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Small-pads Resistive Micromegas for Operation at Very High Rates

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The resistive Micromegas detectors have already proved to be suitable for precision tracking in dense particle rate environment up to few kHz/cm^2. In order to achieve even higher rate capability, with low occupancy up to few MHz/cm^2, fine-segmented strips could be replaced by few mm^2 pads.
We present here a solution based on small anode pads, overlayed by an insulating layer with a pattern of resistive pads on top. The readout and resistive pads are connected by intermediate resistors embedded in the insulating layer.
A first prototype has been constructed at CERN, composed of a matrix 48x16 of read-out pads with rectangular shape 0.8mm x 2.8mm (pitch of 1 and 3 mm in the two coordinates), for a total of 768 channels read-out by 6 APV-25 chips.
Characterization and performance studies of the detector have been carried out by means of radioactive sources, X-Rays, cosmic rays and test beam data. The results will be presented.

Summary

We present the development of resistive Micromegas with O(mm^2) pad readout aiming at precision tracking in high rate environment without efficiency loss up to few MHz/cm^2. The requirements of the upgrade projects of the ATLAS detector to extend the muon tracking coverage in the very forward region, up to $|\eta$⊠|=4, offers the reference figures to the developments we are pursuing.
The resistive protection is realized by overlaying the anode copper (readout pads) pads with an insulating layer with resistive pads on top, as shown in the attached file PCBschema.jpg. The readout and resistive pads are connected by intermediate resistors embedded in the insulating layer. The signal is transmitted to the readout pads by capacitive coupling, while the charges are evacuated through the intermediate resistors.
A first small size prototype has been already designed and constructed. The layout is reported in the attached file layout.jpg. It consists of a matrix of 48x16 pads. Each pad has rectangular shape with dimension of 0.8x2.8 mm^2 and pitch of 1 and 3 mm in the two coordinates. The active surface is 4.8x4.8 cm^2 with a total number of 768 channels. A photo of one built anode plane is shown in photoplane.jpg.
The drift and amplification gaps of this Micromegas prototype are 5mm and 128 μm, respectively.
Characterization and performance studies of the detector have been carried out by means of radioactive sources, X-Rays, cosmic rays and test beam data. In the plot attached as gain.jpg the gain dependence on the amplification voltage is reported, as obtained with the detector irradiated with a 55Fe radioactive source for different regions (centre and edges). The results are compatible with other resistive strips bulk Micromegas detectors. A gain of ˜10^4 is reached with the chambers operated at an amplification voltage of 530V. In the attached file residual.jpeg the distribution of the residuals, in the precision coordinate, with respect to high momentum muon is reported. A spatial resolution of 190 μm (from 1 mm pad pitch) has been obtained. The efficiency of the chamber has been moreover evaluated as a function of the amplification and drift voltages. Efficiency higher than 97% at Vamp of 480V and Vdrift of 300 V has been measured. The chamber has been exposed also to a high intensity pion beam to study the effect under high particle flow.

Primary authors: MARIAGRAZIA, Alviggi (Universita e INFN, Napoli); GRIECO, Chiara (Universita e INFN, Napoli); ROSSI, Eleonora (Roma Tre Universita Degli Studi); PETRUCCI, Fabrizio (Roma Tre Universita Degli Studi); SEKHNIAIDZE, Givi (Universita e INFN, Napoli); CAMERLINGO, Maria Teresa (Universita e INFN, Napoli); DELLA PIETRA, Massimo (Universita e INFN, Napoli); IODICE, Mauro (Roma Tre Universita Degli Studi); BIGLIETTI, Michela (Roma Tre Universita Degli Studi); DI DONATO, Michela (Universita e INFN, Napoli); SIDIROPOULOU, Ourania (Bayerische Julius Max. Universitaet Wuerzburg); IENGO, Paolo (CERN); FRANCHINO, Silvia (Ruprecht-Karls-Universitaet Heidelberg); VECCHIO, Valentina (Roma Tre Universita Degli Studi); CANALE, Vincenzo (Universita e INFN, Napoli)

Presenter: MARIAGRAZIA, Alviggi (Universita e INFN, Napoli)

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