IL NUOVO CIMENTO Vol. 33 C, N. 6 Novembre-Dicembre 2010
DOI 10.1393/ncc/i2011-10802-5

Colloquia: IFAE 2010

Inclusive W and Z production at LHC startup with the CMS experiment

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(ricevuto l' 8 Ottobre 2010; pubblicato online il 15 Febbraio 2011)

Summary. — W and Z candidates decaying into leptons can be observed in the very early phase of the LHC run. The results for the W/Z production presented are obtained for 10 TeV simulated data and are fully valid for 7 TeV center-of-mass energy (via a scale factor of the W and Z signals around 0.7).

PACS 13.38.Be – Decays of W bosons.
PACS 13.38.Dg – Decays of Z bosons.

1. – Introduction

W and Z bosons decay into isolated high transverse momentum leptons with a clean experimental signature. The W/Z cross section into muons and electron is given by

$$\sigma(W/Z) = \frac{N_{\rm sig} - N_{\rm bkgd}}{A_{W/Z} \times \epsilon_{W/Z} \times \int L{\rm d}t}\,, \tag{1}$$

where $N_{\rm sig,bkg}$ are the number of signal and background in each channel; $\epsilon_{W/Z}$ are the efficiency to detect and trigger the leptons and the neutrino; $A_{W/Z}$ is the geometric acceptance of the signal from Monte Carlo.

2. – W and Z

High momentum electrons in CMS are reconstructed by matching a cluster in the electromagnetic calorimiter (ECAL) and track in the silicon Tracker. The selection of the W $\to e\nu$ [1] decay starts from a cluster with high transverse energy. The neutrino instead results in events with unbalanced energy in the transverse plane ($E_T^{\rm miss}$). To identify the $Z \to e^+e^-$ [1] decay one looks for two isolated and opposite sign clusters with high E_T and very high Electron ID footprint.

High-p_T muons are reconstructed in CMS matching a track in the muon chambers outside the magnet plus a track in the tracker. The $W \to \mu\nu$ [2] selection starts requiring

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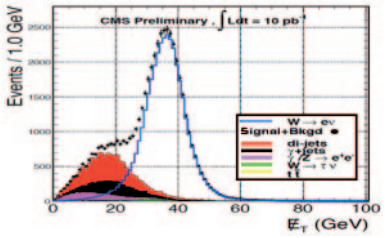

Fig. 1. – E_T^{miss} distribution for $W \to e\nu$ and background after selection.

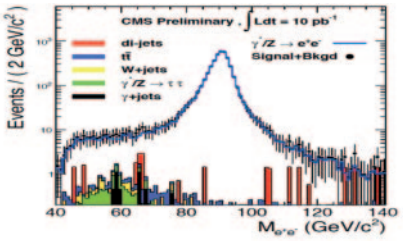

Fig. 2. – M_{ee} distribution for $Z \to e^+e^-$ and background.

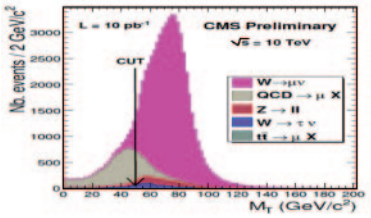

Fig. 3. – M_T^{miss} distribution for $W \to \mu\nu$ and background after selection.

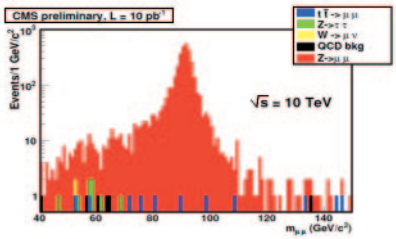

Fig. 4. – $M_{\mu\mu}$ distribution for $Z \to \mu^+\mu^-$ and background.

a global track with high transverse momentum p_T. The transverse mass of the W, M_T, is computed by combining the measured muon and the missing transverse energy in the event. The $Z \to \mu^+\mu^-$ [2] selection requires two opposite signs tracks with high p_T.

Estimation of the background from W signal using data is done with the "template method": the signal missing energy shape is built from the observed missing energy in

Z events, while the QCD shape is obtained applying the full set of selection cuts but reverting the isolation one. The Z signal is instead almost background free.

A common way to measure the efficiencies on data is to use the "Tag & Probe" method on Z events.

Figures 1-4 show the preliminary plots obtained by the CMS experiment using 10 TeV signal and background simulated data for events passing the W decaying into electron and neutrino, Z decaying into electrons, W into muon and neutrino and Z decaying into muons, respectively.

3. – Conclusion

LHC aims to deliver $100\,\mathrm{pb}^{-1}$ of integrated luminosity of pp collision data by the end of 2010. We expect to see about $3000\,\mathrm{W/pb}^{-1}$ in each leptonic channel for the LHC operation at 7 TeV and about $300\,Z/\mathrm{pb}^{-1}$ in each leptonic channel. The high-purity and well-known properties of the W/Z signals make them one of the most promising channels for the commissioning of CMS physics and lepton identification and selection.

REFERENCES

[1] The CMS Collaboration, CMS PAS-EWK-09/004.
[2] The CMS Collaboration, CMS PAS-EWK-09/001.