Appendix C

Backgrounds Update

C.1 Correction from Inelastic e-p Scattering

The strategy to correct the raw Møller asymmetry for the asymmetry in the inelastic background is to make a direct measurement of inelastic e-p asymmetry in auxiliary detectors. Accordingly, we have optimized the radial segmentation of the integrating quartz detectors as shown in Fig. C.1. Bin 5 is the Møller peak, while bins 3 and 4 have significant contributions from inelastic scattering; their asymmetries will be completely dominated by the contribution from the vector coupling to inelastic states.

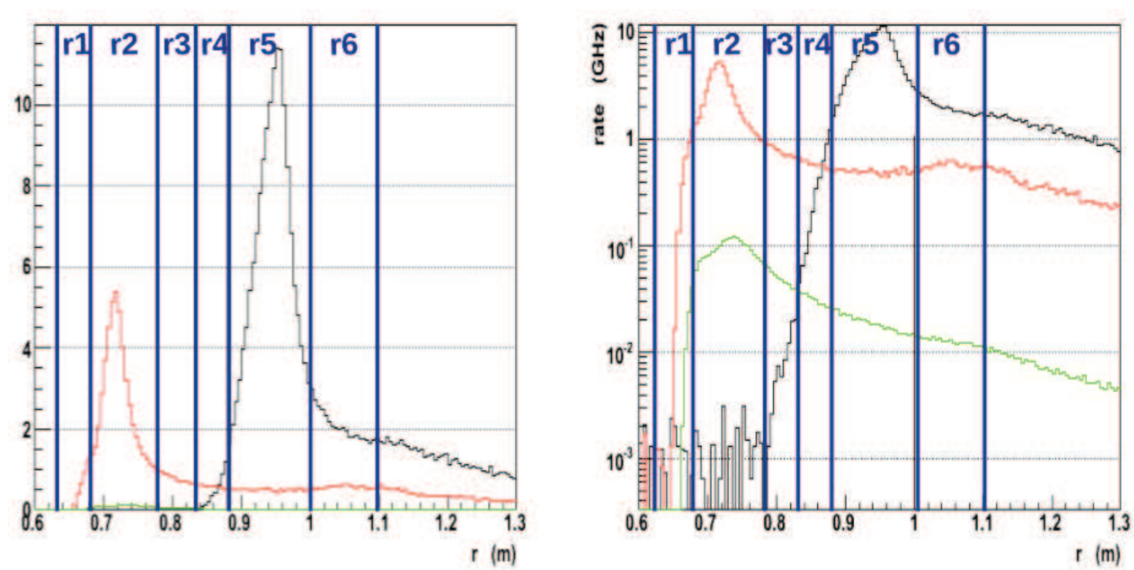

Figure C.1: *Proposed radial segmentation of the scattered electron flux, shown both in linear and log scale. The black, red and green curves are for electrons from Møller, elastic e-p and inelastic e-p scattering.*

We next look at the W^2 distribution of the inelastic events in the various radial bins. We find that the azimuthal binning into the red, green and blue sectors[1] provides important variation in the W^2 distribution that facilitates extraction of the inelastic asymmetry for different ranges of W^2. This is demonstrated in Figs. C.2 and C.3, which are the W^2 distributions for the three different azimuthal sectors in bins 5 and 4 respectively.

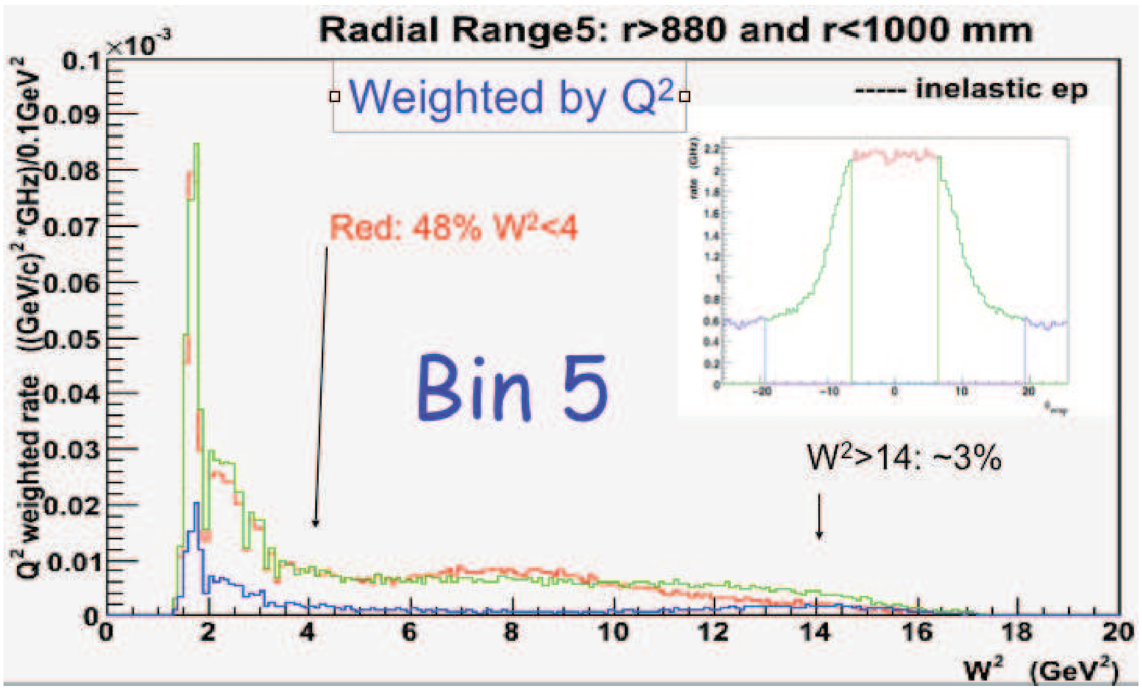

Figure C.2: W^2 *distribution for red, green and blue sectors (see inset figure and footnote below) in Møller peak radial segment (Bin 5).*

We then empirically found combinations of azimuthal sectors in Bins 3 and 4 that mimic the shape of the W^2 distributions for inelastic e-p events in Bin 5. If they match well, it would imply that measured asymmetries in the same bins can be used, with the same linear combinations, to correct for the inelastic background in the Møller peak (Bin 5). Fig. C.4 shows an example of how well this works for one such combination. We conclude that a careful analysis should allow us to reliably make corrections for the inelastic background and the systematic error from the correction should be small compared to the statistical error.

[1]The azimuthal segmentation of the detectors is described in Sec. B6 of the original proposal document.

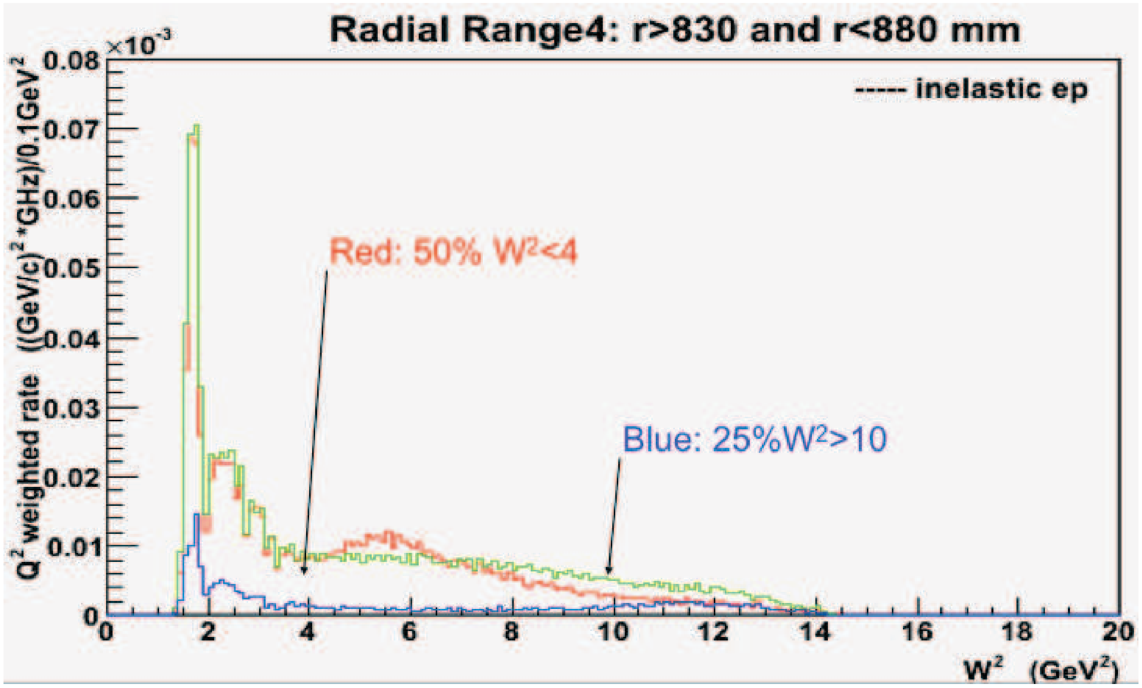

Figure C.3: W^2 *distribution for red, green and blue sectors in Bin 4.*

C.2 Pions from Weak Decays

We have launched a detailed study of exclusive hadron electro- and photo-production, using E158 pion background studies as a starting point. Using very conservative assumptions, we used published data from electro-production at Cornell [6] and SLAC [7], and an analysis [8] by the COMPASS collaboration on polarization transfer in hyperon production in polarized muon and neutrino beams, to estimate that the fraction of the pion flux at E158 from weak decays is $\sim 6 \times 10^{-4}$ and that the polarization transfer is of order 5%, leading to a pion asymmetry of 3×10^{-5}. Since the measured pion asymmetry at E158 was 6×10^{-7}, this is a factor of 50 overestimate, presumably because of kinematic suppressions of the decay pion momenta that were not taken into account.

Using a parameterization of exclusive hadron electro-production from the SLAC data [7] to rescale the flux for a 11 GeV beam, one can deduce that the fraction of pions from weak decays in MOLLER would be 3×10^{-5}. The total pion flux relative to the Møller electron flux should remain roughly the same (6×10^{-3} for thin quartz, factor of 5 less for the quartz/tungsten sandwich). If we assume the same 5% polarization transfer and the same factor of 50 additional suppression observed in E158, then the false asymmetry induced is 0.18 ppb for thin quartz, and correspondingly smaller for a "shower-max." detector.

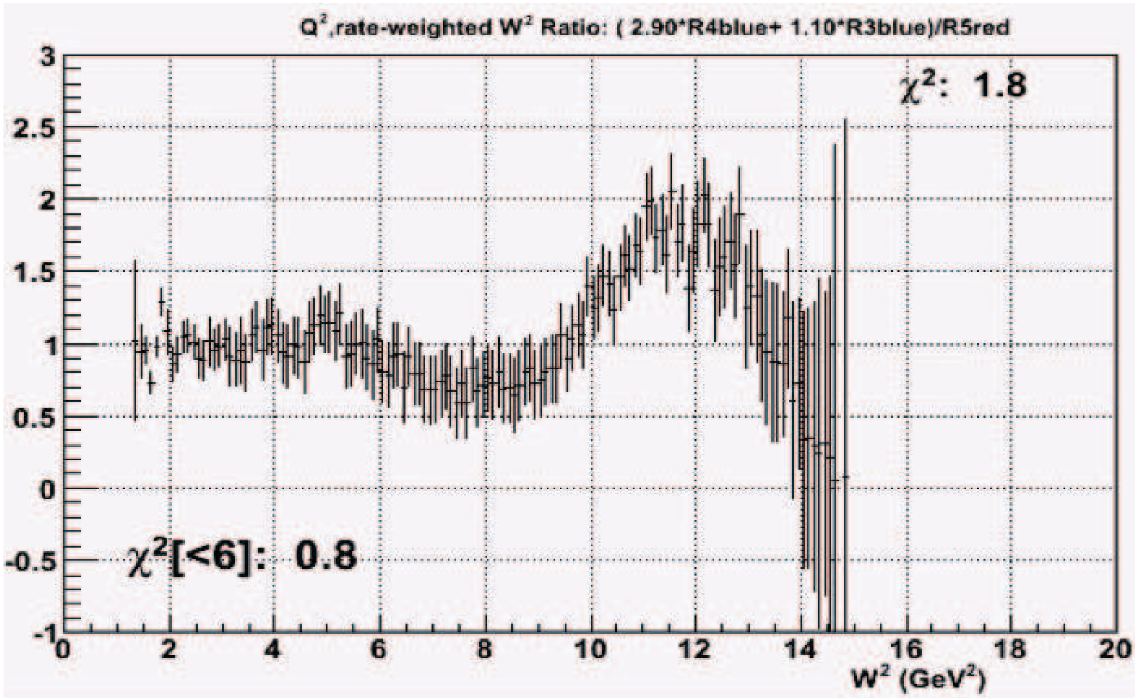

Figure C.4: *Ratio of the W^2 distribution of a specific linear combination of 2 inelastic bins to that of one of the primary Møller bin. It can be seen that they match very well for $W^2 < 6\ GeV^2$.*

Our next task is to incorporate the detailed kinematic dependences as derived from previous analyses of world data into a Monte Carlo study to arrive at more accurate estimates for the E158 spectrometer configuration. This might shed some insight into the additional (likely kinematic) suppression over the naive estimate. We will then carry out a similar study for the MOLLER spectrometer configuration and investigate the level of kinematic suppression. In parallel, we will launch a study of how best to monitor and correct for such an asymmetry by making parasitic measurements of the rate of pion production and the parity-violating asymmetry that results, so that a reliable correction can be made even if it is as large as several ppb.