Beam Energy Dependence of v_n at mid and forward rapidity

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Outline

Correlation function technique

- Two particle azimuthal correlation function $C(\Delta\phi, \Delta\eta)$ can be given as,

$$C(\Delta\phi, \Delta\eta) = \frac{(dN/d\Delta\phi)_{Same}}{(dN/d\Delta\phi)_{Mix}} \tag{1}$$

- $(dN/d\Delta\phi)_{Same}$, the azimuthal pair distributions of two particle from same event.
- $(dN/d\Delta\phi)_{Mix}$, the azimuthal pair distributions of two particle from different events in the same class.
- Event Mixing Technique is to construct the pair distributions from uncorrelated events to remove the physics and retain the residual detector single particle relative efficiencies in two particle distributions.

Event Mixing Classes

- Event-mixing distributions are separated into classes to ensure same characteristics of tracks from different events.
- We divide the mixed events into 20 Z_{vertex} bins and 10 centralities, then we store the latest 10 events from each class to correlate them tracks.
- Two particle Fourier coefficient v_n are obtained from the correlation function as,

$$v_n^2 = \frac{\sum_{\Delta\phi} C(\Delta\phi, \Delta\eta)\ cos(n\Delta\phi)}{\sum_{\Delta\phi}\ C(\Delta\phi, \Delta\eta)}, \tag{2}$$

where $C(\Delta\phi, \Delta\eta) = \frac{(dN/d\Delta\phi)_{Same}}{(dN/d\Delta\phi)_{Mix}}$.

Results

- Results

Correlation function

- All techniques used to extract v_n are related to the correlation function.
- The correlation function carry flow/non-flow signals as well as some residual detector effects(track merging/splitting).
- The non-flow signals and some residual detector effects are reduced by using $|\Delta\eta|$ cut.

TPC–TPC correlation function

p_T integrated correlation functions obtained for all centralities and beam energies for $0.0 < |\eta| < 0.9$, $|\Delta\eta| > 0.7$ and $0.2 < p_T < 4\ GeV/c$.

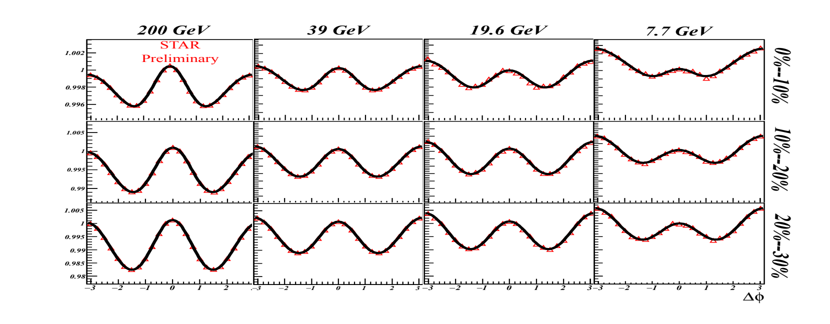

Figure : Good and robust correlation functions obtained, they will be used in Fourier analyses to obtain v_n. The black line represent a fit function "$C_n = 1 + \sum_n 2\ a_n\ cos(n\ \Delta\phi)$".

TPC–FTPC correlation function

p_T integrated correlation functions obtained for all centralities and beam energies for $0.0 < |\eta_1| < 0.9$, $2.8 < |\eta_2| < 3.8$ and $0.2 < p_T < 4$ GeV/c.

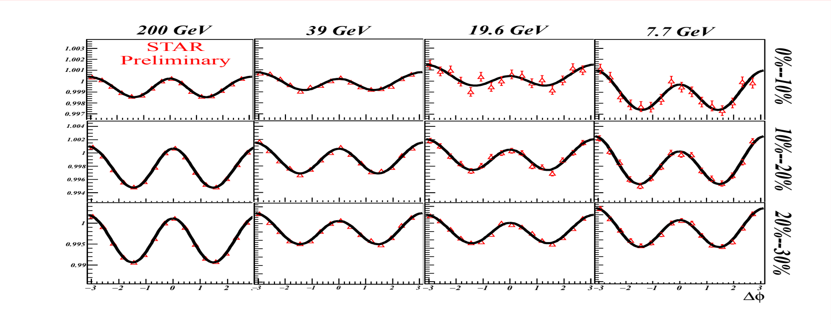

Figure : Good and robust correlation functions obtained, they will be used in Fourier analyses to obtain v_n. The black line represent a fit function "$C_n = 1 + \sum_n 2\ a_n\ cos(n\ \Delta\phi)$".

Results

- $v_n = \dfrac{v_n^2(\eta_1, \eta_2)}{\sqrt{v_n^2(\eta_1, \eta_1)}}$
- TPC/FTPC $v_n(\eta)$

TPC/FTPC $v_2(\eta)$

p_T integrated $v_2(\eta)$ obtained for all centralities, all beam energies and $0.2 < p_T < 4\ GeV/c$.

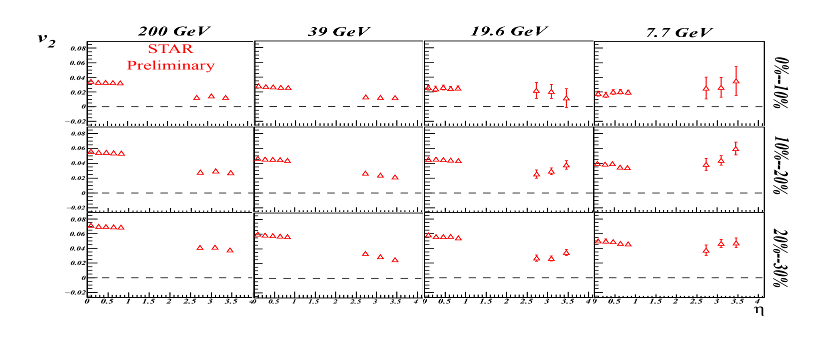

Figure : $v_2(\eta)$ show decreasing trend with (η) at all energies and weaker dependence at lower energies in FTPC.

TPC/FTPC $v_2(\eta)$

p_T integrated $v_2(\eta)$ compared with PHOBOS for $(0-40\%)$ centrality and $0.2 < p_T < 4\ GeV/c$.

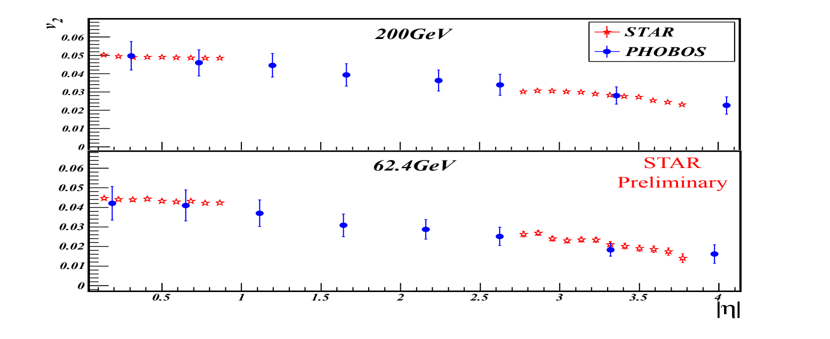

Figure : STAR v_2 values and behaviour of 200 *and* 62.4 GeV are in good agreement with PHOBOS v_2

TPC/FTPC $v_3(\eta)$

p_T integrated $v_3(\eta)$ obtained for all centralities, all beam energies and $0.2 < p_T < 4\ GeV/c$.

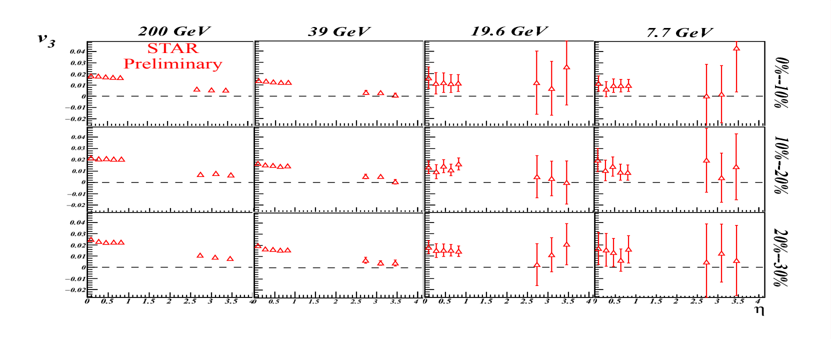

Figure : $v_3(\eta)$ show weaker decreasing trend with (η) at higher energies and apparent constant trend at lower energies.

Results

- TPC/FTPC v_n(Centrality)

TPC/FTPC v_2(Centrality)

TPC/FTPC p_T and η integrated v_2 centrality dependence for all energies and $0.2 < p_T < 4\ GeV/c$.

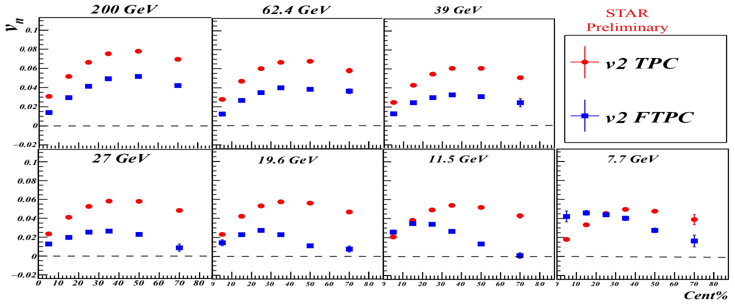

Figure : In both TPC and FTPC v_2 is sensitive to centrality.

TPC/FTPC v_3(Centrality)

TPC/FTPC p_T and η integrated v_3 centrality dependence for all energies and $0.2 < p_T < 4\ GeV/c$.

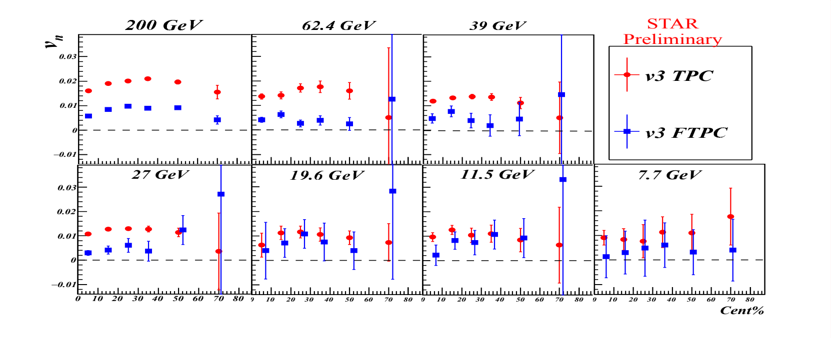

Figure : v_3 is less sensitive to centrality in TPC and approximately constant in FTPC.

TPC/FTPC v_4(Centrality)

TPC p_T and η integrated v_4 centrality dependence for all energies and $0.2 < p_T < 4\ GeV/c$.

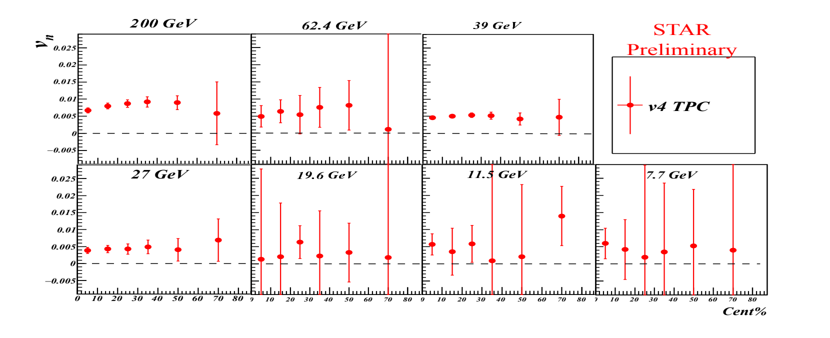

Figure : Except for, $200 GeV$, v_4 is approximately independent on centrality.

Results

- TPC/FTPC $v_n(\sqrt{s_{NN}})$.

TPC/FTPC $v_2(\sqrt{s_{NN}})$

TPC/FTPC p_T and η integrated $v_2(\sqrt{s_{NN}})$ for all centralities and $0.2 < p_T < 4\ GeV/c$.

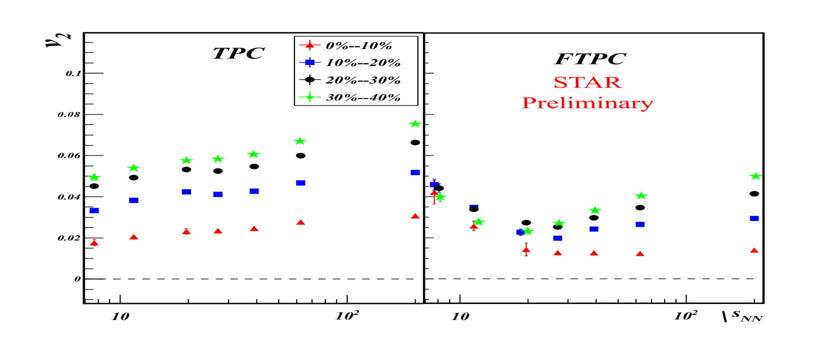

Figure : v_2 shows a monotonic increase with beam energy in TPC(left panel), v_2 shows a minimum around 27 GeV in FTPC(right panel).

TPC/FTPC $v_3(\sqrt{s_{NN}})$

TPC/FTPC p_T and η integrated $v_3(\sqrt{s_{NN}})$ for all centralities and $0.2 < p_T < 4\ GeV/c$.

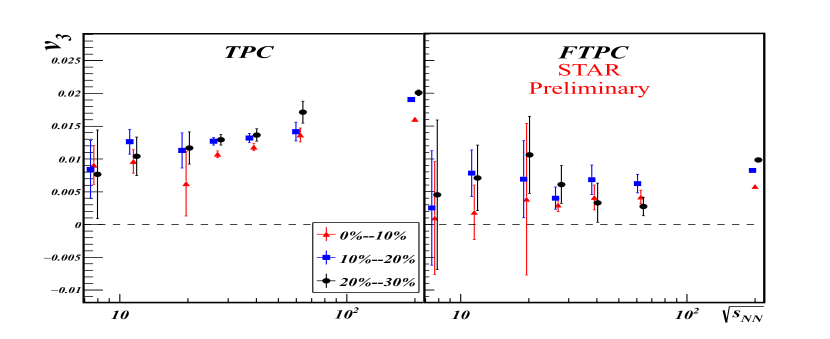

Figure : v_3 shows a monotonic increase with beam energy in TPC(left panel), v_3 shows a approximately constant trend in FTPC(right panel).

Conclusion

We have analyzed the v_n as a function of, p_T, η, centrality and beam energy considering $|\Delta\eta| > 0.7$ to reduces the non flow and residual detector effects. Our analysis draw the following conclusion,

- v_2 shows decreasing trend with (η) at all energies and weaker dependence at lower energies in FTPC
- v_3 shows weaker decreasing trend with (η) at higher energies and apparent constant trend at lower energies
- In both TPC and FTPC v_2 is sensitive to centrality change however v_3 is less sensitive to centrality in TPC and approximately constant in FTPC range
- Except for, $200 GeV$, v_4 is approximately independent on centrality
- Both v_2 and v_3 increase with beam energy in TPC
- In FTPC v_3 is approximately constant however v_2 shows a minimum around 27 GeV.


THANK YOU
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Factorization at 200 GeV

p_T and η integrated v_2 centrality dependence for 200 GeV and $0.2 < p_T < 4$ GeV/c

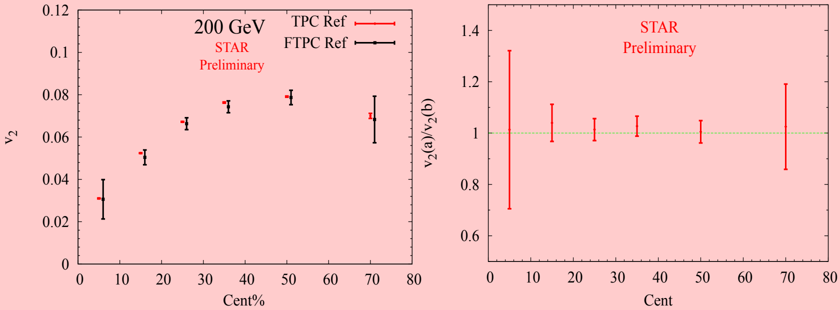

Figure : Centrality dependence of v_2 using TPC and FTPC as reference (left panel), The ratio between v_2 with reference in TPC(a) and FTPC(b)(right panel).

TPC $v_2(p_T)$

η integrated $v_2(p_T)$ obtained for all centralities for each beam energy.

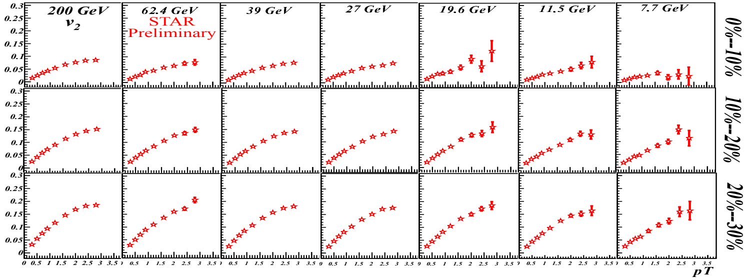

Figure : $v_2(p_T)$ show increasing trend with centrality and beam energy.

TPC $v_3(p_T)$

η integrated $v_3(p_T)$ obtained for all centralities for each beam energy.

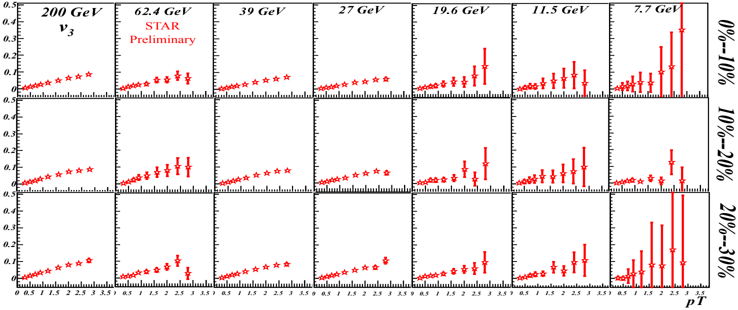

Figure : Finite $v_3(p_T)$ observed for all beam energies - slow increase with centrality and beam energy.

Analysis cuts

At all energies we use $DCA < 3$ cm, $Vr < 2$ cm, $0.2 < pT > 4$ GeV/c, $nhits(TPC) > 15$ and $nhits(FTPC) > 5$.

$\sqrt{s_{NN}}$ GeV	Vz cm
200	$< \|30\|$
62.4	$< \|30\|$
39.0	$< \|40\|$
27.0	$< \|40\|$
19.6	$< \|40\|$
11.7	$< \|50\|$
7.7	$< \|70\|$