EDDA AS INTERNAL HIGH-ENERGY POLARIMETER

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for the EDDA collaboration[a] at COSY

In May 1996, polarized protons were injected ($p_{\mathrm{inj}} = 295$ MeV/c) and accelerated in the cooler synchrotron COSY for the first time. The internal EDDA detector in COSY has been utilized as an fast polarimeter taking advantage of a very fast and efficient method to monitor the polarization of recirculating COSY beam. In November 1997, polarization was observed up to 2.7 GeV/c.

The EDDA experiment is designed for a high precision measurement of proton–proton elastic scattering excitation functions ranging from 0.5 to 2.6 GeV laboratory kinetic energy[1]. It utilizes the proton beam of the cooler synchrotron COSY [2] operated by the Forschungszentrum Jülich. In addition to spin-averaged elastic cross-section $d\sigma/d\Omega$ the analyzing power A_{000n} and the polarization correlation parameters A_{00nn} A_{00ss}, and A_{00sk} will be measured, using the polarized proton beam [3] of COSY and an internal polarized atomic hydrogen gas target.

EDDA as polarimeter for COSY Prior to data acquisition of $\vec{p}\vec{p} \rightarrow pp$ elastic scattering events the EDDA detector has been used as an internal high-energy polarimeter during a dedicated run for the development of the polarized COSY beam in November 1997. The detector granularity enables us to monitor beam polarization while accelerating the beam protons up to 2.7 GeV/c by simply counting protons scattered from a thin CH_2 fiber target into the scintillator semi-rings covering either the left or the right hemisphere concentric to COSY beampipe (Fig. 1) . False asymmetries are eliminated, and for

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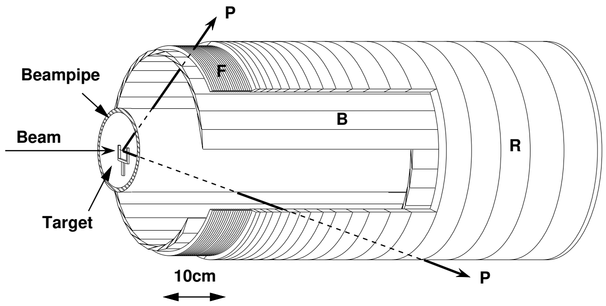

Figure 1: The EDDA detector (not to scale): **Target** fiber (CH_2), now a polarized atomic hydrogen beam; beampipe (2 mm Al in the solid angle covered); **B** scintillator bars; **R** scintillator semi-rings; **F** semi-rings from scintillating fibers.

an efficient suppression of nonelastic background the kinematic coincidence of left- and righthand scattered protons according to elastic pp scattering can be demanded. Since this method does not require any digitizing of data or event reconstruction and classification, it is dead-time free and very fast.

For calibration purposes exclusive elastic $\vec{p}$p scattering data were taken *simultaneously*, but due to dead-time with reduced statistics. For background determination, scattering data with a similar carbon fiber target were analysed. The analyzing power A_{00n0} was taken from the VPI energy-dependent phase shift analysis SAID (solution SM97)[4]. Carefully taking into account false asymmetries, beam polarization has been determined from pp-elastic data redundantly. The lefthand plot of Fig. 2 shows beam polarization versus beam momentum p as determined by the analysis of elastic pp data and is based on data acquired in 18 h. It is evident that this method does not allow a fast measurement of the beam polarization. For a fast determination of the beam polarization this time consuming method is not preferable to the above mentioned, due to an immense amount of data to be digitzed, and analyzed for an exact event-reconstruction

After performing a calibration of the effective analyzing power with respect to the analysis of elastic pp data, the EDDA detector can be used as a fast polarimeter for beam development by acquiring continuously as a function of beam momentum the asymmetry of two-prong scattering events from a CH_2 fiber target. Within 10 minutes, the beam polarization can be measured with a precision of ± 0.05 in 40 MeV/c bins. The righthand plot in Fig. 2 displays the corresponding calibrated two-prong rate asymmetries. An error band Δ shows the systematic uncertainty of the absolute calibration.

Development of polarized proton beam at COSY In order to accelerate the polarized beam to maximum energy of COSY depolarizing imperfection and intrinsic resonances have to be crossed [5]. At five imperfection resonances correcting dipoles have successfully been used to conserve the polarization by exciting total spin flips. The magnetic structure of COSY allows to adjust superperiodicity $P = 6$, leaving only one strong intrinsic resonance, $\gamma G = 8 - \nu_y$. The apparent polarization decrease at other intrinsic resonances will be compensated in future by a more accurate adjustment of the optics. In addition, a tune jumping system can be used, particularly to completely conserve polarization at $\gamma G = 8 - \nu_y$.

Conclusion The EDDA detector has been calibrated and used as a very fast and efficient polarimeter for beam development at COSY in the momentum range $1.1 - 2.7$ GeV/c. Now the calibration is planned to be extended up to maximum COSY energy.

References

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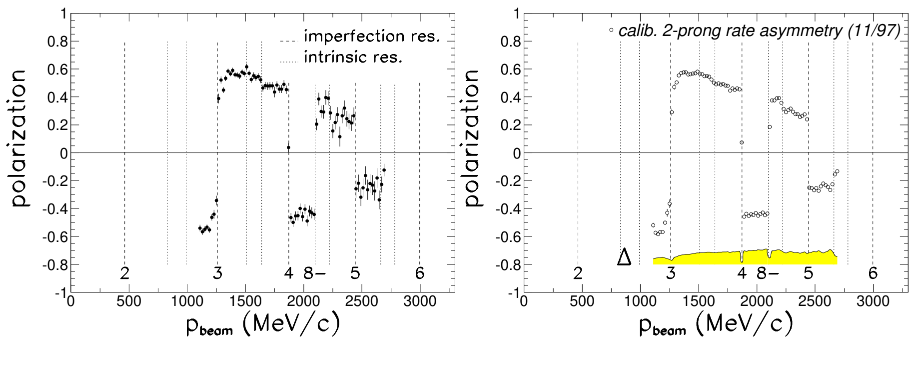

Figure 2: Beam development in November 1997. The lefthand plot displays beam polarization as determined by analysis of pp elastic scattering for calibration purposes. The righthand plot displays calibrated two-prong rate asymmetries.