Production studies of proton-rich T=2 nuclei

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We have continued our investigations of efficiently producing the nuclei of interest to the TAMUTRAP facility using the K150 Cyclotron with the heavy-ion guide. As part of this effort, we performed a ^{24}Si production experiment using the K500 Cyclotron in combination with the MARS spectrometer.

^{24}Si was produced in fusion-evaporation reaction in an inverse kinematic mode. A primary beam of ^{24}Mg at 23 MeV/u was bombarded on a 1 atm ^{3}He gas target cooled to liquid nitrogen temperature. The reaction products were analyzed using the MARS spectrometer, which was operated with a total momentum acceptance of $\Delta p/p$ = 1.92%. Identification of the reaction products was made in the usual way: via a position-sensitive Si-strip detector in the focal plane of MARS. Fig. 1shows the energy deposited in this detector versus the vertical position in the strip detector, with the isotope of interest, ^{24}Si, clearly separated from the other reaction products.

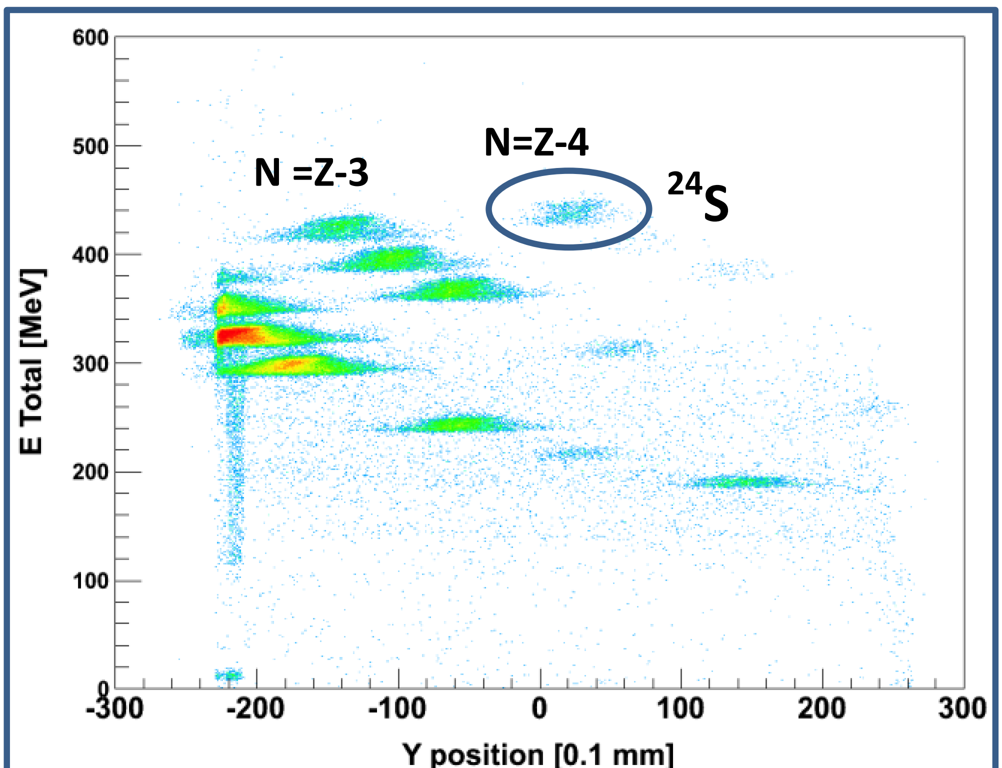

FIG. 1. Results of ^{24}Si production run, The 2D plot of the energy loss versus Y position in the strip detector separates the different reaction products.

The yield of different reaction products and isobars (A=24) produced in this reaction were determined by optimizing the rigidity settings of MARS. The production rate for ^{24}Si observed at the focal plane was twice the production rate of ^{32}Ar [1] which was also produced in fusion-evaporation reaction. Theoretical cross-section calculations for nuclei of interest were carried out using PACE4 code [2]. The calculations predict a factor of two between the production cross-sections ^{32}Ar and ^{24}Si, in agreement with the experiment.

The efficiency of MARS spectrometer needs to be known for determining the absolute cross section experimentally. In this connection, we performed an experiment for determining the transport efficiency of MARS by bombarding ^{36}Ar beam at 17 MeV/u on ^{27}Al target of thickness 75µm. The reason for using this target was to match the rigidity setting of ^{36}Ar primary beam with the ^{32}Ar secondary beam. This leads us to determine the transport efficiency of MARS for a particular rigidity setting. In this experiment, the current of ^{36}Ar after reacting with ^{27}Al target was measured at the target chamber Faraday cup and at the focal plane Faraday cup. We are currently analyzing the data and also trying to estimate the transport efficiency using LISE++ code [3].

In addition to this, we have looked into using a projectile fragmentation reaction for producing beta-delayed super allowed proton emitters. We performed an experiment for producing ^{32}Ar in this mode by bombarding a primary beam of ^{36}Ar at 17MeV/u on ^{9}Be, ^{nat}Ni and ^{27}Al targets of thickness 150µm, 6µm, and 76µm respectively. In the coming year, we will be analyzing the data of projectile fragmentation reaction, estimate the transport efficiency of MARS spectrometer and compare it with the prediction made using LISE++ code [3].

[1] O.B. Tarasov and D. Bazin, Nucl. Instrum. Methods Phys. Res. **B204**, 174 (2003), (Modified version of Julian code incorporated in LISE++ package).

[2] R.S. Behling *et al.*, *Progress in Research*, Cyclotron Institute, Texas A&M University (2013-2014), p. I-58.

[3] O. Tarasov, D. Bazin, M. Lewitowicz, and O. Sorlin, Nucl. Phys. **A701**, 661 (2002).