

Dear Ilya and Sudhir

Thanks a lot for your detail check again for the new draft.
We have adopted all of your comments into account and reflected to a new draft.

new draft - longSC_CR_R2_v7.7.pdf
difference between v7.6 and v7.7 : diff_v7.6_v7.7.pdf

Regards,

DongJo on behalf of PC

Comments from Ilya

comments for 2017-Aug-18-paper_draft-longSC_CR_R2_v7.6.pdf

l9

The results were obtained with the

->

The results are reported in terms of

R : Done

l29

either remove "nuclear", or replace it with "QCD"

R : Done, replace it with "QCD"

l30-32

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.

-> repetition "almond" -> "almond", in general it is not almond due to fluctuations

Difference in pressure gradients and the interactions among matter constituents produced in the spatially anisotropic overlap region of the two colliding nuclei result in anisotropic transverse flow.

R : Taken your suggestion.

l38-39

that most known fluids obey. that most known fluids obey. One such general behavior is that this ratio typically reaches

->

typical to the most known fluids. This ratio reaches

R : Done.

l40

Replace Ref. [26] with

P. Kovtun, Dan T. Son, Andrei O. Starinets

(1857 citations)

<https://inspirehep.net/record/651094>

R : done with an addition to 26 since $\eta/s(T)$ dependence is more emphasized in 26.

Eq. (1)

$d^3 p$

->

$d^3 p$

R : Done.

l65

elliptic flow

->

anisotropic flow

R : Done

Eq. (2)

ϕ in exponent is not defined

R : Probably it is obvious. We leave it as it is.

I101

in Sec. 3 and the

->

in Sec. 3. The

R : Done

I105

Existing measurements

->

Existing measurements for anisotropic flow observables

R : Done

I117

theoretical predictions ... evolution independently.

->

theoretical parameters used to describe ... evolution.

R : Done

Eq. (3)

Start the equation with our notation $SC(m,n)$, i.e.

" $SC(m,n) = \langle\langle \cos(\dots) \rangle\rangle = \dots$ "

Otherwise this notation is not introduced in the paper.

R : Done

I142

Remove "Refs."

R : Done

The data samples analyzed in this article were recorded by ALICE during the 2010 heavy-ion run at the LHC in Pb–Pb collisions at a centre-of-mass energy $\sqrt{s_{NN}} = 2.76$ TeV

->

A sample of Pb–Pb collisions at the centre-of-mass energy $\sqrt{s_{NN}} = 2.76$ TeV analyzed in this article were recorded by ALICE during the 2010 heavy-ion run of the LHC.

R : changed to "The data samples of Pb–Pb collisions at the centre-of-mass energy $\sqrt{s_{NN}} = 2.76$ TeV analyzed in this article were recorded by ALICE during the 2010 heavy-ion run of the LHC."

I163

Reconstructed TPC tracks

->

add her "constrained to vertex"?

R : Done

I179

to be located within 10 cm of the interaction point (IP) to

-> "IP" is not used anywhere in the text

to be within 10 cm of the nominal interaction to

R : Done

I185

The uncertainty on the p_T dependent

->

The uncertainty due to the p_T dependence of the

R : Done

I211

measured in

->

published in

[R : Done](#)

Fig. 1(right)

Y-axis should have as notation $SCN(m,n)$, same as all over figures

[R : Done](#)

Fig. 1 caption

- l1

with flow harmonics from 2 nd up to 5 th order

->

for $m=3-5$ and $n=2,3$

[R : Done](#)

- l3

Note that the

->

The

[R : Done](#)

- l4

correlations and $SC(4,2)$... scaled ... of 0.1

->

correlations. The $SC(4,2)$... downscaled ... 0.1

[R : Done](#)

l218

($NSC(3,2)$ or $NSC(4,2)$)

->

$NSC(3,2)$ and $NSC(4,2)$

[R : Done](#)

l222

ranges > 20%

->

range 20-50%

[R : Done](#)

Fig. 2

Add lines at $Y=0$, same as in Fig. 1

[R : Done](#)

Fig. 2 caption

The normalized $SC(3,2)$ and $SC(4,2)$

->

The $NSC(3,2)$ and $NSC(4,2)$

[R : Done](#)

l243

range < 30%

->

range 0-30%

[R : Done](#)

l244

the > 30% centrality range.

->

the 30-50% centrality.

[R : Done](#)

Fig. 3 caption

v_n ($n = 2, 3, 4$ and 5)

->

v_n for $n = 2-5$

[R : Done](#)

v_n ($n = 2, 3$ and 4)

->

v_n for $n = 2-4$

[R : Done](#)

The $p_{T,min}$... Note that v_5 is also shown in panel (C).

->

v_4 and v_5 are shown in the same panel (C). The $p_{T,min}$...

[R : Done](#)

l250-251

The complete sets of the individual flow ... to calculate

->

The individual flow ... in calculations of

[R : Done](#)

l257

There should be an introductory sentence to Sec. 6 (and subsections 6.1 and 6.2). Add at the beginning of Sec. 6:

"We have performed a systematic comparison of the centrality and transverse momentum dependence of the $SC(m,n)$ and $NSC(m,n)$ to the EKRT+viscous hydrodynamics [45], VISH2+1 [78, 79], and the AMPT [62], [96], [97] models. Comparisons for v_n coefficients with the model calculations are presented in Appendix A."

[R : Done](#)

l257

We have compared the centrality dependence of our observables with event-by-event ... [45], where the initial

->

In the event-by-event ... the initial

[R : Done](#)

l259

spacetime

->

space-time

[R : Done](#)

l266-267

both the QGP ... and even off-equilibrium ... stage

->

the QGP ... and off-equilibrium ... stages

[R : Done](#)

l267-268

With well-tuned ... , , and given initial conditions discussed next, ... LHC

->

By tuning ... for a given scenario of the initial conditions ... LHC energies

[R : Done.](#)

l269-271

Three different initial conditions ... are used in the model [58].

->

Three different types of initial conditions [58] ... have been used for our data to model comparisons.

R : [Done](#).

l271-272

entropy density with contributions from ... profiles [82], and the KLN ... entropy ... to the initial gluon density

->

energy density from ... profiles [82]. The KLN ... energy ... to that of the initial gluons

R : [Done](#)

l274

In MC-Glauber and MC-KLN [84–86], additional

->

In Monte Carlo versions MC-Glauber and MC-KLN [84–86] of these models an additional

R : [Done](#)

l277

decompositions ... spatial coordinates.

->

distribution ... coordinate space.

R : [Done](#)

l279-280

Remove "The detailed quantitative comparisons of the measured v_n to the model calculations are provided in Appendix A.", as this is now introduced in the beginning of the section for all models.

R : [Done](#)

l281-284

achieved in collisions ... as a result of its finite volume ... AMPT has been

->

achieved shortly in collisions ... due to its finite size ... the AMPT model has been

R : [Done and added the original references for AMPT there.](#)

l285

For the initial conditions, the AMPT model uses ... of hard minijet partons and

->

The initial conditions in the AMPT are given by ... of minijets and

R : [Done](#)

l287

The AMPT model can be run in two main configurations, the default and the string melting model.

->

For the data comparisons three different configurations of the AMPT model has been used: the default one and string melting with and without hadronic rescattering.

R : [Done has -> have](#)

Footnote 1

- Move the footnote 1 into the main text, no gain from having it as a footnote.

- used in both configurations -> used in all configurations

R : [Done](#)

l288

default version,

->

default configuration,

R : [Done](#)

l290

melting version

->

melting configuration

R : Done

l293

Remove "also"

R : Done

The third version used in this article is based on the string melting configuration in which the hadronic rescattering phase is switched off to study its influence on the development of anisotropic flow.

->

The string melting configuration of the AMPT without hadronic rescattering was used to study the influence of the hadronic phase on the development of the anisotropic flow.

R : Done

l296

reasonably reproduces

->

reasonably well reproduces

R : Done

l303

Remove "The quantitative comparisons of the measured v_n to various AMPT configurations are provided in Appendix A.", as this is now introduced in the beginning of the section for all models.

R : Done

l306-308

Three different models are compared with the experimental results presented in Sec. 5. We compare ... ; these were shown ... In this previous work it was

->

Comparison ... was shown ... It was

R : Done

l311-312

The NSC(4,2) observable shows better ... but the model cannot ... either .. or ... This observed discrepancy

->

The model calculations for NSC(4,2) observable show that it has better ... but they cannot .. neither ... nor ... The discrepancy

R : Done

l317-319

While we discussed the comparison to these hydrodynamic model calculations with various temperature dependent η/s parameterizations, only two calculations with the parameters ... results

->

The calculations for the two sets of parameters ... data

R : Done

l323

can be ruled

->

is ruled

R : Done ->are ruled

l327

"Most notably, this measurement is so far the most dramatic example of the failure of constant η/s to describe the data."

Remove this sentence, as it is not justified by results in Fig. 4 and Fig. 7

R : Removed. Now a moderate conclusion the later part on chisquare test.

l335

The comparisons

->

Similar to the EKRT+viscous hydrodynamics calculations, the comparisons

R : Removed this sentence since the conclusion might have different meaning because of the difference in initial conditions and/or untuned v_n in VISH models.

Figs. 4,5,6

There should be an entry in the legend indicating that black circles represent the data points

[R : Done](#)

Fig. 4,5,6 captions

"are compared"

->

". Results are compared"

[R : Done](#)

Fig. 5

, 0.16

->

and 0.16

[R : Done](#)

(NSC(m,n)

->

(NSC(m,n))

[R : Done](#)

I355-256

string melting AMPT model ... default model

->

string melting configuration of the AMPT model ... default configuration

[R : Done](#)

I375-276

reversal of the hierarchy ... the magnitudes

->

inverse hierarchy ... different magnitudes

[R : Done](#)

I378

an AMPT model

->

the AMPT model calculations

[R : Done](#)

I396

Finally, we perform a least-square test to the models for each SC observable via ... as following,

->

The agreement of various model calculations with the data is quantified using the χ^2 by calculation

the χ^2 :

[R : Done : calculation -> calculating](#)

I398-399

measurement (model) in a centrality bin, and the systematic

->

measurement (model) value in a centrality bin \sqrt{s} . The systematical

[R : Done](#)

I399-400

The centrality range is restricted in 10–50% bins, corresponding to the total number of data sets in each observable (N) is 4.

->

The total number of data samples N in Eq. (5) is 4, which corresponds to the number of bins in the centrality range 10-50% used in χ^2 calculations.

[R : Done](#)

I400-401

The resulting χ^2 for few selected calculations from three theoretical models which describe the SC observables best is shown in Fig. 7.

->

The χ^2 for model calculations which are best in describing the SC observables for each of the three different types of models is shown in Fig. 7.

R : Done

Fig. 7 Y-axis

10^0

->

1

R : Done

Fig. 7 caption

The χ^2 values from the comparison of few selected calculations from three theoretical models are shown for SC(m,n) (a), NSC(m,n) (b) and individual harmonics v_n (c).

->

The χ^2 values defined by Eq. (5) calculated for SC(m,n) (a), NSC(m,n) (b) and individual harmonics v_n (c).

Results are for model calculations which are best in describing the SC observables for each of the three different types of models.

R : Done. "The χ^2 values defined by Eq. (5) calculated" to "The χ^2 values calculated by Eq. (5) are shown"

l405

This can be explained by the fact

->

This reflects the fact

R : Done.

l407

showing that the

->

where the

R : Done.

l410

worst ... and noticeably larger

->

largest ... especially

R : Done.

l412-413

As for the calculations from event-by-event EKRT+viscous hydrodynamics, the χ^2 values for SC(4,2) and NSC(4,2) are comparable to that for v_2 but they are larger than that for v_4 .

->

The χ^2 values for SC(4,2) and NSC(4,2) for event-by-event EKRT+viscous hydrodynamics are comparable to that for v_2 but larger than for v_4 .

R : Done. "for event" -> "from event"

l414-415

I can turn this argument around and say that I can tune my model to reproduce SC(m,n) and then it will fail to reproduce v_n . I think we need both [N]SC(m,n) and v_n to describe simultaneously, i.e.:

This finding supports the idea that the SC observables can provide better constraints in the model calculations than the individual flow harmonics v_n .

->

This illustrates that the SC observables together with the individual flow harmonics provide better constraints for the model parameters than each of them individually.

R : Done. illustrate-> illustrates

l417

related with v_3 .

->

which includes v_3 .

R : Done. includes-> include

l418-421

depending both ... sensitivities ... properties used in the model calculations.

->

depending ... sensitivity... properties.

R : Done.

l422

Correlations between v_2 , v_3 and v_4

->

Correlations between v_2 and v_3 and v_2 and v_4

R : changed to "between v_2 and v_3 and between v_2 and v_4 "

l423-425

Remove the repetition below (the same text appears on l241-244):

"It can be seen in Fig. 2 that for NSC(3,2) there is no $p_{T,min}$ dependence in the centrality range < 30%, and a moderate decreasing trend with increasing $p_{T,min}$ is observed in the > 30% centrality range. NSC(4,2) shows a moderate decreasing trend as $p_{T,min}$ or centrality increases."

and start Sec. 6.2 from the discussion of the model comparison, i.e. l426 "The NSC(3,2) and NSC(4,2)..."

R : Removed

l428

higher minimum p_T cuts.

->

higher $p_{T,min}$.

R : Done

l429

With the exception of the default configuration, the other AMPT settings

->

The default configuration of the AMPT is well reproducing the NSC(3,2), while the other AMPT configurations

R : Done

l433

the same model which

->

the default AMPT configuration which

R : Done

l434

When the string melting AMPT model is compared to the same model with the hadronic rescattering off, it is observed that the

->

Comparison of the string melting AMPT configuration with that without hadronic rescattering suggest that a

R : Done. suggest->suggests

l446

> 20%

->

30-50%

R : Done.

l449

This

->

The

R : Done.

l456-457

The results are obtained with Symmetric 2-harmonic 4-particle Cumulants (SC)

->

The results are presented in terms of the Symmetric Cumulants $SC(m,n)$.

R : Done.

l457

that this method is

->

that SC(m,n) are

R : Done.

l468-469

these ... lower order harmonic correlations.

->

the ... lower order.

R : Done.

L474

these results

->

the new results for SC(m,n) and NSC(m,n)

R : Done.

Figs. 8,9 caption

"is compared to"

->

". Results are compared with"

R : Done.

Ref. 102

Reduce the list of names to "W.-M. Yao, et.al."

R : Done

l771-772

The comparisons are made only up to v4 because model calculations are not available for v5 at this moment.

->

This sentence asks for a question, because to calculate NSC(5,2/3) for models in Fig. 4-6 we need to calculate individual v_n , and here we state that v5 is not available for the models.

R : Removed. We tried to get the model calculations, was not successful in the end. Probably they want to release in their papers first. We might try to get them again during CR2.

l773

The measured v_n ($n = 2, 3$ and 4)

->

The measured v_n for $n = 2-4$

R : Done

+specify the rapidity and pT range used for the data/model calculations

R : added in the figure and in the text. The v_n is measured for charged particles in the pseudorapidity range $|\eta| < 0.8$ and the transverse momentum range $0.2 < p_{\text{T}} < 5.0$ GeV/c as a function of collision centrality~\cite{Adam:2016izf}.

Figs. A1-A3 caption

v_n ($n = 2, 3$ and 4)

->

v_n for $n = 2-4$

R : Done, also in the main text.

"are compared"

->

". Results are compared"

R : Done

Fig. A1 caption

[45]. The lines are hydrodynamic predictions with two

->

[45] for two

R : Done

Fig. A2 caption
are drawn as different colors
->
are shown in different colors
R : Done

The η/s parameters
->
The results for different η/s values
R : Done

, 0.16
->
and , 0.16
R : Done

Fig. 4 caption
to few selected model calculations from three theoretical models which describe the v_n data best.
->
with selected calculations from three different types of models which are best in describing v_n coefficients.
R : Done

P.S.
I forgot to mention that the reply to the Collaboration Round 1 comments are fine from my side.

There are a few small typos (like expended -> expanded, contain -> constrain, texts -> text), but all the answers are clear.

Comments from Sudhir

Dear DongJo,

1. I share Ilya's concern as expressed in his last mail and observe the following:

(i) The chi-squares seen in Fig. 7 indicate a preference for EKRT + viscous as against VISH2+1 with AMPT initial conditions.

(ii) The chi-squares do not help us conclude the correctness of the model with constant η/s versus temp. dependent η/s .

(iii) An extremely low value of chi-square (for v_4 , the χ^2/dof is ~ 0.05) does not indicate a good fit in as much as a very large value does not invoke a good fit.

(iv) Line 465 (draft dated 15/08/17), the last line just before the last para in summary.
"Based on the tested model parameters, the data favours small η/s and the AMPT initial condition".

Unless I am missing something, this is at variance from what fig. 7 conveys.

R : The chi-square test was done to give readers more quantitative picture suggested by Babara.

I agree fully what you have listed but I am not sure what you can do more than those written in the paper. This is what we can do best now. Instead of this kind of simple chi-square test, we need to go along with the line of an approach, for example <https://arxiv.org/abs/1605.03954> to constrain things. For sure our new observables will be used as soon as they are out.

Also note that χ^2 is ok since the statement is purely based on the model parameters used only in VISH2+1 as written in few places.

Also note that VISH2+1 doesn't have T dependence of η/s and initial conditions are different.

Also new paragraph will give a better insight on what we have now.

(2) Lines 324-325: "As shown in Fig. 4.....within the errors". Correlations between v_5 and v_3 are not well described within error, and large departure can be seen at lower centralities (40-50%). You may want to moderate the statement a little. Here is a suggestion:

"While the correlations between v_5 and v_2 are well described at all centralities, the correlations between v_5 and v_3 are well described for the more central collisions and deviate by a little more than one sigma for 40-50% centrality, as shown in Fig. 4"

R : Done

(3) Line 396: We are performing a least squares method (which can also be derived from log-likelihood). There is no need to mention log-likelihood. 'Suggestion: remove 'log-likelihood or'

R : Done

(4) Line 399- 400: "The centrality range isis 4". May be this was discussed: should we specify why is this analysis restricted to 10-50% and the data points for the most central events are not taken? Also, you may want to rephrase this sentence for want of clarity.

R : We don't have a model calculation for one of EKRT models $< 10\%$.

There are some very minor edit comments. Take them if you like:

Line 24: '.... the present(ed) results provide further constraints on (the) initial conditions and

R : Done

Line 100-101: Change the order...."In Sec. 2 we present the analysis methods and summarise our findings from the previous work" because that is the order in which we have done it in section 2.

R : Done

Line 241: Suggestion: "The NSC(3,2) observable does not show any $p_{T,min}$ dependence for the centrality range $< 30\%$, while showing a moderate....."

R : We think the current version is ok.

Line 298: "....it was seen clearly in a recent study...."Suggestion --> ...it was observed in a recent study....

R : Done

Line 464: '...fail to capture the ...' --> '...fail to describe the', You may want to make this replacement at some other places also.

R : Done for few places.

Thank you and best,

sudhir