Title

MEETING XVIII -- BEVATRON RESEARCH CONFERENCE -- BEVATRON OPERATION and NUCLEAR EMULSION EXPERIMENTS

Author

Lofgren, E.J.

Publication Date

2010-12-01

UCRL - 2587
B - 30

MEETING XVIII BEVATRON RESEARCH CONFERENCE

May 11, 1954
4 PM Auditorium, Bldg. 51

E. J. Lofgren: Bevatron Operation

Ken Green has perturbed the Cosmotron magnetic field to model the field misalignment known to exist in the Bevatron (due to foundation settling). The beam losses are similar in character and magnitude to those observed in the Bevatron. During the present shutdown, the misalignment of the Bevatron magnet has been corrected. It is hoped that beam intensity will improve.

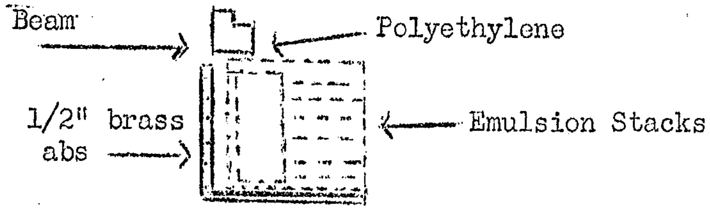
Gerson Goldhaber: Nuclear Emulsion Experiments

GENERAL

Results of preliminary tests with photographic emulsions using a lip target are discussed. Some methods for the search of heavy mesons are suggested.

The preliminary tests with photographic emulsions were designed to investigate exposure conditions inside the Bevatron. These were carried out with stationary targets, since injected targets were not available at that time.

The first exposure was designed to study the shielding required for emulsions placed in the direct beam (9 inches from the magnet centerline) during the entire acceleration cycle. Three 200μ Ilford G5 emulsions embedded in various thicknesses of brass were exposed for 30 pulses. Nominal maximum energy of beam was 3.5 Bev. During the second and third exposure (nominal maximum beam energies 4.1 and 6 Bev respectively) a lip target was placed in front of the emulsions. This was designed so as to dampen out the radial oscillations in the first section (.36 inches thick, 1/2 inch radial length). The beam should then hit the second section (.9 inches thick, .75 inch radial length) which is designed to reduce the beam orbit by ~1 1/4 inches and then hit the emulsions on the next turn. 1/2 inch brass absorber was placed ahead of the emulsions.



RESULTS

The scanning of the plates exposed at 6 Bev, nominal energy, gave the following results. The highest energy component of the beam appeared to be most concentrated in a region starting at the leading edge of the plates and extending about 1 inch radially. This was centered about 1/2 inch above the median plane. Energy discrimination by grain counts is nearly impossible in the energy region 1 - 6 Bev as this is the region of the ionization minimum for protons. Multiple scattering measurements also become very difficult for protons above 1 Bev in energy. To get an estimate of the beam energy distribution, a prong distribution for 700 stars found in the above mentioned region was made. This gave an average prong number ($\bar{N}_H + \bar{N}_S$) of 8.4: a careful survey of 200 other stars gave $N_S = 0.8$. This can be compared with cosmic ray data as given in Table I.

TABLE I

Cosmic Ray Data

Energy of Primary Particle BEV	Average Number of Heavy Prongs in Stars $\bar{N}_H$	Average Number of "Shower" Particles in Stars $\bar{N}_S$
6	14	2.8
5	12.5	2.5
4	11	2
3	10	1.5
2	9	1
1	6.5	0.4
0.5	4.7	0.1

Heavy prongs are defined as those of a grain density greater than 1.4 of minimum whereas shower particles as those of a grain density below 1.4 of minimum.

Table II shows the prong distribution found in the present work.

TABLE II

Experimental Prong Distribution (700 Stars)

Number of Prongs	Percent of Stars
2 - 5	28
6 - 10	45
11 - 15	19
> 15	8

The average beam energy observed would thus be $\sim$ 1.5 Bev. The evidence from the phototube probe, showed that beam was obtained all the way up to 6 Bev with a peak at this final energy. This, combined with the average prong number per star (8.4) would indicate that $\sim$ 10 - 20 percent of the observed tracks correspond to protons of 4 - 6 Bev. The beam intensity in this energy region can thus be estimated very roughly at $\sim 10^5$ protons/pulse. It must be noted that only 200μ emulsions were used in this preliminary survey and thus no careful measurements on events were feasible. In all about 25 stars with more than 20 prongs have been observed. The largest star observed was one of 29 prongs. Four stars were observed with outgoing slow mesons which ended in the emulsion giving σ^--stars. Those were probably all π^--mesons but some were too short to be definitely identified. Two stars were observed with a small angle pair of minimum and near minimum ionizing particles. One is presumed to be an electron pair from the direct decay of the π^0 and another pair consists probably of two π-mesons emitted at a small angle. In all 19 σ^--mesons, 31 π-μ decays and 9 ρ-mesons were found (all starting outside the emulsions). No conclusive evidence for any K-particles or hyperons was found as yet.

The Search for K-Particles and Hyperons

The various methods which appear worthwhile in looking for the different heavy mesons can be divided into 3 groups depending on the lifetime of the particles.

a. $\Lambda^{\pm}$; $\tau \simeq 5 \times 10^{-11}$ sec. These can be expected to decay in flight or at rest within about 1 cm of their creation. These will probably be observable in plates exposed in the direct proton beam. Alternately, if the lip target can be sufficiently perfected to concentrate most of the beam within a small radial spread, the beam could be used to hit some target with emulsions placed adjoining it. Some section of the emulsion stack could also act as target, which would then be exposed very heavily, while scanning takes place in the lightly exposed region. Fragments carrying Λ^{o} particles should also be detectable here.

b. Λ^{o}; $\tau = 3 \times 10^{-10}$ sec, θ^{o} $\tau = 2 \times 10^{-10}$ sec. As is well known these particles travel of the order of "one cloud chamber diameter". A set of three re-entrant wells have been constructed reaching from the top of the west tangent tank to within 6 inches of the center of the beam. These are placed directly above the present phototube plunging probe and allow emulsion to be introduced for observation of secondary particles from ~ 40° to 150° with the incoming beam direction. No vacuum locks are thus required. Studies of lifetimes, differential production cross sections and angular correlations between the planes of production and disintegrations should be possible.

c. Charged K-particles $\tau \geq 3 \times 10^{-9}$ sec. Plans are being worked out to utilize the Bevatron magnet for the deflection of low energy (20 - 200 Mev) K-particles. To the extent that momentum selection is possible, the different mass particles will then have different ranges in the emulsions. This should facilitate scanning by limiting it to definite regions. 180° focussing would be desirable. However, depending on the lifetime, a deflection of 90° may only be feasible. Some compromise will have to be made between the large solid angles attainable by 180° focussing and the higher flux attainable by smaller angular deflections (because of the short lifetime). There again some system of re-entrant wells suggests itself for introducing the emulsions.

The K-particles should of course also be observable by method b.

CONCLUSIONS

1. 1/2-inch brass absorber ahead of emulsions is adequate shielding against low energy apillout.

2. A lip target appears necessary to bring the beam into the emulsions. The lip target behaves roughly as expected.

3. With the injected probe, exposures in the direct high energy proton beam should enable one to select any energy interval for study in emulsions.