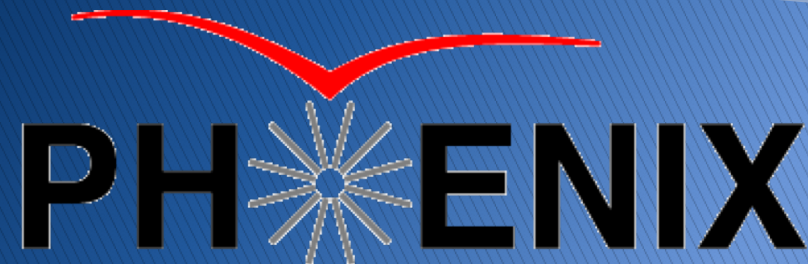









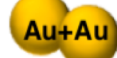



Recent results from PHENIX

Marzia Rosati
Iowa State University



RHIC versatility

\sqrt{s} [GeV]	 p+p	 p+Al	 p+Au	 d+Au	 ³ He+Au	 Cu+Cu	 Cu+Au	 Au+Au	 U+U
510	✓								
200	✓	✓	✓	✓	✓	✓	✓	✓	✓
130								✓	
62.4	✓			✓		✓		✓	
39				✓				✓	
27								✓	
20				✓		✓		✓	
14.5								✓	
7.7								✓	

PHENIX

- 16 years of operation
- 9 collision species
- 9 collision energies

Outline

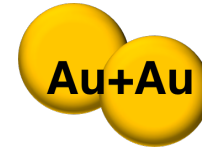
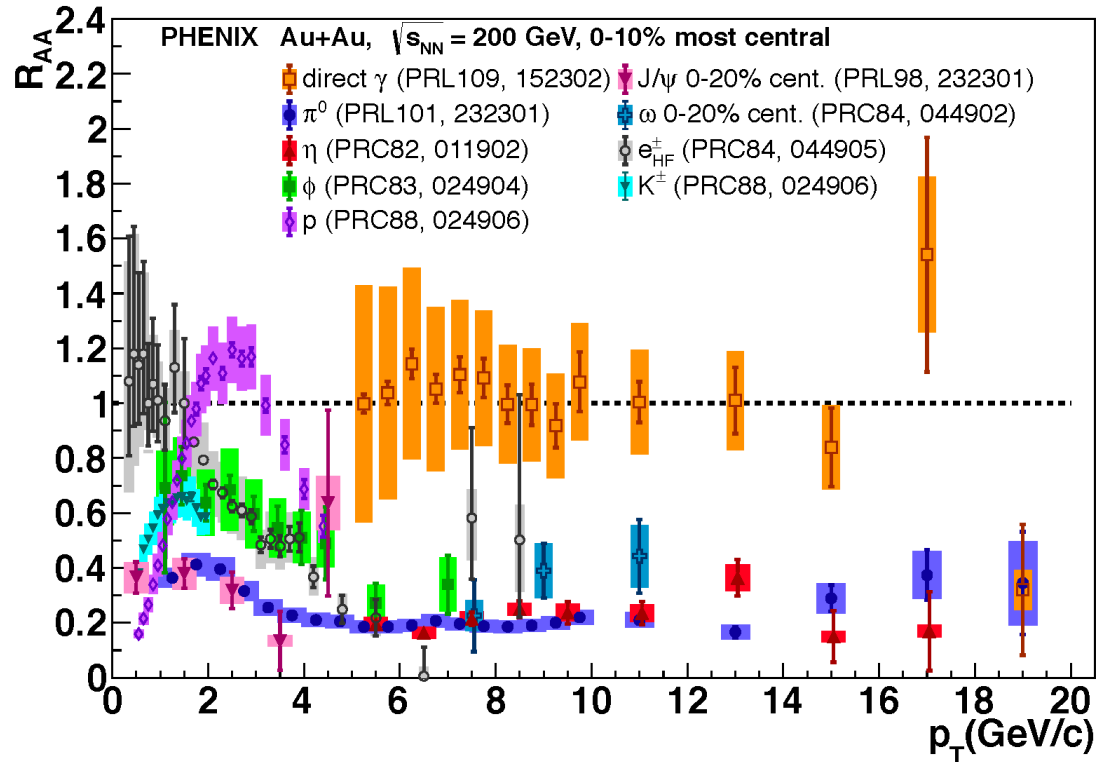
- Identified particle Suppression Factors: R_{AA} R_{AB} R_{pA}
- Spectra of charm and bottom in p+p, Au+Au
- v_2 of charm and bottom in Au+Au

- J/ψ in p+Al, p+Au, $^3\text{He}+\text{Au}$
- Drell-Yan in p+Au

- Away side jet modification π^0 -h correlations
- Direct photons in A+A and p+A

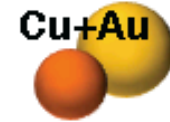
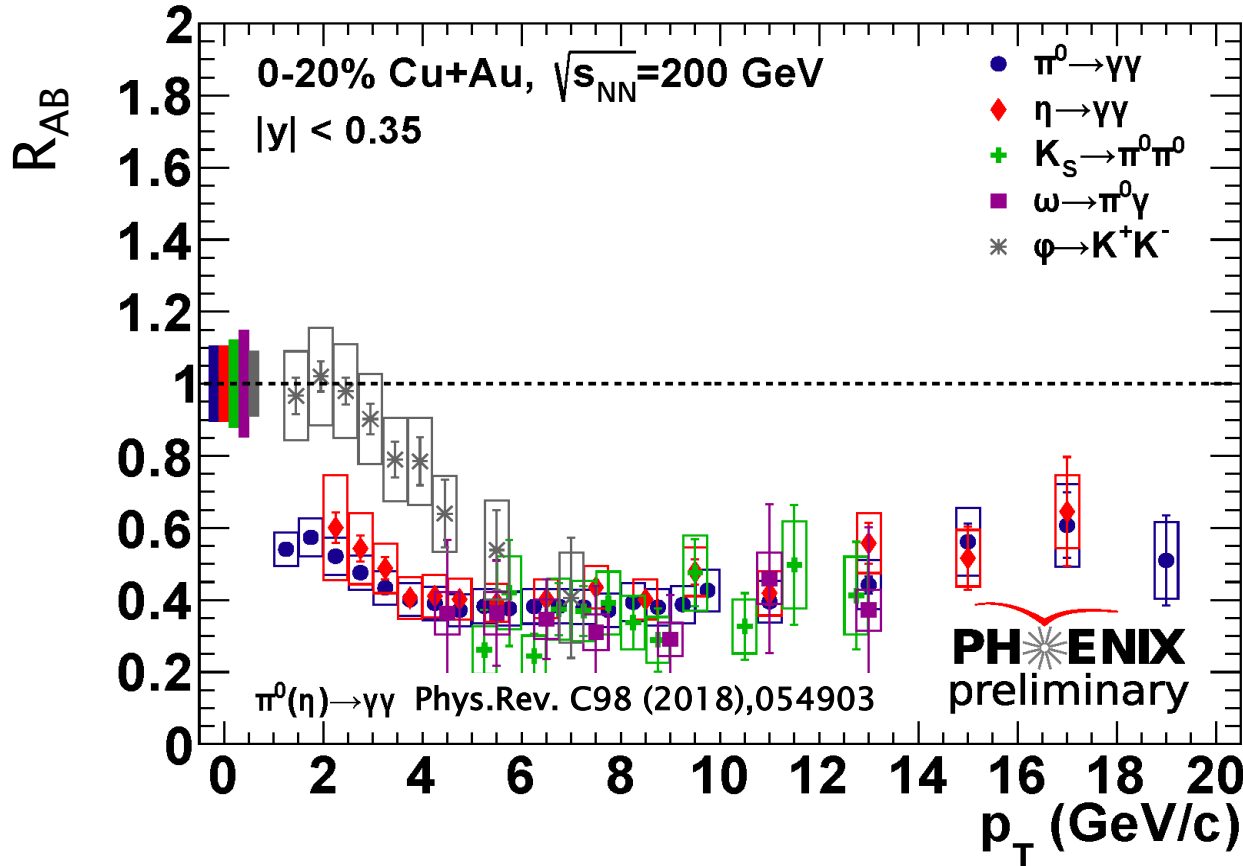
- Longitudinal dynamics in small systems
- Small systems geometry scan

PHENIX Compilation for R_{AuAu}



- Photons unmodified
- Baryons are not suppressed at intermediate p_T
- ϕ is an outlier at low p_T

Nuclear modification in Cu+Au collisions

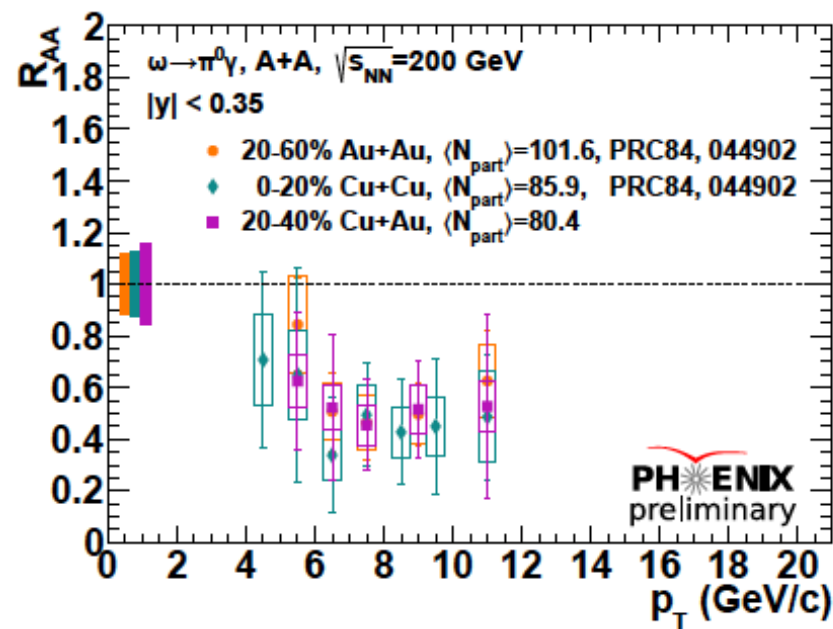
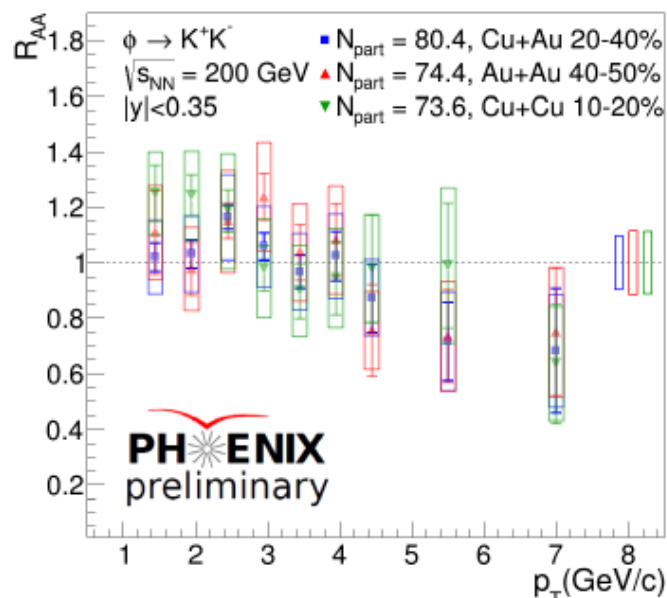


More details in
 Yurii Mitrankov's
 parallel talk
 on Tuesday at 14:40

Again strangeness important at low p_T but ω at high p_T follow η π^0 trend

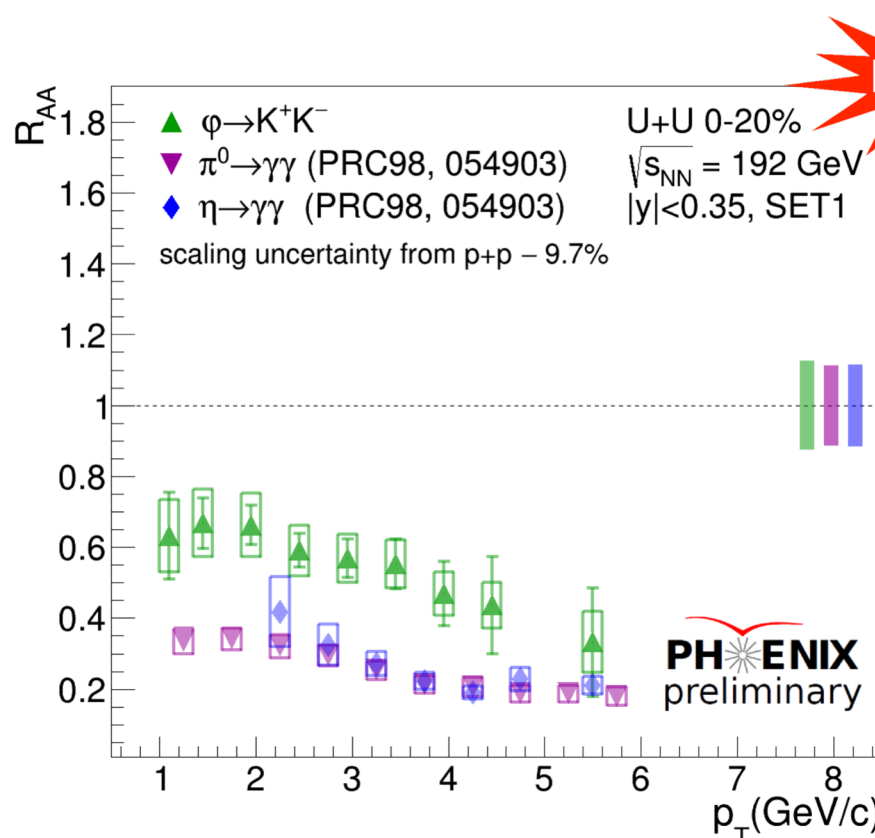
Identified Particle Nuclear

More details in
Yurii Mitrankov's
parallel talk
on Tuesday at 14:40



- ω and ϕ mesons behave similarly in CuCu, CuAu, and AuAu when selecting for similar N_{part}

Nuclear Modification in U+U collisions



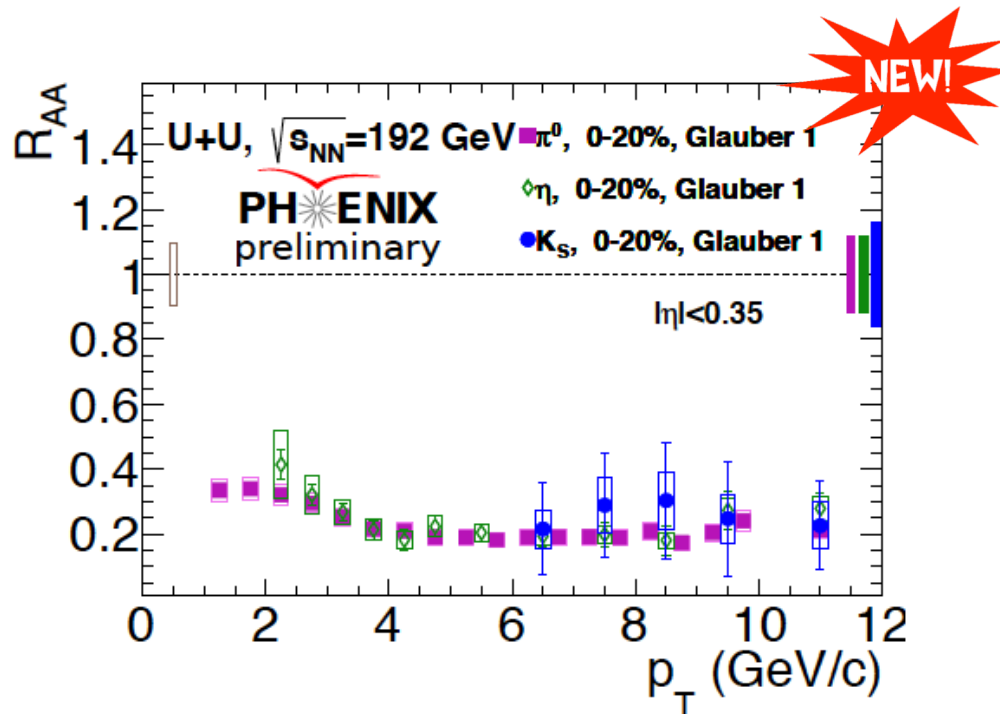
NEW!



More details in
 Yurii Mitrankov's
 parallel talk
 on Tuesday at 14:40

- strangeness important at low p_T , ϕ less suppressed than to π^0 and η

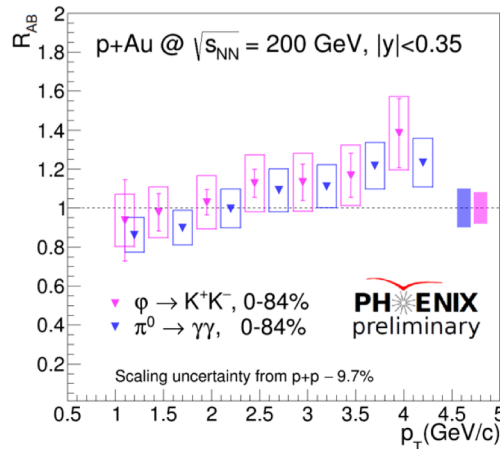
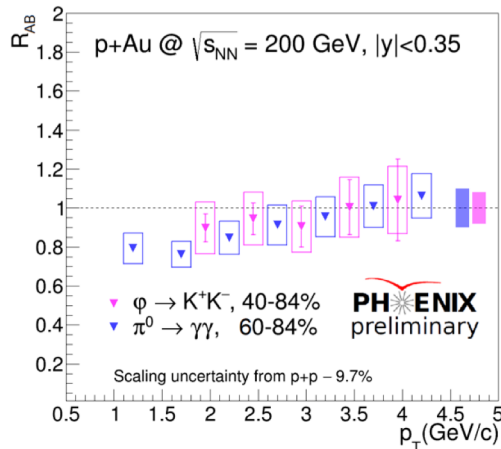
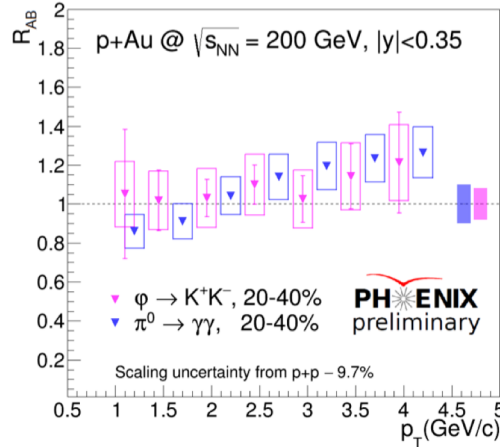
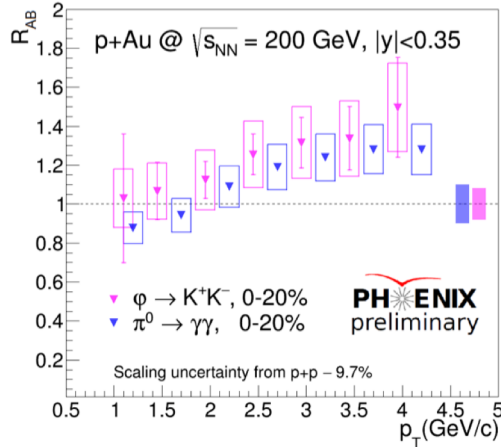
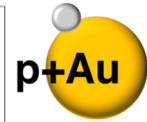
Nuclear Modification in U+U collisions



- Suppression similar for all species including strange mesons at high p_T

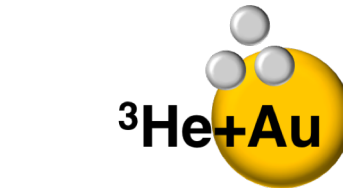
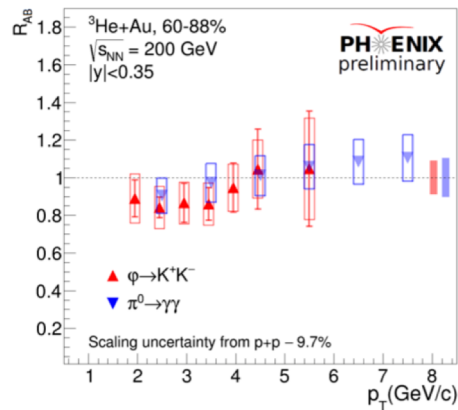
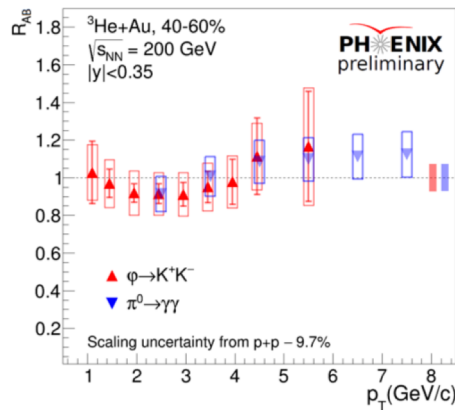
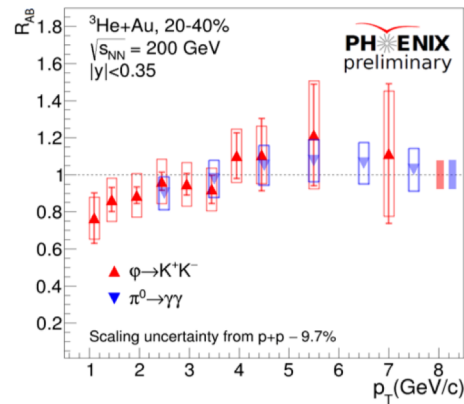
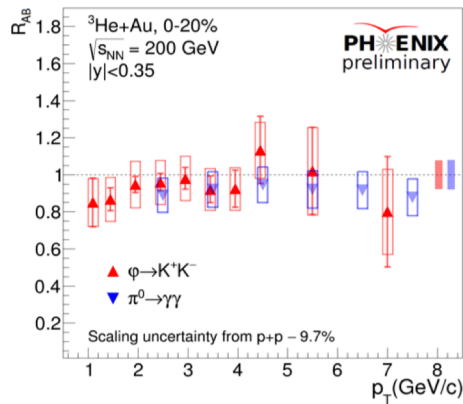
ϕ meson in p+Au

More details in
Yurii Mitrankov's
parallel talk
on Tuesday at 14:40

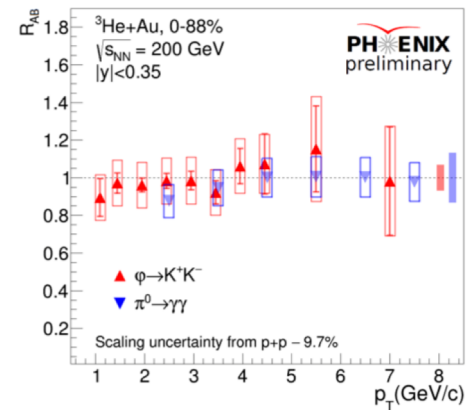


➤ Despite mass difference and strangeness, ϕ shows similar modification to π^0

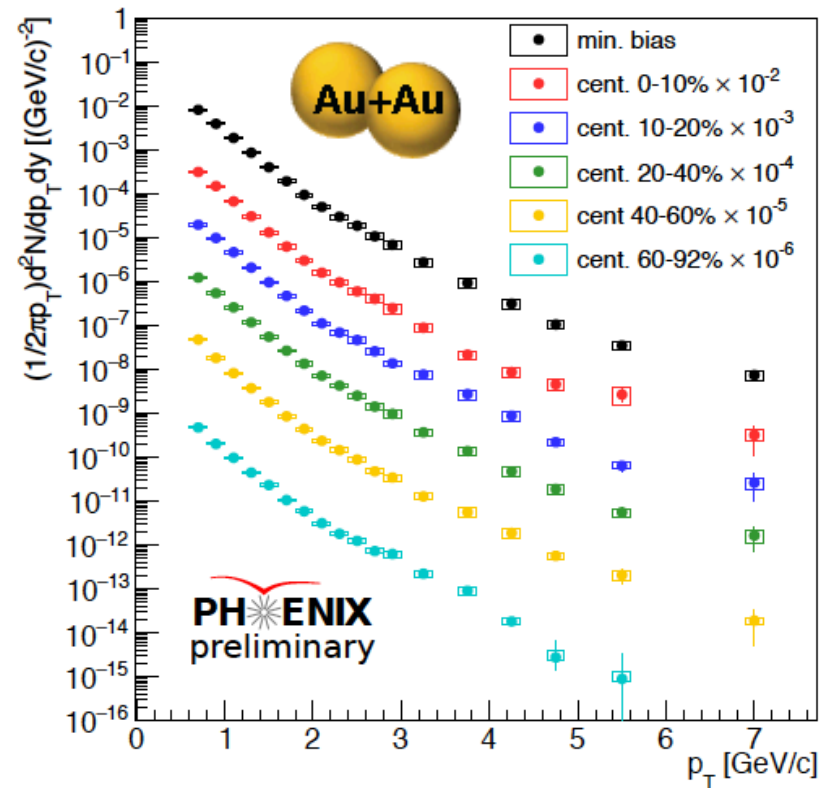
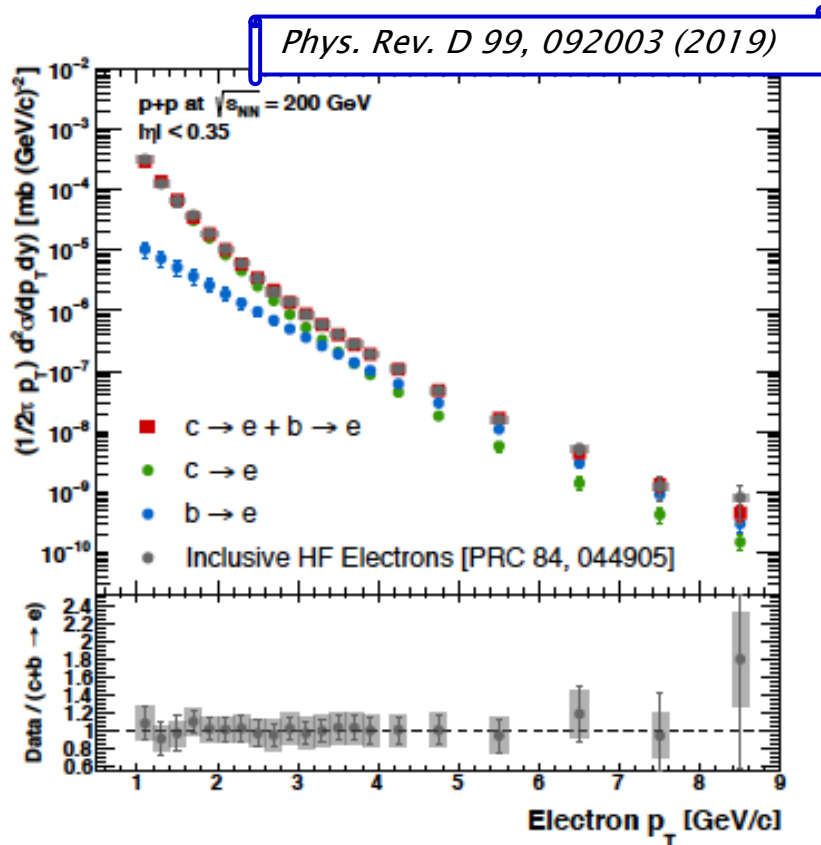
ϕ meson in ${}^3\text{He}+\text{Au}$



➤ Despite mass difference and strangeness, ϕ shows similar modification to π^0

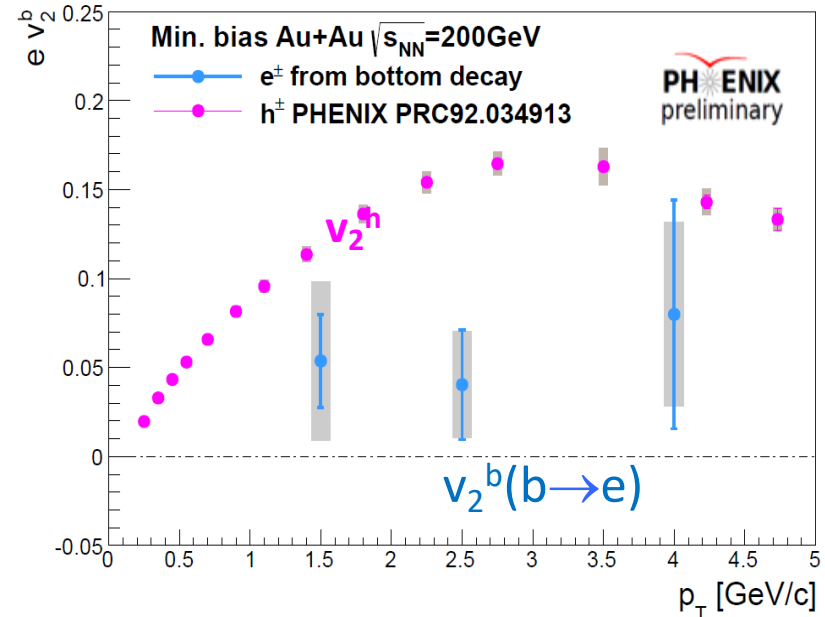
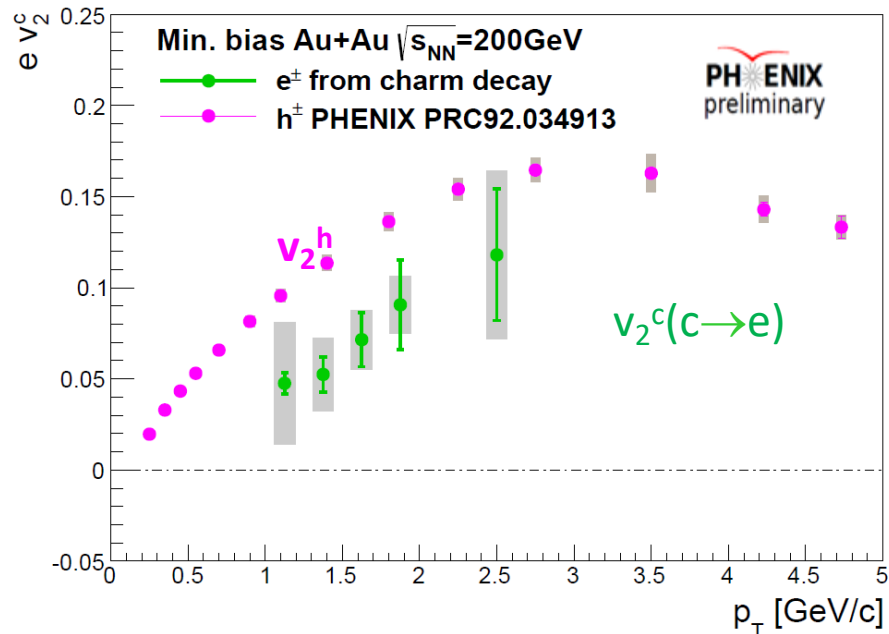


c → e and b → e in p+p and AuAu



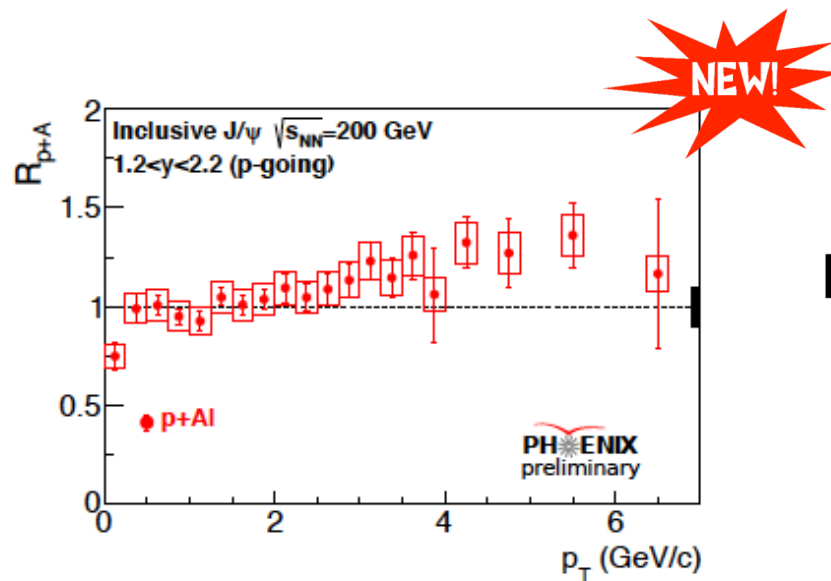
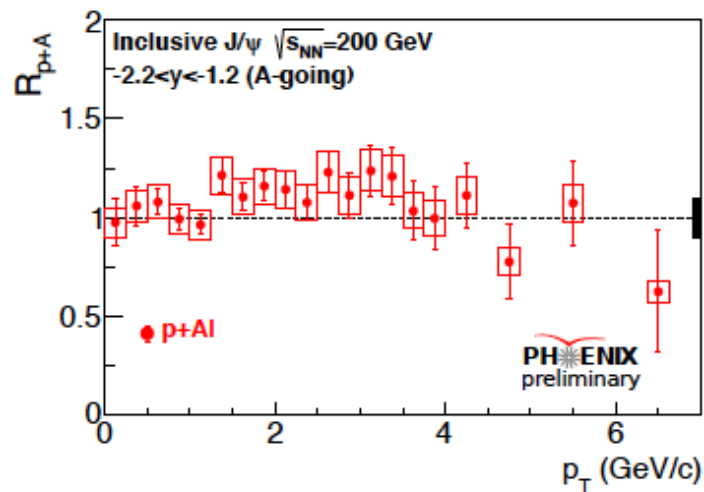
- New p+p reference data now published
- HF electron spectra, all centralities new publication with RAA on the way!

c→e and b→e in AuAu



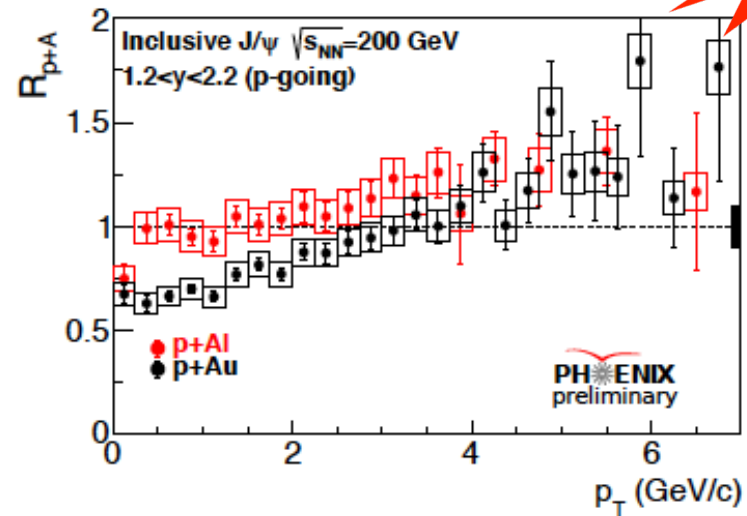
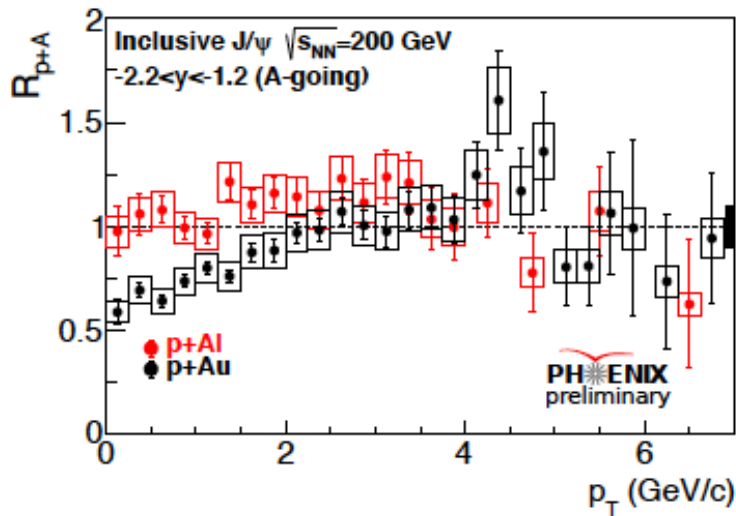
- First v_2^b ($b \rightarrow e$) measurement at RHIC
- Charm flows less than light-flavor hadrons
- Hint of bottom flow, too.

J/ ψ in p+Al



- Little modification

J/ ψ in p+Au

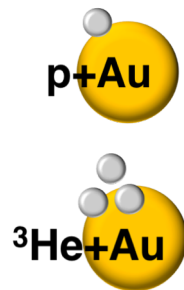
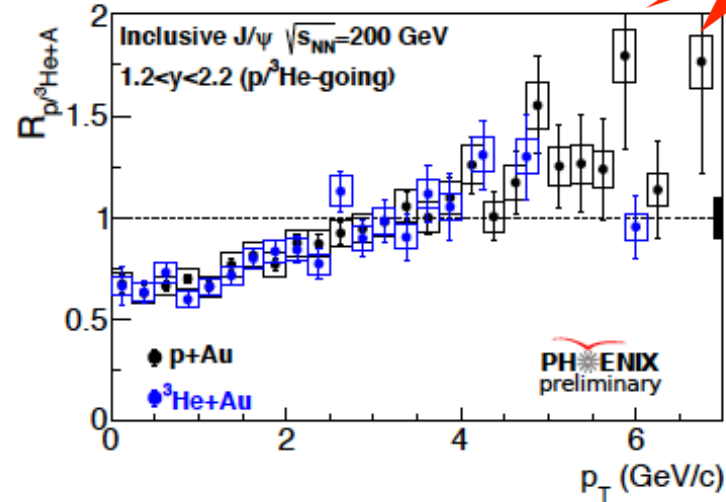
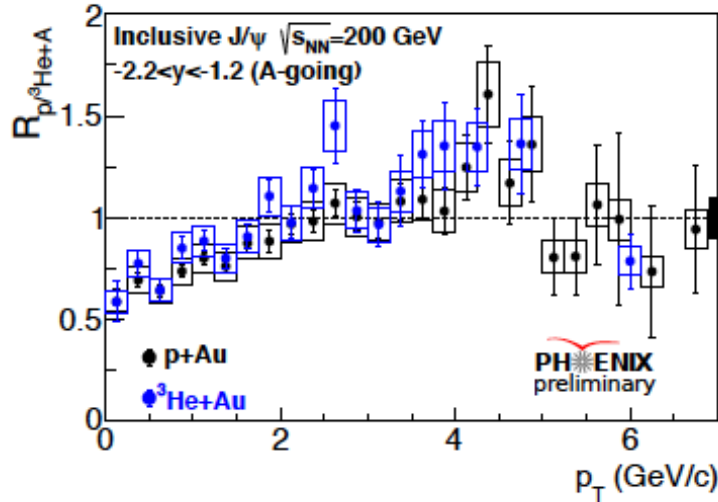


p+Al

p+Au

- Big change in nuclear modification with nuclear target size

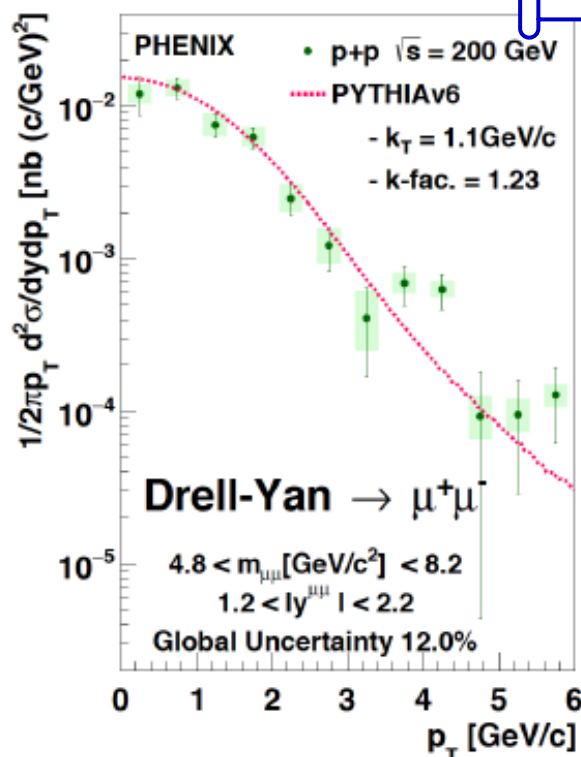
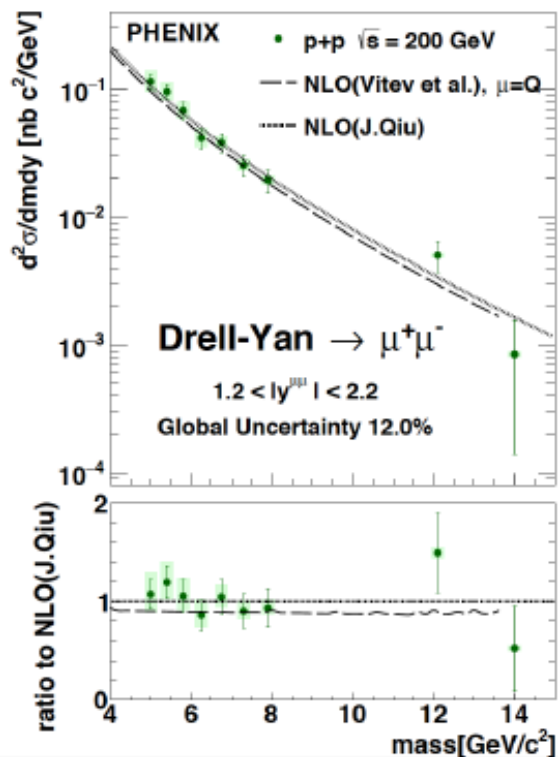
J/ ψ in $^3\text{He}+\text{Au}$



- Small change in nuclear modification when increasing projectile size

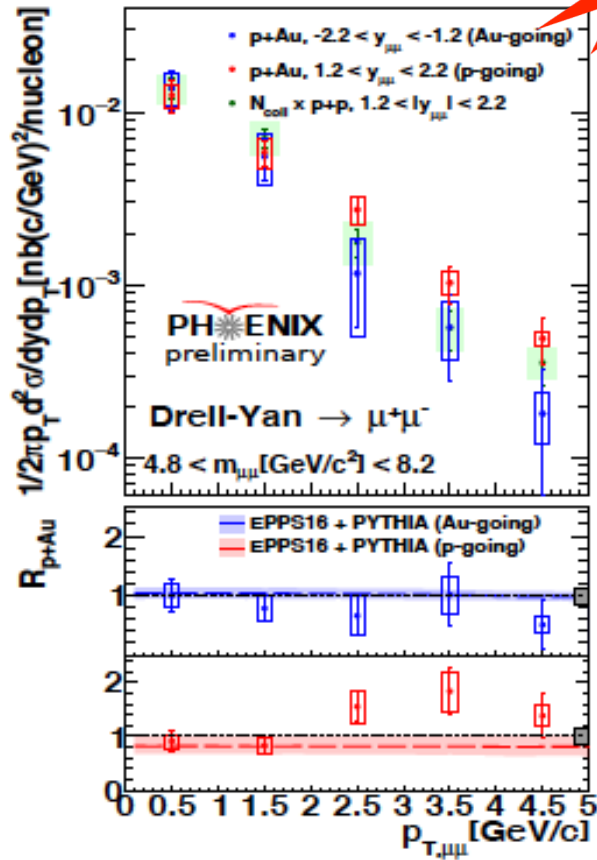
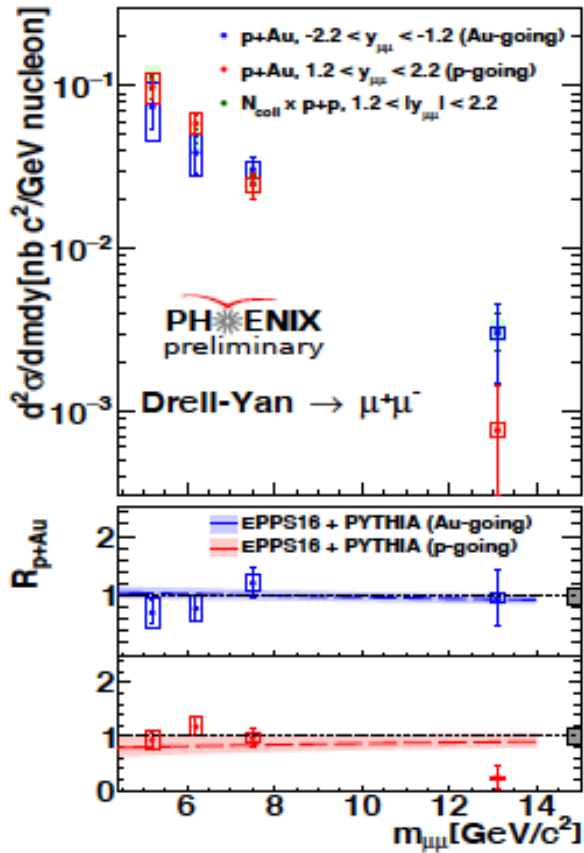
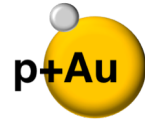
Drell-Yan from angular correlations in p+p

arXiv:1805.04075 (PRD)
arXiv:1805.02448 (PRD)



Well
described by
NLO and
Pythia

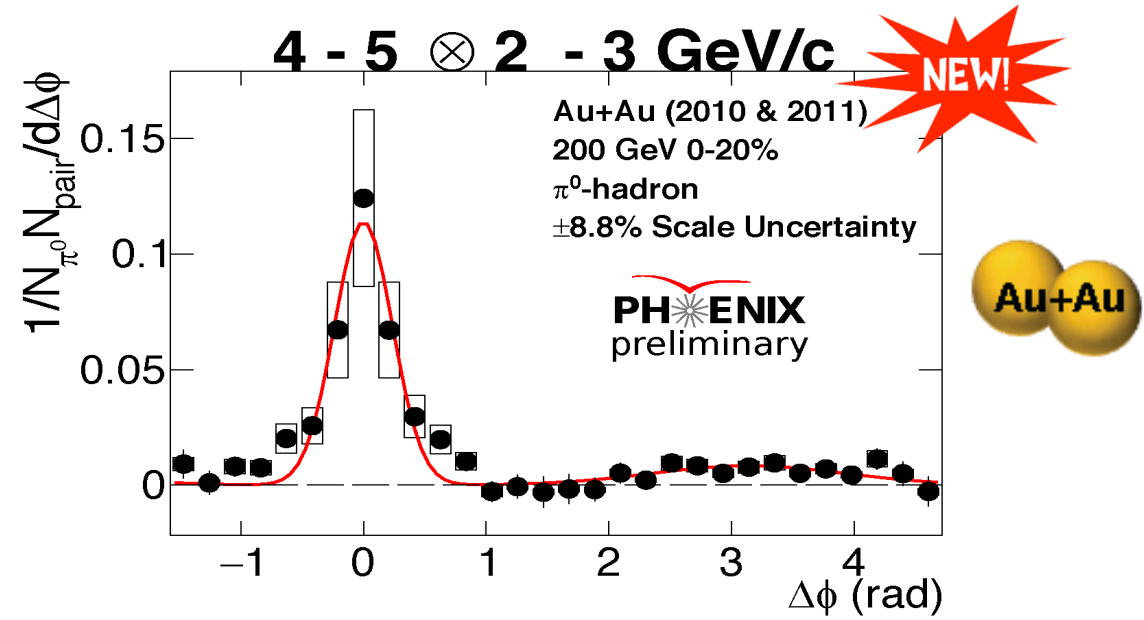
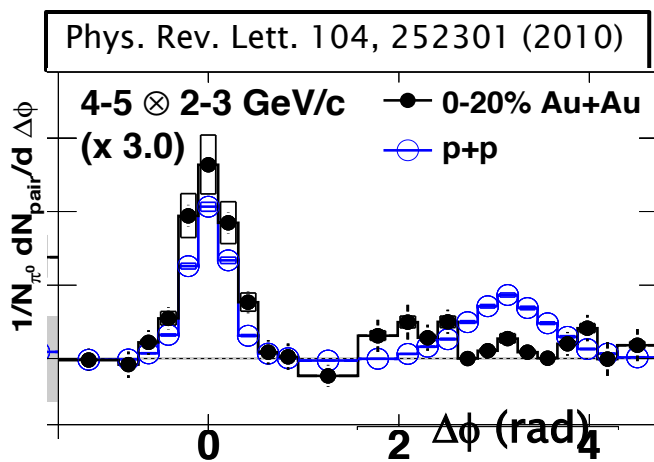
Drell-Yan from angular correlations in p+Au



Hints of modification to Drell-Yan in p+Au, though large uncertainties prevent a firm conclusion

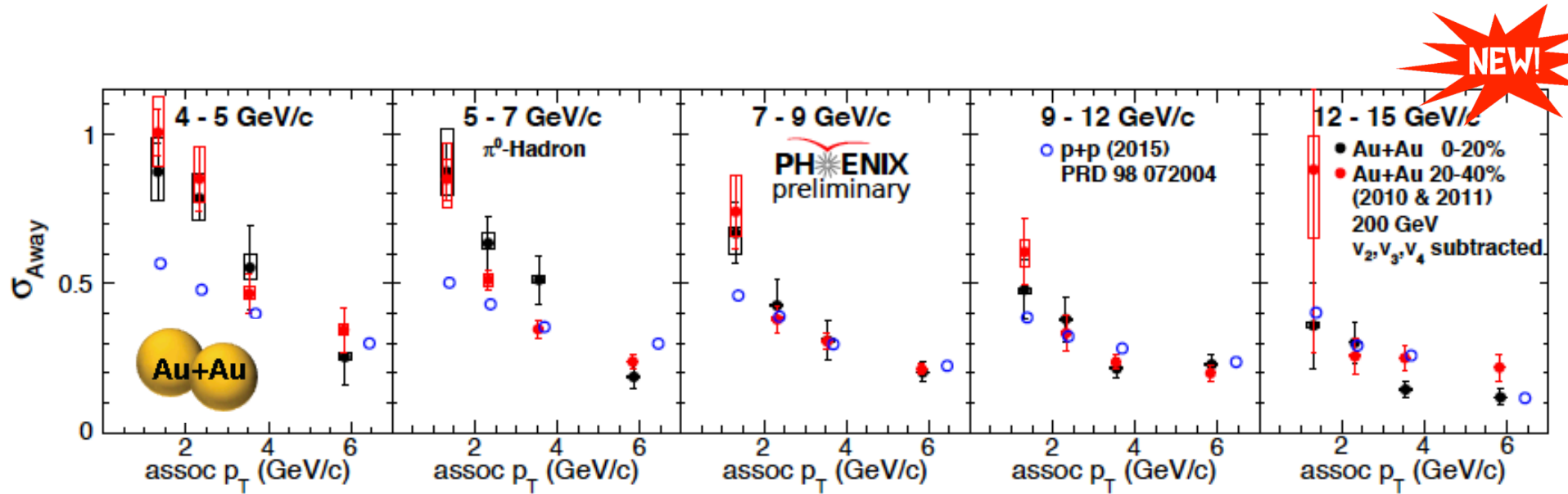
Medium modification of away side jet

- Away side width of $\pi^0-h^{+/-}$ corr. in Au+Au wider compared to $p+p$ (only v_2 subtracted)



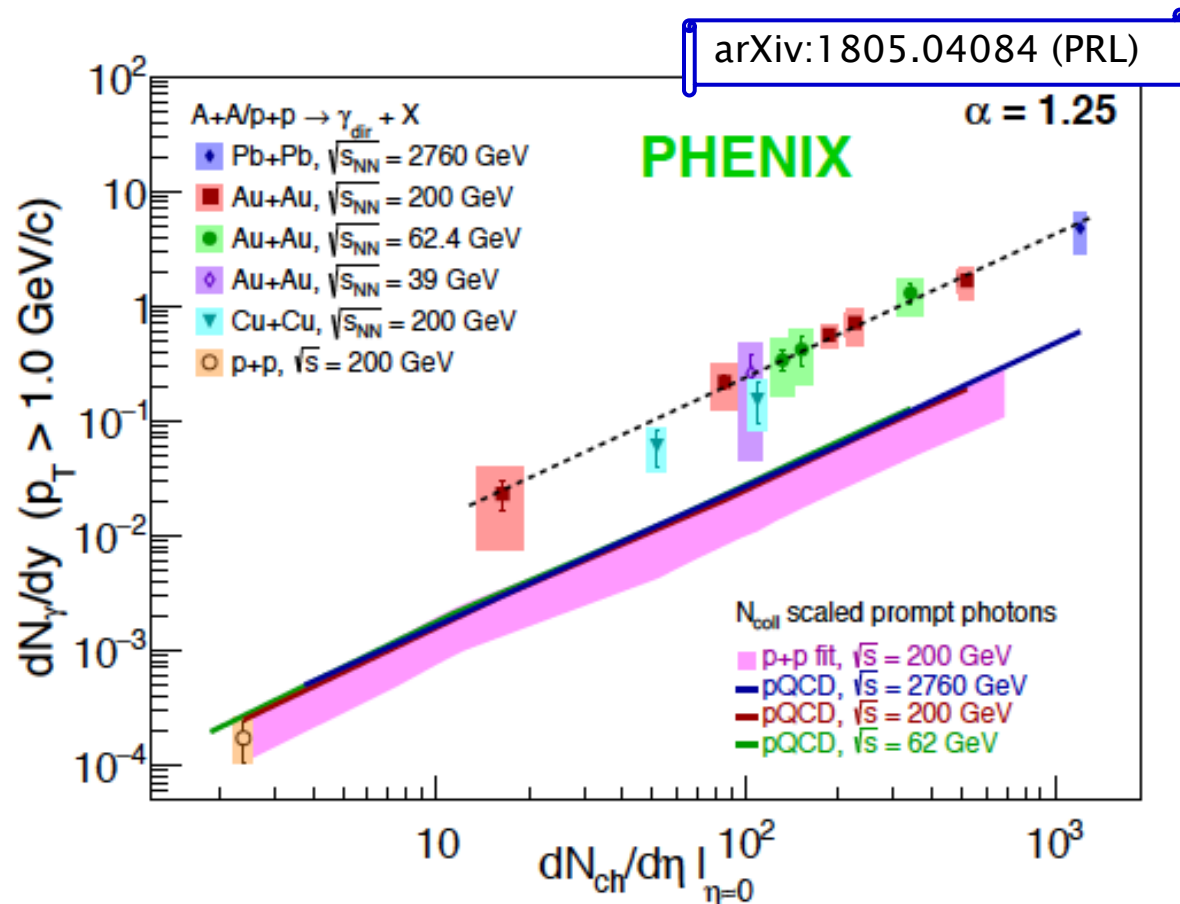
- New: shapes are cleaned up by higher statistics and $v_2+v_3+v_4$ subtraction

Medium modification of away side jet



- Away-side broadening in Au+Au at low p_T , but similar shape at high p_T

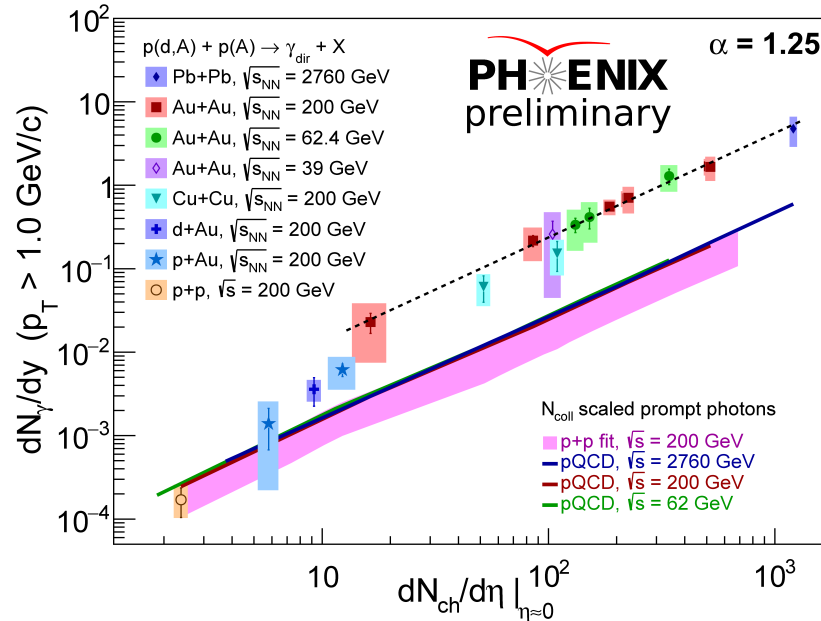
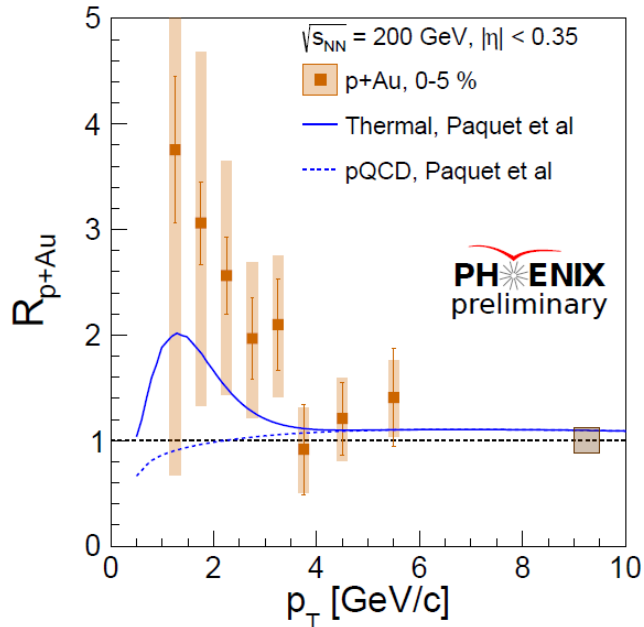
Photon Yields



Common scaling independent of collision energy or centrality for Au+Au and Pb+Pb at different energies;

very different from N_{coll} -scaled p+p

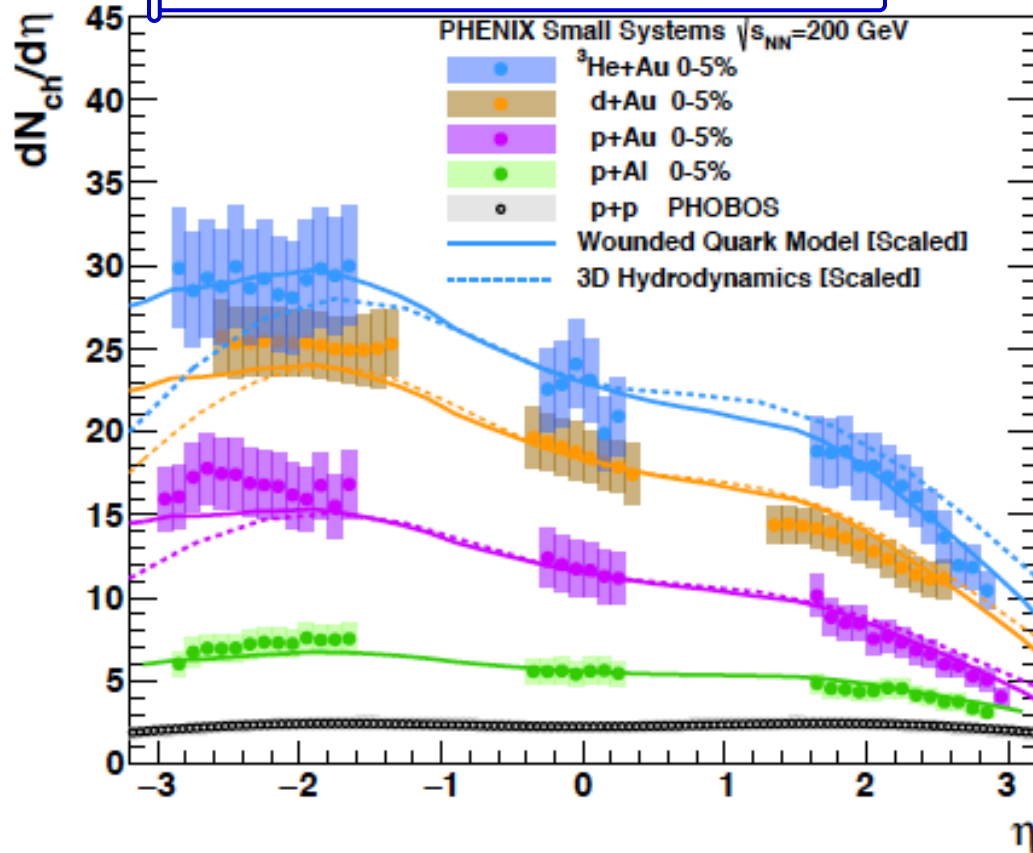
Photon Yields



- $p+Au$ and $d+Au$ data fill the gap smoothly between $A+A$ and $p+p$ collisions.

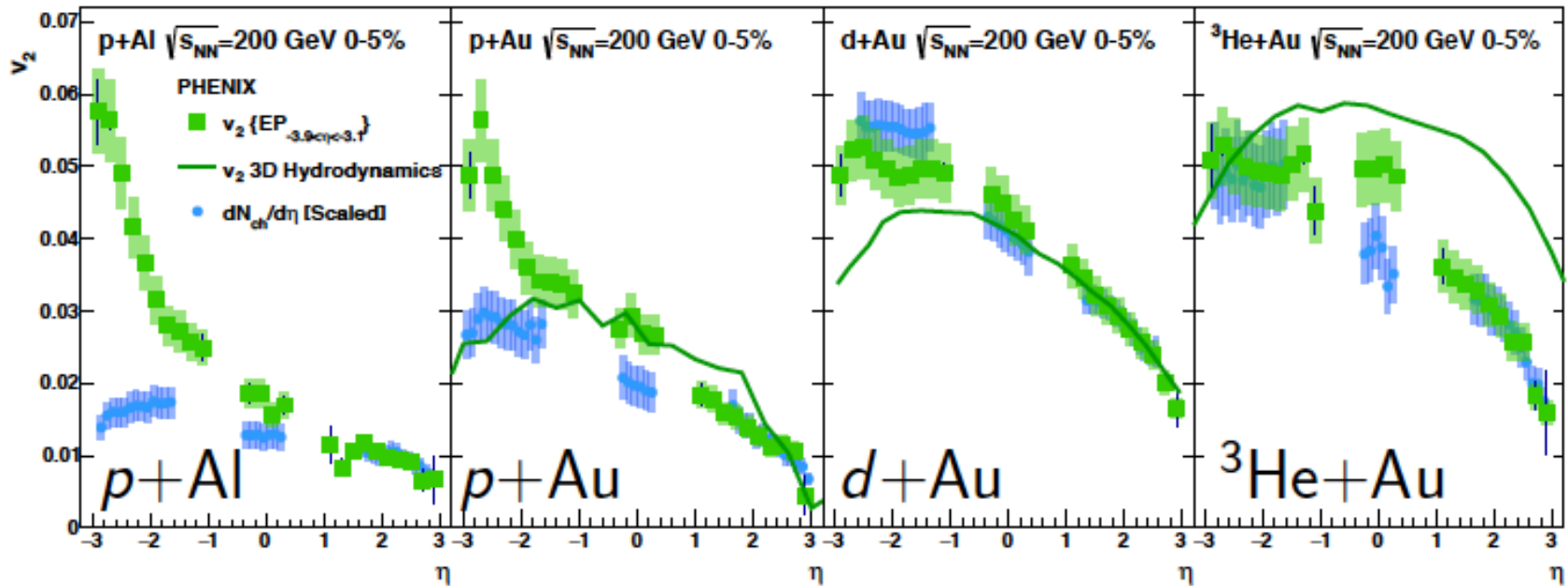
Longitudinal dynamics in small systems

Phys. Rev. Lett. 121, 222301 (2018)



- Good agreement with
 - Wounded nucleon model (M. Barej, A. Bzdak, and P. Gutowski Phys. Lett. B 739, 308, 2014).
 - 3-D hydro (P. Bozek and W. Broniowski, Phys. Lett. B 739, 308, 2014).

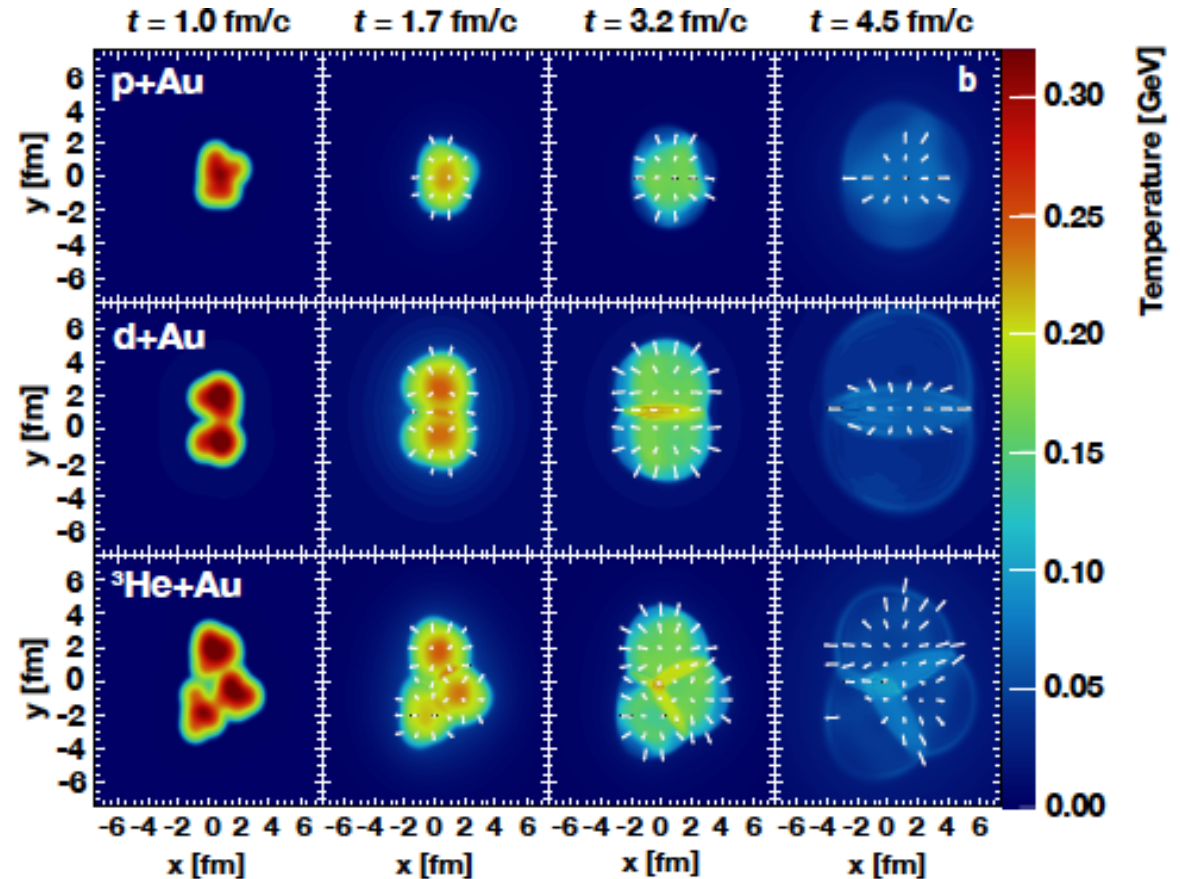
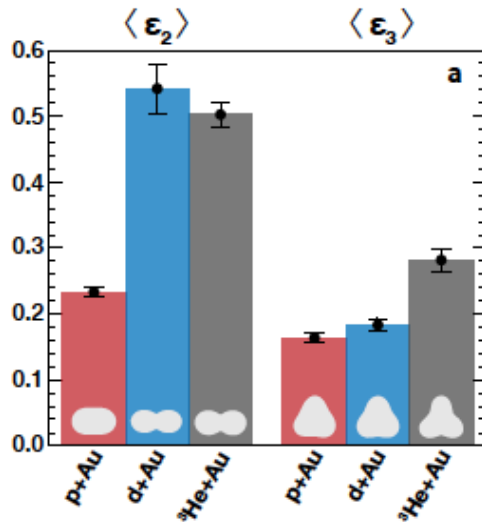
Longitudinal dynamics in small systems



- v_2 agrees with 3-D hydro for p+Au and d+Au (P. Bozek and W. Broniowski, Phys. Lett. B 739, 308, 2014).
- In ³He+Au, 3-D hydro overpredicts the forward rapidity

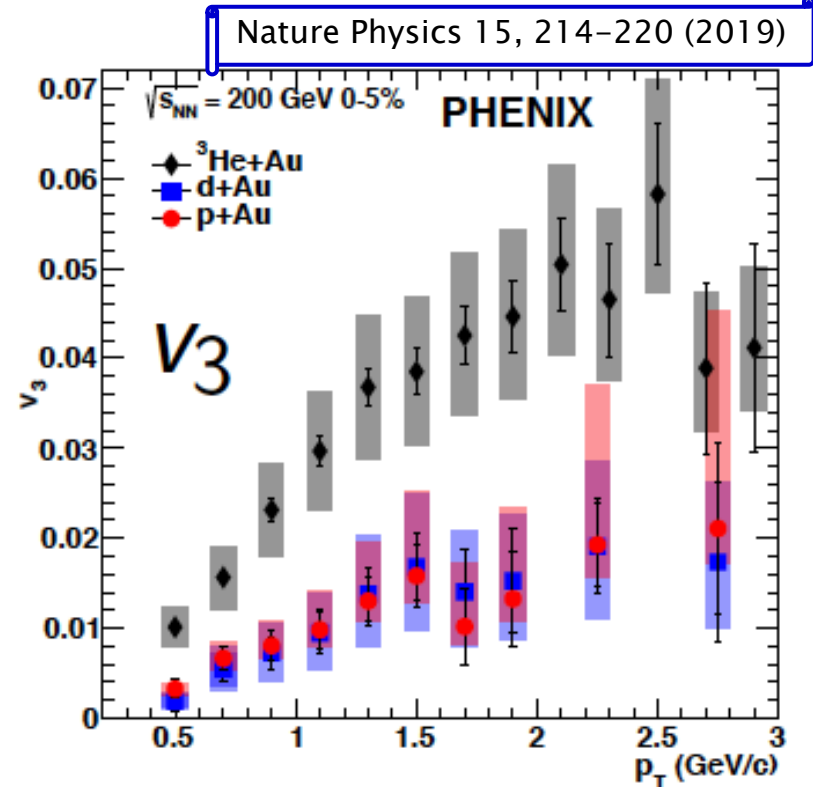
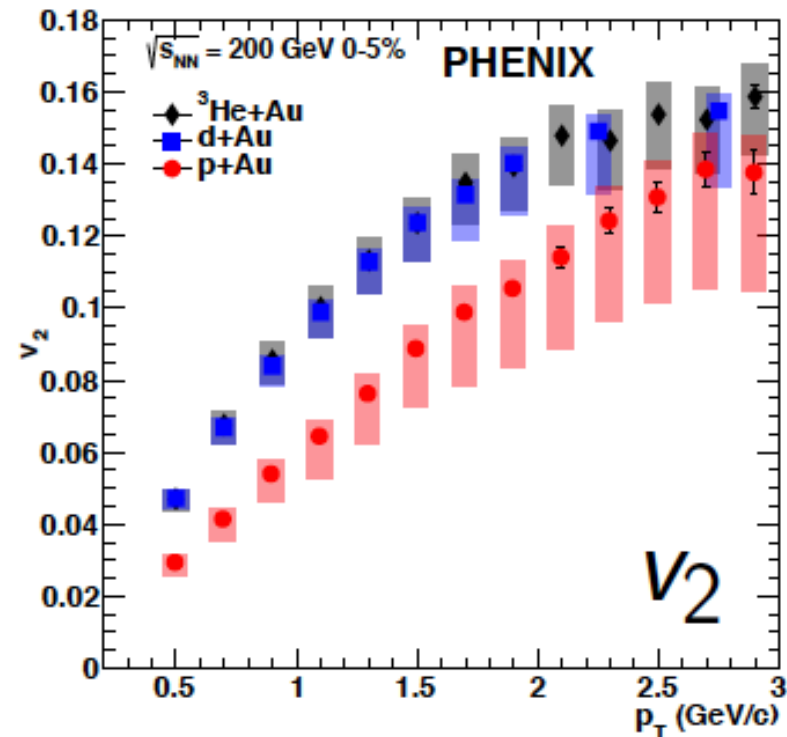
Testing hydro by controlling geometry

Nature Physics 15, 214–220 (2019)



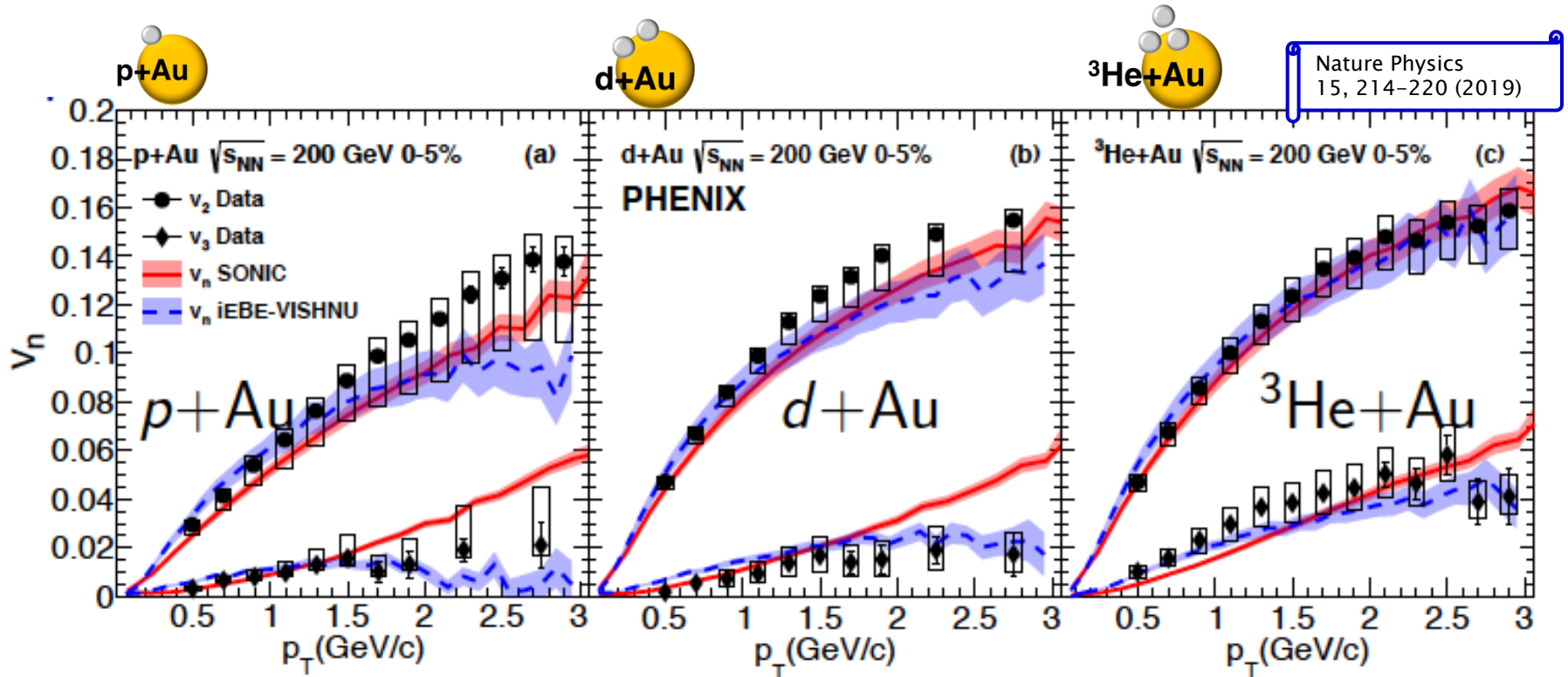
- SONIC model: Habich, M., Nagle, J. L. & Romatschke, Eur. Phys. J. C 75, 15 (2015).

Testing hydro by controlling geometry



- v_2 and v_3 ordering matches ε_2 and ε_3 ordering in all systems
- Regardless of mechanism, the correlation is geometrical

Testing hydro by controlling geometry



- v_2 and v_3 vs p_T described very well by hydro in all three systems

iEBE-VISHNU: C. Shen et al., Phys. Rev. C 95, 014906 (2017).

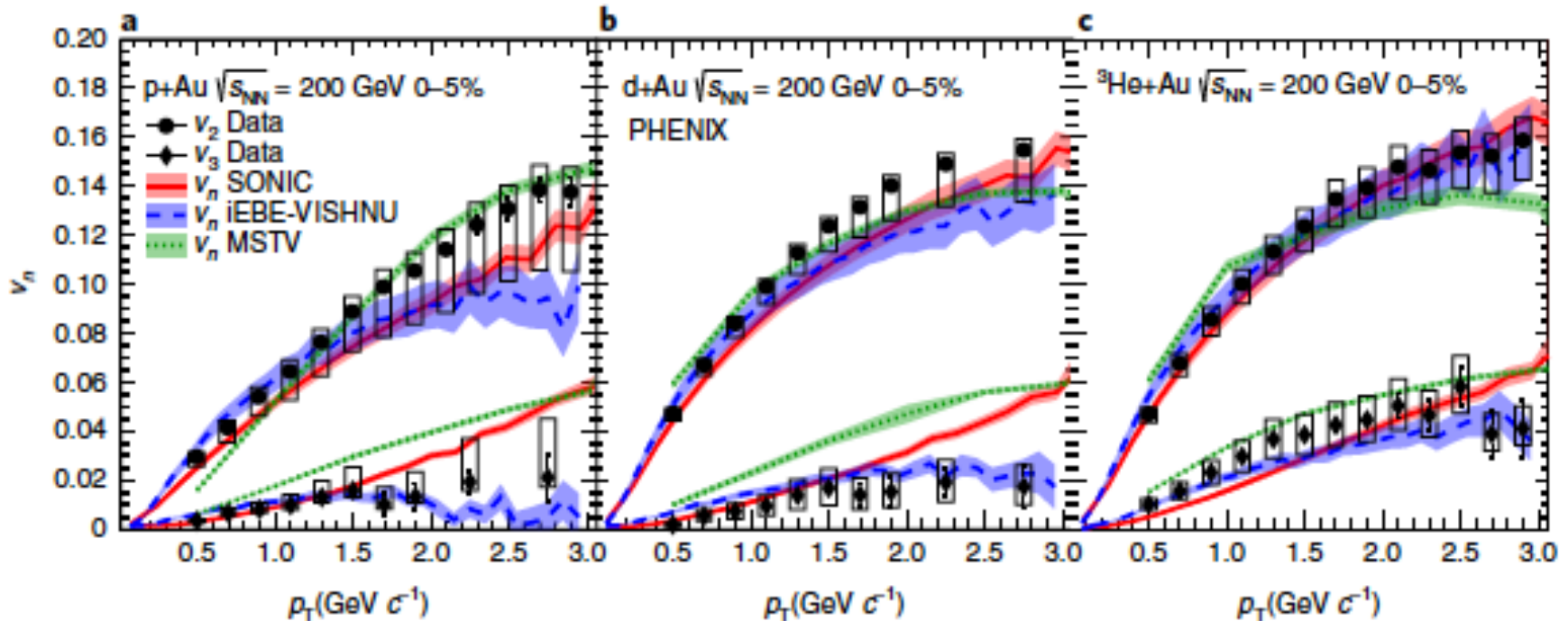
SONIC: M. Habich et al., Eur. Phys. J. C 75, 15 (2015).

Summary

- Single particle R_{AA} independent of collision species when selecting for similar N_{part} . Strangeness very important at low p_T but not at high p_T
- Measurement of $c \rightarrow e$ and $b \rightarrow e$ spectra in p+p and new RAA coming soon. First measurement of bottom flow at RHIC
- Correlation measurements show away-side broadening
Indicates large-angle radiation of high- p_T partons
- J/ψ production shows big change when increasing nuclear target size, small change when increasing projectile size
- Photon enhancement in small systems is important additional evidence in support of QGP droplet formation in small systems
- Comprehensive set of measurements of longitudinal dynamics. Good support for wounded quark model and 3D hydro

Backup

Testing hydro by controlling system geometry



- The dotted green curves represent initial-state momentum correlation from MSTV qualitatively agreed with data...
- But recently discovered issue with calculation reduces p_T scale by factor of 5