

Contents

1	The Hunt for the Higgs Boson	1
1.1	The Standard Model	1
1.2	The Higgs Mechanism	3
1.3	Experimental Limits on the Higgs Boson Mass	8
1.4	The Higgs Boson at LHC	10
1.5	The $H \rightarrow ZZ \rightarrow \ell^+ \ell^- q \bar{q}$ Channel	12
	References	14
2	The Large Hadron Collider and the CMS Experiment	17
2.1	The Large Hadron Collider	17
2.2	The CMS Experiment	19
2.2.1	Magnet	22
2.2.2	Tracker	22
2.2.3	Electromagnetic Calorimeter	25
2.2.4	Hadronic Calorimeter	27
2.2.5	Muon System	28
2.2.6	Trigger	29
2.2.7	CMS Software Components	30
2.3	Electron Reconstruction and Trigger	31
2.4	Muon Reconstruction and Trigger	33
	References	34
3	Jet Reconstruction and Calibration	37
3.1	Hadronization and Jets	37
3.2	Jet Reconstruction	39
3.2.1	Response and Resolution	39
3.2.2	Jet Algorithms	40
3.2.3	Particle Flow Reconstruction	41
3.3	Jet Calibration: The Factorized Approach	43
3.4	Jet Energy Scale Measurement	45
3.4.1	Data Samples and Trigger	46
3.4.2	Photon Identification	47
3.4.3	Photon-Jet Balancing	48

3.4.4	Missing- E_T Projection Fraction Method	50
3.4.5	Balancing Extrapolation Method	54
3.4.6	Jet Transverse Momentum Resolution Measurement	56
3.5	Jet Flavour Tagging: Quark-Gluon Discrimination	57
3.5.1	Treatment of Pile Up.	61
3.5.2	b -Jets.	64
	References	67
4	Event Selection	69
4.1	Datasets and Trigger	69
4.1.1	Data	69
4.1.2	Generated Events	71
4.2	Preselection	74
4.2.1	Muon Identification Criteria	75
4.2.2	Electron Identification Criteria	76
4.2.3	Jet Identification Criteria	77
4.3	Kinematic and Angular Discrimination.	77
4.3.1	Kinematic Distributions	78
4.3.2	Angular Distributions	78
4.3.3	Angular Discriminant	81
4.4	Kinematic Fit to the Decay Chain	86
4.5	Categorization.	88
4.6	Selection Optimization.	92
4.7	Missing Transverse Energy Significance.	93
4.8	Summary of Selection Requirements and Yields	95
4.9	Background Estimation	97
	References	101
5	Systematic Uncertainties.	103
5.1	Lepton Reconstruction	103
5.2	Jet Energy Scale and Resolution	105
5.3	Pile-Up.	106
5.4	b -Tagging	107
5.5	Quark-Gluon Discrimination	108
5.6	Missing Transverse Energy.	110
5.7	Signal Production	110
5.7.1	Cross Section	111
5.7.2	Acceptance.	111
5.8	Higgs Width Modeling.	113
5.9	LHC Luminosity	115
	References	115

6	Statistical Interpretation of Results.	117
6.1	Modeling of the Signal.	117
6.2	Statistical Analysis	120
	References	125
7	Conclusions	127
	Reference	128