Heavy flavour decay electron yield in pp collisions at $\sqrt{s}$=13 TeV with ALICE at the LHC

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Introduction

Heavy quarks (charm and beauty), produced in proton-proton (pp) collisions at the LHC energies dominantly via gluon-gluon scatterings, provide an essential testing ground for perturbative QCD calculations [1]-[2]. In addition they serve as unique tools to understand the role of multiple particle interactions in heavy-flavour production in pp collisions, as well as in heavy-ion collisions. Furthermore, in heavy-ion collisions, heavy quarks are produced in a shorter timescale than the Quark Gluon Plasma (QGP) [3] experiencing the full collision history and, therefore, carrying information on the medium properties. On this regard, heavy-flavour measurements in pp collisions serve as a baseline for the heavy-ion measurements.
In ALICE (A Large Ion Collider Experiment) [4] at the LHC (Large Hadron Collider) at CERN, heavy flavour production is investigated with two complementary approaches, via fully reconstructed hadronic decays, as in the case of $D^0 \to K^-\pi^+$, or via the measurement of leptons from semileptonic heavy-flavour hadron decays (i.e $D, B \to e + \nu_e + X$). In this article we present the heavy-flavour hadron decay electron yield in pp collisions in $0.5 < p_T < 4$ GeV/c at $\sqrt{s} = 13$ TeV, the highest energy so far available at colliders.

Methodology

The electron identification in low and intermediate p_T ($0.5 < p_T < 4$ GeV/c), is ensured by the Time Projection Chamber (TPC) and Time of Flight (TOF) detectors. The Inner Tracking System (ITS) is used for vertex determination and, together with the TPC, for tracking in $|\eta| < 0.8$. The charged particle identification (PID) in the TPC is based on the specific energy loss measurement, dE/dx, of a particle in the gas detector while the TOF detector uses the time of flight of the charged particle. From the TPC dE/dx measurement,

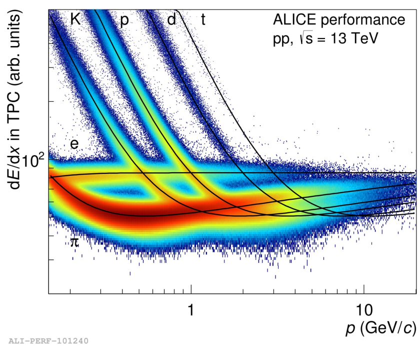

FIG. 1: TPC dE/dx (in arbitrary units) vs. momentum.

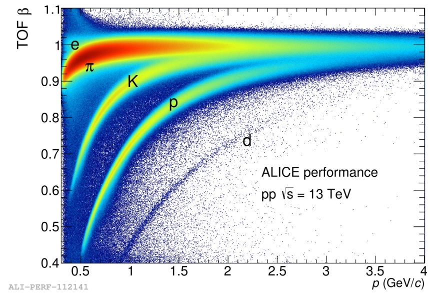

FIG. 2: TOF β vs. momentum.

shown in fig. 1, a clear separation of the electron band from the kaon, proton and π band is seen for $p < 1$ GeV/c. The PID information from the TOF detector, shown in fig. 2, in combination with TPC provides high electron purity in a large momentum range. The electron sample is selected within the optimized TOF PID cut $|n\sigma^{TOF}| < 3$ where $n\sigma$ is the

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difference of the measured signal in the detector from the expected value for electrons. To remove the hadron contamination from the sample, the TPC nσ (dE/dx - <dE/dx>) is evaluated in several momentum slices and the resulting plots are fitted with Gaussian functions for electrons and protons, kaons and a convolution of Landau and exponential function for pions as shown in fig. 3. The electron sample is selected within the TPC PID cut -1< $n\sigma^{TPC}$ < 3. The hadron contamination

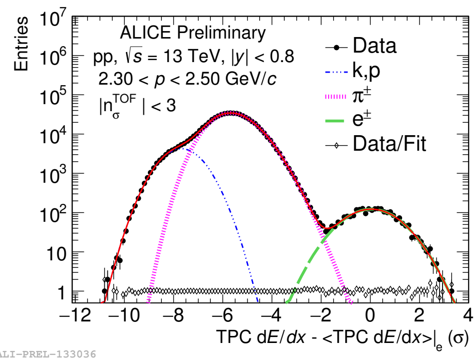

FIG. 3: The fit of the projection of TPC nσ plot in 2.30< $p_{\rm T}$ <2.50 GeV/c.

in the electron sample has been found to be negligible for $p_{\rm T} < 3$ GeV/c and smaller than 2% for $3 < p_{\rm T} < 4$ GeV/c.

To obtain the $p_{\rm T}$-differential invariant yield of electrons from heavy-flavour decays, the non-heavy flavour background sources are subtracted from the inclusive electron spectra. The photonic background electrons mainly come from the Dalitz decay of light neutral mesons (π^0 and η) and γ conversions in the detector material. To identify electrons from photonic sources, opposite signed partners (e^-e^+) are paired in an invariant mass spectrum. While the unlike sign (ULS) pairs give both the correlated signals from actual decay (π^0 and η), γ conversions and uncorrelated combinatorial background, the like sign (LS) pairs are used to estimate and subtract the random combinatorial background. An invariant mass cut of 0.1 GeV/c^2 is used to select the photonic electrons. The number of photonic electrons is given by :

$$N_{\rm non-HFe} = \frac{\rm ULS - LS}{\epsilon}$$

where ϵ is the tagging efficiency obtained from MC simulations, needed to correct for the loss of photonic pairs where the respective partner is outside detector acceptance or did not pass necessary thresholds.

Results

Figure 4 shows the production cross section of electrons from heavy-flavour hadron decays. The measurement is compared to FONLL calculation [5]. The data are compatible with the theoretical calculations within uncertainties, and lie on the upper edge of the model prediction.

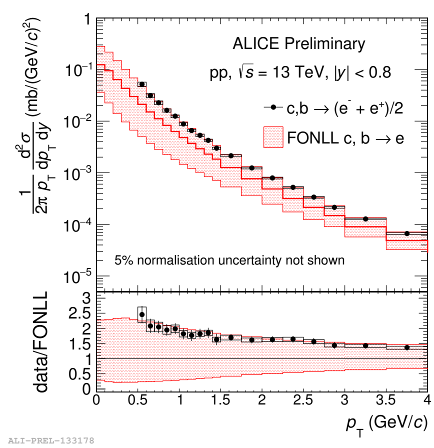

FIG. 4: The $p_{\rm T}$-differential cross section for heavy-flavour decay electrons for pp collisions at $\sqrt{s}$ = 13 TeV, compared to the FONLL theoretical prediction.

References

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