NOTE ON THE SPACING OF THE COILS OF THE 25-FT BUBBLE CHAMBER

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ABSTRACT

We discuss a proposal made in the 1968 Summer Study that the coil spacing of the 25-ft bubble-chamber magnet be increased from 5 ft to about 14 ft. It is concluded that this change is not needed for neutrino physics with the chamber and might even make the neutron background worse. For other experiments, the advantages of having a 40-kG field are felt to outweigh the increased accessibility for wide-angle counters that would result from spreading the coils apart.

In the 1968 Summer Study it was urged[1] that the magnet coils be spread apart from the proposed 5-ft spacing to something more like 14 ft, "to reduce muon background in neutrino experiments and give more accessibility for counters or spark chambers."

Estimates of the backgrounds in 25-ft bubble-chamber neutrino experiments have been made by Peoples.[2] These are being checked and will no doubt be altered in detail,[3] but his estimate of 10 muons from the coils and supports per picture is reasonable. In this connection it should be noted that:

1. Such muons will not introduce error into the analysis since it will be clear in the photographs that they did not originate in the chamber liquid, and

2. They are a negligible background factor, being few in number, evenly spaced, and non-interacting. Bubble-chamber photographs in a neutrino beam will probably not be as clean as in conventional strong-interaction studies, but it should be possible to work through the background, as one now does with heavy liquid chambers.

A possibly more serious background is neutrons resulting from neutrino interactions in the coils. These are concentrated around the equatorial plane of the

interaction, with laboratory momenta in the range 100-400 MeV/c and laboratory angles like 70°-80°. They will scatter on protons in the useful volume of the chamber, simulating the second vertex of the reaction

$$\bar{\nu} + p \rightarrow \mu^+ + n$$
$$\hookrightarrow n + p \rightarrow n + p.$$

Peoples[2] estimates 5 such recoils per pulse. Whatever the number is, spreading the coils apart will not reduce it and may even increase it. In effect, the neutrino beam covers a wider area[4] than the 3.7 m diameter of the chamber photographed volume, so that just as many neutrino interactions would occur in the coils if they were spread to 4.3 m separation as with the present 1.5 m separation. And the upstream as well as broadside portions of the coils would then contribute neutrons in the useful region.

The advantages of having the highest possible magnetic field are so great that any reduction in field in order to permit counter detection of wide-angle particles would have to be justified by very strong physics arguments. The 5-ft coil spacing does permit use of downstream counters to cover a cone of half-angle about 8°. This should be ample for the forward high-energy cone of particles in the final state (e.g. a transverse momentum of 0.5 BeV/c corresponds to an angle of 1.4° at 20 BeV).

In conclusion, we recommend that the 5-ft coil spacing of the BNL-NAL 25-ft bubble-chamber proposal[5] be retained.

REFERENCES

[1] G. Trilling et al., Report of Group A--Large Hydrogen Bubble-Chamber Study, National Accelerator Laboratory 1968 Summer Study Report A.1-68-96, Vol. I, p. 127.

[2] J. Peoples, Background in the 25-Ft Chamber When Used for Neutrino Physics, National Accelerator Laboratory 1968 Summer Study Report B.1-68-97, Vol. I, p. 197.

[3] R. D. Sard, Cosmic Ray Backgrounds in Neutrino Experiments, National Accelerator Laboratory 1969 Summer Study Report SS-15, Vol. II.

[4] Y. W. Kang and F. A. Nezrick, Neutrino Beam Design, National Accelerator Laboratory 1969 Summer Study Report SS-146, Vol. I.

[5] 25-Foot Cryogenic Bubble Chamber Proposal, Brookhaven National Laboratory BNL-12400, March 1969.