A Microstrip Gas Chamber for Relativistic Heavy Ion Tracking

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Due to their low mass density and high count rate capability **M**icro**S**trip **G**as **C**hambers (MSGC) seem to be an appropriate device for high accuracy tracking of relativistic heavy ions. At the *LKM* we built MSGC's with different strip patterns (Al) deposited onto a $210\,\mu m$ thick glass substrate (D263) with metallized back plane. MS1 has an active area $A = 130 \times 70\,mm^2$, $10\,\mu m$ anode strips with a pitch $\Delta x = 200\,\mu m$ and $90\,\mu m$ wide cathode strips. MS2 has a special pattern with an active area $A = 54 \times 24\,mm^2$, $10\,\mu m$ anode strips with a pitch $\Delta x = 406\,\mu m$ and a $200\,\mu m$ wide cathode meander [1]. Both types have a $3\,mm$ drift gap and the anode strips are individually read out using a VLSI charge sensitive circuit based on the GASSIPLEX-chip.

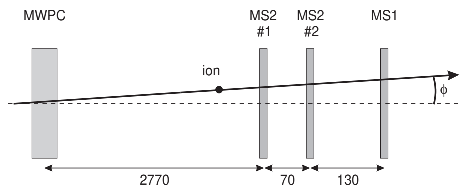

Fig. 1: Schematic view of the experimental setup at FRS

1. Position resolution

At the 0°-magnetic spectrometer FRS at GSI in Darmstadt a setup of MS2 detectors (see fig. 1) was irradiated with a separated beam of heavy projectile fragments ($E_{kin} \simeq 500\,A{\cdot}MeV$, $Z \simeq 39$, $A \simeq 90$) to determine the position resolution. The MSGC's were operated at a gas gain $g \simeq 30$ with Ar-DME (97/3) as detector gas at atmospheric pressure. The energy loss of nuclear charge $Z \simeq 39$ ions in the $3\,mm$ drift gap was $\Delta E \simeq 1.4\,MeV$. With an additional MS1 detector and a multiwire proportional chamber (MWPC) mounted $3\,m$ upstream the particles' incident angle was determined to an accuracy $\Delta\phi \simeq 0.5\,mrad$.

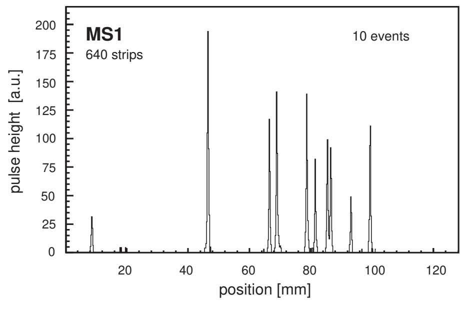

Fig. 2: Accumulted pulse height spectrum of the 640 anode strips of MS1 produced by 10 ions.

Fig. 2 shows an accumulted pulse height spectrum of the 640 anode strips of MS1 produced by 10 ions of different nuclear charge passing MS1.

For each MS2 detector the position of the passing ion was determined by a calculation of the modified pulse height weighted center of gravity of the positions of the hit anode strips taking into account a correction of the ADC-threshold. A coincidence of all 4 detectors was required and a cut on the energy loss in all MSGC's and the incident angle was set. Fig. 3 shows a correlation plot of the particle's position measured in each MS2 detector. Assuming both detectors identical and taking into account multiple scattering in the first MS2 device ($\sigma \simeq 25\,\mu m$) and the accuracy of the angular cut ($\sigma \simeq 30\,\mu m$) an intrinsic position resolution $\sigma \simeq 70\,\mu m$ for a single MS2 detector was deduced.

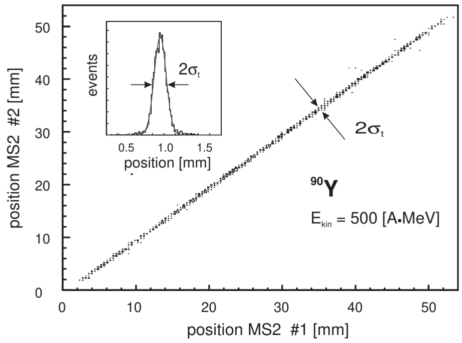

Fig. 3: Correlation of the particle's position measured in each of the MS2 detectors.

2. Count rate capability

MS2 detectors were manufactured on substrates of different electrical conductivity; high bulk resistive D263 glass ($\varrho \simeq 10^{16}\,\Omega\,cm$), D263 glass coated with a CVD-diamond layer ($R_\square \simeq 10^{14}\,\Omega$) and a low bulk resistive S8900 glass ($\varrho \simeq 10^{12}\,\Omega\,cm$). Operated with Ar-DME (70/30) at a gain $g \simeq 3000$ the detectors were illuminated with $8\,keV$ X-rays from a generator source. Fig. 4 shows the count rate stability of the different MSGC's. Due to charging up MSGC's on D263 substrate show a strong gain variation with increasing rate depending on the back plane potential. With diamond coating the variation is decreased but still remarkable. The lowest dependancy is observed with S8900 substrate. Nevertheless, count rates up to $10^5\,[mm^{-2}s^{-1}]$ can be processed with all three devices.

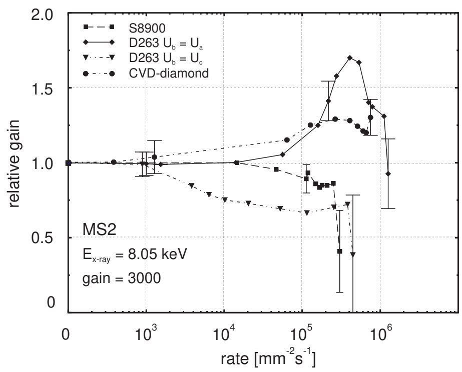

Fig. 4: Count rate stability of MSGC's manufactured on S8900, D263 and CVD-diamond coated D263 substrate.

References

[1] C. Erbe *et al.*, Jahresbericht 1995, p. 104