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Measurement of ZZ production cross section and limits on anomalous triple gauge couplings with the ATLAS detector

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Summary. — The measurement of the ZZ production cross section performed by the ATLAS detector in LHC proton-proton collisions at $\sqrt{s} = 7\,\text{TeV}$ is discussed. The results are based on an integrated luminosity of $4.6\,\text{fb}^{-1}$ collected by ATLAS in 2011 with a fully operational detector and stable beam conditions. The normalized differential cross sections in bins of various kinematic variables together with limits on ZZZ and $ZZ\gamma$ anomalous triple gauge couplings derived using the transverse momentum of the leading Z boson are also presented.

PACS 13.38.Dg – Decays of Z bosons.

1. – Introduction

In several studies, processes involving the electroweak sector of the SM have received much attention as a strong test of the model by the fact that these interactions are intimately related to the gauge group of the model. Among them, Z-boson pair production cross section measurement has a particular importance since it plays a crucial role also in the Higgs boson study. In fact, ZZ dacaying in the four charged leptons channel ($ZZ \longrightarrow l^+l^-l^+l^-$) is an irriducible background that sorrounds the emergence of the Higgs boson events.

Another foundamental aspect carried by interactions involving pair of Z bosons, is the sensitivity to anoumalus triple gauge couplings (nTGC). In particular, since a direct coupling of three neutrally charged gouge bosons is forbidden in the SM, a deviation of sensitive parameters from the SM prediction would provide important information about new physics beyond it [1].

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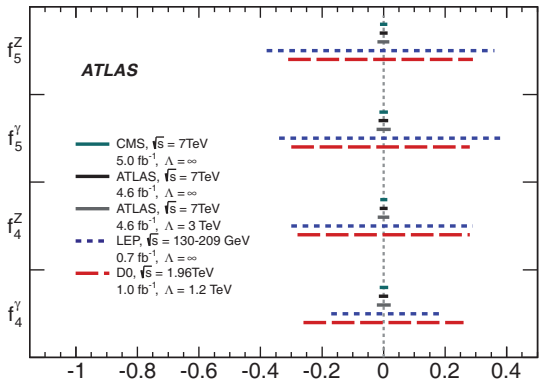

Fig. 1. – Anomalous nTGC 95% confidence intervals from LHC, LEP [1] and Tevatron [5] experiments. Integrated luminosities, centre-of-mass energy and cut-off Λ for each experiment are shown.

2. – Analysis description and results

Events are selected in two channels [2] $ZZ \longrightarrow l^+l^-l^+l^-$ and $ZZ \longrightarrow l^+l^-\nu\nu$. First, a fiducial cross section is measured to reduce systematic uncertainties then the total cross section is calculated using a fiducial acceptance for total phase space extrapolation. Correction factors and fiducial acceptances to measure fiducial and total cross sections are estimeted using NLO POWHEGBOX [3] genereтor and the $gg \longrightarrow ZZ$ contribution is modelled with GG2ZZ [4] generator.

The total ZZ production cross secttion combining the $ZZ \longrightarrow l^+l^-l^+l^-$ and $ZZ \longrightarrow l^+l^-\nu\nu$ channels is determined to be

$$\sigma_{ZZ}^{\text{tot}} = 6.7 \pm 0.7(\text{stat.})^{+0.4}_{-0.3}(\text{syst.}) \pm 0.3(\text{lumi.})\ (\text{pb}). \tag{1}$$

The result in eq. (1) is consistent with the NLO Standard Model prediction of $5.89^{+0.22}_{-0.18}$ pb, calculated with Z bosons with a mass between 66 and 116 GeV. Unfolded distributions of the fiducial cross sections are derived for the transverse momentum of the leading Z (p_T^Z), the angular difference between the two leptons forming the leading Z ($\Delta\phi(l,l)$), and the mass of the four leptons system (M_{4l}) are in agreement with SM predictions. The event yields as a function of the p_T^Z for the $ZZ \longrightarrow l^+l^-l^+l^-$ and $ZZ \longrightarrow l^+l^-\nu\nu$ selections are used to derive 95% confidence intervals for anomalous nTGC as shown in fig. 1.

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