current. The rate asymmetry for the positron was investigated reversing the polarity of the spectrometer magnet.

In the following subsections, we will discuss about the procedure to extract the cross section asymmetry from the rate asymmetry measured directly in the experiment.

4.2.1 The dead time correction

The dead time correction is defined by the ratio between the true trigger rate and the measured trigger rate. The dead time effect basically depends on the trigger rate. Consequently, it may affect the rate asymmetry if the trigger rates for left- and right-handed spills had a large difference.

The rate asymmetry corrected by the dead time effect is expressed as,

$$(\Delta^{e,p}_{\parallel(\perp)})' = \frac{\frac{N^{\uparrow(\leftarrow)\downarrow}_{e,p}}{Q^{\uparrow(\leftarrow)\downarrow}_{e,p}} C_L - \frac{N^{\uparrow(\leftarrow)\uparrow}_{e,p}}{Q^{\uparrow(\leftarrow)\uparrow}_{e,p}} C_R}{\frac{N^{\uparrow(\leftarrow)\downarrow}_{e,p}}{Q^{\uparrow(\leftarrow)\downarrow}_{e,p}} C_L + \frac{N^{\uparrow(\leftarrow)\uparrow}_{e,p}}{Q^{\uparrow(\leftarrow)\uparrow}_{e,p}} C_R} \tag{4.11}$$

where $C_{L,R}$ is the dead time coefficient for the electron (positron) rate obtained by the left- or right-handed spill.

We calculated the dead time coefficient for a given run;

$$C_{L,R} = \frac{\sum\limits_m t_m \sum\limits_n n \times P(n,m)}{\sum\limits_m min(m,4) \times t_m}, \tag{4.12}$$

where t_m is the number of times there were m trigger(s) in a spill, n is the index to indicate the expected trigger rate, and $P(n,m)$ is the matrix element which is defined as the probability to detect m triggers if there are n real triggers. Because the number of triggers in a spill was limited by shower counter electronics to four or less, the measured trigger number could only go up four even if there were more triggers in a spill. The term of $min(m,4)$ was inserted instead of m due to this trigger logic.

The matrix element $P(n,m)$ was calculated by a Monte Carlo simulation[49]. In the simulation, we assumed;

1. Triggers distributed randomly in time,
2. Dead time between triggers was $32ns$,
3. n and m were limited to 10.

The 10 × 10 unitary matrix elements are shown in Table 4.7.

measured trigger	true trigger 1	2	3	4	5	6	7	8	9	10
1	1.000	0.028	0.002							
2		0.972	0.086	0.007						
3			0.913	0.155	0.019	0.003				
4				0.838	0.235	0.049	0.008	0.002		
5					0.745	0.321	0.088	0.022	0.006	0.002
6						0.627	0.371	0.147	0.049	0.013
7							0.532	0.407	0.206	0.083
8								0.422	0.415	0.249
9									0.323	0.405
10										0.249

Table 4.7: The probability matrix to the number of triggers detected by the spectrometer. The matrix elements are calculated under the assumptions dead time=32 ns, Spill length=2200 ns. A blank means the element is 0.

We did not assume symmetry between left- and right-handed spills for the dead time coefficient, i.e. the coefficients were calculated separately for each handedness.

The dead time correction for both spectrometers are shown in Figure 4.27 and 4.28. The dead time coefficient depends on the trigger rate, and that increased the trigger rates by several percents. The corrections for the left- and right-handed spills usually were similar, so the dead time correction was very small on the asymmetry. Figure 4.29 and 4.30 indicate the asymmetry of the dead time correction for left- and right-handed spills defined by,

$$A_{dc} = \frac{C_L - C_R}{C_L + C_R}. \quad (4.13)$$

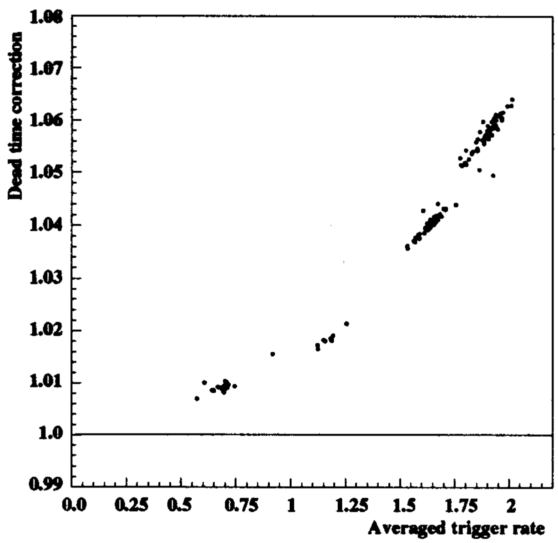

Figure 4.27: Dead time correction as a function of the averaged trigger rate for the 4.5° spectrometer: the horizontal axis shows the averaged rate for main-or trigger. The vertical axis shows the dead time correction. Only the results for left handed spill are plotted.

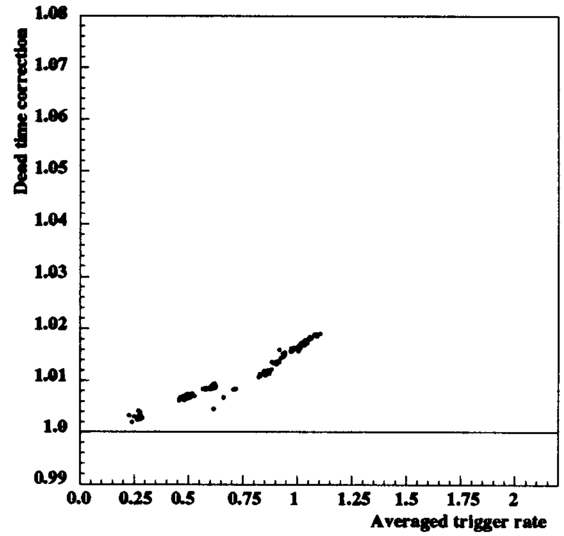

Figure 4.28: Dead time correction for the 7° spectrometer. The data for the left handed spill are shown with the conventions same as Figure 4.27.

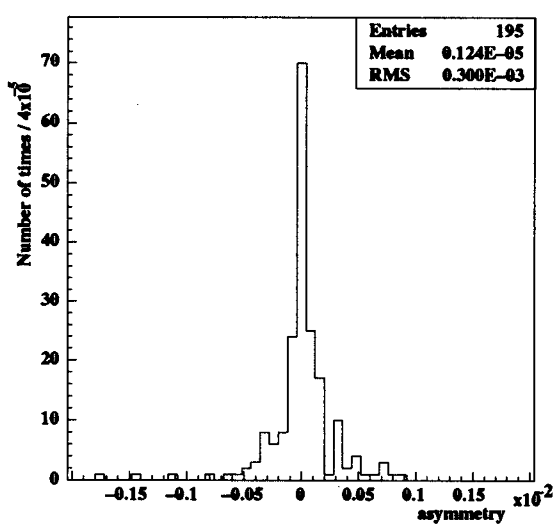

Figure 4.29: The left-right asymmetry on the dead time correction for the 4.5° spectrometer.

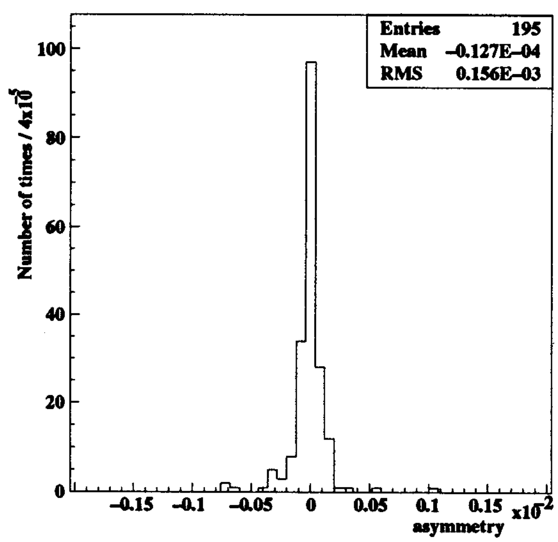

Figure 4.30: The left-right asymmetry on the dead time correction for the 7° spectrometer.

The uncertainty of the dead time correction was estimated to be less than 1.0% of $(1 - C_{L,R})$ from the detail study of the simulation. Therefore, the uncertainty on the asymmetry from the dead time correction was negligible.

4.2.2 beam polarization

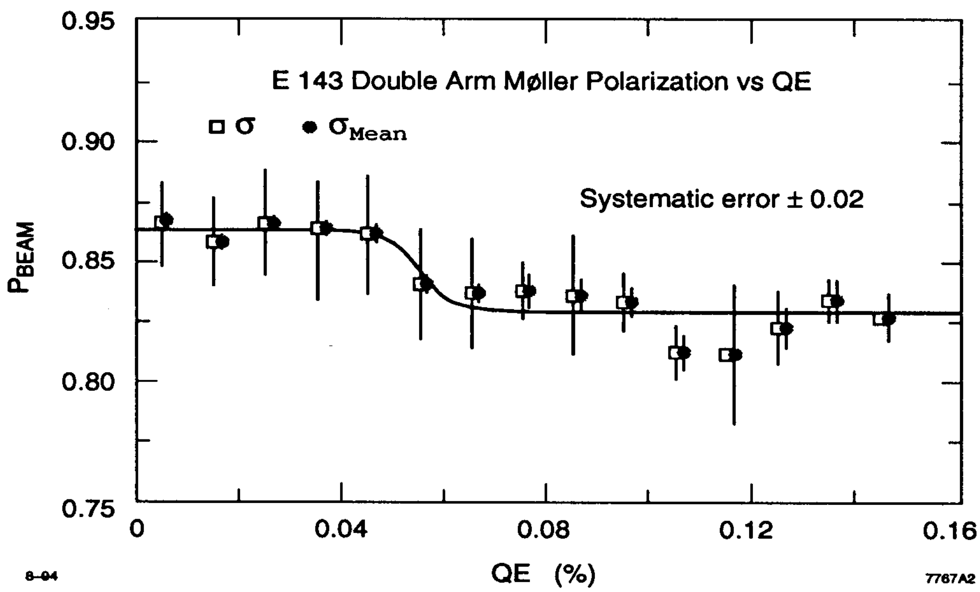

Figure 4.31: The electron polarization is plotted as a function of the quantum efficiency of the cathode of the polarized electron source. The electron polarization is measured by ESA Møller polarimeter. The σ shows the spread of the measurements and the σ_{Mean} shows the mean of these measurements. A step function plotted by a solid line was obtained from the fit with the σ_{Mean} and determined the beam polarization in the analysis.

The beam polarization was determined by ESA Møller polarimeter as mentioned in Section 3. The results from the single arm polarimeter and the double arm polarimeter, and also the Linac polarimeter which is located at the end of the Linac, were in good agreement with each other[34].

Figure 4.31 shows the relation between the quantum efficiency of the electron cathode and the beam polarization measured by the ESA Møller polarimeter. The σ shows the spread of the measurements and the σ_{Meam} is the mean of these measurements. From a