PERFORMANCE OF LARGE-VOLUME, MEAN-TIMED NEUTRON DETECTORS

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This discussion updates information in the 1980 IUCF annual report[1] on the performance of our large-volume, mean-timed neutron detectors. During the past year, we constructed, tested, and successfully commissioned two 30 in × 60 in × 4 in mean-timed NE-102 plastic-scintillator detectors. These new detectors were designed[2] with the aid of a computer program which simulates the light-collection process and the generation of a timing signal in a mean-timed detector. We used this program, which utilizes ray-tracing techniques, to determine the optimum light-pipe geometry for these detectors.

The intrinsic time resolution of these detectors was measured with a cosmic-ray coincidence technique described[3] in the 1979 IUCF annual report. Briefly, with one 30 in × 60 in × 4 in detector placed directly above the other, we measured coincidences with cosmic rays passing through the 4 in dimension of each detector. We deduce an intrinsic time dispersion of 355±15 ps (FWHM) for one of these 30 in × 60 in × 4 in detectors, assuming that each detector contributes in quadrature to the measured time dispersion of 500±20 ps (FWHM).

The large volume (118 ℓ) and good intrinsic time resolution of these new detectors were important to our experimental program at IUCF for 1981. During our 135 MeV (p,n) measurements in August 1981, we were able to measure the analyzing power for a state with a 2 μb/sr cross section [$^{17}O(p,n)^{17}F$ (g.s.) at 63°] with ~ 50 nA of pulse-selected polarized protons on target.

During the past year, we also initiated measurements of the position resolution of our large-volume detectors. Let t_1 and t_2 be the time signals derived from the Amperex XP2041 photomultiplier tubes at the two ends of one of our detectors. The mean time $\bar{t} = (t_1+t_2)/2$ is largely independent of the position of an event along the length of the detector and the time difference $\Delta t = (t_1-t_2)$ is directly proportional to the position of the event. We have begun measurements of the Δt resolution, and hence the position resolution, using cosmic rays passing through the 4 in dimension of a given detector. The energy loss of "minimum-ionizing" cosmic rays is about 20 MeV through 4 in of scintillator.

We "collimated" the cosmic-ray flux with two small scintillators (1 in × 4 in in area and 0.5 in thick), one placed above and one placed below the large-volume detector. A triple coincidence between time signals from these small counters and t_1 restricts the cosmic-ray measurements to a small, 1 in wide strip across the large detector. Figure 1 shows our measurements for three different locations on a 10 in × 40 in × 4 in detector. From these data, we deduce a position resolution of 1.6 in (FWHM) that is independent of position.

1) IUCF Scientific and Technical Report, 1980, p. 121.

2) L. Casson, M.S. Thesis, Kent State University, 1981.

3) IUCF Scientific and Technical Report, 1979, p. 128.

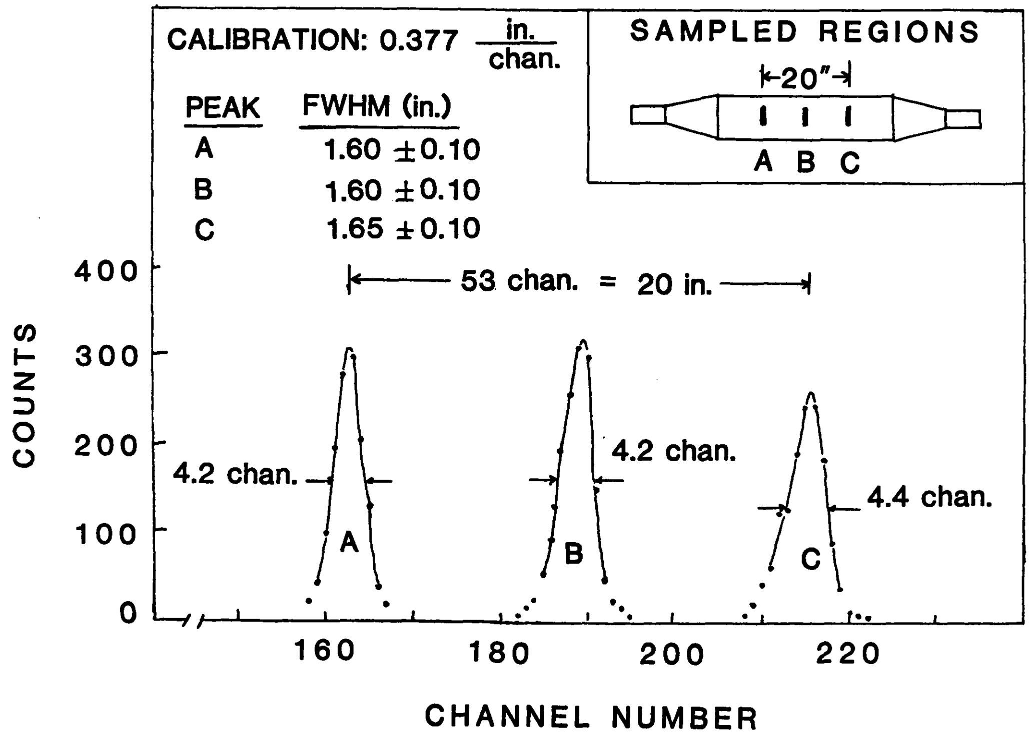

Figure 1. Position resolution for a 10 in × 40 in × 4 in detector. Cosmic rays passing through the indicated areas A, B, and C were selected by small coincidence detectors 1 in × 4 in in area placed above and below the large detector. The measured quantity is Δt, the time difference between the pulses from the photomultiplier tubes at the two ends of the large detector.