

Contents

1	Introduction	1
1.1	The ALICE experiment	1
1.2	Particle identification in ALICE and the HMPID	1
1.3	Physics of the HMPID	3
1.4	A Ring-Imaging Cherenkov (RICH) detector using CsI photocathode	4
1.4.1	General remarks	4
1.4.2	The HMPID layout in ALICE	4
1.5	Overview of the HMPID design and main results	5
1.5.1	R&D, prototypes, and test results	5
1.5.2	Detector description	7
1.5.3	Detector performance	8
2	R&D, Prototypes, Test Results	15
2.1	Basic CsI RICH components	15
2.1.1	The CsI thin film	16
2.1.2	Single-electron detection using pad cathode readout in MWPC	27
2.1.3	Measurements of basic physical RICH parameters	34
2.2	Overview of the CsI-RICH prototypes and modules	37
2.3	CsI RICH performance	39
2.3.1	Test beam facilities and test layouts	39
2.3.2	Results from the PS and SPS beam tests	43
2.4	Event analysis and Monte Carlo simulation	75
2.4.1	Monte Carlo simulation	77
2.4.2	Analysis results: radiator thickness and HV scan	78
3	Detector description	83
3.1	Module production and final prototype	83
3.1.1	The photodetector	83
3.1.2	The radiator array	90
3.1.3	The C ₆ F ₁₄ circulation system	95
3.1.4	The electronics chain	104
3.1.5	The CsI evaporation system	116
3.2	HMPID system description	120
3.2.1	Introduction	120
3.2.2	The CsI RICH modules	121
3.2.3	The evaporation system for CsI photocathodes	124
3.2.4	The readout electronic system	126
3.2.5	The test and monitoring systems	133
3.2.6	Control signal and trigger electronics	135
3.2.7	Low-voltage system/high-voltage system	135
3.2.8	The data-transfer system and data-acquisition systems	136
3.2.9	Gas mixture distribution system	139
3.2.10	The C ₆ F ₁₄ circulation system	143
3.2.11	The slow control system	148

4	Detector performance	153
4.1	Introduction	153
4.2	Simulation of the RICH response in the ALICE radiation environment	153
4.2.1	Particle multiplicities at the HMPID and secondary interactions	153
4.2.2	GEANT description of the RICH	154
4.2.3	Background simulation	156
4.2.4	Results	156
4.3	Pattern recognition	160
4.3.1	Data sample used for pattern recognition	160
4.3.2	The signal from the HMPID readout: the pad hit and the clusters	162
4.3.3	Cluster centroids and deconvolution	162
4.3.4	Reconstruction of the ‘Cherenkov signal’	162
4.3.5	Analysis of single beam events	164
4.3.6	Analysis of overlapped data sets	165
4.3.7	Recognition of Cherenkov patterns in the GALICE environment	170
4.4	Matching of tracks with clusters on the HMPID pad plane	172
4.4.1	Track simulation	172
4.4.2	Track reconstruction	172
4.4.3	Extrapolation to the HMPID	174
4.4.4	Evaluation of the matching efficiency	174
4.5	Optimization of the detector	175
4.5.1	Optimization of the constructive elements of the detectors	176
4.5.2	Reduction of the photon feedback	176
5	Installation and organization	177
5.1	ALICE experimental area	177
5.2	Installation and maintenance of the HMPID	177
5.3	Milestones and construction programme	180
5.4	Safety aspects	182
5.5	Organization	182
5.5.1	Participating institutes	182
5.5.2	Responsibilities	183
5.5.3	Cost estimate and resources	183
	References	185