

Event-activity dependent production of strange and non-strange charmed baryons in the enhanced color-reconnection scheme

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Production of heavy-flavor baryons

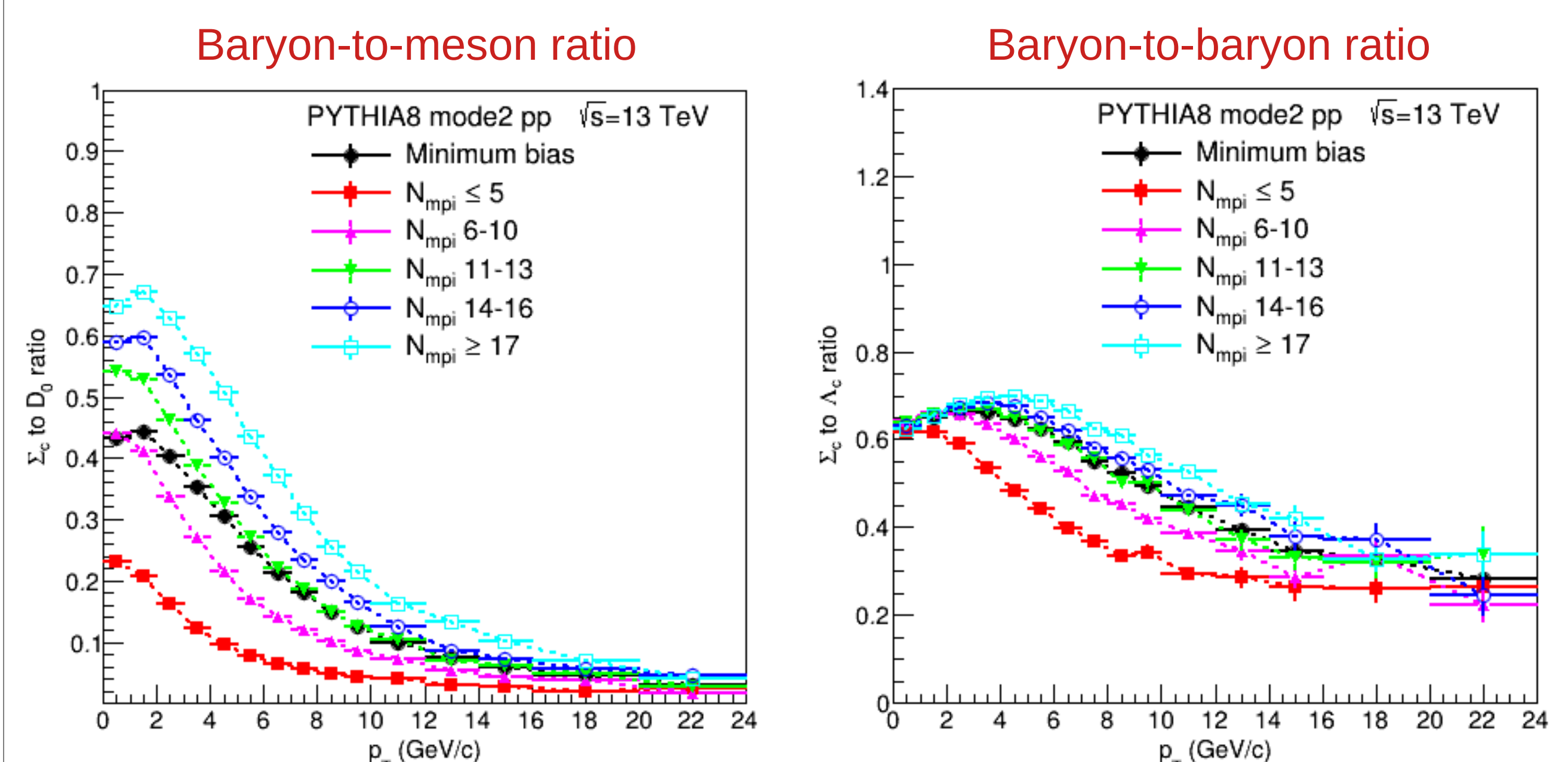
- Heavy-flavor production is usually described with the factorization approach, where incoming hadron PDFs, hard parton-parton scattering and fragmentation are independent:

$$d\sigma_{AB \rightarrow C}^{hard} = \sum_{a,b} f_{a/A}(x_a, Q^2) \otimes f_{b/B}(x_b, Q^2) \otimes d\sigma_{ab \rightarrow c}^{hard}(x_a, x_b, Q^2) \otimes D_{c \rightarrow C}(z, Q^2)$$

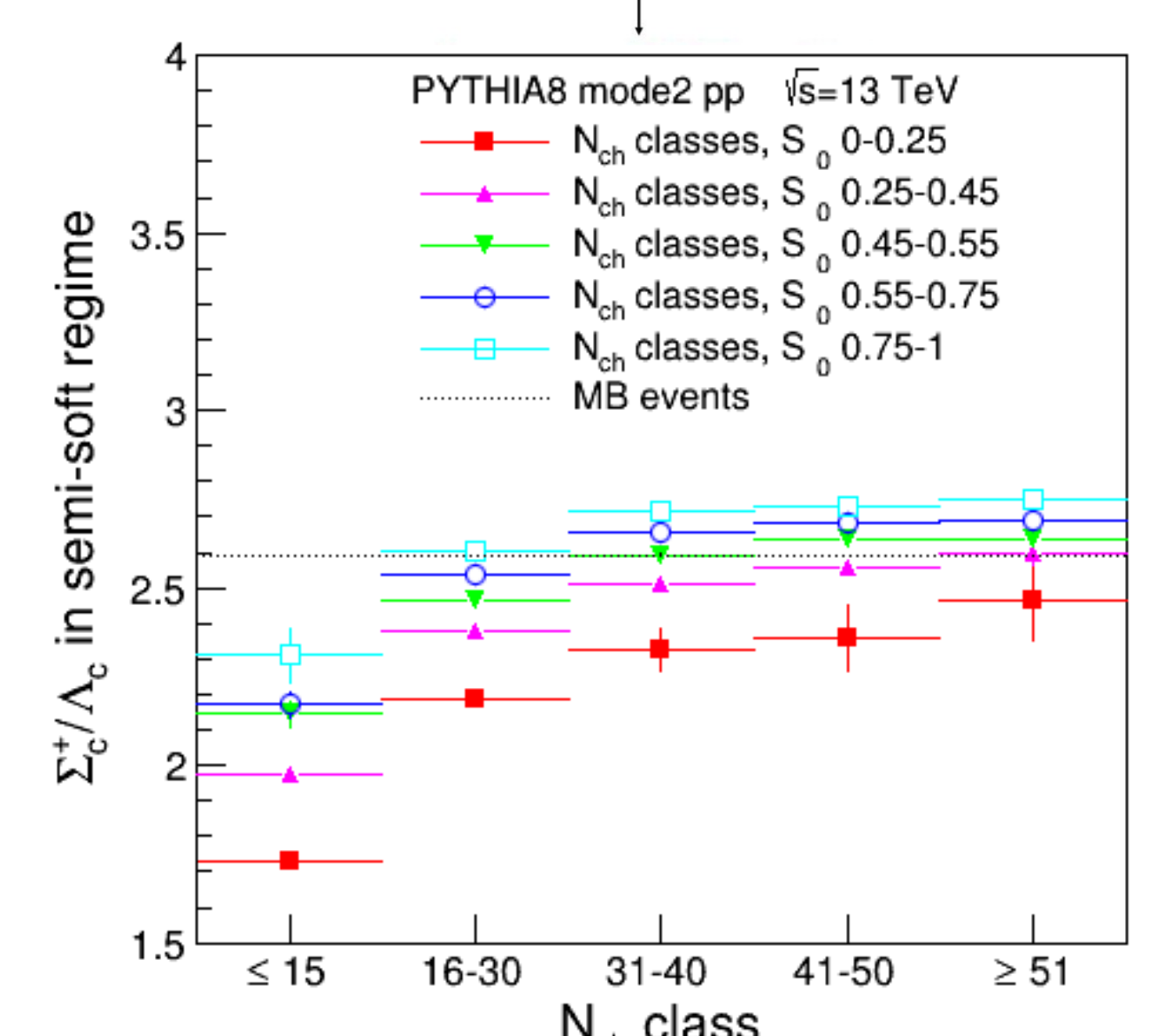
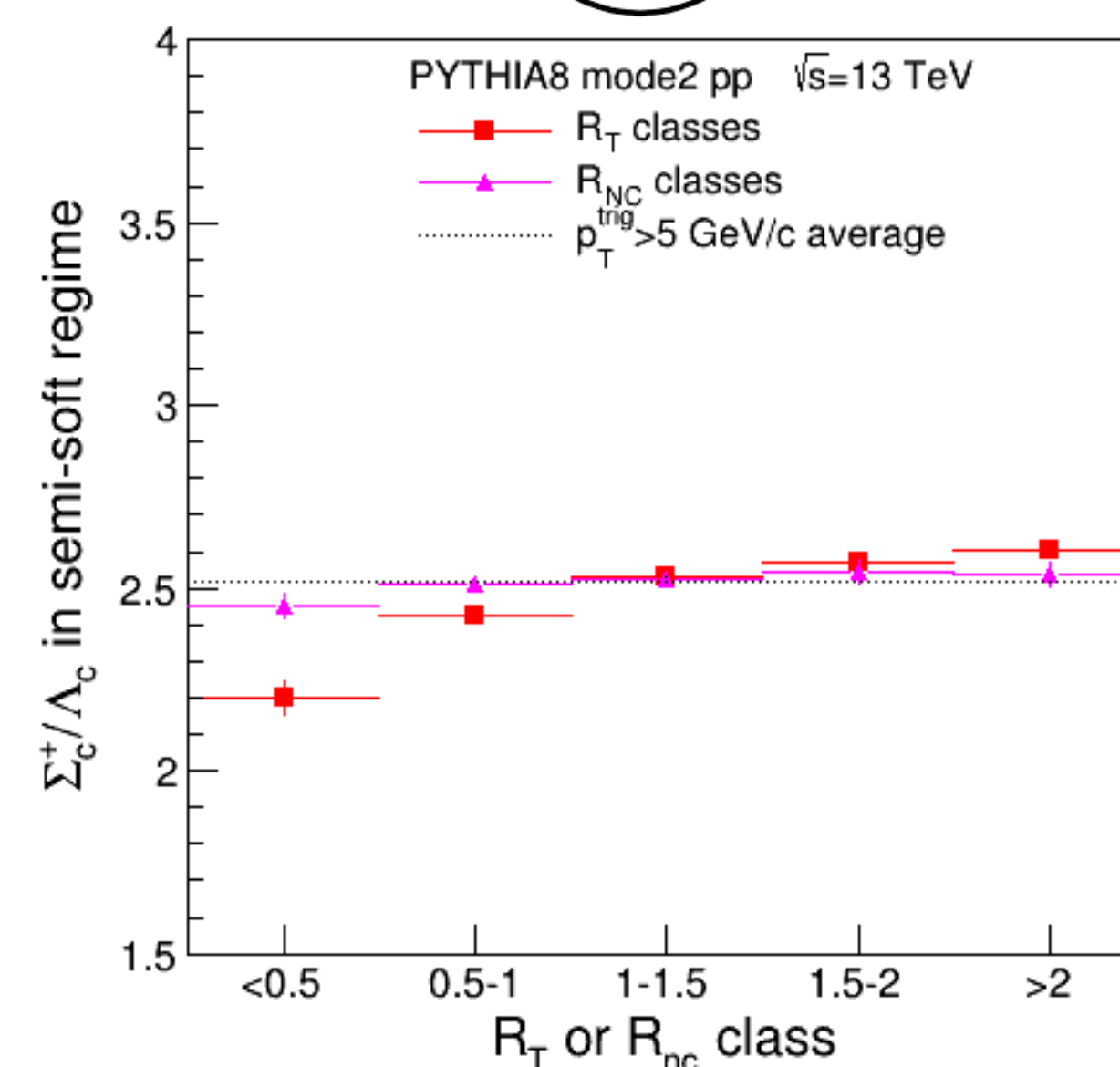
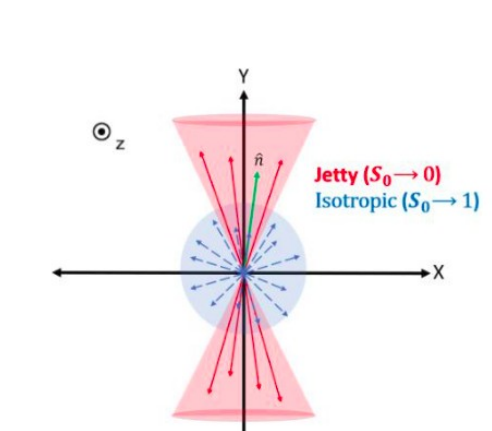
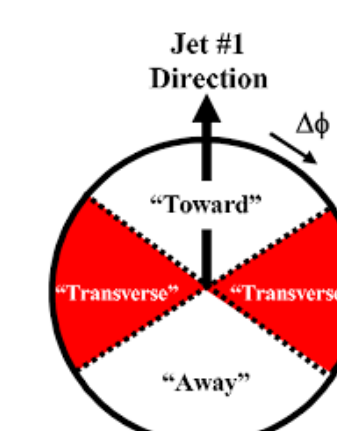
Parton Distribution Function (PDF)
Partonic hard scattering cross-section
Fragmentation Function (FF)

- Traditional assumption: fragmentation functions are **universal** for different collision systems.
 - FF often determined from e+e- (or e-p) collisions, where PDF plays no (or less important) role.
- Recent experimental results (ALICE, CMS, LHCb) on charmed-baryon production **do not support** this assumption! [1]

Charmed-baryon enhancement in jetty and isotropic events



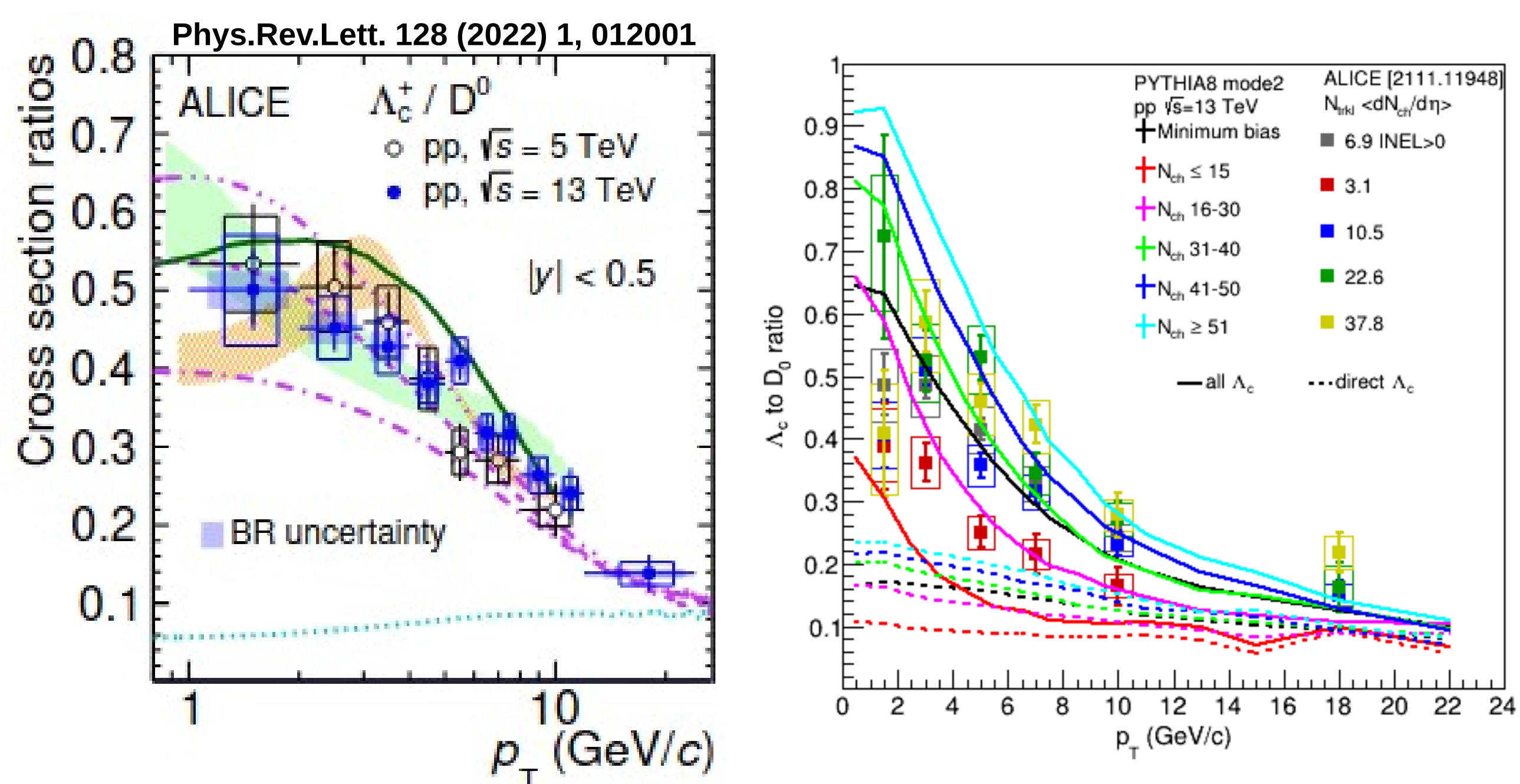
- We studied the $\Sigma_c^{0,+,++}/D^0$ and $\Sigma_c^{0,+,++}/\Lambda_c^+$ ratio with several different event classifiers.
- Left panel:** the $\Sigma_c^{0,+,++}/D^0$ ratio shows the same ordering as it is present in the Λ_c^+ and $\Sigma_c^{0,+,++}$ decays.
- Right panel:** Highlights the difference in the trends between $\Sigma_c^{0,+,++}$ and Λ_c^+ .



- R_T vs. R_{NC} in triggered events (hadron with $p_T > 5$ GeV/c)
- $\Sigma_c^{0,+,++}/D^0$ enhancement depends on UE activity, almost independent on activity within jet
- $\Sigma_c^{0,+,++}/D^0$ enhancement is more prominent in spherical (UE-dominated) than jetty events

• **CR-BLC model links the enhancement to the UE:**
Discrimination power in data from the upcoming LHC Run 3!

Event activity dependence of Λ_c^+/D^0 enhancement



- Significant enhancement in the Λ_c^+/D^0 ratio in the low p_T (2-8 GeV/c) range compared to e+e- predictions [1]: **no universality!**
- PYTHIA Color-reconnection beyond leading color (CR-BLC)**[2,3] describes the multiplicity dependence.
- Multiplicity dependence:** connected to the event activity. Needs to be better understood!
- p_T dependence may be sensitive to baryon type: trend differs for $\Sigma_c^{0,+,++} \rightarrow \Lambda_c^+$ although $\Sigma_c^{0,+,++}$ only differs from Λ_c^+ in isospin.

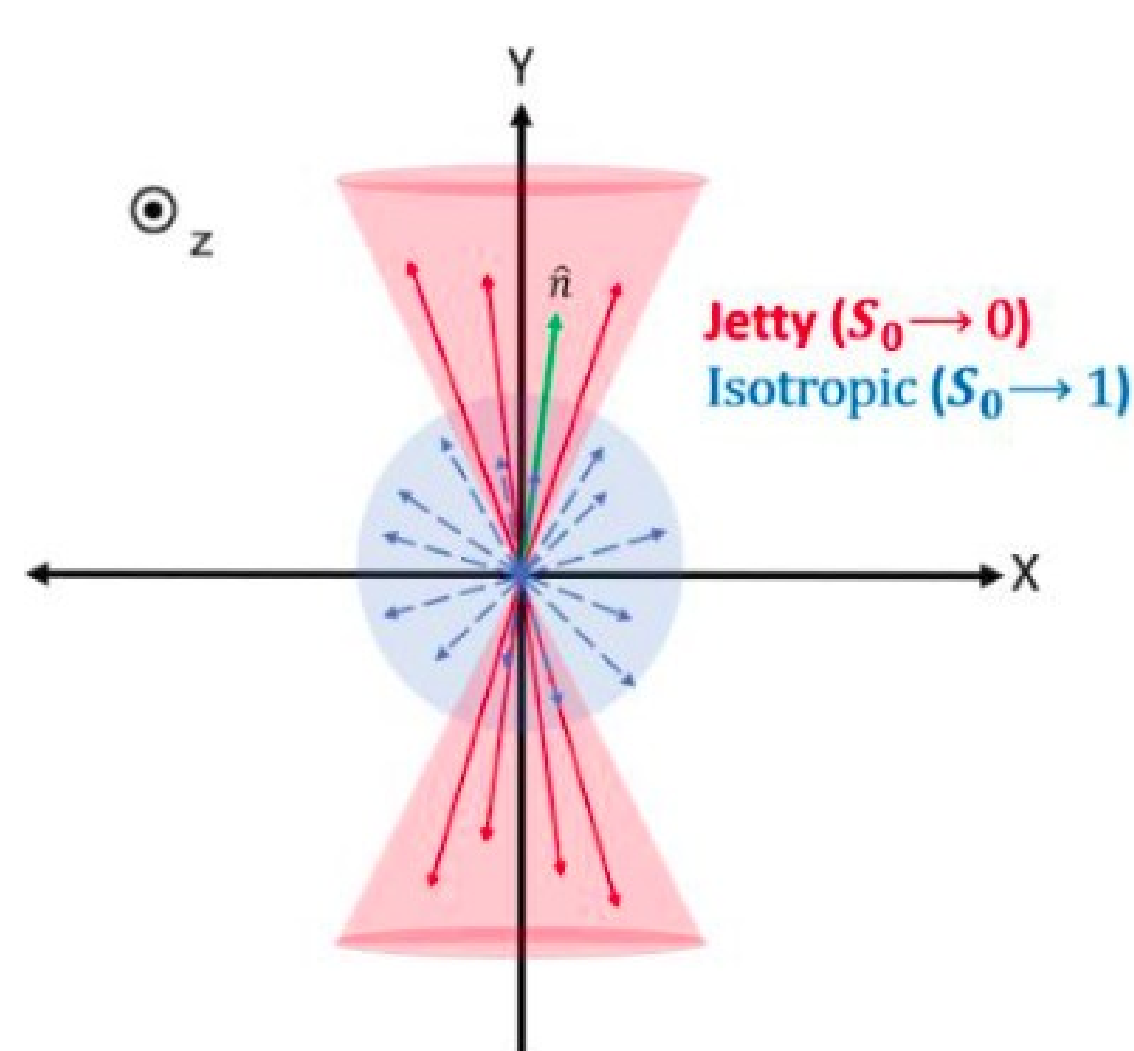
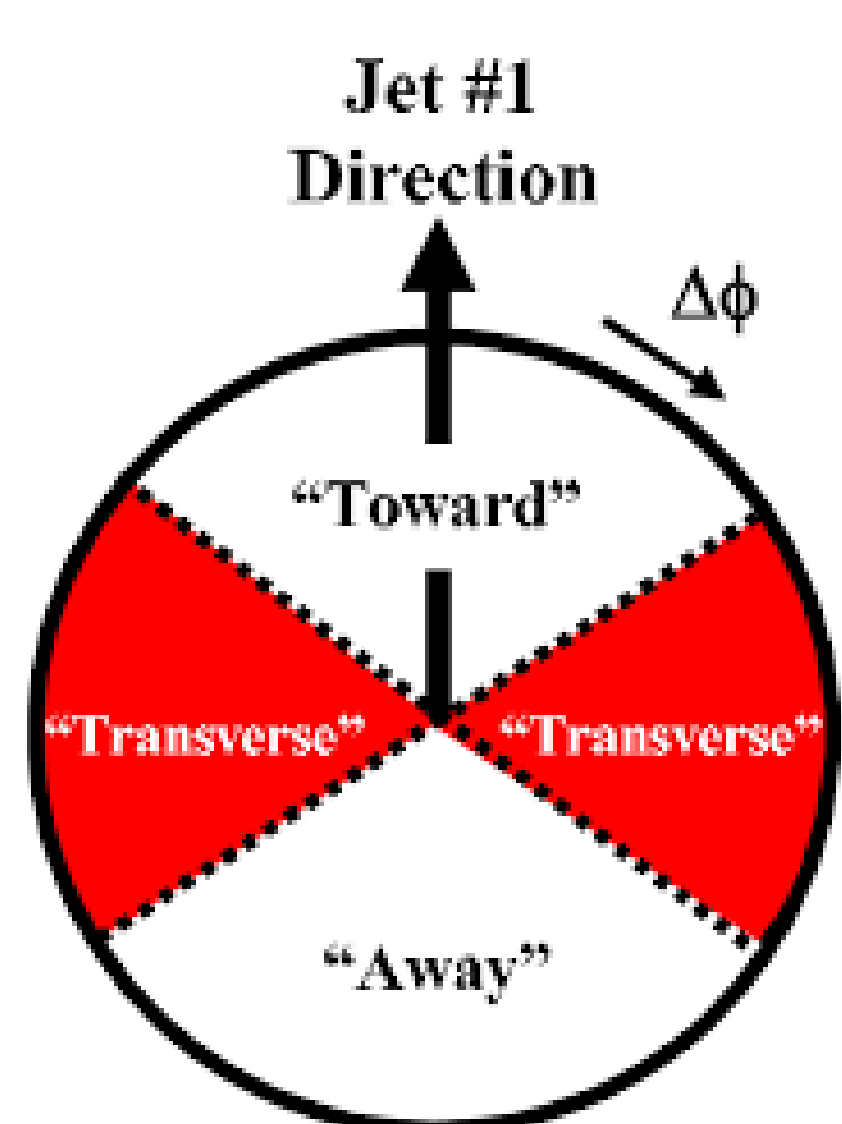
Classifying event based on jettiness and underlying event activity

- Events with $p_T > 5$ GeV/c trigger hadron:

- R_T : underlying event (UE) activity classifier $R_T = \frac{N_{CH}^{transverse}}{\langle N_{CH}^{transverse} \rangle} \frac{\pi}{3} < |\Delta\phi| < \frac{2\pi}{3}$

- R_{NC} : jet region activity classifier $R_{NC} = \frac{N_{CH}^{near-side cone}}{\langle N_{CH}^{near-side cone} \rangle} \sqrt{(\Delta\phi)^2 + (\Delta\eta)^2} < 0.5$

• S_0 : sphericity (how isotropic the event is) $S_0 = \frac{\pi^2}{4} \times \min_{\hat{n}=(n_x, n_y, 0)} \left(\frac{\sum_i |\vec{p}_{T_i} \times \hat{n}|}{\sum_i p_{T_i}} \right)^2$



Summary

- Λ_c^+/D^0 and $\Sigma_c^{0,+,++}/D^0$ ratios: **universality** of fragmentation functions is **broken**. Does the factorization approach work?
- Discrimination power** of differential measurements that focus on event activity in the jet and/or the underlying event region.
- Measurements with different heavy-flavor baryons: more **constraints on models**. Explore the connection to strange-baryon enhancement.

[1] ALICE Coll., "Measurement of prompt D0, Lambda_c+, and Sigma_c{0,++}(2455) production in pp collisions at sqrt(s) = 13 TeV", Phys.Rev.Lett. 128 (2022) 1, 012001
 [2] Christiansen, J.R., Skands, P.Z. "String formation beyond leading colour", J. High Energ. Phys. 2015, 3 (2015)
 [3] T. Sjöstrand et al., "An introduction to PYTHIA 8.2", Comput. Phys. Commun. 191 (2015) 159-177