measured by the Møller polarimeter. [5]. For the target polarization P_t we used the average value of NMR and EPR measurements, interpolated in time for each run. The sign on the right hand side of Eq. (5.30) depends on the configuration of the beam half-wave plate and target spin direction. We denote the status of the beam half-wave plate to be 'IN' if it is inserted, and 'OUT' if not. The target spin direction is always aligned to the holding field direction, e.g., parallel to the beam direction for 0° field, and anti-parallel to beam for 180° field. The measured raw asymmetries are positive for (beam half-wave plate, target spin) = (OUT, 0°) or (IN, 180°), and are negative for (OUT, 180°) or (IN, 0°). The expected asymmetry from Eq. (5.20) is found to be positive. Therefore from Eq. (5.20) the absolute helicity state of the electron beam is determined to be +1 during H+ pulses, and −1 during H− pulses, in the case of the beam half-wave plate not inserted (OUT), and opposite to the helicity signal if the beam half-wave plate is inserted (IN). The elastic asymmetry results are shown in Figure 5-19. The sign for results from runs with (OUT, 180°) and (IN, 0°) has been reversed and the data points are shown as red triangles. The combined asymmetries from all runs agree with the simulation at a level of 4%, which is within its total uncertainty (4.5%). We conclude from this result that the beam and target polarizations from polarimetry measurements are correct within their uncertainties. Also the helicity-dependent part of experimental apparatus is well under control.

5.5 Δ(1232) Transverse Asymmetry

The transverse asymmetry of the Δ(1232) was measured to determine the sign convention for perpendicular electron asymmetries. The kinematics for the measurement was: $E_b = 1.196$ GeV, $E' = 0.796$ GeV/c and $\theta = 20°$.

The perpendicular asymmetry in electron scattering is defined by Eq. (1.46):

$$A_\perp = \frac{\frac{d\sigma_{\downarrow\Rightarrow}}{d\Omega dE'} - \frac{d\sigma_{\uparrow\Rightarrow}}{d\Omega dE'}}{\frac{d\sigma_{\downarrow\Rightarrow}}{d\Omega dE'} + \frac{d\sigma_{\uparrow\Rightarrow}}{d\Omega dE'}} ,$$

where $\frac{d\sigma_{\downarrow\Rightarrow}}{d\Omega dE'}$ $(\frac{d\sigma_{\uparrow\Rightarrow}}{d\Omega dE'})$ is the cross section for scattering off a target polarized perpendicular to the beamline, with incident electron spin anti-parallel (parallel) to the beam direction, and the scattered electrons being detected on the same side of the beamline as that to which the target spin is pointing. $A_\perp$ can be extracted from raw asymmetry given by Eq. (5.29) as

$$A_\perp = \pm\frac{A_{raw}}{f_{N_2} P_b P_t} . \quad (5.31)$$

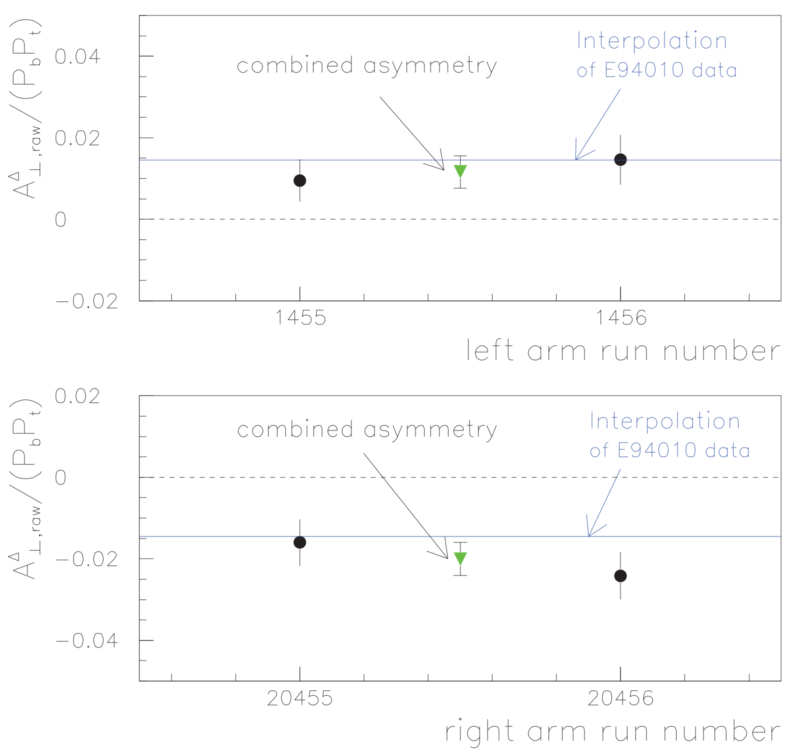
[5] Elastic data were taken on June 5th and 6th, 2001; Compton polarimetry was not available until June 15th, 2001.

The sign on the right hand side depends on the beam half-wave plate status, target spin direction, and in which (left or right) HRS the asymmetry is measured. The asymmetries of the $\Delta(1232)$ resonance have been measured in about the same Q^2 range during a previous experiment in 1998 [150]. Their final results give the $\Delta(1232)$ transverse asymmetry without being corrected for the radiative effect and N_2 dilution, denoted by $A^{\Delta}_{\perp,raw}/(P_bP_t)$, to be [151]

- At $Q^2 = 0.03$ (GeV/c)^2, $A^{\Delta}_{\perp,raw}/(P_bP_t)$=0.79%;
- At $Q^2 = 0.16$ (GeV/c)^2, $A^{\Delta}_{\perp,raw}/(P_bP_t)$=1.81%.

We interpolate these data to our kinematics $Q^2 = 0.115$ (GeV/c)^2, and obtained $A^{\Delta}_{\perp,raw}/(P_bP_t)$=1.45%. Figure 5-20 shows the results for $A^{\Delta}_{\perp,raw}/(P_bP_t)$ from our data. This is the transverse asymmetry before being corrected for the sign, radiation effect and the N_2 dilution. A cut $|W_{^3\text{He}} - M_\Delta| < 0.02$ GeV/c^2 has been applied to select events from the $\Delta(1232)$ resonance, where $M_\Delta = 1.232$ GeV/c^2 is the mass of the

Figure 5-20: Measured $\Delta(1232)$ transverse raw asymmetry $A^{\Delta}_{\perp,raw}/(P_bP_t)$ without sign correction. No correction for radiative effect and N_2 dilution has been applied. A cut $|W_{^3\text{He}} - M_\Delta| < 0.02$ GeV/c^2 has been used to select events from $\Delta(1232)$ resonance. The beam half-wave plate was inserted and target spin direction was 270°. The expected value $A^{\Delta}_{\perp,raw}/(P_bP_t)$=1.45% is shown as a blue line.



$\Delta(1232)$. The asymmetries from the left and the right HRS data have the opposite sign, both are very close to the expected value. We therefore conclude that the measurement is reliable and one can use $A_{\perp}^{\Delta}$ to determine the sign convention for measured transverse asymmetries.

The raw $\Delta(1232)$ transverse asymmetry measured during the A_1^n experiment was positive in the left HRS, with beam half-wave plate IN and target spin at 270°. The sign on the right hand side of Eq. (5.31) should be '+' for (beam half-wave plate, target, HRS)=(IN, 270°, left), (OUT, 90°, left) or (IN, 90°, right), (OUT, 270°, right); and '−' for (beam half-wave plate, target, HRS)=(IN, 90°, left), (OUT, 270°, left) or (IN, 270°, right), (OUT, 90°, right).

5.6 DIS Analysis

The asymmetry and cross section analysis for DIS data is discussed in this section. First, the procedure of removing data collected during beam trips and rampings is described. Then the sign conventions for the longitudinal and transverse asymmetries are clarified. The results of false asymmetry and positron background tests are presented. Next the procedure and results for radiative corrections to the asymmetries will be given. The systematic uncertainties in the DIS cross sections and asymmetries will be discussed. The systematic uncertainties in the asymmetry A_1^n will be presented in detail. The results for the DIS cross sections will be presented at the end. The DIS asymmetry results will be presented in Chapter 6.

5.6.1 Charge Asymmetry and Beam Trips

As described in Section 3.8.3, the average charge asymmetry during one run was controlled to below 200 ppm by the charge asymmetry feedback system. However, for the deep inelastic data taking in the A_1^n experiment, the electron beam was used at an energy of 5.7 GeV. At this energy the beam is not stable and trips typically every 2 minutes. To smooth the heat impact to the target, the beam was ramped on at a slope of 0.1 μA/sec after each trip. During these beam trips and beam rampings, the beam intensity asymmetry measured in Hall A was not stable, which can be explained by the unstable asymmetry from the electron source. To make sure that the beam intensity asymmetries do not affect the results, data during beam trip and rampings were removed, as shown in Figure 5-21. This procedure is called "beam trip removal".

5.6.2 Sign Convention for Asymmetries

The parallel asymmetry is defined by Eq. (1.45) and is repeated here

$$A_{\parallel} = \frac{\frac{d\sigma_{\downarrow\Uparrow}}{d\Omega dE'} - \frac{d\sigma_{\uparrow\Uparrow}}{d\Omega dE'}}{\frac{d\sigma_{\downarrow\Uparrow}}{d\Omega dE'} + \frac{d\sigma_{\uparrow\Uparrow}}{d\Omega dE'}} ,$$