Measurement of non-flow influence on the CMW-sensitive slope parameter from STAR

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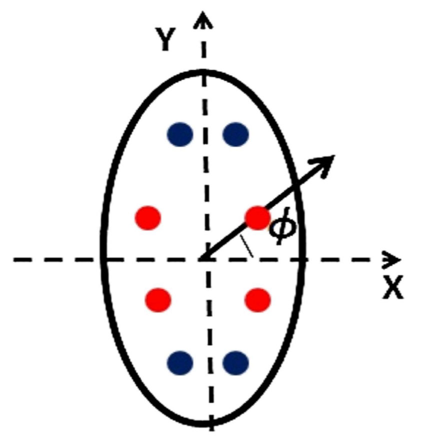
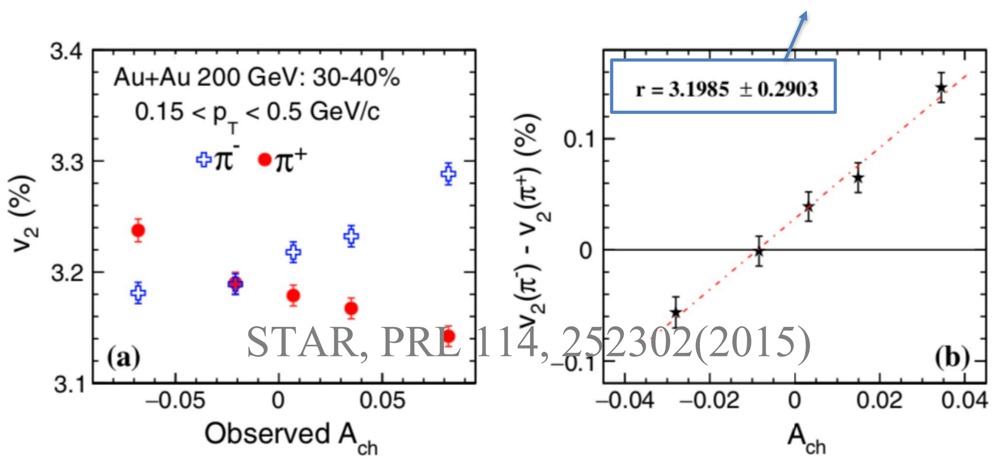
Chiral Magnetic Wave (CMW):

Y. Burnier, et al, PRL 107, 052302(2011)

CMW-sensitive slope parameter





STAR, PRL 114, 252302(2015)

CMW-induced electric quadrupole deformation ⇒ A_{ch} dependence of π elliptic flow

$$A_{ch} = \frac{N_+ - N_-}{N_+ + N_-}$$

- The CMW is a gapless collective excitation of the QGP stemming from the interplay of the chiral magnetic and chiral separation effect.
- The CMW could introduce an electric quadrupole moment, giving opposite contributions to the elliptic flow of π^+ and π^-.
- The contribution of CMW to π triangle flow difference is expected to be zero.

Trivial linear A_{ch} term from non-flow correlations

- The two–particle Q-cumulant method : $Q_n = \sum_{j=1}^{M} e^{in\phi_j}$, $q_n = \sum_{j=1}^{m} e^{in\phi_j}$, $d_n\{2\} = \langle q_n Q_n^*/mM\rangle$ where m, M are the multiplicity of particle of interest (POI) and references (REF) particles, and $v_n^{\pi}\{2;h\} = d_n\{2;\pi h\}/\sqrt{c_n\{2\}}$
- With all charged hadrons as references, $d_n\{2\}$ can be written in a given A_{ch} as

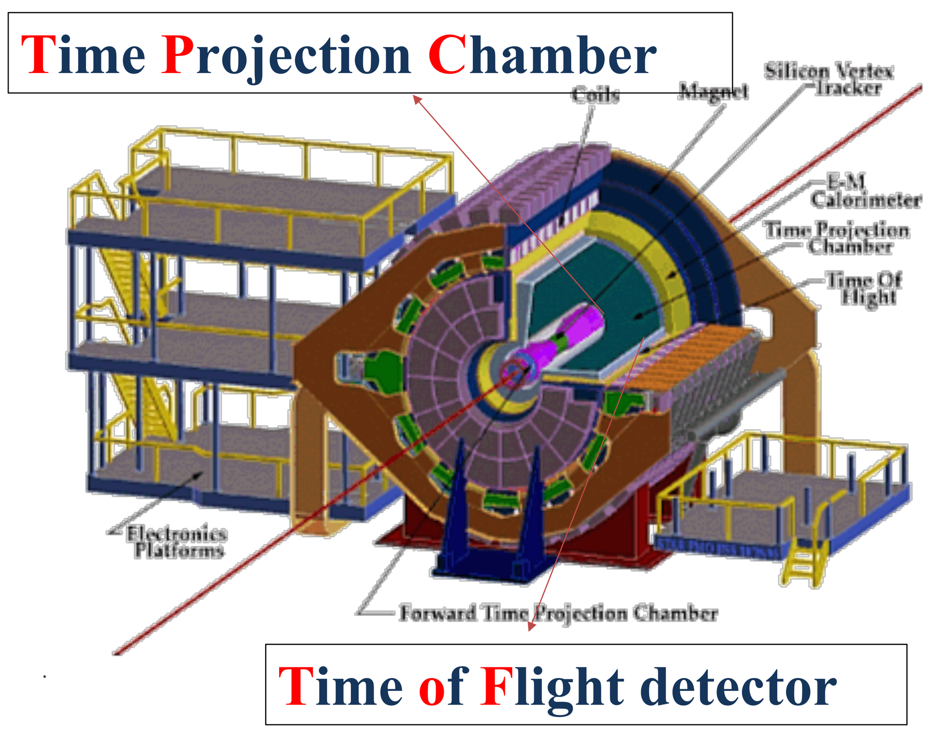
$$d_n\{2;\pi^{\pm}h\} = \frac{\sum q_n^{\pi^{\pm}}(Q_{n+}+Q_{n-})}{\sum mM} = \frac{1+A_{ch}}{2}\frac{\sum q_n^{\pi^{\pm}}Q_{n+}}{\sum mN_+} + \frac{1-A_{ch}}{2}\frac{\sum q_n^{\pi^{\pm}}Q_{n-}}{\sum mN_-}$$

$$\equiv \frac{d_n\{2;\pi^{\pm}h^+\} + d_n\{2;\pi^{\pm}h^-\}}{2} + \frac{d_n\{2;\pi^{\pm}h^+\} - d_n\{2;\pi^{\pm}h^-\}}{2}A_{ch}.$$

- An automatic (trivial) linear- A_{ch} term arises, and is non-zero because the **non-flow differs between like-sign and unlike-sign pairs.**
- **Remove the trivial linear-A_{ch} term:** Use positive (h^+) and negative particles (h^-) as REF separately, and then take the average $v_n^{\pi} = (v_n^{\pi}\{2;h^+\} + v_n^{\pi}\{2;h^-\})/2$.

H. Xu, J. Zhao, Y. Feng, F. Wang, "Complications in the interpretation of the charge asymmetry dependent π flow for the chiral magnetic wave ", arXiv:1910.02896

The STAR experiment:

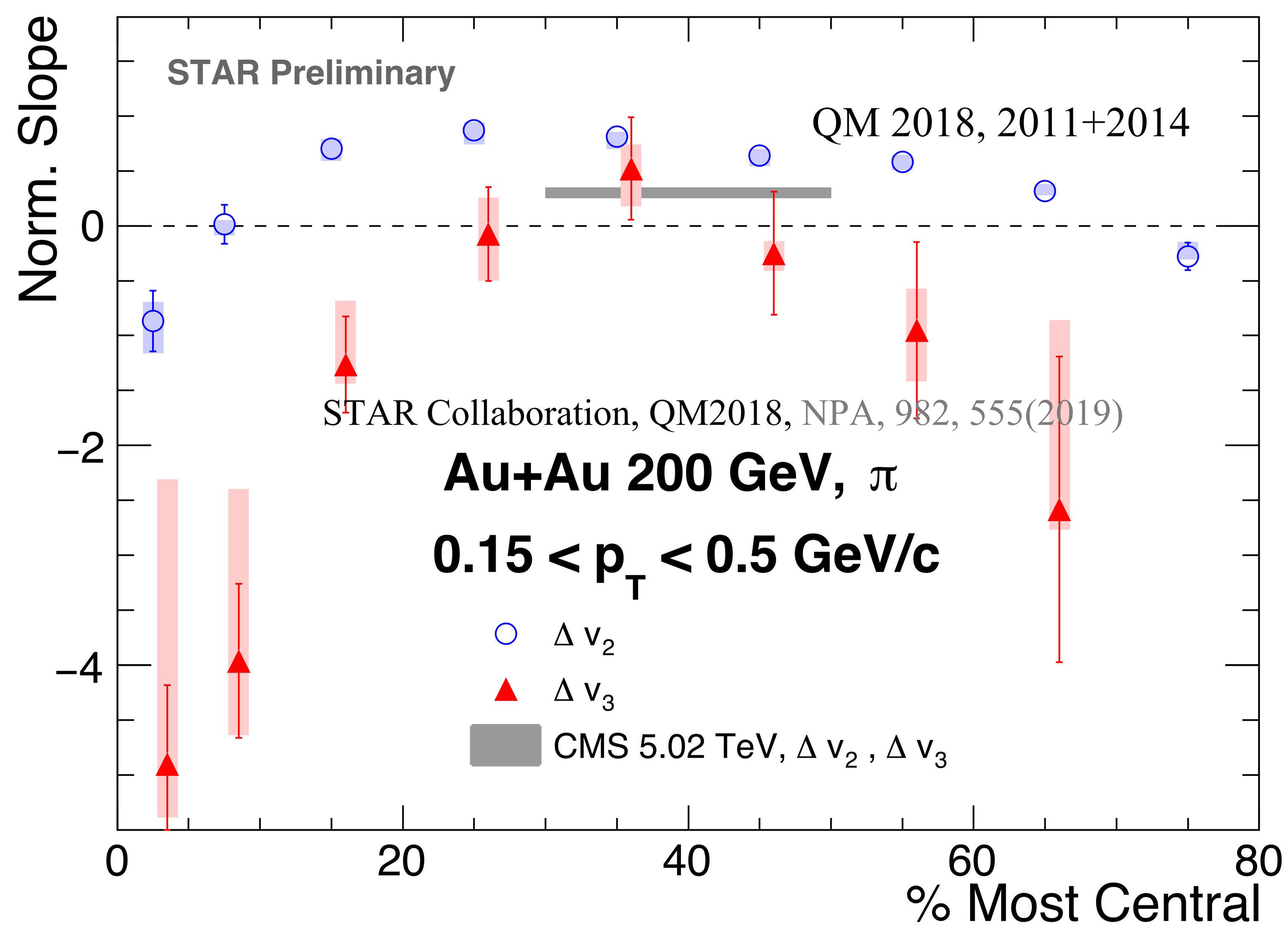


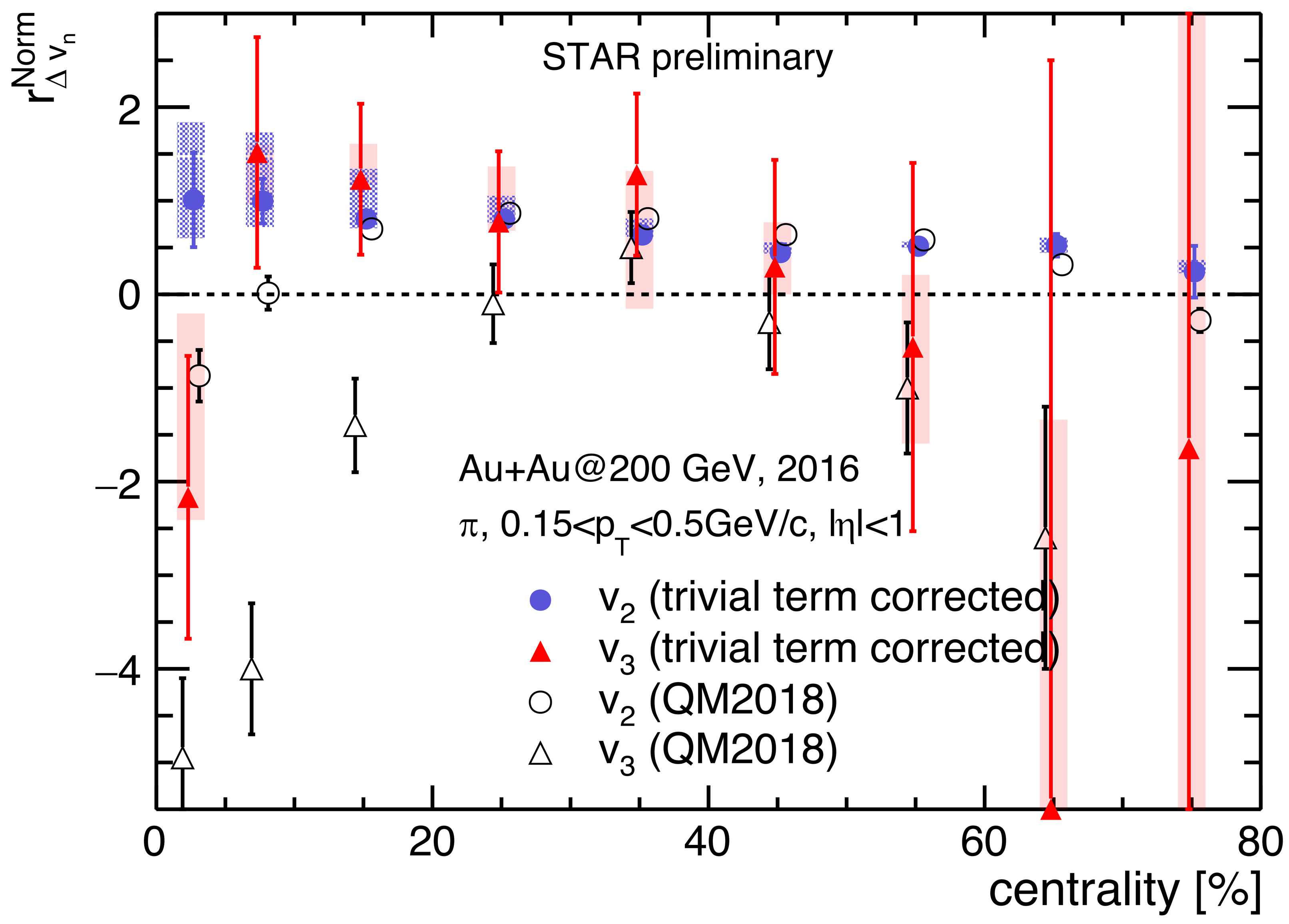
- **Dataset:** Au+Au@$\sqrt{s_{NN}}$ = 200GeV, 2016
- **POI**: TPC and TOF $\pi^{\pm}$ with $0.15 < p_T < 0.5$ GeV/c and $0.3 < |\eta| < 1$
- **REF**: Positive and negative charged hadrons with $p_T > 0.15$ GeV/c and $0.3 < |\eta| < 1$
- Sub-event flow method, $\Delta\eta = 0.6$
- **Systematic studies**: dca cuts, nHitsFit cuts, pion identifications.

Results:

The normalized slope parameter: $r_{\Delta v_n}^{Norm}$ extracted from $\text{Norm.}\Delta v_n(A_{ch}) = 2(v_n^{\pi^-} - v_n^{\pi^+})/(v_n^{\pi^-} + v_n^{\pi^+})$.

- All charge hadrons as REF (previous results): Positive Norm. $\Delta v_2^{\pi}(A_{ch})$ slope, negative Norm. $\Delta v_3^{\pi}(A_{ch})$ slope (central and peripheral). **Trivial contributions to the previous $v_n(A_{ch})$ measurements.**
- **Single-sign charges as REF (new results, trivial term removed):** For 20-60% centrality, **the $r_{\Delta v_2}^{Norm}$ and $r_{\Delta v_3}^{Norm}$ slopes are consistent** with each other within **0.2 σ**, dominated by the $r_{\Delta v_3}^{Norm}$ error. The **$r_{\Delta v_3}^{Norm}$ is 1.5 σ above zero.**





Data points are shifted horizontally for clarity

Summary:

- The CMW flow measurement automatically introduces a trivial linear-A_{ch} term if: (a) there exists non-flow difference between like-sign and unlike-sign pairs; (b) all charged hadrons are used as reference particles.
- After removing the trivial non-flow contribution by using single-sign charges as references, the $r_{\Delta v_2}^{Norm}$ and $r_{\Delta v_3}^{Norm}$ slopes are consistent with each other within 0.2 σ for 20-60% centrality, dominated by the $r_{\Delta v_3}^{Norm}$ error. The $r_{\Delta v_3}^{Norm}$ is 1.5 σ above zero.
- Our results suggest background contributions to the measured CMW-sensitive slope parameter.

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The STAR Collaboration: http://drupal.star.bnl.gov/STAR/presentations

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