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W/Z boson production in muonic final states at the ATLAS experiment

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Summary. — *W* and *Z* boson production has been investigated by the ATLAS Collaboration in proton-proton collisions at $\sqrt{s} = 7$ TeV. New preliminary precision measurements of the inclusive Drell-Yan cross sections based on the complete data statistics collected in 2010, corresponding to a luminosity of about 35 pb^{-1} , are presented, with particular emphasis on the muon decay channels. The accurate control on experimental systematic uncertainties, at the percent level, shows advanced understanding of the muon trigger and reconstruction achieved after the first year of data taking at the LHC. The measured W^{\pm} and Z/γ^* cross sections, and their ratios, are in agreement with next-to-next-to-leading-order (NNLO) QCD calculations and start to be sensitive to the choice of the parton distribution functions.

PACS 14.70.Fm – *W* bosons.

PACS 14.70.Hp – *Z* bosons.

PACS 13.38.Be – Decays of *W* bosons.

PACS 13.38.Dg – Decays of *Z* bosons.

1. – Data samples and event selection

This analysis is based on 35 pb^{-1} of luminosity integrated in 2010 by the ATLAS experiment in *pp* collisions at 7 TeV. Events with at least one muon passing a trigger requirement with a nominal threshold of transverse momentum $p_T > 13$ GeV are selected.

Muons, reconstructed combining tracks from the inner detector and the muon spectrometer, are selected if $p_T > 20$ GeV, pseudo-rapidity $|\eta| < 2.4$ and if they pass a track-based isolation requirement [1] to reject QCD background.

W candidates are selected requiring missing transverse energy $E_T^{\text{miss}} > 25$ GeV and transverse mass $m_T > 40$ GeV. *Z* candidates are selected requiring the invariant mass of the $\mu^+\mu^-$ pair to be within 66 and 116 GeV

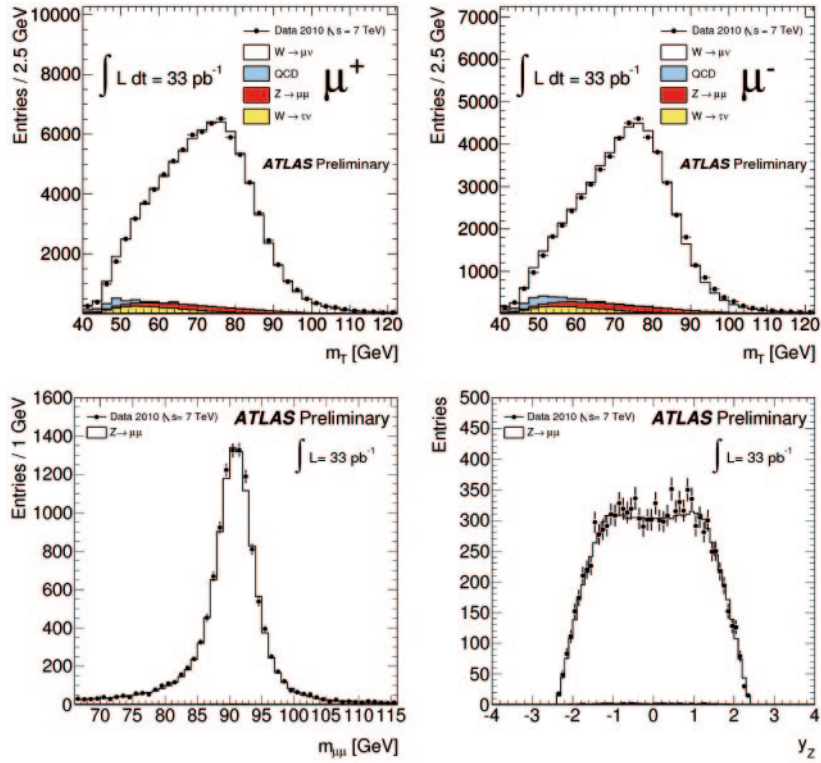


Fig. 1. – Kinematic distributions in the muon channels. Top: transverse mass of W^+ (left) and W^- (right) candidates. Bottom: invariant mass (left) and rapidity (right) of Z candidates.

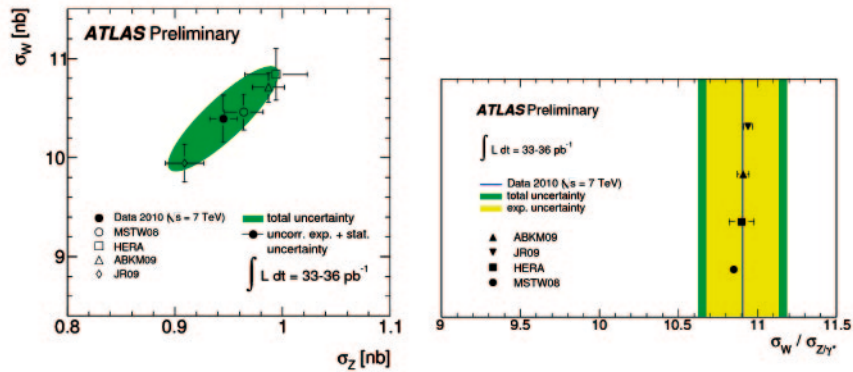


Fig. 2. – Left: measured and predicted W vs. Z cross sections times leptonic branching ratios; the systematic uncertainties on the luminosity and on the acceptance extrapolation are treated as fully correlated. Right: measured and predicted W/Z cross section ratio.

2. – Results in the muon channels

A total of 84103 W^+ , 55163 W^- and 11669 Z candidates are selected. The kinematic distributions in fig. 1 show good agreement with PYTHIA simulation.

Electroweak backgrounds are estimated from Monte Carlo simulation to be 6.9% and 0.38% of W and Z candidates; dominant contributions include $Z \rightarrow \mu\mu$ for W and diboson decays for Z . QCD backgrounds, due to heavy-quark decays, π/K decays and hadrons faking muons, are estimated from data, extrapolating from control regions in the isolation/ E_T^{miss} or isolation/ $m_{\mu\mu}$ variables, to be $(1.7 \pm 0.2 \pm 0.7)\%$ for W and $(0.22 \pm 0.16 \pm 0.09)\%$ for Z .

The measured cross sections, with their statistical, systematic, luminosity and acceptance extrapolation uncertainties are

$$\begin{aligned}\sigma_W^{\text{tot}} \cdot \text{BR}(W \rightarrow \mu\nu) &= (10.322 \pm 0.030(\text{sta}) \pm 0.249(\text{sys}) \\ &\quad \pm 0.377(\text{lum}) \pm 0.310(\text{acc})) \text{ nb}, \\ \sigma_{Z/\gamma^*}^{\text{tot}} \cdot \text{BR}(Z/\gamma^* \rightarrow \mu\mu) &= (0.941 \pm 0.008(\text{sta}) \pm 0.011(\text{sys}) \\ &\quad \pm 0.032(\text{lum}) \pm 0.037(\text{acc})) \text{ nb},\end{aligned}$$

with an experimental uncertainty of 2.4% for W and 1.1% for Z , dominated respectively by the uncertainties on E_T^{miss} scale and resolution and on the reconstruction efficiency.

3. – Combination and W/Z ratio measurement

The combination [1] with the measurement in the electron channel is shown in fig. 2. The measured leptonic cross sections and their ratio are

$$\begin{aligned}\sigma_W^{\text{tot}} \cdot \text{BR}(W \rightarrow \ell\nu) &= (10.391 \pm 0.022(\text{sta}) \pm 0.238(\text{sys}) \pm 0.353(\text{lum}) \pm 0.312(\text{acc})) \text{ nb}, \\ \sigma_{Z/\gamma^*}^{\text{tot}} \cdot \text{BR}(Z/\gamma^* \rightarrow \ell\ell) &= (0.945 \pm 0.006(\text{sta}) \pm 0.011(\text{sys}) \pm 0.032(\text{lum}) \pm 0.038(\text{acc})) \text{ nb}, \\ R_{W/Z} &= 10.906 \pm 0.079(\text{sta}) \pm 0.215(\text{sys}) \pm 0.164(\text{acc}),\end{aligned}$$

in good agreement with NNLO QCD computations using different proton PDF sets. The good agreement of $R_{W/Z}$ with the predictions supports the assumption of a flavour independent light quark sea at high scales and Bjorken x near to 0.01.

REFERENCES

- [1] ATLAS COLLABORATION, *A measurement of the total W^\pm and Z/γ^* cross sections in the e and μ decay channels and of their ratios in pp collisions at $\sqrt{s} = 7$ TeV with the ATLAS detector*, ATLAS-CONF-2011-041.