

Recent d+Au Results from PHENIX

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BNL PAC, 11 June 2013

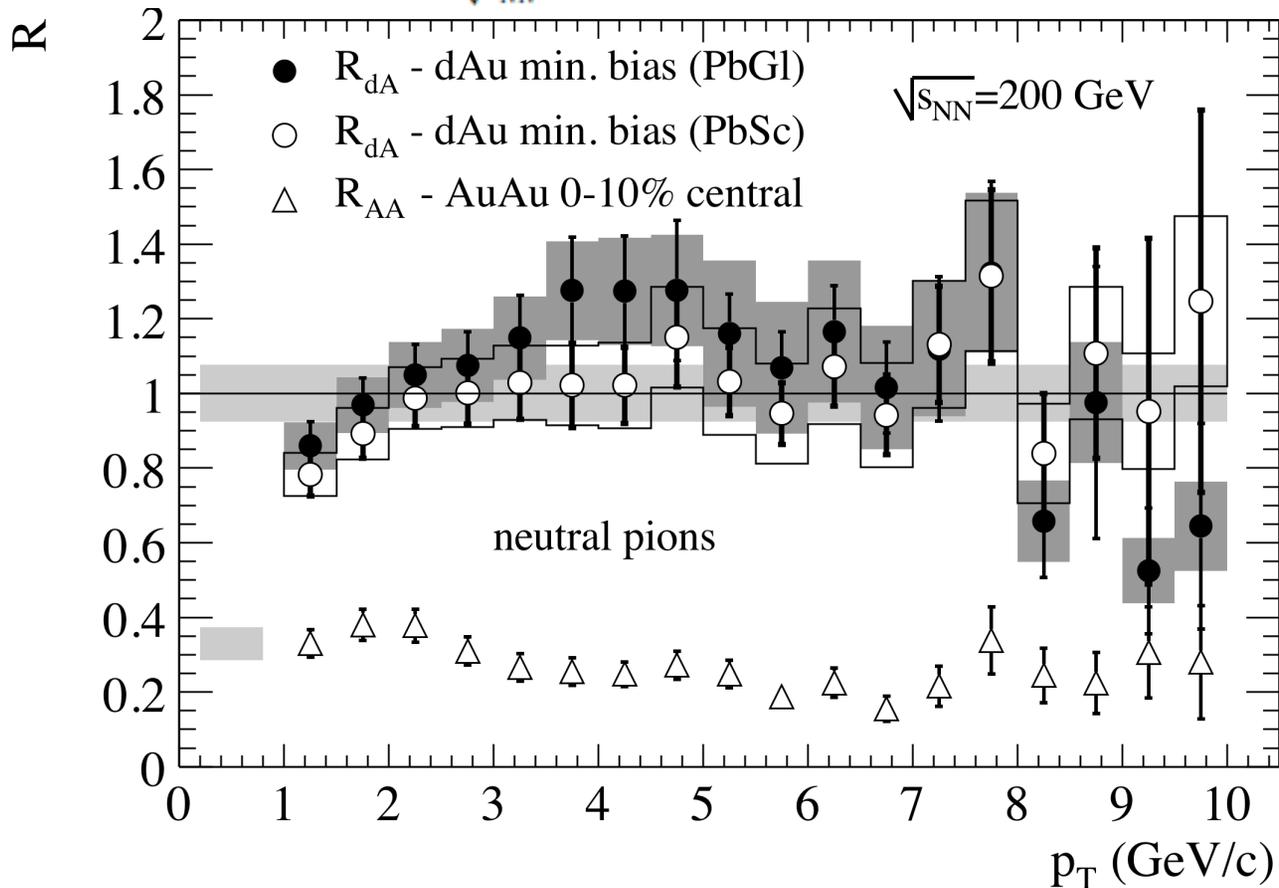
Theme:

Originally d+Au was an A+A control,
with elementary processes + cold
nuclear effects

But now we see a lot more going on
in d+Au! and new studies are
needed to understand new physics

It all made sense in 2003....

**Absence of Suppression in Particle Production at Large Transverse Momentum
in $\sqrt{s_{NN}} = 200$ GeV $d + Au$ Collisions**



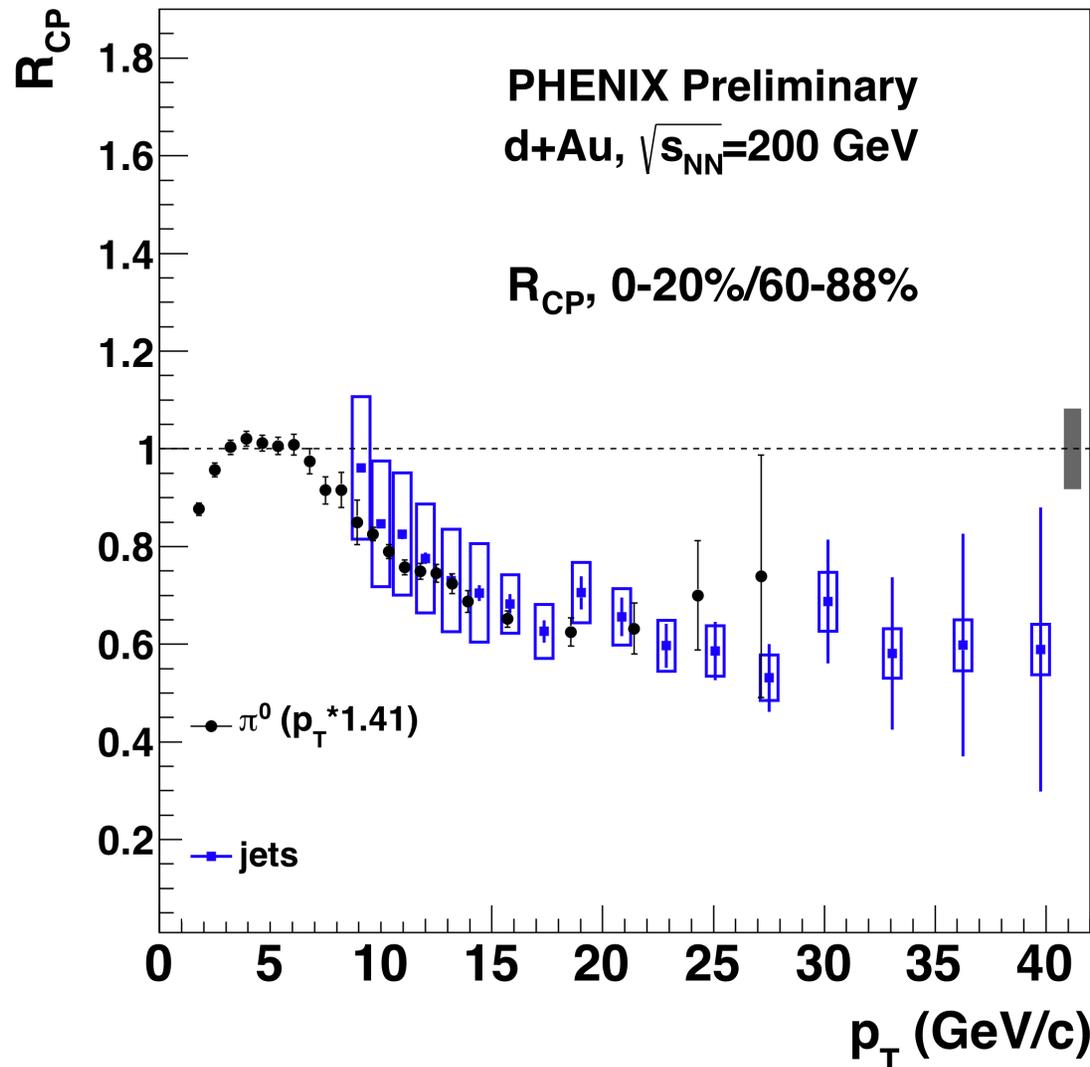
Lack of quenching in (min-bias) $d+Au$ confirmed quenching as medium effect in $Au+Au$.

Nine years later: R_{CP} to high p_T

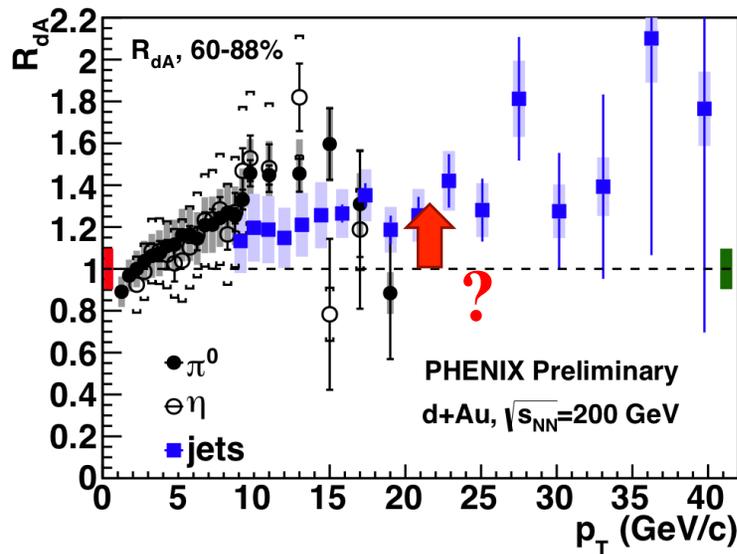
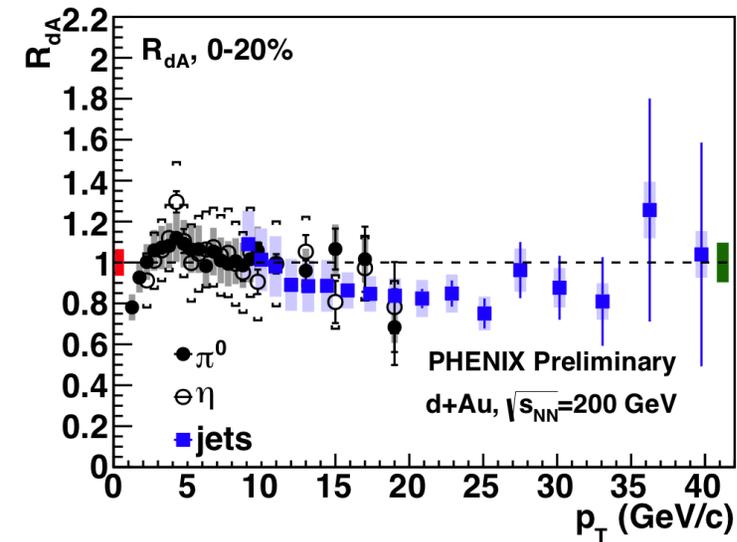
Measure π^0 's and jets to very high p_T

(π^0 p_T is scaled by $1/\langle z \rangle$ as fragments)

Is it the return of quenching at very high p_T ?



R_{dAu} shows excess in *peripheral*



An increasing trend with p_T cannot be explained by changing N_{Coll} alone.

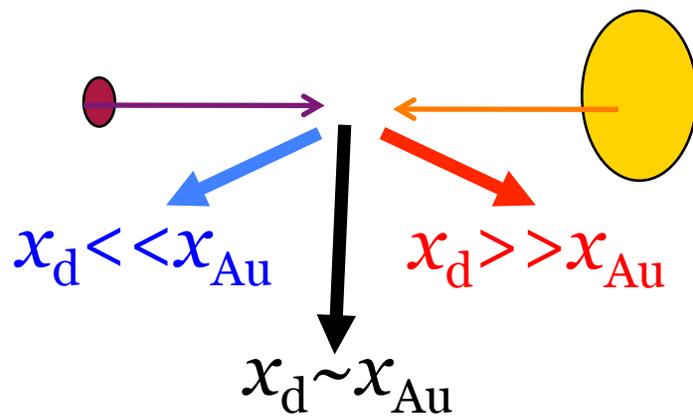
-> Interplay between very high Q^2 at mid-rapidity and general/bulk production at forward $3 < \eta < 4$, *beyond* what we already correct for.

To do:

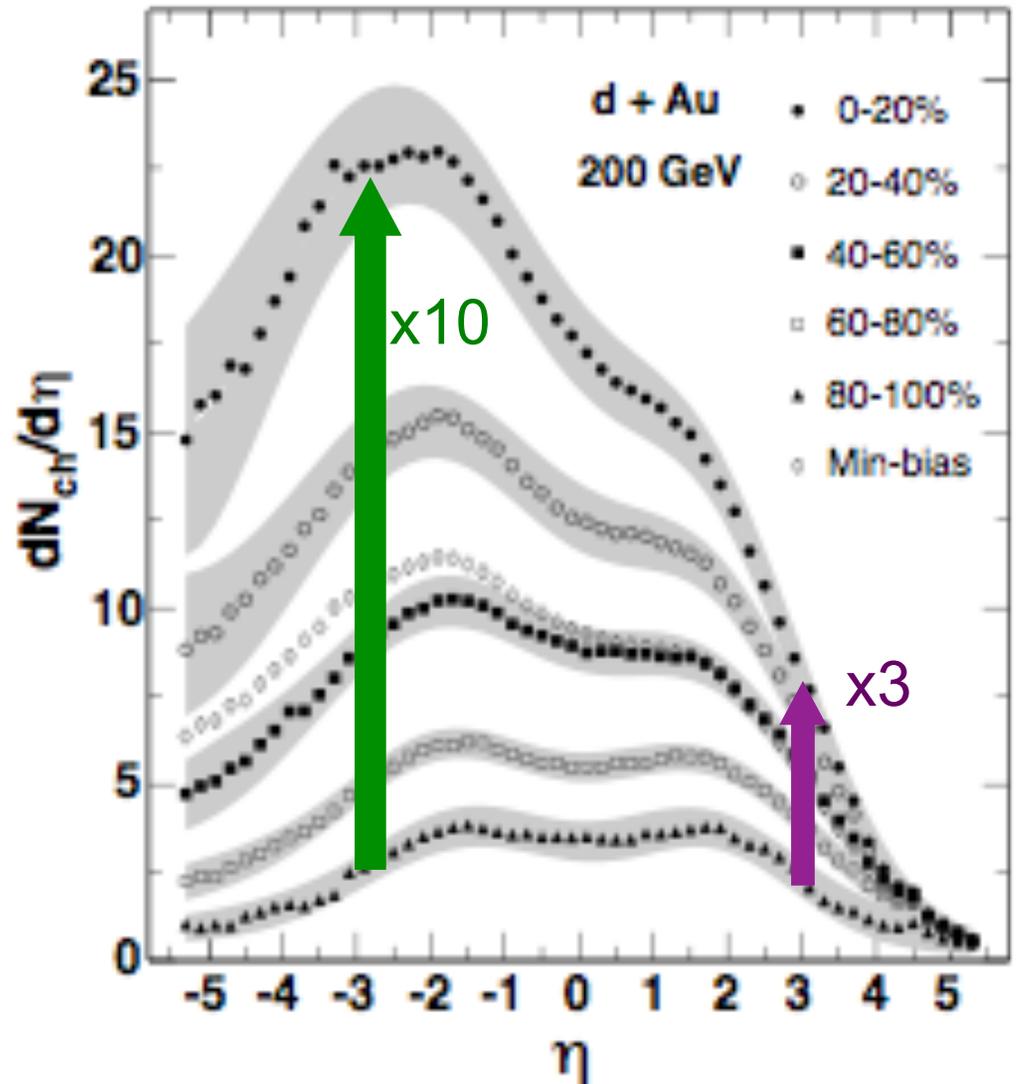
- Systematic study to control N_{Coll} vs centrality
- Need to look at similarly small systems:
e.g. min-bias p+Si has similar $\langle N_{\text{Coll}} \rangle$ as
peripheral d+Au

Across rapidity, Au shows its weight

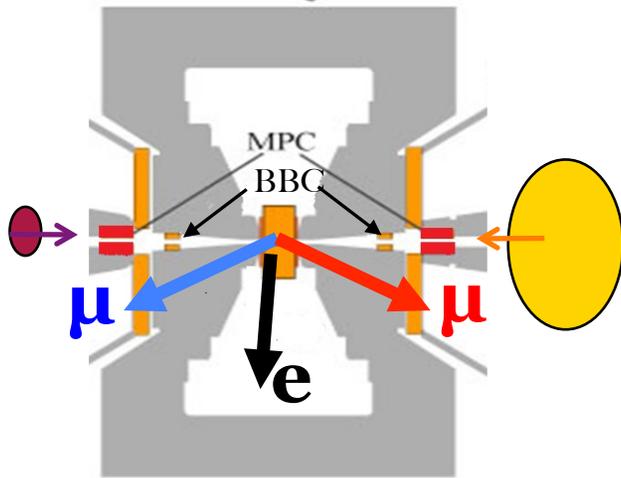
More central d+Au produces more “bulk” going with Au



Is it purely a parton-level effect? Or is there more to it?

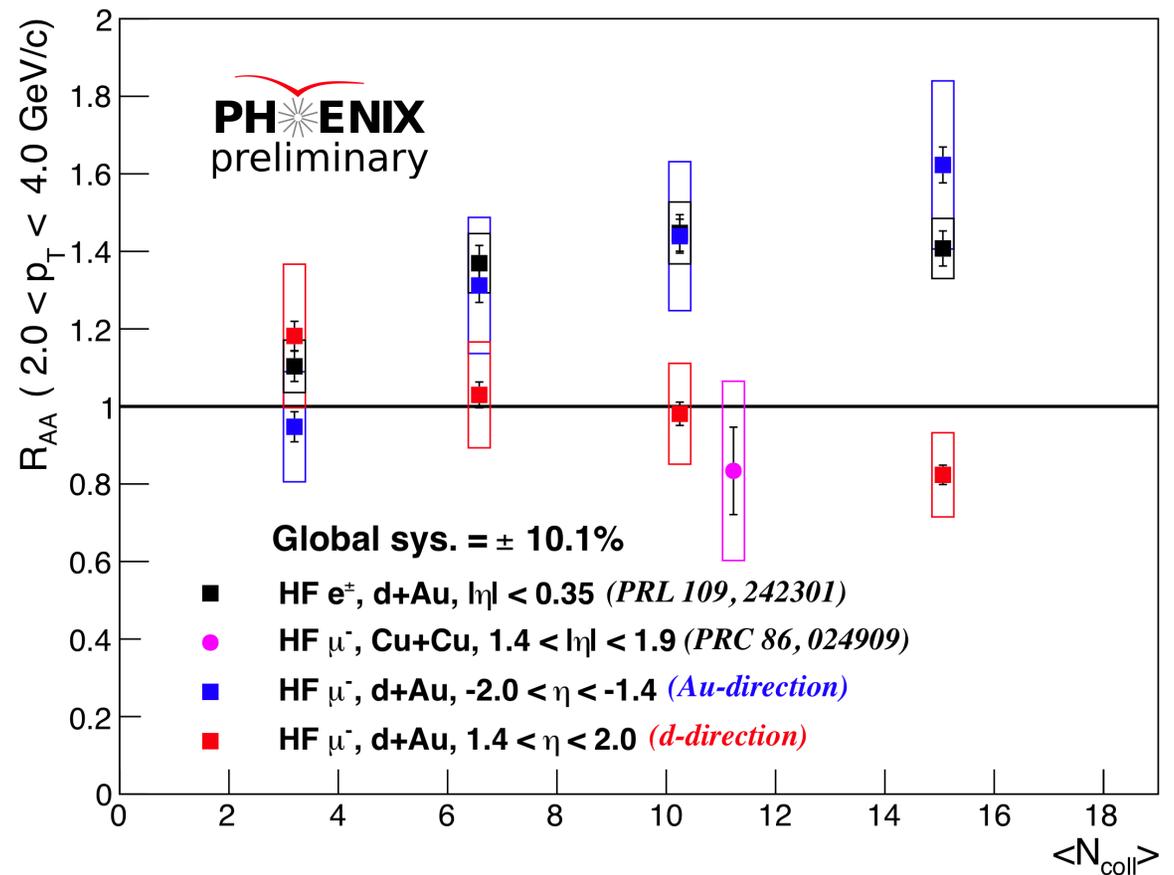


Open heavy flavor across rapidity

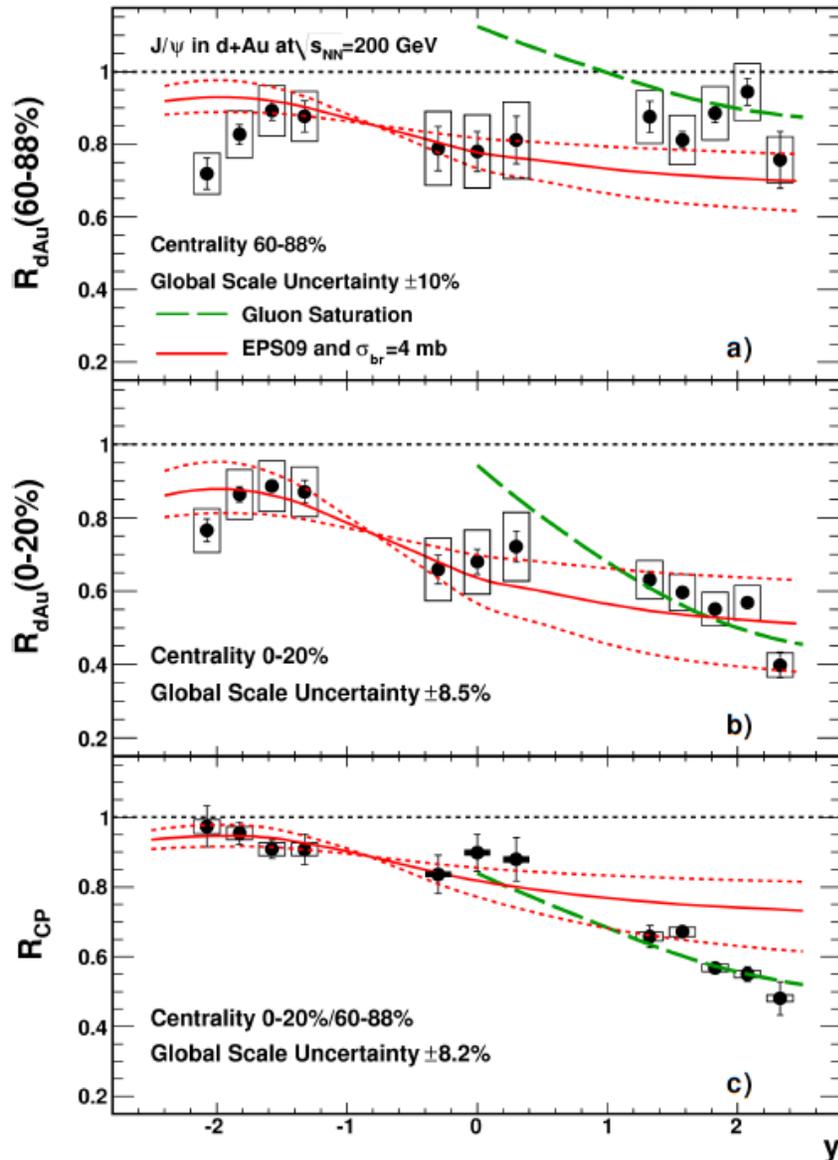


Qualitatively consistent with expectation:
Au-going enhanced
d-going decreased
 with centrality

Single leptons from heavy flavor decays



J/ψ across rapidity & centrality



Trends broadly consistent with more production in Au-going direction. Can we determine transverse spatial dependence of nuclear modification?

Baseline model --EPS09 with linear thickness dependence, plus single breakup-cross section -- *cannot reproduce centrality dependence in detail.*

To do:

- Identify HF leptons via DCA, separate b/c, using VTX in central and FVTX forward
- Measure new observables without final-state effects, e.g. γ^{Direct} with new MPC-EX

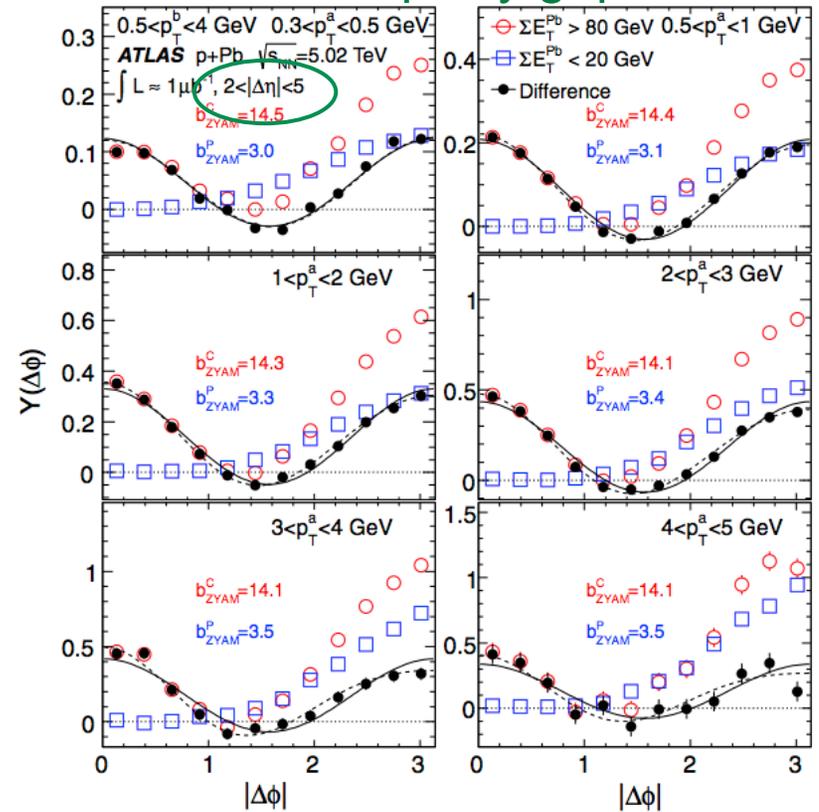
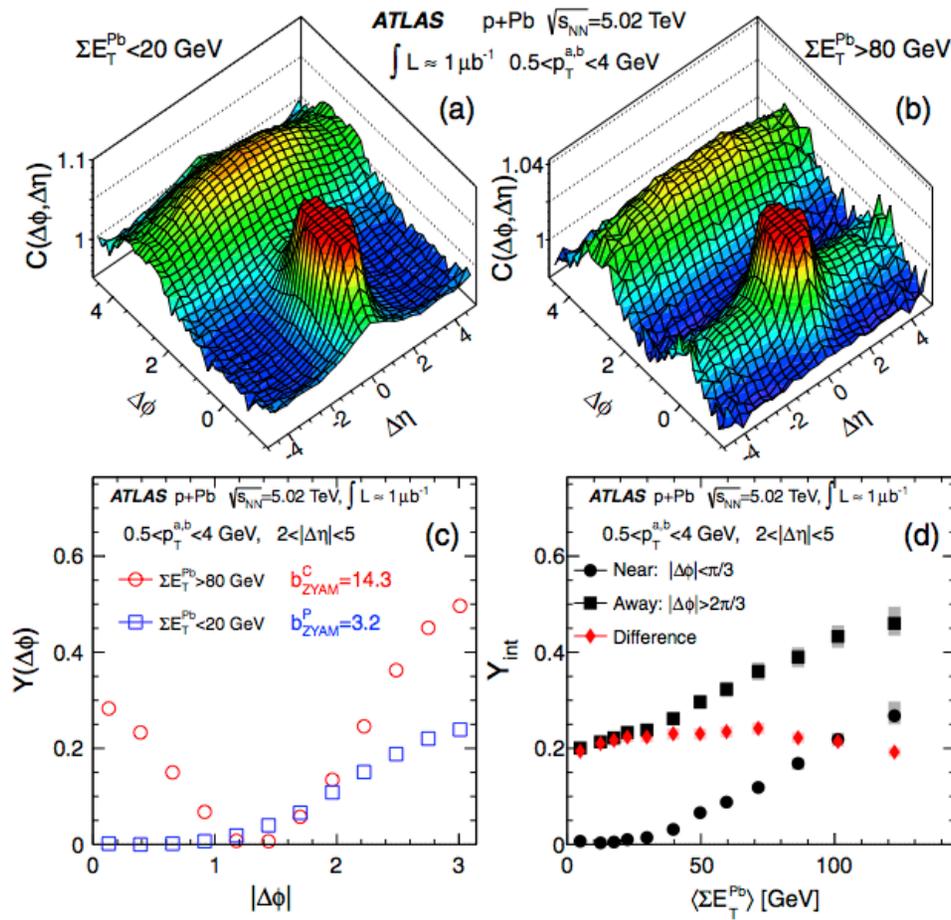
News from p+Pb at LHC

PRL 110, 182302 (2013)

PHYSICAL REVIEW LETTERS

Central: 0-2%
Peripheral: >50%
Measured by ΣE_T in $3.1 < \eta < 4.9$

Note rapidity gap



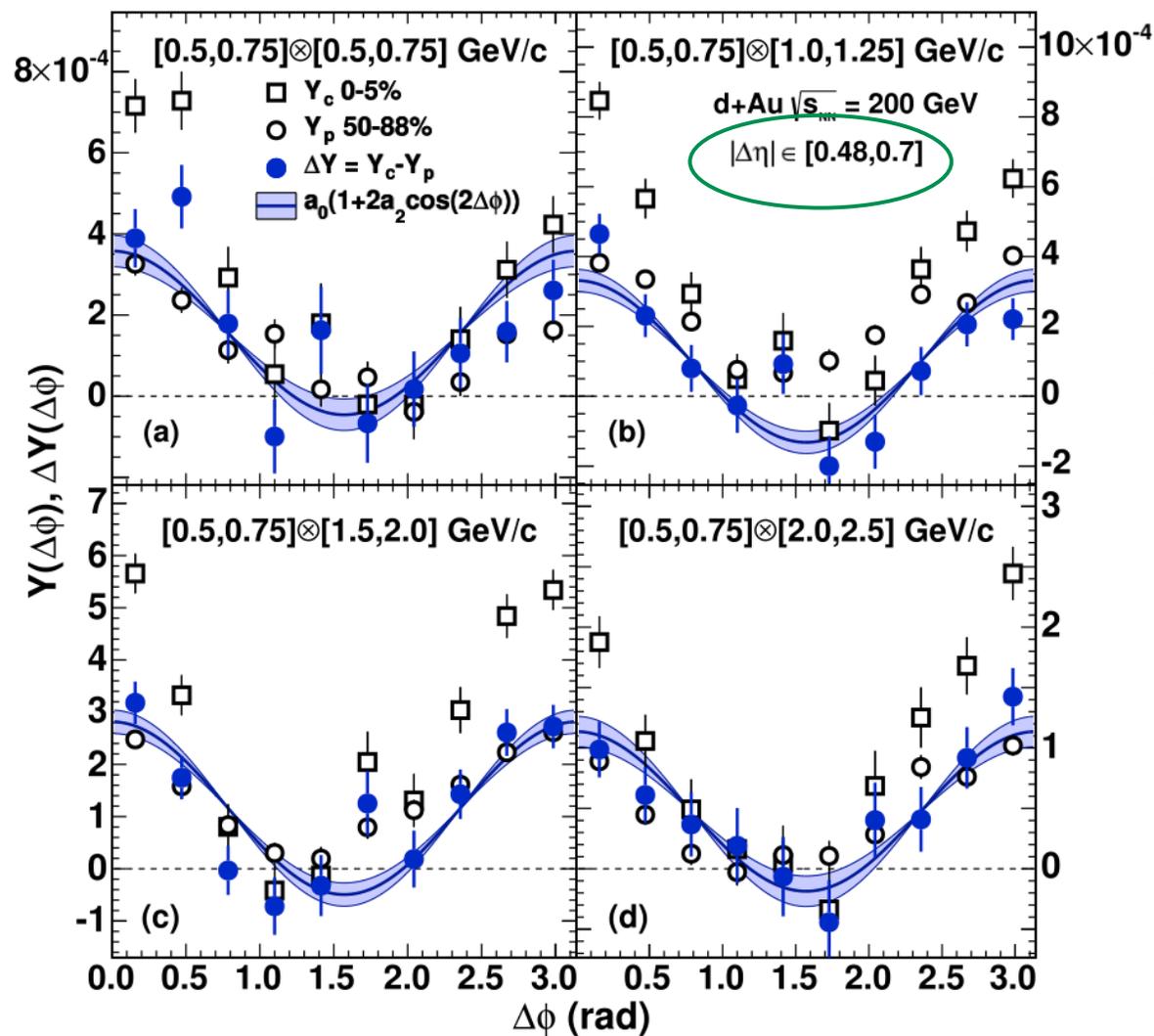
Two ridges? Or flow?

Mid-mid correlations in d+Au in PHENIX

Quadrupole anisotropy in dihadron azimuthal correlations in central d+Au collisions

at $\sqrt{s_{NN}}=200$ GeV

arXiv:1303.1794

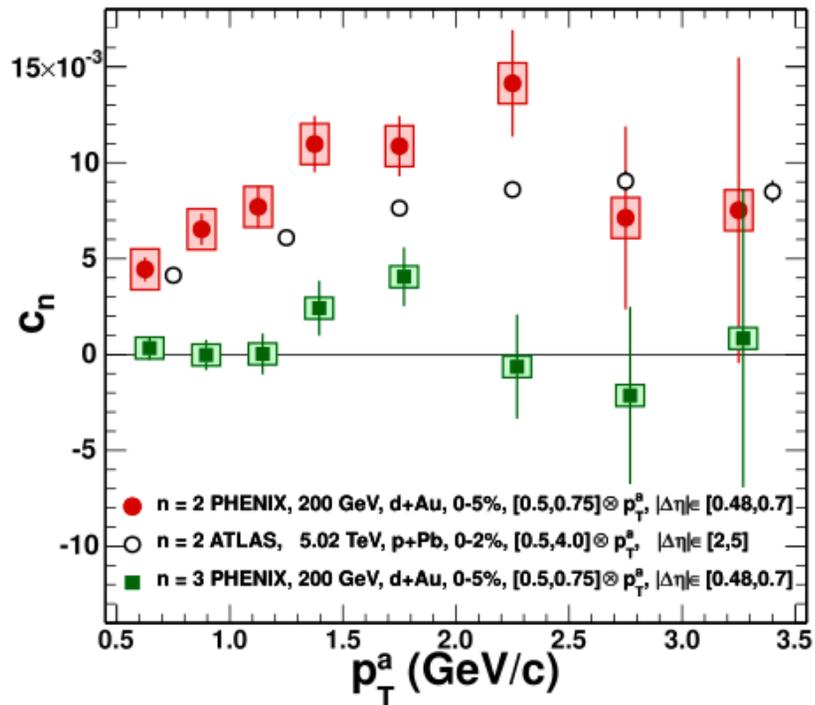


Near- and away-side features seen in both central and peripheral; $\Delta\eta$ gap limited to $\Delta\eta > 0.5$

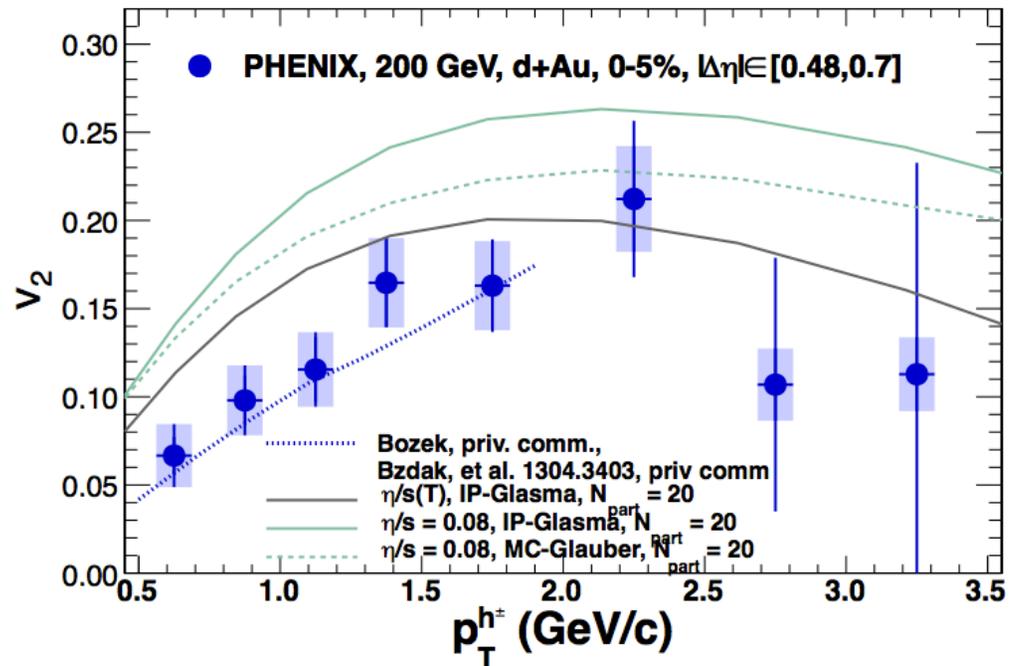
Very similar to LHC!
Central-peripheral difference is symmetric: two ridges? or flow?

Is it geometry+flow in d+Au? Intriguing! But not so fast...

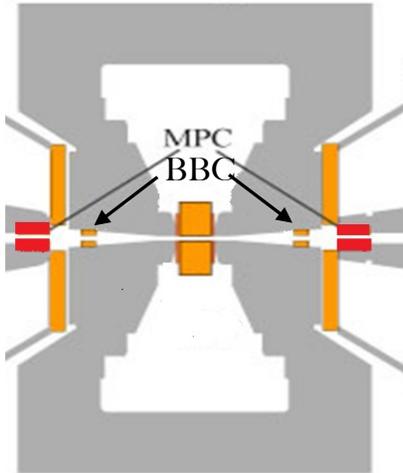
Fourier moments C_n of
(Cent-Periph)
distributions versus
associated p_T



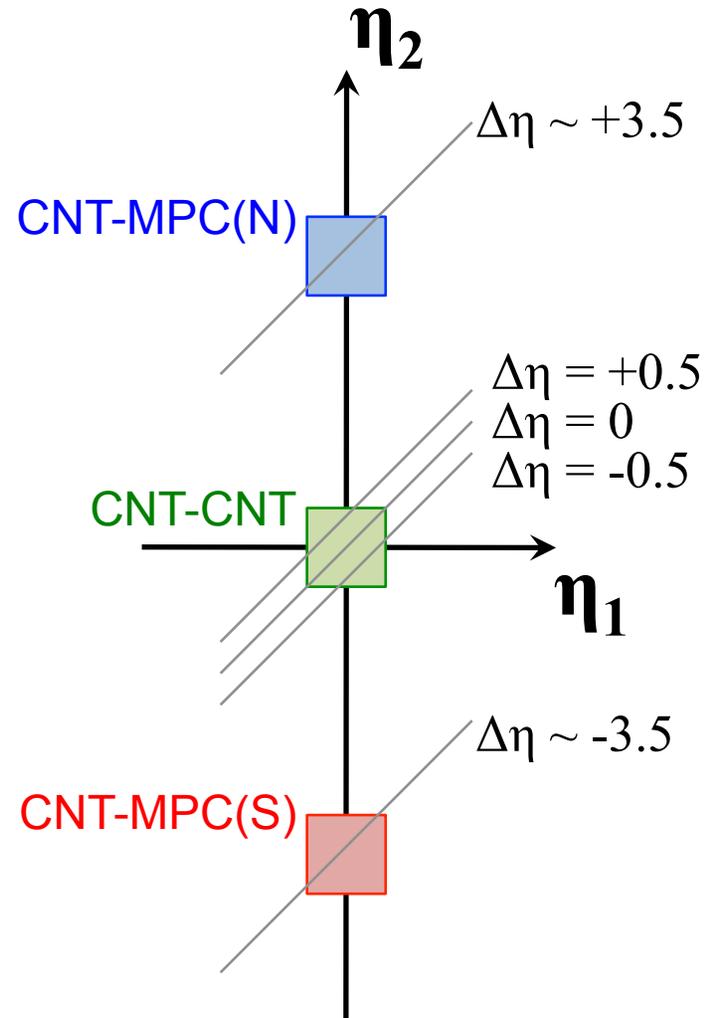
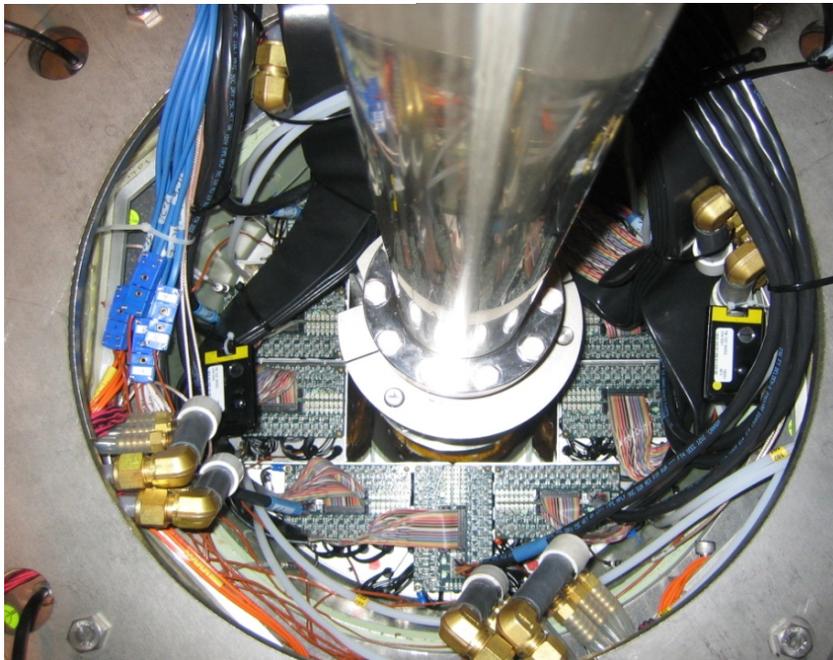
Inferred quadrupolar
anisotropy v_2 of h^+ vs p_T



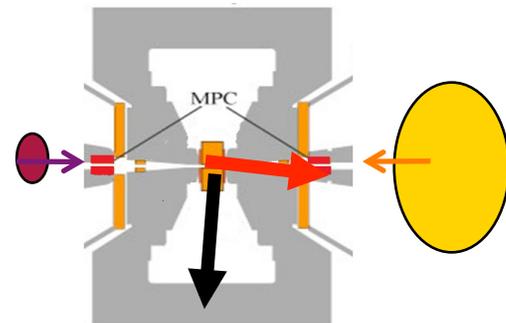
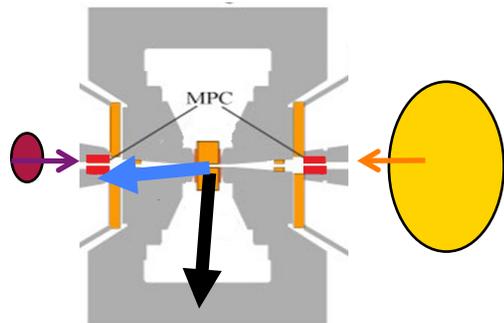
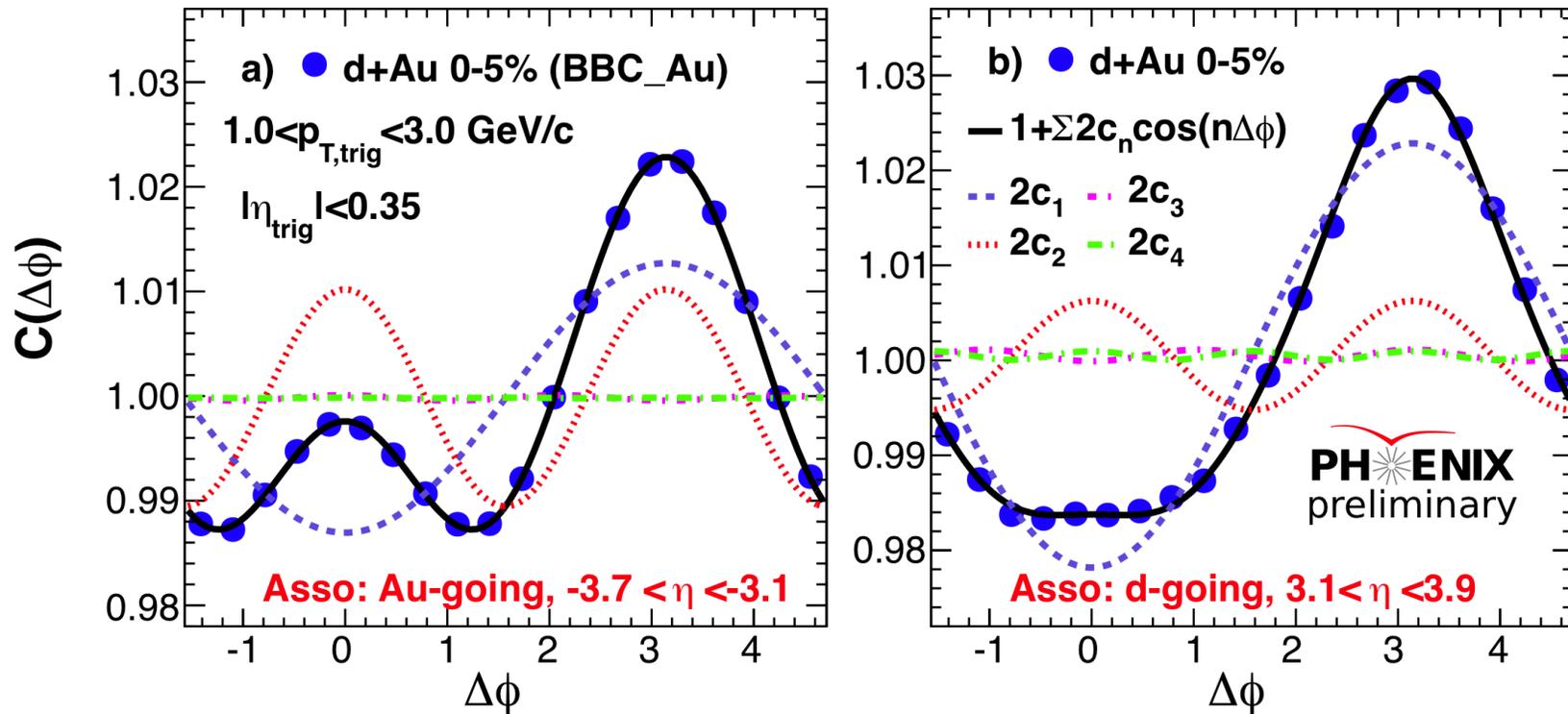
Extending to higher rapidities

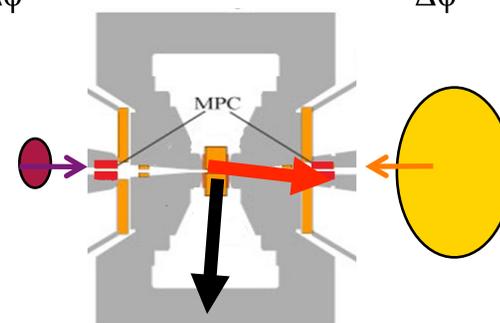
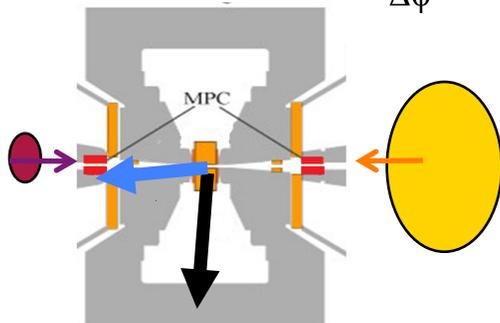
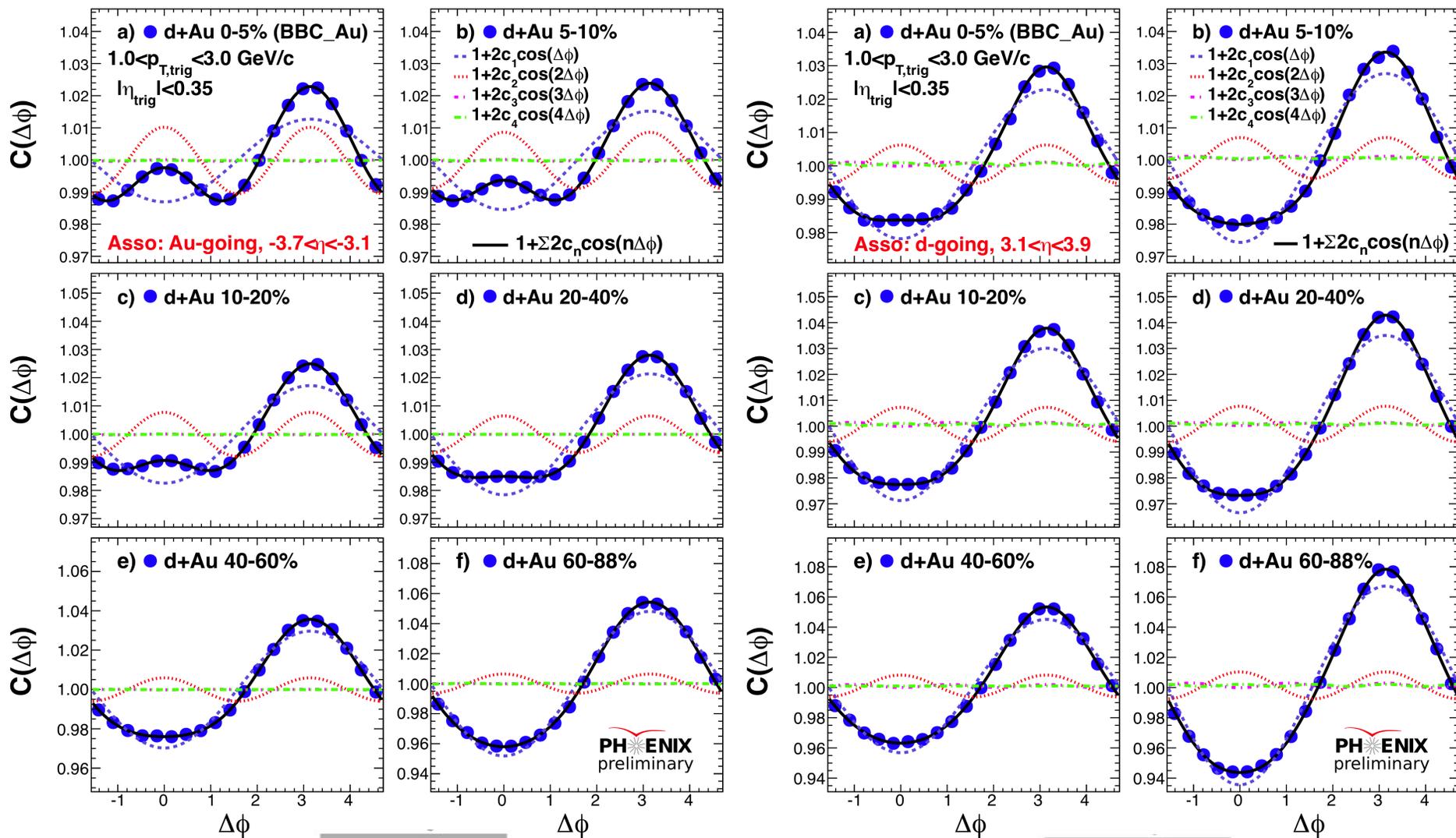


PHENIX MPC
Muon Piston
Calorimeter



New! Mid-Forward Particle/Energy Correlations





To do:

- Control geometry in small systems to test if correlation features result from bulk shape (e.g. hydro flow) or other physics
- Systematic study $p+A$, $d+A$, ${}^3\text{He}+A$ for manifest initial shape variations
- Broaden rapidity coverage with VTX & FVTX

Summary

No longer just an Au+Au control, d+Au is showing new and unexpected phenomena!

- Rising excess at very high p_T in peripheral d+Au
- Nuclear effects versus spatial position/thickness
- Long-range near-side correlations in central d+Au

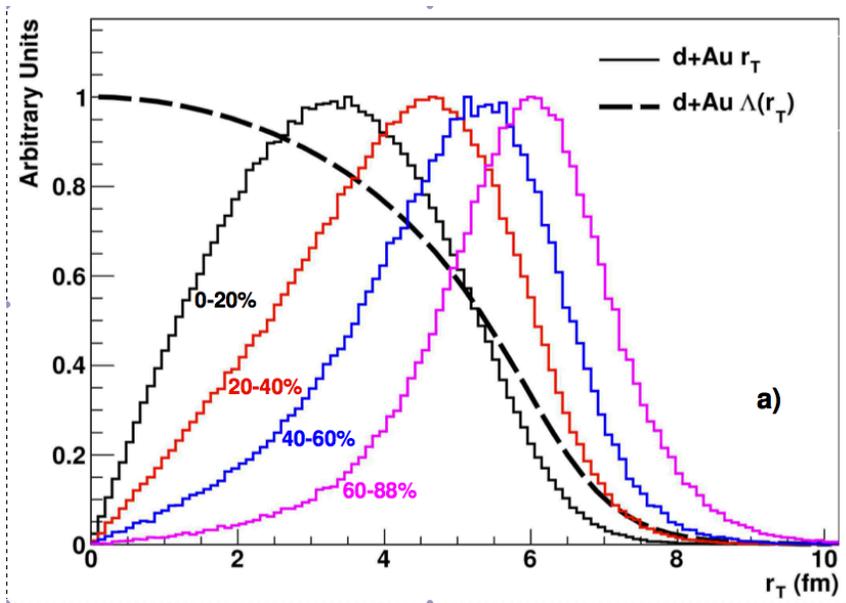
We have a great opportunity to investigate potential new physics in the near future

- Systematic study in p+A for different A
- New observables from new detectors: c/b , γ^{Direct} , etc.
- Initial geometry control with $\{p, d, {}^3\text{He}\} + A$

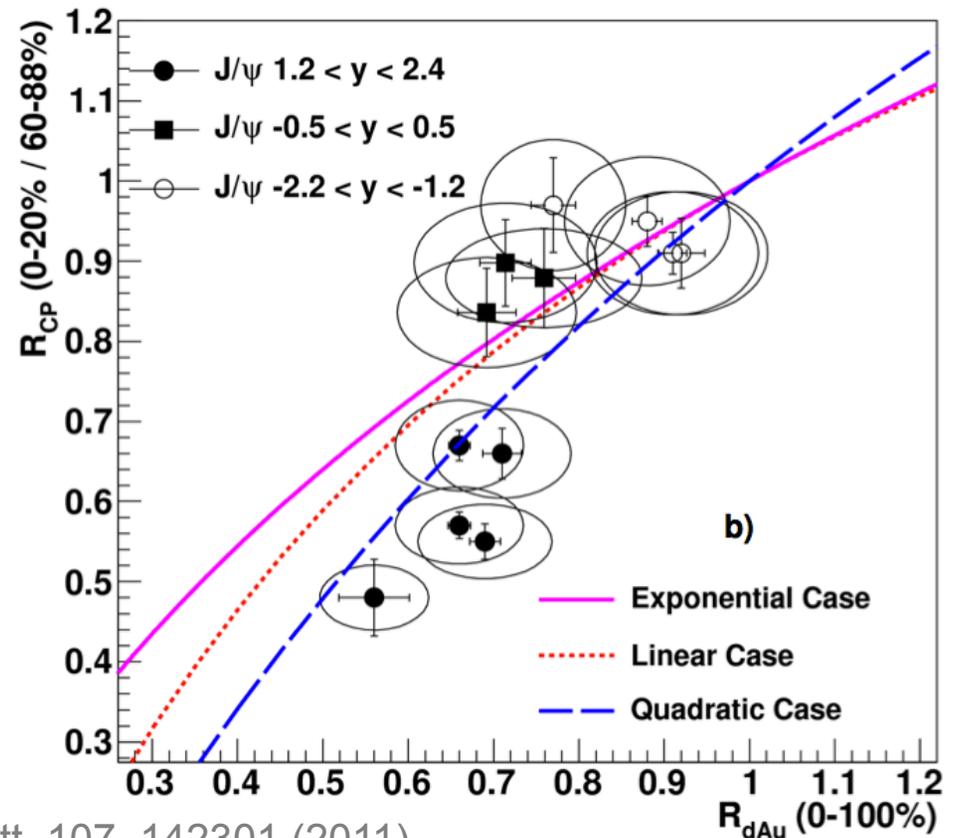
Backup

J/Psi in d+Au: testing radial dependence of nuclear modifications

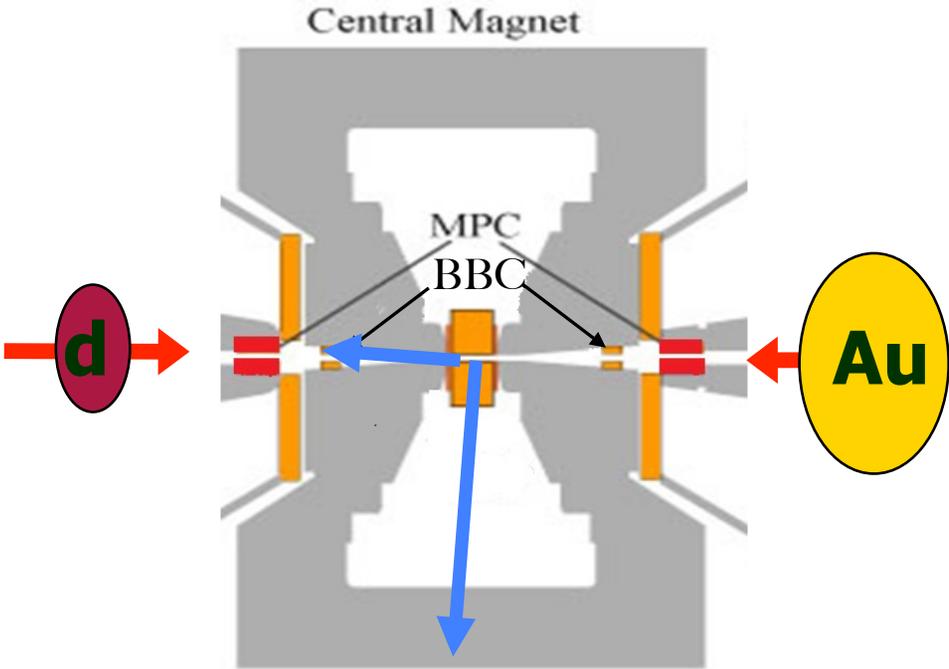
Radial (spatial) r_T dependence of interactions and nuclear thickness $\Lambda(r_T)$



R_{CP} vs R_{dAu} under different assumptions



Counting N+N collisions



Hadrons & jets are measured in PHENIX central arms, but centrality is measured in forward BBC in Au-going direction.

We can reproduce BBC response spectrum with Glauber N_{Part} counting plus an NBD from each participant, then reconstruct N_{Coll} for each centrality bin.

