Title
SUMMARY OF THE RESEARCH PROGRESS MEETING OF MARCH 29, 1951

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Publication Date
1951-09-10

UCRL-1217

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Bonnie E. Cushman

September 10, 1951

Berkeley, California

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I. Mass Spectrograph - Wm. Glenn.

The instrument, described in a previous report (UCRL-636), is based on a time of flight principle and is similar to the Smythe-Wilson Isotron at Princeton. Ions from a thermal source are accelerated by a parallel electrostatic field down a drift tube (see Fig. 1) and their time of flight, which varies with mass, is measured. The ions arrive in bunches at the end of the tube where they are separated by the pulse applied to the second grid. The length of the tube must be known accurately in order to determine the transit time.

Since the grids are only 5 mils apart there is trouble with arcing. Their diameters must be about 1.5 inch in order to handle the beam, and to prevent loss of ions, the wires must be spaced very close together. 0.5-1 mil tungsten wire was used.

The graph of Rb^{85} and Rb^{87} illustrates the resolution obtained by the instrument (Fig. 2). The width is determined primarily by the thermal velocity of the ions and since this quantity stays fairly constant, so does the width of the peak; the resolution is better, therefore, with the heavier elements.

The problem of unionized particles hitting the collecting plate is solved by using a deflector which will deflect only charged particles. A better ion source is needed since thermal emission is not constant; a bombardment source will be tried for abundance ratio work.

Another problem concerns harmonics, which causes a certain ambiguity in the results obtained. This can be corrected by using a high geometry poor resolution spectrometer in cascade with the time of flight instrument, or by using only one pulse each transit time, although this latter method would reduce the collection efficiency of the spectrograph somewhat. At present the collection is 30 percent of the ions formed. It should be possible to reach 80 percent theoretically.

The advantage of this spectrograph over the magnetic kind is that it has no hysterisis problems. The only factors to be measured are the length of the tube, the accelerating voltage and the pulse timing.

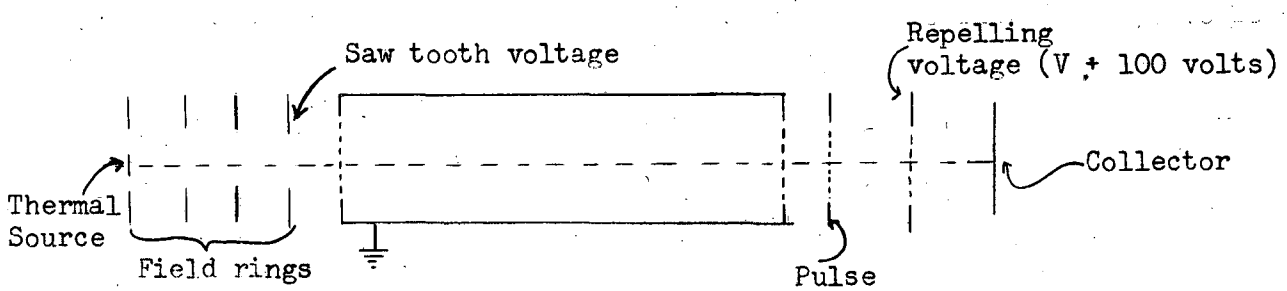


Fig. 1

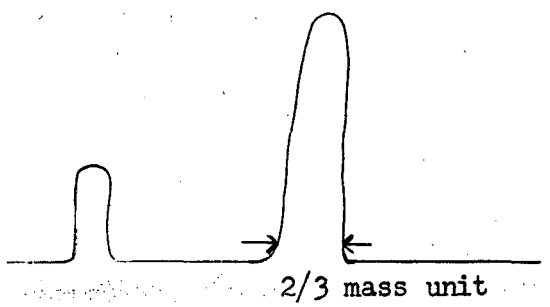


Fig. 2

II. Present Status of Time of Flight of Apparatus for the Detection of High Energy Particles -(A) Lee Neher, and (B) James Carothers

(A) In identifying high energy particles, one works with the quantities of mass, charge and velocity and the several relationships used for this determination are as follows:

1. $H\rho = mv/e$
2. Range = $f(m,e,v)$
3. Specific Ionization, $dE/dx = f(e,v)$
4. Velocity selector or time of flight machine = $f(v)$

The apparatus under discussion employs methods 1, 2, and 4, but not 3, since the detectors during short periods are non-linear. Recent applications of the time of flight apparatus were discussed.

1. Measurement of the neutron spectrum from the cyclotron. 340 Mev protons bombarded a 2-inch beryllium target. The velocity selector consisted of two scintillator and photomultiplier tube arrangements (Fig. 3) and since the velocity of the pulse in the cable is known, the proton's time of flight between the counters can be measured. Then $E_n = E_p/\cos^2\theta$. The resolution of the instrument depends on the counter separation distance (Fig. 4), in this case 15 feet. Ten counts per minute were received. The method seems quite good for determining total neutron cross sections.

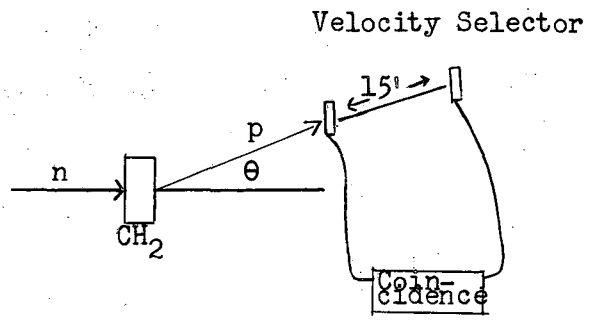
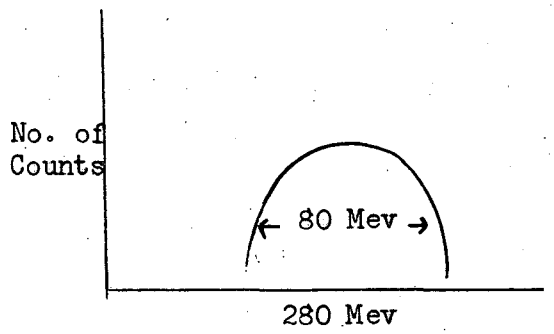


Fig. 3



Resolution of the instrument ≅ 50 Mev

Fig. 4

2. Detection of π^- mesons at the cyclotron. Arrangement and spectrum are given in Figures 5 and 6. A target in/target out ratio of 50/1 was obtained but a number of electrons were observed too. These were easily distinguished from the mesons since their velocity is c whereas v_π is only 0.7 c. It has not yet been determined where these electrons are coming from; they are much too numerous to be explained by π^0 decay.

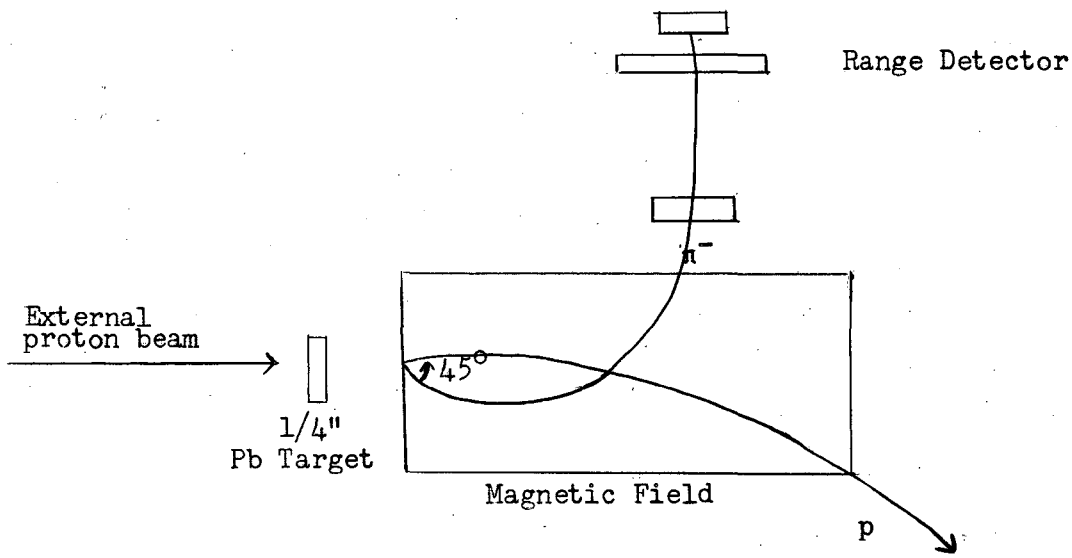


Fig. 5

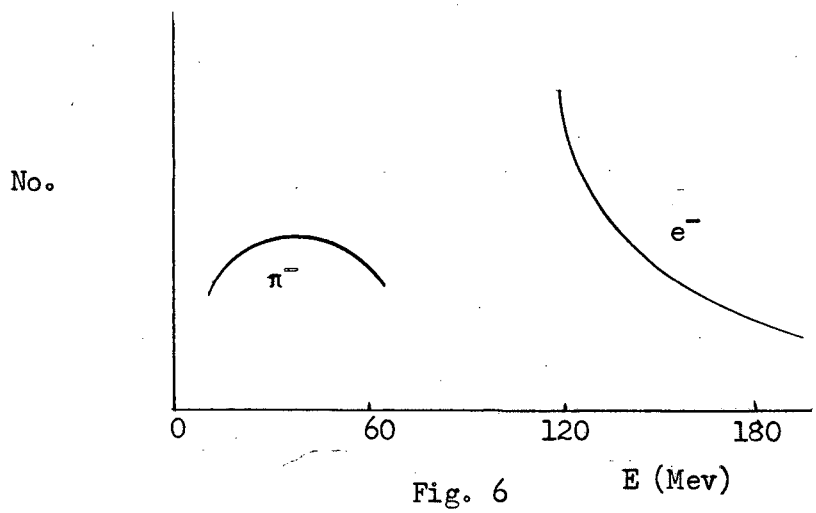


Fig. 6

(B) 3. Meson detection at the synchrotron. The time of flight apparatus provides a method of meson counting which does not depend on the π^- properties. Furthermore, both π^- and π^+ can be counted with the same instrument. The geometry is shown in Fig. 7; the most convenient working angle was 135°. The resolution of the instrument was obtained by observing the electrons produced from a copper target; then the meson spectrum may be extrapolated (Fig. 8). Range measurements have been taken, but they are not very satisfactory because of μ decay in the channel.

The rate is low -- 20-30 counts/hr -- and the solid angles are low due to the separation between the counters. The number of counters has been doubled but they cannot be brought closertogether because of their resolving time, nor closer to the synchrotron because the analyzing magnet interferes with the synchrotron operation. It is planned to shield the pair magnet so that the 30 foot separation may be reduced and the counts brought up to 80-100 per hour.

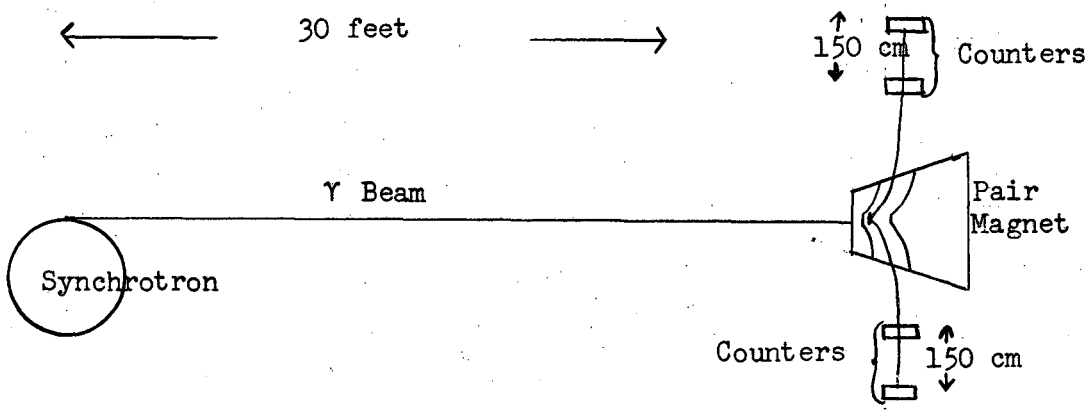
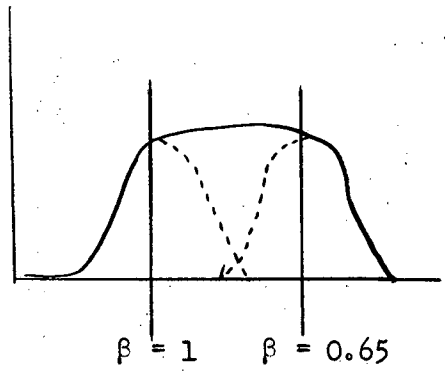


Fig. 7



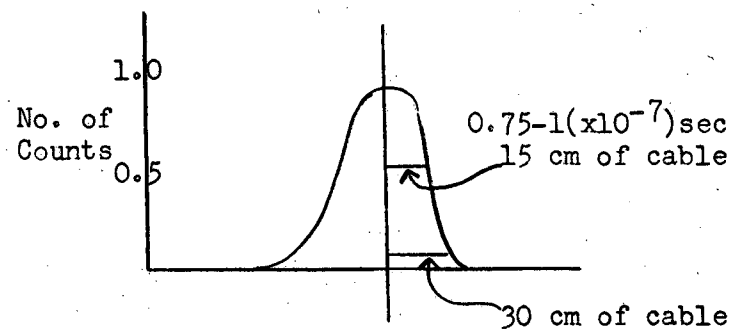


Fig. 8

4. Proton counts from γ-p reactions. The apparatus consisted simply of a two-crystal telescope pointed at the target. Fig. 9 shows the spectrum obtained. The counting rates are good -- 3-4 per minute -- and the spectrum can be easily analyzed. Further evidence that it is protons which are observed is found by plotting number vs proton energy. A straight line is given in agreement with Livinthal's thesis.

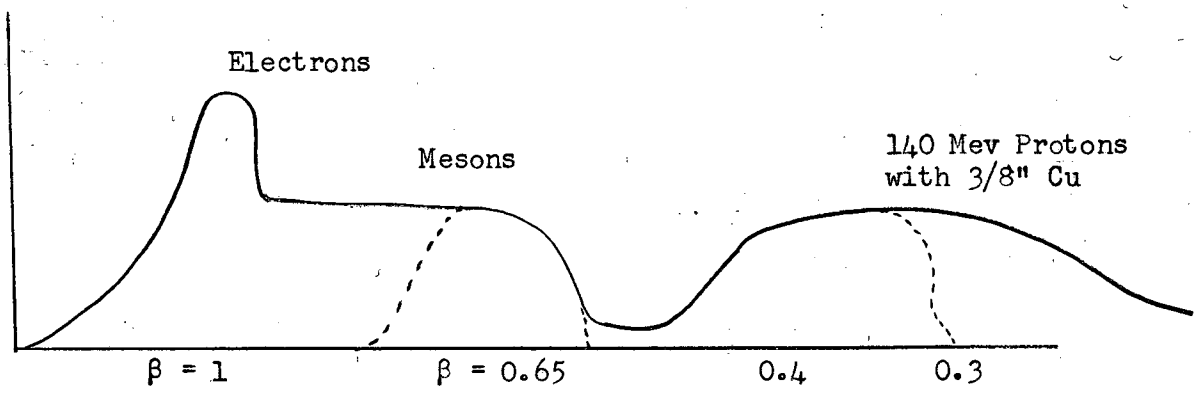


Fig. 9

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