Strangeness Enhancement in Small System at LHCb

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on behalf of the LHCb collaboration
Motivation

• Strangeness enhancement was one of the first proposed signatures of quark-gluon plasma (QGP) formation in heavy ion collisions
  - strangeness production proceeds mainly via gluons in QGP.
  - \( s \) quark mass lower than QGP critical temperature \( T_c \), \( s\bar{s} \) quark pairs can be produced thermally.

• Recently, enhanced strangeness production is observed in high multiplicity \( pp \) and \( p\text{Pb} \) collisions.

A significant enhancement of strange to non-strange hadron production is observed with increasing particle multiplicity in \( pp \) \( p\text{-Pb} \) \( \text{Pb-Pb} \) collisions.

LHCb detector and Datasets

• A single-arm spectrometer in the forward direction, charm & beauty factory
  ➢ Vertex Locator (20 μm IP resolution)
  ➢ Tracking system (∆p/p = 0.5 – 1.0%)
  ➢ RICH: p/K/π separation
  ➢ Flexible software trigger

• pp data was taken in 2016+2017+2018 with 5.4 fb⁻¹.

• pPb data was taken in 2016 with asymmetric collision configuration.
  ➢ Forward (pPb)
  ➢ Backward (Pbp)
  ➢ Luminosity : 13.6 nb⁻¹(pPb) + 20.8 nb⁻¹(Pbp)

• Beam characteristics
  ➢ 6500 GeV proton beam and 2560 GeV/nucleon Pb beam
  ➢ Center of mass rapidity shift \( y^* - y_{lab} = -0.465 \) in direction of proton
Strangeness enhancement with $B$ mesons in $pp$ collisions at 8.16 TeV

- Ratio of $B_S^0/B^0$ cross sections versus multiplicity, in several pt bins
  - Both states are simultaneously accessible in $J/\psi \pi^+\pi^-$. 

\[
\frac{\text{BR}(B_S^0 \to J/\psi \pi^+\pi^-)}{\text{BR}(B^0 \to J/\psi \pi^+\pi^-)} \times \frac{\sigma_{B_S^0}}{\sigma_{B^0}} = \frac{N_{B_S^0}}{N_{B^0}} \times \frac{\varepsilon_{\text{acc}}}{\varepsilon_{\text{acc}}} \times \frac{\varepsilon_{\text{trig}}}{\varepsilon_{B_S^0}} \times \frac{\varepsilon_{\text{reco}}}{\varepsilon_{B^0}} \times \frac{\varepsilon_{\text{PID}}}{\varepsilon_{B_S^0}}
\]
Results: $B_s^0/B^0$ vs multiplicity

- Ratio increases with total multiplicity. At low multiplicity, consistent with fragmentation in vacuum.
- No significant dependence of forward $B_s^0/B^0$ production on backwards multiplicity. (Effect depends on local particle density)
- Modification mostly occurs at low pt, where most of the bulk particles are produced. High pt are unaffected and consistent with $ee$ result.
Work in progress: $D_s^+/D^+$ ratio in $p\text{Pb}$ collisions at 8.16 TeV

• We are studying strangeness enhancement in $p\text{Pb}$ collision by $D_s^+/D^+$ ratio, some clues have been seen.

- Compared with B mesons, the statistics of D mesons are larger.

$$R_{D_s^+/D^+}(p_T,y^*,\text{PV} \text{ nTracks}) = \frac{N(D_s^+ \to K^+K^\mp \pi^\pm)}{N(D^\pm \to K^+\pi^\mp \pi^\pm)} \times \frac{\mathcal{B}(D_s^+ \to K^+\pi^\mp \pi^\pm)}{\mathcal{B}(D^\pm \to K^+\pi^\mp \pi^\pm)} \times \frac{\epsilon_{D^+}}{\epsilon_{D_s^+}}$$

$D_s^+ \to K^+K^-\pi^+$

$D^+ \to K^-\pi^+\pi^+$

![Graph](https://example.com/graph1.png)

![Graph](https://example.com/graph2.png)

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