A Microstrip Gas Chamber for Charged Particle Tracking

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In the last years Microstrip Gas Chambers (MSGC) have found widespread interest as charged particle tracking devices, as they combine high position resolution with high rate capability. We built a MSGC for tracking of heavy ions over a wide dynamic mass and energy range. The device was successfully operated in several experiments with ^{3}He ($E_{kin} = 8\,A \cdot MeV$), ^{12}C ($E_{kin} = 300\,A \cdot MeV$) and ^{187}Re ions ($E_{kin} = 340\,A \cdot MeV$) [1,2]. A schematic view of the detector is shown in Fig. 1.

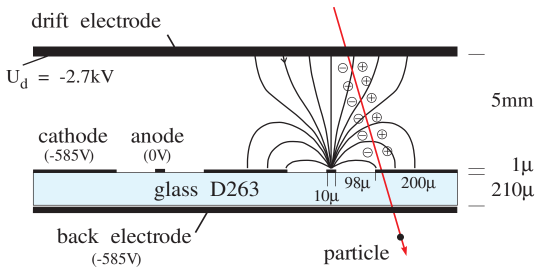

Fig. 1: Schematic view of the MSGC with a pitch $\Delta x = 406\,\mu m$.

The MSGC has an active area $A = 51 \times 24\,mm^2$ with a pitch $\Delta x = 406\,\mu m$ and a $5\,mm$ drift gap. The strip pattern - $10\,\mu m$ wide anode strips and a $200\,\mu m$ wide cathode meander (aluminium) - is deposited onto a $210\,\mu m$ thick glass substrate (D263) with metallized back plane. The anode strips are connected in alternating order to two different resistor chains, which are read out using charge sensitive preamplifiers, shaping amplifiers and ADC's (see Fig. 2).

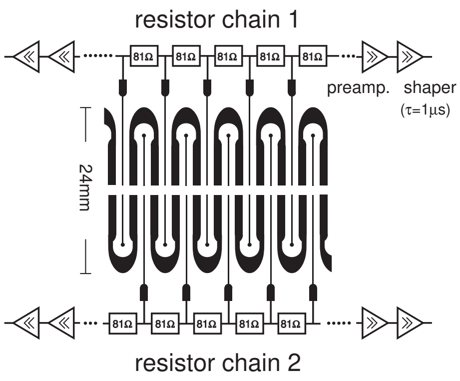

Fig. 2: Strip pattern and readout scheme of the MSGC.

Due to the incident angle of the particle and the diffusion in the gas, the charge deposition in the drift gap is always spread over both resistor chains. Thus, the position of the incident particle is deduced by measuring the position on each chain via charge division and then by interpolating between both chains using a weighted mean method.

At the Munich Tandem the detector was irradiated with $E_{kin} = 24\,MeV$ ^{3}He ions. The energy loss of the ions passing the $5\,mm$ drift gap was $\Delta E \simeq 180\,keV$. The MSGC was operated at $p = 950\,mbar$ with Ar-DME (70/30) as detector gas at a gain $g \simeq 2000$. In Fig. 3, the corresponding position spectrum obtained with a single resistor chain is shown. The position spectrum clearly reflects the strip pattern of a single chain with a pitch $\Delta x = 812\,\mu m$. A position resolution $\Delta x = 406\,\mu m$ is then achieved by an interpolation between the positions of the incident particle measured with both resistor chains.

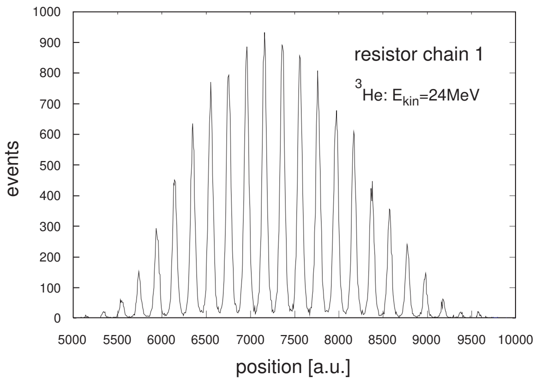

Fig. 3: Position spectrum of $E_{kin} = 24\,MeV$ ^{3}He ions obtained with one resistor chain.

In case of using a high resistive glass substrate, a gain drop of the MSGC is observed with increasing rate of incident particles. This effect is caused by ions from the avalanche process charging up the substrate. In Fig. 4, the dependancy of the gain on the rate of incident ^{3}He ions is displayed for two different modes of operation. In the first mode the voltage of the back plane was set to the voltage of the cathode strips ($V_b = V_c$). A gain drop by almost 50 % is observed with the rate increasing from 10 to 10^3 [$ions/mm^2 \cdot s$]. Operating the device in a mode with the back plane voltage set to the anode voltage ($V_b = V_a$), the gain drop is reduced to about 20 % in the same range. However, this mode is correlated to lower gain at low rate.

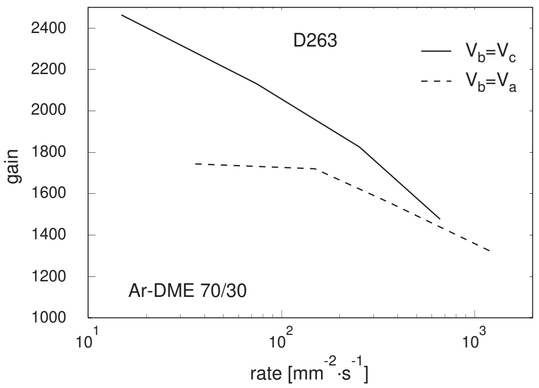

Fig. 4: Rate dependance of the gain for two different settings of the back plane voltage

Nevertheless, stable performance of the detector and high position resolution could be achieved in both modes of operation even at high count rates.

References

[1] H. Gilg et al., this report p. 101
[2] E. Wefers et al., this report p. 52