Title

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CYLINDRICAL SPARK-CHAMBER ARRAY USED FOR THE MEASUREMENT OF ANGLE, RANGE, AND POLARIZATION IN A STUDY OF K^--p INTERACTIONS†

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In studying the interactions of K particles with protons in a liquid-hydrogen target, the spark-chamber technique presents several attractive features. It is possible to achieve large detection solid angle — doubly important in view of the relatively weak intensity of K beams, and the frequent production of several charged reaction products. Further, in contrast to scintillation hodoscope systems, which demand long flight distances to obtain precise angle measurements, the high angular resolution of spark chambers allows the apparatus to be small and to be placed close to the target in order to minimize the loss corrections for the decay of the short-lived K particles. Finally, the resolution is adequate in most cases to resolve multiple-vertex events in K^- interactions, e.g., where Λ^0's, θ^0's, or Ξ^-'s are produced.

An experiment designed to exploit these features in a study of K^- interactions in the momentum region 700 to 1400 MeV/c has recently been completed at the Bevatron. An unseparated negative beam (π^- and K^-) was used. Large solid angle and high angular resolution were obtained by surrounding a liquid-hydrogen target by a ten-gap cylindrical chamber (see Figs. 1 and 2). The

† Work done under the auspices of the U. S. Atomic Energy Commission.

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electrodes were made by rolling 0.010-in. aluminum foil into cylinders 18 in. long, varying in diameter from 10 to 20 in. These were supported at the ends in circular grooves machined in two polished Lucite end plates. The spacing between gaps was 0.375 ± 0.010 in. Electrical and gas connections were made through a Lucite post stretching the length of the chamber; this post also provided a suitable dielectric termination for the straight edges of the electrodes.

In order to measure the range and polarization of certain of the reaction products produced in the forward hemisphere, a large semicylindrical chamber was placed downstream of the target. This contained 21 two-gap spark chambers interleaved with absorbers — 12 one-inch carbon absorbers at radii from 18 to 40 in., then nine one-half-in. curved steel plates extending to a radius of 60 in. The transparent curved insulating edge supports for each spark-chamber cell were made from an annulus of polished Lucite in which three grooves were machined 0.375 in. apart. The whole assembly measured 5 ft. wide by 6 ft. high by 3 ft. deep, and weighed about 6 tons.

In addition, two small spark chambers with 0.003-in. foil plates were used on either end of the final bending magnet to define the incident momentum for each event to within about ± 0.5%. Thus, although a large momentum spread (10 to 12%) was accepted in the K beam in order to obtain a high trigger rate, this a posteriori definition of momentum allowed one to examine any cross-section structure which might require much higher momentum resolution. All spark chambers were filled with a mixture of 10% helium and 90% neon. Eleven triggered spark gaps provided pulses of about 13 kV for the chambers. These gaps were triggered by a spark gap which itself was triggered by a 4PR60A vacuum-tube pulser.

In order to take pictures at a rate of up to 10/pulse, a camera with a 38-msec recovery time was used. Pulsed xenon flash lamps illuminated a set of scribed Lucite sheets to provide fiducial marks for each spark chamber. In order to provide a reasonably uniform high-voltage pulse for each chamber and flash lamp at high pulsing rates, 14 000 J were stored in a capacitor bank between Bevatron pulses.

Depth and dip-angle information was achieved by use of tilted mirrors behind the cylindrical chambers (see Fig. 1). The mirror segments were arranged almost radially on a machined Lucite backing plate and were tilted at $\alpha = 5.7$ deg to a plane normal to the axis of the cylindrical plates, thus providing a "stereo viewing angle" of 11.4 deg. (The distance between a spark and its image is $z \tan 2\alpha$, where z is the distance from the mirror surface to the spark; cf. Fig. 3 where each track appears doubled.) The resolution in depth was therefore about five times worse than the resolution in the direct view.

The K^- mesons in the beam were electronically separated from the π^- mesons by two gas Cerenkov counters. The spark chambers were triggered by a coincidence between six beam-defining counters and any two or more of 17 "barrel-stave" counters placed azimuthally around the small cylindrical chamber. A segmented seven-cell water Cerenkov counter (Fig. 2) was designed to give information on the velocity of particles entering the large chamber. A gated signal from a particle with $\beta > 0.75$ crossing a particular compartment of the counter caused a corresponding light to register on the film.

The total delay between the passage of a particle through the chambers and the start of the high-voltage pulse was about 400 nsec. A clearing field of 35 V was found to achieve the best compromise between high gap efficiency and removal of unwanted background tracks. However, at rates in excess of approximately 2×10^5 sec^{-1} (π and K mesons) the number of pictures with background tracks was unpleasantly large. Accordingly, a long anticoincidence pulse (550 nsec), derived from a beam scintillator in front of the chamber, was employed to insure that when a desirable event occurred any "old" accidental tracks had a minimum age of more than half a microsecond, and thus rarely resulted in spark production. No protection against accidental tracks younger than the triggering K^- meson was used. At large beam rates the high duty cycle of the long anticoincidence circuit resulted in a suppression of the rate of useful events. In practice the maximum rate of accumulation of high-quality pictures, i.e., those without background tracks, occurred for a flux of 4×10^5 particles per second.

FIGURE CAPTIONS

Fig. 1. Photograph of the cylindrical chamber. The segmented mirror is shown at the left.

Fig. 2. Elevation view of the apparatus. The upstream momentum chamber and final bending magnet are not shown.

Fig. 3. Photograph and diagram of an example of K^--p elastic scattering.

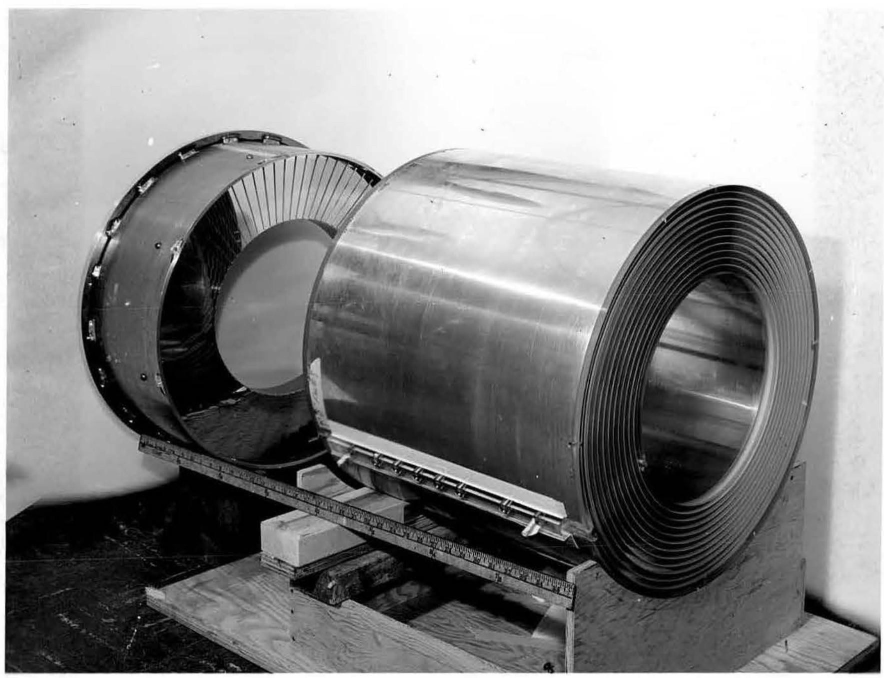

Fig. 1.

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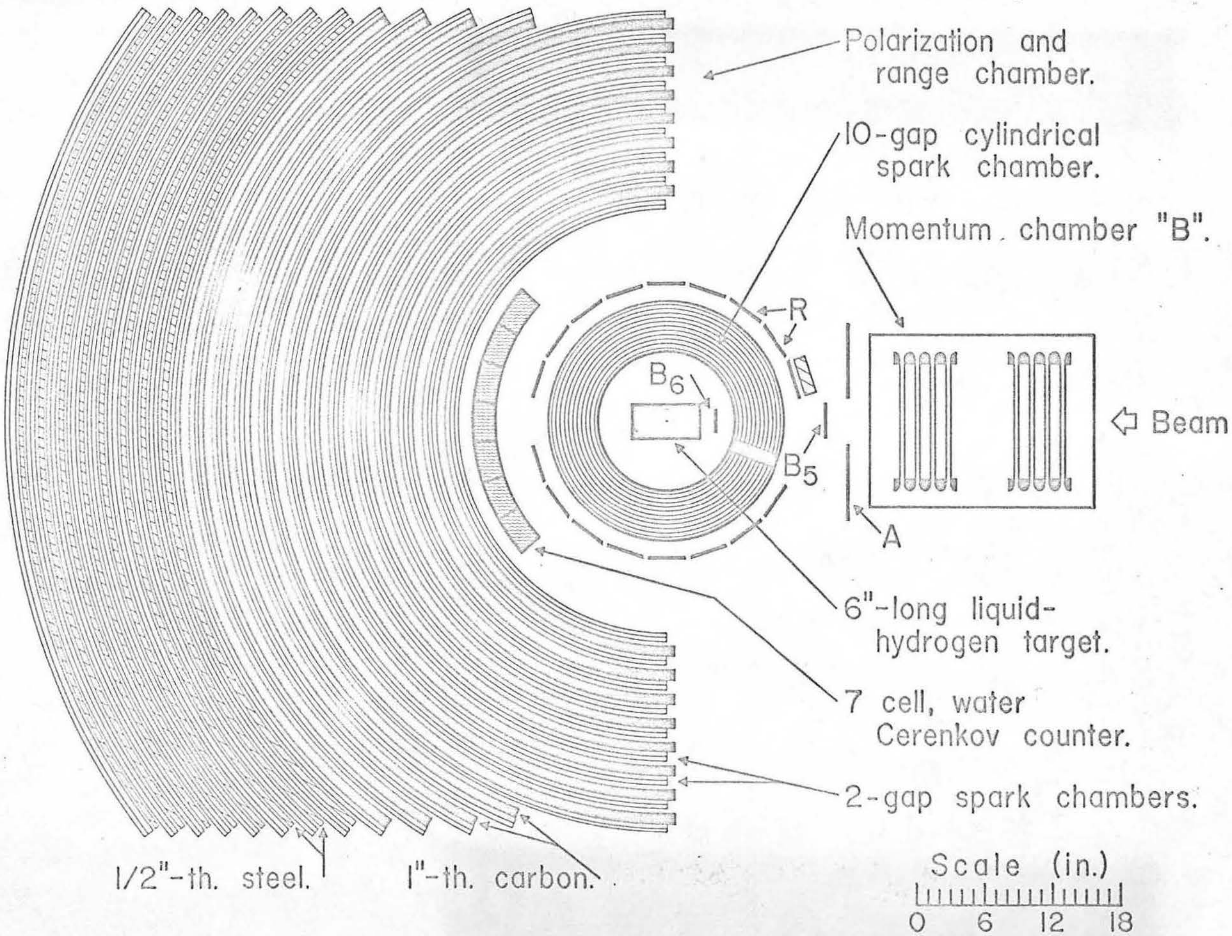

Fig. 2.

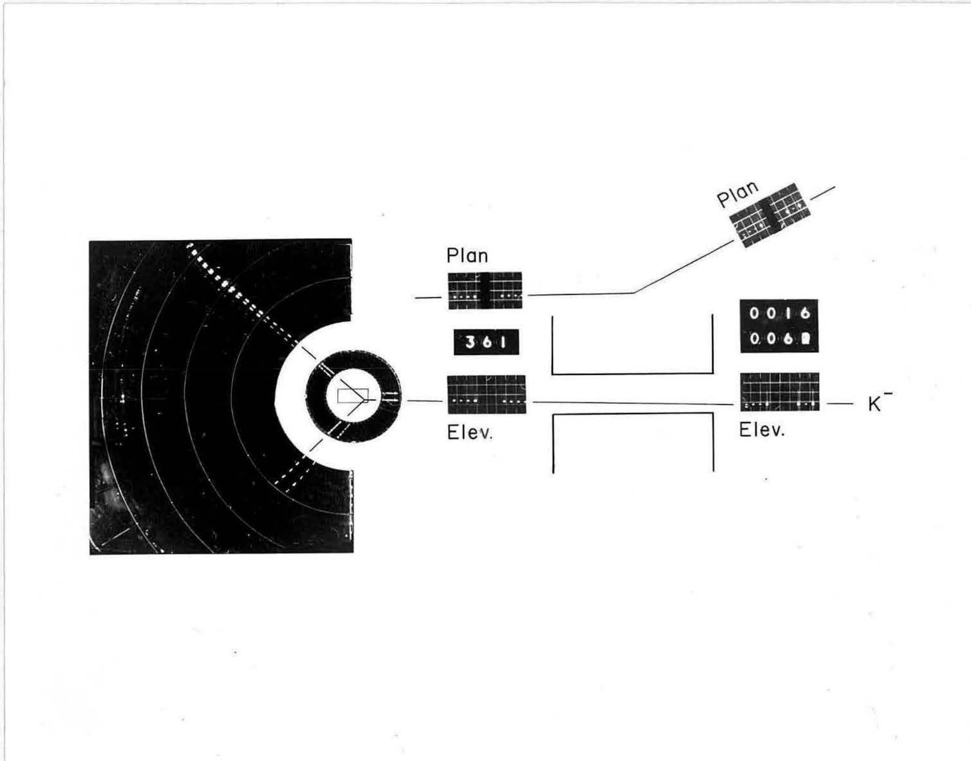

Fig. 3