

Probing beauty and charm production in p-Pb collisions with high p_T electrons measured with ALICE



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Motivation

- Heavy quarks (charm and beauty) are produced in the initial hard partonic interactions in heavy-ion collisions.
 - Ideal probe to study the properties of Quark-Gluon Plasma (QGP).
 - Undergo energy loss in the hot and dense QCD medium.
- Study of heavy-flavour production
 - Semi-electronic decays ($c, b \rightarrow e$) with 10 % BR.
 - Charm component at low p_T , and beauty dominates at high p_T ($p_T > 5$ GeV/c).
 - Modification of heavy-flavour production in heavy-ion collisions can be studied via comparison with binary scaled pp collisions (nuclear modification factor: R_{AA}).
 - Strong suppression of e^{HF} yield observed in Pb-Pb collisions^[1].

$$R_{AA} = \frac{1}{\langle T_{AA} \rangle} \frac{dN_{AA}/dp_T}{d\sigma_{pp}/dp_T}$$

Heavy-flavour production

in p-Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV

Investigate Cold Nuclear Matter (CNM) effects

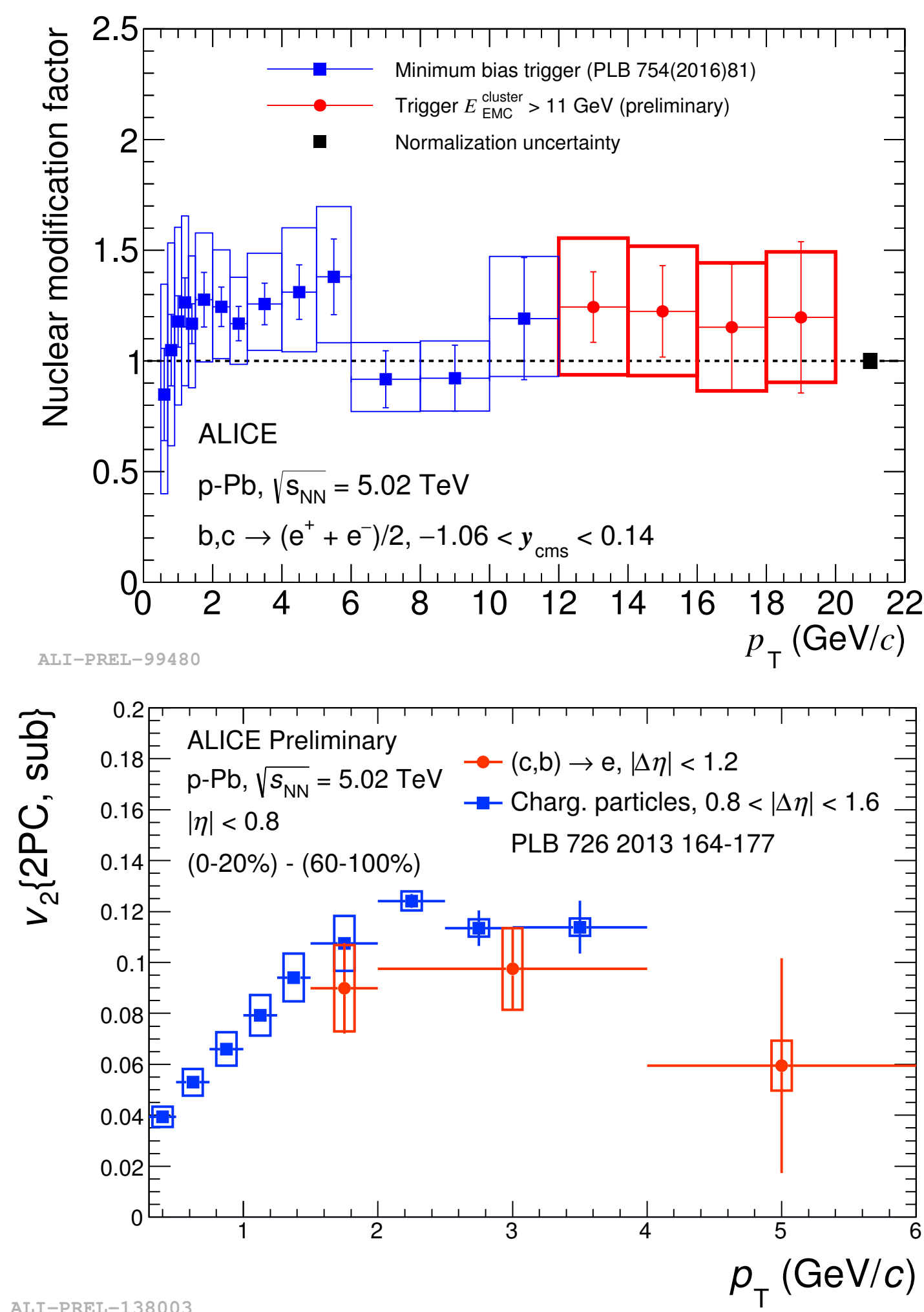
- Shadowing, gluon saturation, k_T broadening...
- R_{pPb} is compatible with unity: p-Pb collisions scale as binary collisions^[2].

Possibility of QGP formation in small systems

- Non-zero elliptic flow (v_2) of e^{HF} could imply the presence of collective motion in p-Pb collisions.
- But no evidence of $R_{pPb} \neq 1$ up to $p_T = 20$ GeV/c.

Study heavy-flavour production in p-Pb collisions at $\sqrt{s_{NN}} = 8.16$ TeV

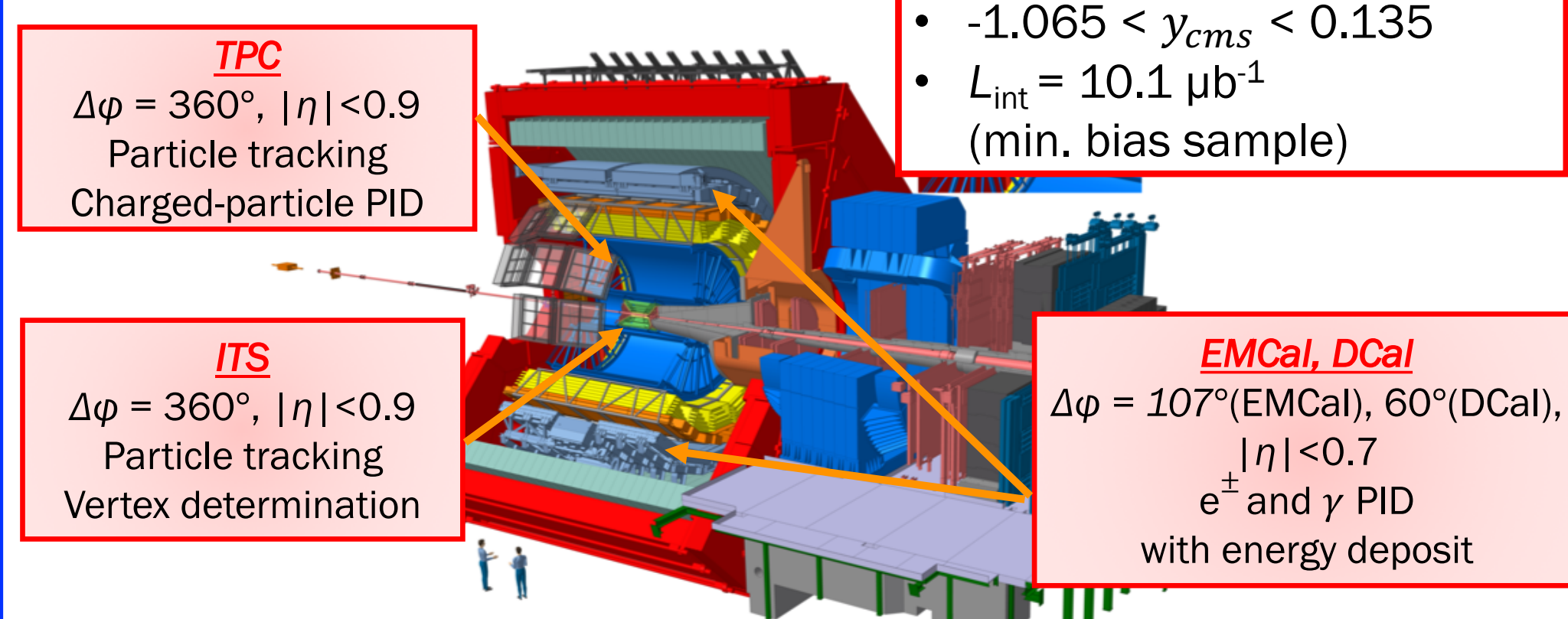
- Energy dependence of CNM effects?
- Possible final-state effects, i.e. energy loss at higher centre-of-mass energy?



ALICE apparatus

Analysed Data set

- $\sqrt{s_{NN}} = 8.16$ TeV p-Pb data
- $-1.065 < y_{cms} < 0.135$
- $L_{int} = 10.1 \mu b^{-1}$ (min. bias sample)



Electron identification with ALICE

- TPC and EM-Calorimeter (EMCal) are used.
- Di-jet Calorimeter (DCal) started data taking in Run-2 period.
 - Expand acceptance of EMCal w.r.t. Run-1 analysis.
 - Performance for electrons is similar to EMCal.

EMCal L1 Gamma trigger

- Single shower trigger (4×4 tower window).
- Two thresholds on energy deposit (5.5 GeV and 8 GeV) in 8.16 TeV p-Pb runs.
- Powerful to increase the high- p_T reach of electron measurement.

Heavy-flavour electron identification

i. Electron identification

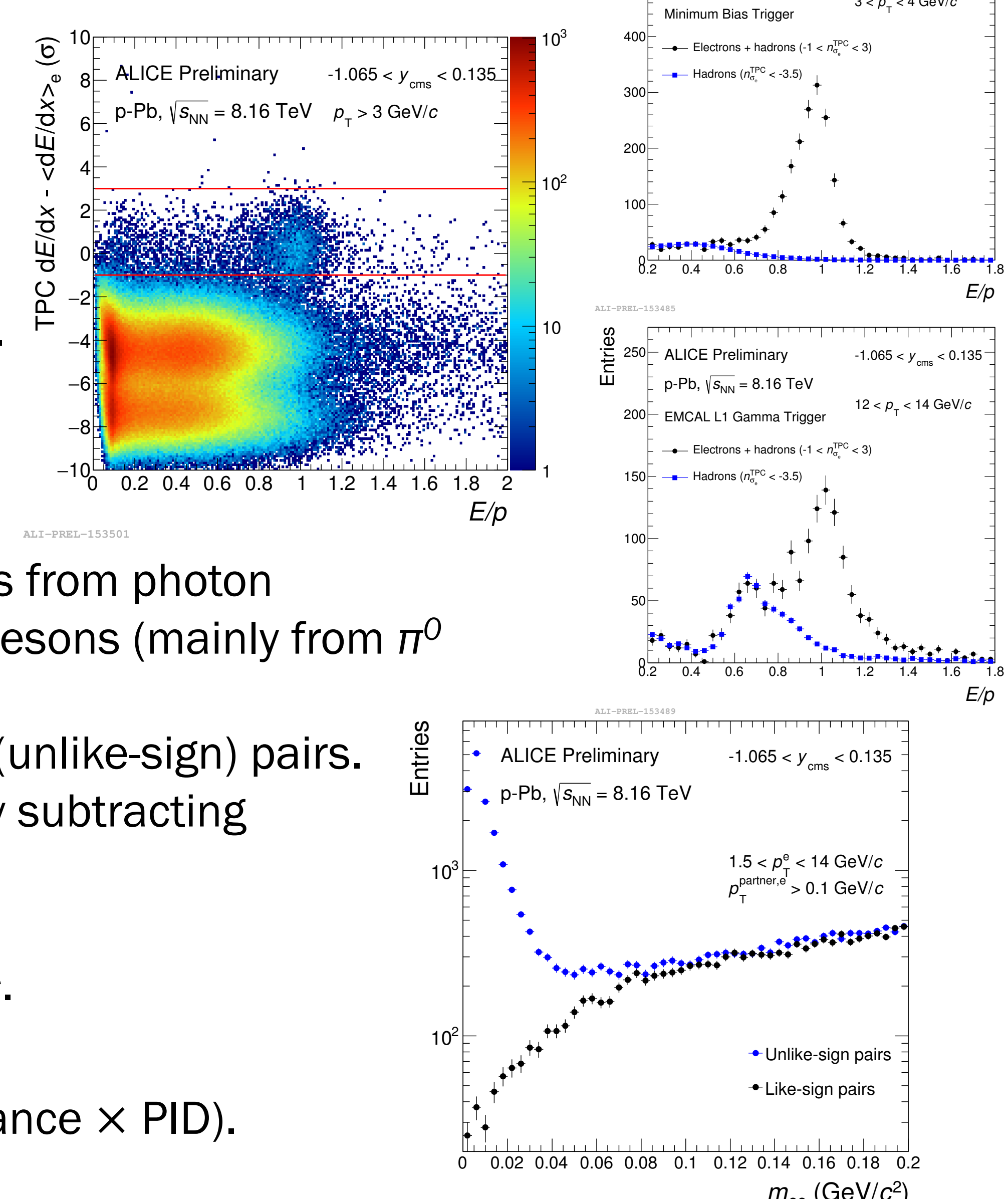
- Based on measured dE/dx , shower shape properties and E/p (TPC + EMCal + DCal).
- Hadron contamination is estimated using E/p distribution after dE/dx requirement, and normalized to the electron distribution.
 - Increase with $p_T \sim 20\%$ at 12-14 GeV/c.

ii. Background subtraction

- Background is statistically subtracted.
- Main background sources include electrons from photon conversions and Dalitz decays of neutral mesons (mainly from π^0 and η).
 - Reconstructed by invariant mass of e^+e^- (unlike-sign) pairs.
 - Combinatorial background is removed by subtracting like-sign pairs.
 - Background finding efficiency $\sim 80\%$.
- W-decay electrons is $\ll 1\%$ at 12-14 GeV/c.

iii. Final e^{HF} spectrum

- Corrected for efficiency (tracking \times acceptance \times PID).
 - $\sim 15\%$ at $p_T > 5$ GeV/c.



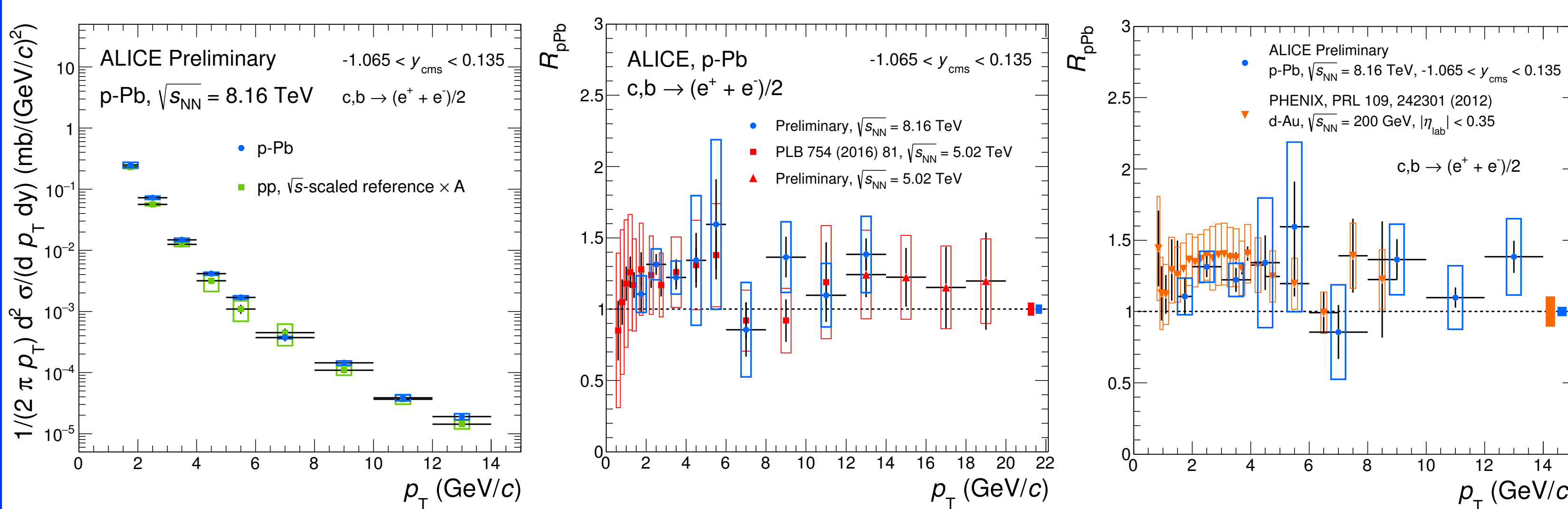
Heavy-flavour production in p-Pb collisions at $\sqrt{s_{NN}} = 8.16$ TeV

pp reference

- $p_T < 8$ GeV/c : ALICE 7 TeV data^[3] ($|y| < 0.6$, $p_T < 4$ GeV/c is updated w.r.t. publication)
- $p_T > 8$ GeV/c : ATLAS 7 TeV data^[4] ($|y| < 2.0$ excluding $1.37 < y < 1.52$)
- Energy scaling and rapidity scaling based on perturbative-QCD FONLL calculation^[5].

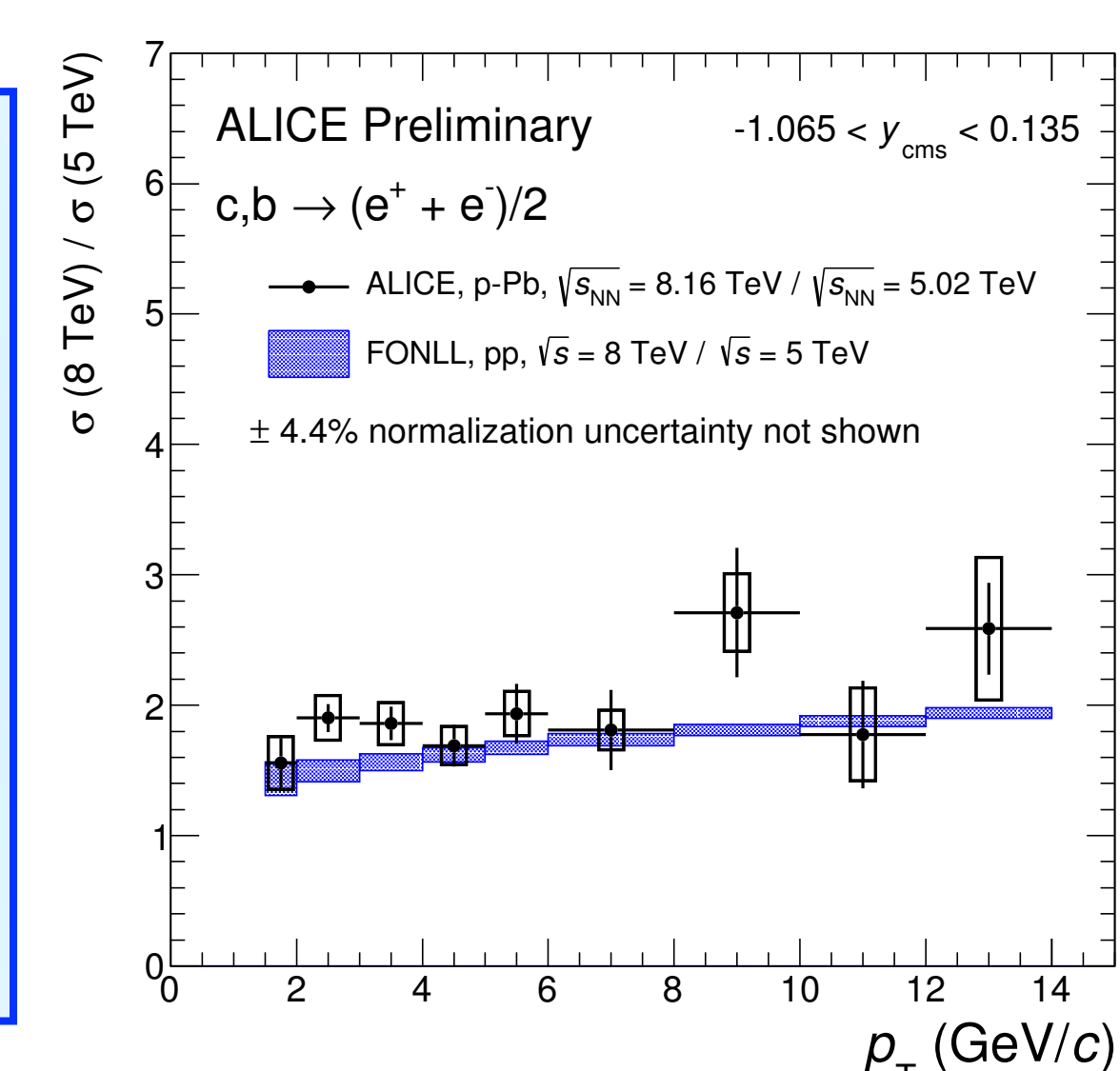
Energy dependence of heavy-flavour production in p-Pb

- $\sigma_{pPb}(8.16 \text{ TeV}) / \sigma_{pPb}(5.02 \text{ TeV})$ is consistent with FONLL prediction.
- Indication of no significant energy dependence of CNM effects on heavy-flavour production.



Nuclear modification factor

- R_{pPb} is measured up to 14 GeV/c using Minimum bias and EMCal trigger data.
- R_{pPb} at 8.16 TeV similar to the one at 5.02 TeV and to R_{dAu} at 200 GeV^[6].
- No suppression of e^{HF} yield observed in p-Pb collisions.



Summary & Outlook

- Heavy-flavour decay electron p_T -differential cross section is measured up to 14 GeV/c in p-Pb collisions at $\sqrt{s_{NN}} = 8.16$ TeV.
 - R_{pPb} at $\sqrt{s_{NN}} = 8.16$ TeV is consistent with R_{pPb} at 5.02 TeV and R_{dAu} at 200 GeV.
 - No suppression of e^{HF} yield observed.
 - p_T -differential cross section at $\sqrt{s_{NN}} = 8.16$ TeV is compared with 5.02 TeV.
 - Indication of no significant energy dependence of CNM effects on heavy-flavour production.
- Outlook: extend p_T range (lower p_T and higher p_T), study multiplicity dependence (Q_{pPb})

References

- [1] ALICE Collaboration, Physics Letters B 771 (2017) 467-481
- [2] ALICE Collaboration, Physics Letters B 754 (2016) 81-93
- [3] ALICE Collaboration, Physical Review D 86, 112007 (2012)
- [4] ATLAS Collaboration, Physics Letters B 707 (2012) 437-458
- [5] M. Cacciari, M. Greco, P. Nason, JHEP, 9805 (1998) 007
- [6] PHENIX Collaboration, Physical Review Letters 109, 242301 (2012)

