T 8: Top Physics I (tt+X)

Time: Monday 16:45–18:15 Location: VG 1.103

T 8.1 Mon 16:45 VG 1.103

Measurement of the associated production of top quark pairs with a photon at $\sqrt{s}$ = 13.6 TeV with the ATLAS detector — Diptaparna Biswas[1], Beatrice Cervato[1], Markus Cristinziani[1], Carmen Diez Pardos[1], Ivor Fleck[1], Arpan Ghosal[1], Gabriel Gomes[1], •Jan Joachim Hahn[1], Vadim Kostyukhin[1], Nils Krengel[1], Buddhadeb Mondal[1], Stefanie Müller[1], Sebastian Rentschler[1], Elisabeth Schopf[1], Katharina Voss[1], Wolfgang Walkowiak[1], Adam Warnerbring[1], and Tongbin Zhao[1,2] — [1]Experimentelle Teilchenphysik, Center for Particle Physics Siegen, Universität Siegen — [2]Shandong University, China

The production of top quark pairs in association with a photon ($t\bar{t}\gamma$) is an important process to investigate the coupling between the photon and the top quark. Precise measurements of this interaction allow testing the Standard Model (SM) and set limits on physics beyond the SM phenomena which affect the electroweak couplings of the top quark. The increased centre-of-mass energy of 13.6 TeV and luminosity of the ongoing LHC Run 3 allow for more precise measurement of this process, compared to the recent result for Run 2. In this talk, the ongoing measurement of the $t\bar{t}\gamma$ production using Run 3 data taken with the ATLAS experiment is presented, including first data-driven measurements of relevant background processes.

T 8.2 Mon 17:00 VG 1.103

Event classification for the measurement of differential cross-sections in single-top + photon events at the ATLAS experiment with $\sqrt{s}$ = 13 TeV — •Lucas Cremer[1], Nils Julius Abicht[1], Tomas Dado[2], and Andrea Helen Knue[1] — [1]TU Dortmund, Experimentelle Physik — [2]CERN

After the observation of single-top quark production in association with a photon at the ATLAS experiment, differential cross-sections of this process are measured. The resulting distributions will be unfolded and interpreted in terms of effective-field-theory operators.

An important step in the analysis is the classification of signal and background events. This classification will be used to define a signal region enriched with $tq\gamma$ events, allowing for a stable unfolding of observables sensitive to physics beyond the Standard Model. A deep feed-forward neural network is trained to classify the events based on the kinematic properties of the objects in the final state. Furthermore, the sensitivity of various high-level variables is studied to optimize the performance of the neural network. The training is applied to the complete ATLAS Run-2 dataset, corresponding to an integrated luminosity of 140 fb^{-1}.

T 8.3 Mon 17:15 VG 1.103

Search for $t\bar{t}\gamma\gamma$ production in lepton+jets channel in pp collisions at $\sqrt{s}$=13 TeV with the ATLAS detector — Diptaparna Biswas[1], Beatrice Cervato[1], Markus Cristinziani[1], Carmen Diez Pardos[1], Ivor Fleck[1], •Arpan Ghosal[1], Gabriel Gomes[1], Jan Joachim Hahn[1], Vadim Kostyukhin[1], Nils Krengel[1], Buddhadeb Mondal[1], Stefanie Müller[1], Sebastian Rentschler[1], Elisabeth Schopf[1], Katharina Voss[1], Wolfgang Walkowiak[1], Adam Warnerbring[1], and Tongbin Zhao[1,2] — [1]Experimentelle Teilchenphysik, Center for Particle Physics Siegen, Universität Siegen — [2]Shandong University, China

The top quark pair production ($t\bar{t}$) in association with one or more photons is a key Standard Model process for measuring the strength of the electroweak coupling of the top quark with the photon. While the production of $t\bar{t}$ with one photon is well-studied, the rarer $t\bar{t}$ production with two photons ($t\bar{t}\gamma\gamma$) still remains unobserved. The $t\bar{t}\gamma\gamma$ process is not only a good candidate for probing the electroweak coupling of the top quark, but it is also an irreducible background to the $t\bar{t}$ production in association with a Higgs boson decaying to two photons. Understanding the $t\bar{t}\gamma\gamma$ process can help tighten constraints on anomalous electric and magnetic dipole moments, through which new CP-violating sources can manifest. The talk will discuss the ongoing efforts in the search for the $t\bar{t}\gamma\gamma$ process in the single-lepton $t\bar{t}$ decay channel using the full Run 2 dataset collected by the ATLAS detector at $\sqrt{s}$ = 13 TeV.

T 8.4 Mon 17:30 VG 1.103

Measurement of tt+X (heavy flavour) processes at the CMS experiment — •Rufa Kunnilan Muhammed Rafeek, Ulrich Husemann, and Emanuel Pfeffer — Institute of Experimental Particle Physics (ETP), Karlsruhe Institute of Technology (KIT)

Top quark - antiquark pairs (tt) produced in association with other particles (X) where X can be the Higgs boson, Z/W boson or QCD-initiated heavy flavour jets (bb/cc), plays a significant role in experimental studies at the LHC. The analysis is challenging as these processes, particularly when the bosons decay into heavy flavour quarks, like for example, tt+H(bb) and tt+bb or tt+Z(bb), share the same signature and very similar kinematic features. These high jet multiplicity final states create ambiguities in the reconstruction and identification of these processes and thus, it is hard to differentiate them from each other. The complex task of simultaneously measuring these tt + X processes is addressed by exploring advanced ML techniques such as Graph Neural Networks. The primary objective is to distinguish the additional heavy flavour jets (not part of the tt-system). This differentiation is crucial for subsequent multi-class event classification, encompassing categories such as tt + bb, tt + (bb), tt + (bb) and tt + cc. Effectively, this involves two classification tasks: a binary classification to identify additional jets and a multi-class classification for event categorization, culminating in promising classification results for tt+X events. In this talk, an overview of the ongoing analysis, designed with the Run-2 data of the LHC using the tt single lepton channel, is given.

T 8.5 Mon 17:45 VG 1.103

Search for vector-like leptons and the $t\bar{t}$+heavy flavour jets modelling — •Mahsana Haleem — JMU-Würzburg, Würzburg, Germnay

Vector-like fermions are predicted by several phenomenological models that extend the Standard Model (SM) with renormalisable frameworks to address the hierarchy problem. Examples include the SU(4) × SU(3)' × SU(2)$_L$ × U(1)' theory, also known as the 4321 model, and composite Higgs models. At the LHC, vector-like leptons can be produced via electroweak interactions, leading to rich and intriguing signatures within the 4321 model framework. Through decay chains involving the vector leptoquark, these particles can produce diverse final states, including multiple top quarks, b-quarks, neutrinos, and charged leptons. The sensitivity of this search depends significantly on the precise modeling of the SM top-quark pair production in association with heavy-flavor jets. In this talk, I will present recent ATLAS measurements of $t\bar{t}$+b-jets, along with the results of the ATLAS search for vector-like leptons.

T 8.6 Mon 18:00 VG 1.103

Development of General Purpose $t\bar{t}+X$ and $t+X$ Classifiers with ATLAS — •Clinton Gonsalves, Steffen Korn, and Arnulf Quadt — I Physikalisches Institut, Georg-August-Universität Goettingen, Friedrich-Hund-Platz 1, 37077 Goettingen

The study of $t\bar{t}+X$ and $t+X$ processes is important for understanding the Standard Model (SM) and exploring potential new physics beyond it. These processes involve the production of a top quark pair ($t\bar{t}$) or a single top quark (t) in association with an additional boson, such as a W, Z, Higgs boson (H), or a photon (γ). Accurately identifying these events is crucial for measuring properties such as the top Yukawa coupling in $t\bar{t}+H$ production and for studying rare electroweak processes such as associated $t-Z$ production. However, the rarity of these events and their similarity to background processes, such as $t\bar{t}+$ jets, make their classification challenging.

This talk presents the development of a neural network-based classifier for $t\bar{t}+X$ and $t+X$ events. The classifier is trained on kinematic variables, event-level observables such as transverse momentum p_T^{Miss} and missing transverse energy E_T^{Miss}, and object counts, including jets, leptons, and b-tagged jets. The neural network architecture is optimised to effectively distinguish signal events from background events by learning correlations in the input features.