Production of proton-rich *T*=2 superallowed β-decaying nuclei

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Part of our recent efforts have been directed in investigating in detail the production and separation of radioactive ion beams in the energy range expected from the K150 cyclotron. Low energy secondary beams for the TAMUTRAP facility will be delivered by the Cyclotron Institute's T-REX upgrade project. In short, a large-bore 7T superconducting solenoid will act as a separator following the production target, and the high-energy RIB will be slowed and collected as a low-energy (15 keV) beam using the ANL-type heavy-ion gas catcher.

We will employ the in-flight method for producing nuclei of our interest. Our recent measurement and calculations indicate that the application of fusion evaporation or projectile fragmentation reactions seems to be a very efficient way to produce proton rich nuclei at the K150 energies. Calculations for nuclei of our interest were carried out using LISE [1] for fusion evaporation and EPAX [2] for projectile fragmentation. In Table I we tabulate proposed target and projectile combination for producing nuclei of our interest via fusion evaporation reaction in inverse kinematic mode. Secondary beams in this mode will be more forward directed with a relative small emittance.

Table I. Calculated production rates of the *T*=2 superallowed proton emitting nuclei that may be measured at TAMUTRAP. All reactions use a ^{3}He gas target cooled to 77K.

RIB	Primary Beam	Calculated Cross-section [$\times 10^{-3}$mb]	Estimated production rate [$\times 10^{5}$ pps]
^{20}Mg	^{20}Ne @ 24 MeV/u	16.2	14.0
^{24}Si	^{24}Mg @ 23 MeV/u	15.5	6.5
^{28}S	^{28}S @ 23 MeV/u	4.5	1.5
^{32}Ar	^{32}S @ 23 MeV/u	7.3	1.4
^{36}Ca	^{36}Ar @ 23 MeV/u	6.3	2.5
^{40}Ti	^{40}Ca @ 23 MeV/u	1.7	0.7

We have recently performed a ^{32}Ar production experiment using the K500 Cyclotron in combination with the MARS spectrometer to: (1) verify that the proposed reaction is able to produce ^{32}Ar; (2) estimate the total isobaric yields (A=32); and (3) determine the experimental production cross section of ^{32}Ar and compare it with the theoretical prediction.

^{32}Ar was produced in an inverse kinematics reaction by bombarding a primary beam of ^{32}S at 23 MeV/u on a 1 atm. ^{3}He gas target cooled to liquid nitrogen temperature. Reaction products were analyzed using MARS with a total momentum acceptance of $\Delta p/p$ = 1.92% . Reaction products were identified using position sensitive strip detector in the focal plane of MARS. Fig. 1 shows the energy loss versus the vertical *Y*-position in the strip detector. The yield of different isotopes/products and isobars produced in this reaction were determined by recording the 2D spectrum for different rigidity settings of MARS. The preliminary conclusion of this measurement is that the proton rich nuclei of our interest can be produced using a fusion evaporation reaction. We are currently working on determining the experimental cross section of ^{32}Ar. In the coming year on the experimental front, we will be performing ^{24}Si production experiment via fusion evaporation reaction, and production of ^{32}Ar via projectile fragmentation. On the theoretical front, we will be estimating the production cross section of proton rich nuclei of our interest using TALYS code [3].

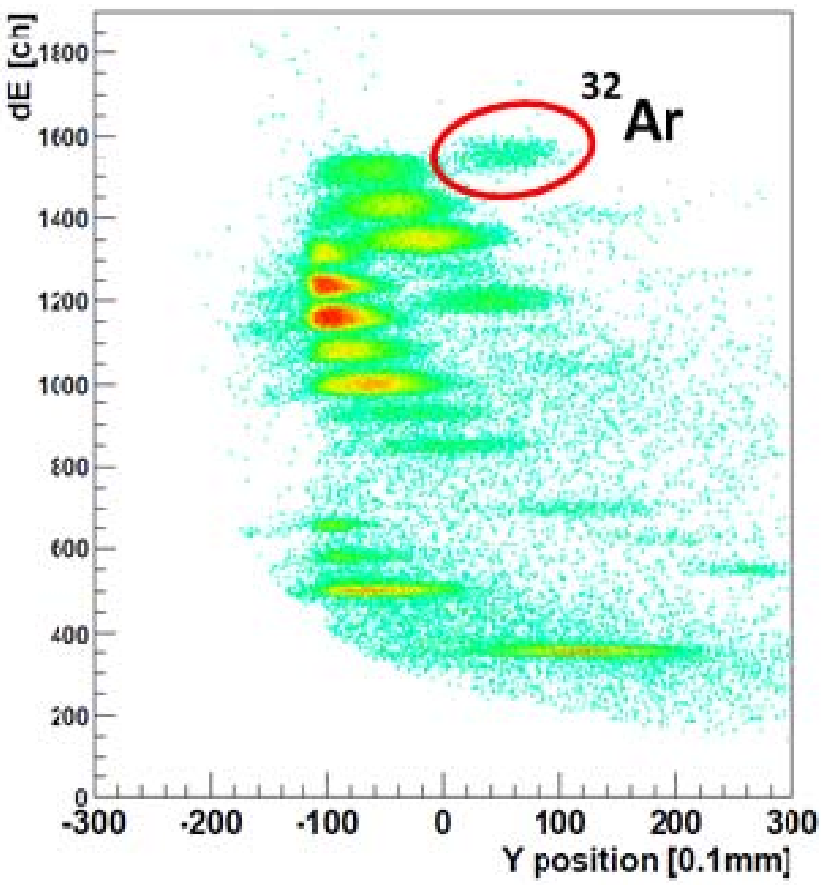

FIG. 1. Results of ^{32}Ar production run. The 2D plot of the energy loss versus Y position in the strip detector separates the different reaction products; the isotope of interest, ^{32}Ar, is clearly resolved.

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

[2] K. Suemmerer and B. Blank, Phys. Rev. C **61** (2000) 034607.

[3] http://www.talys.eu/