FORWARD–BACKWARD CHARGE ASYMMETRY IN Z PRODUCTION AT THE LHC*

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(Received November 29, 2007)

We present here a study on the determination of the effective weak mixing angle, $\sin^2\theta_{\rm eff}^{\rm lept}$ from the measurement of the forward–backward asymmetry with a high a statistical precision, 10^{-4}. To reach such a precision it is necessary to identify the electrons in the forward regions of the ATLAS detector. It is demonstrated that one can reach an electron-jet rejection of more than 100 with an efficiency on electron reconstruction better than 50%, by using a multivariate analysis.

PACS numbers: 14.70.Hp

1. Introduction

At the LHC, a Z production rate of $\sim 1.5\times10^8$ per year at high luminosity of which $\sim 5\times10^6$ decay to an electron-positron pair is expected. The determination of the weak mixing angle from the measurement of the forward–backward asymmetry in the $Z\to e^+e^-$ with a very small statistical error comparable to the LEP one is possible. The electron channel was chosen instead of the muon due to the limited coverage of the muons (up to $|\eta|=2.7$).

2. Analysis method

The aim of this analysis is the measurement of the forward–backward charge asymmetry in the $Z\to e^+e^-$ events and its precision. This measurement provides a determination of the weak mixing angle $\sin^2\theta_{\rm eff}^{\rm lept}$ by using the relation:

$$A_{\rm FB}=b\left(a-\sin^2\theta_{\rm eff}^{\rm lept}\right)\,. \tag{1}$$

* Presented at the Symposium "Physics in Collision", Annecy, France, June 26–29, 2007.

The selection cuts of our analysis in the electron channel requires an electron transverse momentum higher than 20 GeV ($p_{\rm T} > 20$ GeV) to simulate the energy threshold of the electron trigger, and a window of 12 GeV around the Z mass, 85.2 GeV $< M_{(e^+e^-)} <$ 97.2 GeV (Z pole). One requires that one of the two electrons lies in the central region ($|\eta| < 2.5$), while the other electron is either in the central region (case 1) or in the forward region (case 2) up to $|\eta| = 4.9$. In the region $2.5 < |\eta| < 3.2$ the calorimeters used are the EMEC and the HEC and for $|\eta| > 3.2$ the forward calorimeter (FCal) is used. Note that we can not reconstruct the electron track in the forward region ($2.5 < |\eta| < 4.9$) as the tracking system of ATLAS is limited to the region $|\eta| < 2.5$. In addition, the forward calorimeters have a coarser granularity than in the central one and we expect the electron identification in this region to be less performant than in the central one.

3. Results

Fig. 1(left) shows the variation of asymmetry versus the rapidity of the two electrons. It is observed that the asymmetry increases by a factor 2 when allowing the second electron to be in $|\eta| < 4.9$. As shown in the right plot of Fig. 1, the accuracy on the forward backward asymmetry improves while the jet rejection increases in the forward regions and it is almost constant for rejection greater than 100. The statistical error reached here (for a forward rejection of 100 and forward electron efficiency of 50%) on the weak mixing angle is of $\sim 10^{-4}$.

The statistical error on $\sin^2\theta_{\rm eff}^{\rm lept}$ is deduced from the relation 2 where the parameters, a and b, are derived from theory including the radiative corrections.

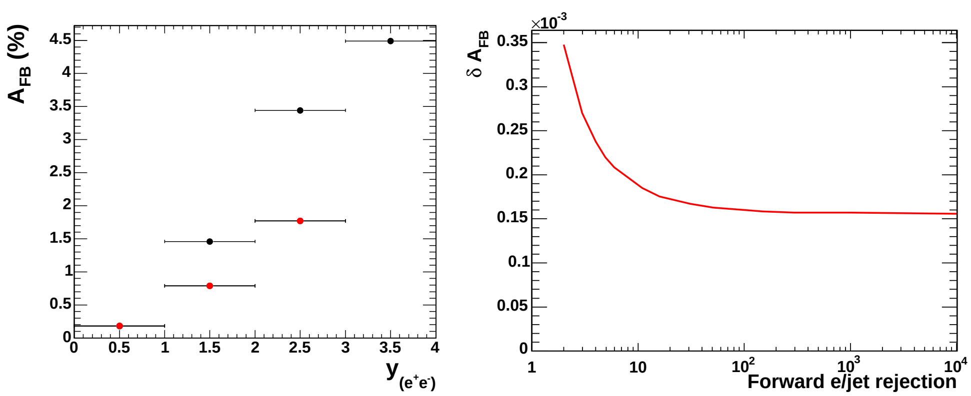

Fig. 1. Left: Forward-backward asymmetry versus dilepton rapidity in the case 1 (red points) and in the case 2 (black points). Right: Forward–backward asymmetry accuracy versus the forward electron/jet rejection in the events of the case 2.

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