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May 1975

BNL-20118
NG-311

Informal Report

MEASUREMENT OF "NEUTRON SEA" AT MPS

APPENDIX 3 TO AGS-667

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As indicated in the original proposal, we expect most of our triggers to be due to accidental "neutron sea" counts in our neutron counter. If the "neutron sea" is too high, this would lead to an unacceptable number of accidental events. We have therefore measured the level of background neutrons in the area behind the MPS. Our data were taken in March of 1975.

The experimental apparatus consisted of a neutron counter 3" x 3" x 10" of Pilot B plastic surrounded by anti-counters in front (3" x 3" face) and on all four sides (3" x 10" faces). There was no anti in the rear where the light was funneled from the neutron counter by a 15" long air light guide to a 56 AVP phototube.

Our trigger requirement was that the neutron counter fire and no anti-counter fire within a 40 nanosecond gate. Phototube noise counts and cosmic rays were removed by taking a noise rate during the AGS "beam off" time and subtracting from the rate observed at "beam on" time.

We calibrated the energy scale of our neutron counter by comparing to the energy dumped by beam particles in the 3" and 10" dimension (15 MeV and 50 MeV respectively) and calibrating our discriminator

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accordingly. We believe our energy scale is good to ±20%. Note that the light output of scintillator is not linear with respect to energy dumped. The pulse height is less for heavily ionizing particles such as slow recoil protons than for lightly ionizing particles such as relativistic electrons for the same deposition of energy. The recoil proton energy spectrum is approximately flat up to the neutron energy.

The neutron rate was measured on March 22, 1975, when the MPS beam was set for 3.86 GeV/c antiprotons and was receiving 25,000 $\bar{p}$'s per pulse according to the MPS beam trigger which we used as a monitor. During this time the AGS was providing 1.8 x 10^{12} protons/pulse on the B Target feeding the MPS. The A Target was getting 5 x 10^{11} protons/pulse; C Target -- 1.9 x 10^{12}; and G-10 -- 1.4 x 10^{12}.

Our measurements were made about 40 ft. behind the MPS (a) near the beam line (swept east from 0^o by the magnet), (b) at 0^o to the beam entering the MPS (out of the charged beam). We made measurements with the neutron counter pointed (along its 10" dimension) toward the MPS and also with it pointed perpendicular to the MPS. We also measured at about 20 ft. behind MPS. In all these configurations, the flux we measured was the same to within 10%. We therefore conclude that the neutron background is indeed sea-like being relatively homogeneous behind the MPS. We also placed 1 1/2" of lead in front of the neutron counter to convert gamma rays and saw no change in the counting rate. Four feet of concrete in front of the counter, however, did reduce the rate some 25%.

The results of our measurements are shown in Fig. A3-1, normalized to 25,000 $\bar{p}$'s/pulse. The two energy scales correspond to minimum ionizing particles and recoil protons. The counter we used was .052 cu. ft. in

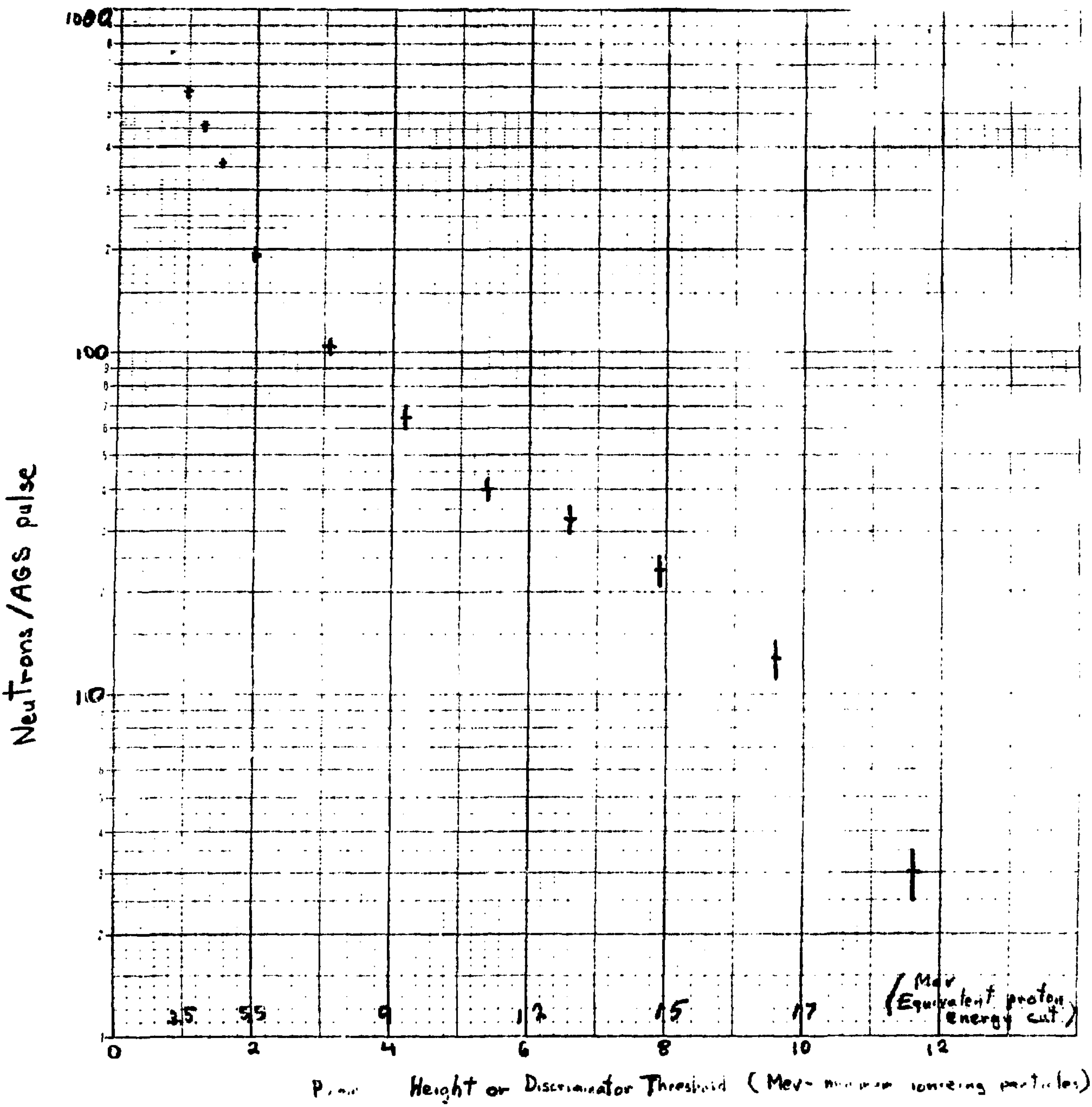

Fig. A3-1 Data of March 22, 1975
~40' behind MPS
Neutron counter 3' x 3' x 10"

volume. Our proposed counter would be 16 cu. ft. in volume -- 300 times larger. If we made our discriminator cut at 5 MeV (corresponding to proton recoils greater than 10 MeV for 30 MeV neutrons), we measure a rate of 45/pulse giving 1.35×10^4 for our proposed counter. In the proposal we estimated that a tolerable rate would be 2×10^4/pulse so we are well within our estimate.

We could easily sacrifice some neutron counting efficiency and make a discriminator cut at 10 MeV (proton recoils greater than 17 MeV) and reduce the accidentals by a factor of 5. Thus it seems quite feasible to run the proposed experiment from the point of view of accidental background.

These measurements roughly agree with the experience of Prof. Stu Smith during the recent Princeton experiment. Each of their neutron counters saw a background rate of $1\text{-}2 \times 10^4$ neutrons/pulse with a volume of 3 1/3 cu. ft. with a threshold of 3 MeV. We measure 100 neutrons/pulse which scales to 6.4×10^3 neutrons/pulse for their volume. However, they were very near the C Target which was getting about 2.5×10^{12} protons/pulse so that their background should have been worse. Their counters are viewed by two phototubes which they claim improves background rejection a factor of two over a single phototube. Thus we can expect another factor of two suppression over our measurements if we use a two phototube system.

Thus if we use a 10 MeV cut and two phototubes our rate will be $\lesssim 2 \times 10^3$ neutrons/pulse -- 10 times lower than our original estimate. This gives about two accidental triggers/pulse for our proposed experiment, in comparison with 1.7 real $\pi^- p \rightarrow nx$ triggers/pulse -- a very comfortable ratio.