Production of electrons from beauty-hadron decays in pp collisions at $\sqrt{s}$ = 13 TeV with ALICE

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1 Introduction

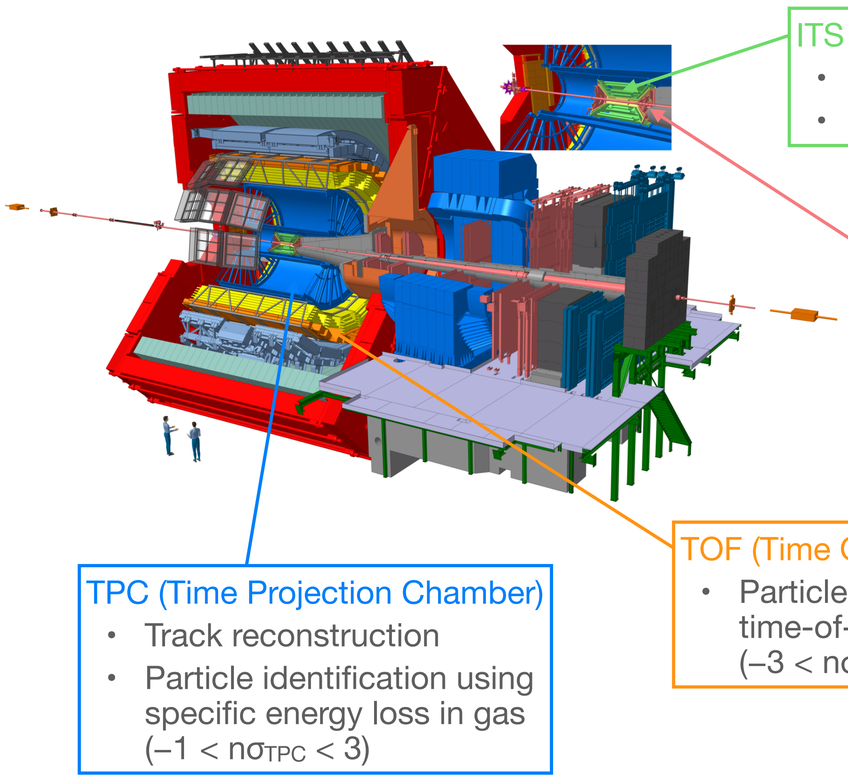
In proton-proton (pp) collisions, heavy quarks (beauty and charm) are produced in hard scattering processes, and therefore the production cross section of heavy quarks can be described by perturbative quantum chromodynamics (pQCD) calculations based on factorisation theorem.

$$\frac{\mathrm{d}\sigma_{\mathrm{AB}\to H_q}}{\mathrm{d}p_{\mathrm{T}}} = f_{i/\mathrm{A}}(\mathrm{x}_i, Q^2) \otimes f_{j/\mathrm{B}}(\mathrm{x}_j, Q^2) \otimes \frac{\mathrm{d}\sigma_{ij\to q\bar{q}}}{\mathrm{d}p_{\mathrm{T}}} \otimes \mathrm{D}_{q\to H_q}(\mathrm{z} = \frac{p_{H_q}}{p_q}, Q^2)$$

parton distribution functions (PDFs) | hard scattering cross section (pQCD) | fragmentation function (hadronisation)

In addition, measurements in pp collisions provide comparisons with those performed in p–Pb and Pb–Pb collisions.

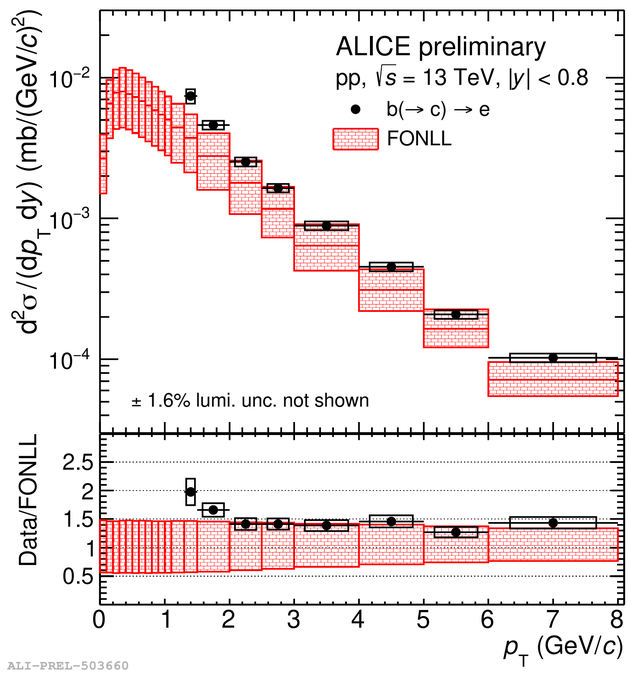
2 ALICE detector



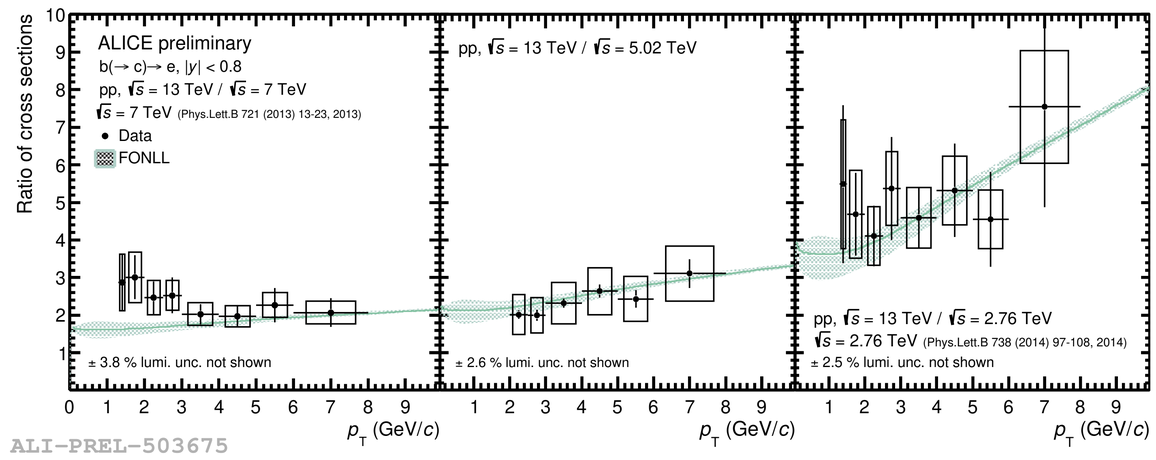
3 Methodology

- Substantial branching ratio of semi-leptonic decays of beauty hadrons (B → $e^+ + \nu_e + X$: ~10%).
- Relatively large decay length ($c\tau \approx 500$ μm) of beauty hadrons, leading to a broader track impact parameter (IP) distribution.
  - IP : distance of closest approach to the primary vertex in a plane perpendicular to the beam direction.
- Signal extraction done by a template fit method [1], taking into account the finite statistics of the templates.
- The templates are obtained from Monte Carlo simulations generated by PYHTIA 6 [2] and corrected to ensure realistic behaviour with respect to data and models.

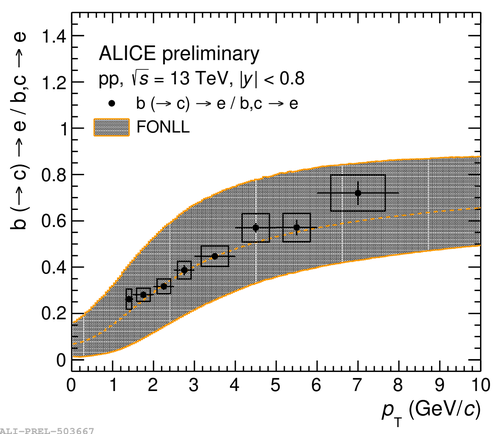
4 Results



- Production cross section of electrons from beauty-hadron decays as a function of p_{T}.
- Data are consistent with FONLL pQCD calculations [3–5] within uncertainty for $p_{\mathrm{T}} > 2$ GeV/c.
- Smaller uncertainties with respect to FONLL whose uncertainties are dominated by renormalisation and factorisation scales.



- Production yields of beauty-hadron decay electrons increase with $\sqrt{s}$.
- Agreement with FONLL calculations.
  - FONLL uncertainties are reduced considering correlations of parameters (quark mass, PDFs, renormalisations scale) in the pQCD calculations.
- More precise measurements at different energies will provide further constraints.



- Fraction of beauty-decay electrons with respect to inclusive heavy-flavour decay electrons [6].
- Beauty contribution becomes dominant at higher p_{T}.
- Good agreements with FONLL pQCD calculations.

5 Conclusion

- Electrons from beauty-hadron decays in pp collisions at $\sqrt{s}$ = 13 TeV, collected during LHC Run 2, show consistency with pQCD calculations.
- The measurements show relatively smaller uncertainties compared to FONLL predictions.
- Full B-hadron reconstruction in Run 3 will enable more detailed studies.

References

[1] R. Barlow *et al*, CPC 77, 219 (1993)
[2] T. Sjöstrand *et al*, JHEP 05 (2006) 026
[3] M. Cacciari *et al*, JHEP 05 (1998) 007
[4] M. Cacciari *et al*, JHEP 03 (2001) 006
[5] M. Cacciari et al, JHEP 10 (2012) 137
[6] ALICE Collaboration, JHEP 08 (2023) 006

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