Inclusive Muon Production in dAu Collisions

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Key words
– Heavy quark semileptonic decay
– Light hadron weak decay

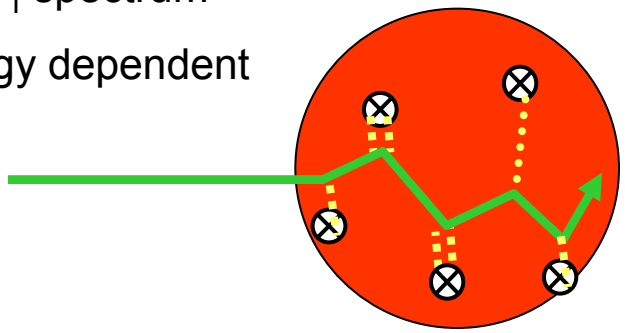
Motivation

- Striking difference of d+Au and Au+Au results in charged hadron production in central rapidity y=0
- What happens in the forward and backward rapidity in asymmetric d-Au collisions?

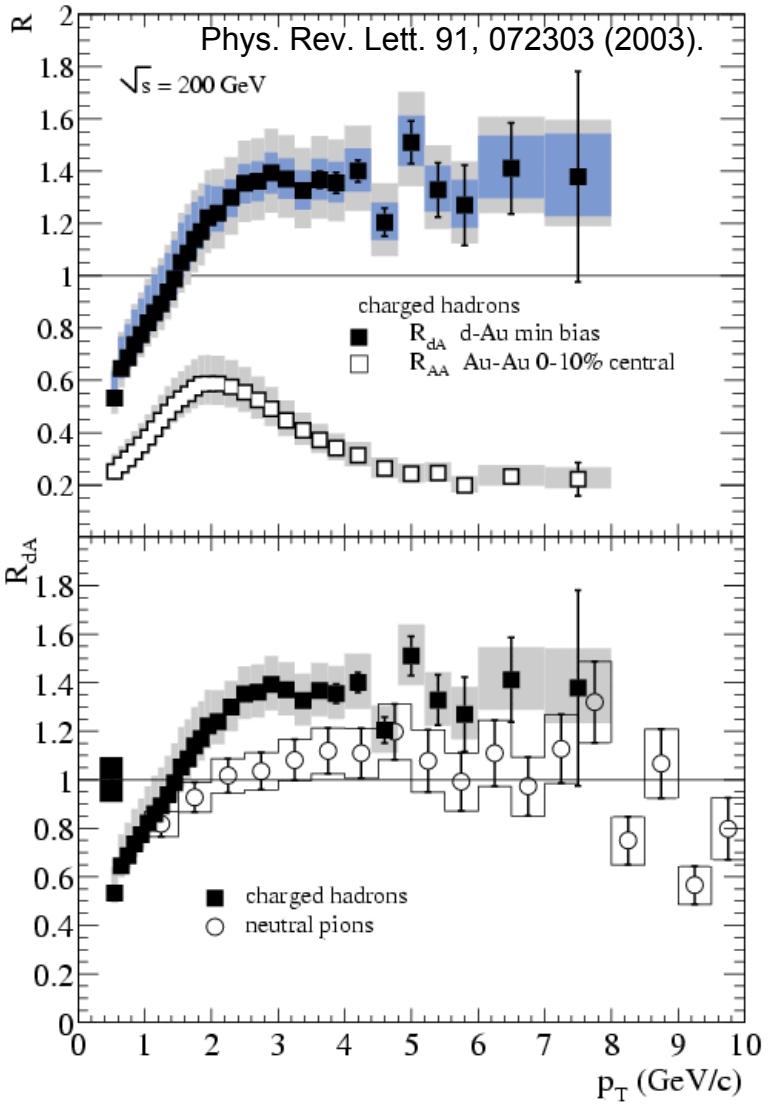
Cronin Effect:

•Multiple collisions broaden high P_T spectrum

•Energy dependent



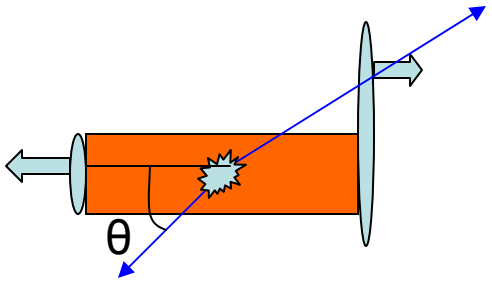
Ref: PHENIX
Phys. Rev. Lett. 91, 072303 (2003).



Motivation (cont.)

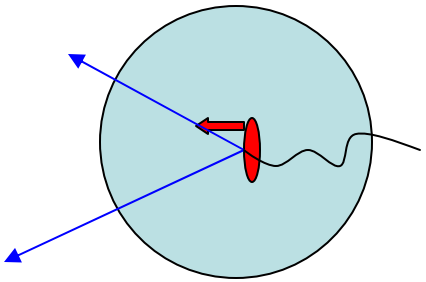
- Nuclear medium effects
  - Initial and final state interactions
  - Modified parton distributions
  - Forward vs backward
    - Very diff. energy in Au-frame
    - dN/dy
    - dN/dP_T
    - $R_{dAu}(P_T, y)$

$$d\sigma_{X\to\mu^{\pm}} \propto f_d(x_1) \otimes f_{Au}(x_2) \otimes D_X(z) \cdot d\hat{\sigma}_{a+b\to X}$$



C.M.F.

- Flavor dependent ?
  - Heavy flavors
    - Open charm, beauty
  - Light hadrons
    - Pion, kaon weak decays

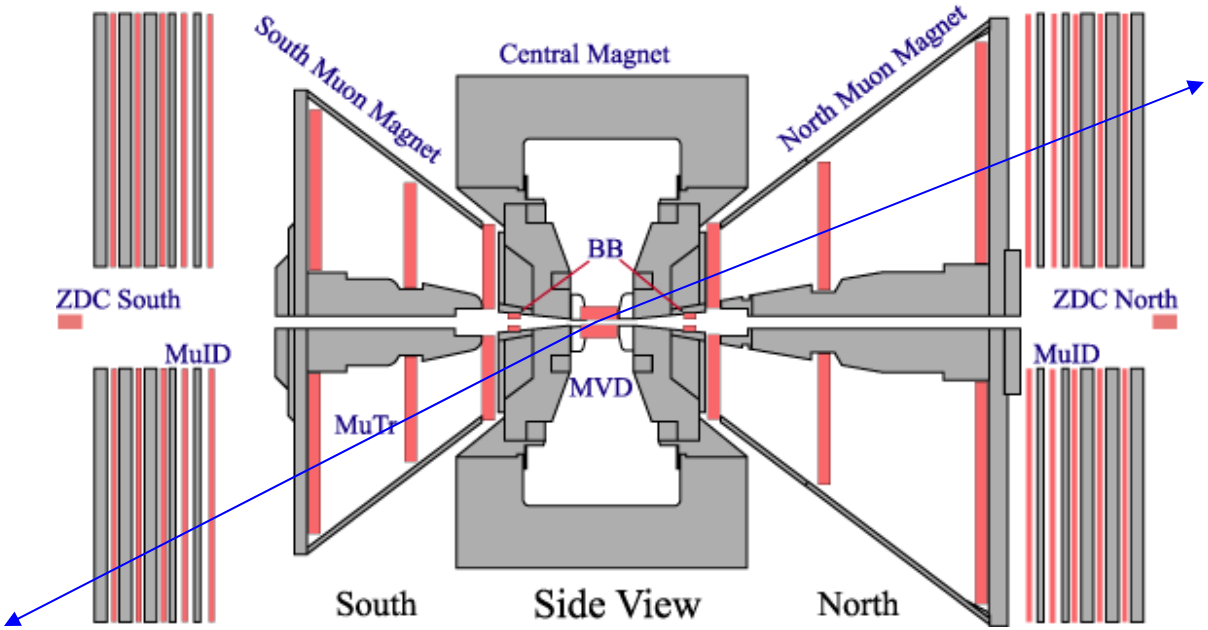


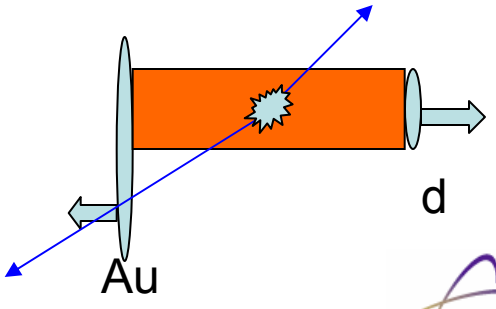
$$p'_T = p_T$$
$$p'_z = \gamma \cdot E(\cos\theta + \beta)$$

Au rest frame

PHENIX Detectors

- Muon arms
  - 1.2<|η|<2.4
  - Δφ=2π
  - P>2GeV/c
  - triggers

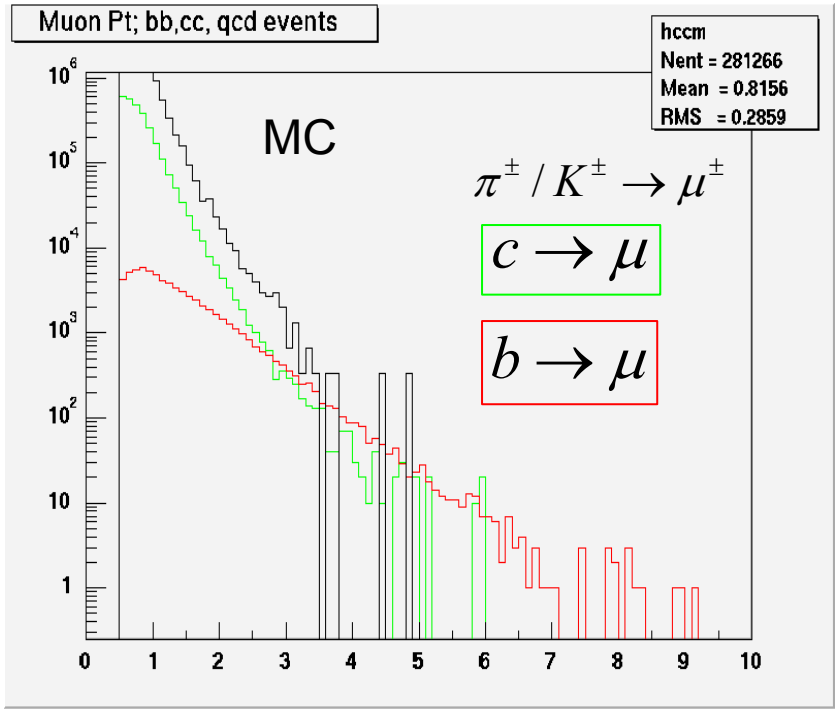




Muon Production

- Origins of muons
  - PYTHIA p+p @ $\sqrt{s}$=200GeV
  - low P_T:
    - light hadron decays
  - high P_T:
    - Heavy quark decays

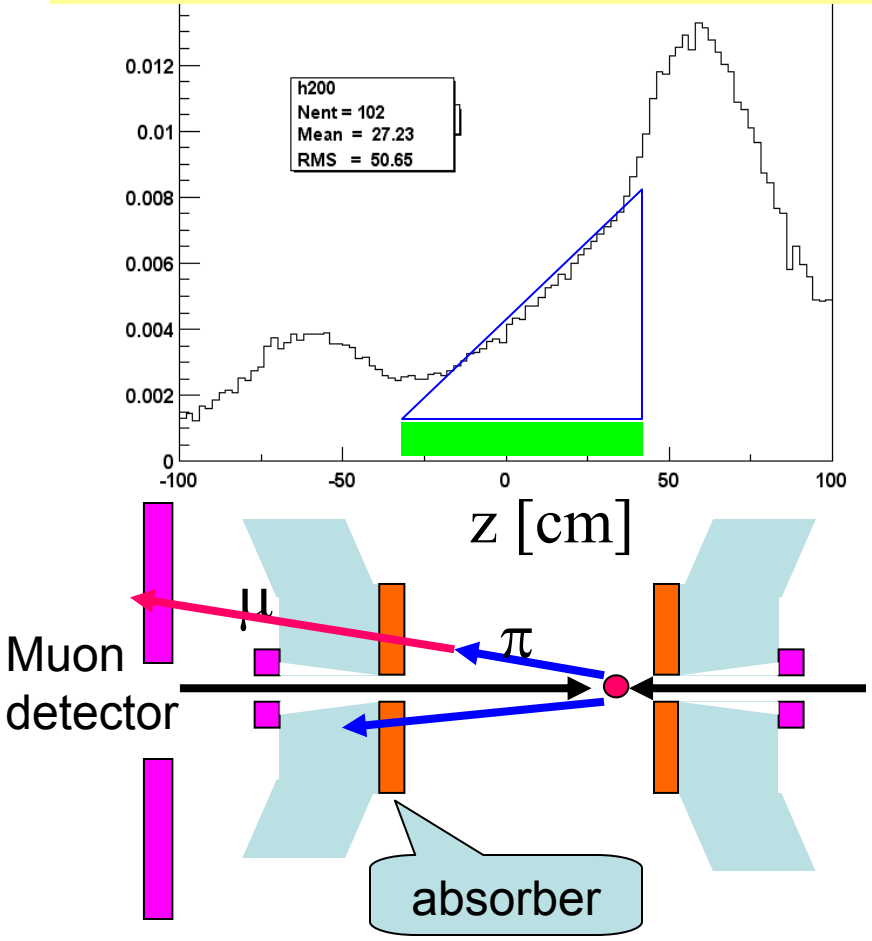
$$BR(c \to \mu^+ + X) = 10\%$$
$$BR(b \to \mu^- + X) = 10\%$$
$$BR(\pi^+ \to \mu^+ + \nu_\mu) = 99.99\%$$
$$BR(K^+ \to \mu^+ + \nu_\mu) = 63\%$$



Single muon P_T distribution

Light Hadron Decay

Normalized Muon Event Z vertex



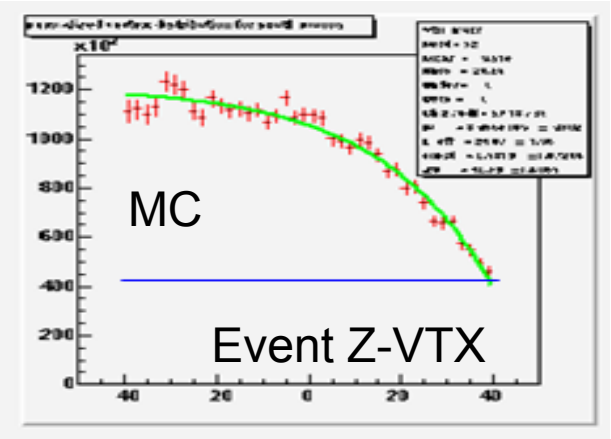
- Muon yield increases as a function of distance from the absorber - due to muons from π/K decays

- Linear shape of ***z*** vertex slope, because $c\tau\gamma$~100 [m].
- Prompt μ and hadron punch-through create the constant distribution in vertex.

Muon Measurements

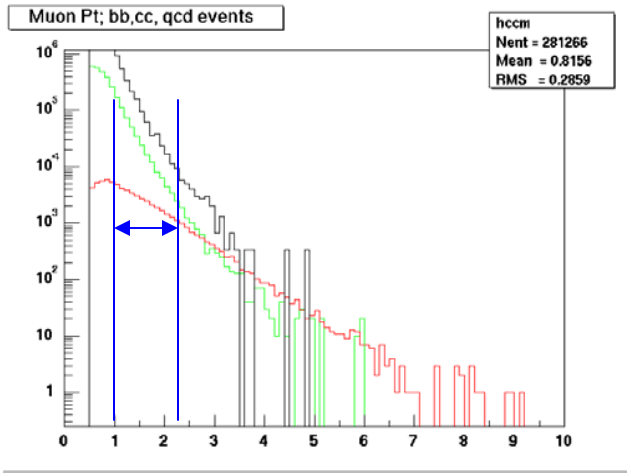
- Event vertex analysis
  - Decay muons: strong vertex dependent
  - Prompt muons and hadron punch-throughs

$$\frac{dN(z)}{dz} \approx N_{eff} \cdot [1 - \exp(-\frac{(Z_{eff} - Z)}{<\lambda_{eff}>}) + Q]$$



- Extract prompt (or decay) muons
  - P_T bins
  - Rapidity bins

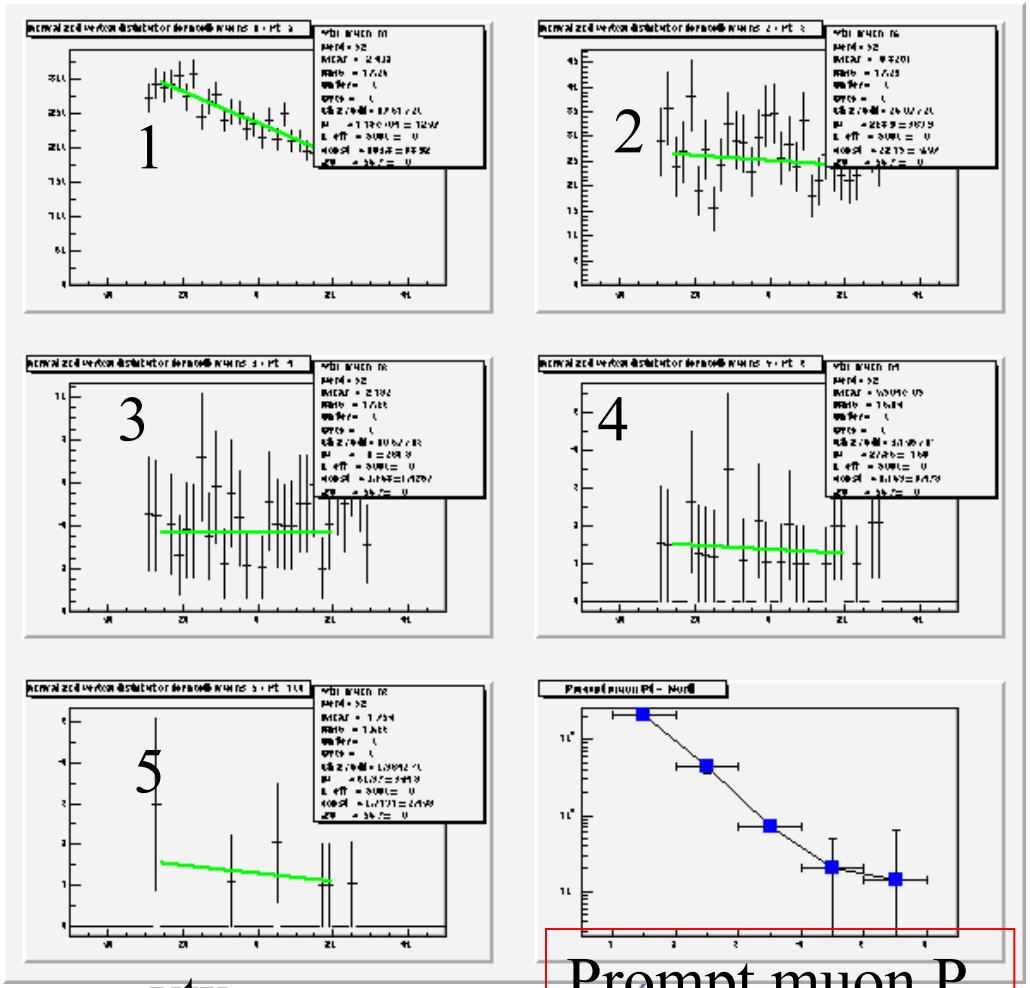
$$R_{dAu} = \frac{\frac{dN_{d+Au}}{dP_T}(P_T)}{N_{bin} \cdot \frac{dN_{p+p}}{dP_T}(P_T)}$$



Single muon P_T

Forward Muons (d-direction)

- Normalized muon event vertex distributions
  1. 1<Pt<2
  2. 2<Pt<3
  3. 3<Pt<4
  4. 4<Pt<5
  5. 5<Pt
- Prompt muon raw P_T spectrum
  1. Open charm production
  2. Light hadron production

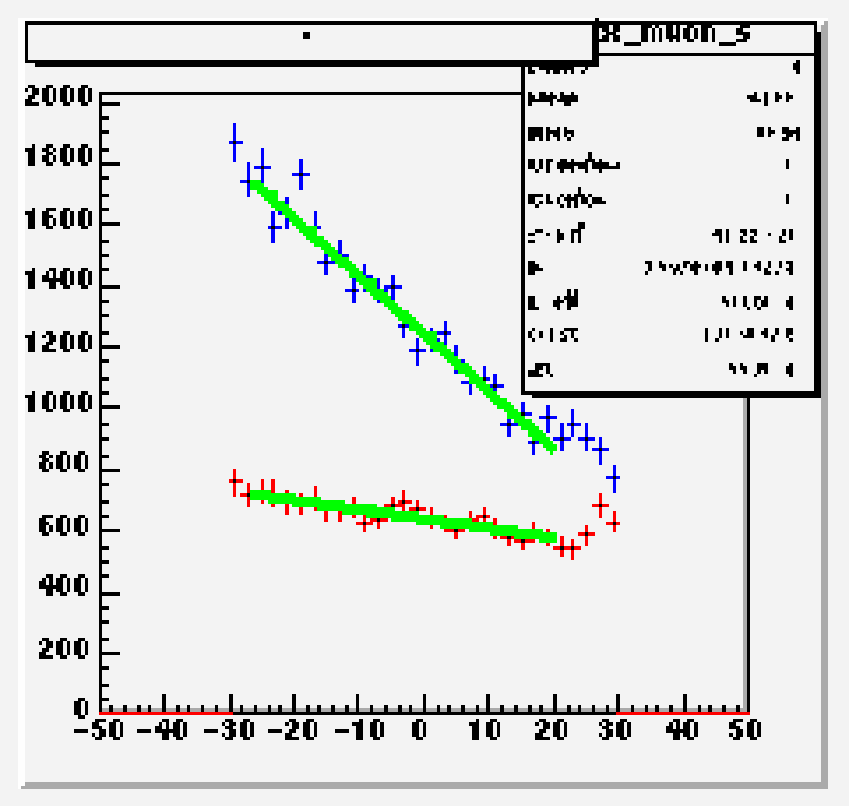


vtx

Prompt muon P_T

Forward vs Backward

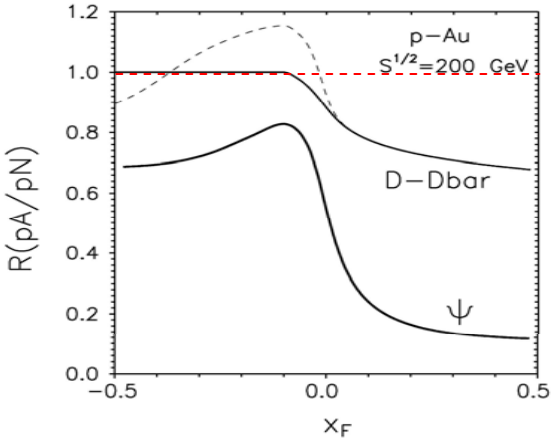
- Normalized muon event vertex distributions
  - Forward
  - Backward
- More decay muons in backward rapidity(Au-dir.)



Normalized Z-vertex distribution

Outlook

- Very Interesting physics
  - Unique: R_{dAu} @ forward/backward rapidity
  - Energy/Flavor dep. cold nuclei medium effects
    - R_{dAu} (P_T) : energy loss of light/heavy quarks
    - R_{dAu} (X_F) : parton shadowing
  - First R_{AB} with heavy flavors
  - Baseline for future Au-Au measurements



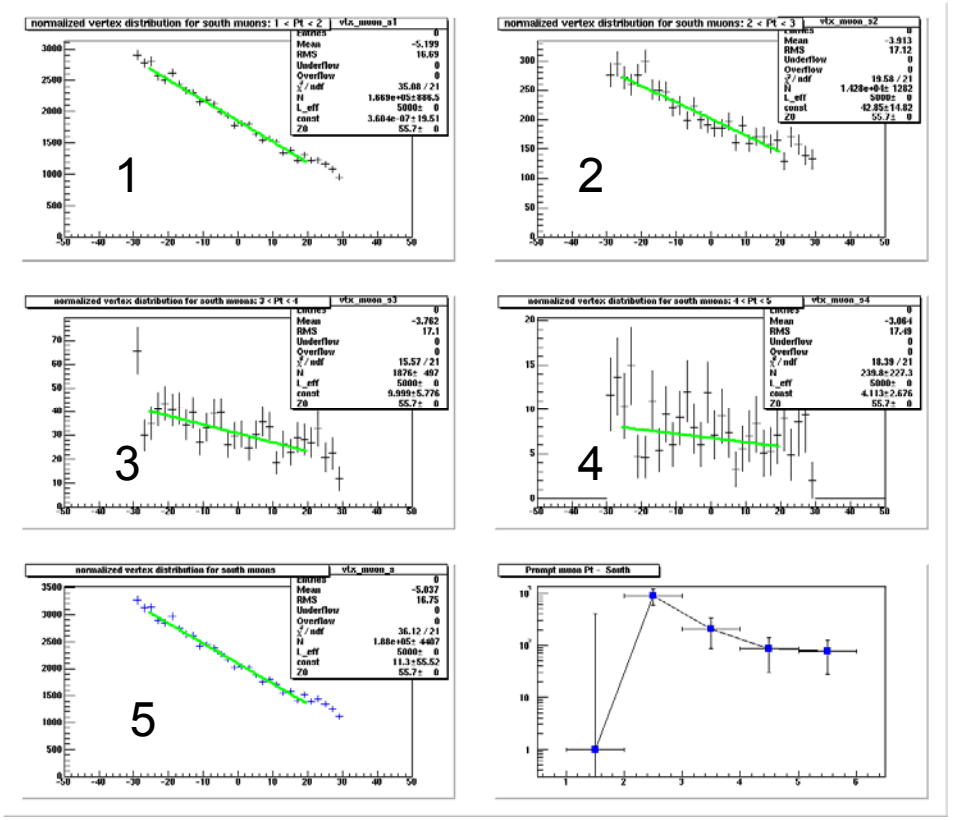
$R_{dAU}(X_F)$

Kopeliovich et al hep-ph/0205151

- Work in progress
  - Open heavy flavor production
  - Inclusive light hadron production
  - Data production in progress
  - Looking forward to seeing results by QM04

Backward muons (Au-direction)

- Normalized muon event vertex distributions
  1. 1<Pt<2
  2. 2<Pt<3
  3. 3<Pt<4
  4. 4<pt<5
  5. all
- Prompt muon raw P_T spectrum
  1. Open charm production
  2. Light hadron production

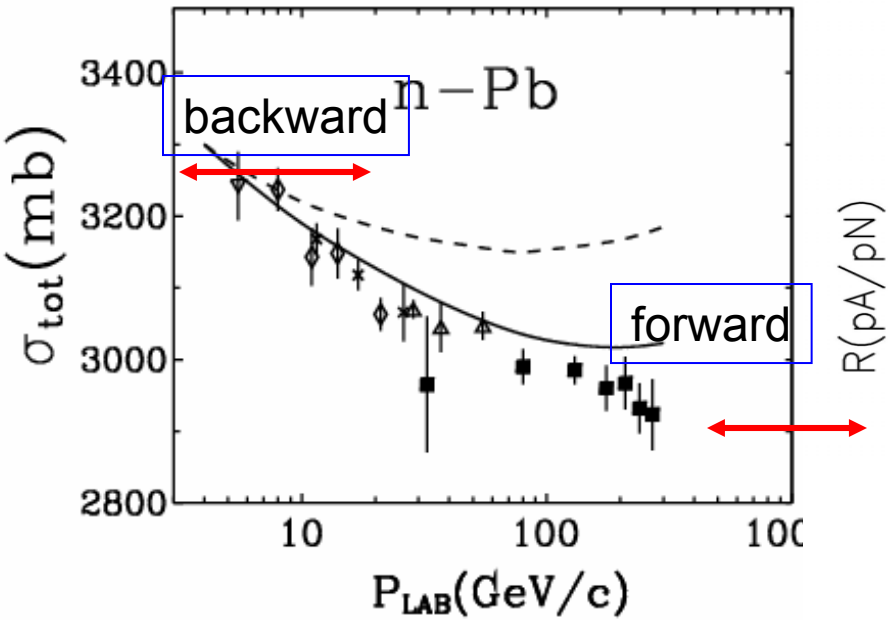


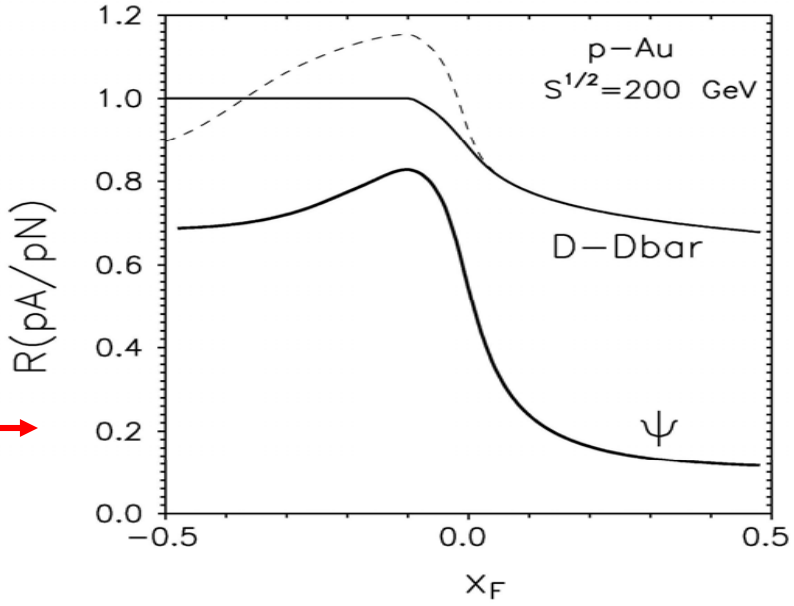
vtx P_T

More on nuclear medium effects

$$R_{dAu}(P_T, y, \ldots)$$

- Energy dependent nuclear cross section
- Gluon shadowing





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