DEVELOPMENT OF A π^o DETECTOR SYSTEM

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Our activity for the past year has consisted of developing detectors that give a very clean π^o identification and searching for relatively simple detector configurations to give both an accurate value for the (p,π^o) total cross section and a reasonable measure of the differential cross section. In our previous measurements neither the detector response nor the importance of the detector geometry was understood well enough to allow extraction of absolute cross sections.

The primary building block for our detector system is a Pb-glass Cerenkov detector. The new Pb-glass detectors differ from the old ones by their dimensions (6 x 6 x 12 inches, rather than 6 x 6 x 10 inches) and the use of fast, 14 stage photomultiplier tubes. The efficiency and energy resolution of the detectors was calibrated using the tagged photon beam facility at the University of Illinois. The detectors had a detection efficiency of approximately 100% in the energy range investigated (42 MeV to 52 MeV). The new detectors were found to have a resolution of 40% and 50% FWHM for 52 MeV and 42 MeV photons, respectively, while the old detectors had resolutions of 60% and 75% at the same energies. This large increase in energy resolution facilitates discriminating against low energy background.

To test their performance under operating conditions at IUCF, two of the new detectors were set up as illustrated in Fig. 1. The gammas from the π^o decay were collimated so that they had to travel through a minimum of 12 inches of Pb-glass. We bombarded a 24.2 mg/cm^2 ^{9}Be target with a 144.3 MeV proton beam of about 60 nA. Only one final state of ^{10}B contributed since we were only 0.6 MeV above the ground state threshold. Gamma rays from π^o decay were identified by examining the time spectrum of one detector against the other, versus the time spectrum of one detector against the RF (Fig. 2). One sees that a time resolution of about 2 nsec permits an unambiguous identification of the π^o's. If one considers that the total cross section for the test reaction is on the order of 10-20 nb, the figure also illustrates the low background level for such a system. Using conditions on the 2-dimensional time spectrum to gate the pulse

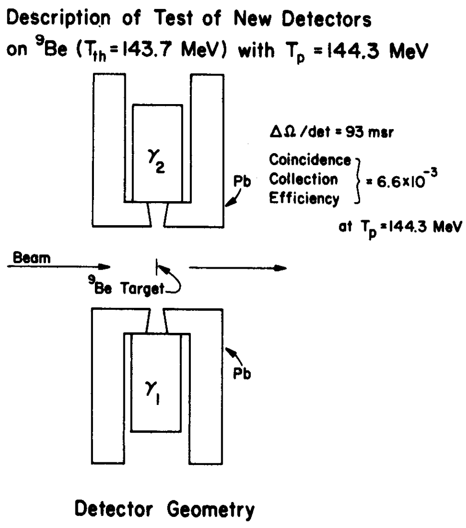

Figure 1.

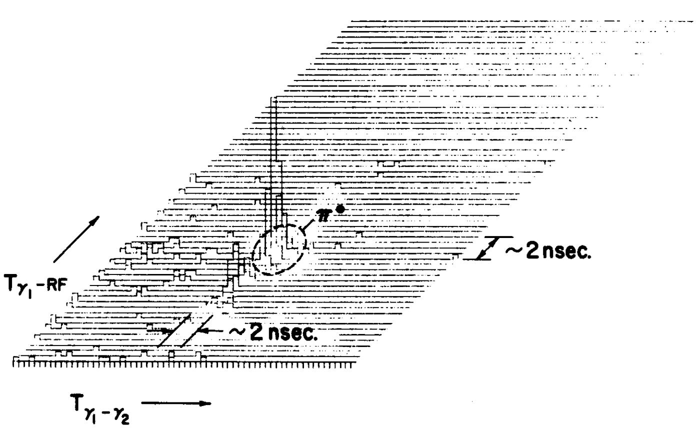

Figure 2.

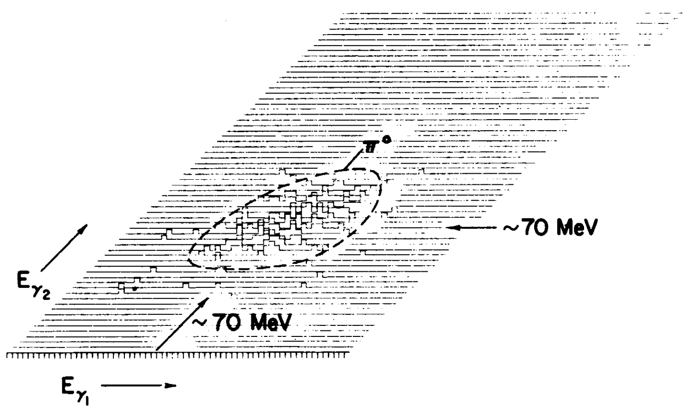

Figure 3.

height spectrum one finds, as illustrated in Fig. 3, a well-defined grouping of gamma rays from the decay of π^o's, brought about by the increased energy resolution of the new detectors.

Currently, we are assembling eight of these new detectors. In additions, we are investigating possible configurations that will allow us to extract accurate total cross sections and geometries that are sensitive to the angular distribution of the (p,π^o) differential cross section.

Another experiment in which these Pb-glass Cerenkov detectors are to be used is a study of the reaction $d(p,\pi^o)^3He$ in the energy range of 0.4 to 4.0 MeV above the 198.70 MeV threshold. The π^o's will be tagged by a signal from two Pb-glass detectors, and the momentum of the associated recoil ^3He will be determined by the QDDM spectrograph to obtain the differential cross section for the reaction. By measuring the time of flight of the recoils we can also obtain the analyzing power for the reaction, because the flight time for particles of a given momentum is a function of the angle at which they enter the spectrograph. The hope is that the data from this experiment will help in understanding the pion production mechanism, because the d and ^3He wave functions are relatively well understood.

We are also investigating the feasibility of using an analagous method to study the reaction $d(p,\pi^+)^3H$, although tagging a π^+ is somewhat more difficult than tagging a π^o. Charge independence with the inclusion of electromagnetic effects, predicts

$$R \equiv \sigma(pd \rightarrow \pi^{+3}H)/\sigma(pd \rightarrow \pi^{0\,3}He) = 2.20 \pm 0.07.$$

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1) E.M. Henley, "Charge Independence and Charge Symmetry of Nuclear Forces," Chap. 2, Isospin in Nuclear Physics, ed. D.H. Wilkinson (1969), North-Holland.