Summary

At JLab, we have a unique opportunity to dramatically improve the F_π database. Much can be learned about the usefulness of QCD sum rules and relativistic potential models for understanding the structure of the pion in the (presumably) difficult and non-perturbative Q^2 regime of 1-5 (GeV/c)^2.

This proposal deals with the continuation of our successful F_π program. Using the Hall C spectrometers and beam with energy up to 4.045 GeV, we have recently obtained a result (E93-021) for the charged pion form factor (F_π) up to Q^2=1.6 (GeV/c)^2 at W=1.95 GeV. Based on this result, a number of issues arise which we address in this proposal:

1. The E93-021 result extends the region of high quality F_π data from Q^2= 0.7 (GeV/c)^2 to 1.6 (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. (A certain recipe was taken for the transverse cross section, which according to the E93-021 results gives too small $\sigma_{\rm T}$ values.) The higher energy beam that is now available allows 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 data are used as input to several of the QCD-related models of F_π to constrain the treatment of the soft contributions.

2. The higher-energy beam also allows us to perform high quality measurements at higher W than in E93-021. As extraction of F_π from the data inherently depends 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.

   In addition, for the E93-021 result, the Regge model used in the extraction of the form factor had a shallower $d\sigma_L/dt$ dependence than the data, resulting in a F_π model dependence comparable to the experimental uncertainty. A likely reason for this is that the value $W = 1.95$ GeV of the measurement was a bit low, and resulted in resonance contributions to the cross section. This model dependence is expected to be reduced if the measurements are performed at higher W, as proposed here.

In 1996, we received approval for a 13 day beam extension to the E93-021 run to obtain data at the highest Q^2 then accessible with 5 GeV beam. However, beam scheduling constraints and the ongoing analysis of the E93-021 data precluded our use of this beam before the jeopardy rule time limit. We are now requesting time to extend the F_π measurements using up to 5.3 GeV beam, as well as improved priority, so that the experiment can be performed in a timely manner. The measurements we propose break down as follows:

Q^2 (GeV/c)^2	W (GeV)	$-t$ (GeV/c)^2	ϵ	Total Hours
2.5	2.22	0.189	0.540	132
			0.277	140
2.0	2.22	0.133	0.571	60
			0.292	104
1.6	2.22	0.093	0.600	31
			0.316	38
Total				21 days