ATLAS NOTE

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Performance of a new prototype of resistive micromega

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Abstract

Resistive micromegas v2.0 are an evolution of the prototype v1.0, the performance of which is described in the note ATLAS-COM-UPGRADE-2013-019. The resistive anode of prototype v1.0 is constructed by etching a 64 mμ layer of kapton, filling the grooves with resistive paste, and polishing the anode to a flat surface. To simplify the production and reduce costs, the resistive anode of v2.0 consists of 35 mμ-thick ribbons of resistive paste laid on top of the kapton foil. The kapton pillars supporting the mesh rest on the resistive ribbons. In the v1.0 detector, the breakdown voltage knee does not depend on the radiation intensity. As it was the case for non-resistive micromegas, in which the gap between anode strips is not filled with insulator, the breadown knee of v2.0 prototype does depend on the radiation intensity. In addition, the radiation-induced breakdown is self-sustained and can be eliminated only by lowering the voltage of the amplifying gap by 100 volts.

1 Detector description and result

As for the resistive micromega v1.0 (see Fig. 1), the amplifying gap of the v2.0 prototype is 128 μm thick. The cathode is a woven stainless mesh with 400 lines/in and a wire thickness of 18 μm. The mesh is kept at the 128 μm distance from the anode by a matrix of Pyralux pillars with 400 μm diameter and spaced by 2 mm in the x and y direction. The anode of v2.0 consists of resistive ribbons 35 μm thick, 100 mm long in the x direction, 180 μm wide, and with a 250 μm pitch. Each resistive strips is connected to ground with a 45 MΩ resistor. The resistance of each strip is 100 MΩ/cm. The 70 μm gaps between resistive strips are not filled with insulator. The resistive layer is built on top of the y-readout electrode. The y electrode consists of 18 μm thick copper strips, 80 μm wide, with a 250 μm pitch and 10 cm long in the y direction. The y readout is separated from the resistive anode by a 64 μm layer of photo-imageable cover-lay. A similar cover-lay separates the y readout from the x readout which consists of 18 μm thick copper strips, 200 μm wide, with a 250 μm pitch, and 10 cm long in the x direction. The y readout is built on top of a 1 mm thick FR4 board, copper cladded and grounded on the opposite side. The drift gap

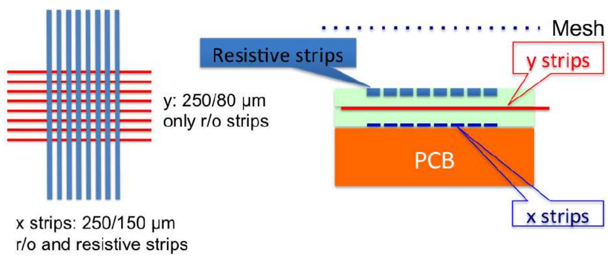

Figure 1: Resistive chamber sketch. Readout trip layout (left): the bottom x-readout strips are parallel to the resistive strips and orthogonal to the y-readout strips. Vertcal cross section (right). The figure is reproduced from Ref. [1].

is built on top of the amplifying gap. Its thickness is 5 mm.

The resistive micromega v2.0 has been produced by the CERN PCB facility in January 2013. Upon arrival, we apply 1050 V to the amplifying gap filled with air using a CAEN N1470 power supply with a current limit of 2 μA. After two days, the gap does not draw any dark current at 1050 V. Thereafter, the chamber is filled with a 93%Ar+7%CO2 or a 85%Ar+15%CO2 gas mixture. The mesh is set to ground and the resistive anode to positive voltages between 400 and 620 V depending on the gas mixture. The electric field across the drift gap is set to 200 V/cm. We measure the micromega amplification factor or gain by using a 10 μCi Fe^{55} source and assuming that 6 keV photons produce 300 electron-ion pairs in the drift volume. As in the previous study [2], the x-readout electrodes are floating and the charge of the signal induced on the sum of all y-readout strips is integrated with an ORTEC 142C preamplifier.

Fig. 2 shows the micromega v2.0 gain as a function of the voltage. For the same voltage, the gain of the v2.0 micromega is appreciably higher than that of the v1.0 detector because, due to the smaller thickness of the resistive anode, the y readout is closer to the mesh and the value of the effective field is higher [2]. The gain of the detector is measured up to the breakdown voltage, beyond which the gain is constant. For the 93% Ar + 7% CO_2 mixture, a 10^4 gain at the y electrodes is reached at 545 volts whereas the breakdown voltage knee is at 560 V. For comparison, the v1.0 detector provides a 10^4 gain at 560 V with a breadown knee of 575 V. The breakdown knee of the v1.0 detector does not depend the amount of radiation. In the case of the v2.0 micromega, a rate of ionizing particles of the order of 1 kHz/cm^2 provided by a ^{207}Bi source lowers the breakdown knee to 540 V. The rate of sparks at the lower breakdown knee is self-sustained and does not vanish when removing the radioactive source. The spark-induced current is solely reset by bringing the voltage below 500 V.

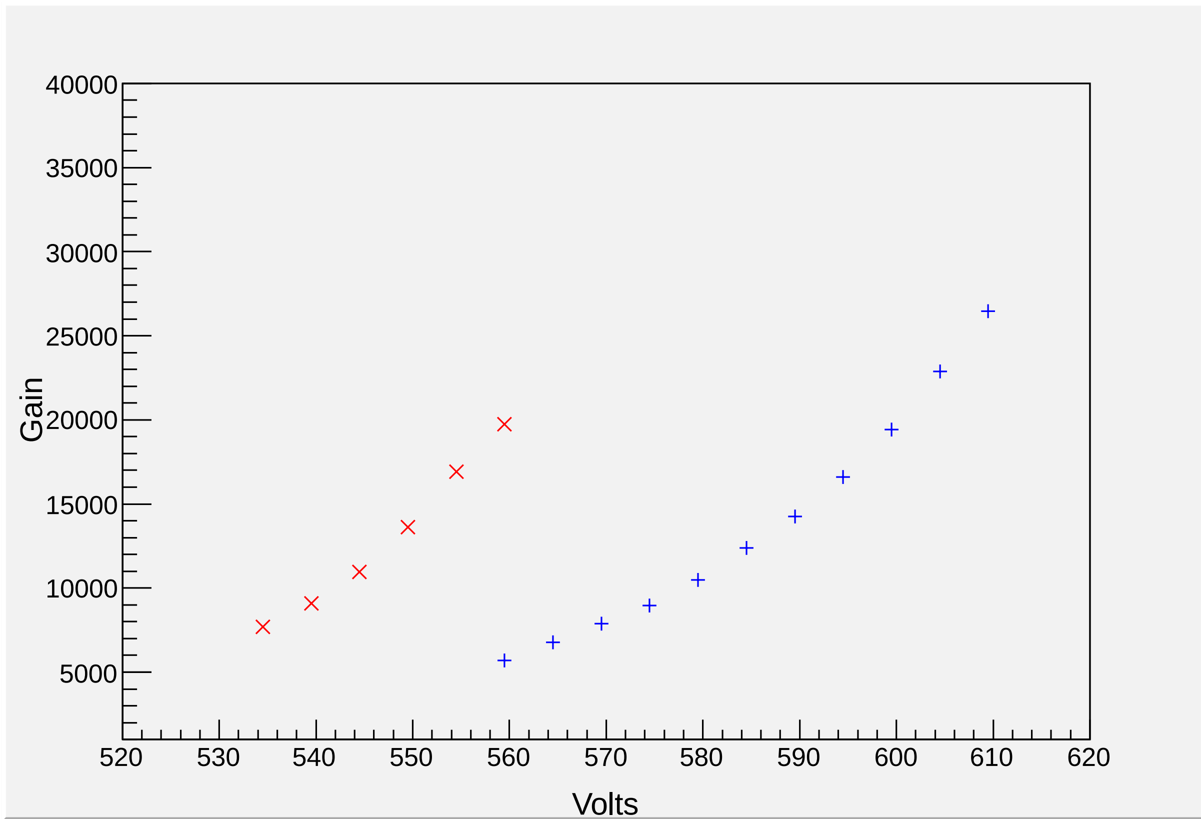

Figure 2: Gain of the resistive micromega filled with (red crosses) a 93% Ar + 7% CO_2 mixture and (blue crosses) a 85% Ar + 15% CO_2 mixture as a function of the anode voltage. The signal is read from the y electrode.

References

[1] M. Byszewsky and J. Wotschack, doi:10.1088/1748-0221/7/02/C02060

[2] J. Connors *et al.*, ATLAS-UPGRADE-2013.