E01-004: The Charged Pion Form Factor - II

The π^+ electric form factor, F_{π}, is a topic of fundamental importance to our understanding of hadronic structure. The success of QCD sum rule calculations, constituent quark models, and Bethe-Salpeter equation approaches can all be tested in the difficult and poorly understood gap between the ‘‘soft’’ and ‘‘hard’’ regions at intermediate Q^2. The pion holds a unique place in this regard, because its $q\bar{q}$ valence structure is relatively simple, and the asymptotic normalization of the wave function is known from $\pi\rightarrow\mu\nu$ decay.

Our earlier E93-021 result extends the region of high quality F_{π} data to 1.6 $(GeV/c)^2$. $d\sigma_L/dt$ data were obtained in the kinematical region where the t-pole process is dominant. Values for F_{π} were extracted from the longitudinal cross section using a recently developed Regge model, and the data globally follow a monopole form obeying the pion charge radius. No other precise data exist above Q^2=0.7 $(GeV/c)^2$. Even at $Q^2=1.6$ $(GeV/c)^2$, the old Cornell F_{π} values are widely scattered, and are not based on a true L/T separation. The higher energy beam that is now available will allow us to perform high quality F_{π} measurements with the existing Hall C instrumentation up to $Q^2=2.5$ $(GeV/c)^2$. This is the region where the theoretical calculations for F_{π} begin to diverge, and the data are used as input to several of the QCD-related models of F_{π} to constrain the treatment of the soft contributions.

The higher-energy beam also allows us to perform high quality measurements at higher W than in $93-021. As the extraction of F_{π} from the data inherently depend upon a model of the $p(e,e'\pi^+)n$ reaction, the higher W is advantageous because it allows measurements to be taken closer to the π^+ pole than otherwise, where t-channel contributions dominate. This higher W will also allow the Regge model used in the extraction of the form factor from the $d\sigma_L/dt$ data to be applied with greater authority, resulting in a smaller anticipated model dependence to the obtained result.

Extending the range of reliable experimental data to higher Q^2 is clearly needed to delineate the role of hard versus soft contributions at intermediate Q^2, and so aid the further development and tests of the QCD-based models currently under development. Our anticipated data up to $Q^2=2.5$ $(GeV/c)^2$ will be of sufficient quality to distinguish between at least a number of these models, and so will contribute effectively to our knowledge of hadronic structure.

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