What have we learned (recently) in PHENIX?

Paul Stankus

Oak Ridge National Lab

Hard Probes 2013

Nov. 4, Stellenbosch, SA

You are here

NOVA TOTIVS TERRARVM ORBIS GEOGRAPHICA AC HYDROGRAPHICA TABVLA

You are here

The Old World:

Large systems
Symmetric systems
Focus at mid-rapidity

Simplest path to QGP

Standard-ish Model:
CNM+QGP

The New World:
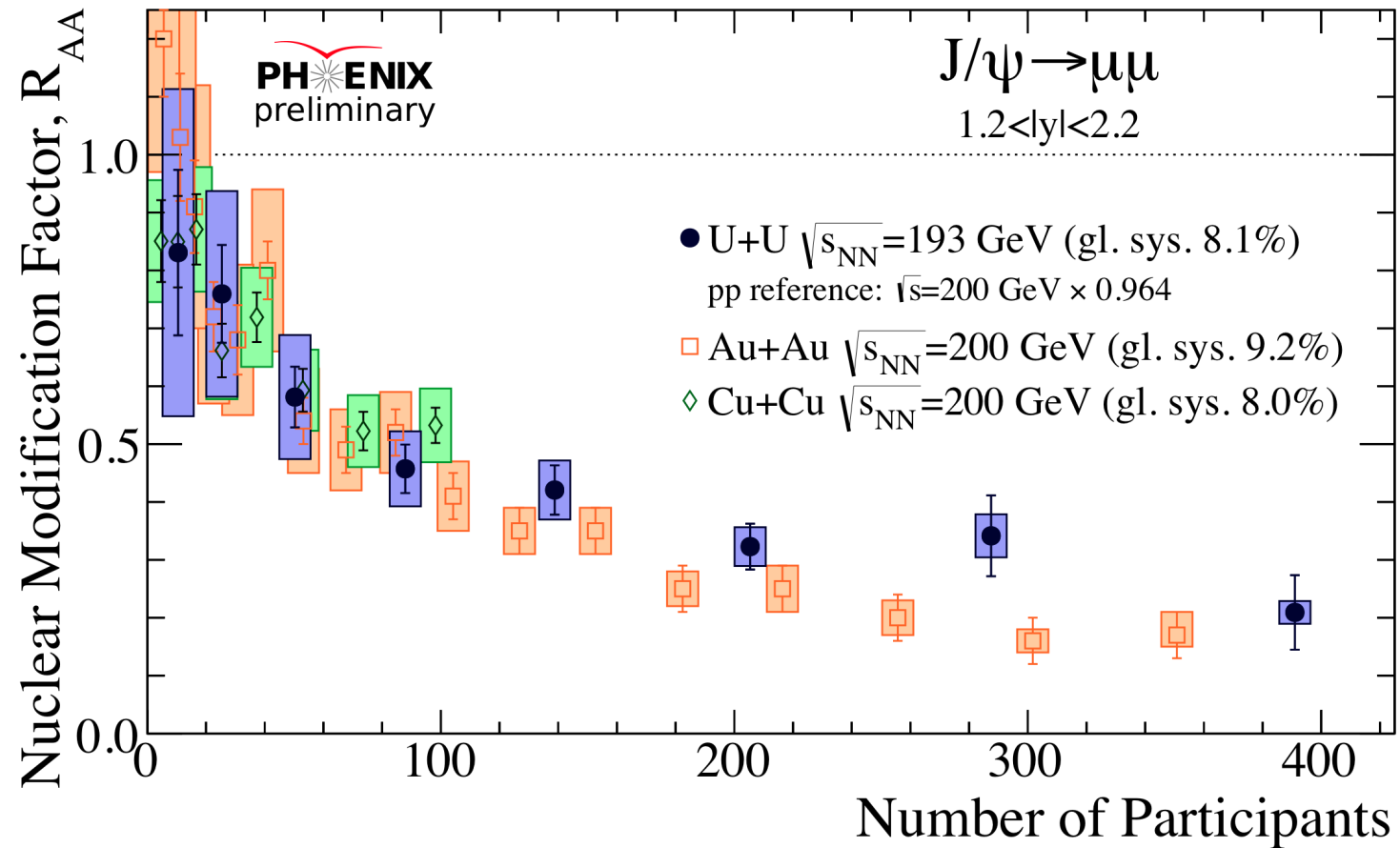
Small systems
Asymmetric systems
Measure away from
mid-rapidity

Take the "Standard
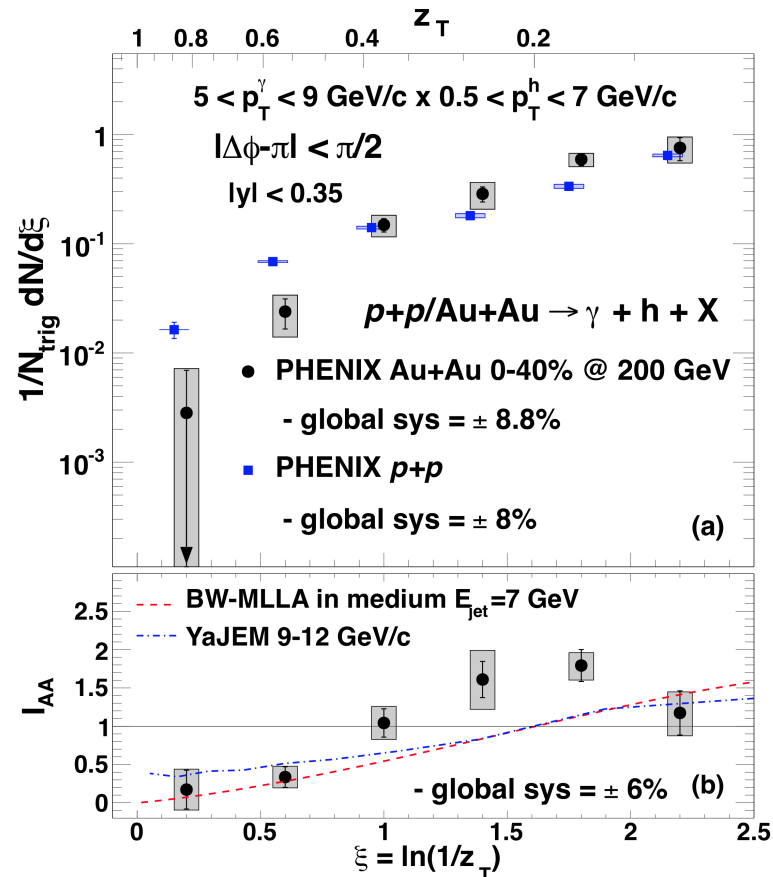Model" out on the
road…

News from the Old World

J/Psi in U+U

Jet-Medium Interactions

PRL 111, 32301 (2013)

Modified FF from γ+jet

A. Hanks, Wed 11:10am

Jet-Medium Interactions

PRL 111, 32301 (2013)

arXiv:1309.4437

Modified FF from γ+jet

v_2, v_4 of π^0, η to 15 GeV/c

A. Hanks, Wed 11:10am
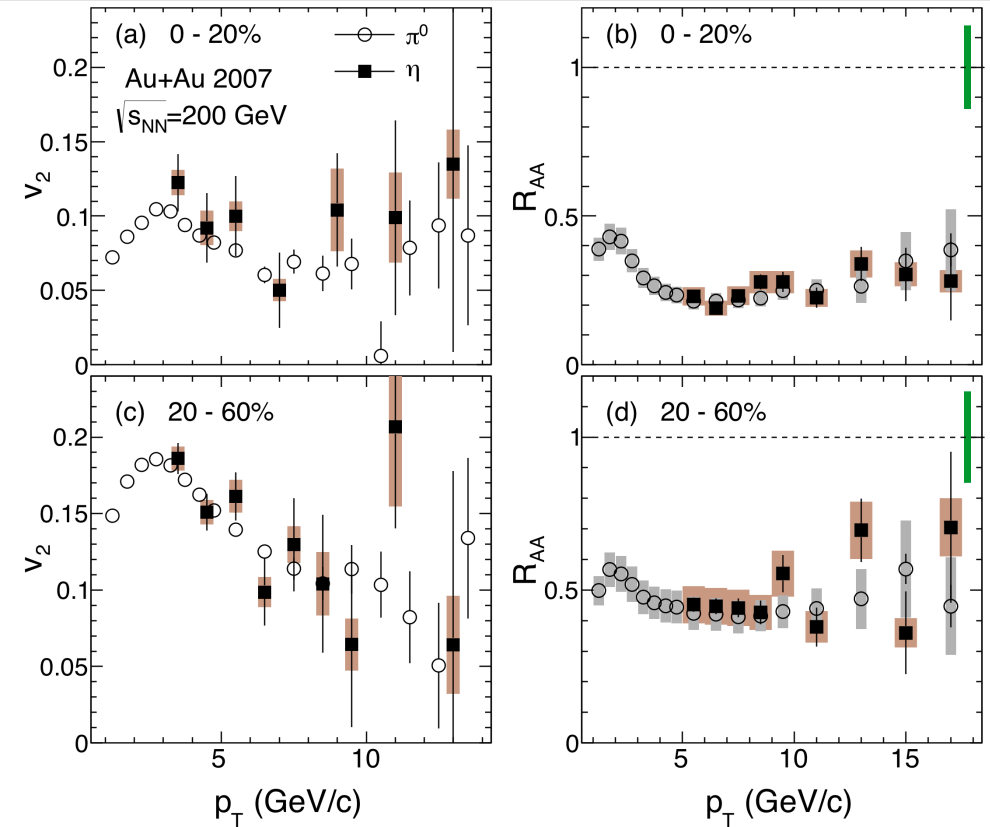
T. Sakaguchi, Mon 5:40pm

News from the New World

J/Psi in Cu+Au

$J/\psi \rightarrow \mu\mu$
Cu(d)-going $1.2 < y < 2.2$
Au-going $-2.2 < y < -1.2$

CuAu (gl. sys. 21%, $N_{part}^{periph} = 5.8 \pm 0.8$)
● Au-going   ○ Cu-going

dAu (gl. sys. 21%, $N_{part}^{periph} = 4.5 \pm 0.2$)
★ Au-going   ☆ d-going

PH✴ENIX
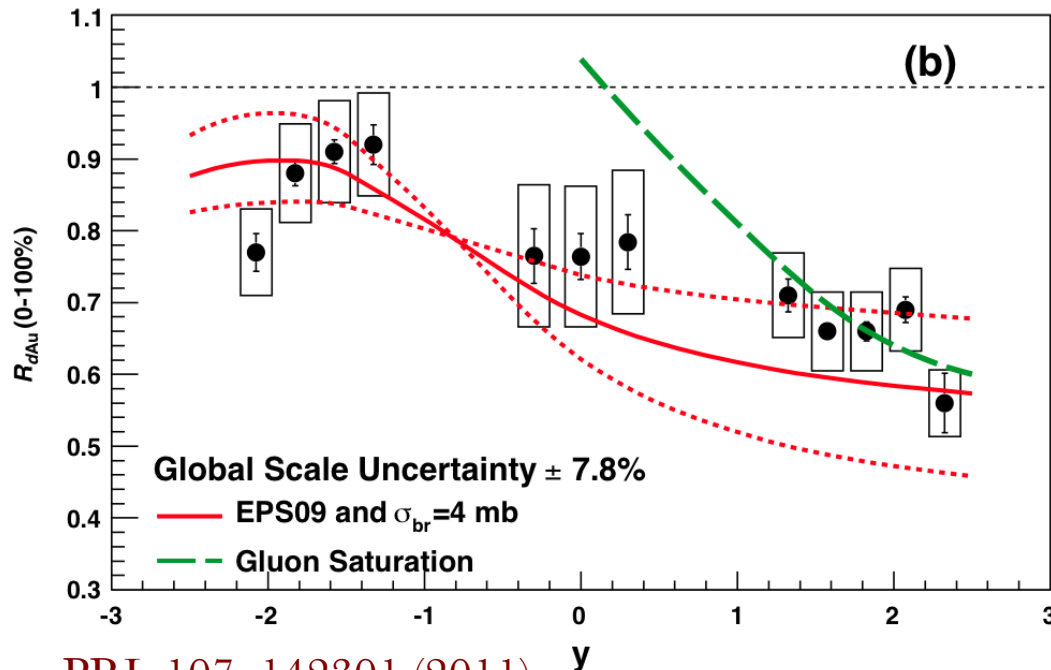preliminary
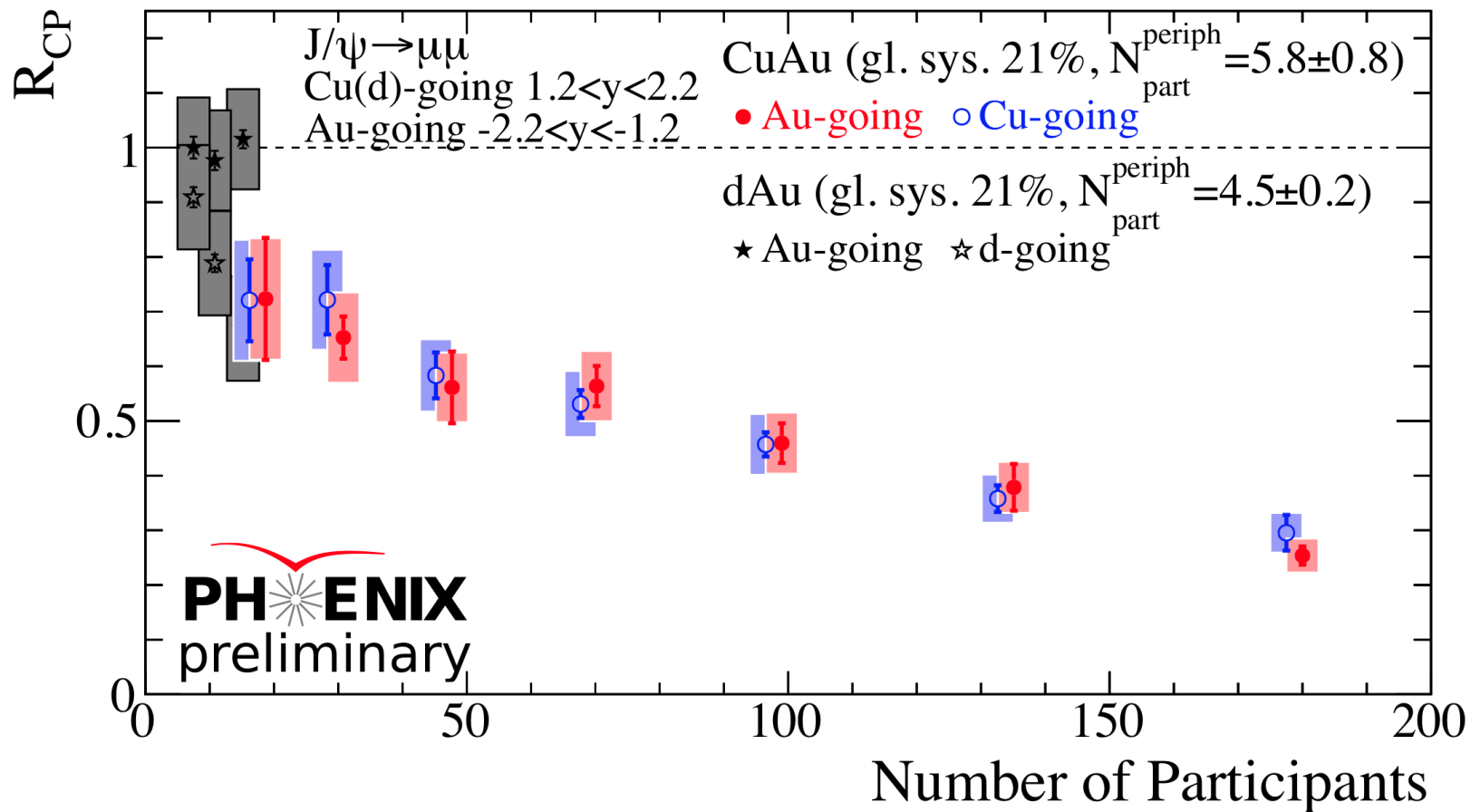
Where is the difference between (denser)
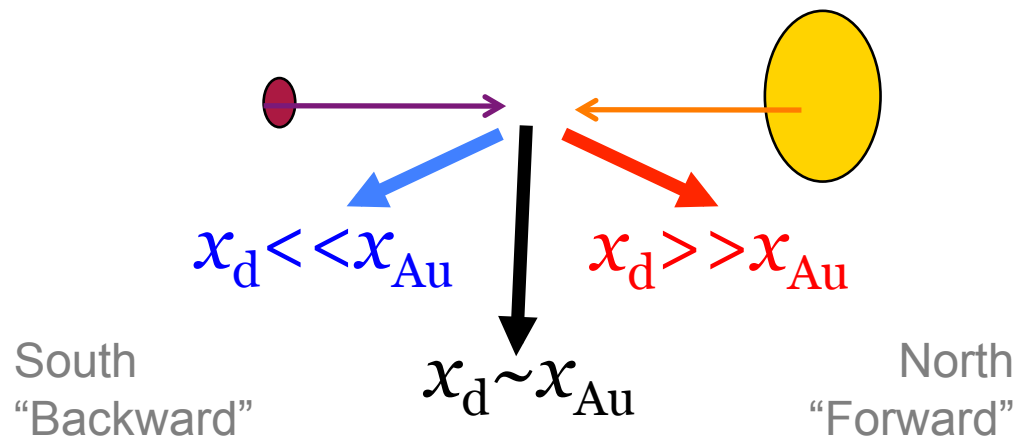Au-going and (thinner) Cu-going hot media?

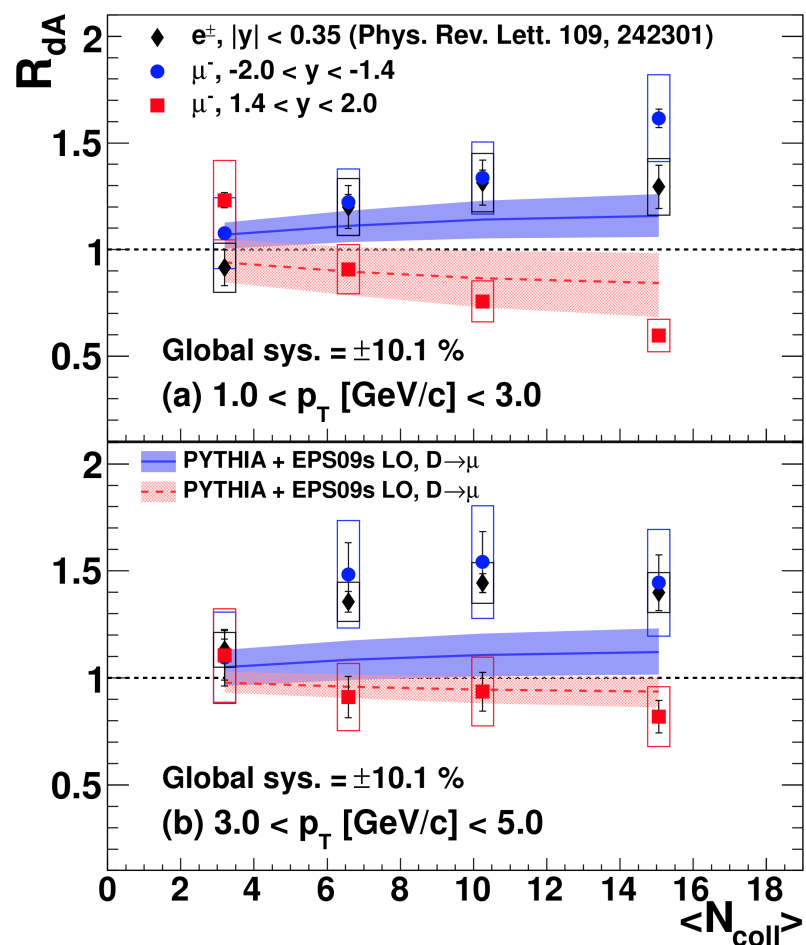# d+Au to forward/backward J/Psi

PRL 107, 142301 (2011)

R_{dAu} for J/Psi in min-bias d+Au

For inclusive d+Au, CNM modifications capture forward/ backward difference (but geometry dependence is harder).

South "Backward"

$x_d <\!< x_{Au}$

$x_d \sim x_{Au}$

$x_d >\!> x_{Au}$

North "Forward"

T. Frawley, Mon 4:00pm

11

Heavy flavor leptons, forward/back

Legend:
- $e^{\pm}$, $|y| < 0.35$ (Phys. Rev. Lett. 109, 242301)
- μ^{-}, $-2.0 < y < -1.4$
- μ^{-}, $1.4 < y < 2.0$

Global sys. = ± 10.1 %

(a) $1.0 < p_T$ [GeV/c] < 3.0

- PYTHIA + EPS09s LO, $D \to \mu$
- PYTHIA + EPS09s LO, $D \to \mu$

Global sys. = ± 10.1 %

(b) $3.0 < p_T$ [GeV/c] < 5.0

Axis labels: R_{dA} (vertical), $\langle N_{coll} \rangle$ (horizontal)

Forward-backward difference
seen, but larger than from EPS09

arXiv:1310.1005

M. Durham, Mon 4:00pm
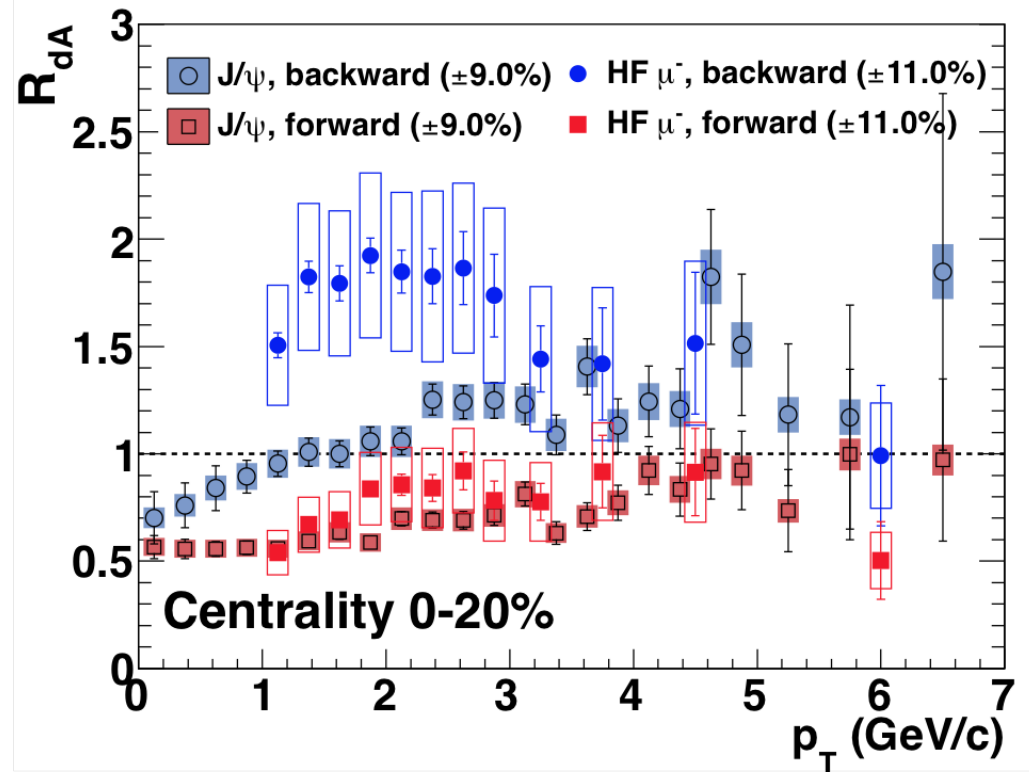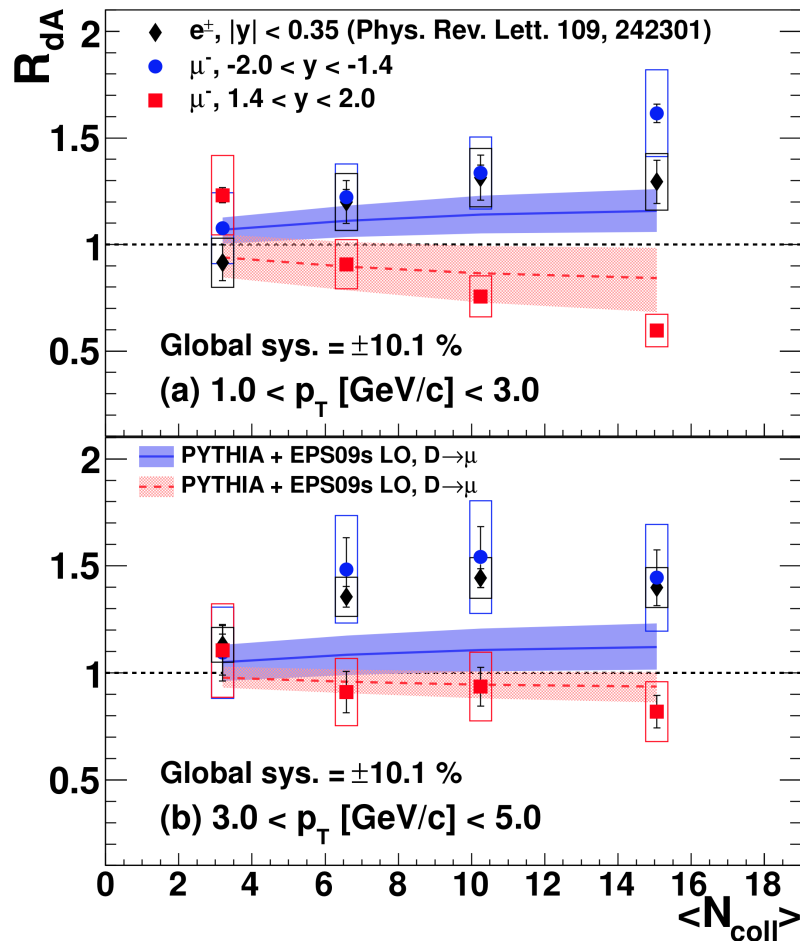
12

Heavy flavor leptons, forward/back

Forward-backward difference
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arXiv:1310.1005

M. Durham, Mon 4:00pm

13
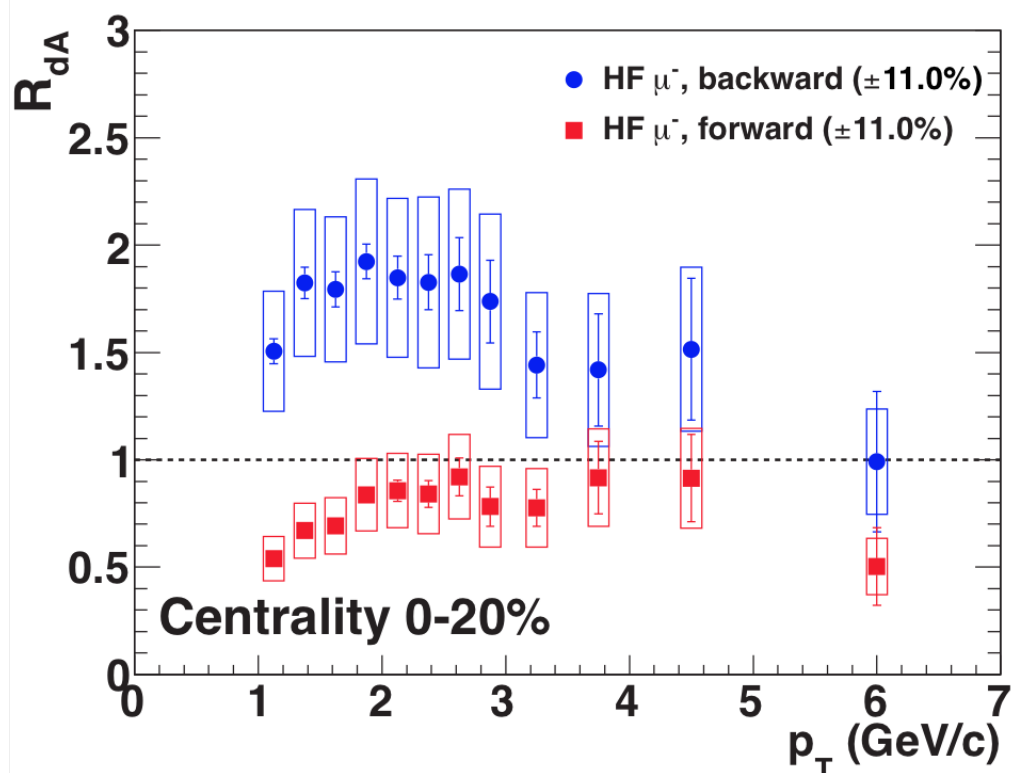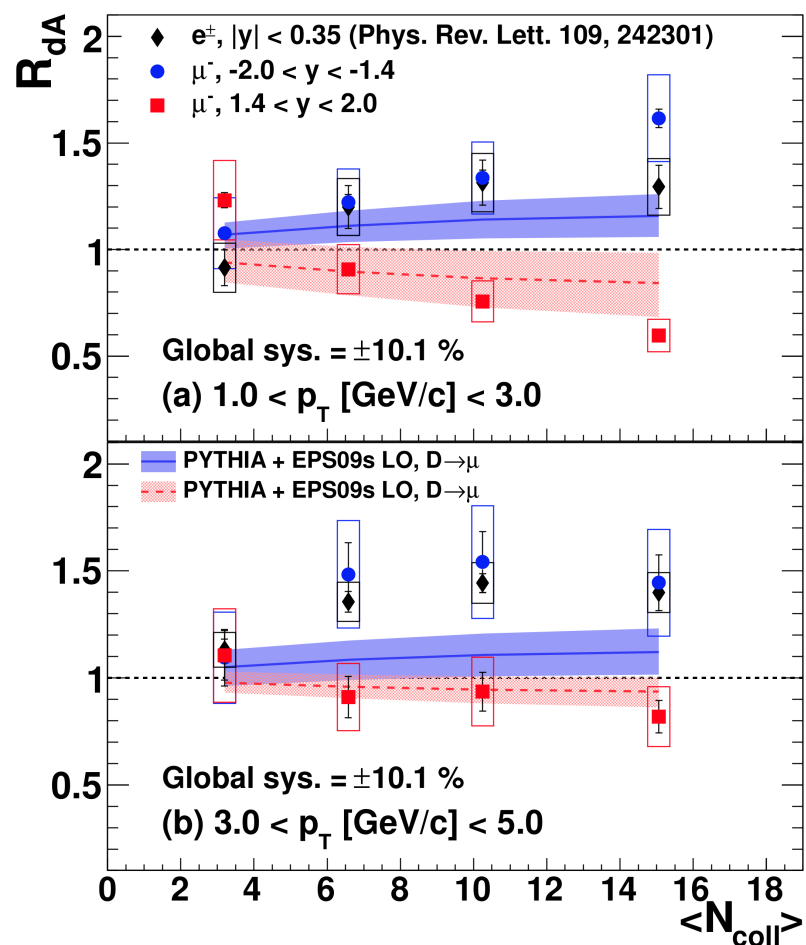
Heavy flavor leptons, forward/back

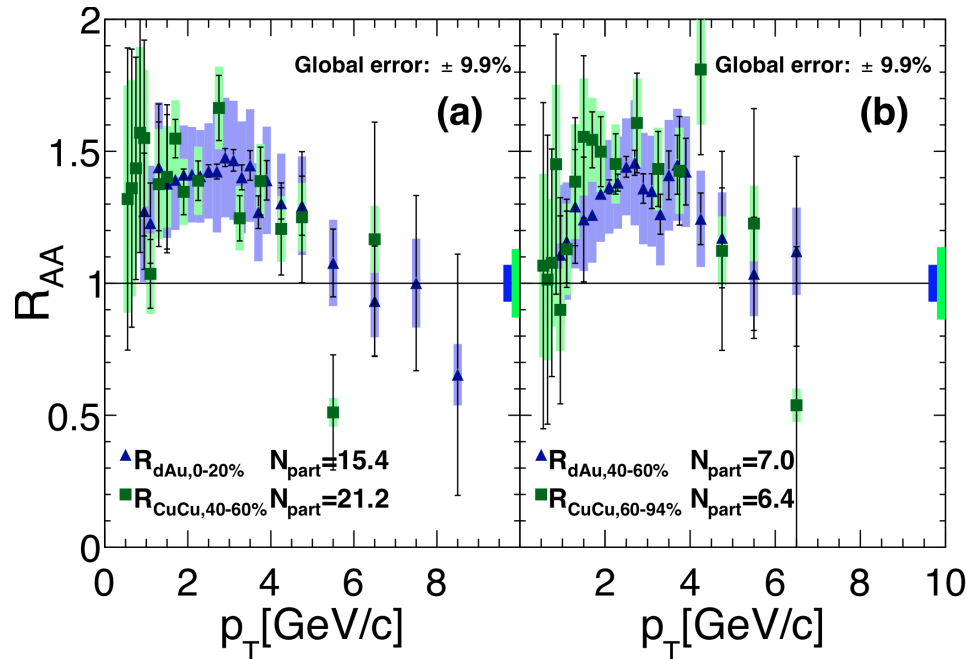Backward, Au-going effect larger for HF than for J/Psi

arXiv:1310.1005

M. Durham, Mon 4:00pm

14

Charm boost follows N_{Part}

Heavy-flavor electrons in three systems
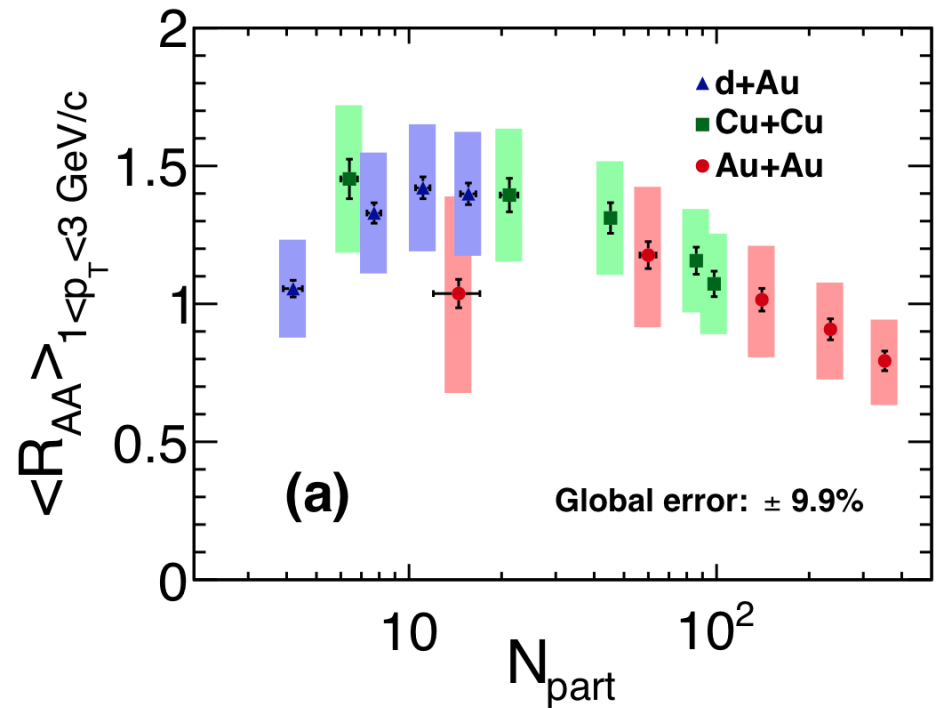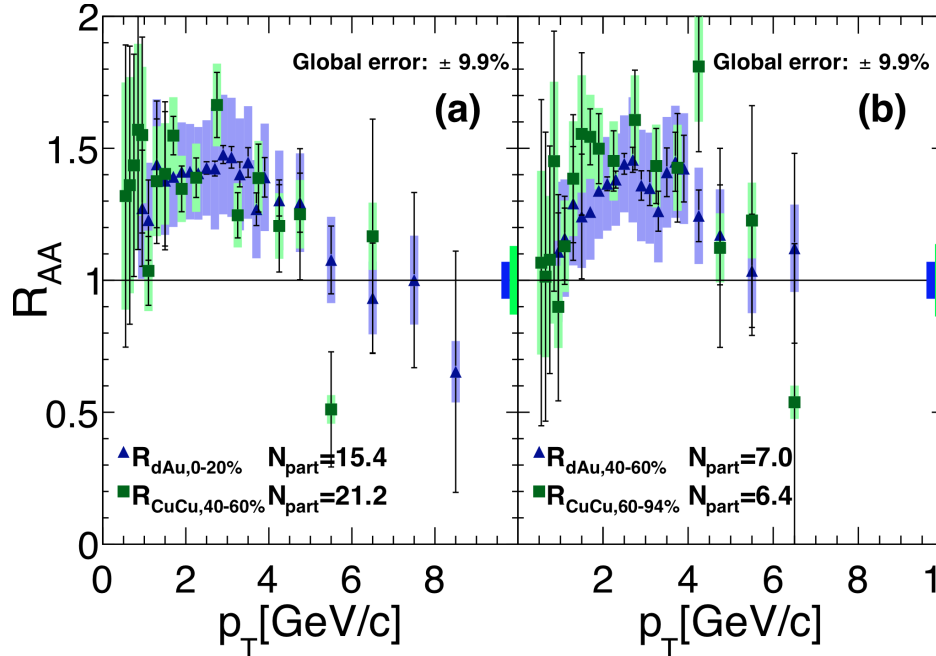
d+Au meets Cu+Cu

arXiv:1310.8286

Charm boost follows N_{Part}
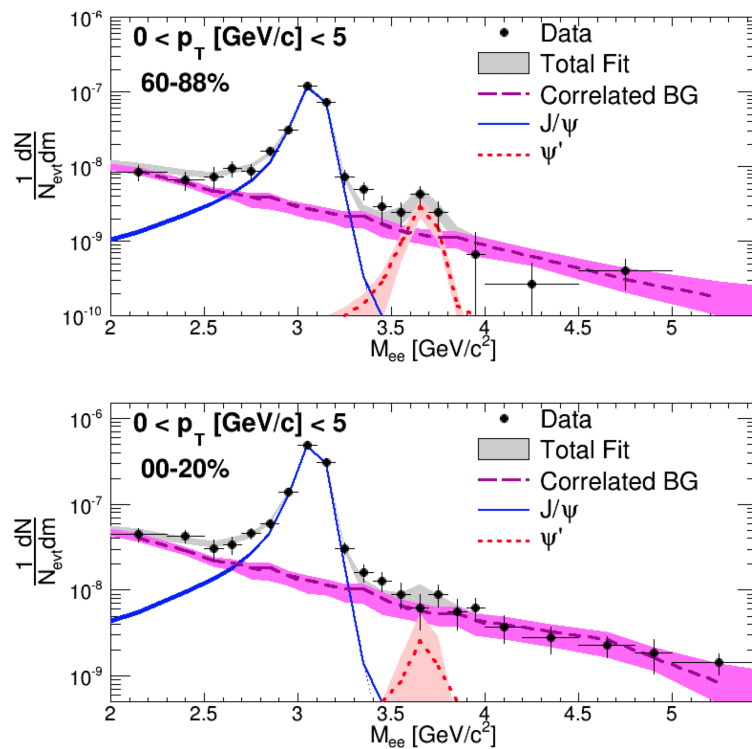
Heavy-flavor electrons in three systems

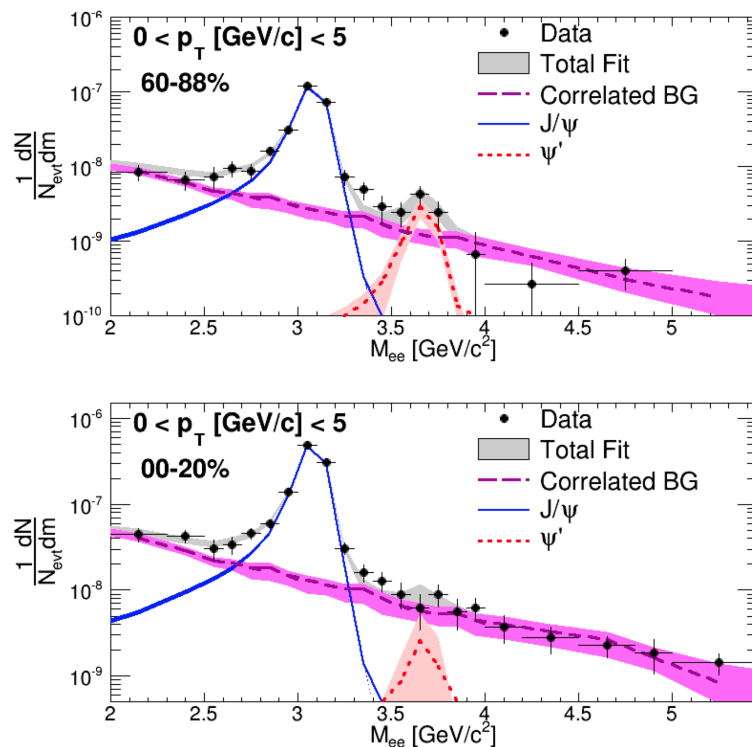d+Au meets Cu+Cu

arXiv:1310.8286

Single charm is pushed but never destroyed; is trend with N_{Part} indicative of medium effect?

16

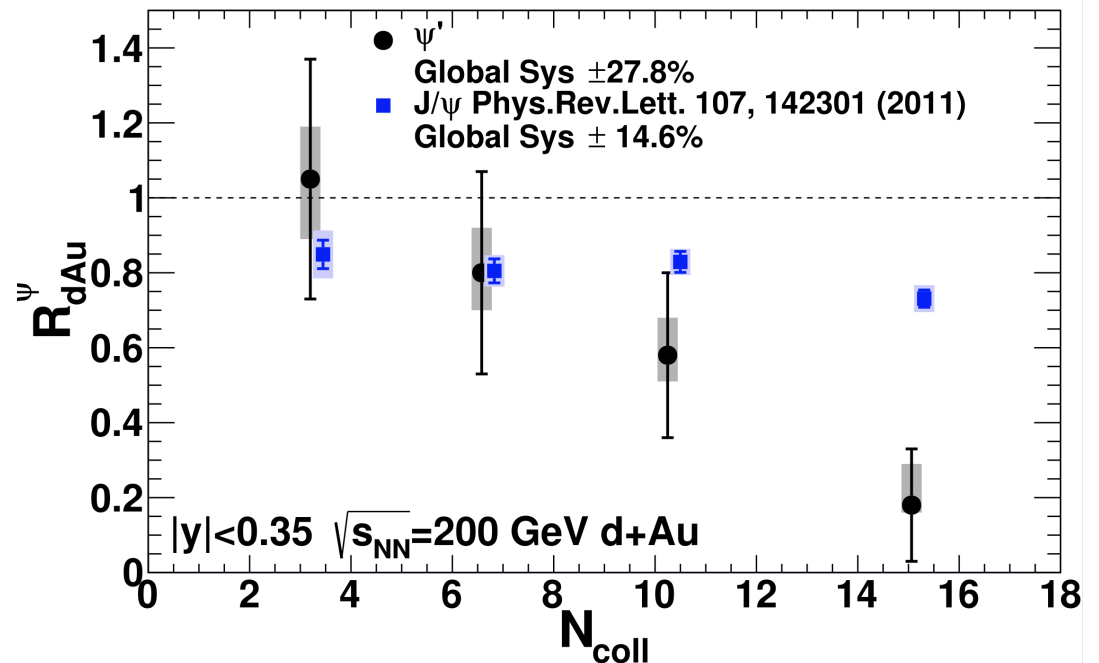# Psi' (over?) suppression in d+Au

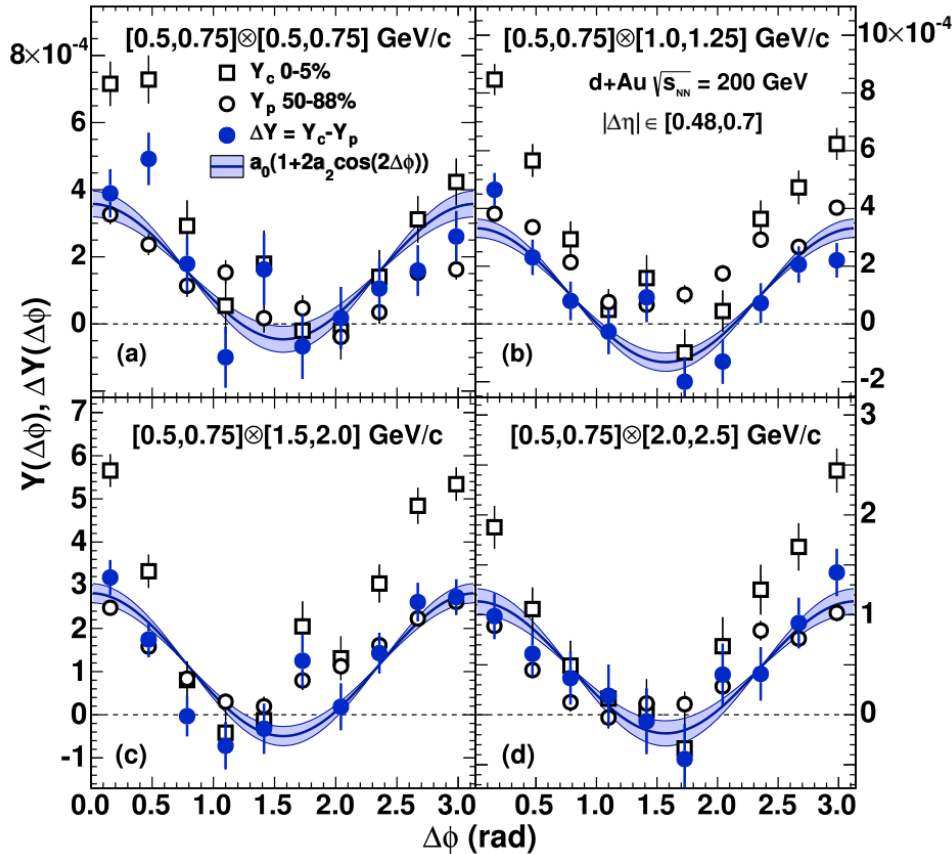arXiv:1315.5516, to be publ PRL

Psi' (over?) suppression in d+Au

arXiv:1315.5516, to be publ PRL

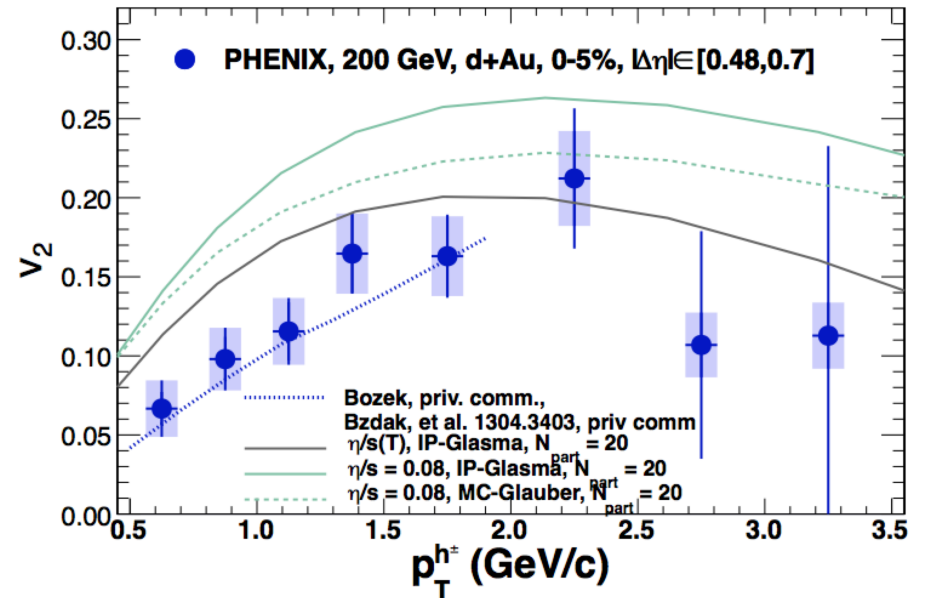Relative suppression of Psi' compared to J/Psi – is it a created medium effect?
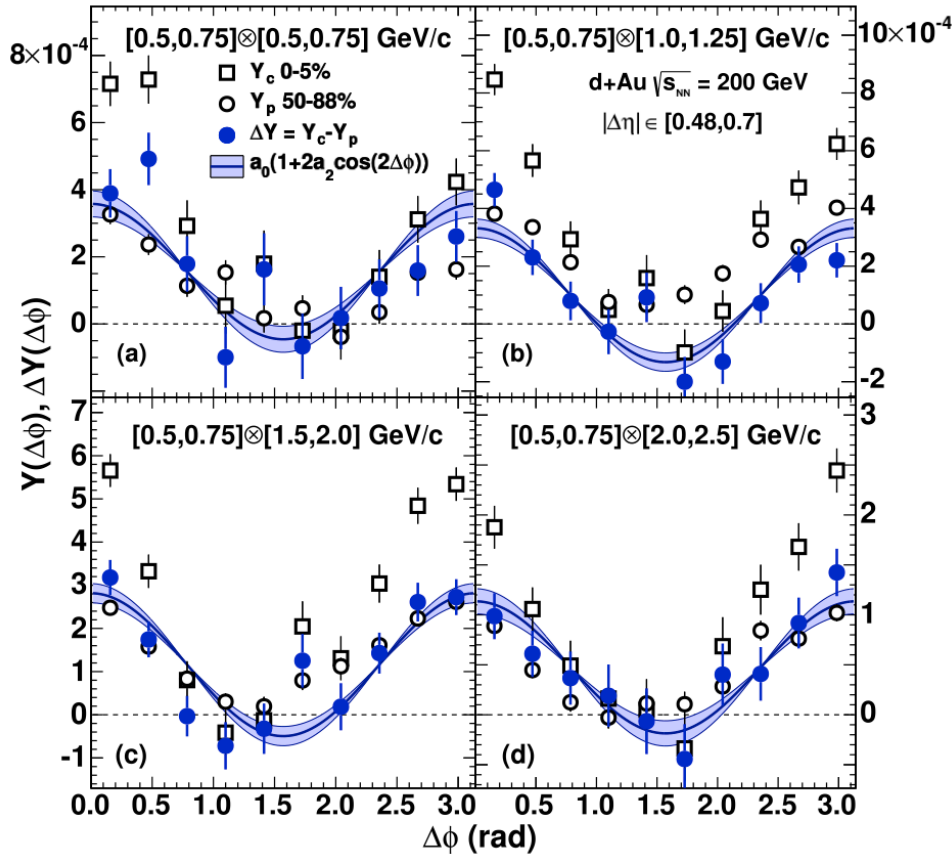
D. McGlinchey, Fri 8:40am

18

Flow in d+Au?

Charged pairs at mid-rapidity over Δφ; central, peripheral and difference

Flow in d+Au?

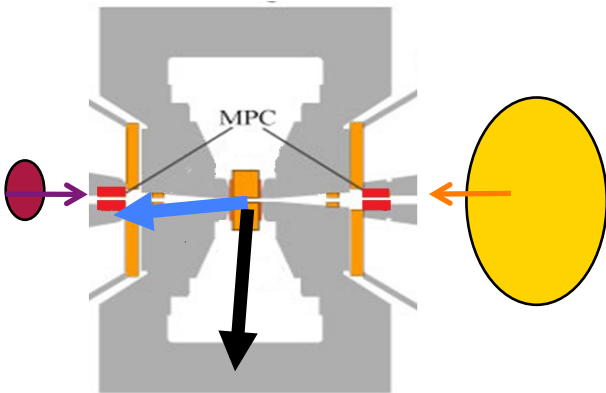## Charged pairs at mid-rapidity over Δφ; central, peripheral and difference

Quadrupole anisotropy allows extraction of singles v_2

arXiv:1303.1794 to be publ. PRL
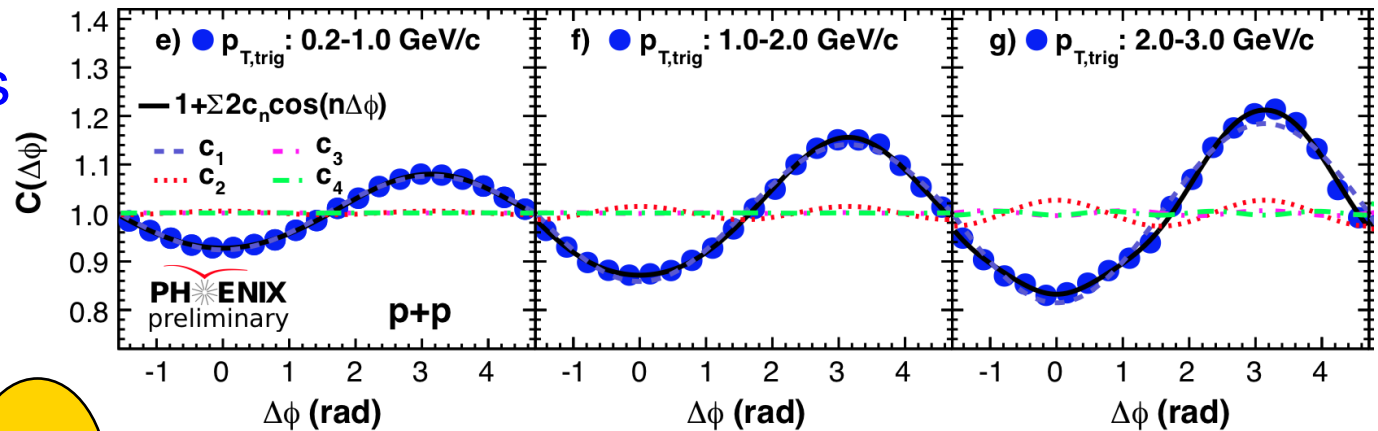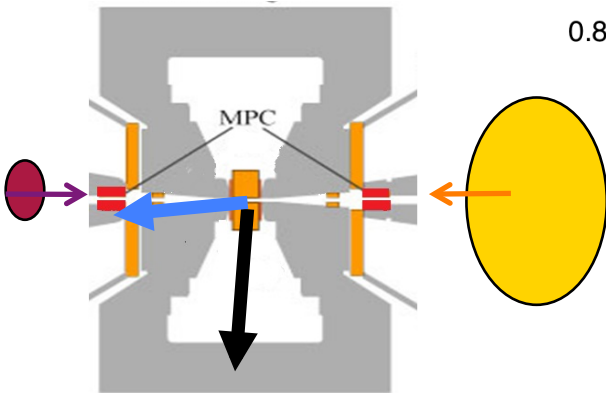
Near-side "ridge" in d+Au?

Pair central arm tracks with MPC-S, $\Delta\eta \sim 3.4$

Near-side "ridge" in d+Au?

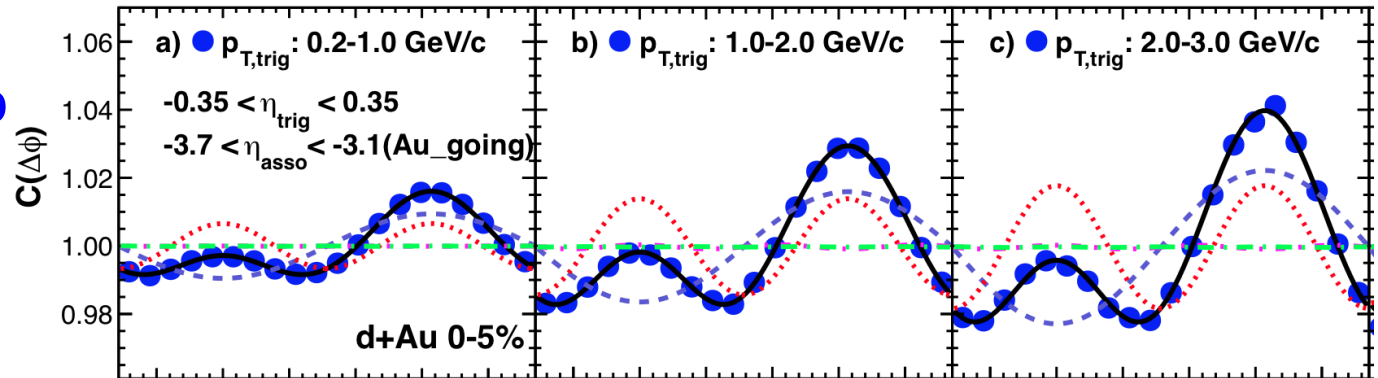## Pair central arm tracks with MPC-S, $\Delta\eta \sim 3.4$
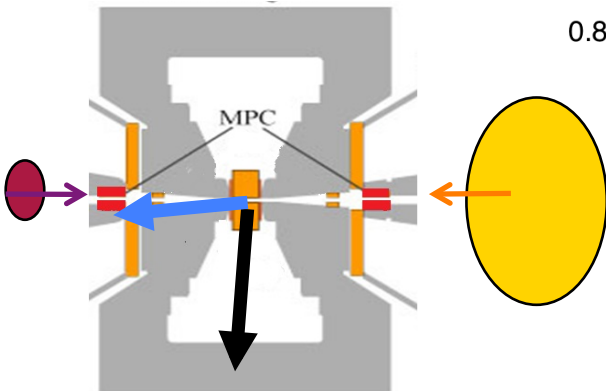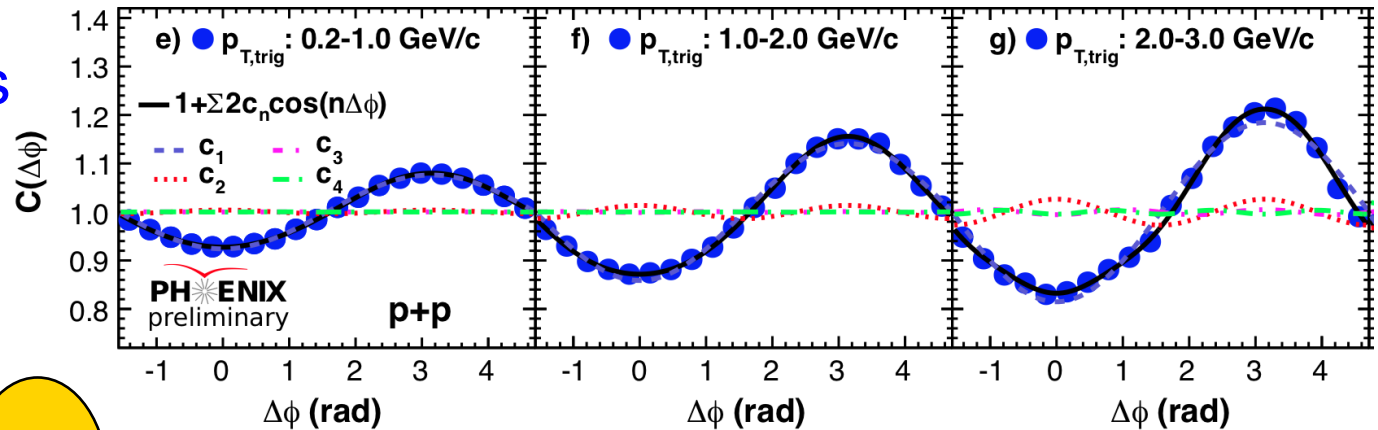
p+p min-bias

Near-side "ridge" in d+Au?

Pair central arm tracks with MPC-S, $\Delta\eta \sim 3.4$
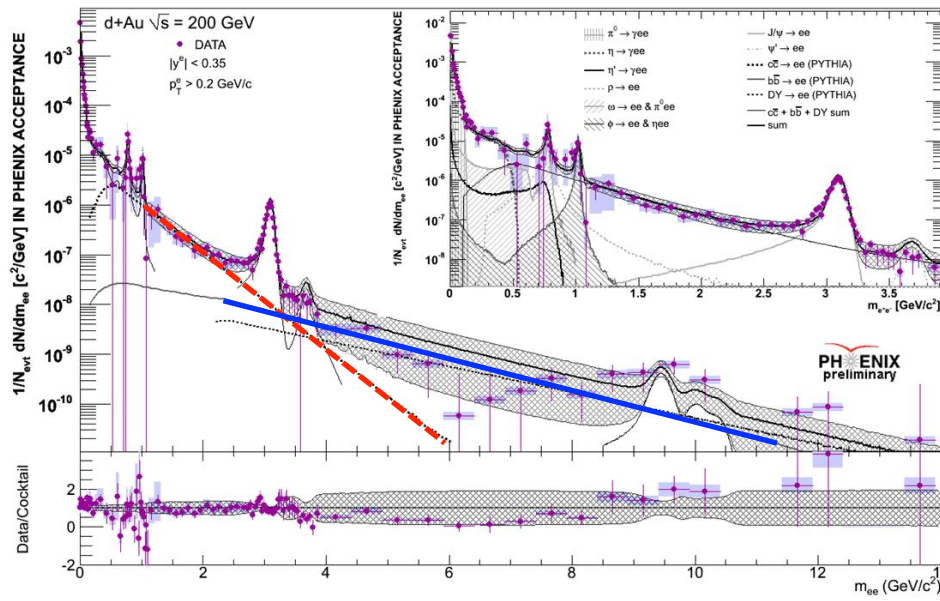
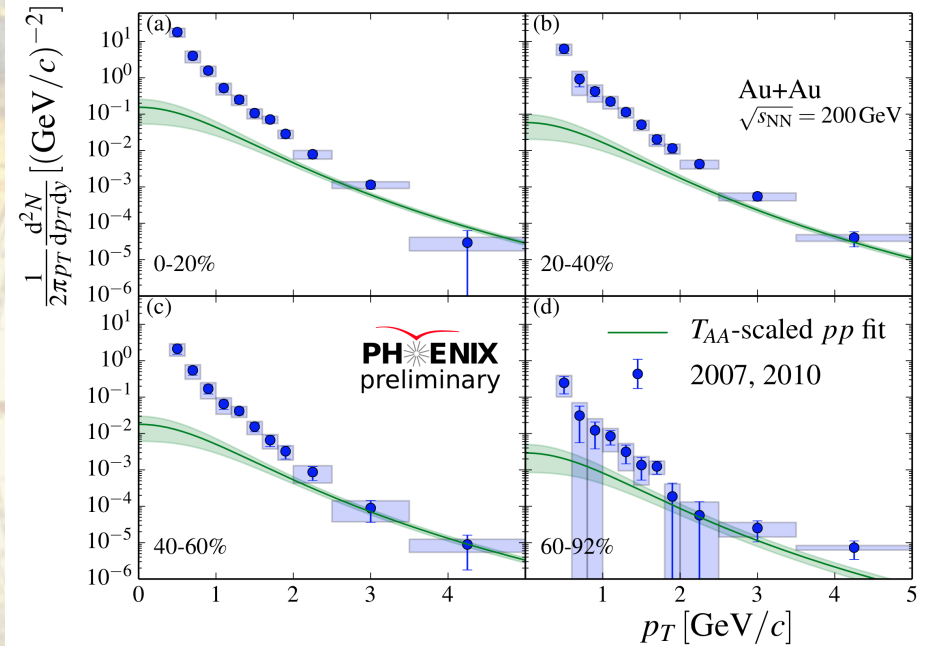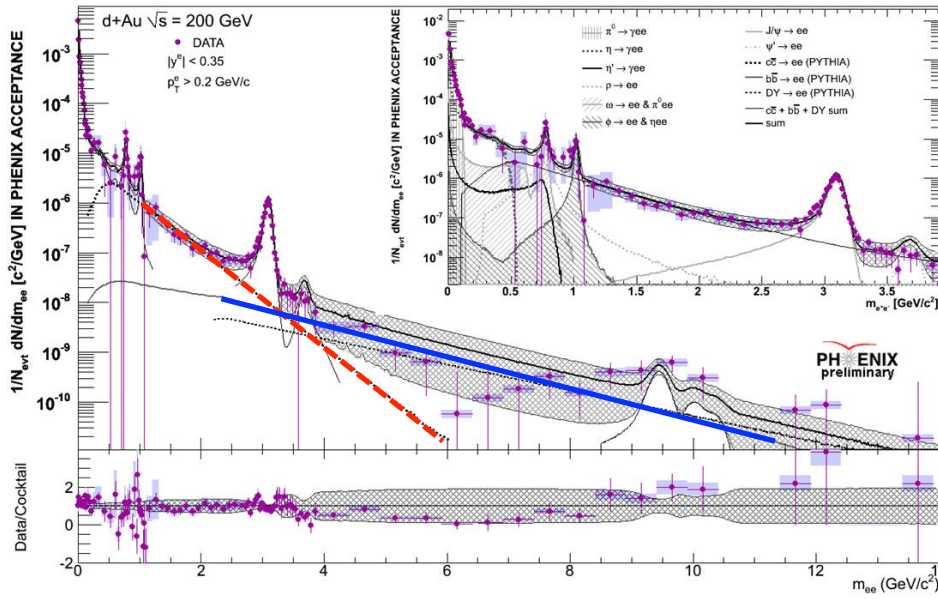d+Au 0-5%

p+p min-bias

More news…

cc vs bb separation via
dielectrons in d+Au
across mass and p_T

D. Sharma, Tue 2:50pm

More news…

cc vs bb separation via dielectrons in d+Au across mass and p_T

Centrality dependence of excess direct photons

D. Sharma, Tue 2:50pm

B. Bannier, Tue 1:30pm

Summary

- New observables in large, symmetric A+A
  - γ+jet, π^0,η v_2 to high p_T, excess direct γ

- Small and asymmetric systems
  - *Wealth* of new results in d+Au
  - Geometry of CNM effects?
  - Many indications of created medium in d+Au:
    - Charm radial boost?
    - Psi' relative suppression
    - Near-side ridge and elliptic anisotropy

Ask me about…
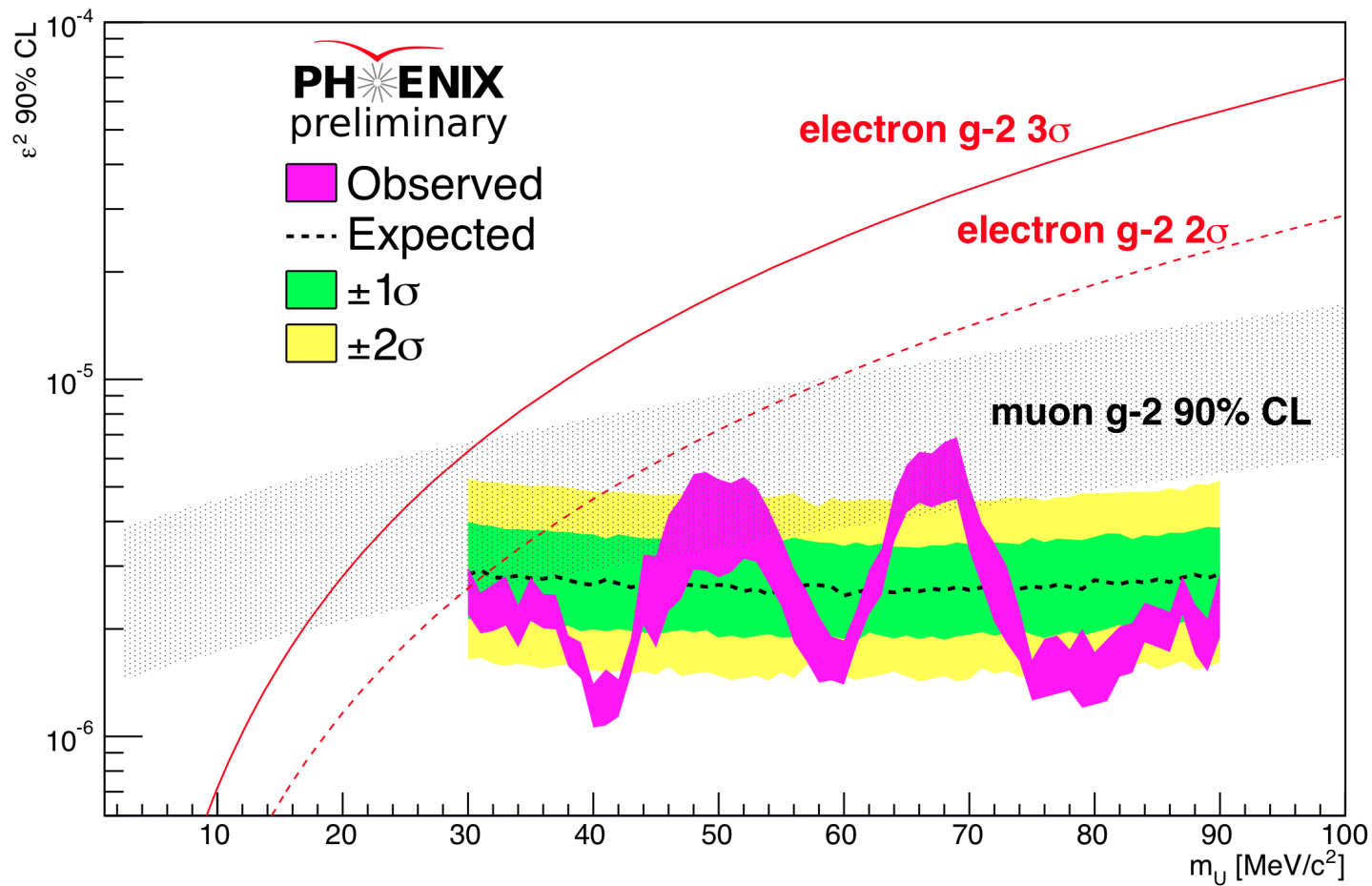
PHENIX limits on "dark photon" production

Backup material

Geometry of CNM effects?

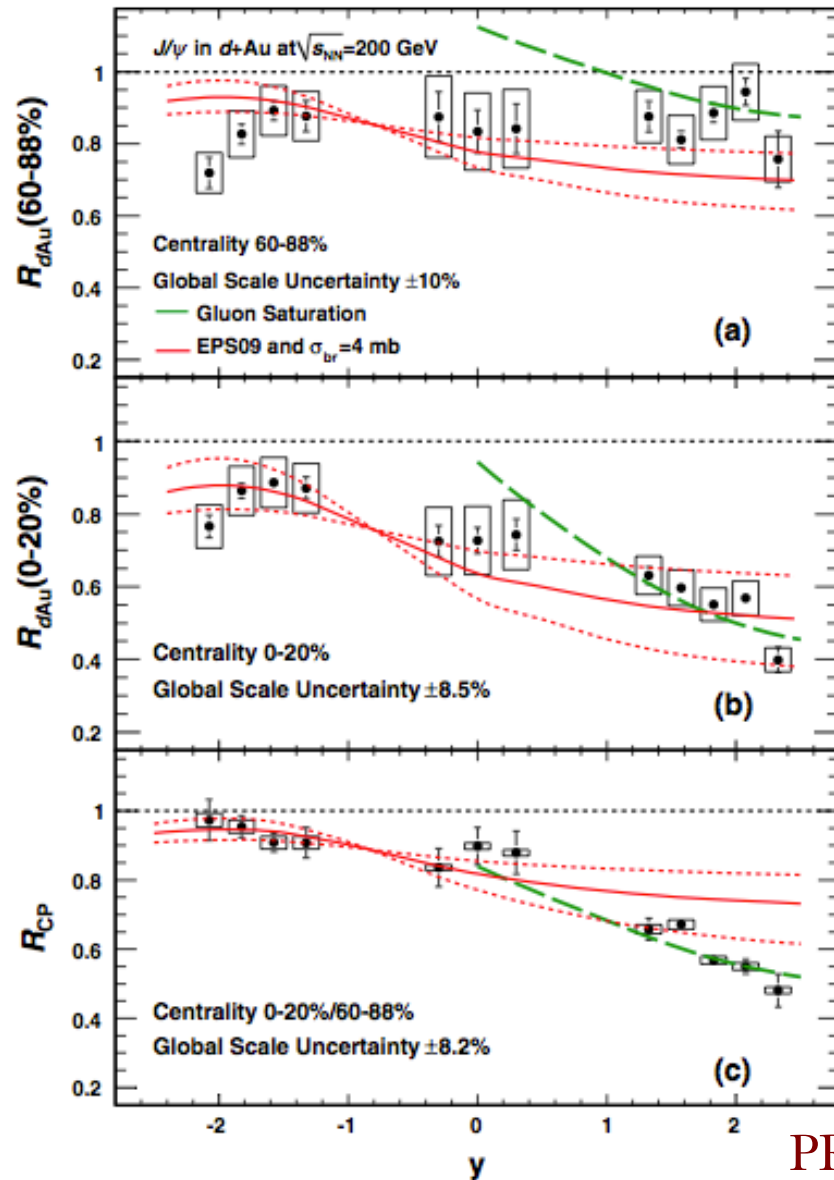J/ψ in d+Au at $\sqrt{s_{NN}}=200$ GeV

Centrality 60-88%
Global Scale Uncertainty ±10%
— Gluon Saturation
— EPS09 and $\sigma_{br}=4$ mb
(a)

Centrality 0-20%
Global Scale Uncertainty ±8.5%
(b)

Centrality 0-20%/60-88%
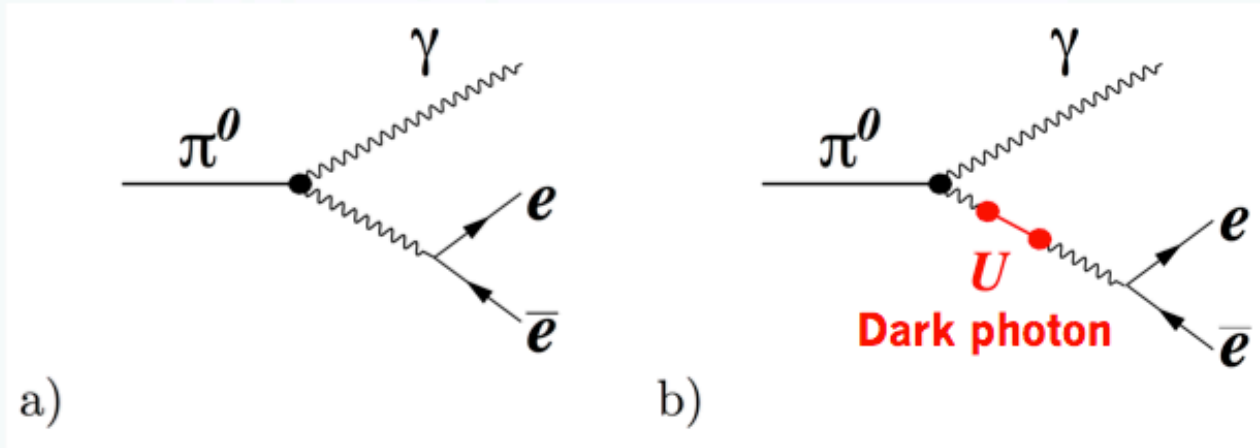Global Scale Uncertainty ±8.2%
(c)

Peripheral

Central

R_{CP}

CNM modification does *not* reproduce centrality/geometry dependence.

29

Search in π^0 Dalitz decays

a) b)

Measurement of $\pi^0 \to \gamma U \to \gamma e^+e^-$ in π^0 Dalitz decays

✧ Detection of e^+e^- pairs from the dark photons in the π^0 Dalitz decayed e^+e^- pairs
   ✓ The dark photon exclusively decays into e^+e^- pair.
   ✓ Its natural width is practically zero.
      • Expected peak width = mass resolution

Important requirements for the dark photon search

1. Large data samples of e^+e^- from π^0 Dalitz decays
2. A very good mass resolution of e^+e^-

Slide from
Yorito
Yamaguchi
DNP 2013