Heavy flavor production at RHIC

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  - Related differential cross sections
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  - Direct reconstruction
  - Non-photonic e & prompt μ
- Results at higher energy
- A question?

Introduction : heavy quarks as a probe

p+p :

pQCD test

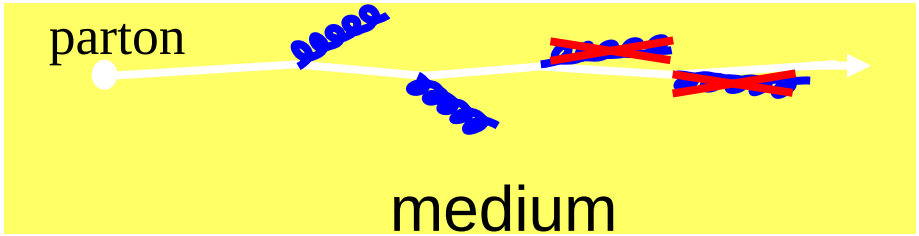
baseline for A+A

A+A :

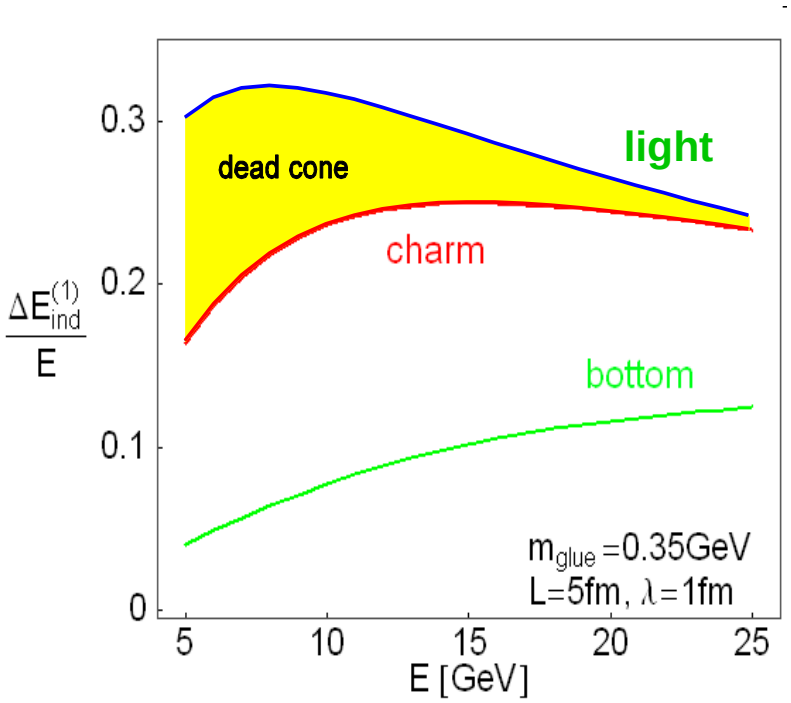
flow → thermalization

high p_T suppression

→ energy loss



ENERGY LOSS



Introduction :
(open) heavy flavor measurement

Direct: reconstruction of all decay products

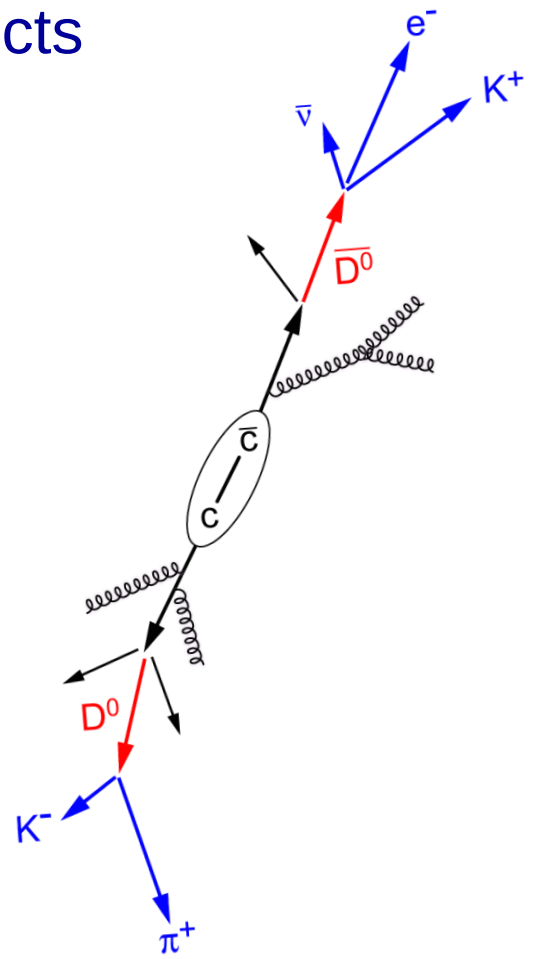
$$D^0 \to K^-\pi^+, \overline{D}^0 \to K^+\pi^-,$$
$$B.R. = 3.80 \pm 0.07\%$$

Indirect: charm and beauty via electrons

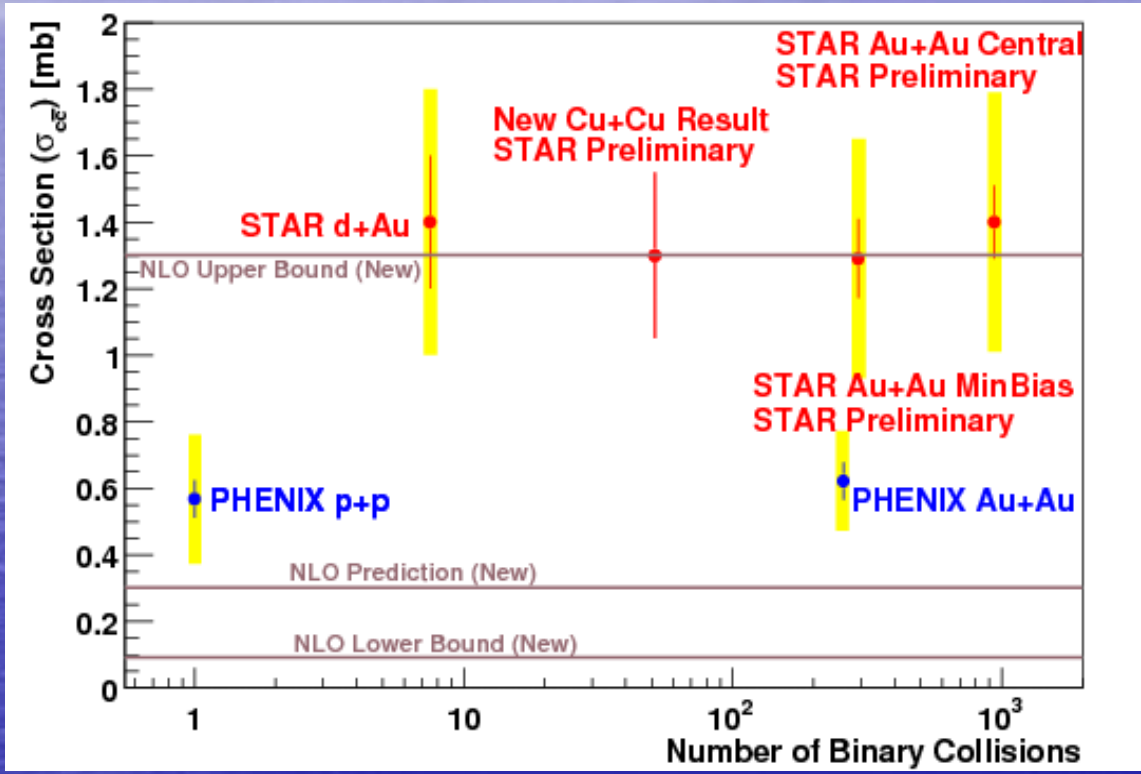
$c \to e^+ +$ anything (B.R.: 9.6%)
$b \to e^+ +$ anything (B.R.: 10.9%)
issue of photonic background

charm (and beauty) via muons

$c \to \mu^+ +$ anything (B.R.: 9.5%)



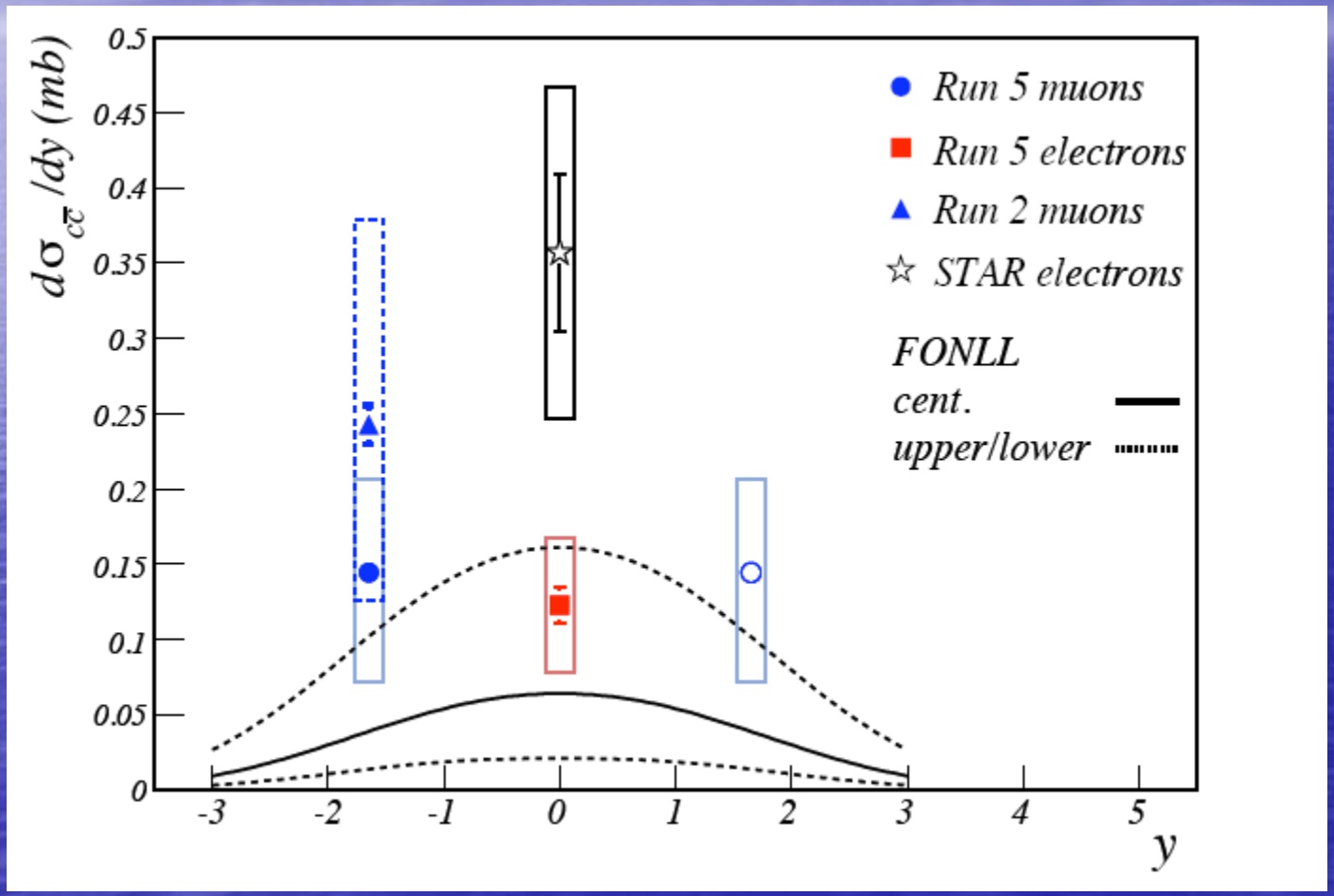
Total cross sections,PHENIX vs STAR



Binary scaling

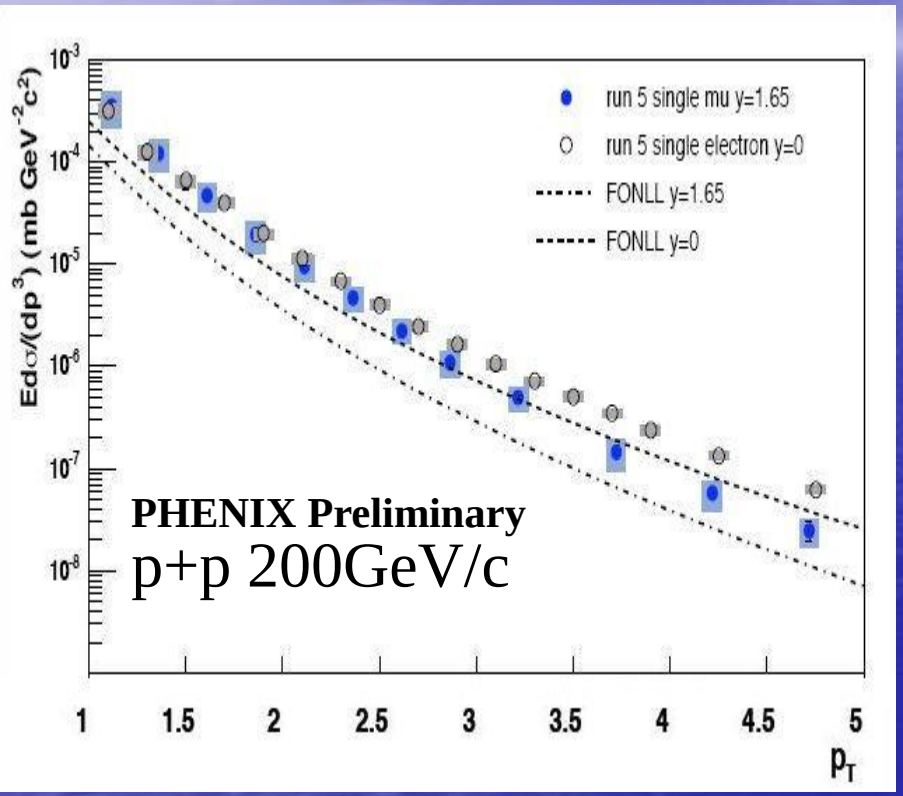
STAR results ~ 2 times larger than PHENIX

Forward prompt μ^- production (PHENIX)

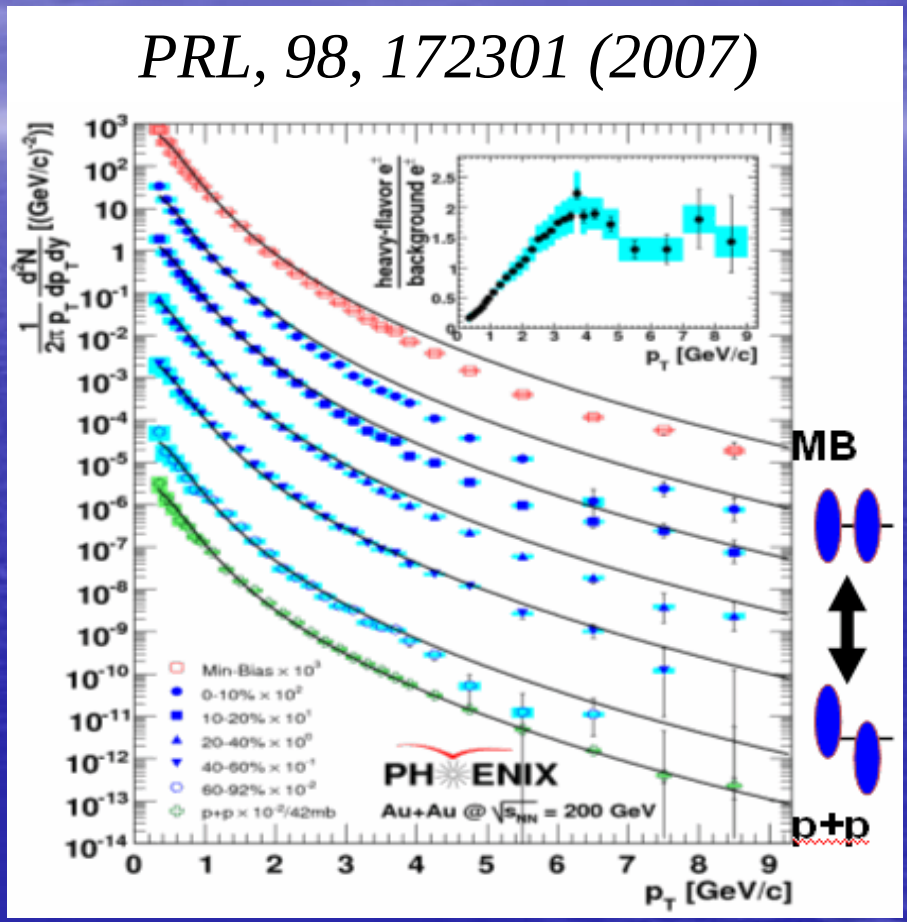


PPG057 : PRD76, 092992(2007)

Leptons from Heavy flavor, PHENIX



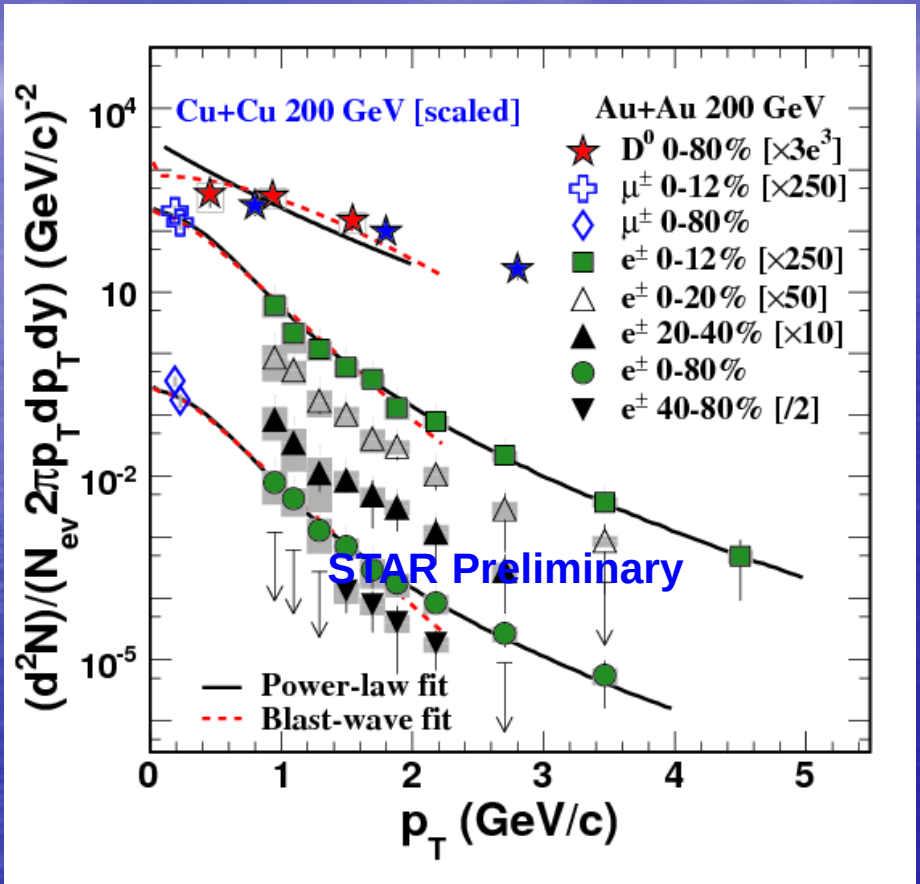
PRL, 98, 172301 (2007)



Systematically higher than FONLL calculation

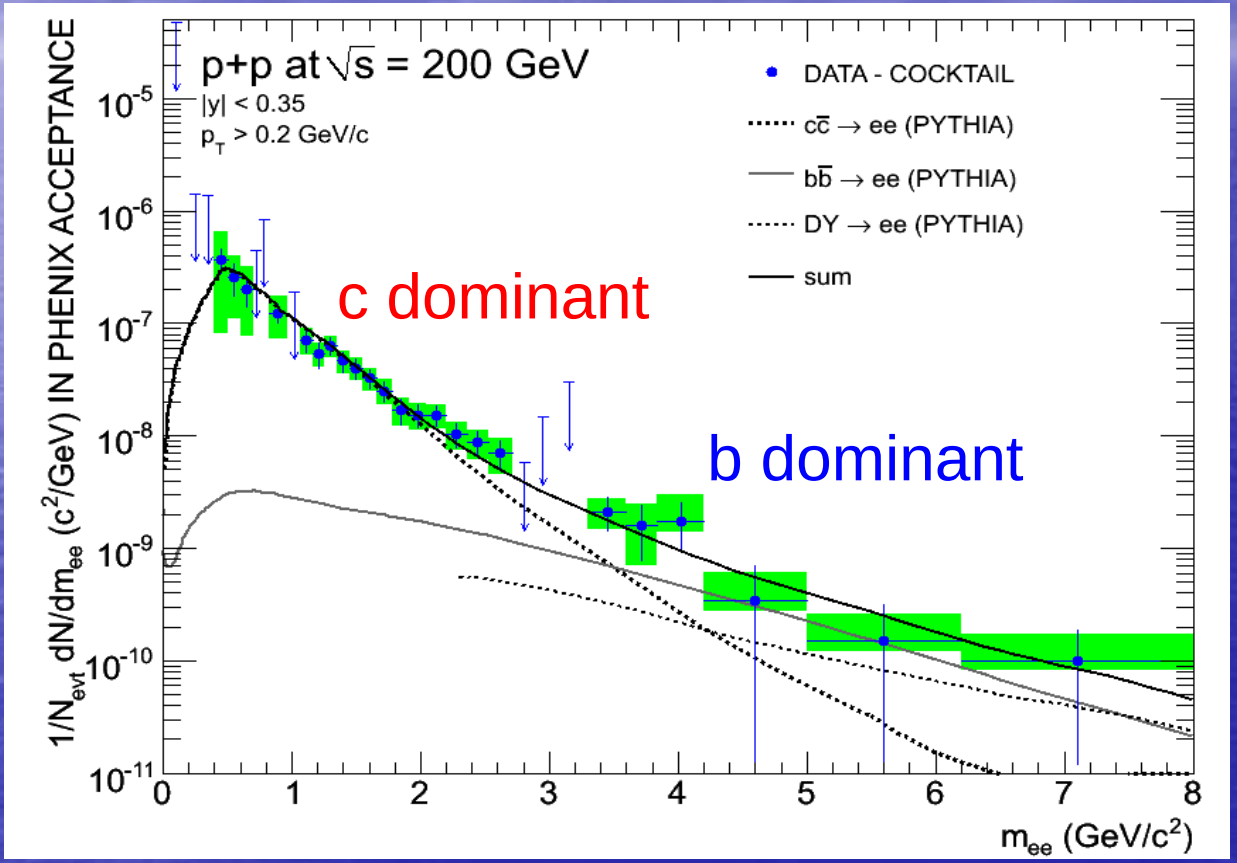
e yield shows binary scaling, high p_T suppression in central Au+Au

Leptons from heavy flavor, STAR



- Combined fit of μ, D^0, low p_T e
- Low p_T muon constrains charm cross-section

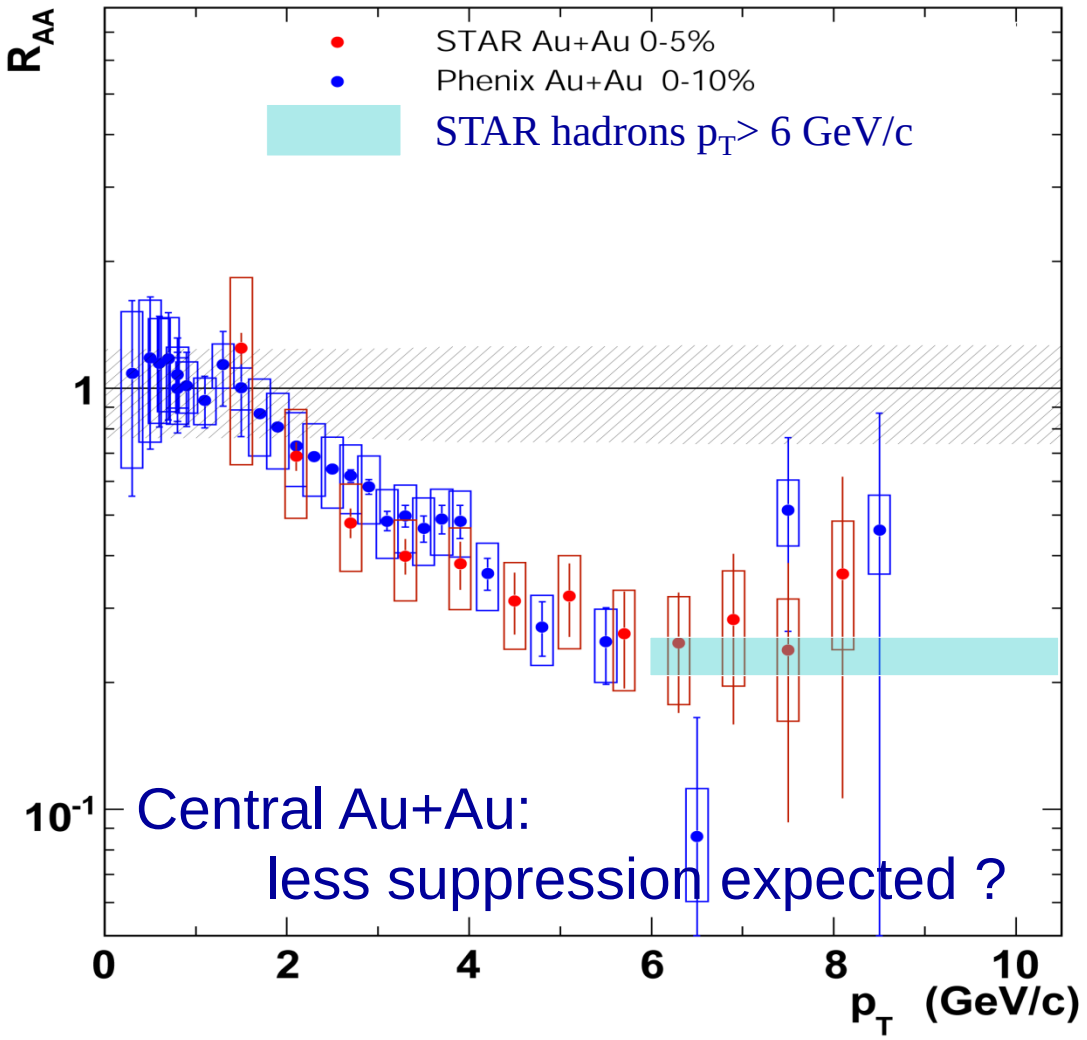
Heavy quarks in p+p from e^+e^- at PHENIX



$$\sigma_{c\bar{c}} = 518 \pm 47(stat) \pm 135(sys) \pm 190(model)\ \mu\text{b}$$

$$\sigma_{b\bar{b}} = 3.9 \pm 2.5(stat)^{+3}_{-2}(sys)\mu\text{b}$$

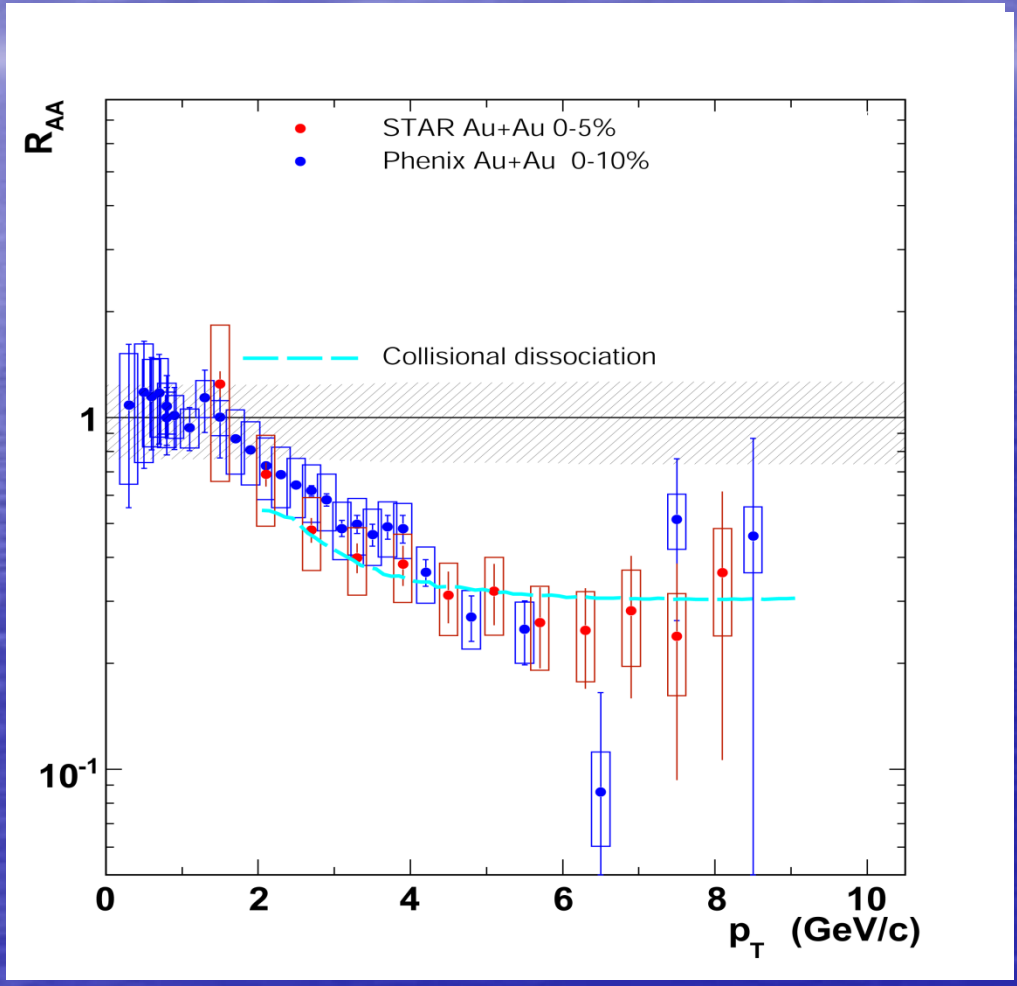
R_{AA}



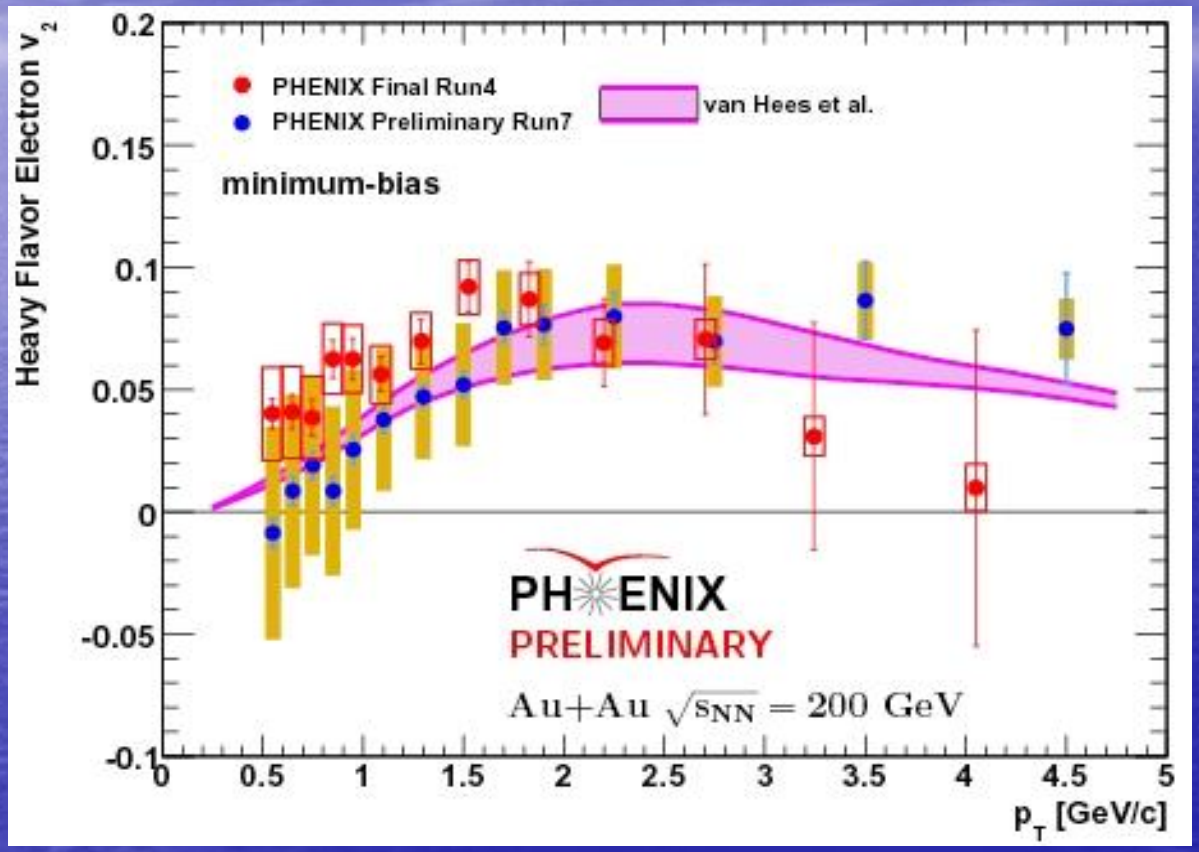
Nuclear modification factor

$$R_{AA}(p_t) = \frac{1}{N_{coll}} \frac{\frac{dN_{AA}}{dp_t}}{\frac{dN_{pp}}{dp_t}}$$

Energy Loss?


R_{AA}
STAR Au+Au 0-5%
Phenix Au+Au 0-10%
Collisional dissociation
1
10^{-1}
0
2
4
6
8
10
p_T (GeV/c)

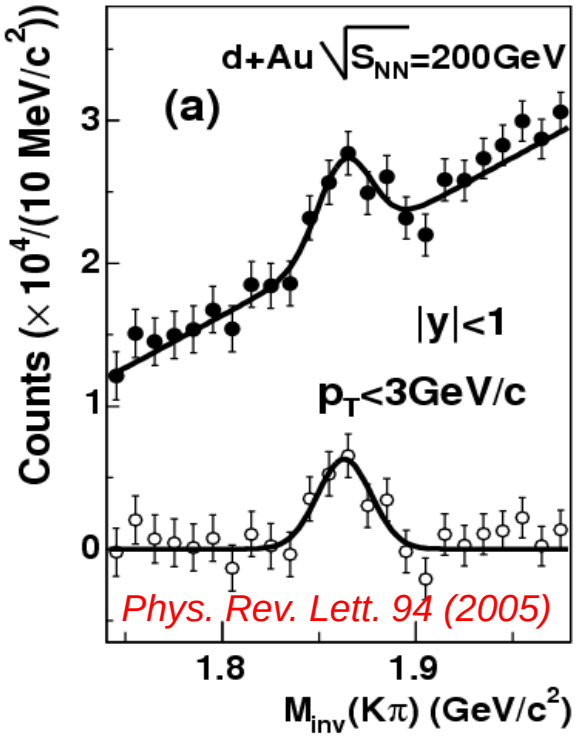
Elliptic flow v_2 – NPE from HF decays

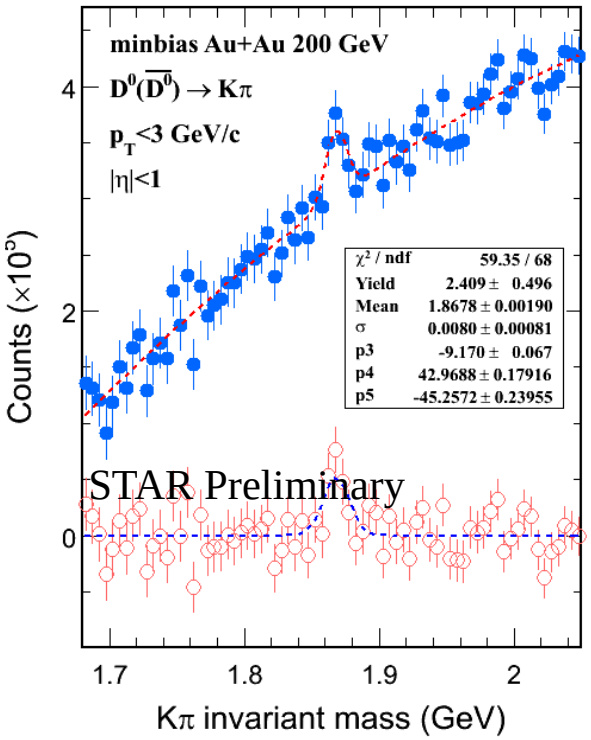


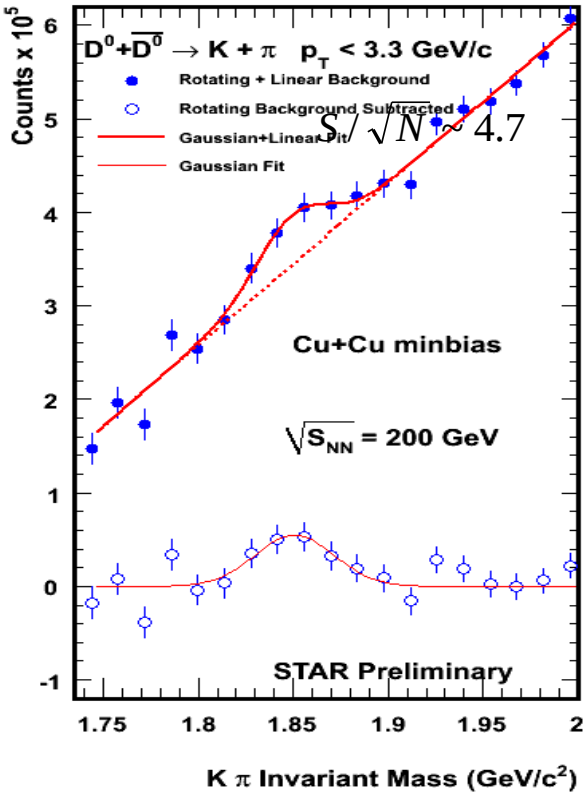
PHENIX RUN4 : *PRL, 98, 172301 (2007)*

How do we obtain the result?

Direct D-meson reconstruction (STAR)

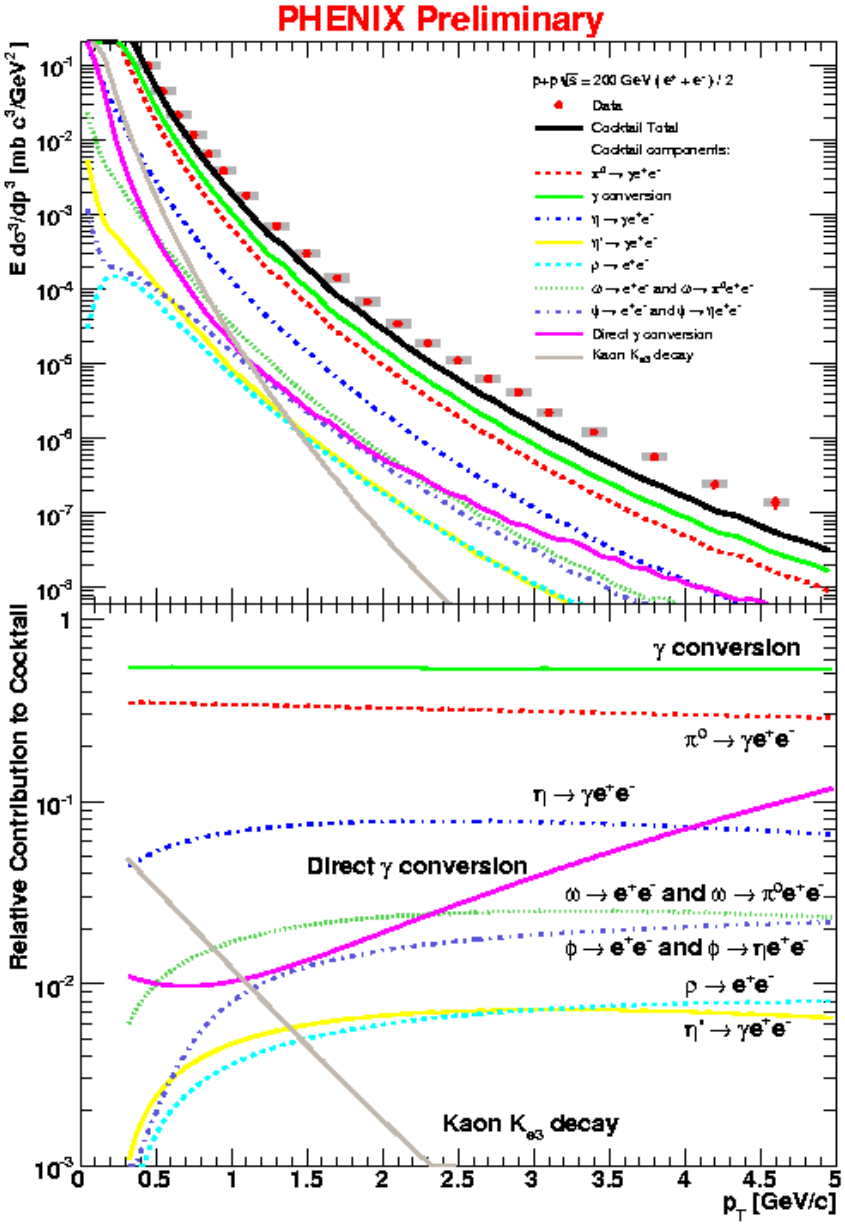






No displaced vertex used

Non-photonic electrons



Inclusive electrons
= photonic + non-photonic electron

Direct measurement

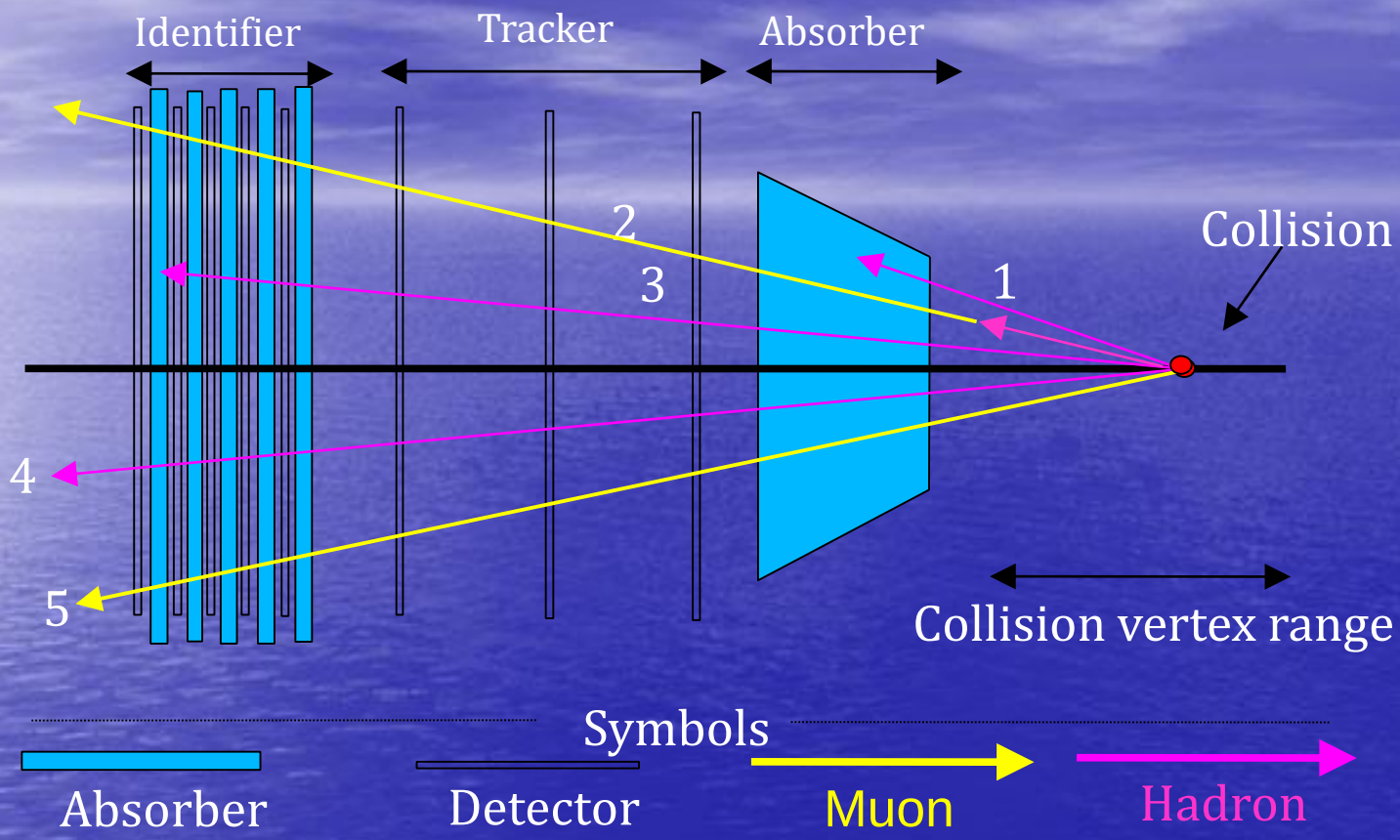
Mostly from heavy quarks

converter method

Estimation based on other (PHENIX) measurement :
Cocktail method

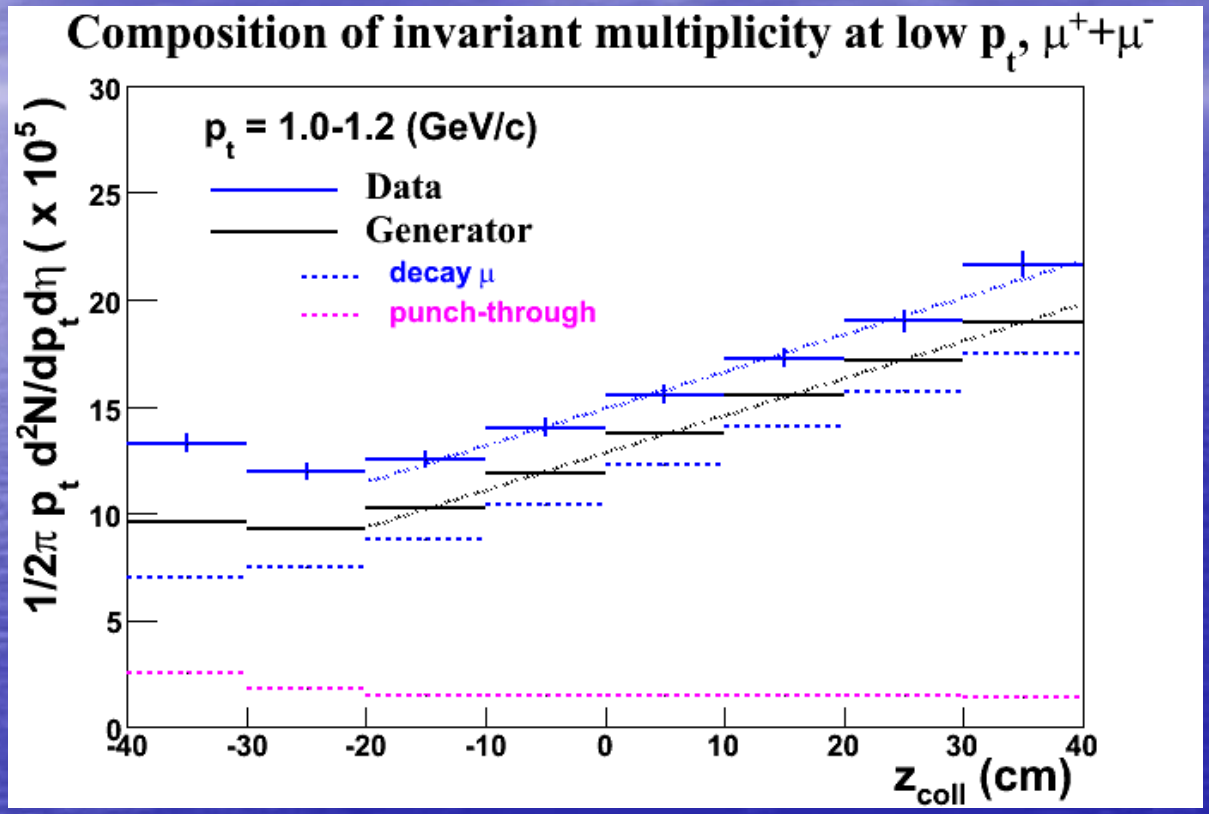
Dominant background :
π^0 Dalitz decay, γ conversion

μ-measurement, sources



1 : Hadrons, interacting and absorbed (98%),
2 : Charged π/K's, "decaying into μ" before absorber (≤1%),
3 : Hadrons, penetrating and interacting ("stopped")
4 : Hadrons, "punch-through",
5 : Prompt μ, "desired signal"

μ-measurement, Signal composition



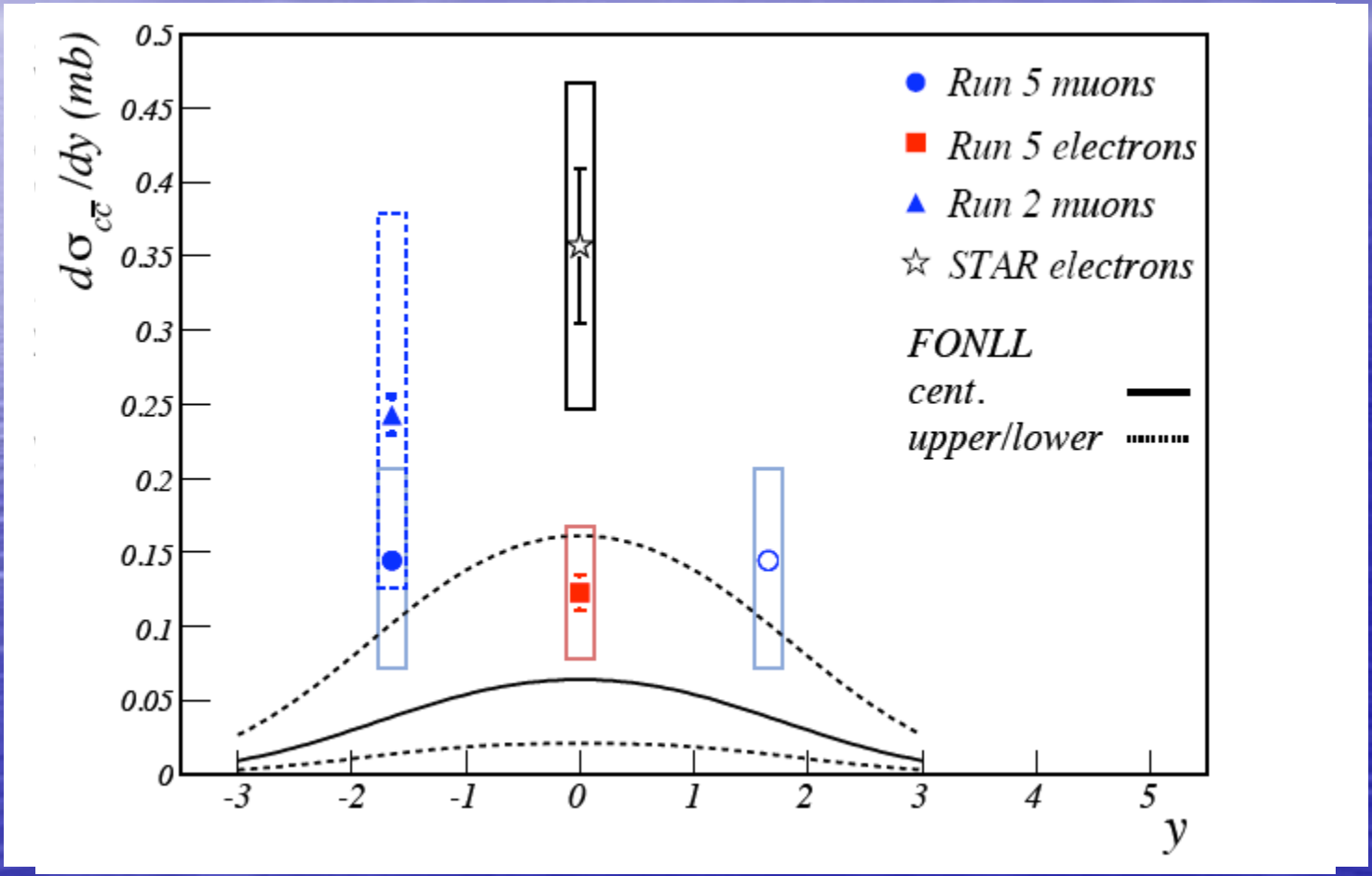
Generator (Decay μ + punch-through)

1. Light hadron measurement by PHENIX central arm (y = 0)

2. Gaussian extrapolation in rapidity to muon arm acceptance (σ = 2.5)

3. Simplified spectrometer geometry.

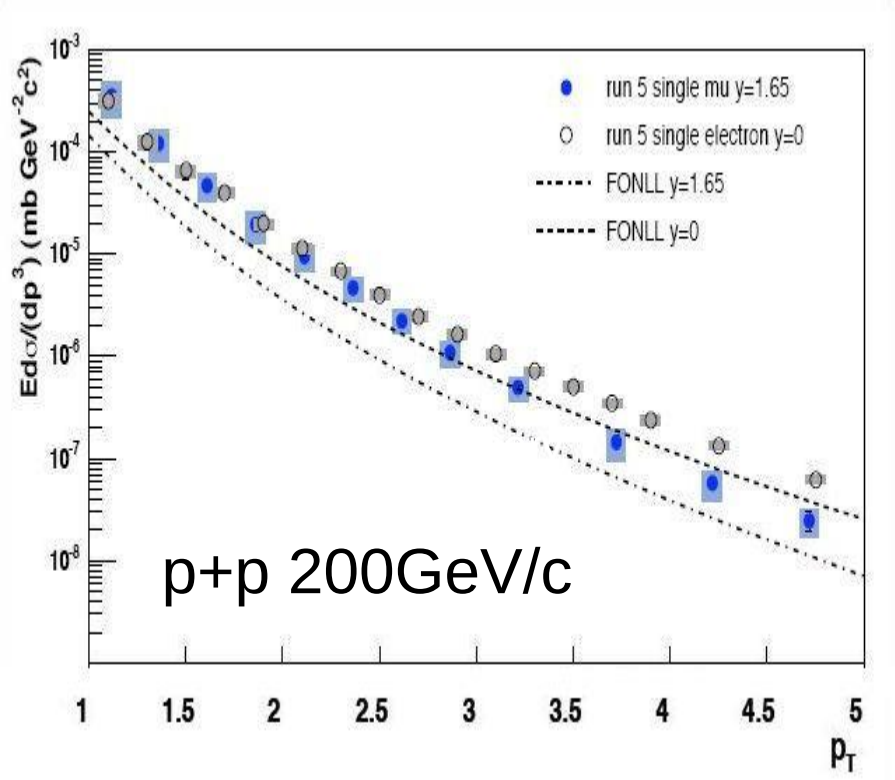
Forward prompt μ^- production (PHENIX)

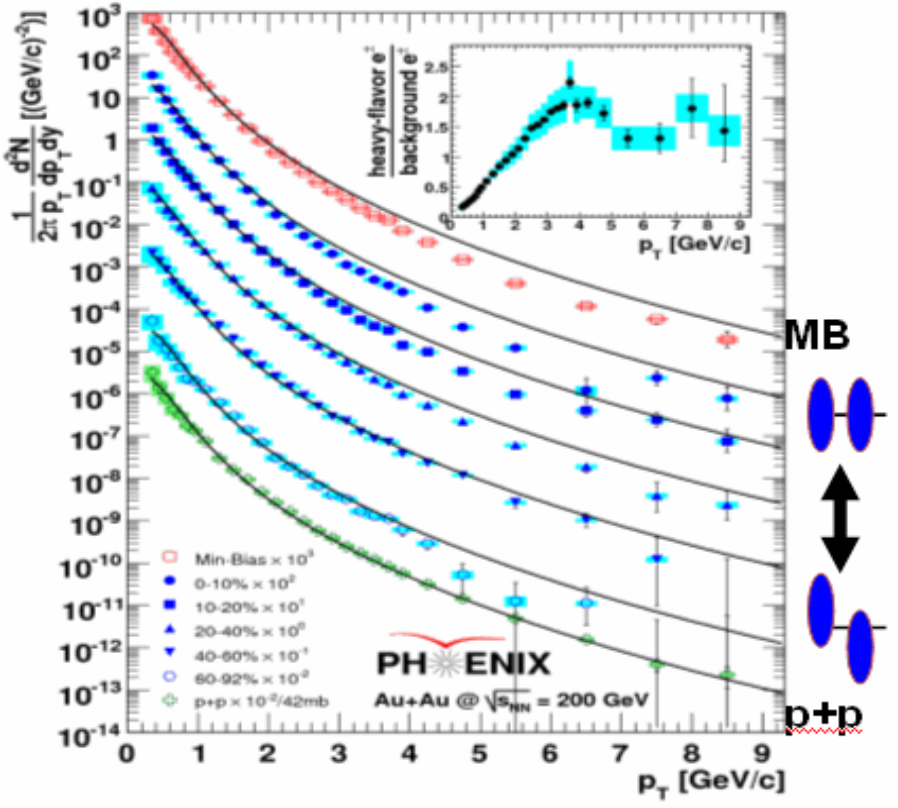


PPG057 : PRD76, 092992(2007)

Leptons from heavy flavor, PHENIX

PRL, 98, 172301 (2007)

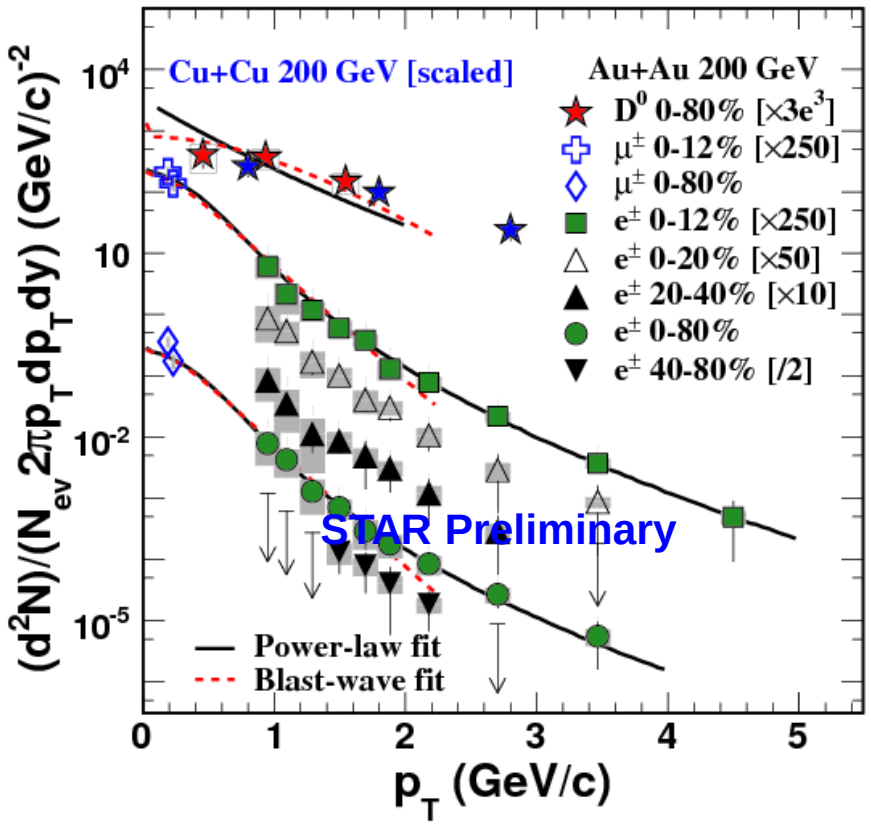




Systematically higher than FONLL calculation

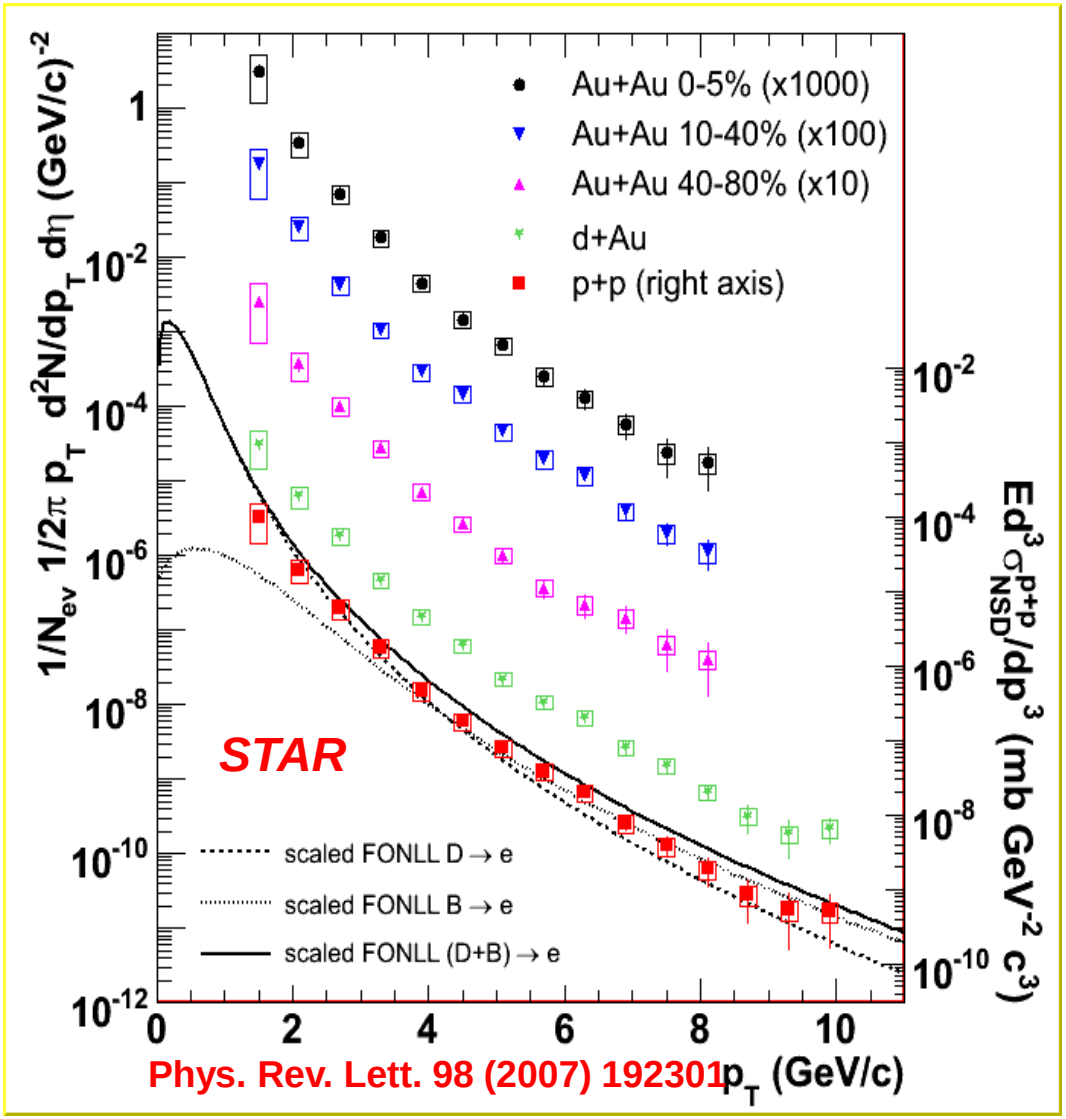
Integral e yield follows binary scaling, strong high p_T suppression at central AuAu collisions

Leptons from heavy flavor, STAR



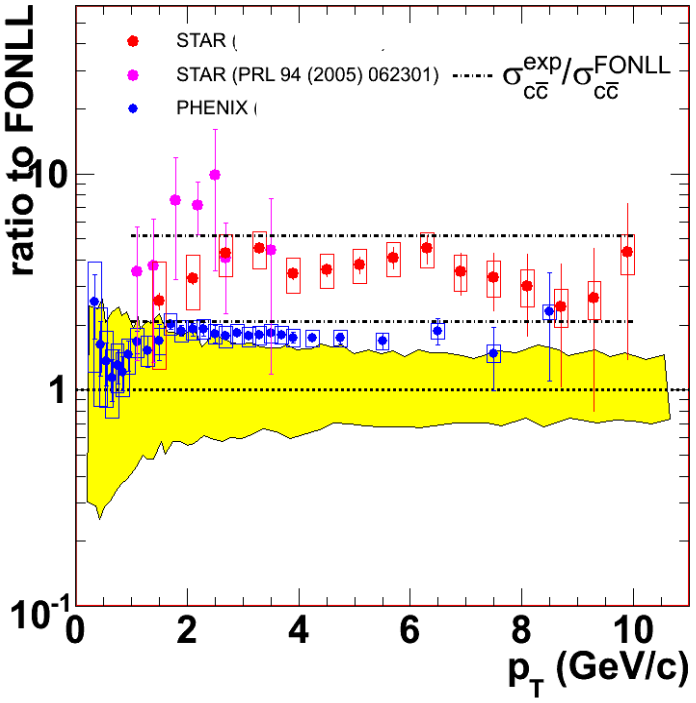
- Combined fit of μ, D^0, low p_T e
- Low p_T muon constrains charm cross-section

STAR high p_T non-photonic electrons

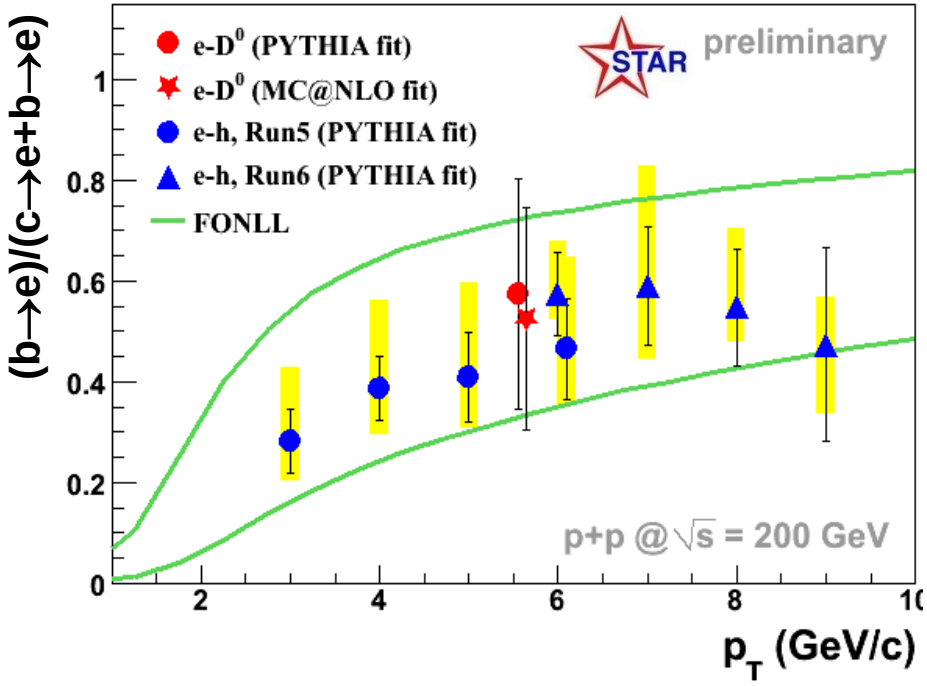


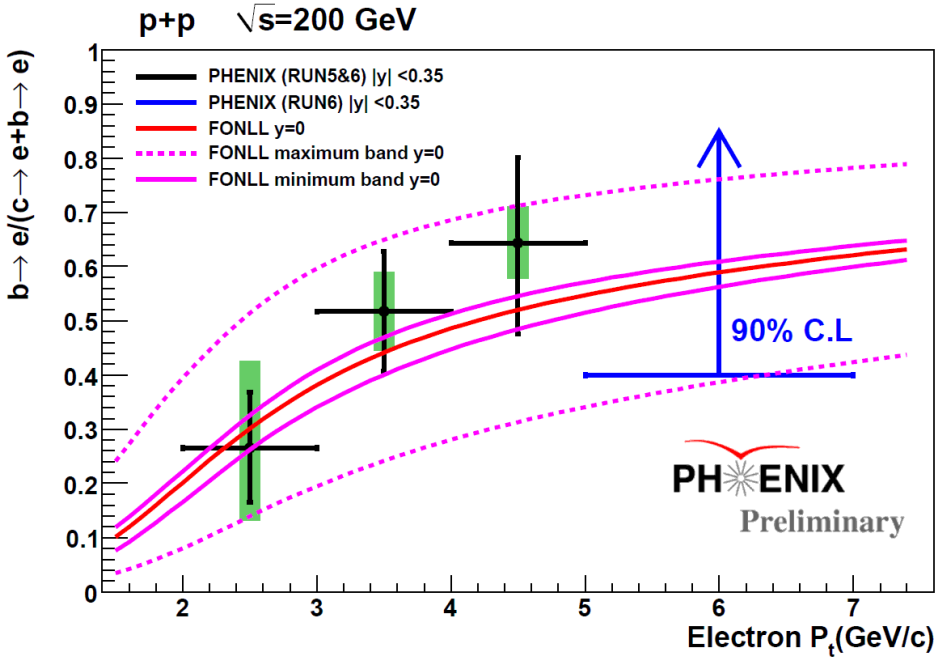
Phys. Rev. Lett. 98 (2007) 192301

High p_T electrons
(EMC trigger)
FONLL * 5 → p+p spectra



Bottom contribution to non-photonic e

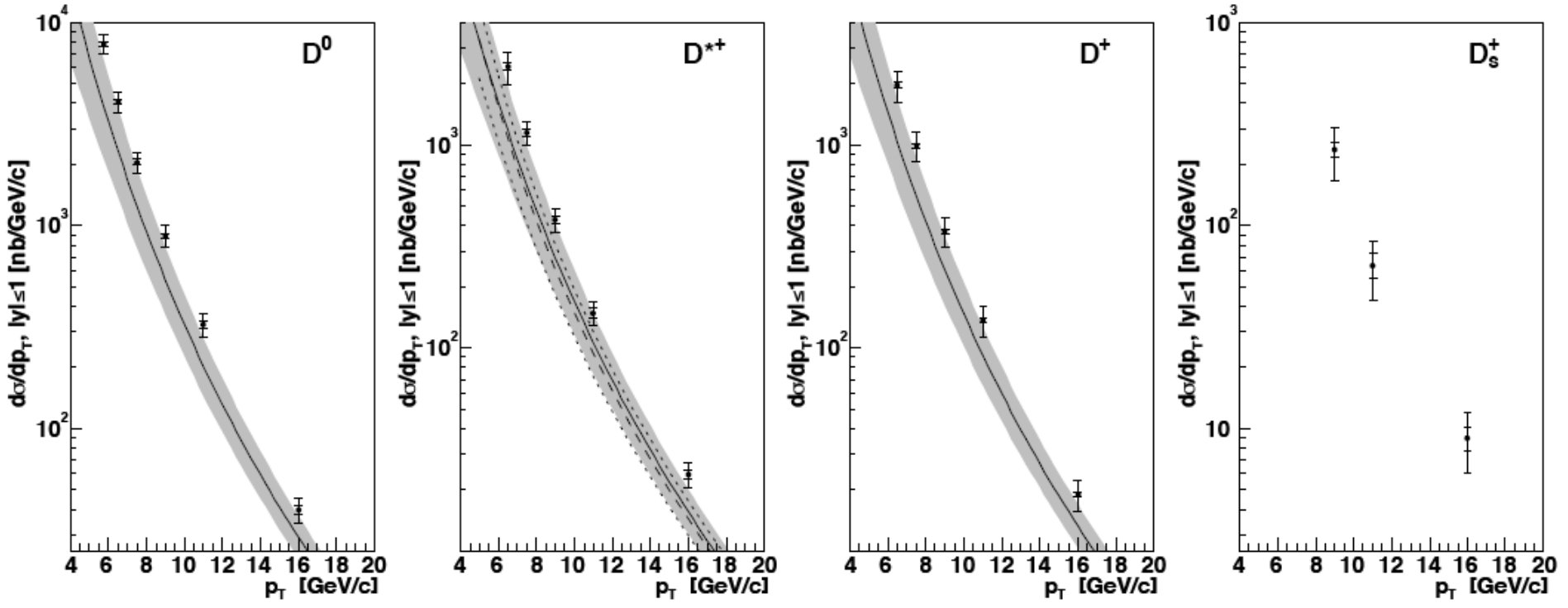




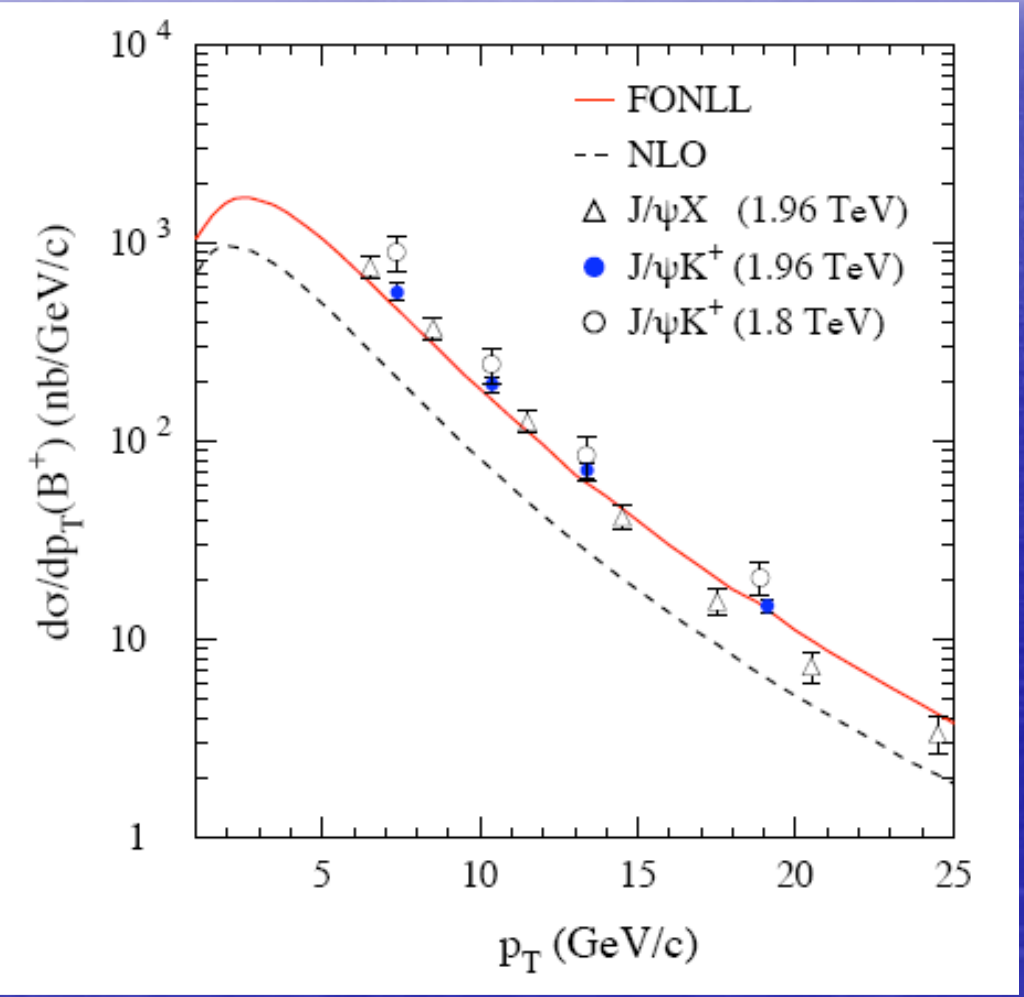
Data consistent with FONLL.

Results at higher energy

Differential charm cross section



Differential bottom cross section



A question?

- STAR high pT electrons?
- If it's problem, normalization (efficiency)?
  - Detector thickness must be varying a lot!