Experiment 94-110 Phase II Update

Measurement Of $R = \sigma_L/\sigma_T$

In The Nucleon Resonance Region

June 1, 2000

We propose to perform a global survey of longitudinal strength throughout the nucleon resonance region ($1 < W^2 < 4 \text{ GeV}^2$) and spanning the four-momentum transfer range $4.5 < Q^2 < 7.5 \text{ (GeV/c)}^2$. Inclusive nucleon resonance electroproduction cross sections will be used to perform Rosenbluth separations to extract the ratio $R = \sigma_L/\sigma_T$. We intend to measure $R$ with an order of magnitude less uncertainty ($\approx 0.05$), than the current errors on $R$ which have uncertainties greater than 0.5. A first phase of this experiment ran in the summer of 1999, where $R$ was measured in the nucleon resonance region out to $Q^2 = 4.5 \text{ (GeV/c)}^2$. The second phase being addressed here, an extension to higher $Q^2$, is conditionally approved. The 1997 Program Advisory Committee (PAC) 11 noted that this experiment will “improve the existing data base significantly”, and conditionally approved Phase II based on a review of Phase I with particular attention to systematic uncertainties.

In this update, we report on the achieved precision running Phase I in Hall C and apply this to our proposed higher $Q^2$ measurements. Additionally, we introduce some recently submitted results of relevance from studies of inclusive resonance electroproduction data and parton-hadron duality in Hall C.

Review of Motivation and Goals

We present here a brief overview of the physics motivation and goals of this proposal. We refer to the original proposal and update (attached) for a more detailed discussion.

The ratio of longitudinal to transverse electron scattering off the proton is a fundamental quantity. Electron scattering is well approximated by the exchange of a single virtual photon, due to the relatively small values of the electromagnetic coupling constant, and so theoretical calculations work well. This and the pointlike nature of the electron allow for clarity and precision in understanding electron-nucleon scattering experiments; the reaction can be interpreted unambiguously in terms of the charge and current structure of the nucleon or nucleon resonance.

Rosenbluth separations have been performed on precision electron-proton elastic cross sections out to $Q^2 = 8.83 \text{ (GeV/c)}^2$ [1, 2, 3, 4, 5]. These separations allow the direct measurement of the proton electric and magnetic form factors, $G_E^p(Q^2)$ and $G_M^p(Q^2)$. Measurements in this moderate $Q^2$ region are important because it is here that the virtual photon becomes sensitive to the internal quark structure of the proton. Measurements in this intermediate momentum transfer region provide valuable con-