A Fast Ionisation Chamber for the Identification of Relativistic Heavy Ions ◇

A. Stolz, T. Faestermann, H. J. Körner, R. Schneider, and E. Wefers

At the GSI in Darmstadt a substantial increase of beam intensities is expected for 1998. This is especially useful for the exploration of exotic nuclei produced by projectile fragmentation, where low production rates are the limiting factor. The fragments are separated by the 0°-magnetic spectrometer FRS and identified by detectors located in its focal planes. To make use of the higher beam currents, an ionisation chamber for measuring energy loss and position of the ions has been developed.

To achieve a high rate capability of up to 10^5 ions per second the very fast and dense CF_4 gas at atmospheric pressure and a small drift gap of 4 cm was used. The overall length of the detector could be limited to 22 cm while still obtaining Z resolution for $Z = 50$ isotopes. The total active area of 200×40 mm^2 is adopted to the geometrical acceptance of the mid focal plane of the FRS.

For field homogenization 1 μm thick aluminium strips with a pitch of 0.76 mm were deposited onto the entrance windows (D263 float glass, 210 μm thick) using photolithography. The SMD resistors for the voltage divider chain were directly mounted on the glass plate with electrically conductive glue. This type of homogenization allows a compact setup and provides a very homogenous mass thickness important for the operation in the magnetic spectrometer.

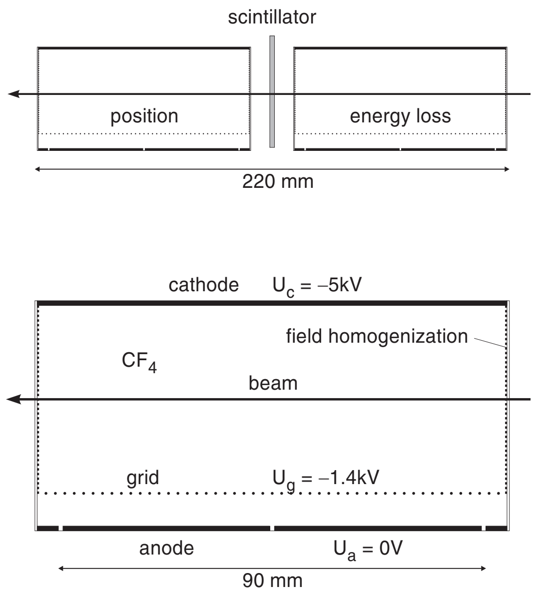

Fig. 1: Schematic view of the detector setup and the ionisation chamber.

A 1 mm thick plastic scintillator (Bicron BC-420) mounted between two identical ionisation chambers provided the trigger signal for the readout which could be also used for the start of a time of flight measurement in the FRS. The scintillation light was detected by fast photomultipliers (Hamamatsu R2083) separated 10 cm from the scintillator edges realizing a time resolution of $\Delta(t_{left} - t_{right}) =$ 115 ps (FWHM).

◇ supported by BMBF

At the FRS the ionisation chamber was irradiated with $E_{kin} = 850$ MeV·A ^{179}Au ions and with fragments with a nuclear charge of $Z = 30 - 60$.

A position resolution in x direction $\Delta x = 2.5$ mm (FWHM) was realized by a 3 fold segmented backgammon anode. By the measurement of the drift time a position resolution in y direction $\Delta y = 1.5$ mm (FWHM) was achieved. The measured drift velocity of $v_d = 11$ cm/μs at an electric field of $E = 0.8$ kV/cm and the average energy required to produce one electron-ion pair $W_i = 52$ eV are in good agreement with the results reported in [1] and [2].

For a segment of 9 cm active gas length an energy resolution $\Delta E/E = 2.1\,\%$ (FWHM) for bare ^{179}Au ions was determined. For fragments in the $Z = 50$ region a nuclear charge resolution $\Delta Z = 0.71$ was achieved. Though CF_4 gas with an impurity concentration of less than 10 ppm and a purification system (Oxisorb, Messer Griesheim) was used a loss of charge in the order of 0.5% per cm drift length was observed. For the Z identification this effect can be corrected using the measured y position.

For a comparison the same ionisation chamber was also operated with argon-methane (90/10). Using this common detector gas an energy resolution of only $\Delta E/E = 2.6\,\%$ (FWHM) was possible, while the nuclear charge resolution resulted to $\Delta Z = 0.84$ (see figure 2). The detected energy loss signal was not dependent on the drift length.

A new version of this ionisation chamber with an active length of 40 cm of CF_4 gas will provide a nuclear charge resolution of better than $\Delta Z = 0.35$ for $Z = 50$ ions.

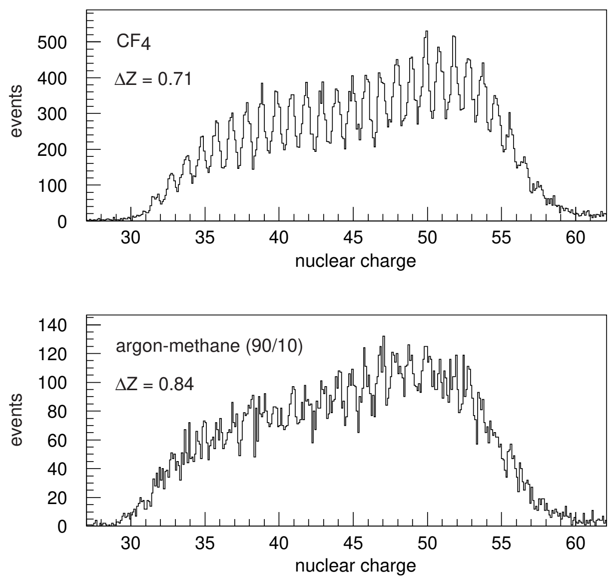

Fig. 2: Nuclear charge spectrum obtained with a 9 cm active gas length in the ionisation chamber operated with CF_4 and argon-methane (90/10).

References

[1] A. Peisert and F. Sauli, CERN 84-08, 1984
[2] A. Sharma and R. Veenhof, CERN internal report, 1997