E04-107, Detailed study of the ^{4}He Nuclei through Response Functions Separation at High Momentum Transfers

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The predecessor to this experiment, E89-044, has produced three Ph. D. theses and several publications which have drawn much interest. We expect interesting differences between ^{3}He and ^{4}He to reflect differences in the relativistic structures of the ground state wave functions. There is also the issue of additional modes of sharing the momentum transfer comparing the A=3 to A=4 systems. This experiment, following on the interest generated by the ^{3}He measurement is timely. Hall A is the only facility in the world where such measurements can be performed.

E04-107 has been approved for 480 hours. It would be preferable to schedule the entire experimental program, however, the experiment has several stand alone goals which allow it to be divided into two runs. At a fixed beam energy of 4.8 GeV it is possible to obtain nearly all the data needed in perpendicular kinematics. This will allow a response function separation to 500 Mev/c, a determination of the asymmetry A_{LT}, and the cross section measurements at high missing momentum to 1.2 GeV/c. We can also obtain a part of the parallel kinematics data. The total beam time for this measurement is 239 hours + 56 hours for calibrations for a total of 295 hours. A subsequent scheduling of the remaining time for five beam energies will give the data needed for the R_L/R_T q dependence and would need 185 hours + 56 hours for calibration for a total of 241 hours. Breaking the approved time in this way may facilitate scheduling, and will still produce thesis quality and publishable data. The price in time is the additional 56 hours of calibration. The collaboration now has a promise of additional student(s) including a Ph.D. student from the University of Madrid. Since the experiment requires the standard Hall A setup and it is anticipated that the elastic $^{3,4}He$ experiment E04-018 will be run in this time frame it would be a good use of the Hall's time to include the helium experiments in a contiguous block of time.