Tests with slowed down beams at GSI.*

P. Boutachkov[1], M. Górska[1], N.A. Kondratjev[2], S. Pietri[1], F. Naqvi[1], J. Gerl[1], H. Weick[1], W. Prokopowicz[1], H. Schaffner[1], C. Nociforo[1], H. Geissel[1], I. Kojouharov[1], M.A.G. Alvarez[3], I. Mukha[3], K. Hadynska[4], P. Napiorkowski[4], and D. Pietak[4]

[1]GSI, Darmstadt, Germany; [2]FLNR, JINR, Dubna, Russia; [3]Seville University, Seville, Spain; [4]Warsaw University, Warsaw, Poland.

The NuSTAR HISPEC slowed down beams project at GSI/FAIR aims to produce rare isotopes with energies of 10 MeV/u and less, to be used for spectroscopy and reactions studies.

The radioactive beams produced at the NuSTAR FAIR facility of sufficient intensity to perform Coulomb excitation, resonance or transfer reactions studies are included in the nuclear chart shown on Figure 1. There is limited or no information on the excited sates of many of these nuclei. The high production rates of slow down beams at FAIR will allow detail studies of these systems.

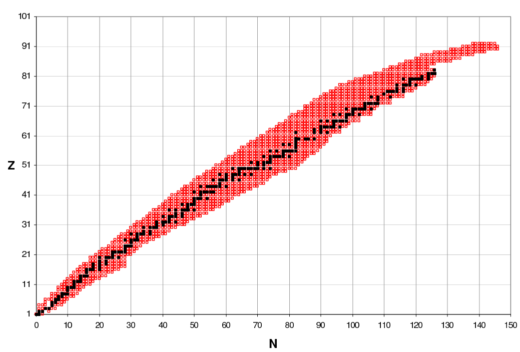

Figure 1: Radioactive beams which are expected to have sufficient intensity for reaction studies after slowing down. The simulation includes expected production rates at Super FRS.

The slowed down beam setup at the FRS utilizes a thick degrader positioned after the fragment separator. The ions of interest are tracked and identified before the slowing down with the detectors available at the FRS [1]. After the degrader the fragments enter an evacuated tube and are detected in a transmission position sensitive Time Of Flight (TOF) detector, positioned 1.5 m down stream. The measured TOF and position are used to determine the ion velocity and trajectory on event-by-event basis. Simulation of this setup were discussed in Reference [2].

To remove the uncertainty due to the energy loss in the TOF detector, two thin transmission detectors based on Micro Channel Plates(MCP) were constructed. The detectors were tested with alpha source and fission fragment source. The measured time resolution with alpha particles between the two MCP detectors was ΔT(FWHM) $\sim$ 140 ps. The position resolution for alpha particles was ΔX_α(FWHM) $\sim$ 3 mm and ΔX_{fr}(FWHM) $\sim$ 1.5 mm for fission fragments.

In September-October 2008 a test experiment with slowed down ^{64}Ni was performed at the FRS. The experiment utilized the MCP-TOF detectors described above, 2 DSSSD detectors and NaI detectors surrounding a gold target. The averaged beam intensity on target was about 10^5 pps. The rate was limited by the response of the scintillator used for start of the TOF measurement, positioned in front of the degrader. The test provided information on the performance at high rates of the auxiliary FRS detectors (TPC, MUSIC and scintillator detectors) used for beam tracking before the degrader.

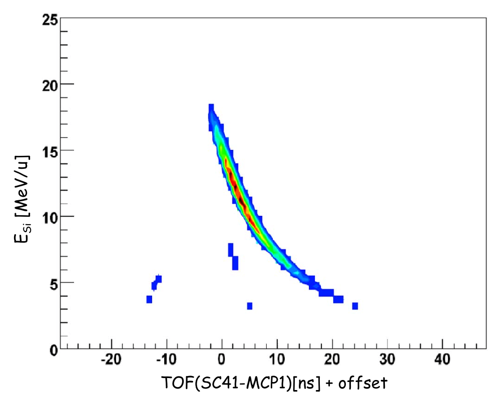

Figure 2: Energy of ^{64}Ni after slowing down, determined with a thick Silicon and a thin MCP-TOF detector.

In Figure 2 the energy spectrum after slowing down is shown. It was measured with a 300 μm Si detector and a TOF between the scintillator in front of the degrader and a the first MCP detector up stream from the target position. The energy spread in Figure 2 is smaller compared to the analogous measurement shown in Reference [2]. In the latter the energy distribution is broader due to the straggling in the TOF detector, a 100 μm scintillator.

The data is presently under analysis, which will provide an answer to the feasibility of Coulomb excitation experiments with the proposed approach.

* Work supported by EU, EURONS contract No. 91606 and Spanish MEC, FPA2006-13807-C02-01.

References

[1] H. Geissel *et al.*,Nucl. Instr. and Meth. B **70** (1992) 286

[2] P. Boutachkov *et al.*, “Simulations and first tests of slowed down beams project at GSI.”, Annual report 2007, GSI, Darmstadt