POLARIMETRY OF GEV PROTONS IN RECIRCULATING SYNCHROTRON BEAMS

D. ALBERS, F. BAUER, K. BÜSSER and W. SCOBEL
I. Institut für Experimentalphysik, Universität Hamburg,
Luruper Chaussee 149, D 22761 Hamburg, Germany
e-mail: karsten@kaa.desy.de

for the EDDA COLLABORATION[a]

A new polarimeter for the proton synchroton COSY has been developed. Asymmetries in elastic pp scattering are measured by detecting forward and recoil protons in coincidence in dedicated detector systems. Polarimetry has been done at fixed energies as well as during beam acceleration in the energy range of 300 to 2600 MeV.

The COSY accelerator of the Forschungszentrum Jülich is a cooler synchrotron which is capable of delivering a proton beam in the energy range from 40 MeV up to 2600 MeV to 4 internal and 3 external target places.[1]

During the last years, emphasis has been put on the acceleration of polarized protons in COSY. Polarization diagnostics have been performed so far using the EDDA detector with its internal fiber target[2].

We have now developed a polarimeter for the internal beam to provide COSY with an easy-to-use device for polarization measurements in a convenient and sufficiently accurate way. Development and construction of this polarimeter have been finished and it has been tested in the accelerated polarized COSY beam. Routine polarization diagnostics will start at the end of 1998.

The conceptual design of the polarimeter foresees the elastic proton-proton scattering as analyzing reaction for the polarization measurements. Polarimeters of this design have been used at several accelerators so far [3,4]. The new

---

[a]M. Altmeier[1], F. Bauer[2], J. Bisplinghoff[1], T. Bissel[1], R. Bollmann[2], M. Busch[1], K. Büßer[2], T. Colberg[2], L. Demirörs[2], O. Diehl[1], F. Dohrmann[2], H.P. Engelhardt[1], P.D. Eversheim[1,2], O. Felden[1], R. Gebel[3], M. Glende[1], J. Greiff[2], A. Groß[2], R. Groß-Hardt[1], F. Hinterberger[1], R. Jahn[1], E. Jonas[2], H. Krause[2], R. Langkau[2], T. Lindemann[2], J. Lindlein[2], R. Maier[3], R. Maschuw[1], T. Mayer-Kuckuk[1], A. Meinerzhagen[2], M. Pfuff[2], D. Prasuhn[3], H. Rohdjeß[1], D. Rosendaal[1], P. von Rossen[3], B. Sanz[2], N. Schirm[2], M. Schulz-Rojahn[1], V. Schwarz[1], W. Scobel[2], S. Thomas[1], H.J. Trelle[1], E. Weise[1], A. Wellinghausen[2], K. Woller[2], R. Ziegler[1]
(1) Inst. f. Strahlen- und Kernphysik, Univ. Bonn
(2) I. Inst. f. Experimentalphysik, Univ. Hamburg
(3) Inst. f. Kernphysik, FZ Jülich.
Work supported by BMBF, contracts 06HH852 and 06BN664I(6), and FZ Jülich, contracts FFE41126903 and FFE41126803.

aspect in our design is to combine this method with a measurement at an *internal* target and with a polarimeter acceptance sufficiently wide for *measurements during beam acceleration* in the range of COSY beam energies from 300 to 2600 MeV where the angular correlation of the outgoing protons varies relativistically.

Elastic scattering of polarized beam protons on unpolarized target protons results in asymmetries in counting rates (L,R) of identical detectors positioned left and right of the beam under equal scattering angles Θ_F [5].

If one defines the asymmetrie ϵ as follows one yields

$$\epsilon = \frac{L-R}{L+R} = P_N \cdot A_N \tag{1}$$

from where the polarization of the beam (P_N) can easily be calculated if the analyzing power (A_N) of the reaction is well known.

The polarimeter design consists of two pairs of kinematical conjugate and coplanar arms. Each pair is designed to detect the forward scattered proton in a scintillating detector telescope (FW1 and FW2) in coincidence with the recoil proton in the backward detector telescope (BW1 and BW2). Figure 1 shows a not to scale drawing of the active detector elements.

The whole setup can be rotated under remote control around the axis of the beamline to exchange the two pairs of arms and to account for detector asymmetries by replacing L and R in eq. 1 by the respective geometric means.

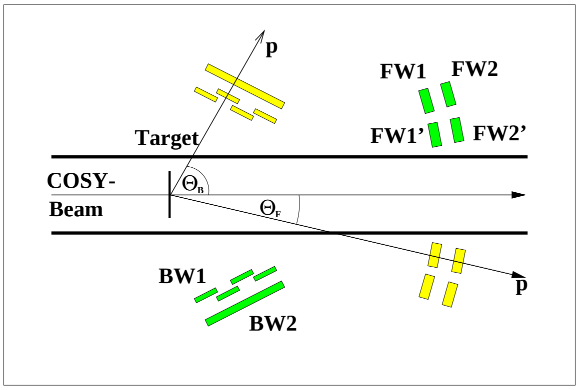

Figure 1: Schematic drawing of the active detector elements. Additional forward detectors FW1' and FW2' enlarge the kinematical range during measurements with accelerated beams. Not to scale.

The polarimeter uses a 14μm thick CH_2 fiber target. The background from quasielastic and inelastic pC scattering is corrected by doing additional

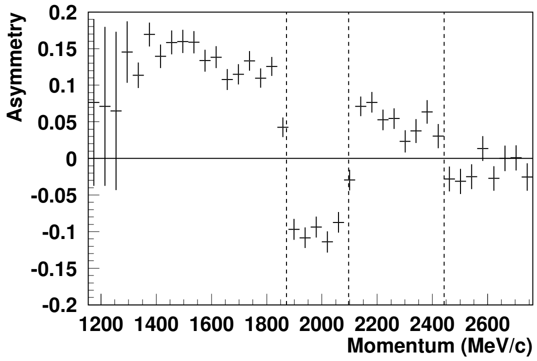

Figure 2: Asymmetry measured during beam acceleration. The dashed lines show the positions of depolarizing resonances where spin flips occur.

measurements with a carbon fiber and by extrapolating its contribution by means of the position sensitivity of BW1 outside the kinematic correlation.

In 1996 first tests of the polarimeter have been done performing measurements at fixed energies. It has been shown that absolute statistical errors in the order of 1% can be achieved in flat-top measurements. Statistical errors in the order of 5% can be achieved with data taking time of less than 5 m.

In 1997 the polarimeter has been used during acceleration of the polarized COSY beam. The beam lifetime with the fiber target is in the order of 1-2 s so that acceptable counting rates are achieved during acceleration with $\Delta p/\Delta t$ = 1.15 $GeV/c \cdot s^{-1}$ up to high energies. Second pairs of forward telescopes (FW1' and FW2') have been installed to keep the scattering angles during acceleration close to the maximum of the analyzing power which varies with the beam energy. The broad backward detector system covers the kinematically varying recoil angles in the whole energy range up to 2600 MeV.

Figure 2 shows asymmetries which result from 1.5 h data taking with an average luminosity in the order of 10^{30} cm^{-2} s^{-1}.

References

1. R. Maier, *Nucl. Instrum. Methods* A **390**, 1 (1997)
2. V. Schwarz *et al.*, these proceedings
3. H. Spinka *et al.*,*Nucl. Instrum. Methods* **211**, 239 (1983)
4. J. Bystricky *et al.*, *Nucl. Instrum. Methods* A **239**, 31 (1985)
5. G. Ohlsen, P.W. Keaton jr., *Nucl. Instrum. Methods* **109**, 41 (1973)