MEASUREMENT OF A_y FOR pp SCATTERING IN THE COULOMB-NUCLEAR INTERFERENCE REGION

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The goal of this experiment is to measure the analyzing power A_y of 185 MeV pp scattering at forward angles ($\theta_{lab} = 2.4° - 10.6°$) using the Cooler ring. The desired accuracy of this measurement is $\delta A_y = \pm 0.004$ for each of about 10 angle bins. Separate determination of the nuclear amplitudes and phases is possible at the more forward angles where the observables are sensitive to the interference between the Coulomb and nuclear amplitudes.[1] In contrast, measurements at larger angles are sensitive to the products of the nuclear amplitudes only. Note also (Fig. 1) that various phase shift solutions differ by

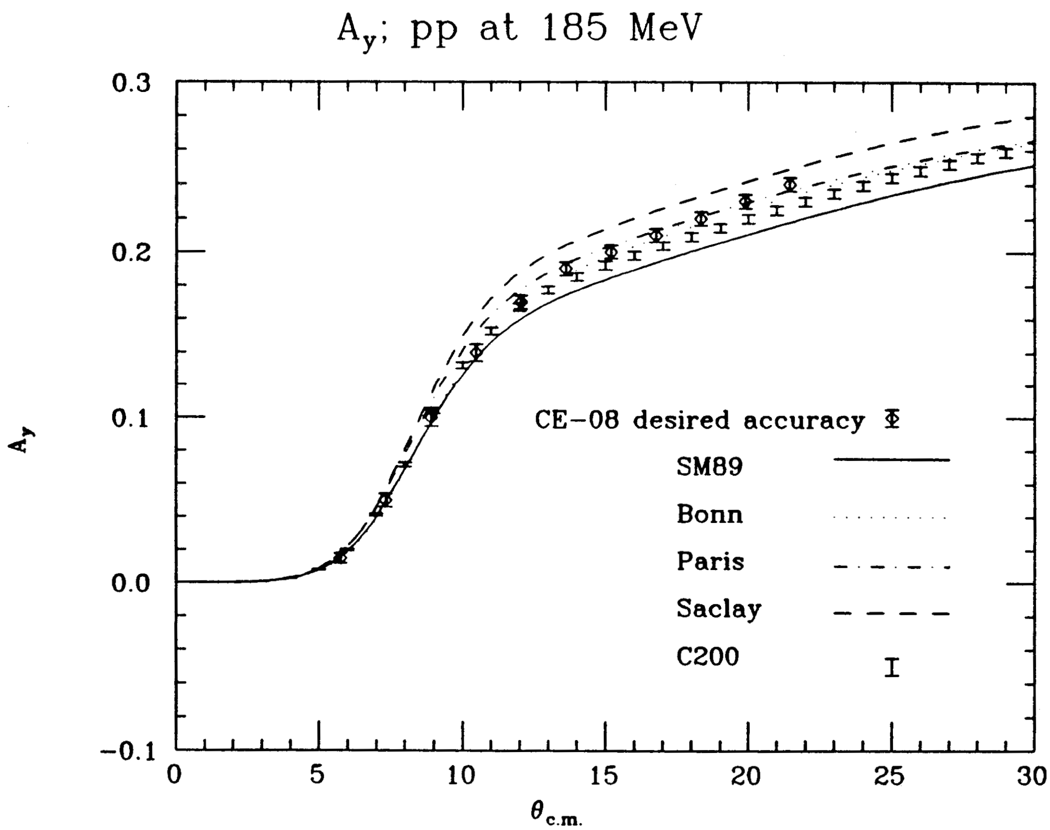

Figure 1. Expected data from this measurement (diamonds) compared to the results of phase shift analyses and potential models. The SM89 phase shift is the Arndt global analysis while the C200 analysis (vertical bars) is the 200 MeV single energy solution. Calculations were carried out using the program SAID.[2]

up to 20% in the range of this measurement,[2] and a measurement of A_y to our desired accuracy will distinguish between these solutions.

This measurement is in the "G"-region of the Cooler, and uses both the forward detector and gas jet target developed for the CE-01 experiment. The Cooler ring has definite advantages for our experiment since the combination of the small beam emittance and windowless gas jet target reduce the background compared to a conventional experiment, and detection of the struck nuclei at large angles is straightforward. During the past year we have succeeded in isolating elastic pp scattering events by also detecting the coincident, low energy protons at large angles with a silicon strip detector inside the Cooler. Detection of these protons was necessary since the CE-01 collaboration detected a large background of high energy protons, and this background has not been eliminated by manipulating the beam. Silicon strip detectors were chosen due to a combination of good energy resolution at low energy, large area, good vacuum compatibility, and reasonable cost. These particular detectors (Micron Semiconductor type "I") are 300 micron thick wafers each with an active area of 4×6 cm^2 divided into 7 individual strips.[3] Either 3 or 4 segments are coupled together to reduce the number of UHV feedthroughs and electronic modules required. A resistive chain readout would give a poor signal to noise ratio at the lower proton energies (300 keV minimum). The acceptance of the four detector array is about 500 msr total. Permanent magnets of strength $\int Bdl = 700$ gauss-cm at normal incidence eliminate the flux of δ-rays with energy less than 40 keV.

During a test run in January 1990, the performance of both the silicon strip and standard silicon surface barrier detectors was tested with a 177 MeV proton beam. The strip was noisy due to poor grounding and microphonics from the turbomolecular pumps but the spectra still show a clear pp elastic scattering locus (Fig. 2). This plot shows the correlation between the angle of the forward scattered proton and energy of the recoiling proton, and has been gated by pulse height in the plastic scintillators and position information from the wire chambers. Note the large number of events (y-axis) which originate outside the region viewed by the silicon detector. The coincident background was less than about 1% for forward scattering angles greater than 3°. The detector mount has since been redesigned to totally enclose the detectors with a Faraday cage at detector ground, reducing the noise from the turbomolecular pumps to acceptable values. The front face of the Faraday cage is a screen, eliminating the energy loss and straggling associated with thin aluminized mylar foils. A resolution of 1% has been recently acheived for 5.5 MeV α particles with all but one turbomolecular pumps at nearly full speed. This excellent resolution, combined with a calibration using α sources of different energies, will give an independent check on the scattering angle measured with the wire chambers.

Another development project of this collaboration has been the conversion of the IUCF polarized source to pulsed operation, resulting in an increase in the peak beam current. A gain of 65% has been measured at IUCF; a complete description is included in the Technical Status section of this report.[4]

We now plan a data run in June 1990.

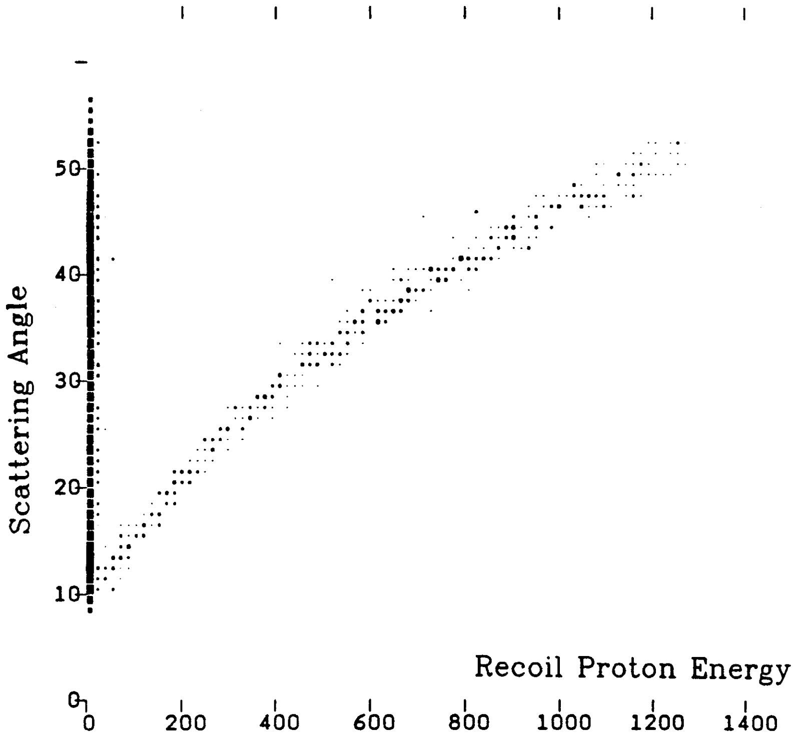

Figure 2. Energy deposited in the silicon strip detector versus angle of the forward proton at 177 MeV. The scale of the horizontal axis is 5 keV/channel and the scale of the vertical axis is 0.2°/channel. The dot size is proportional to the number of counts. The angular acceptance was 2° − 10° in the laboratory.

1. C. Lechanoine *et al.*, Nuovo Cimento **56A**, 201 (1980).
2. R.A. Arndt, Phys. Rev. D **35**, 128 (1987), and program SAID.
3. Micron Semiconductor, Ltd., Lansing, Sussex England.
4. W.K. Pitts and H. Petri, IUCF Scientific and Technical Report, May 1989–April 1990.