Measurements of Two-Particle Correlations with respect to Higher-Order Event-Planes in $\sqrt{s_{NN}}$ = 200 GeV Au+Au Collisions at RHIC-PHENIX

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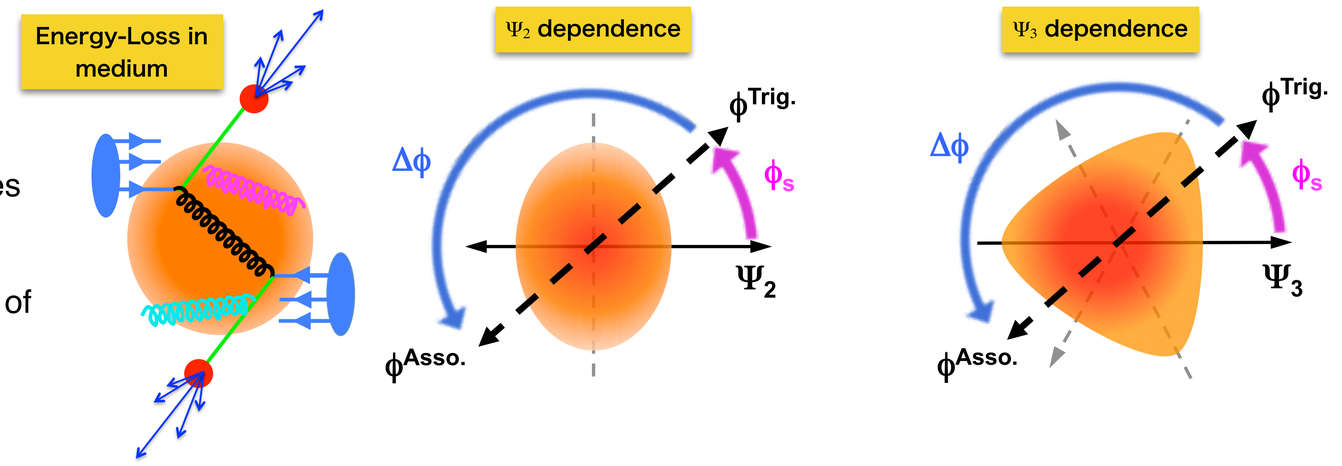
Motivation

Two-particle correlations are considered to be sensitive to the interaction of hard-scattered partons with the hot and dense medium. Monotonic suppression of high-p_T correlation yield with increase of parton path length inside the medium is observed by selecting trigger particles with respect to the second-order event-planes using its ellipticity [1].
The next interest is the destination of the deposited energy from the high-p_T partons. The key to catch the deposited energy is p_T scanning measurement of the event-plane dependent correlations down to low-p_T with a background subtraction of higher-order flow harmonics v_n [2]. Third-order event-plane (triangular) dependent correlations are also of interest to search for possible different parton behavior from that in second-order geometry.



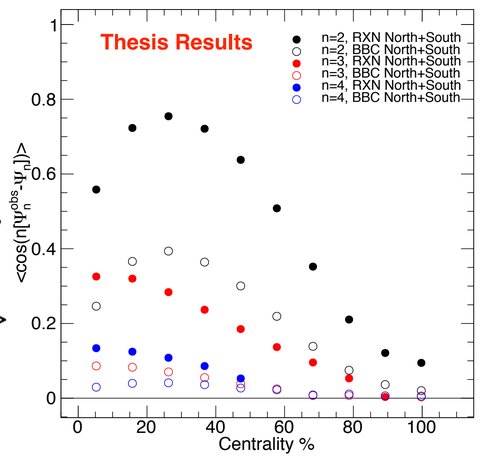
Event Planes & Flow Harmonics v_n

★ Event-Planes determined by Reaction Plane Detector (RXN) & Beam Beam Counter (BBC)

✔ Pseudorapidity range of EP detectors

RXN : 1.0 < |η| < 2.8
BBC : 3.0 < |η| < 3.9

$$\Psi_n^{obs} = \frac{1}{n}\tan^{-1}\left(\frac{\sum_i w_i \sin(n\phi_i)}{\sum_i w_i \cos(n\phi_i)}\right), \quad Res\{\Psi_n\} = < \cos n(\Psi_n^{obs} - \Psi_n^{true}) >$$

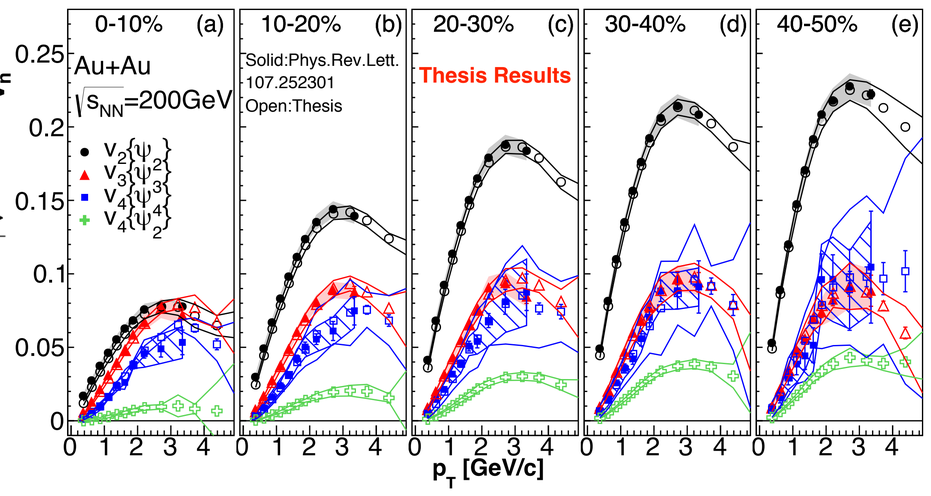


★ Charged hadron v_n at |η|<0.35 measured by EP Method

✔ Used for background subtraction in correlation analysis

$$\frac{dN}{d\phi} \propto 1 + \sum 2v_n \cos n(\phi - \Psi_n), \quad v_n\{\Psi_n\} = \frac{< \cos n(\phi - \Psi_n^{obs}) >}{Res\{\Psi_n\}}$$

✔ Systematics
RXN segment selections
RXN-BBC difference



Correlations & Flow Backgrounds

★ Correlation functions

✔ Charged Hadron Pairs

$$C(\Delta\phi) = \frac{d^2N^{ta}_{real}/d\Delta\phi}{d^2N^{ta}_{mix}/d\Delta\phi}\frac{N^{ta}_{mix}}{N^{ta}_{real}}, \quad \Delta\phi = \phi^a - \phi^t$$

$$\phi^{trig} - \Psi_n : [-\pi/n, \pi/n]$$

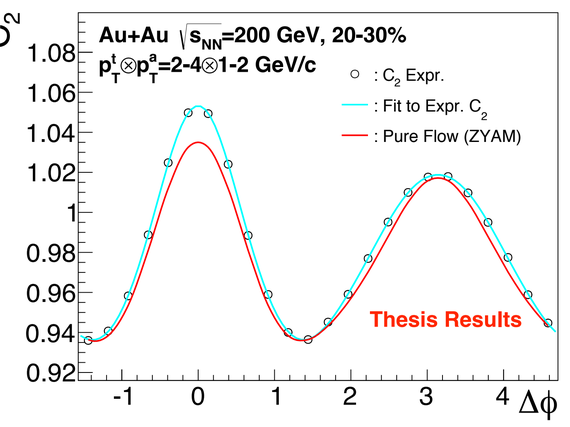
✔ Trigger range divided into 8 bins in EP dependent correlations.
✔ RXN is used for trigger categorization

★ Flow subtraction by ZYAM

$$j(\Delta\phi) = C(\Delta\phi) - b_0 F(\Delta\phi)$$

✔ Inclusive Trigger Case

$$F(\Delta\phi) = 1 + \sum 2v_n^t v_n^a \cos(n\Delta\phi)$$

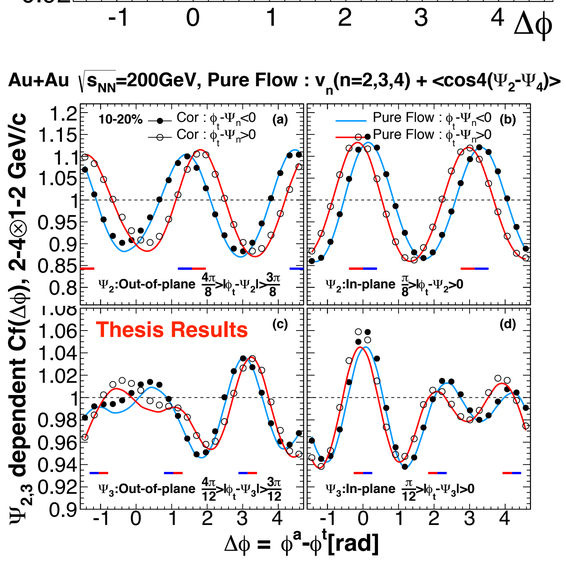


✔ Event-Plane Dependent Case

✳Monte Carlo simulation employed
✳Azimuthal distribution generated using
- Measured v_n (n=2,3,4)
- Correlations between EPs

$$< \cos 4(\Psi_2 - \Psi_4) >= v_4\{\Psi_2\}/v_4\{\Psi_4\}$$
$$< \cos 4(\Psi_2 - \Psi_3) >= 0$$

✳ Calculate pure flow correlations



★ Per Trigger Yield (PTY)

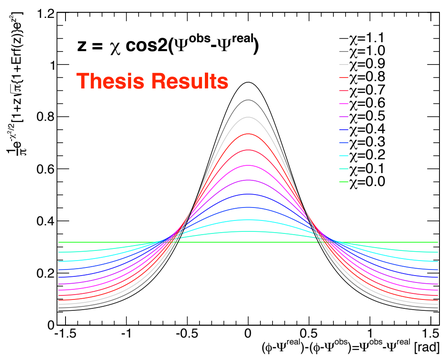
$$\frac{1}{N^t}\frac{dN^{ta}}{d\Delta\phi} = \frac{1}{2\pi\varepsilon}\frac{N^{ta}}{N^t} j(\Delta\phi)$$

★ Unfolding of EP resolution for PTY

✔ Degree of smearing by neighboring trigger bins in PTY "**S**" can be estimated by relative distribution between true and observed EP using an analytical formula [3]

✔ Solve simultaneous equations among resolution corrected/uncorrected (observed) PTY "**Y**"

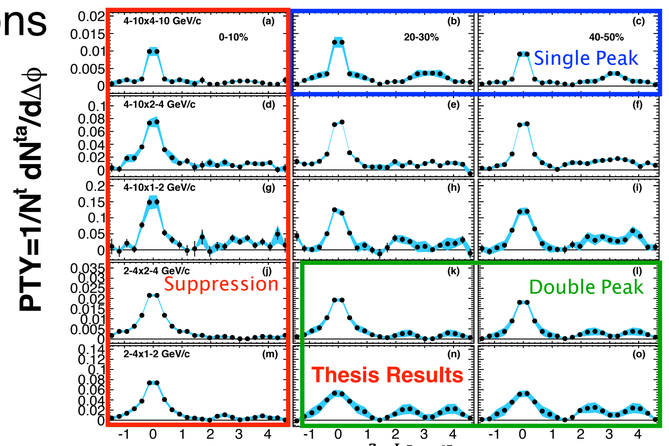
$$\mathbf{Y^{uncor}} = \mathbf{S}\mathbf{Y^{cor}} \quad \Updownarrow \quad \mathbf{Y^{cor}} = \mathbf{S^{-1}}\mathbf{Y^{uncor}}$$



Results

★ Inclusive Trigger Correlations

✔ Away-Side suppression in most-central collisions even at low-p_T correlations
✔ Away-Side single peak of high-p_T correlations in mid-central collisions
✔ Away-Side double humps in mid-central collisions even after v_n subtractions



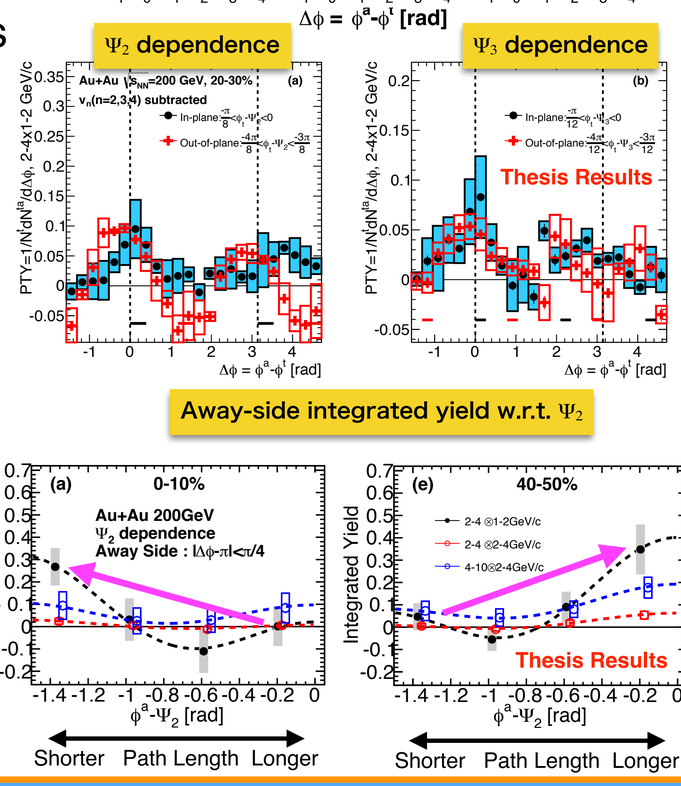
★ EP Dependent Correlations

✔ In-Plane/Out-of-Plane dependence is **not** observed in Ψ_3 dependent correlation

✔ In-Plane/Out-of-Plane dependence is observed in Ψ_2 dependent correlations

✔ Away-Side Yield of Out-of-Plane Ψ_2 dependent correlations (Longer Path Length) has larger value than that of In-Plane correlations (Shorter Path Length) for p_T : 2-4x1-2 GeV/*c* but not for other high-p_T pair selections

✔ Re-distribution of deposited energy from high p_T partons to the medium is one of hypotheses



Conclusion

✔ Two-particle correlations are measured with v_n background subtractions with respect to second and third-order event-planes in Au+Au $\sqrt{s_{NN}}$ = 200 GeV collisions
✔ In-Plane/Out-of-Plane dependence is observed in Ψ_2 dependent correlations, but not for Ψ_3 dependent correlations
✔ Enhancement of Away-Side Yield of most-central Ψ_2 dependent correlations in Out-of-Plane larger than in In-Plane can be taken as possible re-distribution of deposited energy from high p_T partons to the hot and dense medium

References

[1] A. Adare *et. al.* (PHENIX Collaboration), PRC 84, 024904 (2011)
[2] A. Adare *et. al.* (PHENIX Collaboration), PRL 107, 252301 (2011)
[3] J. Y. Ollitrault PRD 48, 1132 (1993)