Search for Weak Scale Supersymmetric Particles in Compressed Scenarios

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Submitted to the graduate degree program in Department of Physics and Astronomy and the Graduate Faculty of the University of Kansas in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

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Date defended: July 02, 2019

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Graham Wilson, Chairperson

Date approved: August 06, 2019

Abstract

This is the abstract

Acknowledgements

Thanks everybody

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1.1 Introduction

The Compact Muon Solenoid (CMS) experiment consists of a detector housed at the Large Hadron Collider (LHC). The detector encapsulates two synchronous bunches of high energy protons which counter rotate through the LHC accelerator ring. The protons collide at the center of the detector with a significantly large energy and the expectation that more massive and potentially new particles are produced. Each particle produced in the collision can either decay, interact, or escape the detector. The particles that interact have their energy or momentum measured by the detector, where different layers specialize in measuring certain classes of particles. From the final state energy and momentum measurements, the initial state proton-proton collision and everything in between is reconstructed.

1.2 The Large Hadron Collider

The LHC is a circular collider designed to collide proton beams with a centre-of-mass energy of 14 TeV and an instantaneous luminosity of 1034cm^{-2}s^{-1}.(cite lhc paper direct quote). The main accelerator ring consists of two counter rotating proton beams which are incased in an ultra high vacuum to prevent unintended interactions. The beams are accelerated with cryogenic electro-magnets which operate at -273C and are cooled by liquid helium. There are two types of magnets present, 1232 dipole magnets which bend the beam around the ring and 392 quadrapole magnets which focus the beams. The beam itself is structured with proton bunches, with each bunch spaced 25ns apart and 2808 bunches per beam. The period of recording collision data are referred to as runs. There are two completed runs, denoted as Run I, and Run I with integrated luminosities 58fb^{-1} and 138fb^{-1} respectively. There is also an expected cumulative integrated luminosity of up to 500fb^{-1} including the presently ongoing Run III.

1.3 The CMS Detector

The CMS detector is a hermetic shell that encapsulates the two counter rotating proton beams. The beams collide at the center of the detector and produce outgoing showers of particles that travel transverse to the beam axis. The observable outgoing particles, depending on the type of particle, are then measured in one of the specialized concentric layers of the detector. The initial transverse depiction of sub atomic interaction and intermediate particles can then be reconstructed from the energy and momentum measured in the detector. The total longitudinal momentum is not reconstructable for two reasons: first being that the momentum fraction of the initial quarks is unknown and second is that some particles travel along the beam line outside detector acceptance. There are an abundance of collision seen by the detector but not every event is recorded. Instead, interesting events, say due to the presence of a muon or large missing energy, trigger the detector to take a snap shop and permanently record said interesting event.

The chronology of a particle traversing the detector show in Figure 3.1 is as follows. Particles are produced post-collision at a primary interaction point, or primary vertex, other p-p interactions can occur in the same snapshot and are denoted as pile-up which is a form of noise obfuscating the primary interaction. From either primary or secondary vertices, both charged and neutral particles traverse the first region of the detector, the silicon tracker. The silicon tracker consists of concentric thin electronic sensors that register "hits" from only charged particles. Each sequence of hits can be connected into a "track" represents the path and origin of the charged particle. The next stop for particles, is the Electromagnetic Calorimeter (ECAL). The ECAL consists of scintillating pbW04 crystals that are designed to stop and measure the energy deposits of photon and electrons. The energy deposits from the two are distinguished by tracks that seed ECAL showers. Anything that makes it through the ECAL, encounters the hadronic calorimeter (HCAL). The HCAL consists of brass and plastic scintillators that stop the remaining massive particles and measures their energy. The last two regions of the detector are generally only seen by muons and are the centerpieces of CMS. First is the the solenoidal magnet, which generates a 4 Tesla uniform magnetic field throughout all of the inner regions of the detector. The magnetic field allows the measurements of two important observables charge and momentum. A charged particle's path will bend in the presence of a magnetic field, and the clockwise or counter clockwise trajectory indicates the charge while the curvature of the bend determines the momentum. The outer-most part of the detector is the muon chamber, which similar to the tracker, registers a sequence of hits via drift tubes or cathode strips. The tracks in both the tracker and muon chambers can then be combined to precisely measure the momemntum of the muon in addition to resistive plate chambers which act as a hardware level muon trigger.

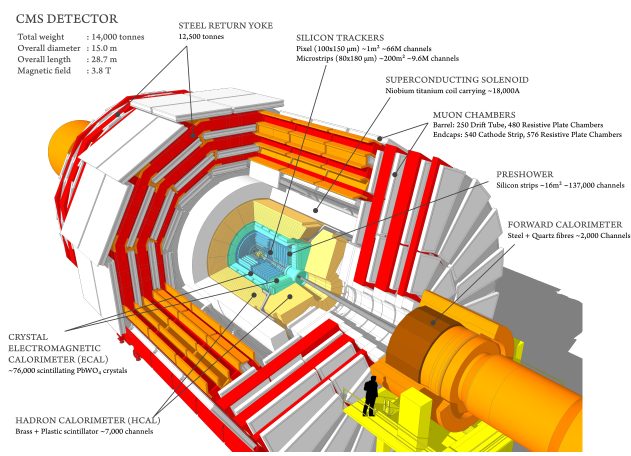

Figure 1.1: plot from CMS of CMS