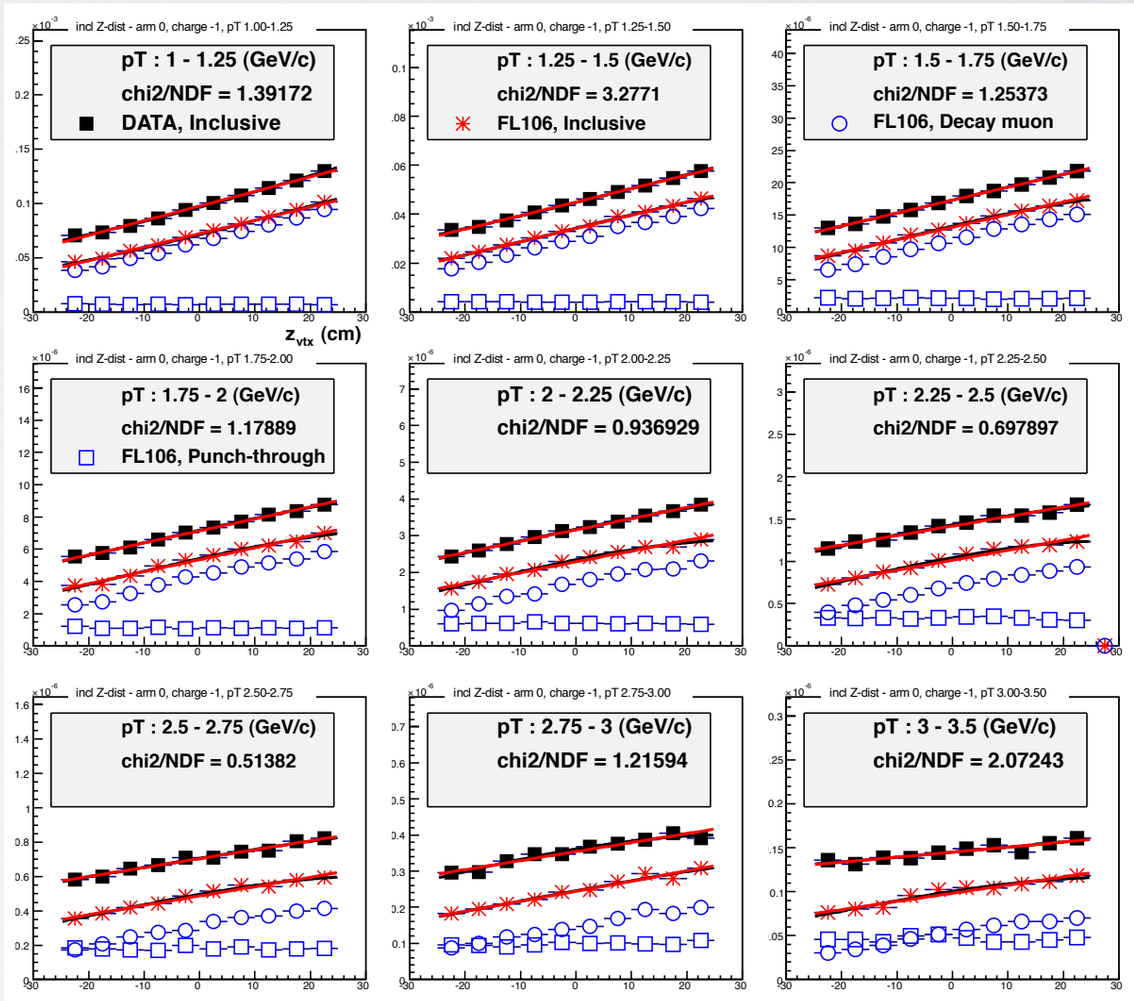
- Main background sources are **decay muons** from light hadrons and **punch-through hadrons**.

- Full data-driven MC simulation of hadron cocktail (π, K, p)
  - Tune to data by using z-vertex dependence of decay muons at MuID Gap 4 and yields of stopped hadrons at MuID Gap 2 and 3

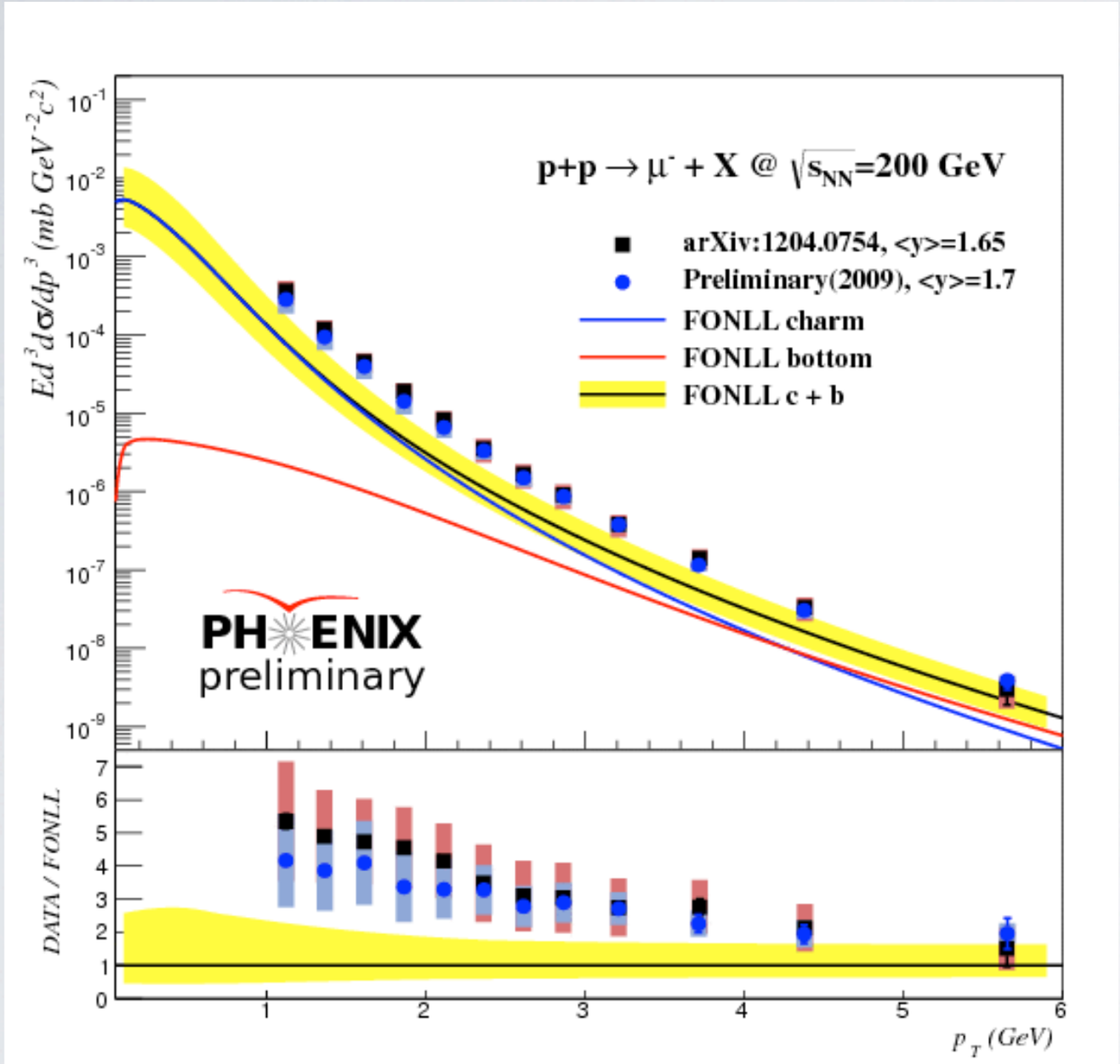
Tuning the cocktail

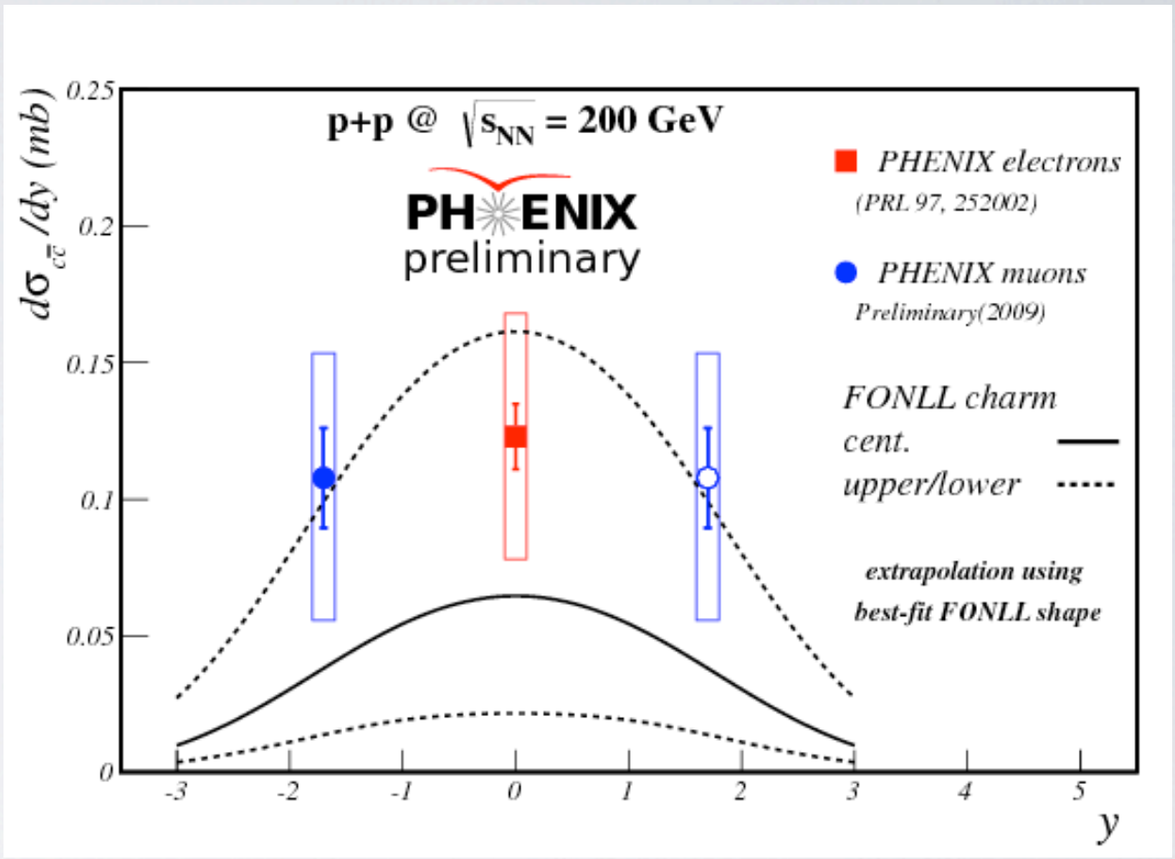
- Tune the input hadron information by matching cocktail simulation to data at **MuID Gap 2, 3 and 4**
  - Qualified hadron packages which show good agreement with data at MuID gaps simultaneously have been used to background estimation
    *(package : a hadron shower code with modified nuclear cross section by a certain fraction)





Heavy flavor single muons in p+p



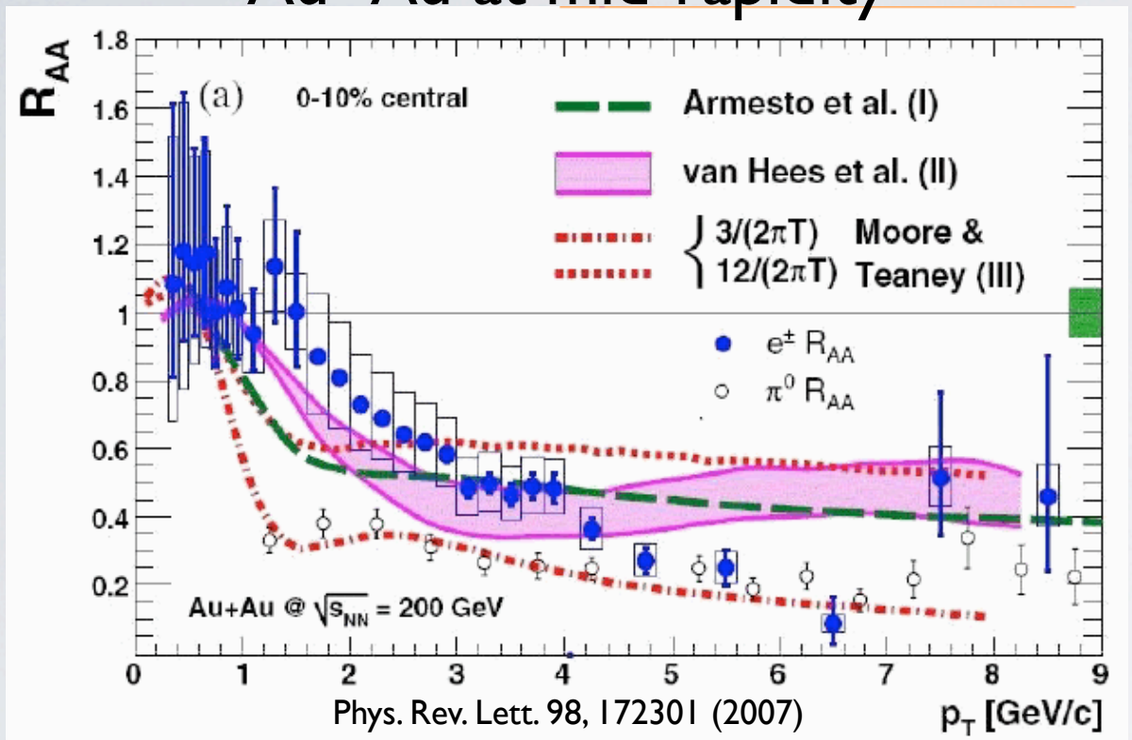


- Charm cross section by extrapolating to p_T=0 using FONLL shape

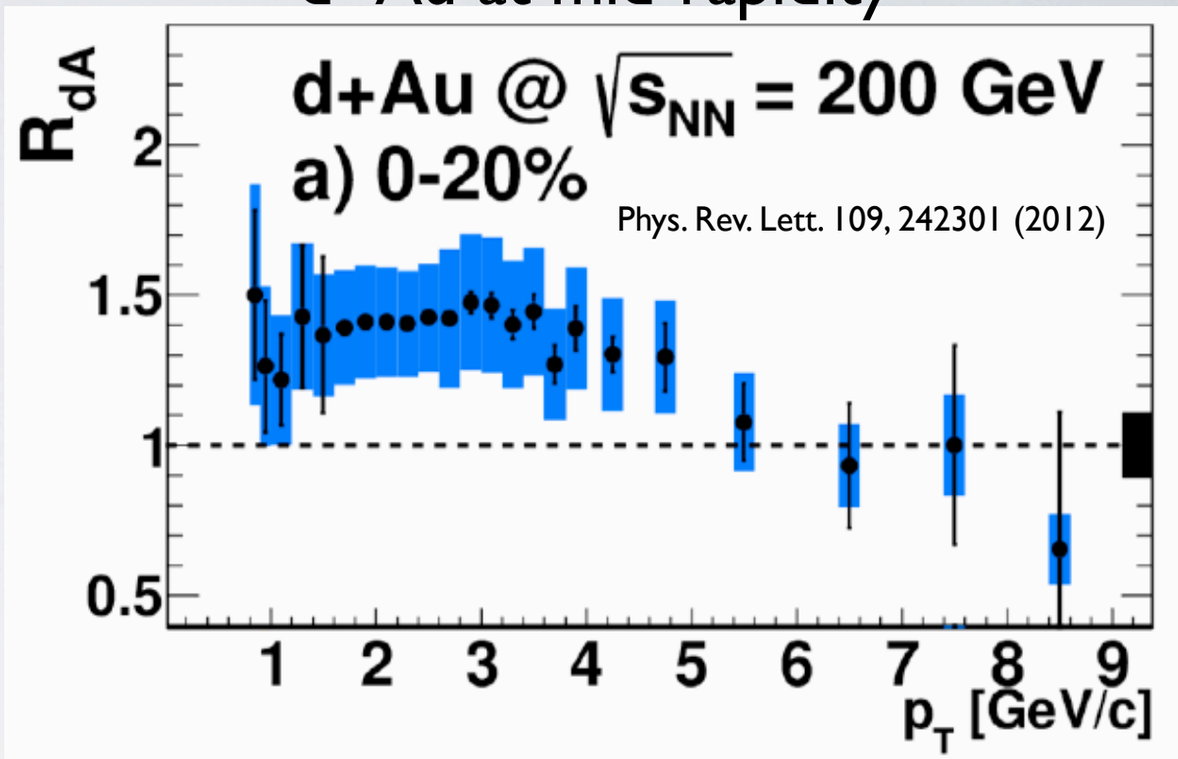
- Analysis with data collected in 2009 of enhanced statistics
  - consistent results with published results
  (Phys. Rev. C. 86, 204909 (2012))

Quick review of heavy flavor results

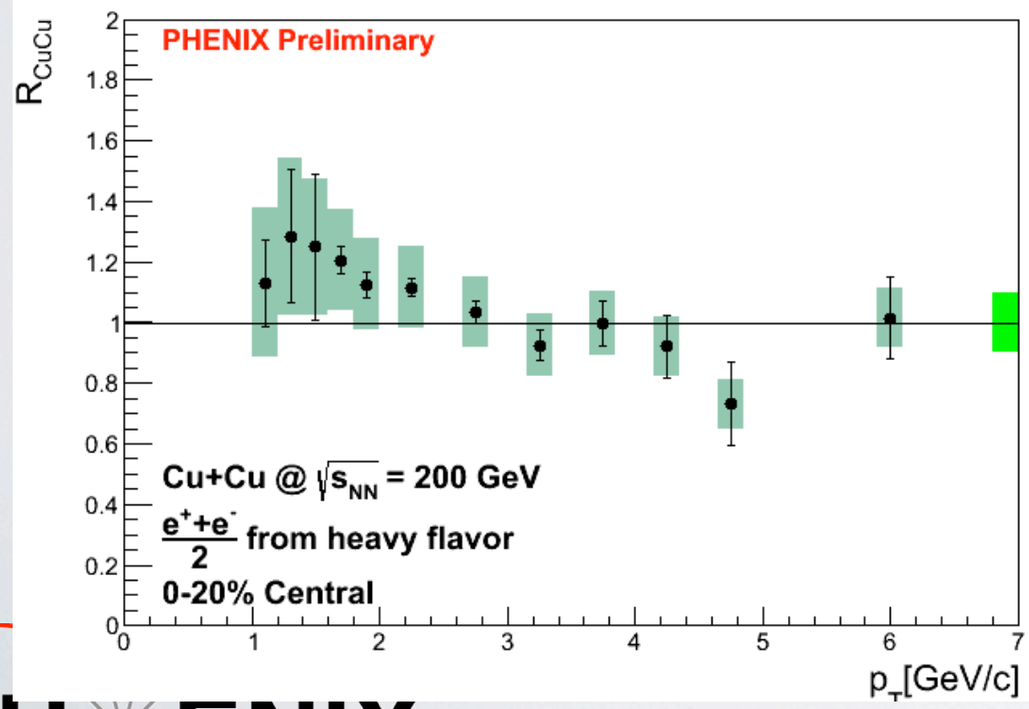
Au+Au at mid-rapidity



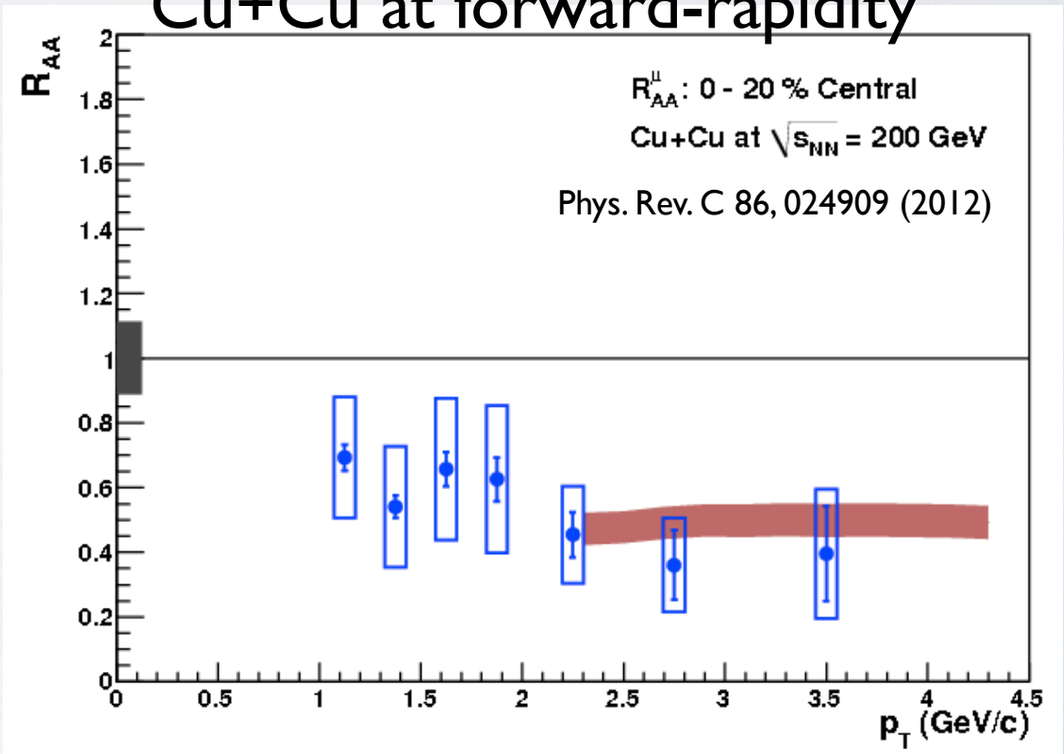
d+Au at mid-rapidity



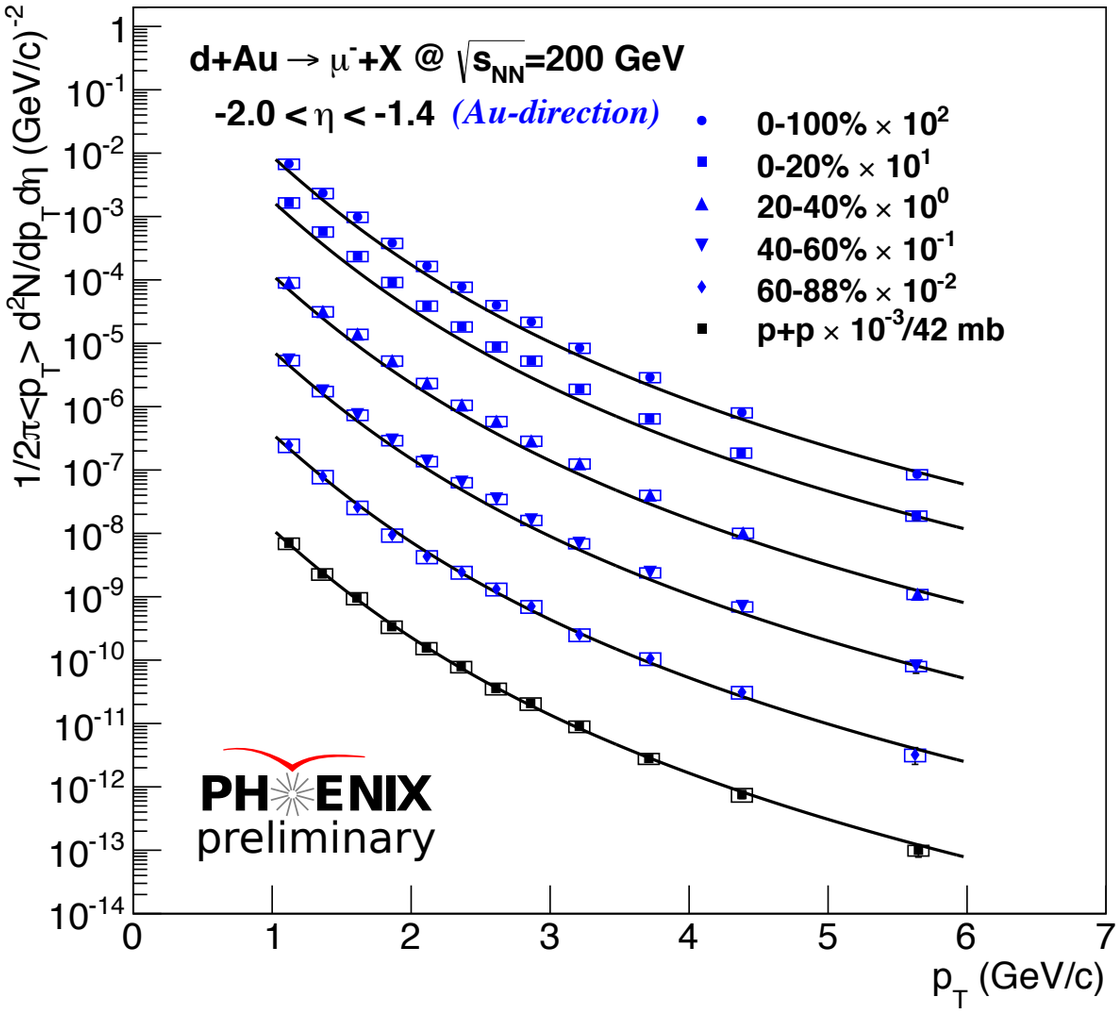
Cu+Cu at mid-rapidity

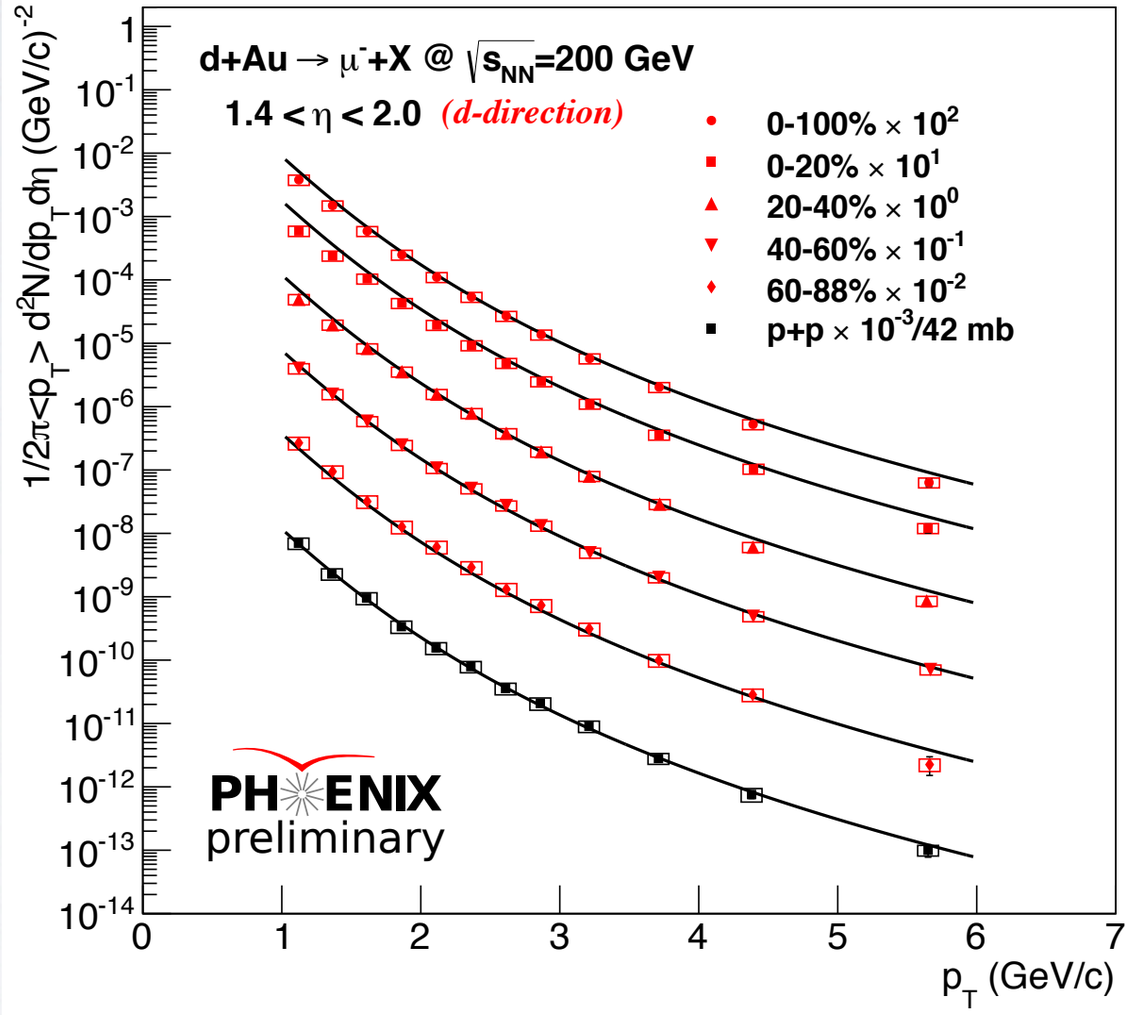


Cu+Cu at forward-rapidity



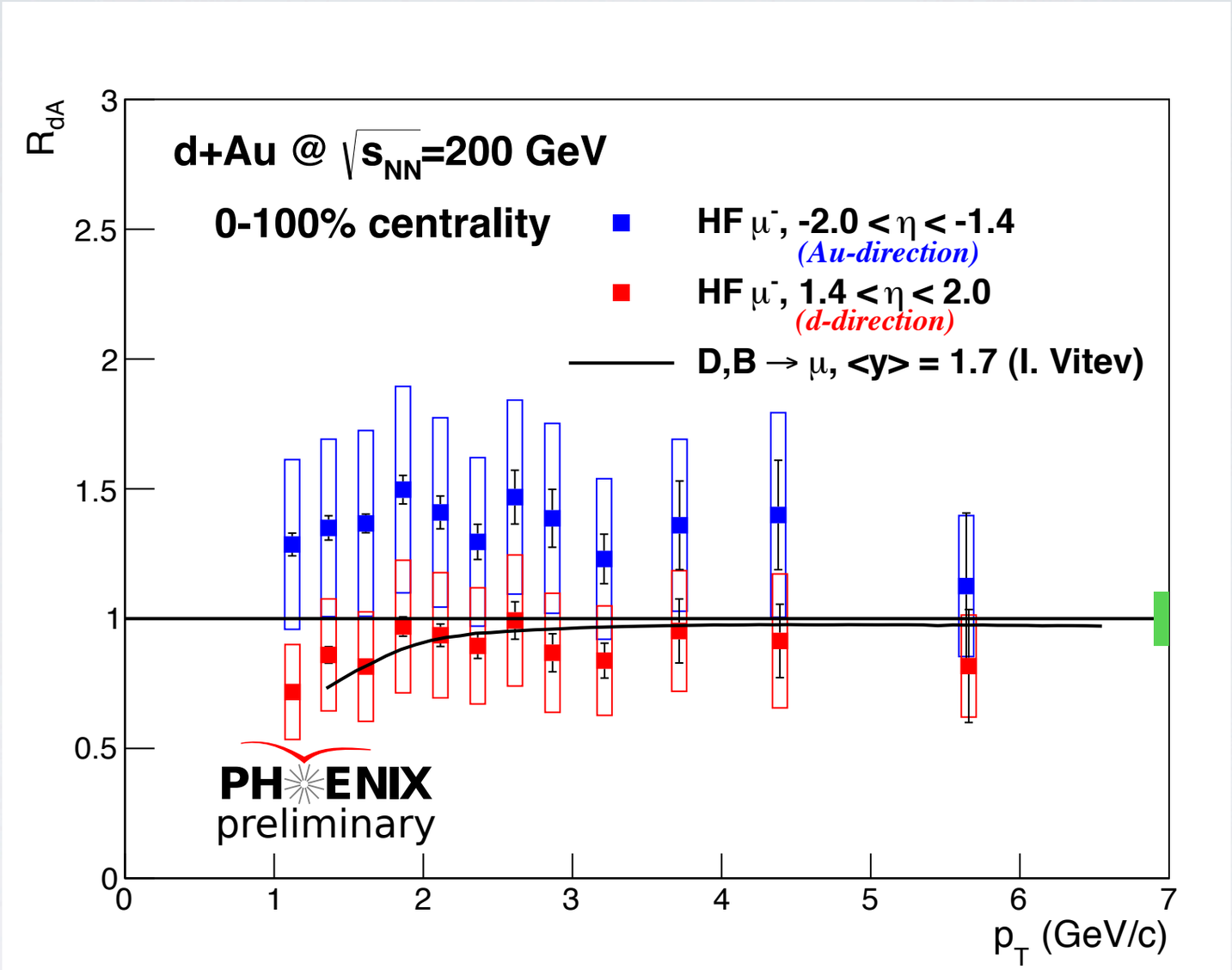
Heavy flavor single muons in d+Au





- HF single muons p_T spectra at **backward(Au-direction, left)** and at **forward(d-direction, right)** in d+Au collisions
  - lines are T_{AB} scaled of fit to spectra in p+p collisions

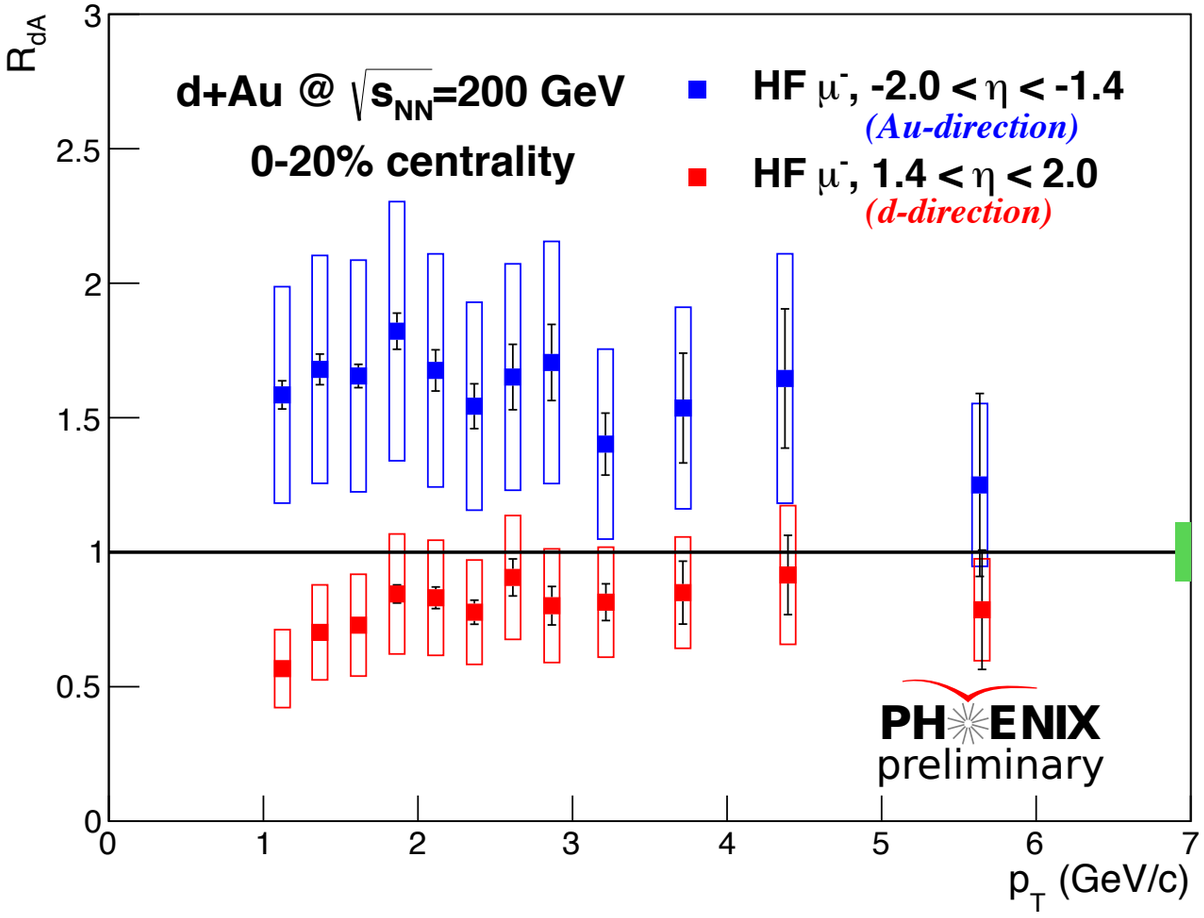
Heavy flavor muons R_{dA}, Min Bias



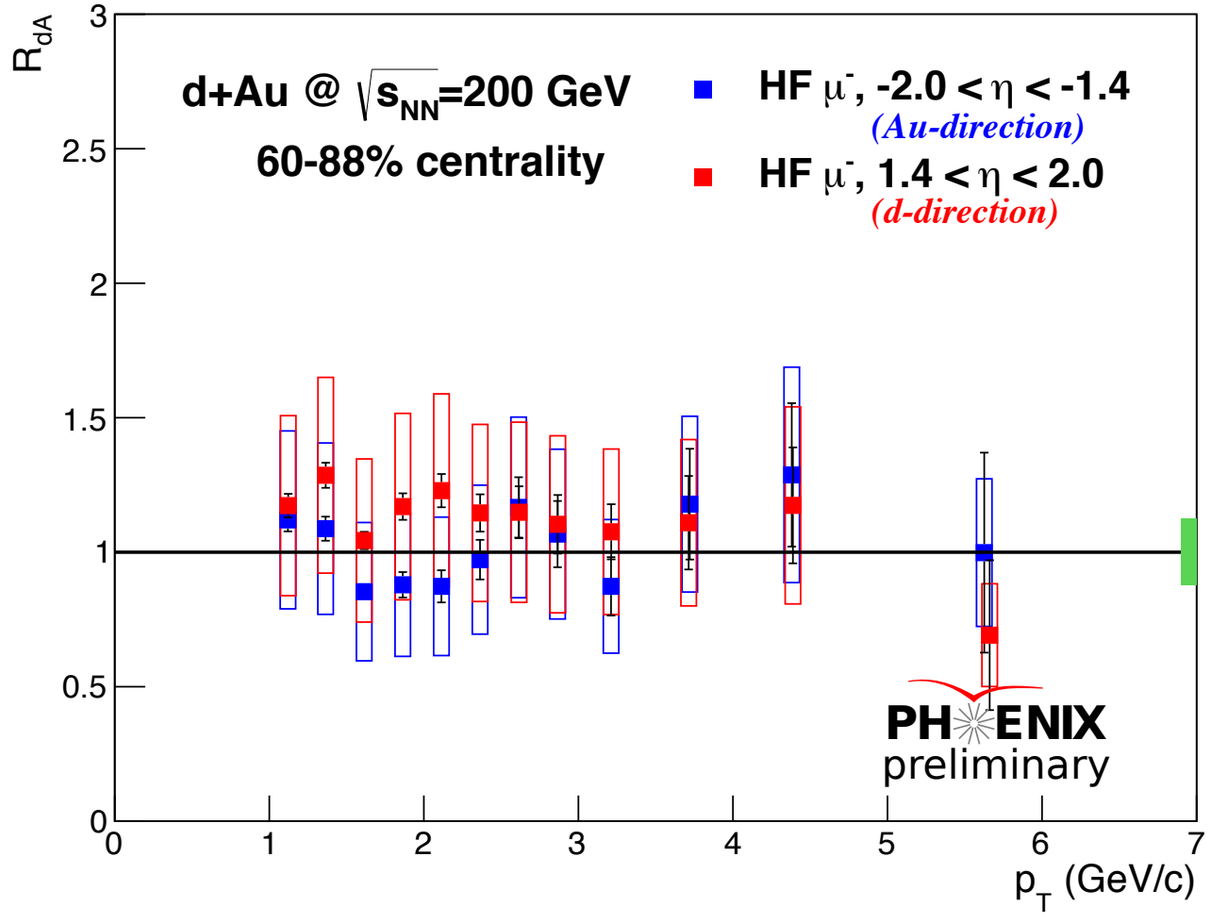
- good agreement with the prediction from I.Vitev
  - muon production from D and B meson at <y>=1.7
  - considering shadowing, Cronin effect and initial parton energy loss

Heavy flavor muons R_{dA}, central vs. peripheral

0 - 20% centrality



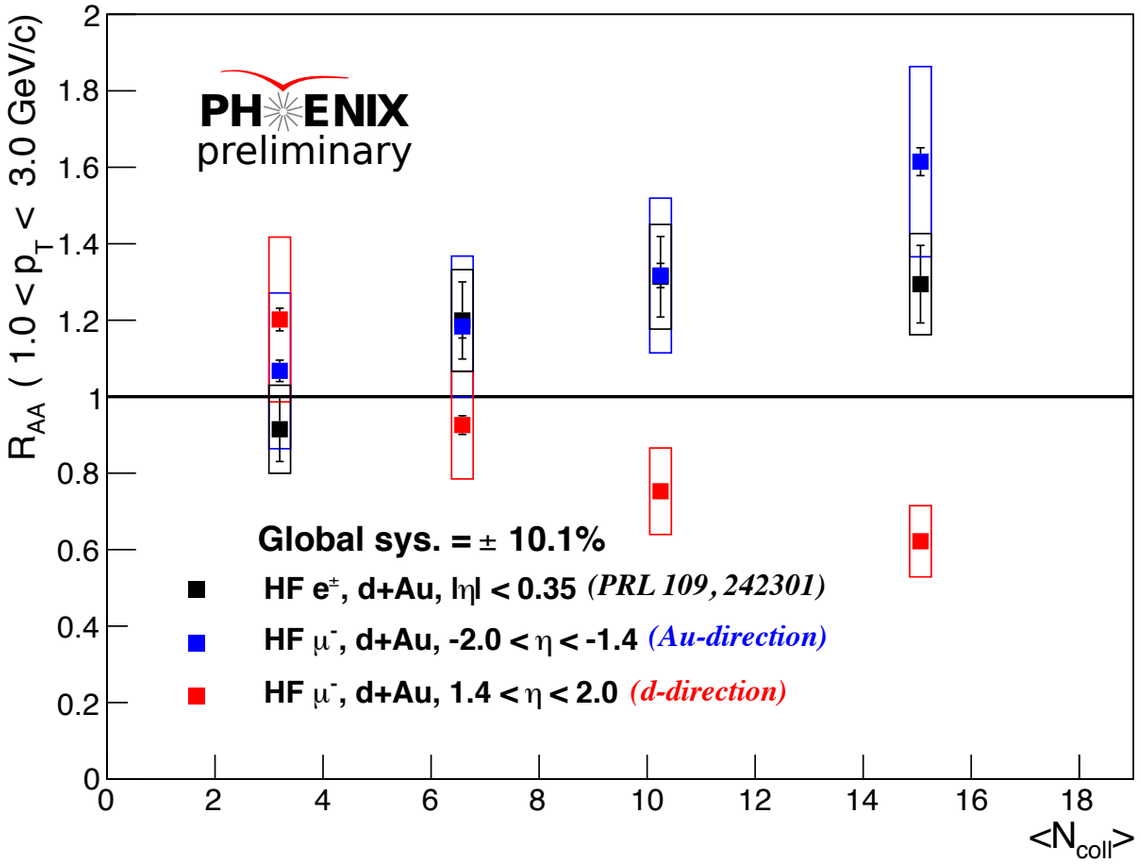
60 - 88% centrality



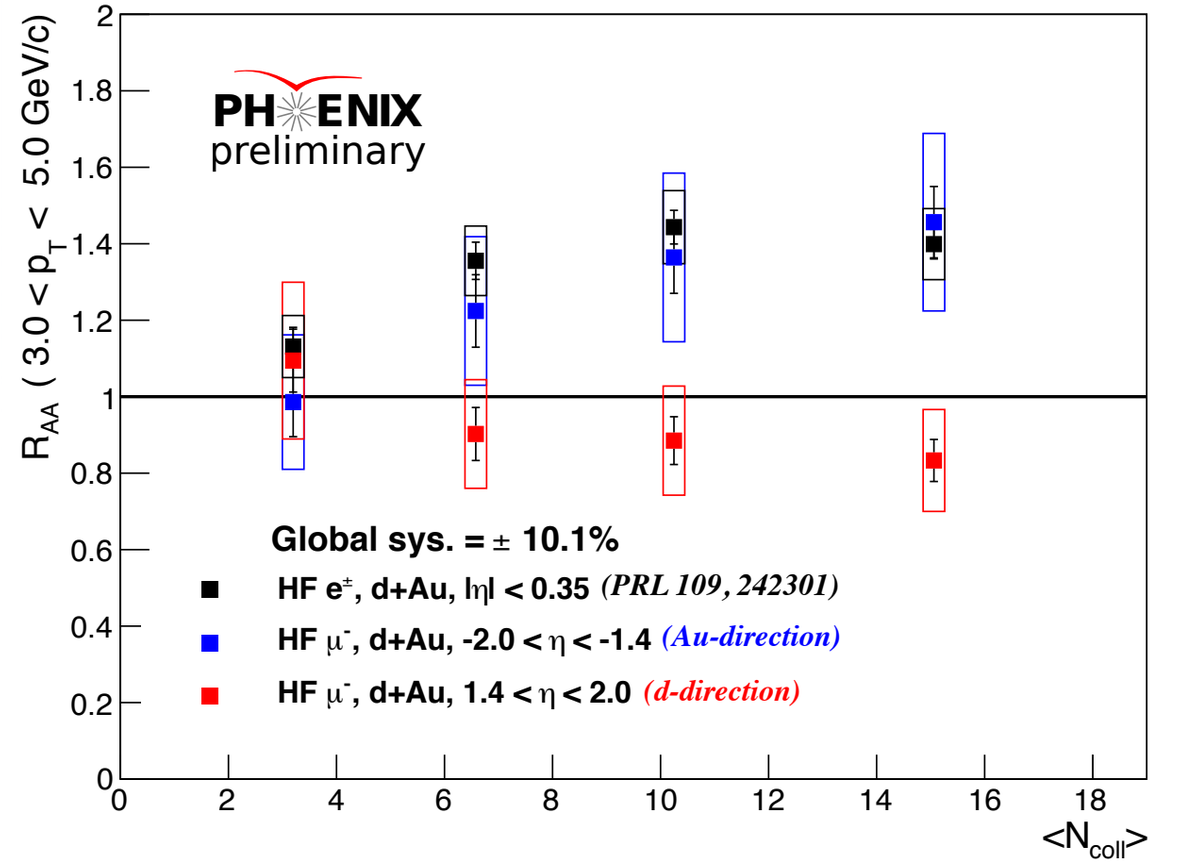
- Strong CNM effects in the most central d+Au collisions!
  - enhancement at backward rapidity similar to mid-rapidity
  - suppression at forward rapidity

Integrated R_{dA} vs. N_{coll}

$1.0 < p_T < 3.0$ GeV/c



$3.0 < p_T < 5.0$ GeV/c



- Stronger centrality dependence at low p_T region
  - similar trends at backward and mid-rapidity
  - opposite trend at forward, more suppression as larger N_{coll}

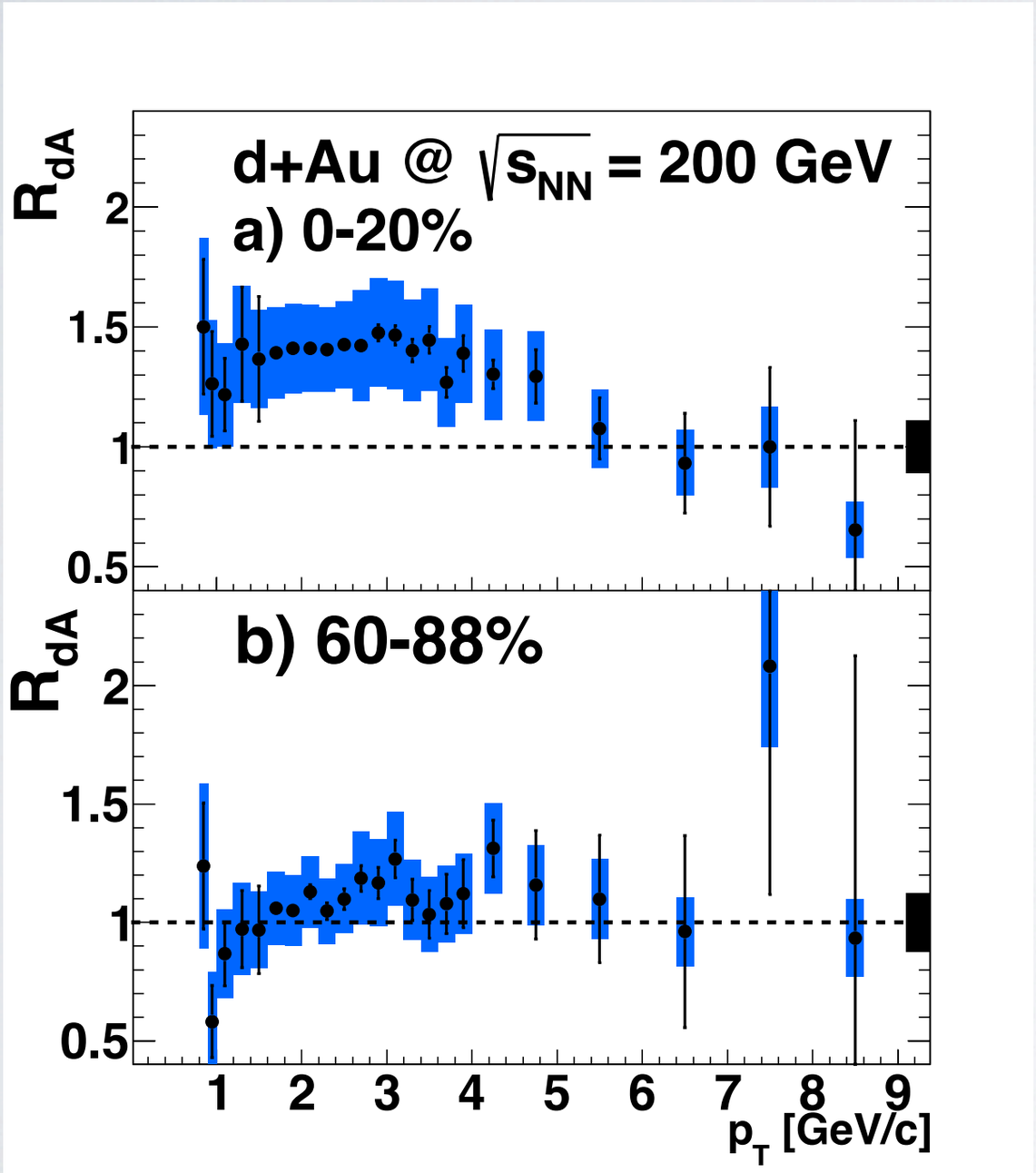
Summary & outlook

- We measured single muons from open heavy flavor in d+Au collisions at backward and forward rapidities for minimum bias and 4 centrality intervals
  - R_{dA} ~ 1 at backward and forward rapidities in the most peripheral collision
  - enhancement(suppression) of HF muon productions at backward(forward) in the most central collision
  - good agreement with theoretical model from I.Vitev at forward rapidity in minimum bias collisions.

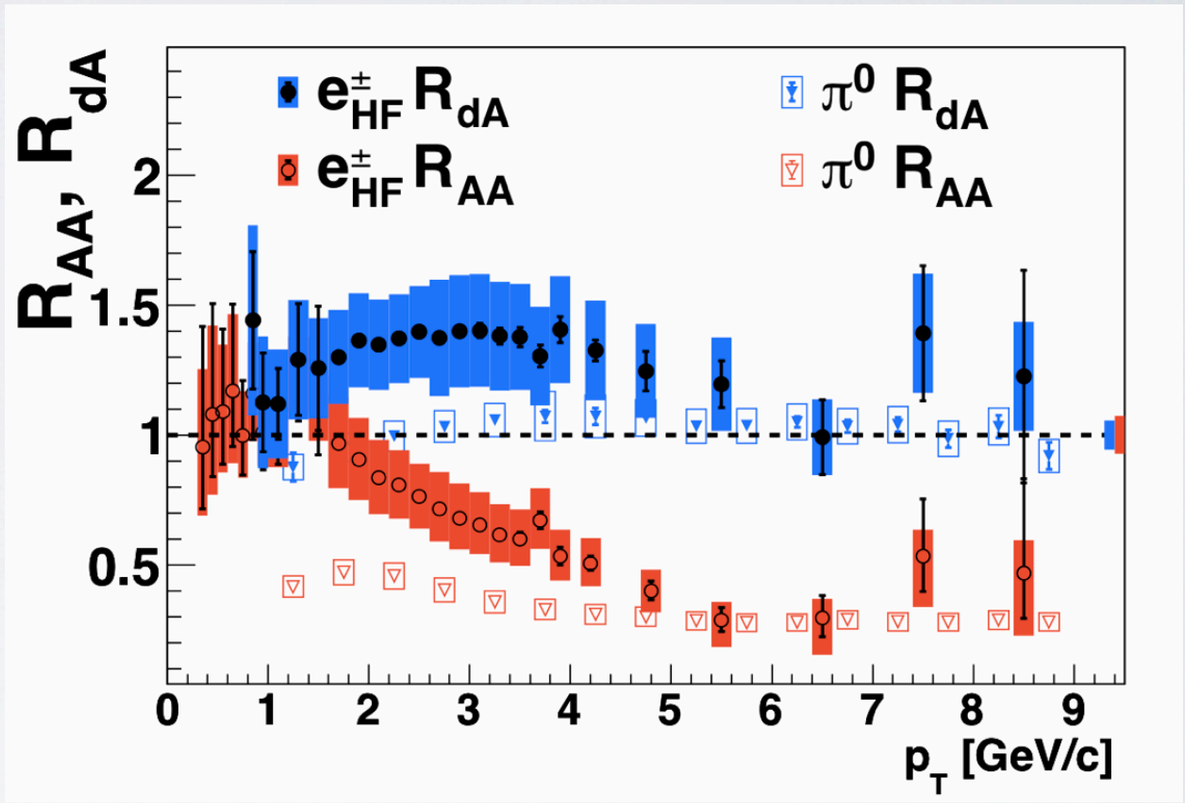
- New PHENIX inner silicon vertex tracker system (VTX & FVTX) provides precise vertex position and allows to separate charm and bottom meson.

Back up

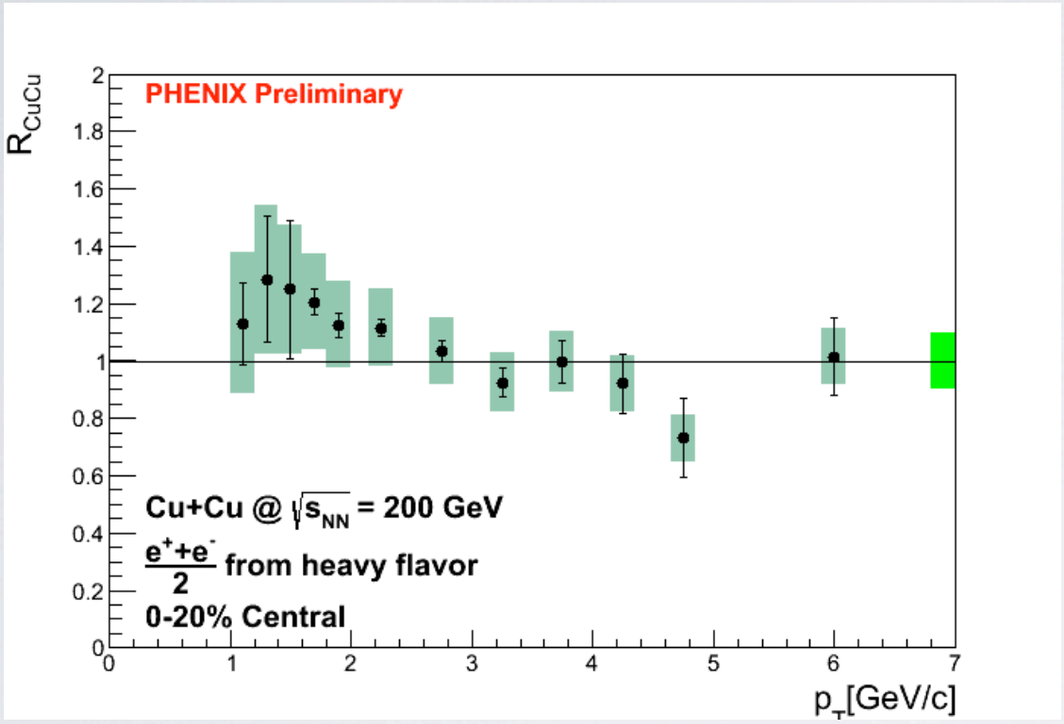
Heavy flavor single electrons R_{dA} at mid-rapidity

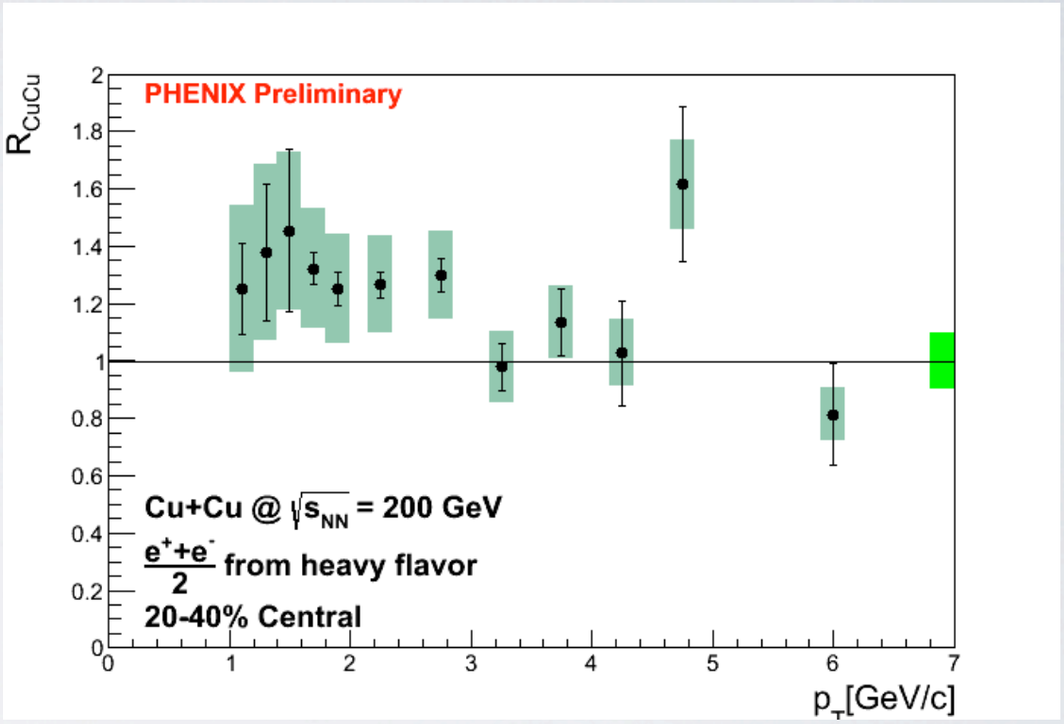


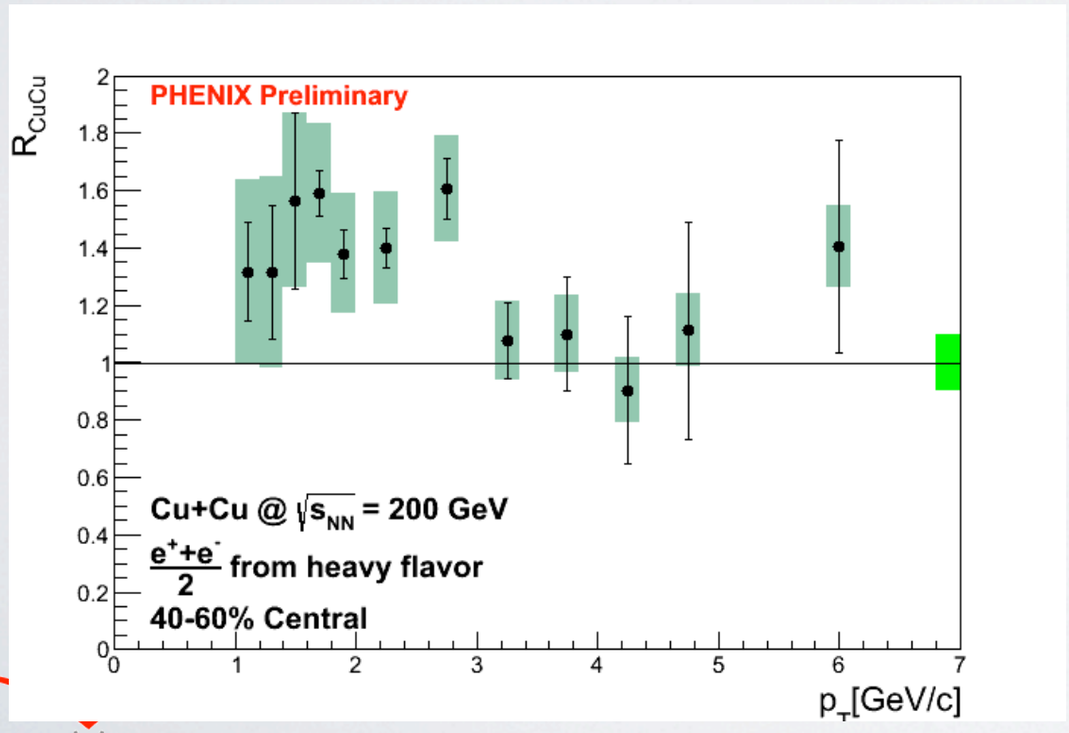
Phys. Rev. Lett. 109, 242301 (2012)

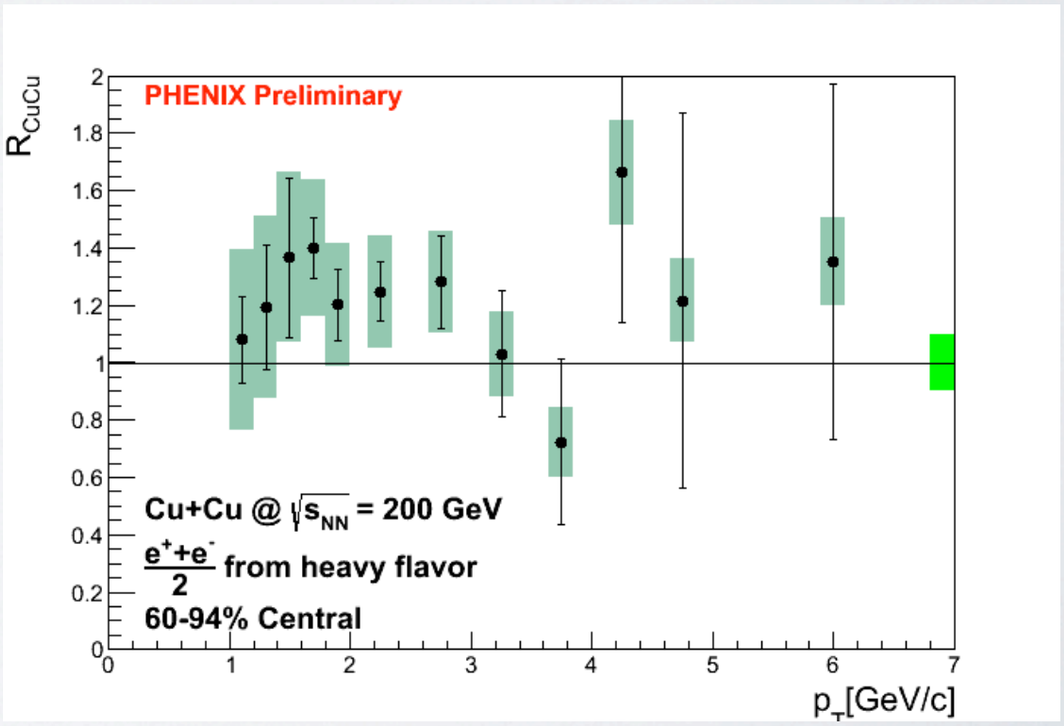


Heavy flavor electrons R_{AA} at mid-rapidity

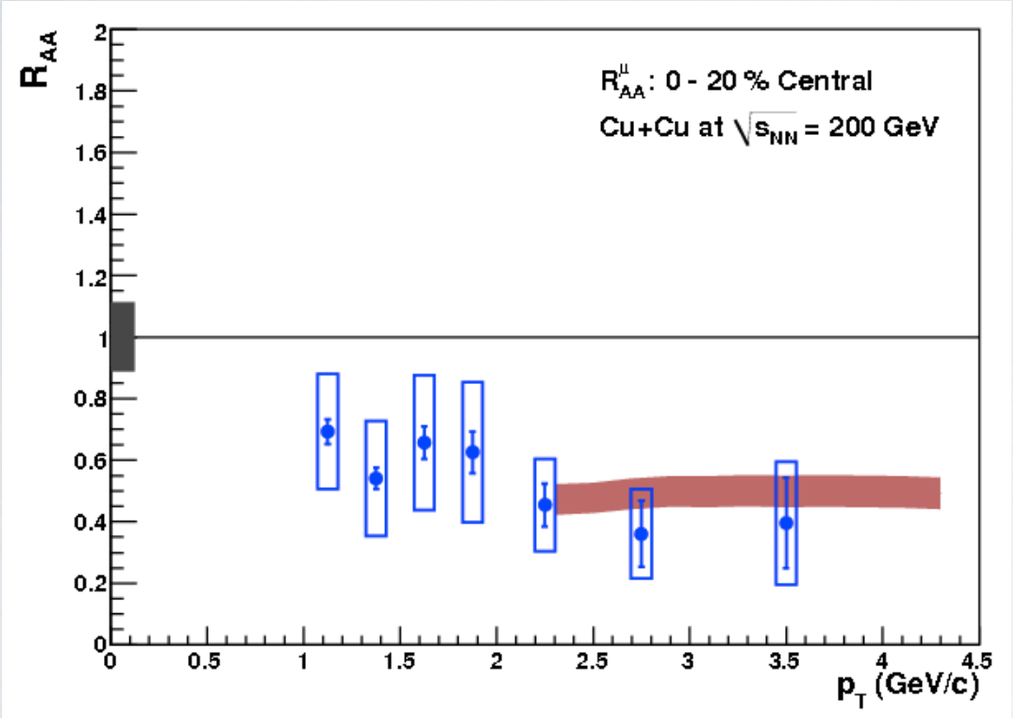


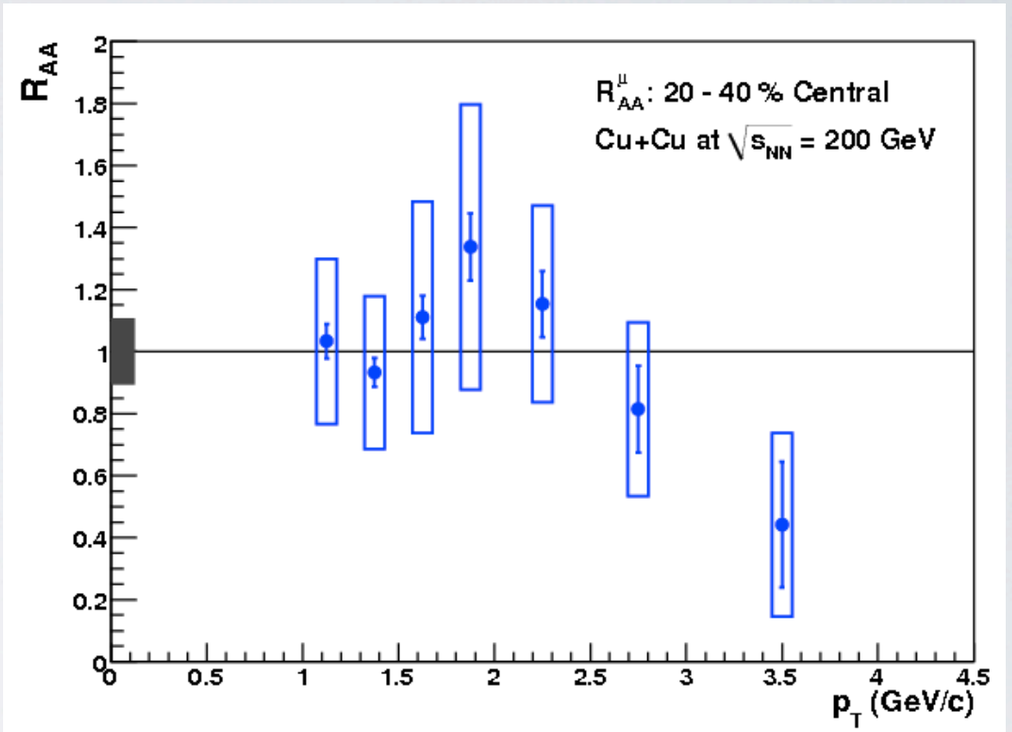


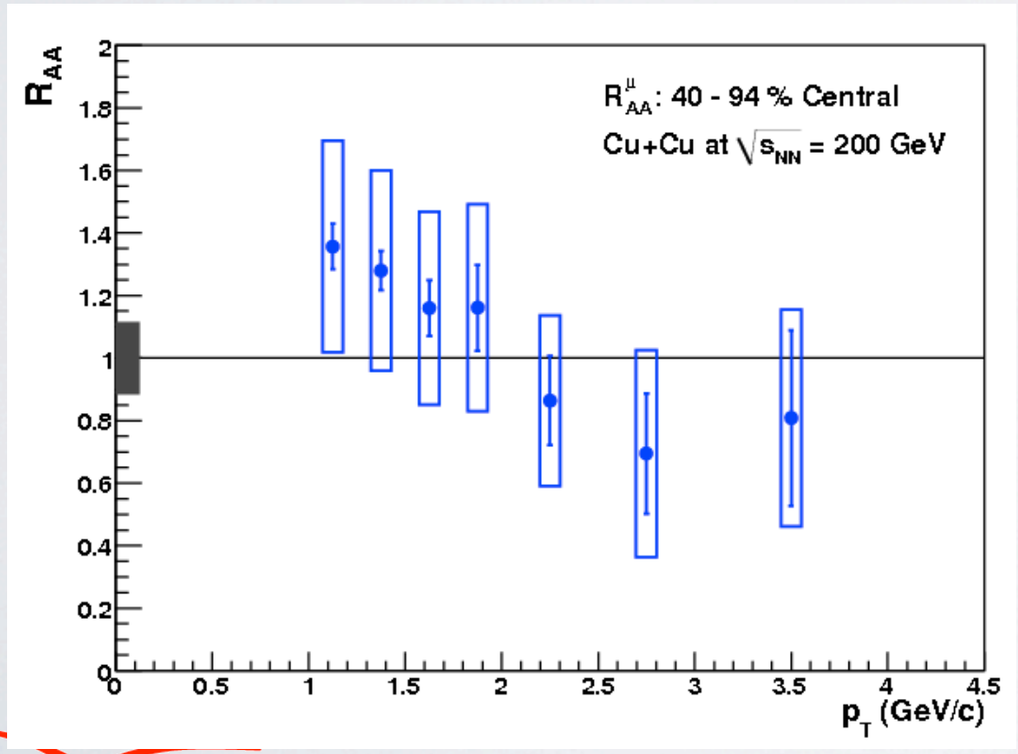


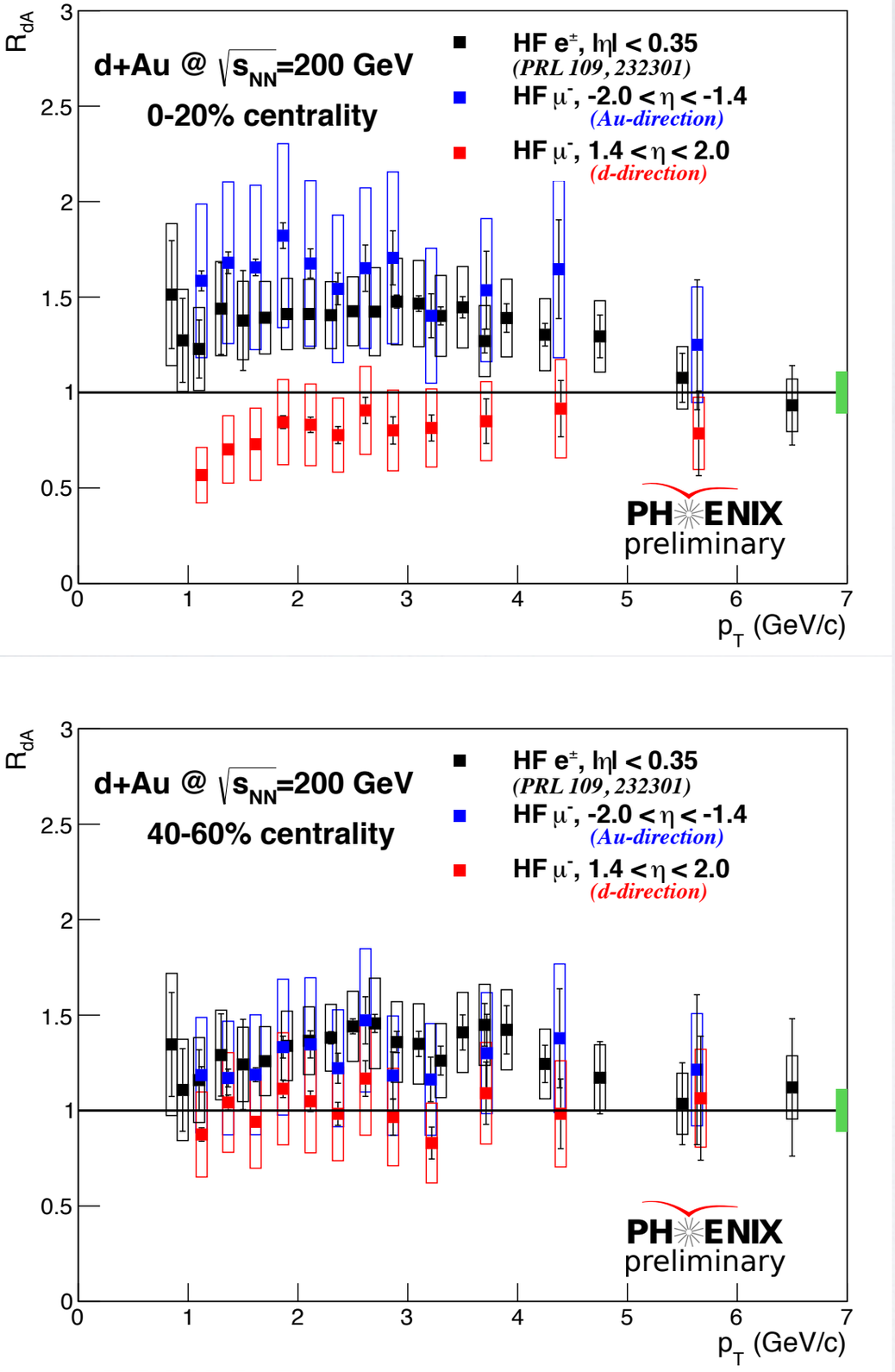
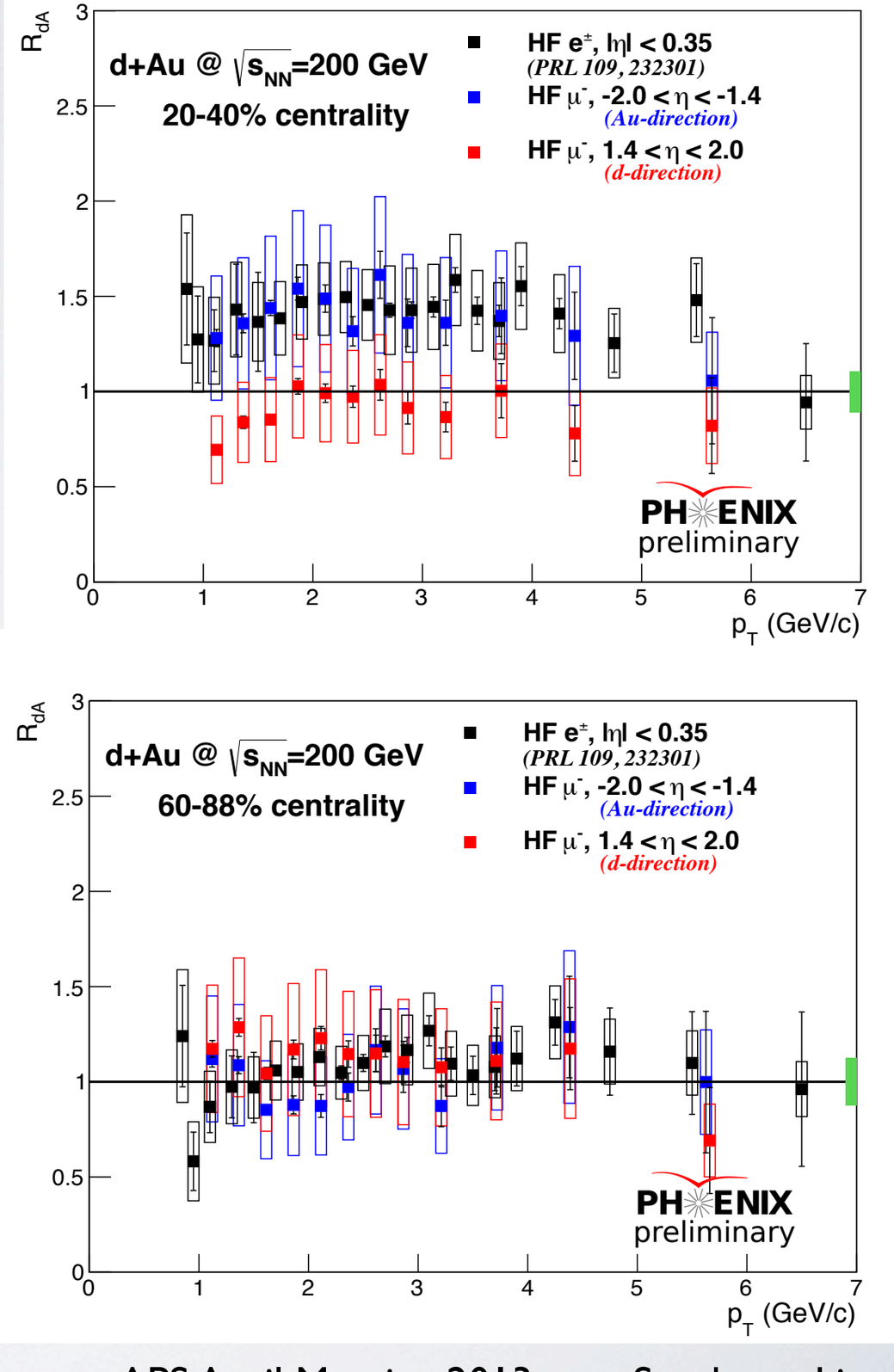


Heavy flavor muons R_{AA} at forward-rapidity







Phys. Rev. C 86, 024909 (2012)

Heavy flavor R_{dA}