Characteristics of Photon Multiplicity Detector Modules in the ALICE Experiment

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Introduction

The Photon Multiplicity Detector (PMD) in the ALICE experiment at LHC is designed to measure the multiplicity and the spatial distribution of photons, in the pseudo-rapidity region of 2.3 to 3.9. The basic principle of detection of photons in PMD is similar to the preshower detectors used in WA93, WA98 at CERN SPS and STAR experiments at RHIC. The PMD in ALICE consists of two planes, each with 24 gas tight enclosures (modules) [1]. Each module consists of an array of closely packed hexagonal proportional counters, with wire readouts. A mixture of Ar + CO2 (70:30 by weight) is used as the active medium. The electronics mainly consists of processing through a Multiplexed Analog Signal Processor (MANAS) with the final readout done through a Cluster Readout Concentrator Unit System (CROCUS). Here we present present results of the response of the detector modules obtained using pion and electron beams, at different energies, carried out at CERN PS.

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Test beam Setup

Two PMD modules each having an array of 48 x 96 hexagonal cells of radius 0.25cm are mounted back to back on a movable X-Y stand.

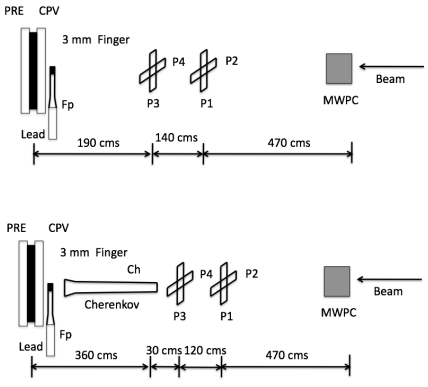


FIG. 1: Trigger Setup

A four fold scintilator signal was used as pion trigger whereas a cherenkov signal was used for electron trigger. The schematic 1 shows about the beam setup for the test beam.

Analysis and Result

The response of the charged particle of PMD is studied both in MC and in the test beam. For this π^- beam was selected at 3GeV. The data points

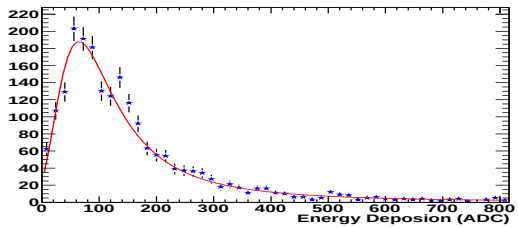


FIG. 2: Energy deposition of a 3 GeV pion beam

are fitted to a Landau function to extract the Most Probable Value (MPV) value as shown in Figure 2. The MPV value in simulation is 0.560 keV where as it is 69 ± 2 ADC at 1300 volts operating voltage in test beam.

The study of gas mixture was carried out at three different gas ratios ($(Ar : CO_2 = 65 : 35)$, 70 : 30, 75 : 25) keeping the operating voltage of the detector at 1300 Volts. The MIP energy deposition also increases with the increase of Argon contents. As the Argon content increases by 5%, the MIP value increases by a factor of 2 as shown in 3

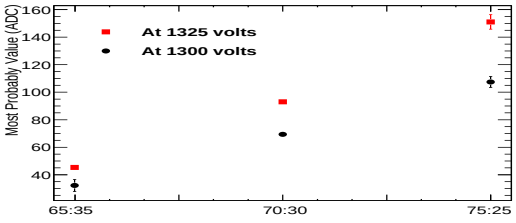


FIG. 3: Pion energy deposition (mpv value) as a function of gas mixture ratio

After fixning gas mixture at ($Ar : CO_2 = 70 : 30$) the efficieny over operating voltage was obtain and t he efficiency is almost constant beyond 1300 Volts as shown in figure 4.

In the present case simulations of energy deposition were carried out using single particles

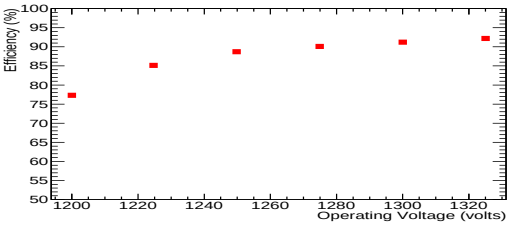
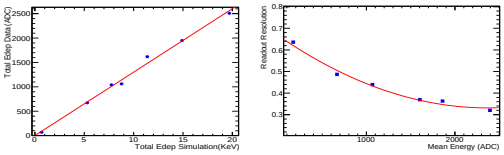


FIG. 4: Efficiency at different operating voltages of PMD



(a) (b)

FIG. 5: The cluster signal in simulation to cluster signal in data for different energy with combination converter of different radiation length at 1300v, b. Read out resolution

electrons of different energy with various converter thickness. Fig. 5 shows a comparison of the simulated data (in keV) with the experimental data in ADC units as obtained for the operating voltage of -1300 V. Further introducing the readout resolution the data was reproduced in simulation. The results indicate a nice correlation which is expected to be useful for photon counting using the PMD in ALICE.

Acknowledgment

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