SOME COMMENTS CONCERNING ELASTIC PION-ELECTRON AND KAON-ELECTRON SCATTERING AT NAL

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ABSTRACT

It is proposed that the electromagnetic radius of the pion can be measured to an accuracy of 0.03 F at NAL energies (NAL Proposals 49 and 71). We suggest that a simultaneous measurement of the kaon radius be made to an accuracy of 0.07 F.

A measurement of the pion radius by scattering charged pions from atomic electrons in liquid hydrogen has been discussed at past NAL summer studies by J. A. Poirier,[1] R. Wilson,[2] and D. Luckey.[3] Proposals 49 (Biswas et al.)[4] and 71 (Buchanan et al.)[5] both propose experiments to measure the pion radius to 0.03 F.

It should be emphasized that the pion energies attainable at NAL are necessary for a measurement of the pion radius to the accuracy stated above. At NAL energies, a 1% error in the measurement of the π-e cross section corresponds to an error of 0.03 F in the pion radius. At AGS energies, the same error in the π-e cross section corresponds to an error of 0.1 F in the pion radius. Since one can separate a vector dominance radius (0.64 F) from a nucleon-like radius (0.81 F) by six standard deviations at NAL, the advantage over doing such an experiment at lower energy accelerators is obvious.

The purpose of this note is to point out that along with a pion measurement, one can simultaneously measure the radius of the charged kaon. Because the K is heavier than the π, the maximum momentum transfer to the recoiling electron from an incident K is smaller than from a π of the same momentum. Figure 1 compares the sensitivity of a π-e experiment at NAL to a simultaneous measurement of the K radius. The maximum recoil energy of an electron in collision with an incident 80 GeV/c π and K are 64 and 19 GeV/c respectively. If one assumes a π^-/K^- ratio of 10 in the Area 2 15-mrad beam,[6] then one can measure the K radius to an accuracy of 1% which corresponds to an error in the K radius of 0.07 F. The errors shown in Fig. 1 are statistical and were calculated using the standard prescription of Bhabha.[7] The statistical error for both the π-e and K-e cases are smaller than 1%, but the expected systematic effects, e.g., strong-interaction background, radiative corrections, etc., bring the error for both cases to 1%.

It is essential that one identify the incident kaon with a high reliability, i.e., an 80-GeV/c π can give the same momentum to the recoiling electron as an 80-GeV/c K. Since one has ten times as many pions in the beam as kaons, one must reject pions with an inefficiency of at most 10^{-4}. This rejection can be achieved by the use of a DISC counter installed in the incident beam set to count K's. The efficiency of such a counter for detecting K's is about 70-80%, but this represents only a slight decrease in the effective number of K's in the beam. The important consideration is the ability of such a counter to reject pions and in this regard the DISC counter is completely satisfactory.[8]

The experimental configuration might appear as in Fig. 2. The assumption here is that the 15-mrad beam can be designed with a parallel section[9] containing a DISC counter for tagging K's and another DISC counter for tagging π's. The 20-kG, 5-m long magnet called for in Proposal 71 is adequate for the K-e experiment. M. Goitein[10] has pointed out that in a π-e experiment using negative pions, one must use shower counters not only in the electron detector but also in the pion detector as well to avoid a large systematic correction to the data. This arrangement of shower counters positioned in both the electron and pion detectors is ideal. Whereas, in a π-e experiment, an 80-GeV/c π can give 64-GeV/c momentum to the electron, an 80-GeV/c K can give 16-GeV/c momentum to the electron and retain 64 GeV/c. Hence, the kinematics of the pion and electron in a π-e collision of interest corresponds to the kinematics of an electron and kaon, respectively, in a K-e collision.

A large magnet of the 100 kG-m class is necessary for this type of experiment because the momentum of a 60- to 70-GeV/c particle must be measured to ±0.2%. The reason for such a precise measurement is to insure that the event observed was indeed a π-e or K-e scattering rather than a strong interaction resulting from a π (or K) striking a proton in the liquid-hydrogen target. This type of background is discussed in Proposal 71. The 2 DISC counters required have been discussed at this summer study by R. Meunier and will most probably become standard apparatus.

REFERENCES

[1]J. A. Poirier, The Electromagnetic Form Factor of the Charged Pion (Muon, Kaon, Electron), National Accelerator Laboratory 1968 Summer Study Report C. 1-68-10, Vol. III, p. 49.

[2]Richard Wilson, Comments on "The Electromagnetic Form Factor of the Charged Pion" by J. A. Poirier, National Accelerator Laboratory 1968 Summer Study Report C. 1-68-69, Vol. III, p. 57.

[3]D. Luckey, Form Factor Experiments, National Accelerator Laboratory 1968 Summer Study Report C. 1-68-101 (Revision), Vol. III, p. 59.

[4]N. N. Biswas, N. M. Cason, V. P. Kenney, J. A. Poirier, O. R. Sander, W. D. Shephard, and T. E. Toohig, The Electromagnet Form Factor of the Charged Pion from π^+e^- Elastic Scattering, National Accelerator Laboratory Proposal 49, 1970.

[5]C. Buchanan, D. Drickey, D. Rudnick, P. Shephard, D. Stork, H. Ticho, and A. Wehmann, A Measurement of the Pion Radius, National Accelerator Laboratory Proposal 71, 1970.

[6]E. J. Bleser (National Accelerator Laboratory), personal communication, 1970.

[7]H. J. Bhabha, Proc. Roy. Soc. (London), A 164, 257 (1938).

[8]R. Meunier (CERN), personal communication, 1970.

[9]A. Wehmann (National Accelerator Laboratory), personal communication, 1970.

[10]M. Goitein, Two Comments Concerning π-e Elastic Scattering (Proposals 49 and 71), National Accelerator Laboratory 1970 Summer Study Report SS-165, p. 245.

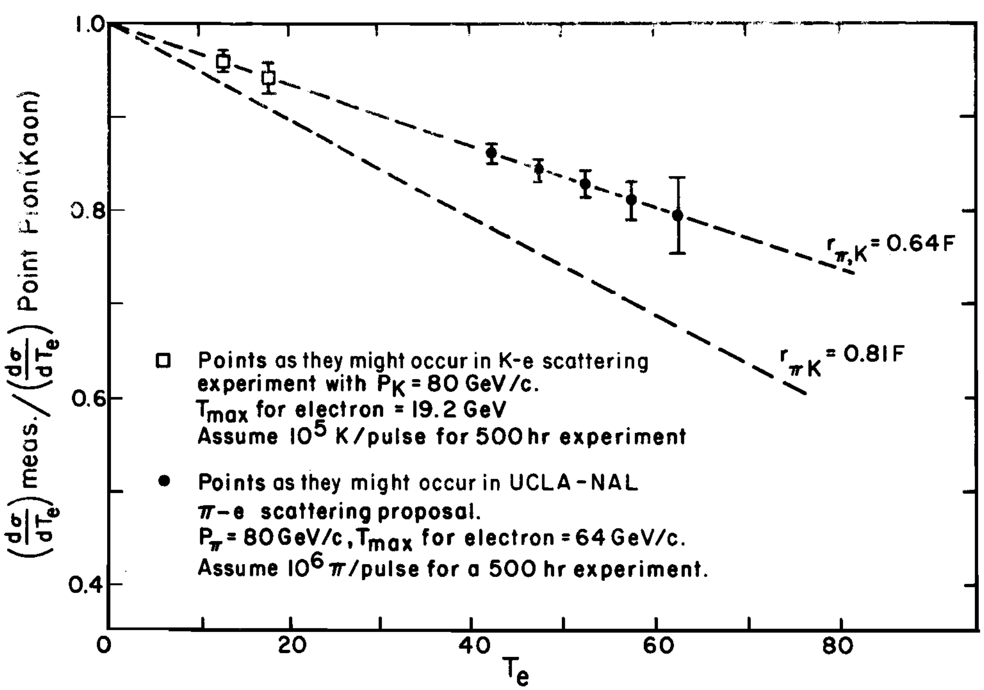

Fig. 1. Distribution of data points as they might occur in a simultaneous measurement of π-e and K-e scattering.

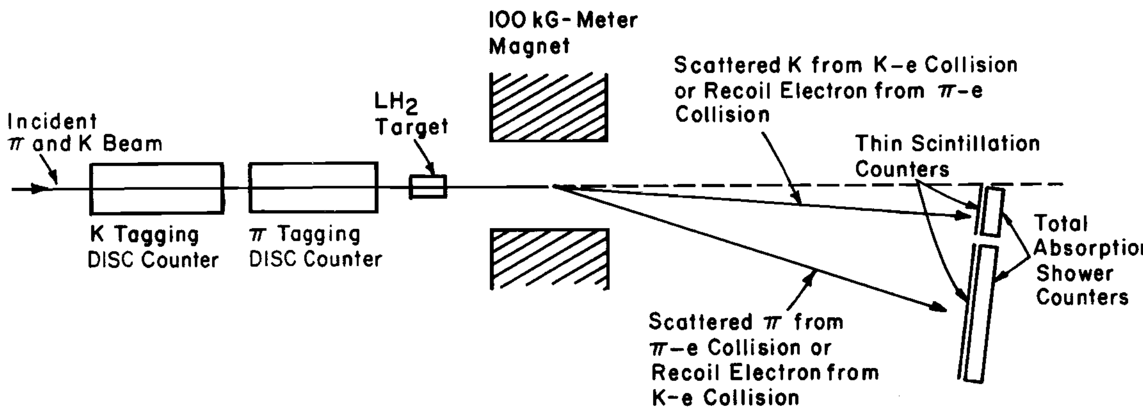

Fig. 2. An experimental configuration for the simultaneous measurement of π-e and K-e scattering.