



INVESTIGATING NON-PERTURBATIVE QCD MECHANISMS IN PP COLLISIONS VIA FORWARD-BACKWARD CORRELATIONS

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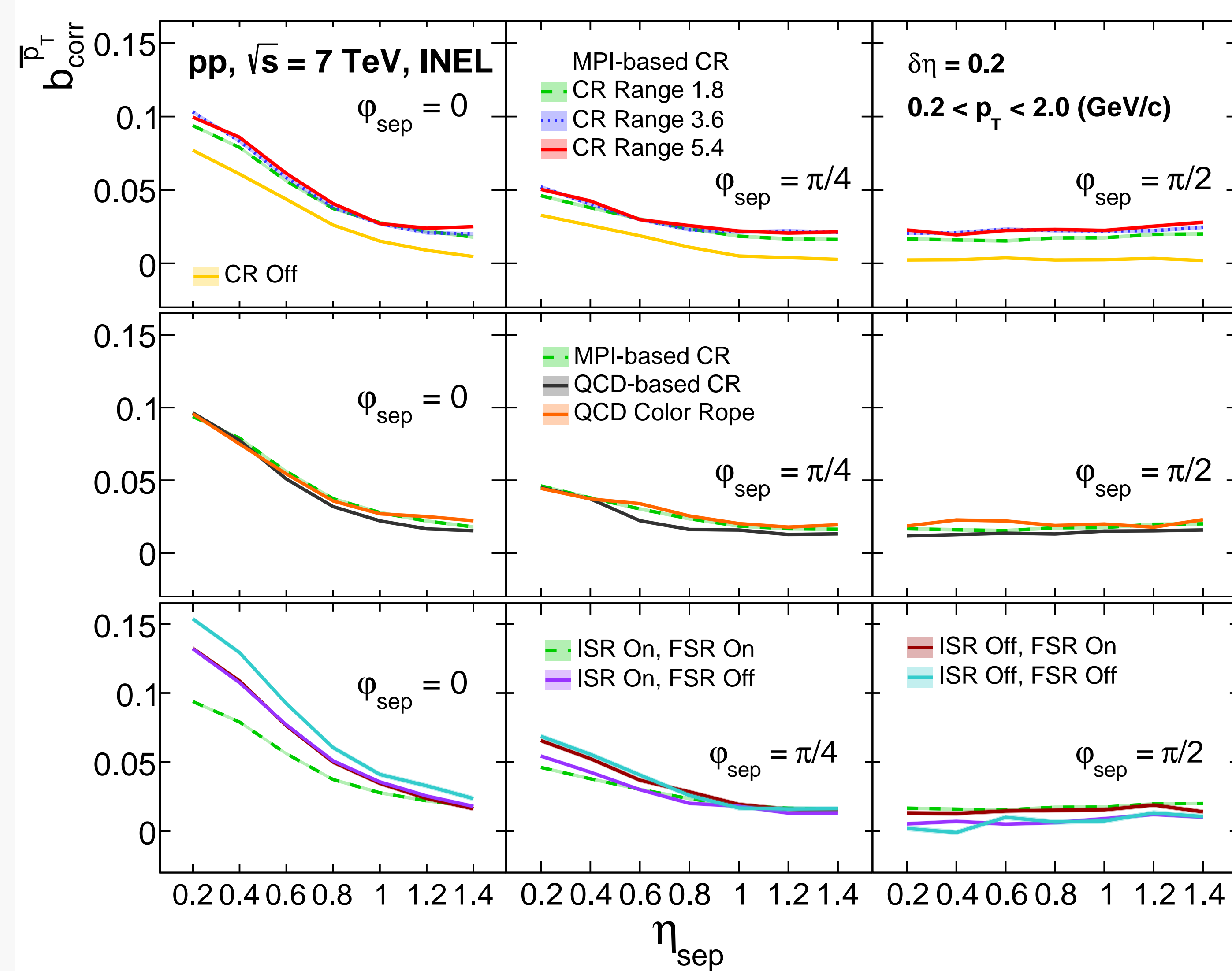
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INTRODUCTION & METHODOLOGY

- FB correlations are a powerful tool to disentangle SRCs from LRCs in multiparticle production, probing the QCD dynamics [1].
- 50M pp collision events are simulated at 0.9 and 7 TeV using **PYTHIA8** [2], a robust framework that integrates both pQCD and npQCD.
- We calculate FB correlations using **extensive** ($b_{\text{corr}}^{\sum p_T}$), **intensive** ($b_{\text{corr}}^{\bar{p}_T}$), and **strongly intensive** ($\Sigma_{N_f N_b}$) observables in symmetric η intervals, validating our baseline against available experimental data.
- To investigate npQCD origins, we systematically vary the model parameters for CR and Parton Showers (ISR/FSR). Different **PYTHIA8** tunes are compared to assess how specific implementations of CR and Showers impact the correlation strength.

Figure 1 – $b_{\text{corr}}^{\bar{p}_T}$ plotted as a function of η_{sep} for PYTHIA8 simulated pp collisions



OBSERVABLES OF INTEREST

$$b_{\text{corr}}^{\sum p_T} = \frac{\langle (\sum p_T^f - \langle \sum p_T^f \rangle) (\sum p_T^b - \langle \sum p_T^b \rangle) \rangle}{\sqrt{\langle (\sum p_T^f - \langle \sum p_T^f \rangle)^2 \rangle \langle (\sum p_T^b - \langle \sum p_T^b \rangle)^2 \rangle}} \quad (1)$$

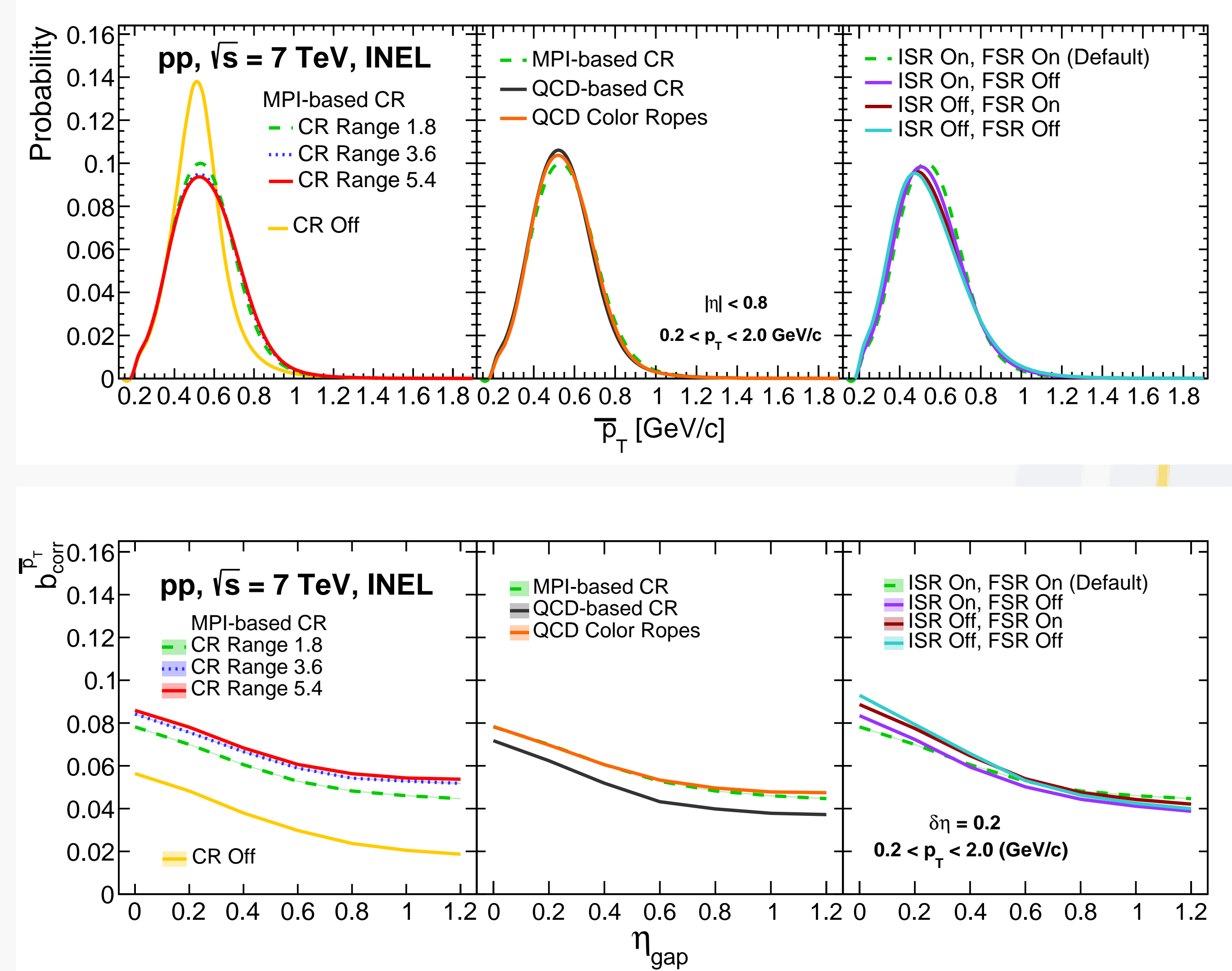
$$b_{\text{corr}}^{\bar{p}_T} = \frac{\langle \bar{p}_T^f \bar{p}_T^b \rangle - \langle \bar{p}_T^f \rangle \langle \bar{p}_T^b \rangle}{\langle \bar{p}_T^f \rangle \langle \bar{p}_T^b \rangle} \quad (2)$$

$$\Sigma_{N_f N_b} = \frac{\omega_{N_b} \langle N_f \rangle + \omega_{N_f} \langle N_b \rangle - 2 \text{Cov}(N_f, N_b)}{\langle N_f \rangle + \langle N_b \rangle} \quad (3)$$

RESULTS

Figure 2 – Top: \bar{p}_T distribution, plotted for pp collisions at $\sqrt{s} = 7$ TeV;

Bottom: $b_{\text{corr}}^{\bar{p}_T}$ plotted as a function of η_{gap} for PYTHIA8 simulated pp collisions



RESULTS AND DISCUSSIONS

Figure 3 – $b_{\text{corr}}^{\sum p_T}$ plotted as a function of η_{gap} for INEL pp collisions simulated using PYTHIA8 at $\sqrt{s} = 0.9$ and 7 TeV alongside ATLAS [2] results.

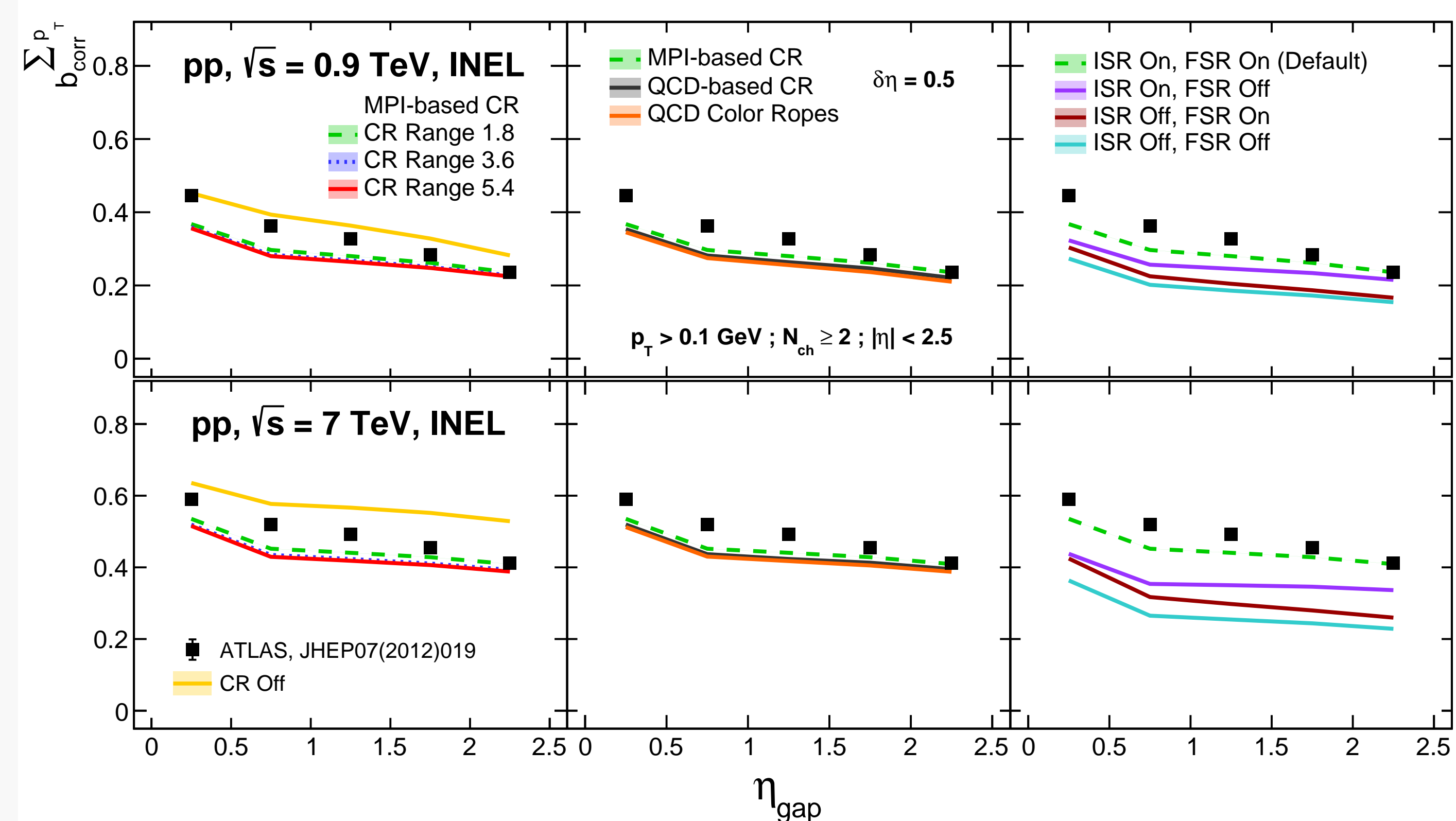
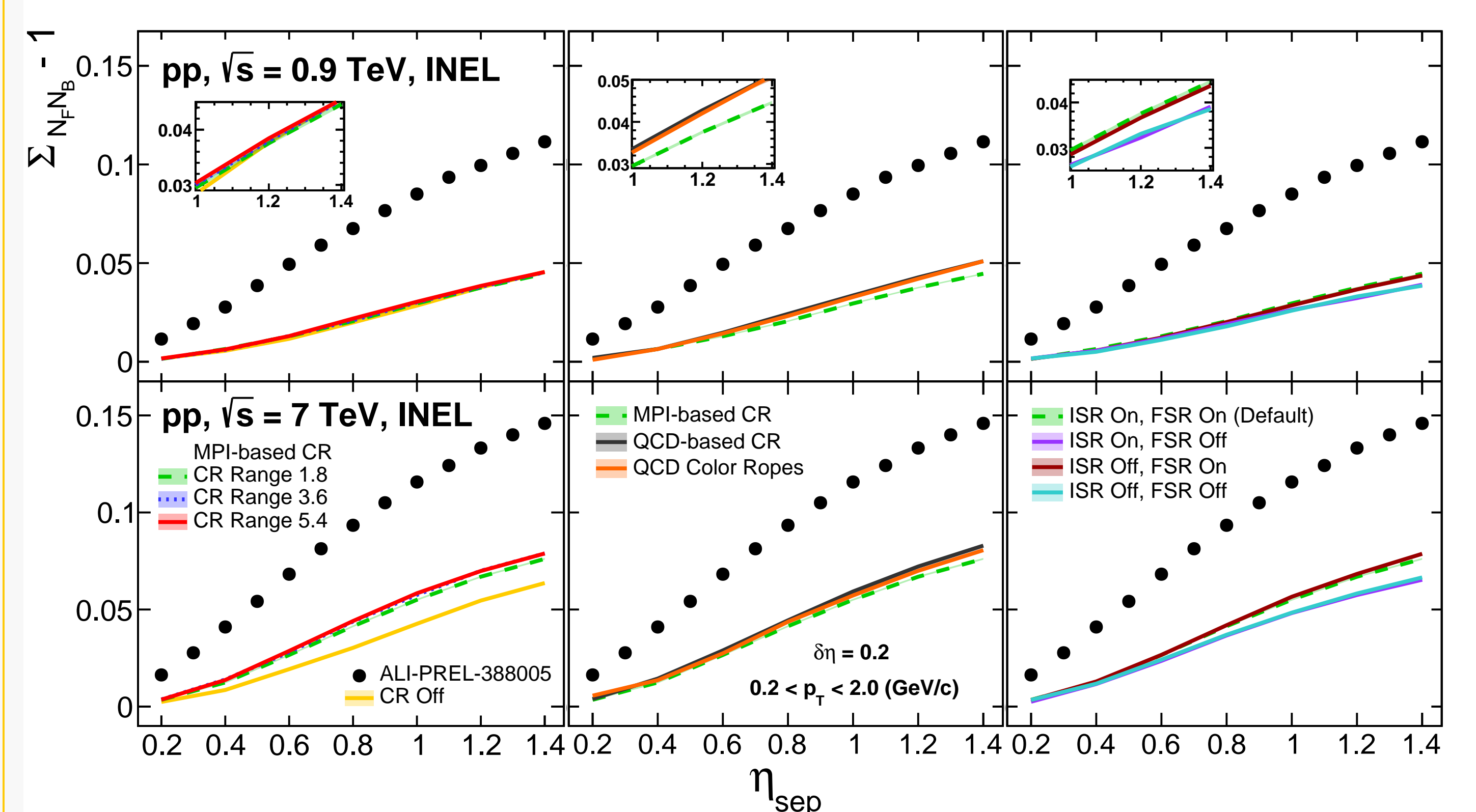


Figure 4 – $\Sigma_{N_f N_b} - 1$ plotted as a function of η_{sep} for INEL pp collisions simulated using PYTHIA8 at $\sqrt{s} = 0.9$ and 7 TeV alongside ALICE [3] results.



SUMMARY AND CONCLUSIONS

- The η - ϕ dependence of $b_{\text{corr}}^{\bar{p}_T}$ reveals parton showers as the dominant mechanism for short-range correlations. In contrast, CR Range has an opposite effect on intensive vs. extensive observables (Figs. 1, 2, & 3).
- Disabling ISR/FSR fails to replicate the η_{gap} -dependent trend of $b_{\text{corr}}^{\sum p_T}$ (Fig. 3).
- FSR** has a particularly strong impact on $\Sigma_{N_f N_b}$ at $\sqrt{s} = 7$ TeV, highlighting its role in final-state multiplicity fluctuations (Fig. 4).
- The QCD-based CR scheme, with its strict SU(3) color rules, produces the weakest $b_{\text{corr}}^{\bar{p}_T}$, suggesting it suppresses LR collectivity through localized string reconnections (Fig. 2).

ORGANIZING INSTITUTES



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