

Physics Highlights from Bulk-Correlation

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BUR Committee Meeting

Outline



- Bulk-Correlation 2020 Publications
- Physics Highlights from Bulk-Correlation
 - ✓ Net-proton number fluctuations measurements
 - ✓ Global Polarization measurements
 - ✓ Global spin alignment
 - ✓ Nuclear Deformation measurements
 - ✓ Flow-correlations and fluctuations measurements
 - ✓ Small systems measurements
 - ✓ Hanbury Brown-Twiss measurements
- Summary

Publications (2020)



- Beam-Energy Dependence of the Directed Flow of Deuterons in Au+Au Collisions
e-Print:[2007.04609](#)
- Investigation of the linear and mode-coupled flow harmonics in Au+Au collisions at 200 GeV
e-Print: [2006.13537](#)
- Pair invariant mass to isolate background in the search for the chiral magnetic effect in Au+Au collisions at 200 GeV
e-Print:[2006.05035](#)
- Charge separation measurements in p(d)+Au and Au+Au collisions; implications for the chiral magnetic effect
e-Print:[2006.04251](#)
- Beam energy dependence of net- Λ fluctuations measured by the STAR experiment at RHIC
e-Print: [2001.06419](#)
- Net-proton number fluctuations and the Quantum Chromodynamics critical point
e-Print:[2001.02852](#)

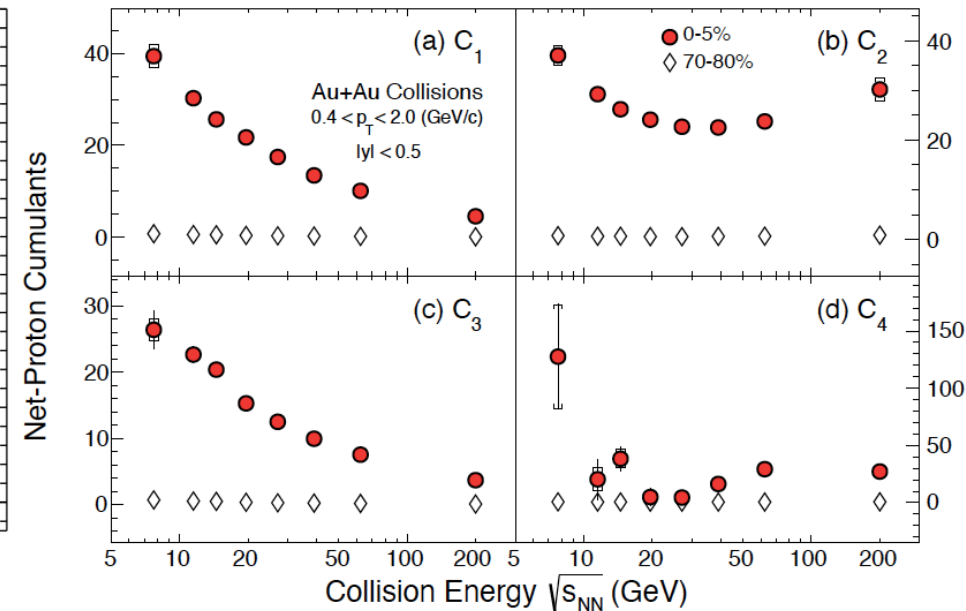
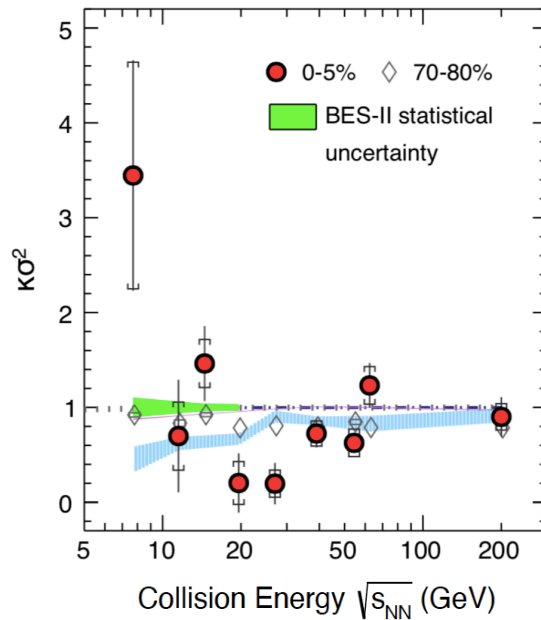
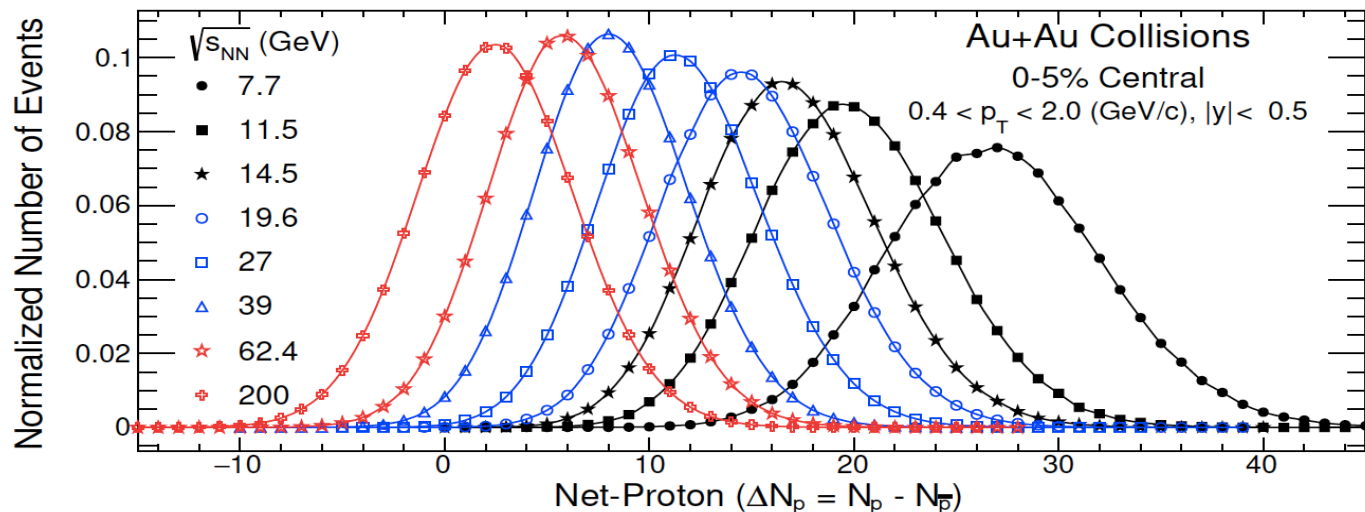
- Physics Highlights from Bulk-Correlation
 - ✓ Net-proton number fluctuations measurements
e-Print:2001.02852

- Event-by-Event net-proton number distributions for 0-5% central Au+Au collisions vary with beam energy

- Cumulants (C_n) of net-proton distribution vary with beam energy:
 - C_2 and C_4 show a non-monotonic beam energy dependence

- The $\kappa\sigma^2$ ($\chi_4^B / (\chi_2^B / T)$) shows a non-monotonic variation, with a possible minimum between 11.5 and 39 GeV.

- The observed non-monotonic behavior, as a function of beam energy in net-proton $\kappa\sigma^2$ in central Au+Au collisions has a significance of 3.0σ .



➤ Physics Highlights from Bulk-Correlation

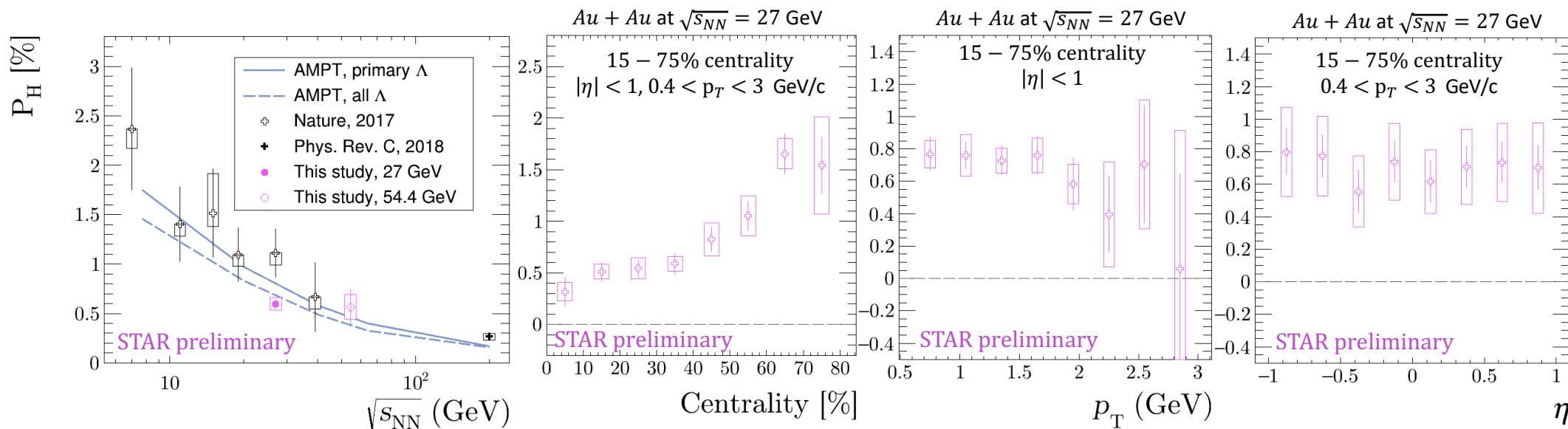
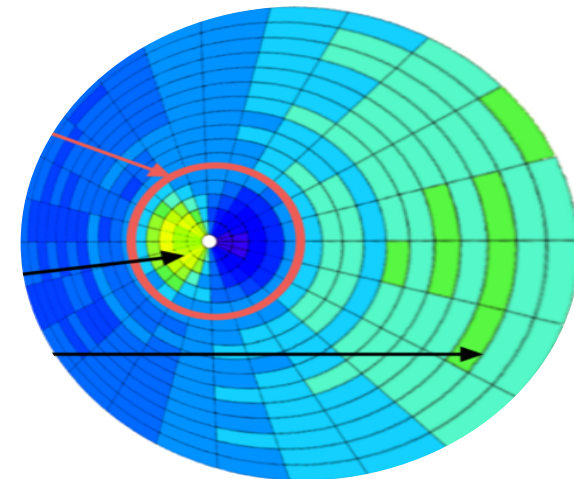
- ✓ Polarization measurements

J. Adams (QM-19)

➤ Using the new installed EPD at 27 GeV:

- ✓ P_H increasing with centrality (consistence with prior measurements at 200 GeV)
- ✓ P_H shows no p_T dependence
- ✓ P_H shows no η dependence

➤ These new studies agree with prior beam energy measurements trend



No significant p_T dependence, as expected from the initial angular momentum

➤ Physics Highlights from Bulk-Correlation

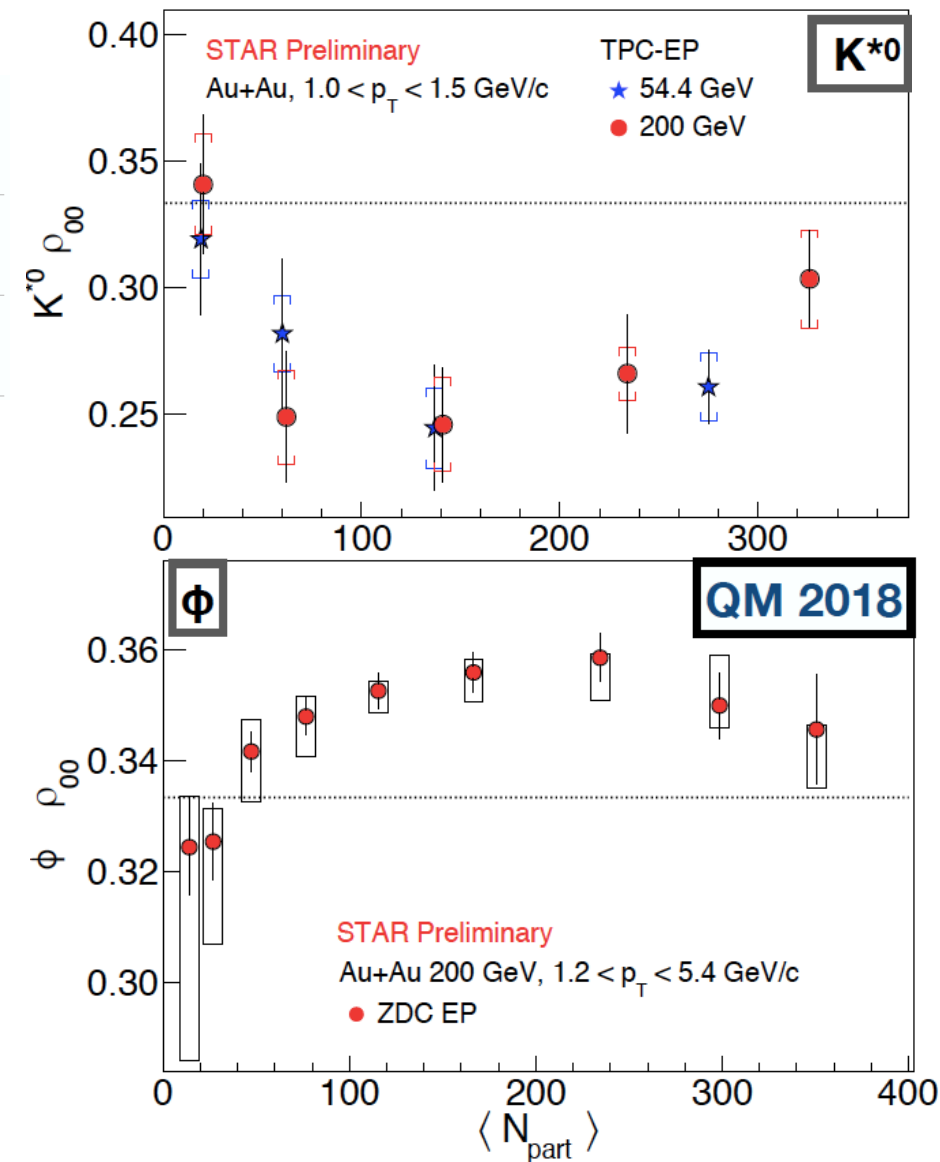
- ✓ Global spin alignment

S. Singha (QM-19)

Species	Quark content	J^P	For midcentral collisions	
			ρ_{00}/P_H at top-RHIC	ρ_{00}/P_H at LHC
K^{*0}	$d\bar{s}$	1^-	$\rho_{00} < 1/3$ ($\sim 4\sigma$)	$\rho_{00} < 1/3$ ($\sim 3\sigma$)
ϕ	$s\bar{s}$	1^-	$\rho_{00} > 1/3$ ($\sim 3\sigma$)	$\rho_{00} < 1/3$ ($\sim 2\sigma$)

- For midcentral collisions, $\rho_{00}(K^{*0}) < 1/3$, while $\rho_{00}(\phi) > 1/3$

- Need quantitative estimation from models to better understand the data

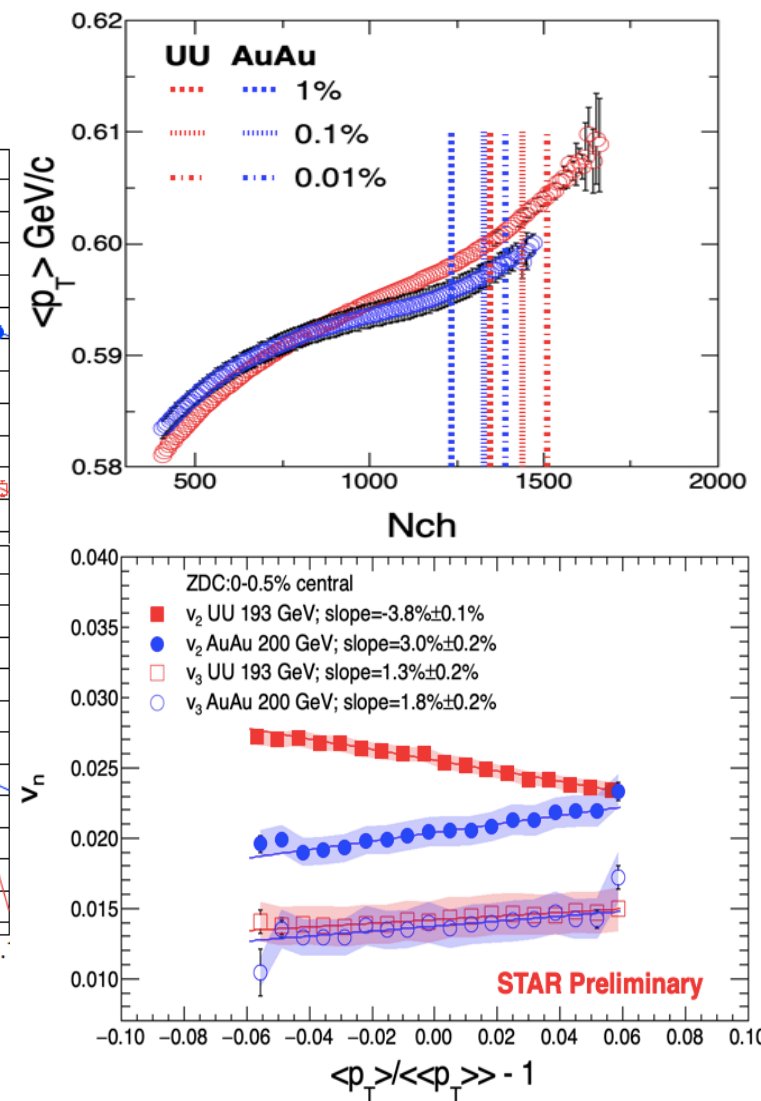
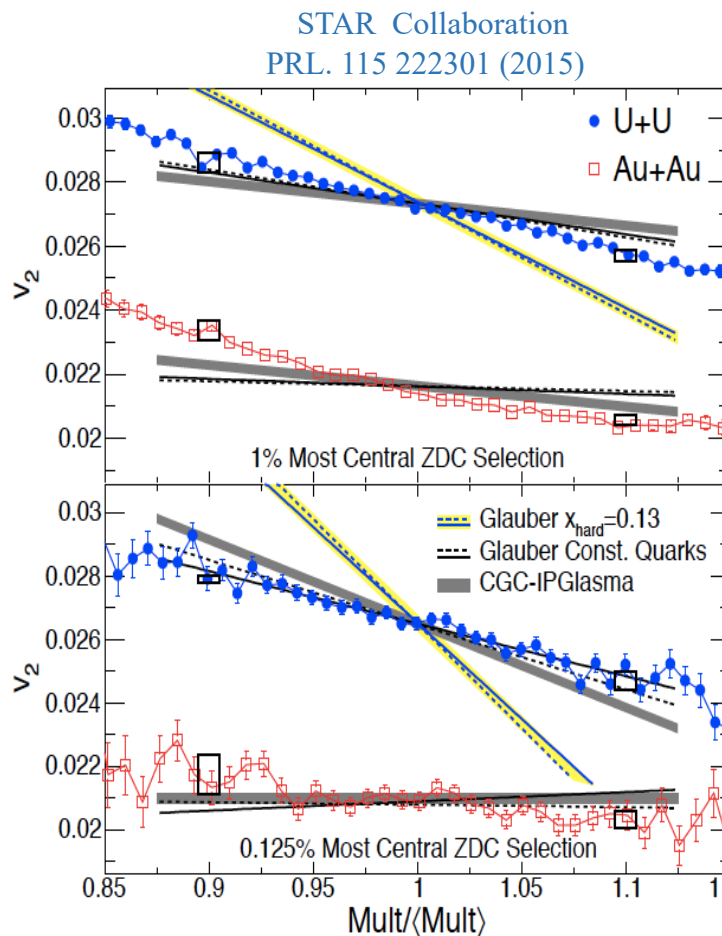


➤ Physics Highlights from Bulk-Correlation

- ✓ Nuclear Deformation measurements

Shengli Huang (WWND-20)

- Many atomic nuclei are not spherical in their ground states but present a quadrupole deformation.
- Can we use the nucleus-nucleus collision experiments at relativistic energies as a probe of nuclear structure?
- Prior measurements was able to spot the anti-correlation between v_2 and scaled multiplicity as a first indication of the U+U deformation from heavy ion collisions
- Recent study of the anti-correlation between v_2 and scaled p_T shows that the scaled p_T is more sensitive variable to the nuclear deformation impact on the system

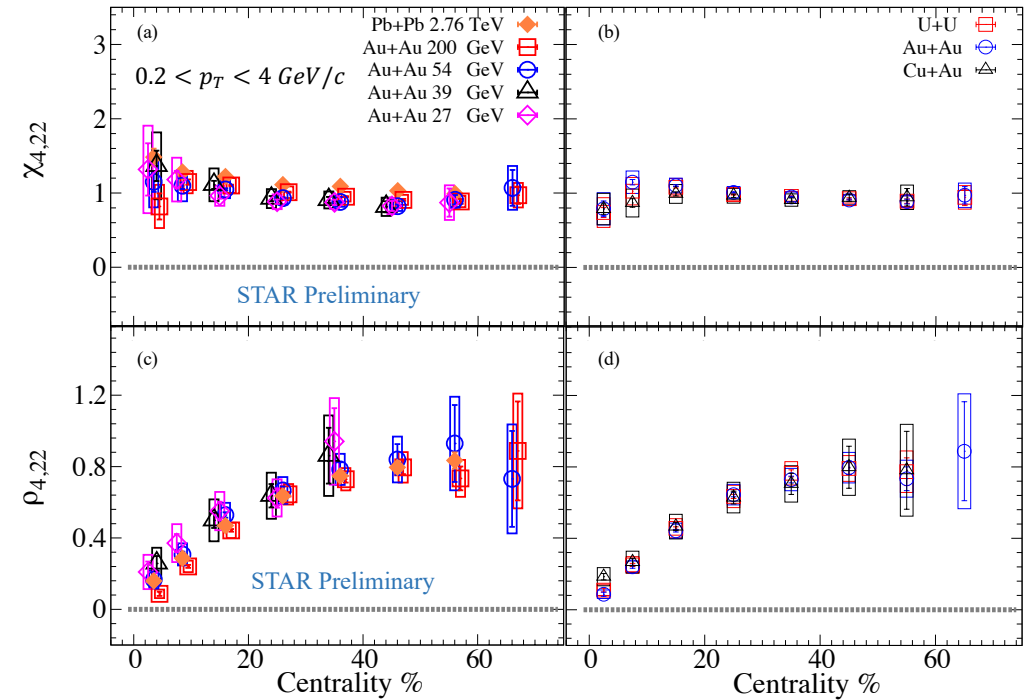
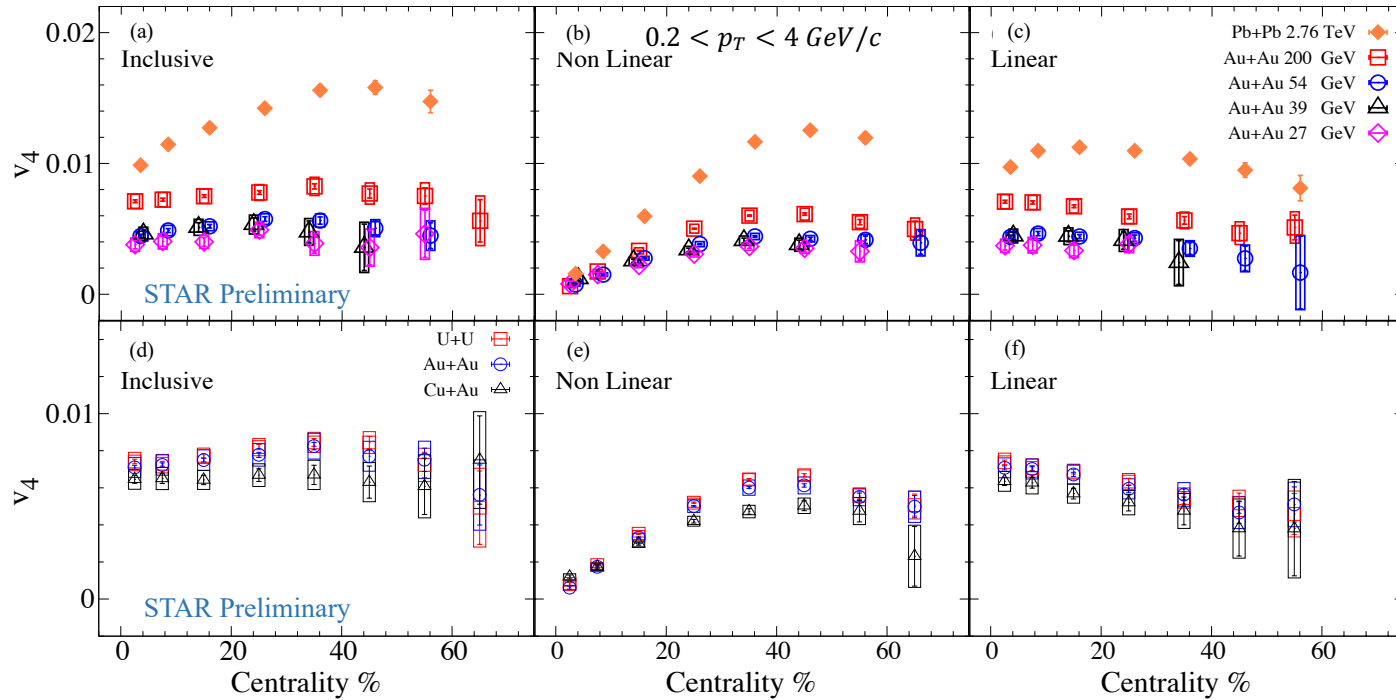


➤ Physics Highlights from Bulk-Correlation

- ✓ Flow-correlations and fluctuations measurements

Niseem Magdy (QM-19)

- Measurements which cover large beam energy (T , μ_B) range can shed light on the η/s dependence on T and μ_B since the initial-state effects vary weakly with beam energy.



- The linear terms dominates the central collisions
- The inclusive, linear and mode-coupled v_4 shows a BES dependence

- The dimensionless quantities, χ_{422} and ρ_{422} are beam energy and system size independent

The integrated measurements, which are compared LHC measurements, will add important constraints on initial- and final-state effects

➤ Physics Highlights from Bulk-Correlation

- ✓ Small systems measurements

Roy A. Lacey (QM-19)

- The well-known techniques of leveraging the two-particle p+p correlator to mitigate non-flow, are employed three methods!

- ✓ 1. via c_0 : $c_{n,sub}^{sys.} = c_n^{sys.} - (c_0^{pp}/c_0^{sys.}) \times c_n^{pp}$; $n=2,3$
 - ✓ 2. via c_1 : $c_{n,sub}^{sys.} = c_n^{sys.} - (c_1^{sys.}/c_1^{pp}) \times c_n^{pp}$; $n=2,3$
- $$v_{n,sub}^{sys.} = \sqrt{c_{n,sub}^{sys.}}$$

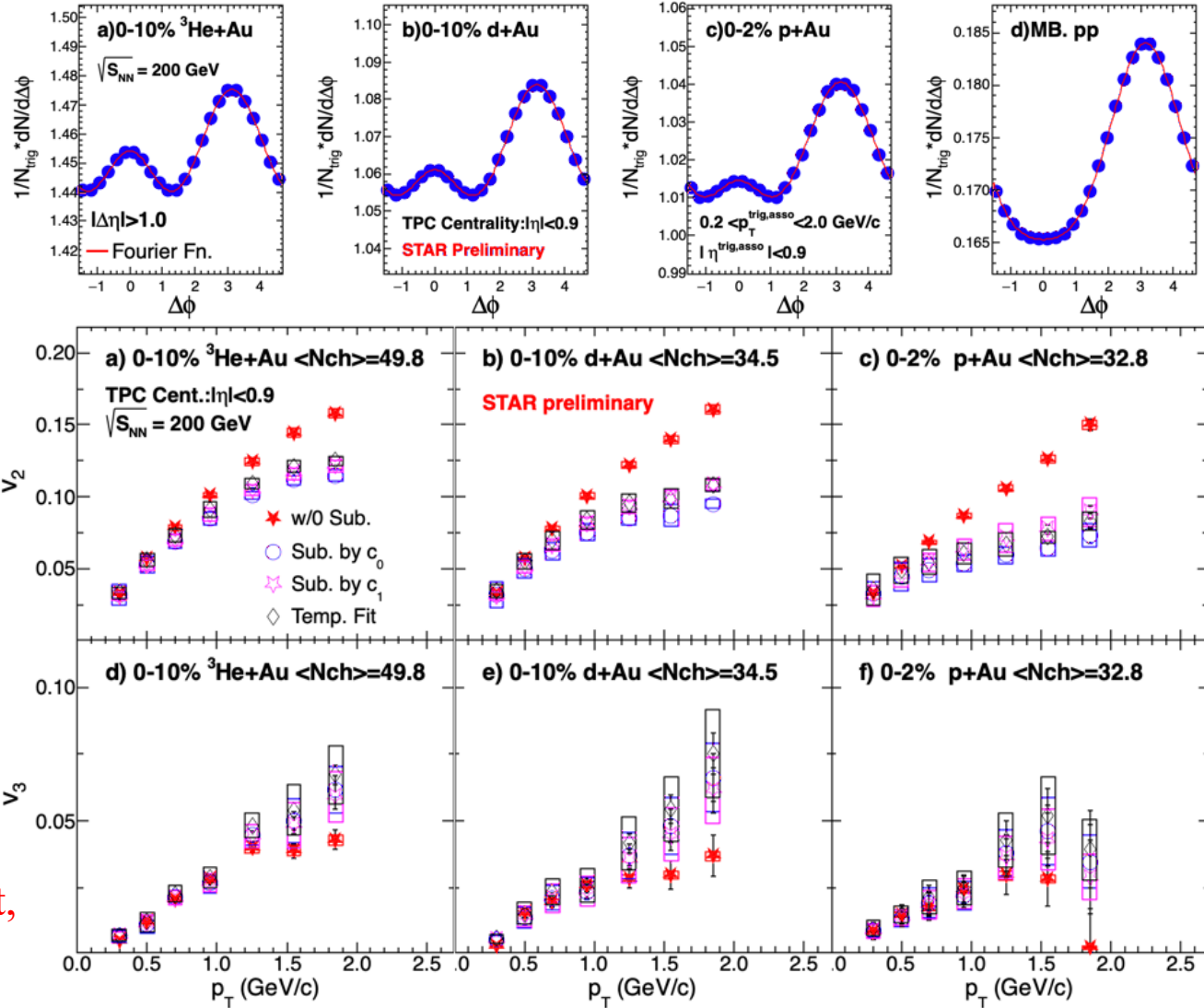
- Characteristic ridge apparent for p/d/3He+Au; little, if any, for min. bias p+p

- ✓ Requires non-flow mitigation to obtain robust v_n values

- The $v_{2,3}$ results are method-independent within uncertainties

- For similar multiplicity

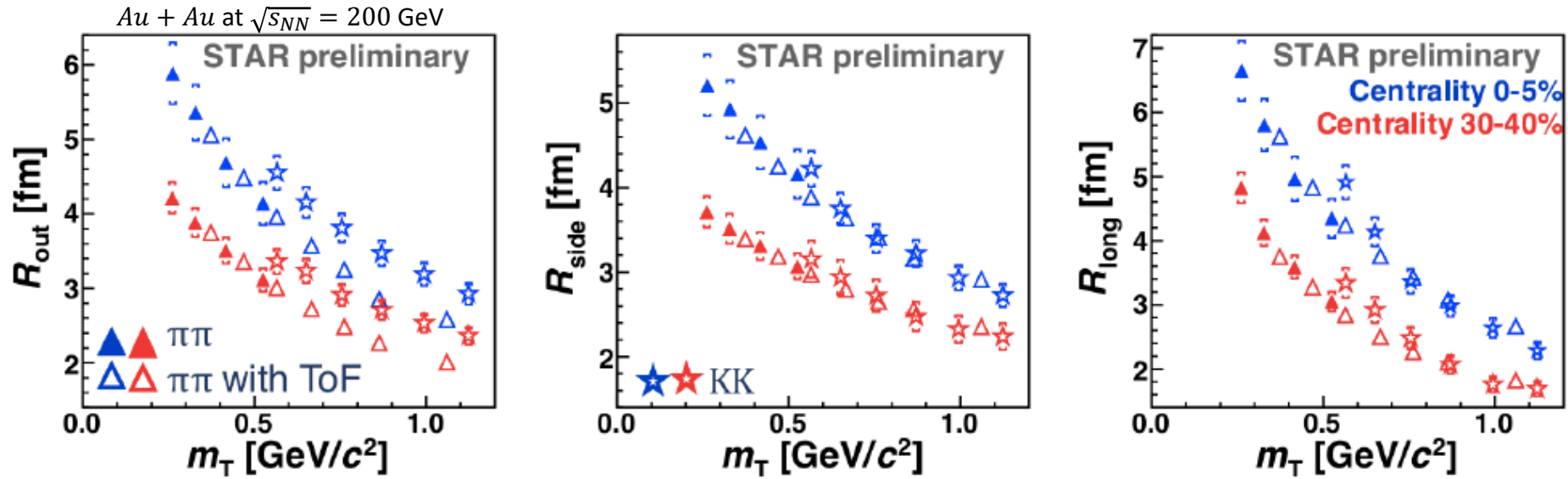
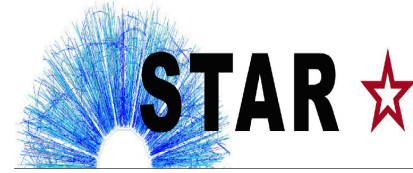
- ✓ Both v_2 and v_3 are observed to be system independent, consistent with the important role of both “size” (N_{ch}) and the fluctuations-driven eccentricity (ϵ_n)



➤ Physics Highlights from Bulk-Correlation

- ✓ Hanbury Brown-Twiss measurements

G. Nigmatkulov (WPCF-19)



- Using the ToF PID the HBT measurements extended to large m_T
- At large m_T :
 - ✓ R_{out} shows larger values for KK than $\pi\pi$
 - ✓ R_{side} and R_{long} show good agreement between KK and $\pi\pi$
- KK and $\pi\pi$ has different emission duration?

Summary:



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