Abstract

With the idea of precise measurements of the elastic proton proton scattering the EDDA experiment was developed as an internal experiment at the cooler synchrotron COSY at the Forschungszentrum Jülich. The detector setup consists of two cylindrical scintillator hodoscopes, which account for the kinematics of the reaction and concentrically surround the beam pipe. Data acquisition can take place already during acceleration of the COSY proton beam and leads to complete excitation functions from 350 $MeV \leq T_{Lab} \leq 2500\ MeV$. The polar angular acceptance comprises $30^o \leq \vartheta_{cm} \leq 90^o$.

The experiment can be classified in three phases, which are devoted to different observables. The first two phases were aimed at the unpolarized differential cross section $d\sigma/d\Omega$ and the single polarized analyzing power A_N. Their Results have been published already. The completing third phase then turned to three double polarized spin correlation coefficients, namely A_{NN}, A_{SS}, und A_{SL}.

The measurement of double polarized scattering has taken place during four periods until summer 2001 and finally reached more than 70% of beam polarization of 10^{10} circulating protons at maximum energy. This equals luminosities of $2 \cdot 10^{27} cm^{-2} s^{-1}$ with a typical target thickness of $1.8 \cdot 10^{11} cm^{-2}$ (and effective target polarizations between 60% and 70%). Decreased cross sections at high energies result in low counting rates during the measurement of excitation functions, which has been compensated for by extended storage times at ten different energies for further data accumulation. As a whole the data base includes 4.6 mio. events within the excitation functions and 12.4 mio. more events at fixed energies.

This work is devoted to the analysis of excitation functions of double polarized scattering observables A_{NN}, A_{SS}, and A_{SL}. The results at fixed energies are used for consistency checks only. The data analysis has been carried out on the basis of asymmetries arising from the polarizations in the azimutal angle. Corrections have been applied to the asymmetries with respect to the polarizations, and the data sets have been tested for internal consistency. Final results comprise 343 data points in either excitation functions and angular distributions in each of the three spin correlation coefficients, which have been compared to other experiments and phase shift analyses. A_{SS} has been measured for the first time above 792 MeV and shows strong deviations from phase shift analyses. Normalization of the spin correlation coefficients uses angle and energy dependant Legendre polynomials based upon the EDDA data of the analyzing power. Below 1700 MeV normalization uncertainties are less than 0.07, and the systematical errors are not exceding 0.06.

The expanded world data base provides the basis for a direct reconstruction of the scattering amplitudes at five fixed energies. Finally this work includes an attempt to phenomenologically expand a meson exchange modell in order to describe the medium energy range satisfyingly above 1 GeV. The spin observables turn out to be partially very stiff and extremely difficult to reproduce in detail.