T 53: Electroweak Interactions I

Time: Wednesday 16:00–18:30 Location: Tc

T 53.1 Wed 16:00 Tc

Measuring lepton universality, mass and width of the W-boson with the ATLAS detector — Lennart Adam[2], Nassim Ainouz[1], Philip Bechtle[1], Klaus Desch[1], Oleh Kivernyk[1], Jakub Kremer[2], •Philipp König[1], and Matthias Schott[2] — [1]Rheinische-Friedrich-Wilhelms-Universität Bonn — [2]Johannes Gutenberg-Universität Mainz

In 2017, the ATLAS collaboration measured the W-boson mass using *pp*-collision data taken at $\sqrt{s} = 7$ TeV in 2010, resulting in the most precise single measurement with a precision of 19 MeV. We present a revised analysis of the same dataset, improving the fit methods and including a measurement of the width of the W-boson. A precise measurement of these quantities and a test of lepton universality in the decay of the W-boson represent an excellent precision test of the Standard Model (SM).

A deviation of the branching fraction $BR(W \to \tau\nu)$ from the SM prediction would be an indicator for new physics coupling predominantly to heavier particles. Experimentally, it is preferable to measure the ratio of the branching ratios of the tau lepton decay into light leptons compared to the direct W decay into light leptons. However, it implies that numerator and denominator only differ in kinematic distributions from which the result is extracted in a fit. The most important observables for the fitting procedure will be discussed as well as possibilities increasing the sensitivity of the measurement. Finally, the expected sensitivity will be compared to previous measurements by other experiments.

T 53.2 Wed 16:15 Tc

Polarized same-sign W boson scattering at the CMS experiment — Thorsten Chwalek[1], Nils Faltermann[1], Abideh Jafari[2], Thomas Müller[1], and •Komal Tauqeer[1] — [1]Institut für Experimentelle Teilchenphysik (ETP), Karlsruher Institut für Technologie (KIT) — [2]Deutsches Elektronen-Synchrotron (DESY), Hamburg

Polarized vector boson scattering (VBS) provides an opportunity for testing the Higgs mechanism in the electroweak sector of the standard model. At the LHC, the scattering of the weak gauge bosons can reveal the actual process by which they get their masses. In particular, the longitudinal polarized state of these bosons can reveal new information about the Goldstone bosons of the electroweak symmetry breaking sector.

The most promising VBS channel for this type of study is same-sign WW scattering, which has a good balance between signal and backgrounds. In particular, the dileptonic decay channel provides a larger cross section than the fully leptonic decay channel; however, this channel faces large background contributions from V + jets process.

To increase the signal sensitivity and to identify the W boson decaying into hadrons along with its charge and polarization, our study aims for advancements in the boosted W-jet tagging techniques via jet substructure variables.

T 53.3 Wed 16:30 Tc

Estimation of non-prompt lepton background in same-sign WW production at 13 TeV with ATLAS detector — •Shalu Solomon — Albert-Ludwigs University of Freiburg, Freiburg, Germany

The production of same-sign W boson pair via vector boson scattering is one of the pivotal processes to experimentally probe the electroweak symmetry breaking mechanism. The analysis of 2015-2016 ATLAS data at $\sqrt{s} = 13$ TeV resulted in the observation of the process with the signal significance of 6.5 σ. With the entire Run 2 data set, corresponding to an integrated luminosity of 139 fb^{-1}, the signal event yield has increased approximately by a factor of 4, which gives the potential for the first differential cross-section measurement of this process. The final state consisting of two prompt leptons of the same electric charge, two neutrinos and two forward jets is considered. The second-largest background source, non-prompt lepton background, arises due to leptons from heavy-flavour hadron decays and jets misidentified as electrons, passing the lepton selection criteria. A data-driven technique, called fake factor method, is used to estimate this background. The fake factors are extracted from a jet-enriched sample kinematically close to the signal region. The performance of this background in various validation regions and the estimation in the signal region are presented.

T 53.4 Wed 16:45 Tc

ATLAS measurement of photon induced WW production in pp collisions — •Filip Nechansky — DESY, Zeuthen

The LHC is currently the largest hadron collider, where strong interaction between the colliding protons or ions results in a production of large number of energetic particles. Under special circumstances, however, there can be an interaction of the electromagnetic fields of the colliding particles, resulting in high energetic photon-photon interactions. These are characterized by a clean final state driven mainly by the electroweak force and provide an important probe of the electroweak sector.

This talk reports on the recent observation of the two photon interaction producing a WW final state measured by the ATLAS detector at the LHC. This process is identified by the presence of two leptons and no additional activity in the proximity of the interaction vertex. Beside the signal isolation, the estimation of the dominant backgrounds is discussed as well.

T 53.5 Wed 17:00 Tc

Data-driven estimation of the non-prompt background in same charged $W^{\pm}W^{\pm}$ boson scattering within the ATLAS experiment — •Max Stange, Michael Kobel, Joany Manjarres, and Carsten Bittrich — IKTP, TU Dresden, Germany

The scattering of electroweak vector bosons offers a unique opportunity to study the electroweak sector of the Standard Model of particle physics, the Higgs mechanism, and furthermore physics beyond the Standard Model. One of the cleanest channel to investigate vector boson scattering at the LHC is the scattering of same charged $W^{\pm}$ bosons. In the previous publications largest experimental uncertainty of the measurement, was coming from the data-driven estimation of misidentified leptons (non-prompt leptons).

This study aims to improve the data-driven method used so far to estimate this non-prompt background. The method is adapted to use a new dilepton control region and thoroughly tested with Monte Carlo simulated events. This dilepton control region is kinematically closer to the signal region than the dijet control region used in the previous publications. The data studied in this thesis were measured with the ATLAS experiment at a collision energy of 13 TeV with an integrated luminosity of 138.7 fb^{-1}.

To validate the data-driven method using data the low dijet invariant mass validation region is used, which is kinematically very close to the signal region. The data in this validation region is sufficiently well modeled by the data-driven method, making this method a valuable alternative to the one currently in use by the $W^{\pm}W^{\pm}jj$-EW analysis.

T 53.6 Wed 17:15 Tc

Data-driven methods for the estimation of the non-prompt lepton background for the W^+W^- measurement with the ATLAS detector — •José Antonio Fernández Pretel — Albert-Ludwigs Universität Freiburg, Freiburg im Breisgau, Deutschland

Fiducial and differential cross sections of W^+W^- pair production are key measurements to test self-couplings predicted by the electroweak sector of the Standard Model, but also to validate QCD corrections and to accurately estimate important background contributions to other measurements such as Higgs boson decays into W boson pairs. Single W boson production in association with jets can contribute to the selected W^+W^- candidate events when an associated jet is misreconstructed as a lepton. These are referred to as "non-prompt" or "fake" leptons. Due to the production cross section of W+jet, orders of magnitude larger than diboson W^+W^-, these contributions become an important background for this measurement, corresponding to about 10

T 53.7 Wed 17:30 Tc

Search for anomalous couplings in the hadronic decay channel of Vector Boson Scattering at the LHC — Steffen Albrecht[1], Thomas Müller[2], and •Max Neukum[2] — [1]Institut für Experimentalphysik, Universität Hamburg — [2]Institut für Experimentelle Teilchenphysik (ETP), Karlsruher Institut für Technologie (KIT)

Vector boson scattering (VBS) is at the LHC the dominating processes to investigate the quartic vertex of electroweak theory and the cross section is ultimately determined by the Higgs boson. New physics in the Higgs sector may thus alter the cross section noticeably even if it is currently out of reach of direct measurements.

Deviations of couplings at high energies are formulated in an effective field theory, a bottom-up approach, which parametrizes a multitude of explicit theories. Limits on introduced parameters allow to draw conclusions regarding the strength and energy scale of new physics.

This presentation describes the search for anomalous couplings in the hadronic decay channel of VBS at a center-of-mass energy of 13 TeV. Jet substructure techniques are used to distinguish between signal and background events and a three-dimensional fit supresses contributions from QCD events.

T 53.8 Wed 17:45 Tc

Measurement of the charged-current Drell-Yan differential cross-section at high transverse masses at $\sqrt{s} = 13\,\text{TeV}$ with the ATLAS detector — Frank Ellinghaus, •Frederic Schröder, and Christian Zeitnitz — Bergische Universität Wuppertal

The charged-current Drell-Yan (DY) cross-section is measured for the leptonic decay of the W boson $W \to l\nu$ with $l = e, \mu$. While the cross-section at the peak of the W boson mass is known very well, the measurement of the differential cross-section for transverse masses up to $\mathcal{O}(1\,\text{TeV})$ is measured for the first time. In addition, the double-differential cross-section will be measured as a function of the transverse mass of the W boson and the pseudorapidity of the lepton.
The charged-current DY can be used to constrain the density function that describes the partonic content of the proton and to measure fundamental parameters of the Standard Model. In particular, the high m_T^W region of the charged-current DY allows probing new physics by constraining effective field theory parameters, because these parameters are sensitive to small deviations in the cross-section with respect to the theory prediction.
An overview of the analysis including the fake lepton background estimation based on the matrix method as well as the unfolding procedure will be presented. The data has been taken at the ATLAS experiment based on pp-collisions at a center-of-mass energy of $\sqrt{s} = 13\,\text{TeV}$ at the LHC.

T 53.9 Wed 18:00 Tc

Determination of angular coefficients of the Z boson production at ATLAS — •Julian Fischer and Stefan Tapprogge — Institut für Physik, Johannes Gutenberg-Universität, Mainz

A better understanding of QCD production processes at hadron colliders is a key aspect for theoretical predictions of perturbative QCD at higher accuracy and thus allows for more precise measurements of Standard Model parameters and background estimations for searches. This contribution focusses on the measurement of angular coefficients that are used to describe the differential cross section of the Z boson production and subsequent decay into leptons in the 'Collins-Soper-frame'. These angular coefficients allow to probe in detail QCD contributions in Z production processes. Two of the coefficients can also be used to make inferences about the weak mixing angle. For the measurement the full Run 2 ATLAS dataset with an integrated luminosity of $L \approx 139\,\text{fb}^{-1}$ at $\sqrt{s} = 13\,\text{TeV}$ is used, which increases the statistical accuracy significantly at a higher centre-of-mass energy than previous analyses. Major challenges of the measurement and uncertainties are discussed and insights into the expected precision of the measurement will be shown.

T 53.10 Wed 18:15 Tc

Measurement of $Z\gamma\gamma$ production in pp collisions at $\sqrt{s} = 13\,\text{TeV}$ with the ATLAS detector — •Philipp Ott — Kirchhoff-Institute for Physics, Heidelberg University

The simultaneous production of three electroweak gauge bosons is a rare process predicted by the Standard Model of Particle Physics (SM). The theory predictions of the electroweak sector of the SM can be validated by measuring the cross section of the aforementioned process. The analysis presented in this talk aims to measure the simultaneous production of a Z boson and two photons ($Z\gamma\gamma$). In order to determine the cross section of this process, it is crucial to separate signal events from events arising through background processes mimicking the signal topology. The most dominant background is the production of non-prompt photons within jets. Due to the abundance of hadronic activity in the ATLAS detector, such processes have a non-negligible contribution to the total number of events selected in the signal region. A data-driven method is used to determine the non-prompt photon production by exploiting variations in the shape of the energy deposited in the proximity of photons. Templates describing the different energy behavior are used in a maximum likelihood estimation to measure the amount of prompt and non-prompt photon events in the signal region.

After giving a general introduction about the $Z\gamma\gamma$ analysis, highlighting the motivation and challenges of the measurement, an overview of the data-driven method used to determine the dominant background process is presented.