

Contents

Abstract	v
Resumen	vii
Resum	ix
Agradecimientos	xi
Contents	xv
Introduction	1
1 The NEXT Experiment	5
1.1 Neutrinoless Double Beta Decay ($\beta\beta_{0\nu}$)	6
1.2 NEXT Concept	11
1.3 NEXT-DEMO	12
1.4 NEW	21
1.5 NEXT-100 and Beyond	40
1.6 Seeing the invisible: Silicon PhotoMultipliers (SiPM)	42
1.6.1 Semiconductor devices	42

1.6.2 Silicon PhotoMultipliers	48
1.6.3 SiPMs and MPPCs in Physics Experiments	55
2 The NEXT-DEMO Tracking Plane	57
2.1 Design Requirements	58
2.2 From Mother and Daughter Boards to CuFlon DICE-Boards	60
2.3 Front-end and Readout Electronics	64
2.4 Results	66
2.5 State of the art in SiPM Front-end Electronics	72
3 From the Beginning: Front-end Prototype	75
3.1 First Scheme	76
3.2 Single ended Scheme	77
3.2.1 Circuit	77
3.2.2 Results	85
3.2.3 Conclusions	87
3.3 Moving to a Differential input Scheme	88
3.4 Noise Analysis	91
4 Front-end Electronics: The FEB64	97
4.1 Power Supply Requirements	98
4.2 From Prototyping to Full Design	99
4.3 Board Layout Distribution: a Matter of Size	101
4.4 A Functional Design: FEB64v2.	103
4.5 The zener issue	105
4.5.1 Malfunction detection	105
4.5.2 Solution	107
4.6 Planned design modifications: Future FEB64v3.	108

4.7	SRS-ATCA & Java Interface	110
4.7.1	ATCA	110
4.7.2	DAQ Architecture	111
4.7.3	DAQ Features	113
5	New SiPM array: The Kapton DICE-Board	115
5.1	Embedded microstrip	117
5.1.1	Crosstalk	118
5.1.2	Stackup	120
5.1.3	Transmission Line Parameters	121
5.1.4	Bypass Capacitors	124
5.1.5	Simulation.	125
5.2	Broadside Coupled Traces.	130
5.2.1	Stackup	131
5.2.2	Line Parameters	131
5.2.3	Simulation.	134
5.3	Finishing the DICE-Board.	136
5.3.1	Mechanical Design.	136
5.3.2	Radiopurity issues	140
6	From the SiPM to Front-end: The Cabling Problem	145
6.1	Inner Cables.	146
6.2	Outer Cables	149
6.2.1	Cable specifications	150
6.2.2	Noise.	154
6.2.3	Crosstalk	159
6.3	Custom Feedthrough.	160
6.3.1	FR4 PCB feedthrough prototype.	161
6.3.2	NEW FR4 PCB Feedthrough	163
6.3.3	Adapter Boards.	164

6.4 SiPM & Cabling connection test ("Check System")	166
6.5 Protection against ESD	168
7 Programmable Power Supply with SiPM gain stabilization	171
7.1 Requirements for NEW and NEXT-100	172
7.2 Design	173
7.2.1 Temperature Compensation	173
7.2.2 Output channel	175
7.2.3 I/O Interfaces	176
7.2.4 Mechanical Design	177
7.3 Results and Outlook	178
8 First Results of NEW Tracking Plane	181
8.1 NEW Tracking Plane Calibration	182
8.2 First run with ^{22}Na	184
9 Conclusions	189
Publications	195
List of Acronyms	197
References	201