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Authors

Gilbert, F. Charles
Ise, John
Pyle, Robert V.
et al.

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F. Charles Gilbert, John Ise, Jr., Robert V. Pyle
and R. Stephen White

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NEUTRONS AND ELECTRONS FROM A LINEAR DEUTERIUM PINCH

by

F. Charles Gilbert, John Ise, Jr., Robert V. Pyle
and R. Stephen White

Radiation Laboratory, University of California
Berkeley, California

The neutrons produced in the summer of 1955 in the linear pinch tubes of Anderson and Baker have been shown to be of nonthermonuclear origin. An instability mechanism has been suggested by Colgate which apparently explains the production process. Few, if any, electrons with energies greater than 100 kev are observed.

At the time of the October 1956 Princeton Meeting, the time and space distributions of neutrons from a linear deuterium pinch in the apparatus of Anderson and Baker favored a thermonuclear reaction and excluded reactions from deuterons accelerated near one electrode and projected along the axis of the tube. The rapid quenching of the reaction by small percentages of impurities or weak axial magnetic fields was also reassuring. Ilford C.2 emulsions exposed along the side of the tube showed appropriate proton recoil energies, although the number of events measured was low.

At the suggestion of Stirling Colgate, we exposed C.2 emulsions at both ends (on the axis) of the pinch tube in an effort to completely exclude the possibility of axial electric acceleration, and found the energy distributions shown in Fig. 1. A calibration Cockcroft-Walton bombardment of a solid target is given in Fig. 2. Deuterons are apparently accelerated to energies that are usually between 50 and 100 kev, with events recorded up to 200 kev. The accelerating electric fields are in the direction of the applied voltage (35 kv), but the total voltage across the tube is only a few kilovolts at the time of neutron emission.

A mechanism for reconciling all of the experimental data (with the possible exception of an experiment at Los Alamos in which the addition of tritium did not increase the neutron yield as expected) has been discussed by Colgate.[1] Large electric fields are expected across the multiple constrictions in the discharge created by sausage-type instabilities. Deuterons can be accelerated across these constrictions and strike other deuterons that are at rest in the following blob of plasma.

Figure 1 gives a hint of a low-energy neutron component in the forward direction, which is not very significant statistically, but a similar effect was reported by the Los Alamos group at Gatlinburg and we are continuing the measurements in an effort to verify or disprove the effect.

It seemed possible that under certain conditions high-energy electrons might be produced by the same instability mechanism. Ilford G.5 emulsions were exposed at the ends of the discharge tube and scanned for electrons with energies of 100 kev or greater. Some electrons of many Mev were detected in an apparently statistically significant fashion, although the measurements were not repeatable. The effect may well be spurious, and the electrons accelerated to such energies are very few at best.

Similar neutron-energy measurements are continuing on a faster pinch device constructed by Anderson and Baker.

1 Colgate, Stirling A., Neutron Production in the Pinch Due to Instability Breakup, UCRL-4702, May 1956.

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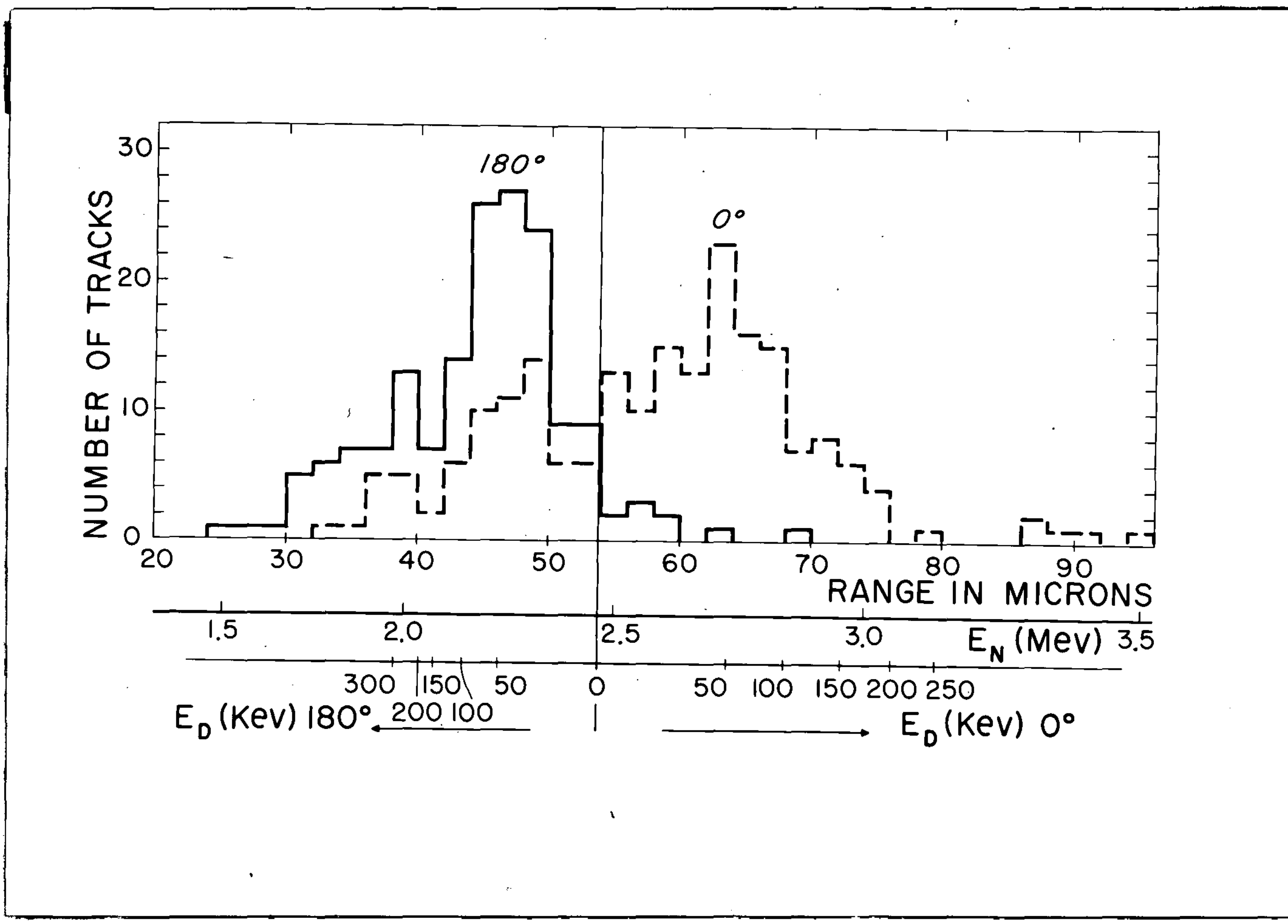
FIGURE CAPTIONS

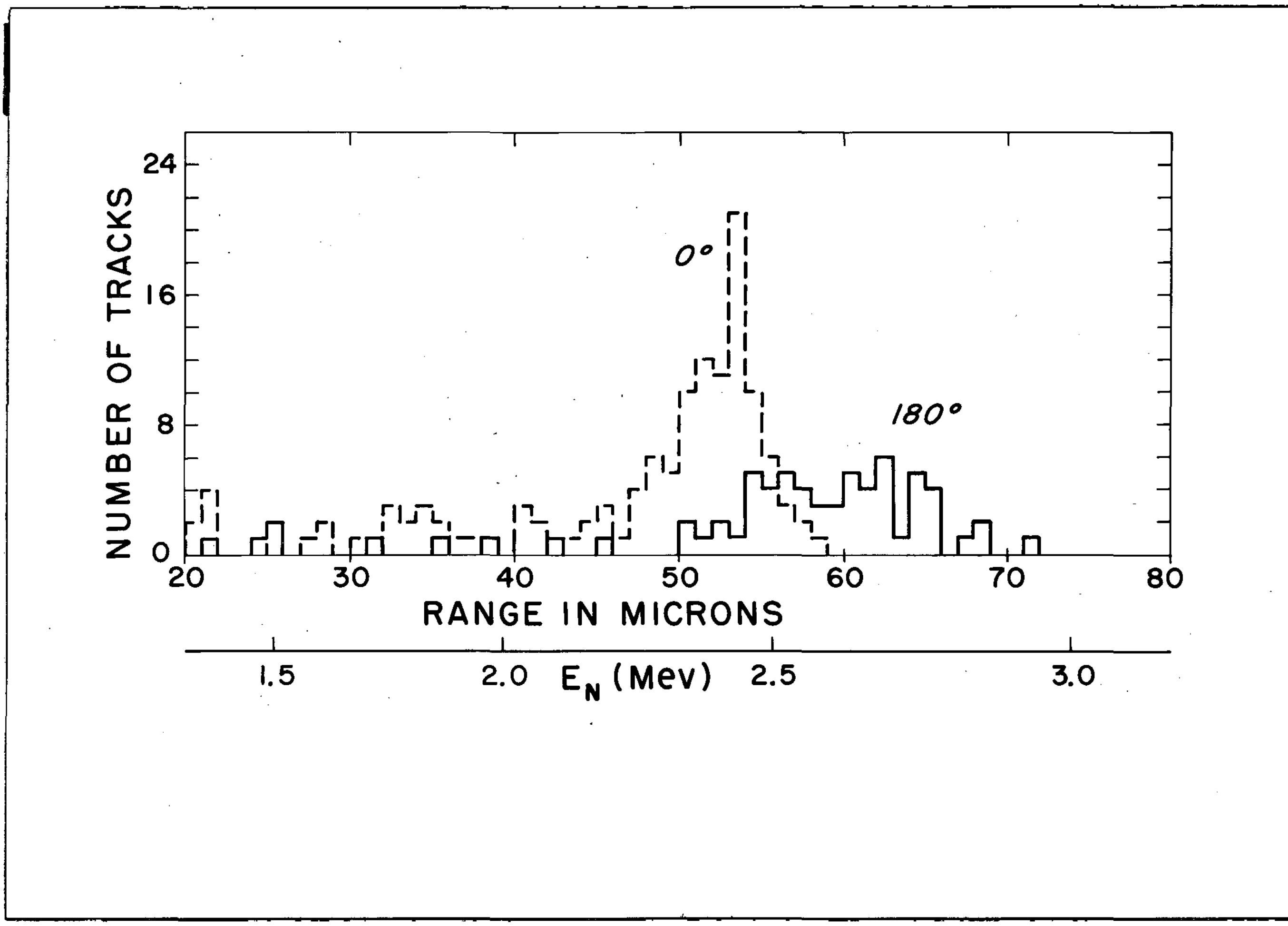
Fig. 1. Recoil proton histograms at 0° and 180° to the direction of the applied electric field. Equivalent neutron and bombarding deuteron energies are shown.

Fig. 2. Recoil proton histograms at 0° and 90° to the direction of the 45-kev Cockcroft-Walton deuteron beam. The neutrons were produced in a deuterium-loaded metal target.



NUMBER OF TRACKS
180°
0°
RANGE IN MICRONS
E_N (Mev)
E_D (Kev) 180°
E_D (Kev) 0°

Fig. 1



NUMBER OF TRACKS
0
8
16
24
0°
180°
20
30
40
50
60
70
80
RANGE IN MICRONS
1.5
2.0
2.5
3.0
E_N (Mev)

Fig. 2