each x bin, the asymmetries $A_{\parallel}$ and $A_{\perp}$ were formed:

$$A_{\parallel}\,(\text{or } A_{\perp}) = C_1\Big(\frac{1}{fP_bP_t}\frac{N_L - N_R}{N_L + N_R} - C_2\Big) + A_{rc}. \tag{5.2}$$

Here f is the dilution factor, P_b and P_t are the beam and target polarizations, A_{rc} is the radiative correction to the asymmetry, and $C_{1(2)}$ are the corrections needed due to the presence of nitrogen in the targets, with C_2 disappearing for the proton target. Also, here $N_{L(R)}$ is the number of left or right-handed helicity events corrected as

$$N_{L(R)} = N_{L(R)}^{(raw)} d_{L(R)}/Q_{L(R)} \tag{5.3}$$

where $d_{L(R)}$ is the appropriate deadtime correction and $Q_{L(R)}$ is the appropriate incident charge. All of the corrections that have to be made to the raw rates to form physics asymmetries, as well as the unpolarized structure functions, are discussed below.

5.3.1 Dead Time

For this experiment, there were two ways in which we could miss incoming data. First, the electronics were set up such that for each spill, only the first four MAIN-OR triggers could be read by the ADC modules. Any triggers that came after the first four were not recorded. We also missed data due to the actual electronics dead time: once the MAIN-OR was triggered, any signal arriving within the next 32ns could not trigger the MAIN-OR again. When a trigger occurred the discriminators opened a 32 ns gate which then allowed signals from the ADC's and TDC's to enter. If another trigger signal then entered the data stream within the next 8 ns, the discriminator would not see it. This 8 ns is known as the "double pulse" resolution of the discriminator. If the next trigger signal came within the following 24 ns but still within the 32 ns gate, the discriminator gate was extended for another 32 ns from that time, and the signal was not recorded as a separate trigger. The discriminators were run in this "updating mode" so as to prevent loss of data if the detectors became particularly noisy.

In measuring the asymmetry $A_{\parallel}$ at large x, the cross section for events when the proton and electron are antiparallel is larger than for events in which the proton and electron are parallel. This means that the rate of events into the detectors is higher with one electron helicity versus the other, so the probability of overlapping signals increases, and hence the loss of data due to both electronics deadtime and the four-per-pulse maximum is larger with this helicity. Because this then reduces the measured asymmetry, it was necessary to correct for the data we failed to acquire.

The deadtime correction was made by generating a multiplicative coefficient d for the raw number of events counted.

$$d = \frac{N_{real}}{N_{meas}} > 1. \tag{5.4}$$

To obtain N_{meas}, for each run the number of spills N_i with $i = 0, 1, ...16$ triggers were recorded from the TDC outputs. The number of MAIN-OR triggers per spill was rarely more than 12, so $i = 16$ is taken here to be the maximum. Then

$$N_{meas} = \sum_{i=0}^{i=16} \bar{i} N_i, \tag{5.5}$$

where $\bar{i} = min(i, 4)$ to provide for our four-per-pulse ADC limit.

The actual number of MAIN-OR triggers was found using a probability matrix, P whose elements $P(i, j)$ denote the probability that i hits will be measured when there are j real triggers. This matrix was obtained from a Monte Carlo simulation in which it was assumed that the spills were distributed randomly throughout a 2200 ns spill length, and that the electronics dead time

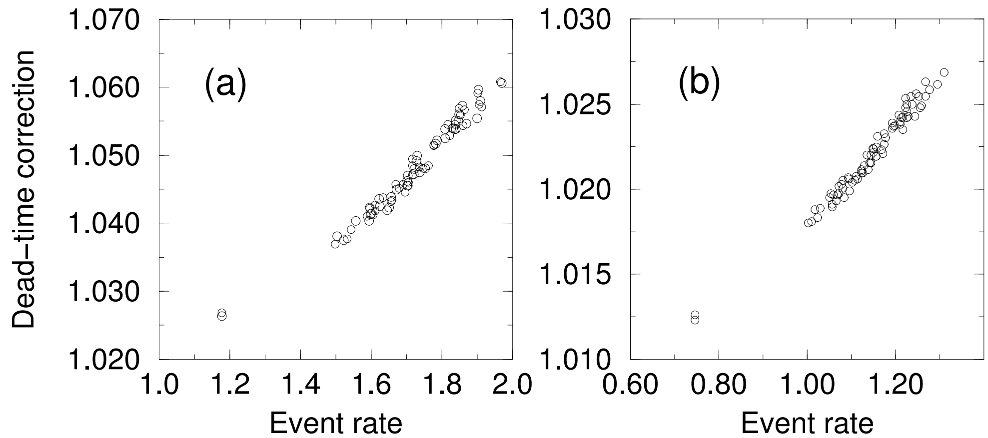

Figure 5.11: Dead time correction factors as a function of rate for both spectrometers.

was 32 ns. The number of real events was then

$$N_{real} = \sum_{j=1}^{j=16} j \sum_{i=1}^{i=16} P^{-1}(i,j) N_i. \tag{5.6}$$

The statistics for the quantity N_{meas} were accumulated for each run, for each spectrometer, and for each beam helicity separately. The deadtime correction, d, was then applied to the rates N_L^{raw} and N_R^{raw} for each x and Q^2 bin. The rates then used for the asymmetry in Equation 5.2 looked as follows, normalizing them by the incident charge:

$$N_L = d_L \frac{N_L^{raw}}{Q_L} \qquad \text{and} \qquad \mathrm{N_R} = \mathrm{d_R} \frac{\mathrm{N_R^{raw}}}{\mathrm{Q_R}}. \tag{5.7}$$

Figure 5.11 shows the deadtime corrections for the proton 29 GeV runs. Typical 4.5° dead-time correction coefficients were $d_{L,R} \approx 1.05$, while for the 7° they were closer to $d_{L,R} \approx 1.01$ due to the lower event rate.