Muon Production in Forward and Backward Rapidities in dAu Collisions at RHIC

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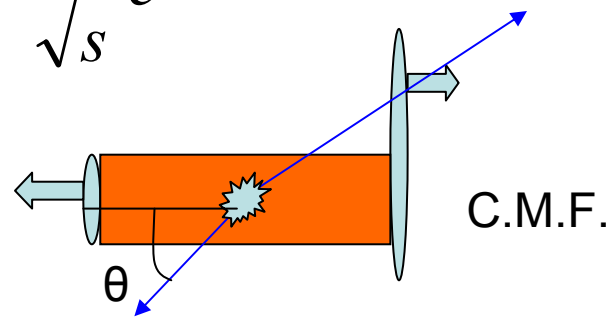
(for the PHENIX Collaboration)

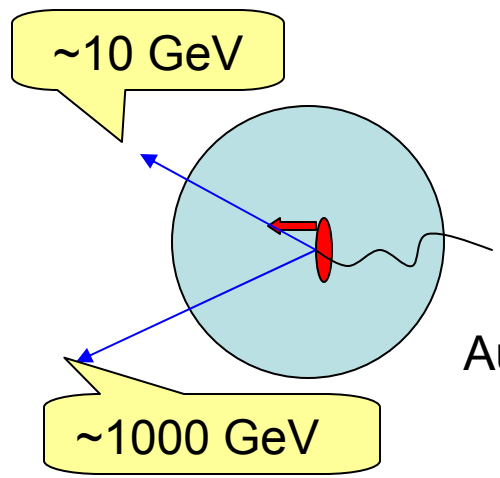
Key words
– heavy quark semileptonic decay
– light hadron weak decay
– (anti)shadowing/CGC

Motivation

- Nuclear medium effects in forward and backward directions in dAu reactions
  - Different "x" range: initial state
    - (anti)shadowing/CGC
  - Final state (co-moving): very much energy dependent
- Flavor dependence?
  - Heavy flavors
    - Open charm, beauty
  - Light hadrons

$$x = \frac{M}{\sqrt{s}} e^{-y}$$





$$p'_T = p_T$$

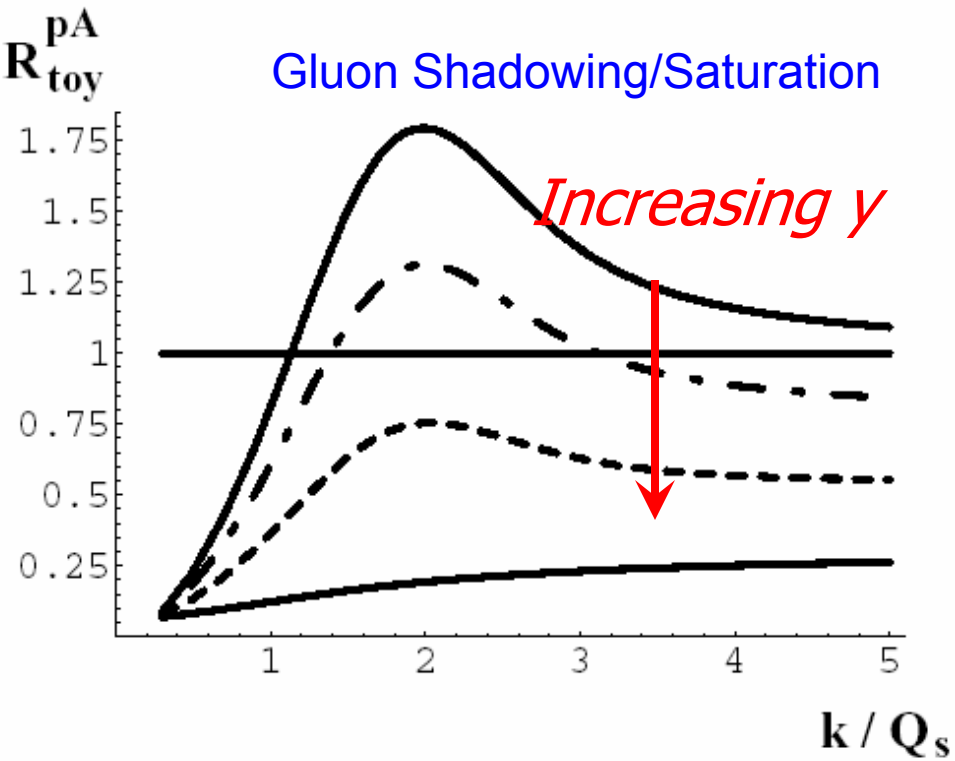
$$p'_z = \gamma \cdot E(\cos\theta + \beta)$$

Au rest frame

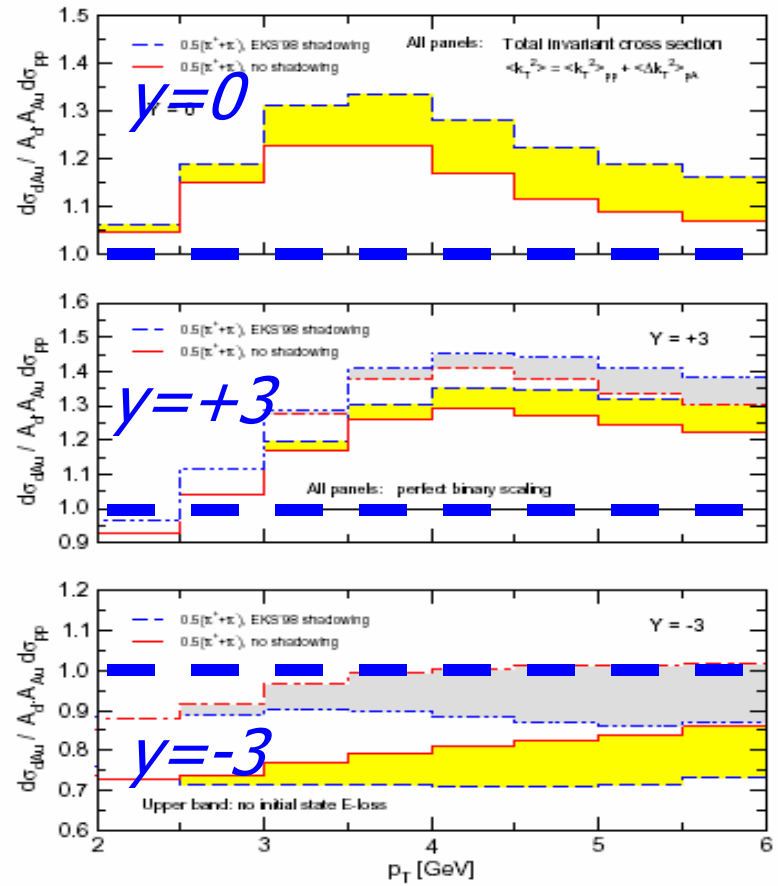
dAu: a test ground!

Theoretical Predictions

D. Kharzeev hep-ph/0307037



I. Vitev nucl-th/0302002



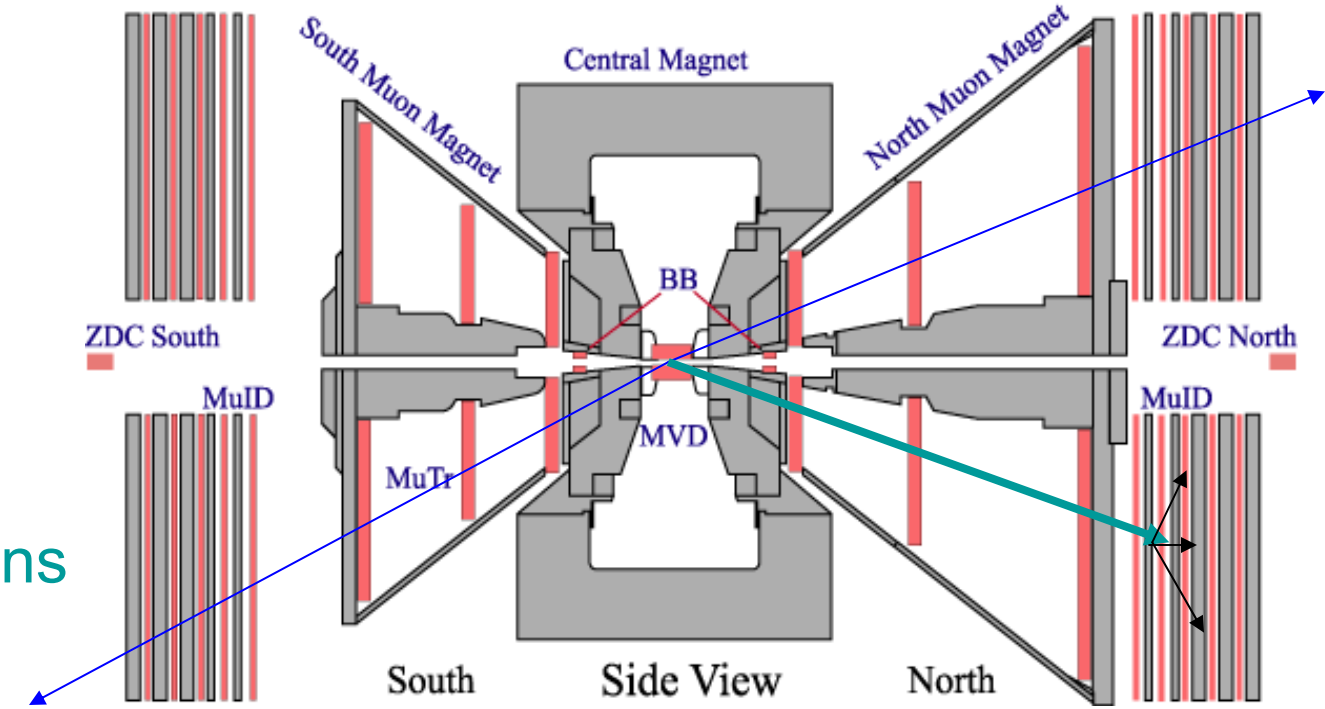
Questions

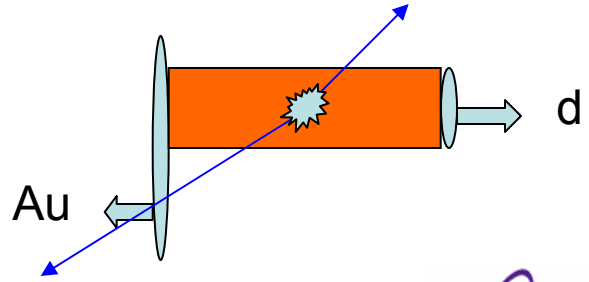
1. What happens in the forward (d) AND backward (Au) directions?
2. Any collision centrality dependence?
3. Charge dependence?
   - h^+ vs h^-
4. Flavor dependence?
   - Light vs heavy quarks

Is there shdowing/CGC at RHIC?

PHENIX Muon Detectors

- Muon arms
  - $1.2<|\eta|<2.4$
  - $\Delta\varphi=2\pi$
  - P>2GeV/c
  - Triggers
- "Muons"
  - Stopped hadrons
  - Light meson decays
  - Heavy decays



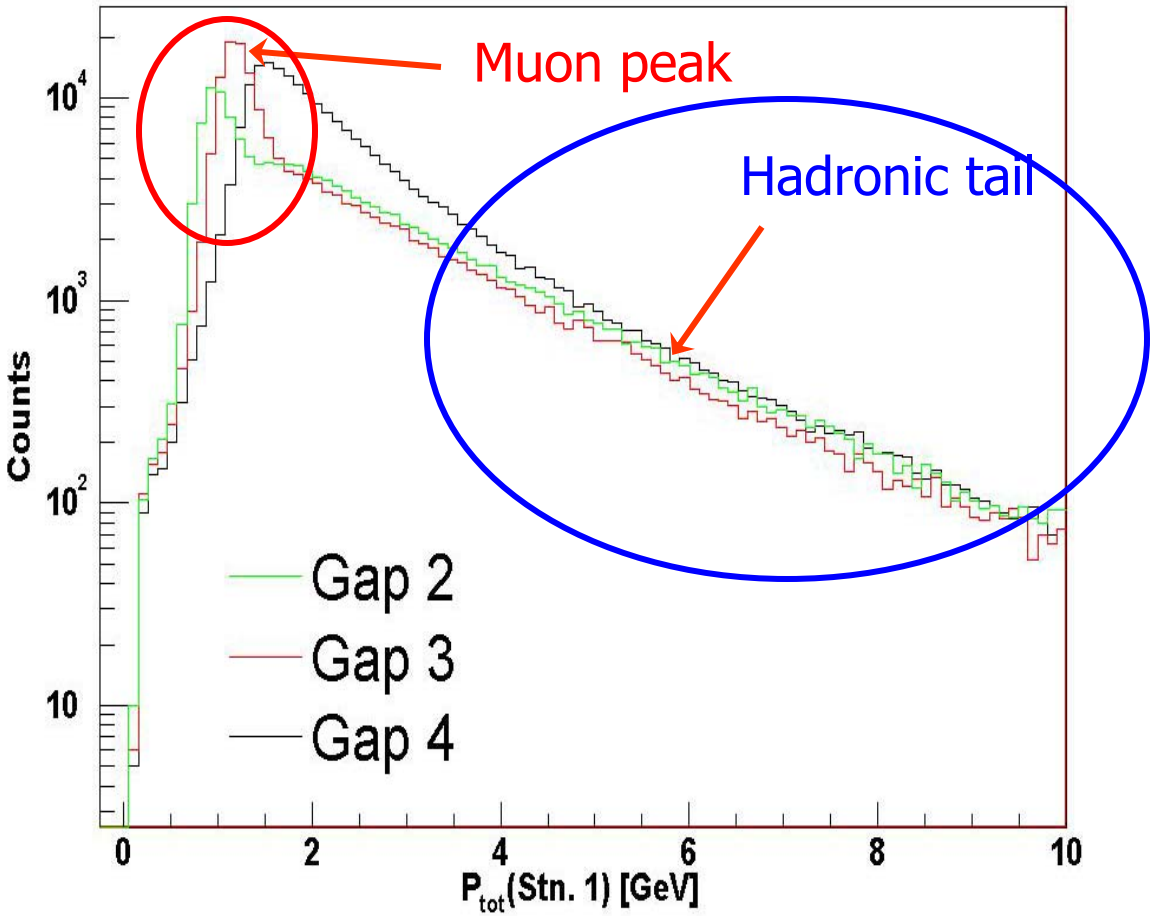


Measurement of Stopped Hadrons

Stopping power:

Use shallow MuID absorber layers to select stopped hadrons

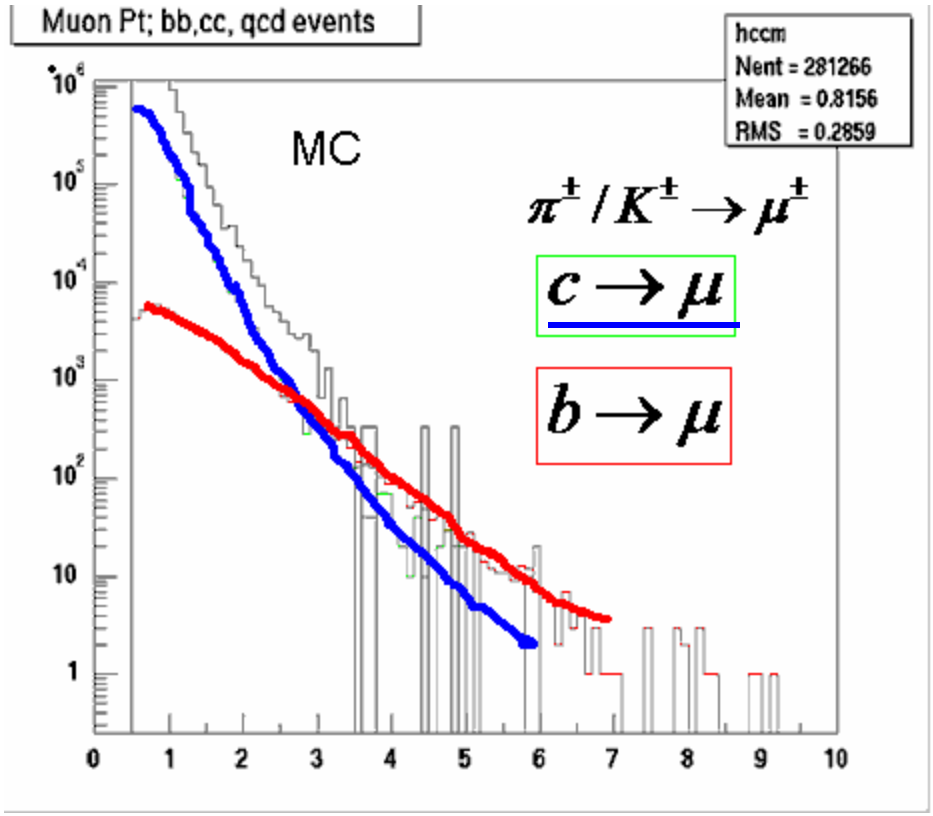
for Ptot > 1.9GeV:
muon contamination < 3%



Muon Production

- Origins of muons
  - PYTHIA p+p @ √s=200GeV
  - low P_T:
    - light hadron decays
  - high P_T:
    - Heavy quark decays

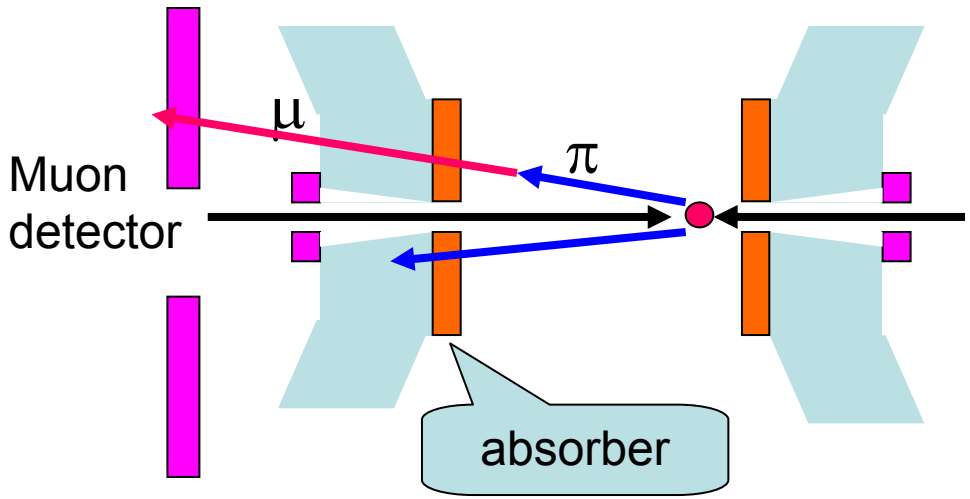
$$BR(c \to \mu^+ + X) = 10\%$$
$$BR(b \to \mu^- + X) = 10\%$$
$$BR(\pi^+ \to \mu^+ + \nu_\mu) = 99.99\%$$
$$BR(K^+ \to \mu^+ + \nu_\mu) = 63\%$$

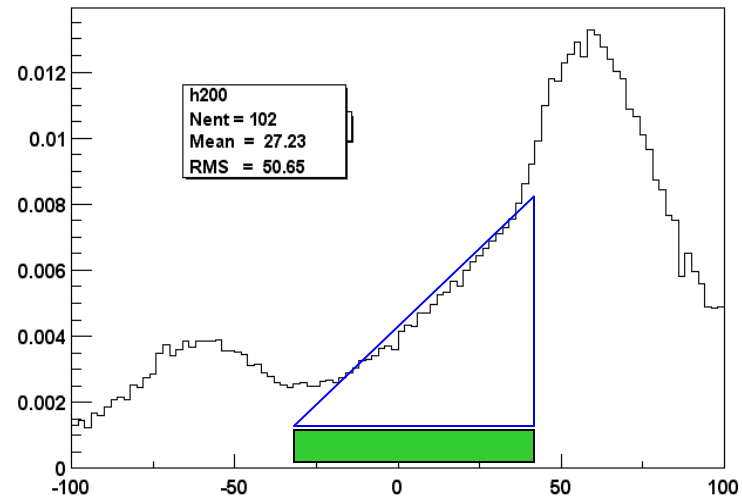


Muon P_T distribution

Muons from Light Meson Decays

- Muon event collision vertex distribution





Collisions Vertex Z

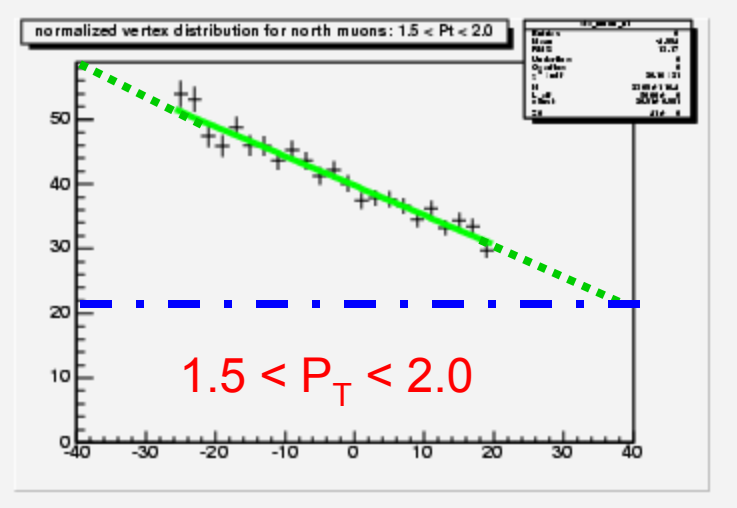
Measurements of Light/Heavy

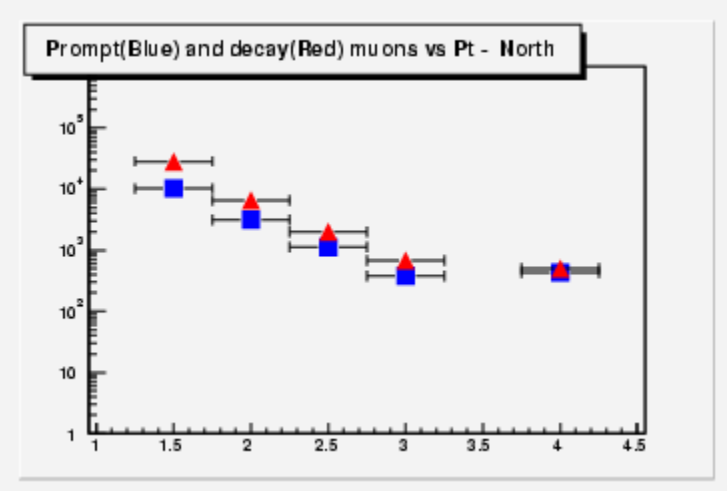
- Muons from light meson decays

$$\pi^{\pm} \rightarrow \mu^{\pm} + \nu$$

$$K^{\pm} \rightarrow \mu^{\pm} + \nu$$

- Prompt muon P_T distributions
  1. Light hadron punch-throughs(work in progress)
  2. *Charm/Beauty!*





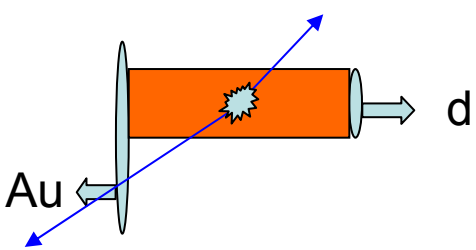
P_T

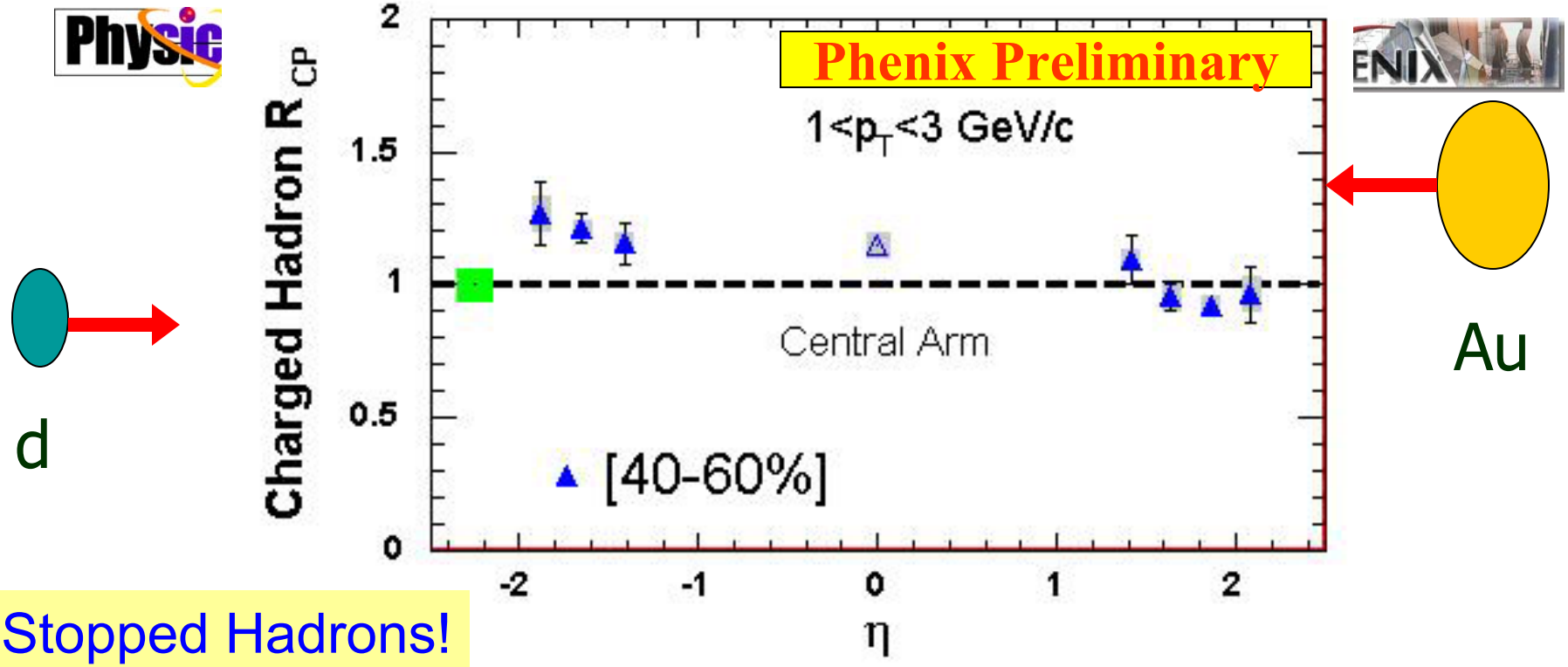
Centrality Dependence of Particle Production @Fwd/Bwd Directions

1. Stopped hadrons
   - Mesons + Baryons
2. Light mesons
   - Pions + Kaons
3. Heavy flavors
   - Charm + Beauty

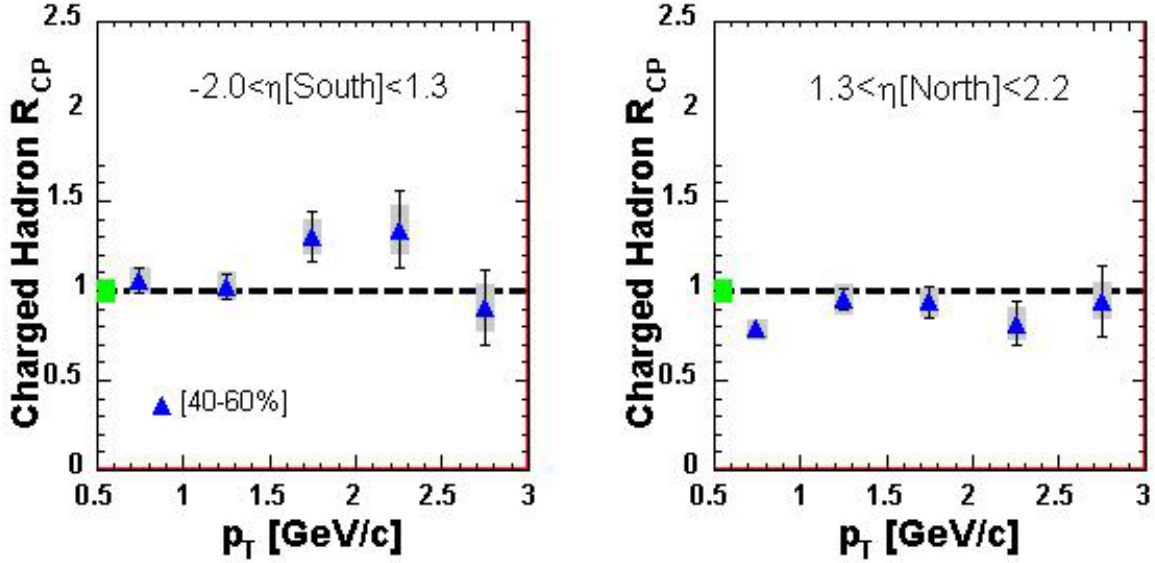
$$R_{CP}^{dAu}(P_T, y) \propto \frac{\dfrac{\Delta N^{cent-XX}}{<N_{coll}>}}{\dfrac{\Delta N^{60-88\%}}{<N_{coll}>}};$$

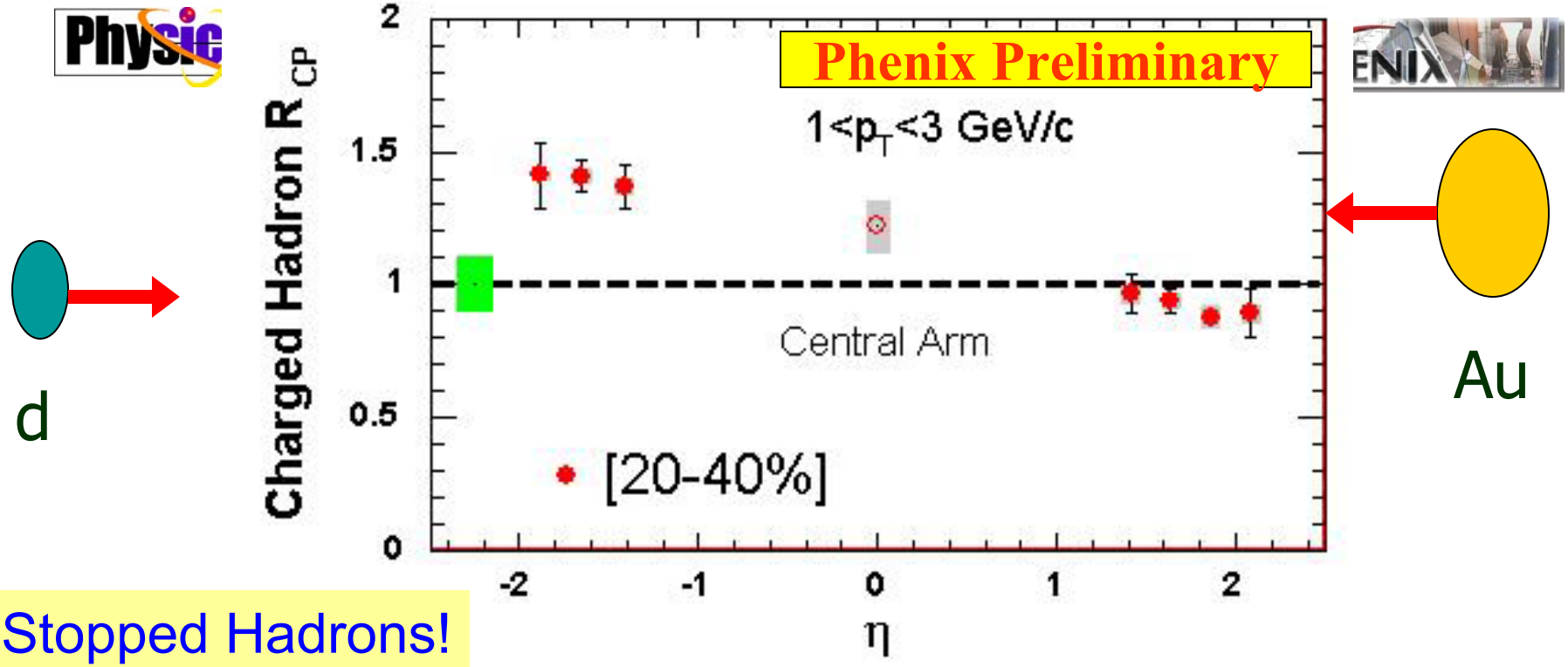
$$cent-XX = 0-20\%, 20-40\%, 40-60\%$$





Stopped Hadrons!





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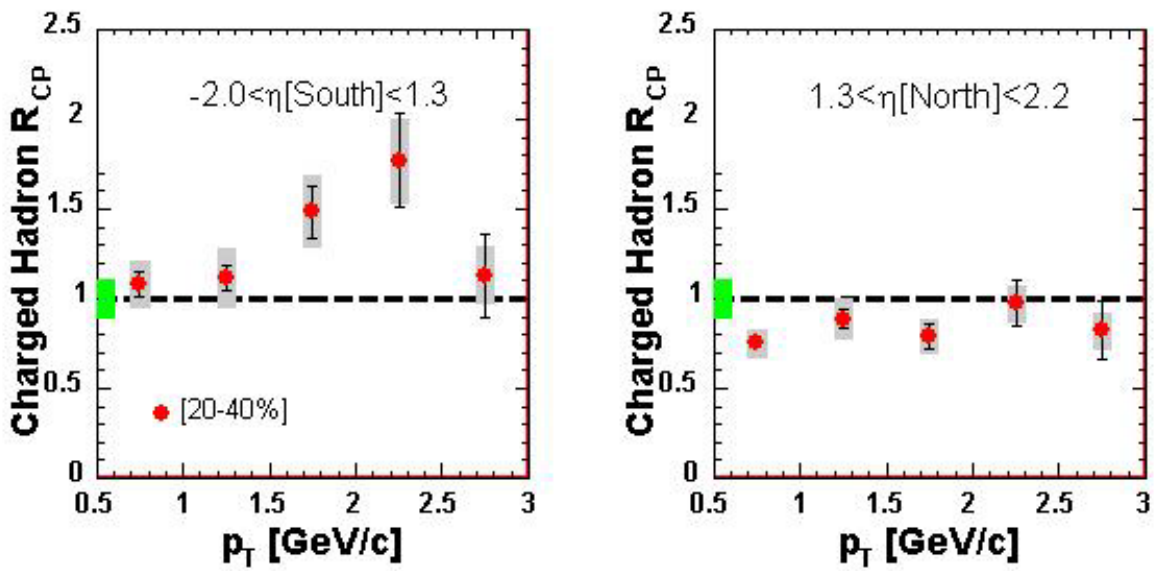

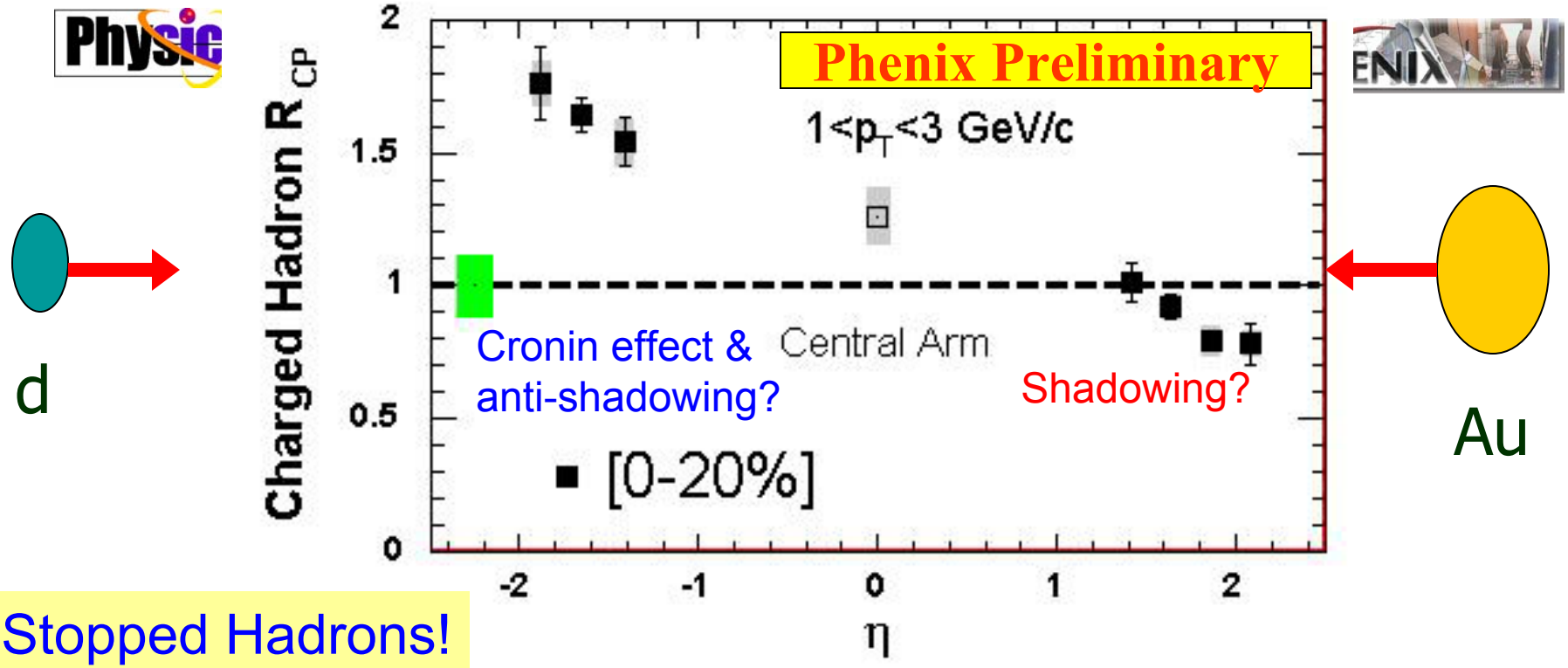

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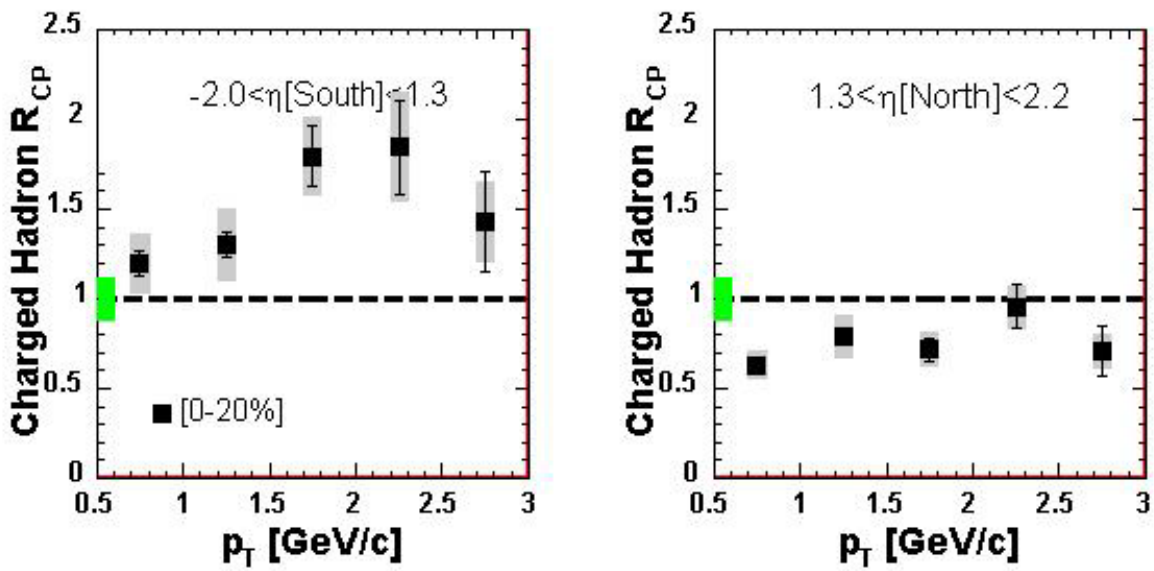
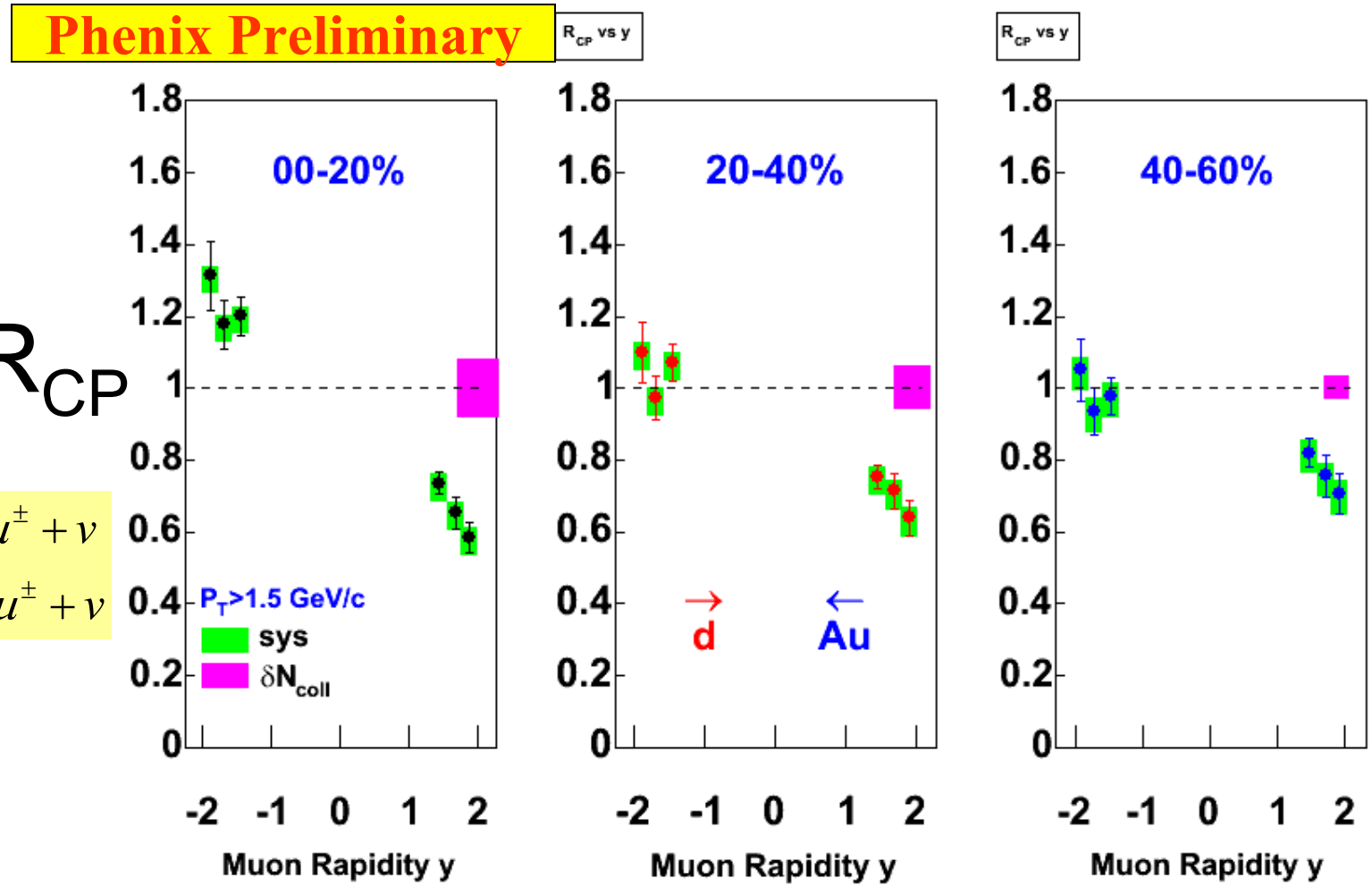


$R_{CP}(y)$: Muons from Light Meson Decays



$\pi^{\pm} \rightarrow \mu^{\pm} + \nu$

$K^{\pm} \rightarrow \mu^{\pm} + \nu$

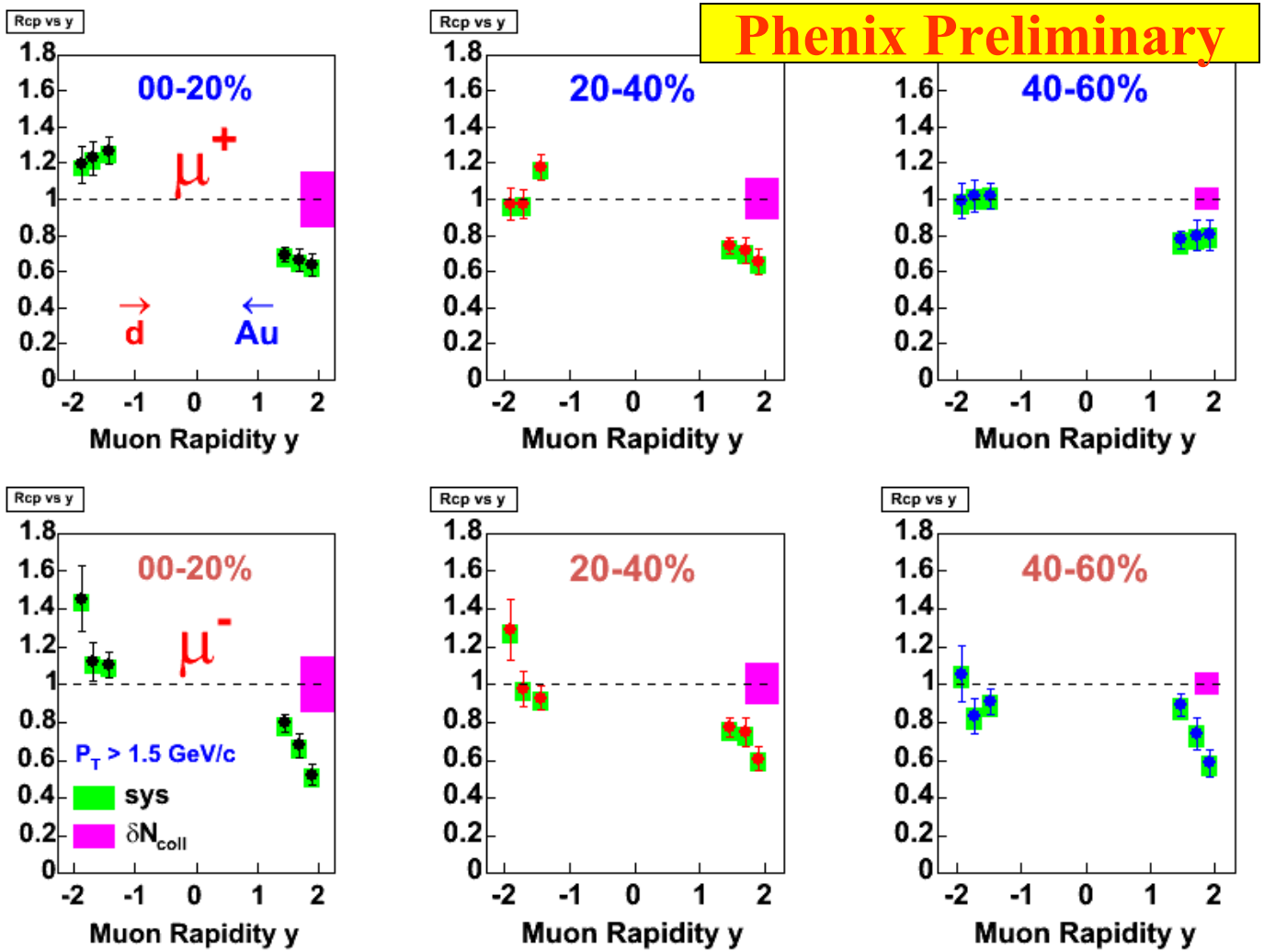
$R_{CP}(y)$: Charge Dependence

μ^+

μ^-

$\pi^\pm \rightarrow \mu^\pm + \nu$

$K^\pm \rightarrow \mu^\pm + \nu$



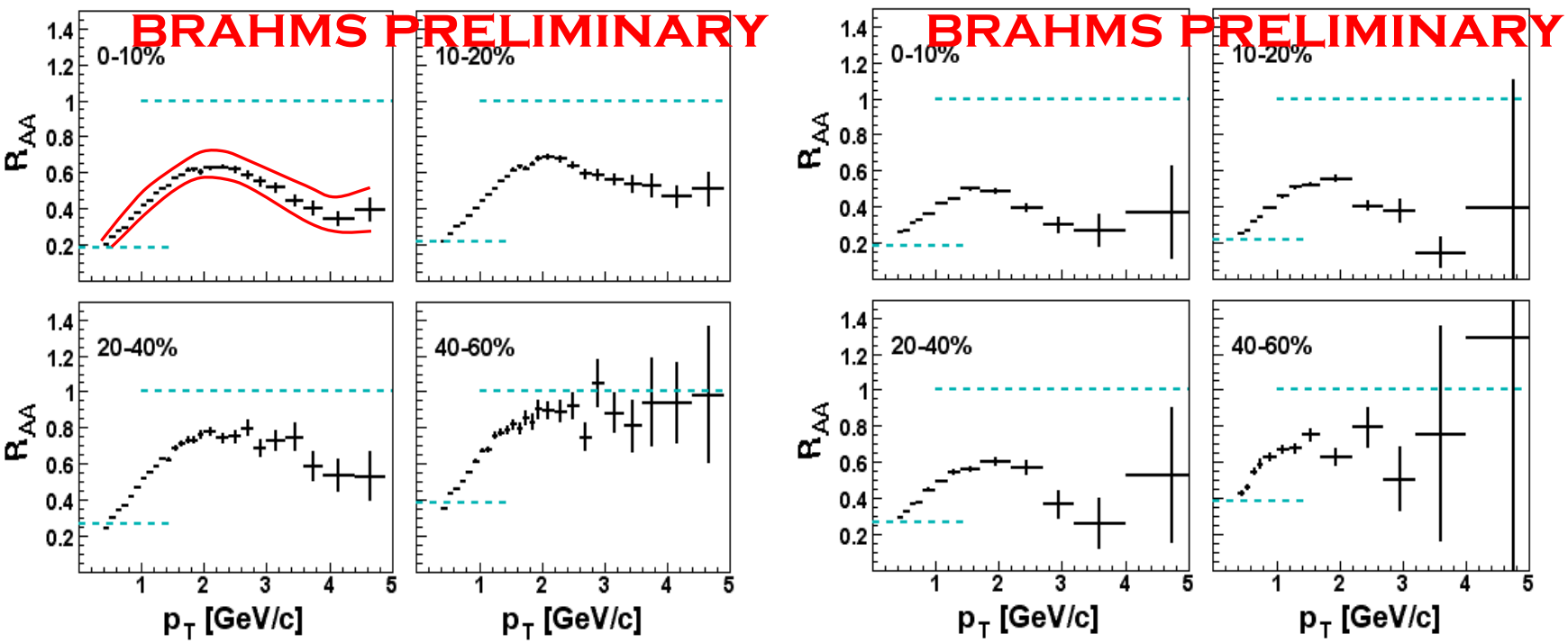
Answers to Previous Questions

1. What happens in the forward (d) AND backward (Au) direction? ☺
2. Centrality dependence? ☺
3. Charge dependence? ☺
   - h^+ vs h^-
4. Flavor dependence?
   - Light vs heavy quarks

Amazing Grace

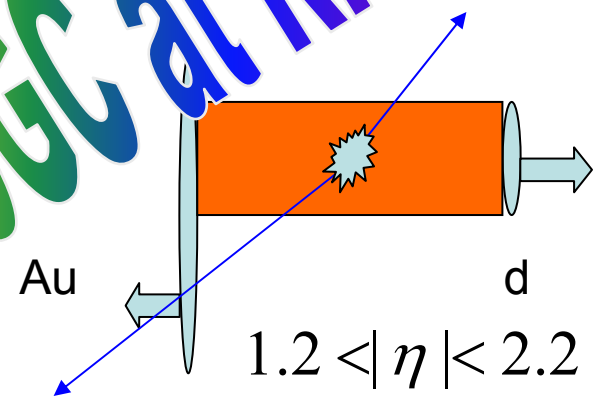
"I once was lost but now I am found"

η=0 Au+Au at 200GeV (2003 BNL dAu PR) η=2



Summary and Outlook

- R_{CP} @ forward and backward rapidity
  - **Very different from y = 0 !**
    - Forward : suppression!
    - Backward: enhancement!
  - Parton scattering/energy loss
  - Parton (anti)shadowing
- Work in progress
  - Open heavy flavors
  - R_{CP} with heavy flavors



Is there shadowing/CGC at RHIC?

Posters

- <Q13> Anuj Purwar/Chun Zhang, "Charged hadron R_{CP} measurement using the Phenix Muon Arms for d-Au collisions at 200 GeV "
- <Q27>Dave Lee, "Muon production in forward and backward rapidity in dAu collisions"
- <Q3> Ken Read; <Q5> Youngil Kwon; <Q6> Andy Glenn.