

Third Harmonic Flow of Charged Particles in Au+Au Collisions at $\sqrt{s_{NN}} = 200$ GeV

Art Poskanzer for the STAR Collaboration

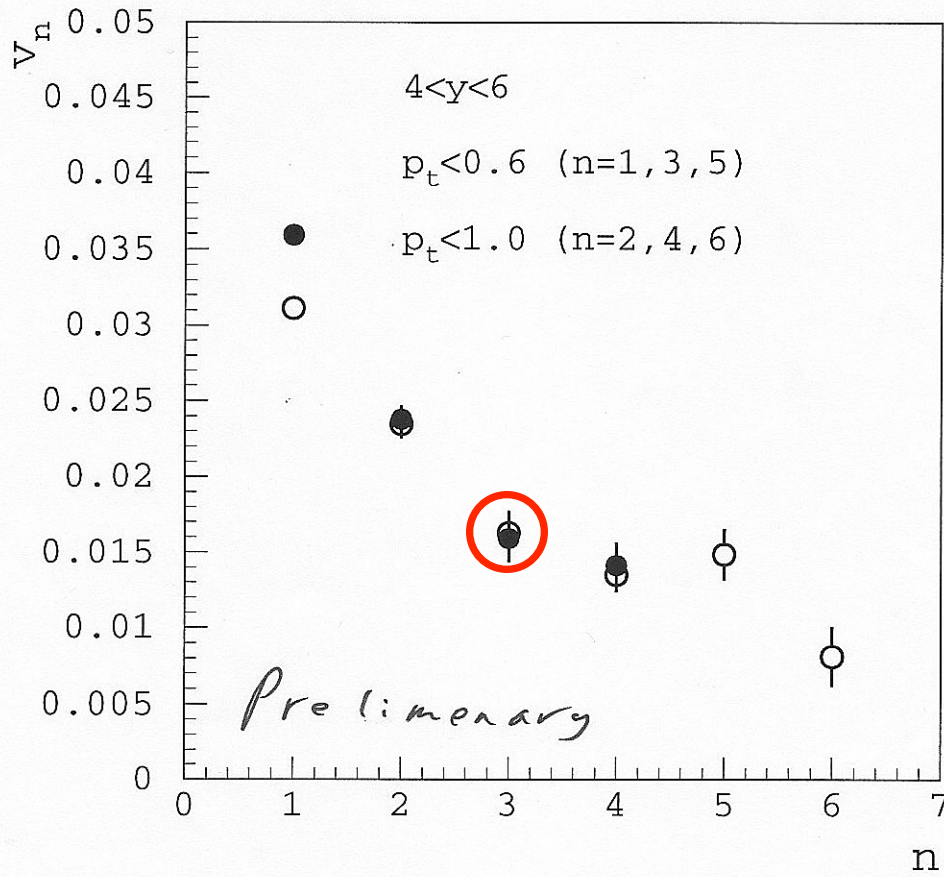
Initial State Fluctuations and Final State Correlations

2-6 Jul 2012 Trento (Italy)



Trento: 14 Years Ago Higher Harmonics

98/03/24 11.18



NA49

Too large, especially
for odd harmonics.

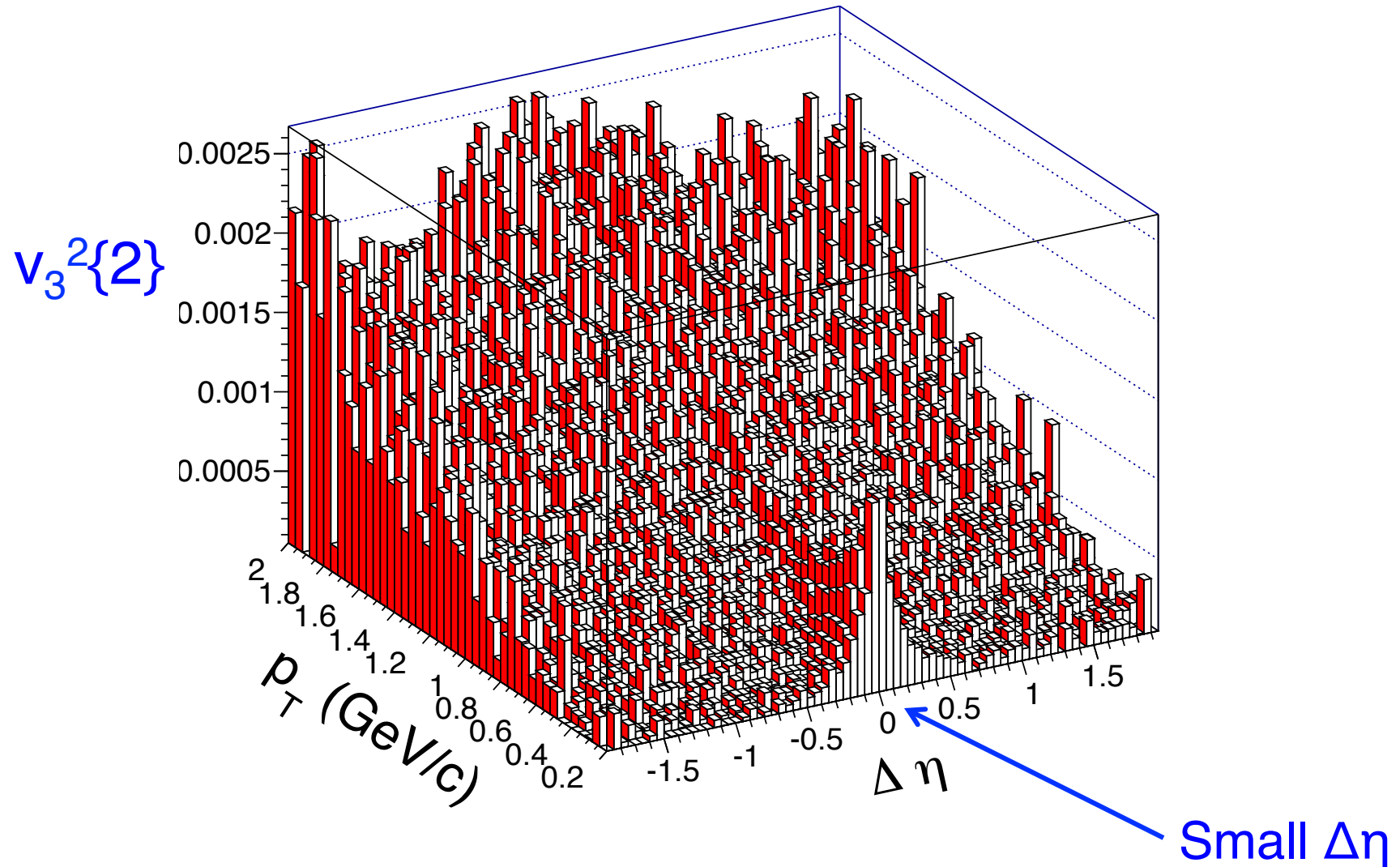
All non-flow?

Voloshin and I gave up.

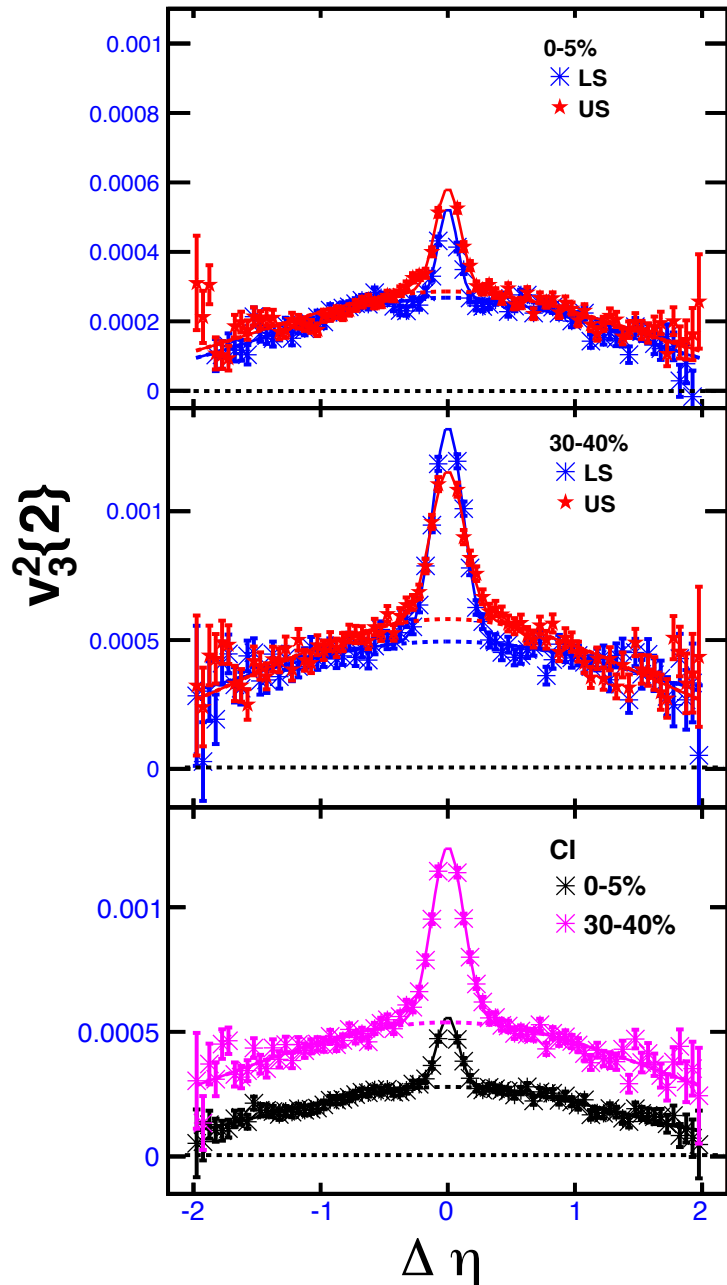
Fathers of v_3 :
Alver and Roland

n ← Harmonic number

Short-Range Correlations



Narrow and Wide Gaussians

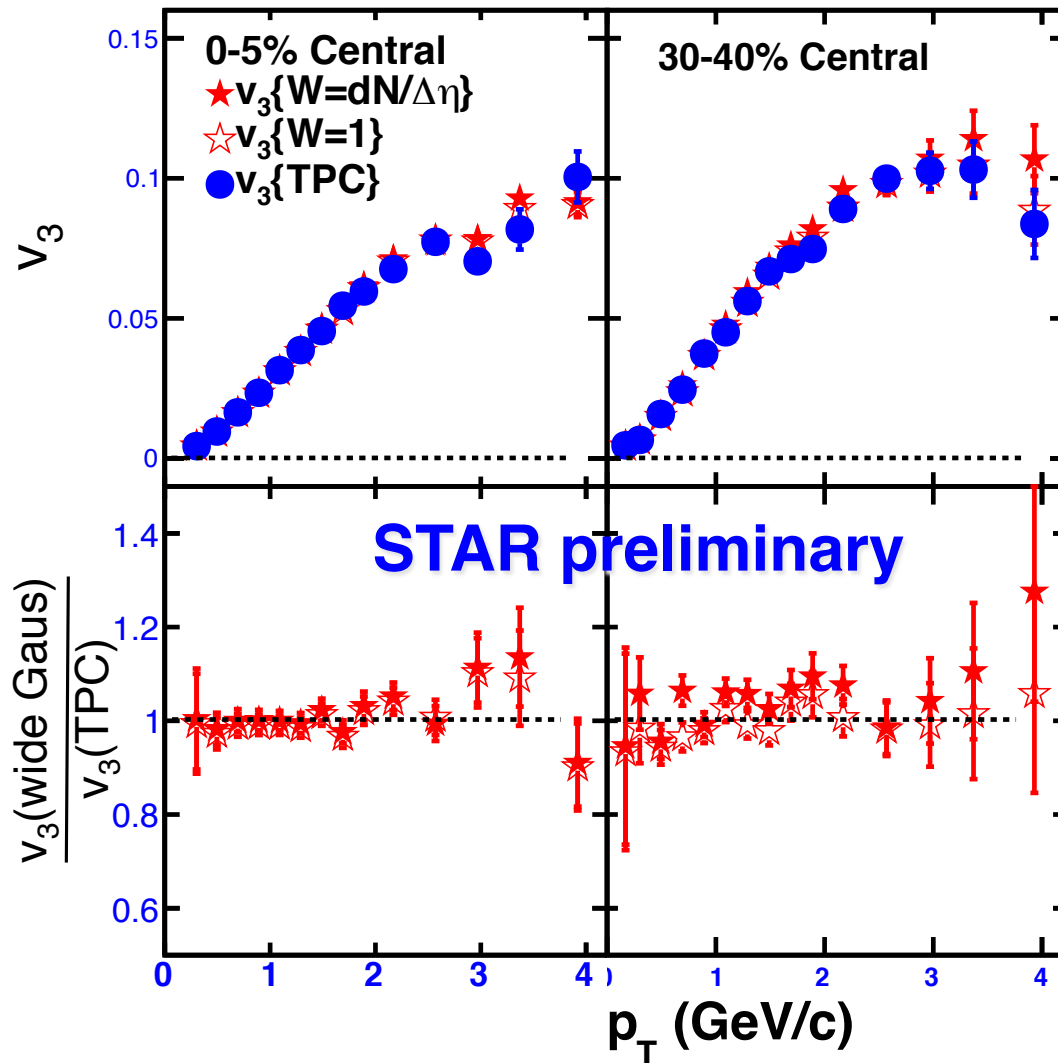


- Two Gaussian fit vs. $\Delta\eta$ for each p_T
- Dashed lines are wide Gaussians
- Get rid of narrow Gaussians

Methods

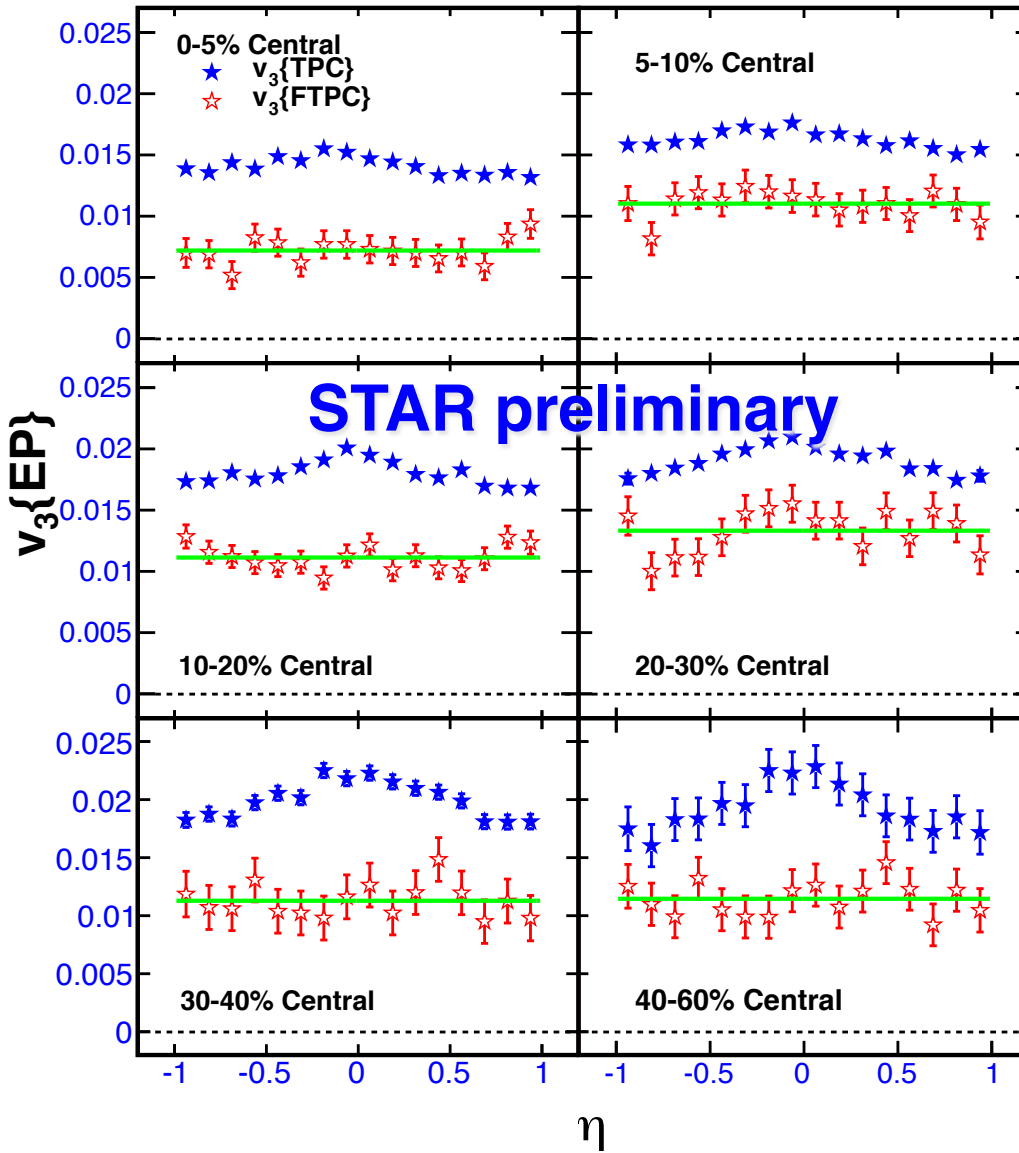
- 2-particle correlations $v_3\{2\}$
 - Wide Gaussian
 - Small η separation cut
- 4-particle correlations $v_3\{4\}$
- TPC η sub-events $v_3\{\text{TPC}\}$
 - with additional ± 0.05 separation
 - Each particle with EP of opposite sub-event
- FTPC $v_3\{\text{FTPC}\}$
 - Each TPC particle with the EP of combined FTPCs

p_T Dependence



Wide Gaussian the same as TPC sub-EP.
Short-range correlations in $v_3\{TPC\}$ using opposite η -sub event plane are not significant.

Pseudorapidity Dependence

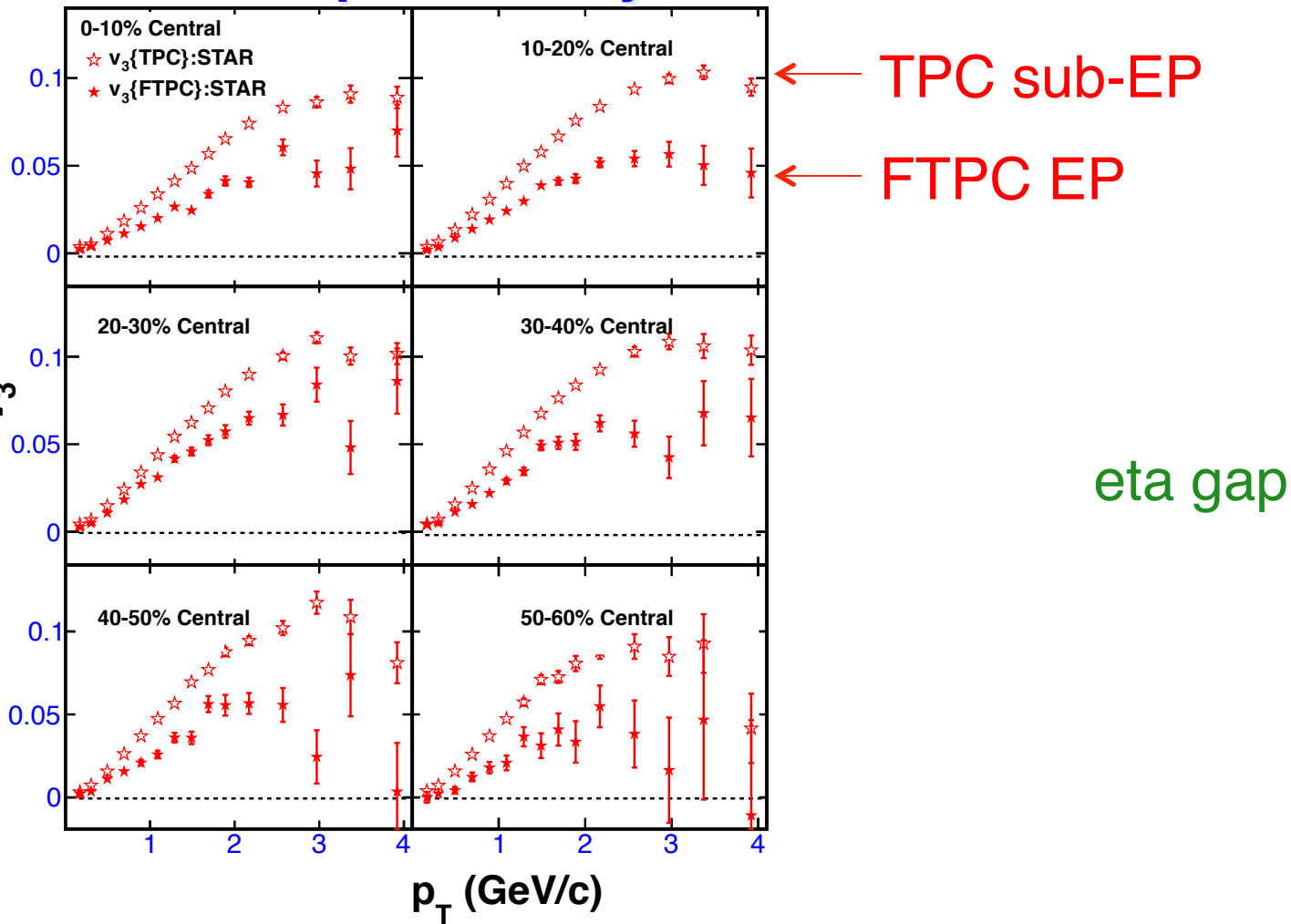


← TPC η -sub EP
← FTPC full EP

← flat

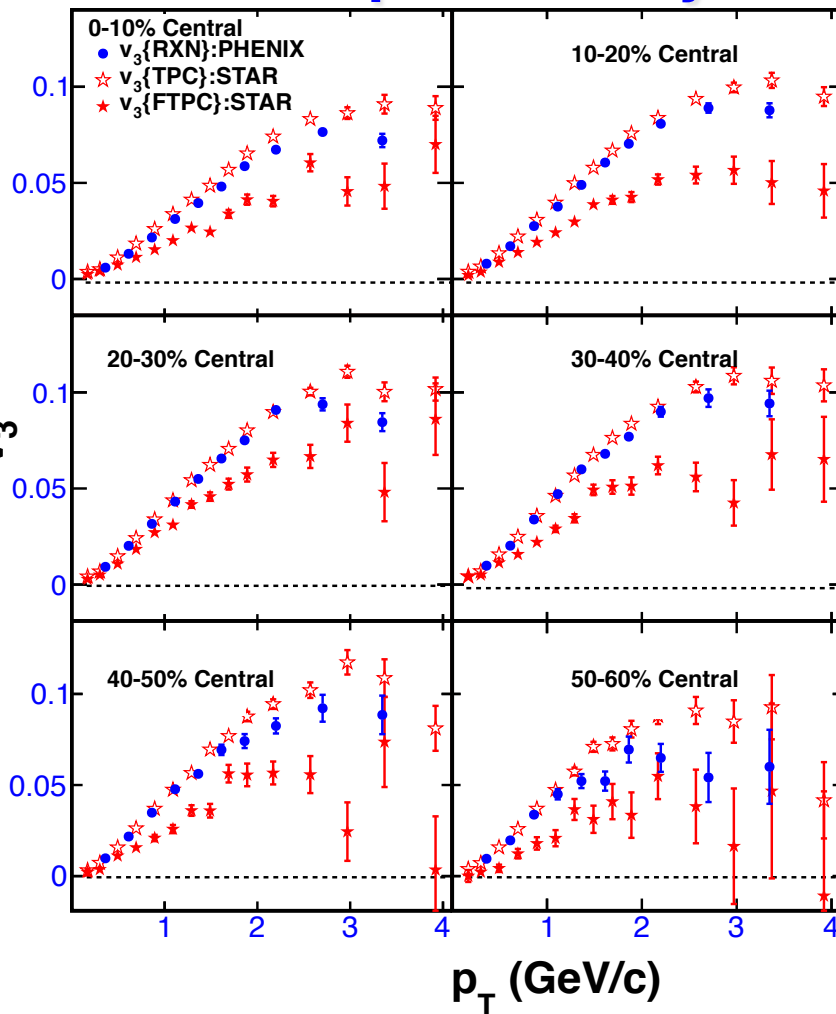
FTPC

STAR preliminary



FTPC and PHENIX

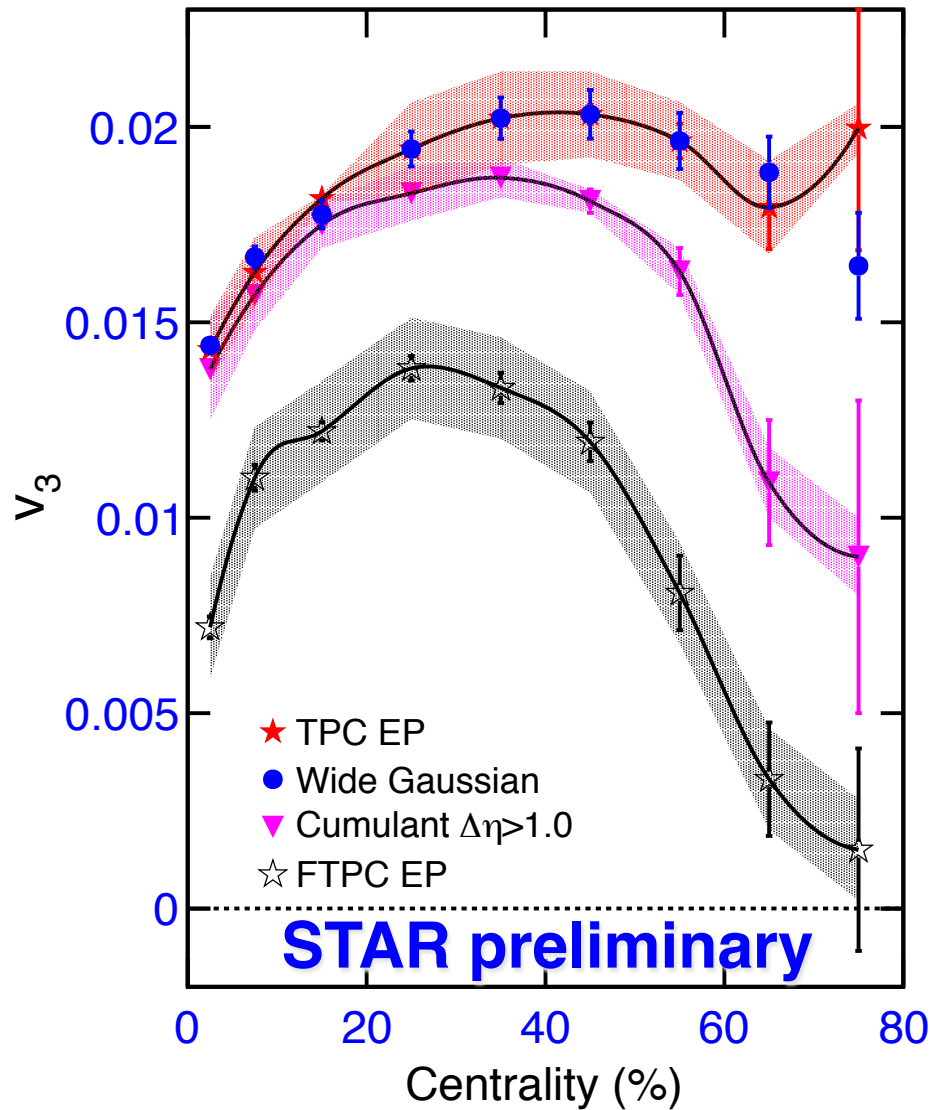
STAR preliminary



← TPC sub-EP
 ← PHENIX RXN EP
 ← FTPC EP

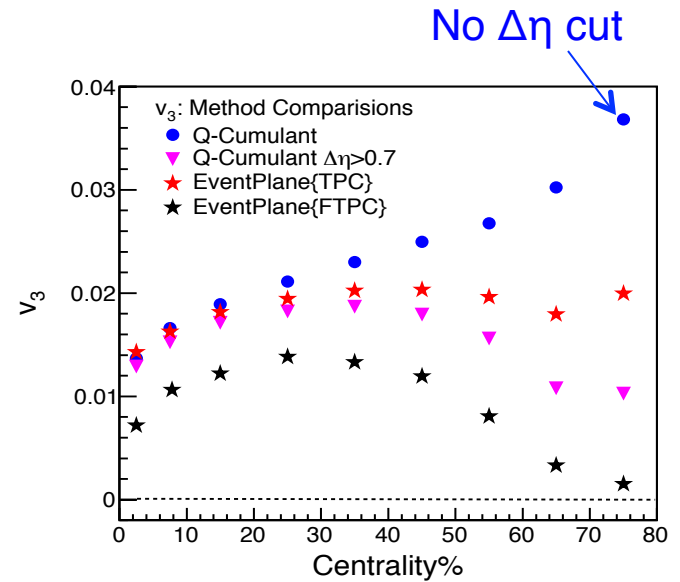
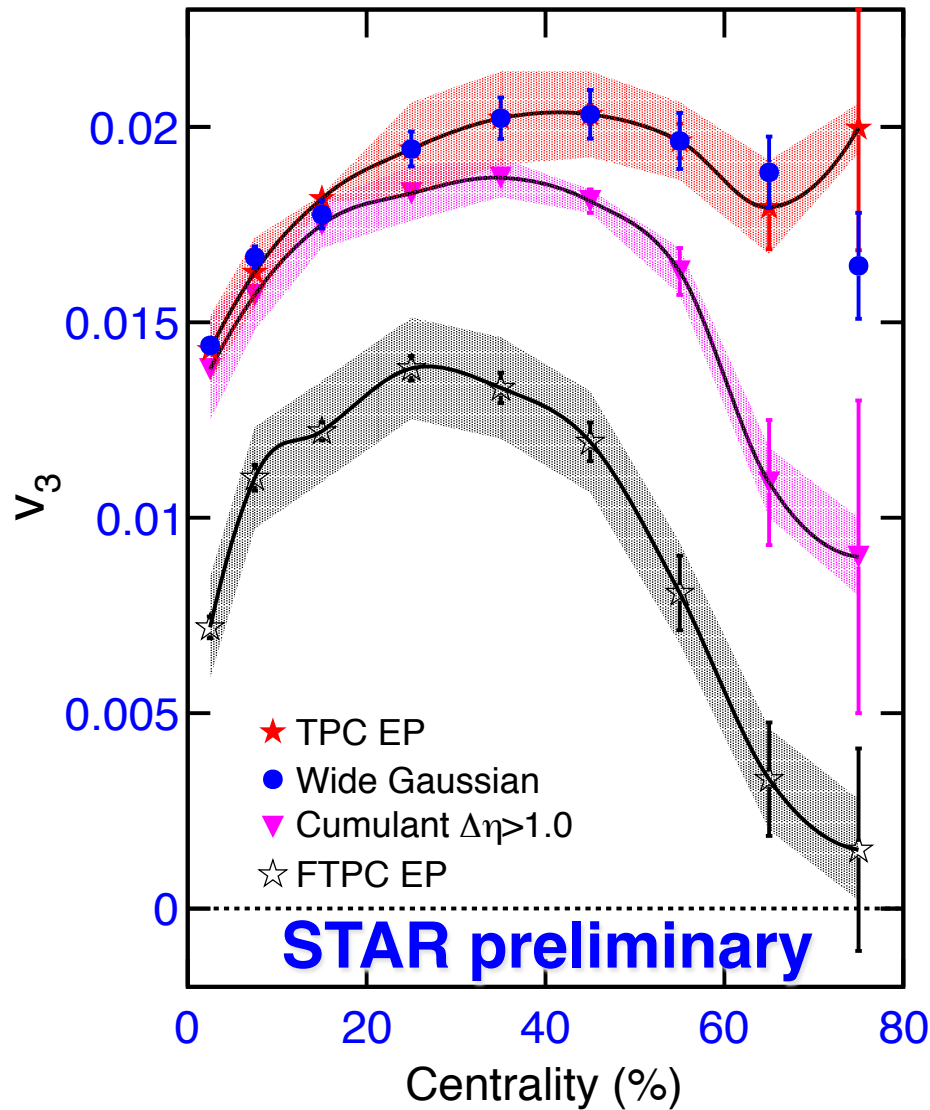
	$\langle \Delta\eta \rangle$
TPC EP	0.63
PHENIX	≈ 1.9
FTPC EP	3.21

Centrality Dependence



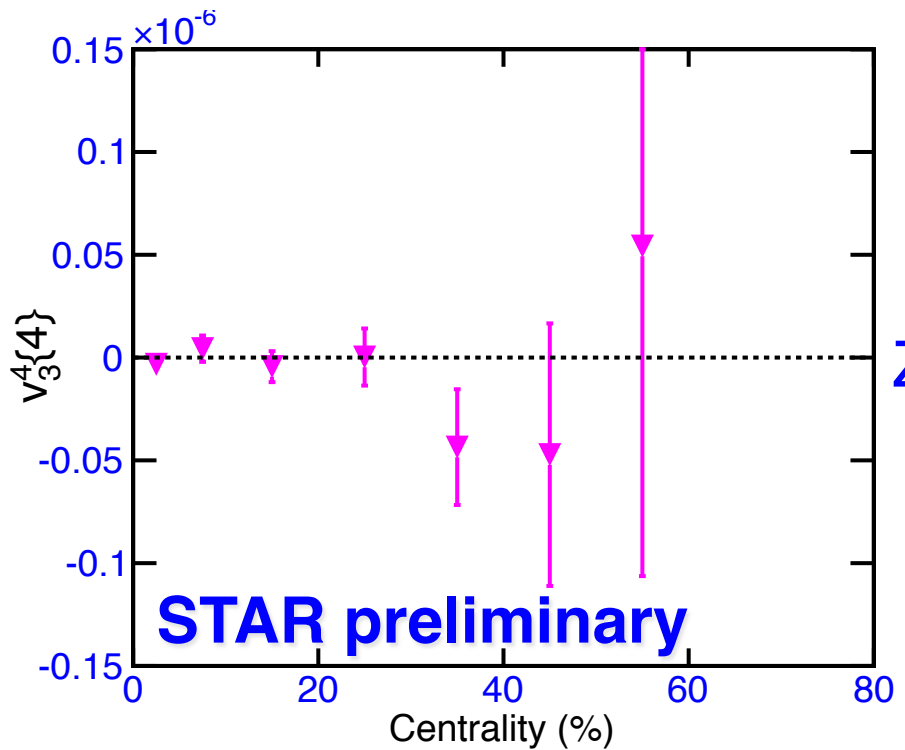
Big effect of $\Delta\eta$

Centrality Dependence



Big effect of $\Delta\eta$

Four-particle Cumulant

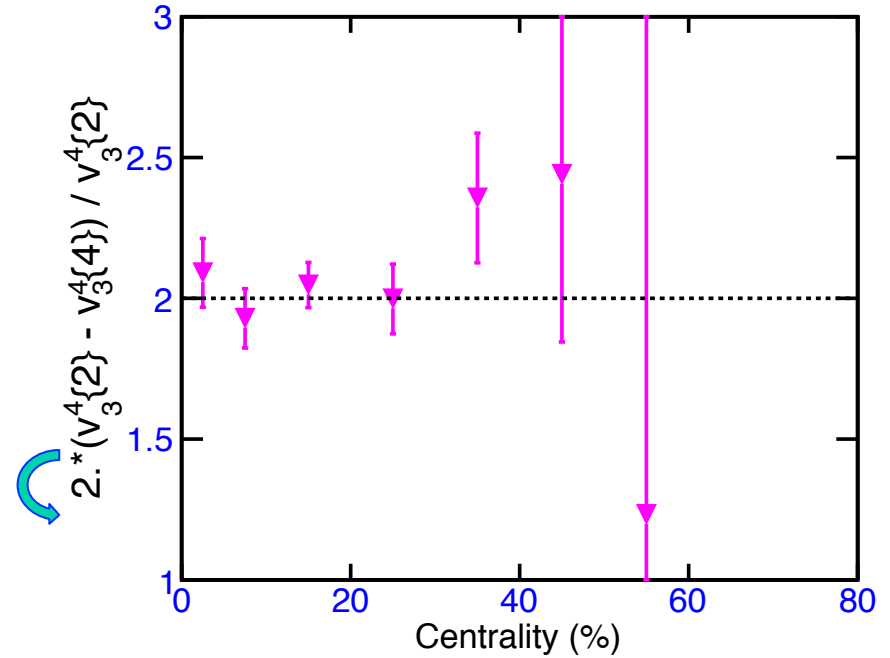
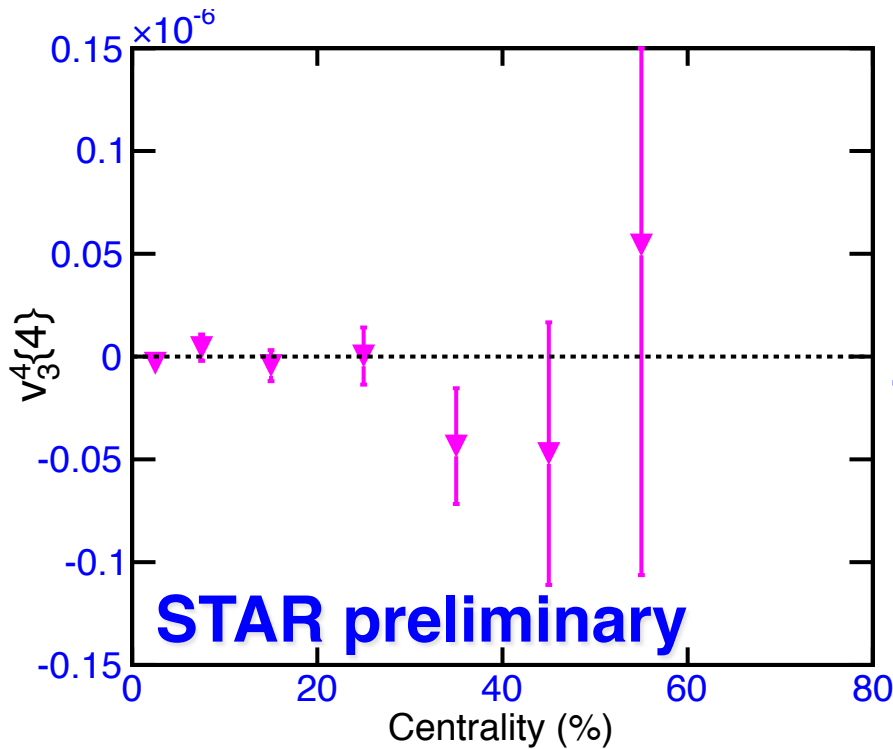


Zero

Just non-flow and
Gaussian fluctuations

$v_3^4\{4\}$ divided by $v_3^4\{2\}$

Bhalerao, Luzum, and Ollitrault:

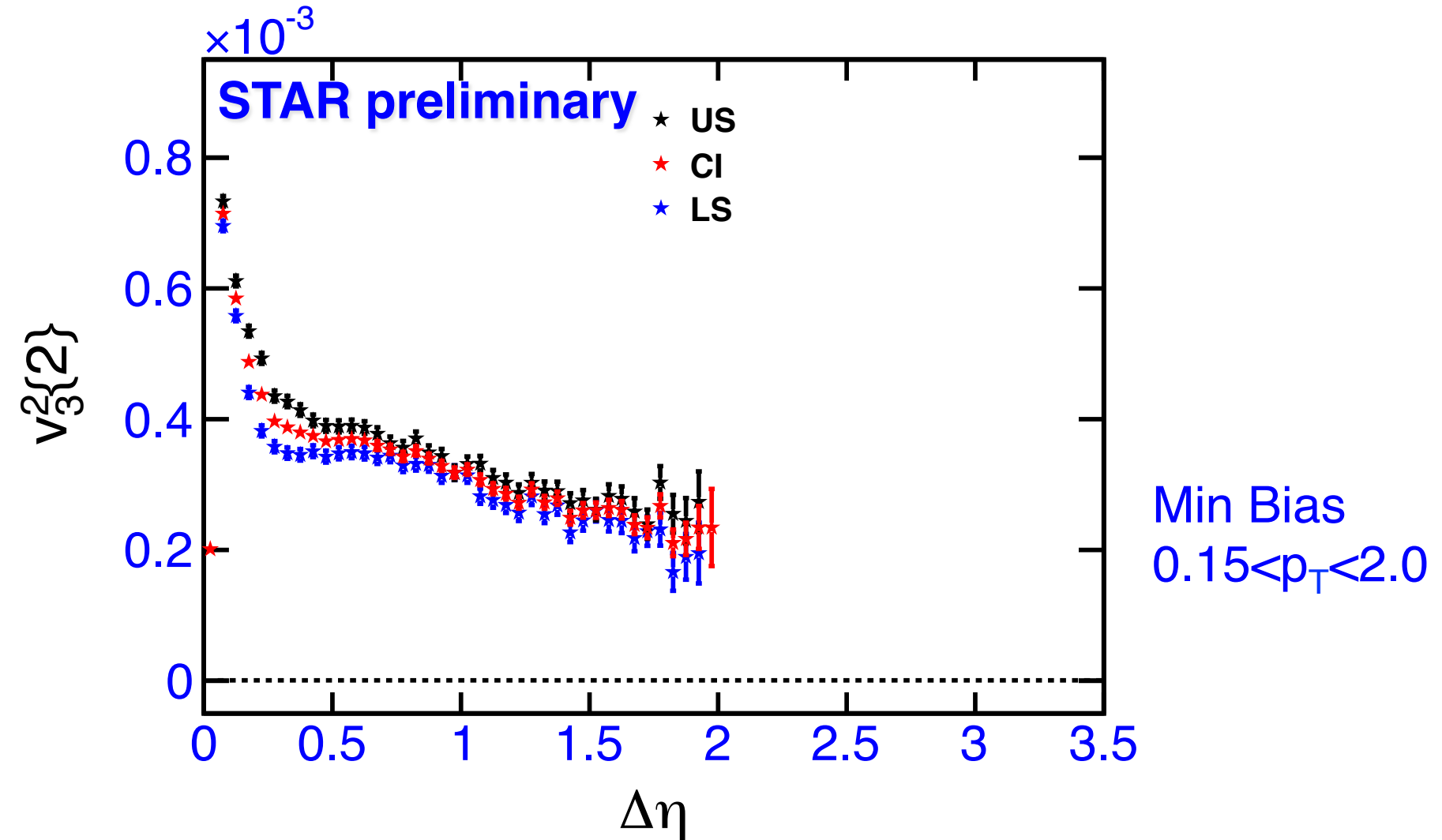


Zero

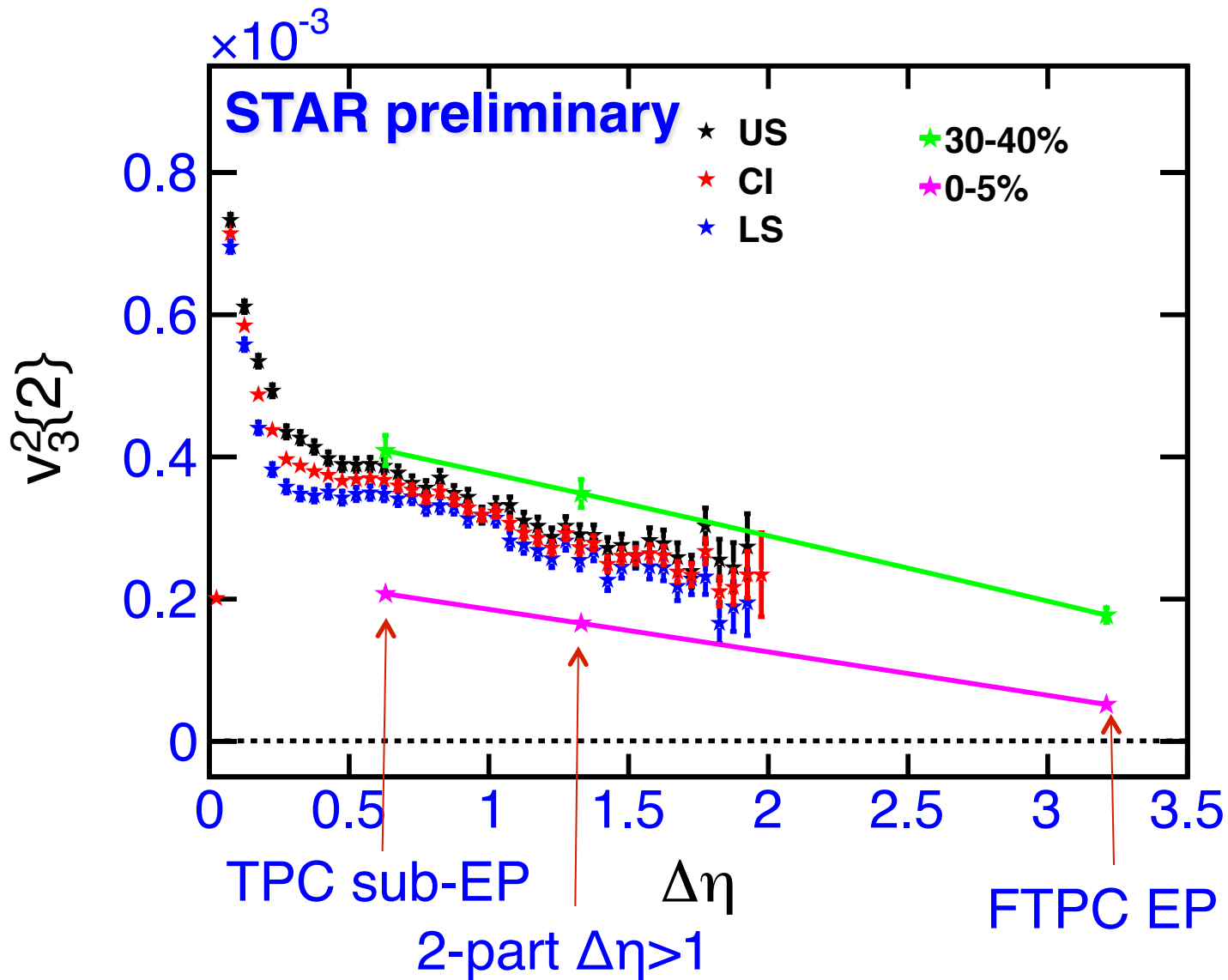
Gaussian fluctuations

Not incompatible with ALICE

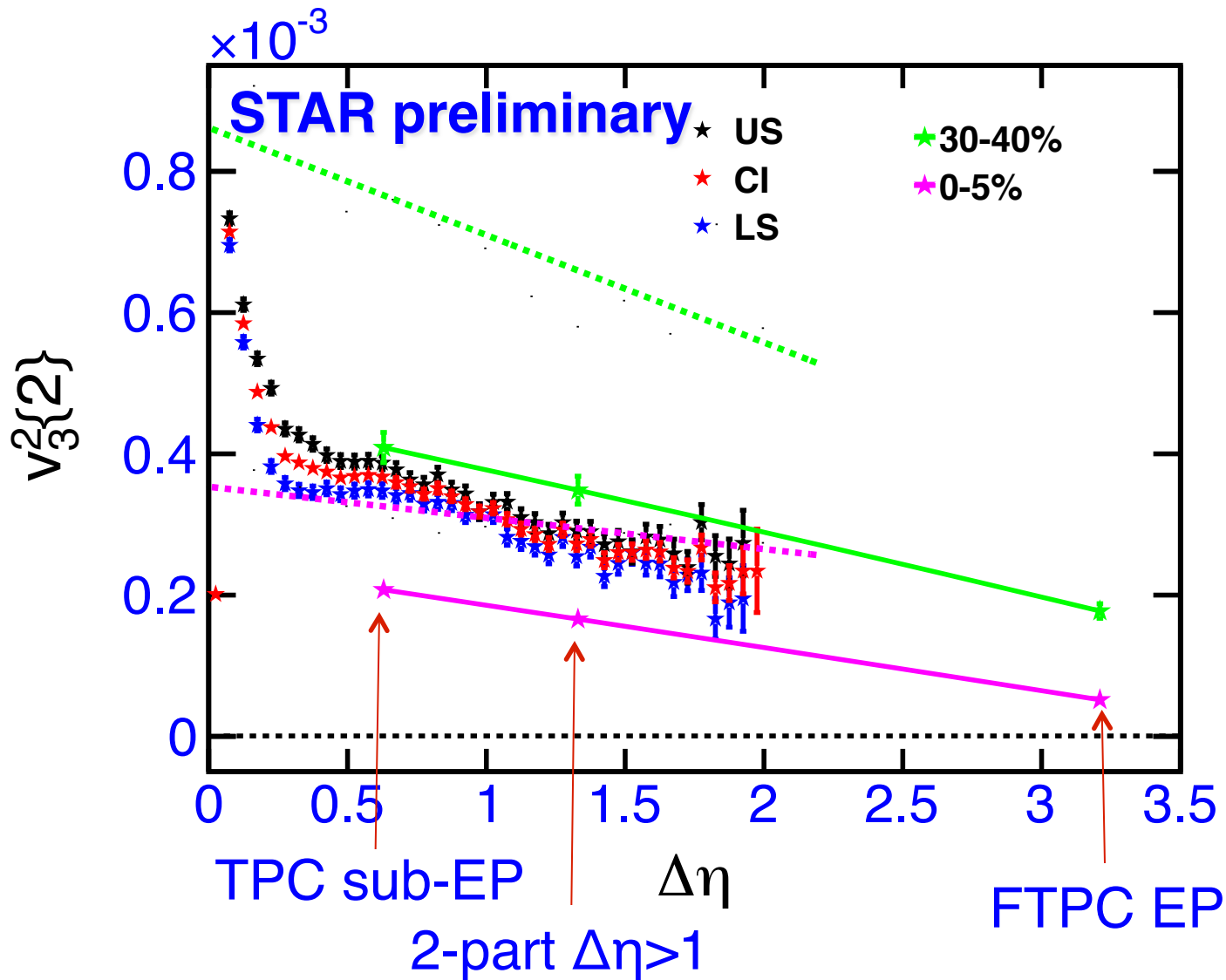
Pseudorapidity Gap Dependence



Pseudorapidity Gap Dependence



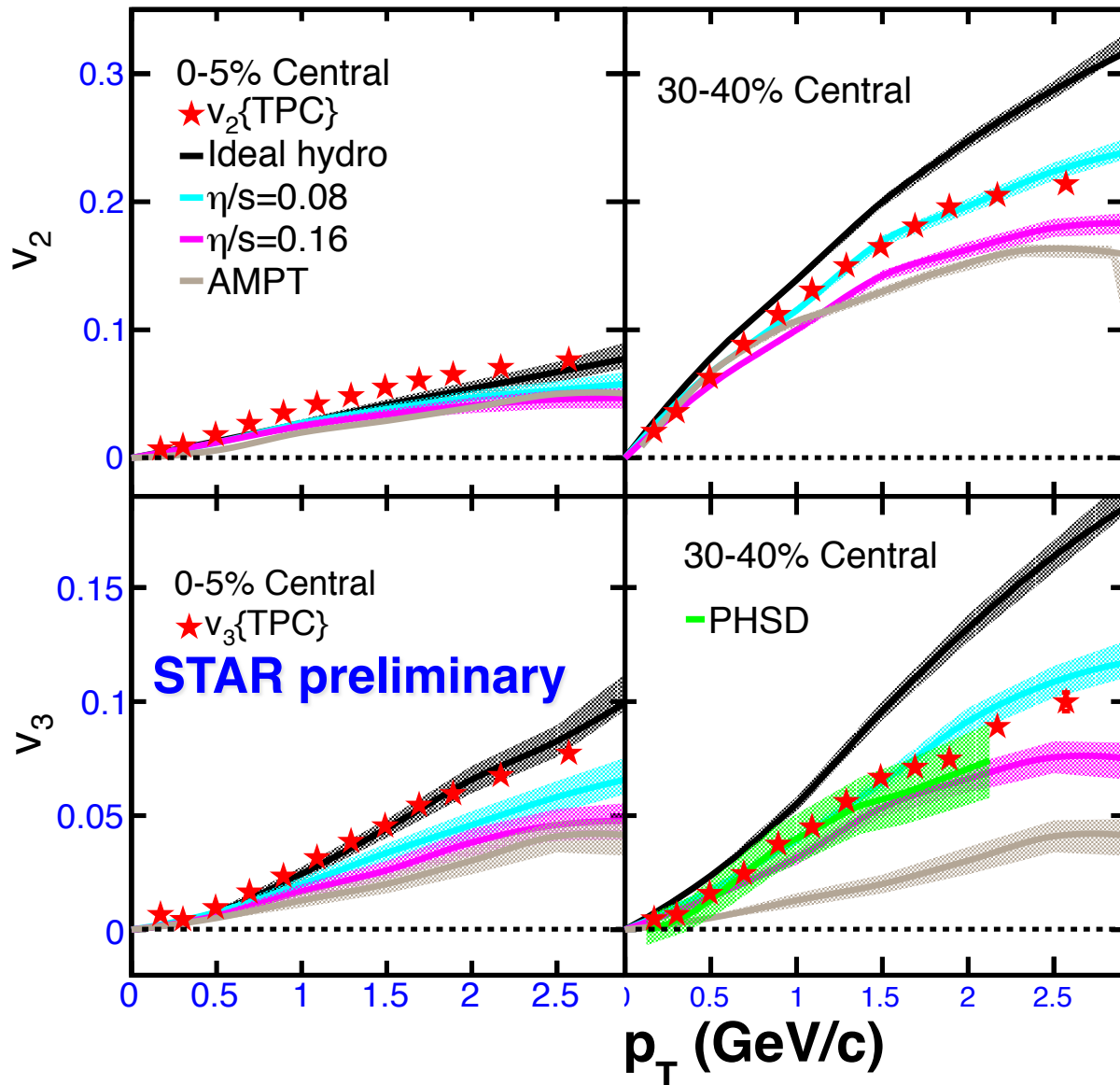
Pseudorapidity Gap Dependence



Dashed: Bozek and Broniowski
Charge balance

No, because small
charge sign effect
at $p_T \approx 0.3$

Model Comparisons



← $V_2\{\text{TPC}\}$

Hydro: Schenke (old)

AMPT: Alver

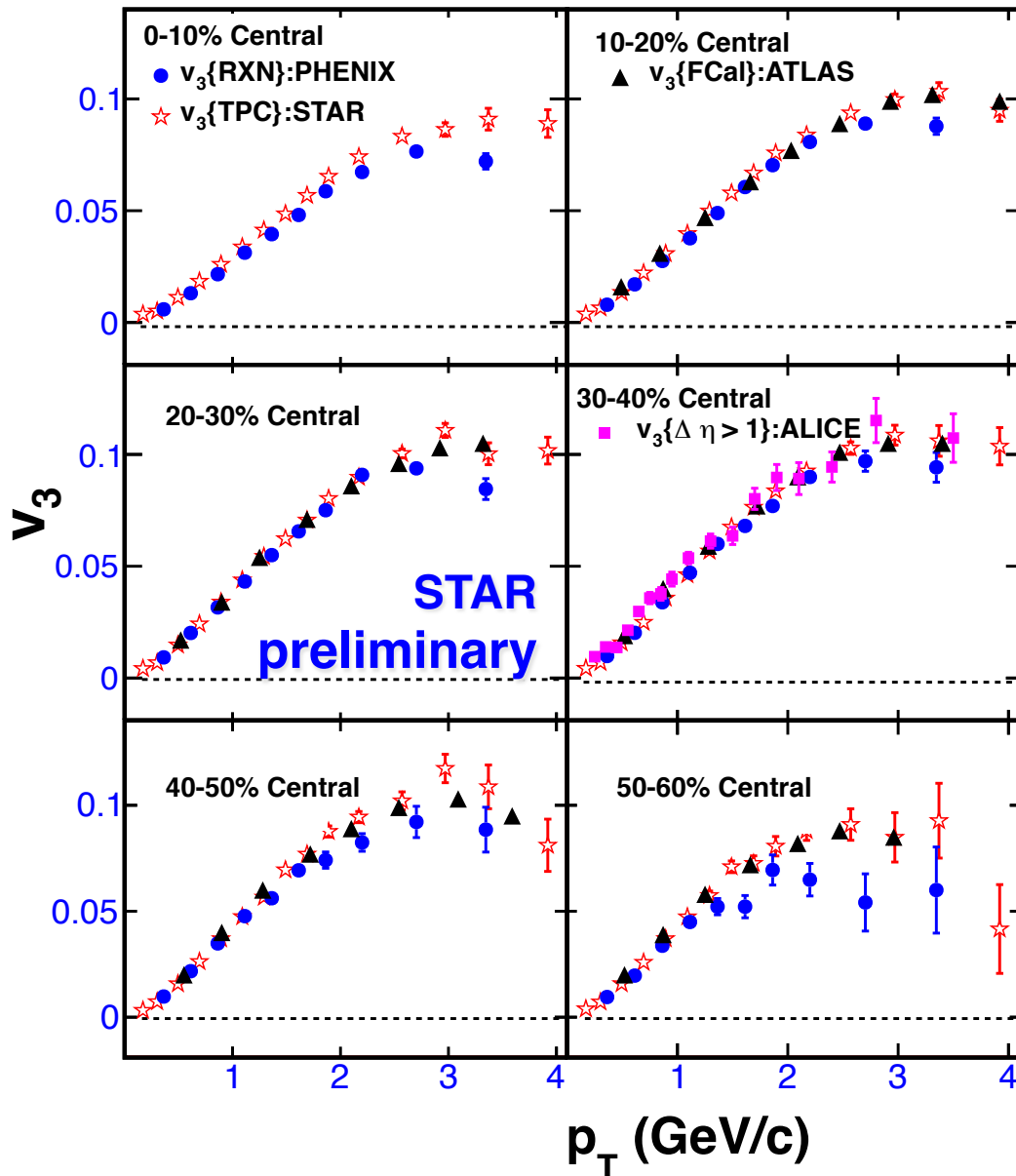
PHSD: Konchakovski

HIJING very small

← $V_3\{\text{TPC}\}$

No narrow Gaussian
 but $\Delta\eta$ cut small

LHC Pb+Pb at $\sqrt{s_{NN}} = 2.76$ TeV



The v_3 {TPC} values agree with ALICE and ATLAS, as well as PHENIX, despite different $\Delta\eta$

	$ \eta $	$\langle\Delta\eta\rangle$
STAR	<1.0	0.63
PHENIX	<0.35	≈ 1.9
ALICE	<0.8	>1.0
ATLAS	<2.5	>0.8

Summary

- Short-range correlations with η -sub method not significant
- Strong **decrease with increase of η gap**
- Experiment and theory must use **same $\Delta\eta$**
- Calculations of non-flow at large $\Delta\eta$ small
- Most likely **fluctuations**
- Experimentally the same at higher beam energies (LHC)
- Should be the same at lower beam energies (BES)

References

Hydro: B. Schenke, S. Jeon and C. Gale, Phys. Rev. Lett. 106, 042301 (2011) [arXiv:1009.3244 [hep-ph]].

AMPT: J. Xu and C. M. Ko, Phys. Rev. C 84, 014903 (2011) [arXiv:1103.5187 [nucl-th]].

PHENIX: A. Adare et al. [PHENIX Collaboration], Phys. Rev. Lett. 107, 252301 (2011) [arXiv:1105.3928 [nucl-ex]].

Non-flow: P. Bozek and W. Broniowski, arXiv:1204.3580 [nucl-th].

Fluctuations: K. Dusling, F. Gelis, T. Lappi and R. Venugopalan, Nucl. Phys. A 836, 159 (2010) [arXiv:0911.2720 [hep-ph]].

ALICE: B. Abelev et al., arXiv:1205.5761 [nucl-ex]; K. Aamodt et al., Phys. Rev. Lett. 107, 032301 (2011) [arXiv:1105.3865 [nucl-ex]].

ATLAS: G. Aad et al., arXiv:1203.3087 [hep-ex].

PHSD: V. P. Konchakovski, E. L. Bratkovskaya, W. Cassing, V. D. Toneev, S. A. Voloshin and V. Voronyuk, Phys. Rev. C85, 044922 (2012) [arXiv:1201.3320 [nucl-th]].