Investigating the ridge structure in Δη-Δφ correlations at STAR

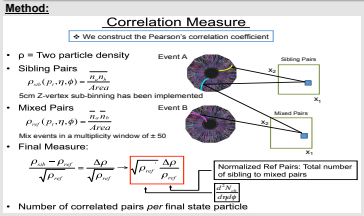
L. Chanaka De Silva, *for the STAR Collaboration* (University of Houston)

Abstract

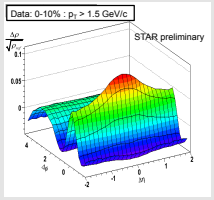
Studies of 2-dimensional (Δη, Δφ) di-hadron correlations associated with selected high p_T trigger particles in 200 GeV Au+Au collisions recorded by STAR have revealed a novel "ridge-like" structure [1]. Similar structure was also observed in inclusive di-hadron correlations of all particle pairs (no p_T condition) [2]. In this work we study the evolution of angular correlations with systematic increase of a lower p_T cut on charged hadrons used in the analysis. The measured correlations evolve smoothly with $p_T^{low\ cut}$ toward the shape reported in the high p_T trigger measurements appearing by approximately at $\langle p_T \rangle$ = 2.7 GeV/c. We further quantify the correlation structure evolution by fitting a 2D model function. The model function includes harmonic components v_n (n=1,2,3,4,5), some of which may relate to possible initial-state fluctuation contributions. A "remainder," assumed in that context to represent jet-related information in certain peak structure, is modeled via an asymmetric 2D Gaussian. Extracted harmonic parameters are compared to model predictions [3,4], and the remainder peak is compared to p+p data trends at 200 GeV. This analysis describes 0-10% central Au+Au collisions at 200 GeV.

[1] B. I. Abelev et al. (STAR Collaboration), Phys. Rev. C 80, 064912 (2009) [2] G. Agakishiev et al. (STAR Collaboration), arXiv:1109.4380 [3] B. Alver et al., Phys. Rev. C 81, 054905 (2010)
[4] C. Gombeaud et al., Phys. Rev. C 81, 014901 (2010)

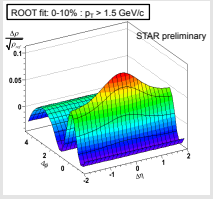
Method:



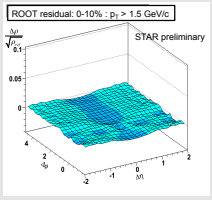
Data:



Fit:

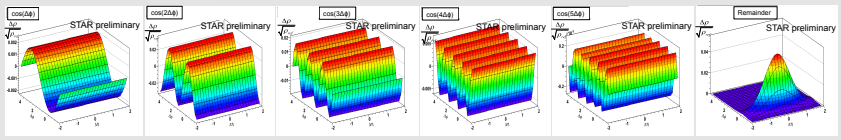


Res:

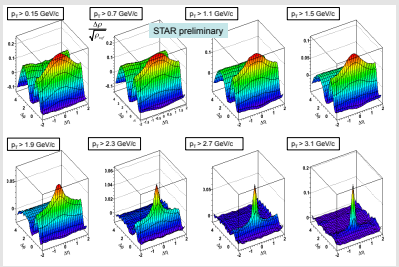


Decomposition:

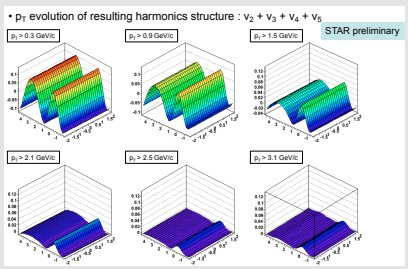
$f_1 \propto c_0$	offset	
$f_2 \propto c_1 * \cos(\Delta\Phi)$	$\cos(\Delta\Phi)$	Away side p_T conservation
$f_3 \propto c_2 * \cos(2\Delta\Phi)$	$\cos(2\Delta\Phi)$	2nd order Fourier term
$f_4 \propto c_3 * \cos(3\Delta\Phi)$	$\cos(3\Delta\Phi)$	3rd order Fourier term
$f_5 \propto c_4 * \cos(4\Delta\Phi)$	$\cos(4\Delta\Phi)$	4th order Fourier term
$f_6 \propto c_5 * \cos(5\Delta\Phi)$	$\cos(5\Delta\Phi)$	5th order Fourier term
$f_7 \propto c_6 * \exp(-0.5*((\Delta\eta/c_7)^2 + (\Delta\Phi/c_8)^2))$	2D asymmetric Gaussian	Asymmetric 2d Gaussian

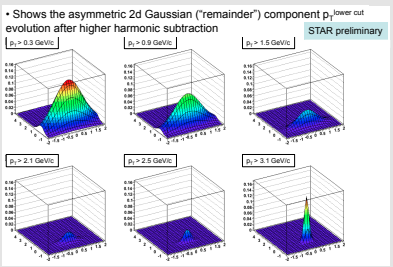


Momentum evolution : Data



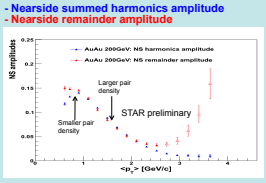
Momentum evolution: Fit decomposition





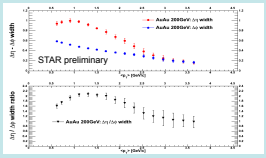
Model parameter evolution

- Nearside summed harmonics amplitude
- Nearside remainder amplitude



✓ Remainder and harmonics amplitudes are comparable at 0.9 < p_T < 2.1 GeV/c

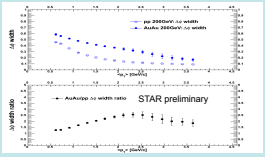
- Nearside remainder Δη-Δφ widths



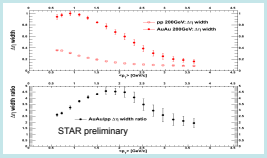
✓ Remainder widths become symmetric ~ 2.5 GeV/c
✓ Δη width peaks around 0.9 GeV/c
✓ Δη/Δφ widths ratio is ~ 2:1 around 1.3 GeV/c

Model parameter evolution : Comparison to p+p 200 GeV

- Open symbols : p+p 200 GeV
- Closed symbols : Au+Au 200 GeV



✓ Maximum Δφ width ratio peaks around 2.3 GeV/c
✓ Maximum Δφ width modification is a factor of 2.5 compared to p+p
✓ At the highest $\langle p_T \rangle$ Δφ width is modified by a factor of 2 compared to p+p

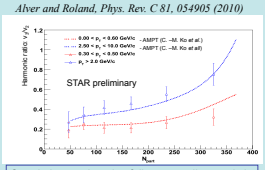


✓ Maximum Δη width peaks around 1.7 GeV/c
✓ Maximum Δη width modification is a factor of 4.5 compared to p+p
✓ At the highest $\langle p_T \rangle$ Δη width is modified by a factor of 2 compared to p+p

Model parameter evolution : Higher order harmonic scaling

- Related data compared to the AMPT Monte Carlo

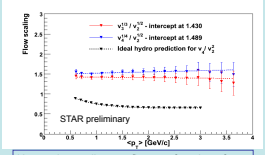
Alver and Roland, Phys. Rev. C 81, 054905 (2010)



Certain harmonic ratios follow centrality trends in agreement with the AMPT Monte Carlo

- Compare to a theory prediction by Gombeaud and Ollitrault

Phys. Rev. C 81, 014901(2010)



Harmonics scaling are flat as a function of p_T consistent with hydro predictions

Summary and conclusions

- Near-side correlations of charged hadron pairs on Δη-Δφ show a smooth evolution as a function of $\langle p_T \rangle$. The data are fitted with a 2D model that represents the near-side peak structure with a combination of five Fourier harmonics and an asymmetric 2D Gaussian.

- The analysis includes higher-order harmonics which could theoretically be related to effects from initial-state density fluctuations, and the 2D Gaussian may represent a modified jet-related peak.

- The extracted harmonic amplitudes are found to reproduce scaling trends predicted by hydrodynamics both as a function of centrality and $\langle p_T \rangle$.

- The parameters of the 2D Gaussian are compared with p+p data at the same collision energy. Observed differences may represent medium-induced jet modification.

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

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