

Contents

Resumen.....	5
Resum.....	7
Abstract.....	9
Introduction.....	11
1. Acoustics in Underwater Neutrino Telescopes.....	14
1.1 Introduction to Neutrino Telescopes.....	14
1.1.1 Neutrino Particle.....	15
1.1.2 Neutrino Detection and Neutrino Astronomy.....	15
1.1.3 ANTARES.....	17
1.1.4 NEMO.....	17
1.1.5 KM3NeT.....	17
1.2 Fundamentals of Underwater Acoustics.....	20
1.2.1 The Acoustic Wave.....	21
1.2.2 The Acoustic Wave Propagation in Seawater.....	23
1.2.3 Ultrasounds.....	26
1.2.4 Piezoelectric Acoustic Transducer.....	27
1.2.5 Electro-Acoustic Transducer Calibration.....	31
1.2.6 Acoustic Transducer Array.....	33
1.2.7 Acoustic Parametric Generation.....	34
1.2.8 Undersea Acoustic Positioning.....	36
1.3 Acoustic Positioning System (APS) of KM3NeT.....	38
1.3.1 Introduction to the APS.....	38
1.3.2 The Long Base-Line APS.....	39
1.3.3 DOM positioning procedure.....	41
1.3.4 The Internal Acoustic Receivers (Piezo-Electric Sensors).....	44
1.3.5 The External Acoustic Receivers (Digital Hydrophones)	45
1.3.6 The Acoustic Beacon.....	46
1.4 Neutrino Acoustic Detection.....	47
1.4.1 The UHE Neutrino and the Thermo-Acoustic Effect.....	48
1.4.2 Acoustic Background.....	50
1.4.3 Acoustic Sensors Array.....	52
1.4.4 Acoustic Signal Processing.....	52
1.4.5 Acoustic Neutrino Calibration.....	53
2. Acoustic Beacon Development for the positioning system of KM3NeT.....	57
2.1 Validation of the Emitter Prototype.....	57
2.1.1 Ultrasonic transducer FFR SX30.....	57
2.1.2 Sound Emission Board (SEB).....	58
2.1.3 Detection Strategy and Signal Processing Techniques.....	58
2.1.4 In Situ Tests in ANTARES and NEMO.....	60
2.1.4.1 ANTARES <i>In Situ</i> Test.....	61
2.1.4.2 NEMO <i>In Situ</i> Test.....	65
2.2 Design of the Acoustic Beacon.....	68
2.2.1 General description of the Acoustic Beacons.....	68

2.2.2	Acoustic Beacon Piezo-Ceramic Transducer.....	68
2.2.3	Electronic specifications of the Acoubeacon.....	69
2.2.4	Mechanical specifications of the Acoustic Beacon.....	71
2.2.4.1	Pressure Tests.....	72
2.2.5	Acoustic Test Calibration.....	73
2.3	Acoustic Beacon Integration in the Positioning System.....	75
2.3.1	First APS in Situ Tests.....	78
2.4	APS simulation for the installation of extra Acoustic Beacons in KM3NeT-It (ARCA-Phase I) and KM3NeT-Fr (ORCA-Phase I).....	81
2.4.1	Study for the installation of four extra AB in the APS of KM3NeT-It (ARCA-Phase I).....	81
2.4.2	Study for the installation of an extra AB in the APS of KM3NeT-Fr (ORCA-Phase I).....	84

3. Design of a Transducer Array for the Calibration of Acoustic Neutrinos

Detector.....	89	
3.1	Introduction to the Array Calibrator based on the Parametric Technique.....	89
3.2	Piezoelectric Transducer Selection and Calibration.....	91
3.2.1	Transmitting Voltage Response and Directionality.....	92
3.3	Design of the First Single Transducer.....	94
3.3.1	Backing.....	94
3.3.2	Matching layer.....	96
3.4	Studies on Parametric Emission.....	98
3.4.1	Parametric Sine Sweep Signal.....	99
3.4.2	Parametric Bipolar Pulse Signal.....	103
3.5	Design of the multi-element transducer array calibrator.....	106
3.5.1	Simulation.....	106
3.5.2	Mechanics.....	107
3.5.3	Test of the transducer line-array.....	108
3.5.3.1	Experimental Test setup.....	109
3.5.3.2	Array characterization. Primary beam.	110
3.5.3.3	Array characterization. Parametric (secondary) beam.....	111
Summary and Conclusions.....	121	
Bibliography.....	124	
Acknowledgements.....	129	
Table List.....	130	
Figure List.....	131	
Acronyms.....	139	