Abstract

A series of measurements of single pion electroproduction on the proton, deuteron, and \(^3\)He was completed recently at Jefferson Laboratory by the NucPi Collaboration. The data form the first part of a study of longitudinal electroproduction in light nuclei. The goal is a determination of the longitudinal cross section in parallel kinematics by means of a Rosenbluth separation, and a search for target-mass dependent effects. Longitudinal pion electroproduction should be sensitive to nuclear pion currents because of the dominance of the pion-pole process for charged-pion emission in the direction of the virtual photon. The mass dependence of the longitudinal cross section should provide insight into the absence of any enhancement of sea quark distributions in nuclei as measured in deep-inelastic scattering. Data have been obtained at \(Q^2 = 0.4\ \text{GeV}^2\), for \(W = 1.15\) and \(W = 1.6\ \text{GeV}\) from \(H, 2H,\) and \(3\)He, and for a range of values of \(Q^2\) on \(H\) and \(2H\) at \(W = 1.95\ \text{GeV}\). Results from the analysis of these data are discussed, and a run plan of 400 hours of beam for completing this study is presented.

1 Introduction

According to the simplest models of the nucleon-nucleon force, pion-exchange currents in nuclei should give rise to a mass-dependent enhancement\(^1\) of the nuclear pion charge distribution. Longitudinal pion electroproduction should be sensitive to nuclear pion currents because of the dominance of the pion-pole process for charged-pion emission in the direction of the virtual photon. If current conceptions of pion-exchange currents in nuclei are correct, longitudinal electroproduction will be suppressed at lower momentum transfers and enhanced at higher momentum transfers. These currents should also manifest themselves in quark-antiquark distribution functions\(^2,3\) as observed in deep-inelastic scattering(DIS) on nuclei. However, analysis of parton distribution functions shows no evidence for any nuclear enhancements of sea quarks. Recent data from Drell-Yan studies\(^4\) which directly probe the antiquark sea, show no mass dependence. These results suggest that a reformulation of pion-exchange models of nuclear forces may be required. In an attempt to probe exchange currents directly, we have carried out a series of measurements of single-charged-pion electroproduction on the proton, deuteron, and \(^3\)He at TJNAF. The goal is to measure the longitudinal cross section in parallel kinematics by means of a Rosenbluth separation, and to search for target-mass dependent effects. The results from these measurements should provide insight into the absence of any enhancement of sea quark distributions in nuclei as measured in DIS.

E91-003 was approved for an initial phase of 500 hours to make measurements at two of the four kinematic configurations proposed and for four targets, \(H, 2H, 3\)He, and \(4\)He. Because the shakedown and commissioning of the Hall C cryogenic target proved much more difficult than anticipated, only a portion of this program was completed in the initial run, but enough data was obtained with \(2H\) and \(3\)He to provide a useful examination of the mass dependence of the longitudinal cross sections. The data obtained and the details of the analysis of the data are the basis of the run plan presented here. This proposal will complete the experiment and provide a coherent examination of single charged electroproduction on light nuclei.