

# Università di Pisa

Facoltà di Scienze Matematiche Fisiche e Naturali

Corso di Laurea Specialistica in Scienze Fisiche

Anno Accademico 2003–2004



Tesi di Laurea Specialistica

*Analysis of the optical background sources in the  
ANTARES experiment and preliminary studies related  
to a larger scale detector.*

Candidato:  
Sara Vecchio

Relatore:  
Chiar.mo Prof. Vincenzo Flaminio



# Contents

<b>Introduction</b>	<b>5</b>
<b>1 High energy neutrino astronomy</b>	<b>9</b>
1.1 A new glance at the edge of the Universe . . . . .	9
1.2 Cosmic rays and open problems . . . . .	10
1.2.1 Reachable energy in the acceleration process . . . . .	12
1.3 Neutrino signature for different sources . . . . .	13
<b>2 Present status of very high energy neutrino experiments</b>	<b>21</b>
2.1 Neutrino Telescopes . . . . .	21
2.1.1 Detection techniques . . . . .	21
2.1.2 Background sources . . . . .	23
2.1.3 Detector parameters . . . . .	24
2.2 Present projects . . . . .	27
2.3 Baikal . . . . .	28
2.4 AMANDA . . . . .	31
2.5 Future projects: KM3-net . . . . .	36
2.5.1 NESTOR . . . . .	37
2.5.2 NEMO . . . . .	39
2.6 Other detection techniques . . . . .	41
<b>3 The ANTARES experiment</b>	<b>43</b>
3.1 Architecture . . . . .	47
3.1.1 The Detector Strings . . . . .	50
3.1.2 The Instrumentation Line . . . . .	54
3.2 Offshore electronics and DAQ . . . . .	55
3.2.1 Data formats . . . . .	58
3.3 On shore data handling . . . . .	60

3.4	Trigger logic and rates . . . . .	61
3.5	Status of the experiment . . . . .	64
3.5.1	Site environmental parameters . . . . .	64
3.5.2	Prototype lines deployed in 2003 . . . . .	67
<b>4</b>	<b>The Optical Background</b>	<b>71</b>
4.1	Background analysis . . . . .	71
4.1.1	Radioactive decays . . . . .	74
4.1.2	Bioluminescence . . . . .	75
4.1.3	Sea current & background . . . . .	80
4.2	Data obtained in 2003 . . . . .	83
4.3	CRM and L0 . . . . .	87
4.4	Burst analysis . . . . .	92
4.4.1	Raw burst analysis . . . . .	94
4.4.2	Analysis on fitted bursts . . . . .	99
4.4.3	Comparison with a simulation. . . . .	106
<b>5</b>	<b>An attempt to improve the performance of a large underwater Čerenkov detector through the use of Hybrid PhotoDiodes (HPD)</b>	<b>111</b>
5.1	Characteristics . . . . .	111
5.2	Development status . . . . .	115
5.3	Proposal for a 10" hemispheric HPD . . . . .	116
5.4	Analysis of the consequences of using an HPD in a large scale neutrino telescope. . . . .	124
5.4.1	Detector configuration . . . . .	124
5.4.2	Simulation parameters . . . . .	126
5.4.3	Simulation results . . . . .	127
5.5	A possible further improvement: the use of the spatial information by segmenting the silicon pad . . . . .	137
<b>6</b>	<b>Summary and conclusions</b>	<b>139</b>
	<i>Bibliography</i>	<b>141</b>
<b>A</b>	<b>List of acronyms</b>	<b>147</b>
<b>B</b>	<b>Monte Carlo simulation tools</b>	<b>149</b>