KSETA Annual Report 2017

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In April 2017, I started my PhD. at Institut für Experimentelle Teilchenphysik (ETP), Karlsruher Institut für Technologie (KIT). Since then, I have worked on several projects and tasks. My primary task is performing a physics analysis in the electroweak sector using the CMS experiment. I have also contributed to tracker alignment as part of my CERN service work. Both these contributions have been presented at various conferences and meetings. For KSETA I have worked as website administrator and handled transcripts and course evaluations for KSETA doctoral fellows. In addition, I've actively attended topical courses and seminars organized by KSETA.

Work in CMS Experiment

aTGC Analysis

One of the best ways to search for physics beyond the Standard Model (SM) is in the framework of the Effective Field Theory. The Large Hadron Collider (LHC) at CERN with 13 TeV center of mass energy in Run II has opened new doors for such novel searches. We work with the Compact Muon Solenoid (CMS) experiment of the LHC on an analysis which focuses on anomalous triple gauge couplings (aTGC) in the electroweak sector. The analysis deals with the WW/WZ final states in the semileptonic decay channel, where the hadronically decaying vector boson is reconstructed in the boosted regime.

The major backgrounds in our analysis are top quark pair production (ttbar), W+Jets, single top quark processes and the SM di-boson production. Out of these, the first two are dominant and we use control regions to extract their parameters in addition to Monte Carlo (MC) simulations, while the latter two are minor backgrounds and we extract their parameters entirely from MC. Figure 1 shows, as an example, the initial data to Monte Carlo comparison for one of the most important variables in our analysis, the soft-drop jet mass, for a selected control region (ttbar) and a channel (electron).

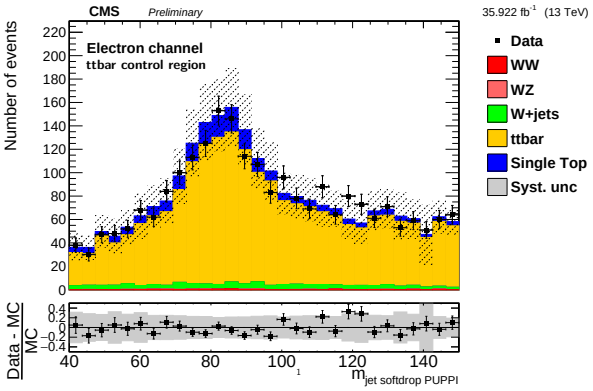

Figure 1: *Data-MC comparison for jet mass in the electron channel in ttbar control region*

We use parametric functions to fit Monte Carlo jet mass for the backgrounds. These functions are then fit to the observed data from the CMS to fix the normalization of ttbar and W+Jets backgrounds. Shown in Figure 2 is an example.

In order to correct the shape of the W+Jets background we use an unorthodox technique. We take the fit to the observed diboson mass in the sideband region and multiply it with a transfer function (which is ratio of Monte Carlo fits in the signal to the sideband region) to get the shape in the signal region. Shown in Figure 3 is one of the fits to the data in the sideband region.

We also use Monte Carlo simulations in order to know how our signal should look like. The MC generated data is modelled with a function having different terms that represent different parameters and their interference. One of the fits to the signal MC is given in Figure 4 as an example.

The systematic uncertainties we are considering in our analysis arise from sources such as PDF, scale, lu-

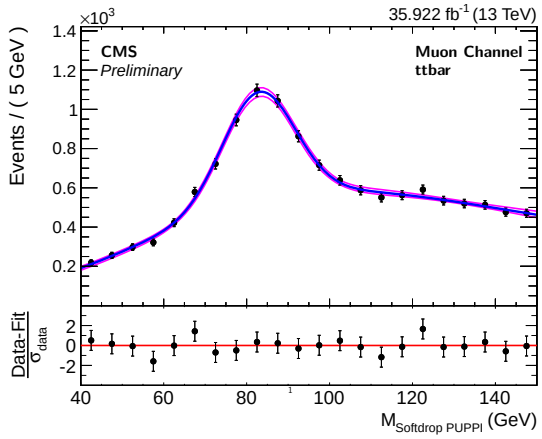

Figure 2: *Soft-drop jet mass fit*

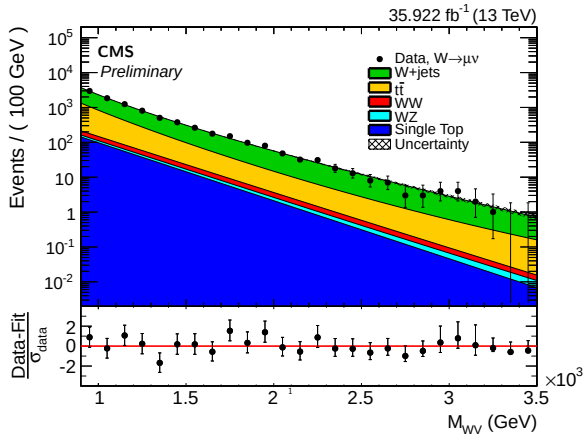

Figure 3: *Diboson mass fit*

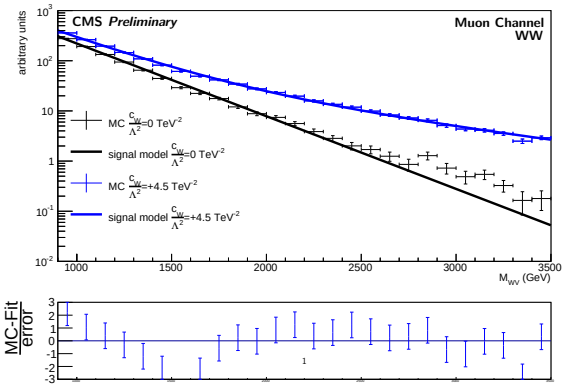

Figure 4: *Signal fit in the WW category for one of the aTGC parameters being non-zero*

minosity, jet energy corrections, lepton energy, tagging efficiencies etc. We are currently in the process of calculating limits on anomalous triple gauge couplings with all the above mentioned results using the full 36 fb^{-1} of 2016 data from the CMS.

Tracker Alignment

For CERN service work, I have been working with the CMS tracker alignment group at Campus North and contributing in two ways. One is the regular alignment jobs which have to be done regularly to keep the CMS tracker aligned. The other is contributing to "Lorentz Angle Correction" improvement to the millipede alignment framework.

KSETA Community Work

I have been working as KSETA website administrator and handling the course evaluation and transcript generation system for the KSETA doctoral fellows as well.

Conferences and Talks

1. "Search for Anomalous Triple Gauge Couplings in the Semileptonic WW and WZ Decays Using the CMS Experiment"
   FSP CMS Workshop, Aachen (Germany), October 4-6, 2017
2. "Search for Anomalous Triple Gauge Couplings in the Semileptonic Channels""
   SMP Multiboson Meeting, CERN, Geneva (Switzerland), November 28, 2017
3. *SMP Physics with Boosted Objects, CERN, Geneva (Switzerland), December 11, 2017*

KSETA Courses

1. Scientific Writing
2. Software Design for Scientists
3. Quantum Field Theory for Experimentalists
4. Introduction to Multivariate Classification: Traditional Techniques and Deep Learning
5. Neutrino Physics and Neutrino Oscillations
6. Self-assessment and Application
7. Memorizing, Reading and Working Strategies