Abstract

As part of a program to determine the charged pion form factor at Q^2 = .5 - 5 $(GeV/c)^2$, we now request approval for measurements which require beam energies between 4 and 5 GeV. Assuming the dominance of t-channel one pion exchange in the charged pion forward longitudinal response, the charged pion form factor F_π can be determined. The measurements of F_π proposed here would dramatically improve on the existing data set and provide an important test of soft predictions in the transition between soft and perturbative regimes. Model tests are proposed as well to search for physics backgrounds which may be present in the longitudinal response. Measurements in Hall C at Q^2 of .5, .75, 1.0, and 1.6 are already approved (E93-021) and scheduled for Fall 1997. We request time to extend those measurements to Q^2 = 2.4 and 3.2 during the same running cycle because 5 GeV beam should be available.

1 Introduction

This extension request contains only a fraction of the background material from the original E93-021 proposal. Please refer to that document if needed. This document is mainly concerned with updating the experimental issues since we now possess two years of operational experience in Hall C, and have even completed a short $(e, e'\pi)$ test run.

One of the great hopes for research at TJNAF 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, it is a simpler object than the nucleon. Perturbative QCD descriptions of elastic form factors should be valid at much lower Q^2 for the pion than for the nucleon since the former contains one fewer quark. In fact, for $Q^2 \simeq 4$ $(GeV/c)^2$, roughly half the F_π amplitude may be due to pQCD contributions. Another feature which makes the pion case particularly interesting is that the pion β-decay constant f_π normalizes the asymptotic form factor Q^2F_π. No such independent normalization exists for G_M^P, which is a function of the (unknown) proton structure function. Existing data on G_M^P at up to Q^2=30 $(GeV/c)^2$ are also believed by some authors to be very far from asymptotia.

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_π data base, and would allow one to distinguish between existing treatments of soft contributions.

1.1 Previous Experiments

1.1.1 Data

Although this field has been dormant since the late 1970's, the field was quite mature at that time. Hence, we briefly review here some of the hard lessons learned by our predecessors.

The first major work largely above the baryon resonance region (W > 2 GeV) was by Brown *et al.* at the Cambridge Electron Accelerator ("CEA") [3]. The longitudinal response could not be extracted model independently since only high ϵ data were taken. The model of Berends [4] which