

Contents

1	Introduction	1
	References	2
2	Theoretical Background	3
2.1	The Standard Model	3
2.1.1	Matter Particles	3
2.1.2	Particle Interactions	3
2.1.3	Gauge Theories	4
2.2	The Top Quark	5
2.2.1	Discovery	5
2.2.2	Properties	5
2.2.3	Decay	6
2.3	Electroweak Top Quark Production	6
2.3.1	Introduction and Motivation	6
2.3.2	Production Modes	7
2.3.3	Measurement of $ V_{tb} $	8
2.3.4	Single Top Kinematics	9
2.3.5	Polarization	9
2.3.6	New Physics	11
	References	12
3	Experimental Setup	13
3.1	The Accelerator Chain	13
3.1.1	Luminosity and Cross Sections	14
3.2	The DØ Detector	15
3.2.1	The DØ Coordinate System	15
3.2.2	The Central Tracking	17
3.2.3	Silicon Microstrip Tracker	18

3.2.4	Central Fibre Tracker	19
3.2.5	Preshower Detectors	19
3.2.6	The DØ Calorimeters	19
3.2.7	Muon System	22
3.2.8	Triggers	22
	References	23
4	Event Reconstruction	25
4.1	Tracks	25
4.2	Primary Vertices	26
4.3	Calorimeter Clusters	26
4.4	Electrons	27
4.5	Jets	28
4.6	Muons	31
4.7	b Jets	31
4.8	Missing Transverse Energy, E_T	32
	References	33
5	Analysis: Event Selection	35
5.1	Strategy	35
5.2	Data Set	36
5.3	Background Processes	36
5.4	Signal and Background Modeling	38
5.4.1	Monte Carlo Simulation.	38
5.4.2	Monte Carlo Signal Samples	38
5.4.3	Monte Carlo Background Samples	39
5.4.4	Monte Carlo Corrections	42
5.4.5	Monte Carlo Sample Normalization	45
5.4.6	Multijets and W +jets Normalization	46
5.5	Event Selection Criteria	47
5.5.1	General Selection	47
5.5.2	b -Tagging Selection	48
5.5.3	Electron Channel Selection	48
5.5.4	Muon Channel Selection	48
5.5.5	Multijet Reduction Criteria.	48
5.6	Event Yields.	50
5.7	Data-Background Model Comparison.	52
5.8	Systematic Uncertainties.	53
	References	60
6	Analysis: Decision Trees.	61
6.1	Motivation	61
6.2	Overview of Decision Trees	62
6.2.1	History and Usage.	62

6.2.2	What is a Decision Tree?	62
6.2.3	Advantages and Limitations	63
6.3	Growing a Tree.	64
6.3.1	Node Splitting	65
6.3.2	Impurities.	66
6.4	Pruning the Tree	67
6.4.1	Pre-Pruning	68
6.4.2	Post-Pruning.	68
6.5	Forests of Decision Trees	69
6.5.1	Bagging	69
6.5.2	Random Forest	70
6.5.3	Boosting	70
6.6	Decision Tree Options	71
6.7	Evaluating the Performance	72
6.7.1	Cross Section Significance, $\mathcal{S}_\sigma$	73
6.7.2	Excess Significance, $\mathcal{S}_s$	73
6.8	Thoughts and Suggested Improvements	74
6.8.1	Weighted Events and Pre-Pruning	75
6.8.2	Impurity Optimization	75
6.8.3	Consideration of Systematic Uncertainties	76
6.8.4	Logging	76
	References	76
7	Analysis: Measurements	79
7.1	Decision Tree Analysis	79
7.1.1	Input Samples.	79
7.1.2	Discriminating Variables	80
7.1.3	Choice of Decision Tree Parameters	82
7.1.4	Output Transformation.	89
7.1.5	The Final Decision Trees	93
7.1.6	Cross Checks	93
7.2	Cross Section Measurement	95
7.2.1	Bayesian Analysis.	96
7.2.2	Numerical Calculation	97
7.2.3	Ensemble Tests.	98
7.2.4	Observed Results	99
7.3	Event Kinematics	102
7.4	Signal Significance	102
7.4.1	Combined Significance	105
7.5	Measurement of $ V_{tb} $	106
	References	110

Appendix A. 111

Appendix B. 119

Appendix C. 131

Appendix D. 137

Appendix E. 141

<http://www.springer.com/978-1-4419-7798-4>

Discovery of Single Top Quark Production

Gillberg, D.

2011, XIV, 142 p., Hardcover

ISBN: 978-1-4419-7798-4