Λ and K^0_S production in jets in p–Pb collisions – Support document

PC members

July 25, 2016

Todo

- The reply of comments at [L. 175, p. 5].
- Update of the systematic uncertainty.

1 Response of inline comments

[L. 175, p. 5] MP: Sentence added on req. by Jana: add a description how the Λ and K^0_S sample is clean after topological selection $\Rightarrow$ check number – extract from the invariant mass for the lowest p_T bin considered – 0.5 GeV/c.

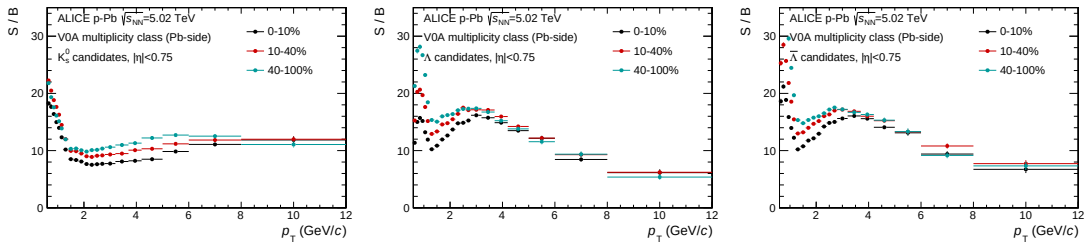

Figure 1: S/B ratio of inclusive V^0s with default selection cuts.

Figure 1 shows the S/B ratio of inclusive V^0s with default selection cuts. **Conclusion:** The S/B ratio is $\gtrsim 10$ and achieves to 20 (30) for K^0_S (Λ) at low p_T.

[L. 175, p. 5] more details needed?

To be added

[L. 185, p. 5] check number

I did not have a precise value of this fraction. But a hint can be gotten from the figure in **p. 3** in [1]. It shows that the per-event multiplicity of jets in $p_{\mathrm{T}} > 10$ GeV/c is $\mathcal{O}(10^{-3})$. If the total number of MB events is N, then only $\sim 0.1\%N$ events contain the hard scattering which provides charged particle jets in $p_{\mathrm{T}} > 10$ GeV/c (they may be di-jet events, but the away-side jet does not overlap to the nearside one). With a simple estimation, the number of events which contain two (independent) tagged hard scatterings is $\sim (0.1\%)^2 N$. If the jet overlapping probability in such events is α (< 1), then the probability for a V^0 candidate match to two selected jets is

$$P \simeq \alpha(0.1\%)^2 N/0.1\%N = \alpha 0.1\% < 0.1\%.$$

Conclusion: According to the above estimation, the number cited in the paper should be reasonable/safe.

Indeed, the following approach was applied in the analysis to avoid double counting in the JC sample.

1. Loop over all V^0 candidates in a given event.
2. Tag the V^0 candidate as a JC V^0 if it can match to at least one selected jet.

For calculating the JC V^0 acceptance (the area), the double counting of areas between two overlapped jets is avoided via a MC approach (see [2] for details).

[L. 225, p. 6] MP: check numbers

The feeddown fraction of inclusive V^0s and V^0s in jets are shown in figure 47 (p. 37) and figure 48 (p. 38) in [2], respectively. **Conclusion:** For inclusive V^0s, the maximum feeddown correction is $< 25\%$ and slightly depends on p_{T}, the feeddown correction of V^0s in jets is $\sim 15\%$ and is p_{T} independent.

[L. 230, p. 8] MP: remove the table; adjust the figure (remove fluctuations) and add the proper text

[L. 240, p. 8] MP/Jana: Description in the figure does is not aligned with the description in the table. Uncertainties should be smoothed (local minima in some cases are unphysical).

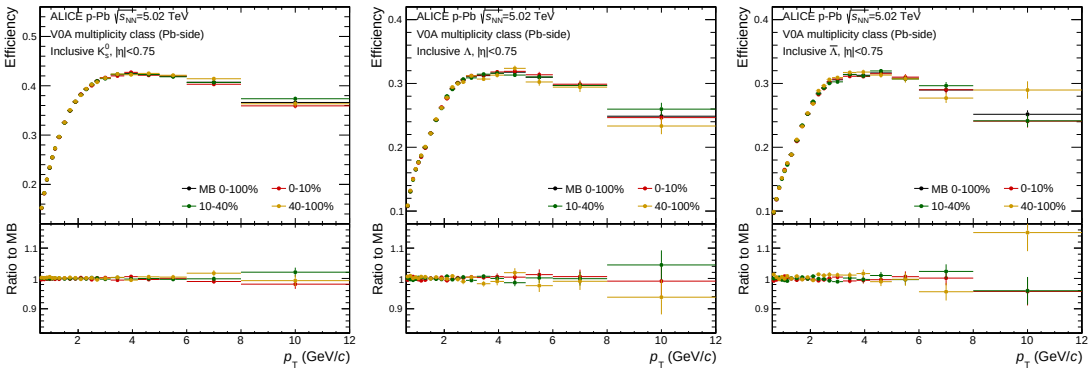

Figure 2: Efficiency of inclusive V^0s in three event activities and MB events.

Working on the uncertainty flattening.

[L. 235, p. 7] explain competing V^0s and proper lifetime

Their definitions can be found in section 8 (p. 7) in [3]. The cut values used in this analysis are listed in table 6 (p. 32) in [2].

[L. 240, p. 8] Jana: Add explanation how the systematic uncertainties were propagated to the Λ/K^0_S ratio.

See section 3.1.3 in this doc for details.

[L. 250, p. 8] check numbers

The values are returned in figure 3 in paper draft and they are reasonable.

[L. 260, p. 8] check numbers

The values are returned in figure 3 in paper draft. But the uncertainty on jet p_T scale is slightly increasing with p_T at high p_T (to be discussed).

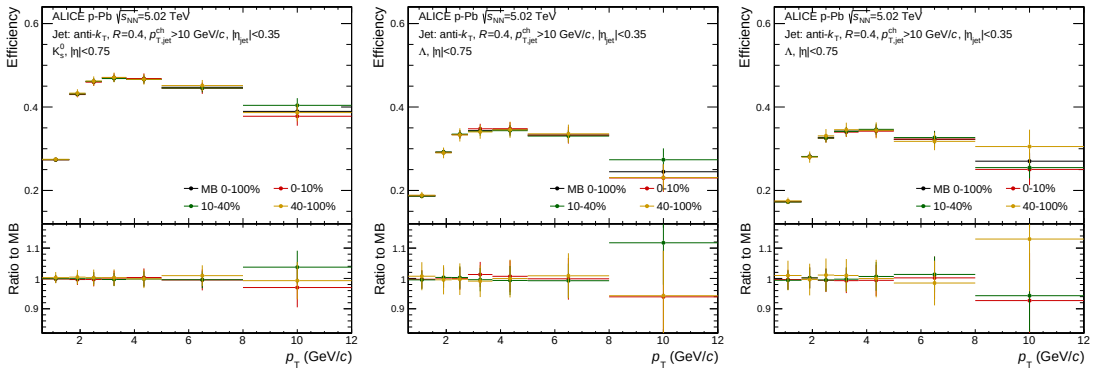

Figure 3: Efficiency of the V^0 in jets in three event activities and MB events.

2 Efficiency

The efficiency of inclusive V^0s and that of the V^0 in jets are shown in figure 2 and figure 3, respectively. The results are shown in three event activities and compared to that in MB events. It shows that these two kind of efficiencies are insensitive to event multiplicity.

In paper, we used the efficiency in 0–10% event activity estimated by V0A. But these choice does not change any physics information, since:

- Efficiency is insensitive to event multiplicity.
- Results in MB events should close to that 0–10% event activity due to the most central collisions have the largest (multiplicity) weight.

Conclusion: The efficiency in MB events will be used in the paper.

3 Systematic uncertainty

3.1 Old uncertainty strategy for paper proposal

3.1.1 Uncertainty source of inclusive V^0s

The source of systematic uncertainty of inclusive V^0s is concluded in [2] see also [3] for details. It includes:

- Uncertainty on V^0 yields
- Uncertainty on material budget
- Uncertainty on feeddown correction (for Λ and $\overline{\Lambda}$)

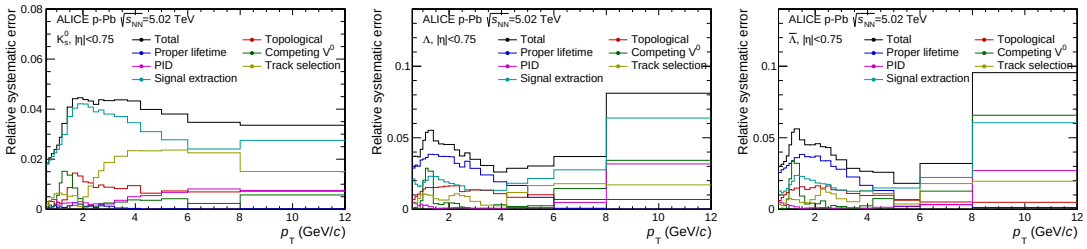

Figure 4: Systematic uncertainty of inclusive V^0s.

The first one is obtained in this analysis and the other two are taken from [4] since these two analyses used the same data and MC samples. The uncertainty on V^0 yields contains:

1. Topological selections
2. Proper lifetime selection
3. Competing V^0 rejection
4. Track selection in TPC
5. Track PID in TPC
6. Signal extraction

in which

- The uncertainty on topological selections is obtained by varying five kind of cuts defined in table 5 (p. 32) in [2], results are shown in figure 42 (p. 33) in [2].
- The uncertainty on track selection in TPC is dependent on two variables defined in table 7 (p. 32) in [2], results are shown in figure 43 (p. 34)in [2].
- Other uncertainties on V^0 yields are obtained by following the same criteria defined in [3].

The sources of systematic uncertainty on V^0 yields are shown in figure 4.

3.1.2 Systematic uncertainty of V^0s in jets

The uncertainty source of V^0s in jets includes:

- Uncertainty on V^0 yields

- Uncertainty on material budget
- Uncertainty on feeddown correction
- Uncertainty on jet p_{T} scale
- Uncertainty on UE estimation

in which the uncertainty on material budget is taken from [4] and the same as inclusive V^0s.

For V^0s in jets, the uncertainty on V^0 yields has the same sources as inclusive V^0s. But they are separated into two catalogs:

- Uncertainty independent on statistics (the first five uncertainty sources)
- Uncertainty depend on statistics (the last one uncertainty on signal extraction)

The uncertainties in the first catalog is taken from the inclusive analysis directly. The last uncertainty is estimated by using V^0s matched to the jet with the same criteria as inclusive V^0s. The uncertainty on signal extraction is sensitive to statistic fluctuations a constant value of 6% (10%) is aligned to V^0s in jets in $p_{\mathrm{T}} > 10$ GeV/c (> 20 GeV/c).

By considering the feeddown contribution for inclusive V^0s and V^0s in jets may be different, based on PYTHIA simulations, an additional 5% uncertainty is added in uncertainty on feeddown correction to cover the difference.

Uncertainty on jet p_{T} scale is estimated by varying the jet p_{T} within 20%: 2 GeV/c (4 GeV/c) for $p_{\mathrm{T,jet}} = 10$ GeV/c (20 GeV/c).

Uncertainty on UE estimation is obtained via different estimators. The default value is given by PC estimator. The uncertainty is estimated via the OC and NJ estimators.

3.1.3 Uncertainty propagation

The uncertainty of $\Lambda/\mathrm{K}^0_{\mathrm{S}}$ ratio is obtained via the following approach:

1. The uncertainties on V^0 yields, material budget and feeddown correction are propagated to the ratio quadratically (the standard way). Note: according to ref [3] and [4] the uncertainty on material budget should NOT been cancelled in the ratio.

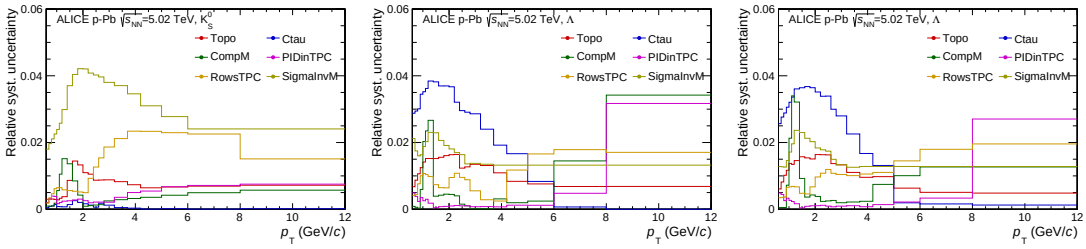

Figure 5: Updated uncertainty on V^0 yield of inclusive V^0s.

2. For the uncertainties on jet p_T scale and UE estimation, they are obtained by calculating the deviation of ratios between the default value and various selections.

3.2 Improved uncertainty strategy

- For inclusive V^0s, flattening uncertainty on signal extraction at high p_T. The observed increasing trend at high p_T is (partly) due to the statistic fluctuations. A flattening procedure is applied for overcoming the high-p_T fluctuations. Figure 5 shows the updated uncertainty on V^0 yield of inclusive V^0s. The uncertainty curves are smoothed to overcome local fluctuations.

- For V^0s in jets, uncertainty on V^0 yields, now, is fully taken from that of inclusive V^0s. There is no physics reason shows that this uncertainty should be different between V^0s in jets and inclusive V^0s. Using the uncertainty of inclusive V^0s avoids statistic fluctuations.

References

[1] X. Zhang, "K^0_S and Λ in jets." ALICE-PWG-JE meeting, Jun, 2013. `https://indico.cern.ch/event/255770/contributions/573220/attachments/448522/621933/PWGJE20130611XZhang.pdf`.

[2] X. Zhang, "Λ to K^0_S ratio inside and outside Jets in p–Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV with ALICE." ALICE-ANA-1595, Apr, 2014. `https://aliceinfo.cern.ch/Notes/node/306`.

[3] D. Dobrigkeit Chinellato, "K^0_S, Λ and $\overline{\Lambda}$ Spectra in pp at 7 TeV." ALICE-ANA-501, May, 2012. `https://aliceinfo.cern.ch/Notes/node/32`.

[4] **ALICE** Collaboration, B. B. Abelev *et al.*, "Multiplicity Dependence of Pion, Kaon, Proton and Lambda Production in p–Pb Collisions at $\sqrt{s_{\rm NN}} = 5.02$ TeV," *Phys. Lett.* **B728** (2014) 25–38, arXiv:1307.6796 [nucl-ex].