The NN interaction: New results from polarized pp scattering at COSY

F. Hinterberger for the EDDA collaboration[a] at COSY
ISKP, Univ. Bonn, Nußallee 14-16, D-53115 Bonn, Germany

The EDDA experiment at the cooler synchrotron COSY measures proton–proton elastic scattering excitation functions in the momentum range 0.8 – 3.4 GeV/c. In phase 1 of the experiment, spin-averaged differential cross sections have been measured continuously during acceleration with an internal polypropylene (CH_2) fiber target, taking particular care to monitor luminosity as a function of beam momentum. The results provide excitation functions and angular distributions of unprecedented precision and internal consistency. No evidence for narrow structures was found. In phase 2 of the experiment excitation functions of the analyzing power $A_{\rm N}$ and the polarization correlation parameters $A_{\rm NN}$, $A_{\rm SS}$ and $A_{\rm SL}$ are measured using a polarized proton beam and a polarized atomic beam target. This phase 2 has been started with the measurement of analyzing power excitation functions.

The proton-proton elastic scattering [1] is fundamental to the understanding of the strong interaction. At 1-2 GeV kinetic energies it provides a focus on the short-range part of the nucleon-nucleon interaction, i. e. in the framework of meson exchange models, on the role of the ω-meson [2]. Another important problem is the question of existence or nonexistence of dibaryons [1]. Precise data are also needed for the improvement and extension of phase shift analyses [3] at higher energies.

The EDDA experiment [4] is designed to measure excitation functions of spin-averaged and spin-dependent cross sections with a high relative accuracy over a wide momentum range during the proton beam acceleration in the cooler synchrotron COSY [5]. In phase 1, differential cross sections were measured in the momentum range 1100-3300 MeV/c using 4 μm $\times$ 5 μm CH_2 fiber targets and 5 μm diameter C fiber targets for background subtraction [4]. On the basis

[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], 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[1], 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],
Spokesmen: J. Bisplinghoff[1], F. Hinterberger[1] and W. Scobel[2],
(1)Inst. f. Strahlen- und Kernphysik, Univ. Bonn,
(2) I. Inst. f. Experimentalphysik, Univ. Hamburg,
(3) Inst. f. Kernphysik, FZ Jülich.

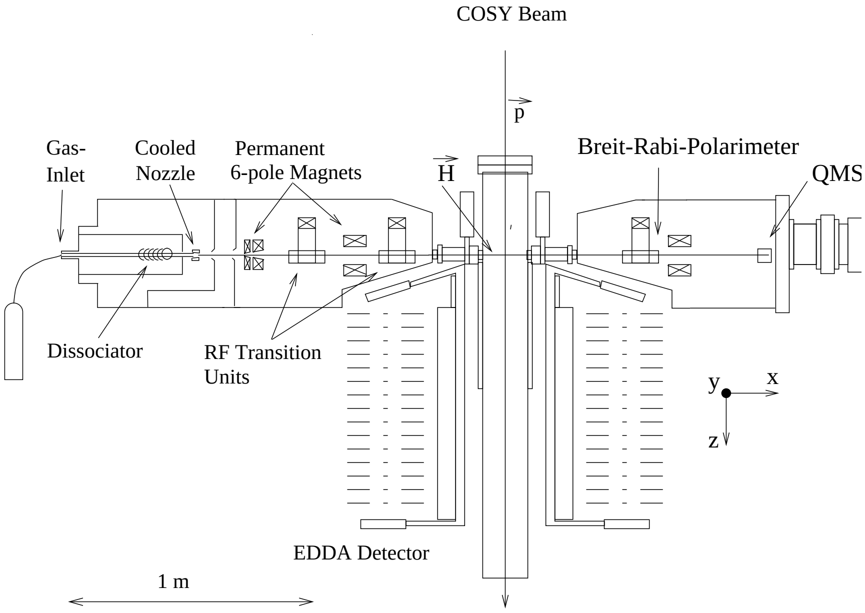

Figure 1: Scheme of polarized atomic beam target and EDDA detector.

of those data Arndt et al. [3] increased the maximum beam momentum of their partial-wave analysis from 2300 to 3300 MeV/c. In phase 2 the analyzing power $A_{\rm N}$ and the polarization correlation parameters $A_{\rm NN}$, $A_{\rm SS}$ and $A_{\rm SL}$ will be measured as a function of momentum using a polarized atomic beam target and a polarized proton beam.

The polarized atomic beam target[6] and the EDDA detector are shown schematically in Fig.1. The polarized hydrogen atoms are prepared using an atomic beam source with dissociator, cooled nozzle, permanent sextupole magnets and rf-transition units. In the beam dump the polarization is continuously monitored using a Breit-Rabi polarimeter. Preparing a polarized atomic beam in the pure hyperfine state 1 yields an effective and peak polarization of 60 and 85 %, respectively and an effective target density of $2{\cdot}10^{11}$ atoms/cm^2 (see fig. 2). The width at the target point is $\sim$12 mm (FWHM). The magnetic holding field (0.8 mT) can be switched between $\pm x$, $\pm y$ and $\pm z$.

For the analyzing power measurements an unpolarized COSY beam is used. With $1.5 \cdot 10^6$ turns/s and $3 \cdot 10^{10}$ protons in the ring a luminosity of about 10^{28}/cm^2/s is achieved. Data are taken during the acceleration and

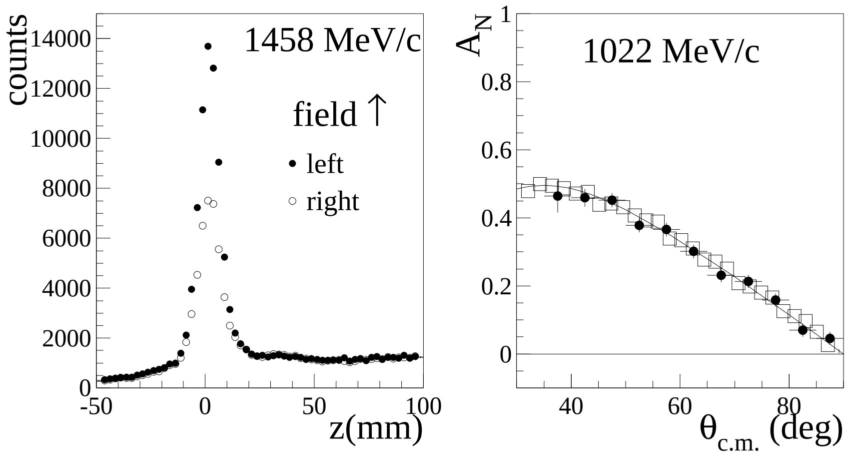

Figure 2: Test run results. Left: z-distribution of scattering vertex for pp elastic scattering to the left and right of the detector at 1458 MeV/c. Right: A_{N} versus $\Theta_{\mathrm{c.m.}}$ at 1022 MeV/c, black dots: this work, open symbols: data from IUCF[7], solid curve: SAIDSM97[3].

deceleration of the COSY beam. The idea of the experiment is to reach a high relative accuracy by accumulating many cycles in a multipass measurement. Since the target polarization is constant during an acceleration/deceleration cycle (time period $\sim$20 s) a high relative accuracy can be achieved. In the first run of phase 2 about $6 \cdot 10^6$ elastic scattering data were taken. The data analysis is underway. The absolute calibration is established with reference to angular distributions measured at 1022 and 1458 MeV/c [7,8] (see fig. 2).

To summarize, the method of using the internal synchrotron beam during acceleration works well and can now be used to measure excitation functions of polarization correlation parameters. The EDDA collaboration gratefully acknowledges the great support received from the COSY accelerator group. This work was supported by BMBF and FZ Jülich.

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