

handle higher rates. We concluded that a NaI detector system would be much more complicated than the present system and most likely not justified at this time.

We hope to take a few more shifts in the spring to further improve the proton beam focus. A modest time in studying the beam could greatly increase our

data collecting rate by allowing us to run with higher beam intensities. We then plan to take more data on oxygen to improve the statistical accuracy of our measurement of the angular distribution parameters.

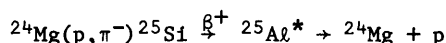
1) C.A. Heusch, R.V. Kline, and S.J. Yellin, Nucl. Inst. and Meth. 120, 237 (1974).

MEASUREMENTS OF $(p, \pi^- xn)$ AND $(^3\text{He}, \pi^- xn)$ TOTAL CROSS SECTIONS BY ACTIVATION TECHNIQUES

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In these measurements we hope to take advantage of the distinctive properties of delayed proton emitter spectra as a highly selective indicator that the reactions under study have taken place.

The initial reaction of interest is



with measurements of the β -delayed proton spectrum and the lifetimes of the various peaks being used to select events corresponding to the decay of ^{25}Si . If adequate signal-to-noise ratios and high counting efficiencies can be achieved, cross sections (which correspond to the production of ^{25}Si in any of its seven particle-stable states below the 3.42 MeV proton separation energy) will be measured as a function of energy. These data are intended to complement rather than replace spectrometer data. Using this target, it might also be possible to observe the production of ^{24}Si , produced by the $^{24}\text{Mg}(p, \pi^-)^{24}\text{Si}$ reaction.

Other targets and reactions in which the production of ^{25}Si would provide the signatures are $^{25}\text{Mg}(p, \pi^-)^{25}\text{Si}$; $^{26}\text{Mg}(p, \pi^- 2n)^{25}\text{Si}$; and $^{23}\text{Na}(^3\text{He}, \pi^- n)^{25}\text{Si}$.

Among the additional possibilities for use of the apparatus we are developing are studies of this family of reactions leading to the production of ^{21}Mg [i.e., $^{19}\text{F}(^3\text{He}, \pi^- n)^{21}\text{Mg}$] and of

^{17}Ne [i.e., $^{16}\text{O}(p, \pi^-)^{17}\text{Ne}$; $^{18}\text{O}(p, \pi^- 2n)^{17}\text{Ne}$; $^{14}\text{N}(^3\text{He}, \pi^-)^{17}\text{Ne}$; and $^{15}\text{N}(^3\text{He}, \pi^- n)^{17}\text{Ne}$].

It was hoped initially that counting on one target could proceed while the next was undergoing bombardment. This proved to be not possible because of background probably arising from neutron induced reactions in and near the detectors. A mechanical chopper was then designed and installed between the pre-injector and the injector cyclotron to provide convenient, clean beam pulsing on a time scale $\geq \sim 10$ m sec. The target wheel, its drive motor, and the associated detectors are presently being installed for runs in the 64" scattering chamber; and the chopper motor, target motor, and counting system control pulses are provided by a 6800 microprocessor.

Two runs have provided data useful for diagnostics and evaluation of the practicality of the technique. Figure 1 shows typical data summed over the time channels. The background present comes from the comparatively large amounts of ^{21}Mg and ^{17}Ne produced, together with that arising from continuum low energy protons and from the energy loss of the more energetic ^9C delayed protons passing through the 500 μm Si detector (which lose from 3 to 8 MeV in the detector). This background obscures the region in which the

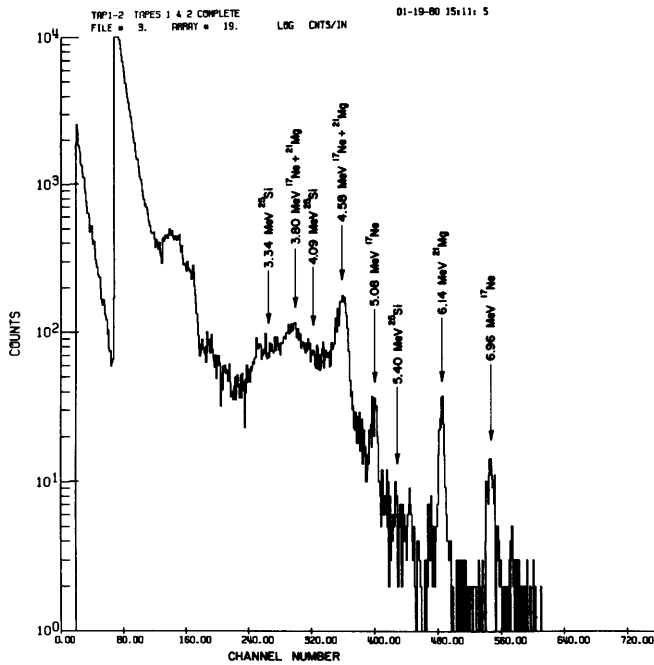


Figure 1. Delayed proton spectrum observed following 175 MeV proton bombardment of ²⁴Mg. The energies listed are the laboratory proton energies associated with the various peaks. The 5.40 MeV peak appears to decay at a rate consistent with that of ²⁵Si.

dominant ²⁵Si peak at 4.089 MeV should be seen. In the next run, use of a 1000 μm thick detector and modification of the target assembly geometry to take advantage of the unique kinematics of the (p, π⁻xn) reactions near threshold are expected to improve the signal-to-noise ratio. Relatively clean ²⁵Si peaks have been observed with lower background by using longer delays prior to the initiation of counting. This allows the shorter lived ²¹Mg, ¹⁷Ne, and ⁹C activities (~ 110-130 ms) to decay to a greater extent than the ²⁵Si activity (220 ms). This, however, reduces the overall counting efficiency considerably. We believe that the planned steps will make a significant improvement of the data quality in our next run. In addition, we plan to install ¹⁶O targets, in which case the only background protons will arise from ⁹C and the ¹⁷Ne activity and should be correspondingly easier to detect. In this case, only two states of ¹⁷Ne are particle stable.

RECOIL DETECTION OF THRESHOLD PION REACTIONS

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The technique of observing the (p, π⁰) reaction threshold by detection of the product nucleus 0° recoil was described in the IUCF 1978 report. During 1979 this technique was applied to the reactions ⁹Be(p, π⁰)¹⁰B(g.s.) and ⁹Be(p, π⁰)¹⁰B*(E_x = 1.74 MeV). The excited state is of particular interest as the third member of an isospin triplet for which the ⁹Be(p, π⁺)¹⁰Be cross section has been recently determined within 2 MeV of threshold¹, and for which the ⁹Be(p, π⁻)¹⁰C(g.s.) cross section is known at higher energy. The ⁹Be(p, π⁰)¹⁰Be(g.s.) cross section has recently been independently determined by a different technique² so that

the recoil experiment can provide information on the excited state cross section independent of absolute normalization of the recoil detection efficiency.

The excitation function for the recoil yield is shown in Fig. 1. The method used to change cyclotron energies by a fraction of an MeV requires only a few minutes so that many data points could be taken in a run of 2 or 3 shifts. The right side of the figure shows a search for the threshold ⁹Be(p, π⁻)¹⁰C(g.s.) reaction by the same apparatus. The detector in this run was set first for mass-10, charge state 5⁺, for which it was sensitive to a large background from the total (p, π⁰)