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Open and hidden strangeness production study via high p_{T} dihadron correlations in pp and p-Pb collisions with ALICE at the LHC

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Two-particle correlations in $\Delta\eta$ and $\Delta\varphi$ are used to study jets, in particular, their particle composition. While in Pb-Pb collisions this is done to characterize the quark-gluon plasma, pp and p-Pb collisions serve as a reference and are of interest on their own for their input into the understanding of particle production mechanisms. Recent ALICE results on the production of strange particles in small systems (pp and p-Pb collisions) reveal the possibility of having similar strange hadron production mechanisms in all collision systems. We study the production mechanism of hidden strangeness (ϕ meson) and open strangeness (K^0_S meson) in jets via two-particle correlations between the strange hadrons and charged primary hadrons in pp collisions at $\sqrt{s}$ = 13 TeV and p-Pb at $\sqrt{s_{\mathrm{NN}}}$ = 5.02 TeV collected with the ALICE experiment at the LHC.

In this paper, the dependence of the per-trigger yields of strange hadrons on the transverse momenta of the trigger and associated particles, as well as on the event multiplicity, is presented on both the near-side and away-side of the h-K^0_S, K^0_S-h and h-ϕ correlation functions. Moreover, the ratios of these yields to the yields extracted from the h-h correlation function are shown. In addition, a comparison to different MC generators is presented.

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1. Introduction

Different measurements showed that some of the observables typical for heavy-ion collisions show similar trends also in high-multiplicity events in small collision systems. One of them is the strangeness enhancement. The p_{T}-integrated ratio of the strange hadron to pion yields was measured as a function of event multiplicity in all possible systems with ALICE and it was shown in [1] that the ratio continuously increases and saturates with multiplicity through all collision systems. Moreover, the increase is more pronounced for hadrons including more strange quarks.

One of possible approaches to study this phenomenon is the dihadron correlation method with identified particles, where the jet contribution can be separated from the underlying event contribution. For this purpose K^0_S (open strange) in pp collisions at 13 TeV and ϕ (hidden strange) mesons in p–Pb collisions at 5.02 TeV were used. Three different combinations were studied: h-ϕ correlations with $4 < p_{\mathrm{T}}^{\mathrm{trigg}} < 8$ GeV/c and $2 < p_{\mathrm{T}}^{\mathrm{assoc}} < 4$ GeV/c and K^0_S-h and h-K^0_S with $3 < p_{\mathrm{T}}^{\mathrm{trigg}} < 15$ GeV/c and $1 < p_{\mathrm{T}}^{\mathrm{assoc}} < p_{\mathrm{T}}^{\mathrm{trigg}}$. From this one should be able to find out how the K^0_S/h and ϕ/h ratios in jets depend on multiplicity and contribute to the inclusive strangeness enhancement in high-multiplicity events of small collisions systems and how the presence of strange particles changes the jet-peak yield with respect to the jet-peak yield triggered with unidentified particle.

The ϕ meson was reconstructed via its most probable decay channel : $\phi \rightarrow K^- + K^+$ (BR = (49.4±0.5)% [2]) and the K^0_S meson was reconstructed via the following decay channel: $K^0_S \rightarrow \pi^- + \pi^+$ (BR = (69.2±0.05)% [2]).

2. h-ϕ correlations in p-Pb collisions

The correlation function for h-ϕ and h-h (two primary hadrons) was calculated in three multiplicity classes: 0-20%, 20-50% and 50-80%. After extraction of the yields one can build a ratio h-ϕ/h-h, which is shown in Figure 1. The total per-trigger yield ratio increases with event multiplicity. Moreover, both the underlying event and jet-like per-trigger yield ratios increase with multiplicity, thus it can be concluded, that the increase comes both from soft and hard process. The underlying event and total yield ratios are closer to each other in the high-multiplicity events than at low multiplicity, just like was shown in the inclusive ϕ/π measurement [3]. From this behaviour, it can be concluded that the jet-like peak yield has a smaller contribution to the total yield in the highest multiplicity class than in the lowest one.

3. h-K^0_S and K^0_S-h correlations in pp

In Figure 2, the $\Delta\varphi$ projection of h-K^0_S correlations in minimum-bias collisions is compared with two MC models. None of the models is able to describe well the correlation function. EPOS-LHC [5] underestimates the size of the near-side peak, but overestimates its width. PYTHIA8 [6] both with and without colour-reconnection (CR) overestimates the size of the near-side peak. Moreover, PYTHIA8 with CR reproduces data worse than without CR, however CR is part of the tuning and it is essential to describe other observables. After extracting the yields one can plot the yield ratio h-K^0_S/h-h as a function of $p_{\mathrm{T}}^{\mathrm{assoc}}$ for different $p_{\mathrm{T}}^{\mathrm{trigg}}$ intervals, which is shown in Figure 3. The yield ratios increase with $p_{\mathrm{T}}^{\mathrm{assoc}}$ through all $p_{\mathrm{T}}^{\mathrm{trigg}}$ intervals, which is described by all used MC

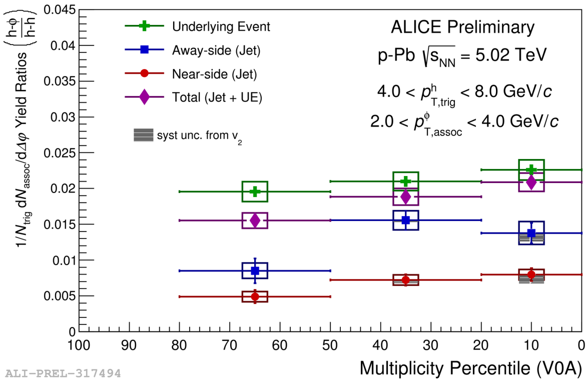

Figure 1: h-ϕ/h-h yield ratios as a function of multiplicity.

models and consistent with previous inclusive K^0_S/π measurement [4]. This also implies that the production of K^0_S with respect to charged primary hadrons (mostly pions) within jets is enhanced for high $p_{\rm T}$. The h-K^0_S/h-h yield ratio dependence on the $p_{\rm T}^{\rm trigg}$ in different multiplicity classes is shown in Figure 4. A slightly decreasing trend with $p_{\rm T}^{\rm trigg}$ can be observed in each multiplicity class, which is reproduced by all models. No visible multiplicity dependence could imply that the enhanced production of K^0_S in high multiplicity events comes mostly from the soft processes.

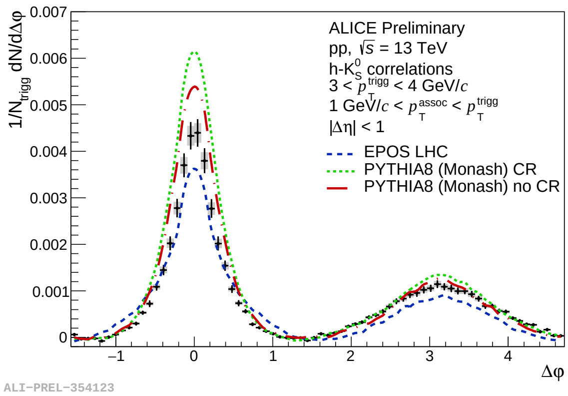

Figure 2: $\Delta\varphi$ projection of the h-K^0_S correlation function compared with MC models.

In order to study the jet yields, in which a strange particle is included, the K^0_S-h/h-h yield ratio was studied. In Figure 5, this ratio is plotted as a function of $p_{\rm T}^{\rm assoc}$ in different $p_{\rm T}^{\rm trigg}$ intervals, where a decreasing trend is observed. This implies that the associated particle yield in jets with unidentified trigger particles decreases slower with $p_{\rm T}^{\rm assoc}$ than in jets triggered with K^0_S. This behaviour can be described in the highest $p_{\rm T}^{\rm trigg}$ intervals by all used models, but is overestimated in the lowest $p_{\rm T}^{\rm trigg}$ intervals by EPOS-LHC and PYTHIA8 with CR. In Figure 6, the K^0_S-h/h-h yield ratios are plotted as a function of $p_{\rm T}^{\rm trigg}$ in 3 multiplicity classes and for minimum bias events. For all multiplicities, the ratio is below unity, which implies that the jets triggered with a strange meson have smaller associated yields than jets with unidentified trigger particles. Moreover, a slight multiplicity dependence of the yield ratios can be observed at low $p_{\rm T}^{\rm trigg}$, where the ratio has the highest value in the highest multiplicity class (0-10%) and the lowest in lowest multiplicity class (50-100%). A stronger multiplicity dependence is predicted by EPOS-LHC in comparison to data,

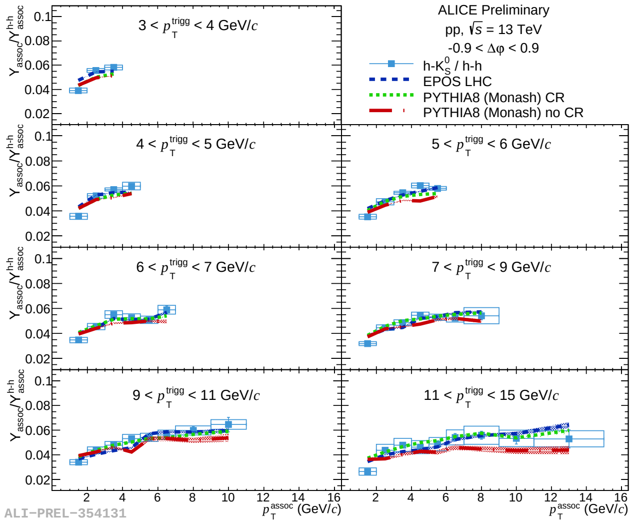

Figure 3: h-K^0_S/h-h as a function of p_T^{assoc} for different p_T^{trigg} intervals.

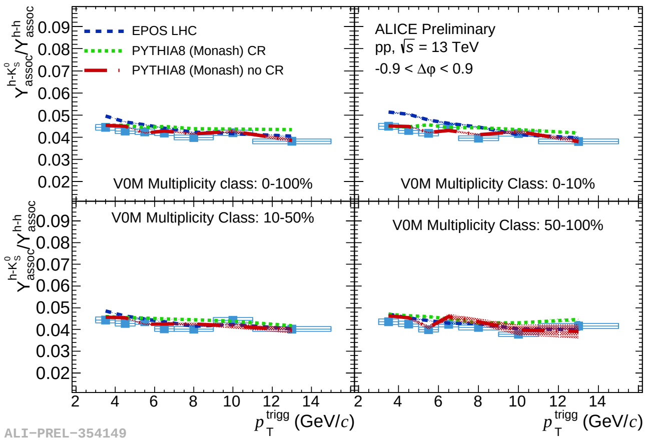

Figure 4: h-K^0_S/h-h as a function of p_T^{trigg} in different multiplicity classes

while PYTHIA8 does not predict a dependence on the multiplicity.

4. Conclusions

The per-trigger yields from dihadron correlations with different strange trigger and associated particles have been measured in small collision systems in ALICE. The total per-trigger yield ratio h-ϕ/h-h in p–Pb collisions increases with event multiplicity in correspondence with the inclusive ϕ/π measurement [1]. Moreover, both underlying event and jet-peak yield ratios increase with multiplicity, so the precise origin of the enhancement can not be concluded. The increase with multiplicity is observed also in the jet-peak yield ratios for K^0_S-h/h-h in pp collisions at 13 TeV, but not in the case of h-K^0_S/h-h. An increasing trend of the h-K^0_S/h-h jet-peak yield ratio as a function of p_T^{assoc} was observed which is consistent with the inclusive K^0_S/π measurement [4]. From comparison with MC models, it is clear that none of the models can describe the shape of the jet-peak correctly, moreover, PYTHIA8 with CR describes the data worse than without CR.

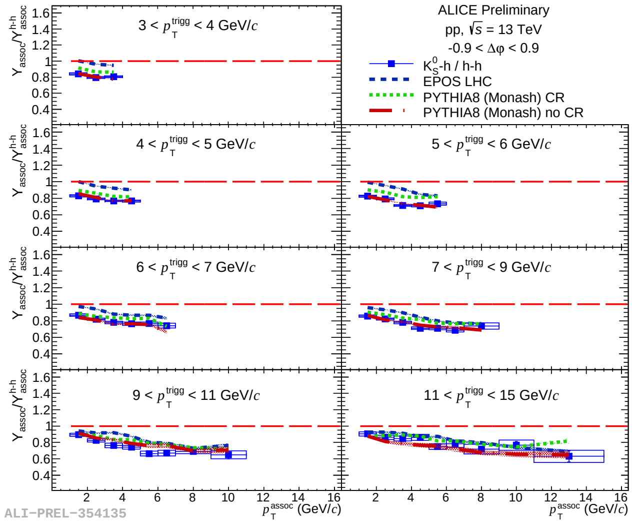

Figure 5: K^0_S-h/h-h as a function of $p_{\mathrm{T}}^{\mathrm{assoc}}$ for different $p_{\mathrm{T}}^{\mathrm{trigg}}$ intervals

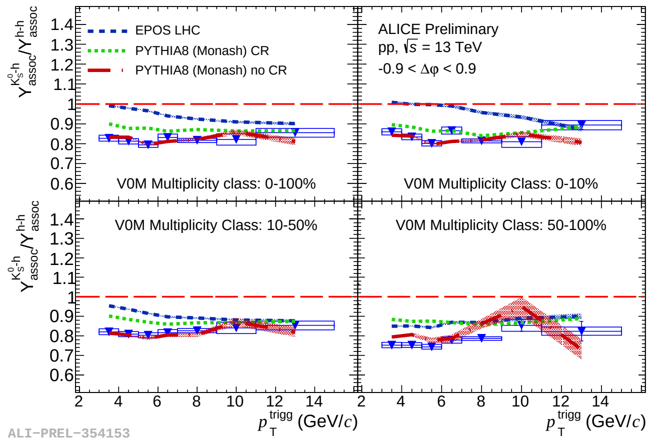

Figure 6: K^0_S-h/h-h as a function of $p_{\mathrm{T}}^{\mathrm{trigg}}$ in different multiplicity classes

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