MARATHON (**MeA**surement of the F_2^n / F_2^p, *d/u* **RA**tios and *A=3* EMC Effect in Deep Inelastic Electron Scattering Off the **T**ritium and **H**elium Mirr**O**r **N**uclei)

Jefferson Lab 12 GeV Program E12-10-103 Hall A Experiment

MARATHON will provide fundamental information on the motion and distribution of the three quarks making up the proton (two "up" and one "down") and neutron (two "down" and one "up") constituents of nuclear matter. This will be made possible by comparing the ratio of the probabilities for an electron with high beam energy to scatter from the similar tritium (3H, made up of two neutrons and one proton) and helium-3 (3He, made up of two protons and one neutron) nuclei. This method is complementary to that used in the past at the renowned Stanford Linear Accelerator experiments, which showed the existence of point-like "partons" inside the nucleons, utilizing inelastic electron scattering from hydrogen and deuterium nuclei. The new method will eliminate inherent theoretical uncertainties present in the analysis of the Stanford data. The results will test long-standing predictions of the Quark Model of the nucleon, and of Quantum Chromodynamics, the theory describing the interactions between the quarks and gluons constituents of the proton and neutron.

The experiment will make use of a 3H, 3He, and 2H (deuterium) cryogenic target system, presently under development at Jefferson Lab. Electrons with energy up to 11 GeV will be scattered from these nuclear targets and detected in state-of-the-art magnetic spectrometer detection systems in the Hall A Facility of the Lab. The ratio of the measured cross sections for 3H and 3He, which are proportional to the scattered electron rates, will determine reliably the ratio of the neutron to proton F_2 structure functions, and subsequently the *d/u* ratio of the up to down quark probability distributions in the nucleon. The ratio of the 3H and 3He cross sections to the 2H cross section will provide the EMC effect for the three-nucleon nuclei, which provides vital information for the modification of free nucleons embedded in nuclear matter. A comparison of this effect for the two 3H and 3He mirror nuclei is considered to be essential for its full explanation and understanding.

The MARATHON project is expected to make significant contributions to the advancement of basic nuclear physics science, and to graduate education and training by offering pre- and post-doctoral dissertation topics on related science and instrumentation, which provide experience needed for careers in education, medical physics, homeland security, high technology, and national laboratories research.