Pb-GLASS DETECTOR EFFICIENCY TESTING AT THE UNIVERSITY OF ILLINOIS TAGGED PHOTON FACILITY

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In the upcoming $\vec{p}(\vec{n},d)\gamma$ experiment (E328), photons will be detected in coincidence with deuterons. The small total cross section for this reaction, ≈ 10 μb, combined with a luminosity of $\approx 10^{29}$ cm^{-2}s^{-1}, results in a total production rate of about 1 s^{-1}. This low count rate dictates the use of very efficient photon detectors. Recently, IUCF acquired 160 Pb-glass Cerenkov detectors from the University of Basel. These detectors are blocks of Schott F2 glass measuring 4.2 by 6.4 cm on the front face, and 6.4 by 6.4 cm on the back face, and 50 cm in length. With an absorption length of 5.2 cm in the energy range of interest, 80-120 MeV, the 50 cm length of these detectors ensures almost 100% detection efficiency provided only a small portion of the electromagnetic shower escapes the detector.

The $\vec{p}(\vec{n},d)\gamma$ experiment will use these detectors in stacks 4 blocks wide by 5 blocks high. The question of interest is then: by adding together the pulse heights of all the detectors in a stack, what is the photon detection efficiency as a function of incident photon position on the face of the stack? To answer this question, a 3 by 3 stack of detectors was tested in July of 1989 using a tagged photon beam facility at the University of Illinois. This facility uses a primary electron beam that illuminates a converter foil, producing photons via electron bremsstrahlung. The residual electrons, primary electrons, and photons proceed through a magnet that bends residual electrons of a selected energy range onto a counter array (See Figure 1). The firing of a particular array element determines the photon energy and thus, provides tagging. The tagged photon beam energy was 70 ± 3 MeV with a width (at 1/e of maximum intensity) of about 2 cm. A plastic scintillator paddle, placed on top of the stack, served as a cosmic ray trigger. Coincidence events between this paddle and the Pb-glass stack provided a means of tracking the gains of the detectors since these events have a fixed energy. A laser beam aligned along the path of the photon beam allowed accurate positioning of the stack in the beam, and the response at 57 positions over the face of the stack was mapped. Figure 2 shows the efficiency of this stack of detectors versus distance of an incident photon from the edge of the stack, where the efficiency was normalized to the data taken with the photon beam centered on the stack. The finite photon beam size was taken into account.

Our measurements indicate that there is no loss of efficiency when crossing the boundary between two detectors. There is, however, a significant loss in efficiency as one approaches the edge of a stack. Using this measured function, the *relative* efficiency of a 4 by 5 stack of detectors (the configuration that will be used in the $\vec{p}(\vec{n},d)\gamma$ experiment) was computed to be 0.88 ± 0.04. Since the depth of these detectors span about 10 absorption lengths, the interaction probability is approximately 100% for photons that travel down the center of the detector. Thus, the *total* efficiency of a 4 by 5 stack will be nearly 88%.

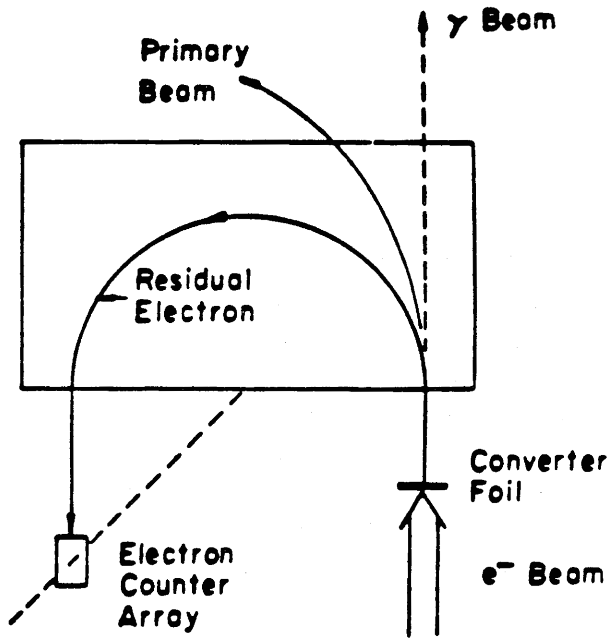

Figure 1. Schematic of the University of Illinios tagged photon facility.

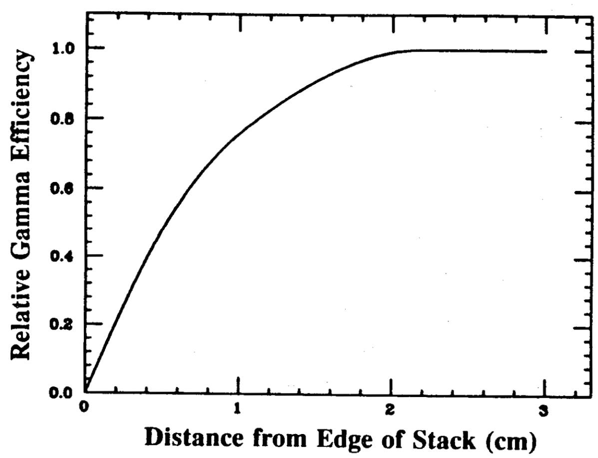

Figure 2. Relative photon detection efficiency vs. distance of incident photon from the edge of a Pb-glass detector stack (in cm).

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