Beam Polarization Measurement for the ANKE deuteron break-up experiment

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The first polarization study at ANKE has been carried out in Sept 2001 to measure the proton vector analyzing power A_y^p of the deuteron break-up process $p + d \to (pp)_S + n_{\rm backward}$ [1] at a beam energy of 0.5 GeV. To that aim, the Münster deuterium cluster target [2] was bombarded with polarized protons. The beam polarization was measured with the EDDA detector [3]. A calibrated measurement of the beam polarization at EDDA is possible only at energies above $\approx$ 0.7 GeV (1343 MeV/c). In addition, the employed polyethylene targets do not tolerate beam intensities exceeding about $5 \cdot 10^8$ stored protons. Since initially, we wanted to perform a measurement of A_y^p at 0.5 *and* at 1.0 GeV, a macro cycle was realized, which consisted of two flattops at 0.5 and 1.0 GeV (Fig. 1). The beam polarization was

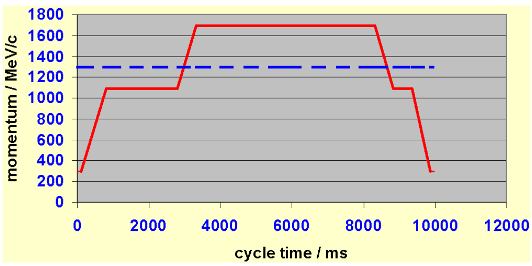

Fig. 1: Schematic picture of the cycle with two flattops, at $T = 0.5/1.0$ GeV (1.090/1.696 GeV/c).

measured in separate cycles with appropriately reduced intensity (micro-pulsing), but otherwise identical to the data-taking cycles. At 0.5 GeV for instance data were taken for 10 min, subsequently the beam was ramped to a very short 1 GeV flattop. The beam polarization was alternated from cycle to cycle. Polarization data with EDDA were recorded once or twice per day, *a)* during flattop at 1 GeV to monitor the polarization and *b)* during the ramp, with modified flattop durations. Since between 0.5 and 0.7 GeV the depolarizing resonances in COSY are understood and compensated, this procedure provides the beam polarization at 0.5 and at 1.0 GeV. Since the polarization data recorded with EDDA did not provide a continuous monitoring of beam polarization, the beam spin up/down ($\uparrow, \downarrow$) asymmetry of protons scattered off the deuterium target was measured with ANKE. Elastically and quasi-elastically scattered protons between $\theta_{\rm lab} = 5° \ldots 11°$ were registered in the Forward Detector (FD). At the same time proton pairs from the break-up process under study were recorded. The relative luminosity $\mathcal{L}_\uparrow/\mathcal{L}_\downarrow$ was determined from inelastically scattered protons near zero degree, simultaneously detected in the FD. Online track reconstruction provided information (angle and momentum) to select the scattered protons. Both proton count rates and observed asymmetry were sufficiently large to monitor the beam polarization during the run. The resulting polarizations (EDDA) and asymmetries (ANKE)

$$\varepsilon(\uparrow,\downarrow) = \frac{N_\uparrow/\mathcal{L}_\uparrow - N_\downarrow/\mathcal{L}_\downarrow}{N_\uparrow/\mathcal{L}_\uparrow + N_\downarrow/\mathcal{L}_\downarrow}$$

are shown in fig. 2. The asymmetries from ANKE were obtained for 2 h runs carried out right after the EDDA polarization measurements. The data are quite stable in time, thus averaging is justified and yields:

T [GeV]	$P_{beam}^{\rm EDDA}$
0.7	0.645 ± 0.009
1.0	0.577 ± 0.001

The measured asymmetries at ANKE are given below:

T [GeV]	$\varepsilon(\uparrow,\downarrow)$	$[\varepsilon(\uparrow,\uparrow) + \varepsilon(\downarrow,\downarrow)]/2$
0.5	0.294 ± 0.006	-0.002 ± 0.009

Here $\varepsilon(\uparrow,\uparrow)$ and $\varepsilon(\downarrow,\downarrow)$ denote false asymmetries by analyzing cycles with the same polarization direction. The effective analyzing power of ANKE, given by the ratio $\varepsilon(\uparrow,\downarrow)/P_{beam}^{\rm EDDA}$, is thus $A_y^{\rm eff} = 0.456 \pm 0.011$. The data at 0.5 GeV are currently processed to arrive at a first measurement of the vector analyzing power in the break-up process. Unfortunately, the low beam intensity during the run did not permit to record deuteron break-up data at 1.0 GeV.

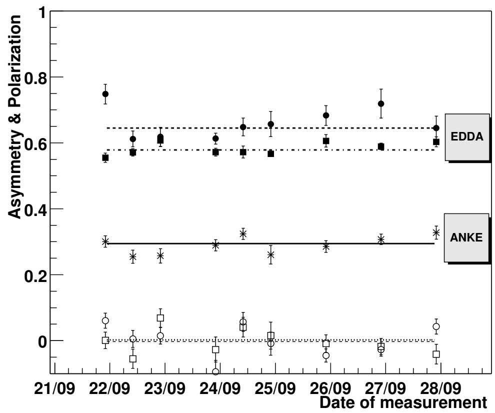

Fig. 2: EDDA beam polarization and asymmetry measured at ANKE. Filled circles denote the measured beam polarization at 0.7 GeV at EDDA, filled squares the 1 GeV flattop polarization. Stars indicate the asymmetry of small-angle scattered protons off the deuteron target, and the open symbols correspond to the measured false asymmetries $[\varepsilon(\uparrow,\uparrow)$ and $\varepsilon(\downarrow,\downarrow)]$.

The first measurement with polarized beam at ANKE, described here, became possible only through help from the EDDA collaboration, which we hereby gratefully acknowledge.

References:

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