

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

Von der Fakultät für Mathematik, Informatik und Naturwissenschaften der RWTH Aachen University  
zur Erlangung des akademischen Grades eines Doktors der Naturwissenschaften genehmigte  
Dissertation

vorgelegt von  
**Jan-Frederik Schulte, M.Sc.**  
aus Münster

Berichter:  
**Prof. Dr. Lutz Feld**  
**Prof. Dr. Michael Krämer**

Termin der mündlichen Prüfung: xx.xx.2015

Diese Dissertation ist auf den Internetseiten der Hochschulbibliothek  
online verfügbar.



## **Zusammenfassung**

## **Abstract**



---

# Contents

Zusammenfassung . . . . .	i
Abstract . . . . .	i
<b>1 Introduction</b>	<b>1</b>
<b>2 The Standard Model and its extension to Supersymmetry</b>	<b>3</b>
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
<b>3 Experimental setup</b>	<b>5</b>
3.1 The CERN Large Hadron Collider . . . . .	5
3.2 The CMS detector . . . . .	5
3.3 Data acquisition and event reconstruction . . . . .	5
<b>4 Data analysis and event selection</b>	<b>7</b>
4.1 Trigger and event processing . . . . .	7
4.2 Object reconstruction . . . . .	7
4.3 Datasets . . . . .	7
4.4 Event selection . . . . .	7
<b>5 Estimation of Standard Model backgrounds</b>	<b>9</b>
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
<b>6 Results</b>	<b>11</b>
6.1 Result of the counting experiment . . . . .	11
6.2 Result of the search for a kinematic edge . . . . .	11
<b>7 Interpretation in simplified models</b>	<b>13</b>
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
<b>8 Outlook to LHC Run II</b>	<b>15</b>
<b>9 Conclusion</b>	<b>17</b>

---

# 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**

### **3.2 The CMS detector**

### **3.3 Data acquisition and event reconstruction**



---

## **4 Data analysis and event selection**

### **4.1 Trigger and event processing**

### **4.2 Object reconstruction**

### **4.3 Datasets**

### **4.4 Event selection**



---

## **5 Estimation of Standard Model backgrounds**

**5.1 Flavour-symmetric backgrounds**

**5.2 Backgrounds containing a Z boson**

**5.3 Investigation of possible further backgrounds**

**5.4 Search for a kinematic edge with a fit**



---

## **6 Results**

### **6.1 Result of the counting experiment**

### **6.2 Result of the search for a kinematic edge**





---

## **7 Interpretation in simplified models**

### **7.1 Simplified Models for Supersymmetric Signatures**

### **7.2 The T6bblledge and T6bbslepton model**

### **7.3 Interpretation of the counting experiment in simplified models**



---

## **8 Outlook to LHC Run II**



---

## 9 Conclusion