

Contents

1	Theoretical Overview	1
1.1	The Particle Content of the Standard Model	2
1.2	Dynamics of the Standard Model	4
1.2.1	Gauge Theories in the Standard Model	5
1.2.2	Renormalisation	6
1.2.3	The Description of Mass	7
1.3	Quantum Chromodynamics	8
1.3.1	Structure of a Hadronic Event	9
1.3.2	The Perturbative Regime	10
1.3.3	Non-perturbative Effects	13
1.4	Going Beyond the Standard Model	13
1.4.1	Foundations of SUSY	14
1.4.2	Implications of SUSY	17
1.4.3	Experimental Constraints	19
1.5	Conclusion and Motivation	21
	References	21
2	The Large Hadron Collider and the ATLAS Experiment	25
2.1	The Large Hadron Collider	25
2.2	ATLAS Detector Overview	27
2.2.1	Coordinate System	28
2.2.2	Inner Detector	29
2.2.3	Calorimetry	30
2.2.4	Muon Spectrometer	32
2.3	Trigger	33
2.3.1	Jet Triggers	34
2.4	Detector Simulation	35
2.5	Object Reconstruction	35
2.5.1	Tracks	36
2.5.2	Electrons	36
2.5.3	Muons	36

2.5.4	Jets	37
2.5.5	b-Tagging	39
2.5.6	Missing Transverse Momentum	40
	References	41
3	Search for New Phenomena in Events with Large Jet Multiplicities	43
3.1	Introduction	43
3.1.1	Overview of the Analysis	44
3.2	Analysis Strategy	46
3.2.1	Signal and Backgrounds	46
3.2.2	Dataset and Trigger	50
3.2.3	Physics Object Definitions	52
3.2.4	Kinematic Variable Definitions	53
3.2.5	Event Cleaning	54
3.2.6	Optimisation of the Signal Region Definitions	55
3.3	Estimation of the Standard Model Background	59
3.4	Estimation of the Multi-jet Background	62
3.4.1	Soft Energy Correction	64
3.4.2	The Template Method in Events with b-Jets	65
3.4.3	Sensitivity to Pile-Up Effects	67
3.5	Systematic Uncertainties of the Multi-jet Background Prediction	68
3.5.1	Closure Systematic Uncertainty	68
3.5.2	Heavy-Flavour Systematic Uncertainty	68
3.5.3	Soft Energy and Pile-Up Systematic Uncertainties	71
3.5.4	Trigger Systematic Uncertainty	73
3.5.5	Leptonic Background Subtraction	74
3.6	Estimation of the Leptonic Backgrounds	74
3.6.1	Estimation of the Leptonic $t\bar{t}$ and $W + \text{Jets}$ Backgrounds	75
3.6.2	Estimation of Other Minor Backgrounds	77
3.7	Systematic Uncertainties on the Leptonic Backgrounds	83
3.7.1	Experimental Systematic Uncertainties	84
3.7.2	Theoretical Systematic Uncertainties	85
3.8	Results and Interpretation	87
3.8.1	Fitting Procedure	87
3.8.2	Fit Results and Interpretation	93
3.9	Summary and Outlook	97
	References	99
4	Measurement of the Cross Section of Four-Jet Events	103
4.1	Introduction	103
4.1.1	Overview of the Analysis	104
4.1.2	Useful Concepts	105

4.2	Object Definitions and Event Cleaning	106
4.2.1	Jets	106
4.2.2	Event Cleaning and General Cuts	106
4.3	Trigger	108
4.3.1	Single-Jet Triggers	109
4.3.2	Four-Jet Triggers	110
4.3.3	Combination	112
4.4	Variables of Interest	113
4.4.1	Definitions and Truth-Level Distributions	115
4.4.2	Truth- to Reconstructed-Level Correlations	122
4.5	Binning	129
4.5.1	Statistical Uncertainties and Rounding	131
4.6	Unfolding of Detector Effects	132
4.6.1	Method Description	132
4.6.2	Choosing the Nominal Monte Carlo	134
4.6.3	Shape Systematic Uncertainty	137
4.6.4	Selection Efficiency Systematic Uncertainty	140
4.6.5	Statistical and Systematic Uncertainties	141
4.6.6	Optimisation of the Unfolding Algorithm	142
4.7	Theoretical Calculations and Uncertainties	143
4.7.1	Leading-Order Predictions	146
4.7.2	Next-to-Leading-Order Predictions	147
4.7.3	Other Predictions	147
4.8	Results	148
4.9	Summary and Outlook	166
	References	166
	Conclusion	169
	Appendix A: Trigger Efficiencies	171
	Appendix B: Deriving Variable-Width Binnings	173
	About the Author	177

<http://www.springer.com/978-3-319-43460-5>

High Jet Multiplicity Physics at the LHC

Crispin Ortuzar, M.

2016, XXII, 177 p. 95 illus., 62 illus. in color., Hardcover

ISBN: 978-3-319-43460-5