Heavy Flavor Dileptons at PHENIX

Outline

- *motivation*
- *likesign correlations*
- *results*

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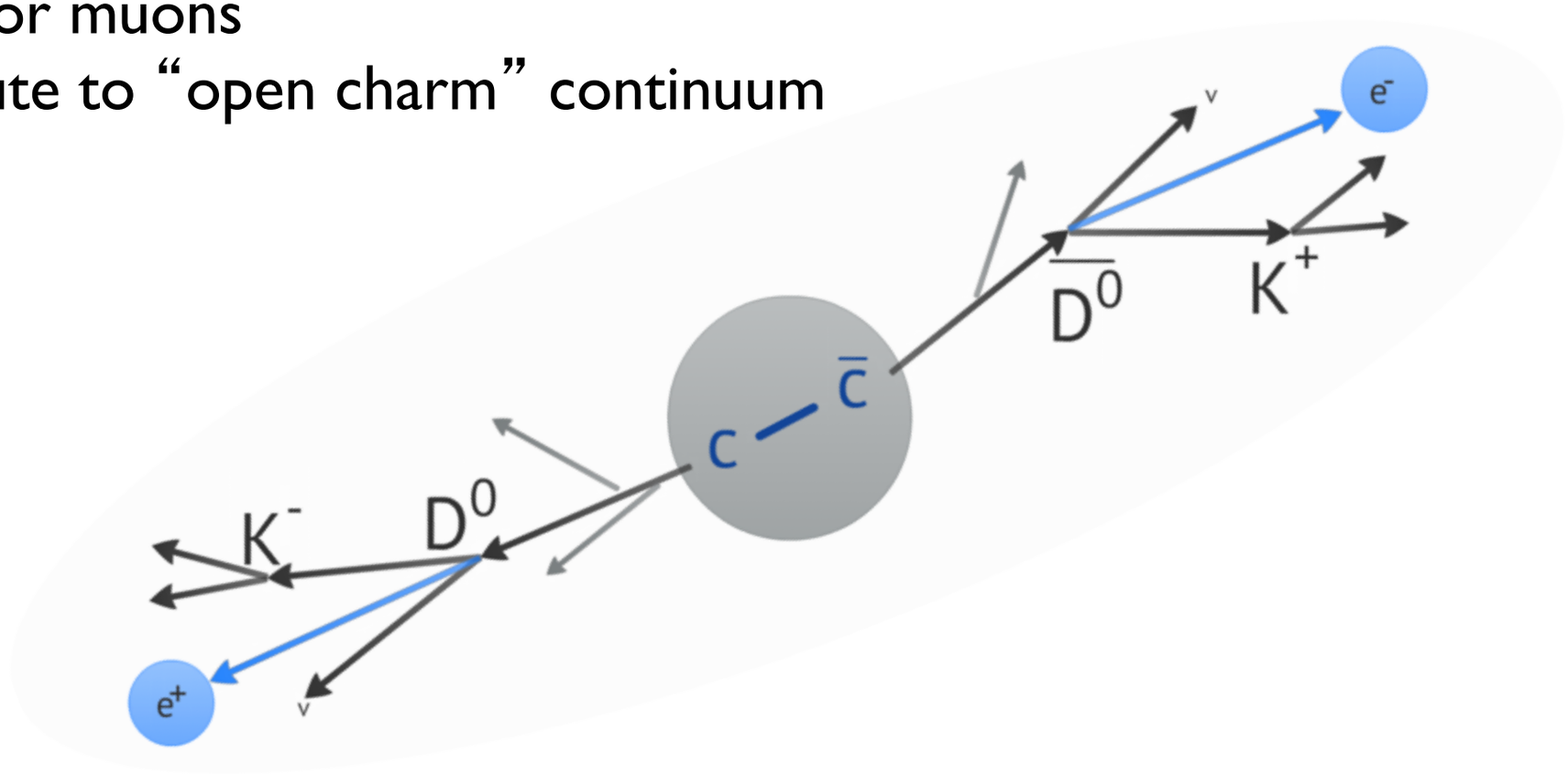
Dileptons from Heavy Flavor

- HF mesons decay semi-leptonically
- ~10% c and b quarks decay to electrons
- similar for muons
- contribute to "open charm" continuum

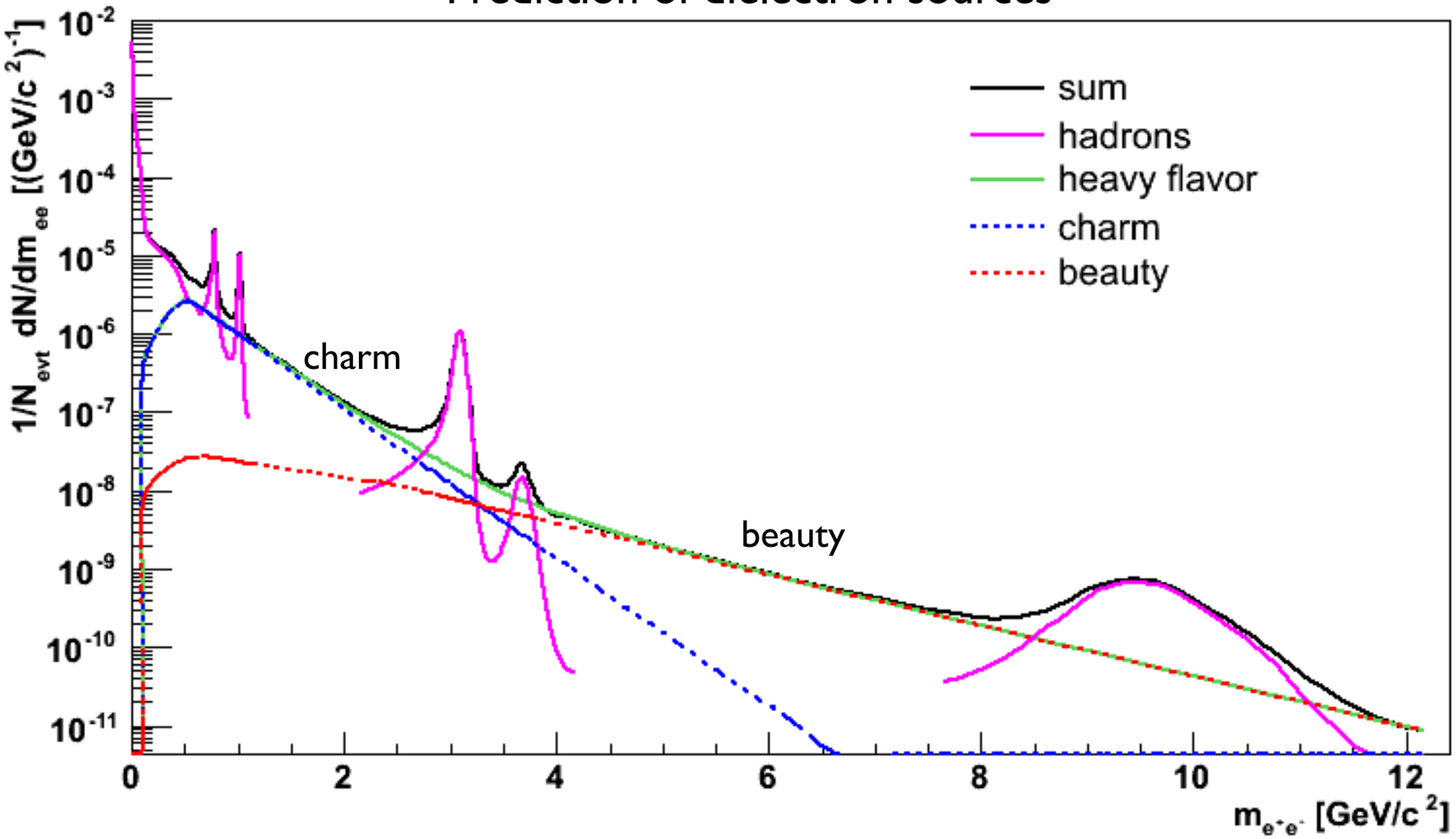


- typically e^+e^- have large opening angles
- manifest as high mass pairs

Signal to Background

hadronic contamination

Prediction of dielectron sources

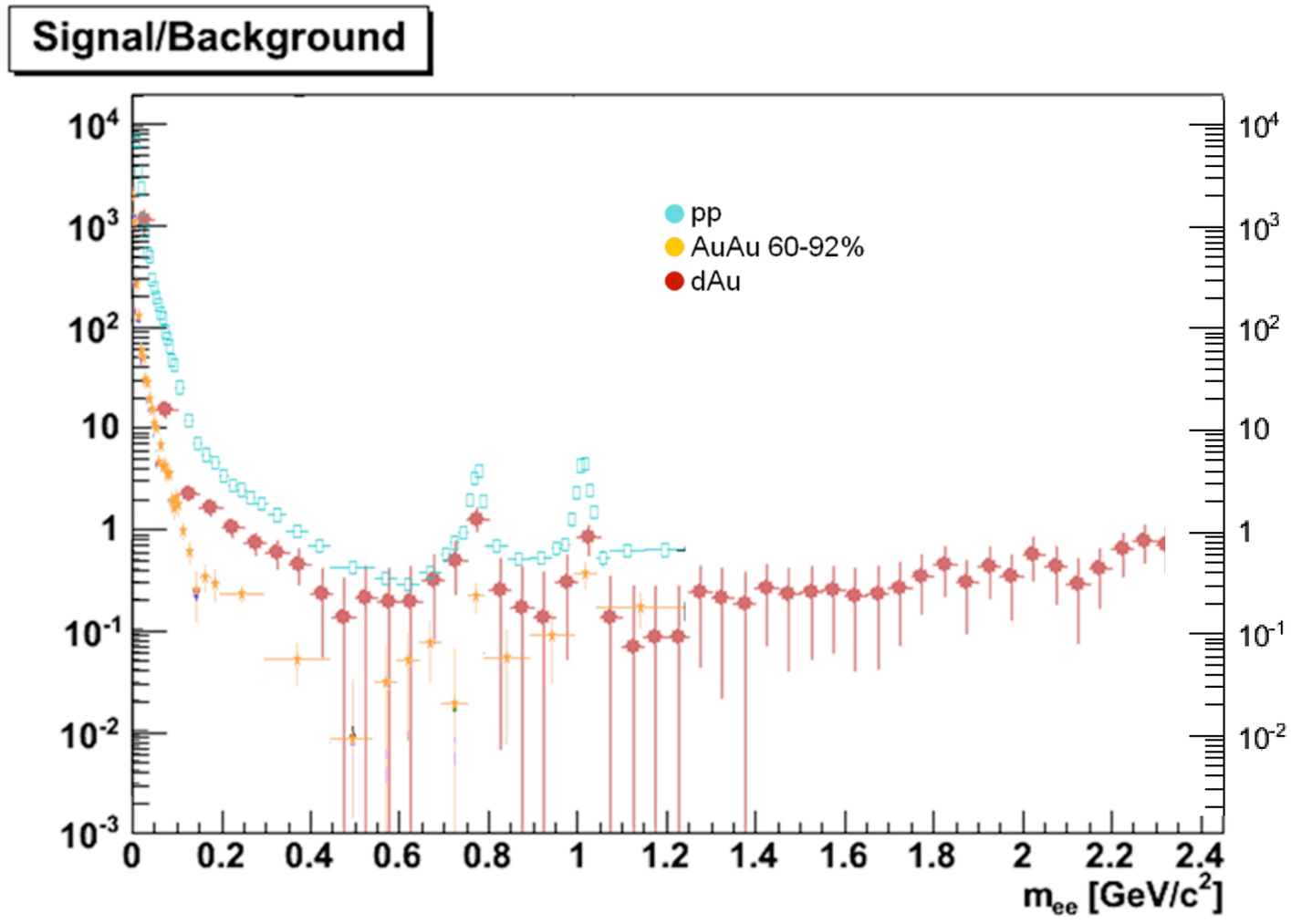


- clean measurement:
- isolated from other hadronic contributions
- note: pythia used for heavy flavor
  Drell-Yan neglected

Signal to Background

combinatorial

- charm: d+Au S/B ~ 1.0
  - higher for p+p
  - higher for beauty



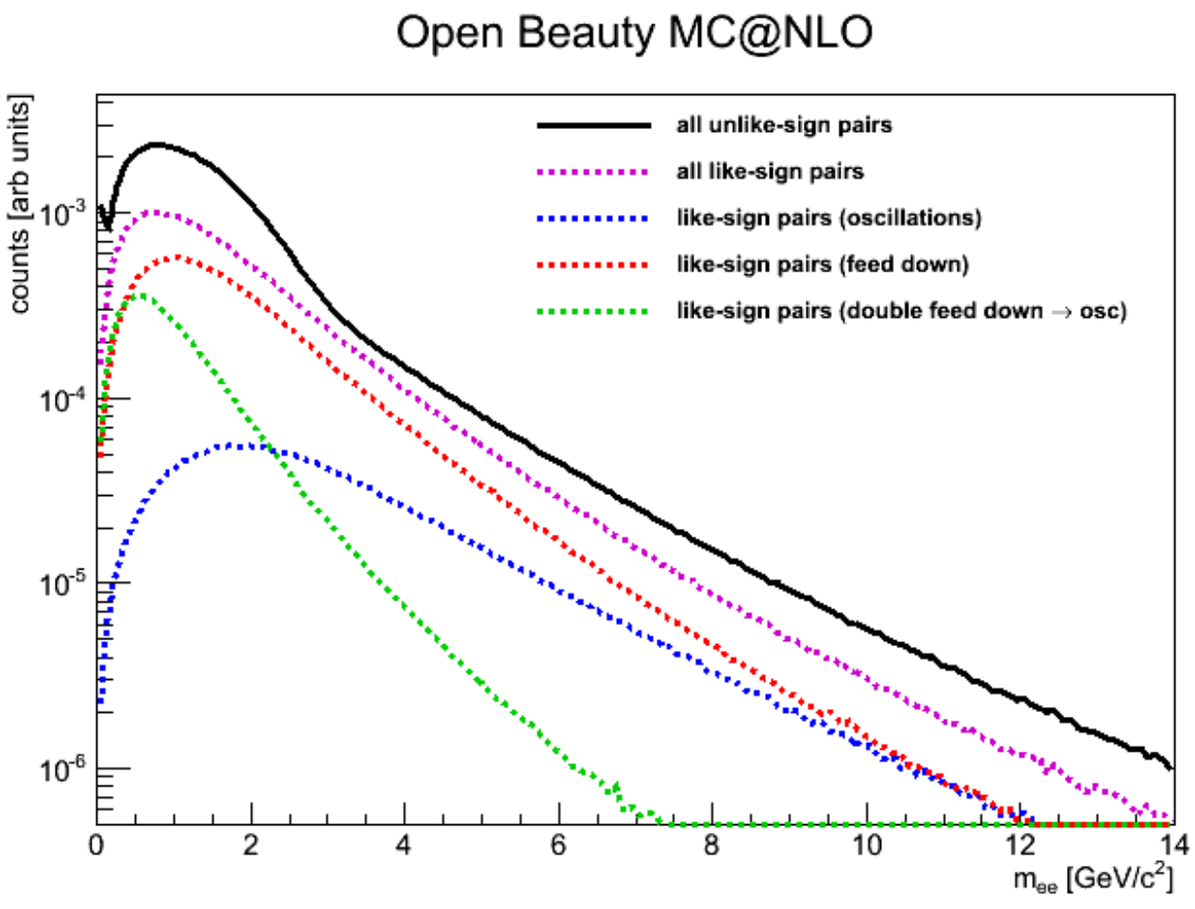
- kinematic range where pQCD begins to be reliable

Likesign Correlations

not just combinatorial

Where can likesign correlated pairs come from?

- Oscillations
  - $B^0\overline{B}^0$ mixing
  - ~60% of pairs are unlikesign
  - ~40% are *likesign*
- Feed-down
  - BR for B→e ~10%
  - BR for B→D ~10%



- Nearly half the bottom yield is likesign !

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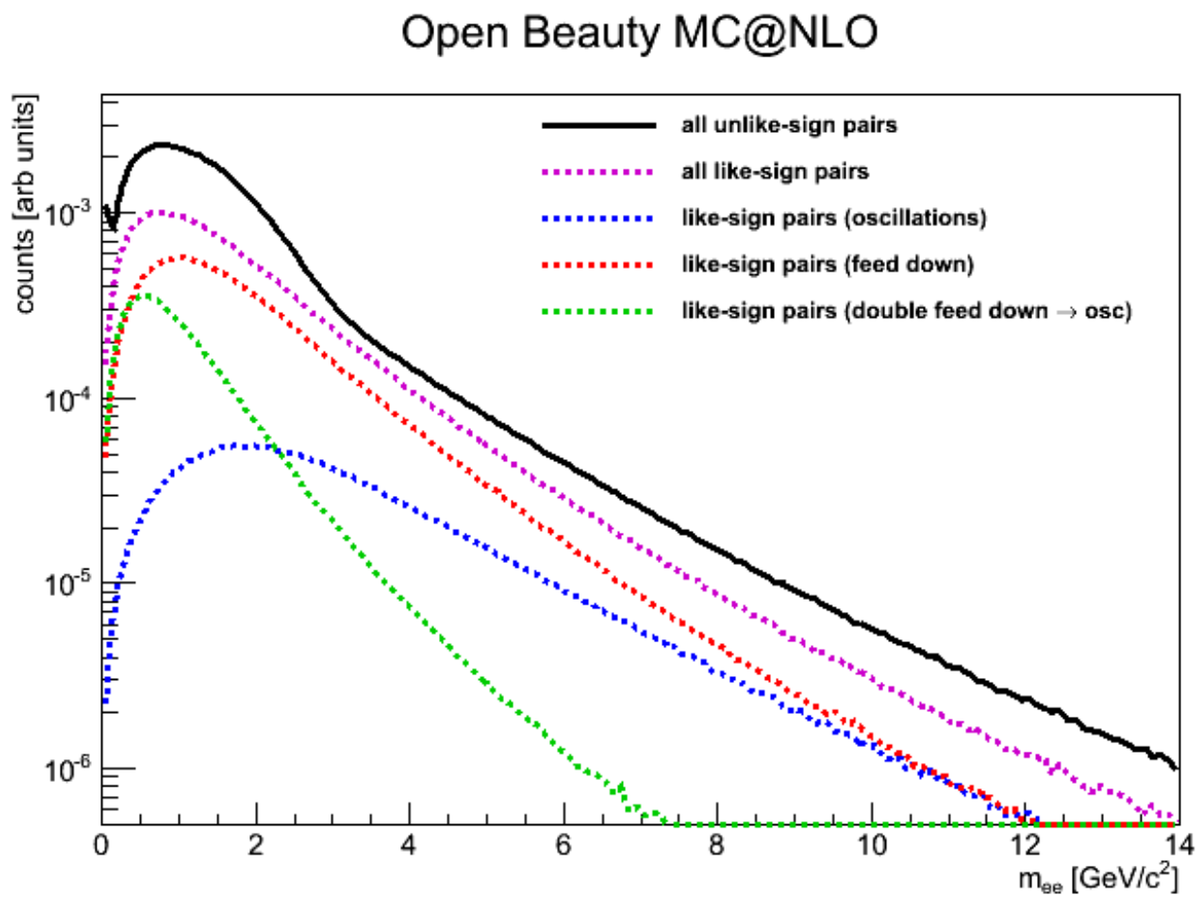
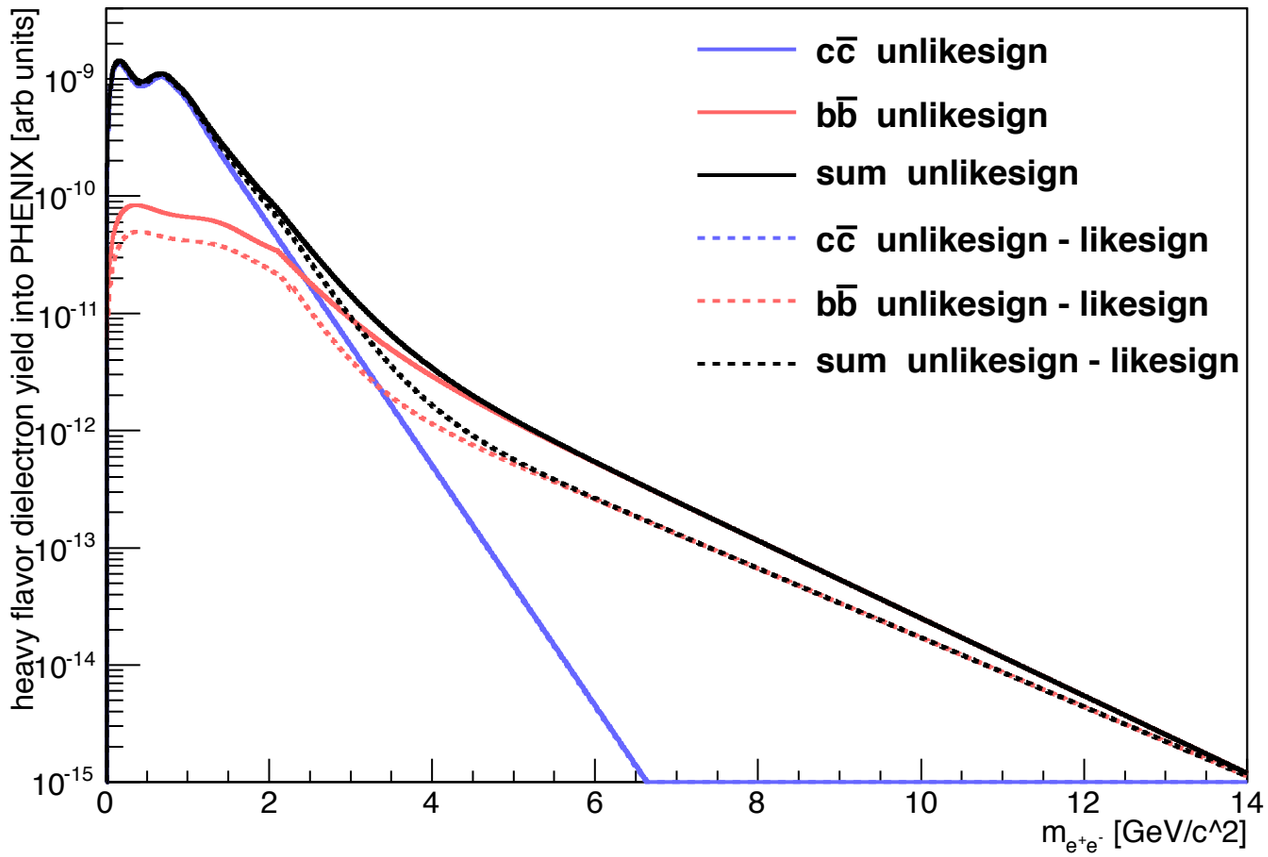


- Nearly half the bottom yield is likesign !
- less extreme for charm
  - within PHENIX acceptance, <1%

Likesign Correlations

likesign subtraction

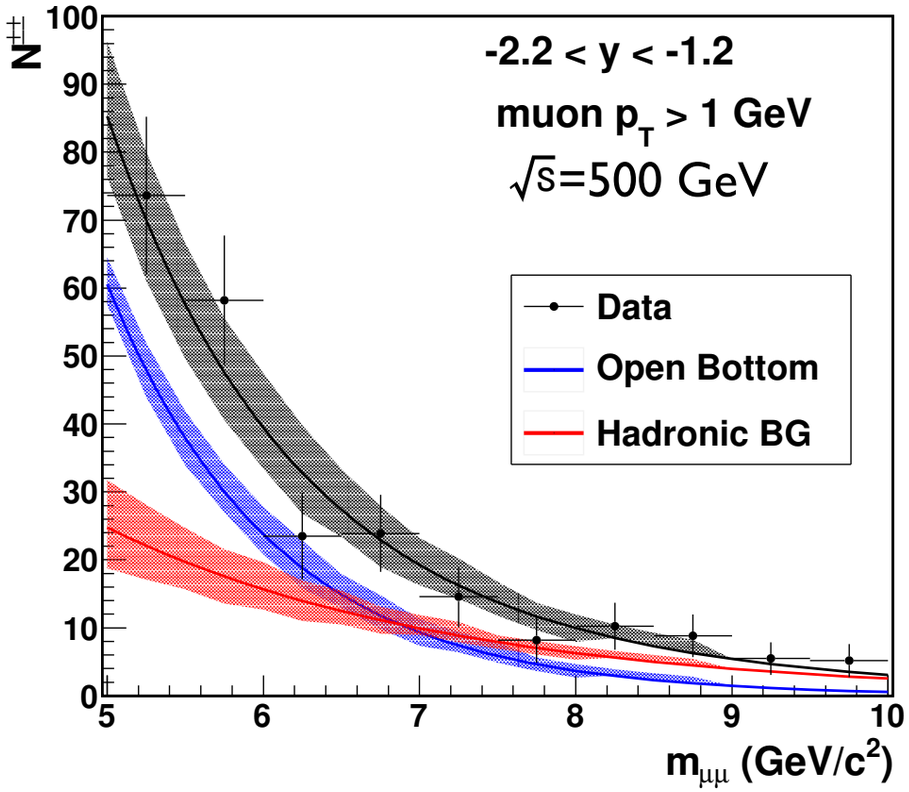


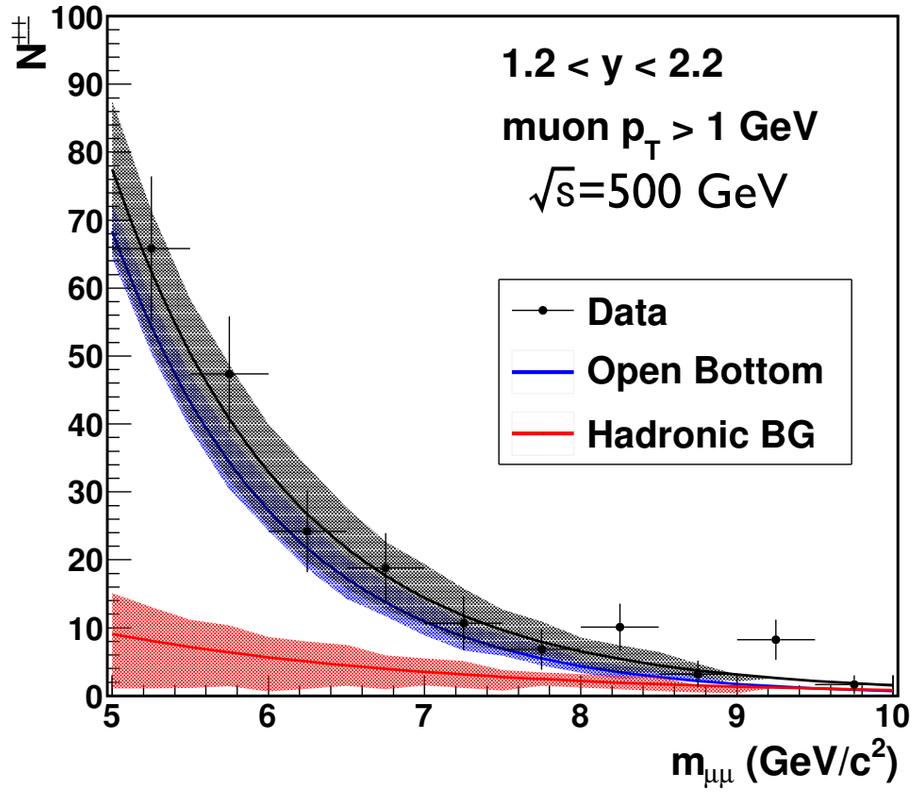
- makes an appreciable difference in mass spectrum.
- *if* one uses a likesign subtraction in data must account for it in simulation also.

- however, this can be a feature, not a bug…

Likesign Correlations

basis for measurement



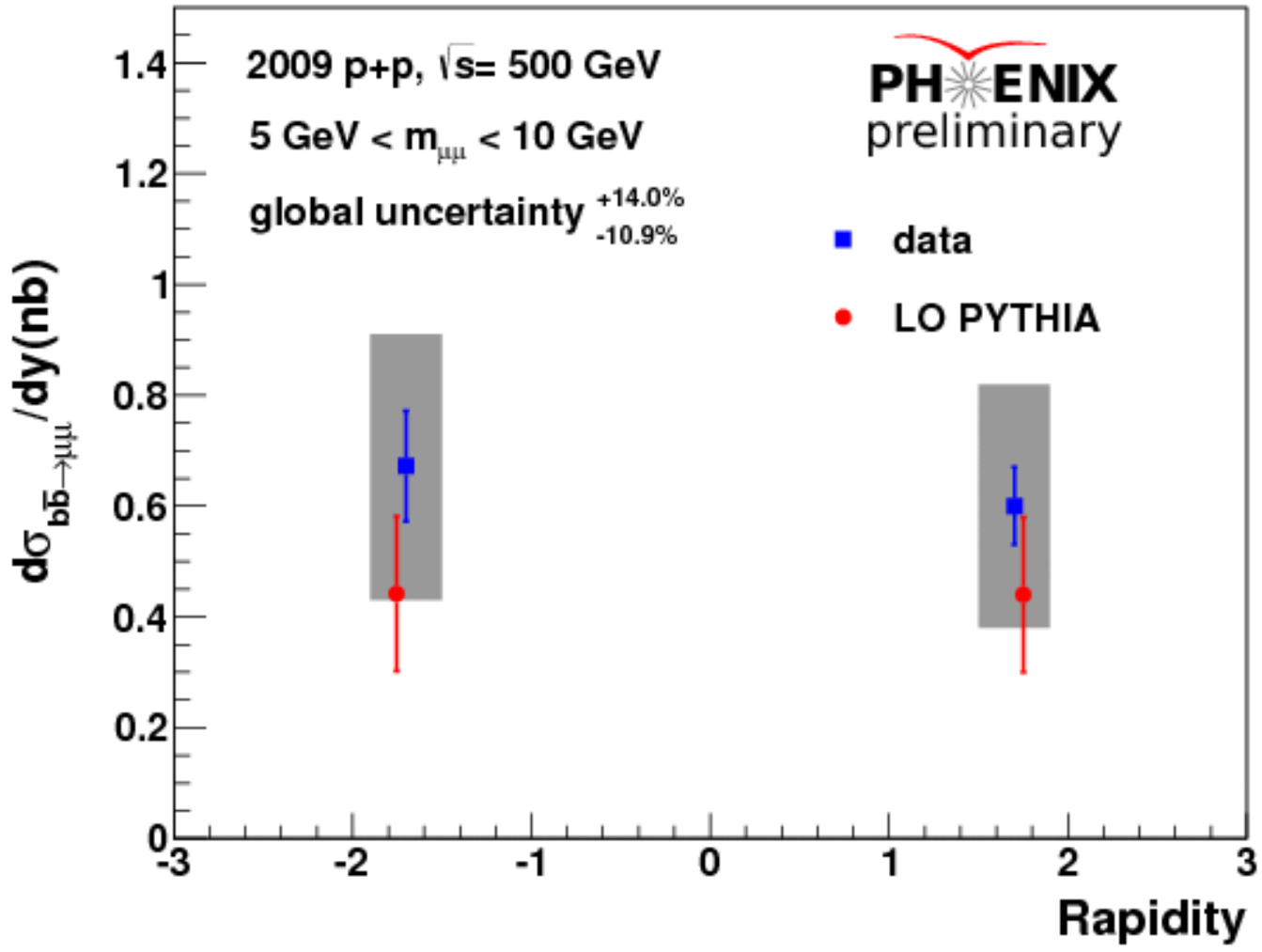


Likesign can be used to measure the cross section too!

- likesign dimuon mass spectrum (forward rapidity)
- low backgrounds
- must know oscillation mixing parameters and BR

Dimuon Results

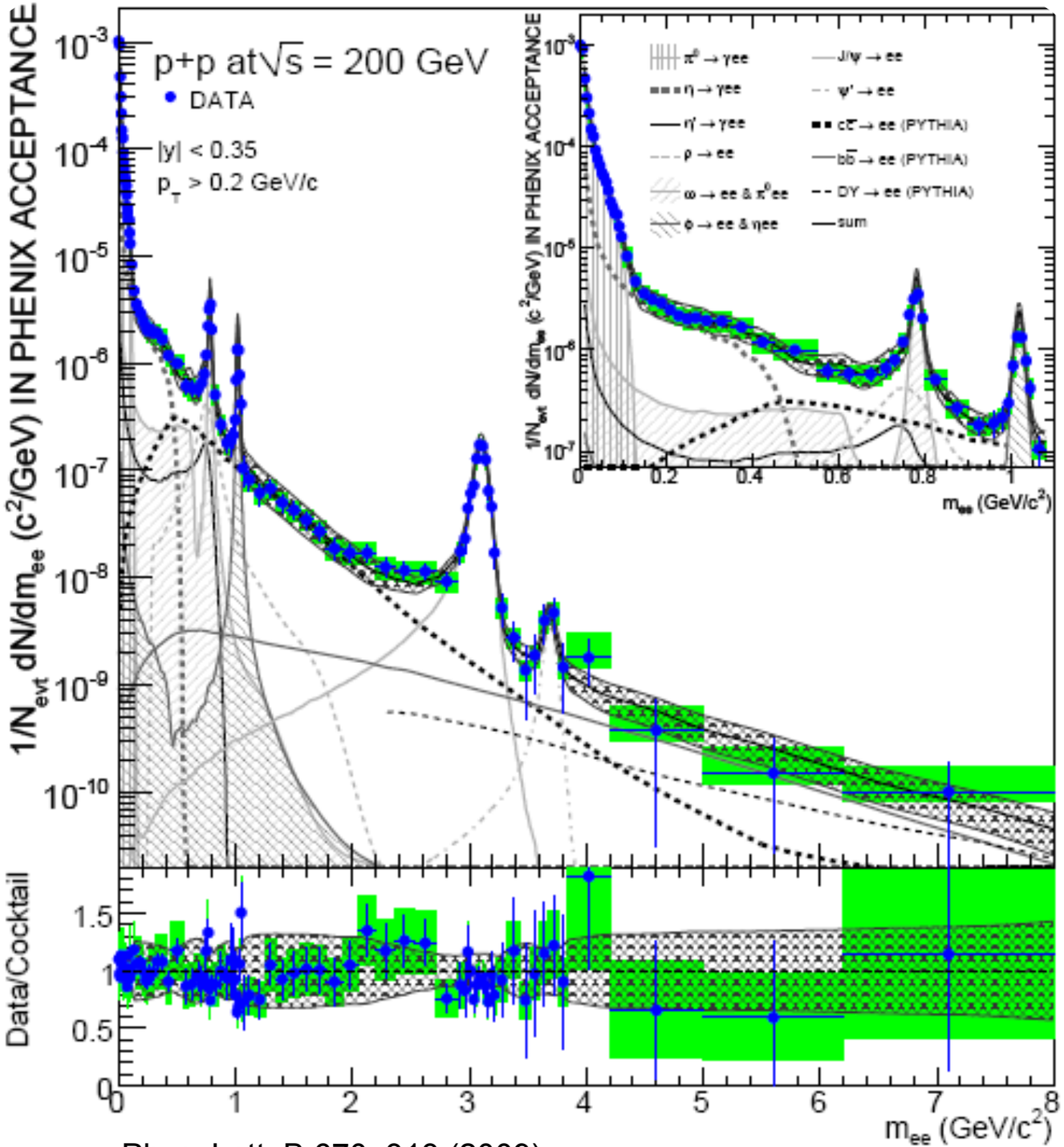
500 GeV



- Exploit likesign correlations in dimuon system
- Extrapolate using PYTHIA
  - $\sigma_{bb} = 25.2 \pm 3.2(\text{stat}) \, ^{+11.4}_{-9.5}(\text{syst})$ μb
- forward rapidity agrees with pQCD

p+p Dielectrons

fundamental baseline for heavy ion



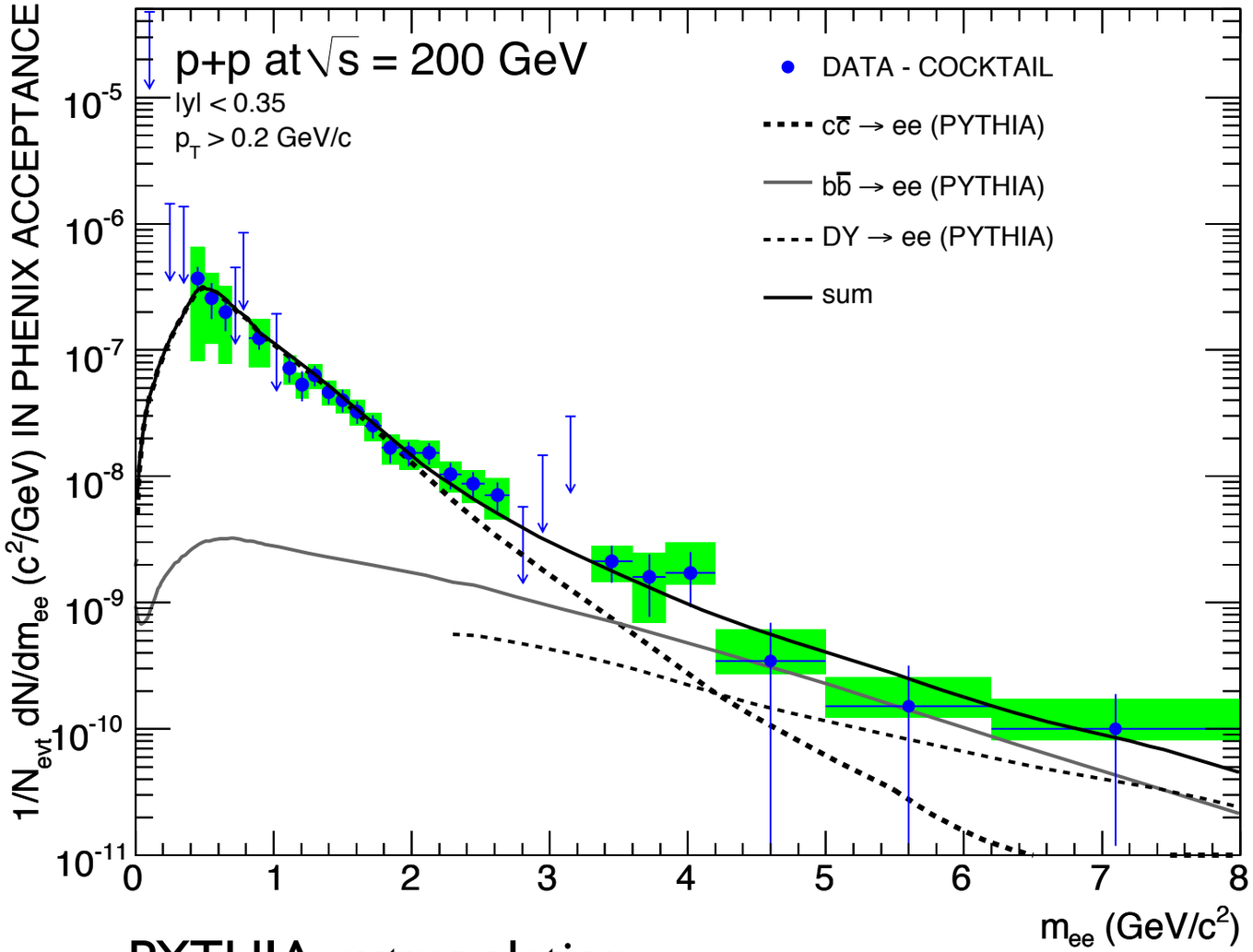
Phys. Lett. B 670, 313 (2009)

- Excellent agreement with hadronic decay cocktail.
- provides baseline for Au+Au
- subtract hadronic cocktail
- PYTHIA for open heavy flavor
  - extrapolated σ_{cc} and σ_{bb}
- large stat uncertainty for beauty

p+p Heavy Flavor

PYTHIA

hadronic components subtracted

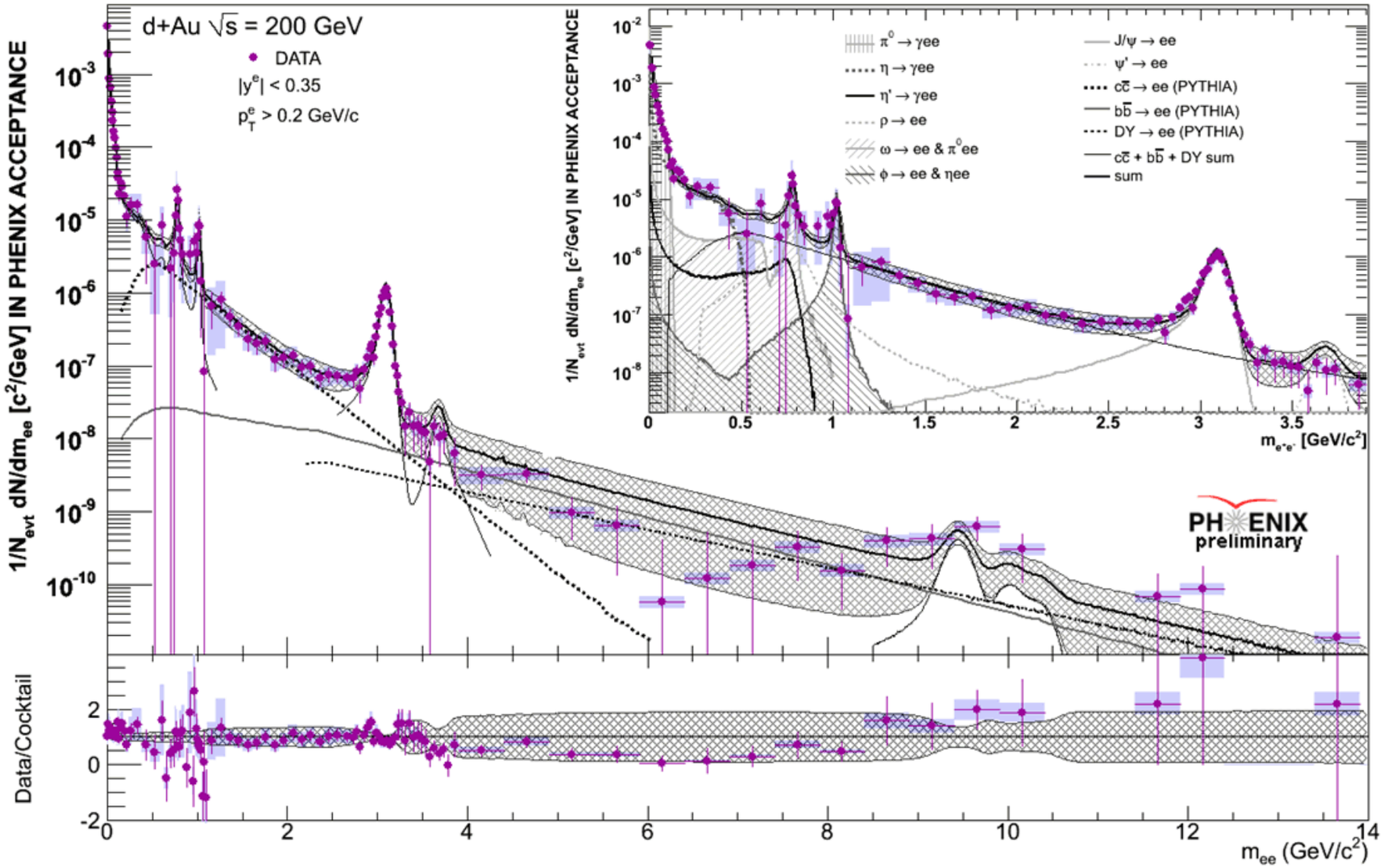


PYTHIA extrapolation

- $\sigma_{c\bar{c}}$ = 544 ± 39(stat) ± 142(syst) ± 200 (model) µb
  - agrees with single electron x-sec:
    $\sigma_{c\bar{c}}$ = 567 ± 57(stat) ± 193 (syst) µb
- $\sigma_{b\bar{b}}$ = 3.9 ± 2.4(stat) $^{+3}_{-2}$ (syst) µb

d+Au Heavy Flavor

PYTHIA

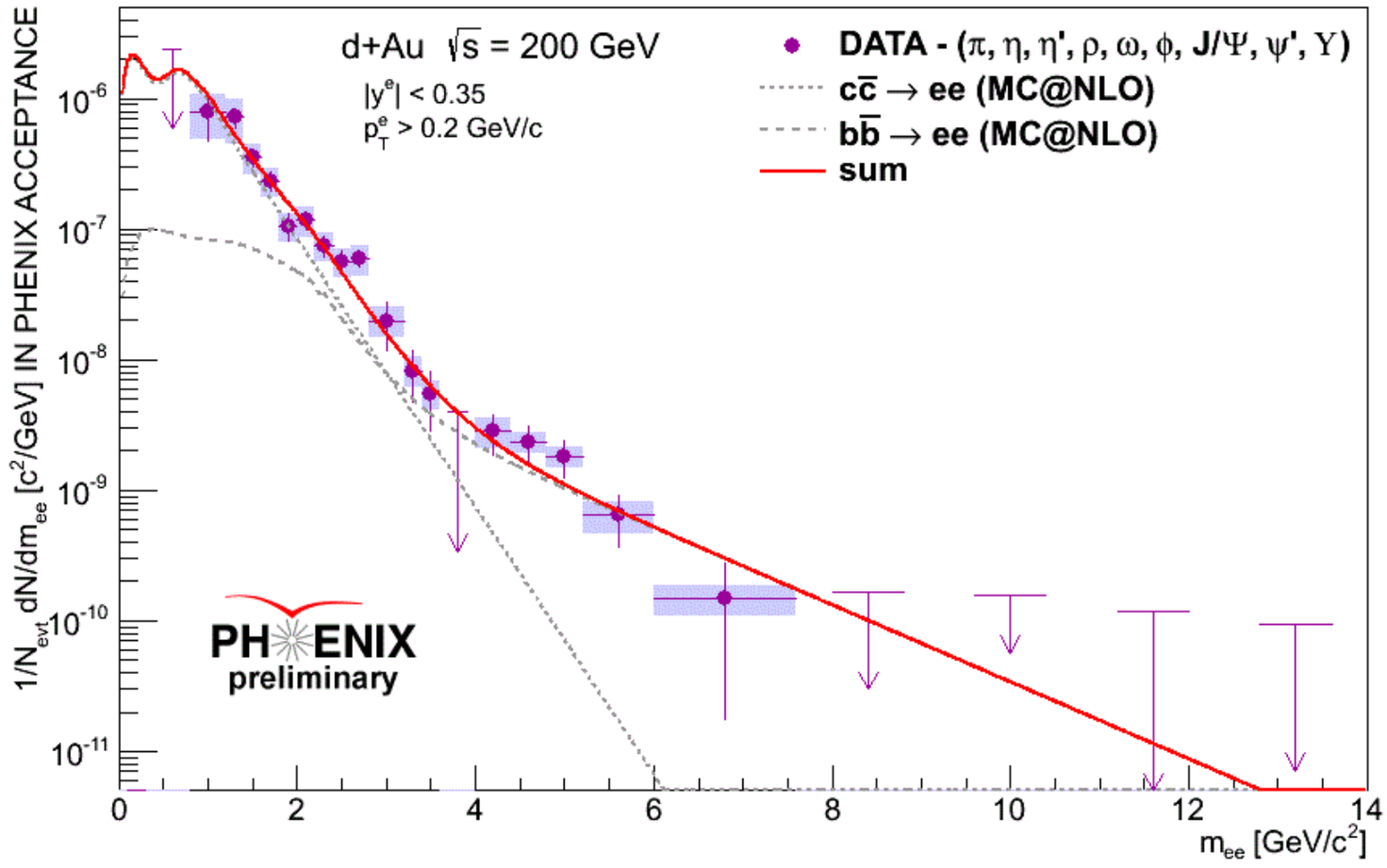


- Good agreement with hadronic decay cocktail.
- open heavy flavor – N_{Coll} scaled PYTHIA for
- σ_{cc} and σ_{bb} consistent with p+p
  - likesign HQ correlations *not* taken into account!

d+Au Heavy Flavor

MC@NLO

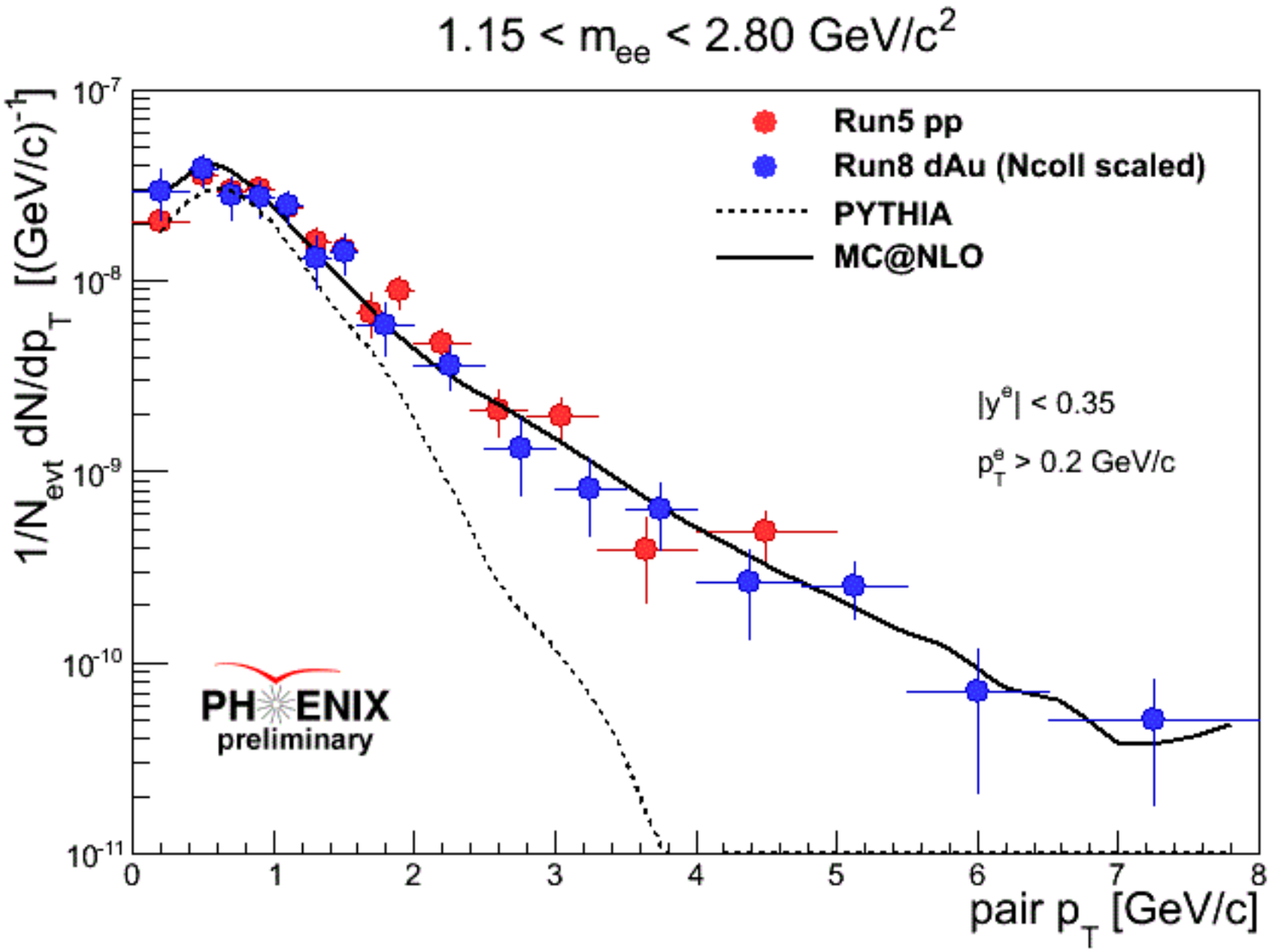
hadronic components subtracted



- likesign HQ correlations subtracted in simulation
- MC@NLO normalization fit to data 2D differentially (m vs pT)
- extrapolated heavy flavor cross sections:
  - σ_{cc} = 711 ± 62(stat) ± 183(syst) ± 80(model) µb
  - σ_{bb} = 4.46 ± 0.70(stat) ± 1.08(syst) ± 0.22(model) µb

LO vs NLO

which is right??



- integrate yield in IMR -> pT dependence
- PYTHIA fails to describe high pT data!
- MC@NLO is in good agreement.

MC@NLO

p_T dependence

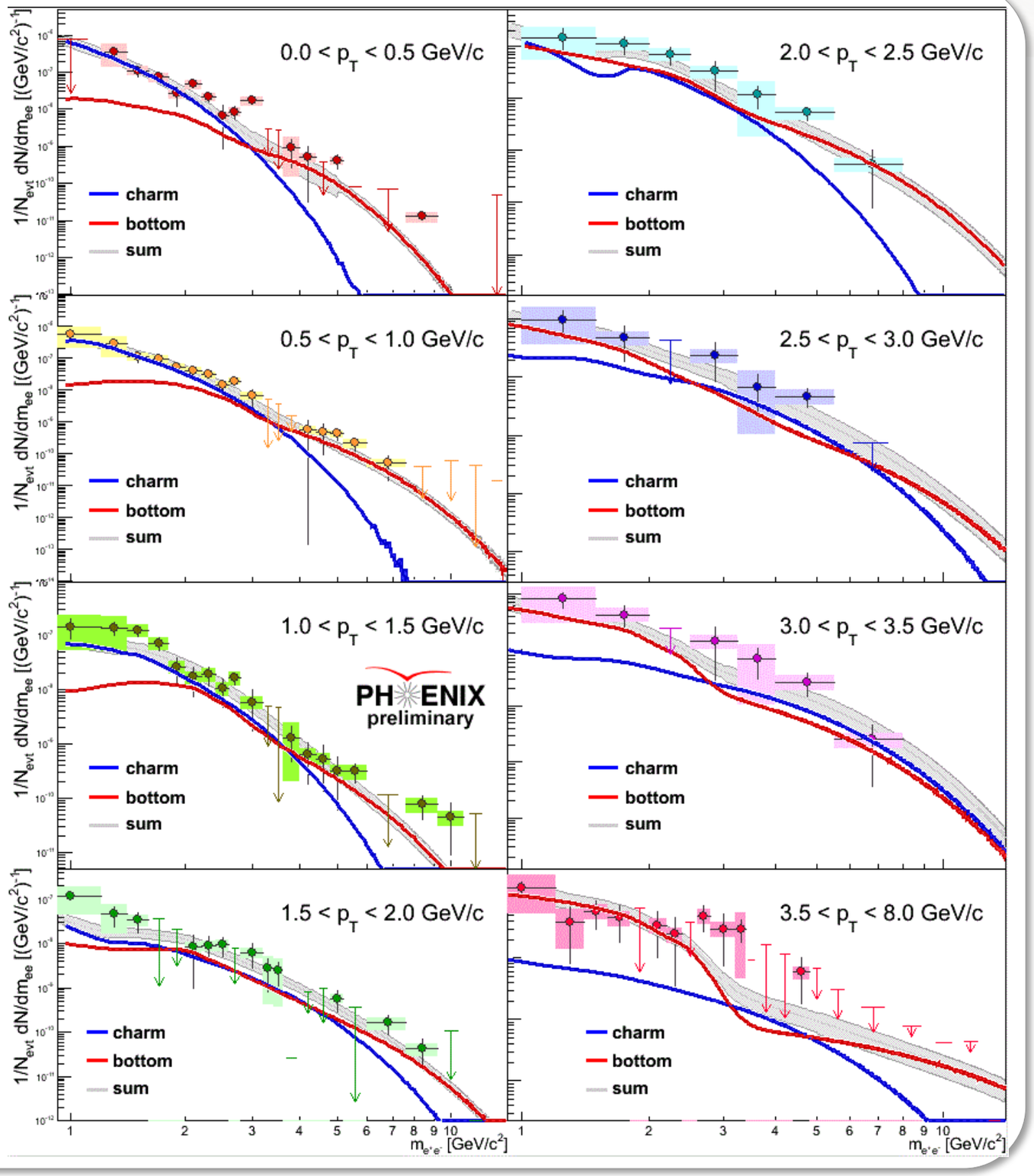
- MC@NLO predicts a complex interplay between charm and beauty

- low pT:
  - IMR – charm
  - HMR – beauty

- intermediate pT:
  - charm and beauty similar

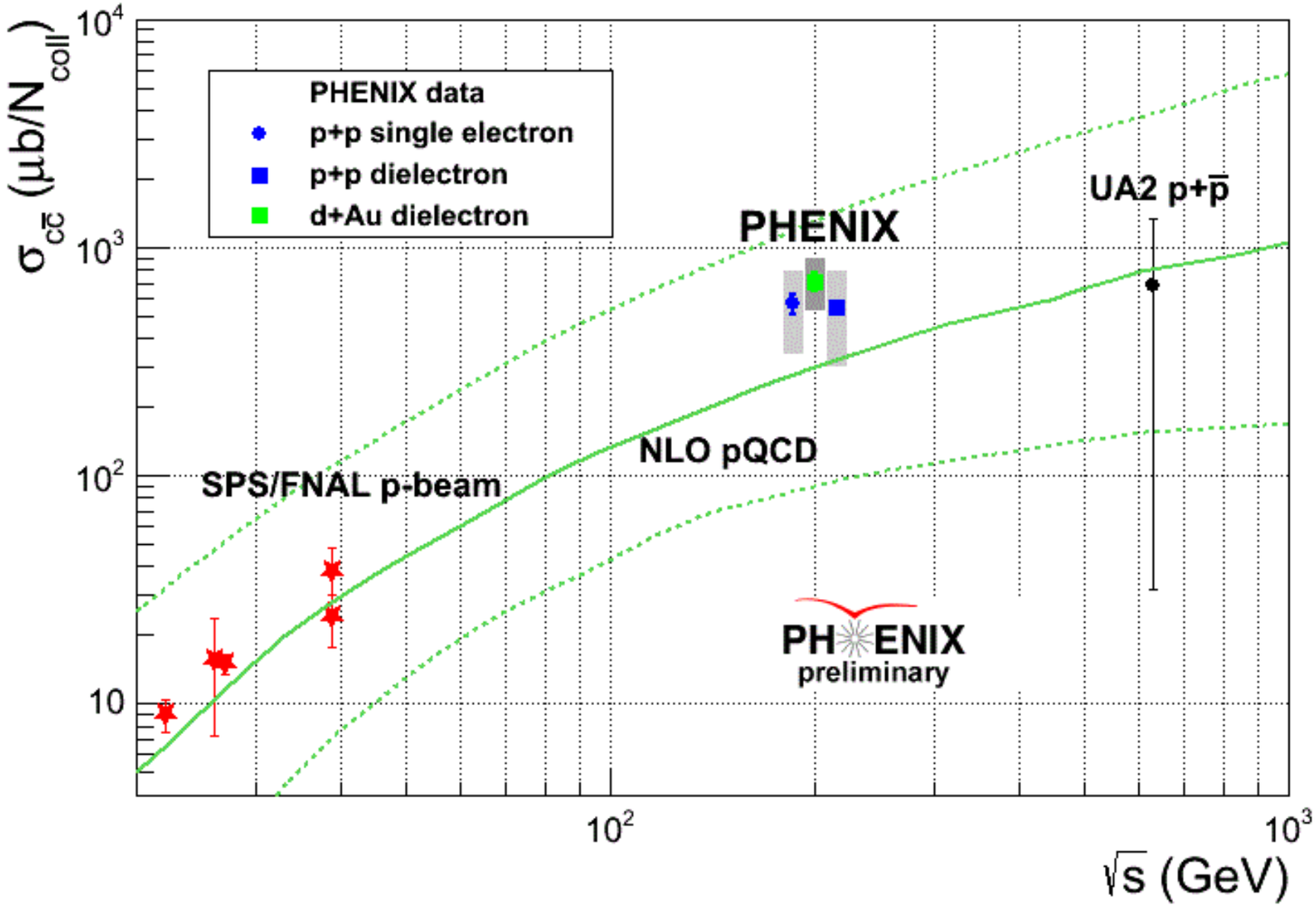
- high pT:
  - IMR – beauty
  - HMR – charm

- MC@NLO predicts the data!
- powerful confirmation of NLO calculation.



Global Perspective

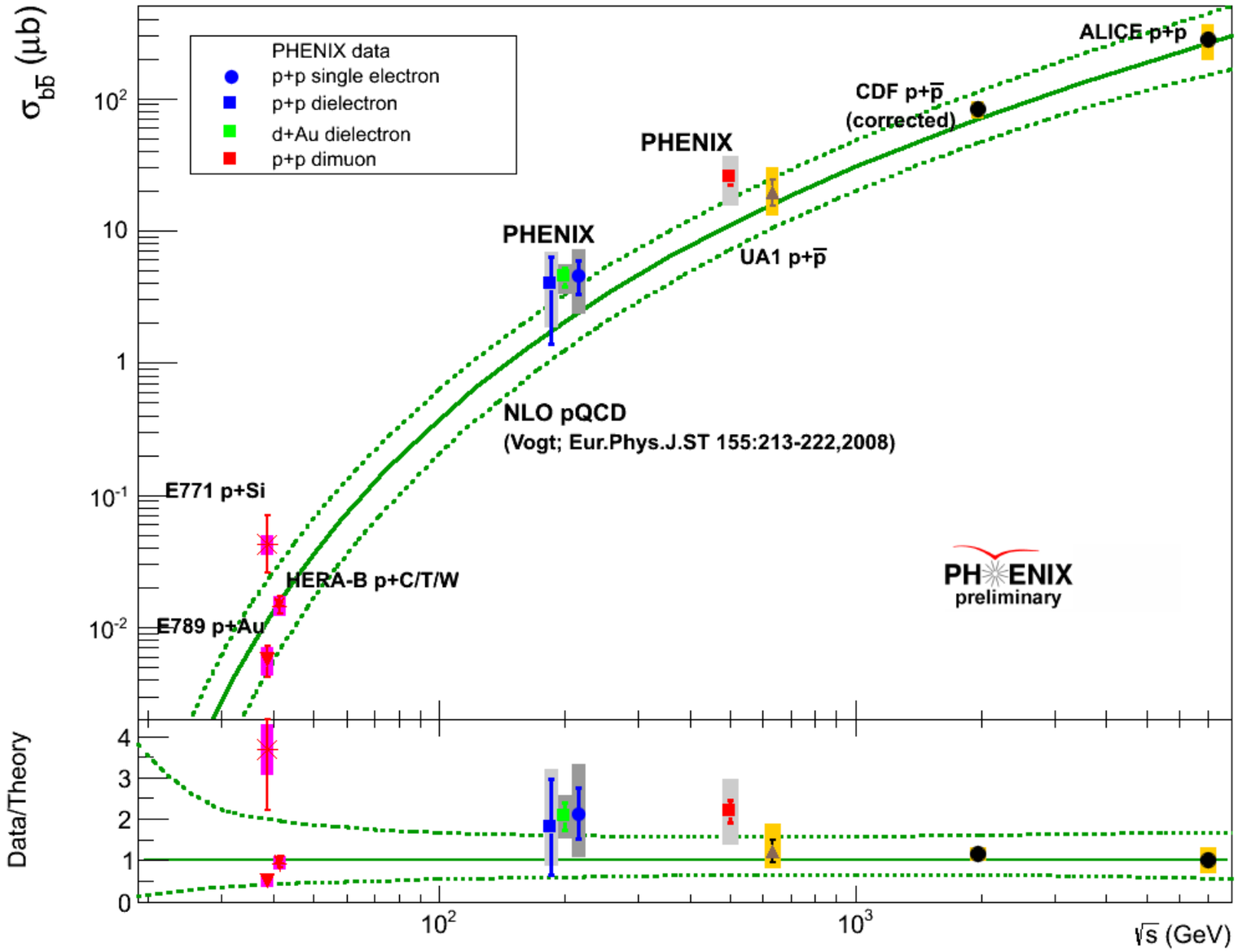
charm cross-section



- PHENIX has 3 electron measurements of extrapolated cross-section
  - all in agreement with each other
  - all fall within pQCD NLO

Global Perspective

beauty cross-section



- PHENIX has 4 lepton measurements of extrapolated cross-section
  - all in agreement with each other
  - all fall within pQCD NLO

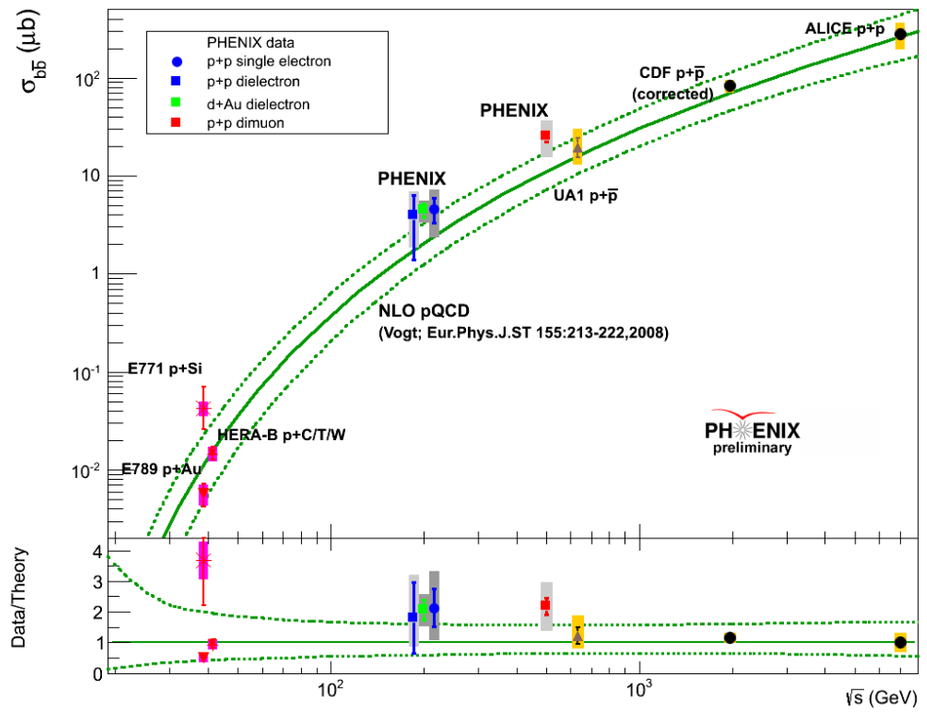
Summary

- dileptons provide a low-background measurement of open heavy flavor
  - free of hadronic contamination
- probes single electron regime where pQCD is more reliable

- dilepton likesign correlations are cumbersome (useful)
  - must be taken into account!
  - can provide a physics signal.

- MC@NLO calculations describe the p_T dependence of heavy flavor.
  - improvement over LO PYTHIA.

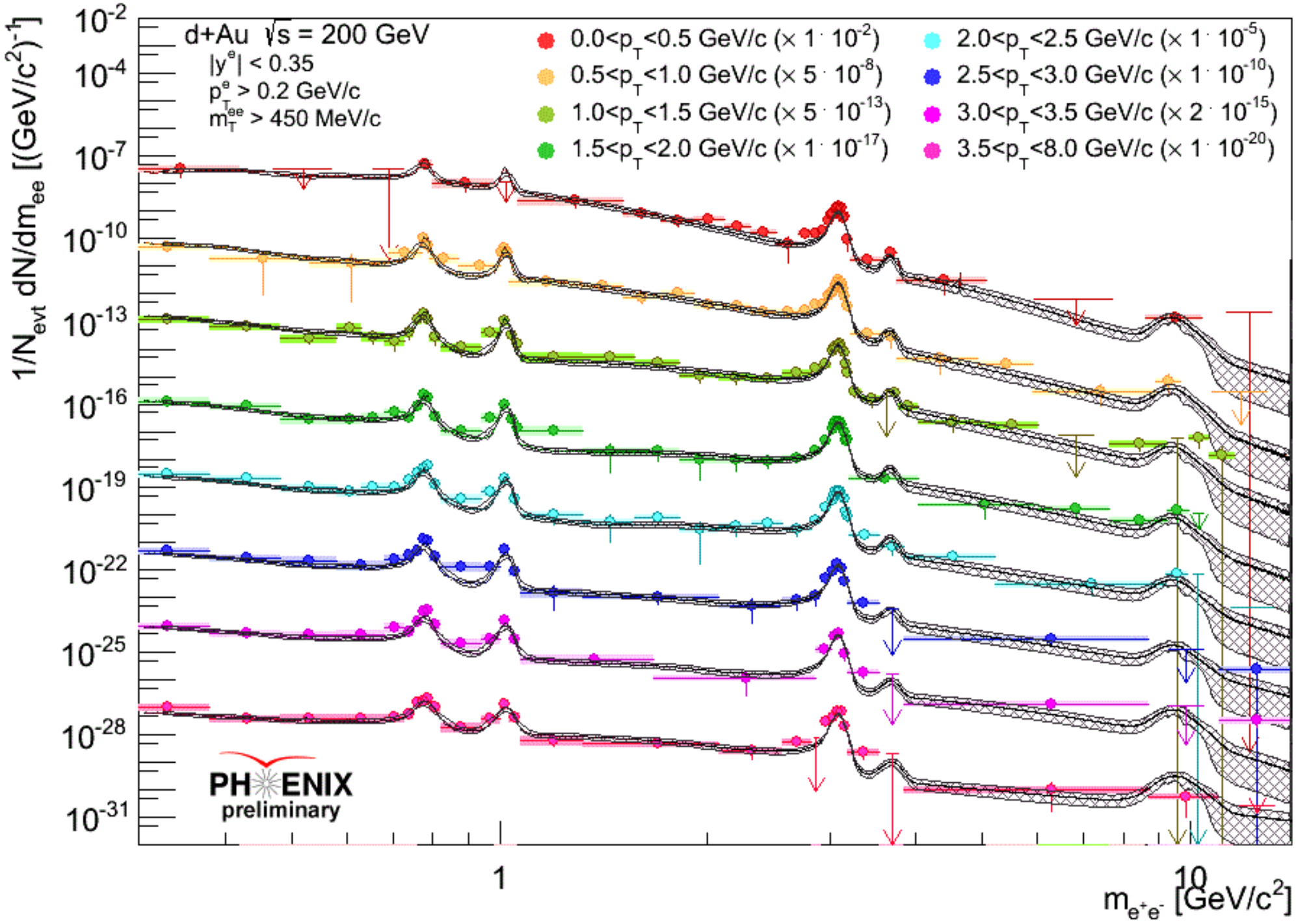
- PHENIX dilepton heavy flavor cross sections in good agreement with pQCD predictions



Backups

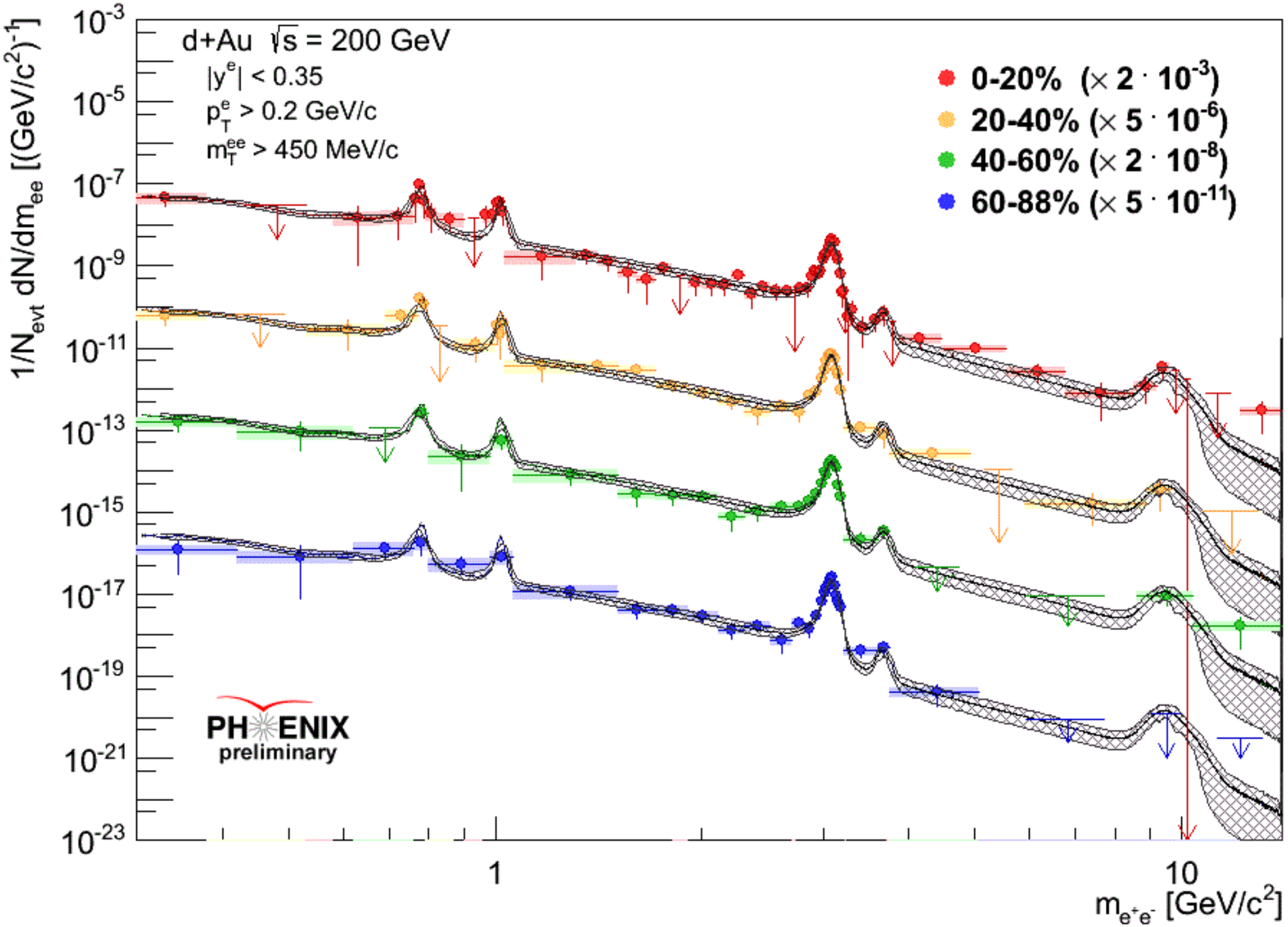
d+Au dielectrons

pT dependence



d+Au dielectrons

centrality dependence



RdA open charm

MinBias