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Angular Correlations of Strange Baryons in pp Collisions at $\sqrt{s} = 13.6$ TeV

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Two-Particle Angular Correlation

- Useful tool in quantifying the complex dynamics in parton fragmentation process (jets)
- Likelihood of observing a pair of particles as a function of $\Delta\eta$ and $\Delta\varphi$
- Enables direct comparison between correlations of particles with different masses

Difference in pseudorapidity
$$\longrightarrow \left\{ \begin{array}{c} \Delta \eta = \eta_1 - \eta_2 \\ \Delta \varphi = \varphi_1 - \varphi_2 \end{array} \right\}$$





- Enables studying different physics mechanisms simultaneously: conservation laws, Bose-Einstein correlations, mini-jets, elliptic flow, resonance decays
- Baseline: results in a $-\cos(\Delta \varphi)$ -like shape
- Each source of additional correlations produces a characteristic distribution in $\Delta\eta\Delta\varphi$ space
- The final shape is determined by both baseline and these phenomena



Motivation



- Studied all combinations of π, K, protons and Λ
- A distinct near-side peak was observed for all meson pairs and well reproduced by the models
- The models fail to reproduce baryon correlations



Data: pp \sqrt{s} = 13.6 TeV recorded in 2022 **Trigger:** sel8 **Event Selection**

- Minimum bias (0 –100%)
- $|V_{
 m z}| < 10\,{
 m cm}$
- 59.7B accepted events

Track Selection

- Protons
 - \circ Global track cuts
 - $\circ~0.5 < p_{\rm T} < 4.0~{\rm GeV}/c$
 - $|\eta| \le 0.8$
 - DCAxy < 0.1 cm
 - DCAz < 0.2 cm
 - \circ Sigma < 3 (TPC, TOF when p > 0.75 GeV/c)
 - Number of TPC clusters 80
 - Number of crossed TPC rows 80
 - Number of ITS clusters 6
 - Number of shared TPC clusters 10

V0 Vertex Selection

- V0 candidate (A)
 - \circ 0.16 < $p_{\rm T}$ < 4.0 GeV/c
 - $\mid \eta \mid \le 0.8$
 - DCA between daughter tracks \leq 1.0 cm
 - Cosine of V0 pointing angle ≥ 0.99
 - V0 radius > 0.7 cm
 - \circ V0 invariant mass cut 1.1 < $m_{
 m V_0}$ < 1.13 GeV $/c^2$

ALICE Detector

Tracking: **TPC+ITS** Particle Identification: **TOF**



V0 Daughter Selection

- \wedge (proton, pion-minus), $\overline{\wedge}$ (anti-proton, pion-plus)
 - Sigma < 5 (TPC)
 - $\circ |\eta| \leq 0.8$
 - DCA of daughter track to primary vertex \ge 0.06 cm
 - Number of TPC clusters 70

Methodology

- $S(\Delta\eta,\Delta\varphi)$ or same-event distribution: pair of particles coming from the same-event
- $B(\Delta\eta, \Delta\varphi)$ or mixed-event distribution: each particle of the pair comes from a different event
- Pair acceptance effects: **same-event** pair distribution normalized by the **mixed-event** distribution

$$C(\Delta \eta, \Delta \phi) = \frac{N^{mixed}}{N^{same}} \frac{S(\Delta \eta, \Delta \phi)}{B(\Delta \eta, \Delta \phi)}$$





• Prominent near-side depression instead of the peak combined with an away-side ridge



- ALI-PREL-587442
 - Correlation functions show a peak at the near-side combined with a weak away-side structure
 - Clear improvement in the precision of the results in Run 3 vs. Run 1



$\Delta \eta$ Integrated Projections

- $|\Delta\eta| < 1.3$ integrated projections of correlation functions for identical pairs of protons and lambdas
- Different pairs show compatibility within uncertainty
- Consistent results with the Run 1 published data with improved statistical uncertainty
- Strong anti-correlation indicates that the mechanism(s) which would produce a peak dominated by effects associated with mini-jets are either not present or produce a very different correlation shape
- PYTHIA models predict a positive correlation in the near-side region and fail to capture $\Delta \varphi$ the dependence

$\Delta \eta$ Integrated Projections

- $|\Delta\eta| < 1.3$ integrated projections of correlation functions for non-identical pairs of protons and lambdas
- Distinct near-side peaks suggest significant mini-jet contributions
- The correlation functions of different baryon/antibaryon pairs differ in magnitude and width -
 - Proton-anti-proton largest in the near-side and lowest in the away-side
 - Proton-anti-lambda lowest in the near-side and highest in the away-side
- PYTHIA models reproduce the general shape of the correlation functions; however, the magnitude is over- or underestimated.



Summary

- Proton-lambda correlations are measured in Run 3 pp collisions at 13.6 TeV
- New results, while compatible, show a clear improvement in detail over the Run 1 results
- Strong depression (anti-correlation) is visible in the near-side regions for all identified identical pairs of protons and Λ
- Clear positive correlation of particles with opposite baryon numbers is observed
- PYTHIA models are unable to describe the observations
- If mini-jet fragmentation process is the one producing a positive near-side correlation, then baryon-anti-baryon pairs are produced in mini-jets but production of more than one such pair in a single fragmentation is suppressed
- More theoretical work needed to interpret the results
- Work-in-progress to extend the measurements for correlations of cascades (Ω , Ξ)

Thank you!