Title

Anisotropic Flow in the Forward Directions

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Anisotropic Flow in the Forward Directions

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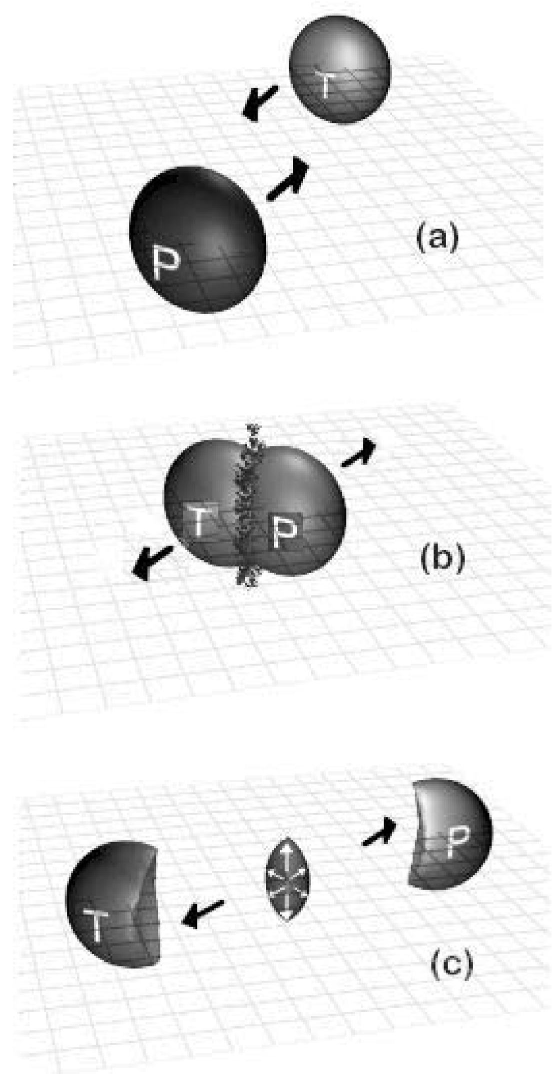
Anisotropic Flow

- initial spatial anisotropy of the collision region in non-central heavy-ion collisions translates into a final state anisotropy in momentum space
- in hydro picture, pressure gradients lead to collective motion (flow) of particles

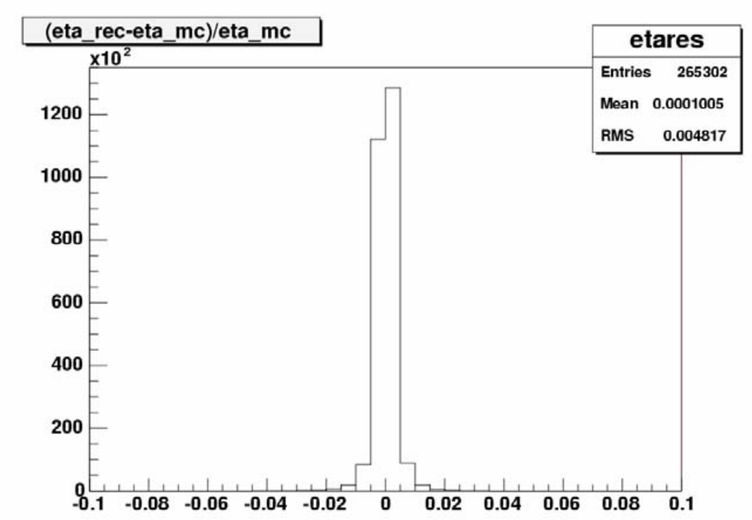
- to measure anisotropic flow: perform a Fourier decomposition on the particle's emission angles with respect to the reaction plane
- apply resolution corrections

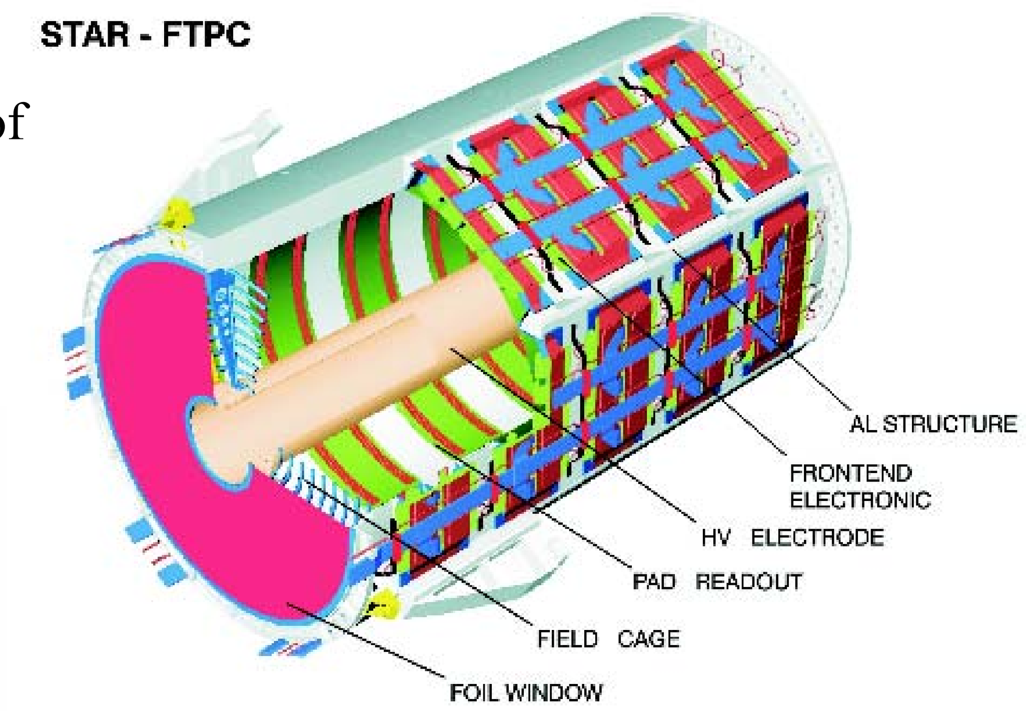
- contributions of non-flow effects might affect the measured flow signal
- extensions of the standard method, like cumulants and Lee-Yang zeros, try to cope with these problems



The STAR Forward TPCs (FTPCs)

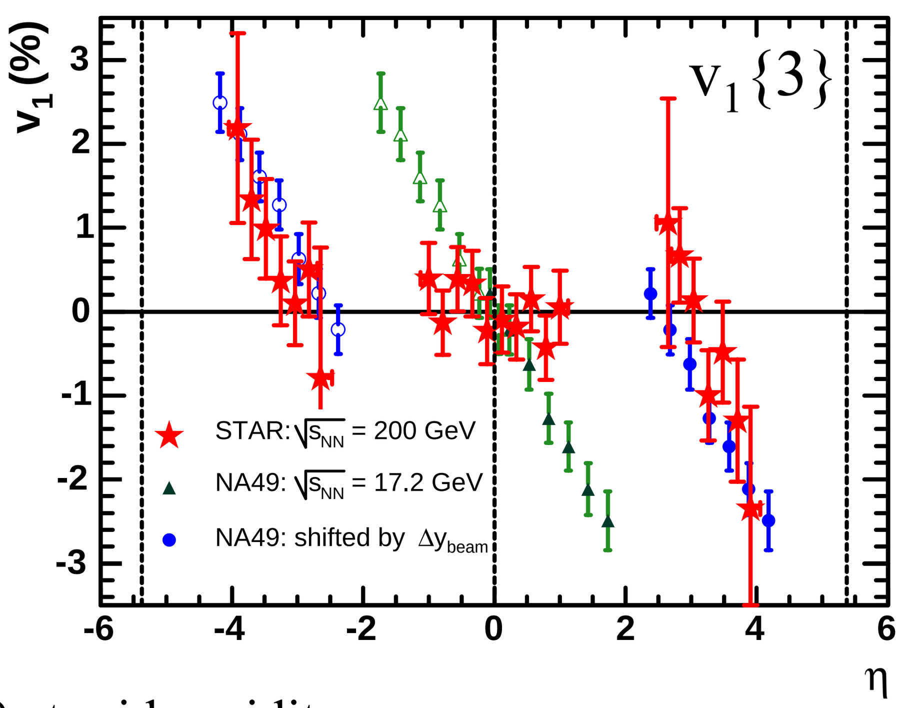
- extend the pseudorapidity coverage of STAR into the region $2.5 < |\eta| < 4.0$
- about 70,000 events including both FTPCs were taken at $\sqrt{s_{NN}} = 200$ GeV (RHIC run 2)





- good pseudorapidity resolution of less than 5% for all eta and pt

Directed Flow v_1



[1] J. Adams *et al.* (STAR collaboration), nucl-ex/0310029; accepted for publication in Phys. Rev. Lett.

- $v_1 \approx 0$ at mid-rapidity
- slope of (-0.25 ± 0.27)% per unit of pseudorapidity at $|\eta| < 1.2$
- sign of v_1 arbitrary in this analysis
- sign plotted to be in agreement with measurements at lower energies

- great difference between STAR and unshifted NA49 results
- in projectile frame relative to the respective beam rapidities STAR and NA49 look the same

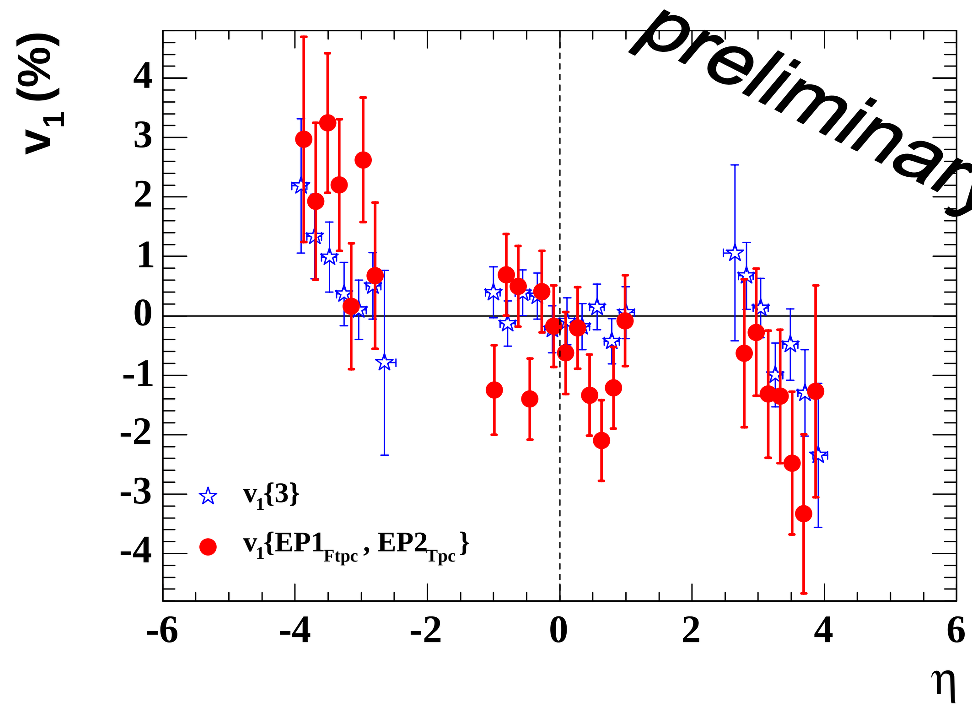
New method to measure $v_1\{EP1,EP2\}$

- combine good capabilities to measure v_1 in the FTPCs and v_2 in the TPCs

- measure $v_1^{Obs.} = \left\langle \cos\left(\varphi + \Psi_1^{FTPC} - 2\cdot\Psi_2^{TPC}\right)\right\rangle$
- apply resolution correction:

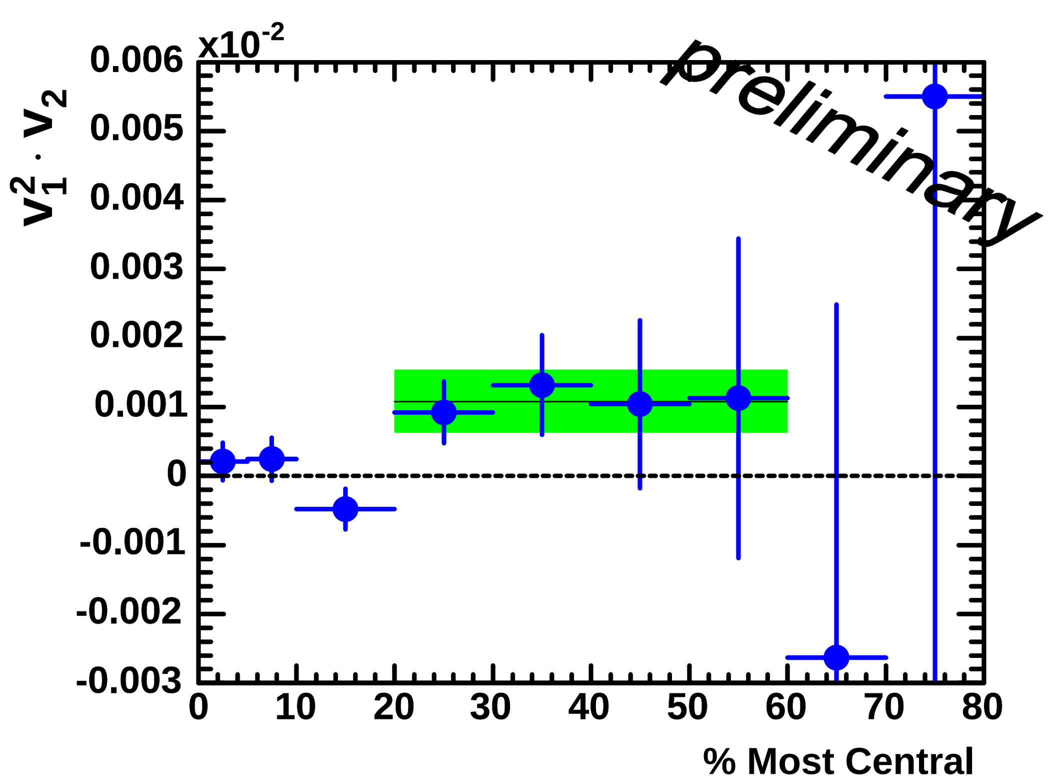
$$v_1\{EP1,EP2\} = v_1^{Obs.} / \sqrt{\left\langle \cos\left(\Psi_1^{FTPC_1} + \Psi_1^{FTPC_2} - 2\cdot\Psi_2^{TPC}\right)\right\rangle \cdot \mathrm{Res}\left(\Psi_2^{TPC}\right)}$$

- results are in reasonable agreement with $v_1\{3\}$



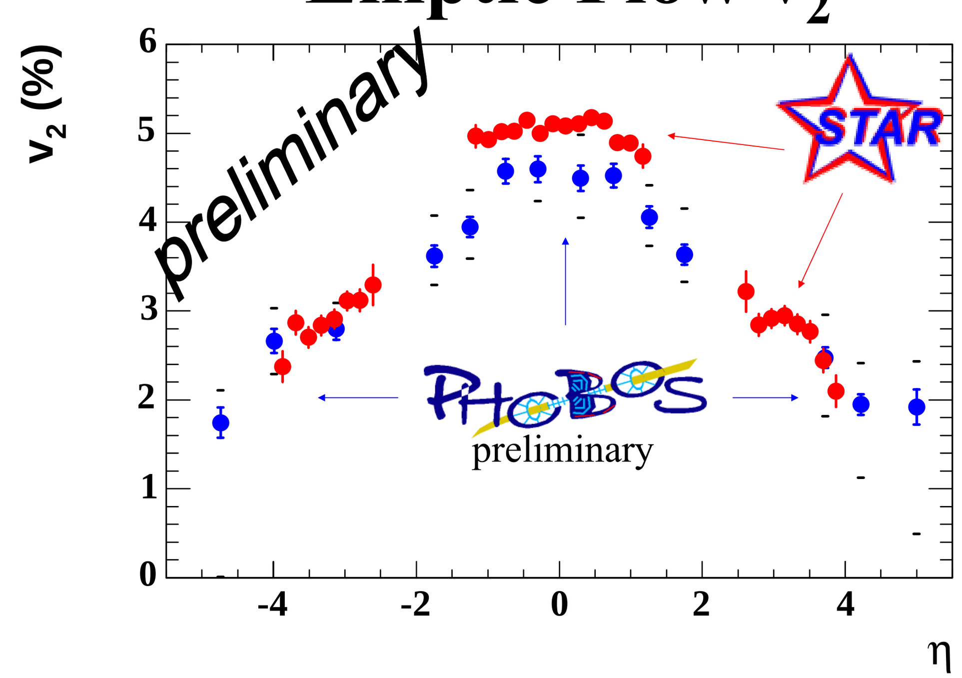
The sign of v_2

- new method allows for direct measurement of $v_1^2 v_2$
- best results are obtained if v_1 is measured in both FTPCs separately and v_2 is measured in the TPC only



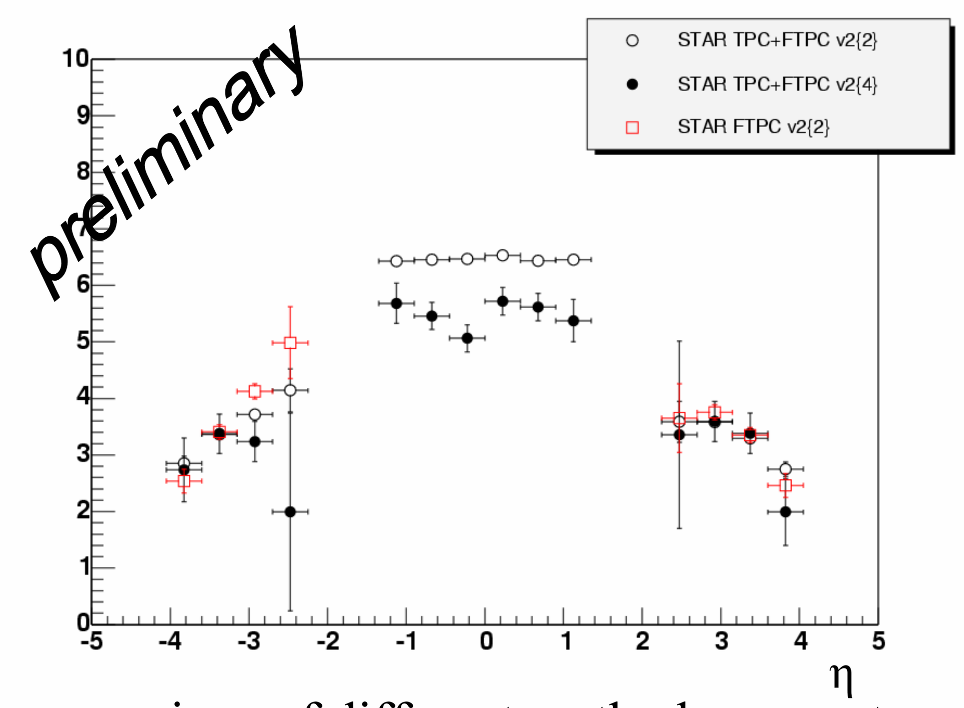
- mean value of $(1.08 \pm 0.46)\cdot 10^{-5}$ confirms that v_2 is positive

Elliptic Flow v_2



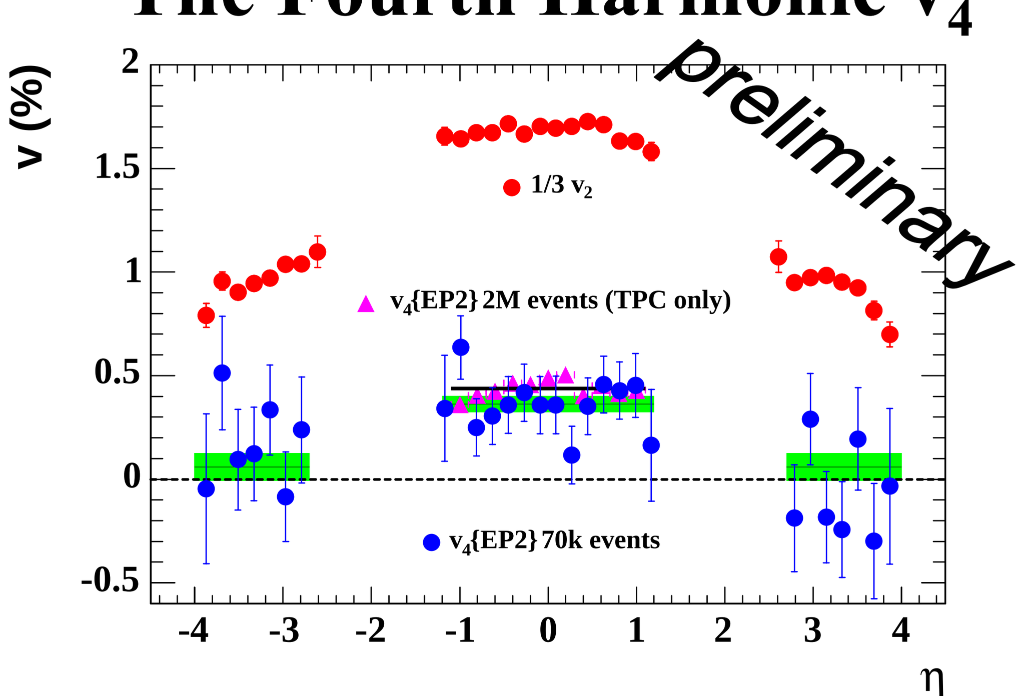
[2] S. Manly, Nucl. Phys. A 715 (2003) 611c

- fall-off from mid-rapidity to forward rapidities (as seen by PHOBOS [2]) confirmed



- comparison of different methods suggests less non-flow effects in the forward regions

The Fourth Harmonic v_4



- v_4 almost flat (like v_2) at mid-rapidities: $v_4(TPC) = (0.4 \pm 0.01)$ %
- consistent with zero in the FTPCs: $v_4(FTPC) = (0.06 \pm 0.07)$ %
- 2σ upper limit of 0.2 %
- fall-off of v_4 from mid-rapidity to forward rapidities stronger than for v_2
- consistent with scaling: $v_4 \sim v_2^2$

Future Developments – Lee-Yang zeros

- First attempts to use the recently proposed method by Bhalerao *et al.* [3] utilizing Lee-Yang zeroes are promising.
- non-flow contributions of higher order particle correlations are reduced by construction
- implementation much easier than for the cumulants

- RHIC run 4 will greatly enhance our data sample and reduce statistical fluctuations of our measurements of anisotropic flow.

[3] R.S. Bhalerao, N. Borghini, J.-Y. Ollitrault, Nucl. Phys. A 727 (2003) 373