Searching for Supersymmetry with the α_T variable in $p\bar{p}$ collisions with the CMS Detector at the Large Hadron Collider

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A thesis submitted in fulfilment of the requirements
for the degree of Doctor of Philosophy
to Imperial College London
December 2011

Chapter 1

Theoretical Overview

The theoretical interpretation of particle physics is an essential part of the experimental strategy, providing known information and motivation for new searches. The currently accepted picture of the building blocks of the universe is described in the successful theory, the Standard Model, which contains all known particles and describes their interactions. A quick overview is given in this chapter of this alongside motivation to search for new physics beyond, particularly the popular theory of Supersymmetry which motivates the analysis documented in this thesis.

1.1 The Standard Model

The Standard Model (SM) is a quantum field theory which successfully describes the elementary particles and their fundamental interactions.

It is a non-Abelian Yang-Mills type gauge field theory based on the symmetry group $SU(3)_C \times SU(2)_L \times U(1)_Y$.

The particle content exists in two types, the fermions, which are the building blocks for matter, and the bosons which act as intermediate The fermions can be described in three families as such:

$$\begin{bmatrix} \nu_e & u \\ e & d \end{bmatrix}, \begin{bmatrix} \nu_\mu & c \\ \mu & s \end{bmatrix}, \begin{bmatrix} \nu_\tau & t \\ \tau & b \end{bmatrix} \tag{1.1}$$

3 forces tests

1.1.1 Spin

1.1.2 Gauge Bosons/INvariance

1.1.3 EWK Unification

1.1.4 Full Particle Content

1.2 Motivation for New Physics

1.2.1 The Hierarchy Problem

1.2.2 Dark Matter

1.2.3 Grand Unification Theories

1.3 Supersymmetry

1.3.1 R-Parity

1.3.2 CMSSM

1.3.3 Current Limits on the CMSSM

1.3.4 Production Mechanisms at the LHC

Bibliography

[1] Oliver Sim Brning, Paul Collier, P Lebrun, Stephen Myers, Ranko Ostojic, John Poole, and Paul Proudlock. *LHC Design Report*. CERN, Geneva, 2004.

[2] Thomas Sven Pettersson and P Lefvre. The Large Hadron Collider: Conceptual Design. Technical Report CERN-AC-95-05 LHC, CERN, Geneva, Oct 1995.

[3] The CMS Collaboration. The Compact Muon Solenoid Technical Proposal. *CERN/LHCC*, 94-38, 1994.

[4] K et al. Nakamura. Review of particle physics, 2010-2011. review of particle properties. *J. Phys. G*, 37(7A):075021, 2010. The 2010 edition of Review of Particle Physics is published for the Particle Data Group by IOP Publishing as article number 075021 in volume 37 of Journal of Physics G: Nuclear and Particle Physics. This edition should be cited as: K Nakamura et al (Particle Data Group) 2010 J. Phys. G: Nucl. Part. Phys. 37 075021.

[5] The CMS Collaboration. *The CMS hadron calorimeter project: Technical Design Report*. Technical Design Report CMS. CERN, Geneva, 1997.

[6] Efe Yazgan. The CMS barrel calorimeter response to particle beams from 2-GeV/c to 350-GeV/c. *J. Phys. Conf. Ser.*, 160:012056, 2009.

[7] The CMS Collaboration. *The CMS muon project: Technical Design Report*. Technical Design Report CMS. CERN, Geneva, 1997.

[8] Sergio Cittolin, Attila Rcz, and Paris Sphicas. *CMS trigger and data-acquisition project: Technical Design Report*. Technical Design Report CMS. CERN, Geneva, 2002.