A Detector System for the Identification of Relativistic Heavy Ions at High Rates

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

After the installation of the electron cooler in the synchrotron SIS at GSI the beam intensity was increased by a factor up to 10. To make use of the higher beam currents in the 0°-magnetic spectrometer FRS, a fast ionisation chamber for measuring energy loss and ionisation chambers for tracking have been developed. These detectors were successfully operated together with fast plastic scintillators for the measurement of time of flight in the S192 experiment at GSI in december 1998 [1].

The ionisation chamber for the nuclear charge determination has an active length of 400 mm segmented into 8 anode strips. To achieve a high rate capability up to 10^5 ions per second the very fast ($v_d = 11\,\mathrm{cm}/\mu\mathrm{s}$) and dense CF_4 gas at atmospheric pressure and a small drift gap of 40 mm was used. The total active area of 200×40 mm^2 is adopted to the geometrical acceptance of the mid focal plane of the FRS. The entrance windows consist of 210 μm thick float glass with a field homogenization as described in [2]. The anode stripes are read out by a newly designed preamplifier/shaping amplifier combination with a shaping time of 250 ns. Using a purifier filter (Micro Torr, SAES getters) with an achievable impurity concentration of less than 1 ppb no drift length dependent charge loss in the CF_4 gas was observed.

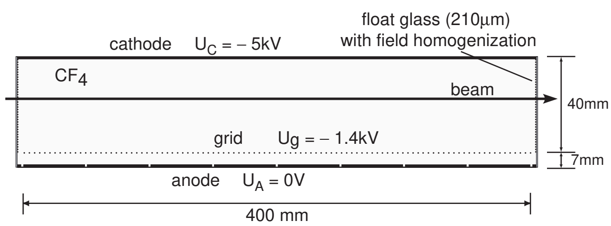

Fig. 1: Schematic view of the ionisation chamber.

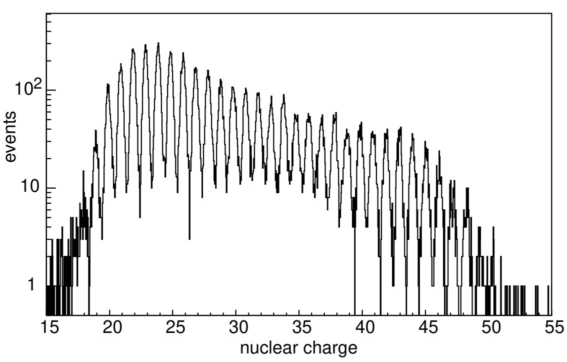

Fig. 2: Nuclear charge spectrum for fragments with an energy $E_{kin} =$ 400 MeV·A.

During the S192 experiment the ionisation chamber was installed at the mid focal plane of the FRS. For rates up to 10^5 ions per second an energy resolution $\Delta E/E = 1.2\,\%$ (FWHM) for bare ^{112}Sn ions was determined. For fragments in the region $Z = 20-50$ a nuclear charge resolution $\Delta Z = 0.42$ (FWHM) was achieved (see fig. 2). At a rate of 100 kHz a fraction of 3% of the events with an increased pulse height due to pile-up were observed. These events could be discarded using a fast scintillator signal ($\Delta t = 5$ ns) as a pile-up rejection. Accepting a reduced efficiency the chamber could be operated at rates up to 250 kHz.

For the measurement of the time of flight 2 mm thick plastic scintillators (BC-420) were mounted at the the focal planes F2 and F4 of the FRS. The scintillation light was detected by fast photomultipliers (Hamamatsu R2083) separated 10 cm from the scintillator edges (see [2]).

For the position determination of the ions tracking ionisation chambers with a highly segmented cathode and single-strip readout were used. These chambers have an active area of 200×60 mm^2 and a drift length of 10 mm in the direction of the beam. One chamber with a cathode strip pitch of 1.75 mm operated with CF_4 gas was installed at the central focal plane, while two chambers with a strip pitch of 1 mm at the end focal plane (operated with argon-methane) provided angular resolution. The strips were read out by integrated GASSIPLEX chips, which consist of 16 preamplifiers, shapers, a track and hold stage and an analog multiplexer. Most of the double hits occuring at very high rates at the central focal plane can be discriminated by using the fast but low-resolution position determination of the scintillator.

With this setup we achieved a mass number resolution of $\Delta A = 0.34$ (FWHM) for neutron-deficient fragments with mass $A \approx 100$.

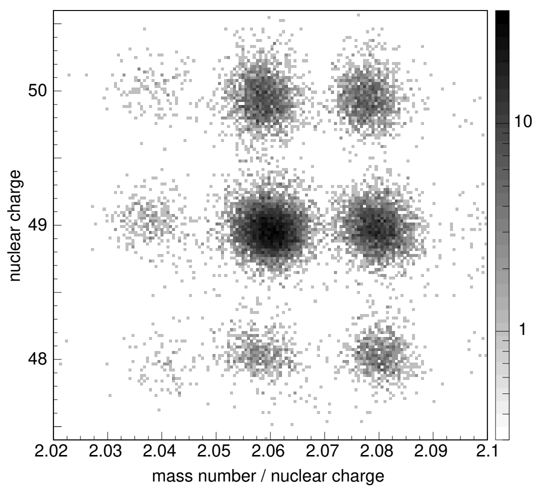

Fig. 3: Identified isotopes for a central fragment of ^{102}Sn produced by fragmentation of a ^{112}Sn beam.

References

[1] T. Faestermann *et al.*, this report p.13
[2] A. Stolz et al., GSI Scientic Report 1997, p. 188