E12-06-101 - Measurement of the Charged Pion Form Factor to High Q^2

Spokespersons: G.M. Huber, D. Gaskell

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 $\pi \to \mu\nu$ decay.

The high quality, continuous electron beam of Jefferson Lab makes it the only place to seriously pursue a program of F_π measurements. Before our JLab 6 GeV program, no other precise data existed above Q^2=0.7 GeV^2. Even at Q^2=1.6 GeV^2, the old Cornell F_π values are widely scattered, and are not based on a true L/T separation. Our E93-021 and E01-004 results extended the region of high quality F_π data to Q^2 =2.45 GeV^2.

E12-06-101 will continue these measurements to dramatically higher Q^2=6.0 GeV^2, to test QCD-based models of hadron structure in the most rigorous manner. This requires the separation of the L/T/LT/TT terms in exclusive $p(e,e'\pi^+)n$ data at low $-t < 0.2$ GeV^2, W well above the resonance region $\sim$ 3 GeV, and over a wide range of Q^2. We also plan a measurement at Q^2=0.30 GeV^2, near the upper limit of the F_π values determined exactly from π^+ elastic scattering data, as a definitive test of the electroproduction method of extracting F_π. These data will allow the charged pion form factor to be extracted with unprecedented accuracy and precision, and provide a meaningful test of QCD-based models in the transition region between perturbative and non-perturbative QCD.

Our measurement of the pion form factor is a good match to the anticipated characteristics of the Hall C spectrometers and focal plane package and is a natural application of the proposed SHMS+HMS spectrometer system. Jefferson Lab will make a unique contribution to our knowledge of hadronic structure via this charged pion form factor experiment.