PROCEEDINGS OF SCIENCE

Measurements of the inclusive electron cross-section in proton-proton collisions at $\sqrt{s} = 7$ TeV with the ATLAS detector

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We present the measurement of the inclusive differential cross-section as a function of the transverse momentum p_T for electron production in proton-proton collisions at a center of mass energy of $\sqrt{s} = 7$ TeV. From a data sample corresponding to an integrated luminosity of 1.3 pb^{-1} collected by the ATLAS detector at the LHC, the electron cross-sections is measured in the range $7 < p_T < 26$ GeV and within $|\eta| < 2.0$ (excluding the $1.37 < |\eta| < 1.52$ region) where the electron spectrum is dominated by decays of charm and beauty hadrons.
After subtraction of the $W/Z/\gamma^*$ contribution, the differential cross-section is found to be in good agreement with theoretical predictions for heavy flavor production obtained from Fixed Order NLO calculations with NLL high-p_T resummation.

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1. Introduction

The understanding of electron production in proton-proton (pp) collisions is a prerequisite for measurements and searches including these leptons in the final state. At low transverse momentum (p_T) the inclusive electron spectrum is dominated by decays of charm and beauty hadrons. Indeed, the inclusive production of electrons can be used to constrain theoretical predictions for heavy flavour (HF) production, for which large uncertainties exist. The measurement [1] is performed using a data sample recorered by ATLAS corresponding to an integrated luminosity of 1.3 pb^{-1}.

2. The cross-section measurement

The differential cross-section measurement, as a function of the transverse momentum p_T, for charged leptons within a chosen kinematic acceptance, is defined by:

$$\frac{\Delta\sigma_i}{\Delta p_{T_i}} = \left(\frac{N_{\text{sig}_i}}{\varepsilon_{\text{trigger}_i} \cdot \int \mathscr{L} dt} - \sigma^{W/Z/\gamma^*}_{\text{accepted}_i} \right) \cdot \frac{C_{\text{migration}_i}}{\varepsilon_{(\text{reco+ID})_i} \cdot \Gamma_{\text{bin}_i}} \tag{2.1}$$

where N_{sig_i} is the number of signal electrons from HF hadrons decay having the reconstructed transverse momentum p_T in the bin i of width Γ_{bin_i}, $\varepsilon_{\text{trigger}_i}$ is the trigger efficiency, $\int \mathscr{L} dt$ is the integrated luminosity, $\sigma^{W/Z/\gamma^*}_{\text{accepted}_i}$ is the predicted cross-section for electrons from $W/Z/\gamma^*$ decays, $\varepsilon_{(\text{reco+ID})_i}$ is the combined reconstruction and identification efficiency and $C_{\text{migration}_i}$ is the bin migration correction factor taking into account the detector resolution effects.

3. The electron candidate selection and the signal extraction

Electron from HF quarks semi-leptonic decays are non-isolated and characterized by low p_T. The criteria applied to select the signal electron candidates are based on the performances of the Inner Detector (ID) and of the electromagnetic Calorimeter (EM-Cal) of the ATLAS detector [2], and are optimized to reject the main sources of background: mis-identified hadrons and electrons from photon conversions. To exploit the discriminating power against hadrons of the transition radiation tracker system of the ID, the analysis is restricted to its coverage region ($|\eta| < 2.0$). The applied criteria ensure the reconstruction quality of tracks, EM-clusters and their matching. The cluster energy spectrum for the selected electron candidates is shown in figure 1(a). The analysis is restricted to the 7-26 GeV region where the electron spectrum is dominated by decays of charm and beauty hadrons. In order to extract the heavy flavour plus Drell Yan signal electrons from the selected candidates, a binned maximum likelihood fit is used. The likelihoood is based on three discriminating variables chosen for their discriminating power against the background components.

4. The signal efficiency measurement

The signal efficiency term in Equation 2.1 has to take into account the trigger conditions ($\varepsilon_{\text{trigger}_i}$) and the selection applied to reconstruct and identify the electron candidates ($\varepsilon_{(\text{reco+ID})_i}$). The trigger efficiency is estimated from data considering electron candidates with respect to those passing a looser trigger requirement. The combined reconstruction and identification efficiency, and the bin migration correction factor, are estimated from simulated samples of HF electrons.

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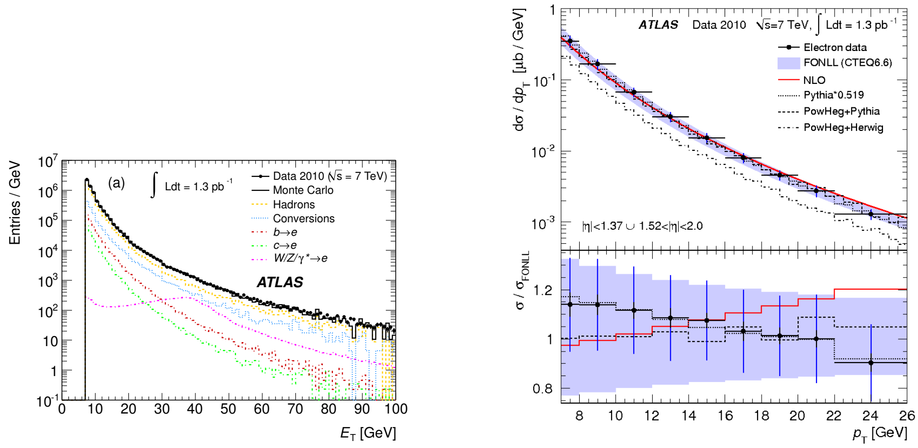

(a) (b)

Figure 1: *(Left) Distribution of the cluster transverse energy, E_T, for the electron candidates. (Right) Inclusive differential electron cross-section as a function of the charged lepton transverse momentum for* $|\eta| < 2.0$*, excluding the* $1.37 < |\eta| < 1.52$ [1].

5. The electron production cross-section

The differential cross-section for electrons from HF production is obtained using a bin-by-bin unfolding method. As shown by Equation 2.1 the predicted theoretical contribution of signal electrons from $W/Z/\gamma^*$ decays ($\sigma^{W/Z/\gamma^*}_{\text{accepted}}$) [3], within the considered acceptance, is subtracted.

The resulting electron cross-section measurement for electrons from HF hadrons decays, is shown in figure 1(b). The overall systematic uncertainty, dominant with respect to the statistical error, varies as a function of p_T and is estimated to be about 14-17%. The leading sources are related to the possible bias in the signal extraction procedure and in the mis-modelling of the discriminating variables on the Monte Carlo simulation. The measurement is compared to the theoretical prediction obtained by the FONLL (Fixed Order Next to Leading Log [4]) framework and a good agreement is observed. Additionally, theoretical predictions from different simulations (`PYTHIA`, `POWHEG+PYTHIA` and `POWHEG+HERWIG`) are also compared and found to yield to consistent results.

References

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