ATLAS NOTE

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Sensivity to *WW* Scattering with Phase 2 Upgrade

The ATLAS collaboration

Table 1: Summary of expected upper limits for a_4 at the 95% confidence level using the $pp \to WW + 2j \to e\mu + 2j$ search at pp collision center-of-mass energy of 14 TeV.

model	300 fb^{-1}	1 ab^{-1}	3 ab^{-1}
a_4	0.066	0.025	0.016

1 Introduction

The Phase 2 upgrade of the ATLAS detector greatly increases the sensitivity to an extended electroweak symmetry-breaking sector beyond the Standard Model (SM) Higgs mechanism. A salient feature of such an extended sector is the enhancement of longitudinal vector boson scattering at high energy. In this section we discuss WW scattering using the generalized electroweak chiral langrangian [1] as a benchmark model of new physics. We present the expected gain in sensitivity if the ATLAS dataset were increased from 300 fb^{-1} to 1 ab^{-1} and 3 ab^{-1} at a center-of-mass energy of 14 TeV.

At next-to-leading order, the generalized electroweak chiral lagrangian contains eleven bosonic terms that are C- and CP-invariant. Of these, three terms induce oblique corrections to the gauge boson propagators, and another three terms contribute to anomalous trilinear gauge couplings. The remaining five operators induce anomalous quartic couplings only, of which two conserve weak isospin (i.e. maintain the custodial $SU(2)$ symmetry) to all orders as suggested by $\Delta\rho = (\rho - 1) \approx 0$, where $\rho = m_W^2/m_Z^2 \cos^2\theta_W$. These two operators are scaled by numerical coefficients a_4 and a_5. In the following, we have used WW scattering in the dilepton channel to study the sensitivity to the a_4 parameter while setting all other non-SM terms to zero.

2 WW scattering

The WW scattering cross section at high diboson mass is sensitive to a_4. The two leading jets are used to tag the diboson fusion process $pp \to WW + 2j \to e\nu\mu\nu + 2j$. The dilepton channel is relatively free of mis-identification backgrounds from W+jets and QCD multi-jet processes, and the $e\mu$ channel is also free from the Z+jets background. Some increase in sensitivity can be obtained by including the same-flavor dilepton channels. We further protect against jet mis-identification backgrounds by requiring the tagging jets to have $p_T > 50$ GeV. The dominant background is from $t\bar{t}$ production, followed by diboson production.

The statistical analysis is performed by constructing templates of the m_{lljj} distribution for backgrounds plus WW signal at different values of a_4. Here m_{lljj} is the 4-body invariant mass of the two leading leptons and the two leading jets in the event, which we found to be a robust and sensitive variable. At each value of a_4, the likelihood function of the floated signal cross section is defined as the Poisson probability product over all m_{lljj} bins for the pseudo-data given the expectation in each bin. The diboson background normalization is given by the theory cross section, while the $t\bar{t}$ background is floated and is effectively constrained by the low-m_{lljj} region. The SM WW scattering is included in the analysis by setting $a_4 = 0$. The expected upper limits on a_4, which we quote as a measure of sensitivity, are shown in Table 1. The distributions of various kinematic quantities and a representative limit curve as a function of a_4 are shown in Fig. 1.

3 Conclusions

We have shown results of sensitivity studies for high-mass WW scattering in an extended Higgs sector, comparing ATLAS datasets of 300 fb^{-1}, 1 ab^{-1} and 3 ab^{-1} of integrated luminosity at a pp collision

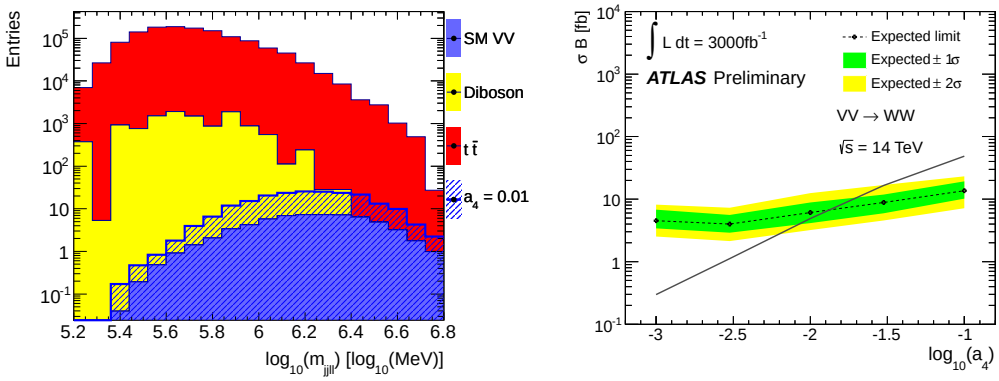

Figure 1: The reconstructed 4-body mass spectrum using the two leading leptons and jets (left) and limits as a function of a_4 using the $e\mu$ channel with 3 ab^{-1} at pp center-of-mass collision energy of 14 TeV.

center-of-mass energy of 14 TeV. We have used the a_4 parameter in the generalized electroweak chiral lagrangian as a benchmark parameter. The increase of a factor of ten in integrated luminosity makes ATLAS sensitive to a_4 values smaller by a factor of four.

References

[1] Dobado, A. and Herrero, M.J. and Pelaez, J.R. and Ruiz Morales, E., Phys. Rev. **D62** (2000) 055011, and references therein.