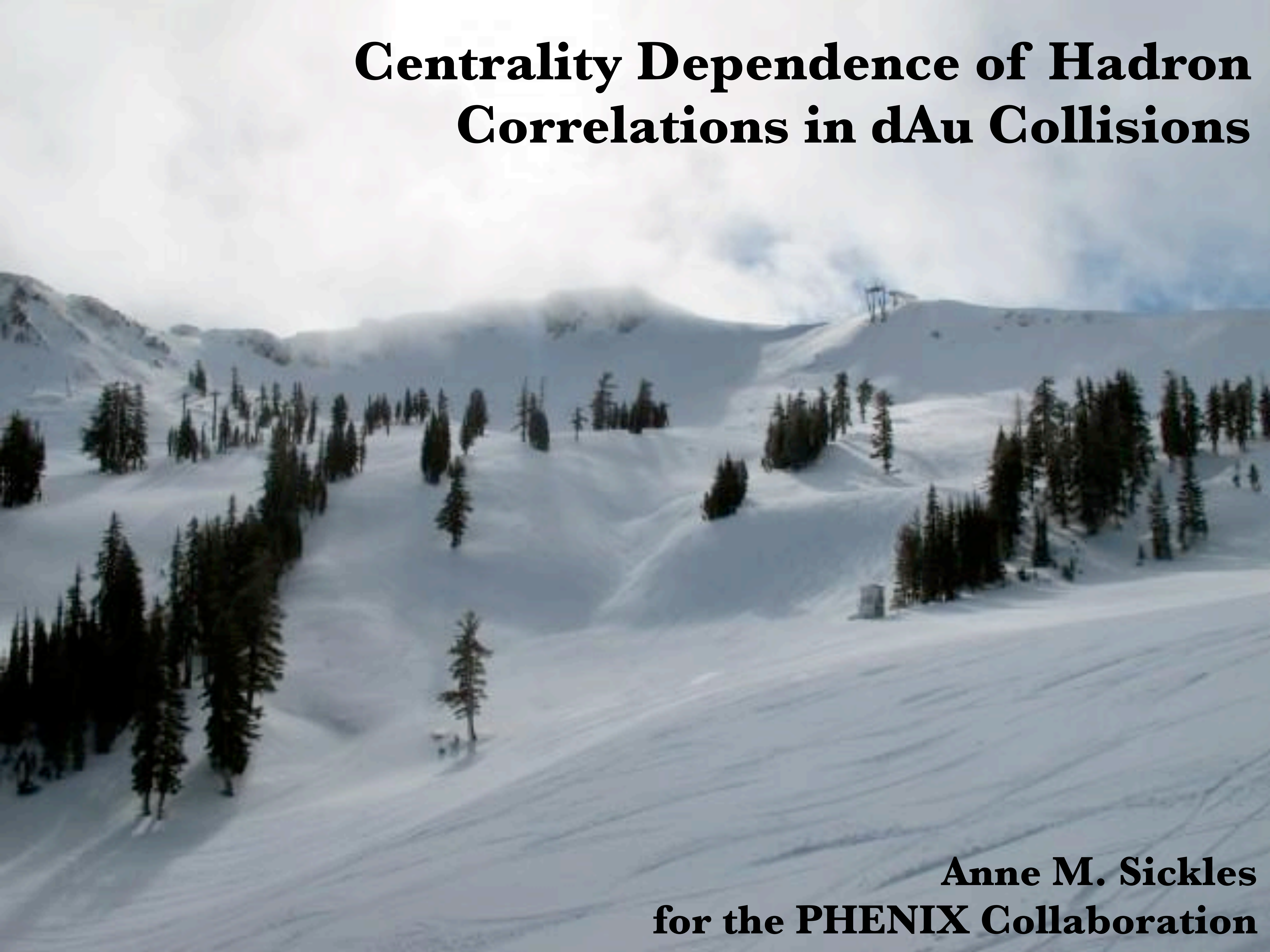
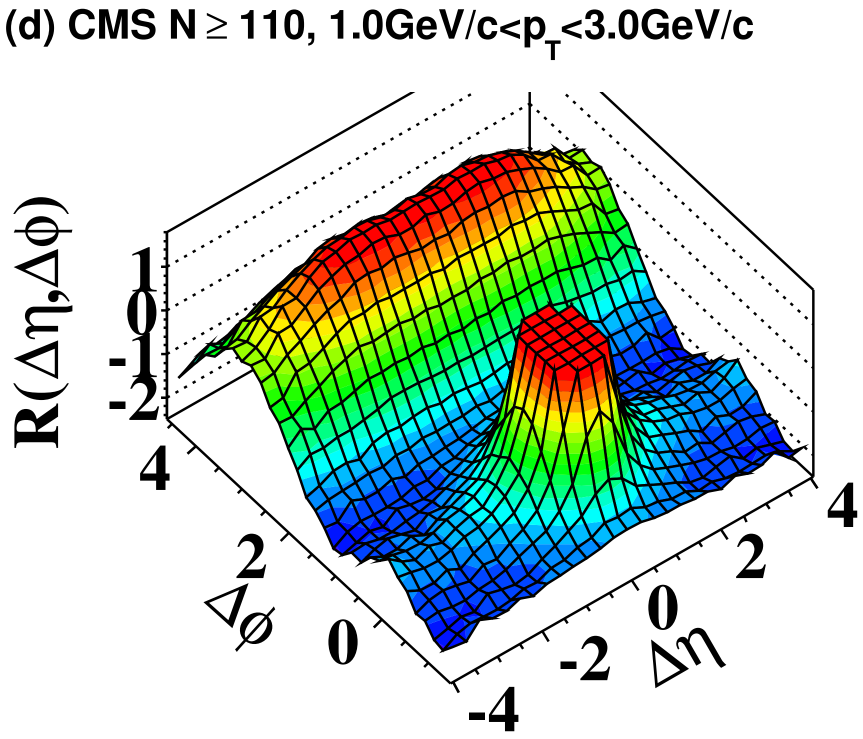


Centrality Dependence of Hadron Correlations in dAu Collisions

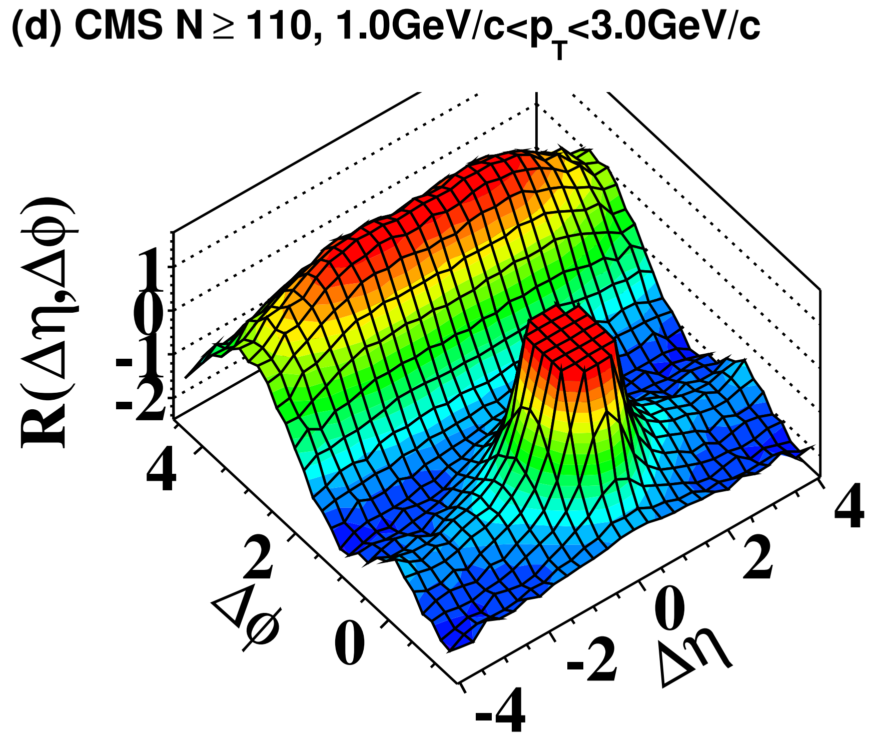
Anne M. Sickles
for the PHENIX Collaboration

p+p @ 7TeV

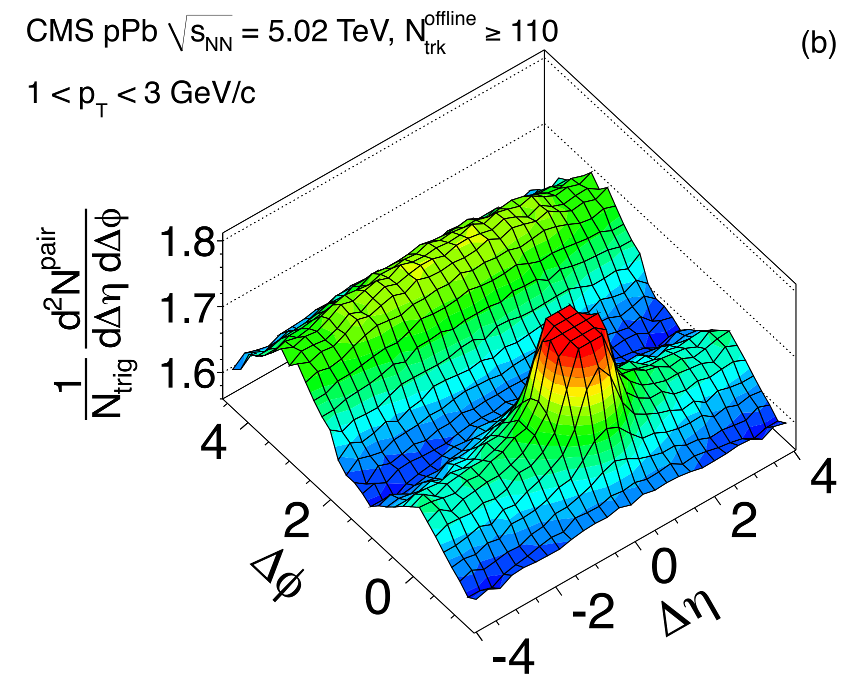


LHC results

p+p @ 7TeV

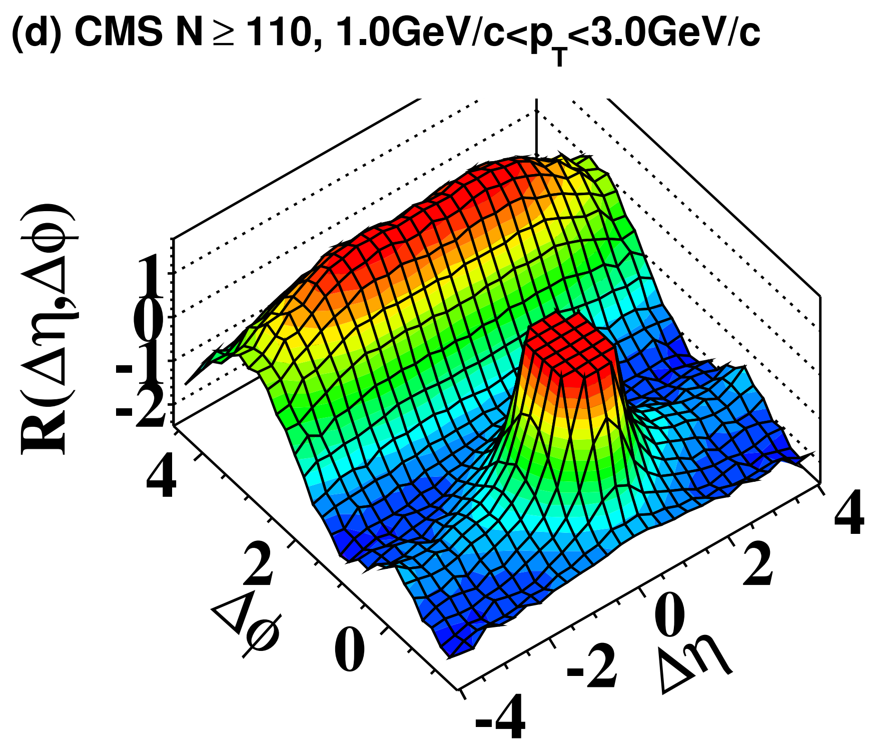


p+Pb @ 5.02TeV

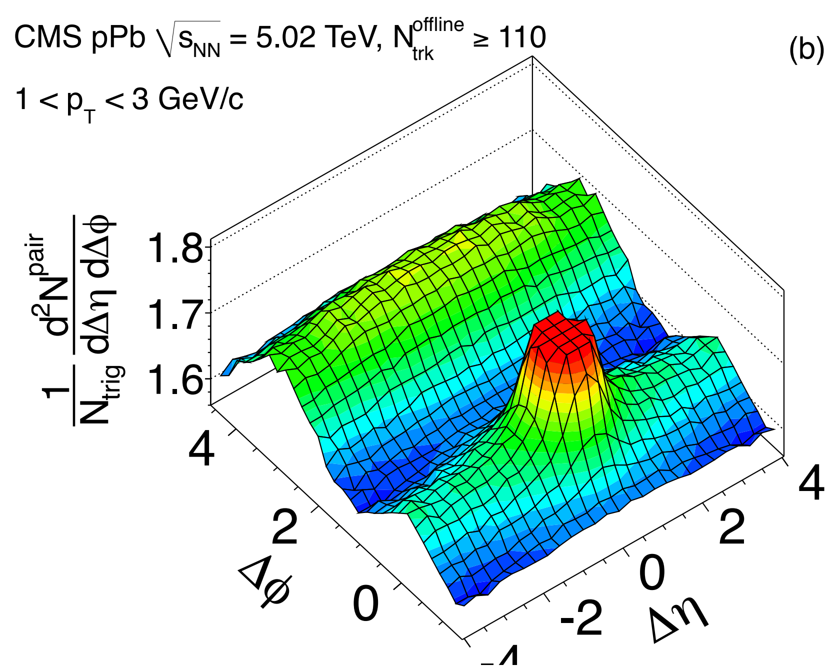


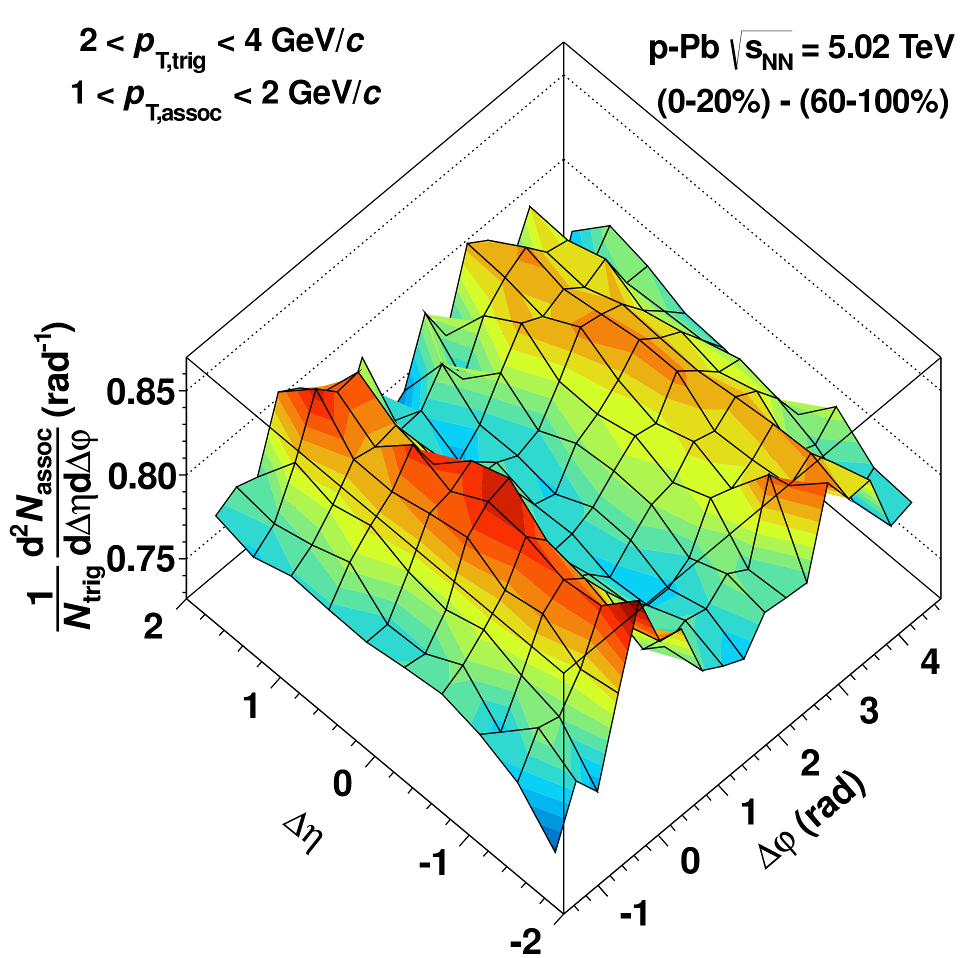
LHC results

p+p @ 7TeV



p+Pb @ 5.02TeV





LHC results

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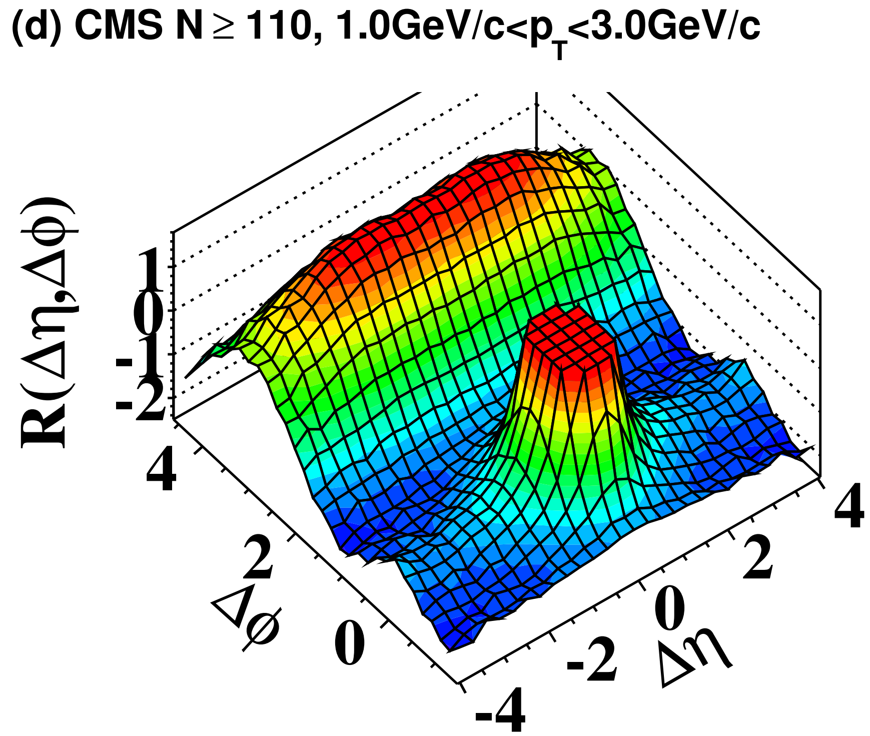

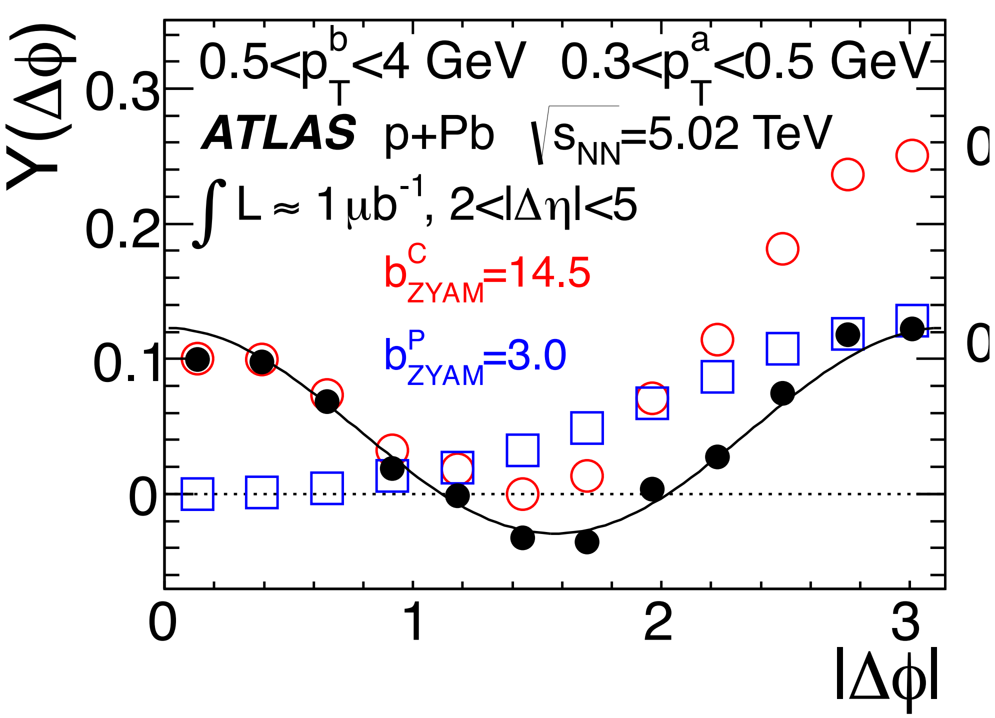

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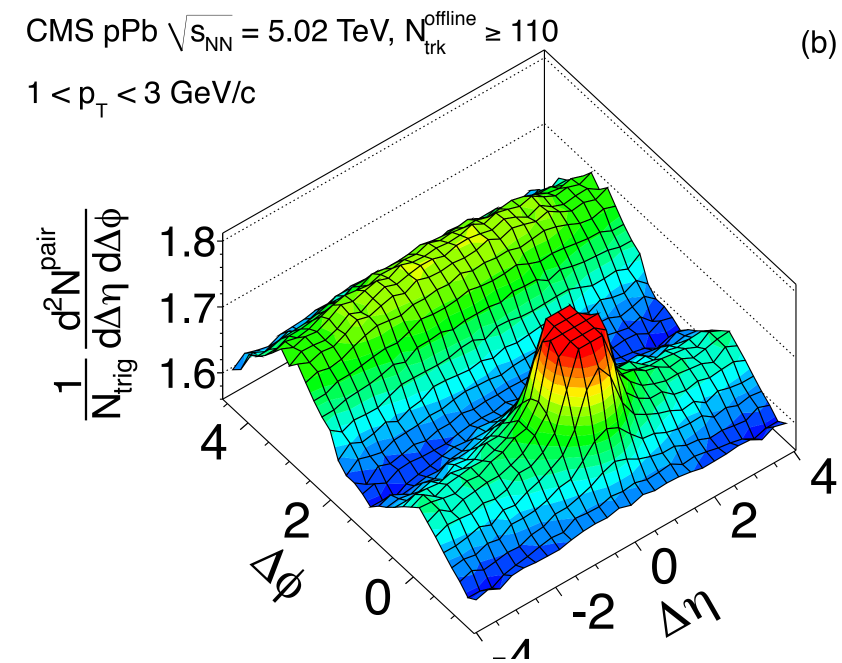
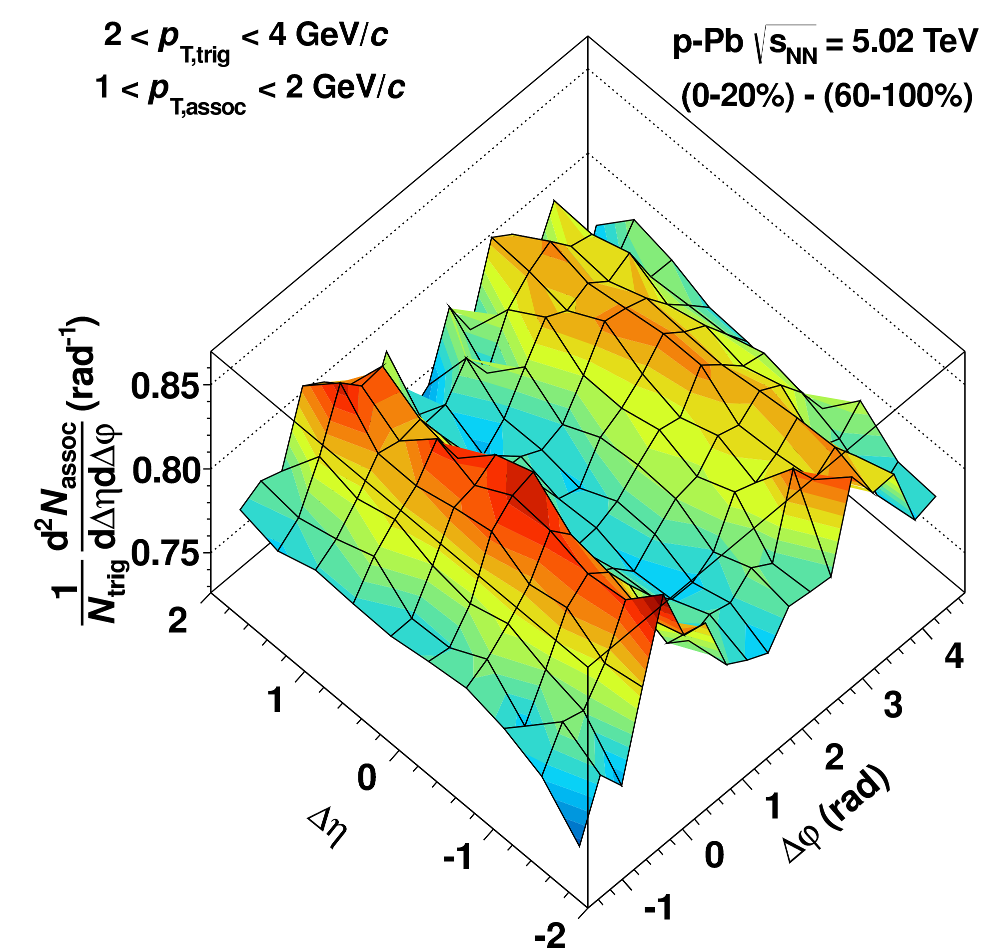
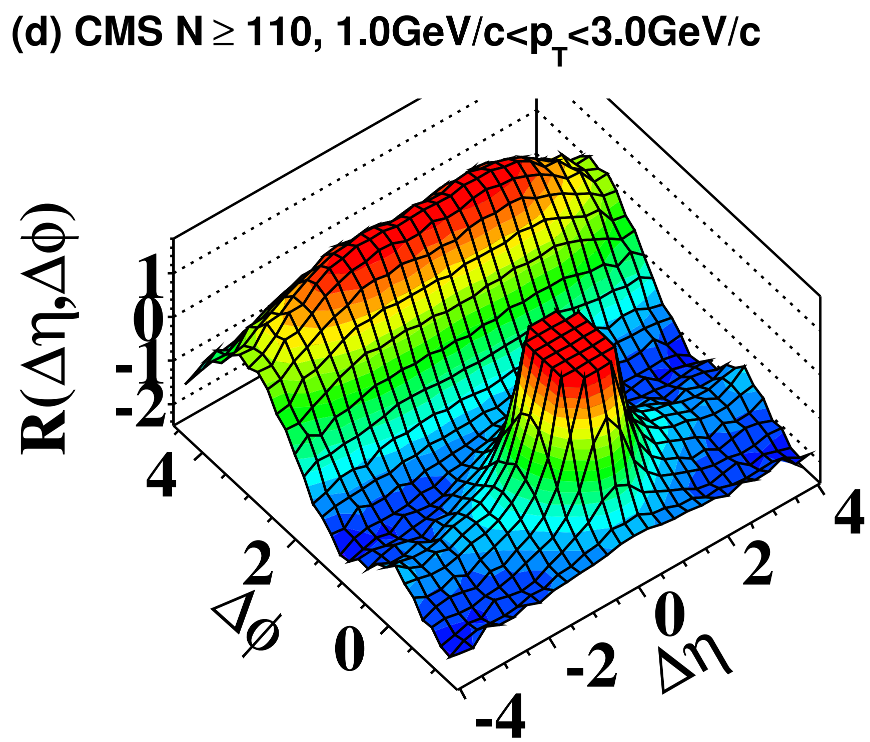
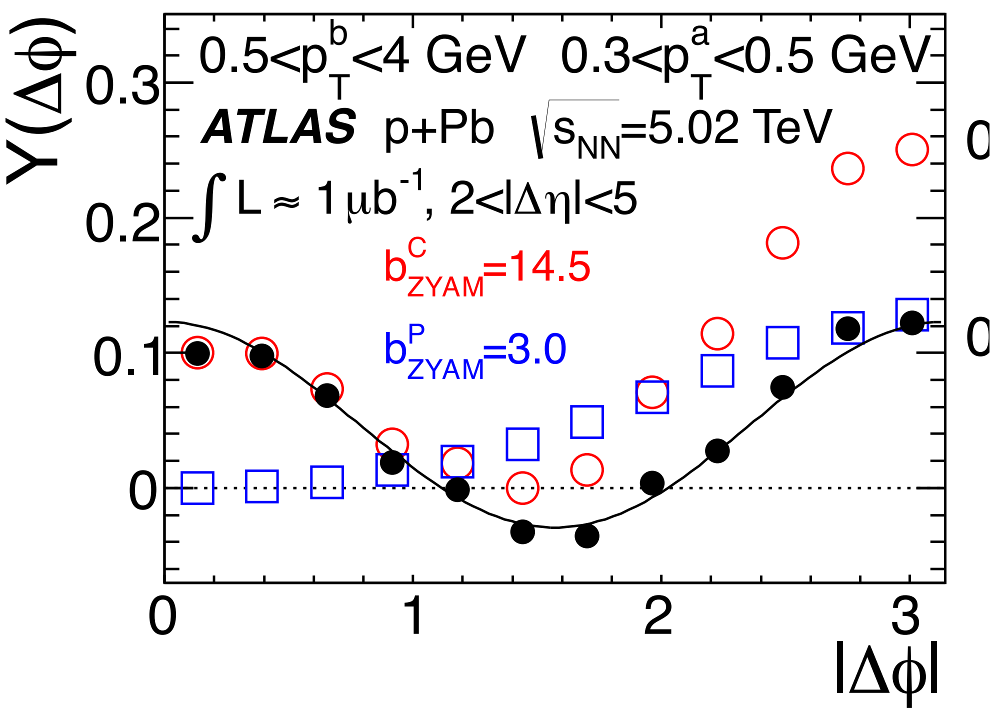




LHC results

p+p @ 7TeV





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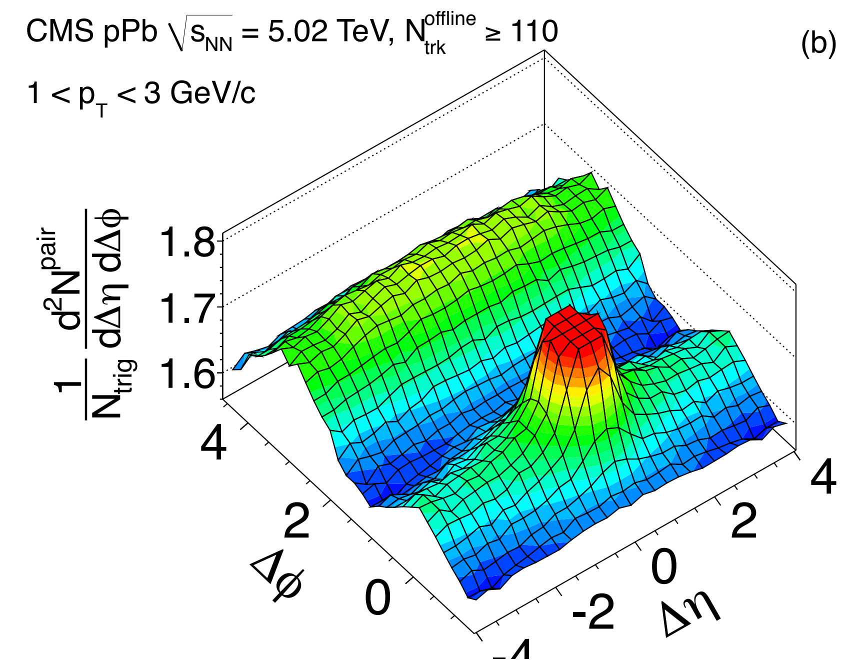
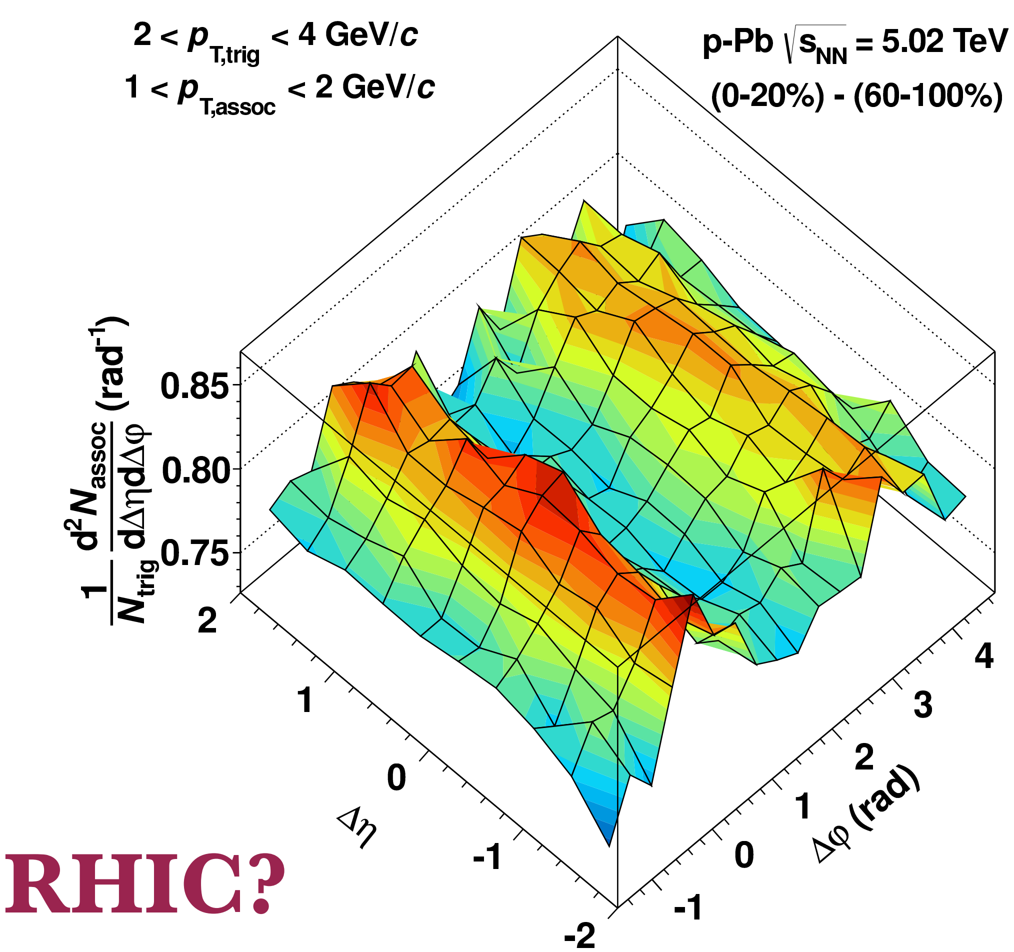
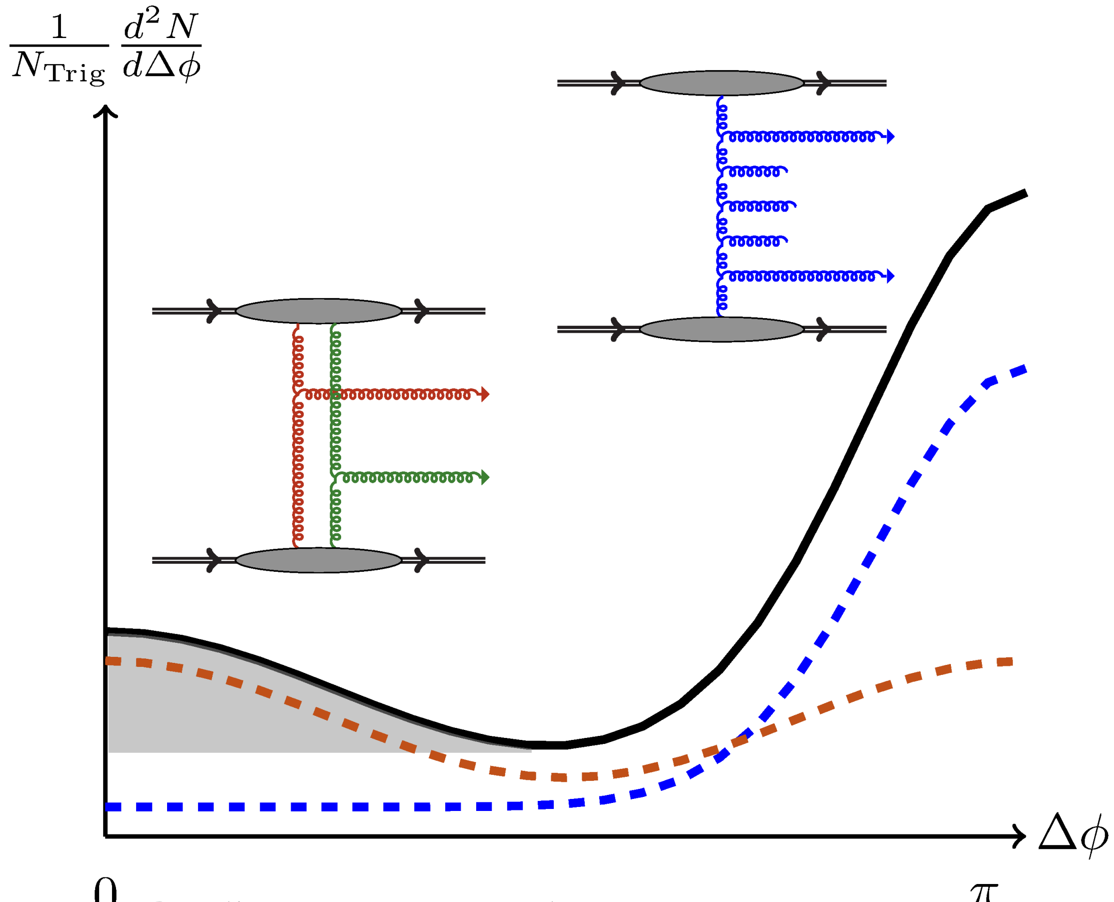




can we look for such phenomena at RHIC?

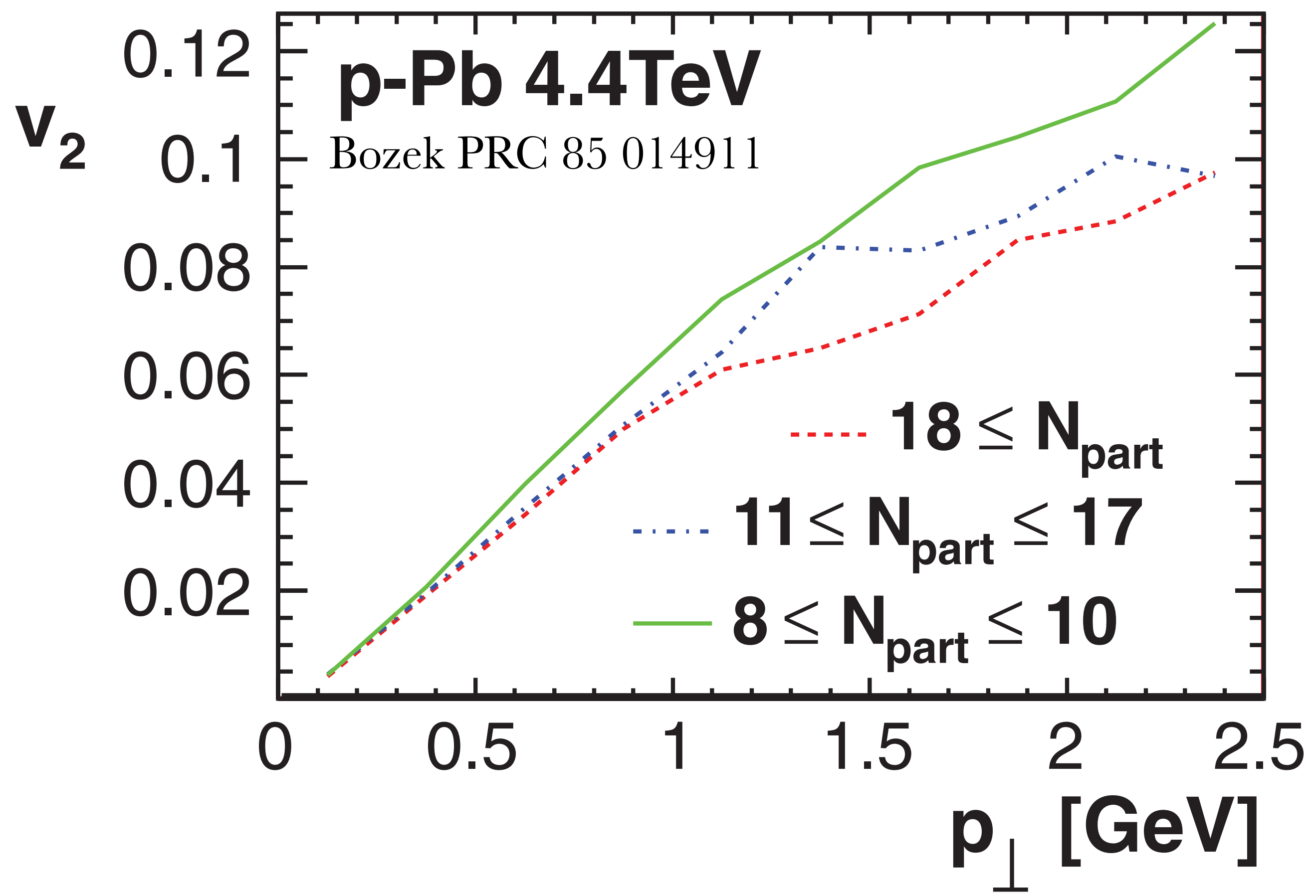
initial or final state effect?

CGC/Glasma



Dusling & Venugopalan 1211.3701

hydrodyanmics



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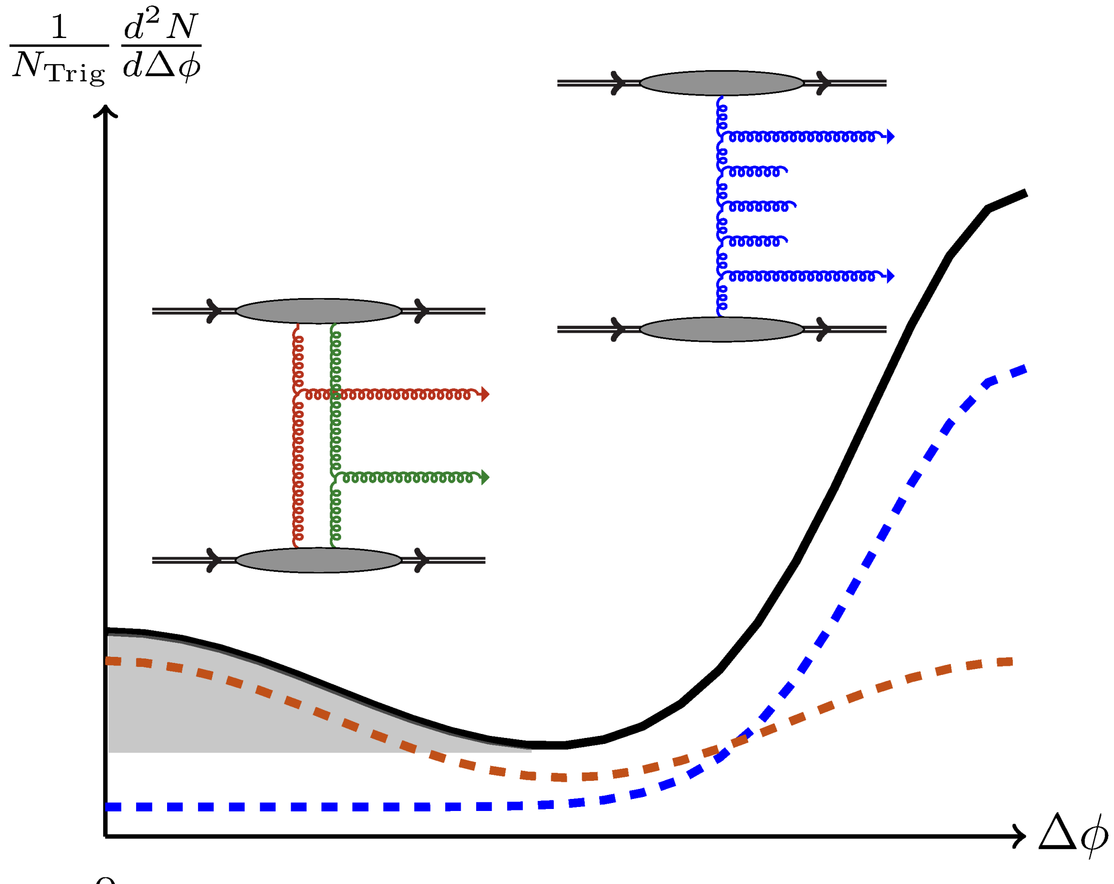

Dusling & Venugopalan 1211.3701

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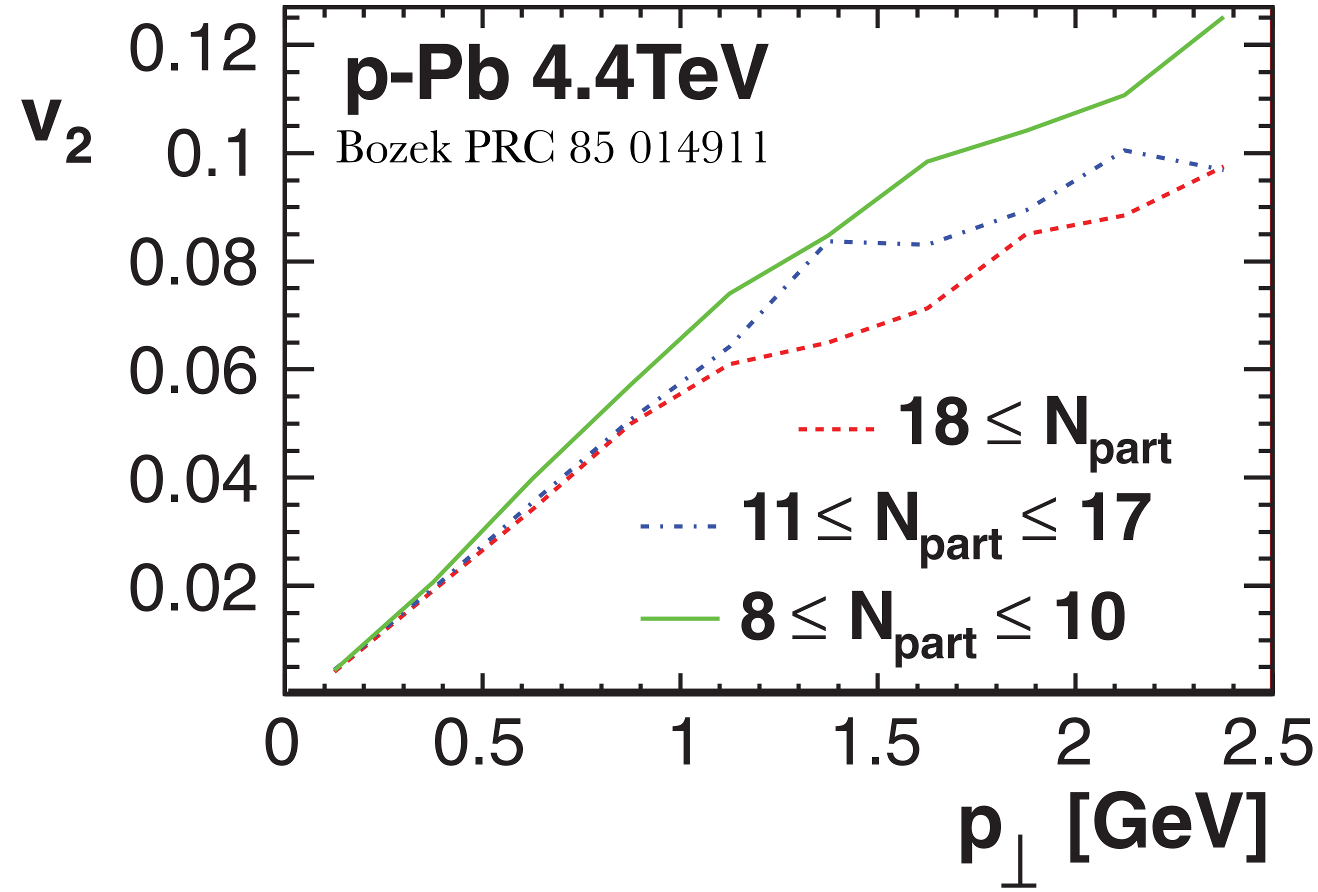


RHIC d-Au data can provide excellent constraints due to the difference in collision energy, saturation scale and initial geometry

large data sample from 2008

rapidity separated correlations

rapidity separated correlations

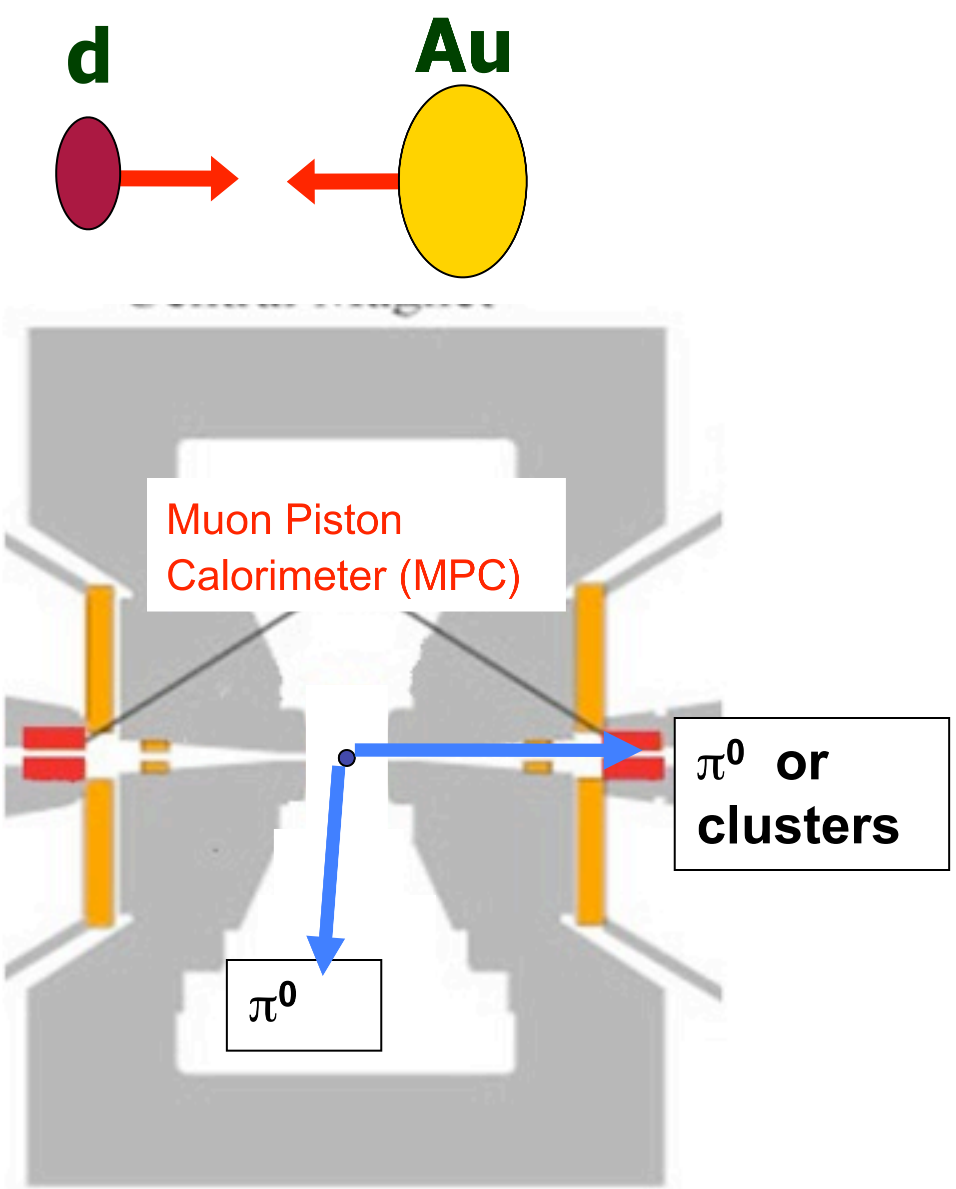
PRL **107,** 172301 (2011) PHYSICAL REVIEW LETTERS week ending 21 OCTOBER 2011

Suppression of Back-to-Back Hadron Pairs at Forward Rapidity in d + Au Collisions at $\sqrt{s_{NN}} = 200$ GeV

rapidity separated correlations

PRL **107,** 172301 (2011) PHYSICAL REVIEW LETTERS week ending 21 OCTOBER 2011

Suppression of Back-to-Back Hadron Pairs at Forward Rapidity in d + Au Collisions at $\sqrt{s_{NN}} = 200$ GeV



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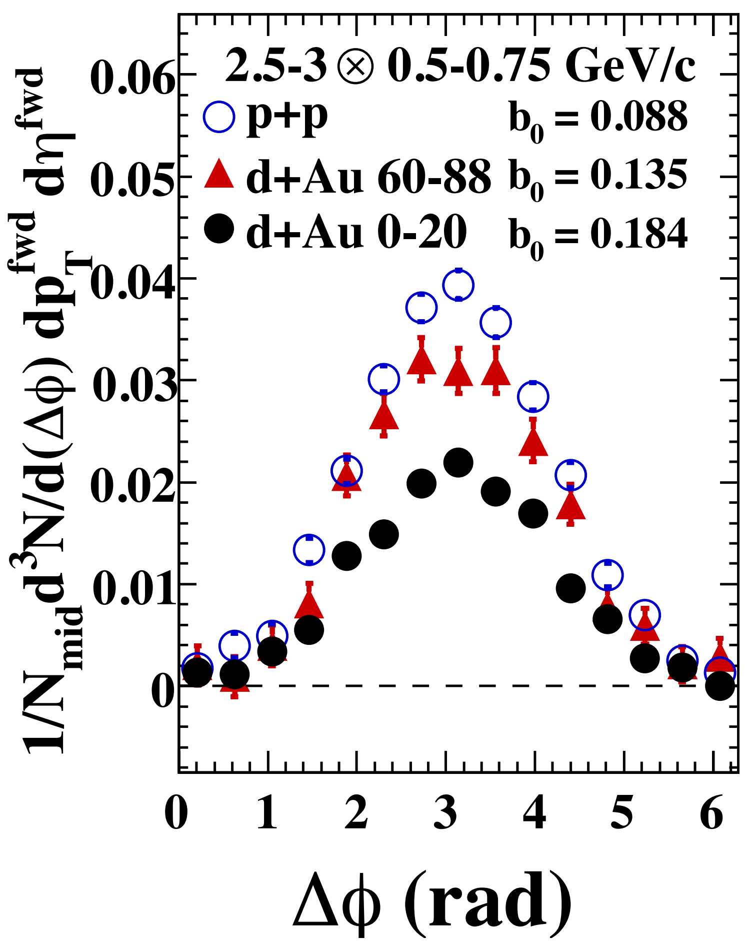

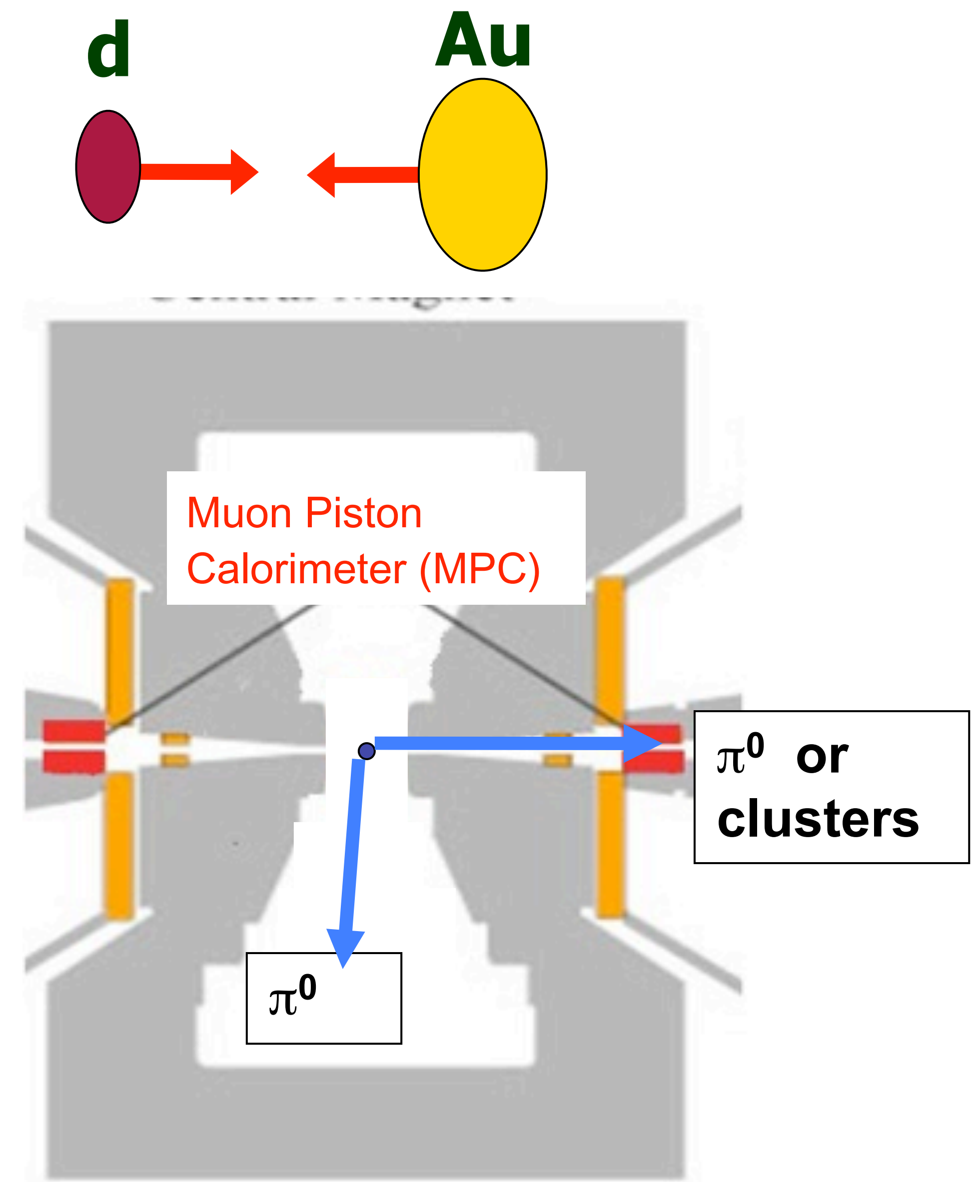

rapidity separated correlations

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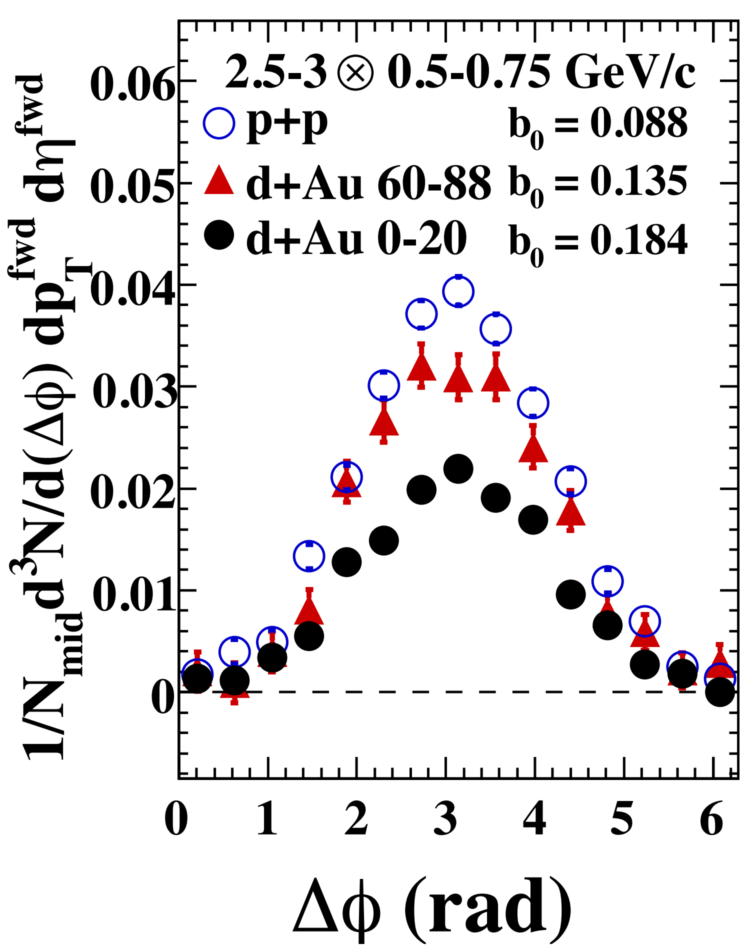

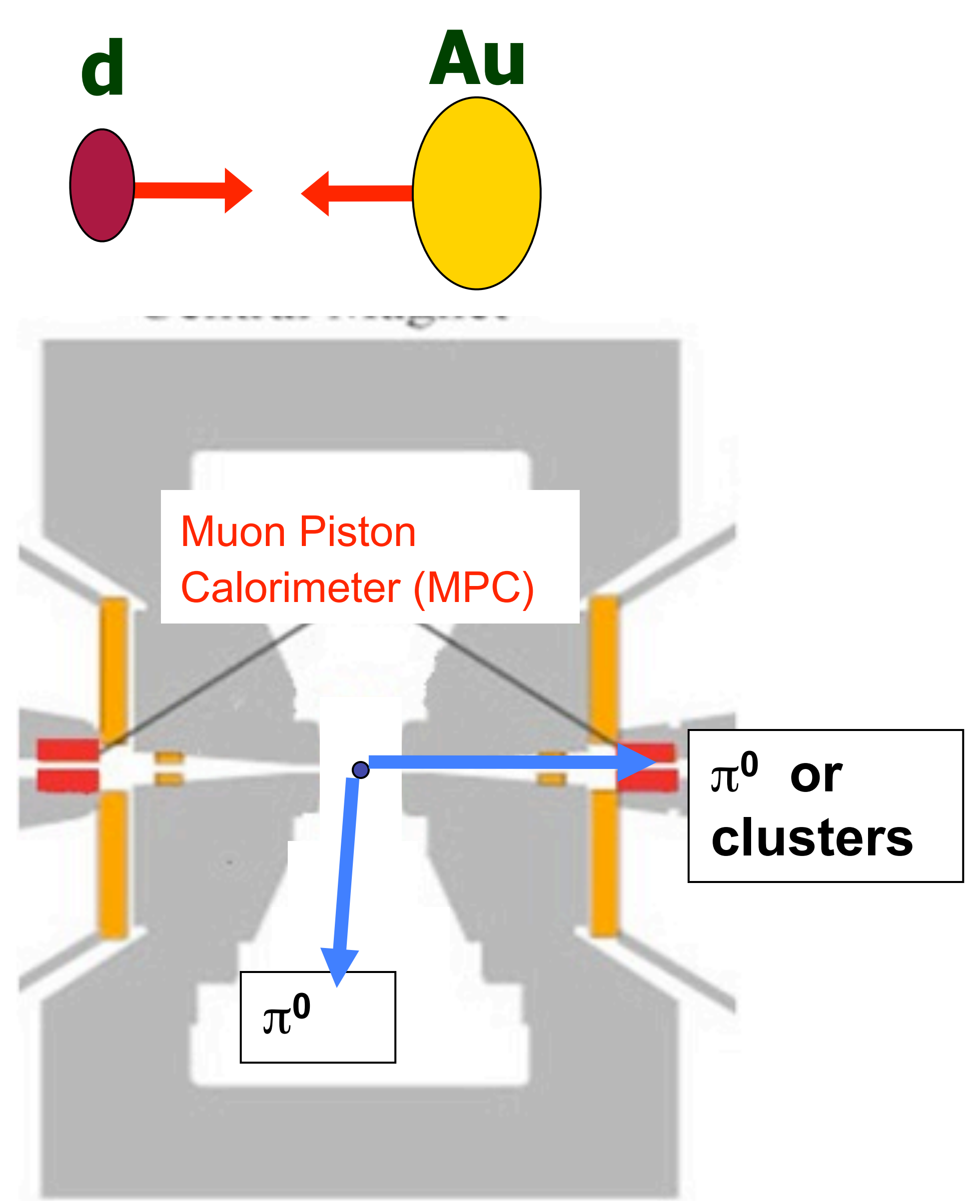

no evidence for long range correlation at $\Delta\phi \sim 0$

rapidity separated correlations

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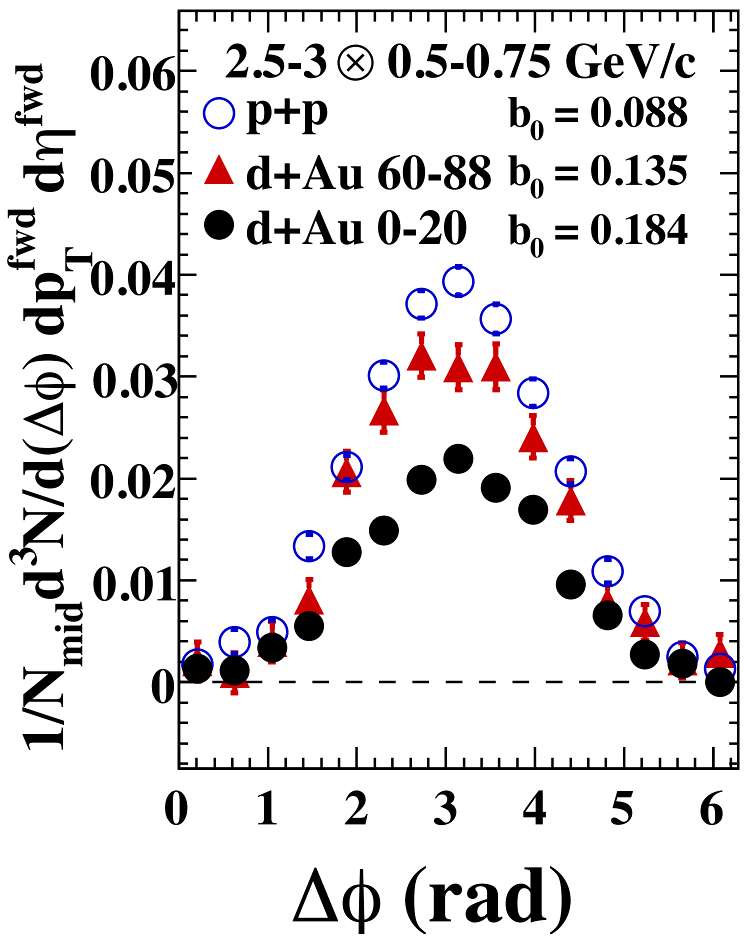
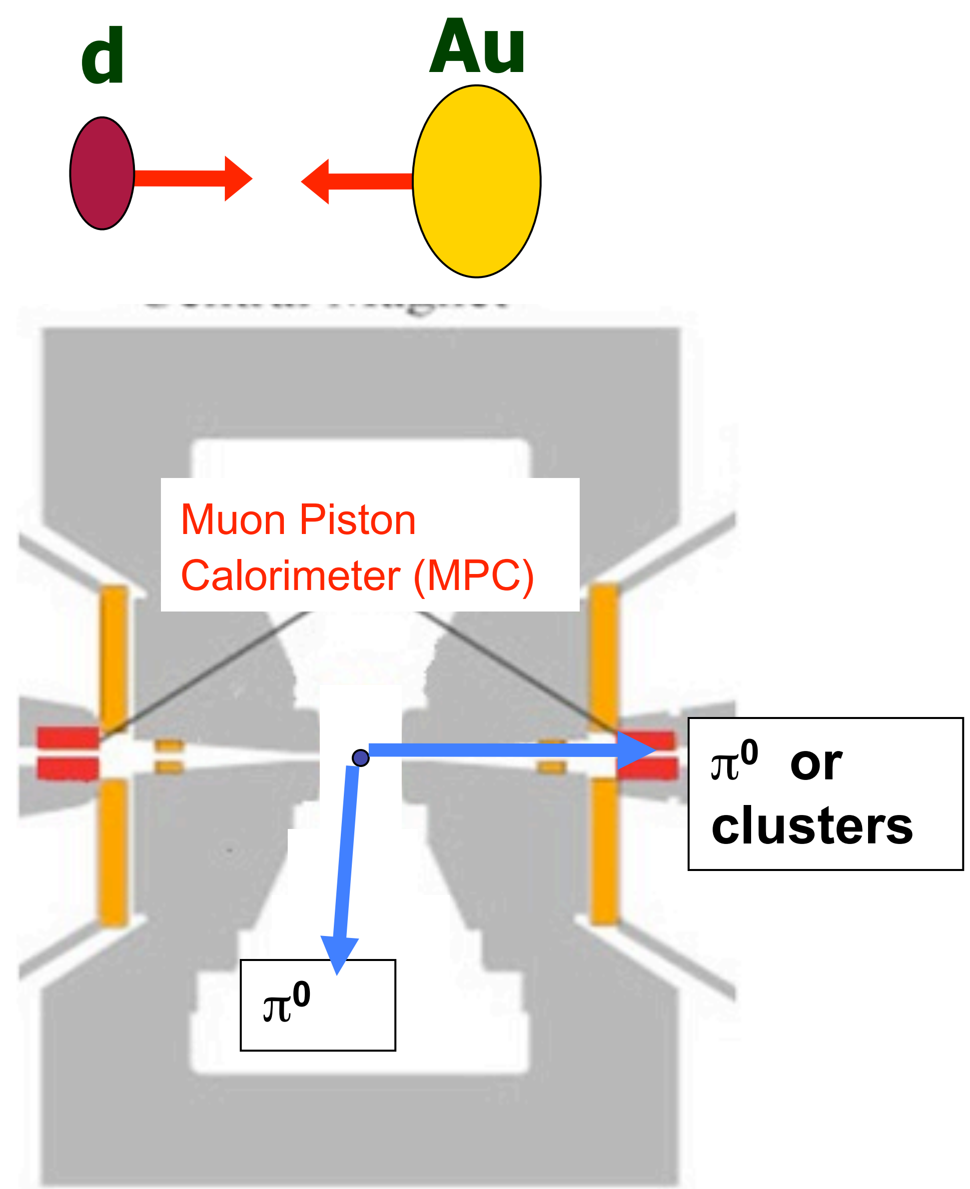
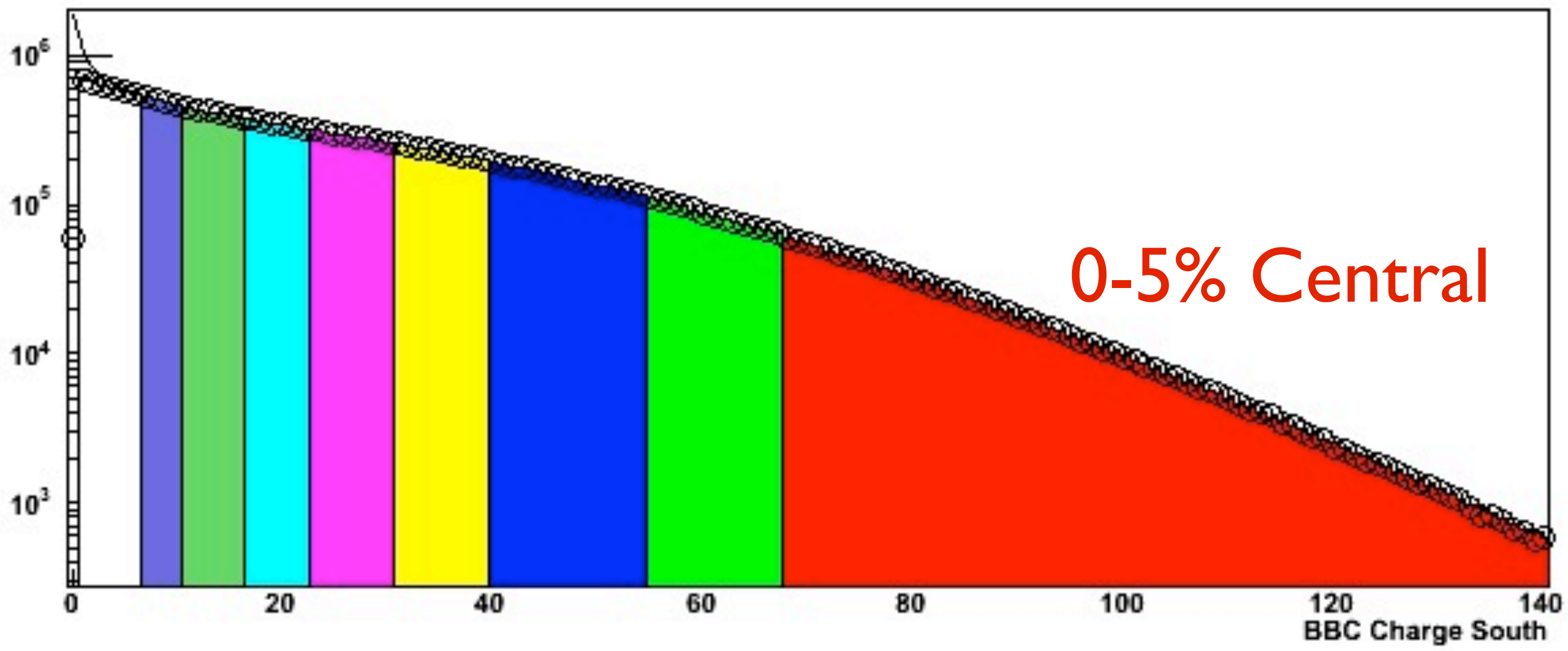


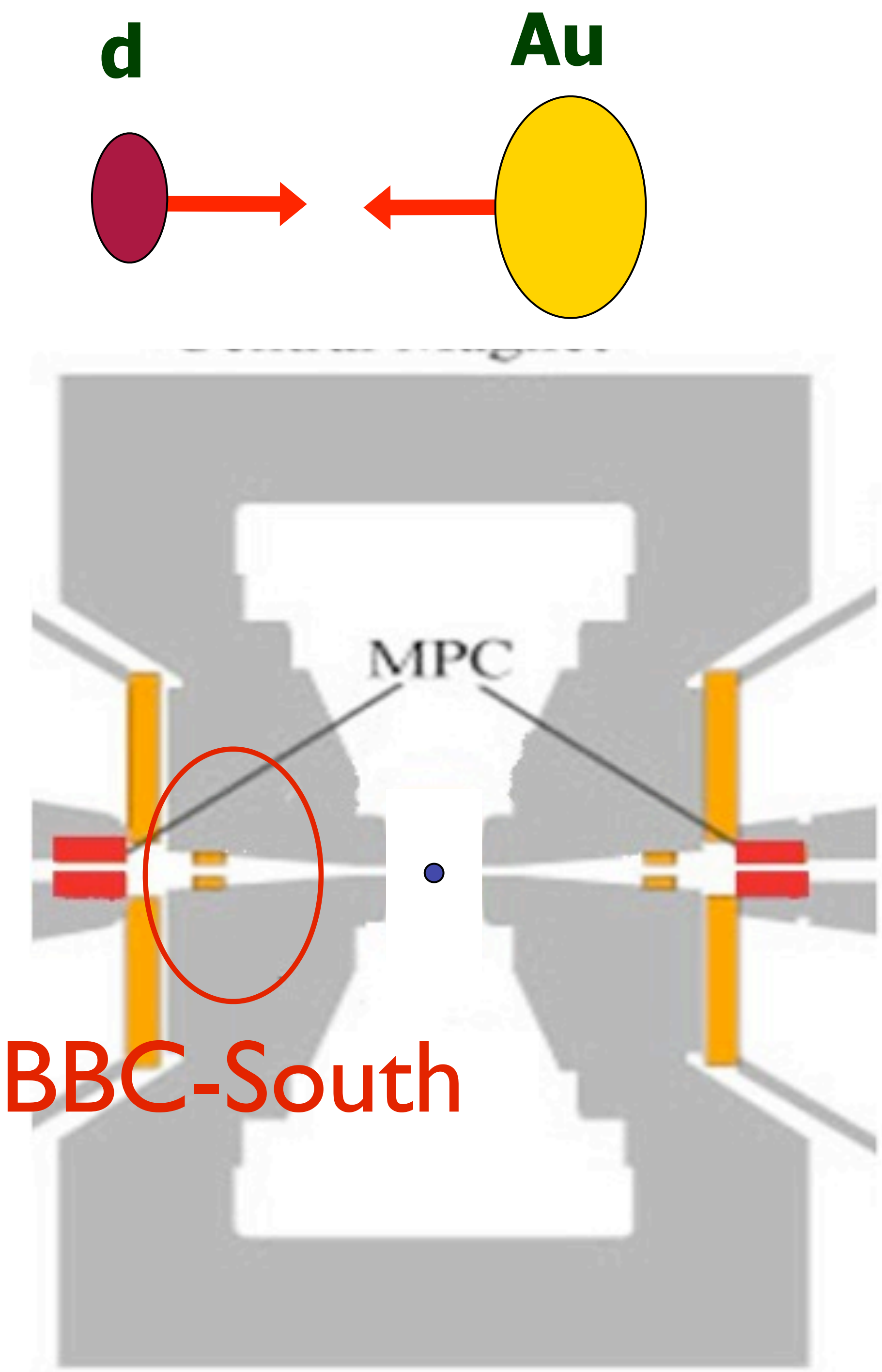


no evidence for long range correlation at $\Delta\phi \sim 0$

however, this is at relatively high p_T and only 0-20% central→not necessarily the most sensitive place to look...

Centrality Selection

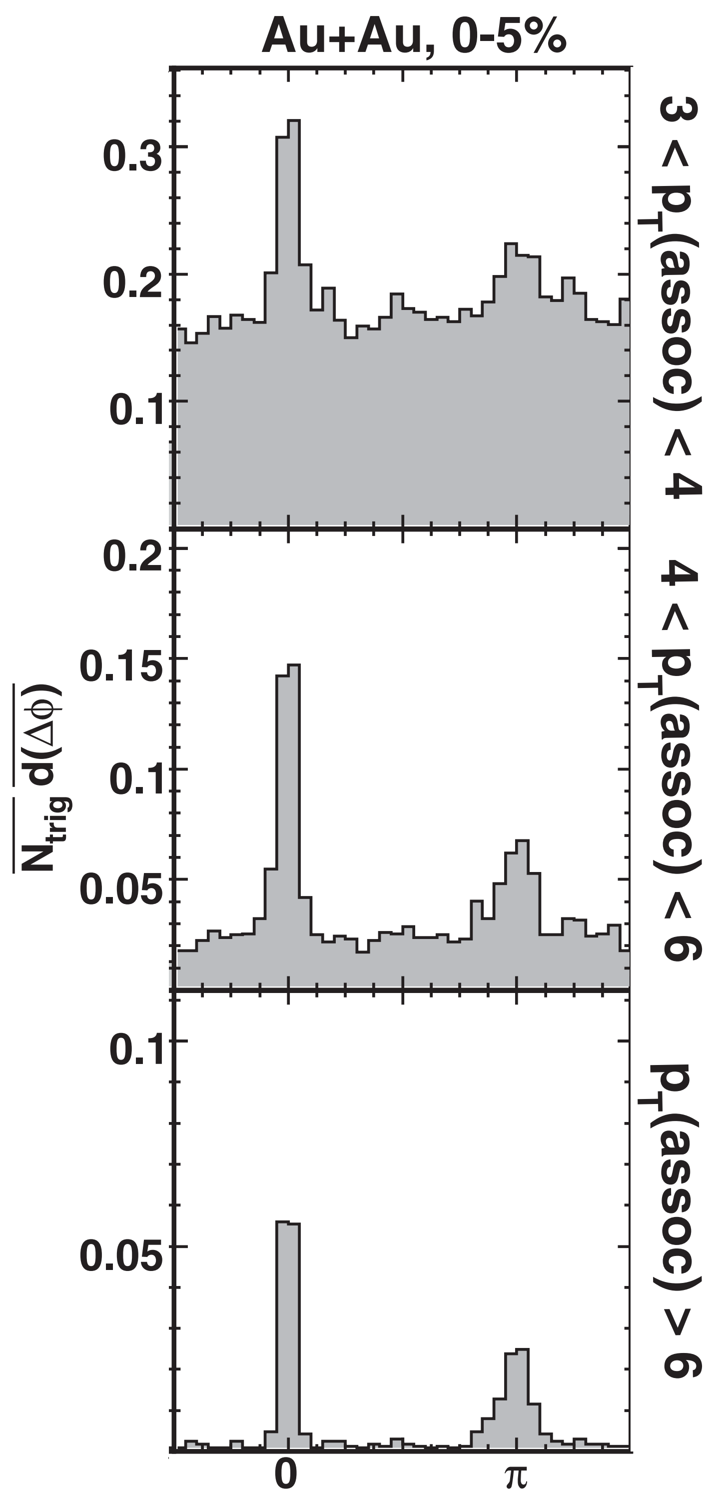




BBC Charge distribution well described by Glauber MC + negative binomial distribution

minimizing jet contributions

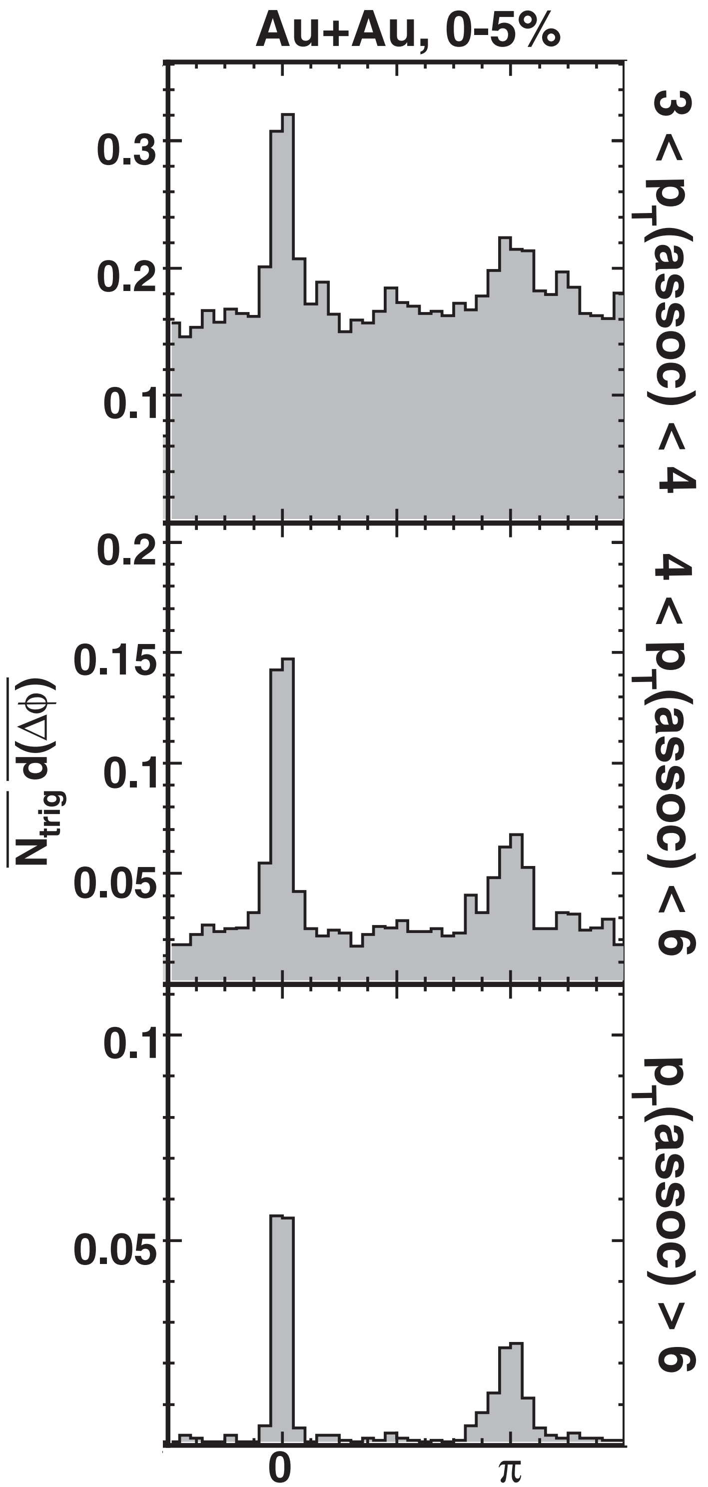
Normal Jet Correlations



- normal two particle correlations: look at as high p_T particles as possible
  - minimizes combinatoric background, maximizes jet correlations
- near side jets are a small $|\Delta\eta|$ correlation

minimizing jet contributions

Normal Jet Correlations



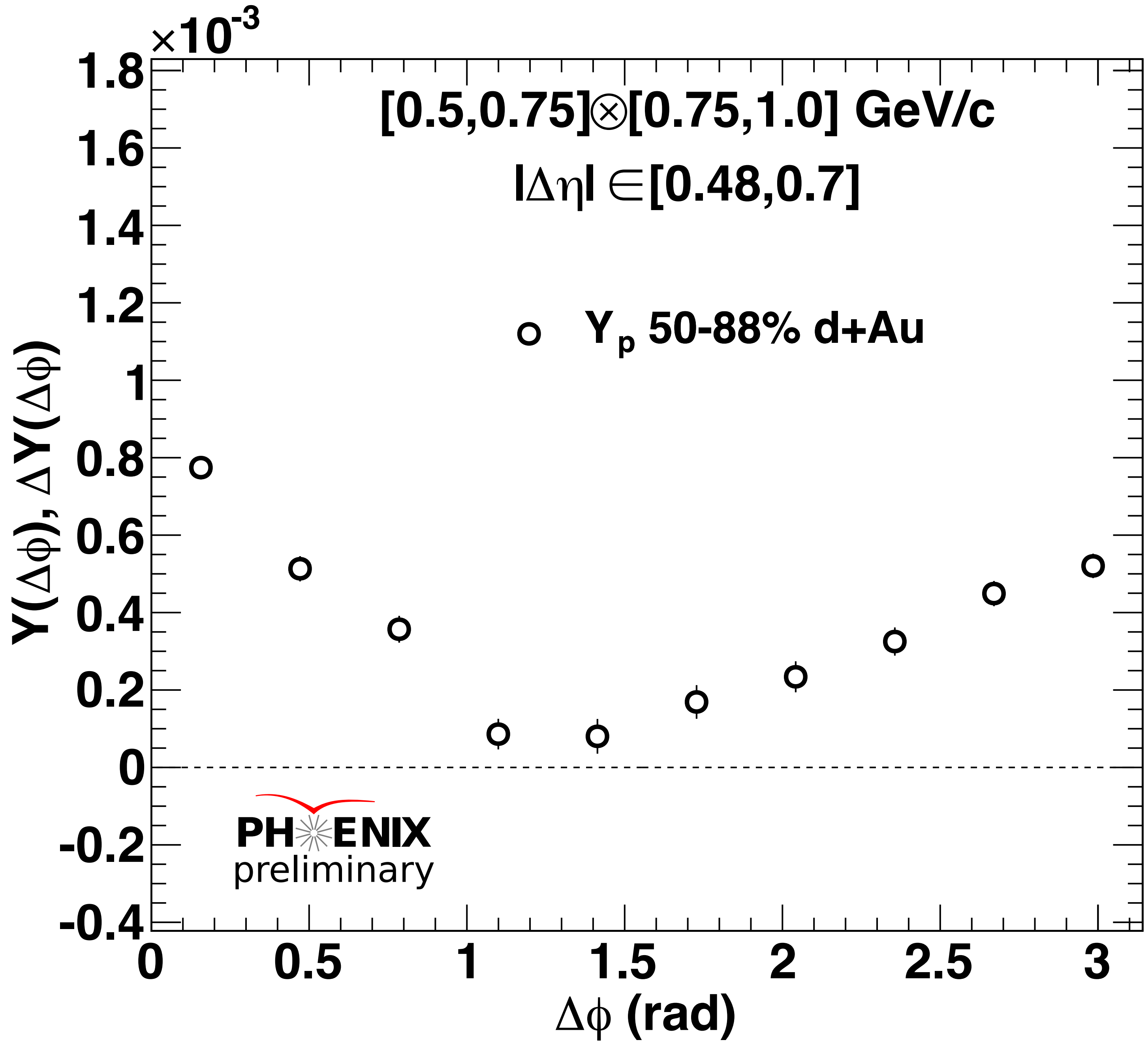
- normal two particle correlations: look at as high p_T particles as possible
  - minimizes combinatoric background, maximizes jet correlations
- near side jets are a small $|\Delta\eta|$ correlation

the plan: keep one particle at very low p_T to maximize sensitivity to underlying event & select as large $\Delta\eta$ as possible within mid-rapidity acceptance

centrality dependence of correlations

central events: 0-5%
peripheral events: 50-88%

$p_{T,a}$: 0.5-0.75GeV/c
$p_{T,b}$: 0.75-1.0GeV/c



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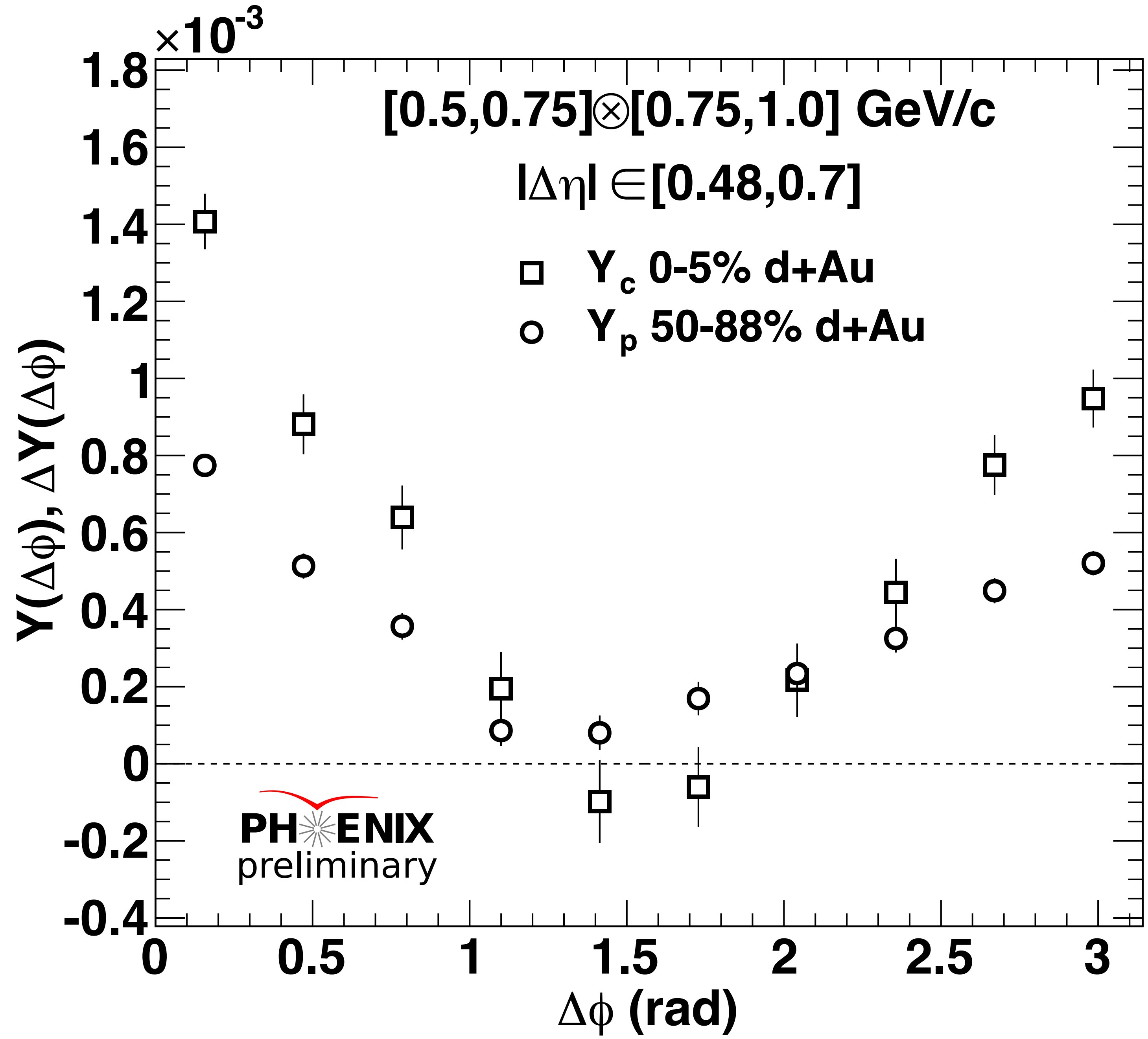

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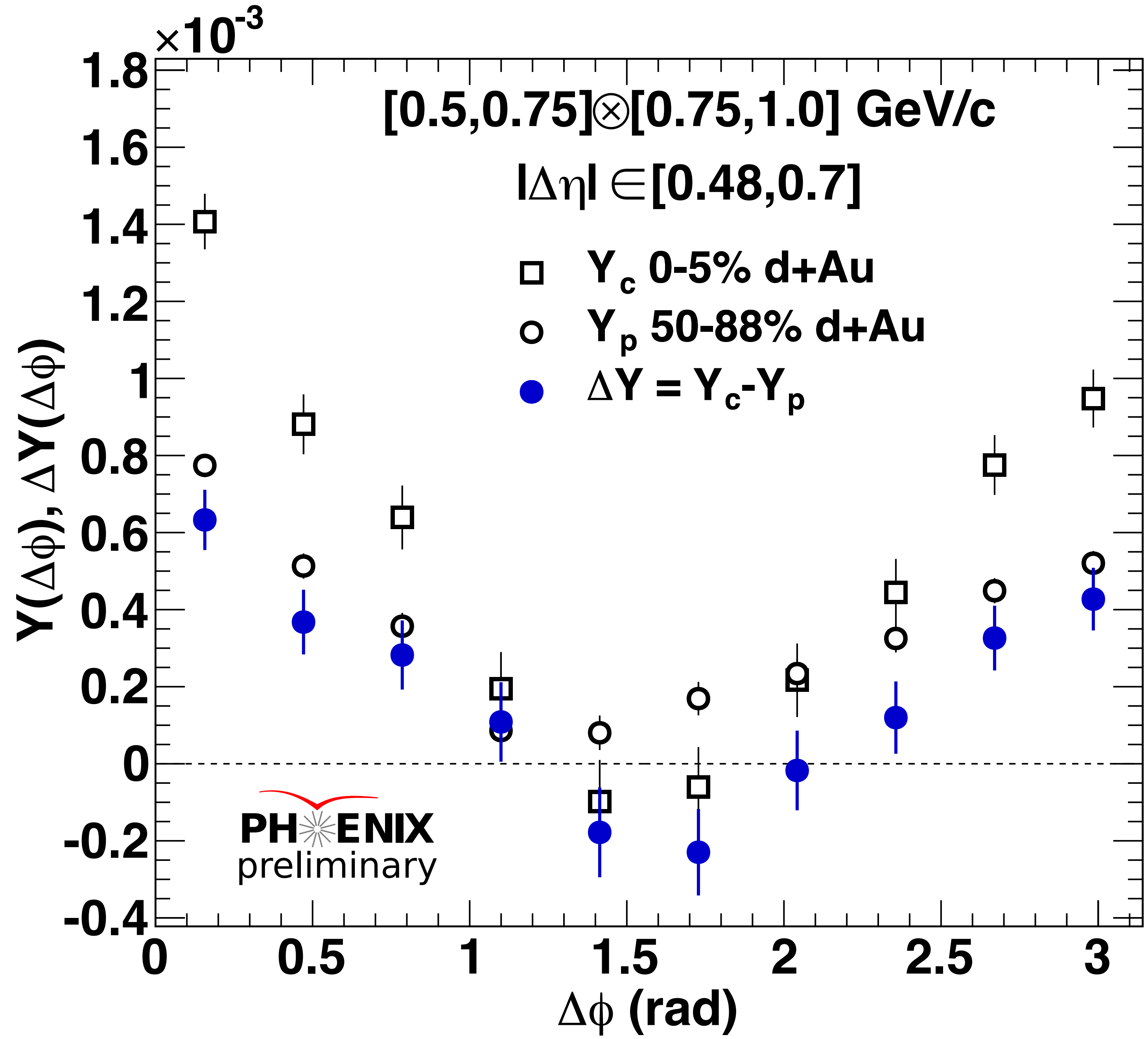

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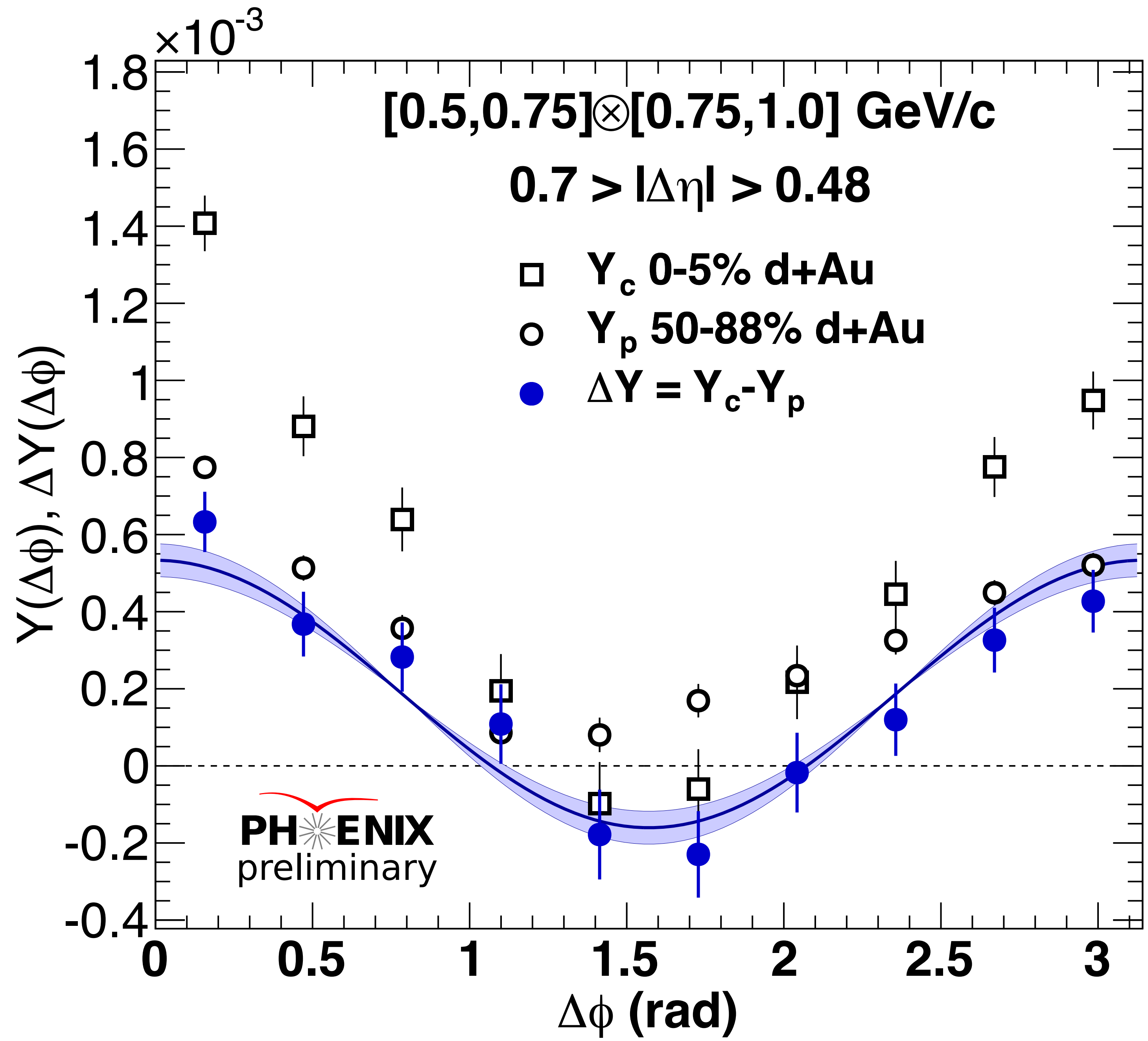
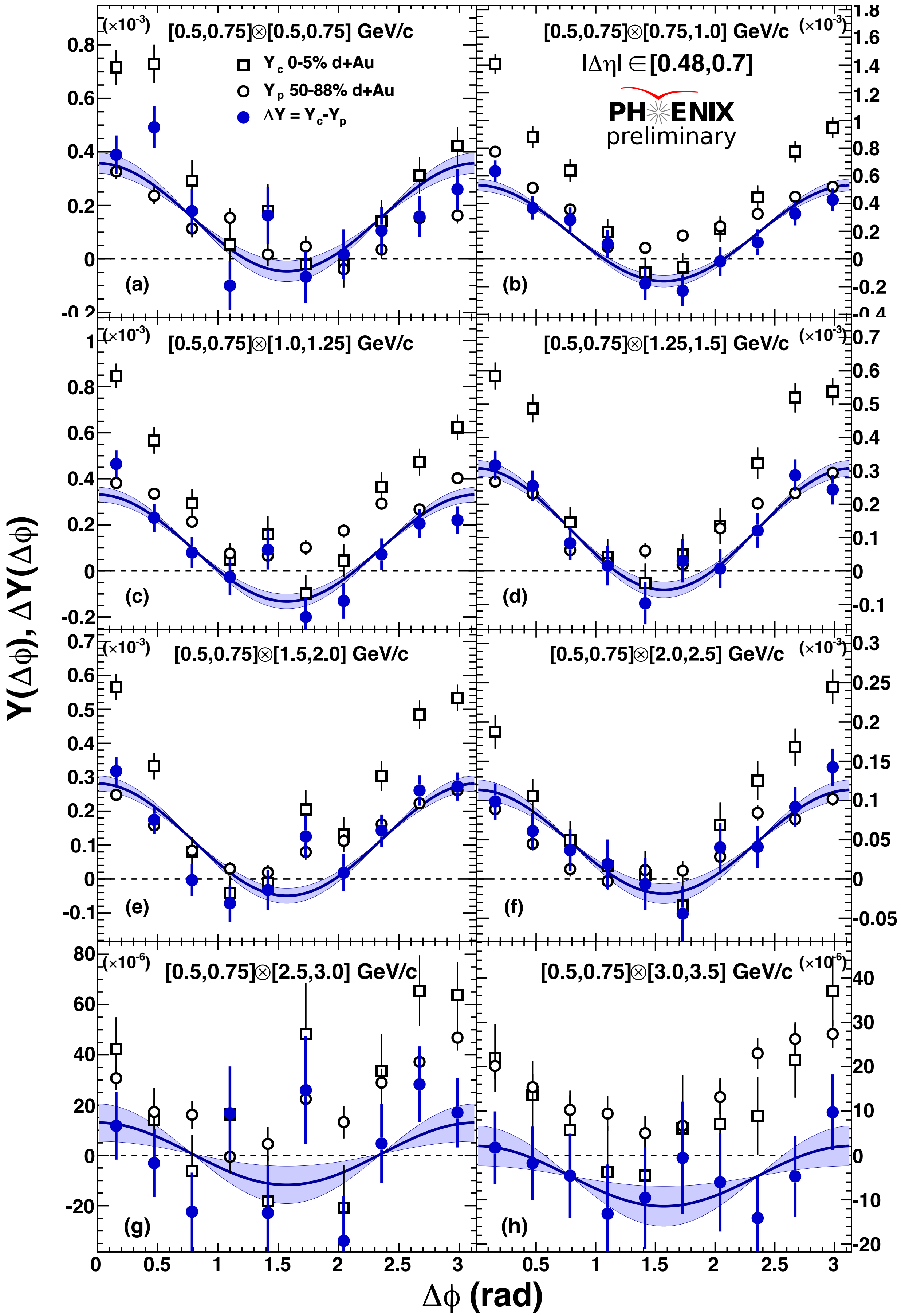


as a function of p_T

- keep one particle at 0.5-0.75GeV/c
- move other particle up in pT from 0.5-3.5 GeV/c



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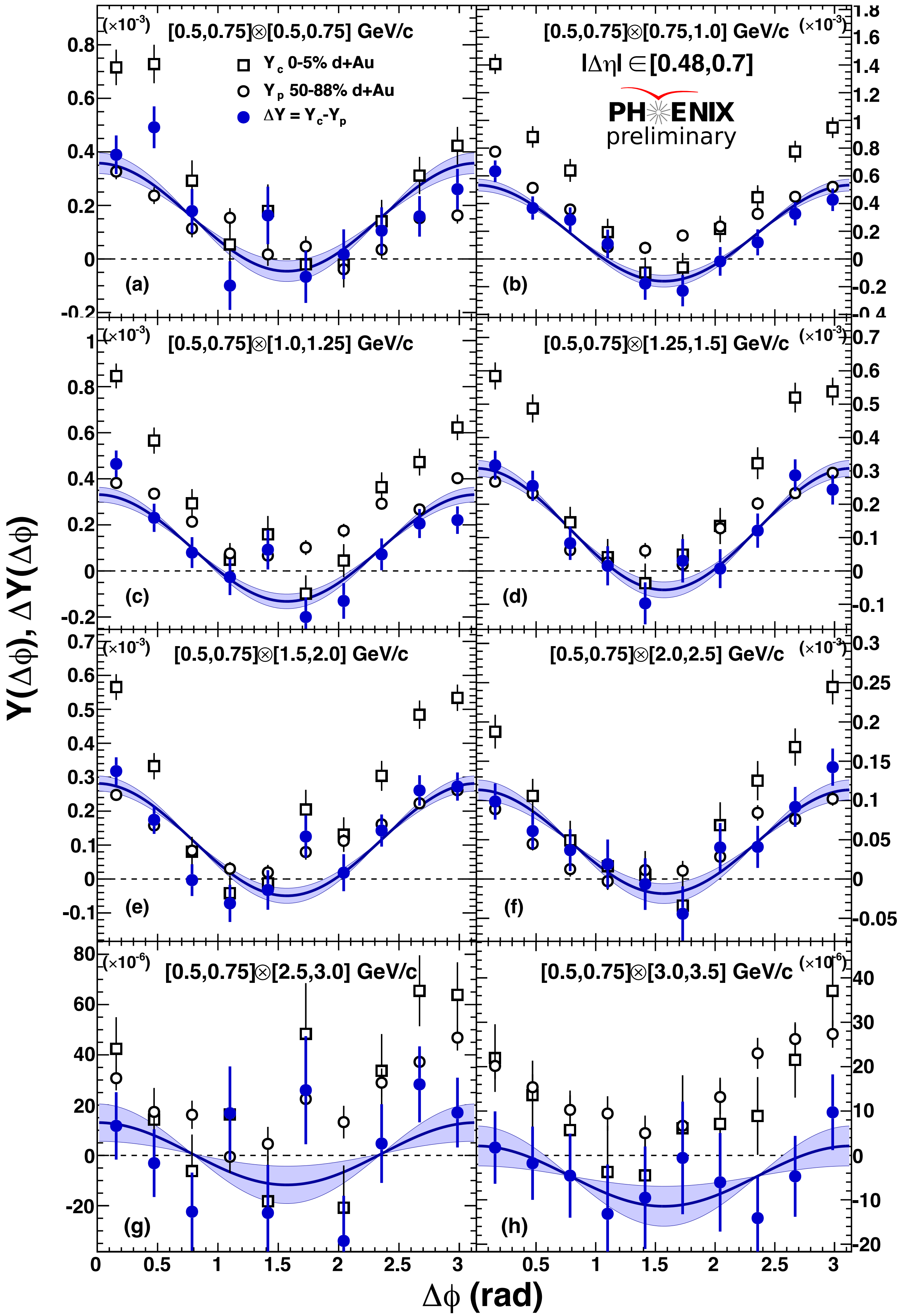
how much of this could be due to incomplete subtraction of the jets?



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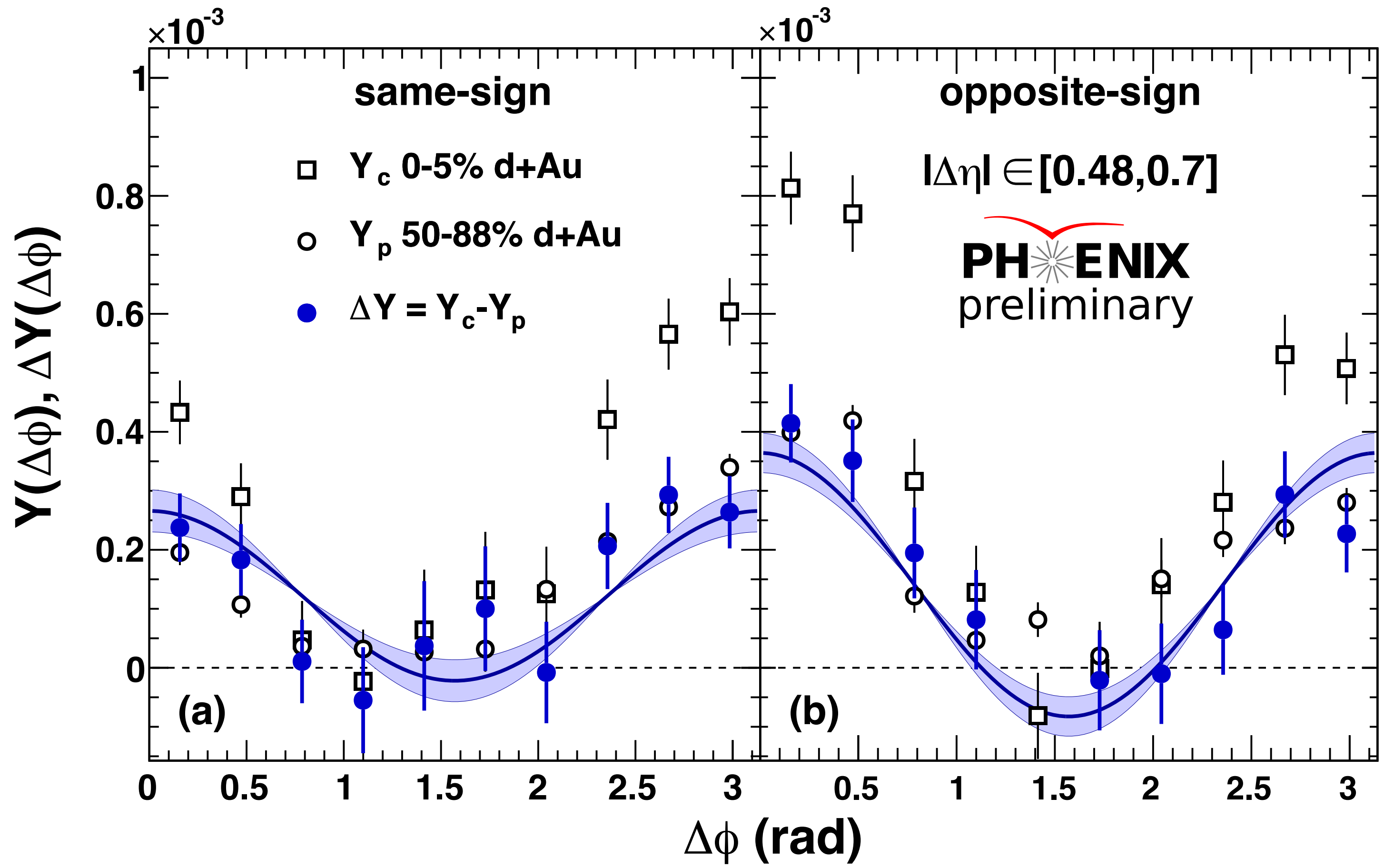

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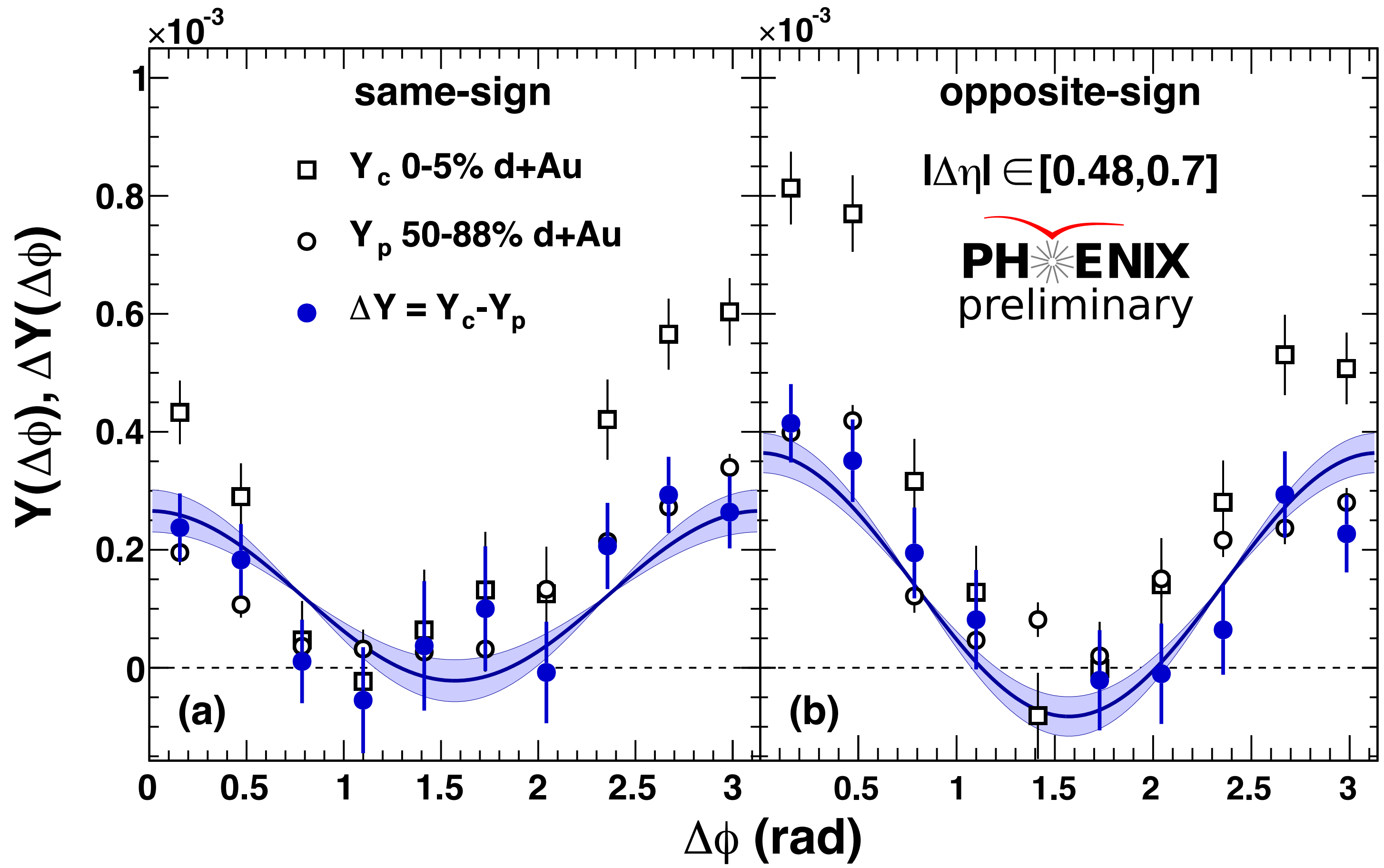

larger modulation with opposite sign pairs, however, same sign pairs show a significant signal

so, how big is this effect?

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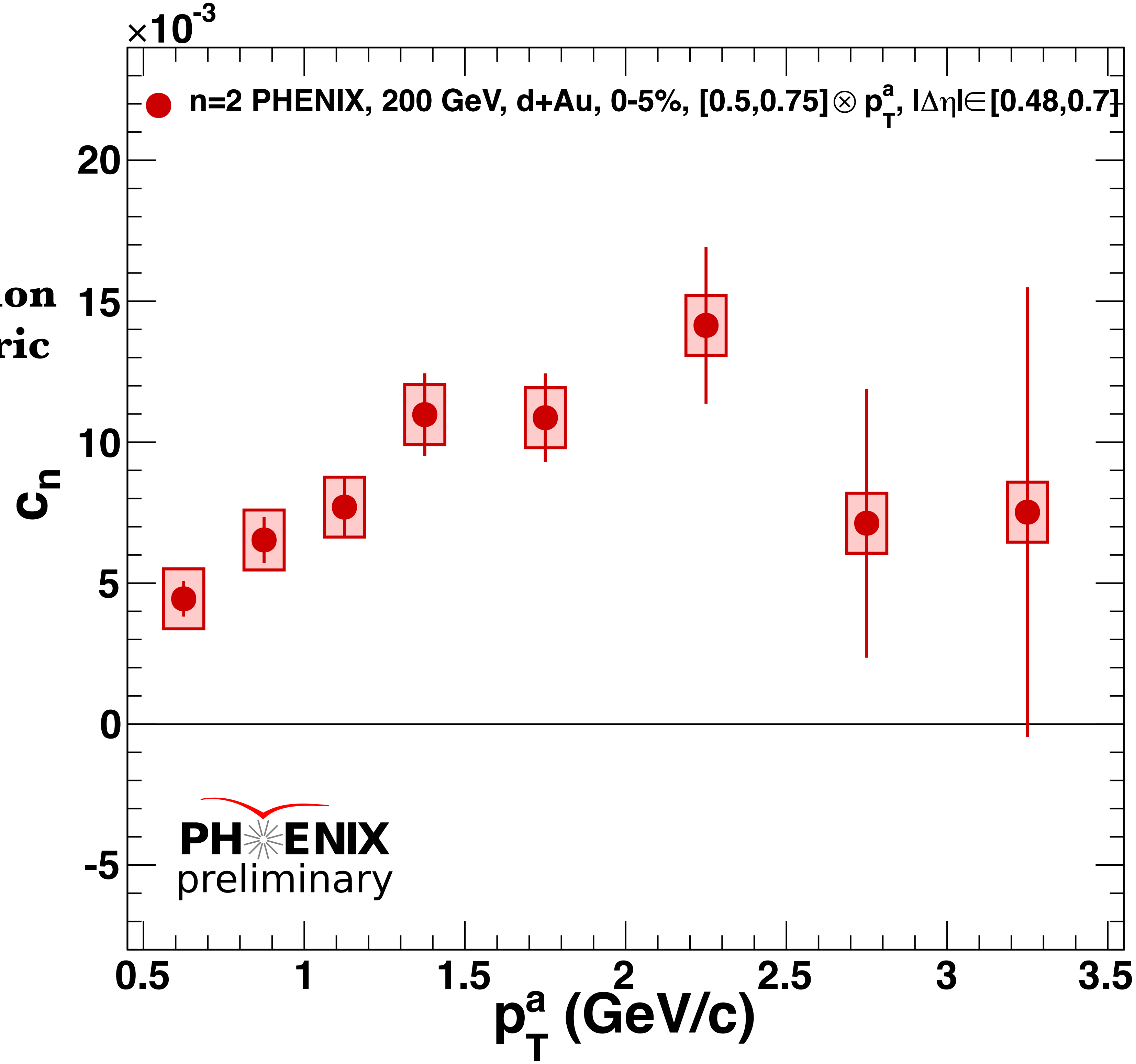
c_2: amplitude of modulation relative to the combinatoric background



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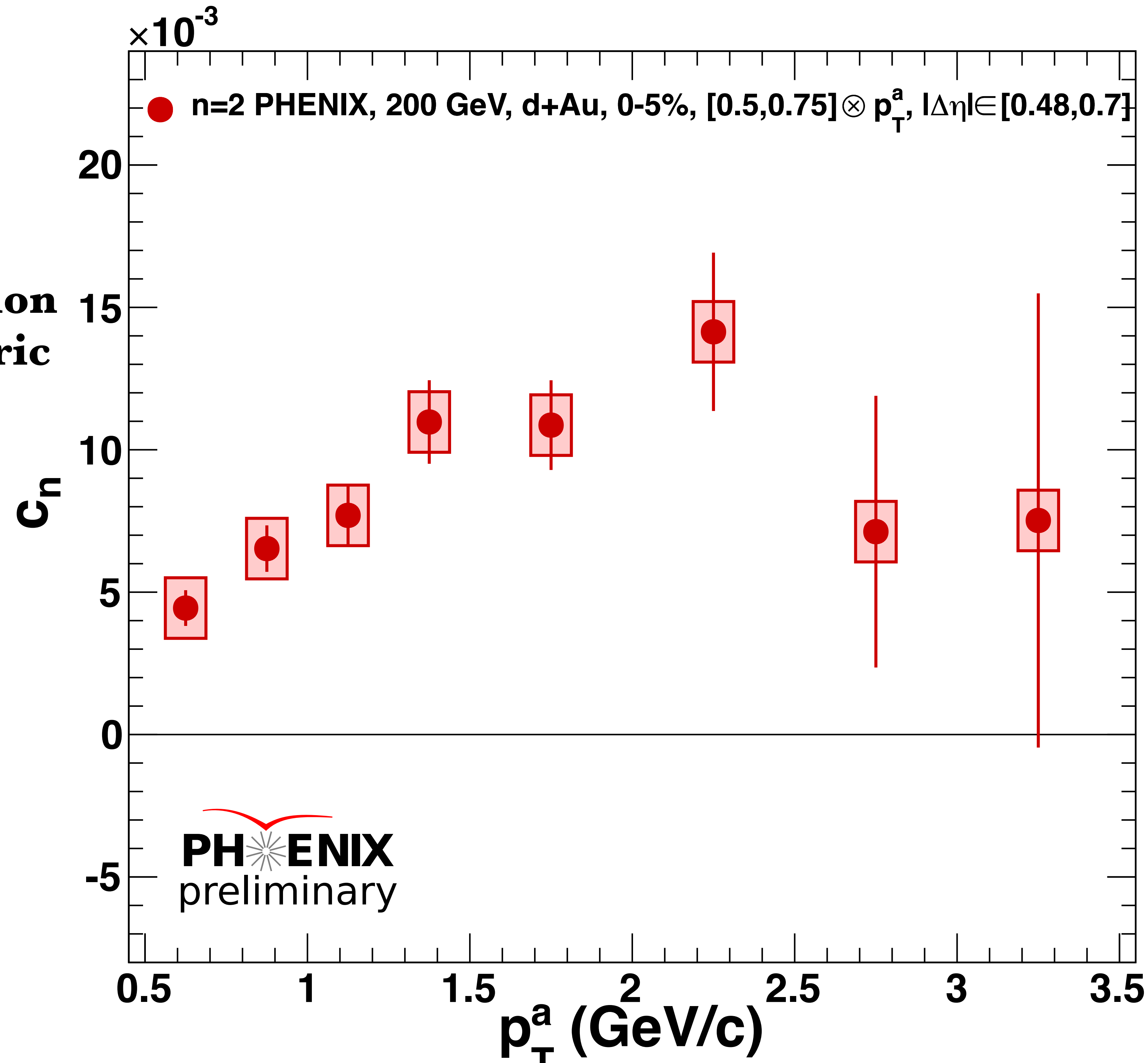
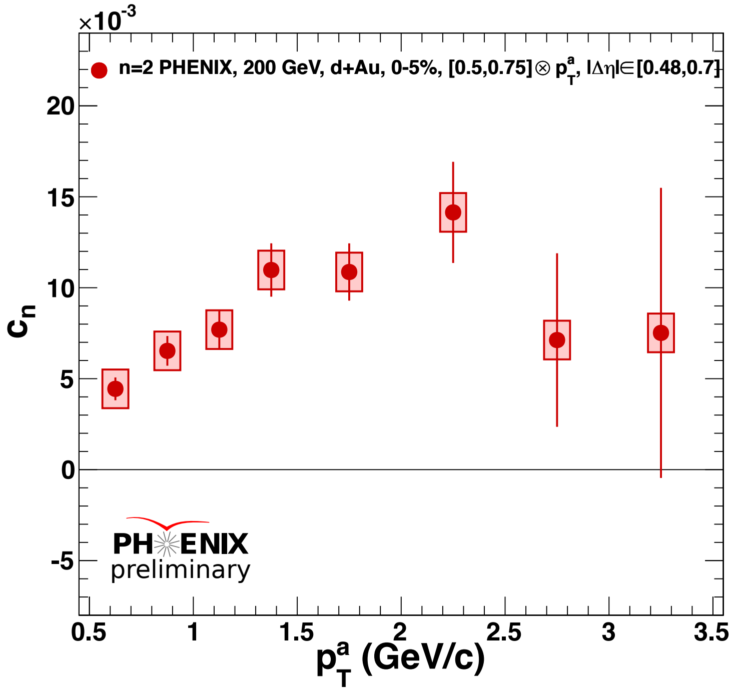


observe a significant modulation, increasing with p_T up to about 1% for $1.5 < p_T < 2.5$ GeV/c

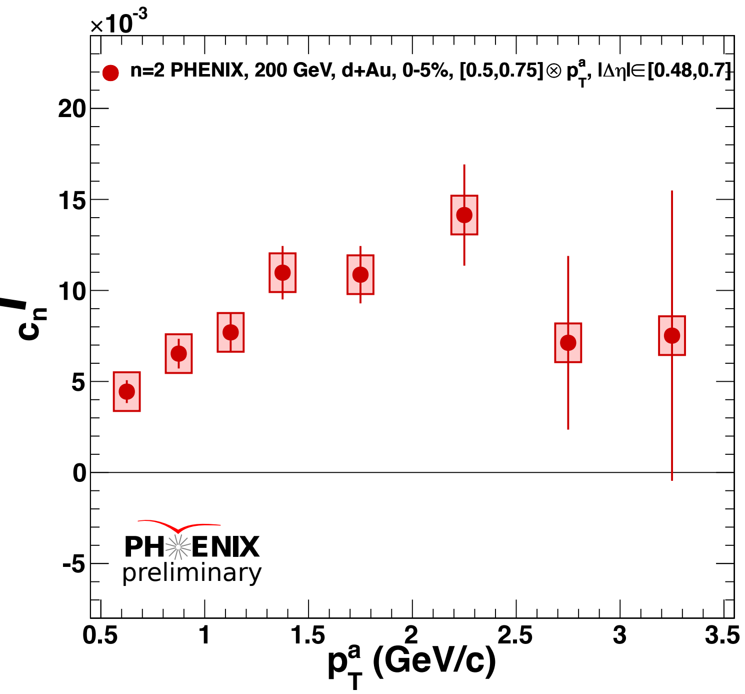
back to previous results

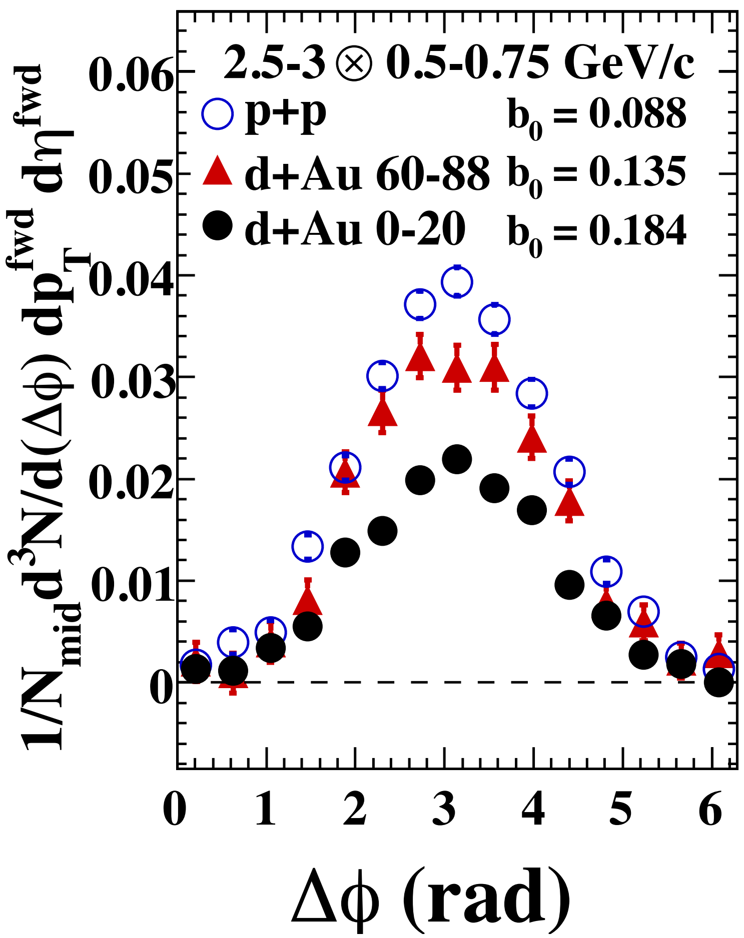
back to previous results



back to previous results

would a 1% modulation of the background be visible here?





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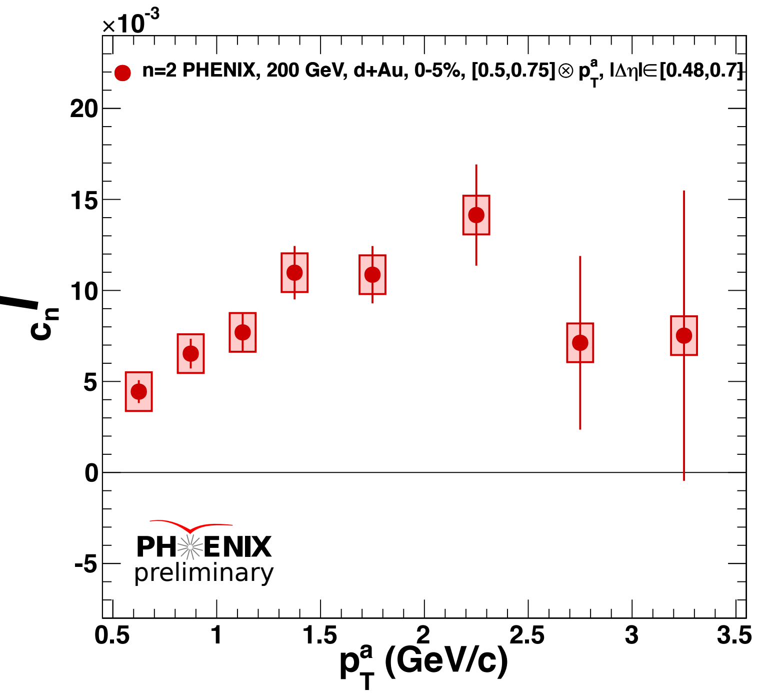

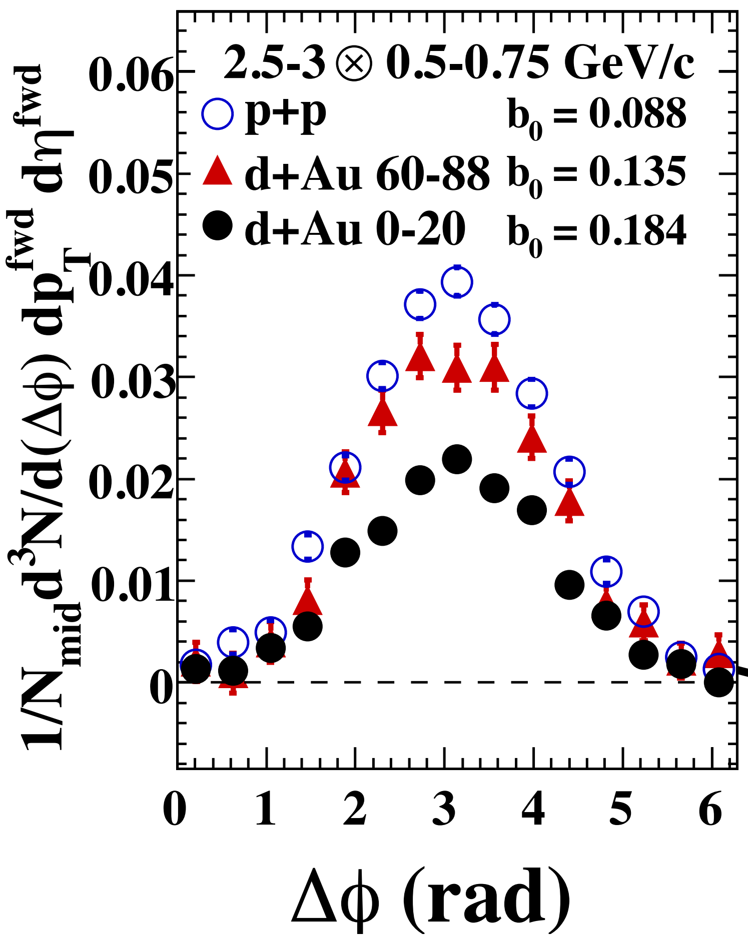

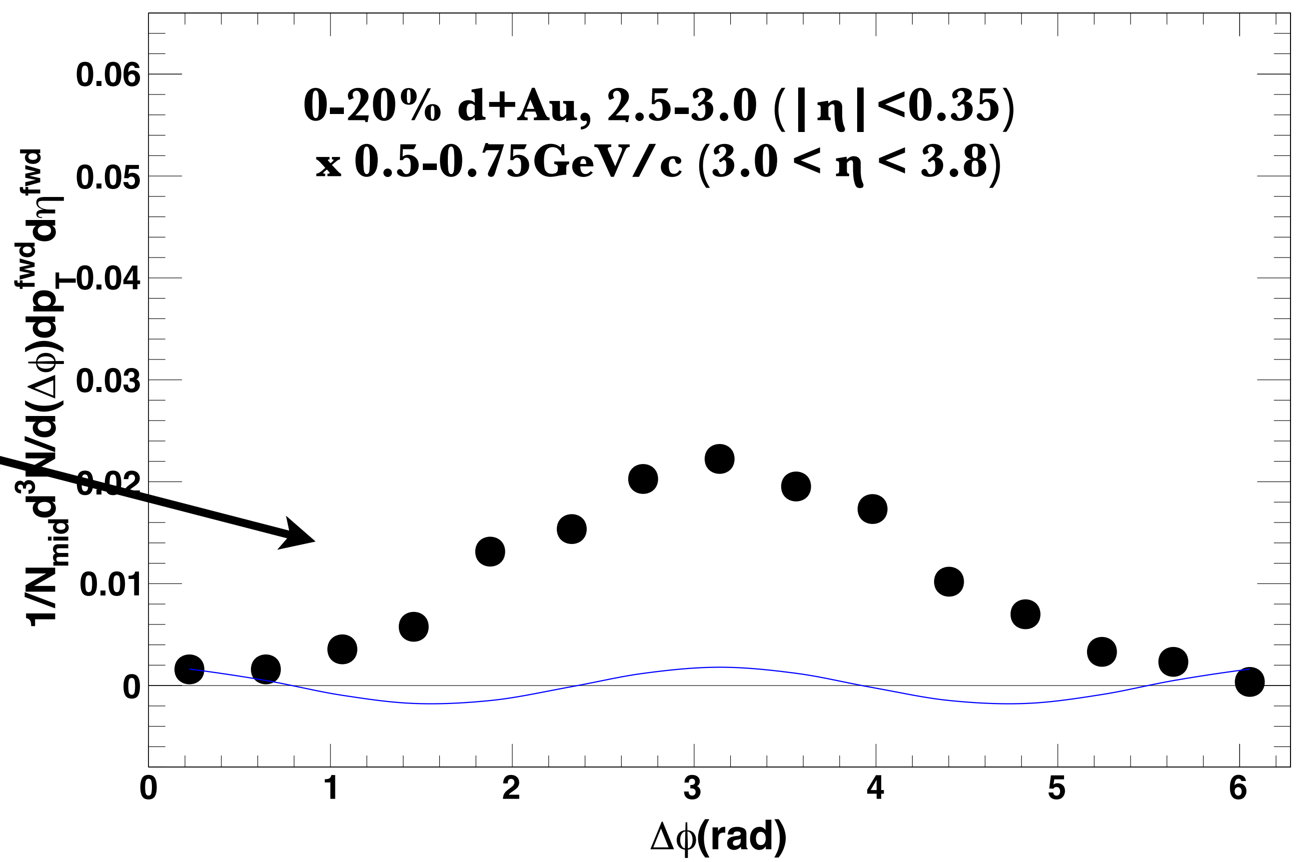

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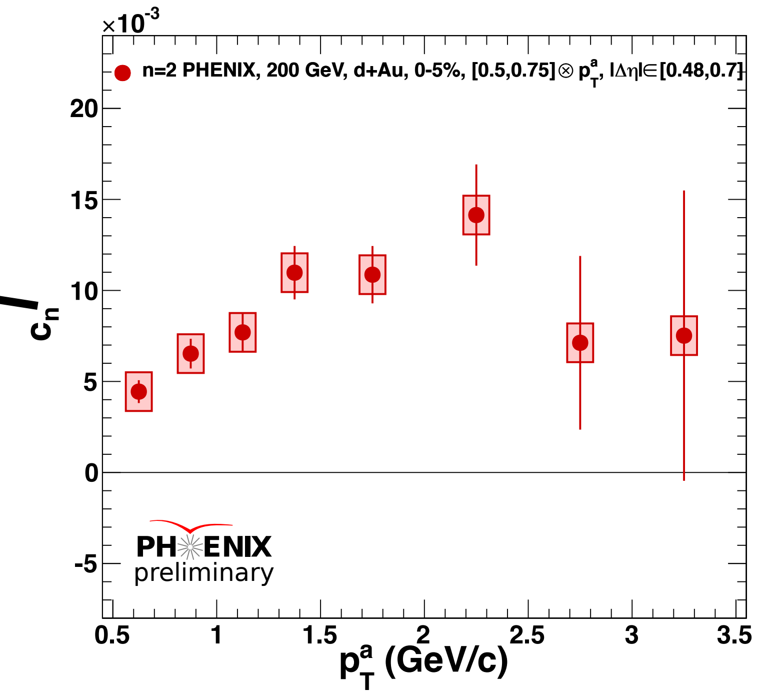
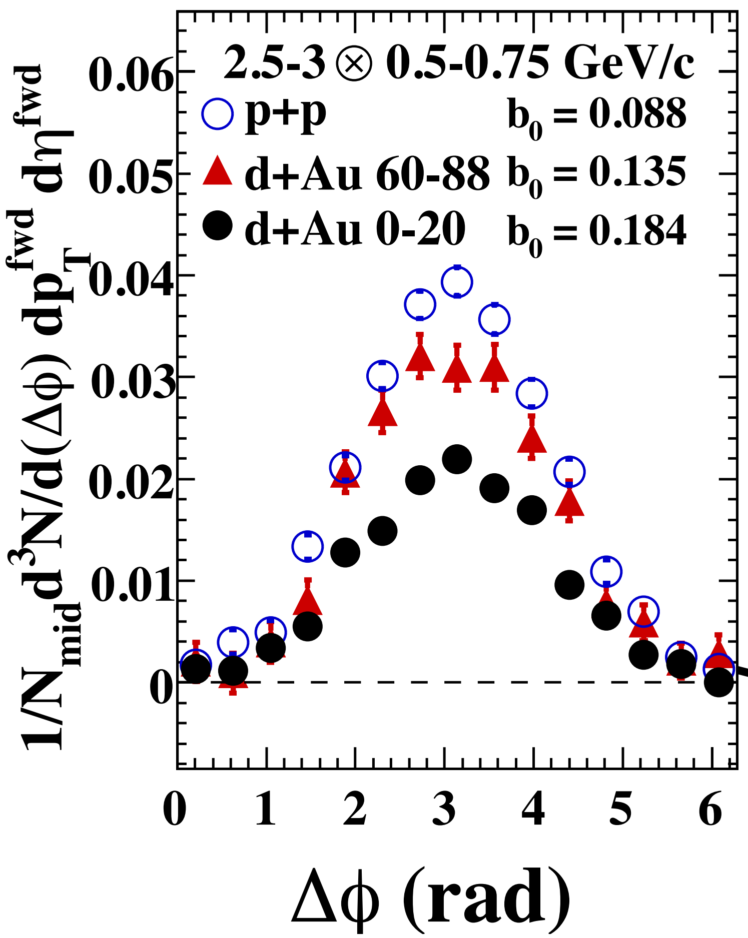
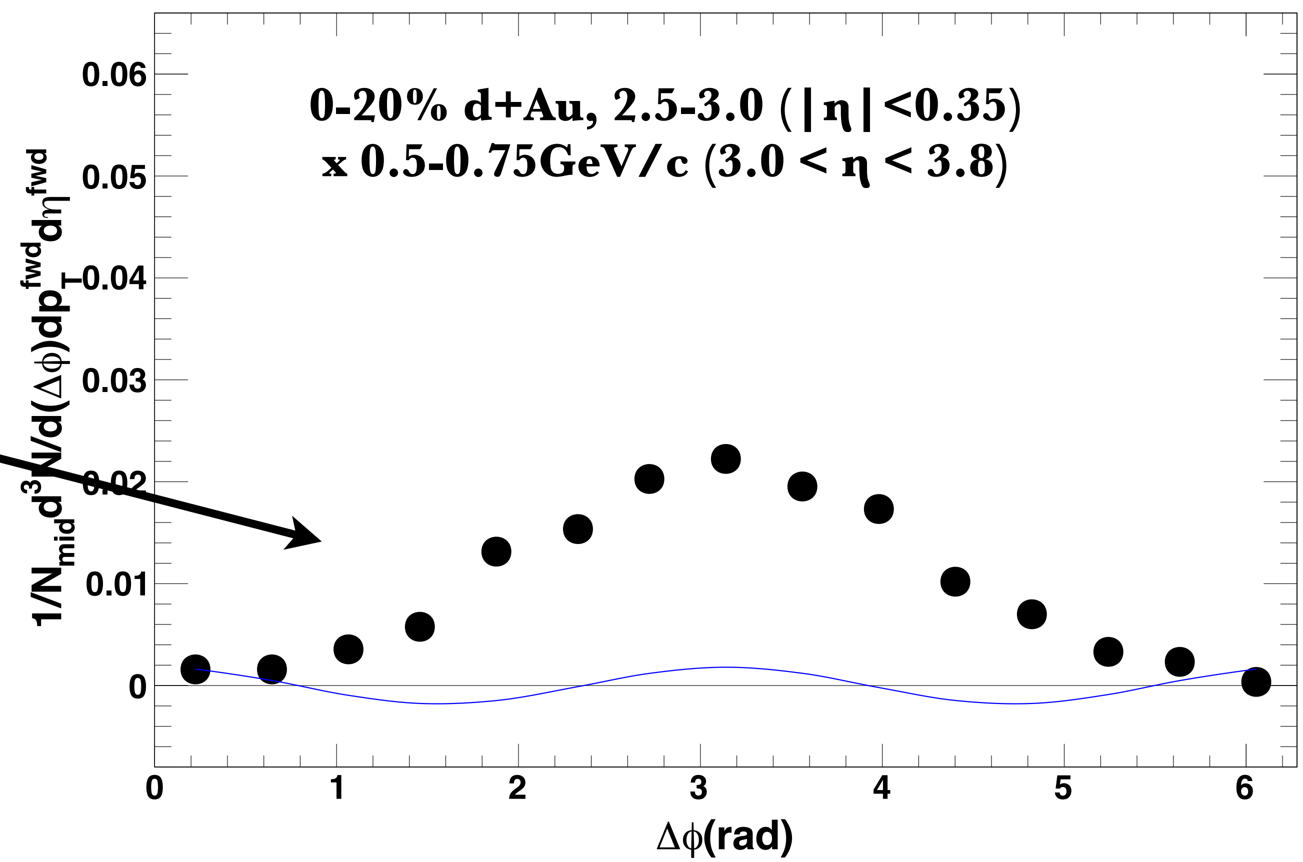




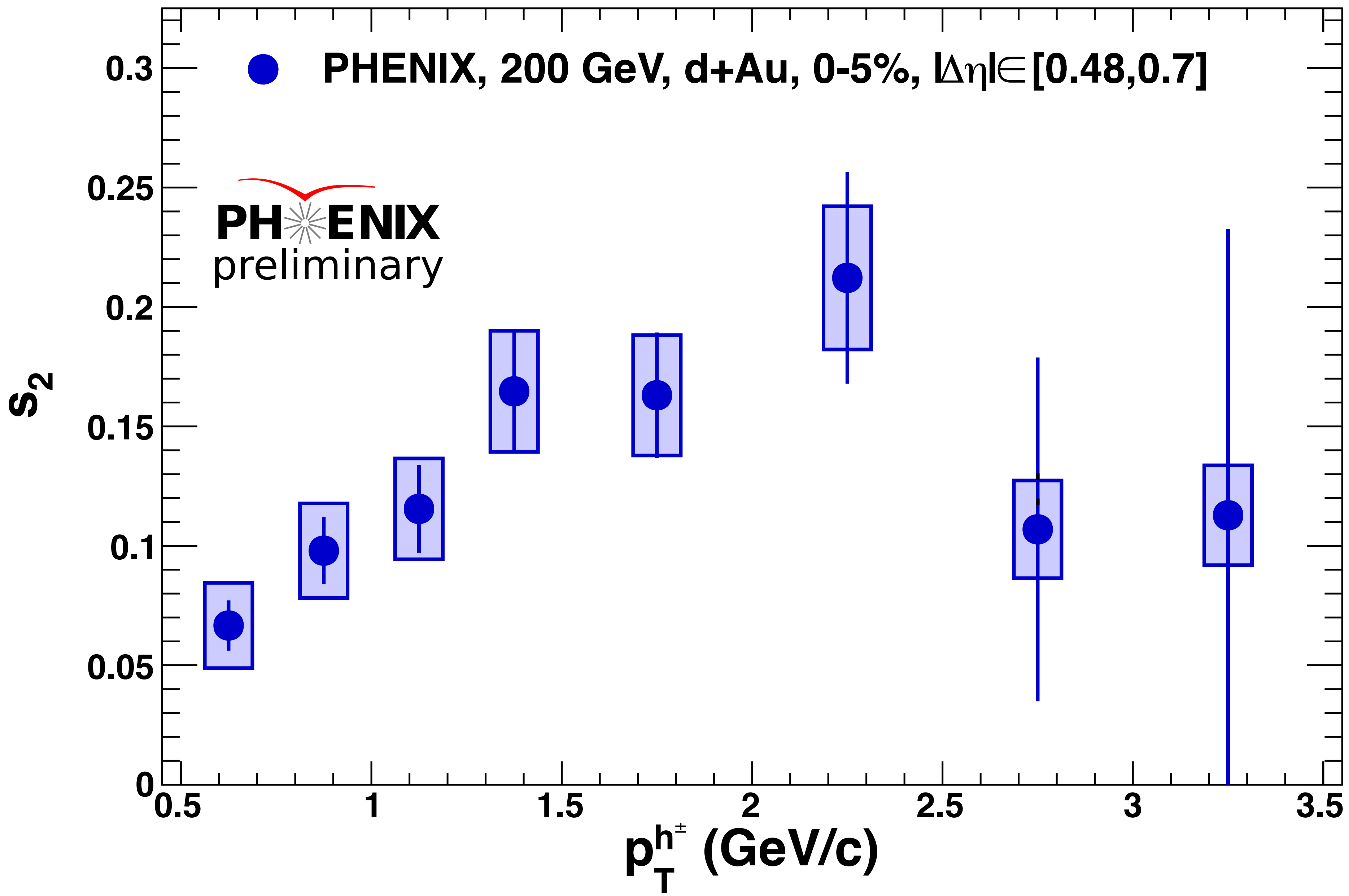


NO! previous results not sensitive to this effect

single particle anisotropy

$$c2(p_{T,a},p_{T,b}) = s2(p_{T,a})s2(p_{T,b})$$

→factorization assumption: two particle modulation is the product of the single particle anisotropies



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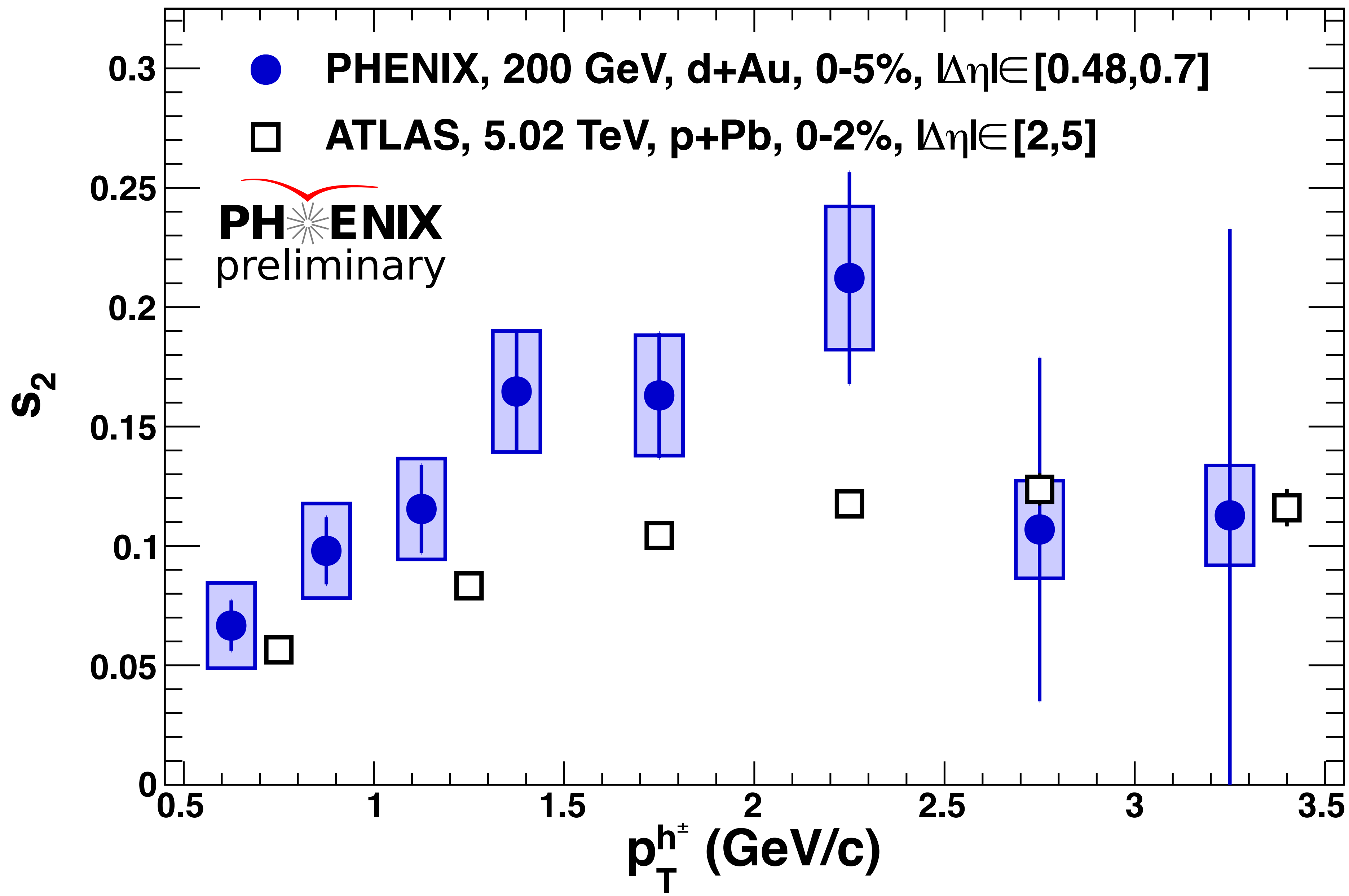
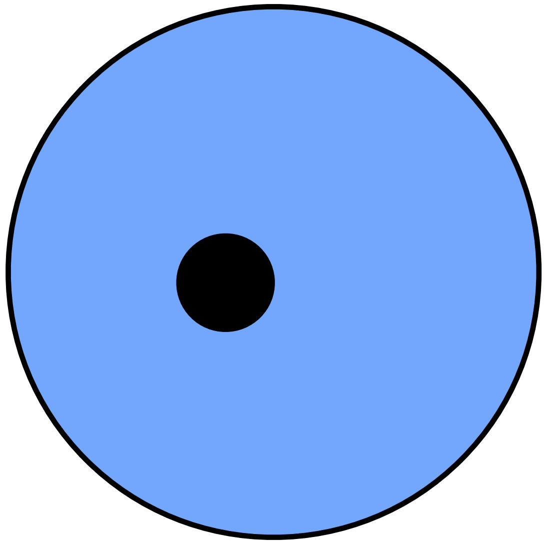
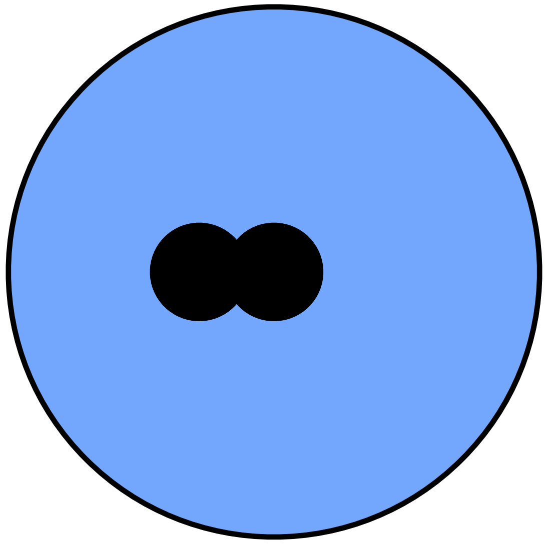


larger anisotropy observed than at ATLAS!

pPb vs dAu





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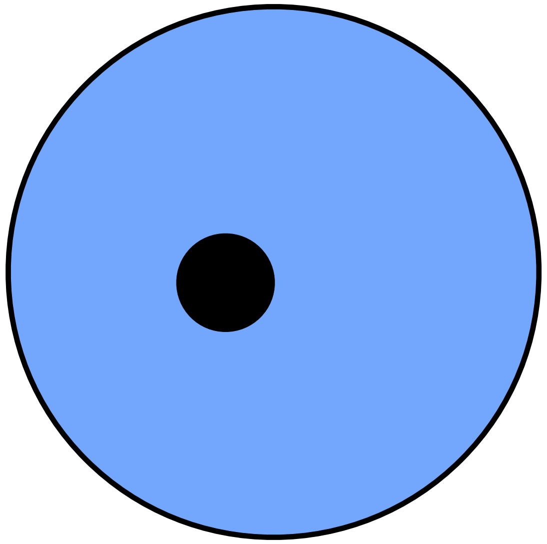
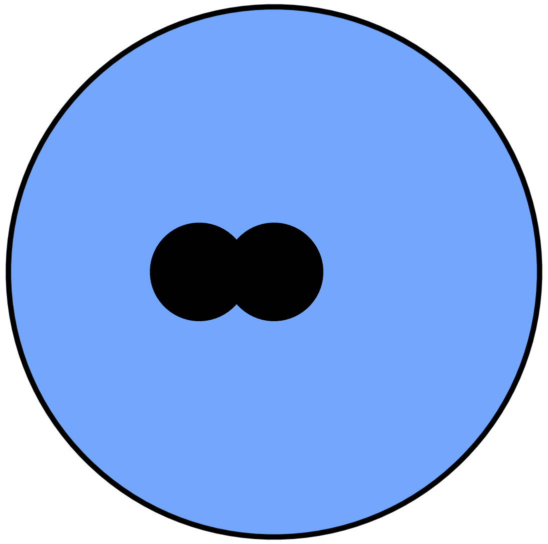
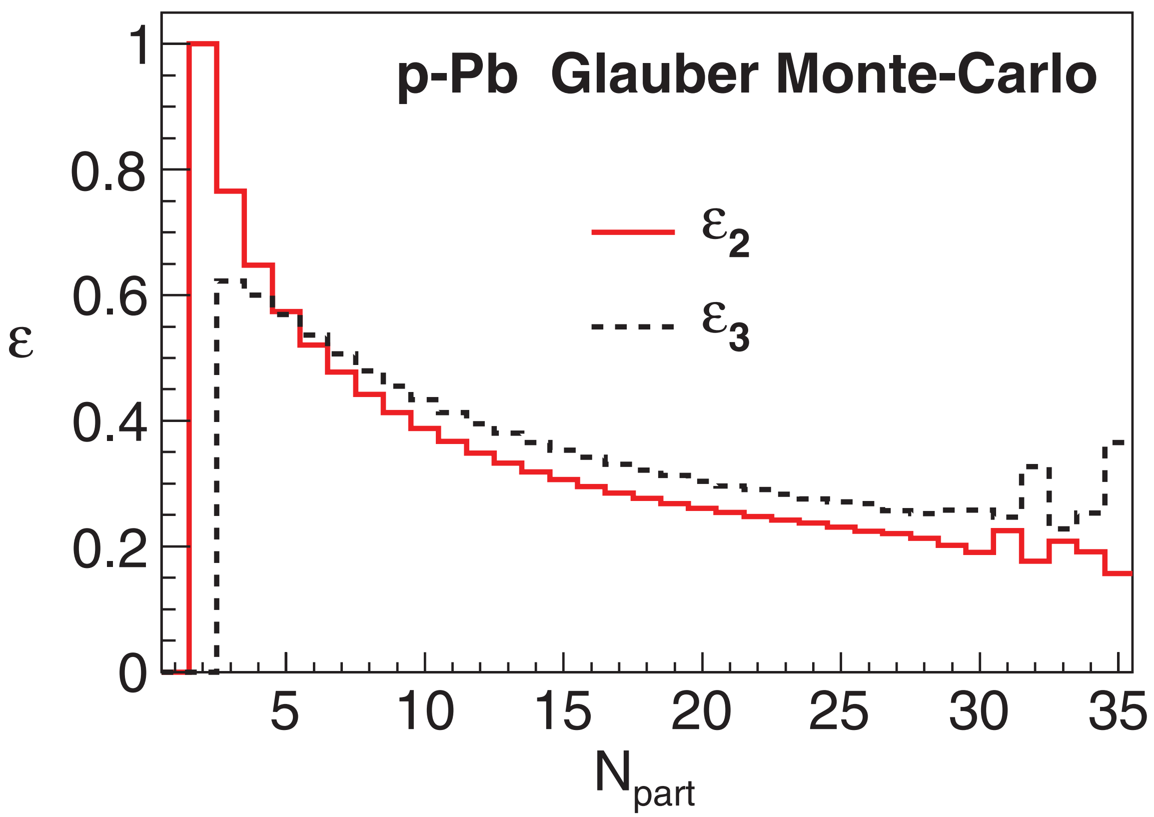
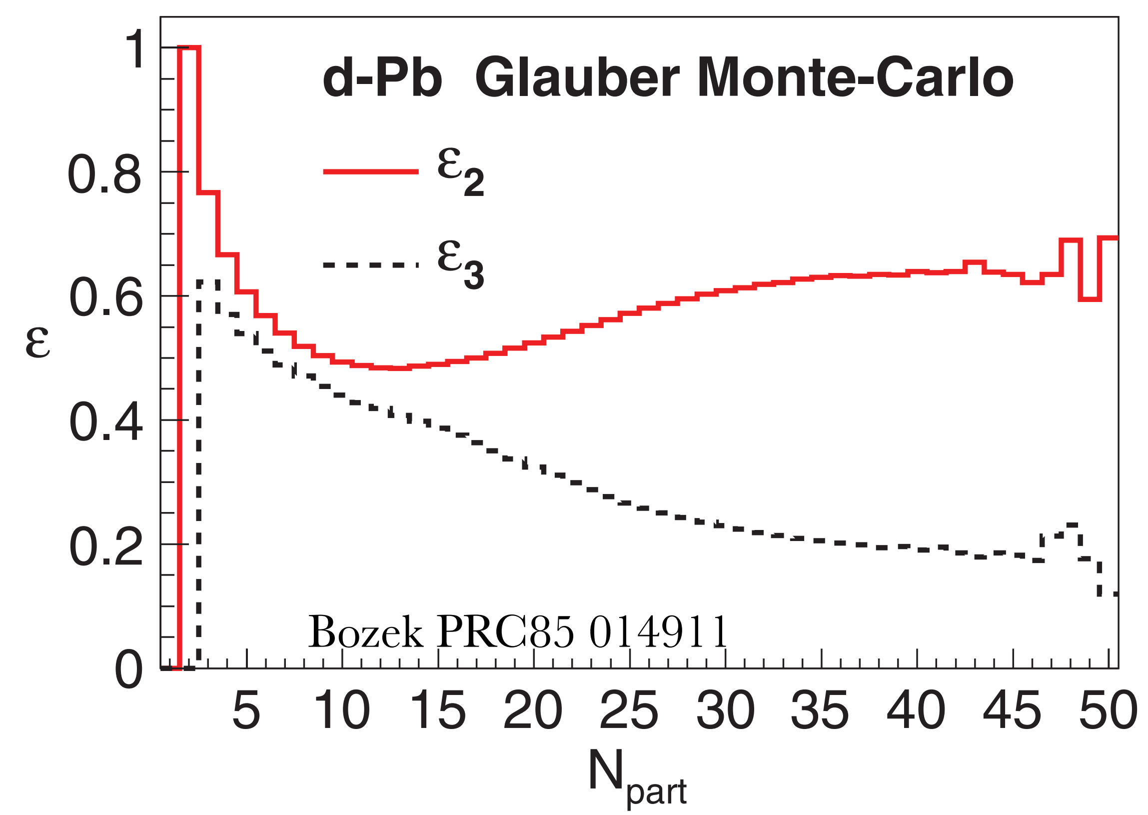
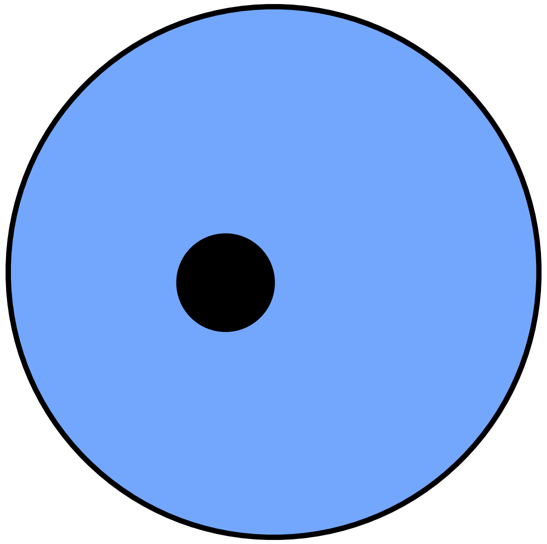


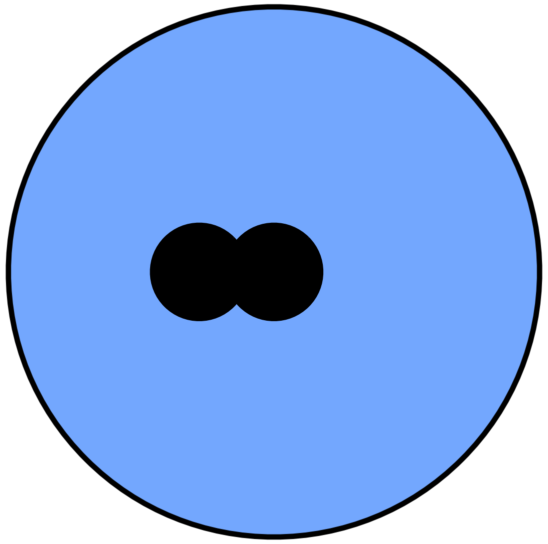


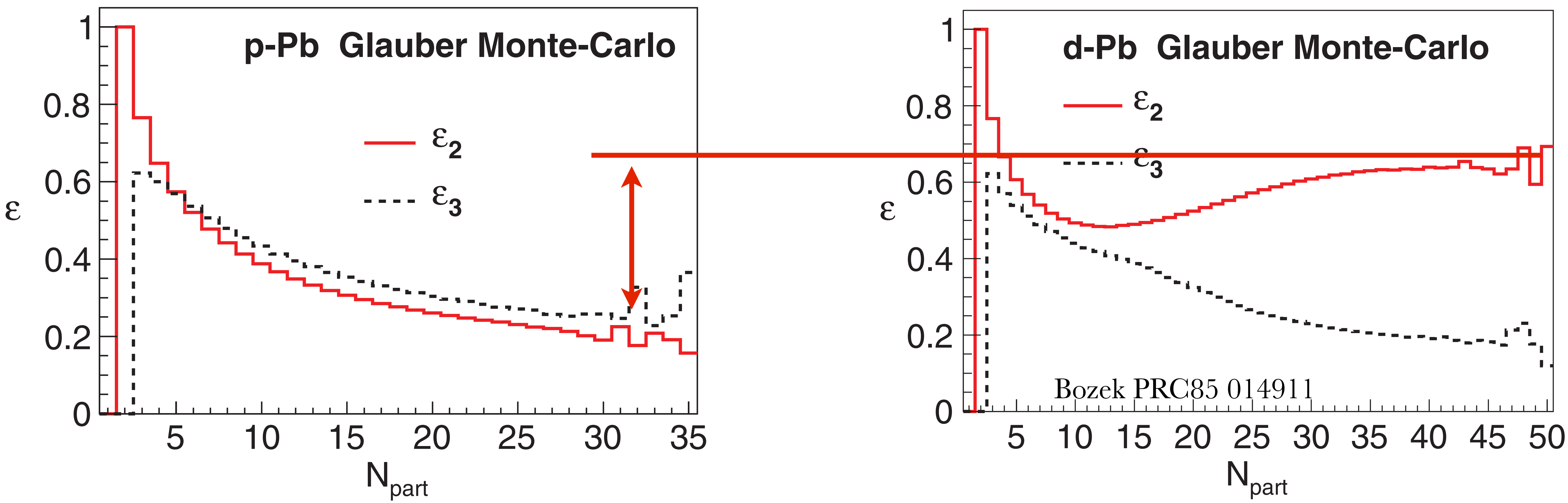

p-Pb Glauber Monte-Carlo
ε₂
ε₃
ε
N_part
0
0.2
0.4
0.6
0.8
1
5
10
15
20
25
30
35


d-Pb Glauber Monte-Carlo
ε₂
ε₃
ε
N_part
Bozek PRC85 014911
0
0.2
0.4
0.6
0.8
1
5
10
15
20
25
30
35
40
45
50

pPb vs dAu



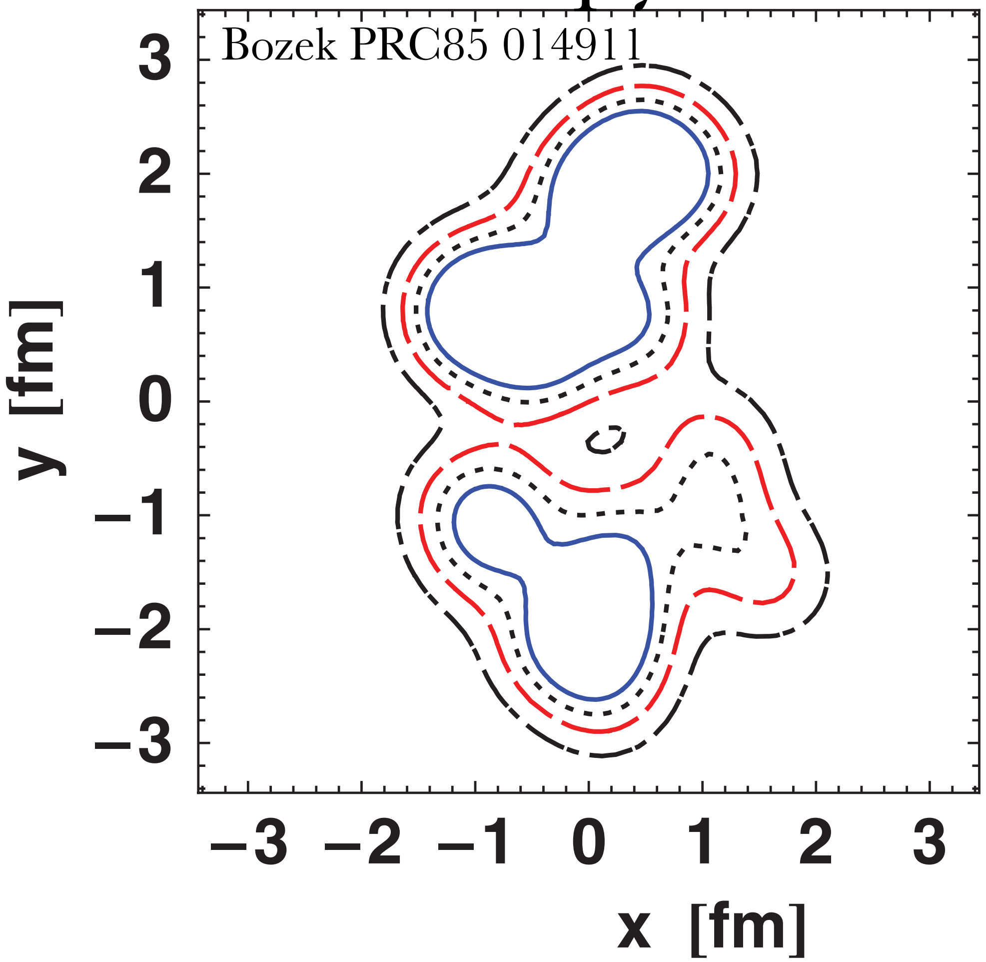




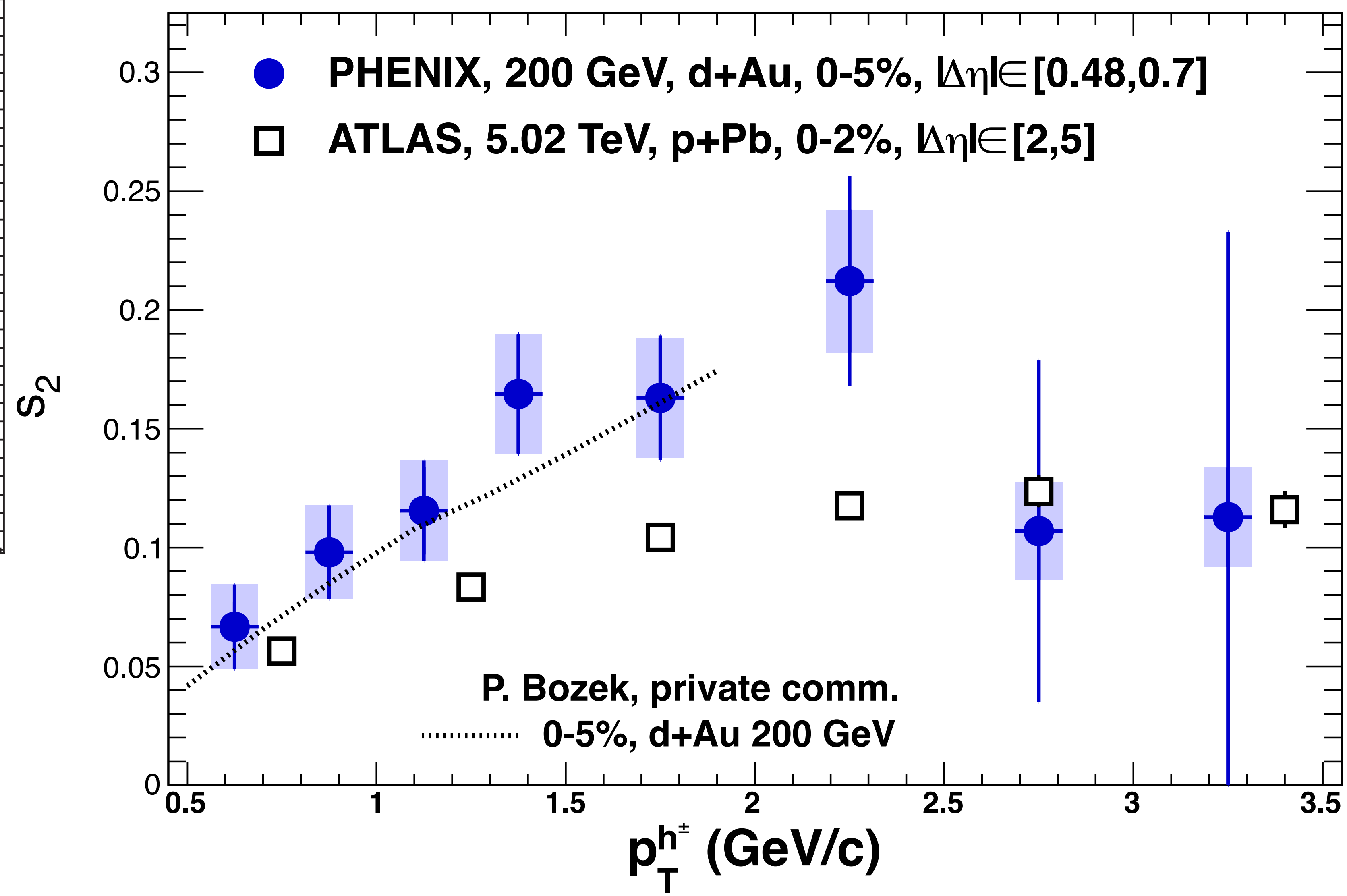
d+A central collisions have much larger ε_2 than p+A

comparison with hydro

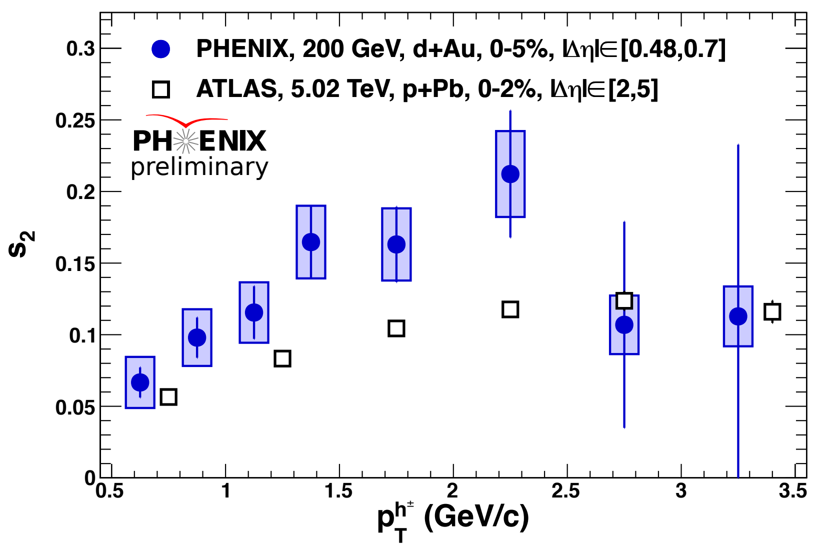
initial entropy densitiy

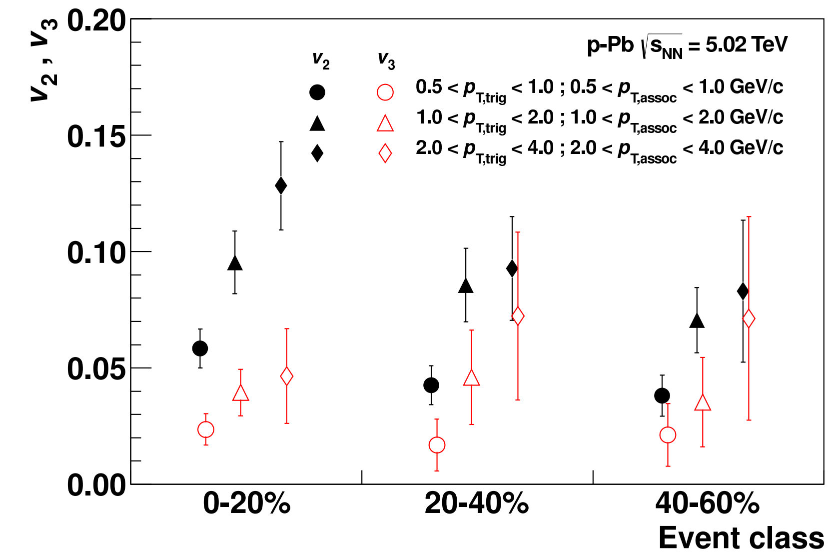


apples to apples comparison

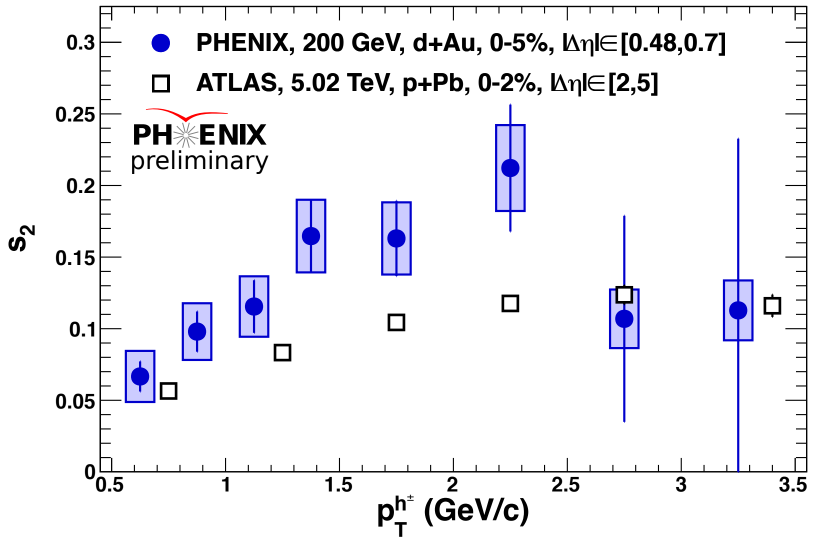


- good agreement with hydro calculation done at 200 GeV for 0-5% centrality


PHENIX, 200 GeV, d+Au, 0-5%, |Δη|∈[0.48,0.7]
ATLAS, 5.02 TeV, p+Pb, 0-2%, |Δη|∈[2,5]
PHENIX
preliminary
s_2
$p_T^{h^\pm}$ (GeV/c)


p-Pb $\sqrt{s_{NN}}$ = 5.02 TeV
v_2
v_3
$0.5 < p_{T,trig} < 1.0$; $0.5 < p_{T,assoc} < 1.0$ GeV/c
$1.0 < p_{T,trig} < 2.0$; $1.0 < p_{T,assoc} < 2.0$ GeV/c
$2.0 < p_{T,trig} < 4.0$; $2.0 < p_{T,assoc} < 4.0$ GeV/c
v_2 , v_3
0-20%
20-40%
40-60%
Event class

dAu vs pPb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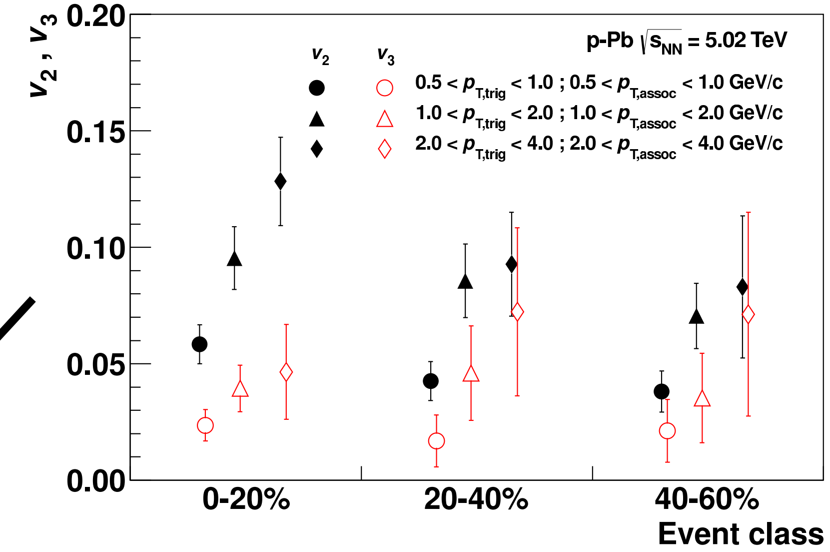
PHENIX preliminary
s2
pT (GeV/c)


p-Pb √sNN = 5.02 TeV
v2 , v3
0.5 < pT,trig < 1.0 ; 0.5 < pT,assoc < 1.0 GeV/c
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0-20%
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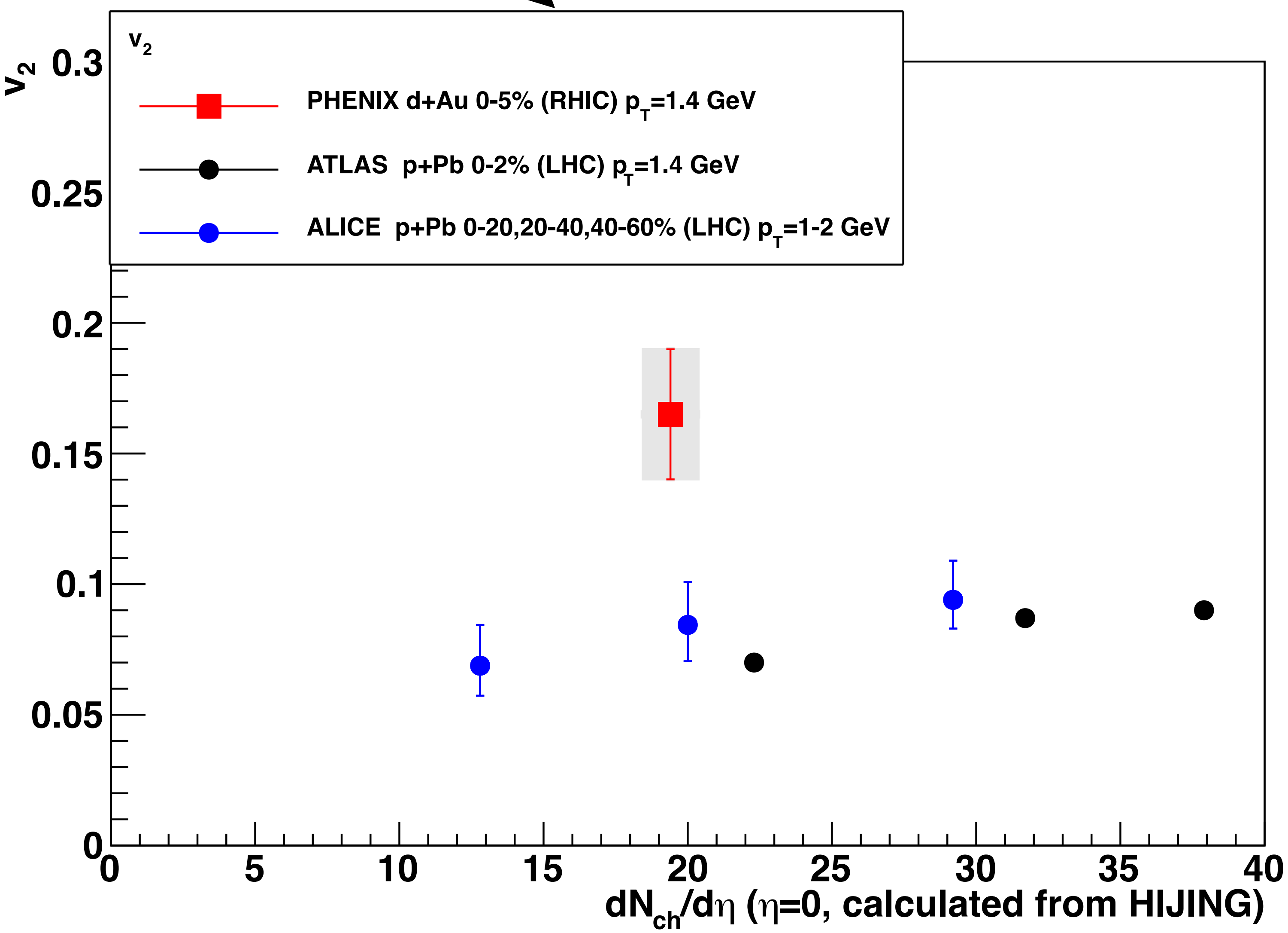
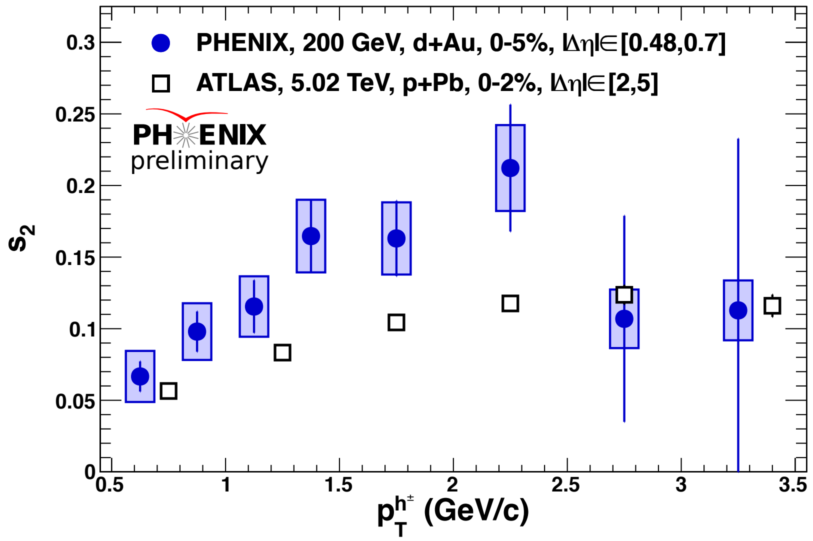
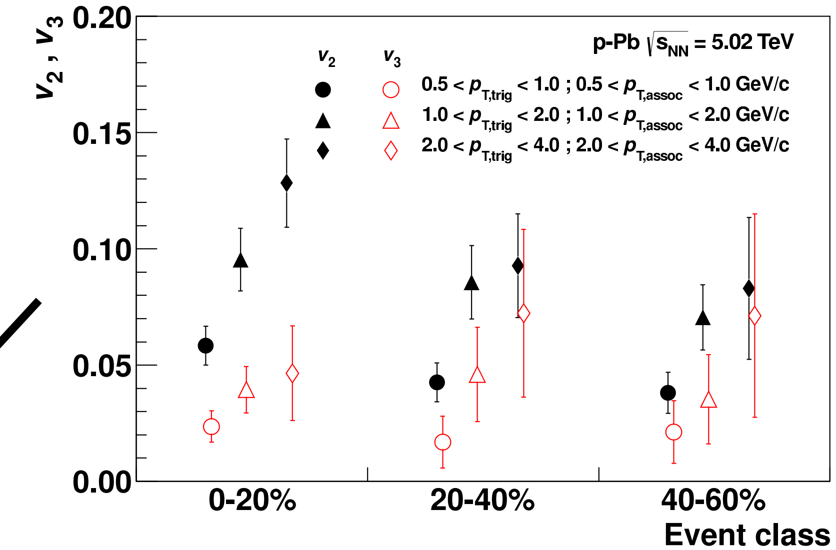
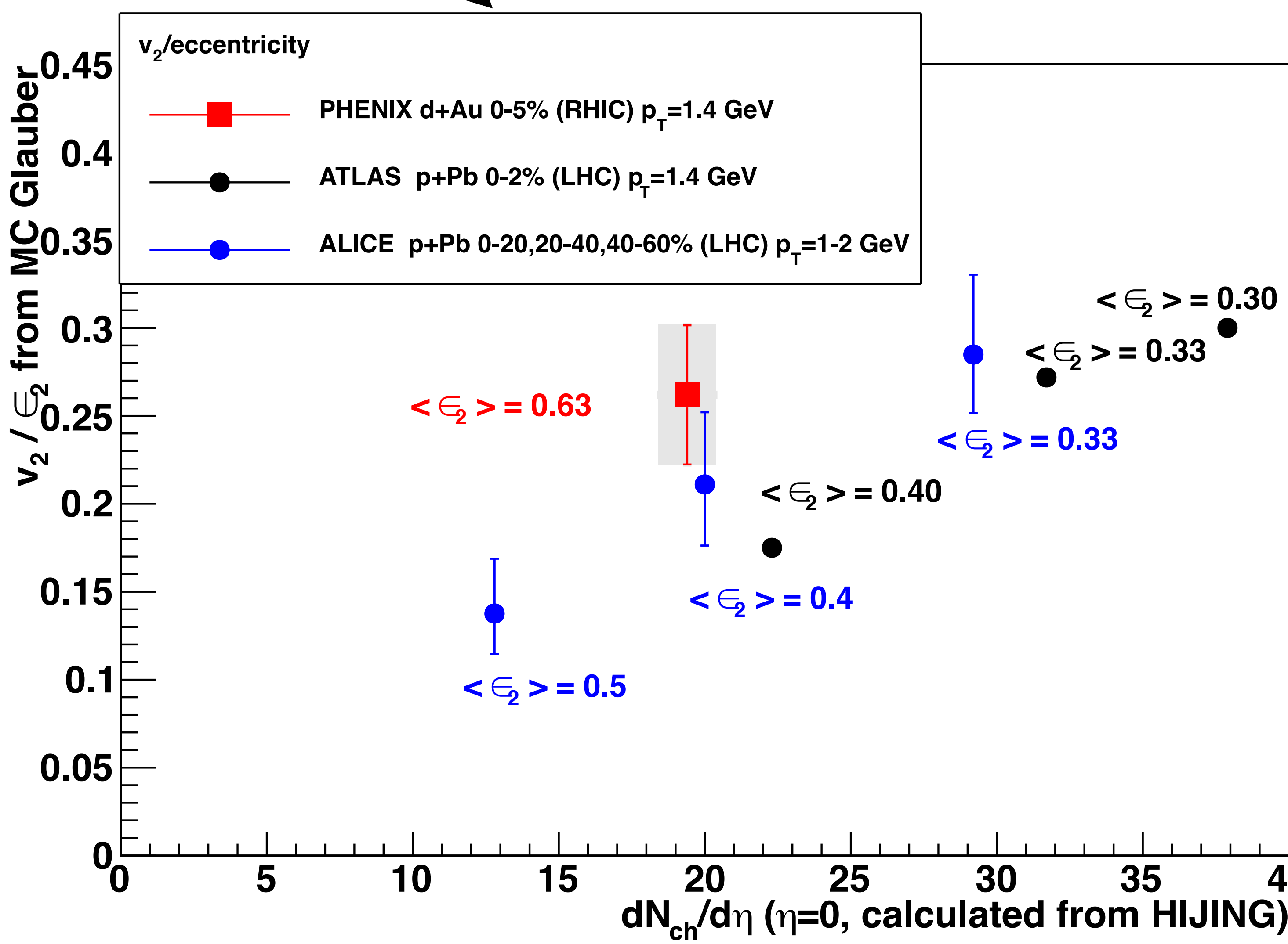
40-60%
Event class

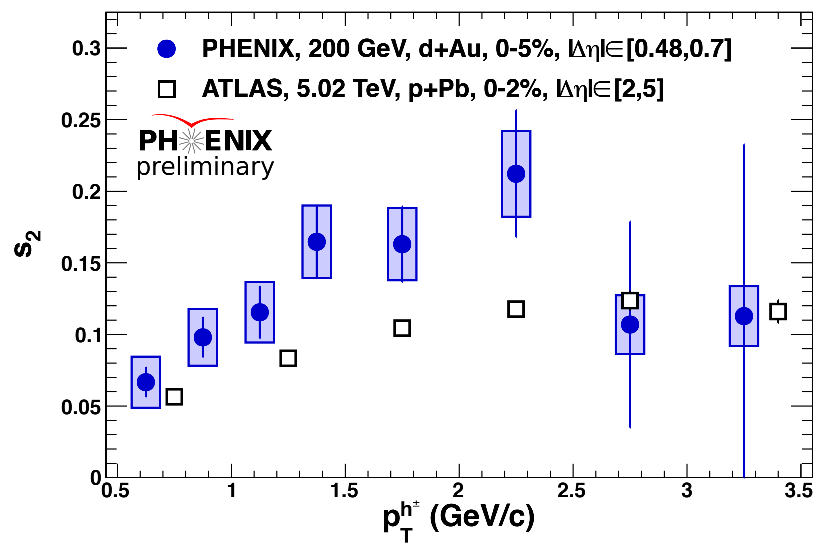

v2
PHENIX d+Au 0-5% (RHIC) pT=1.4 GeV
ATLAS p+Pb 0-2% (LHC) pT=1.4 GeV
ALICE p+Pb 0-20,20-40,40-60% (LHC) pT=1-2 GeV
dNch/dη (η=0, calculated from HIJING)

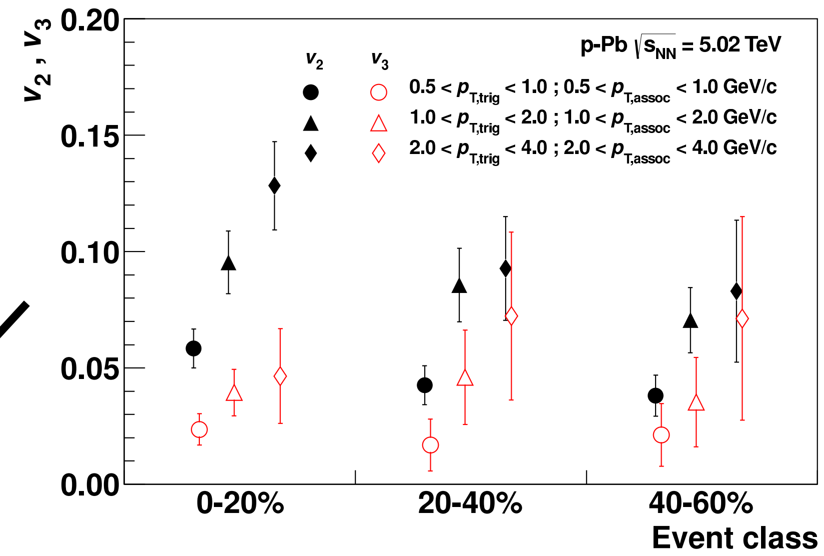


scaling by ε_2

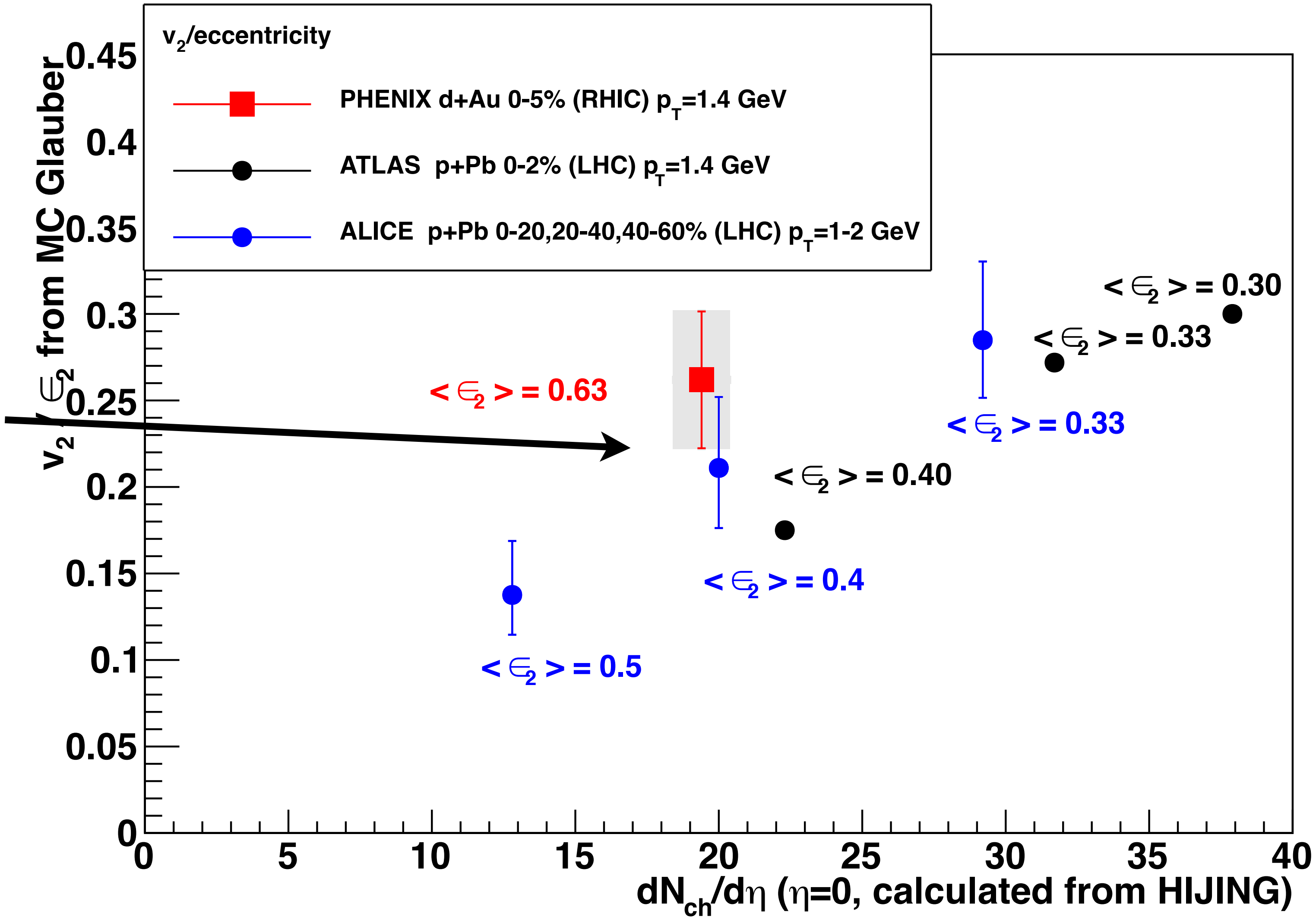




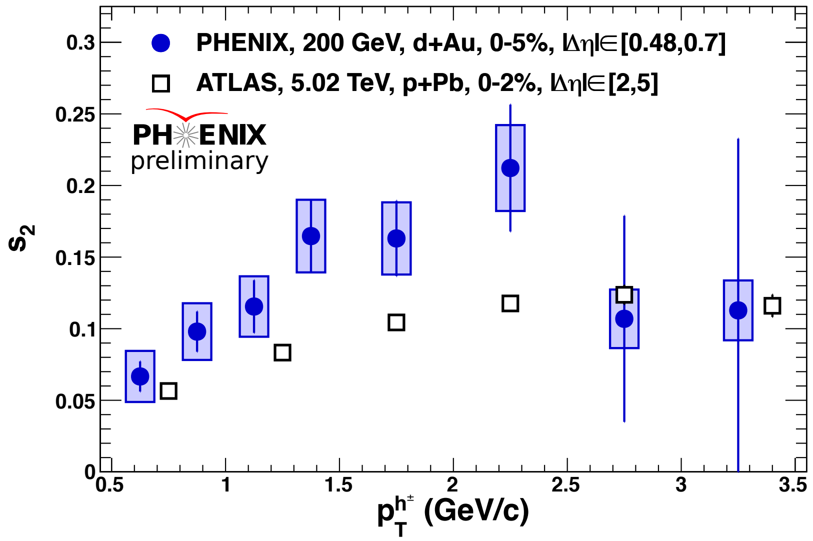




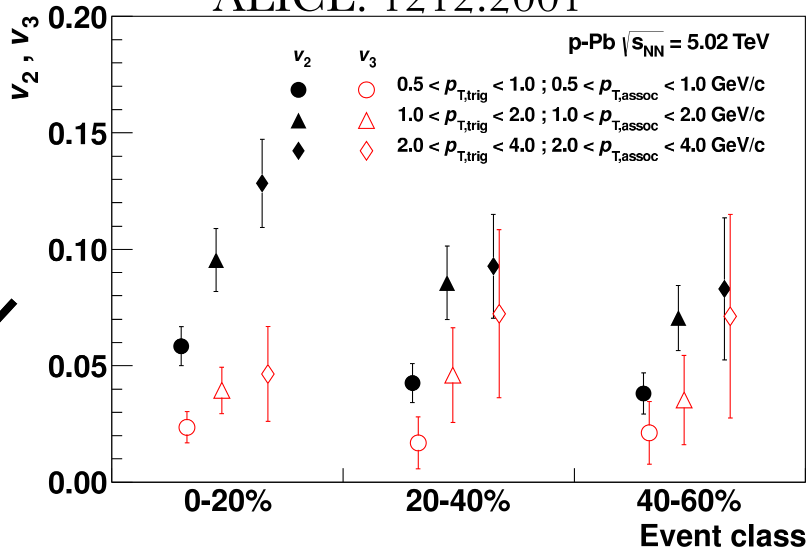
scaling by ε2



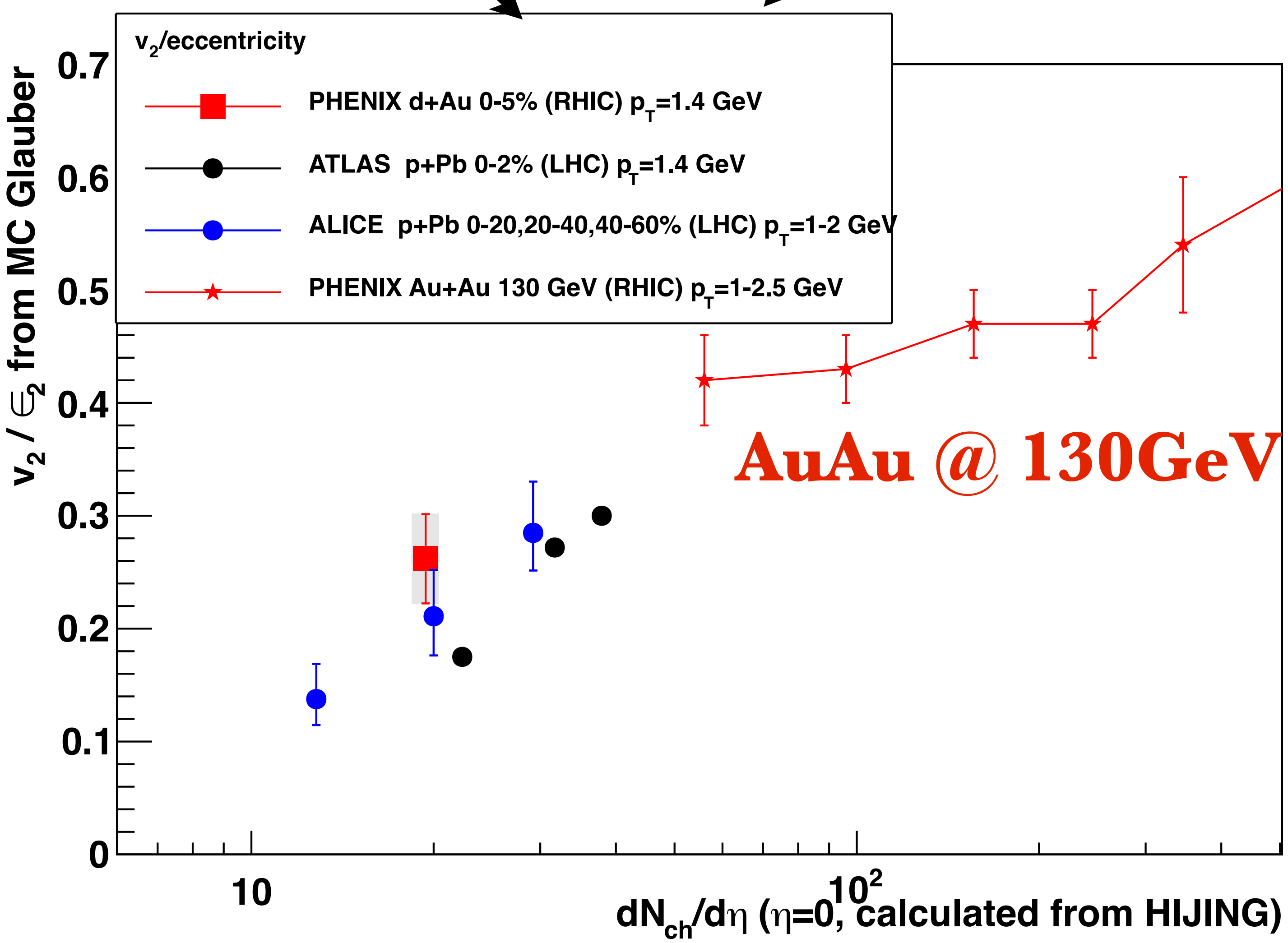
similar dNch/dη
50% greater ε2 in dAu



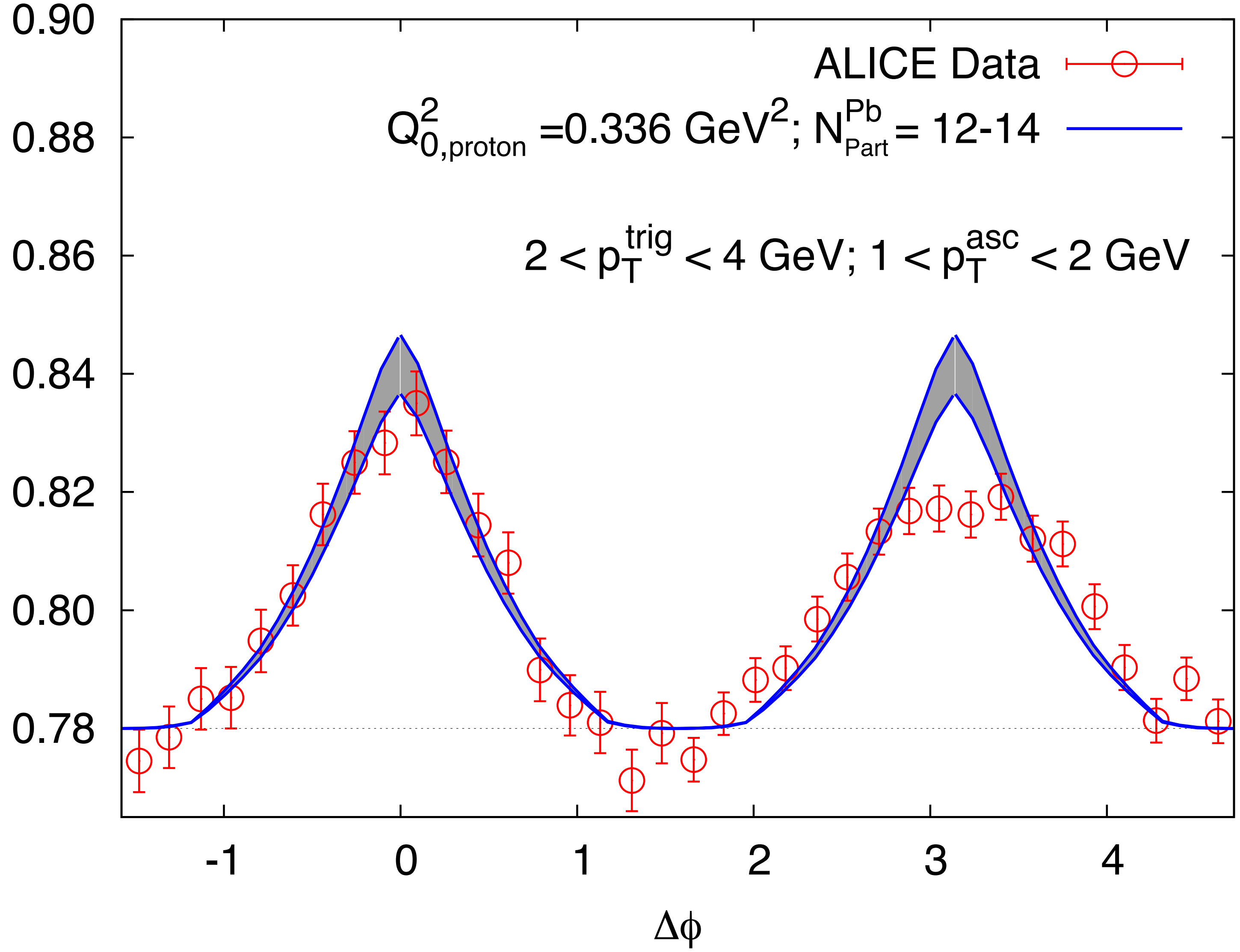
ALICE: 1212.2001



scaling by ε_2



what about the CGC?



good description of the ALICE data

Dusling & Venugopalan 1211.3701 & private comm.

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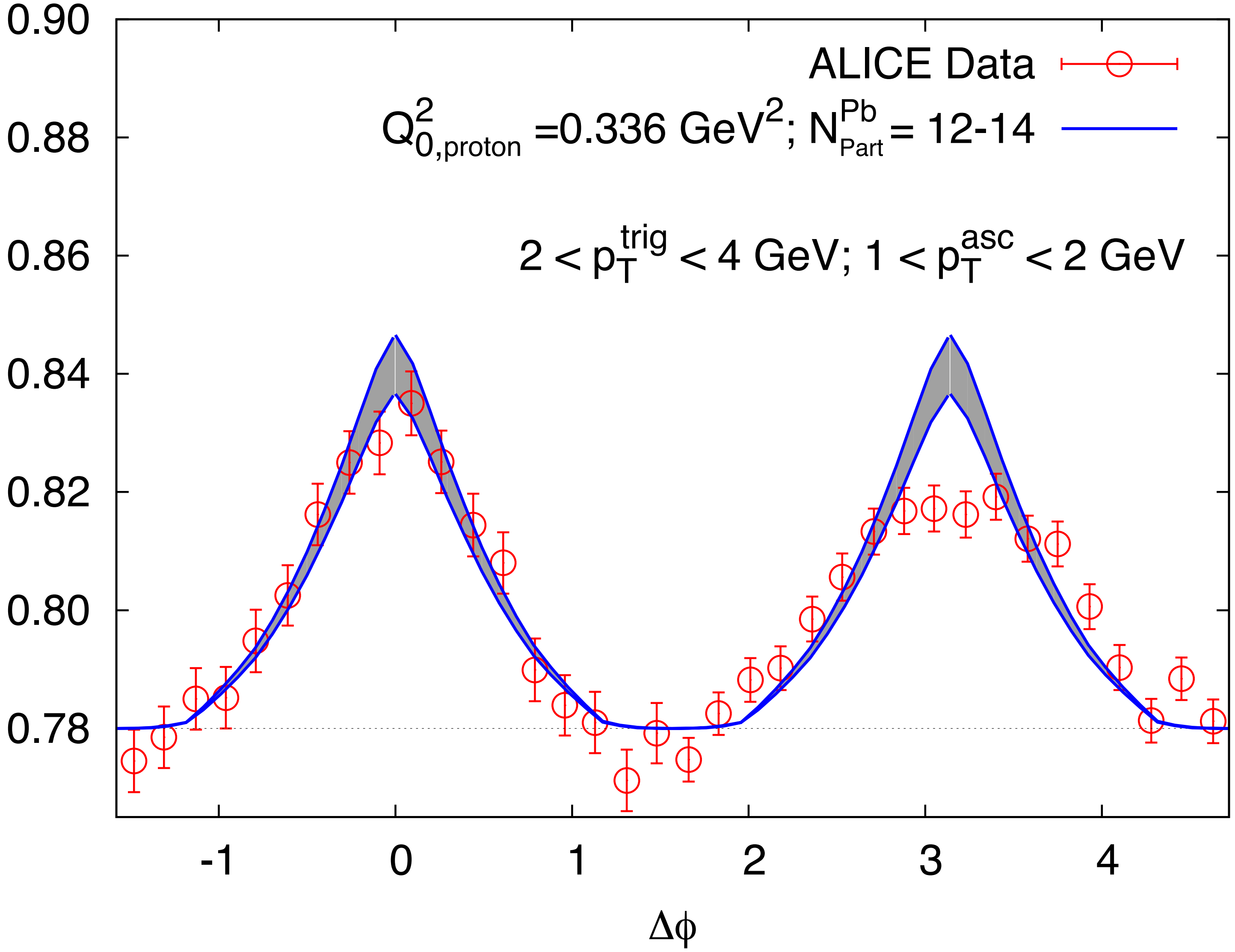


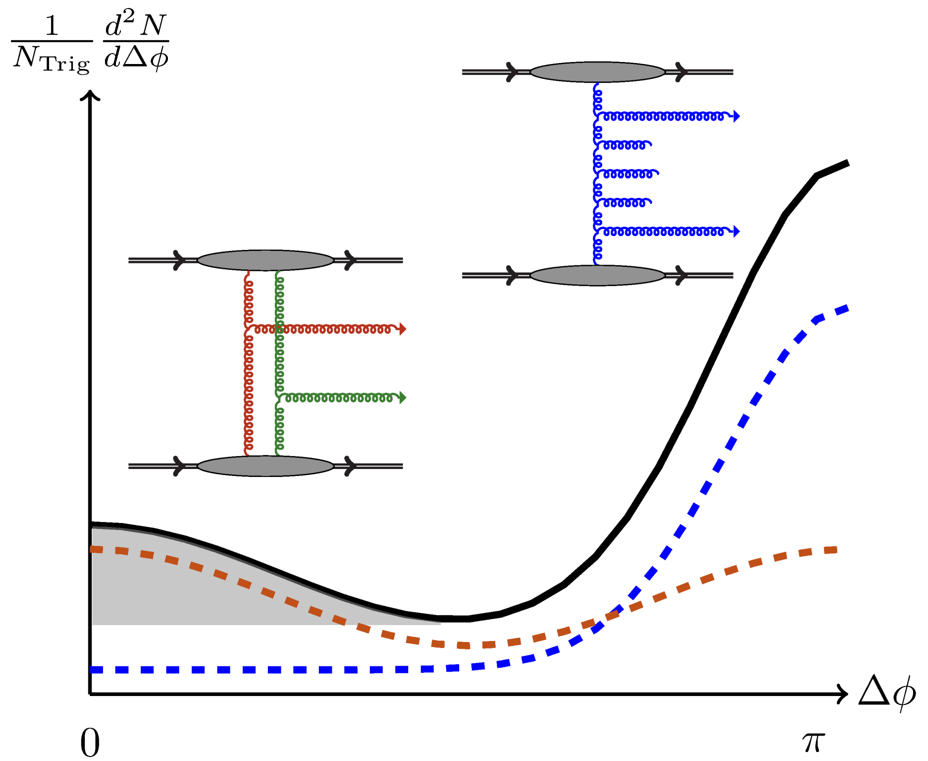
good description of the ALICE data

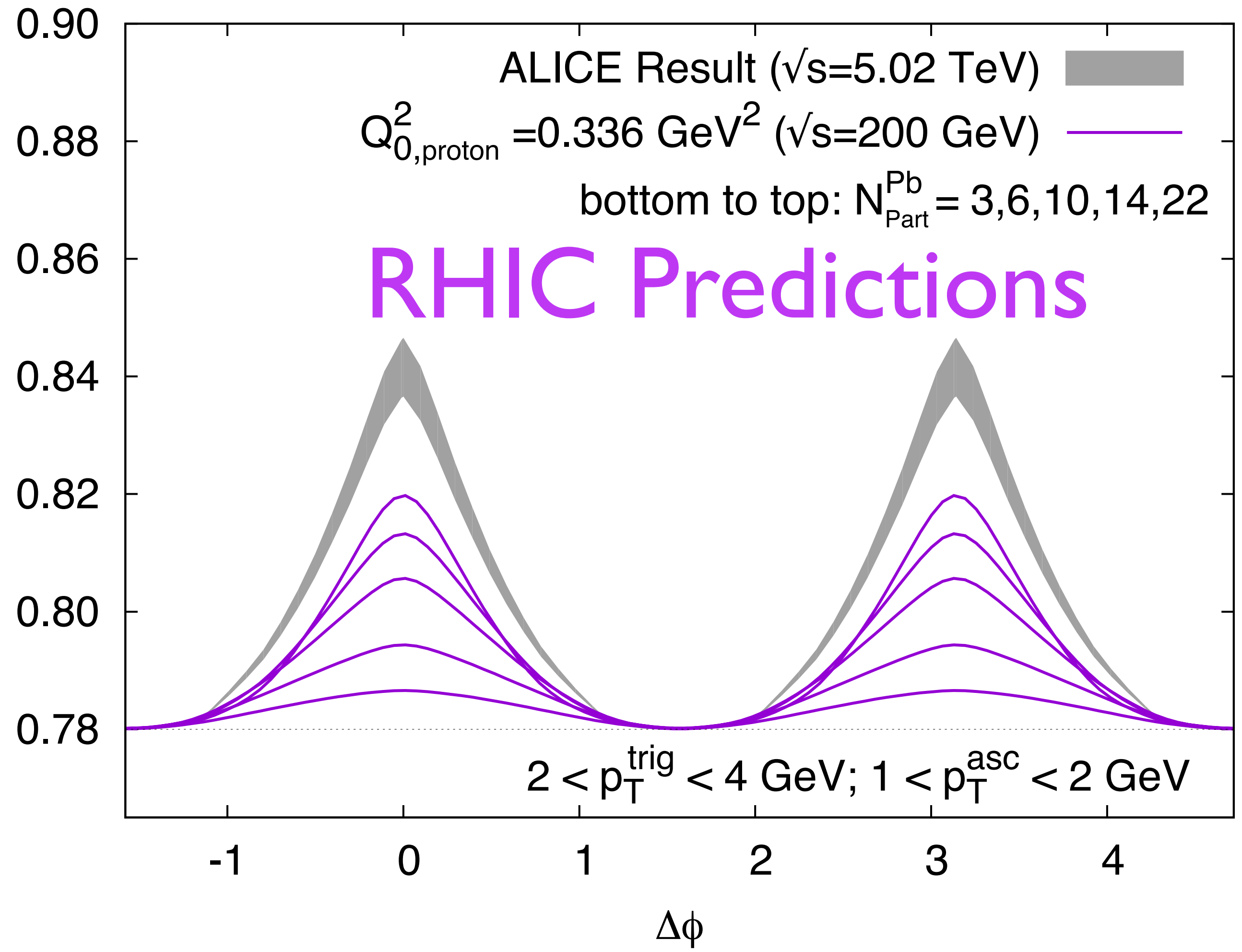
- Fourier coefficients are not the natural framework for these results
- calculate a normalized associated yield, which we presently don't have

Dusling & Venugopalan 1211.3701 & private comm.

what about the CGC?

significant signal expected at RHIC!



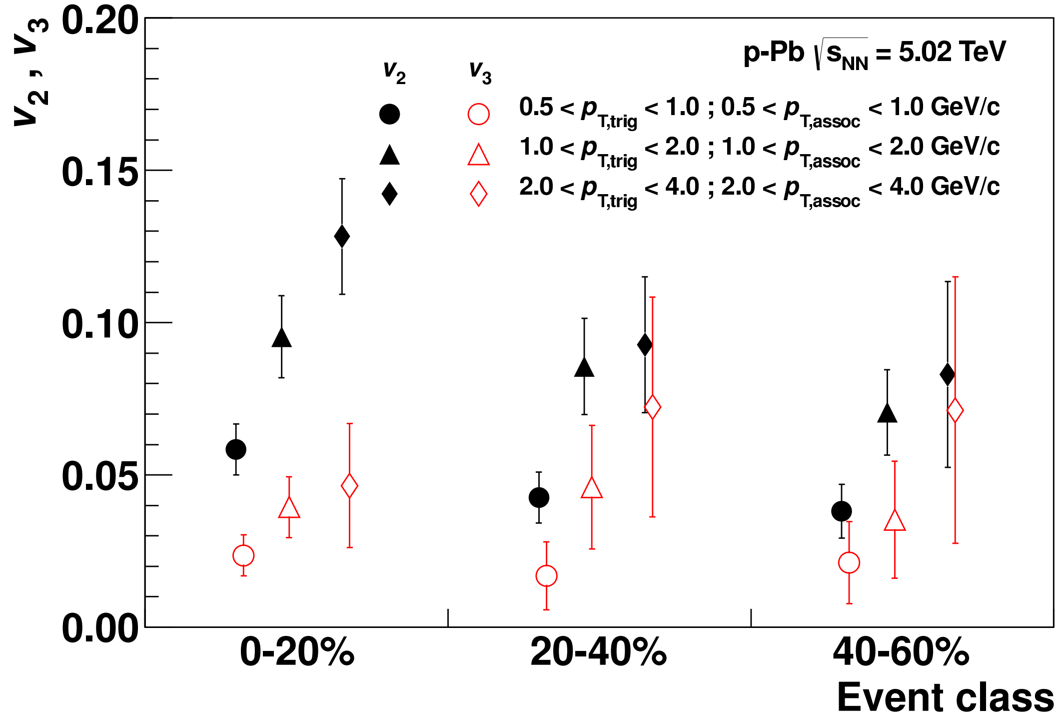


WARNING!!

cannot compare directly to data! We measure a modulation relative to the combinatoric background, not all of which is included in this calculation!

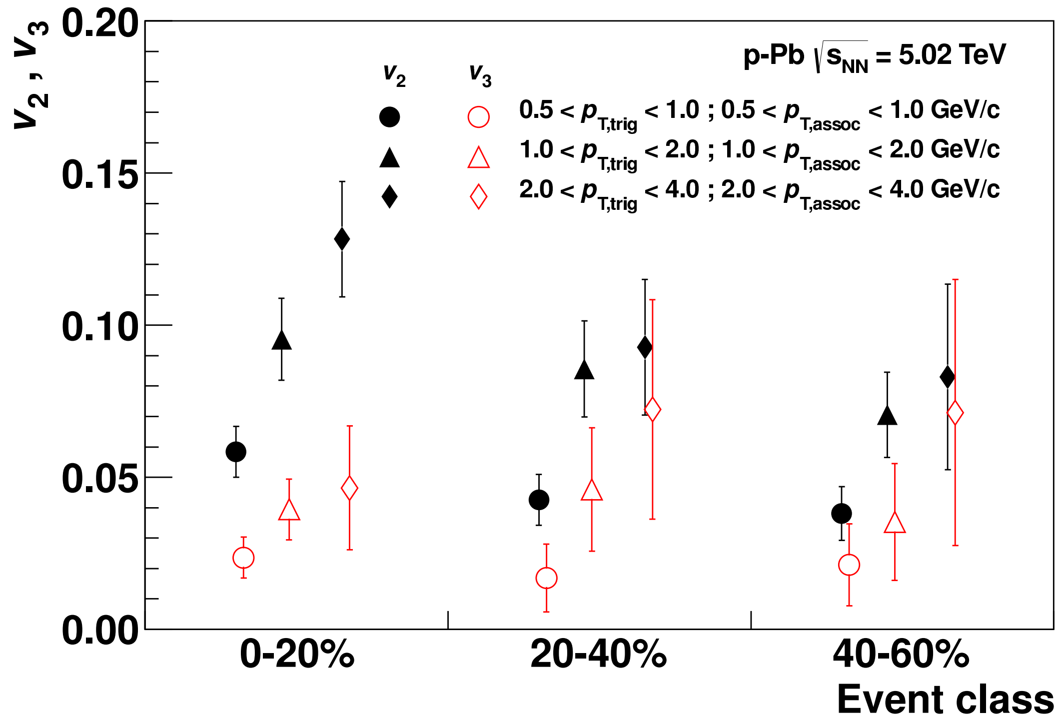
Dusling & Venugopalan 1211.3701 & private comm.

ALICE: 1212.2001



ALICE sees v3 > 0,
what about at RHIC?

ALICE: 1212.2001



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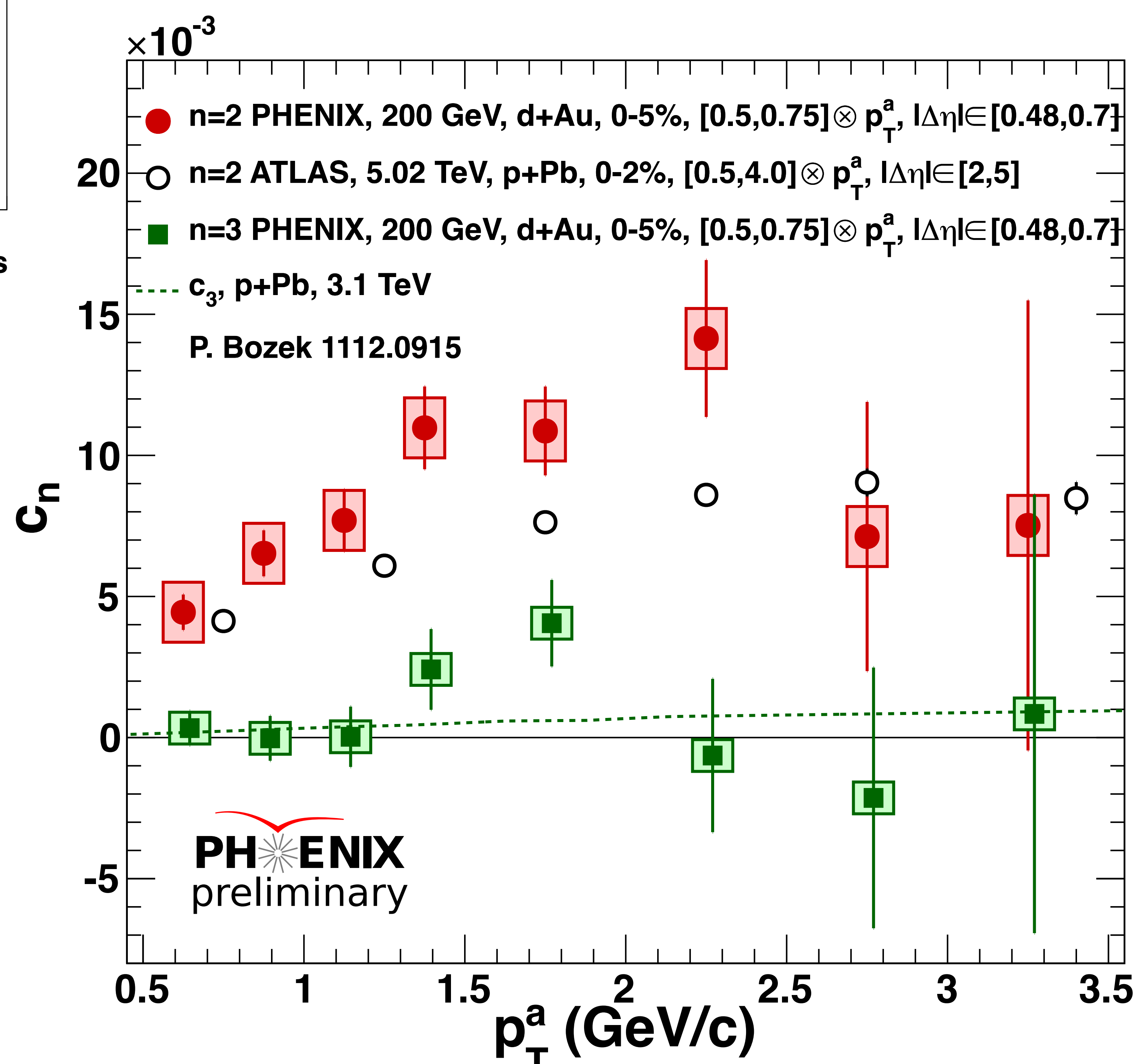

intriguing, but not significantly non-zero result

conclusions

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- quadrupole anisotropy seen in central dAu collisions at RHIC

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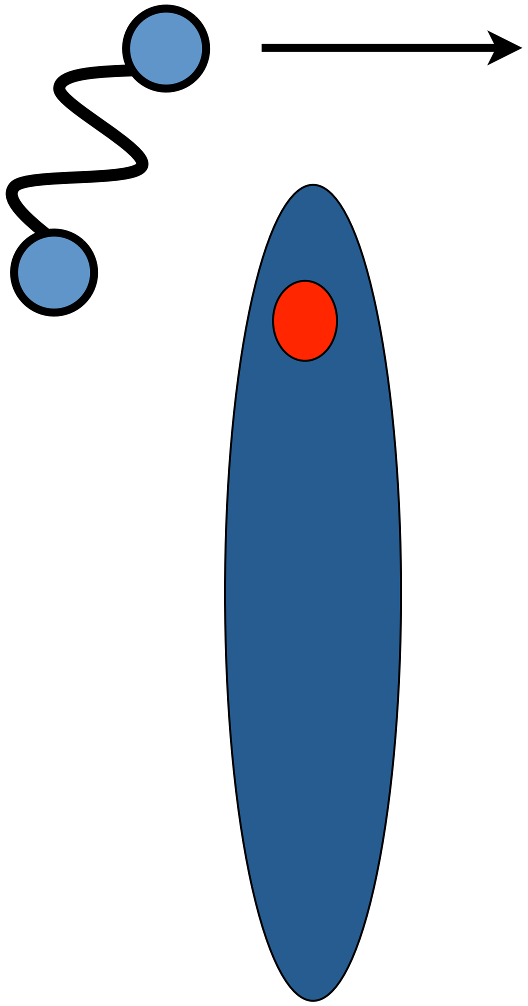
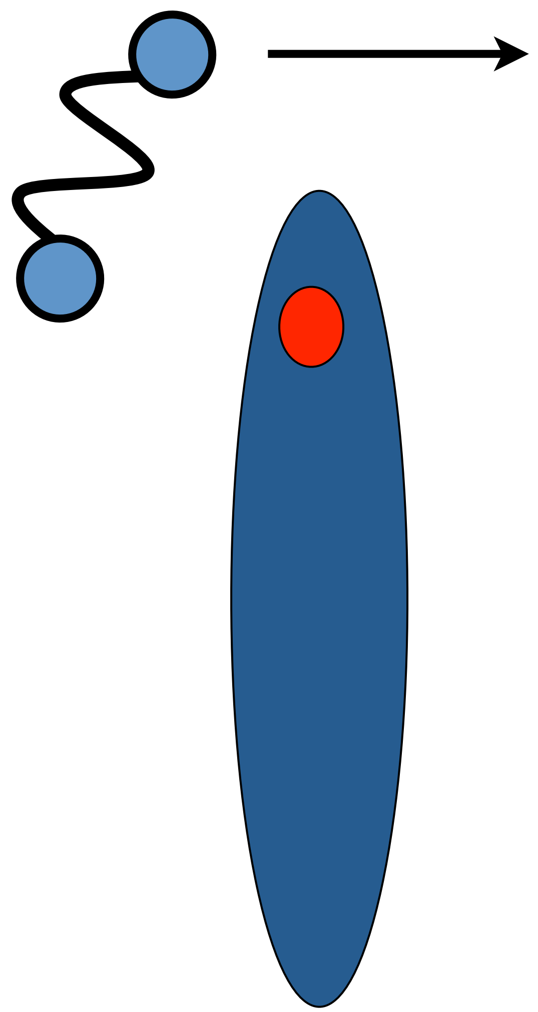
conditional yields, neutron tagging, centrality dependence coming soon!

going forward: dAu vs pAu



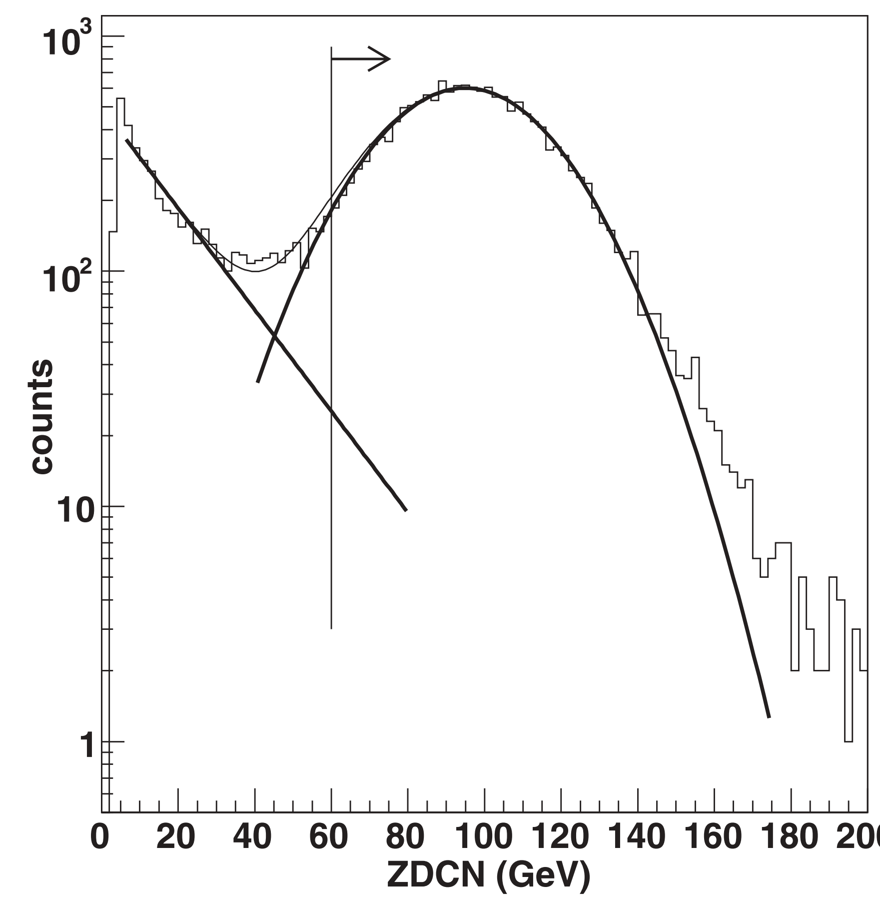
going forward: dAu vs pAu



neutron goes forward,
missing the Au

100GeV neutron peak
in the d-going ZDC

PHENIX PRC77 014905



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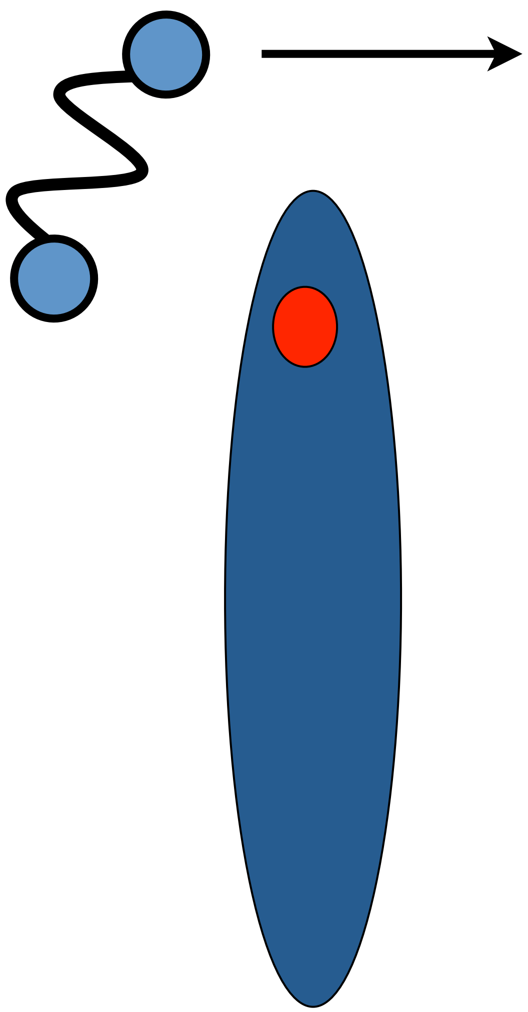

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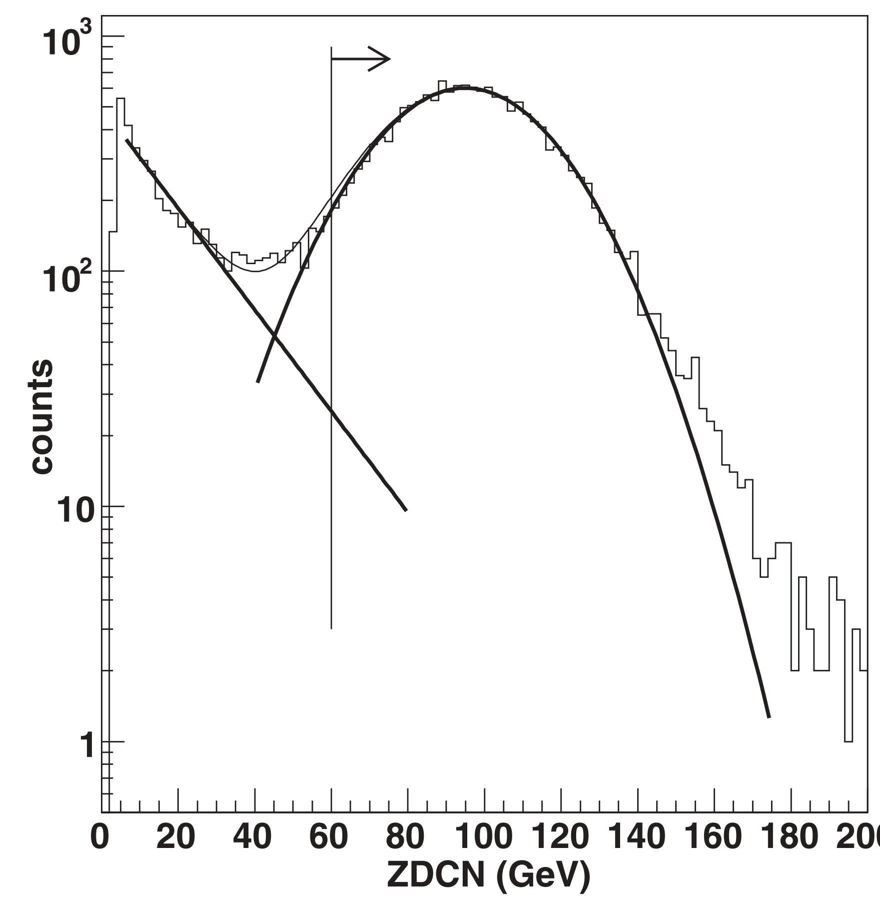
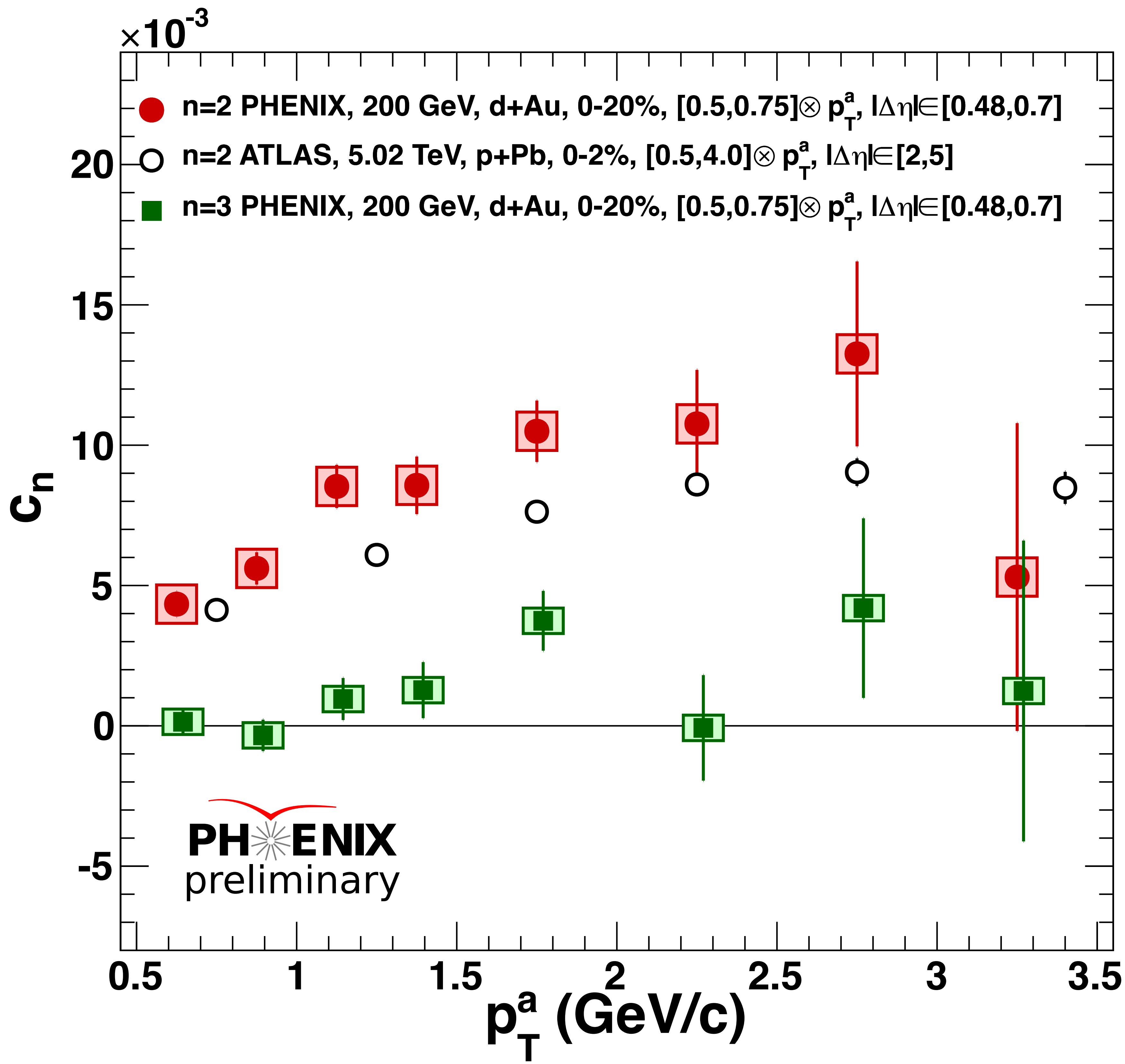


opportunity to constrain geometry effects within a single experiment!

extras

0-20% central



$\times 10^{-3}$
n=2 PHENIX, 200 GeV, d+Au, 0-20%, [0.5,0.75]⊗ p_T^a, |Δη|∈[0.48,0.7]
n=2 ATLAS, 5.02 TeV, p+Pb, 0-2%, [0.5,4.0]⊗ p_T^a, |Δη|∈[2,5]
n=3 PHENIX, 200 GeV, d+Au, 0-20%, [0.5,0.75]⊗ p_T^a, |Δη|∈[0.48,0.7]
20
15
10
5
0
-5
c_n
PHENIX
preliminary
0.5
1
1.5
2
2.5
3
3.5
p_T^a (GeV/c)

- PHENIX central arm eta acceptance too small to get away from the jet contribution entirely
- jet fragmentation effects can be suppressed by looking at same sign pairs: