

CEBAF EXPERIMENT 93-021

The Charged Pion Form Factor

D. Mack, Spokesperson

One of the great hopes for CEBAF is that it will lead to a better understanding of QCD between the non-perturbative and perturbative regimes. Improvement in our knowledge of F_π the pion charge form factor, would be an important step. Although the pion is not an easy experimental target, perturbative QCD descriptions of elastic form factors should be valid at much lower Q^2 for the pion than for the nucleon since the pion contains one less quark. In fact, for $Q^2 \cong 5 \text{ (GeV/c)}^2$, roughly half of the F_π amplitude may be due to PQCD contributions. On the other hand, existing data on G_M^p at up to $Q^2=30 \text{ (GeV/c)}^2$ are believed by some authors to be very far from asymptotia. Another feature which makes the pion case particularly interesting is that the pion β -decay constant f_π normalizes the asymptotic form factor. No such independent normalization exists for G_M^p , which is a function of the (unknown) proton structure function.

The only way to measure F_π at high Q^2 is to use virtual pions emitted from light nuclear targets. For forward $p(e, e'\pi^+)n$ kinematics in which the pion pole diagram dominates σ_L , we have

$$\sigma_L \cong K(eg)^2 \frac{-2tQ^2}{t - m_\pi^2} F_\pi(Q)^2$$

where K is a kinematic factor, t is the Mandelstam variable, and e and g are the electromagnetic and strong coupling constants, respectively.

Although the location of the pole at $-t = m_p^2$ is not kinematically accessible in electroproduction, it is possible to approach the pole quite closely. This will be the case for our lowest Q^2 (Phase I) points. At the higher Q^2 (Phase II) points, $-t_{\min}$ will increase due to CEBAF beam energy limitations. Any physics backgrounds present in σ_L will become relatively more significant as one moves away from the pole. Although we will test for physics backgrounds, it is important to run these experiments at the highest available energy.

New data for F_π covering the Q^2 range .5 - 5. (GeV/c)^2 with combined statistical, systematic, and model errors of order 10% would dramatically improve the F_p data base. This would allow one to distinguish between existing treatments of soft contributions such as QCD sum rules and relativistic potential models. We expect our errors to be even smaller at the lower Q^2 values where kinematics considerations allow us to approach the pion pole rather closely.

The collaboration is engaged in commissioning the Hall C spectrometers and beamline and looks forward to cryotarget commissioning by Fall 1995. A workshop on errors in $(e, e'\pi)$ cross section measurements was held February 17, 1995. MCEEP and GEANT simulations have begun in earnest. Phase I of these important measurements will be made in later 1996 or early 1997. The Phase II measurements require beam energy over 4 GeV, which is a strong argument for upgrading CEBAF's energy to 6 GeV in a timely fashion.