

Index

1	Introduction	1
1.1	Background and Motivation	1
1.2	Objectives and Challenges	11
1.3	Thesis Structure	14
2	Electromagnetic Analysis of Wedge-shaped Waveguides	17
2.1	Computation of the Modal Solution	17
2.1.1	Wedge-shaped Waveguide and Rectangular Reference Box	17
2.1.2	Normalised Arbitrary TE Modes	19
2.1.3	Normalised Arbitrary TM Modes	20
2.1.4	Unnormalised Arbitrary TE Modes	20
2.1.5	Unnormalised Arbitrary TM Modes	21
2.1.6	Grid Interpolation	21
2.2	Simulation of the EM Behaviour	23
2.2.1	Comparison Wedge-Rectangular Field Patterns	23
2.2.2	Inclination Angle Limits	27
2.2.3	Modes and Cutoff Frequencies	28
2.3	Discontinuities and S-Parameters of Stepped Waveguide Devices	31
2.3.1	Discontinuities with Wedge-shaped Waveguides	31
2.3.2	Analysis of Stepped Waveguide Structures	34
3	Multipactor Effect Analysis of Wedge-shaped Waveguides	37
3.1	Electron Emission in Metals	37
3.1.1	Models for the Secondary Emission Yield	37
3.1.2	Rebound Energy Models	40
3.1.3	Multipactor Susceptibility Regions	43
3.2	Multipactor Prediction Tool	44
3.2.1	Overview	44

3.2.2	Electron Dynamics	47
3.2.3	Algorithm for the Prediction of the Multipactor Discharge	50
3.2.4	Trapped Trajectories and Launch Position Prediction	52
3.3	Validation of the Formulation	57
3.3.1	Example of Chojnacki	57
3.3.2	Example of Semenov	59
3.4	Study of the Optimal Inclination Angle	62
3.4.1	Introduction to the Angle Sweep Analysis	62
3.4.2	Results and Interpretation	62
3.5	Susceptibility Maps	66
3.5.1	Definition	66
3.6	Summary	68
4	Design of a Wedge-shaped Bandpass Filter	69
4.1	From Waveguide to Filter	69
4.1.1	Searching an Implementation	69
4.1.2	Filter Requirements	70
4.1.3	Filter Topology and Cross Section	72
4.1.4	Design Procedure	74
4.1.5	Simulation Results	79
4.2	Hardware and S-parameters Measurement	79
4.2.1	Preparation of the Manufacturing Models	79
4.2.2	Manufactured Bandpass Filters	84
4.2.3	Contact Problems and Workaround	85
4.2.4	Comparison Between Measured and Simulated Filter Responses	88
4.2.5	Out-of-band Frequency Response	91
4.3	Multipactor Prediction	93
4.3.1	Extension of Multipactor Prediction Tool	93

4.3.2	Traditional Multipactor Prediction Tools	94
4.4	Measured Multipactor Thresholds	96
4.4.1	Multipactor Test Report	96
4.4.2	Comparison Between Measurements and Predictions	97
4.5	Summary	98
4.5.1	Demonstration of Multipactor Resistance	98
4.5.2	Potential Design Improvements	98
5	Optimum Design of Wedge-shaped Bandpass Filters for Improved Multipactor Resistance	101
5.1	Optimisation Studies	101
5.1.1	New Design Target	101
5.1.2	Inclination Angle	102
5.1.3	Out-of-band Frequency Response	103
5.1.4	Manufacturing Enhancements	106
5.2	Second Wedge-shaped Bandpass Design	108
5.2.1	Structure Characteristics and Requirements	108
5.2.2	Simulation Results	114
5.2.3	Manufactured Hardware	114
5.3	Electrical Performance	116
5.3.1	Narrow-band Comparison	116
5.3.2	Wide-band Comparison	116
5.4	Multipactor Performance	118
5.4.1	Multipactor Predictions	118
5.4.2	Multipactor Test Campaign Results	120
5.4.3	Evaluation of Results	120
5.5	Guidelines for Optimal Design	122
6	Conclusiones y Perspectivas	125

A	Formulation of the Electromagnetic Fields of Rectangular Waveguides	131
A.1	Fields and Power	131
A.2	Normalised Electromagnetic Fields	133
A.2.1	Transverse Electric Case	133
A.2.2	Transverse Magnetic Case	134
A.3	Retrieval Electromagnetic Fields	135
A.3.1	Transverse Electric Case	135
A.3.2	Transverse Magnetic Case	136
B	Losses in Waveguides due to the Finite Conductivity of the Metallic Walls	139
B.1	Losses in the Frontal Walls	139
B.1.1	Implication of Considering Losses in Wedge-shaped Waveguides	139
B.1.2	Coupling Integrals in the Frontal Walls	140
B.2	Losses in Propagation	143
B.2.1	Derivation of the Attenuation Constant	143
B.2.2	Resolution for the Wedge-shaped Waveguide Case	145
C	Multipactor Detection Test	151
C.1	Test Setup and Procedure	151
C.2	Detection Methods	157
D	Curriculum Vitae	163
D.1	Education	163
D.2	Professional Experience	163
D.3	Fields of Expertise	164
D.4	Informatics Skills	165
D.5	Languages	165
E	Publications	167
E.1	Papers in International Scientific Journals	167
E.2	Patent	167

E.3 Papers in International Congresses	168
E.4 Research Reports	168
List of Acronyms	169
List of Symbols	173
Bibliography	177