Search for Heavy Gauge Bosons Decaying to Tau Leptons using Vector Boson Fusion Processes in Proton-proton Collisions at CMS

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One primary goal of particle physics is to explain the fundamental physics of the universe: that is, to analyze the nature of particles and the forces by which they interact. Previously, physicists have used a theoretical framework called the Standard Model (SM) to describe these particles and force interactions, and, although it has been extremely successful in some ways, the SM fails to explain several recently discovered phenomena. Examples of these shortcomings include the absence of a candidate for dark matter (DM), the failure to account for matter-antimatter asymmetry, and the lack of explanation for force hierarchy asymmetry. Therefore, theoretical extensions to the SM, called beyond standard model (BSM) frameworks, have been introduced to offer solutions to these problems. Although the motivations and implications of these models can vary significantly, a common characteristic is the manifestation of new particles with TeV-scale masses. These high-mass particles can be probed in proton-proton (pp) collisions at the Large Hadron Collider (LHC).

This presentation will describe my methodology for discovering a BSM TeV-scale particle called Z′ (Z-prime). I will first provide introductory information on this topic, including the background elementary particle physics information, a discussion of the physics of the LHC, and a description of previous research on Z′ searches. Then, I will discuss my own project: a search for Z' via vector boson fusion (VBF) with a hadronic ditau final state, using data collected from the Compact Muon Solenoid (CMS) experiment at the LHC. This search included signal optimization studies and background estimation studies. Finally, I will give a summary of the final predictions for a Z' signal.