Forward di-π^0 correlations at STAR

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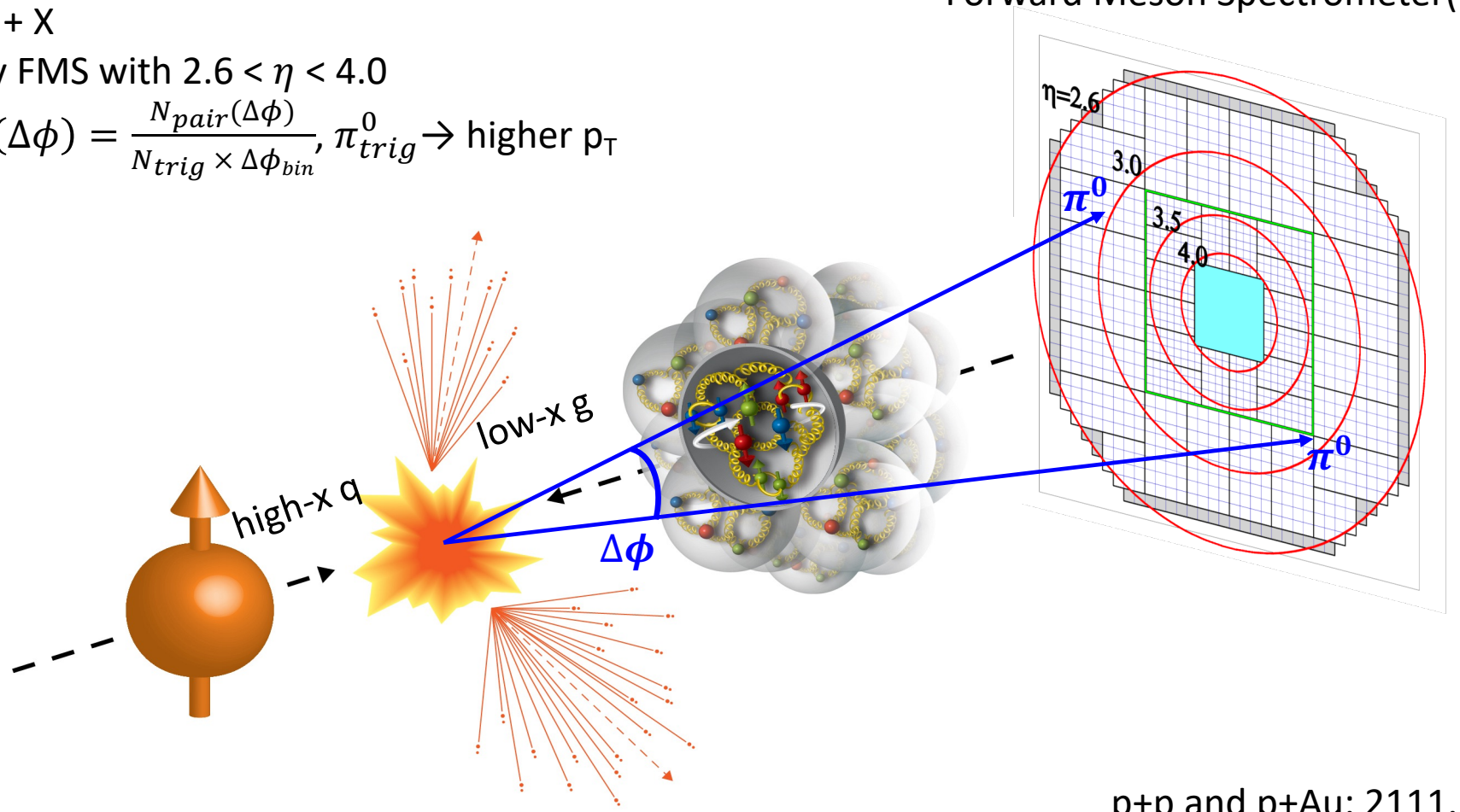
BNL EIC meeting

Experimental measurement

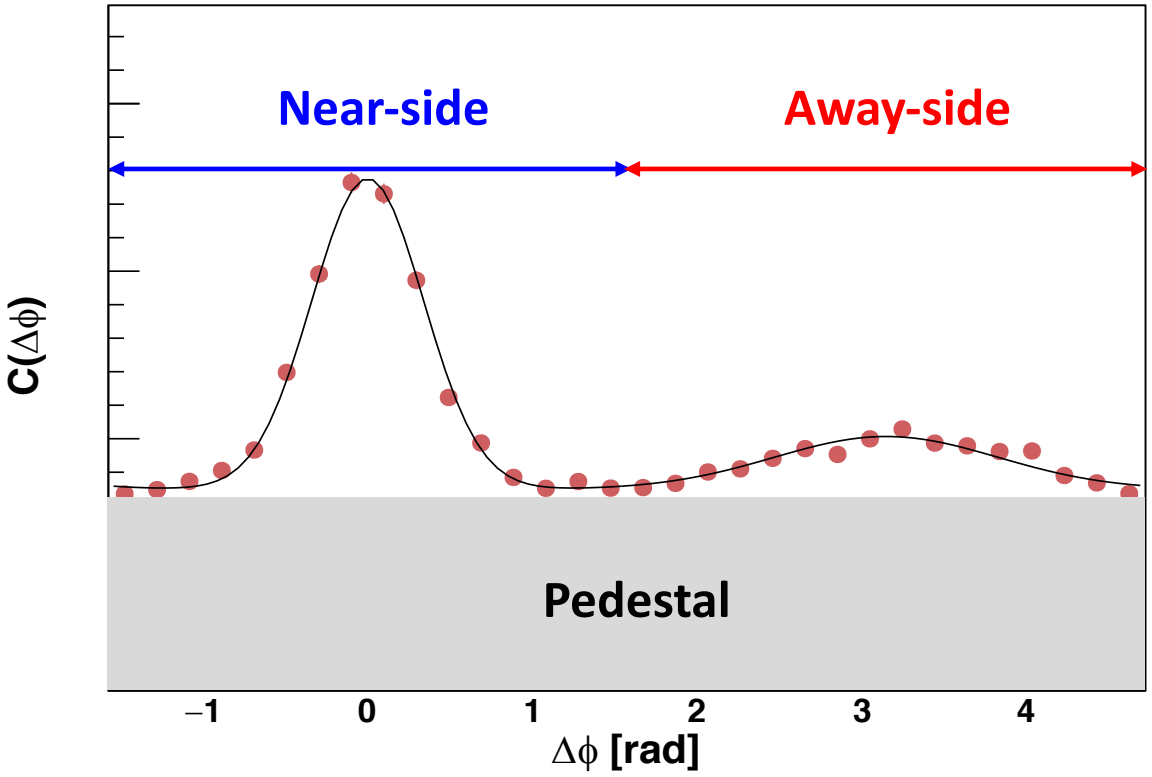
- p+p, p+Au and d+Au collisions at $\sqrt{s_{NN}} = 200$ GeV
- NN → π^0 + π^0 + X
- π^0 detected by FMS with 2.6 < η < 4.0
- Observable: $C(\Delta\phi) = \frac{N_{pair}(\Delta\phi)}{N_{trig} \times \Delta\phi_{bin}}$, π^0_{trig} → higher p_T

Forward Meson Spectrometer(FMS)

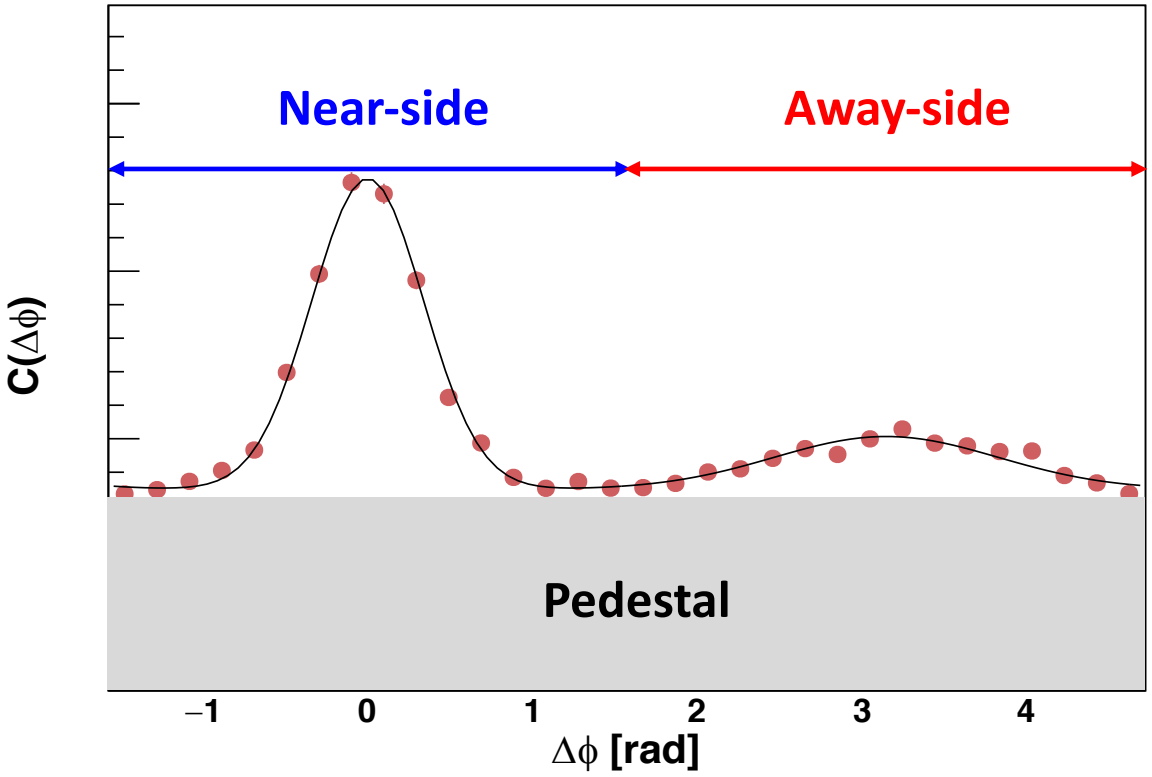


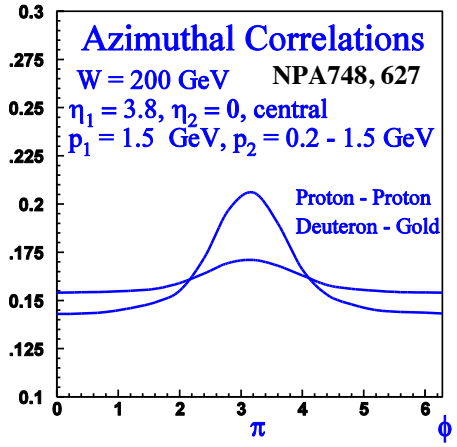
p+p and p+Au: 2111.10296
d+Au: STAR *preliminary*

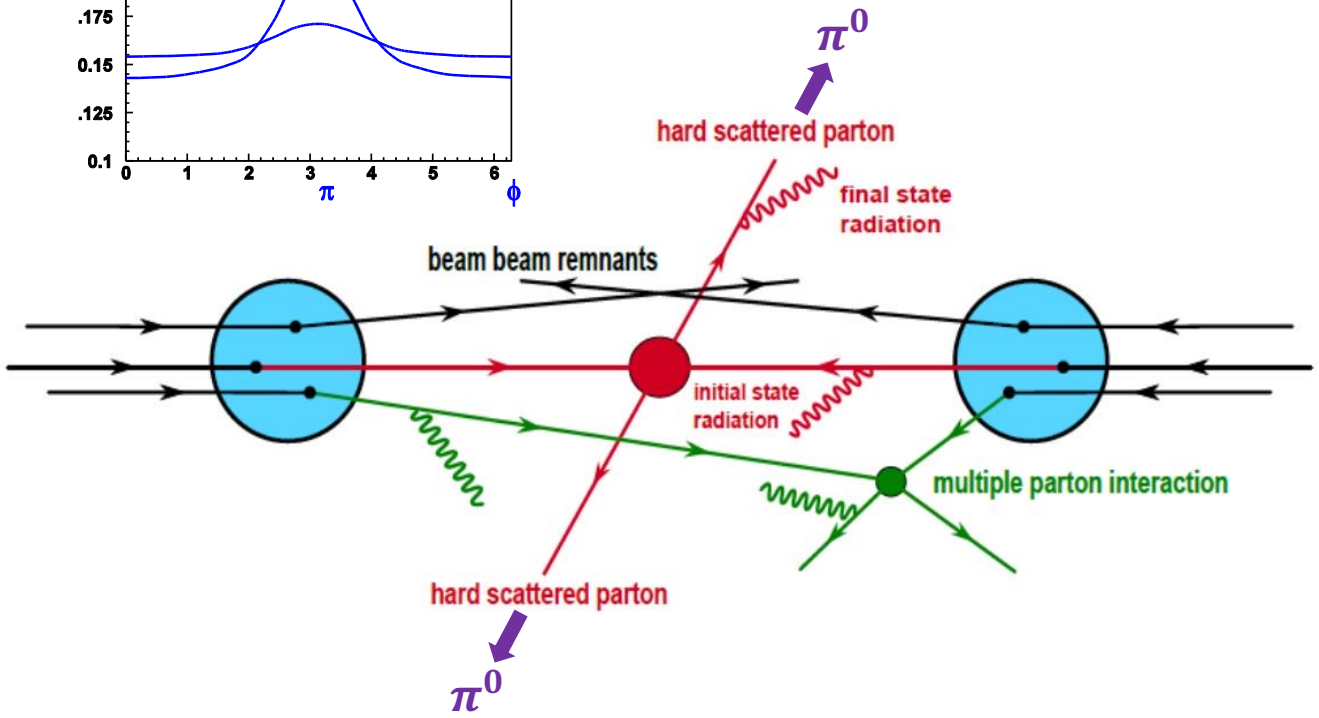
What physics?



Away-side

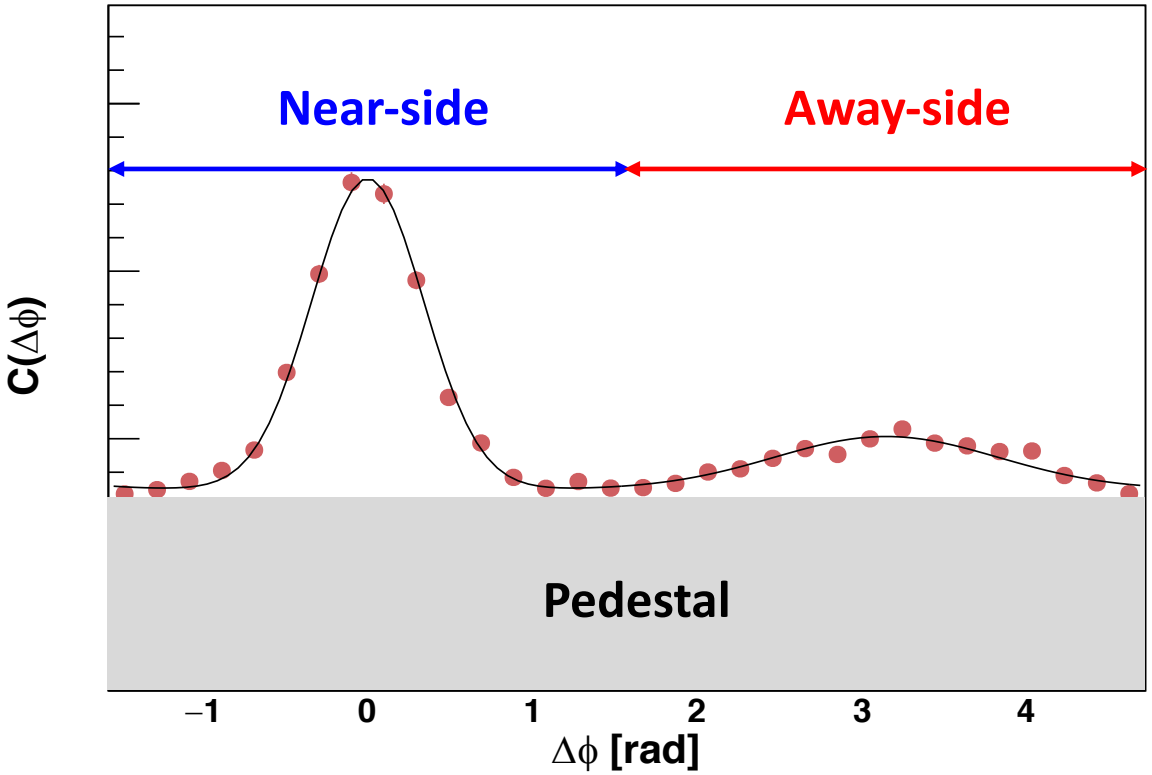


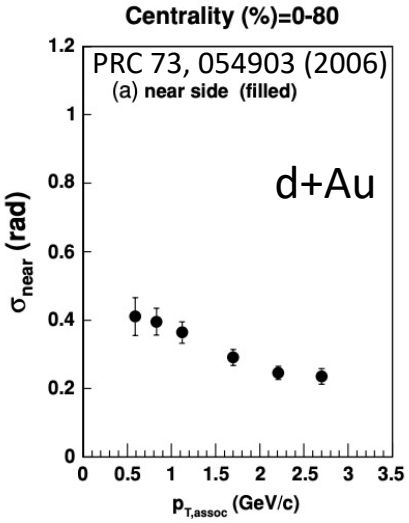


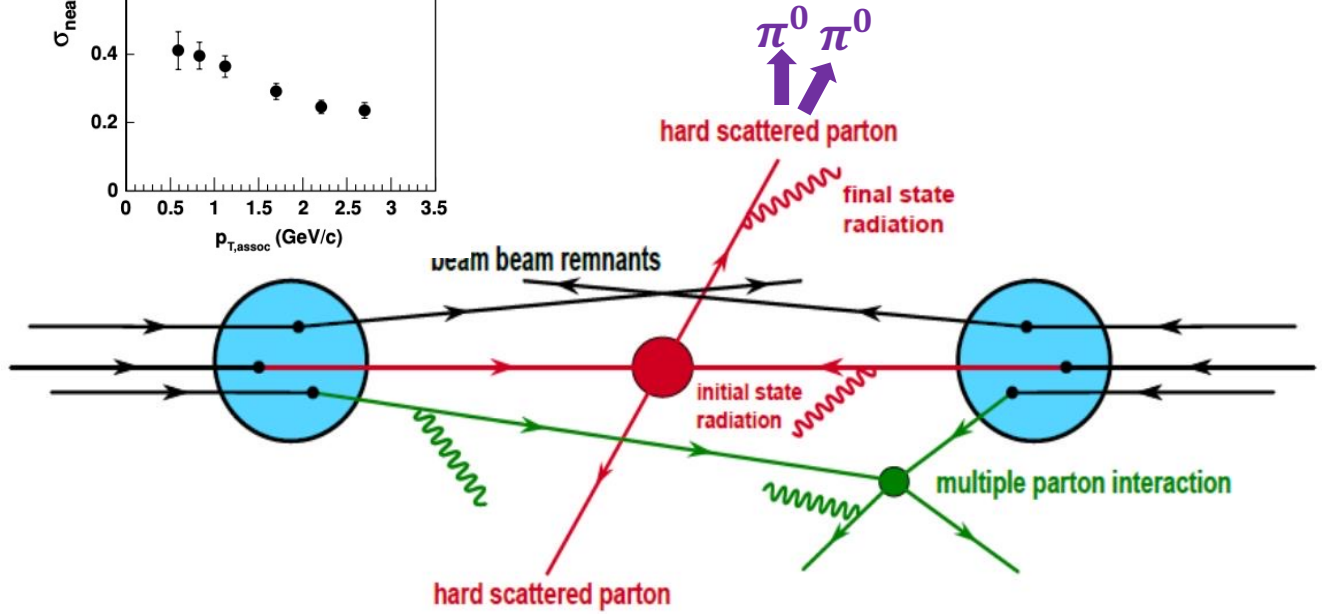


- Away-side: π^0s come from back-to-back jet; comparison in p+p/p+Au/d+Au → small x gluon dynamics

Near-side

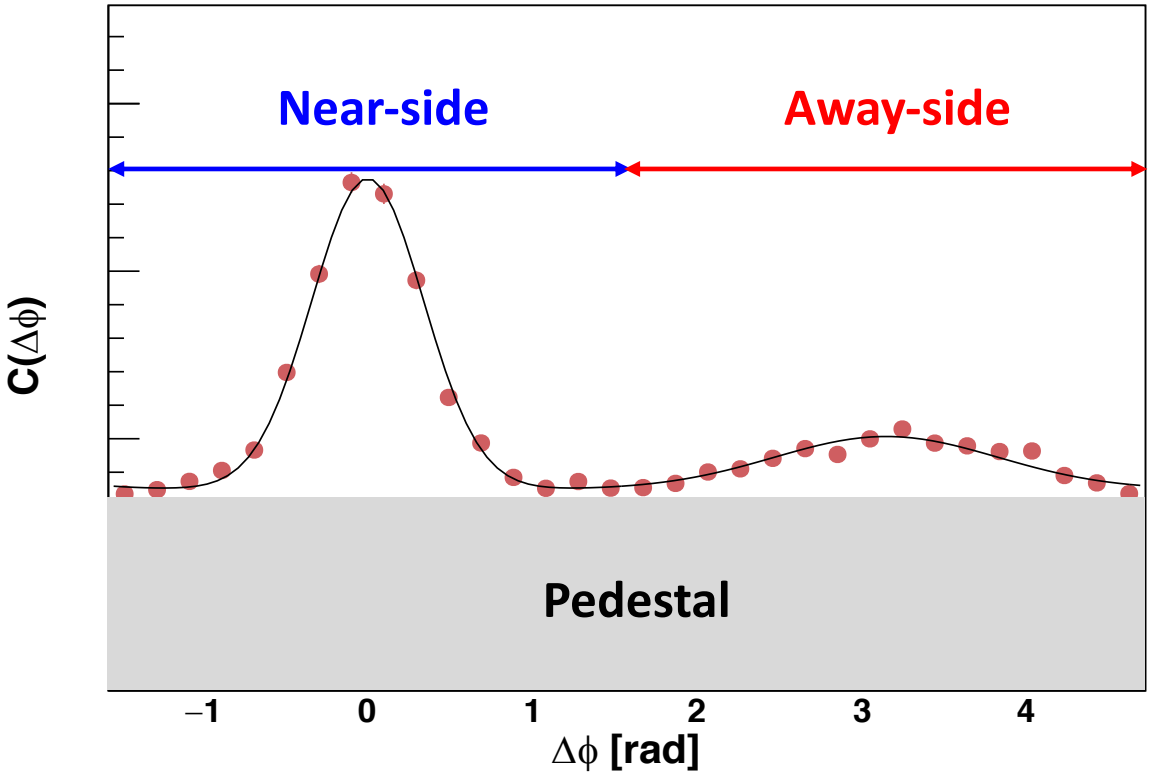


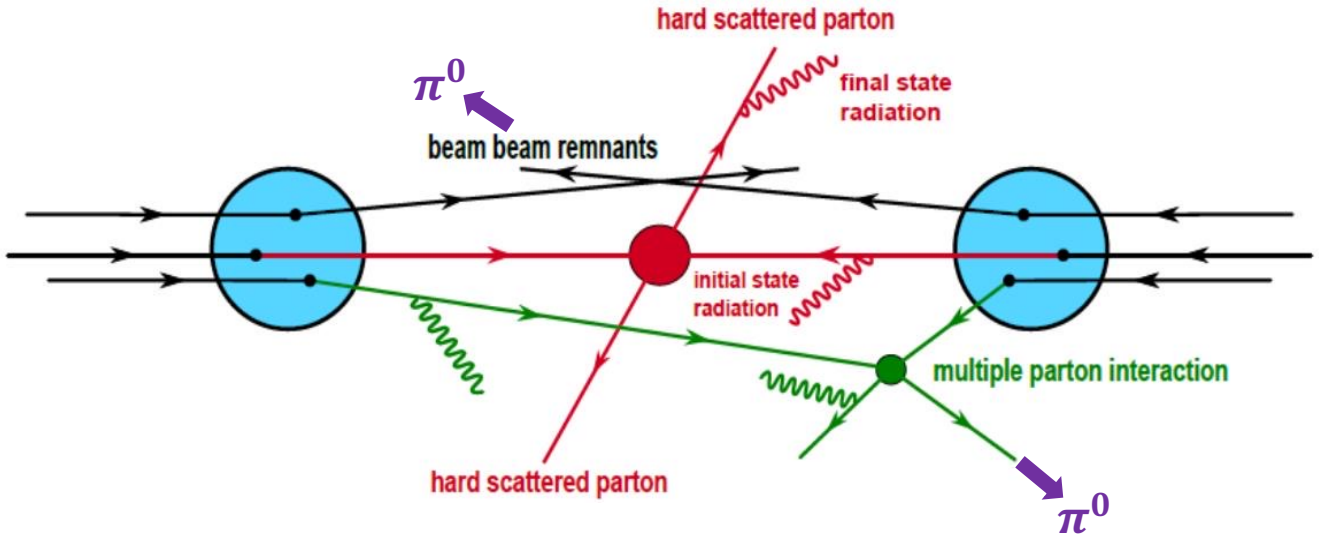




- Away-side: π^0s come from back-to-back jet; comparison in p+p/p+Au/d+Au → small x gluon dynamics
- Near-side: π^0s come from the same jet; fragmentation; jet structure; nuclear modification of fragmentation

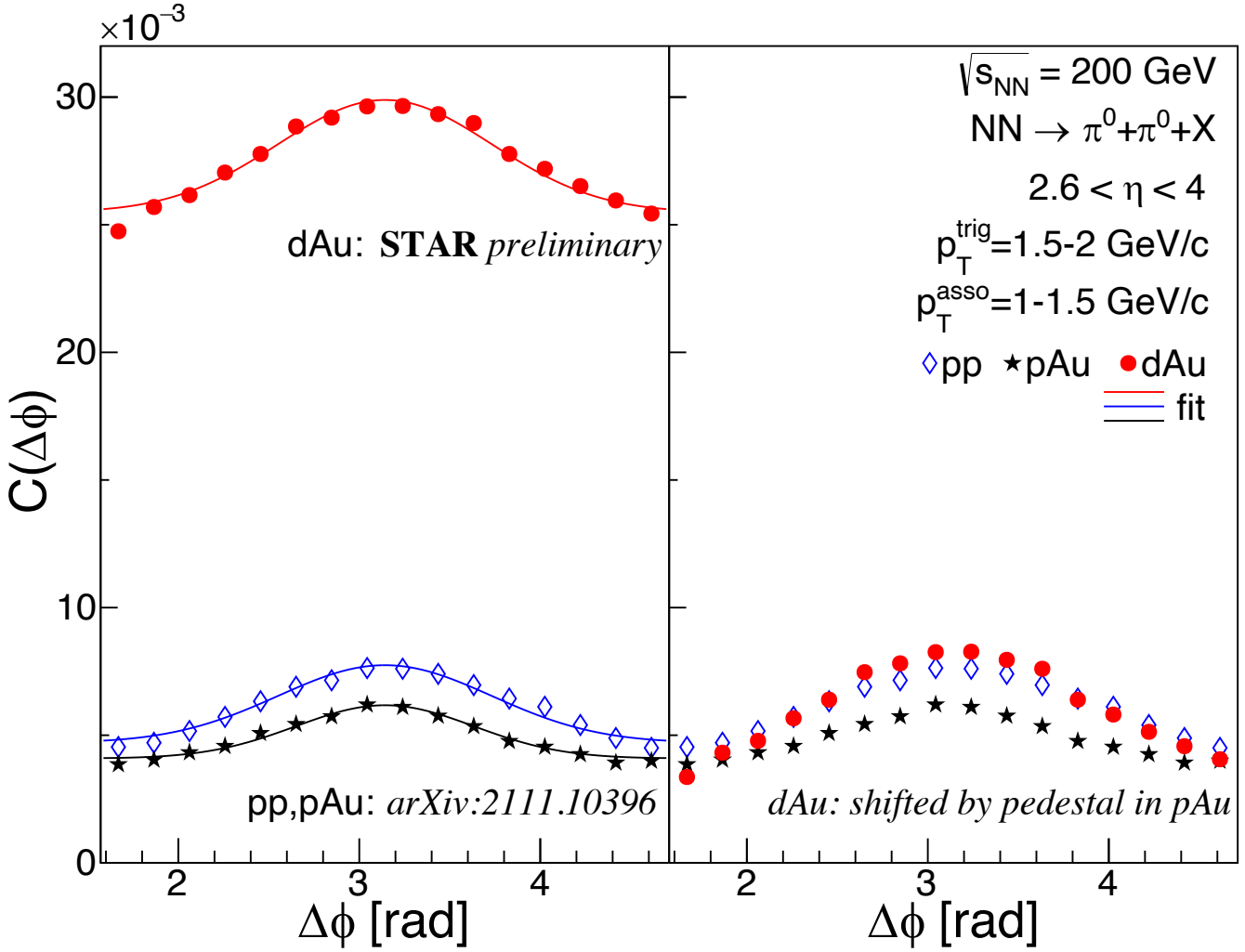
Pedestal





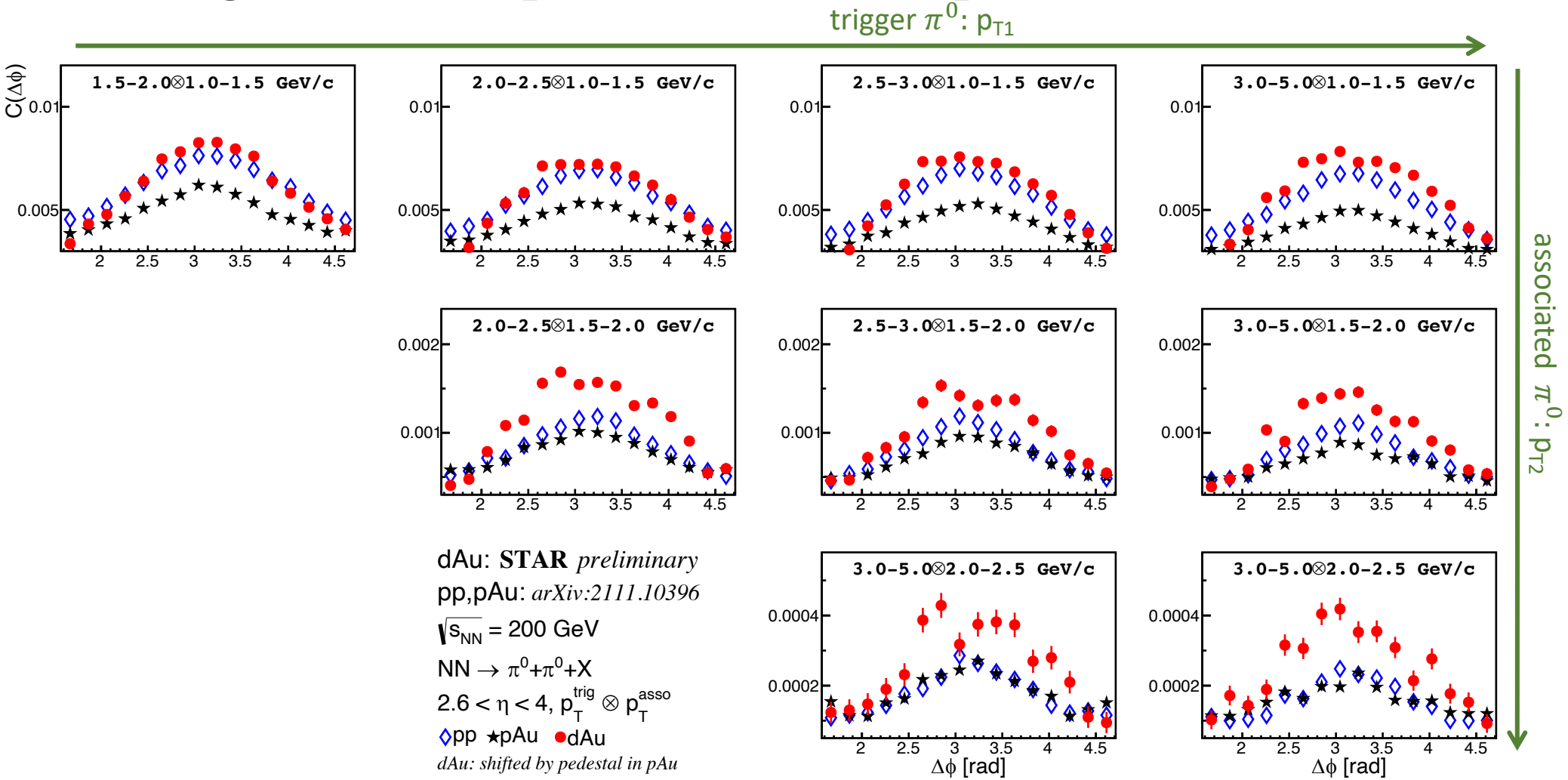
- Away-side: π^0s come from back-to-back jet; comparison in p+p/p+Au/d+Au → small x gluon dynamics
- Near-side: π^0s come from the same jet; fragmentation; jet structure; nuclear modification of fragmentation
- Pedestal: π^0s come from underlying events; multiple parton interaction (MPI) in dAu?

Away-side peak comparison



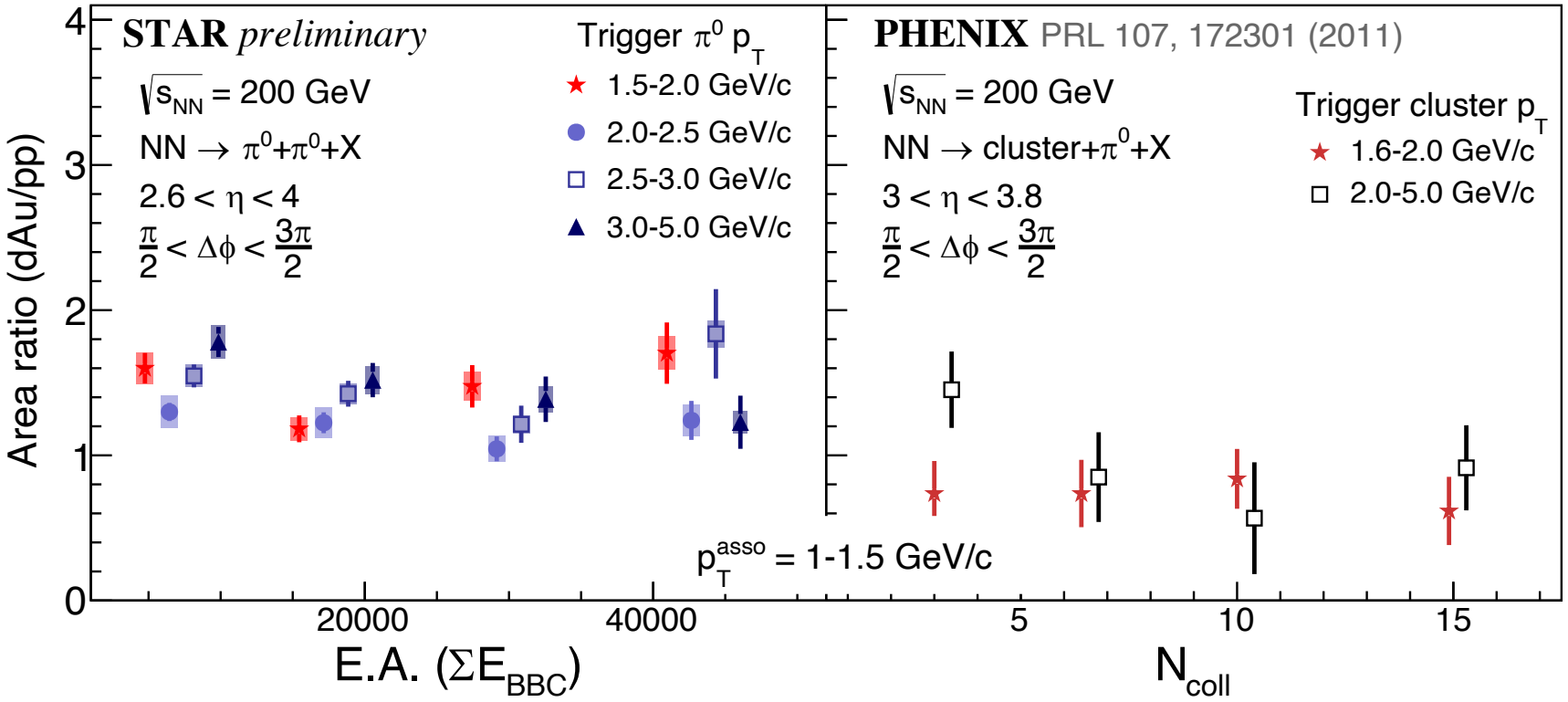
- Pedestal: dAu is 5 times higher than pp or pAu
- Compared to pp: suppression exits in pAu → nonlinear gluon dynamics
- Why away-side peak in dAu is high: close to pp; no suppression observed?

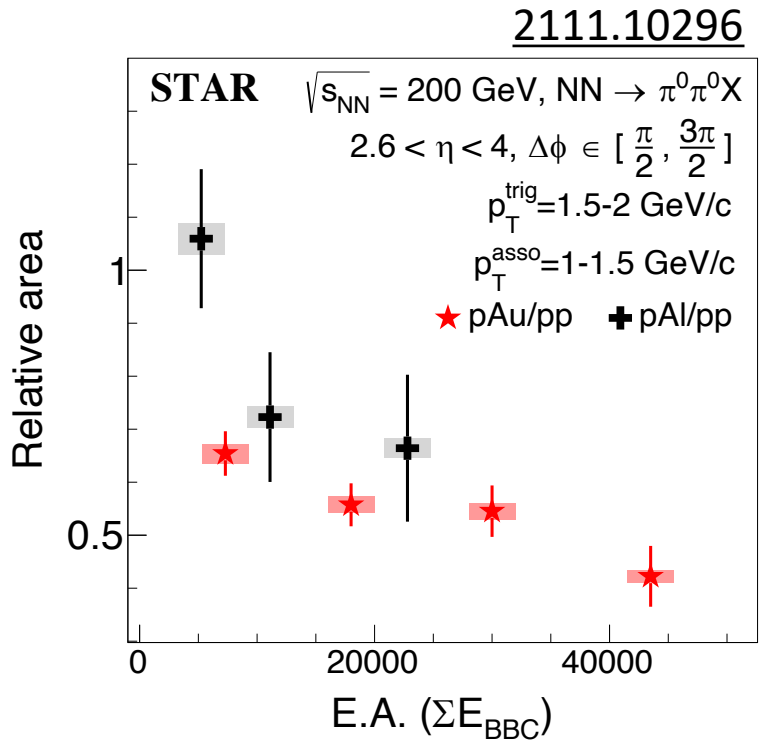
Away-side peak comparison



Compared to pp: with increasing p_T, enhancement observed in dAu

STAR and PHENIX

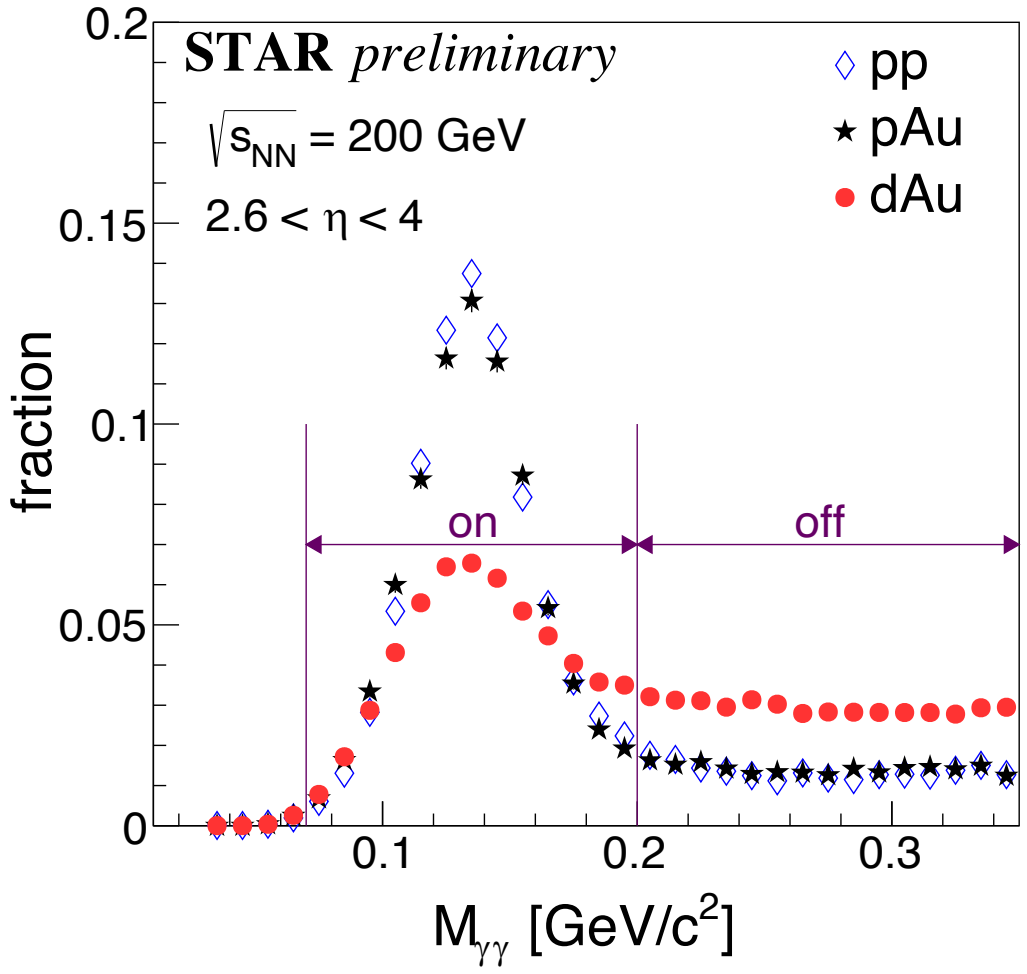




Roughly consistent results of STAR and PHENIX in the overlapping p_T range: no suppression in dAu; no E.A. or centrality dependence

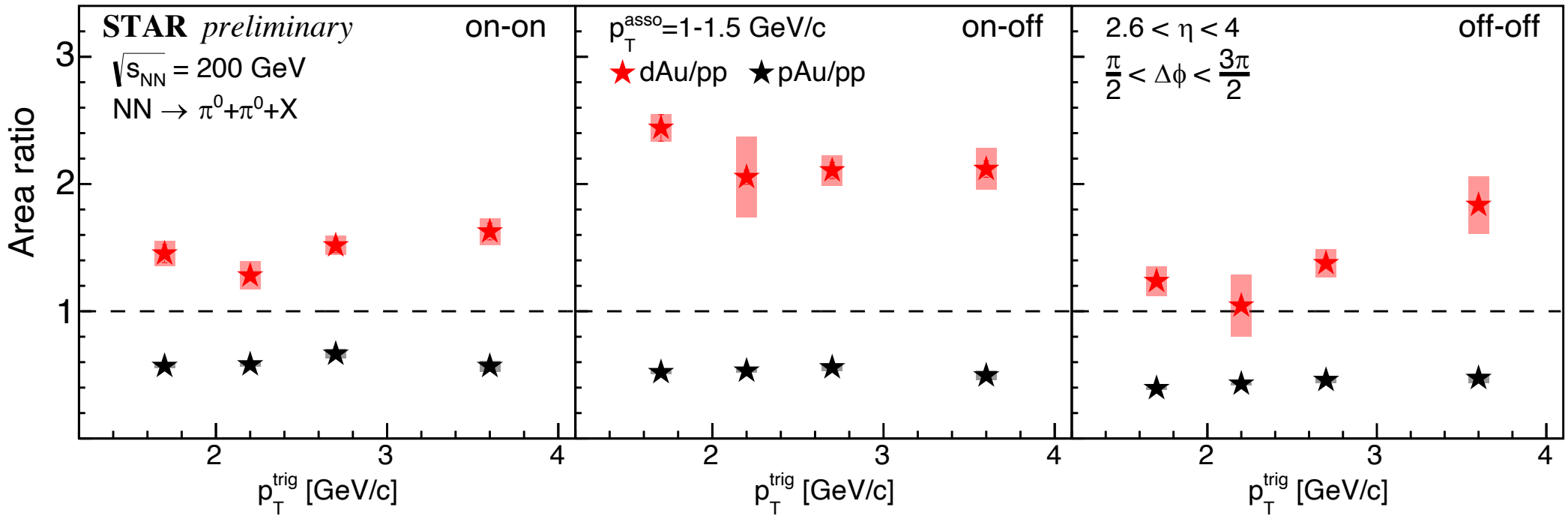
STAR: Suppression exits in pA compared to pp

STAR: di-photon invariant mass



- π^0 is reconstructed by two decay photons
- Di-photon invariant mass spectra are similar in pp and pAu
- Background is high in dAu: what is the combinatoric contribution to $C(\Delta\phi)$?

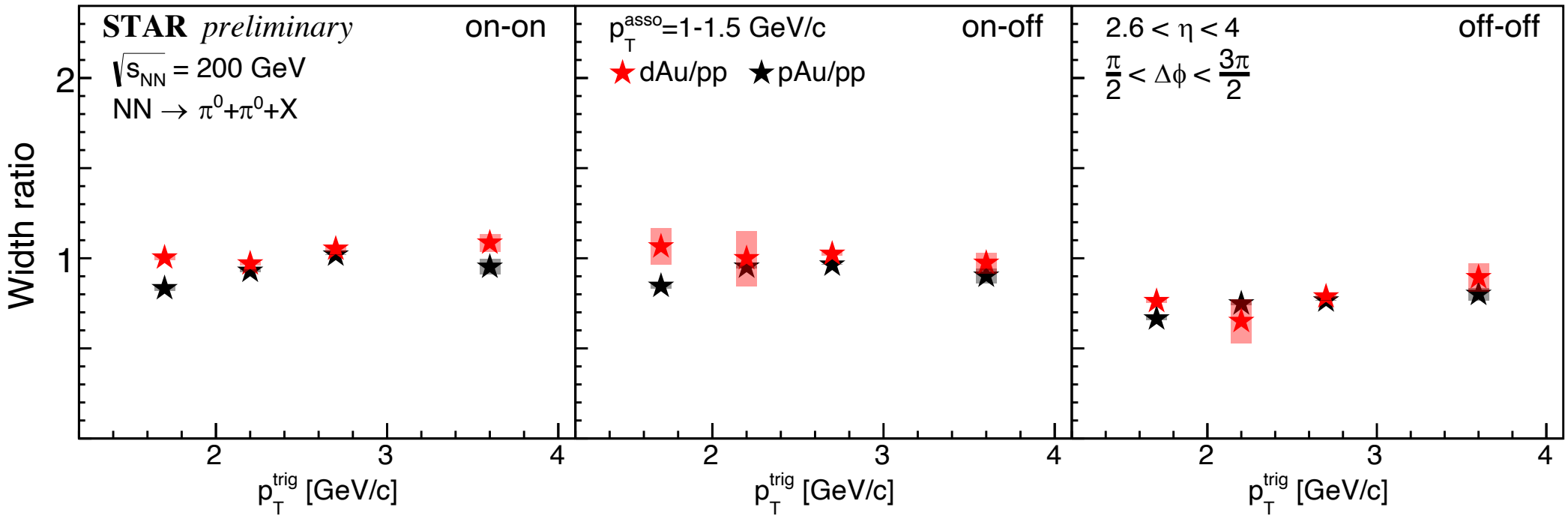
Combinatoric contribution to area



Conclusion:

- In three cases: pAu is a factor of 2 suppressed to pp
- On-on and off-off are similar in dAu/pp: 1- 1.6
- Correlation for on-off case: dAu is over 2 times higher than pp

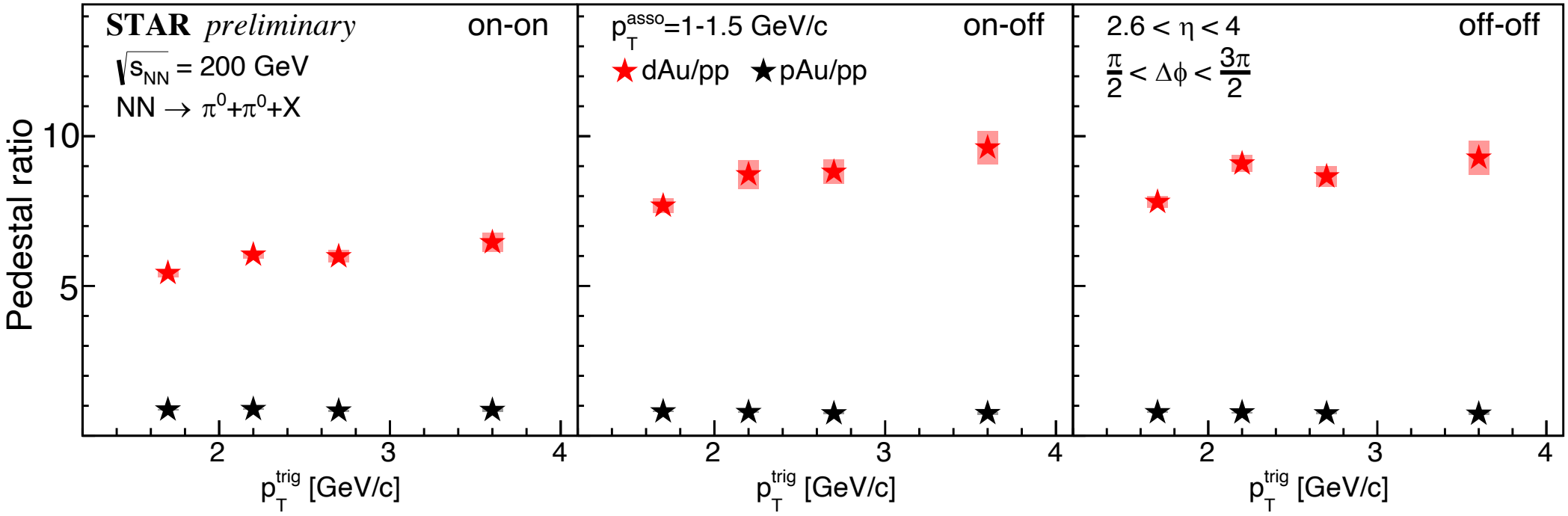
Combinatoric contribution to width



Conclusion:

- Generally, width in pp, pAu and dAu are similar in on-on and on-off cases
- Off-off: width in pp and dAu is slightly lower than pp

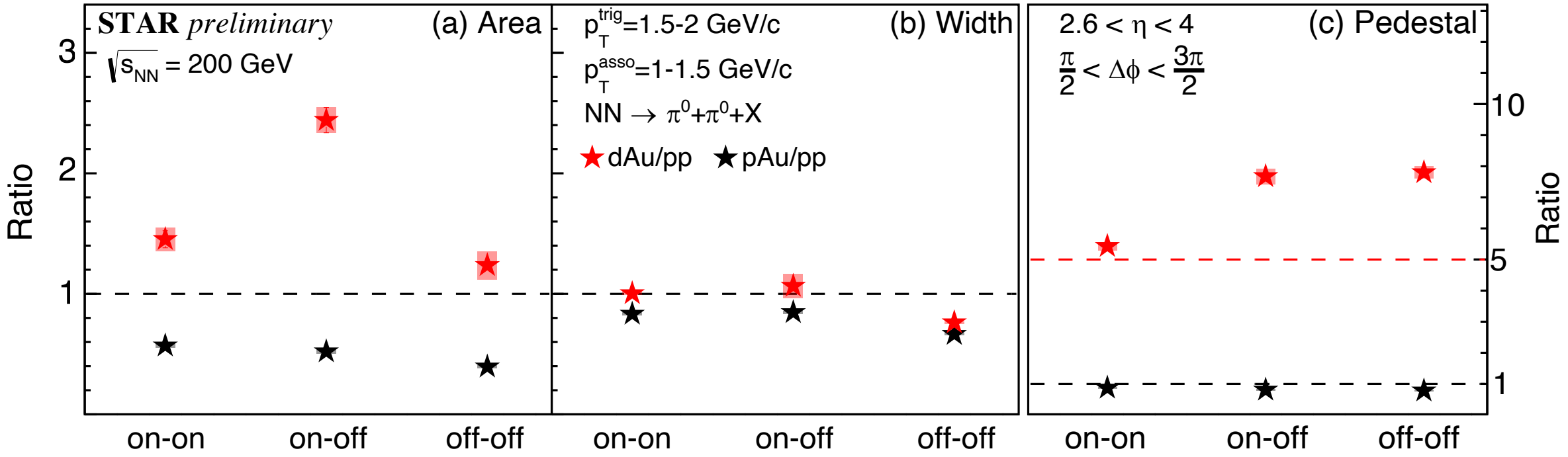
Combinatoric contribution to pedestal



Conclusion:

- In three cases: pedestals in pp and pAu are similar
- On-on: pedestal in dAu is over 5 times higher than pp
- On-off/ off-off: pedestal in dAu is over 7 times higher than pp

Combinatoric contribution



Conclusion for the correlation (Area and pedestal):

- Sideband correlation is very high, we don't know the reason, and so far we can not subtract the sideband contribution

Conclusion so far

- No suppression is observed in dAu compared to pp with STAR FMS dipi0 data

- Combinatoric background correlation affects the on-on correlation in dAu but not pp or pAu
  - We don’t have an explanation why on-off correlation is higher than on-on
  - Since we don’t fully understand the background, we cannot perform a subtraction

- The STAR dAu/pp results are slightly higher than PHENIX results, but not very different in the overlapping pt range
  - Note there is difference in set up for two measurements

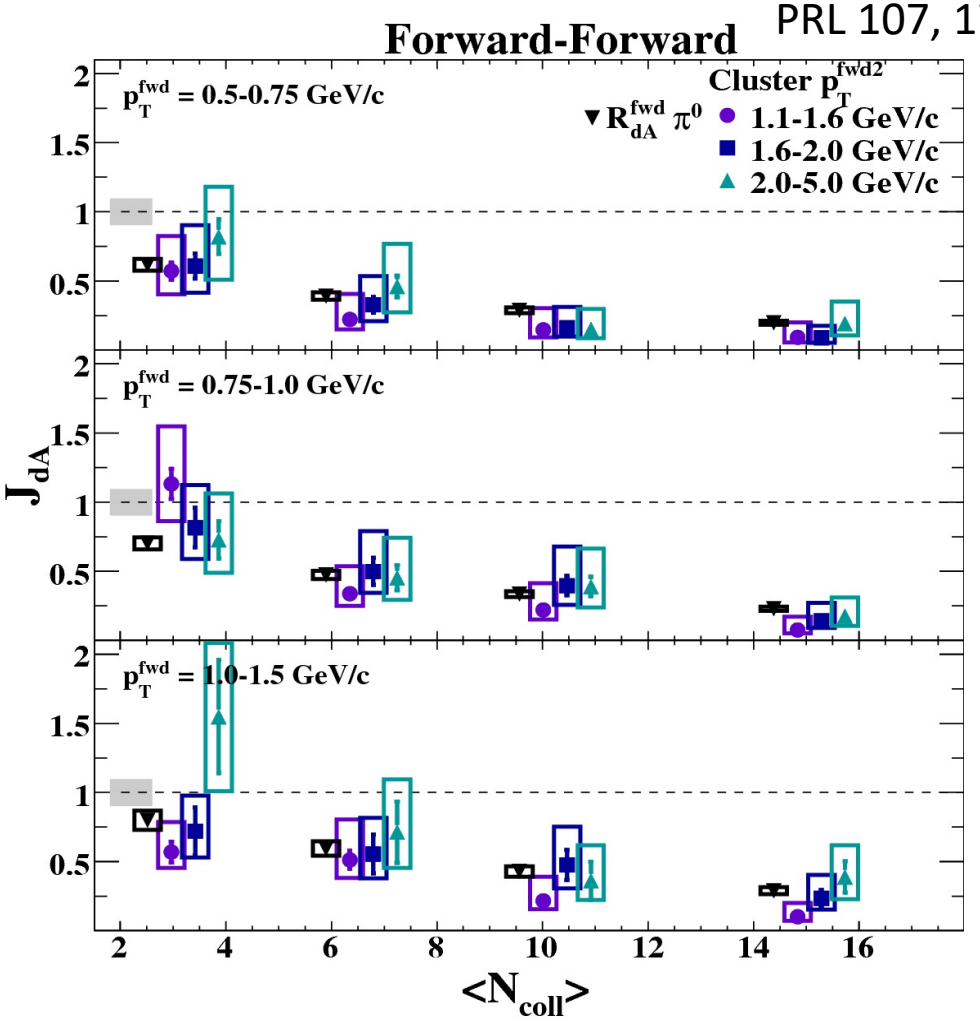
- It’s difficult to measure the real correlation in dAu. So this measurement should be performed in cleaner pAu or future eA collisions instead of dAu collisions
  - Invariant mass distributions of the pi0 candidate is too wide in dAu

- Or, we measure the charged hadron correlations from tracking.

Back up

Some clarifications

PRL 107, 172301

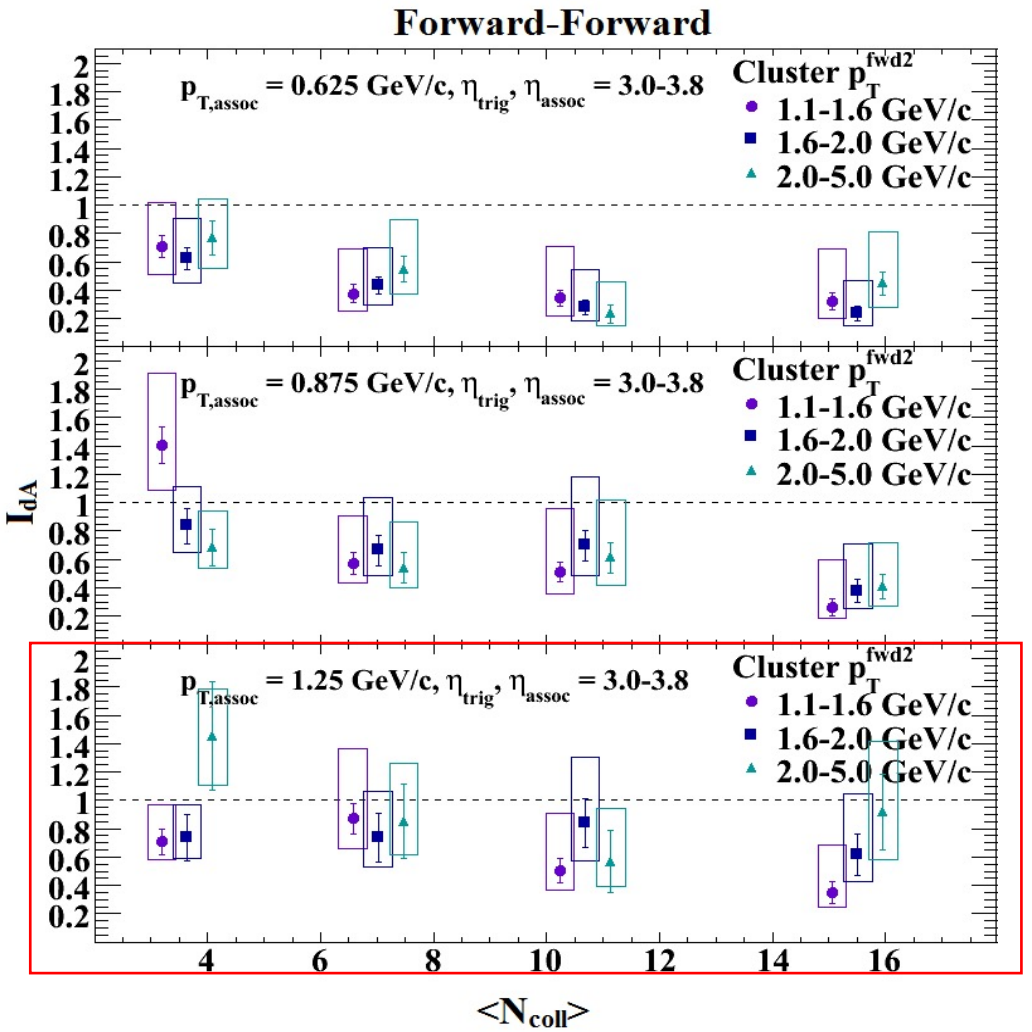


J_{dA} = area ratio * R_{dAu}

I_{dA} = area ratio

R_{dAu} ~ $2/N_{coll}$

From the PhD thesis

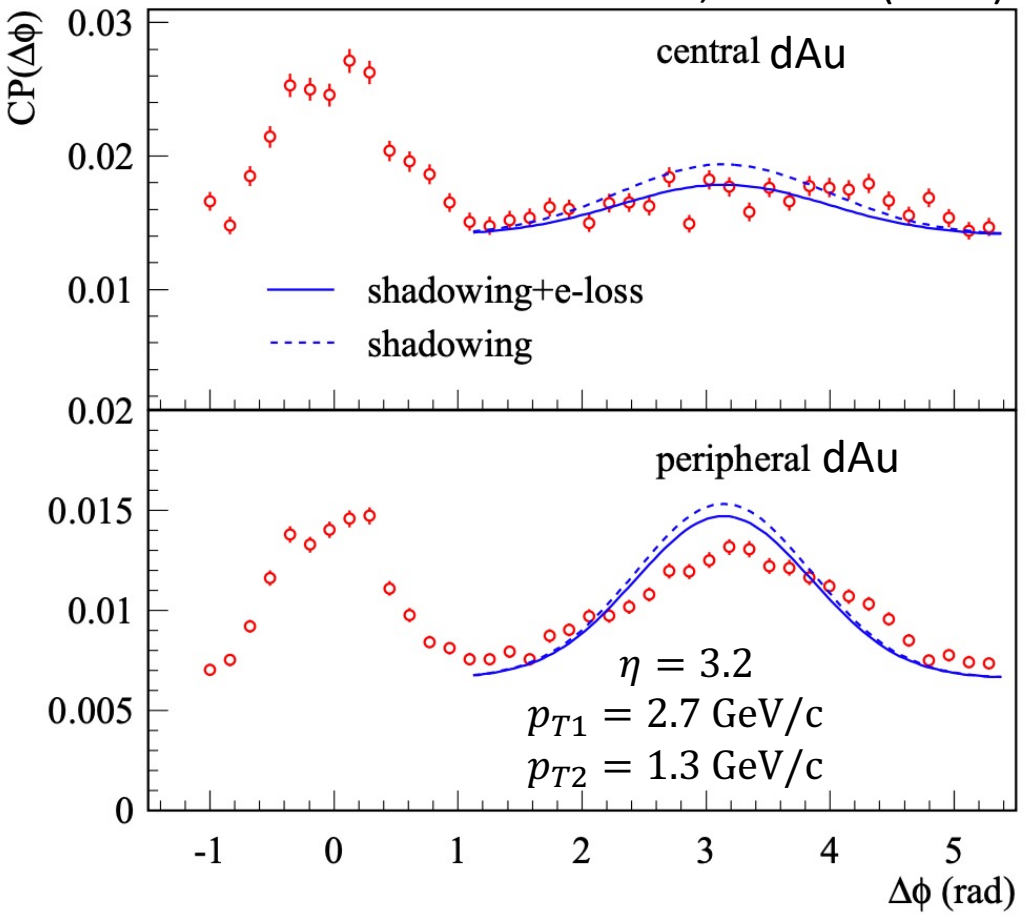


The results are misleading: $J_{dAu} \rightarrow 0.1$ that "10 times suppression observed in central dAu" is not correct

In fact, in the highest associated p_T bin (red box), no suppression or centrality dependence is observed

Clarification of example predictions

PRD 85, 054024 (2012)

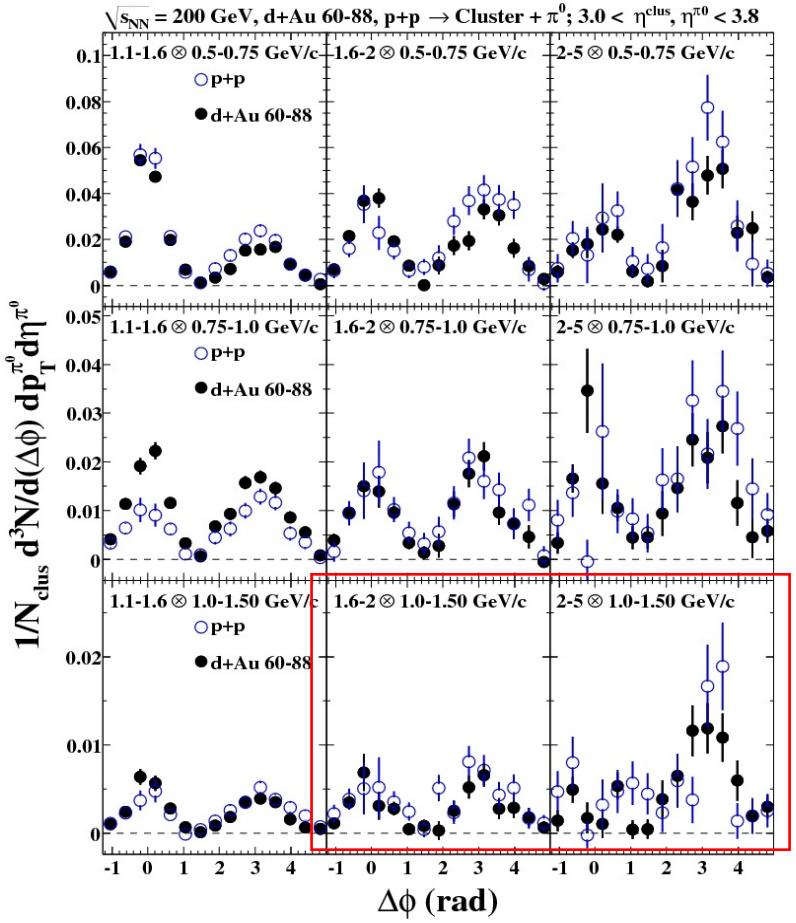


"calculations are consistent with the experimental measurements at PHENIX" is not correct: should not be centrality dependent according to data

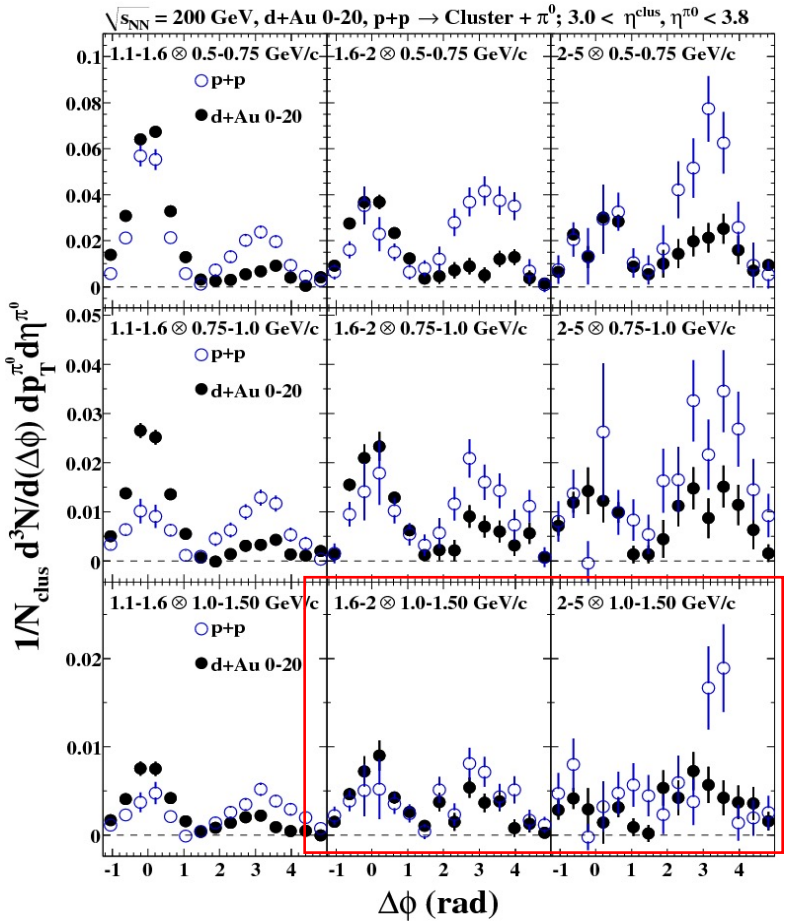
What we've from PHENIX

p+p/d+Au: 3.0 < η < 3.8, PHENIX Collaboration, PRL 107, 172301 (2011)

dAu peripheral



dAu central



- Away-side suppression exits in low p_T but not high p_T
- At the overlapping pT range of STAR and PHENIX (red box): no suppression or centrality dependence
- At p_T^{asso} = 0.5-0.75 GeV/c, pedestal in dAu is 2-3 times higher than pp

Summary

Preliminary page:
https://drupal.star.bnl.gov/STAR/blog/xchu/dipi0-correlation-pp-pAu-dAu-analysis-preliminary-results

1. PHENIX:
   - Suppression exits when p_{T2} = 0.5-0.75 GeV/c.
   - The variable J_{dAu} doesn't describe the physics we worked on, which is misleading.
   - The conclusion of 10 times suppression in central dAu to pp should be clarified.
   - The conclusion of centrality dependence all the way to high p_T (p_{T2}=1-1.5 GeV/c) should be clarified.

2. We should be careful with some relevant theoretical predictions following PHENIX paper, which take the suppression in the wrong way.