

Effects of Jets in the Flow observables

Jun Takahashi & Rafael D. De Souza

Collaboration with NeXSPheRIO group

(T. Kodama)



Introduction

Hydro describes well the experimental data in low p_T .

NexSPheRIO simulates Heavy Ion Collision including:
IC+ 3D hydro evolution + hadronization.

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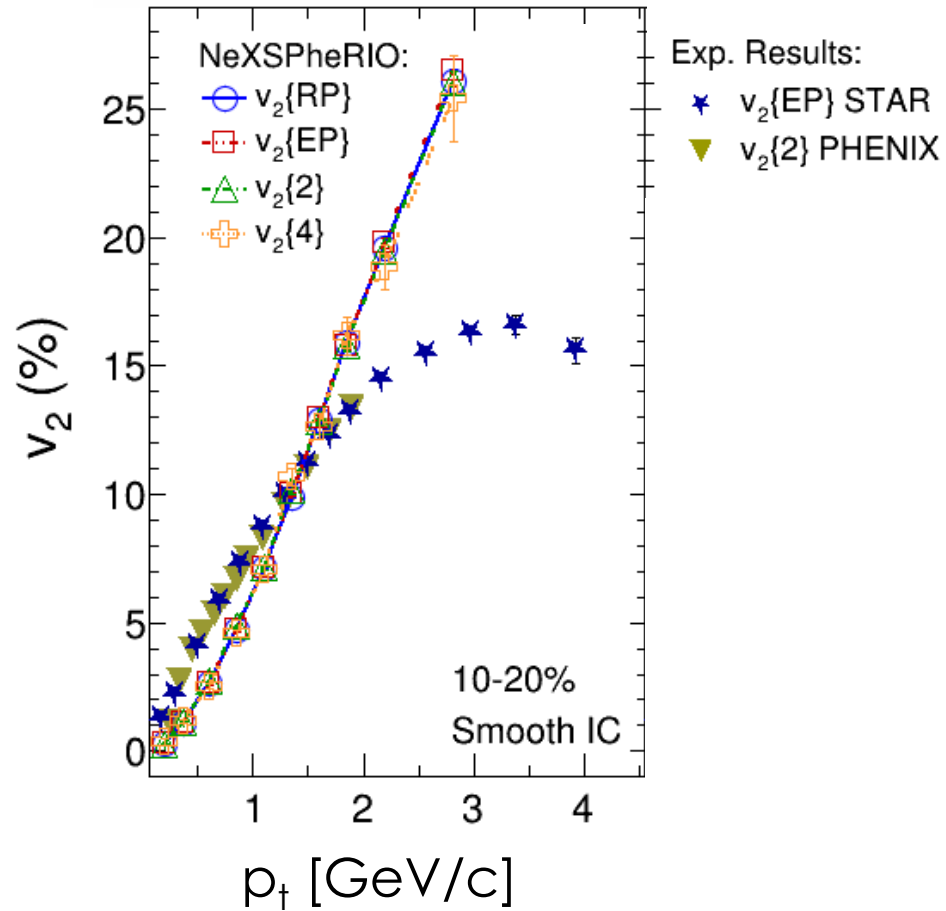
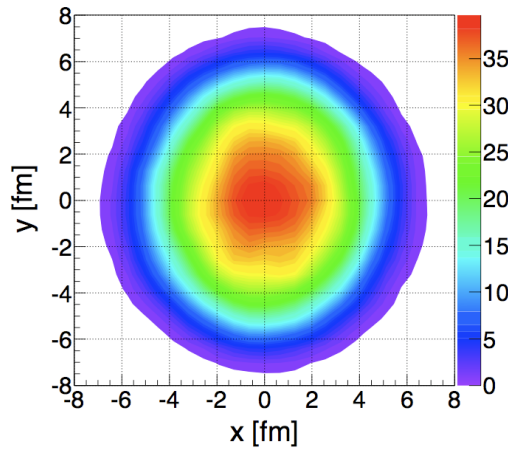
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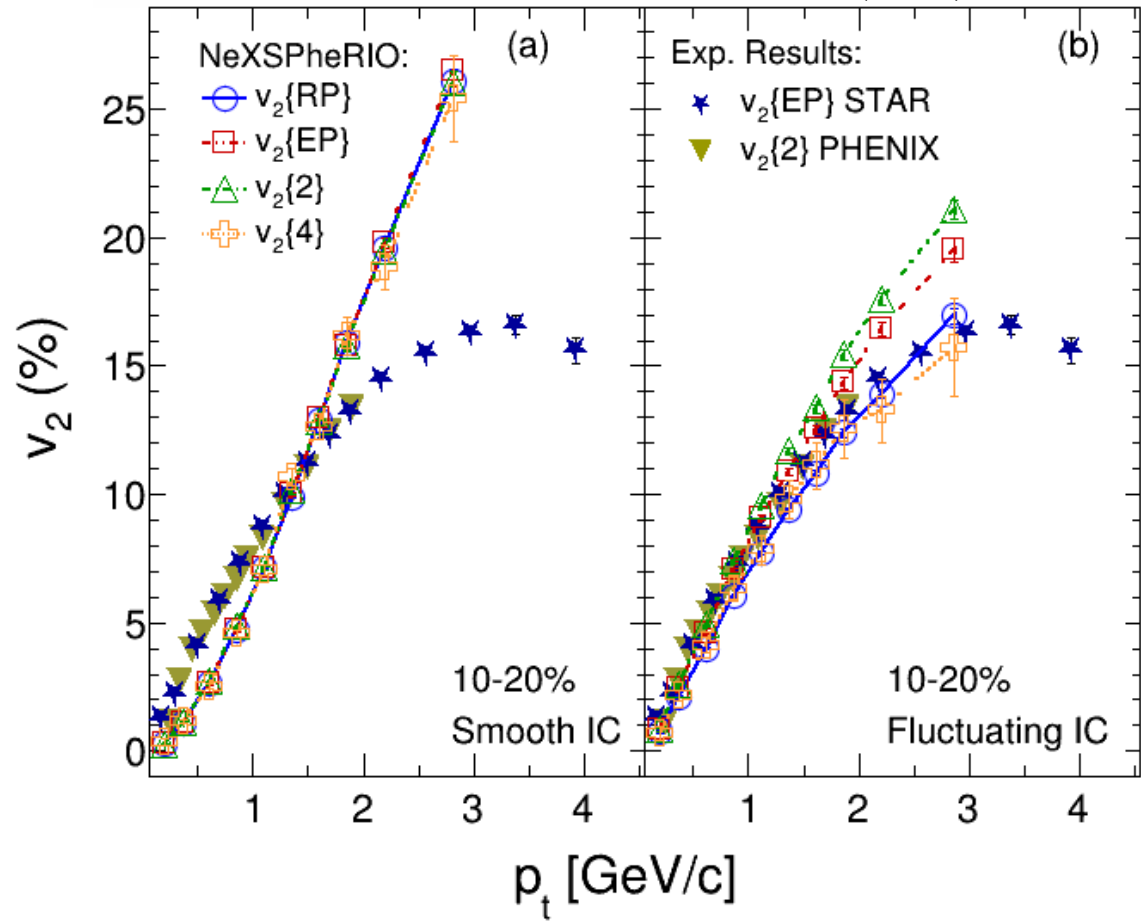
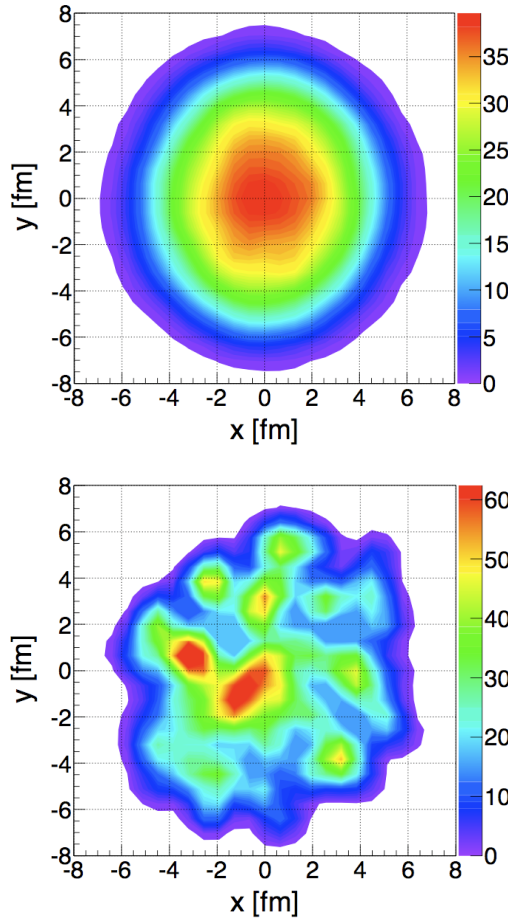
Fluctuations of IC are key to describe many of the experimental observables.

Effects of IC fluctuation

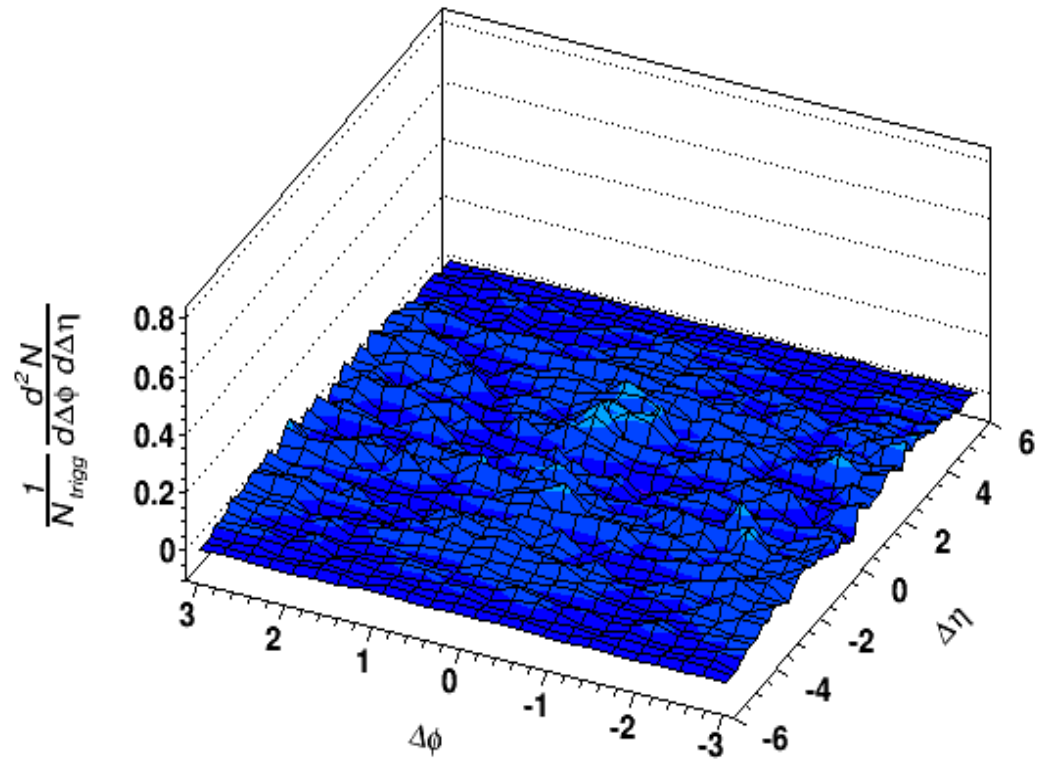
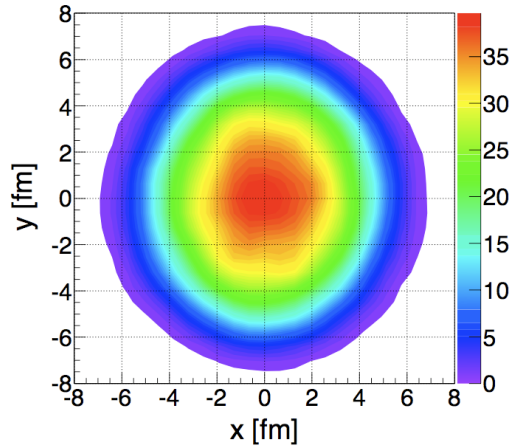


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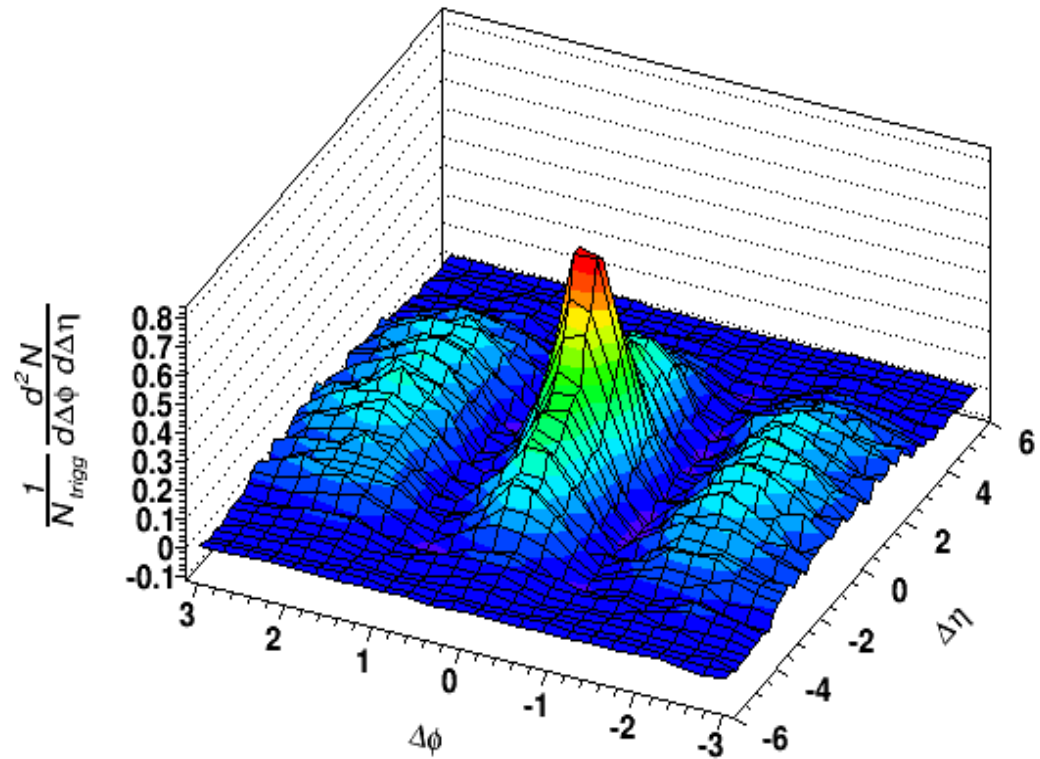
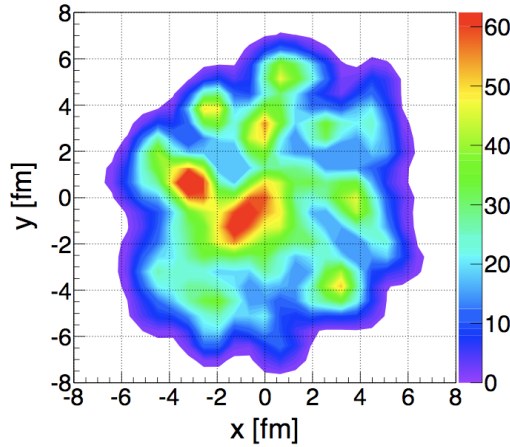
R. D. de Souza et al. PRC 85, 054909 (2012)



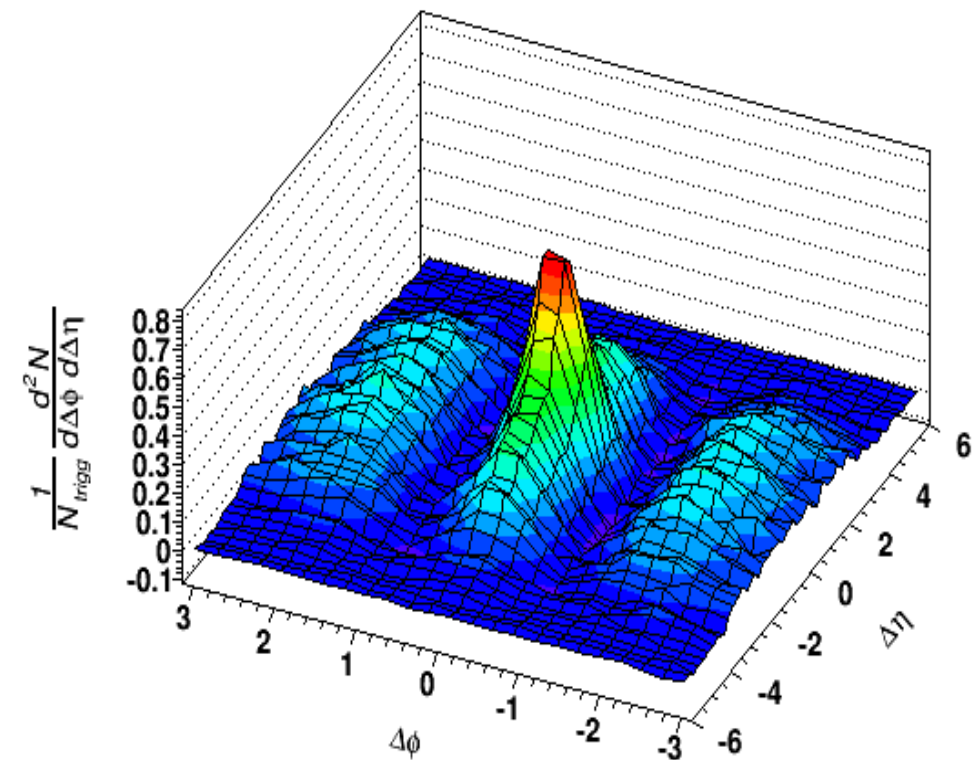
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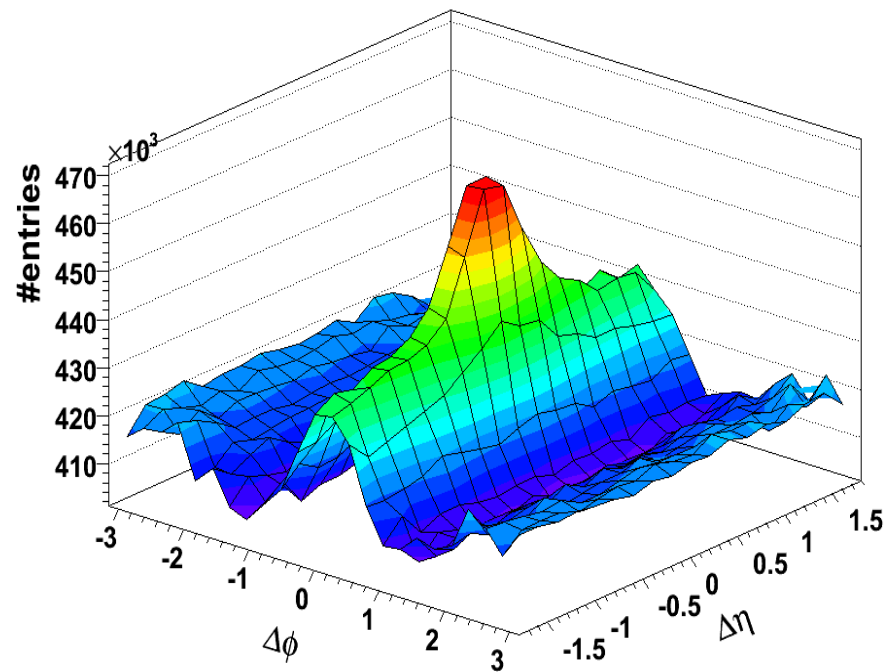
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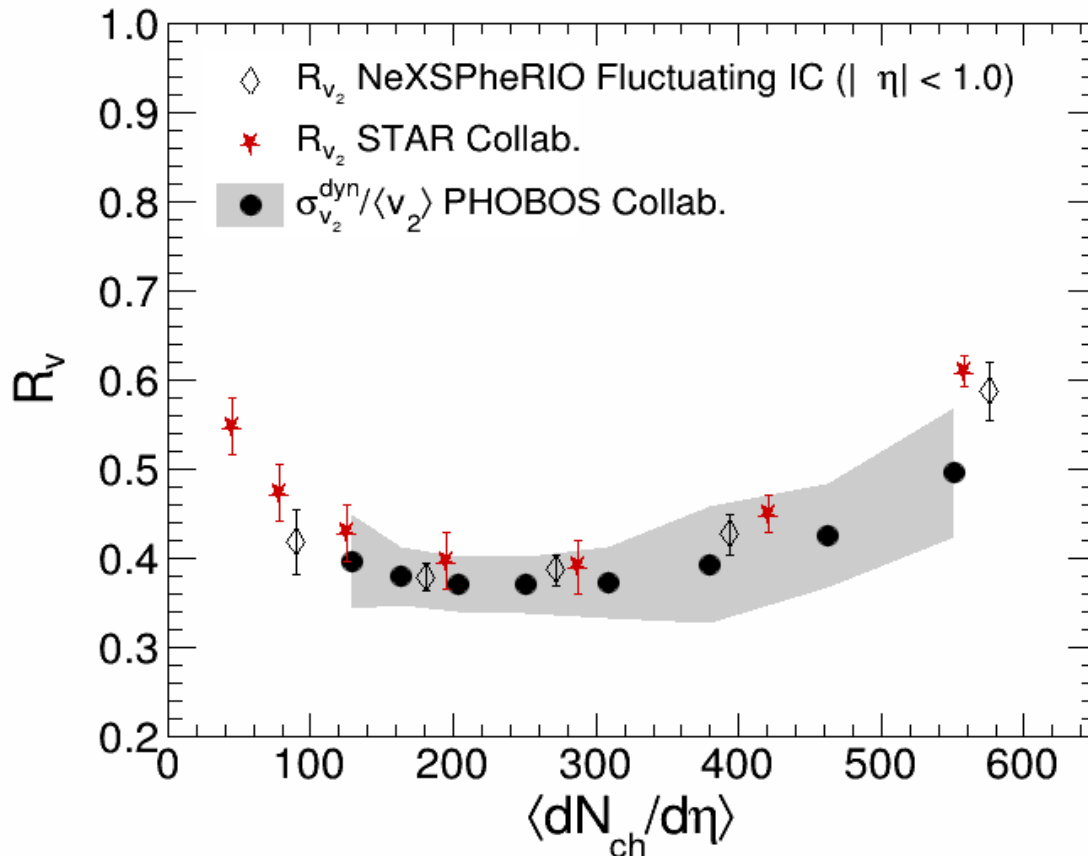


NexSPheRIO EbyE
PRL 103, 242301 (2009)



STAR DATA
PRC 80, 064912 (2009)

Probing the fluctuation

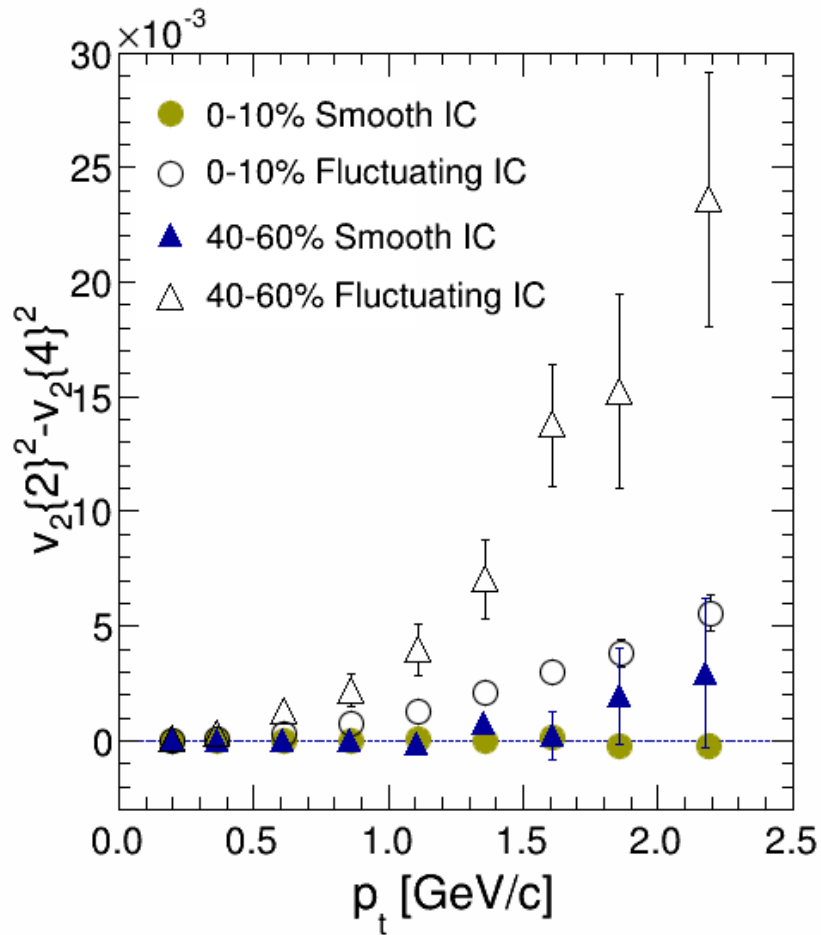


From: arXiv:0809.2949

$$\begin{aligned}
 R_v &= \sqrt{\frac{v_2\{2\}^2 - v_2\{4\}^2}{v_2\{2\}^2 + v_2\{4\}^2}} \\
 &= \sqrt{\frac{2\sigma_{v_2}^2 + \delta}{2\langle v_2 \rangle^2 + \delta}} \approx \frac{\sigma_{v_2}}{\langle v_2 \rangle}
 \end{aligned}$$

R. D. de Souza et al. PRC 85, 054909 (2012)

Probing the fluctuation



From: arXiv:0809.2949

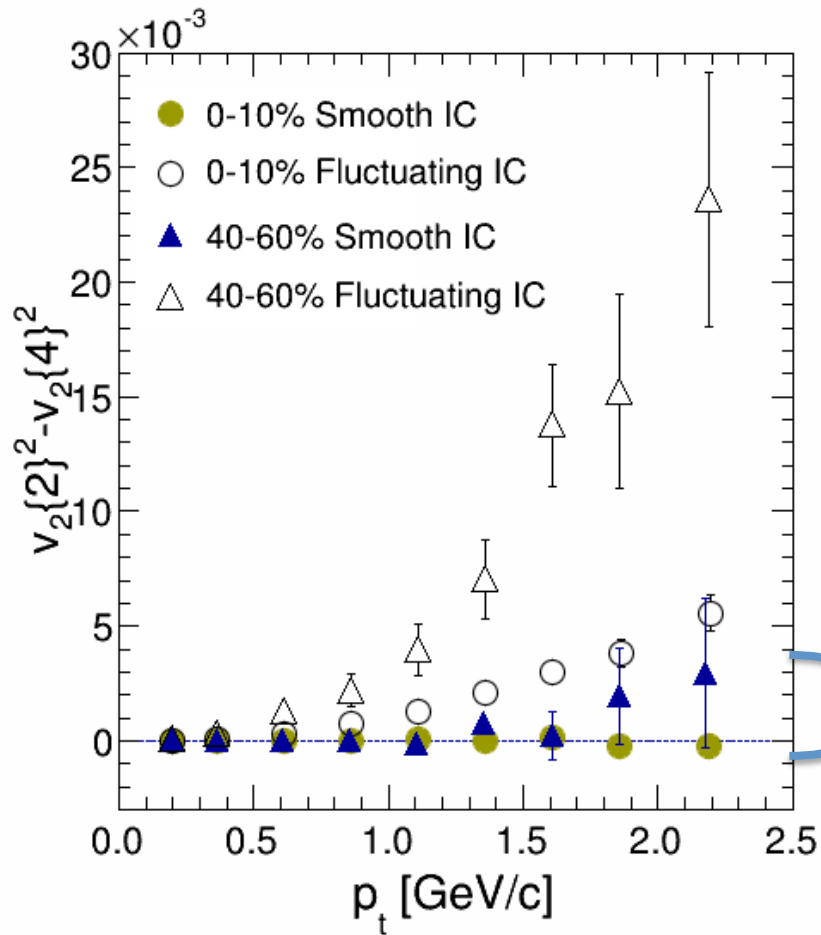
$$v_2\{2\}^2 \approx \langle v_2 \rangle^2 + \delta + \sigma_{v_2}^2,$$

$$v_2\{4\}^2 \approx \langle v_2 \rangle^2 - \sigma_{v_2}^2,$$

$$v_2\{2\}^2 - v_2\{4\}^2 \approx \delta + 2\sigma_{v_2}^2$$

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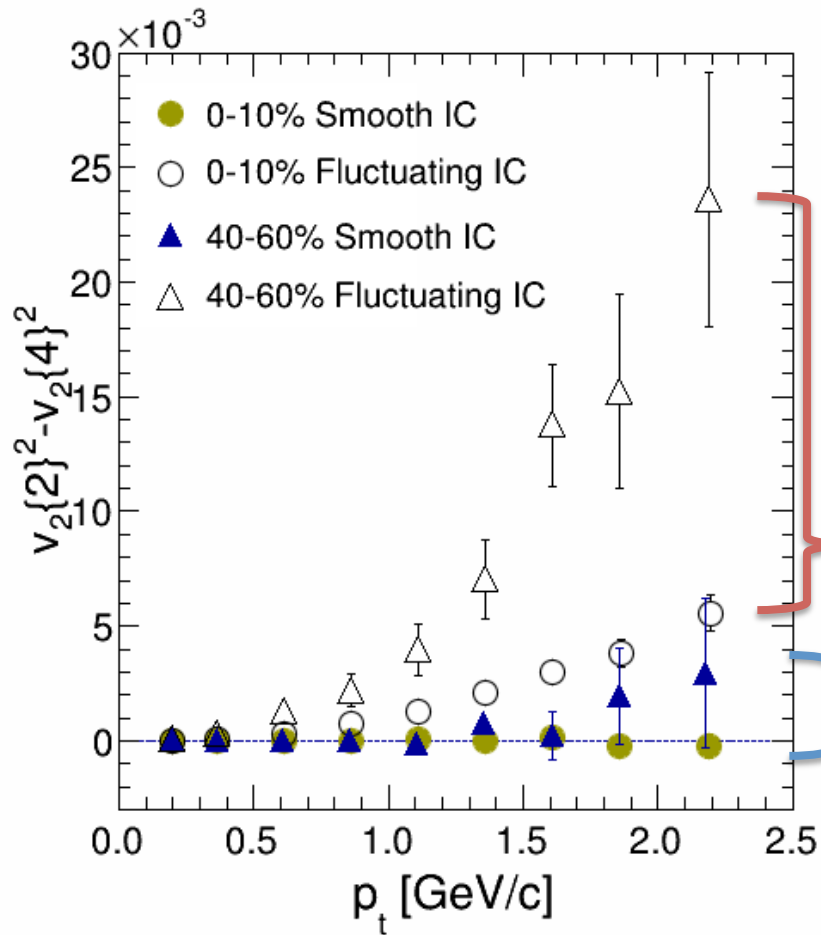
$$v_2\{4\}^2 \approx \langle v_2 \rangle^2 - \sigma_{v_2}^2,$$

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Smooth IC

R. D. de Souza et al. PRC 85, 054909 (2012)

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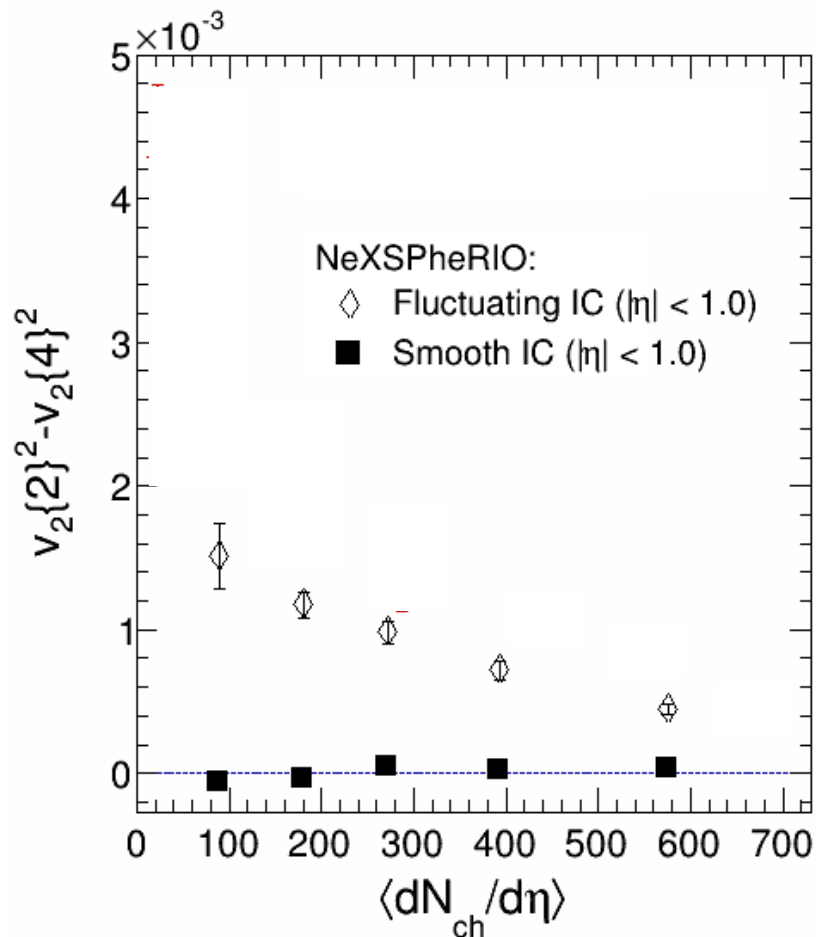
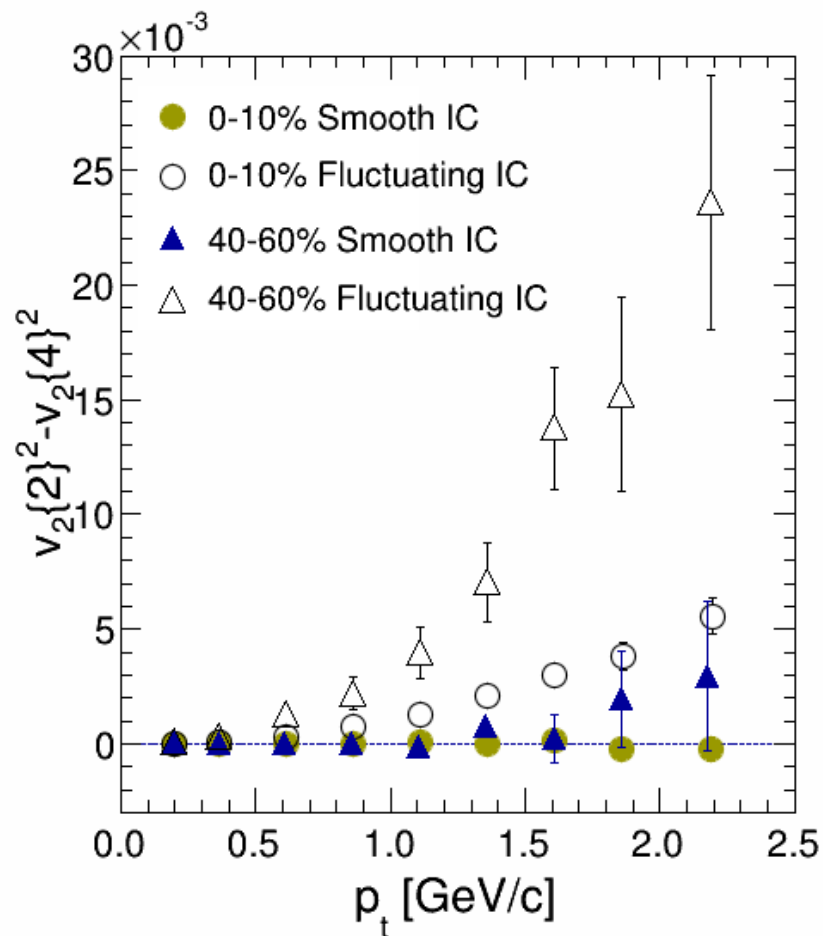
$$v_2\{2\}^2 - v_2\{4\}^2 \approx \delta + 2\sigma_{v_2}^2$$

Fluctuating EbyE IC

Smooth IC

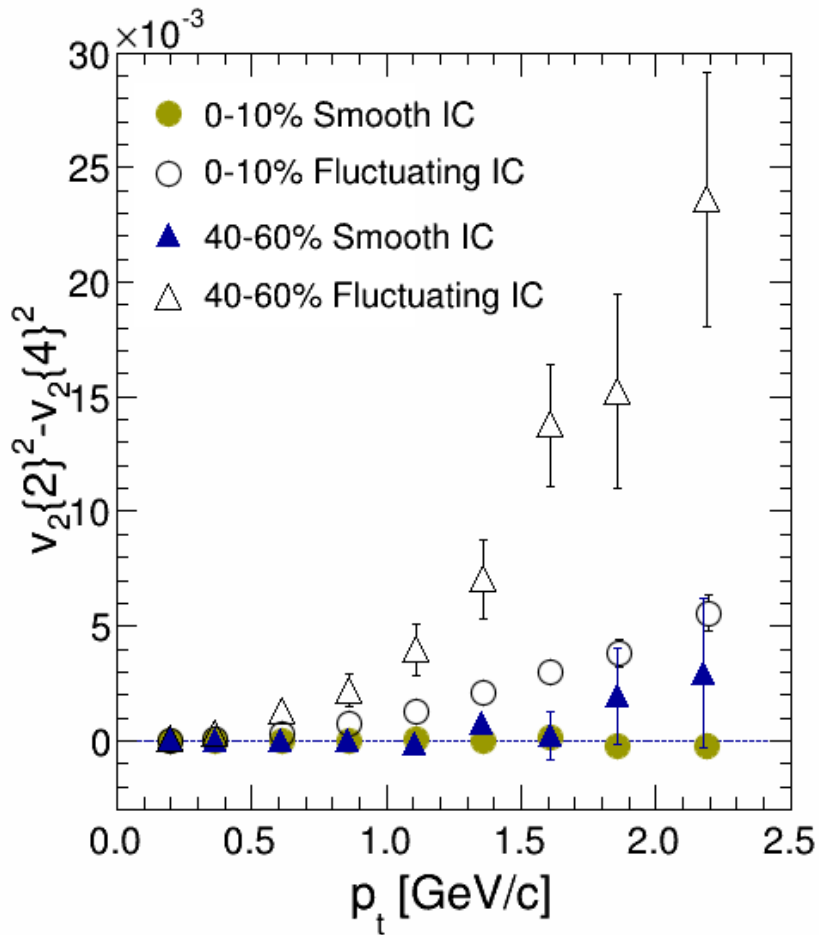
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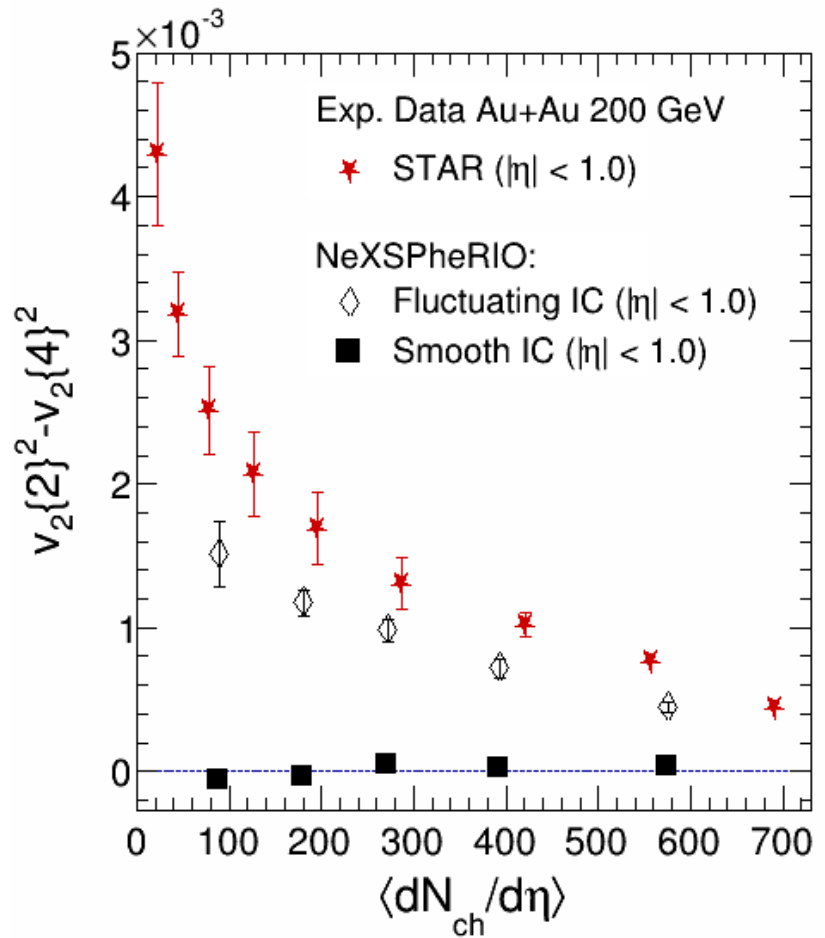


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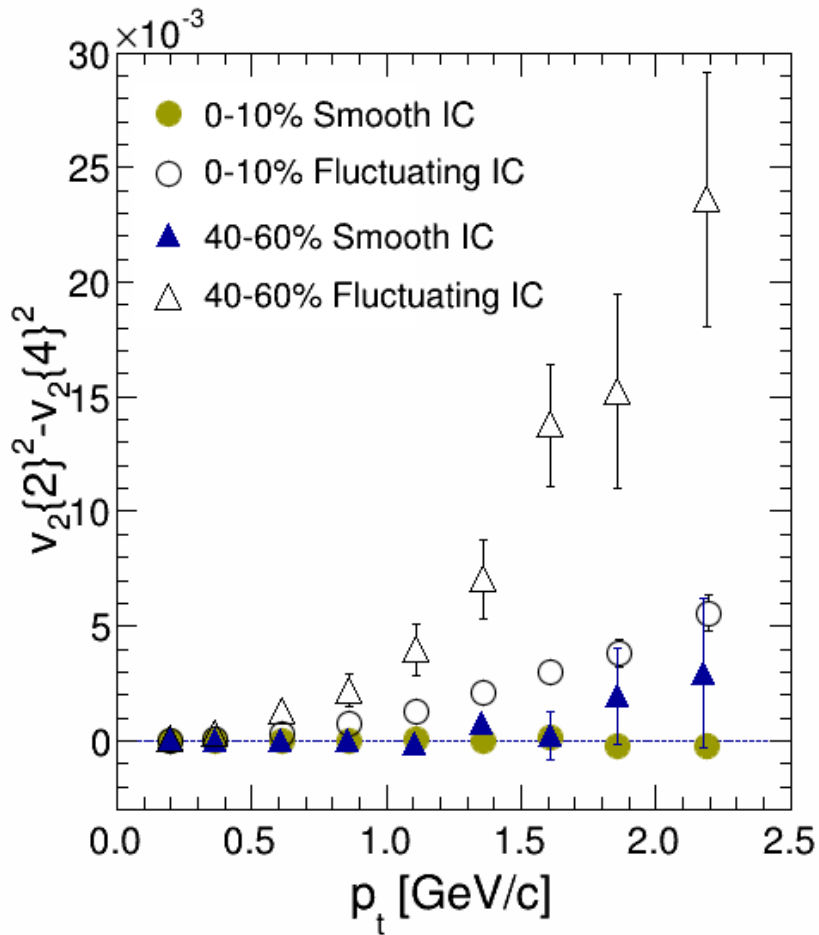


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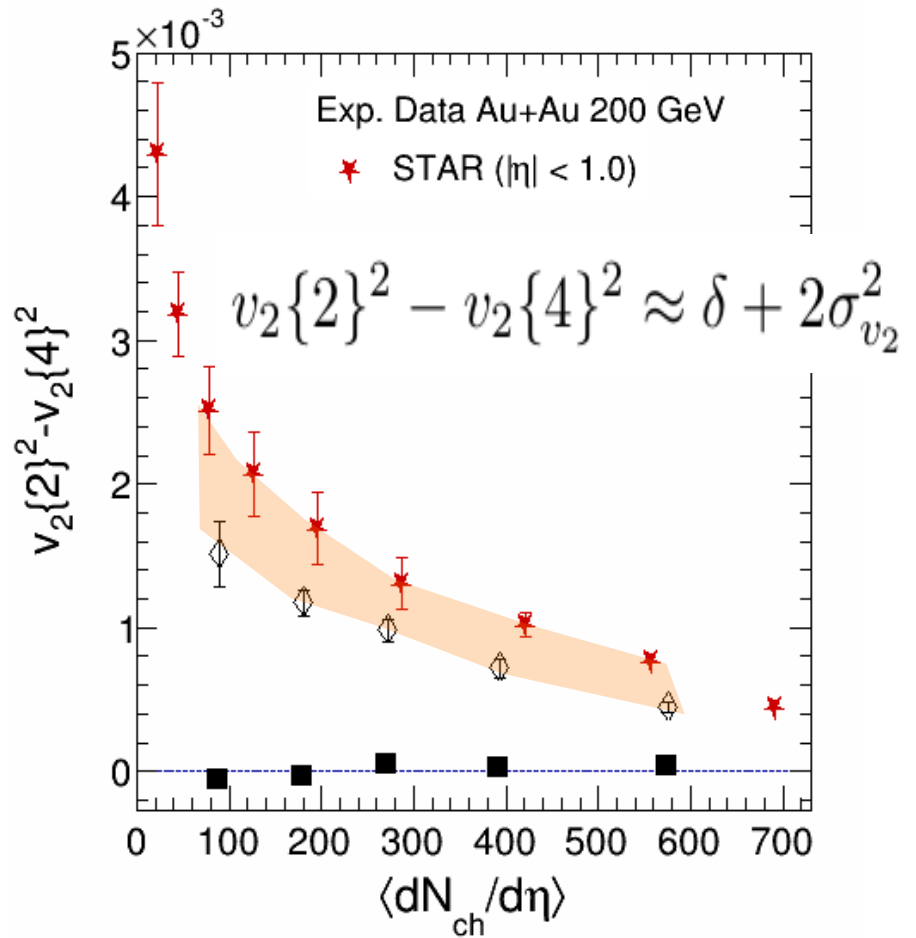


STAR data: PRC 86, 014904 (2012)

Probing the fluctuation

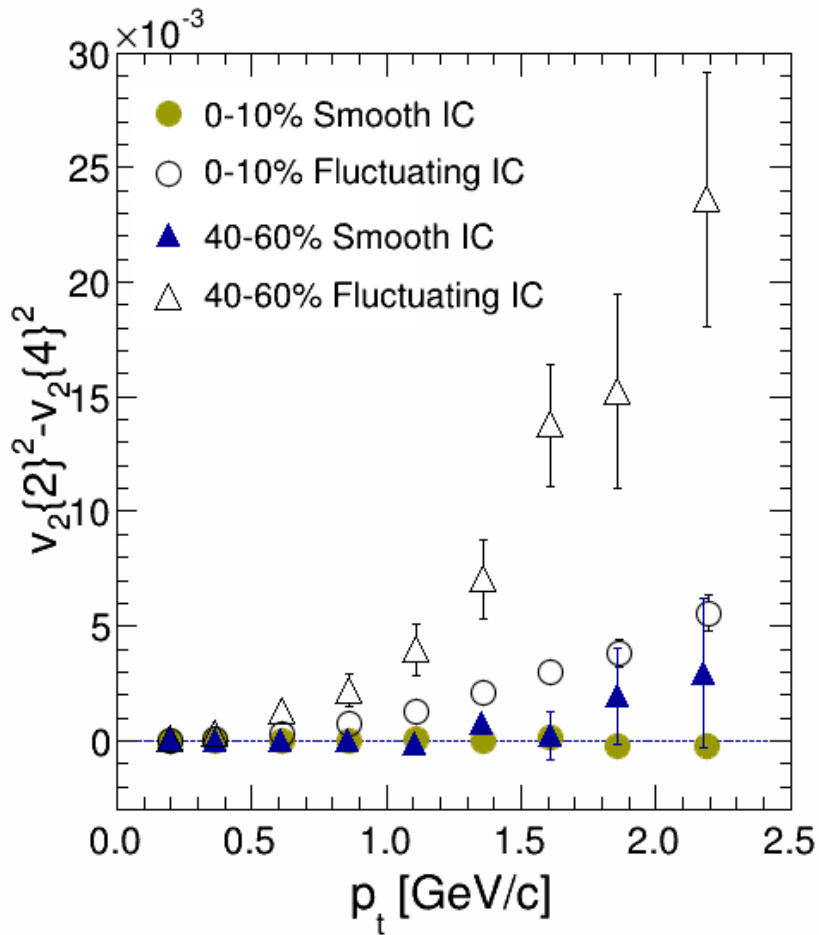


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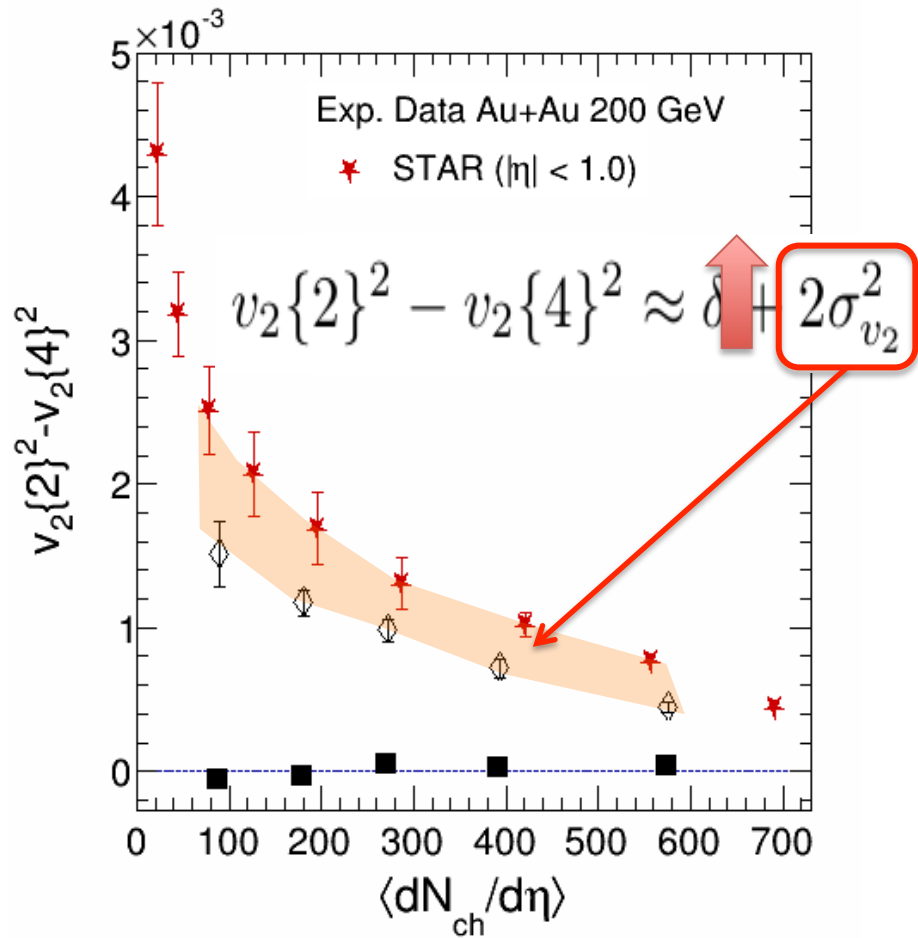


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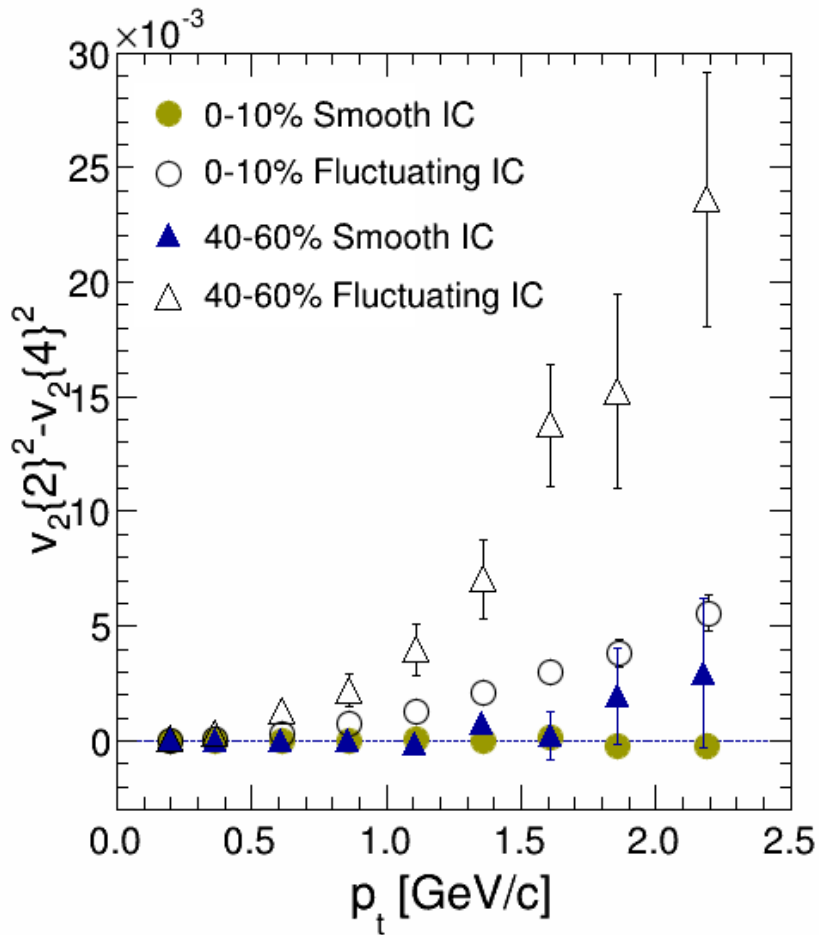


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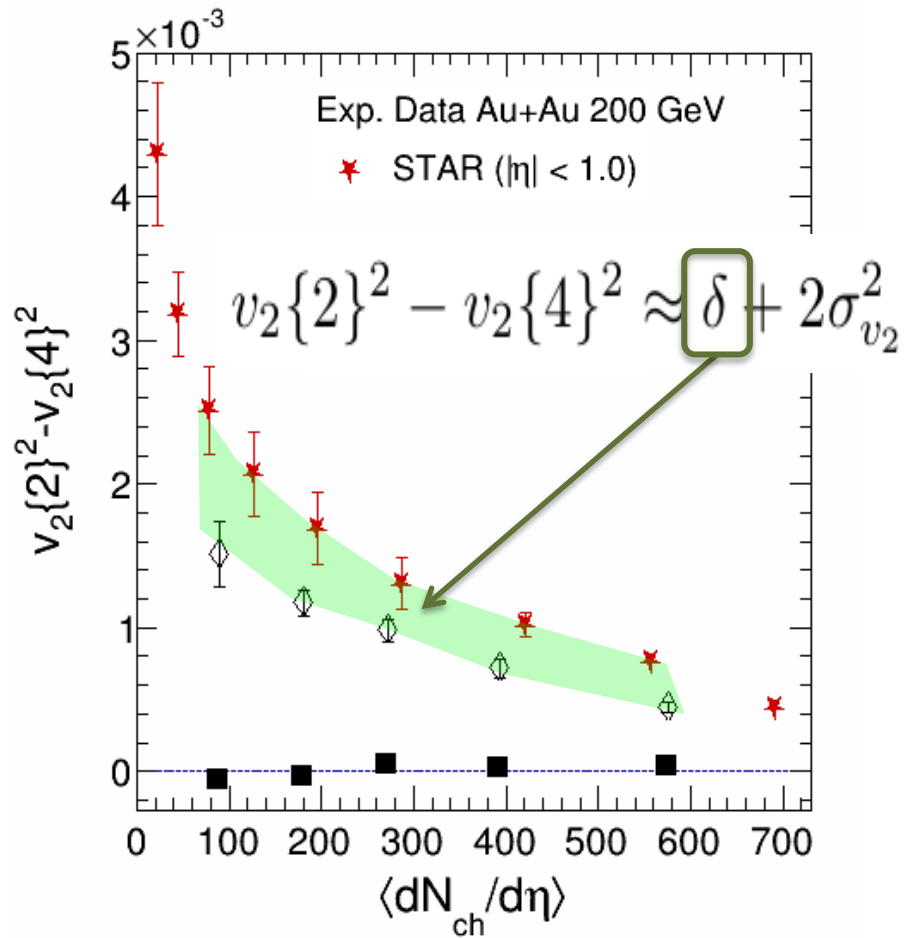


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SPheRIO + Pythia

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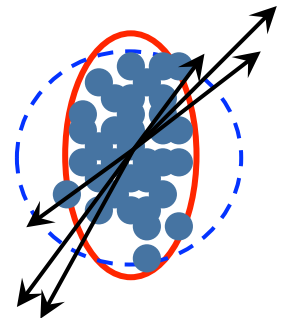
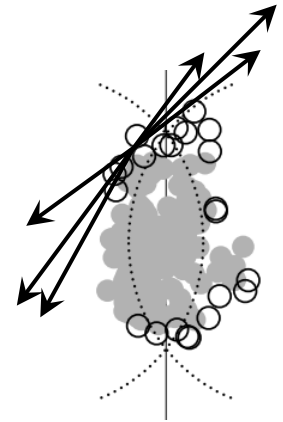
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- Different Pythia configurations used.



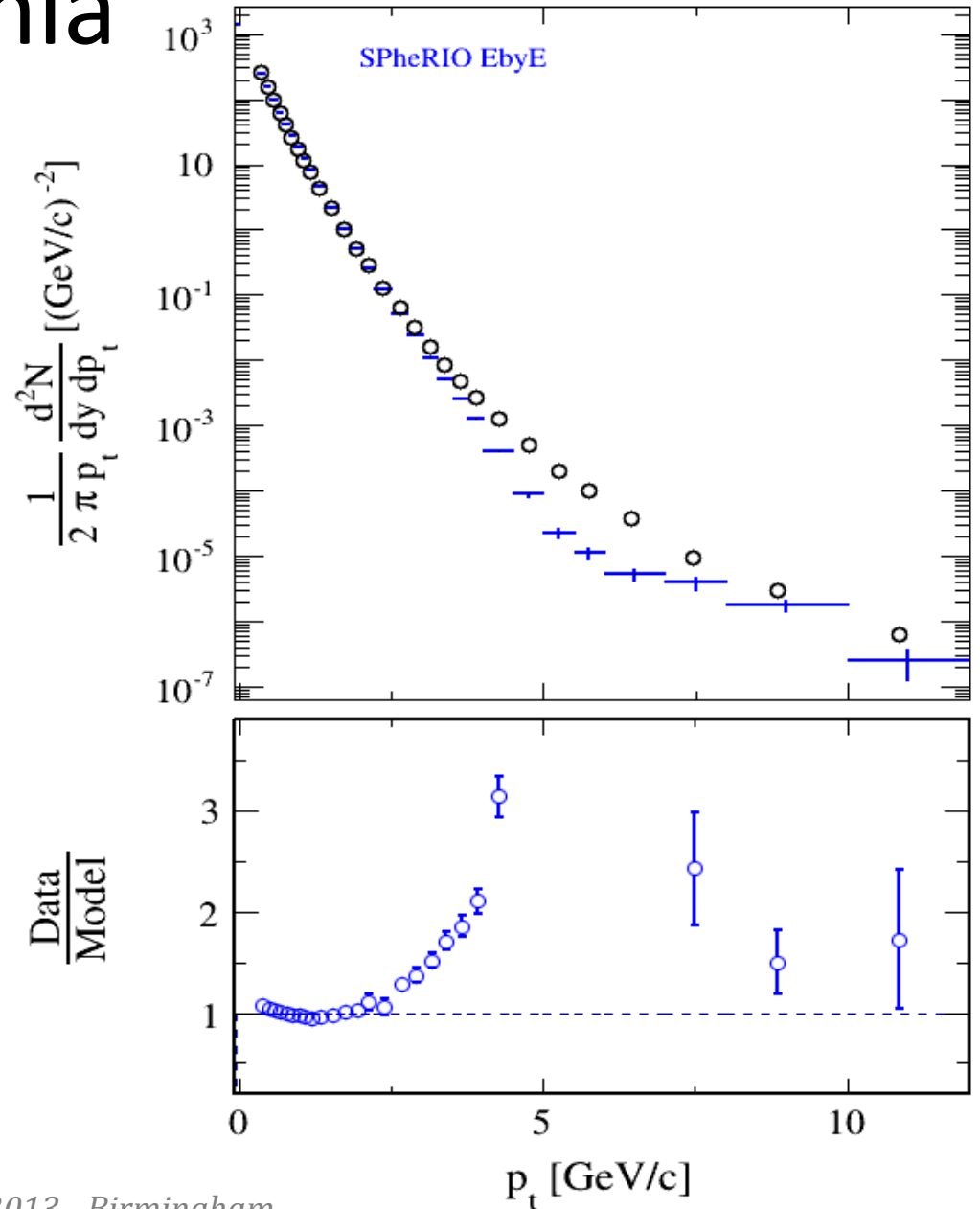
SPheRIO + Pythia

Pions from Au+Au: 10-20%

STAR data:

PRL97,153201 (2006)

SPh EbyE



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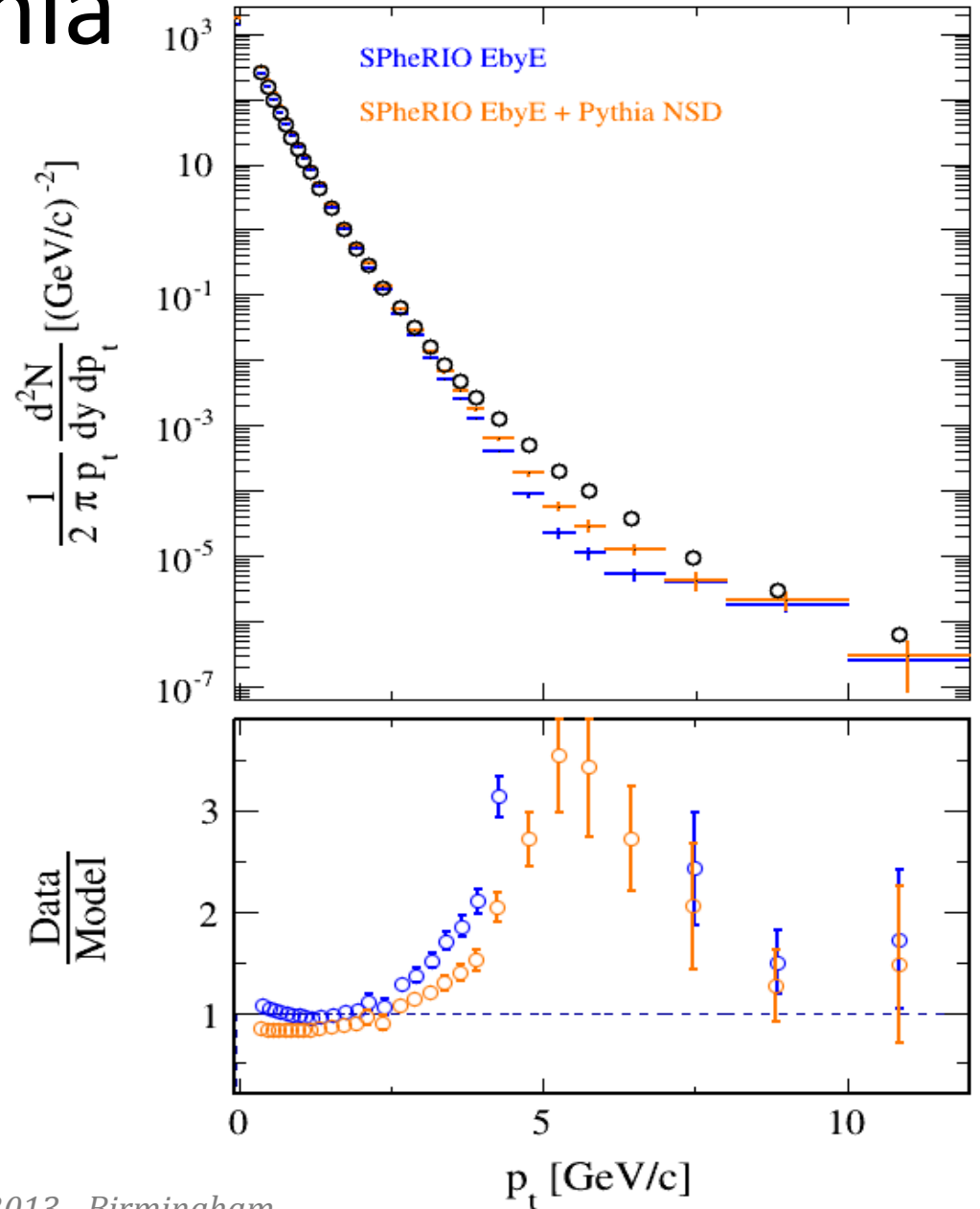
STAR data:

PRL97,153201 (2006)

SPh EbyE

SPh EbyE + Pyth(NSD)

~35 events



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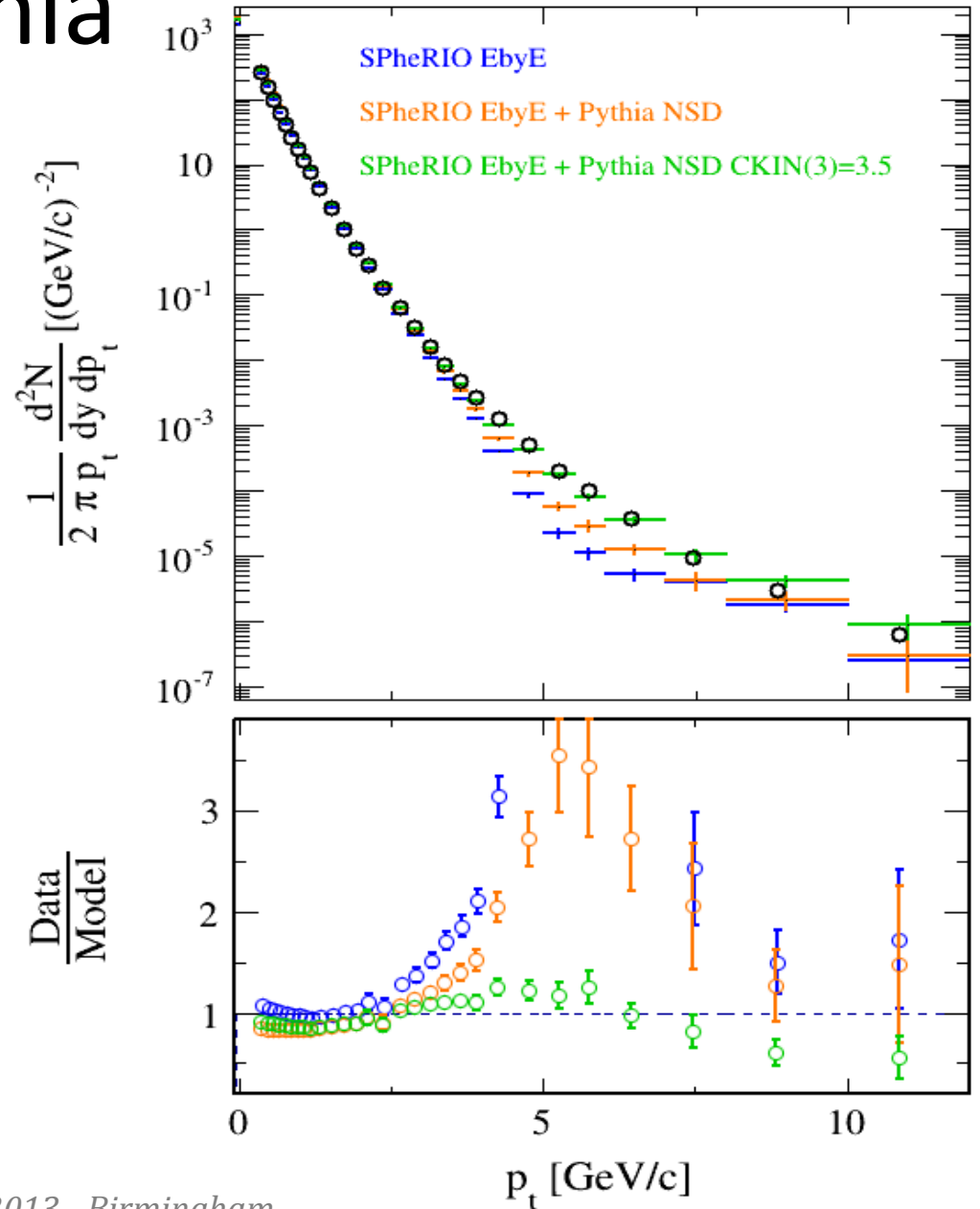
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SPh EbyE + Pyth(NSD)KinCut

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SPheRIO EbyE

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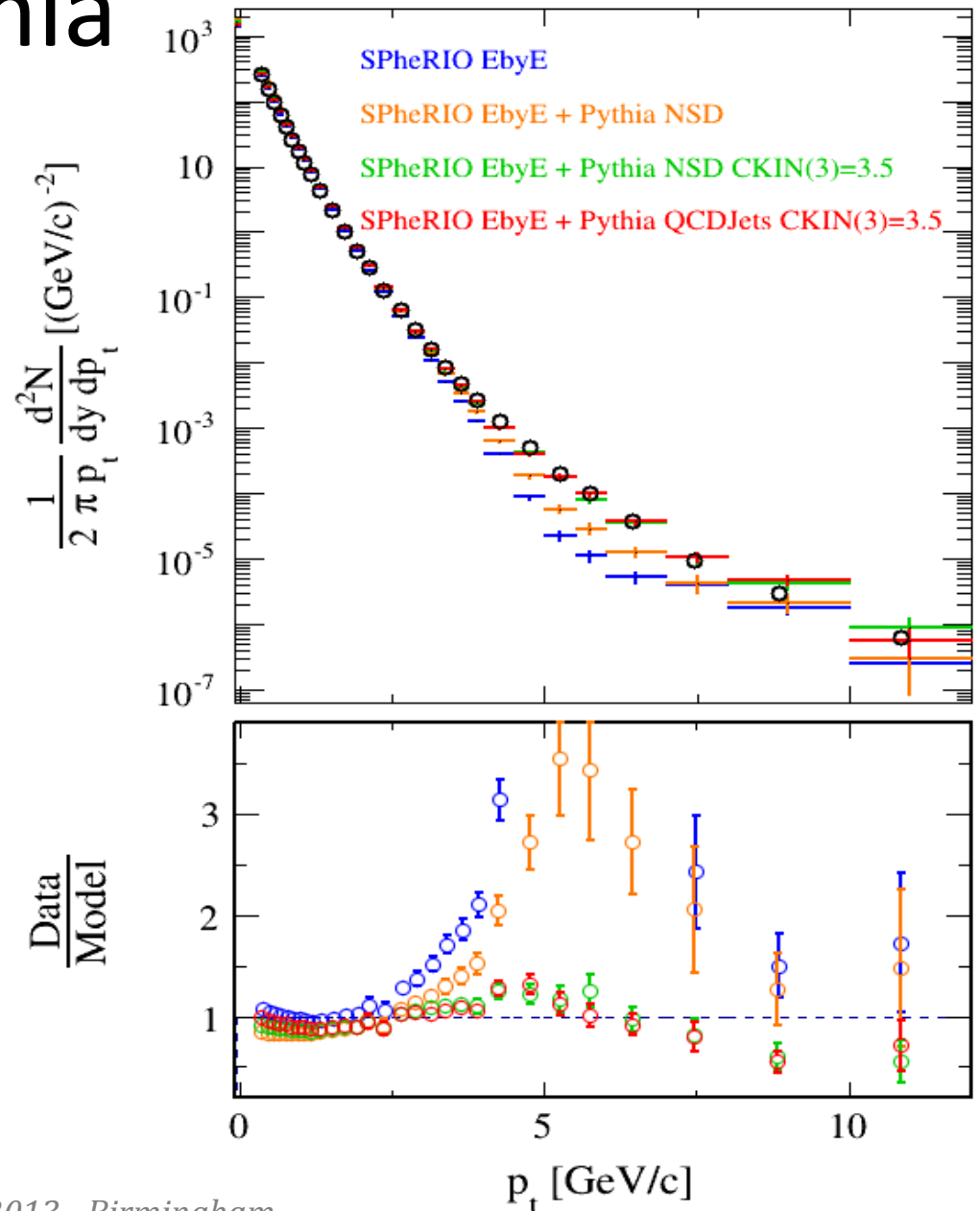
~35 events

SPheRIO EbyE + Pyth(NSD)KinCut

~20 events

SPheRIO EbyE + Pyth QCD Jets

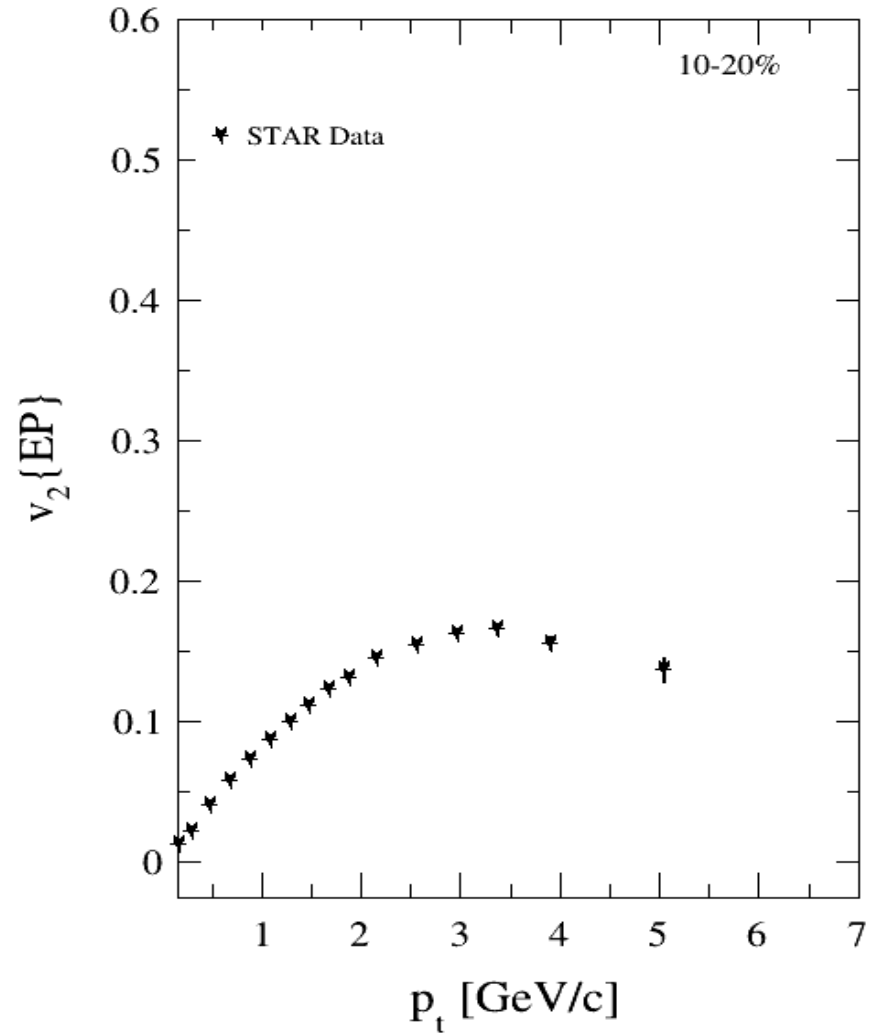
~6 events



$V_2(p_T)$

Au+Au: 10-20%

STAR data: PRC72, 014904 (2005)

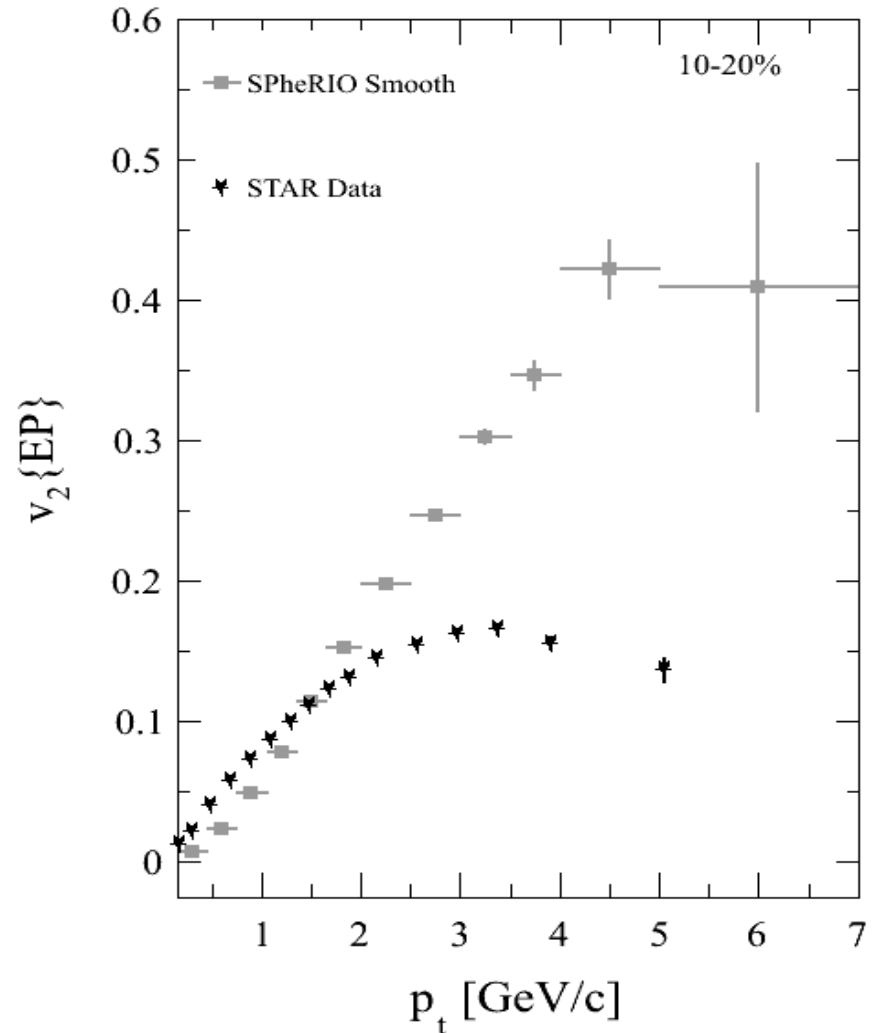


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SPh Smooth



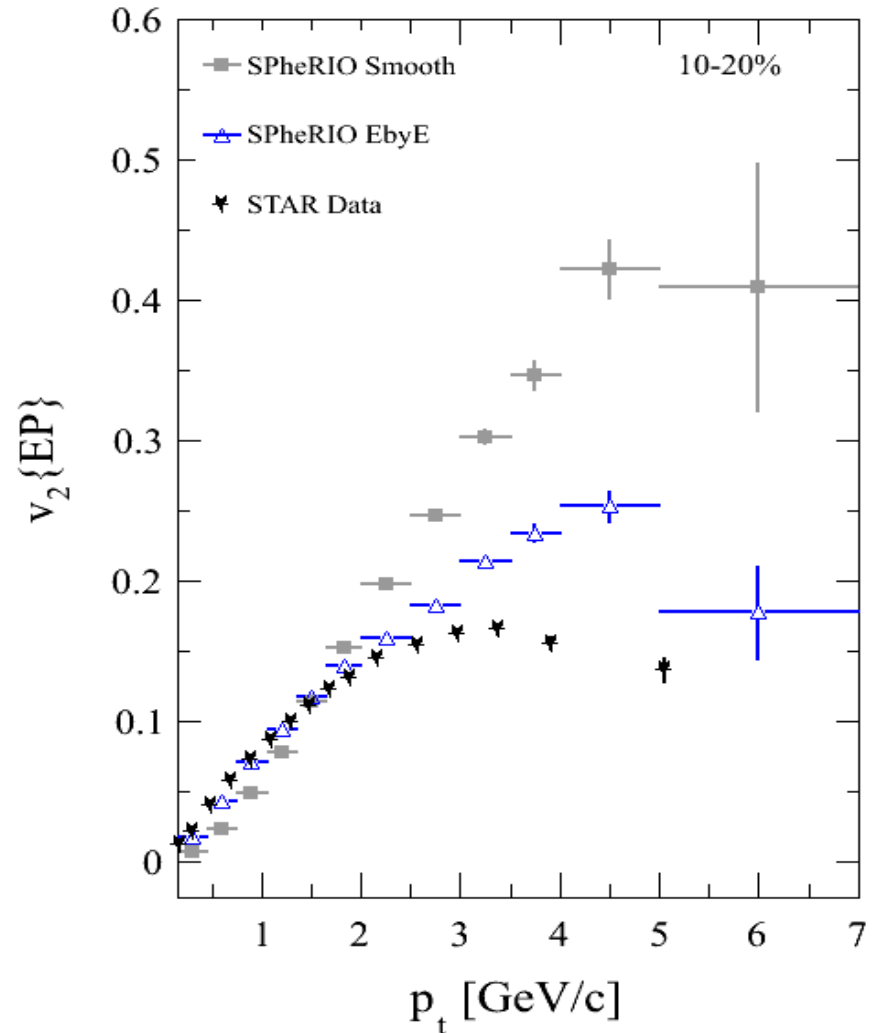
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SPh Smooth

SPh EbyE



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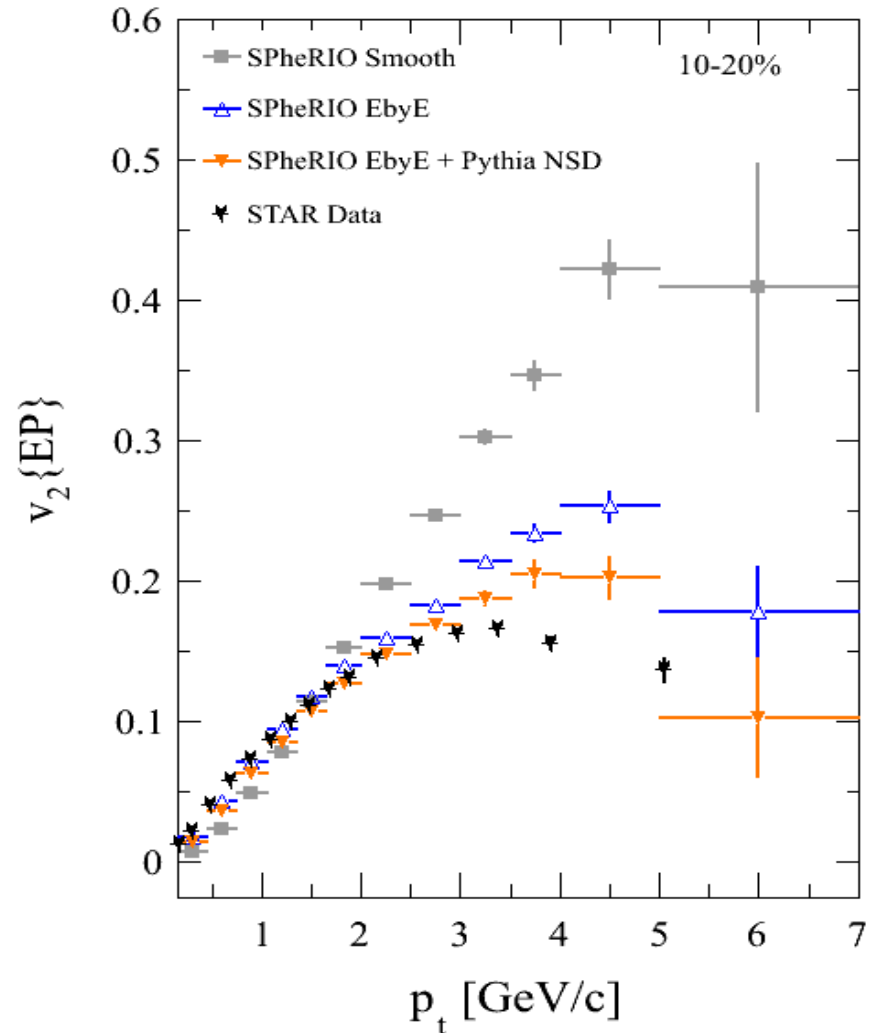
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SPh Smooth

SPh EbyE

SPh EbyE + Pyth(NSD)



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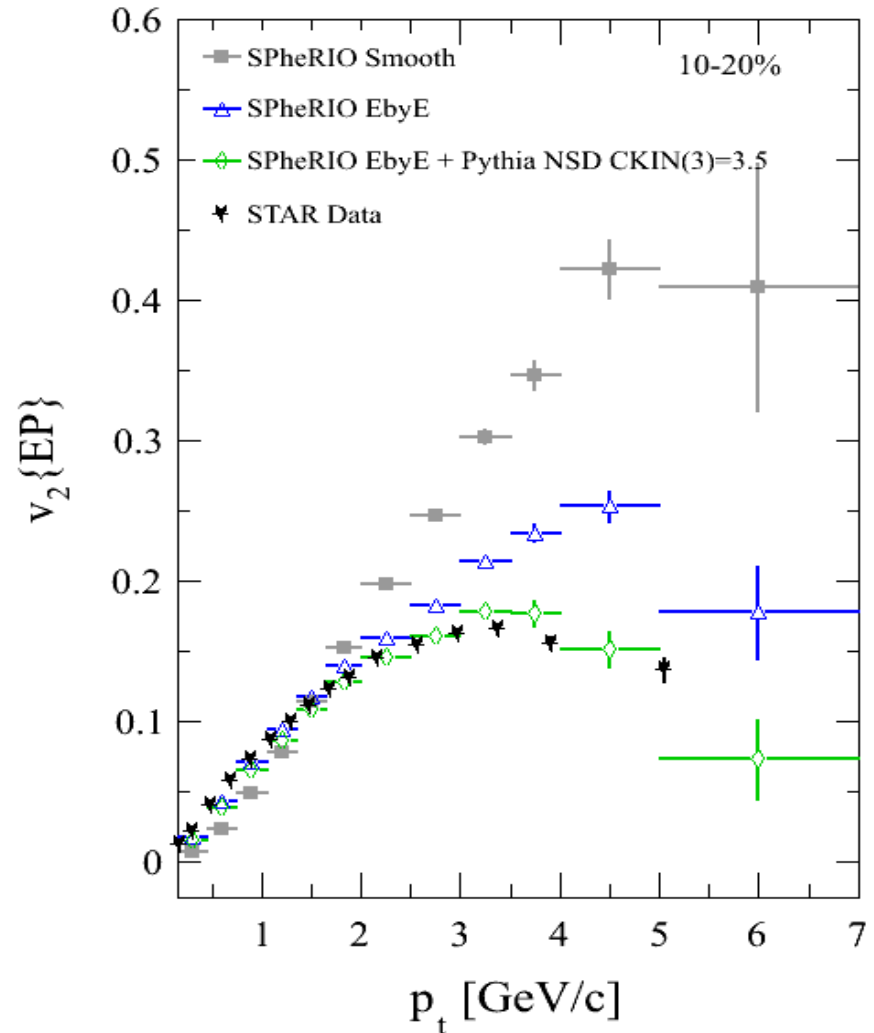
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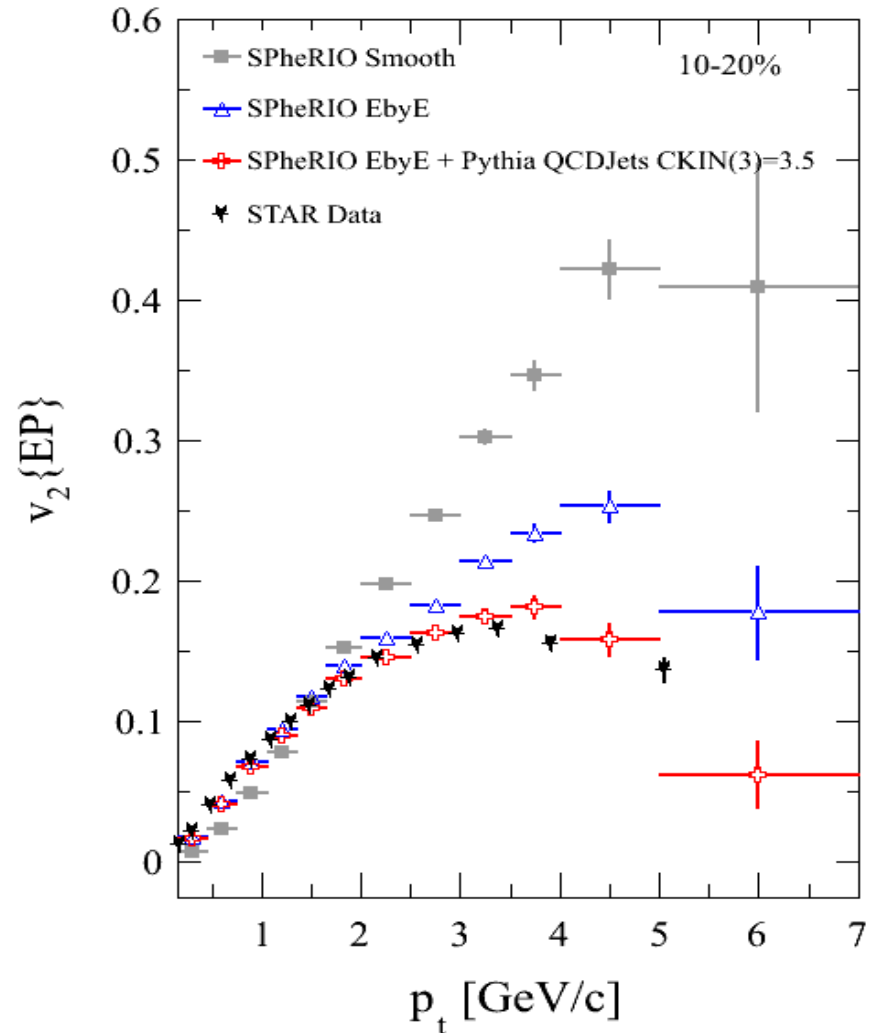
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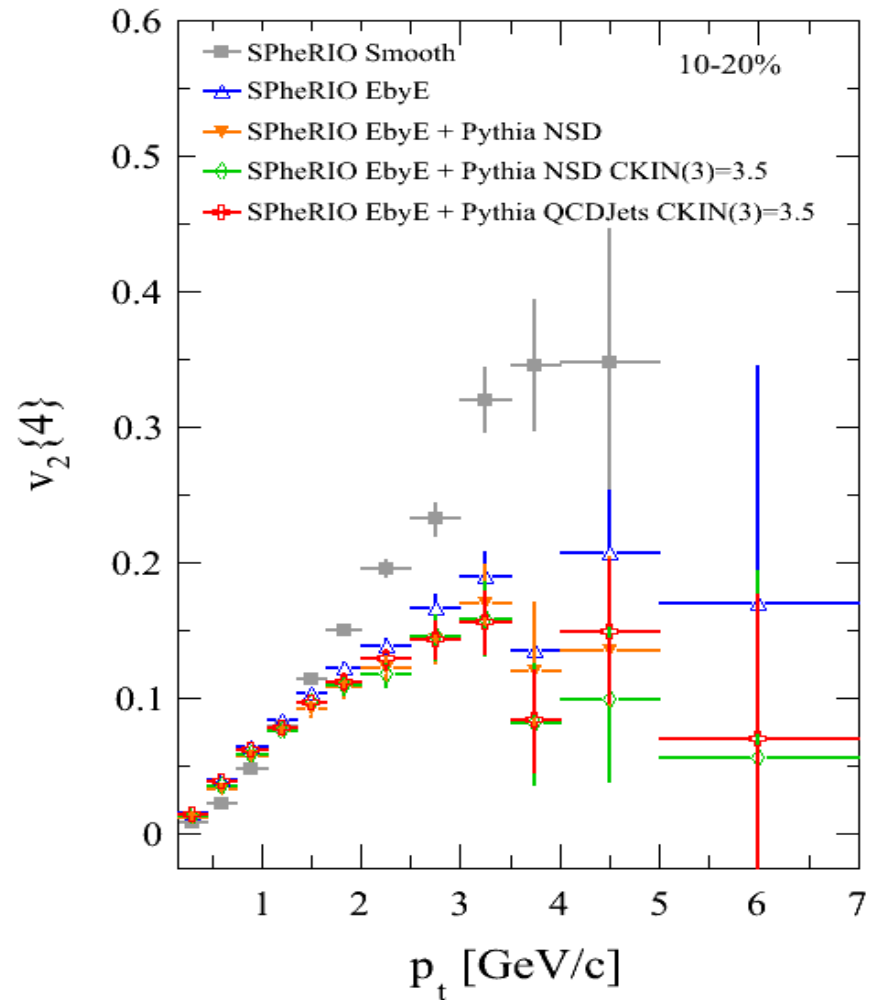
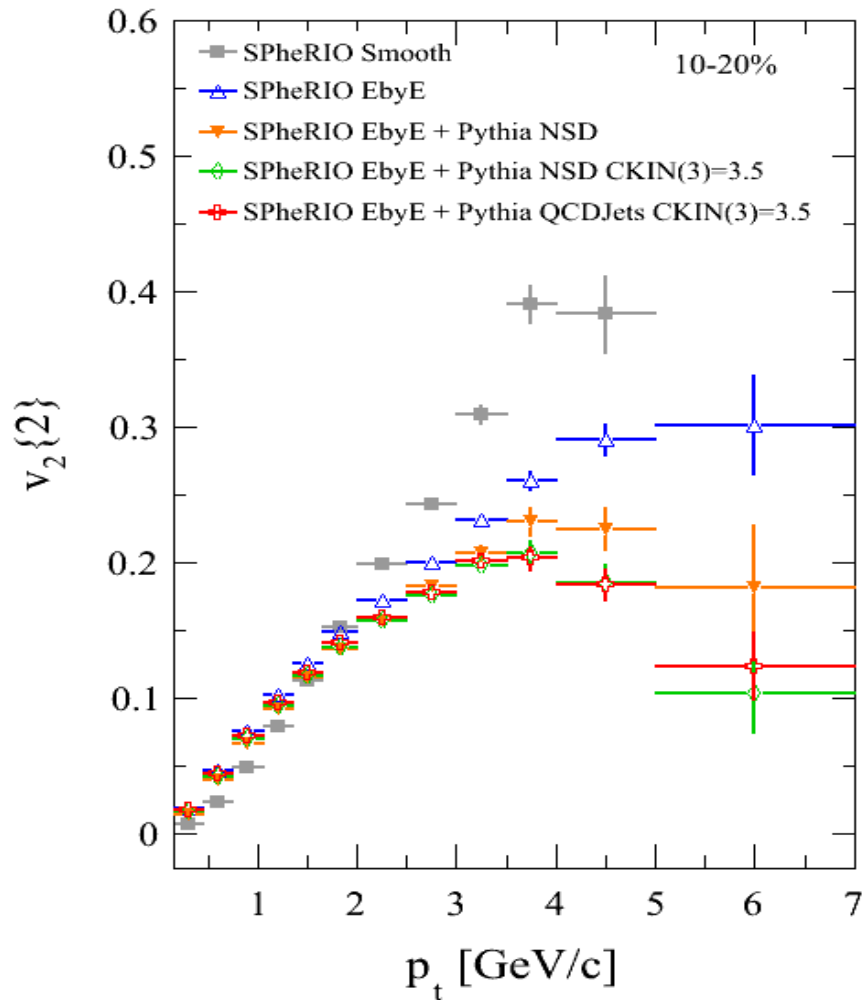
SPh Smooth

SPh EbyE

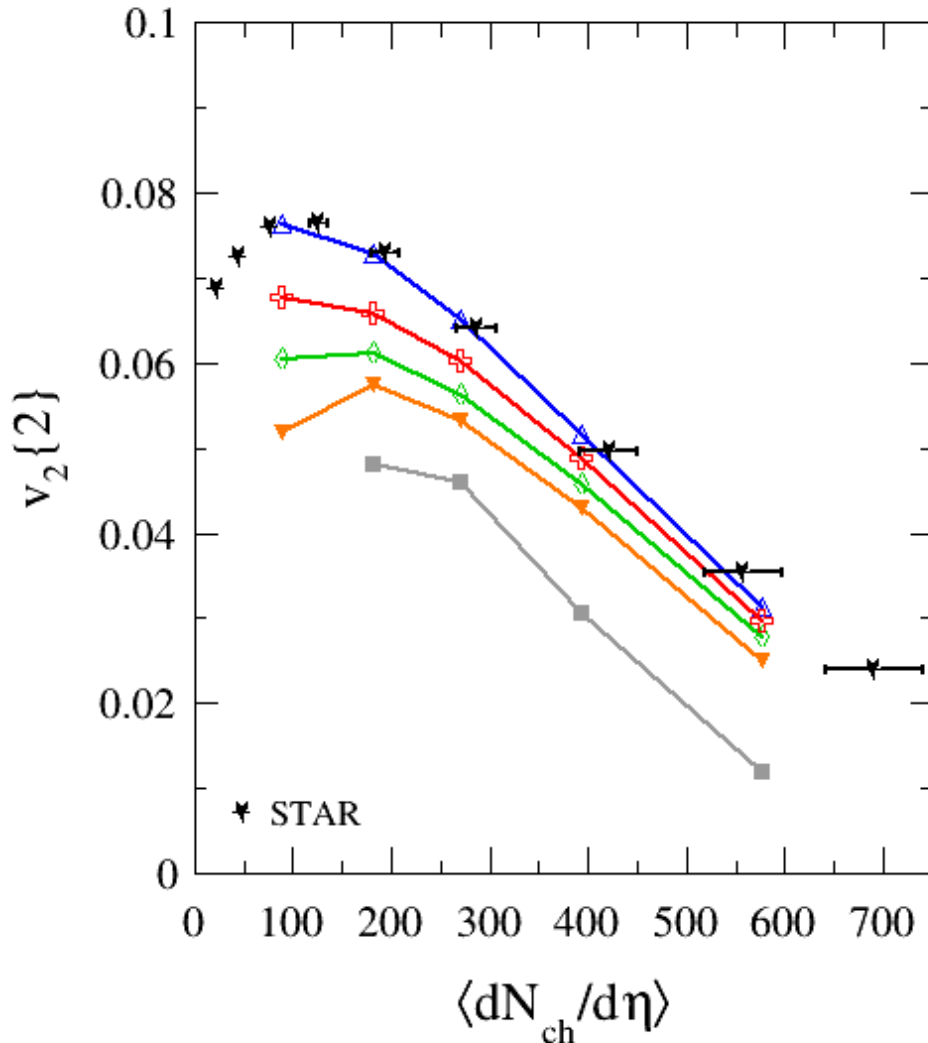
SPh EbyE + Pyth QCD Jets



$V_2\{2\}$ & $V_2\{4\}$ for 10-20%



Integrated v_2



STAR data:

PRC 86, 014904 (2012)

SPh Smooth

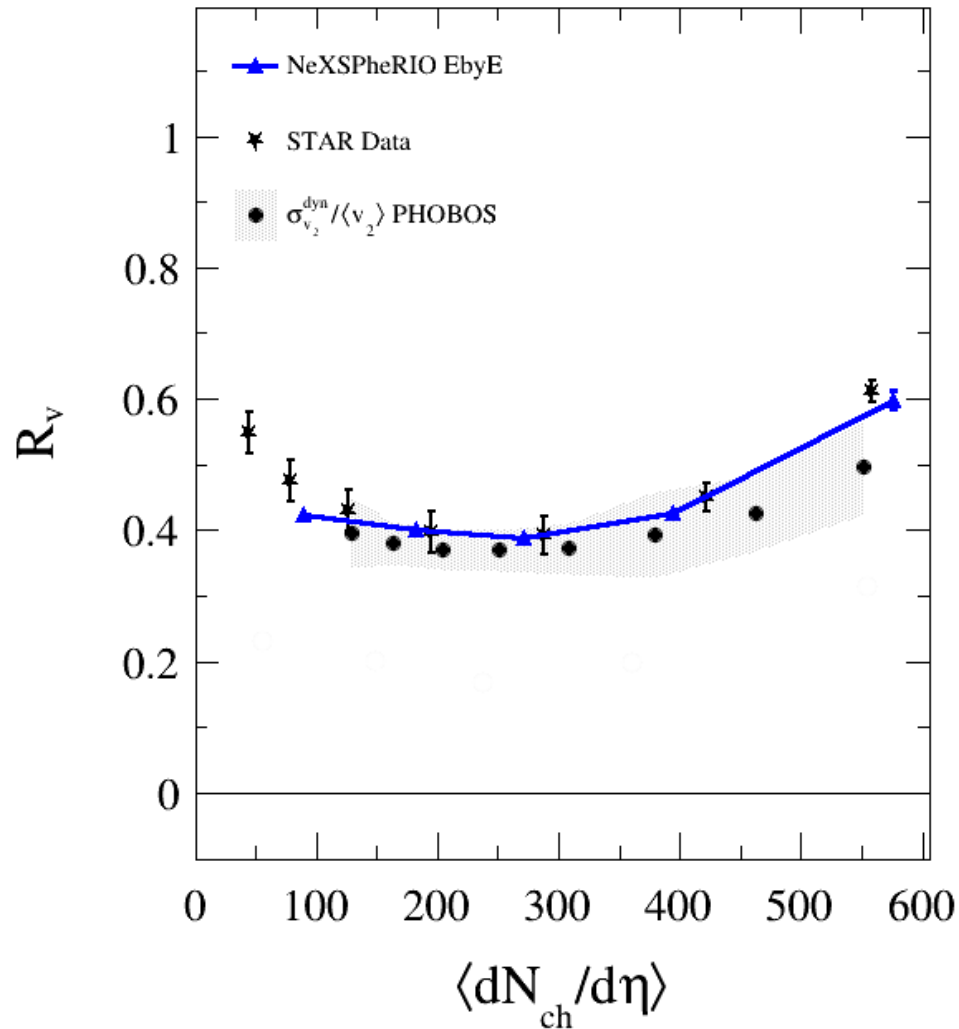
SPh EbyE

SPh EbyE + Pyth(NSD)

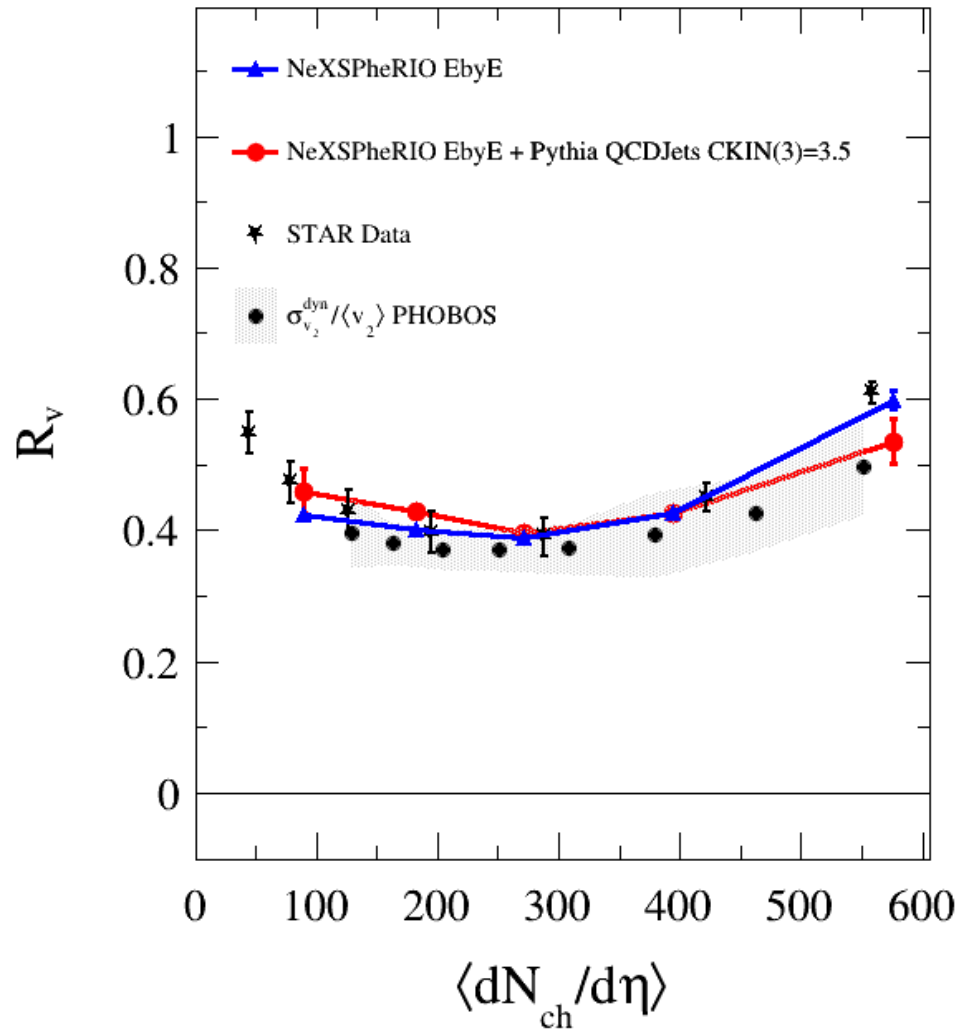
SPh EbyE + Pyth(NSD)KinCut

SPh EbyE + Pyth QCD Jets

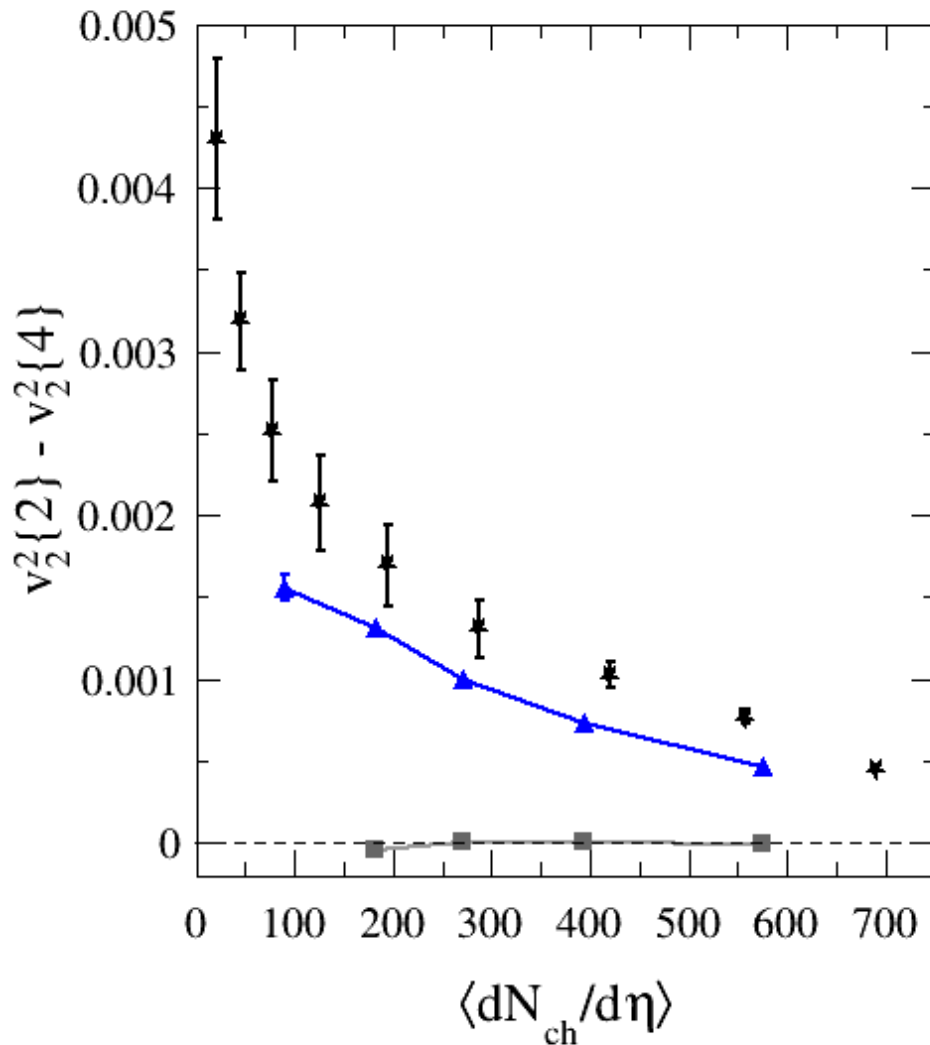
Relative fluctuations



Relative fluctuations



Looking back at: $v_2\{2\}^2 - v_2\{4\}^2$

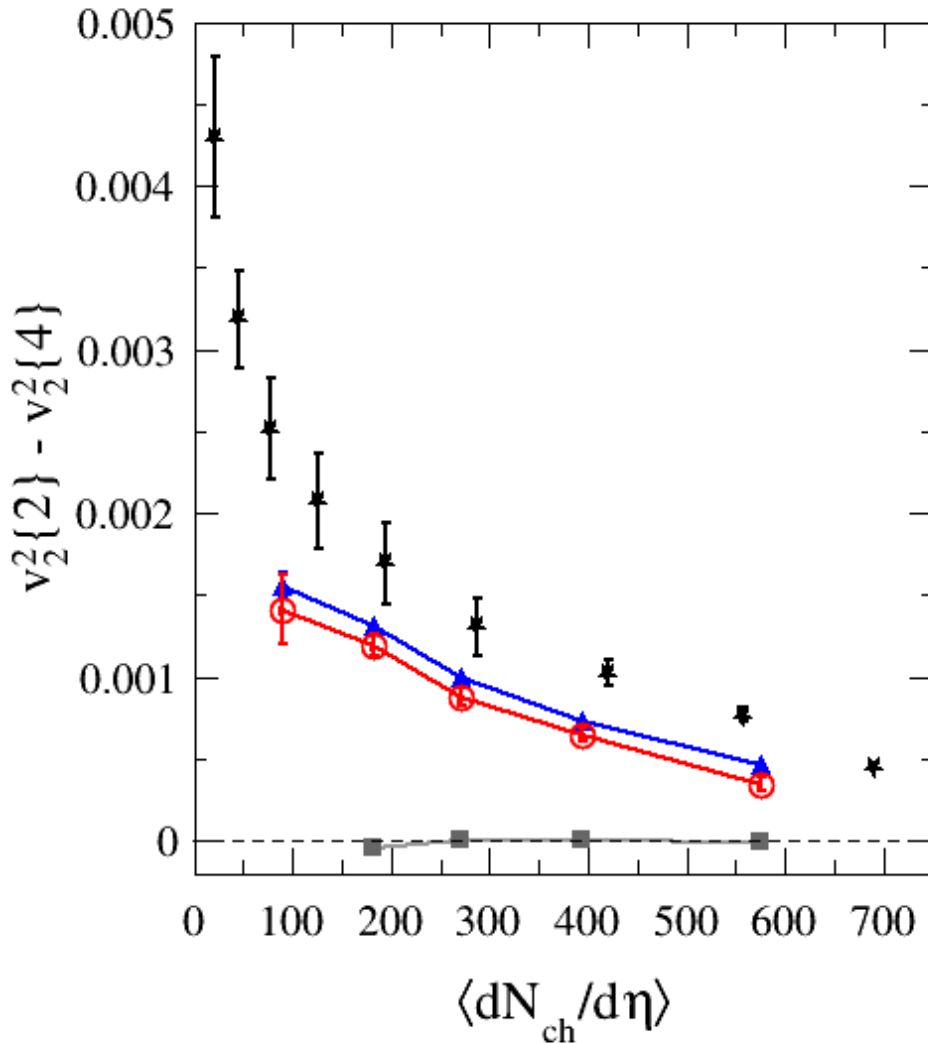


STAR data:

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SPh EbyE

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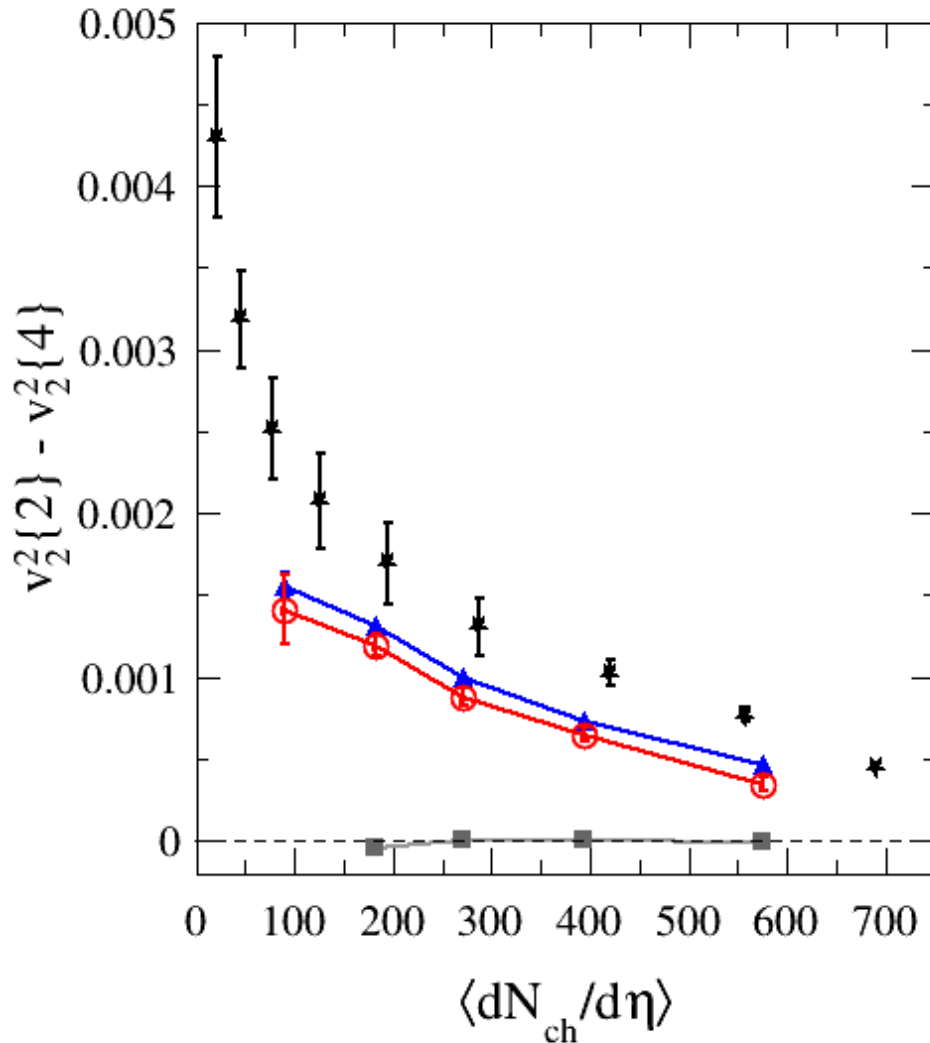
STAR data:

PRC 86, 014904 (2012)

SPh EbyE

SPh EbyE + Pyth QCD Jets

But ...



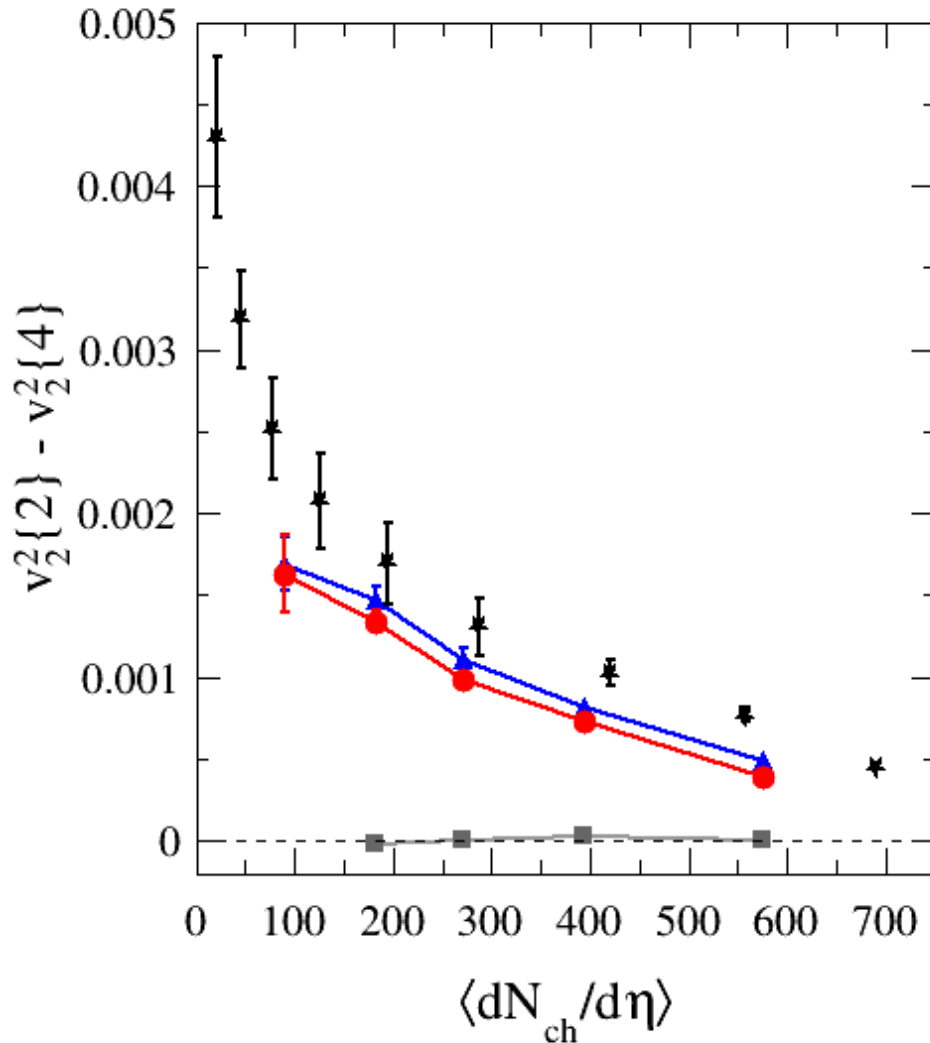
STAR data:

PRC 86, 014904 (2012)

SPh EbyE ($p_T > 0.15$ GeV/c)

SPh EbyE + Pyth QCD Jets
($p_T > 0.15$ GeV/c)

But ...



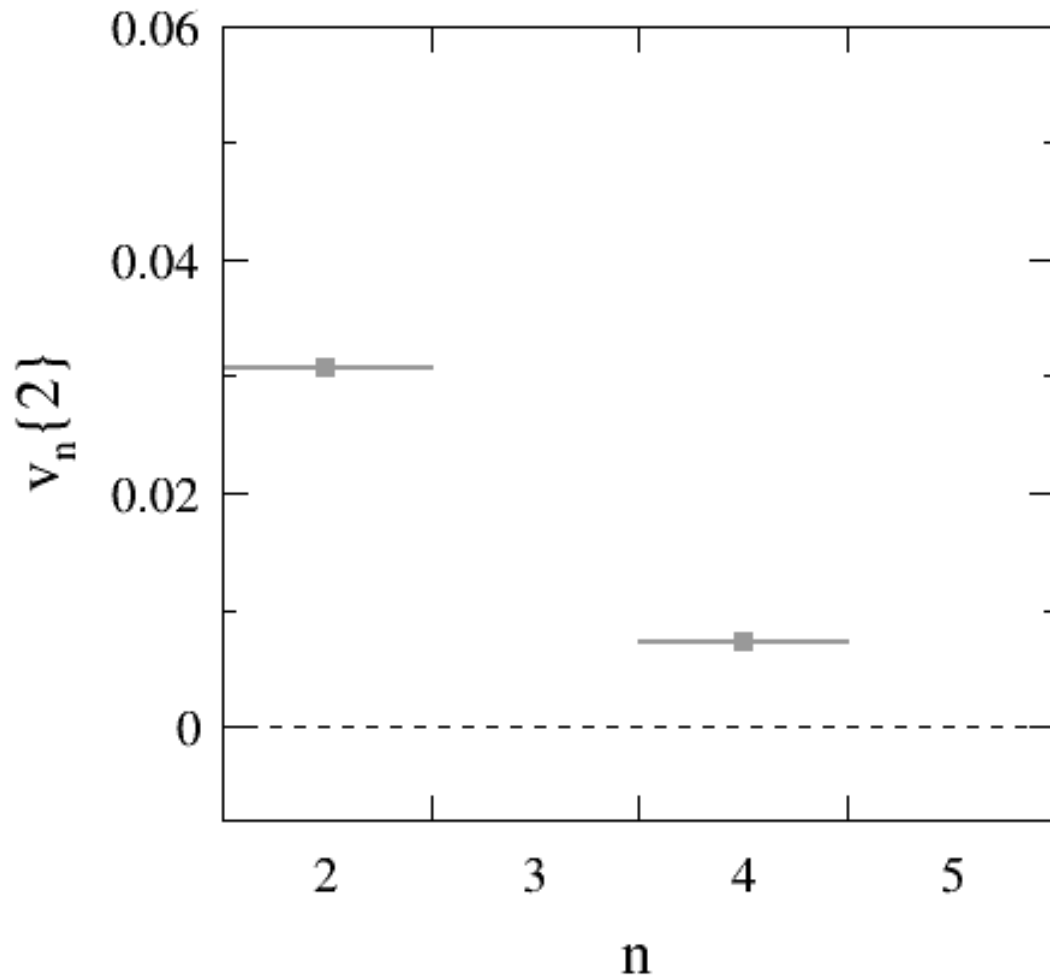
STAR data:

PRC 86, 014904 (2012)

SPh EbyE ($p_T > 0.2$ GeV/c)

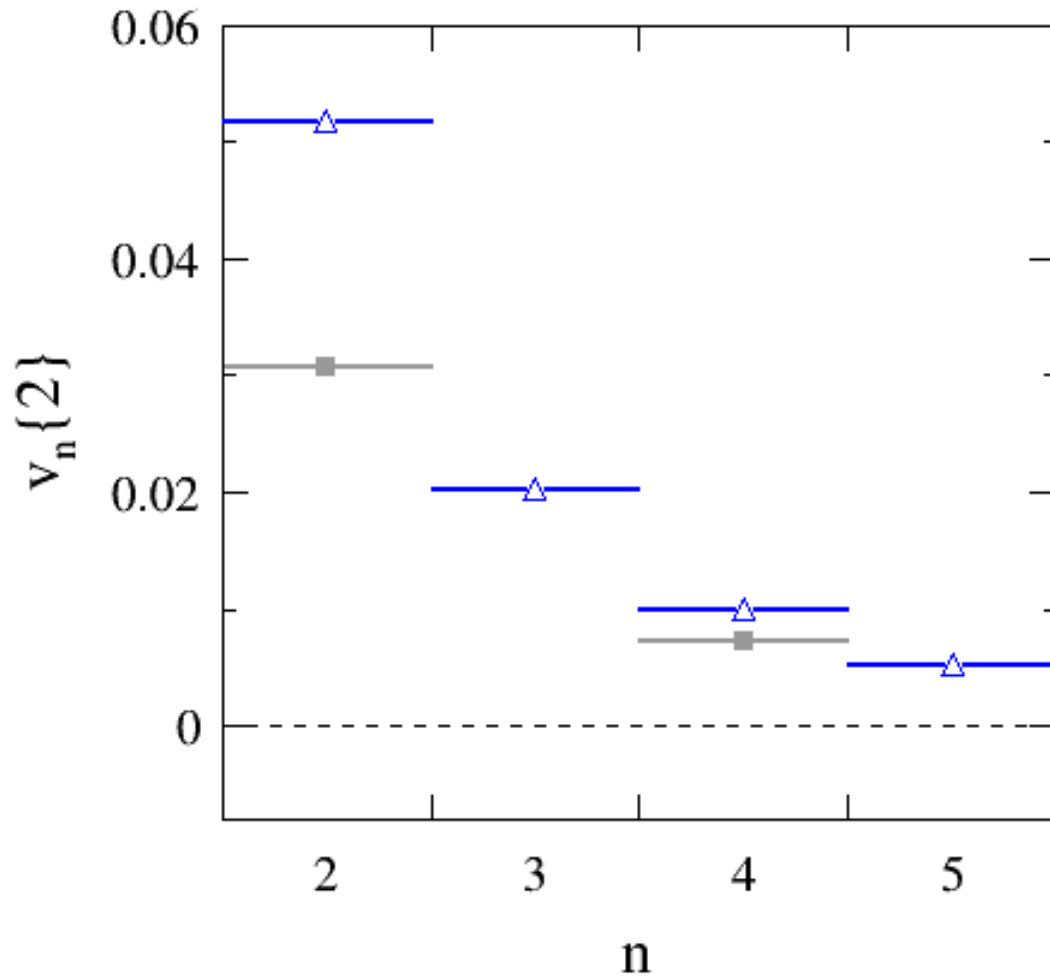
SPh EbyE + Pyth QCD Jets
($p_T > 0.2$ GeV/c)

Higher order v_n



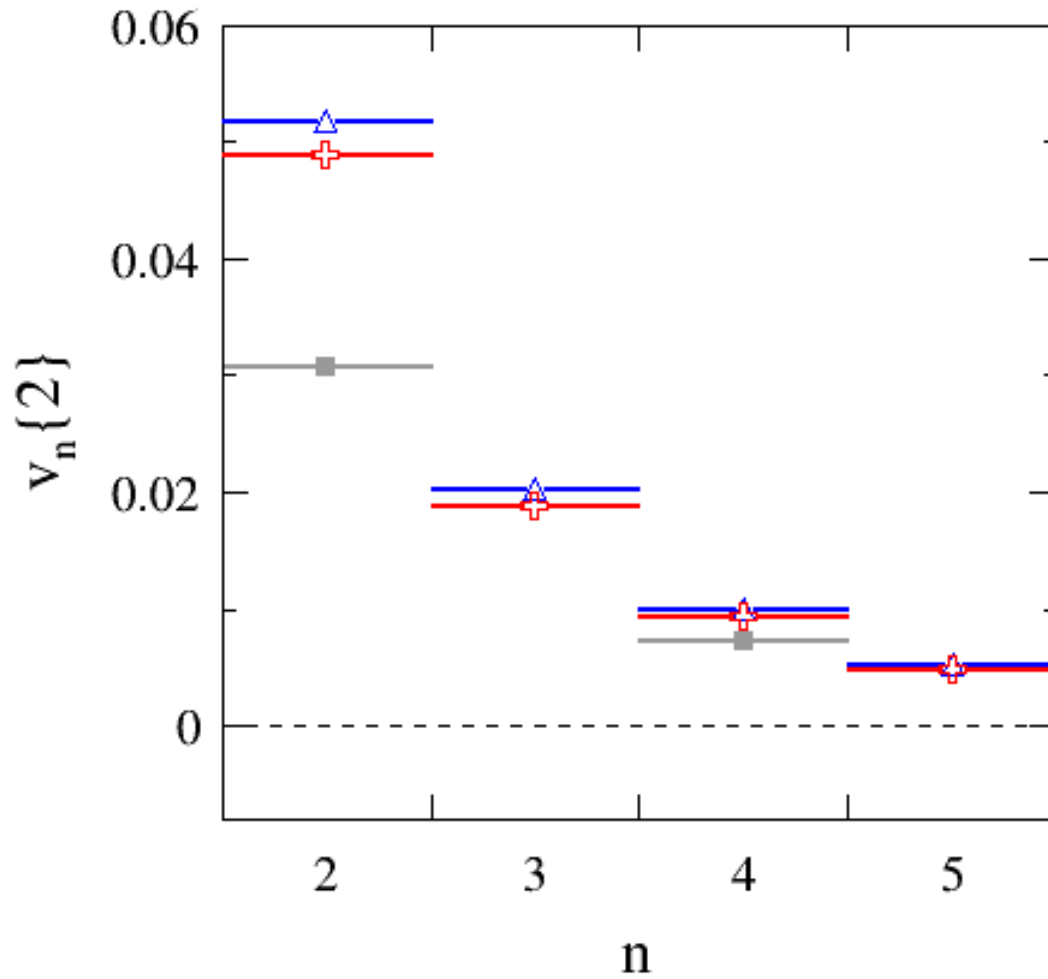
Au+Au 10-20%
SPh Smooth

Higher order v_n



Au+Au 10-20%
SPh Smooth
SPh EbyE

Higher order v_n



Au+Au 10-20%

SPh Smooth

SPh EbyE

SPh EbyE + Pyth

2 particle correlations

$$S(\Delta\eta, \Delta\phi) = \frac{A(\Delta\eta, \Delta\phi)}{B(\Delta\eta, \Delta\phi)}$$

A } same event
B } mixed events

$$|\eta| < 1.5$$

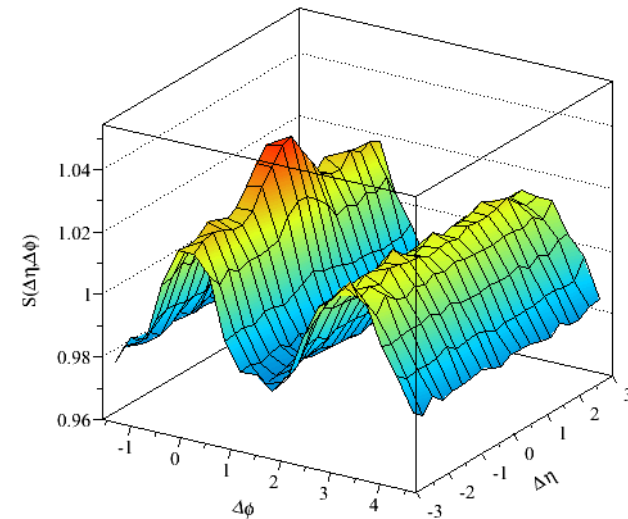
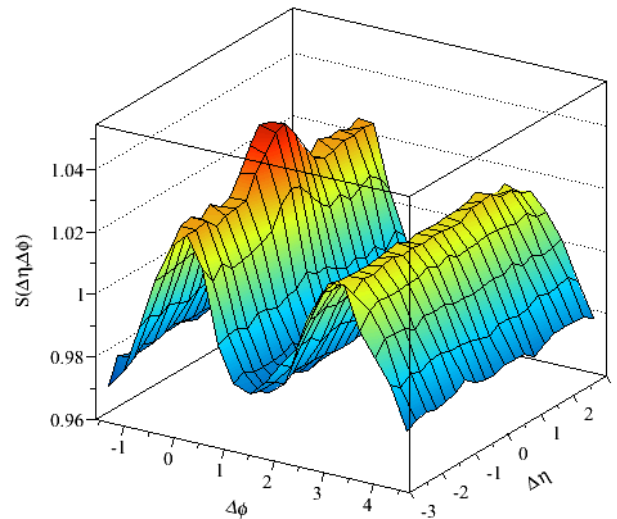
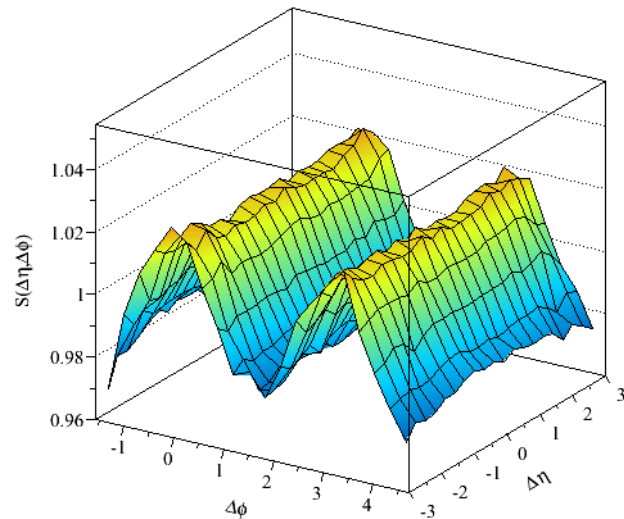
Trigger part.: $p_T > 2.0$ GeV/c

Assoc. part.: $0.5 < p_T < 1.5$ GeV/c

Smooth
SPheRIO

EbyE
NeXSPheRIO

EbyE SPh
+
Pythia



2 particle correlations

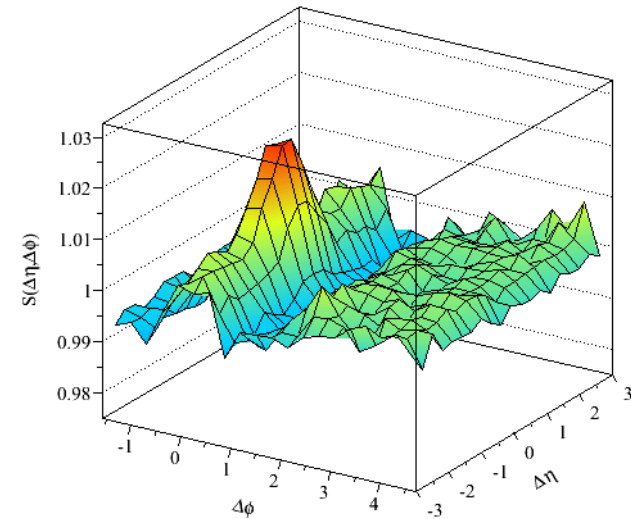
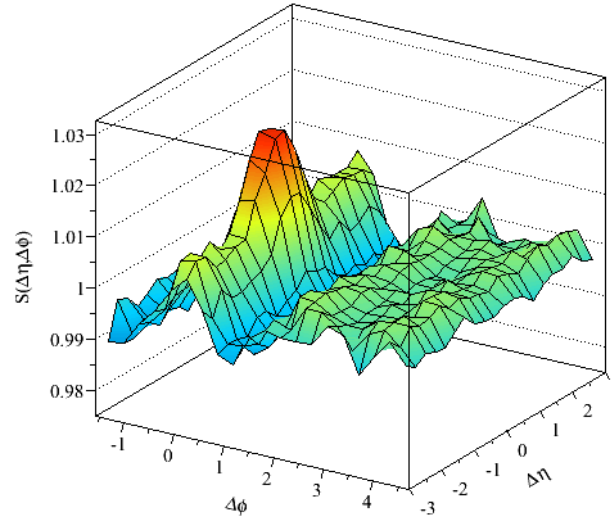
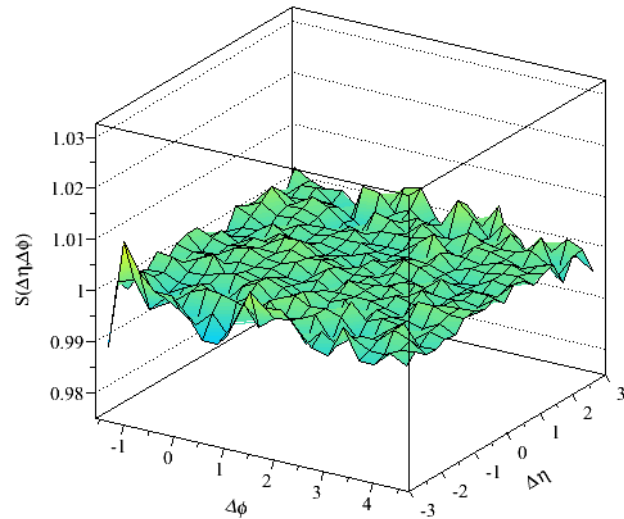
$$S(\Delta\eta, \Delta\phi) = \frac{A(\Delta\eta, \Delta\phi)}{B(\Delta\eta, \Delta\phi)}$$

same event
mixed events aligned with IC eccentricity (part. plane)

Smooth
SPheRIO

EbyE
NeXSPheRIO

EbyE SPh
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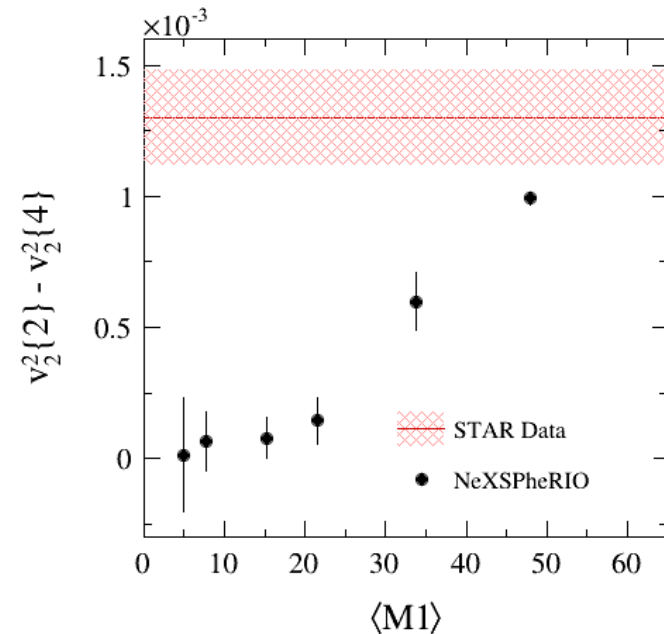
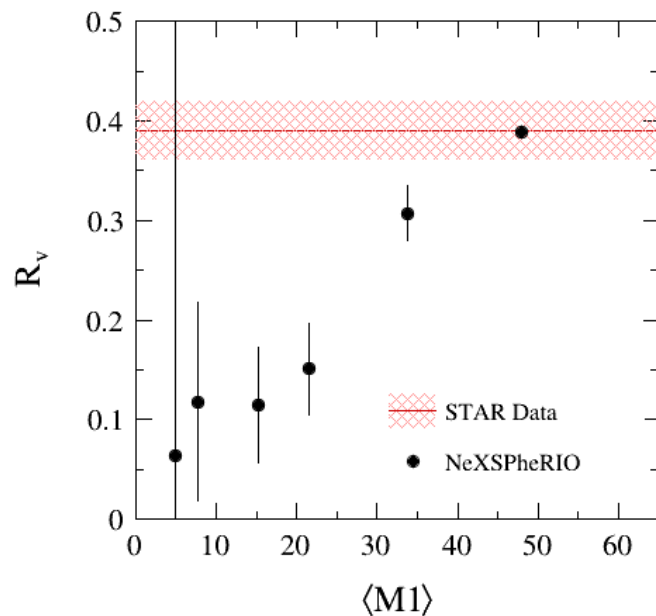
Final Remarks

- With our model we can test sensitivity to IC fluctuations in observables such as differences in $v_2\{2\}$ and $v_2\{4\}$. We have also studied the variation of these observables with the degree of fluctuation.
- Inclusion of non-interacting Pythia particles to NexSPheRIO results improve v_2 agreement with data to higher p_T values.
- Non-interacting Pythia particles have small effect on fluctuation observables and on the two particle topology results.
- Other observables such as PID ratios also show interesting results. (one of Boris' wish list)

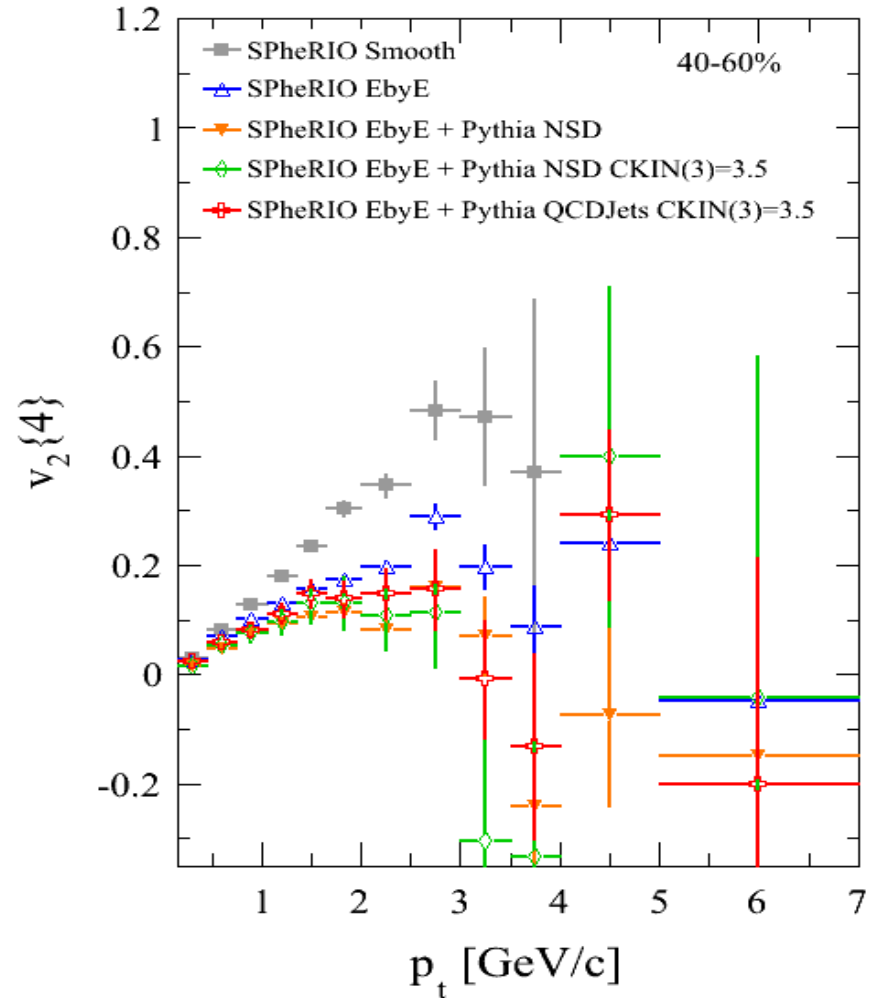
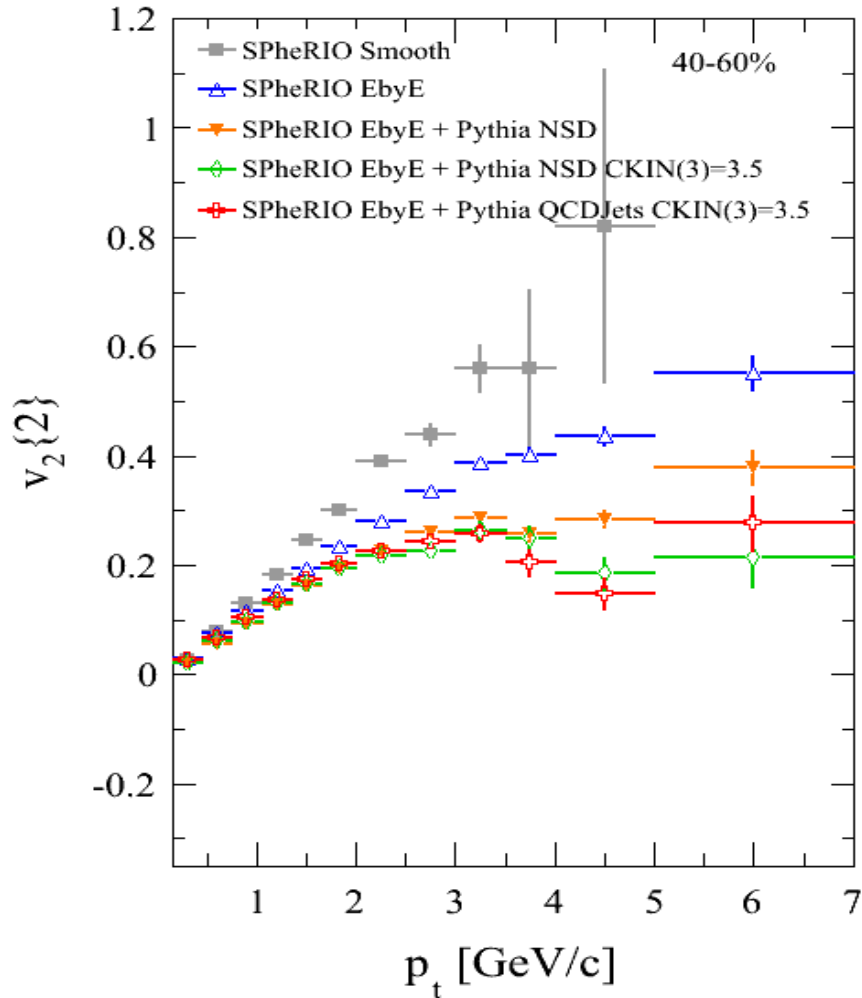
Back-ups

Changing the IC fluctuations

We use the Fourier-Bessel decomposition to quantify the degree of IC fluctuation.
(arXiv:1204.5774)



$V_2\{2\}$ & $V_2\{4\}$ for 40-60%



2 particle correlations

$$S(\Delta\eta, \Delta\phi) = \frac{A(\Delta\eta, \Delta\phi)}{B(\Delta\eta, \Delta\phi)}$$

$\left. \vphantom{\frac{A(\Delta\eta, \Delta\phi)}{B(\Delta\eta, \Delta\phi)}} \right\}$ (same event)
 $\left. \vphantom{\frac{A(\Delta\eta, \Delta\phi)}{B(\Delta\eta, \Delta\phi)}} \right\}$ (mixed events)

$$|\eta| < 1.5$$

Trigger part.: $p_T > 2.0$ GeV/c

Assoc. part.: $0.5 < p_T < 1.5$ GeV/c

NeXSPheRIO
Smooth IC

Pythia QCDJets
CKIN(3)=3.5
(~6 evts)

Smooth
NeXSPheRIO
+
Pythia

