Rapidity dependent flow fluctuations at RHIC

Matthew Luzum
(with F. Gardim, F. Grassi, J. Noronha-Hostler, J-Y Olitrault)

Universidade de São Paulo

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RAPIDITY FLUCTUATIONS

- Fluctuations are important
  - Essential for understanding measurements
  - Suggests new measurements
- Fluctuations depend on rapidity in addition to transverse coordinates
- $\Longrightarrow$ must take into account when analyzing measurements
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- NeXus is a model for hydrodynamic initial conditions that includes dynamic, rapidity-dependent fluctuations
- Fits RHIC data well with ideal hydro "NeXSPheRIO"
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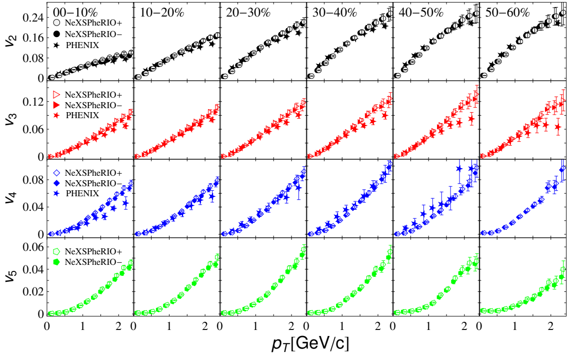

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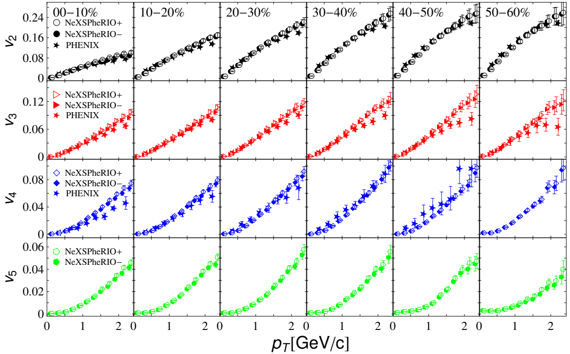

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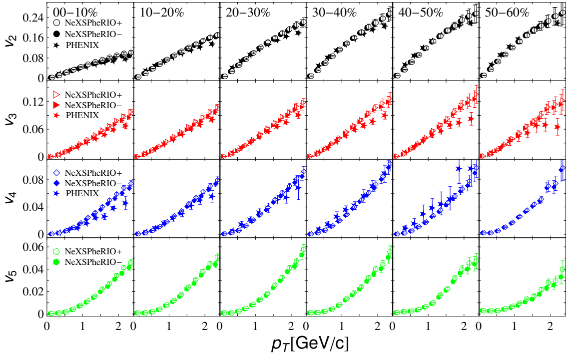

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CORRELATIONS

- Prerequisite notation:

$$P(\phi) = \sum_{n=-\infty}^{\infty} V_n(\eta) e^{-in\phi}$$

- In hydro picture, particles are independent
- Azimuthal measurements are multiparticle correlations.

$$\langle m \rangle_{n_1,n_2,\ldots,n_m} \equiv \left\langle \langle \cos(n_1\phi + n_2\phi \ldots + n_m\phi) \rangle_{m \text{ particles}} \right\rangle$$

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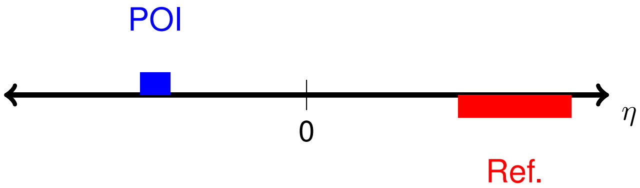

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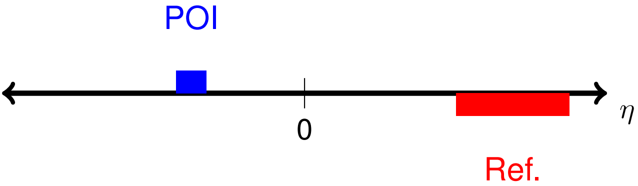

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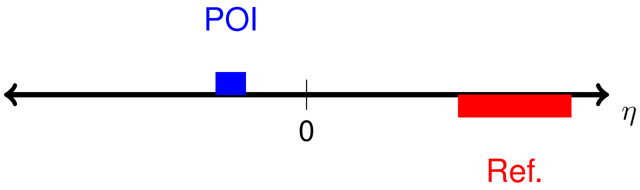

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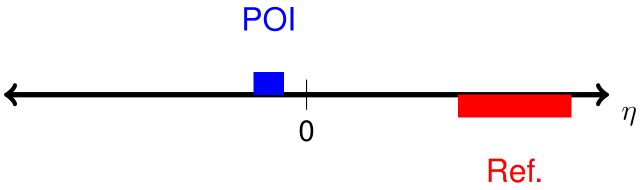

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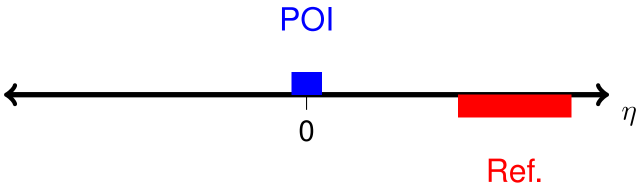

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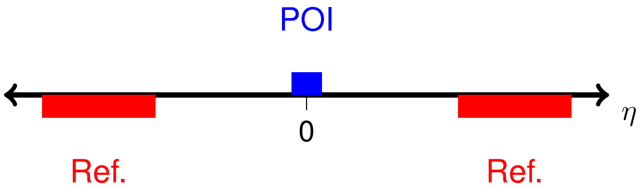

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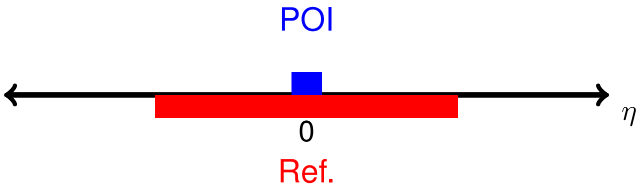

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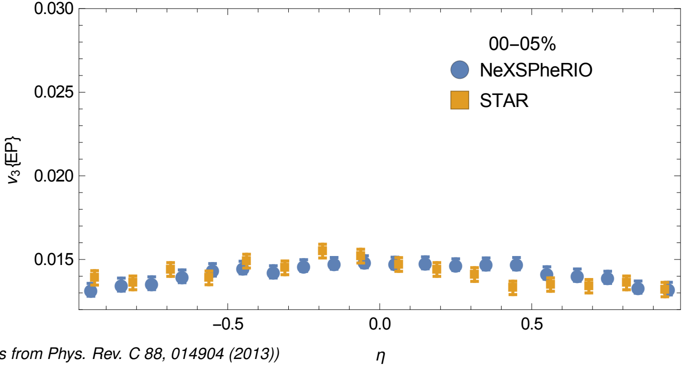

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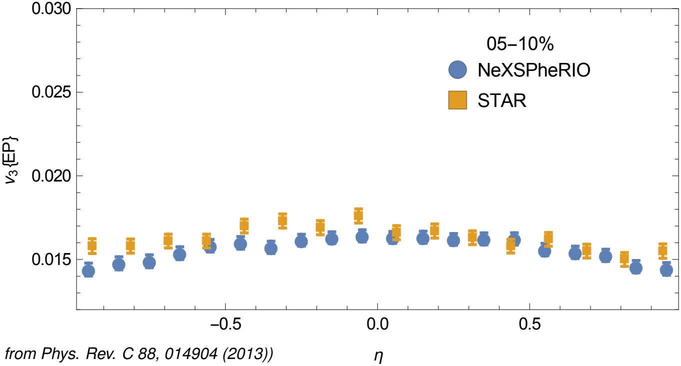

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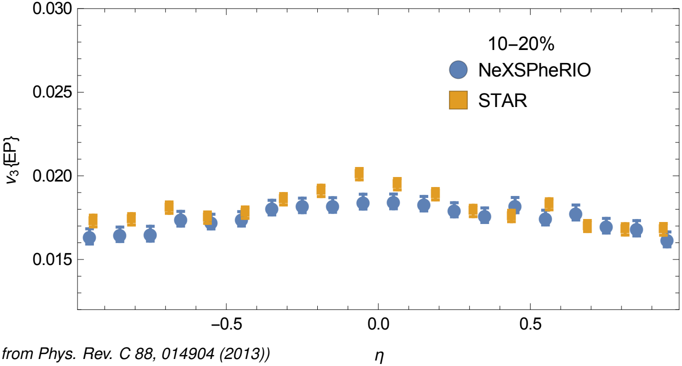

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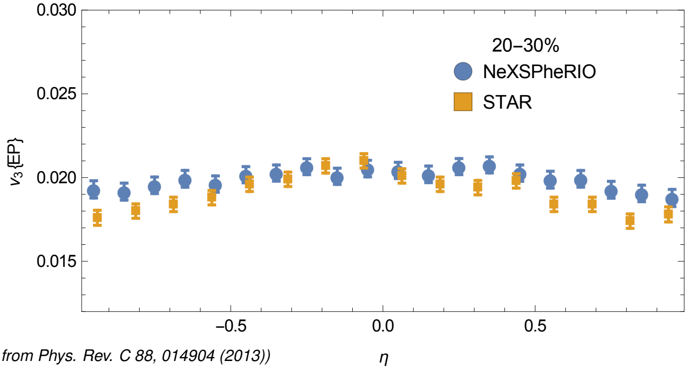

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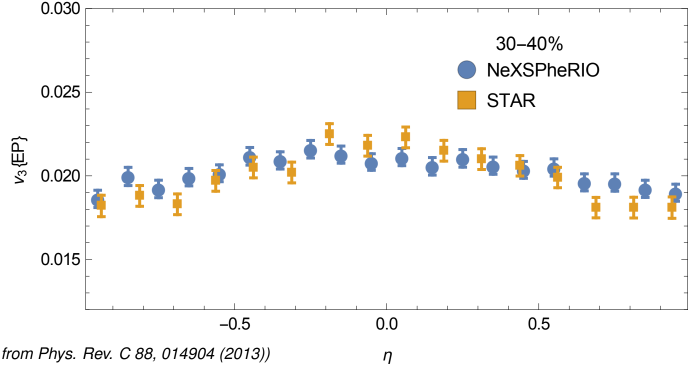

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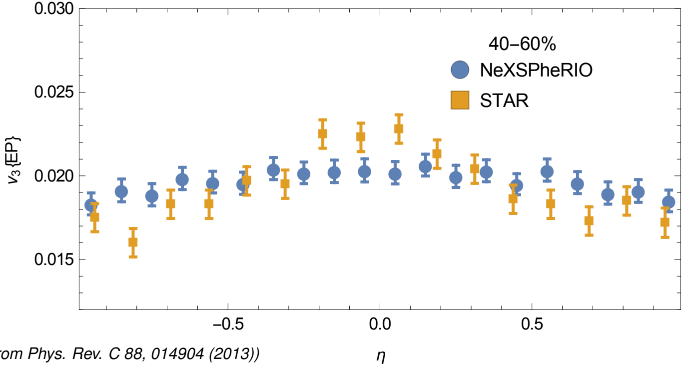

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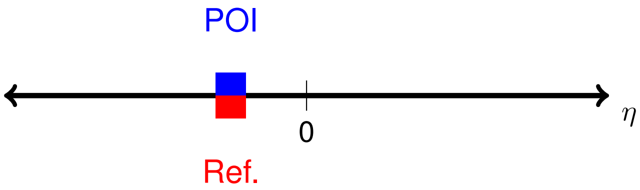

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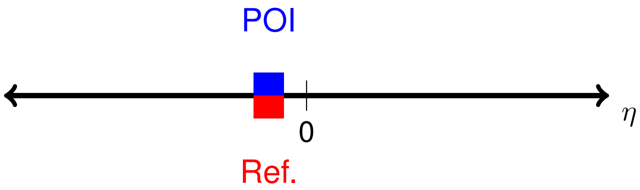

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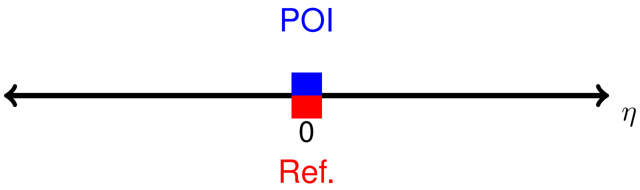

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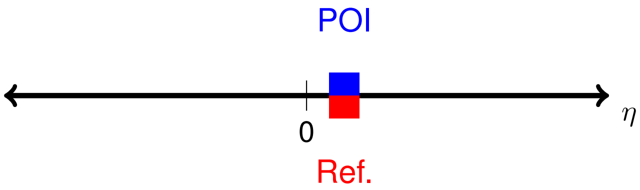

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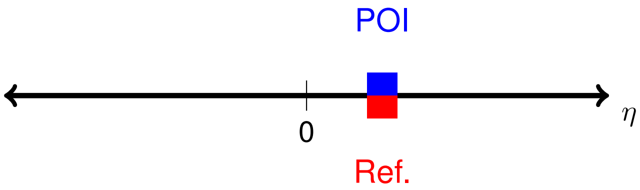

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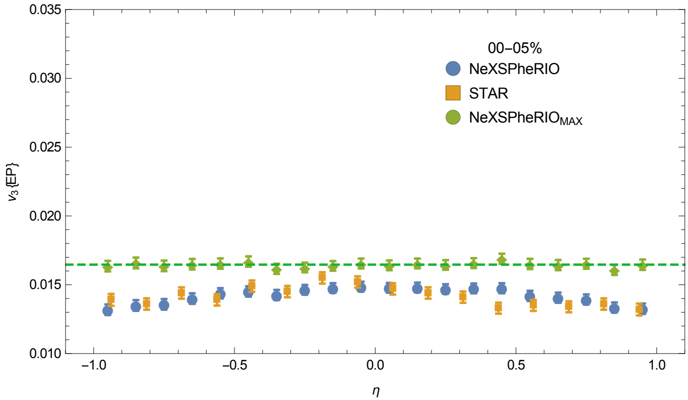

- Average magnitude of v_3 does *not* depend on η within TPC
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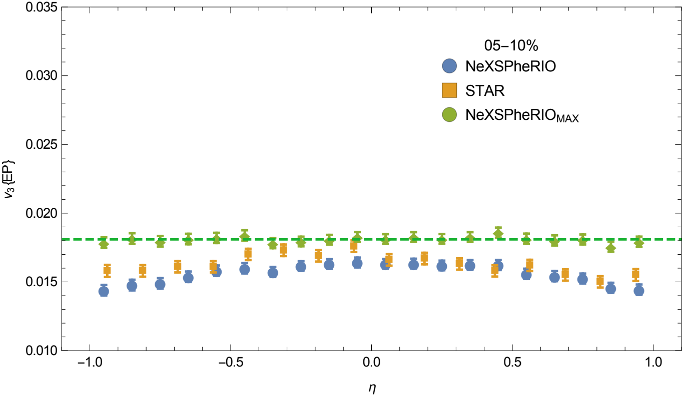

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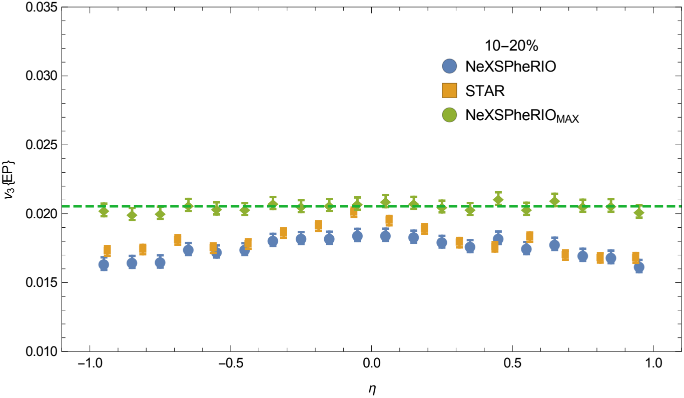

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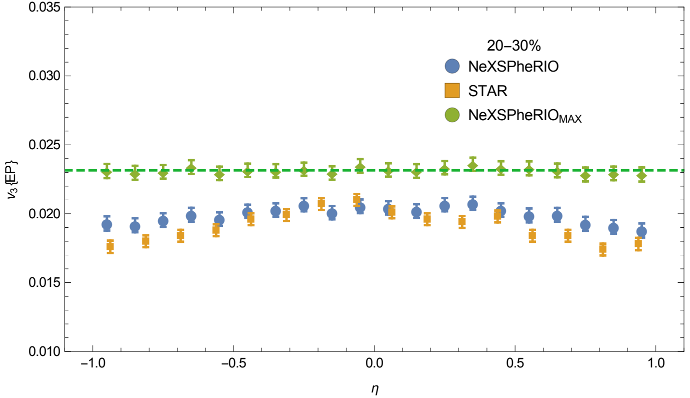

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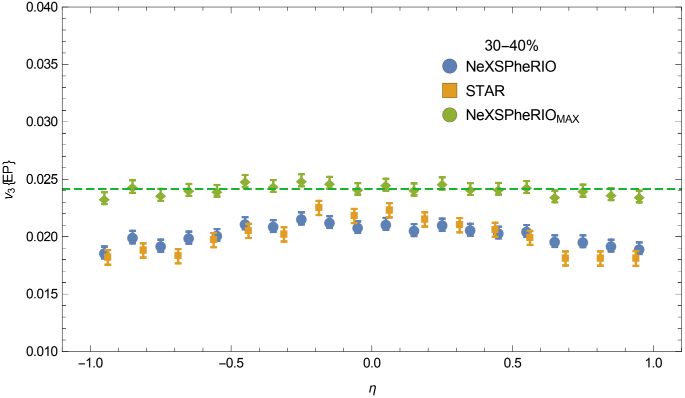

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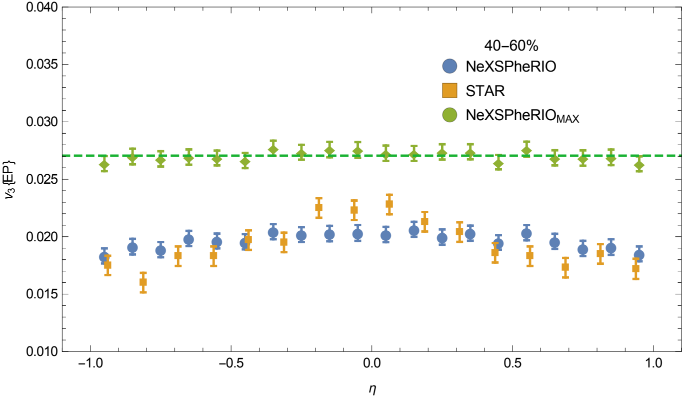

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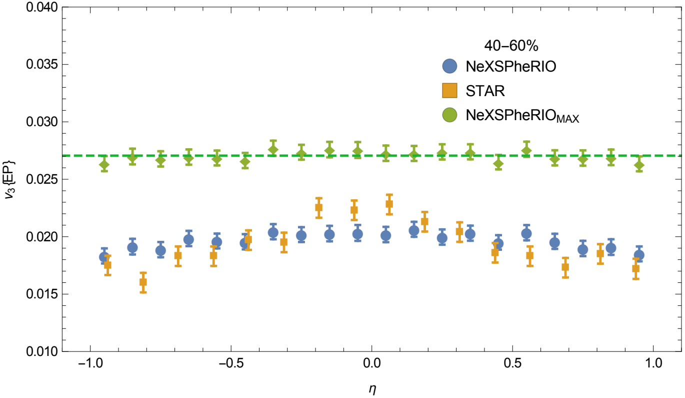

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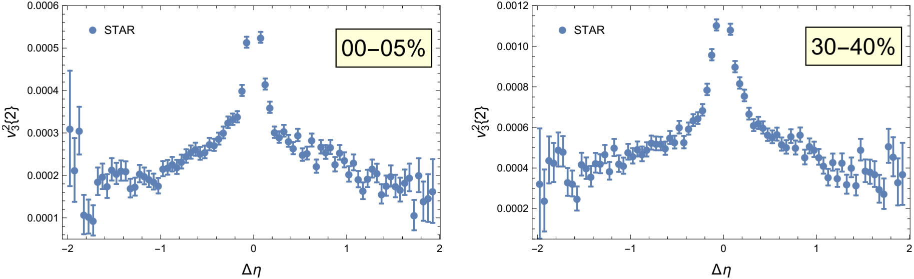

(STAR, Phys. Rev. C 88, 014904 (2013))

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- Data fit by narrow Gaussian plus wide Gaussian
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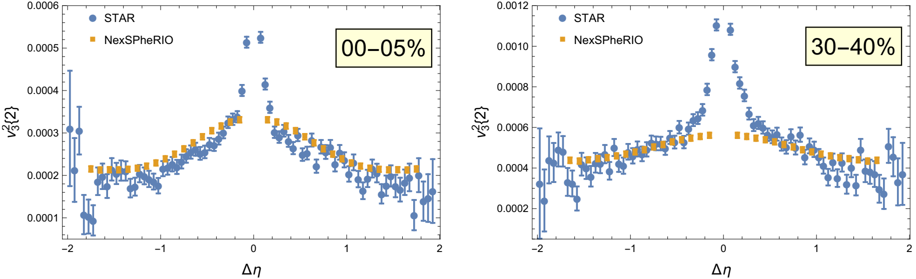

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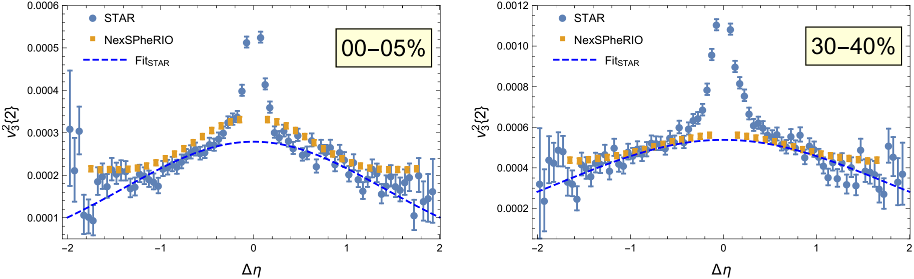

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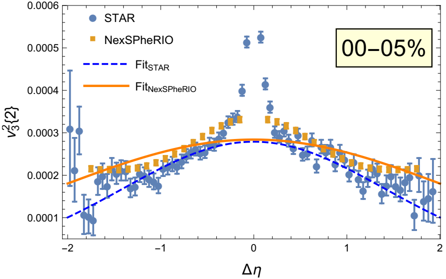

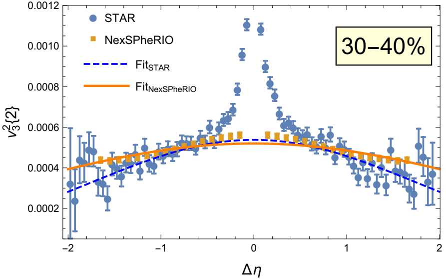

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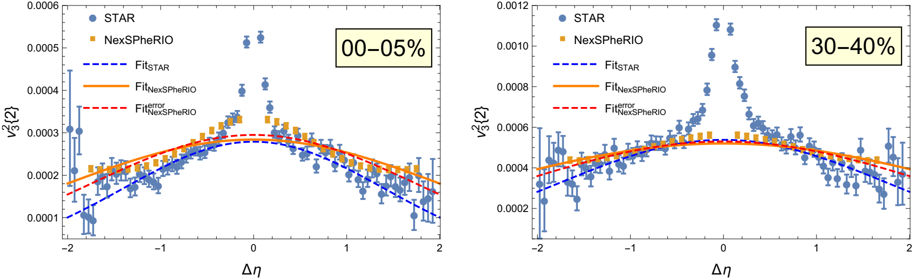
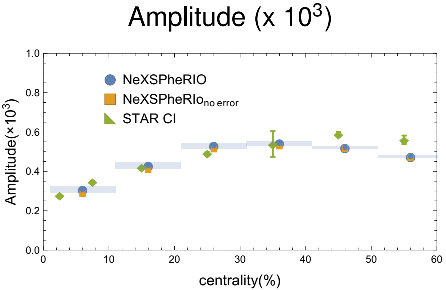
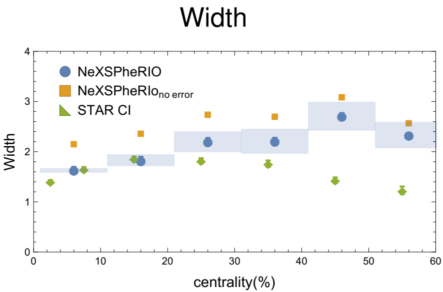


(STAR, Phys. Rev. C 88, 014904 (2013))

- Can investigate $\Delta\eta$ dependence explicitly
- Data fit by narrow Gaussian plus wide Gaussian
- Calculation not Gaussian; small error bars $\Longrightarrow$ too wide, despite reasonable fit to data
- $\Longrightarrow$ use experimental error bars with Gaussian fit to calculation

Gaussian fit parameters vs. centrality





- Experimental weighting improves agreement
- NeXSPheRIO still too wide in peripheral collisions

Higher Cumulants

- Can also measure cumulants of >2 particles

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$$v_n\{4\} = \left(2\langle |V_n|^2\rangle^2 - \langle |V_n|^4\rangle\right)^{1/4}$$

- $\implies$ $v_n\{2\}$ vs. $v_n\{4\}$ is measure of EBE v_n fluctuations
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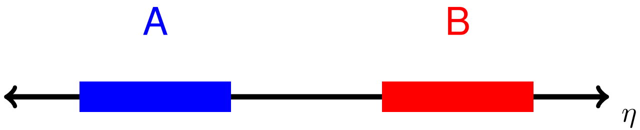

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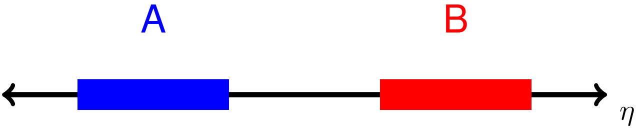

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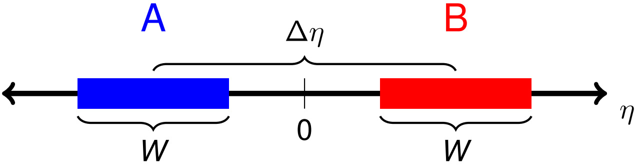

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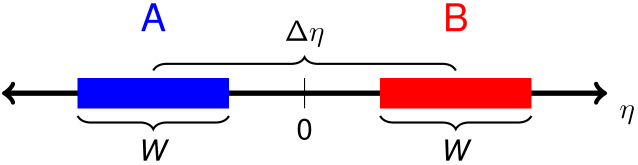

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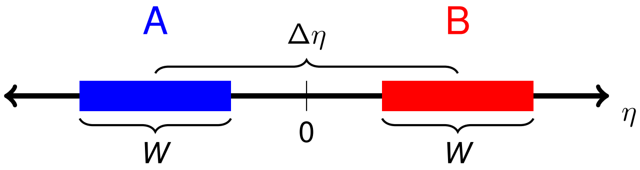

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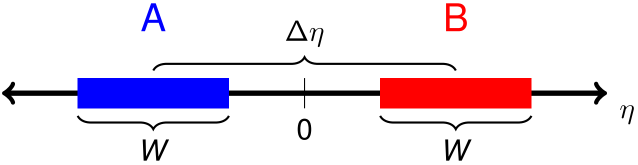

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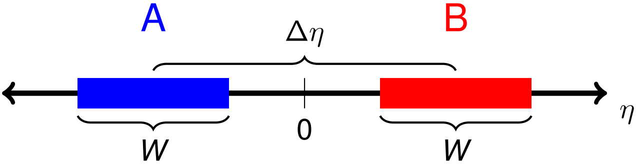

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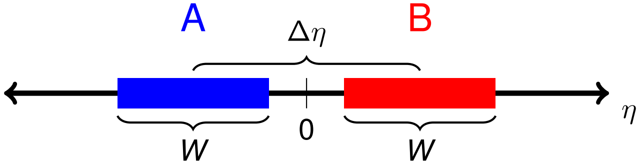

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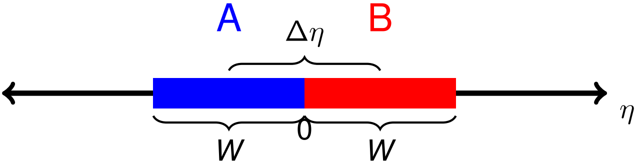

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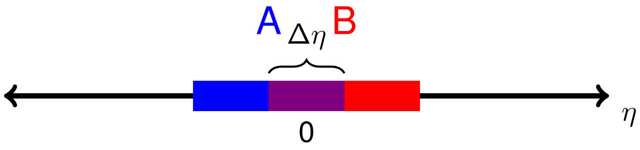

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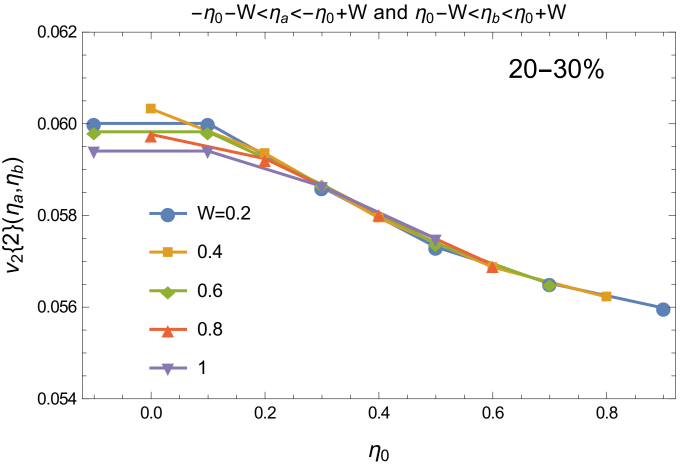

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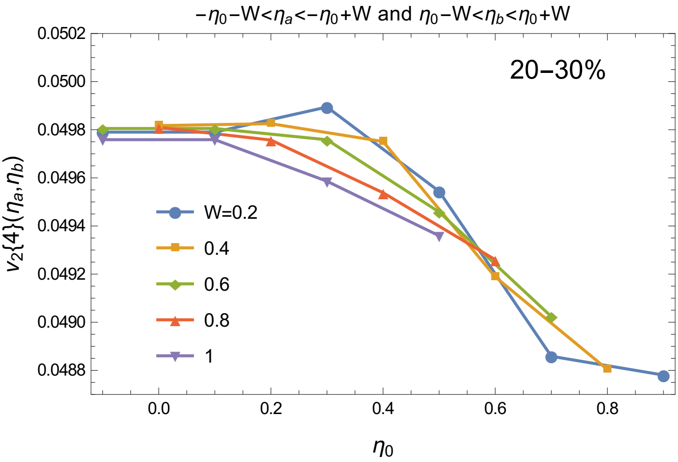

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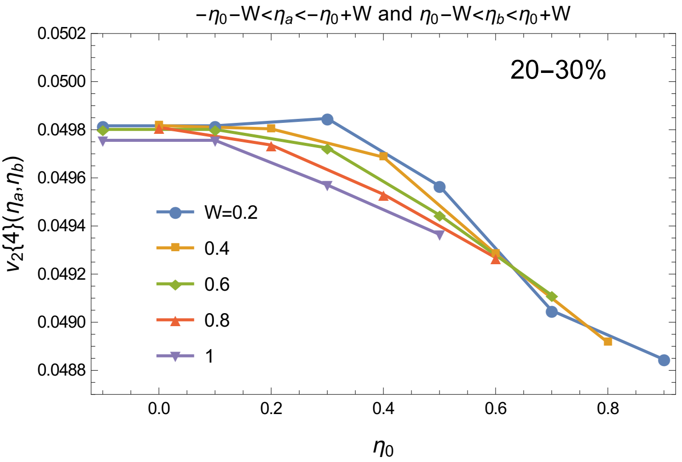

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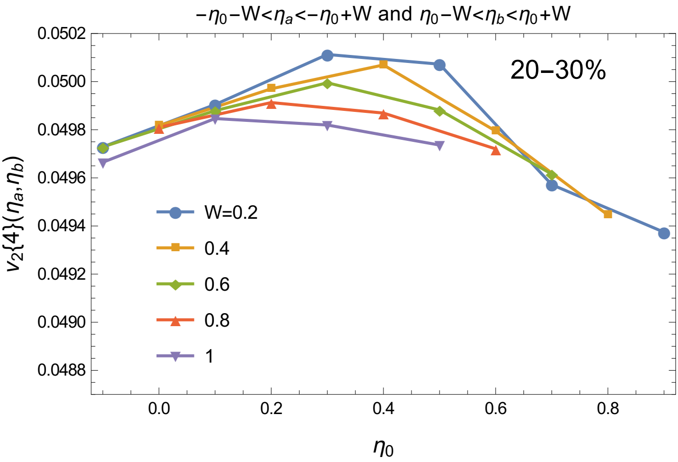

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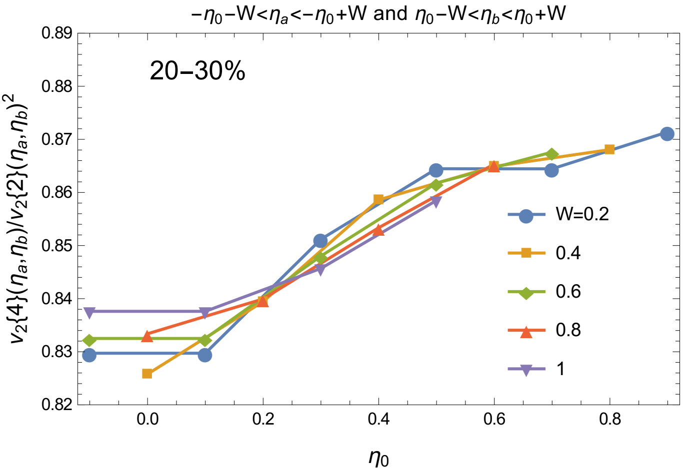

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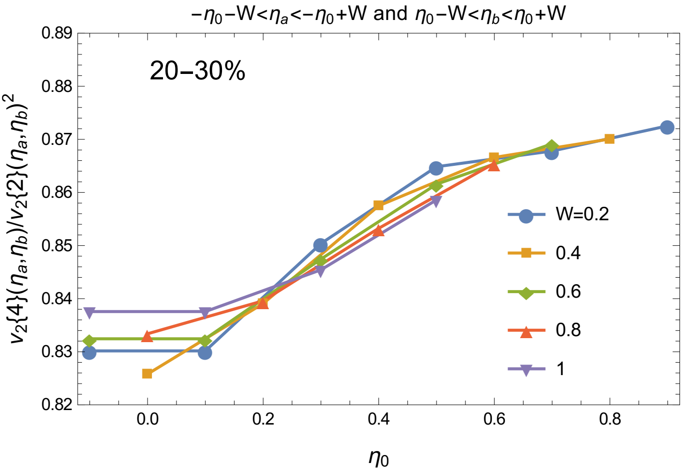

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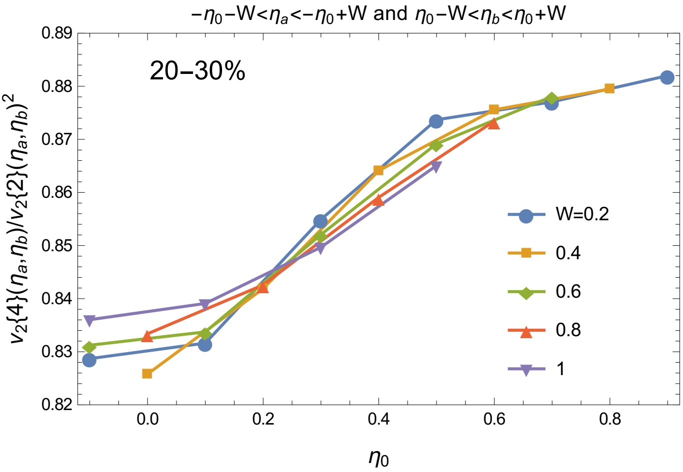

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- Need to take into account for precise understanding of data (even "fixed rapidity" measurements)
- Rapidity-dependent fluctuations can be studied in detail
- The rapidity-dependent fluctuations in NeXus give reasonable description of data
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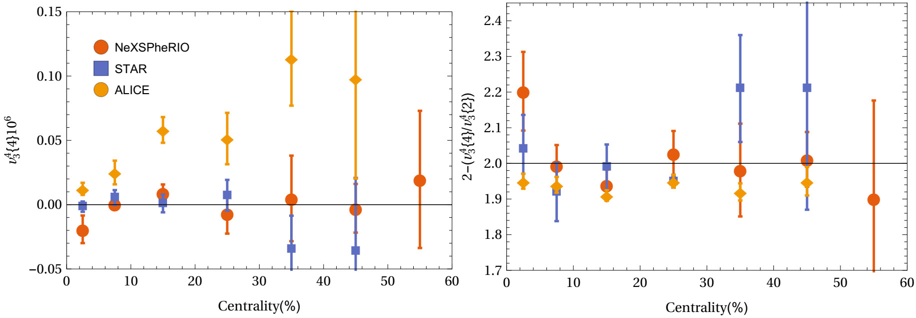
Bonus Slides

$v_3\{4\}$



- $v_3\{4\}$ from NeXSPheRIO consistent with STAR
- $v_3\{4\}$ is inconsistent between RHIC and LHC, but ratio $v_3\{4\}/v_3\{2\}$ is consistent