Fragmentation of Instable Nuclei in the Mass Region A≃100 ◇

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We investigated projectile fragmentation of instable nuclei in the mass region 75<A<97 at the magnetic spectrometer FRS at GSI [1]. Instable nuclei ("primary fragments") were produced by fragmentation of $E_{kin} \simeq$ 1AGeV ^{96}Zr and ^{96}Ru ions from the heavy ion synchrotron SIS impinging on the $4g/cm^2$ Be FRS-production target. In the first stage of FRS these fragments were separated in Bρ and identified in nuclear charge Z and mass A with a detector setup mounted in the momentum dispersive central focal plane F2 (see fig. 1). The fragments' position (x $\Rightarrow$ B$\rho = \frac{p}{Z}$) was measured with multi wire proportional chambers (MWPC) and the energy loss was determined in two layers of silicon detectors (Δ E $\Rightarrow$ nuclear charge Z).

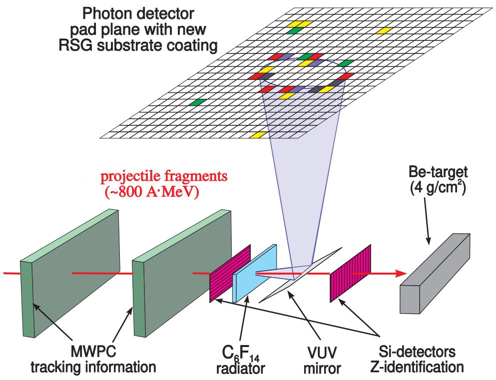

Fig. 1: Schematic view of the detector setup at the central focal plane F2 of the FRS providing a full particle identification

The fragments' velocity β was measured with a **R**ing **I**maging **CH**erenkov (RICH) detector. Cherenkov light produced by the fragments ($\beta \simeq 0.84$) passing through a 8mm thick liquid radiator (C_6F_{14}) is emitted into a cone with aperture cos $\Theta = \frac{1}{\beta n}$ and reflected by a planar $400\mu m$ thick VUV-mirror into rings on a large area 2d-position sensitive photon detector with solid CsI converter [2]. A typical ring pattern produced by a single Z = 40 fragment is shown in fig.2. Background due to scattered light, δ-electrons or electronic noise is negligible. Using a least square fit we were able to determine the ring radius (and hence the aperture Θ) with an accuracy of $800\mu m$. This corresponds to a velocity resolution of $\frac{\Delta\beta}{\beta} = 8 \cdot 10^{-4}$ (FWHM) resulting in a mass resolution ΔA = 0.42 (FWHM). Together with a nuclear charge resolution ΔZ = 0.46 (FWHM) this allowed an unambiguous identification of the primary fragments, which now formed a kind of "radioactive beam" impinging on a secondary $4g/cm^2$ Be target mounted at F2 (see fig.1). With the second stage of FRS "secondary fragments" produced in this target were separated in Bρ and completely identified in A and Z by a position measurement in the central and the final focal plane F2 and F4 using MWPCs, a determination of the energy loss in an ionization chamber (MUSIC) and a time of flight measurement (F2 $\Rightarrow$ F4) with scintillation counters.

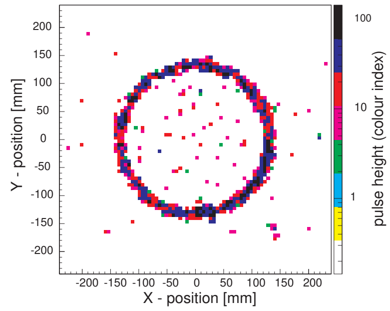

Fig. 2: Typical ring pattern on the 2d-position sensitive photon detector produced by a single Z = 40 particle

For the secondary fragments a mass resolution ΔA = 0.45 (FWHM) and a nuclear charge resolution ΔZ= 0.34 (FWHM) was achieved. Fig. 3 illustrates the quality of the isotopic separation of both, primary and secondary fragments. Measuring at different magnetic settings of FRS we were able to determine systematically the fragmentation cross sections for a variety of instable nuclei in a wide range of the mass to charge ratio A/Z (2.1 < A/Z < 2.4). A very preliminary analysis of the data shows good agreement with the empirical parameterization EPAX [3].

The concept of using a RICH detector for velocity determination offers the unique possibility of a full primary fragment identification already at the central focal plane of FRS. This is a powerful tool not only for this study but for many other experiments exploiting a well defined "radioactive beam".

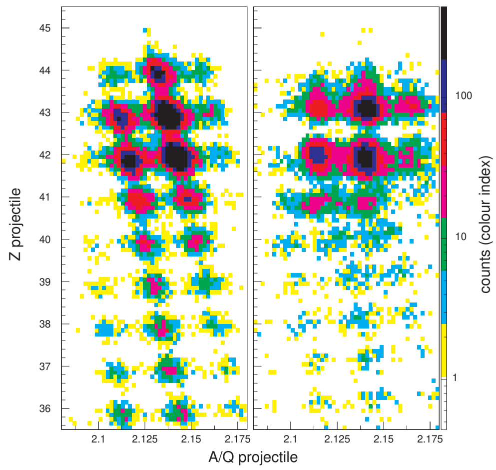

Fig. 3: Particle identification for primary fragments (left part) and for secondary fragments (right part) for ^{96}Ru beam

References

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[3] K. Sümmerer *et al.*, Phys. Rev. **C42** (1990) 2546

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