ELASTIC SCATTERING OF 50 - 150 GeV/c $\pi^{\pm}$, $K^{\pm}$, and $p^{\pm}$ FROM PROTONS AT LARGE MOMENTUM TRANSFERS

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ABSTRACT

The design of an apparatus for studying elastic scattering with large momentum transfers in the range 50-150 GeV/c is presented.

An experiment design is discussed for studying $\pi^{\pm}$, $K^{\pm}$, and $p^{\pm}$ elastic scattering from protons at high momentum transfer, with incident momenta in the range 50-150 GeV/c. The momentum transfer limit that can be achieved is not known until an estimate of expected cross sections is obtained; we note that a Regge-type parametrization of large $|t|$ data for 6-10 GeV/c incident pions (see Ref. 1), if extrapolated to 100 GeV/c gives cross sections above $-t \sim 2$ (GeV/c)^2 unmeasurable with our design. However, we regard this as a pessimistic assumption and note that some theoretical work indicates that as energies increase, an asymptotic elastic cross-section curve may be reached; if this should be the case, then measurements can be made out to a larger momentum transfer. Consequently, we have attempted to design a flexible system to measure out to much larger $|t|$ values. Our lower limit is taken as $-t = 0.25$ (GeV/c)^2 since detection of the recoil proton becomes difficult below that value.

Our approach has been to extend the method successfully used by the Cornell-BNL group[1] in measurements up to 13 GeV/c. The philosophy there was to apply as many constraints to the reaction as possible. At large $|t|$ the differential cross section is exceedingly small and completely swamped by inelastic background, and it has been found that a conservative approach to the experimental design is useful. Thus we do not apologize for what may appear to be some overdesign in this experiment. A layout is shown in Fig. 1. We list now some of our design criteria:

1. We momentum-analyze both scattered and recoil particles.
2. In the forward spectrometer, we require a resolution such that in principle, elastic scattering can be resolved using this spectrometer alone, even at 150 GeV/c. This requires $\Delta p/p \approx 0.1\%$.

3. In each spectrometer, the trigger counters are composed of a number of 2 or 3 counter telescopes, each of which subtends a small Δp. Appropriate telescopes from each spectrometer are put into coincidence to form the master trigger to fire the wire chambers. In the forward spectrometer, the $\Delta p/p$ of the telescope is about 1%.

4. Trajectories of scattered and recoil particles are measured before and after each spectrometer magnet with 4 wire chambers in each position; in each set of chambers, alternate chambers have wires rotated by 45°.

5. No attempt is made to design special magnets--presently available types (120D36 and 30D72) are used. This will involve some magnet moving for different t ranges, but since we wish to measure at several different momenta and both polarities, these changes will not occur more frequently than every 2 weeks.

6. The incident beam is as designed by Reeder.[2] High incident momentum resolution is desirable, but so is flux, and we therefore adjust the momentum bite to give $\sim 10^7$ particles/pulse.

7. Three DISC Cerenkov counters, set for π, K, and p respectively, are placed in the incident beam to tag the incoming particles; this involves an extra stage in the beam using 3 quadrupoles and a bending magnet (see Ref. 3).

8. Two sets of counter hodoscopes in the incident beam measure the angle and position at the hydrogen target of each incoming particle.

9. Lead-scintillator sandwich counters are placed around the hydrogen target in anticoincidence to veto inelastic events.

10. Triggers are vetoed if more than one particle simultaneously traverses either spectrometer, for reduction of inelastic triggers.

We note that the vertical apertures of the two spectrometers in our design are matched to give approximately the same azimuthal acceptance. Thus to increase the solid angle acceptance, both spectrometer vertical apertures would have to increase in the same proportion. This can be done if special magnets are designed for both spectrometers, but we do not consider the cost of increasing the apertures by a worthwhile factor justified for this experiment alone.

It is obvious that this experimental equipment can be used for a number of other experiments, including backward π-p elastic scattering, but we have not considered them in detail.

REFERENCES

[1] J. Orear et al., Phys. Letters 28B, 61 (1968); Phys. Rev. Letters 21, 387 (1968) and Phys. Rev. (to be published).

[2] D. Reeder, High Quality Unseparated Beams, National Accelerator Laboratory 1969 Summer Study Report SS-41, Vol. I.

[3] O. Danielsson et al., ECFA Vol. I, p. 357.

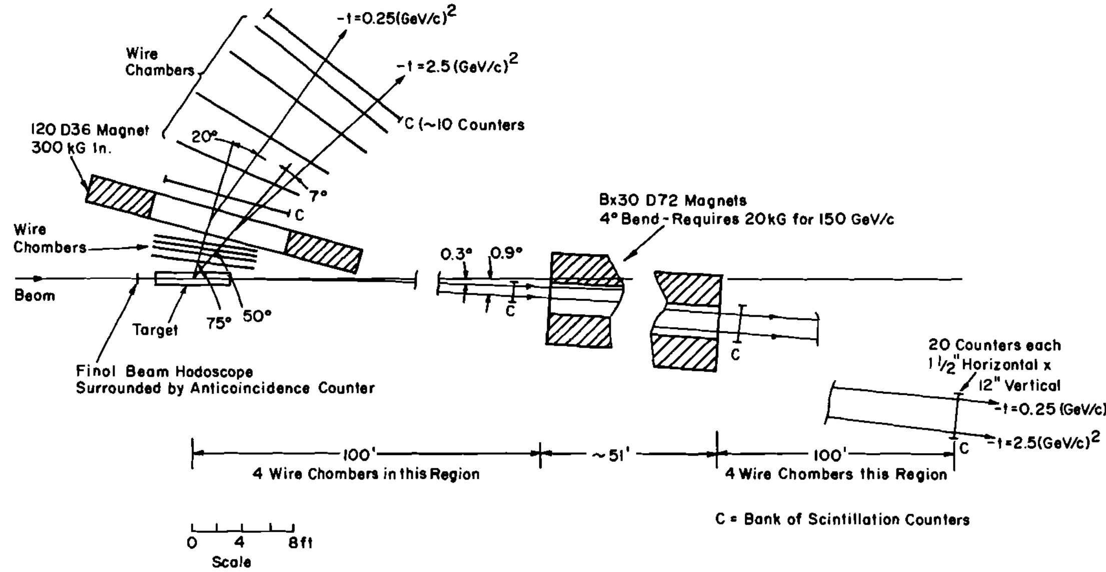

Fig. 1. Two-arm spectrometer for elastic scattering at 50-150 GeV/c.