Simulations and first tests of slowed down beams project at GSI.*

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The availability of radioactive beams has opened new opportunities for the investigation of exotic nuclei. The NuSTAR HISPEC slowed down beam project [1] at GSI/FAIR aims to produce rare isotopes with energies of 10 MeV/u and less, to be used for spectroscopy and reactions studies. This paper reports on the ongoing feasibility study of slowed down beam production at the GSI FRagment Separator(FRS) facility.

At FRS the nuclei of interest are produced at high energy, they are identified with the standard tracking detectors [2] and slowed down with a thick degrader. Due to the low energy of the slowed down fragments a beam line was constructed after the thick degrader. A position sensitive transmission Time Of Flight (TOF) detector was used to reconstruct the slowed down ions trajectory and velocity on event-by-event basis.

A calculation using EPAX [3] cross sections and ATIMA [4, 5] stopping powers showed that about 80% of the fragments survive the slowing down process. The simulation also predicted that the majority of fragments created due to secondary fragmentation reactions in the degrader have different velocity compared to the ions of interest. Figure 1 shows an example calculation of the yield due to reactions in the degrader when ^{62}Co is slowed down to 10 MeV/u. The square root of the energy per nucleon is proportional to the fragment velocity. Hence, the simulation predicted that ^{62}Co will dominate by three orders of magnitude the ions created due to reactions in the degrader when a TOF gate corresponding to an energy of 10 MeV/u is applied. Based on the simulations only a TOF detector was considered for the first experiments with slowed down beams at the FRS.

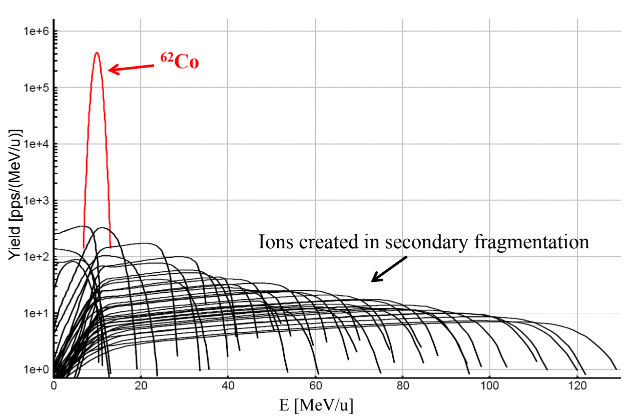

Figure 1: Calculated energy per nucleon distribution of the fragments created when ^{62}Co is slowed down to 10 MeV/u.

To test the simulations an experiment with a 100 μm scintillator TOF detector and a Si detector positioned after the scintillator was performed in 2007. The Si detector thickness was sufficient to stop 20 MeV/u, ^{62}Co ions. A ^{64}Ni beam was used to create ^{62}Co, which was slowed down to 10 MeV/u. The experiment confirmed the simulated energy and angular straggling. Figure 2 shows the ^{62}Co energy detected with the Si detector as a function of the TOF. A narrow energy distribution around 10 MeV/u was selected with a TOF gate applied to the spectrum shown in the figure. It was observed that the width of the energy distribution is 5 times larger than the expected one. This was attributed to the inhomogeneity of the scintillator detector used in the experiment. Hence, to remove

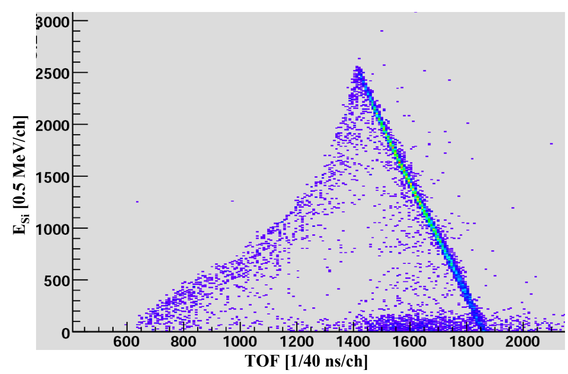

Figure 2: Energy of ^{62}Co deposited in the Si detector versus the TOF measurement with the 100 micron scintillator detector.

the uncertainty due to the energy loss into the TOF detector, a development of fast timing from a large area thin Double Sided Silicon Strip Detector (DSSSD) was initiated. In a follow up test experiment at UNILAC, a 40 μm, 5x5 cm^2 DSSSD detector was tested with pre-amplifiers developed at GSI. A time resolution of 80 ps was obtained, based on the noise level and signal rise time.

Currently there is an on going development of thin TOF detectors to be used at the slowed down setup at FRS. This development will be followed by a proof of principle experiment with slowed down beams.

References

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