A fast ionisation chamber for the identification of relativistic heavy ions

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At the SIS a substantial increase of beam intensity 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 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 $200 \times 40$ mm$^2$ is adopted to the geometrical acceptance of the mid focal plane of the FRS.

For the field homogenization 1 µm thick aluminium strips with a pitch of 0.76 mm were deposited onto the entrance windows (D263 noat 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 electric field. 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 $\Delta Z = 0.84$ (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 CF$_4$ gas will provide a nuclear charge resolution better than $\Delta Z = 0.35$ for $Z = 50$ ions.

At the FRS the ionisation chamber was irradiated with $E_{\text{kin}} = 850$ 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. This effect can be corrected for the $Z$ identification with the measured $y$ position.

References