V^0-h and h-h correlations in pp collisions at 13 TeV with ALICE

Graduiertenkolleg 2149 Research Training Group

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Motivation

1. Results from e^+e^- collisions for gluon and quark jets show:
   - Gluon jets have higher multiplicity [1]
   - Gluon jets are wider [2]
   - Gluon jets exhibit 40% higher production of Λ baryons, equal production of K^0_S mesons [3]

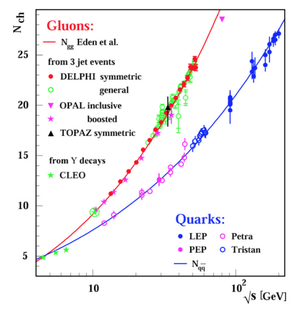


Figure 1: Multiplicity of quark and gluon jets measured at different experiments [4]

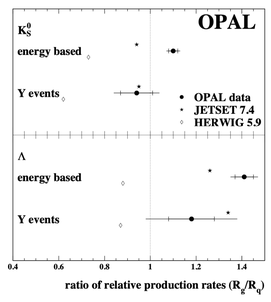
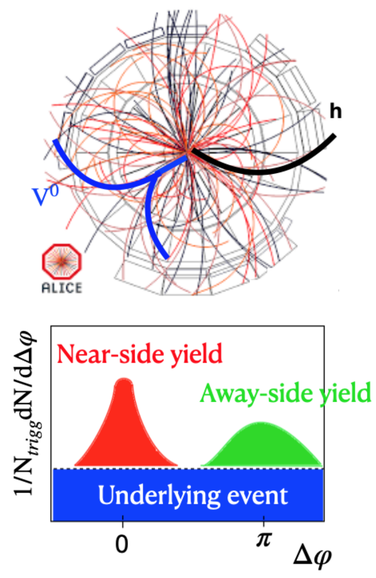


Figure 2: Ratio of production of K^0_S and Λ relative to charged particles in gluon jets to that in quark jets [3].

Dihadron correlations



- Trigger particle with high p_T → proxy for hard-scattered parton
- Associated particle - lower p_T
- Angular difference:

$$\Delta\varphi = \varphi_{trigg} - \varphi_{assoc} \quad (1)$$

$$\Delta\eta = \eta_{trigg} - \eta_{assoc} \quad (2)$$

In presented results:

- K^0_S, $\Lambda(\overline{\Lambda})$ and charged hadrons as trigger particles with $p_T^{trigg} > 3$ GeV/c
- Charged hadrons as associated particles 1 GeV/c $< p_T^{assoc} < p_T^{trigg}$
- Correlation function:

$$\frac{1}{N^{corr}_{trigg}}\frac{d^2N^{corr}_{pair}}{d\Delta\varphi d\Delta\eta} = \frac{1}{N^{corr}_{trigg}}\frac{d^2N^{raw}_{pair}}{d\Delta\varphi d\Delta\eta}\frac{1}{\epsilon_{trigg}}\frac{1-C}{\epsilon_{assoc}}\frac{1}{\epsilon_{pair}} \quad (3)$$

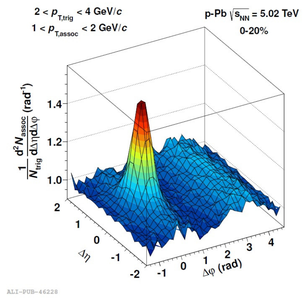


Figure 3: Example of corrected 2D correlation function [5].

- $\Delta\varphi$ projection → Background subtraction → yield calculation:

$$Y_{assoc} = \int_{\Delta\varphi_1}^{\Delta\varphi_2} \frac{1}{N^{corr}_{trigg}}\frac{dN^{corr}_{pair}}{d\Delta\varphi}d\Delta\varphi \quad (4)$$

$\Delta\varphi$ projections

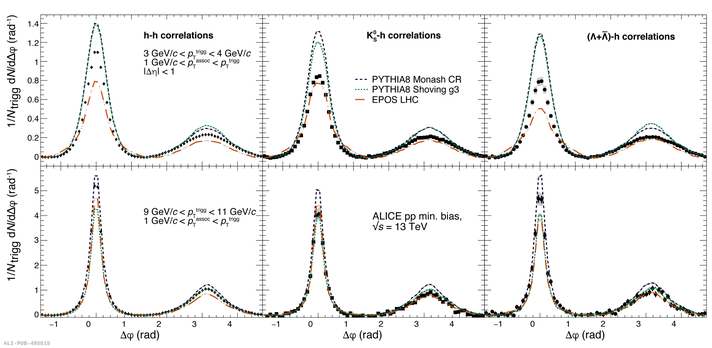


Figure 4: $\Delta\varphi$ projection of correlation functions after background subtraction compared with MC predictions [6].

- No model can give a proper description
- EPOS LHC underestimates both peaks for all trigger particles except for K^0_S at higher p_T
- Bigger difference between PYTHIA8 Monash and shoving at higher p_T

Per-trigger associated yields as a function of p_T^{trigg} and multiplicity

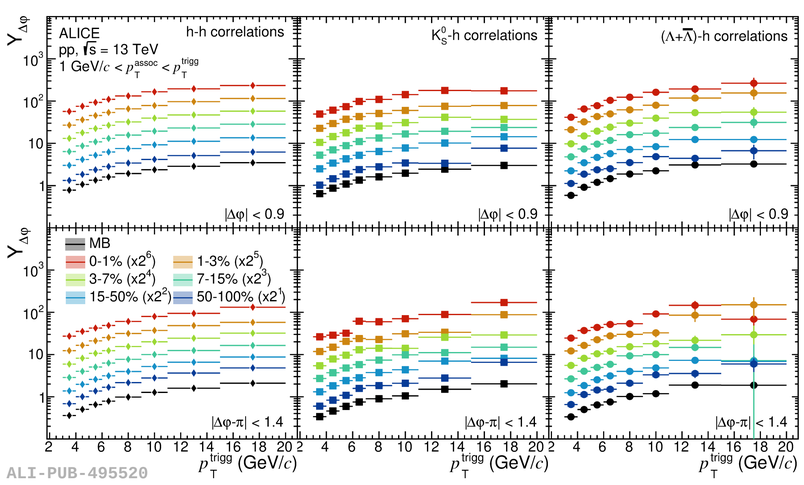
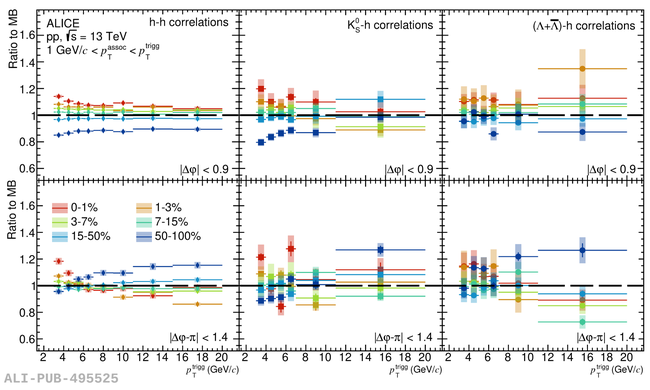


Figure 5: Per-trigger yields of h-h (left), K^0_S-h (middle) and $(\Lambda+\overline{\Lambda})$-h (right) correlation functions as a function of p_T^{trigg} [6].

- An increasing trend with p_T^{trigg} caused by more available energy
- Quantitatively similar yields for all 3 trigger particles at both sides

Per-trigger associated yield ratios to minimum bias sample



Clear multiplicity ordering in h-h, a hint of similar behaviour visible also in V^0-h

- At the near side - collective ridge-like structure ?
- At the away side - caused by multiplicity selection bias

Figure 6: Ratio of the per-trigger yields in different multiplicity classes to the corresponding minimum bias yield for h-h (left), K^0_S-h (middle) and $(\Lambda+\overline{\Lambda})$-h (right) correlations [6].

Comparison with models

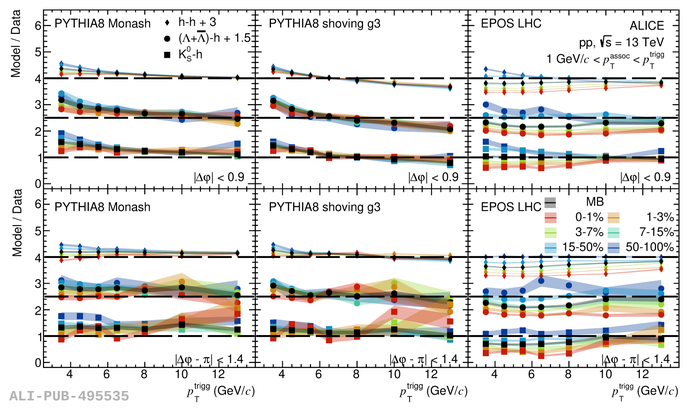
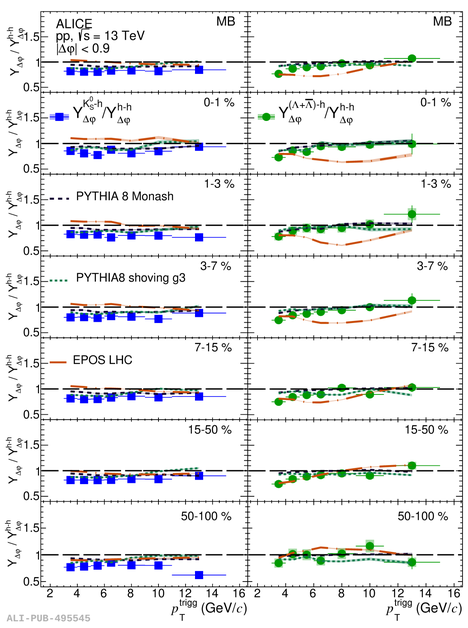
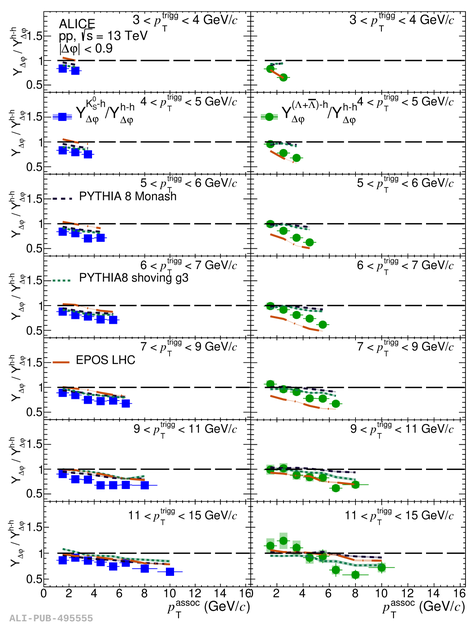


Figure 7: Models to data ratio of integrated per-trigger yields as a function of p_T^{trigg} [6].

- PYTHIA8 - the deviation from data depends weakly on multiplicity
  - Monash tune - better for hard processes
  - Shoving better for intermediate p_T
- EPOS LHC - strong dependence on multiplicity

Ratios to h-h correlations





- Different trends of the ratio for different trigger particles:
  - K^0_S - rather flat with p_T^{trigg} and below unity
  - Λ - increasing with p_T^{trigg}
- The difference is most pronounced for the softer part (low p_T^{assoc}) of the harder processes (high p_T^{trigg})
- No dependence on the event multiplicity
- Based on the PYTHIA8 simulation of hard processes with only quarks ($q+\overline{q} \to q+\overline{q}$) or gluons ($g+g \to g+g$) in the final state (Fig. 8) ⇒ Triggering with high-p_T Λ or $\overline{\Lambda}$ causes a bias towards gluon jets

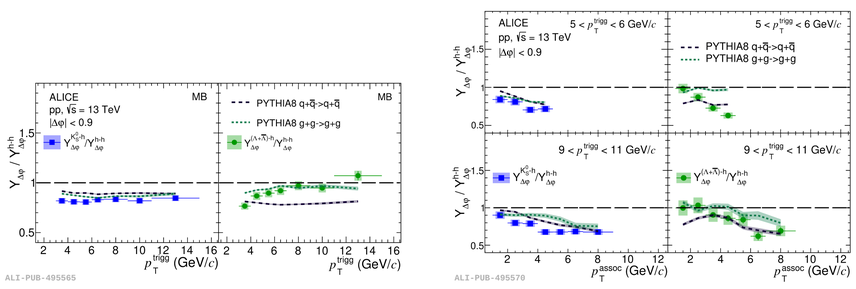


Figure 8: Per-trigger yield ratios of K^0_S-h (left column) or $(\Lambda+\overline{\Lambda})$-h (right column) to h-h at the near-side as a function of p_T^{trigg} in the left plot and as a function of p_T^{assoc} in the right plot, compared with the PYTHIA8 calculation of the quark and gluon jets [6]

Summary

- None of used model provides good description of the correlation functions
- A difference between jet-like particle yields triggered with K^0_S and Λ with respect to charged hadron was observed in pp collisions at 13 TeV
  - Explanation for pp (through PYTHIA8): triggering with Λ causes a bias towards gluon jets
  - Pronounced for high-p_T^{trigg} and low-p_T^{assoc}
- No multiplicity dependence of yields in pp collisions at 13 TeV

References

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[5] A. Rasoanaivo, W.A. Horowitz, 2017, arXiv:1712.06292

[6] S. Acharya, et al. https://arxiv.org/abs/2107.11209