Title
ALPHA-DEUTERON DISCRIMINATION BY PULSED ARC POSITION IN AN FM CYCLOTRON

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R. D. Watt

October 20, 1950

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October 20, 1950

During experiments to determine optimum conditions for meson production by alpha bombardment, it was found that the relative numbers of alphas and deuterons being accelerated were actually unknown and all methods of tuning for their discrimination very unreliable. Deuterium gas required only single ionization to accelerate as compared with the double ionization required for helium, and the small amount of residual deuterium contamination when helium is flowing in the tank will contribute a large percentage of deuterons to the accelerated beam.

In order to find the best way to tune the FM cyclotron for alpha-deuteron discrimination the following steps were tried:

A. An accurate frequency monitor on the arc pulse position versus oscillator frequency was set up. This monitor consisted of a Navy model LM-14 frequency meter, as a standard, to which a frequency discriminator circuit was tuned. The discriminator, then being at a known frequency, was triggered by the r.f. from the oscillator. The output of this combination was used to synchronize a synchroscope upon which the actual pulsed arc was observed. In this way it was possible to monitor the start of the pulsed arc to within about 5 kc easily,

and with more effort to a much closer value than 5 kc. This accurate knowledge of pulsed arc position timing on the FM cycle was necessary because it was thought that separation could be accomplished by taking advantage of the slight difference in $\frac{E}{M}$ ratio of the particles and consequent difference in accelerating resonant frequency.

B. Range pictures were taken of the alphas and deuterons with Ilford B-1 research plates. The relative intensity of the two particles could be seen and information obtained as to their intensities versus the pulsed arc position. The range in film of deuteron acceleration in the cyclotron is known to be twice that of alpha-particles accelerated to the same radius. Figure 1 shows the relative range of the particles and how it is possible by examination to find the relative numbers of particles accelerated.

C. A discriminating current probe was constructed of copper in such a manner that one section of a double probe shaded the other section of the probe from the beam as shown in Figure 2. The first, or beamward, section of the probe was slightly thicker than the range of alpha-particles in copper and the second section plus the first section was slightly more than the range of deuterons in copper. In this manner it was possible to read the relative currents of alpha and deuteron particles. The

currents (Figure 3) obtained by this method were only relative and could not be used as absolute determinations.

Data

The data taken were mostly in the form of pictures and calibration curves. Figure 3 was taken with a 110 microsecond arc pulse width and a helium gas flow of 1/2 of the normal operating amount. Figure 4 was taken with fifty microsecond arc pulse width and a normal amount of helium gas flow. The relative amplitudes of the deuteron peak with respect to the alpha peak is lower in Figure 4 than in Figure 3 because it was taken after helium had been flowing several hours and some of the deuterium had been cleared out.

Results

Figures 3 and 4 show that it is quite possible to discriminate between alphas and deuterons by accurate timing of the arc pulse position with respect to the r.f. frequency. A 20 to 1 ratio can be obtained after several days of alpha operation, and with careful tuning on the double probe.

The pictures in Figure 5 bear out the double probe tuning results remarkably well and their numbers are marked on the curve in Figure 4 so than an idea can be obtained of the relative intensities of alphas and deuterons on the pictures versus those on the curves.

This work was materially aided by the help of Mr. James Vale and by the suggestion of basic ideas by Mr. F. Yeater.

This work was done under the auspices of the Atomic Energy Commission.

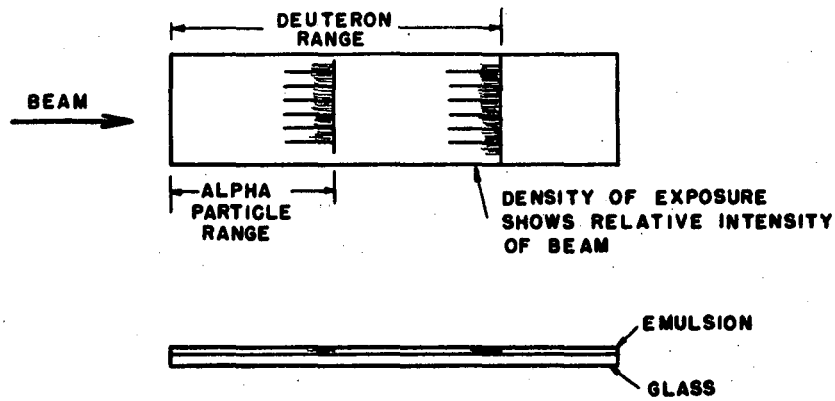

FIG. 1

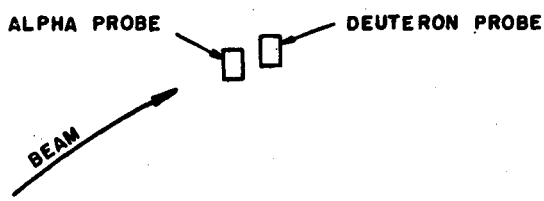

FIG. 2

MU 932

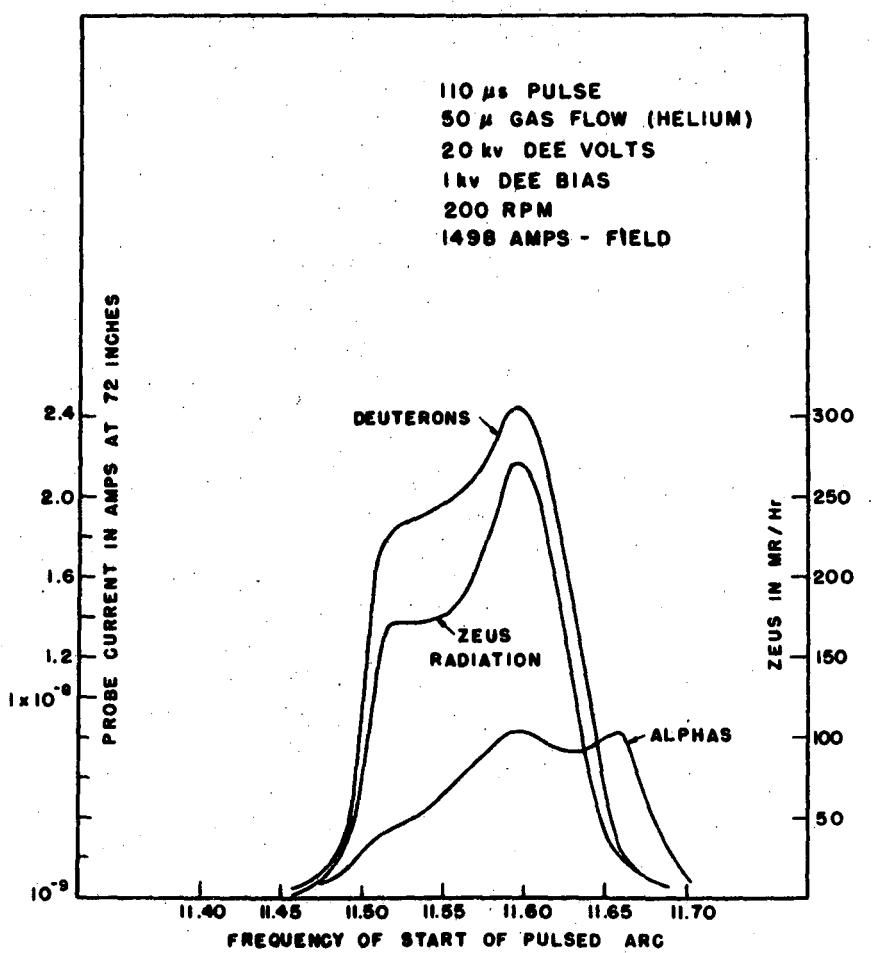

FIG. 3

MU 930 16107-1

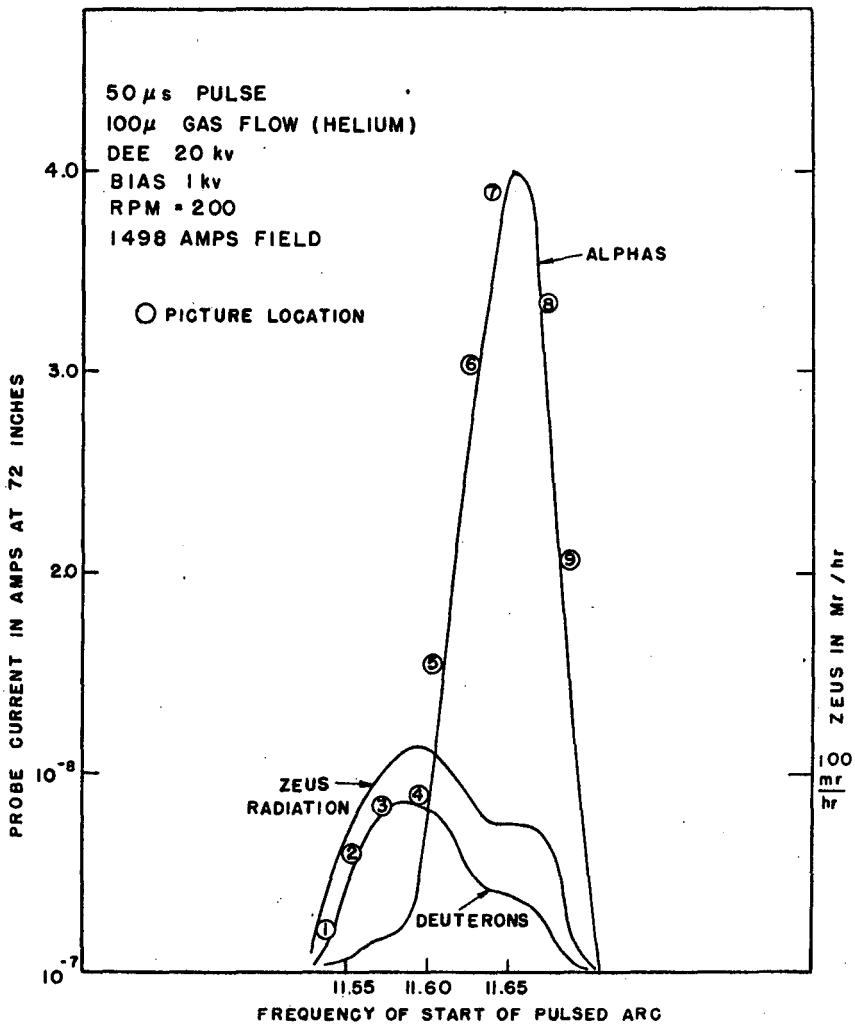

FIG. 4

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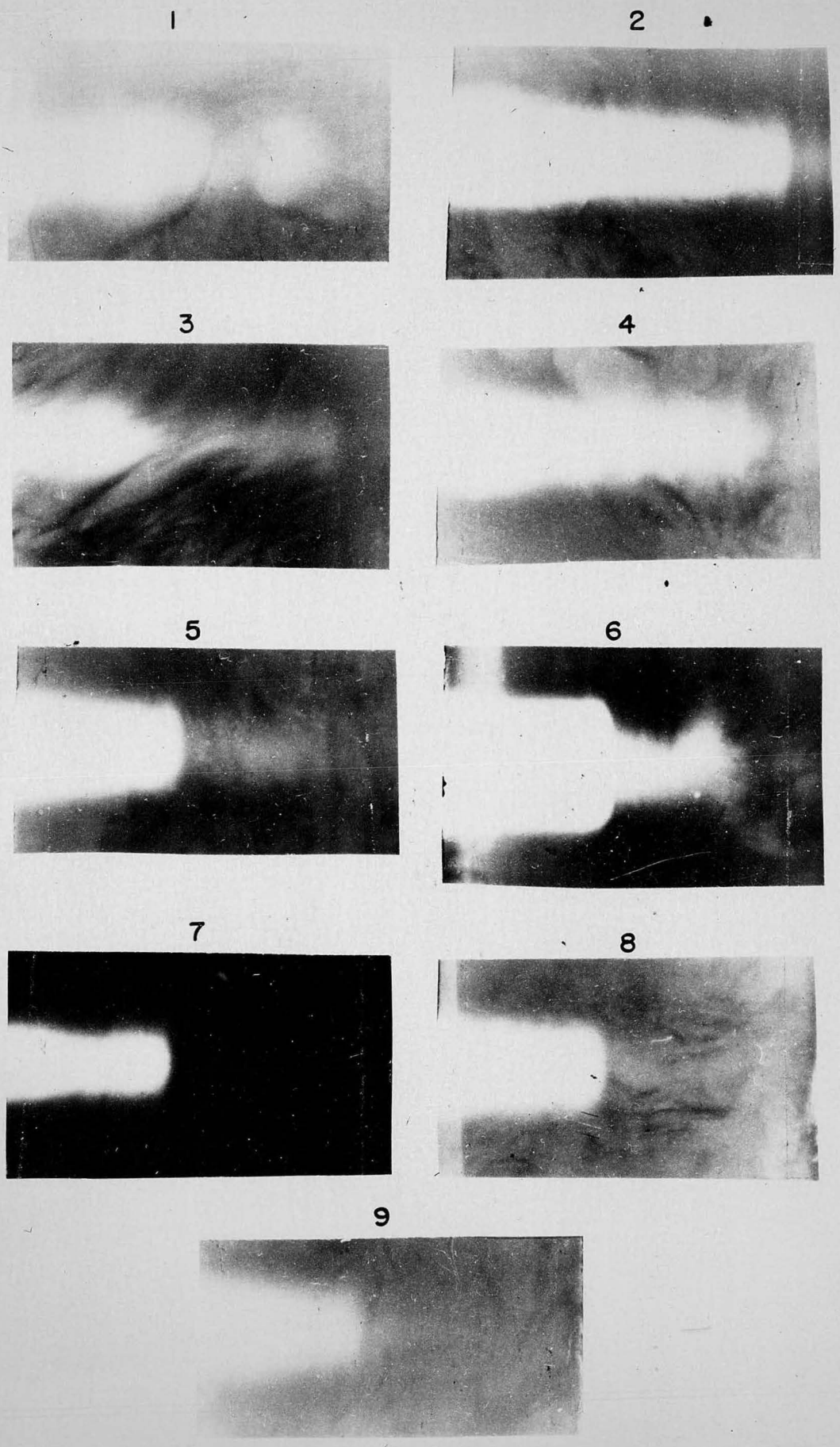

FIG. 5