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RANGE DISTRIBUTION OF ALPHA PARTICLES FOLLOWING THE DECAYS OF Li8 AND B8



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# UNIVERSITY OF CALIFORNIA

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# RANGE DISTRIBUTION OF ALPHA PARTICLES FOLLOWING THE DECAYS OF $Li^8$ AND $B^8$

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In recent experiments[1] designed to analyze the high energy disintegration products produced by 375 Mev alpha particles bombarding beryllium, a large number of $B^8$ and $Li^8$ hammer tracks (note Fig. 1) were found in the nuclear track emulsions used as detectors. Dr. Walter H. Barkas has suggested that by analyzing the range distribution of the alpha tracks resulting from the reactions

$$\left.\begin{array}{l}(1)\ B^8 \rightarrow e^+ + Be^{*8} \\ (2)\ Li^8 \rightarrow e^- + Be^{*8}\end{array}\right\} Be^{*8} \rightarrow 2\,He^4$$

the energy level structures arising from these mirror processes in the short lived $Be^8$ nuclei may be compared. Although the $Be^8$ from the decay of $Li^8$ has been studied by many investigators,[2,3,4] additional measurements were taken on the alpha particles from reaction (2) as a means of calibration of the method and in the hope of improving the statistics over previous investigations. The alpha particle range distribution from reaction (1) was studied for the purposes of (a) checking the similarity of the two mirror nuclei, $Li^8$ and $B^8$, and (b) searching for a possible new level in the excited $Be^8$ nucleus. The probability of a second level is enhanced for reaction (1) because of the slightly greater energy ($\sim$1 Mev) available in the $B^8$ nucleus as compared to the $Li^8$ nucleus.

The $B^8$ tracks could be differentiated from the $Li^8$ tracks by the differences in range and in grain density for a given radius of curvature in the cyclotron magnetic field. Owing to the short range of the $Li^8$ or $B^8$ tracks penetrating the emulsion, in about one-third of the decays one of the alpha tracks left the emulsion before the end of its range. In these cases the range of the remaining alpha particle was measured from the end of the $B^8$ or $Li^8$ track. In the events in which both alpha particles remained in the emulsion, the two ranges were averaged. The later cases provided a means for estimating the errors involved in the measurement of the alpha ranges. Since the two alpha particles come apart with equal energies in their center of mass, the difference in their measured ranges gives an estimate of the errors due to range straggle, recoil of the $Be^8$ nucleus from the beta decay, indeterminacy of the end points, and human error. In this manner the standard deviation in the measurement of individual alpha ranges was estimated to be about 0.5 micron. The alpha energies as a function of range were determined from a range energy relation for C-2 emulsions worked out by Wilkins.[5]

The alpha ranges from 100 $B^8$ disintegrations and 257 $Li^8$ disintegrations, normalized to 100 for comparison, are shown in Fig. 2. No significant difference is detectable; in particular, no additional long-range alpha particles were found following the decay of $B^8$. The $Li^8$ distribution is similar to that found by previous investigators.[2, 3, 4]

The combined 357 events shown in Fig. 3 have a maximum at about $E_\alpha = 1.5$ Mev and a width at half maximum, $\Delta E_\alpha \approx .7$ Mev. Near resonance the distribution may be fitted by a single resonance theory due to Wheeler[6] as modified for the alpha penetrability by Bonner, et al.[7], where $E_o = 2.9$ Mev, $\Gamma = 1.2$ Mev, and J, the angular momentum of the excited state of $Be^8$, is 2. Roughly 15 percent of the decays, principally the higher energy alpha particles, are not included by this resonance and must be explained by the presence of higher levels in the $Be^8$ nucleus. It is to be noted that the data may be fitted satisfactorily over the entire energy range of this experiment by the single resonance theory if J is chosen to be 4 in agreement with the analysis by Bonner, et al.[7]

The presence of the longer range alpha particles, 15 to 25 microns, from the decay of $B^8$, and the similarity of the $B^8$ and $Li^8$ distributions, suggest that the $B^8$ beta decay leads to the same energy levels in $Be^8$ as does the $Li^8$ beta decay. This is in essential agreement with the interpretation of the positron spectrum of $B^8$ as measured by Alvarez.[8]

I am particularly indebted to Dr. Walter H. Barkas for his invaluable guidance and to Mrs. Doreen Hornback for having made many of the measurements that were necessary for this experiment.

## REFERENCES

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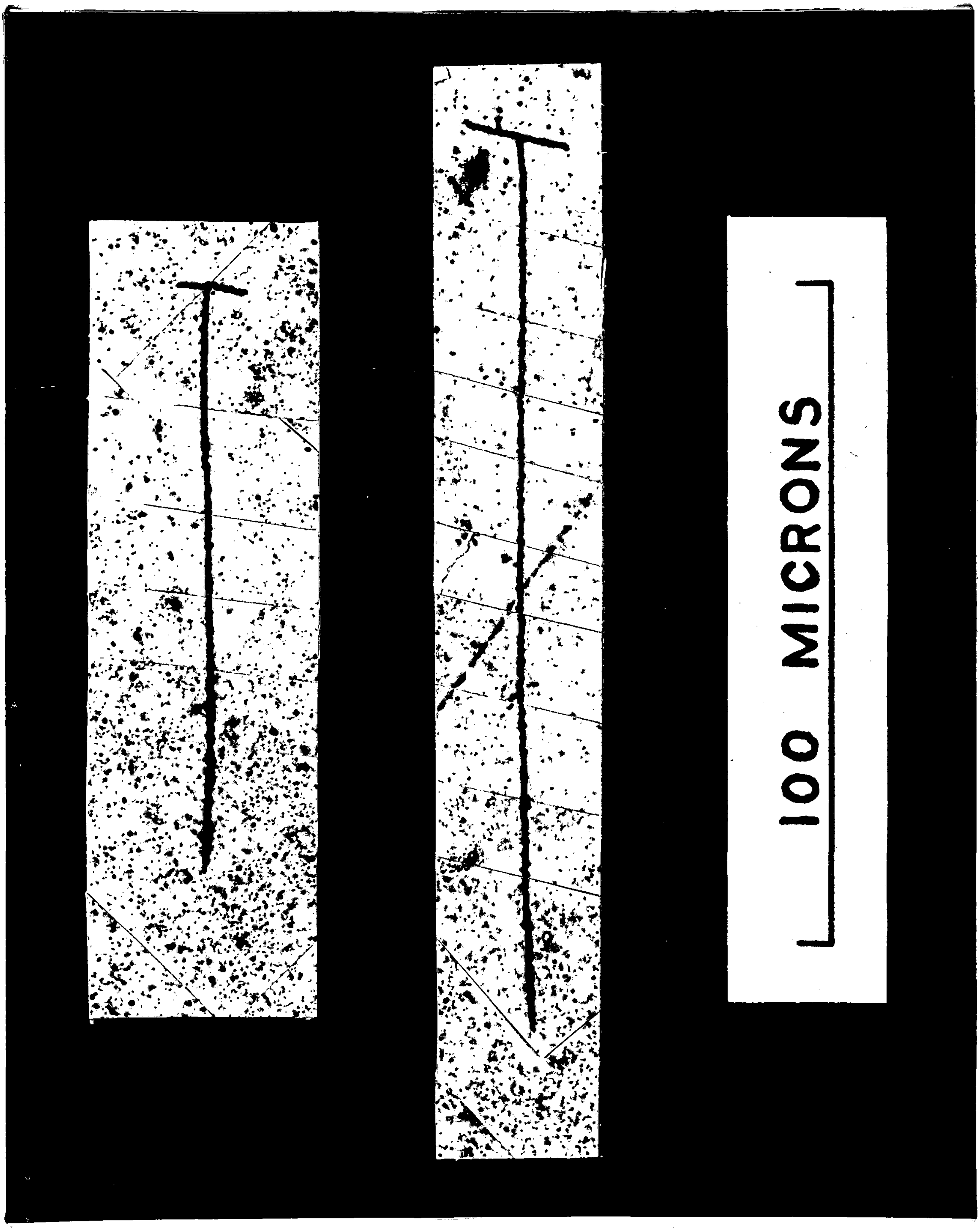
## FIGURE CAPTIONS

Fig. 1 - Photomicrographs of tracks of $Li^8$ and $B^8$ nuclei: (Top) a 28 Mev $Li^8$ track, (Bottom) a 66 Mev $B^8$ track.

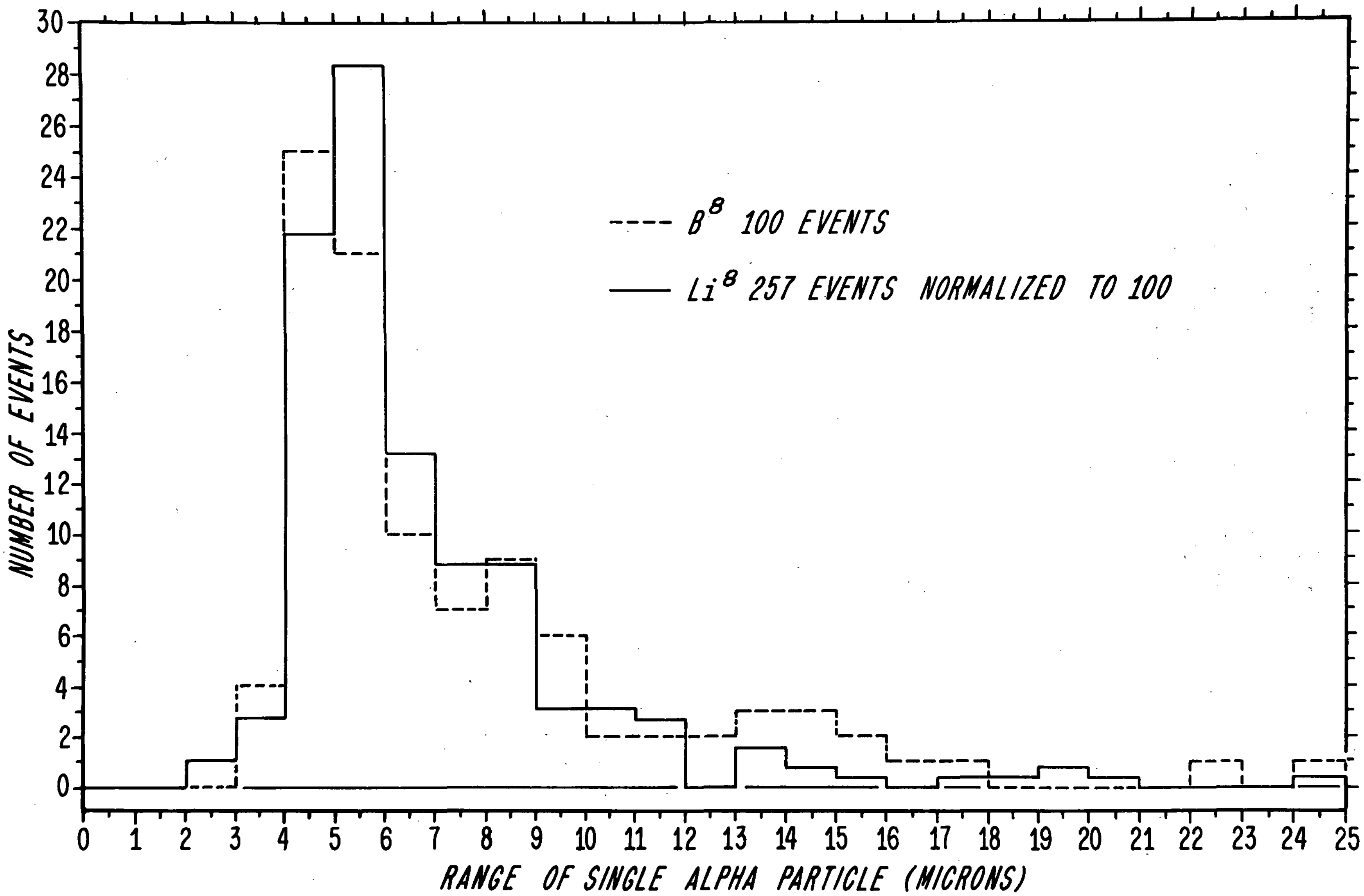
Fig. 2 - The alpha particle range distributions following the decays of 100 $B^8$ nuclei and 257 $Li^8$ nuclei. The 257 $Li^8$ events have been normalized to 100 for comparison.

Fig. 3 - The combined alpha particle range distribution following the decay of 357 $Be^8$ nuclei.


100 MICRONS

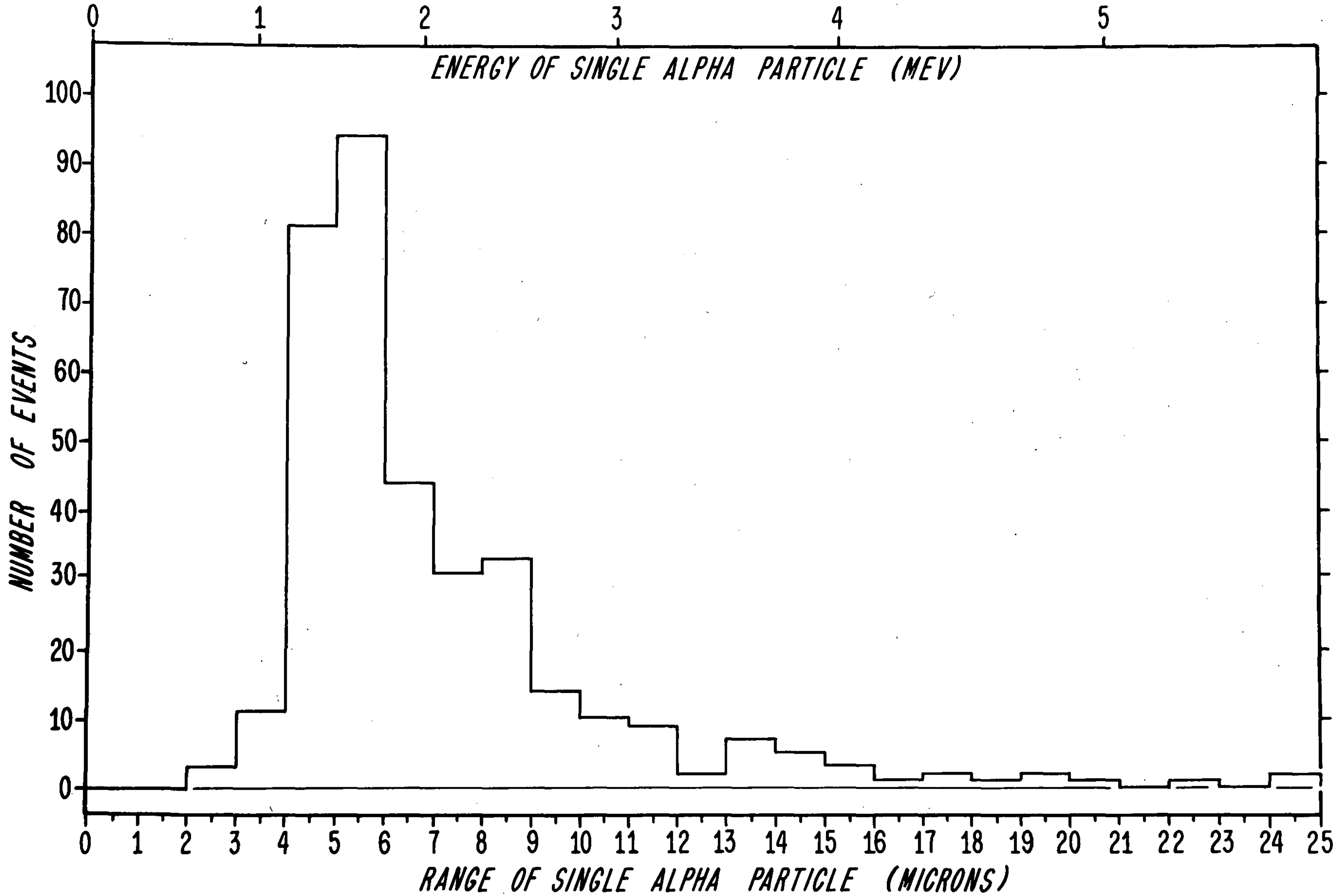
Film Pro 740

Fig. 1



B^8 100 EVENTS
Li^8 257 EVENTS NORMALIZED TO 100
NUMBER OF EVENTS
RANGE OF SINGLE ALPHA PARTICLE (MICRONS)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25

Fig 2



ENERGY OF SINGLE ALPHA PARTICLE (MEV)
0
1
2
3
4
5
NUMBER OF EVENTS
100
90
80
70
60
50
40
30
20
10
0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
RANGE OF SINGLE ALPHA PARTICLE (MICRONS)

MU-6190

Fig 3