Long Symmetric Cumulant paper : 1st Collaboration review

Dear Institute reviewers

We would like to thank you for your careful reading and important comments. The summary of the changes made in the updated version of the manuscript are provided below briefly.

New version:
https://aliceinfo.cern.ch/ArtSubmission/sites/aliceinfo.cern.ch.ArtSubmission/files/draft/djkim/2017-Aug-15-paper_draft-longSC_CR_R2_v7.4.pdf

Difference between new and reviewed version:
https://aliceinfo.cern.ch/ArtSubmission/sites/aliceinfo.cern.ch.ArtSubmission/files/draft/djkim/2017-Aug-15-paper_draft-diff_CR1_EB.pdf

The reply to the comments :
https://aliceinfo.cern.ch/ArtSubmission/sites/aliceinfo.cern.ch.ArtSubmission/files/draft/djkim/2017-Aug-15-paper_draft-CR_R1_Reply.pdf

Reviewed version :
https://aliceinfo.cern.ch/ArtSubmission/sites/aliceinfo.cern.ch.ArtSubmission/files/draft/djkim/2017-Jul-19-paper_draft-longSC_CR_R1_v7.3.pdf

In addition to adopting the institutional comments, we have changed the following two things.
1. cited few more relevant papers in the introduction.
2. added chi-square test results of the models for the SC observables as suggested by Babara.

Regards,

DongJo on behalf of PC

Institutional review - Jyväskylä

Dear PC,
Thanks from the interesting and very fluently written paper! Here are a few comments from Jyväskylä (although DongJo is a member of PC :)):

31 : particles emitted —> particles are emitted ??
R : This sentence is reformulated according to WUT review.

34-35 : can you remove this sentence from here because the same is repeated in lines 41-42 (and maybe fit there better).
R : Since this sentence is introduced shortly as a general remark and it was expended in the next paragraph in detail, we think it is ok.

68 : I feel that “in transverse plane” a kind implicitly refers to boost invariant hydro, used in most of the theory studies. This is clearly the most important in any case, because the fragmentation region do not contribute to these observables in mid-rapidity (asymptotically suppressed as ~exp(-cosh(eta))~exp(-exp(|eta|)/2)) and typically the longitudinal evolution may play a small role. However, I wonder if one should include to this sentence “(in mid-rapidity)” to indicate this?
R : We think it is ok since the details can be found in the reference.

394 (and also the related discussion in many places) : conclusions say that theory has a different sign than the data, and the same is said in the discussion of the results. However, the sign of EKRT is actually negative. And also, only the first point in VISH2+1 is positive and for some initial condition only barely, maybe could be even negative at 10% most central bin. Hence it seems to me that the statement is a bit strong and should be reformulated both in conclusions and the results section. Although it is clear that hydrodynamical models clearly deviate from the data.
R : Correct, we now reformulated the discussion, removed the discussion on the sign.

Best regards,

-Sami Räsänen

WUT review of the paper: "Systematic studies of correlations between different order flow harmonics in Pb-Pb collisions at $\mathbf{\sqrt{s_\mathrm{NN}} = 2.76}$ TeV"
Paper in the system: https://aliceinfo.cern.ch/ArtSubmission/node/3182
Version: 2017-Jul-19-paper_draft-longS C_CR_R1_v7.3.pdf

Congratulations on very interesting results. Below you can find detailed comments, which concern mostly wording used in the paper.

Abstract
- L. 10. Sentence “with the multiparticle correlation observables dubbed Symmetric Cumulants” does not read well.

R : We think it is ok.

1. Introduction
L. 30 - 32. “Due to anisotropic pressure gradients in the plane transverse to the beam direction, more particles emitted in the direction of the largest gradients results in anisotropic transverse flow.” - Looks like unsuccessful merge of two sentences. Rewrite. Right now the implication suggested by this sentence is strange and misleading.
Also, maybe mention “in non-central collisions”, because the radial expansion mentioned in the previous sentence does not automatically lead to the transverse flow.
R : This sentence is reformulated to
“The matter produced in a heavy-ion collision exhibits strong collective radial expansion. Geometrical anisotropy of the almond shaped overlap region of the colliding nuclei causes larger pressure gradients into shorter direction of the almond,
that results in anisotropic transverse flow in the momentum space through interactions of the matter constituents.”

L. 33. You should mention also measurements of elliptic flow of other LHC experiments; otherwise journal review will point it out. e.g. https://arxiv.org/abs/1405.3936
R : Done

L. 36. “The temperature dependence..fluids obey.” - Again, please rewrite. This sentence now seems to imply that the nature of fluids is ruled by the eta/s temperature dependence, while we usually present it other way around.
R : We think it is OK.

L. 50. “The brackets” - actually, in this equation there are 3 different types of brackets; please specify.
R : Fixed.

L. 51 - 53. In sentence “The anisotropic flow.. ..profile.” we have a repetition of explanation of what elliptic flow is (first appeared in lines 30-32). Try to avoid or phrase differently.
R : We think that the current phrasing is already different enough.

L. 73, 106, 108, 111, 112, 121, 132, 141, and many more... - you use “Refs.” inconsistently. Sometimes it appears, sometimes not. Please
- Delete “Refs.” from everywhere or
- Keep “Ref.” or “Refs.” each time you directly reference the citation, i.e. “in [13]” → in Ref. [13]”.

R : We think it is OK, in few places we use those to emphasize the content.

L. 101 - 102. - Strange repetition of explanation of Sec. 6. Please keep only the first one (or merge).
R : Removed 2nd sentence.

2. Experimental Observables
L. 109. What “and only rather qualitative” means? Seems very unspecific.
R : We refer here to "different parameterizations of \eta/s(T)", and since it was mentioned in the very previous sentence, we see no reason to repeat it here again.

3 Data Analysis
146. “Data recorded by ALICE in Pb–Pb collisions at √sNN = 2.76 TeV during the” → rewrite (recorded by ALICE in PbPb collisions??)
R : changed to “The data samples analyzed in this article were recorded by ALICE during the 2010 heavy-ion run at the LHC in $\PbPb$ collisions at a centre-of-mass energy $ \snn=2.76$~TeV.“

156. “Increases” add “with transverse momenta”
R : Done.

161. “Reconstructed TPC tracks were required to have at least 70 space points (out of a maximum of 159).” → past tense (all other sentences are in present)
R : Done

162. Delete “of” from of 159.
R : We think both are OK.

183 - 185. “uncertainty on the pT dependent track reconstruction efficiency was also taken into account. Magnetic field polarity variation and reconstruction efficiency effects contribute less than 2% to the systematic uncertainty” → what does it mean?
R : The details of reconstruction efficiency effect to flow was discussed in the cited paper in Sec2. As it is described at Page4 Eq8 from https://arxiv.org/pdf/1312.3572.pdf, those effects are studied and described here.

4. Systematic uncertainties

L. 186. “due to the track reconstruction was” → add “procedure” (“track reconstruction procedure”)
R : Done

L. 186 - 191. - Chaos in the description. First you say that you were comparing between TPC-stand alone and tracks with combined information from TPC+ITS. The next sentence gives a feeling of a “general” one (for all tracks), but then zones in the SPD are mentioned resulting in a confusion (why there are zones in the SPD for TPC only tracks?). After reading all these sentences I also don’t know which of those (if any) are the default tracks.
- We understand that description of filter bit variation for general audience is difficult, but with the current description even as ALICE insider I had problems in understanding what was actually done.
R : As written, the default track selection was described in details in sec3, then L189-192 we describe the other selection, hybrid cut only. We think the current version is ok.

L. 193. “In addition, ...” - this part looks strange inside the paragraph about track reconstruction. Create new paragraph. And move it to the end of section, e.g. after the non-uniformities in the reconstruction efficiency.
- Actually, the last reconstruction efficiency paragraph right now looks like a repetition. Please merge it with previous discussions about the track reconstruction so that the difference would be more visible.
R : Now the efficiency is in azimuth which is different as written, originates from azimuthal non-uniformities in the reconstruction efficiency. We think the current version reads OK.

5. Results
Caption Fig. 2. SC(2,3) and SC(4,2) ((a) and (c)) → (a) SC(2,3) and (b) SC(4,2). The same for (b) and (d).
R : We think it is not necessary to change.

L. 231. “To study.. we show” → Please, change the implication or the verb. Showing is not really related to studying. It is rather presenting the results of the study.
R : we change “show” -> “present”

L 232. - “this avoids large” → this decreases
R : Done.

L. 337 - 339. “The comparisons [...] quantitatively.” → Please rewrite the sentence.
R : changed "though the" => "but it is clear that this"

Fig. 3.
Less labels on the left Y-axis for (B) and (C) plots. Other pads look fine.
R : Done

Caption Fig. 3. → Move v5 note just after the first sentence. Remove double brackets: ((A), (B) and (C)) → (A), (B) and (C). The same for (a), (b) and (c).
Please apply the same correction to text (remove brackets), L. 250.
R : We think double brackets are needed there.

Caption Fig. 4. → "labeled in the same way as in [31] - why is it needed?
R : Removed.

L. 395. reproduce the sign → reproduce it
R : Done

References
- Please correct the sqrt(s_NN) that does not look nice, i.e. [1], [7]

R : taken from inspire bibtex, fixed them manually.
- Sometimes names of authors do not start with capital letter, see [71], [73], [81]

R : taken from inspire bibtex, we will go through again over CR2.
- Reference [54] - There is only title of document – more information needed

R : added author names and report number manually.

Appendix A
L. 687, Comma after Therefore
R : Done
L. 703 and L. 716 → use long hyphen for 10-20% (5-20%)
R : Fixed
L. 717-720:
Remark-1: "all orders" is rather non-realistic, maybe "higher orders" would be enough ?
R : We think it ok, it refers n>=2.
Remark-2: It is unclear to what the word "together" relates:
- "model parameters .." "together with ..."
- "initial conditions ..." "together with ..."
- "simultaneous description..." together with..."

or maybe something like:
relativistic heavy-ion collisions, together with SC(m,n) and NSC(m,n) observables analysis.
Move the end to beginning of sentence:
"Together with SC(m,n) and NSC(m,n), the simultaneous description…"
R : Yes, moved the end to beginning of sentence.

Fig. A.3. Caption "various AMPT models" → Versions? Parametrizations? Options?
R : Since those are used in the other places and described what it means in Sec6, we think it is ok.

Institutional review - Tsukuba

Dear EB,

I attached the comments from Tsukuba on this paper draft. Sorry for the delay.

Best regards,
Tatsuya (for Tsukuba)

General: past and present tense are mixed please unify
R : Taken care of..
L 30: strong collective radial expansion -> missing references
R : Done, now we added two papers, one is PhysRevD.34.794 as very early paper and a recent overview on RHIC and LHC hydro, arXiv.1301.2826

L 31: the beam direction "in non-central collisions”
R : This sentence is reformulated according to WUT’s comment.
L 30-32: I think the information about thermalization is missing in the sentence.
R : We think we don't need to mention here.
L 32: at RHIC energies [1] -> add more references
R : Done
L 33: at LHC energies "in heavy-ion collisions”
R : We only talk about the heavy-ion. Probably no need there.
L 36: The temperature dependence of eta/s has some generic features that ...
=> not clear the relation with the later sentences
R : We think the description is good for general reader. It is generic feature but in HI, we see the minimum as a lowest bound than other substances.
L 71 $dxdy$ -> dxdy
R : Done
L 78-80 This sentence seems just a repetition of the previous sentences
R : We have expanded it since it was not obvious for some others, comments from IRC or EB round.
L 91: nonflow correlation => explain what is the nonflow correlation
R : We now added the reference [8], the detail studies on this were done.
L 104-107: I think this is in introduction, and it's good to mention what was discussed in the reference [13]
R : We think the current version is ok.
L 118: It would be nice if you could add a sentence explaining the physical reason why the correlation is sensitive to the temperature dependence of eta/s somewhere.
R : It was based on the detailed model calculations cited there but it is bit obvious that mode-mixing or correlation should have better sensitivities than the averaged main mode in Fourier decomposition. We think we don’t need to point this out there.
L 123: SC -> SC(m,n)
R : We think the current version is ok.
L 123: SC(m,n) = Eq. 3 ?
R : We think the current version is ok.
L 136-137: I think it's needed some more detail explanation why the temperature dependence of eta/s play an important (for me, it's not clear the relation the previous description that fluctuation is dominant in central and geometrical is dominant in mid-central)
R : As written, it is for SC(4,2) and based on the detailed hydro calculation. As it is written in L135, the details of the centrality dependence differ because of relative contributions. The model demonstrated that with a controlled fluctuation and geometry, the observables show a sensitivity on the detail settings of eta/s(T).
L 166: Systematic uncertainties: did you study/check bias from pile-up ?
R : No need for lhc10h data used for this analysis.
L 194: like-sign technique might be a jargon
R : We now added the reference [8], the detail studies on this were done.
L 207: why the measurement is up to 50% ?

R : >50%, the statistical error is large and non-flow contribution is not under control for individual flow harmonics or not fully studied.
L 207: what is the motivation to measure SC(5,2), SC(5,3) and their relation ?
R : it was explained at L73-87.
L 209-211: I'm not familiar with the analysis, but those trends are obvious ?
R : Those trends are seen in the hydro models and were more or less expected because of the fluctuations. These measurements were the very first constraints on the nature of SC observables.

L 210-211: ", which reveals..." not needed? (this part seems just a repetition of the same thing)
R : We think it is ok.
L 220: "within the errors": not needed?
R : We think it is ok.
Fig 2(b) : why there is large difference between the centrality 5-10% and 10-20% ?
R : It depends on the centrality or pt dependence of v2 and e-b-e correlation.
Fig 2(b) : NSC(3,2) in 40-50% shows rather pT dependent, what is the reason for ?
R : We refer to the discussion in Sec6. It is somewhat moderate change.
L 246-253: This part better fits in the "Data Analysis" section?
R : We think it is ok since it is not the main results of the paper but a supporting material.
L 248-249 : I think it's good that Fig.3 shows before Fig1 and Fig 2
R : Same answer as the previous comment.
L 306: temperature dependence of eta/s(T) -> how much is the T ?
R : for the “param1” parameterization the phase transition from the hadronic to the QGP phase occurs at the lowest temperature, around 150 MeV. See L319-324 or the reference 31 for full settings.
L 318-319: you mention that the models in Fig.4 best describes the lower order correlation data, but the agreement does not look so nice for SC(3,2) and NSC(3,2).
R : Yes, it was mentioned and emphasized in serval places, i,e L391.
L 328: The temperature dependent eta/s is also failing in Fig. 4, so is this claim justified?
R : The slopes in eta/s(T) are parameters in the models. This failure would help to contain it.
L 389: point(i) seems in contradiction with the statement at L 337
R : It is not contradictory since the remarks here are purely based on the initial conditions used in this particular set of the hydro calculations as written. Also note that it is significantly underestimated in hydrodynamic model calculations in mid-central collisions. There are room for improvement. We didn’t specify it in texts but VISH2+1 calculation is not really tuned to describe vn as shown in Appendix A and L337 comes mostly from EKRT and previous hydro studies.