https://alice-publications.web.cern.ch/node/5115
Comments/suggestions by Laura, Konstantin and Marek

Abstract:
General Comments:

In general, the draft of the paper is written well enough.
The draft is slightly overloaded with details that can be reduced.

Maybe too many technical plots: We risk to overload the paper with redundant details.
In the description of the PID and V0 cuts, partially too verbose, maybe reduce a little the text for sake of simplicity. The text is nicely written but it reads a bit as a PhD thesis, normally journal articles are more compact.
Also, the plural form ' we ' is used throughout the manuscript, but the impersonal form is better in papers. Please change.

From the point of view of the analysis, the discussion of the 3 and 10 residuals should be modified. First the discussion should be more clearly explained in terms of short lived resonances (K* Sigma*) and their contributions and not only via this nomenclature 3-10 residuals, since it is misleading.
Since the results of the scattering paramters are very different for the 2 approaches, we think that both should be discussed in the paper. Indeed, it is not very clear if kaons and Lambda stemming from short lived resonances feel the same final state interaction that primary particles do.

I remember that during the development of the analysis you carried out also some systematics studied for the two cases with and without short lived resonances. It would be necessary to present these systematics as well.

The scattering parameters are particularly different in the case LambdaK0s.
This is maybe also due to the fact that you use the linear extrapolation for the background evaluation and not Therminator.
This is another point which we don't understand. First of all the figures that show the comparison between the measuread and simulated correlations in Fig 4 display and agreement, so we don't understand why you write that for LK0s therminator does not work.
Moreover, since the LK+ and LK- backgrounds are very similar in each centrality bins, one could use them or the average of them for LK0s and not this linear fit.
The figures in the analysis note suggest indeed that because of the slightly larger background obtained with the linear fit for LK0s and the smaller lambda parameters in case of the 10 residuals, the two effects concur to produce different scattering parameters for K0s (in the sign) between the 3 and 10 residuals cases.
For this reason we recommend to drop the linear fit and either use Therminator also for K0s or take the LK+ LK- bacgkrounds.

Since the K0s are a mixture of kaons and antikaons, we expect the scattering parameters to be a kind of average of the one obtained for LK+ and LK-.
It seems also that the results go into this direction.

From the analysis note we also know that the lambda parameters obtained in the case of the 10

residuals are not 1. On the other hand, if we understand correctly the analysis, this parameters concerns only the coefficient that multiplicate the sum of all secondaries in eq. 15, lambda_fit. In this case, since the lambda_KL (genuine) varies between 3 and 10 residuals, it is also normal that the lambda parameter varies.
So, we are not sure that this is a problem.

Detailed Comments:
Abstract:

It should be mentioned that the experimental correlation functions are fit with the same radius and lambda parameter for all three pairs in each centrality bin.

L 11-14

maybe shorten to:

Extensive studies with the THERMINATOR 2 generator allow to quantify the non-femtoscopic backgorund, mainly due to collective effect, with unprecedented precision.

l.11-14 There is an information about the simulation of the background with the THERMINATOR model but nothing said about the residual contribution.

l.15-16 It is noted that there is a difference between ΛK+ and ΛK- pairs but nothing said about the ΛK0s pair.

L18-19 :

The underlying cause dictating this interesting difference in the strong force between the two systems is not completely understood.

This is not a statement. You should write that the different arises from the different quark content from which the strong interaction depends upon. Maybe remove this sentence and leave only the next one.

L22-23:
We understand.. -> We interpret this effect as the separation….

Introduction:
General Comments:

The first section is really general and does not mentions Lambda-Kaon explicitely. Then you jump to the mt scaling and different radii.
The sequence is rather abrupt and a story is missing.
The scope of the analysis is to measure the not-known scattering parameters of Lambda Kaon pairs and also to study the mt dependence of the extracted radii. This should be the beginning of the introduction.
Lambda-kaon scattering parameters are not known at all. Here you can also mention that Kaon(anti)-proton scattering parameters are measured and a different behavious is found (the strong part of the K-p nteraction is attractive and K+p interaction is repulsive), hence what you are doing here is extendeing Low energy QCD meaurements (Check the introduction and references there in the pK- paper by Ramona and Co https://alice-publications.web.cern.ch/node/4742)

Then you explain why it is important to study the mt dependence, introducing the universal scaling that is apparently broken by Lambda-Kaon pairs but for which you find an explanation. And then you start with line 52 where you summarize the results.

Another point: you write several times that ‘ it is not completely understood’ why LambdaK+ has different scattering parameters than LambdaK-, but this sounds negative. This is your fundings,hence it is a new information for the Low energy QCD sector.

Mention also what does it mean to have positive or negative parameters (attraction or repulsion) already in the introduction.

Concerning the separation in space-time: maybe you can anticipate that you discuss this difference in the paper

Detailed Comments:

L33-34: Non-identical particle pairs-> Lambda-kaon pairs

L38: and therefore deconfined QM : Im not sure that flow can be defined as that. I would delete this part

L 42: how picture -> how the picture

L58: We find the -> We find that the

lines 58-71: I would not reveal main results in the Introduction. I think in the Introduction we should write what we are going to measure, but it would be to soon to write what we have actually measured. I would move this part (if applicable) to Results/Summary part.

L 62-63: are these positive and negative real scattering parameter implying attractive or repulsive interactions?

l.65-66 Again, similarly to the abstract, the interaction of ΛK0s pairs is not discussed.

L72-75: maybe it is premature to discuss the common source here. You can discuss this later in the text.
The introduction should be more general.

L 81: mention the content of the appendixes.

line 83: I would also mention year of data taking (2010 or 2011)

Section 2:

l. 93 the TPC only and constrained to the primary vertex. A minimum requirement on the number of reconstructed TPC clusters was imposed
The number of clusters should be mentioned here.

Table 1: why are the nSigma cut varied depending on p? Can you add a sentence?

Fig.1 dE/dx – It will be reasonable to change this figure from dE/dx to the purity of the charge kaon versus momentum as was done in the charge kaon femtoscopy papers. In this case, the reader will better understand why the N_TPC is set to unity at the momentum range 0.4-0.45 GeV/c and why N_TOF decreases with increasing momentum.
In addition, the purity should be different for different centralities.

line 107: the charged Kaons are accepted until 1.5 GeV/c.
I would say in interval 1.0-1.5 GeV/c kaons start to overlap with protons (for dE/dx in TPC). Is the value 1.5 GeV/c still safe, or did you try to reduce the contamination for protons as well (as you did for pions and electrons)?

L118-120 and formula 1: too detailed. Just mention the purity after you have explained that you rely on Montecarlo for the PID.

L121: remove

Fig2: maybe also redundant

L131-133: The daughters… imposition. -> cut the sentence

L138: Why is the minimum tranverse momentum cut reducing the fake contamination? Which fake you mean here? Single fakes or K0s fakes to Lambda and viceversa?

L139-141: too long description of maximum DCA for V0. Keep it shorter.

L 143-145: same here.. Maybe remove the following sentence:

We want the V0 candidate's momen144 tum to point back to the primary decay vertex, and therefor a small qpa; we achieve this by appointing a minimum value on cos(qpa)

L146-150: On occasion, L($\bar{L}$) particles are misidentified as K0 146 S, and vice versa. To attempt to remove these contam147 inations without throwing away good candidates, we impose a set of misidentification cuts. The intent of these cuts is to judge whether a candidate is more likely a L($\bar{L}$) or a K0
148 S, and are implemented as described below. For a given V0, we calculate the mass assuming different identities (L, $\bar{L}$, K0 149 S) of the candidate;

Simplify in:

In order to remove the contamination to Lambda and K0s due to misenditifaction of the protons and pions for each V0 the mass assuming different identities (..) of the candidates is calculated.

L152-154: maybe footnote?

lines 157 and 168: why choosing 9 MeV/c^2 ? Wouldn't it be better to change it to more general value such as 3 or 5 sigma?
It should not make a big difference for low pt, but have you run your code with a new V0 finder/vertexer? more at https://github.com/alisw/AliRoot/pull/864

in Table 2 and 3: Cosine of pointing angle seems to be too strict, have you tried to loosen it while maybe introducing a new cut like - V0 transverse decay radius? Are chosen cut values based on some asumption, like desired S/B ratio? But, if you are happy with you final V0 statistics, then it should be fine.

lines 185-188: I had to re-read those sentences (including corresponding part in Sec. 2.3) in order to understand the difference. Could it be written more clearly?

in Table 3: what is the reason for asymmetric mass interval - is the mean of the mass peak shifted w.r.t. PDG value?

l.168 Why the rejection criteria for the mass difference is equal to 9 MeV/c^2 for both K and Λ? It seems that the widths of the invariant mass distribution are different.

L 159-164 and 170-171 are not necessary, get rid of them

L 173: At this stage, we have a collection of V0 candidates satisfying all of the aforementioned cuts. However, this collection is still polluted by fake V0s, for which the daughter particles happen to pass all of our cuts, but which do not actually originate from a V0. Although the two daughter particles appear to reconstruct a V0 candidate, they are lacking one critical requirement: the system invariant mass does not match that of our desired V0 species (these can be seen outside of the mass peaks in Fig. 3). Therefore, as our final single-particle cut, we require the invariant mass of the V0 candidate to fall within the mass peak of our desired species. Note, however, that some fake V0s still make it past this final cut, as their invariant mass also happens to fall without our acceptance window.

This I would modify completely into:

The resulting invariant mass for Lambda and Kos is shown in figure … A mass precision and resolutios of .. and .. are obtained for L and Kos, respectively .A final cut on the invariant mass is applied to enhance the purity. The cuts are shown in table…

L 181:186: reduce to 1 sentence and move before the discussion of the invariant mass distribution

L 189 190 and equation 2: remove

lines 192 and 195 - construction of distribution before m_inv cut - this information is there twice.

l.194-196
It is vital that this distribution be constructed immediately before the final minv cut, otherwise it would be impossible to estimate the background.
This phrase contains unnecessary details and may be removed.

Up to line 200: shorten mentioning here the final purities only.

Line 202-206: shorten to:
In order to reduce the contamination to the two-particle correlations due to split or merged tracks

and pairs sharing daughters, two main pair cuts are applied: a shared daughter cut, and an average separation cut.

L 209-210: remove text in the brackets.

L 211-213 This mistake…. -> remove

Fig 3: Labels and legend in the figures are too small. Remove purity label. Enlarger the Sign and S/B labels.

Caption Fig 3: reduce the text.
Remove: immediately before… bin). Remove last sentene about purity, discuss it in the text.

L 221-228: shorten this part.

Section 3:

l.234 The formula for k* is needed here.

L239: Enture > entire

L245: Ideally, …[1]. -> remove.

l.247 by forming mixed-event pairs[we would propose to add here the reference to the original paper by G. I. Kopylov, Physics Letters B 50(4):472-474 · June 1974 https://www-sciencedirect-com.ezproxy.cern.ch/science/article/pii/0370269374902639?via%3Dihub]

l.248-250 The rotation method is not used in this paper, therefore I propose to not mention it and remove it from the appendix.

L 251-253: In forming the reference distribution, it is important to mix only similar events; mixing events with different phase-spaces can result in an unreliable reference, and can introduce artificial signals in the correlation function. Therefore, in this analysis,

Simplify to:

In order to mix only similar events

line 255: I am not sure whether non-ALICE reader would understand Nmix variable, could you define it?
line 256: Also, could you elaborate more this vertex correction? Is it applied only for events in mixing procedure? How the binning of mixed events is done (2cm bin width for primary vertices) when z=0? I guess I am missing something here.
Are OmegaK residual correlations negligible since they are not mentioned in the text?

L260: I understand that you consider the kt integrated functions because of the statistics limitation but
You might add here a sentence motivating that the kt dependence of the three LK combinations shold be the same and hence the integrated analysis is ok

Eq 6: redundant. If you mention a weighted average, it is clear what is meant here.

Eq 9: drop it

L. 284: ‘ in case of no residual correlations’
I don’t understand this formula with lambda. If there are no RC then lambda is 1 and then generic formula does mean anything anymore. Why did you write it like that?

L286: Why include the QS story with formulas and so on if in the end you are treating indistinguishable particles? I would stick to the correlations you need in the description.

L 291-293: I would here emphasize the fact that aside fake contributions you have contributions from resonances. It is not very clear in the current formulation.

L 300: It is not true that residual correlations are only important if the parent correlation is large. You can have a shallow correlation for the parent but a large contribution that will automatically dump the lambda parameter of your genuine correlation.
I would get rid of this list of 3 itmes. It seems confusing to me.

L 303-304: remove up to ‘ our fit’.

L 304: ‘ may be combined’ is combined out of..

L. 310-311: ‘Lambda parameters… are normalized to unity:
Actually is the sum of all lambda parameters Lambada’ _{ij} + lambda’ _KL that should be unity or?
The text is not clear here

L 322-328: the choice of 3 and 10 contributors is not clear at all here. You should explain why you can reduce to 3 at all. It is also not clear what it means, ‘ reduce to ctau<4 fm for consistency’. The role played by short-live resonances should be emphasized.

l.332-333
The particle yields can be estimated using THERMINATOR 2 simulation (Ni Tj HERM), while the reconstruction efficiencies (REi j) are estimated with MC HIJING data, which has been run through GEANT to
It should be explained why the yield was not estimated with HIJING.

l.335 What does the first row in the table A.1 mean (ΛK+ 0.527 and so on)? Are these direct pairs?
Why is the value of other pairs greater in case of 10 residuals?

Table A.1 : see general comments
L 346:351: too poetic, shorten please.(avoid things as ‘ the world in which we live is not perfect’)

L374:377: remove it. We don’t need a generic description of how Montecarlo is used to extract the momentum resolution.

line 387-389: the difference is not due to any interesting physics - I guess the checks were done in analysis note?

Just to better understand the figure 4: the data points are with mixed events binned also in Psi_EP?

L399-407: I would get rid of this paragraph since normally in papers one only explain the strategy that is finally used.

Fig 4: Improve these figures. 1) the y axis should be all zoomed in (in case you can rebin the first two bins). 2) all labels and legend text should be a factor 3 larger 3) get rid of the 'therminator' label in each panel.

Fig.4 It is reasonable to change the gold color to the dark green one.

L. 420 421: The description of the LK0 421 S is good at a qualitative level, but not quantitatively good enough to be utilized in our fit. As such, we use a linear form to model the background in the LK0
422 S system

I don't understand at all why you write that Fig 4 shows that the Therminator background is not good enough for Lk0s. Also, why a linear form? You wrote on the paragraph before that you fit Therminator with a polynomial function.

L426:432: Im not sure that we need to show the Stravinkiy method. One can add a line mentioning that the method was used as a cross check but I wonder whether we can remove this from the appendix. And from this text.

L 441,442: remove

L 446: the overall lambda parameter here is lamda_fit?
Do you mean that this is the same factor for all centrality classes or what? The sources of secondaries are different for the three LambdaKaon combinations.

L470: why is the background, that is independently determined via Therminator and also fix to it, multiplied by the correlation? Should not you sum it?
Maybe you can include in the systematic errors evaluation the case where the background is summed to the femto correlation.

line 472: Section 3.7: are also purities for K0, Lambda and charged K (or maybe fake candidates) somehow included in the final systematic uncertainty?

L 473 478: I have seen in recent CR1 that people tend to ask the logic of systematic cuts variation.
Personally I don't care and I find the table sufficient but it could be beneficial to explain the systematic cuts in text maybe.

Section 4:

Fig 5 Horrible as the others ☺
I would not include the radius and lambda parameters in the legend. I would label the different lines.

I would also not include here the scattering parameters since you have later dedicated plots.

l.500 The black solid curve shows the primary (ΛK) contribution to the fit
Does the black curve mean that all lambda for the residual function were set to zero?
Why is the biggest difference for 30-50% centrality?
In lines 452-453: the cases of zero and ten residual contributors were also investigated, but the case of three contributors was deemed most reasonable
It will be interesting to see the third curve corresponding to the case of ten residual contributors.

l.501 the green curve shows the fit to the non-femtoscopic background, and the purple curve shows the final
What was used as a background in the end (green curve)? Was it a result of using the THEMINATOR model or an approximation of the data?

l.509-511 The ΛK0s real(f0) is close (the same within errors) to ΛK-. Please, give a comment here.

Fig.6 Left panel: change square symbols to circles in the legend on the left. The legend on the right is not clear. I can guess that it corresponds to the theoretical prediction mentioned in the caption. Please, check it.

line 500: boxes represent systematic errors - there are no visible boxes in figure 5 - are they smaller than markers?
Figure 6: There are no green and yellow points showing theoretical predictions.
Figure 7: x-axis label - is it an average pair transverse mass?

L 515: here you can discuss the repulsive character of LambdaK+ and attractive character of LambdaK- in parallel to the K+N and K-N interactions. Those are also repulsive and attractive, respectively.
As I suggested for the abstract and introduction this shold be mention also before.

On the other hand although, K+N has a very small imaginary part, since absorption is not occurring and K-N has a large imaginary part.
Here you see for all three channels a seazible imaginary part and you could discuss it a bit.

L 543-550: Maybe we have to move the spherical decomposition part to the main body of the paper in a reduced form.
In this section you might consider repeating that the difference between Lambda and Kaon sources comes from flow.

Section 5:

Appendices:

Typos:

line 21: grammar purists only: minus sign is hyphen (should be in math mode) - same can be applied for the rest of the draft (S=-2, 0-10%, ..)
line 36: pion -> pions
line 43: corrections, and -> corrections and
line 56: Lednicky -> Lednický
line 80: (I am not native speaker, maybe it is wrong): estimation systematic uncertainties -> systematic uncertainties estimation
line 89: lease -> least
line 111: the the -> to the
line 122: You might consider changing V0 to V^0 (i.e. to use superscript) throughout the text, just to avoid confusion with V0 as detector. There is no strict rule for this (you can keep it if you want), but we prepare a paper in Strangeness PAG, where V-shaped decay is denoted as V^0 . :-)
line 157: c in italic
line 209: does "ex." mean "for example"? Please, check whether using "e.g." is more correct.
line 239: enture -> entire
line 244: equal -> equals
line 260: perhaps change both ++ and -- to latex math mode?
line 288: the spins are switched (should be 1/2 for Lambda and 0 for K)
line 585: Lyuboshitz -> Lyuboshitz,
line 598: hijing -> HIJING (according to the title in the paper)