

Search for Supersymmetry in opposite-sign same-flavour dilepton events with the CMS detector in proton-proton collisions at $\sqrt{s} = 8 \text{ TeV}$

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Zusammenfassung

Abstract

Contents

Zusammenfassung	i
Abstract	i
1 Introduction	1
2 The Standard Model and its extension to Supersymmetry	3
2.1 The Standard Model of particle physics	3
2.2 Motivation for extending the Standard Model and Supersymmetry	3
2.3 Production of lepton pairs in supersymmetric models	3
2.4 Kinematic edges in the dilepton invariant mass spectrum	3
3 Experimental setup	5
3.1 The CERN Large Hadron Collider	5
3.2 The CMS detector	6
3.3 Data acquisition and event reconstruction	6
4 Data analysis and event selection	7
4.1 Trigger and event processing	7
4.2 Object reconstruction	7
4.3 Datasets	7
4.4 Event selection	7
5 Estimation of Standard Model backgrounds	9
5.1 Flavour-symmetric backgrounds	9
5.2 Backgrounds containing a Z boson	9
5.3 Investigation of possible further backgrounds	9
5.4 Search for a kinematic edge with a fit	9
6 Results	11
6.1 Result of the counting experiment	11
6.2 Result of the search for a kinematic edge	11
7 Interpretation in simplified models	13
7.1 Simplified Models for Supersymmetric Signatures	13
7.2 The T6bblledge and T6bbslepton model	13
7.3 Interpretation of the counting experiment in simplified models	13
8 Outlook to LHC Run II	15
9 Conclusion	17

1 Introduction

2 The Standard Model and its extension to Supersymmetry

2.1 The Standard Model of particle physics

2.2 Motivation for extending the Standard Model and Supersymmetry

2.3 Production of lepton pairs in supersymmetric models

2.4 Kinematic edges in the dilepton invariant mass spectrum

3 Experimental setup

3.1 The CERN Large Hadron Collider

The Large Hadron Collider (LHC) [1], located at CERN near Geneva and stretching far into the french countryside, is capable of colliding protons and lead ions at higher energies than any of its predecessors. Also the instantaneous luminosity delivered to the experiments exceeds that of any previous machine at the energy frontier. It was constructed in the tunnel formerly inhabited by the LEP electron-positron collider in 100m depths below the surface with a circumference 27km. It was designed to collide protons at a centre-of-mass energy of $\sqrt{s} = 14\text{ TeV}$ with instantaneous luminosities of $10^{34}\text{ s}^{-1}\text{ m}^{-2}$.

The LHC consists of eight arcs, as shown in Figure 3.1, where superconducting dipole magnets are used to provide a magnetic field of up to 8.3 T at the highest planned energies to bend the charged particles along the curvature of the tunnel, while quadrupole and other specialised magnets are used to focus the beams. In straight segments between these arcs, LHC infrastructure and the experiments are located. The infrastructure components include the cooling facilities necessary to reach a temperature of 1.9 K around the ring, the superconducting cavities in which the protons are accelerated by standing electromagnetic waves, collimators for beam cleaning and the beam dump, where the beam is ejected from the LHC at the end of fills. In the other four straight segments the beam is brought into collisions, which are studied by the four large experiments at the LHC. Of these, CMS [2] and ATLAS [3] are multi-purpose detectors with a diverse physics program, while ALICE [3] and LHCb [4] are more narrowly focused on heavy ion collisions and flavour physics, respectively.

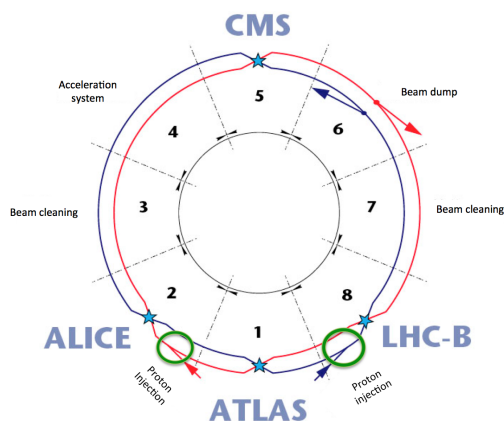


Figure 3.1: Schematic view of the LHC with its eight arcs. The four interaction points, where the experiments are located, are marked with blue stars. Other important parts of the LHC infrastructure are also indicated [5].

The protons circulating the LHC are injected at an energy of 450 GeV after running through a chain of pre-accelerators, the Linac2, the Proton Synchrotron Booster (PSB), the Proton Synchrotron (PS) and the Super Proton Synchrotron (SPS). The proton beams are separated into bunches of about 10^{11} particles. Though being 25 ns by design, corresponding to up to 2808 bunches in the LHC, the smallest spacing between bunches in time was 50 ns throughout the running in 2012 and most of 2011. In

these running conditions, after three years of running in the years 2010 to 2012, constituting the so called Run I of the LHC, a centre-of-mass energy of $\sqrt{s} = 8 \text{ TeV}$ has been reached. The instantaneous luminosities delivered to the experiments reached a maximum of $7.7 \cdot 10^{33} \text{ s}^{-1} \text{ m}^{-2}$ in late 2012, as can be seen on the left side of Figure 3.2. The integrated luminosity delivered to the CMS experiments in 2012 was 23.3 fb^{-1} , exceeding that of 2011 by almost a factor of four [6], as shown on the right side of Figure 3.2.

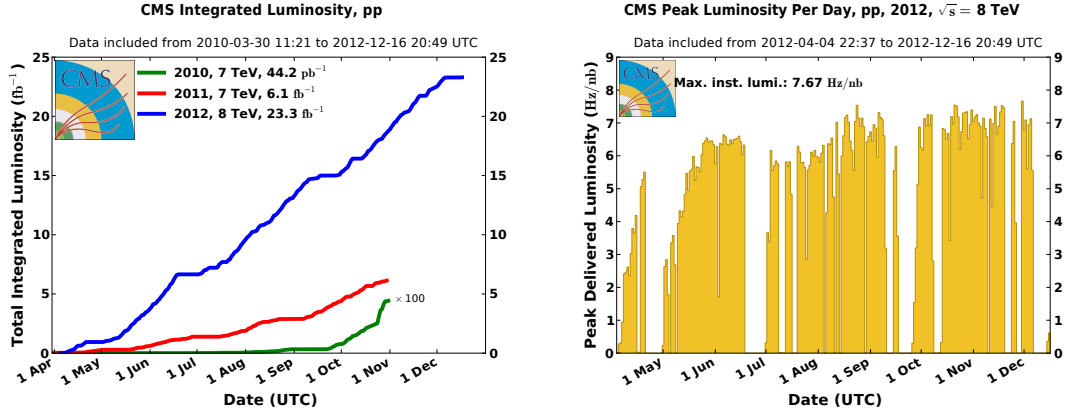


Figure 3.2: Development of instantaneous (left) and integrated (right) luminosity delivered to the CMS experiment. The left plots shows the results for all three years of data taking, while the right one only shows the 2012 data taking.

3.2 The CMS detector

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6.1 Result of the counting experiment

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7 Interpretation in simplified models

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7.2 The T6bblledge and T6bbslepton model

7.3 Interpretation of the counting experiment in simplified models

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