T 56: Electroweak Physics II (Multi-boson Processes)

Time: Wednesday 16:15–18:00 Location: VG 2.103

T 56.1 Wed 16:15 VG 2.103

Sensitivity study of VBS WZjj semi-leptonic final states to vector boson polarisation observables — •Aryan Borkar, Thomas Trefzger, Raimund Ströhmer, and Gia Khoriauli — Julius-Maximilians-Universität Würzburg

The electroweak symmetry breaking mechanism can be experimentally tested in the electroweak vector boson scattering (VBS) processes that occur in proton-proton collisions at the LHC. The unitarity of VBS cross sections of longitudinally polarised bosons $V_{1,L}V_{2,L} \to V_{3,L}V_{4,L}$, where $(V = W^{\pm}, Z)$, in the Standard Model are preserved by including the Feynman diagrams with the Higgs boson propagator in calculations. Thus, precise measurements of VBS processes of longitudinally polarised vector bosons are important experimental tests of the validity of the Brout-Englert-Higgs mechanism. We present the preliminary study of the potential of measurements of WZ VBS polarisation observables in the Run-2 data sets collected by the ATLAS detector. VBS processes with semi-leptonic final states are considered in the study.

T 56.2 Wed 16:30 VG 2.103

Polarization Measurement in Same-Charged WW Scattering with the ATLAS Experiment — •Erik Bachmann, Frank Siegert, Max Stange, Tim Herrmann, and Mareen Hoppe — TU Dresden, Dresden, Germany

In 2023, the ATLAS experiment published the first differential cross-section measurement of same-charged W-boson scattering – an essential process for understanding electroweak symmetry breaking. Since W-bosons gain their mass and, consequently, their longitudinal polarization through the Higgs mechanism, studying the scattering of longitudinally polarized W-bosons offers a promising way to probe this mechanism and search for new physics beyond the Standard Model.

However, since W-bosons decay into a charged lepton and a neutrino, directly reconstructing their original polarization is not possible. To overcome this, the analysis presented in this talk employs neural networks to separate the longitudinal component of the same-charged W-boson scattering signal from other polarization states and background processes. This talk aims to give an overview of the analysis strategy and to discuss state of the art techniques used to include higher-order QCD and EW effects in the polarized signal prediction.

T 56.3 Wed 16:45 VG 2.103

Measurement of the differential di-boson cross-section in semileptonic final states at $\sqrt{s} = 13$ TeV in $140\,\mathrm{fb}^{-1}$ of pp collisions with the ATLAS detector — •Anubhav Gupta, Chris Malena Delitzsch, and Amartya Rej — Otto-Hahn-Str. 4A 44227 Dortmund

The measurement of electroweak vector boson pair (VV) production cross-sections is a critical test of the Standard Model (SM), probing electroweak boson self-interactions and the electroweak theory. While VV production has been well-studied in fully leptonic decay channels at $\sqrt{s} = 13\,\mathrm{TeV}$, semileptonic channels have only been measured at $\sqrt{s} = 8\,\mathrm{TeV}$.

This analysis presents the first measurement of di-boson production in the semileptonic channel (leptons and a large radius jet) at $\sqrt{s} = 13\,\mathrm{TeV}$, taking advantage of its higher branching fraction compared to fully leptonic decays and a cleaner signature than fully hadronic decays. The semileptonic channel is particularly sensitive at high energies, offering strong potential for detecting new physics beyond the SM in the tails of kinematic distributions.

The study includes particle-level inclusive and differential cross-section measurements, along with constraints on dimension-6 Effective Field Theory (EFT) operators in the Warsaw basis, affecting electroweak triple gauge couplings, at the folded level.

T 56.4 Wed 17:00 VG 2.103

Measurement of the electroweak production of a W boson accompanied by two jets at $\sqrt{s} = 13$ TeV with the ATLAS experiment — •Lisa Marie Baltes — Kirchhoff-Institute for Physics, University Heidelberg, Germany

The observation and measurement of self-interactions of weak gauge bosons provide an indirect search for physics beyond the Standard Model. The electroweak production of a W boson in association with two jets includes the vector-boson-fusion (VBF) production of a W boson and is thus sensitive to the triple gauge boson vertices WWγ and WWZ. In proton-proton collisions, the characteristic signature of VBF includes two high-momentum jets at small angles with respect to the incoming beams and a centrally produced lepton-neutrino pair originating from the W boson decay. This unique signature provides kinematic discrimination from backgrounds such as strongly produced jets associated with a W boson, $t\bar{t}$ and dijet. In this talk, the current status of the electroweak Wjj analysis including event selection and background estimation is presented.

T 56.5 Wed 17:15 VG 2.103

Computation of the parity-odd part of the three-vector vertex function without DimReg — •Nils Kreher and Wolfgang Kilian — University of Siegen, Siegen, Germany

I present the computation of the parity-odd part of the three-vector vertex function with a closed fermion loop in a generic model. The vertex function is evaluated in analytic form in manifest four-dimensional Euclidean space, retaining full dependence on masses and external momenta without making use of dimensional regularization and hence avoiding ambiguities arising from γ_5. I demonstrate that this vertex function is unambiguously determined by the parameters of the model and its symmetry structure, provided it is understood as part of the universal effective action. If the model is interpreted as a gauge theory, the divergence of this vertex function in the asymptotic limit corresponds to the well-known gauge anomaly of the model. The implications for electroweak interactions and beyond are discussed.

T 56.6 Wed 17:30 VG 2.103

Constraining Triple Gauge Boson Couplings at Future Higgs Factories — •Leonhard Reichenbach[1,2], Andre Silva[3,4], André Sailer[1], Christian Grefe[2], Philip Bechtle[2], Jenny List[3], and Klaus Desch[2] — [1]CERN, Geneva, Switzerland — [2]Universität Bonn, Germany — [3]DESY, Hamburg, Germany — [4]Universidade de Coimbra, Portugal

We provide projections on the precision of (anomalous) $ZWW/\gamma WW$ triple gauge couplings (aTGC) using an optimal observable analysis of the process $e^+e^- \to \ell\nu q\bar{q}$ at center of mass energies of 240–250 GeV. The measurements of aTGC provide crucial input to global fits of Higgs couplings and SMEFT-based searches for new physics and offer a unique test of the gauge symmetry of the electroweak interaction. The current aTGC projections for future Higgs factories are either theory-only studies, neglecting experimental effects or extrapolations of older full-simulation studies for energies of 500–1000 GeV. We perform this analysis using the Key4hep framework, which enables us to perform the same analysis using several different detector models at different Higgs factories. This way, we will for the first time present consistently obtained results for the ILD detector for the International Linear Collider (ILC) and the CLD detector for the Future Circular Collider (FCC-ee).

T 56.7 Wed 17:45 VG 2.103

Measurement of $ZZ\gamma$ final states with the ATLAS detector at the LHC — •Anke Ackermann — Kirchhoff-Institute for Physics, Heidelberg University

The Standard Model of Particle Physics (SM) predicts the rare production of triboson final states. Although suffering from small cross sections and hence a limited amount of signal events, such triboson states can be studied with the vast amount of data collected by the ATLAS detector in Run 2. In addition to validating the predictions of the SM for rare processes, sensitivity to New Physics is given via anomalous quartic couplings of e.g. four neutral gauge bosons. This talk will focus on the analysis of the simultaneous production of $ZZ\gamma$. In order to determine the cross sections of this process, it is crucial to separate signal events from events arising through background processes mimicking the signal topology. The most dominant background process contains fake photons, which are non-prompt photons within jets. Due to the limited statistics a new approach with jet ratios is applied to estimate the amount of fake photons in the signal region. Additionally, processes with misidentified leptons contribute to the background. Their contribution is estimated with the matrix method. After giving a general introduction about the triboson production of the $ZZ\gamma$ process, a summary of the analysis, including the event selection and the background estimation, is presented.