WUT review of "ΛK femtoscopy in Pb–Pb collisions" paper

Link to paper page:
https://alice-publications.web.cern.ch/node/5115

Link to paper draft:
https://alice-publications.web.cern.ch/system/files/draft/5115/2019-08-28-lamkpublication_v6.pdf

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GENERAL

Use upfonts for particles \uppi from upgreek package.
Unify the k*, **k, P, p,** p.. (vectors and scalars notations, 3-momentum, 4-momentum)
Unify Fig. Figure Ref. Reference Eq. Equation and so on.
Check for repetitions. The information is several times repeated in the text in neighbouring paragraphs and sentences.

Asymmetry measurement this part of the analysis is very inconclusive and doesn't provide further insight for the reader. It is not clear if the simulation with a different radii would describe better the data, or by changing the interaction parameters. It seems that both are correlated (R and f). The fact that the mT scaling is not followed by the non-identical is expected, but to produce an expected value is not an easy task in the presence of collective motion, as here, for example residual correlations do play a role as they may contribute with a non-flat distribution, as heavier particles will have more flow.

I agree with Georgy here. For the moment the paper focuses on both aspects: the strong interaction measurement, and then the emission asymmetry. In my opinion, the procedure should be the following: we first constrain the parameters, then we use them to extract the asymmetry. Here, after reading the paper, I have an impression that the asymmetry measurement and the whole analysis is incomplete. While this is good for a PhD thesis, personally I would not keep it in this paper. Perhaps a better option would be to use what is in the Appendix C as a basis for a future theoretical/methodological paper, and then just use the developed method while analyzing data in a subsequent ALICE paper.
In addition, here it is assumed that all three radii of LCMS have the same value, but this also may not be true. We know from identical pion measurements for instance, that they are not the same. This was taken into account in the pion-kaon analysis for example. In summary, I think

the paper would benefit more if it had a clear message and really finalized results - so focus on scattering parameters which is very well done, and remove the asymmetry part.
Method from Appendix A is also not used in the final analysis (at least to our understanding), consider removing it.

MINOR GENERAL

Provide equations in parenthesis, like Eq. (10) (mixed ways are used, sometimes with, sometines without)

FIGURES
For almost all figures labels are very small. They are readable only on screen (with zoom) and not on printouts. Please try to increase the labels as much as possible.
Fig. 1 : almost all labels unreadable (axis, legend, Sig/Bkg)
Fig. 2. Legends
Fig. 3. Legends, axis labels
FIg. 4 Axis labels, legend
Fig. 5. Axis labels
Fig. 6. Axis labels

TITLE

ABSTRACT

The abstract should be modified if the asymmetry measurement stays or it is removed from the publication.

INTRODUCTION

L24: In addition to a review paper [1] (by Lisa, Wiedemann, et al) I would also add references to femtoscopy such as Kopylov and Podgoretsky papers.

L26-27: CF are sensitive to FSI and to the source

L31-32 "The momentum and species…" should be before the non-identical femto as it relates to the general and not only to non-identical.

L33 unique environment? Femtoscopy allows one to measure/access/extract...

L33: "in which to measure scattering parameters, many of which are difficult (...), to measure othweise" -> very hard to understand, please rephrase

L34 nuclear scattering parameters? Which and what they are.

L35 "This aspect of femtoscopy is the focal point…." This sentence is superfluous, should be clear from introduction and abstract.

L33: repetition of "analysis" just next to each other

L35-37 "In this analysis, L-K pairs are studied, in which at least one particle is electrically neutral. Quantum statistics and the Coulomb interaction do not contribute, offering a clear signal from the strong interaction." L-K pairs, which only interact strongly, are the subject of this analysis

L42 "This study is particularly interesting": This sentence is superfluous, Don't say it, you have to convince readers about it.

L42-43:   "where not previously not known" ?

                where not previously known

                 where previously unknown

L42-43 Or they are unknown (the parameters) or there is limited knowledge about them. Can not be both simultaneously.

L30: separation of the single particle source emitting regions -> separation of the single-particle source regions; or: "single-particle emission regions" (although I'm not a native speaker)

L44: Scattering parameters for similar systems are also very limited -> it should be rather "information about scattering parameters for similar systems is also very limited"

L47-48 "This paper presents the first measurements of the scattering parameters of LK pairs in all three charge combinations (LK+, LK-, and LK0S)." Repeats sentence from lines L39-40.

L52 Which are the non-femtoscopic backgrounds? In the paper only flow is studied.

L53 "correlations induced by feed-down from resonances". This leads to confusion as you correct for electromagnetic and weak decays, which are long lived particles wrt the time of formation of the femtoscopic signal and drop the short lived resonances. Specify it.

L60 Appendix A is not used for anything in the text. Yes, a method exists to suppress the effect from flow but it also doesn't produce a full decorrelated background in the femtoscopic region. It is a good proof of principle that the non-flat CF comes from flow. Moreover it works for central and semi-central but is not flat in peripheral, meaning that other sources are present.

L63-64 Appendix C and THERMINATOR. The source offset has only limited effect on the radii. See paper A. Kisiel, "Pion-kaon femtoscopy in Pb–Pb collisions at √sNN=2.76 TeV modeled in(3+1)D hydrodynamics coupled to Therminator 2 and the effect of delayed kaon emission," arXiv:1804.06781

The part related to the delayed emission is not conclusive. It is not clear at all if the effect comes just from collectivity or there is something on top as an offset. Moreover the different parameters seem to correlate and instead of mu_out one could change slightly scattering parameters and get a similar result.

L64: the source offset in the "out" direction -> this is jargon; since it is an introduction, why not write what the "out" is?

DATA ANALYSIS

L69-70 "This work reports on the analysis of Pb–Pb collisions at sNN = 2.76 TeV produced by the LHC and 70 measured by the ALICE experiment [16] in 2011." Was already said several times before.

L77: Tracking System -> Tracking System (ITS) ; to be consistent with the previous line.

L77-78 determining and determination too close to each other. Substitute by a synonym one of them.

L79 of the **tracks** was performed using **tracks**
"The determination of the momenta of the tracks was performed using tracks reconstructed with the TPC only" -> The momentum was reconstructed by the tracking algorithm using only TPC clusters.

L79-81 Reorder. In order to achieve high quality you impose minimum number of clusters cut.

L79: A minimum requirement of 80 reconstructed TPC clusters was imposed -> I would add here "requirement of 80 reconstructed TPC out of … possible was imposed"

L81 "remove fakes" -> reject

L85 Bethe-Bloch depends also on charge!

L88 repeated -> tested/applied. Why also to electrons?

L89 hyphens "-", especially followed by "," do not look good.

Regarding the PID nsigma section, say explicitly that it was used to select primary kaons, as well as for acceptance and rejection of V0 (lambda) daughters. Because finally you have a primary kaon sample (where you select kaons and reject electrons and pions) as well as pions and protons of lambdas (where you have acceptance criteria). How it is written now suggests the reader that you actually select all 4 species (electrons, pions, kaons, protons) as primary particles - at least that was my impression.

Perhaps describe the general idea of nsigma for a given example particle instead (that nsigma is deviation in number of sigmas from the mean of the distribution for a given particle)…

Anyhow, I would think of rewriting parts of this paragraph.

L106 2.2 V0 selection -> K0 and Lambda selection

L107-108 Mention the branching ratios of these decays.

L108 The main selection -> remove "main", is there any other?

L 109 "Aside from typical kinematic" -> remove typical

Table 1, Electron rejection: In the definition of the condition for electron rejection, charge is unnecessary ("e$^-$" should be "e", K$^{+/-}$ should be K, I think)

L114-115 "The positive and negative daughter tracks are combined to form the V0 candidate, the momentum of which is the sum of the momenta of the daughters (calculated at the DCA)." Move to L108 after "The obtained candidates are…". Is momentum calculated at the DCA or at the Point of Closest Approach?

Line 114: why "Daughters" has to start with capital "D"?

L120-135 Simplify this paragraph, something like: Each V0 L is tested for the K0 hypothesis by identifying both tracks as pions. In the event that the second hypothesis provides a good K0 mass, both tracks pass well single particle cuts, and the difference of the reconstructed invariant mass to the PDG value is smaller than that of the Lambda, then this V0 is rejected.

L143 "For the purity **estimations**, the background signal is **estimated**" ->
For the purity estimations, the background is obtained from/calculated/extracted

L144-145: fitting the minv distribution outside of the mass peak and assuming the distribution to continue smoothly within the mass peak -> I would add here what is the assumed shape (linear?)

L145 *within* peak -> beneath

Fig. 1: I would add in the caption what is the centrality class for these data (0-50%?)

Fig. 1: "Bkg" and "Bgd" used, perhaps unify, also do we need to provide separately "Sig" and "Sig+Bkg" (which are big numbers and depend also on number of analyzed events, finished jobs on the grid etc.)? Would one number for purity (the division of those two) instead work? That would be more valuable I think

L148 "due to pairs sharing daughters" Already said in L138-139

L149 "split or merged tracks" What they are? Substitute by their definition.
L150 "The purpose of the shared daughter restriction is to ensure the first particle in the pair is unique from the second." Drop the sentence, it is clear.

L162-164 "The constraint values used coincide with the values at which the average separation correlation functions stabilize to unity, signifying the splitting and merging effects are no longer abundant." Simplify; The cut value was chosen by varying it until no effect was visible in the correlation function.

ANALYSIS METHODS

3.5 Non-femtoscopic background: Was THERMINATOR-2 simulation filtered with acceptance-efficiency from experiment in order to reproduce better the experimental distributions?

L176-179 Check for scalars and vectors. Unify notation. Define the asterisk.

L179-180 "Within the Psi2 term the particle interaction information is contained, and therefore the
scattering parameters." Not needed, delete the sentence.

L180 - perhaps move section 3.2 here (continue with description of Psi using Lednicky model) as this is connected. The next section is then the experimental measurement, which is something separate from theoretical approach (for example Eq. (3) is an experimental solution to Eq. (1))

L184: femtoscopic effects -> should be rather "physical effects", since the correlation function contains non-femtoscopic background, as indicated later in the paper.

L184 femtoscopic effects -> correlations

L186 "Typically, B(k) is obtained using mixed-event pairs [28]" ->

B(k) is obtained using the mixed-event technique [28]

L187-189 The rotation by 180 is not used, why mentioning it at all?

L189 "For this analysis, the typical mixed-event method" -> For this analysis each event is mixed with five…

L 190-191: "events" appears many times, like "... events, only events …" -> rephrase

L 192 are mixed -> are used.

L193 -196 "This analysis presents correlation functions for three centrality percentile ranges (0–10%, 10–30%, and 30–50%), and is pair transverse momentum (kT = 1/2 |pT1 +pT2|) integrated (i.e., no restriction on kT) due to limited data. The kT dependences of the three LK charge combinations should be comparable, so an integrated analysis is acceptable." -> This analysis presents correlation functions for three centrality percentile ranges (0–10%, 10–30%, and 30–50%).

L195: "The kT dependences of the three LK charge combinations should be comparable, so an integrated analysis is acceptable." I would remove this sentence or rephrase it. Since we don't know if the kT dependences of the three LK charge combinations are comparable, we can't conclude about whether "analysis is acceptable" or not.

L196-197 "The correlation functions were constructed separately for the two different field polarities applied by the ALICE L3 solenoid magnet during the data acquisition. " ->

The correlation functions were constructed separately for the two different field polarities with *similar statistics in each data sample*.

L197-199 "These are kept separate during the fitting process, and are combined using a weighted average when plotting, where the weight is the number of numerator pairs in the normalization range." This applies to the CF or to the results of the extracted parameters from the fit? Those have likely different errors. Only in plotting or also for the tables?

L210 "with at least one uncharged member" was already said before (L201), drop it.

L. 212: provide a reference to Lednicky & Lyuboshitz paper from 1981 regarding the F1 and F2 functions (they are introduced there)

L218-227. Primaries and secondary particles should be defined before, better in the introduction when introducing residual correlations and feed-downs. Lifetime of the particles is not mentioned.

L236 Lfit parameter, for what is needed? Then is compatible with 1. For what it accounts for?

L232-233 Within the list phi meson in not there. 10% of K+K- are from phi's. It's lifetime is of 40 fm/c, so it should be somewhere mentioned.

L289-294 Simplify the fakes part: e.g. Fakes fractions are obtained from the product of individual particle purities.

L296-299 "Finite track momentum resolution causes the reconstructed momentum of a particle to smear around the true value. This, of course, also holds true for V0 particles. The effect is propagated up to the pairs of interest, which causes the reconstructed relative momentum (kRec) to differ from the true momentum (kTrue). The effects of finite momentum resolution are accounted" ->
Finite track momentum resolution causes the reconstructed relative momentum (kRec) to differ from the true momentum (kTrue). It is accounted….

L. 297: I am not sure we can say "V0 particle" which sound like a slang, however you defined it in L108. Then it's fine, but would it be possible to rephrase this to avoid the "V0 particle"?

L304-306. From "Equation 10 describes that…" and until the end of the paragraph is not needed.

Table 5 Why all the Fakes fractions are identical even though the purity for charged K and K0 are different.

L307 Non-femtoscopic correlations

L313-315 Drop the last sentence of the paragraph.

L331-332: "during the fit of the low-k∗ signal region, the background is fixed" - this part was a bit confusing for me.The first part of the sentence is about fitting the background model to data, but then there is a statement that "the background is fixed" in the "fit". What is the "fit" in this case then? Is it a fit of the experimental data with model of a full correlation function, with fixed background?

L334-340 This is not used. Drop it.

L334-340: agree - as I understand, this is not used in the final analysis (at least to my understanding from the text). Good for a PhD thesis to have this check, but here not needed and provides a bit of confusion. Since you have it here, why wasn't it used for systematics then? In such a case that would be justified to have this part in the paper.
Minor comments regarding this paragraph: "appendix" is not specified (you should say "Appendix A"). Sentence "is to instead attempt to eliminate it" doesn't sound good to me. "The

background MAY be effectively" -> perhaps change "may be" to "can be"? "may be" sounds to me like "may or may not", very weak statement. You also have "Stavinsky method" next to each other in the same line (336)

L352-357 Starting from "For each pair system" until the end of the paragraph is repeated in the next paragraph. Remove it.

L357 "To summarize, the complete fit function" -> The fit function...
(It is already a subsection called summary)

L367 "and has been corrected for momentum resolution…" Already mentioned before in L364

L370 What is the effect of the variations done for the systematic study? Put it to the table 6.

L373-374 The standard deviation is not the best estimator of the uncertainty. In the event of an infinite number of variations with very small steps, you would get 0 error.

L374: I think I didn't get the procedure. You say "the correlation functions from each variation of the selection criteria were averaged". So let's say you have: default -> functionDef, variation1 -> function1, variation2 -> function2, …, variationN -> functionN. This gives you, for each k*, a distribution of values. From this you calculate the average and the standard deviation. But what standard deviation do you calculate? *standard deviation of the average* (error of the mean) or *standard deviation of the distribution of N points* (sqrt of the second moment of the distribution)? If the former one, this is for sure not correct, and would give you 0 if N->infinity. Also, how do you calculate average? Is this a simple average or a weighted average? Anyway, this is very unclear.

L376-378 What is the correlation between the fit parameters?

L380-385 What is the effect of all these changes on the results? Also for Table 6.

RESULTS
L390-394 "but assumed unique among the different LK charge combinations (i.e., a parameter set describing the LK+ & LK- system, a second set describing the LK- & LK+ system, and a third for the LK0S & LK0S system). Each correlation function receives a unique normalization parameter. The fits are corrected for finite momentum resolution effects, non-femtoscopic backgrounds, and residual correlations resulting from the feed-down from resonances."
-> Already said in the previous section. Belongs to method. Drop it.

L393: The fits are corrected for finite momentum resolution effects... -> I would say "The fits (or fit functions) include finite momentum resolution effects...".

L398-400 Why primary contribution is different for different centralities?
The difference due to the non-femtoscopic background should be properly captured by THERMINATOR.

L407-408 "The real part of the scattering length describes the effect of the strong interaction, making the difference in these systems quite intriguing."
Remove it. Should be decided by the reader.

L415 "which is clearly inconsistent with the LK+ system" Considering the errors (specially from [11] this is a too strong statement.

L443: "smaller homogeneity regions", I would explain what a "homogeneity region" is, so far only "source" was used to describe a region from which particles are emitted.
Fig. 4, Tab. 6 and related text - I'm confused by the meaning of "lambda_{Fit}" parameter.
If I understand correctly the Eq. 6 (page 9), lambda_{Fit} is introduced to account for residual correlations. Then, the parameter "lambda_{LambdaK}" is related to the studied correlations of LambdaK system. Why then present "lambda_{Fit}" instead of "lambda_{LambdaK}" as one of the main results of the paper?

Fig. 4 d0 is not commented at all in the text.

L460 and until the end. C00 is identical to the normal analysis for radii. C11 of fig. 6 is not corrected for background. The non-identical radii can not be easily obtained from the single particle radii. Moreover, the mean <m_T> of the particles is not fully correct, as at k*=0, the slowest kaons will be balanced by the fast lambdas. Therefore the relevant m_T is os kaons of those which contribute to the low k* region! This part is very non trivial.

Fig. 5 Why <m_T> changes with centrality for LK by ~50 MeV/c2?

SUMMARY
L483-484 "The non-femtoscopic background is found to result almost entirely
from collective effects" Where any other tested?
"and is described quantitatively with unprecedented precision with" in 30-50% centrality there are systematics. Soften it.

L485-488 "Finally, the LK systems exhibit source radii larger than expected from extrapolation from identical particle femtoscopic studies. This effect is interpreted as resulting from the separation in space–time of the single-particle L and K source distributions (i.e., the emission asymmetry of the source)."
It is not easy to have non-identical radii from identical. What were the expected values?

BIBLIOGRAPHY

Inspirehep bug, name of the journal attached as number (in bold) *Phys. Rev. C 78* (references 3, 6, 7, 8, 9, 10, 11, 13, 14, 17, 19, 20, 24, 27, 28, 29, 30, 33, 34, 35, 37, 39)

Please be consistent with the number of letters in the names of authors, e.g. B. Abelev in [19] and B. B. Abelev in [20].