Proton removal cross-section of neutron-rich nuclei (N~20) as a probe to determine size of the nuclei

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Introduction

Nuclear size is one of the most important properties of nuclei. It carries important information about shell effects, shape deformation, and residual interactions. Measurement of proton and neutron radii in nuclei may provide information on proton and neutron skin for the nuclei near proton and neutron drip line respectively [1]. Measuring the interaction cross section it is possible to estimate the matter radius for nuclei and this technique has been used since mid 1980[2] using relativistic energy nuclear beam. Measurement of all the reaction product with 4π detector coverage for gamma detection can produce almost accurate reaction cross section specially at high beam energy. Neutron rich nuclei around N=20 magic number is our prime interest of study as it offers many open question regarding the existence of magic number for neutron rich nuclei in this region. There is an indication of inversion between *sd* and *pf* shell (island of inversion) for these nuclei. Many theoretical and experimental works in this region support this phenomenon considering the iso-spin dependent tensor forces and others terms in nuclear potential.

Experiment

We have performed an experiment [3] at GSI, Darmstadt in two phases (Jan, 2009 and Sep, 2010) to study nuclei around N=20 region. In this experiment Radioactive Ion Beam of nuclei $^{27-30}$Ne, $^{29-30}$Na, $^{31-33}$Mg, $^{34-35}$Al with energy ~450 MeV/u were produced through fragmentation of ^{40}Ar beam, delivered by the synchrotron SIS at GSI, Darmstadt impinging on ^{9}Be (8gm/cm^2) target. After the Fragment Separator (FRS) the beam was taken at cave C where all the complete kinematical measurements were performed after secondary reaction with lead (^{208}Pb) and carbon (^{12}C) target. Details of various detector calibration has been presented earlier [4,5].

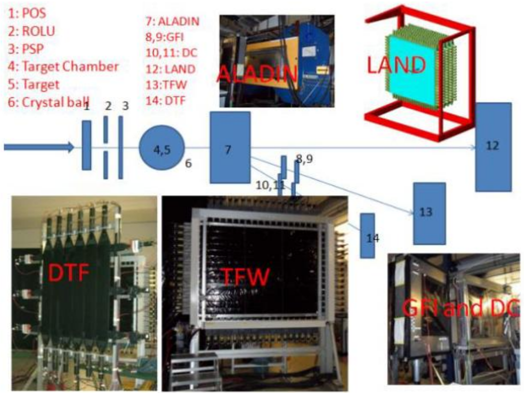

Fig 1: Experimental set up at cave C

Analysis

Incoming beam was identified by the following equation Bρ~ βγA/Z and it was used for the subsequent analysis. Here is the incoming beam profile in fig 2.

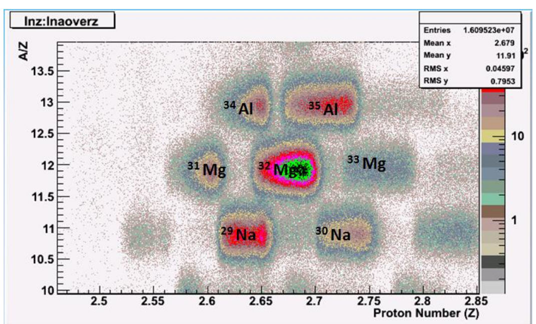

Fig 2: Incoming beam identification

TFW detector was used for the fragment identification after the secondary reaction with either carbon or lead target. Similarly DTF was used for the detection of removed proton after secondary reaction.

Isotope	29 Na	30 Na	31 Mg	32 Mg	33 Mg
σ (1p) in mb	19.95	15.73	18.72	16.39	8.59

Table 1: 1 proton removal cross section for ^{208}Pb target

These two detector have been calibrated and used for the determination of proton removal cross section. Results are presented in the following table for the lead target.

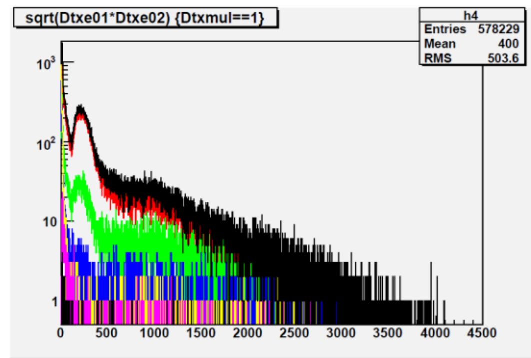

Fig 3: Gain matched individual paddle of DTF

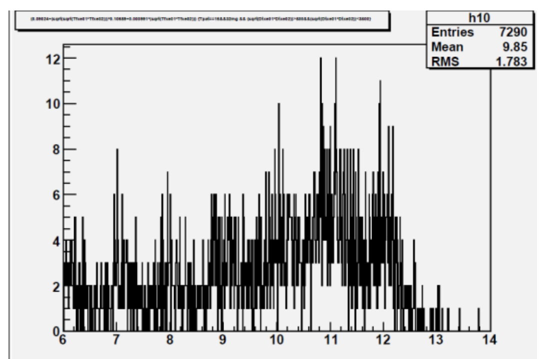

Fig 4: Proton removal spectra at TFW for ^{32}Mg

The one more important detector for this purpose is the crystal ball consist of 162 NaI detector. Calibration of this detector will provide us opportunity to select a particular channel more preciously. Calibration of this detector is going on and including of this detector will make the result more complete. All these results will be presented.

References

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