

line 10 omit ``namely the generic framework''

Answer: done

---

line 15 omit ``Interestingly''

Answer: done

---

\*\*\*\*\*

21-22 ``increased discriminatory power'' -- either prove/show or omit

Answer: what do you suggest to replace it with?

---

51 ``initial density profile of neutrons'' - reads strange, rephrase

Answer: I take by "neutrons" you mean "nucleons" in the text. I removed "anisotropic initial".

---

Eq.1- it should be  $d^p$ , not  $dp^3$ - it does not work with pseudorapidity. Should be corrected

Answer: Thanks for noticing it. I changed it.

---

57 refs 6-10 looks a bit strange for eq. 1. But if one starts from that period, include <http://arxiv.org/abs/nucl-th/0606022> which was the first in this row (e.g. Ref [6] mention these proceedings)

Answer: I would include it but the problem is that we cannot cite proceedings. Maybe you could suggest a paper instead?

In any case, I added two more citations:

arXiv:hep-ph/9407282 [hep-ph]

arXiv:nucl-ex/9805001 [nucl-ex]

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\*\*\*\*\*

62 Refs to RHIC - why do they start from far not the first paper? Similarly for LHC.

Answer: which paper do you mean?

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\*\*\*\*\*

65-67 Ref to a theory paper is needed. Again, why rather late ref [19] and not earlier papers?

Answer: I added this reference for the theory part: arXiv:1007.5469 In reference [19], it is clearly shown that the predictions from the same models separate more in higher harmonics.

---

Eq 3. I believe Eq.3 (as presented) was first written by Teaney-Yan

Answer: ok, I changed the references.

---

\*\*\*\*\*

74 ``recently'' - omit? It should be explain what is meant by ``linearly'' here. For example the nonlinear terms in  $v_n$  dependence on  $\epsilon_{\text{psn}}$  was known long ago.

Answer: I removed recently. by linear I meant there are no other terms and  $V_n$  depends only on one epsilon term.

---

82 not clear what exactly was done in [24], ``in a single event'' looks incorrect

Answer: I removed the reference. Sorry but what do you propose to replace it with? This is also used in the charged particle NL flow paper.

---

87 reads awkward, rephrase

Answer: done

---

88-89 interplay of radial flow and ... coefficients???

Answer: I am not sure if I understood this comment correctly. If you mean that I should replace "coefficients" with something better I removed it and now I simply address it with anisotropic flow.

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\*\*\*\*\*

87-97. The presentation of both most important features of  $v_n(\text{pt})$  is rather poor, with the twisted logic. The ``mass dependence'' was first introduced in: Transverse radial expansion and directed flow Sergei A. Voloshin (Heidelberg U.). Nov 1996. 8 pp.

Published in Phys.Rev. C55 (1997) R1630-R1632

Later, it was discussed in relation to hydro calculations in Radial and elliptic flow at RHIC: Further predictions P. Huovinen (LBL, Berkeley), P.F. Kolb (Ohio State U. & Regensburg U.), Ulrich W. Heinz (Ohio State U.), P.V. Ruuskanen (Jyvaskyla U.), S.A. Voloshin (Wayne State U.). Jan 2001. 6 pp. Published in Phys.Lett. B503 (2001) 58-64

There exist several publication on that published earlier than what is quoted quark coalescence and the corresponding scaling of  $v_n(\text{pt})$  was also proposed before the measurements quoted and not after.

Answer: i included those 2 references in the introduction.  
About quark coalescence, could you suggest the references that are prior to the one we have cited? Thanks

---

95 Remove ``previous''

Answer: done

---

100 what constraints were established in [24]?

Answer: The models need tuning to match the data but if you for example look at  $X_n, m_k$  there is more distinct and evident difference between the models themselves as opposed to the results of the same models for  $v_n$ .

---

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100-104 These statements need support and/or references

Answer: They are measuring the non-linear hydrodynamic response in higher harmonics. We already have established that higher harmonics are more sensitive to transport properties and initial conditions of the system. By measuring nonlinear modes we have take advantage of the fact that they don't require much statistics unlike their total flow harmonics. But in any case i added a reference to the higher order flow papers:

<https://arxiv.org/pdf/1805.04390.pdf>

and

<https://arxiv.org/abs/1105.3865>

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159-161 What was done exactly?

Answer: Do you mean what was done for pile-up rejection? It's a DPG suggestion where one applies a cut on the correlation between the  $V_0$  amplitude ( $V_0M$ ) and the number of clusters in the second layer of the SPD (CL1):  $|V_0M-CL1|>7.5$

---

166 inelastic cross section is ambiguous (and likely not correct).  
What is meant by inelastic cross section here?

Answer: inelastic cross-section between the two colliding nuclei:  
 $\sigma^{\text{inel}}_{NN}$

fraction of inelastic cross-section is how we define centrality with.

"Two nucleons from different nuclei are assumed to collide if the relative transverse distance between centers is less than the distance corresponding to the inelastic nucleon-nucleon cross section  $d < \sqrt{(\sigma^{\text{inel}}_{NN}/\pi)}$ ." As explained in ref. [41]

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189 What was the fraction of tracks with ITS hits?

Answer: I didn't check the fraction of track with/without ITS hits.

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203 What is the systematic error on  $v_n(p_T)$  for kaons with 75% purity?

Answer: I didn't measure  $v_n(p_T)$  in this analysis. But I have to say that this is a minimum purity and depends on  $p_T$ . It is not larger than what I've reported for  $v_{4,22}$ .

---

Eq6 (and 7-9) Is it the definition for  $v_{4,22}$ ? Why this particular denominator?

Answer: Yes, this is the definition. It was also used in the integrated non-linear flow paper (arXiv:1705.04377). It is introduced first in arXiv:1502.02502

---

255-256 The approximation in eq6 does not include  $v_3$ ...

Answer: Of course, this is a general sentence referring to eq. 6 up to 9 and they either include  $v_2$  and/or  $v_3$ .

---

260-261 unless more details are given on ``generic framework'' I would not use this term and directly refer for the method to [40]

Answer: sure, thanks.

---

eq 10 a similar question as to eq.4

Answer: I don't understand. Eq. 4 talks about the cumulant-based initial anisotropy. Eq. 10 is the correlation method used to extract  $v_{4,22}$ .

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Chapter 5 With a very few exceptions, it is totally unclear why these are other cuts were selected for the systematic uncertainty estimates. For example, why decay vertex was varied from 5 to 10 and not to 15 or 20? What exactly was the purpose of this test. Similarly with all other tests. Even when the purpose was clear. e.g. using different PID method to achieve a better purity, it was not clear of the difference was extrapolated to 100% purity... or

something else was done

Answer: The default values are either the default values used in ALICE or the suggestion from DPG. In some cases for example, PID by increasing minimum purity the efficiency drops and in turn the statistics so one has to find a middle ground where the particles have a good level of purity and the results do not suffer as much from fluctuation.

---

328-329 Not clear. It also seems that the cause and the mechanisms are mixed in this sentence.

Answer: Could you suggest a better way of rephrasing it? Thanks a lot.

Would it be better if i rephrase it like:

"Higher order flow coefficients ( $n > 3$ ) are mainly generated by inhomogeneities in the initial density profile, the collision geometry as well as the non-linear hydrodynamic response of the system." ==>>>>

"Higher order flow coefficients ( $n > 3$ ) are generated by inhomogeneities in the initial density profile and the collision geometry."

---

337-338 Does the shorter life-time affects only nonlinear terms?

Answer: No it was also seen in total flow measurements. I changed the text accordingly.

---

344-348 It would be good to compare the centrality dependence of the PID integral  $v_n$ 's with the corresponding linear terms

Answer: I did a comparison using published  $v_n$  results to extract the linear terms in 2 centrality percentiles and these comparisons can be found in the twiki: <https://twiki.cern.ch/twiki/bin/viewauth/ALICE/LinearFlowTerms>

---

352 change ``non-linear response of the system'' to ``anisotropic flow''

Answer: ok thanks.

---

352-352 The explanations, as given, is incorrect. The multiplicity and anisotropic flow are independent quantities. With or without ``depletion'' one might have either large or small flow. Also, reference is needed here

Answer: I disagree. In more central collisions when the system is larger and hence the lifetime is larger, the average radial flow velocity is also larger and in turn the anisotropic flow is pushed

more towards higher pT. And you can see this in the crossing point between different particle species. The crossing point moves to lower pT values as centrality decreases. We have seen this effect also in the anisotropic flow measurements like: arXiv:1805.04390, arXiv:1405.4632, arXiv:1606.06057

ok I will add a reference. <https://arxiv.org/pdf/1105.3226.pdf>

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Fig 6 and following. One would need to compare the relative splitting to that on linear modes

Answer: True, but I only measure non-linear modes in this analysis. I did comparison with the linear terms extracted from the published vn results. I have included them in the twiki: <https://twiki.cern.ch/twiki/bin/viewauth/ALICE/LinearFlowTerms>

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361-362 ``triggering the development of calculations...'', ``as a next step'' --wrong. See comments above.

Answer: Could you explain what is wrong and how you suggest to fix it? Thanks.

---

366-365 The scaling holds at RHIC and LHC approximately with the same accuracy. Text has to be corrected.

Answer: It was first concluded at RHIC that the scaling holds.

"the v2 and pT values have been scaled by the number of constituent quarks (n). While v2 is significantly different for K0S and  $\Lambda + \bar{\Lambda}$ , within errors, v2/n vs pT/n is the same for both species above pT/n ~ 0.7 GeV/c. " in <https://arxiv.org/pdf/nucl-ex/0306007.pdf>

"This scaling behavior was observed in Au+Au collisions at 200 GeV [15]" in <https://arxiv.org/pdf/nucl-ex/0701010.pdf> where [15] is <https://arxiv.org/pdf/nucl-ex/0309003.pdf> and contains the same measurement in <https://arxiv.org/pdf/nucl-ex/0306007.pdf>

Later measurements using other particle species showed the scaling holds only in an approximate level and the same at the LHC. I think the text reflects that: "This scaling, worked initially at RHIC energies, although later measurements revealed sizeable deviations from a perfect scaling [13-16]. Recently, ALICE measurements showed that the NCQ scaling at LHC energies holds at best at an approximate level of 20% for vn [17-19]"

---

366 remove ``at best''. BTW 20% is what would be expected in this model, though in reality it seems to be better than that.

Answer: It is at best 20% and that was also claimed in the elliptic flow paper (arXiv:1405.4632 ) and later higher harmonics paper (arXiv:1606.06057). I have included the double ratios for the scaling in the twiki:

It is at best 20%.

<https://twiki.cern.ch/twiki/bin/view/ALICE/ScalingProperties>

---

Fig 8 and following phi meson its not mentioned in the legend

Answer: Yes, because phi measurements are only done in v422.

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Chapter 6 requires the comparison of the model with the ``plain'' vn's (or the reference where it was done)

Answer: I make a comparison in the twiki between vn, vnL and vn,mk of pions and protons.

<https://twiki.cern.ch/twiki/bin/view/ALICE/LinearFlowTerms>

---

406–410 all those statements need some quantitative support by corresponding numbers. The corresponding text does not fit the conclusion section and better to be moved to technique/systematics sections.

Answer: It is shown many times before that a multi-particle correlation technique is less prone to non-flow. I can put a reference but i don't think it needs to be quantitatively support. As for the systematic checks, they were discussed in the systematics section and I find it important to mention them briefly in the conclusions section.

It's a summary of the whole paper. One needs to summarize the method and then describe the findings

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437 interplay of non-linear modes does not read well. I would change to ``anisotropic flow''

Answer: ok, done

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419 remove ``at best''. How these 20\% were estimated?

Answer: It is at best 20%.

<https://twiki.cern.ch/twiki/bin/view/ALICE/ScalingProperties>

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