Test results on the ALICE photon multiplicity detector modules with electron and pion beams at CERN

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Introduction

The Photon Multiplicity Detector (PMD) is designed to measure the multiplicity and the spatial distribution of photons, in the pseudo-rapidity region ($2.3 < \eta < 3.7$) in ALICE (A Large Ion Collider Experiment) at LHC. It consists of a charged particle veto (CPV) and a preshower plane with full azimuth coverage. A $3X_0$ thick Pb converter is sandwiched in between these two planes. Each plane of the PMD consists of 24 gas tight enclosures called modules[1]. Each module consists of an array of closely packed hexagonal proportional counters, with wire readouts. A mixture of $Ar + CO_2$ (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). In this short communication we present some results obtained with few PMD modules using pion and electron beams, at different energies, carried out at CERN PS.

Experimental setup

Two honeycomb detector modules, each consisting of a matrix of 48×96 hexagonal cells were tested at the CERN PS in a configuration where one module (in the front) was used as a CPV plane, the other placed behind, being the preshower plane. Data were taken for a π^- beam of energy 5 GeV and electron beams at energies of 2, 3, 4 and 5 GeV at different high voltages with and without the Pb converter. The two modules were mounted on a stand having facility for XY movement. Two pairs of scintillator detectors and a finger scintillator, in a five-fold coincidence, produced the trigger for pions. In case of the electron beams, one pair of cross scintillators, a Cherenkov detector and a finger scintillator were used for a four-fold coincidence trigger. A schematic of the experimental setup is shown in Fig. 1.

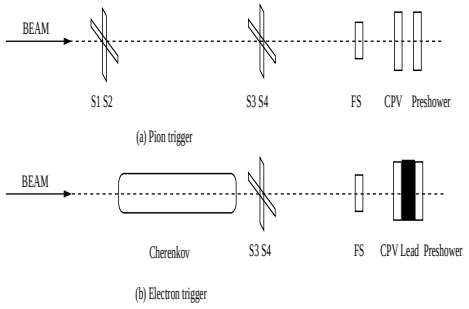

FIG. 1: Schematic of the test beam arrangement. (a) setup for pion trigger, (b) setup for preshower studies with a lead converter (shown as dark block) in between the two modules and a Cherenkov counter for electron trigger.

Results and discussion

First we present the response of the detector (for both preshower and CPV planes) for 5 GeV charged pions, π^-, without the converter. For this the pulse height spectra at different voltages were recorded and studied. For

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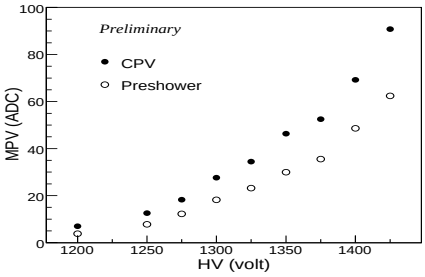

FIG. 2: Variation of the most probable value (MPV) of the pulse height distribution for 5 GeV π^- as a function of applied negative high voltage. The solid and open symbols correspond to the CPV and the preshower planes respectively.

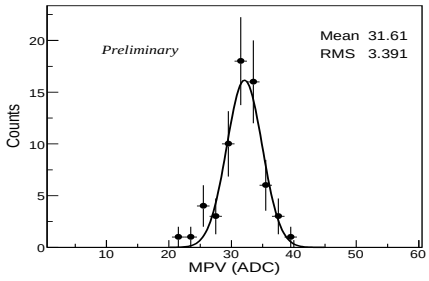

FIG. 3: Cell-to-cell variation of MPV of the pulse height distribution in 63 cells of the preshower plane kept at -1350 V.

all the applied voltages the spectra pulse were found to well developed Landau distributions. Fig. 2 shows the variation of the most probable value (MPV) of the ADC distributions as a function of applied voltage. The curves show good linearity around -1350 V which we take as the operating voltage. The MPV values for both the planes are further seen to increase with increase in applied voltage. However, the results for preshower plane are lower compared to those of the CPV plane. In the absence of the converter, the observed differences could be attributed to the difference in gains for the two detectors.

Using pion beams, the cell-to-cell variation of average pulse height, in the preshower plane was studied at the operating voltage of -1350 V. In this a total of 63 cells were considered. The MPV distribution for these 63 cells is shown in the Fig. 3. The average value of the MPVs and the RMS for all the cells studied were found to be 32 and 3.4 ADC units respectively, indicating a 11% cell to cell variation.

An electron or a photon beam passing through a Pb converter produces electromagnetic showers which result in energy deposition in a cluster of cells in the preshower plane. To get the true energy deposited in the preshower plane it is necessary to calibrate the cluster ADC deposited against the actual energy deposited which is obtained using simulations. In the present case simulations of energy deposition were carried out using single particles electrons of different energy with various converter thickness. Fig. 4 shows a comparison of the simulated data (in keV) with the experimental data in ADC units as obtained for the operating voltage of -1350 V. The results indicate a nice correlation which is expected to be useful for photon counting using the PMD.

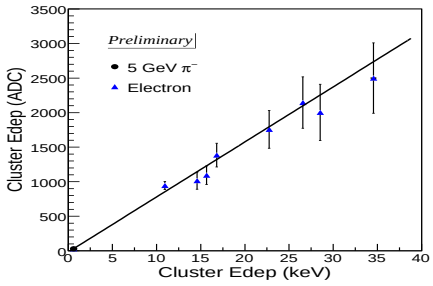

FIG. 4: Average cluster signal in data (in ADC units) vs. average cluster signal in simulations (in keV units) for various combinations of electron energy and converter thickness for preshower configuration at -1350 V.

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References

[1] Addendum to the TDR of the PMD, CERN/LHCC 2003-038.