Development of slowed down beams at GSI/FAIR.

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The GSI/FAIR [1] facility will provide high-intensity relativistic beams of radioactive ions. To perform multi-step Coulomb excitation the relativistic beams will be slowed down to Coulomb barrier energies using a thick degrader. In contrast to the ISOL facilities, in the experiments with such slowed down beams, short lived fragments can be accessed with high survival probability after the deceleration. Feasibility studies of the slowed down beam setup involving deceleration of a ^{64}Ni beam upto the Coulomb barrier energy in a thick Al degrader was performed at the FRagment Separator (FRS) at GSI. The characteristics of a primary ^{64}Ni beam after deceleration were investigated with a detector system optimized for an event-by-event identification. A comparison of experimental data with the simulations is presented in this report.

Slowing down the beam in a thick degrader produces significant energy and angular straggling. The simulated energy spread for a primary ^{64}Ni beam at 250 MeV/u, slowed down to 13 MeV/u in a homogeneous Al degrader of 3.95 g/cm^2 corresponds to 9 MeV/u (FWHM) [3]. During the deceleration nuclear reactions also occur, which leads to the production of unwanted isotopes. The simulated integrated background contribution amounts to $\sim 0.1\%$ of the slowed down ^{64}Ni ions in an energy window of $\pm$0.5 MeV/u at 10 MeV/u [4]. This energy window corresponds to the time resolution of the TOF detectors used in the present experiment.

The experimental setup included a plastic scintillator and an Al degrader positioned at the final focal plane of FRS followed by two position sensitive micro-channel plate (MCP) detectors [3]. The beam velocity after the degrader was obtained from the time-of-flight (TOF) measurement between the fast scintillator and the MCP detectors. The extracted energy distribution (from TOF measurement) of the dominant ^{64}Ni ions after the degrader is shown in Fig. 1. The width of the energy distribution was 8 MeV/u (FWHM). In order to estimate the background underneath the ^{64}Ni energy peak, the simulated background distribution was scaled to the observed distribution in the range of 20 - 60 MeV/u. This resulted in a peak-to-background ratio of 2% in an energy range of 13 $\pm$ 0.5 MeV/u. The difference of an order of magnitude between the simulated and the experimental values is due the technical specifics of the experimental setup.

Summarzing, the experimental results are qualitatively in agreement with the performed simulations and hence, support the suitability of the slowed down beams for selected secondary reactions.

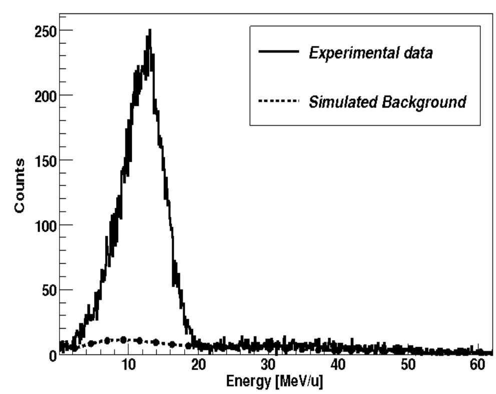

Figure 1: Energy distribution of ^{64}Ni ions after slowing down in Al degrader. An average energy of 13 MeV/u was obtained with a width of 8 MeV/u. The dashed curve represents the simulated background.

References

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