Electrons from heavy flavour decays with the ALICE experiment at the LHC

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In nucleus-nucleus collisions, the formation time of heavy quarks (charm and beauty) is approximately 1/M_Q (0,1 fm/c for c and 0,02 fm/c for b), much smaller than the expected lifetime of the QGP at LHC (about 10 fm/c). Therefore heavy quarks are uniquely suited to probe the QGP over its whole lifetime. The $c\bar{c}$ and $b\bar{b}$ production in pp collisions serves as an important baseline for the nucleus-nucleus studies and allows to test pQCD calculations. The cross-sections can be measured indirectly with semi-electronic decays of heavy flavor hadrons. Compared to the direct measurements of heavy flavor hadrons via their hadronic decay channels the large branching ratios are an advantage. We present first results on electron identification in pp collisions at 7 TeV with the central barrel of ALICE. Electrons are identified using the Time Projection Chamber, the Transition Radiation Detector and the Time Of Flight Detector. Each detector has to be first calibrated and understood.

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Charm ($c\bar{c}$) and bottom ($b\bar{b}$) quark-antiquark pair production in proton-proton (pp) collisions serves as an important baseline for nucleus-nucleus studies and allows to test pQCD calculations. From next-to-leading (NLO [1]) calculations, with an uncertainty factor around 2, 0.10 $c\bar{c}$ and 0.003 $b\bar{b}$ pairs are expected to be produced per minimum-bias pp collision at $\sqrt{s}$=7 TeV. The cross sections can be measured by identifying single leptons from heavy flavor hadron decays or by reconstructing their hadronic decays. Proton-proton collisions at $\sqrt{s}$=7 TeV have been recorded by ALICE [2] (A Large Ion Collider Experiment) at the Large Hadron Collider (LHC) at CERN. In the central barrel ($|\eta|<0.9$) charged particles are tracked using the Inner Tracking System (ITS), the Time Projection Chamber (TPC,) and the Transition Radiation Detector (TRD). The ALICE detector provides excellent particle identification capability based on the energy loss measurement in the ITS, TPC, and the electromagnetic calorimeter (EMCAL), transition radiation in the TRD, and time of flight measurement in the TOF detector. Moreover, the ITS allows to select electrons from heavy flavour decays via a displacement cut on the distance of closest approach to the interaction vertex or more sophisticated B tagging methods based on multi-track analysis ($(c\tau)_{D/B}\approx$200-400 μm). In this analysis the inclusive single electron spectrum is measured.

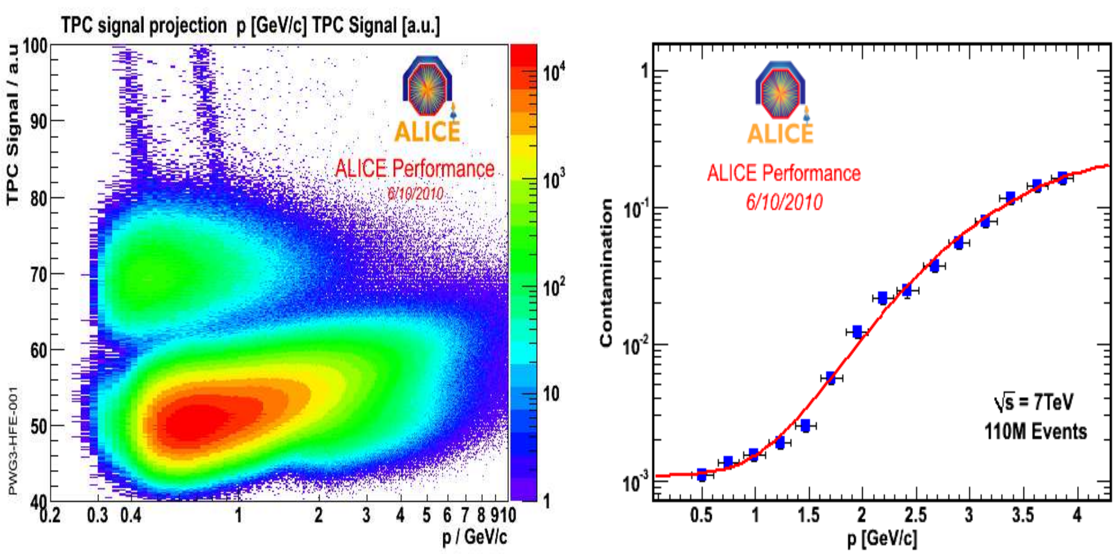

Figure 1: Left panel: The TPC dE/dx signal in 7 TeV pp collisions after TOF selection. Right panel: hadron contamination as function of momentum after TOF and TPC PID.

The data discussed were collected in March and April 2010. Approximately 1.1×10^{8} minimum-bias pp collision events at $\sqrt{s}$=7 TeV are used. The detector readout was triggered requiring the signals from two beam pick-up counters, indicating the presence of passing bunches and a hit in one of the VZERO scintillator hodoscopes or in one of the two pixel layers. Further background rejection was applied offline to reject beam-gas and beam-halo events. One primary vertex was required to be reconstructed within $\pm$10 cm in the beam direction. The tracks used in this analysis were reconstructed within $|\eta|<0.8$ in the TPC and the ITS. To reduce the contribution of electrons from photon conversion a hit in the innermost pixel layer (r=3.9 cm) was required. Electrons are identified up to momenta of about 4 GeV/c with TPC and TOF. Tracks which fall within three sigma of the electron line in the TOF are selected, rejecting most of the protons and kaons. Further selection is obtained by cutting on the number of sigmas from the electron line in the TPC (see Fig.1). The remaining hadron contamination is determined from Gaussian fits of the TPC signal. The right panel of Fig.1 shows the fraction of misidentified hadrons in the raw electron spectrum as function of momentum. After tracking and electron PID the raw single electron spectrum is corrected for hadron contamination and detector efficiencies. Efficiency maps are built with Pythia and Phojet minimum-bias simulations propagated via Geant3 through the ALICE detector. The tracking and PID efficiency was found to be of the order of 30 % at 2 GeV/c including acceptance in $|\eta|<0.8$. In Fig.2 the corrected spectrum is shown normalized to the number of events after online and offline trigger selection. The final spectrum contains background electrons from light hadron decays (mainly π^0 Dalitz decays), photon conversions in the material of the beam pipe and of the inner pixel layer, direct radiation, electrons that comes from no decay photon and J/ψ decays, and signal electrons from charm and beauty hadron decays. The background sources can be subtracted via a cocktail analysis which is currently in progress.

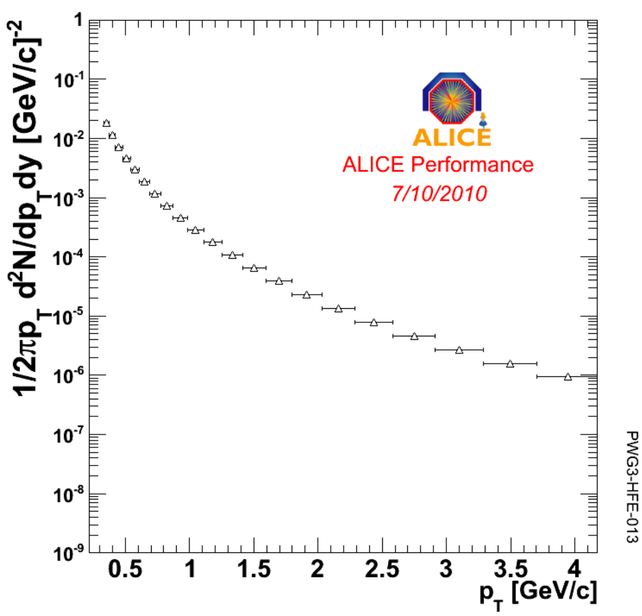

Figure 2: Corrected single electron inclusive spectrum

Better PID up to a momenta of about 15 GeV/c will be achieved with the TRD. The EMCAL will also play an important role in this range of momenta and higher. In addition the displaced vertex measurement with the ITS will help to separate electrons from charm and bottom.

References

[1] Mangano, Nason, Ridolfi, Nucl. Phys. B373 (1992) 295

[2] ALICE Collaboration, Journal of Instrumentation 3 S08002 (2008)