Production of strange hadrons in charged jets in p–Pb and Pb–Pb collisions measured with ALICE at the LHC

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1 Introduction

The baryon-to-meson ratio of inclusive light hadrons in heavy-ion collisions shows a strong increase at intermediate transverse momentum p_{T} with respect to the ratio in pp collisions. This phenomenon was first observed at the Relativistic Heavy Ion Collider (RHIC) [1] and later measured in the inclusive p/π and $\Lambda/\mathrm{K}^0_{\mathrm{S}}$ ratios in ALICE [2]. It cannot be explained by fragmentation. Other hadronisation mechanisms, like coalescence or parton recombination, have been proposed instead. The measurement of the production of $\mathrm{K}^0_{\mathrm{S}}$ and Λ in jets will allow to assess whether hadronisation in jets is affected in a similar way.

2 V^0 particle reconstruction

$\mathrm{K}^0_{\mathrm{S}}$ mesons and Λ baryons decay via the weak interaction into two charged daughter particles. The candidates for V^0 particles are found by combining detected particles of opposite electric charges. The contribution of the combinatorial background is suppressed by applying cuts on specific parameters of the decay topology (see Fig. 1). The signal yield is extracted from the resulting invariant-mass distribution.

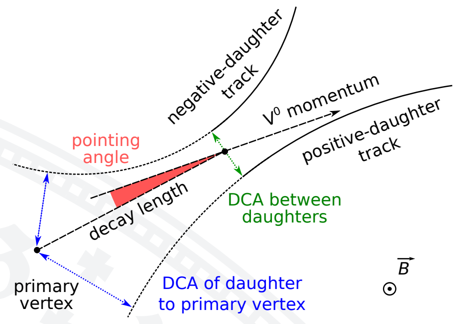
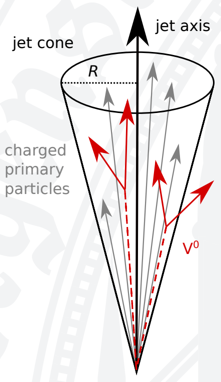


Figure 1: Topological parameters of a V^0 decay.

3 Measurement of particles in charged jets



The measurement of the identified-particle production at low momenta in jets allows to assess whether interactions of the parton shower with partons of the surounding medium affect the particle composition in jets. Jets are reconstructed from charged primary particles. Charged tracks with $p_{\mathrm{T}} > 150\,\mathrm{MeV}/c$ are clustered into jets using the anti-k_{t} algorithm [3, 4] with resolution parameters $R = 0.2, 0.3$ in Pb–Pb and in addition $R = 0.4$ in p–Pb collisions.

Jets reconstructed in heavy-ion collisions are contaminated by soft particles from the underlying event (UE). The average background density is estimated in each event and subtracted from the jet transverse momenta. Jets used for the analysis are further filtered (e.g. by requiring $p_{\mathrm{T}}^{\text{leading track}} > 5\,\mathrm{GeV}/c$) in order to reduce the contribution of purely combinatorial jets. The acceptance of selected jets is required to match the acceptance of reconstructed V^0 particles which is ensured by the criterion in pseudorapidity $|\eta_{\text{jet}}^{\text{ch}}|^{\max} < |\eta_{\mathrm{V}^0}|^{\max} - R$. The V^0 particles are associated with the jets using the geometrical condition in η and azimuth φ:

$$D = \sqrt{(\varphi_{\mathrm{V}^0} - \varphi_{\text{jet}}^{\text{ch}})^2 + (\eta_{\mathrm{V}^0} - \eta_{\text{jet}}^{\text{ch}})^2}, \qquad D < R.$$

4 Corrections

The V^0 p_{T} spectra in the jet cones are corrected for the limited reconstruction efficiency. Both, the efficiencies and measured particle distributions of the various cone methods, depend strongly on particle p_{T} and η. The spectra of particles in jet cones contain a contribution from particles produced in the underlying event (UE), which needs to be subtracted and is estimated by five methods. The corresponding UE V^0 spectra are compared in Fig. 2. After efficiency correction, they differ by less than 5% at intermediate p_{T}.

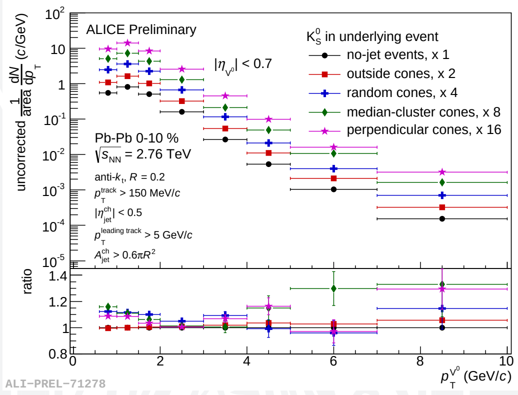


Figure 2: Estimated spectrum of $\mathrm{K}^0_{\mathrm{S}}$ mesons in the underlying event in 10% most central events in Pb–Pb collisions at $\sqrt{s_{\mathrm{NN}}} = 2.76\,\mathrm{TeV}$ and before efficiency correction.

This method comparison is used to estimate a systematic uncertainty for subtraction of the V^0 contribution of the UE. The spectra of measured Λ baryons must be corrected for the feed-down (FD) contribution from the decay of $\Xi^{0,-}$ baryons. The FD fraction is estimated based on measured yields of inclusive Λ baryons to correct the data points. In order to estimate the systematic uncertainty of the FD correction, this correction is compared to the FD fraction estimated from simulated Λ baryons in jets from PYTHIA8 [5, 6].

5 Results

Figure 3 shows the $\Lambda/\mathrm{K}^0_{\mathrm{S}}$ ratio in jets and in high-multiplicity p–Pb events at $\sqrt{s_{\mathrm{NN}}} = 5.02\,\mathrm{TeV}$. The measured ratios in jets show no enhancement at intermediate p_{T} and are significantly below the inclusive ratio (black markers) in p–Pb collisions. The ratios depend only slightly on the jet resolution parameter R and do not vary with $p_{\mathrm{T,jet}}^{\mathrm{ch}}$. They are compatible with PYTHIA8 predictions in pp collisions (the spread of results for $R = 0.2, 0.3, 0.4$ is indicated by dashed lines). The same trend as for the measured ratio in jets in p–Pb collisions can be seen in Fig. 4, where the inclusive $\Lambda/\mathrm{K}^0_{\mathrm{S}}$ ratio in Pb–Pb collisions at $\sqrt{s_{\mathrm{NN}}} = 2.76\,\mathrm{TeV}$ (black markers) is compared to the ratio measured in jets for $p_{\mathrm{T,jet}}^{\mathrm{ch}} > 10\,\mathrm{GeV}/c$ (red markers) and for $p_{\mathrm{T,jet}}^{\mathrm{ch}} > 20\,\mathrm{GeV}/c$ (blue markers).

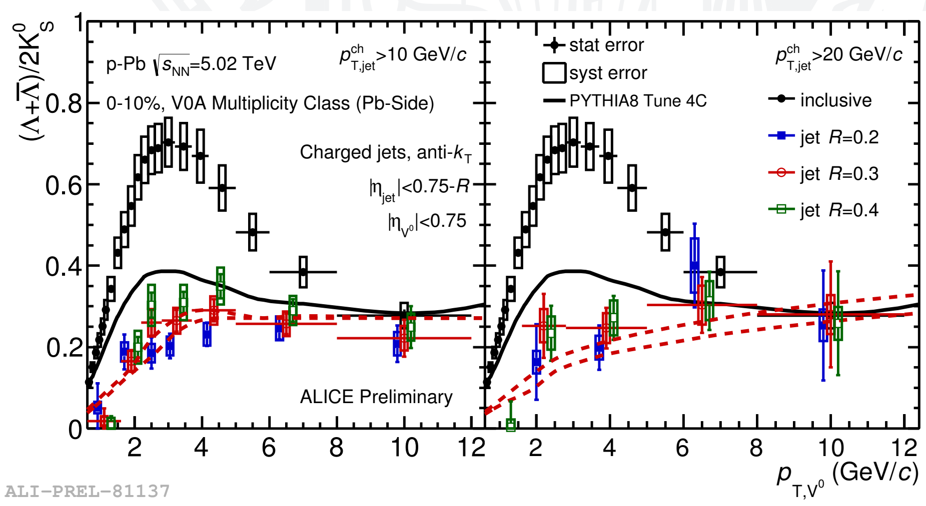


Figure 3: $\Lambda/\mathrm{K}^0_{\mathrm{S}}$ ratio in jets for $p_{\mathrm{T,jet}}^{\mathrm{ch}} > 10\,\mathrm{GeV}/c$ (left) and $p_{\mathrm{T,jet}}^{\mathrm{ch}} > 20\,\mathrm{GeV}/c$ (right) measured in high-multiplicity p–Pb events at $\sqrt{s_{\mathrm{NN}}} = 5.02\,\mathrm{TeV}$. The results are shown for three different jet resolution parameters ($R = 0.2$ (blue markers), 0.3 (red markers) and 0.4 (green markers)).

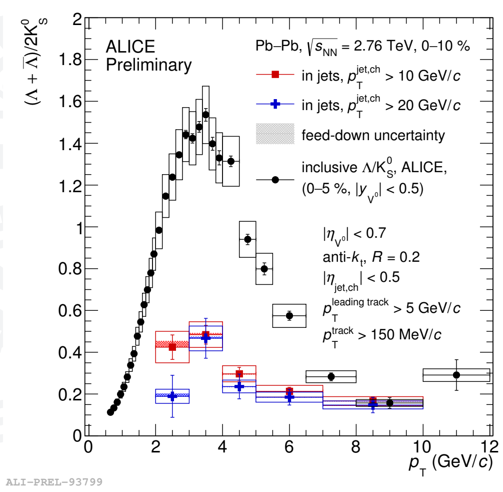


Figure 4: $\Lambda/\mathrm{K}^0_{\mathrm{S}}$ ratio in jets for $p_{\mathrm{T,jet}}^{\mathrm{ch}} > 10\,\mathrm{GeV}/c$ (red markers) and $p_{\mathrm{T,jet}}^{\mathrm{ch}} > 20\,\mathrm{GeV}/c$ (blue markers) in 0-10% Pb-Pb central collisions at $\sqrt{s_{\mathrm{NN}}} = 2.76\,\mathrm{TeV}$. The ratio in jets is far below the inclusive ratio in Pb–Pb collisions and similar to the one measured in pp collisions or predicted by PYTHIA8 calculations.

6 Summary and Outlook

The observed $\Lambda/\mathrm{K}^0_{\mathrm{S}}$ ratio in jets in Pb–Pb collisions does not show a enhanced peak in the intermediate p_{T} region and is significantly smaller than the inclusive measurement and compatible with the expectations of that in jets simulated by PYTHIA8. The analysis in Pb–Pb collisions will lead soon to the first fully corrected particle spectra in charged jets. With the second data taking period of ALICE, higher statistics data samples in Pb–Pb collisions will make it possible to measure in intervals with higher $p_{\mathrm{T}}^{\text{jet}}$ and decrease statistical and systematic errors of the final results.

7 References

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