

DETECTOR DEVELOPMENT AND CALIBRATION

TEST OF ANTIPROTON APPARATUS

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Experiment E277 was performed on March 4-6, 1987 at IUCF. The purpose of E277 was to commission PBAR, a magnetic spectrometer to be used to measure the flux of antiprotons above the earth's atmosphere. We used about 6 of our allotted 9 shifts. This report refers to E277. The antiproton search did occur during Aug. 13-14, 1987 in a NASA-sponsored balloon expedition in Prince Albert, Canada. The antiproton data are now being analyzed, but online analyses and displays indicate that the flight was successful. This success was undoubtedly aided by our E277 run.

E277, located in the QDDM area, studied interactions of 200 MeV protons with CD_2 and CH_2 targets (simultaneously). The targets were each 1.2 mg/cm^2 thick. Figure 1 is a sketch of the detector. S1 and S2 are scintillators, CK is a water Cerenkov counter, and SC MAGNET represents a superconducting magnet. The "Protons" indicated at the top of Fig. 1 represent particles (predominately protons) that come from the scattering targets at a laboratory angle of 45° . CK was not used in E277 because the relatively low 200 MeV energy was below threshold for Cerenkov light to be produced.

The mass of a particle which goes through the spectrometer is measured using its time-of-flight (TOF) between S1 and S2 and its momentum as determined from the drift tubes in the field of the magnet. Eight layers of drift tubes, with their axes parallel to the magnetic field, were arranged as shown in Fig. 2. (Sixteen other layers, constructed using a slightly different manufacturing technique, developed gas leaks and could not be used in E277.) The 107 tubes, 6.5" long and 0.5" in diameter, are made of 0.0011" aluminized mylar, use a $20 \mu\text{m}$ sense wire (100 g tension), and utilize Argon-ethane (50%-50%) gas at atmospheric pressure.

Data were taken with the magnet on (at 0.5 Tesla) and off. The beam intensity was adjusted to give a trigger rate of 7 to 30 Hz. The three primary results of E277 follow.

1. Charge identification. From track bending sagitta measurements we can determine the sign of charge. Figure 3 shows the sagitta measurement with the B-field = 5 kG, and B-field = 0. The sagitta distribution for B-field = 5 kG is observed to be broader than that for the B-field = 0; this because the scattered particles have different momenta. Note that the sagitta averages 0 when the field is off.

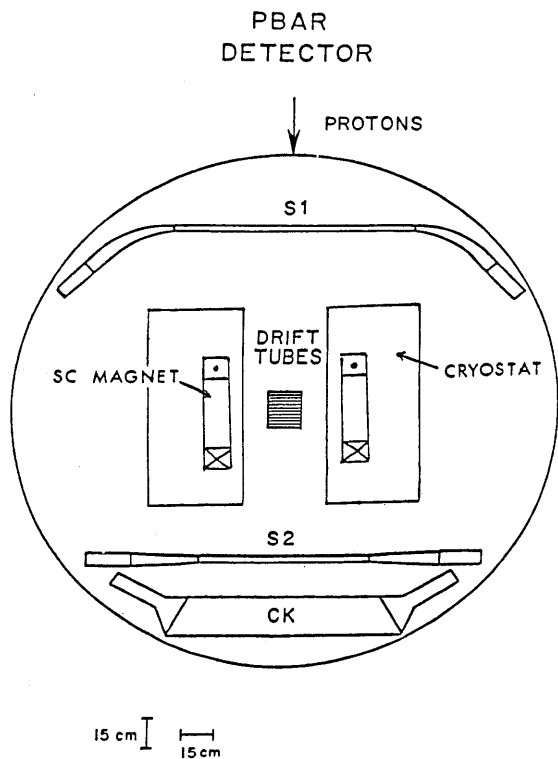
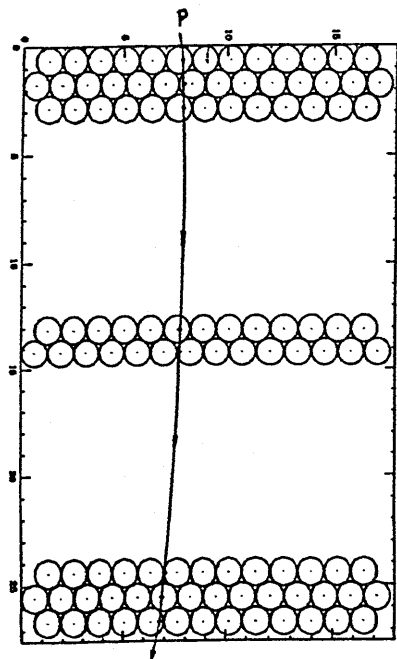


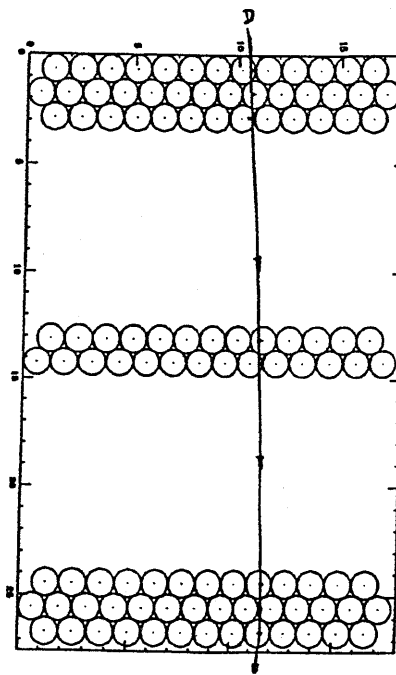
Figure 1. The experimental apparatus.

proton track in D.T. detector



(a)

deuteron track in D.T. detector



(b)

Figure 2. (a) A typical proton track in the drift tube (DT) detector with momentum of 467 MeV. (b) A deuteron track in the DT detector with momentum of 501 MeV.

SAGITTA MEASUREMENT

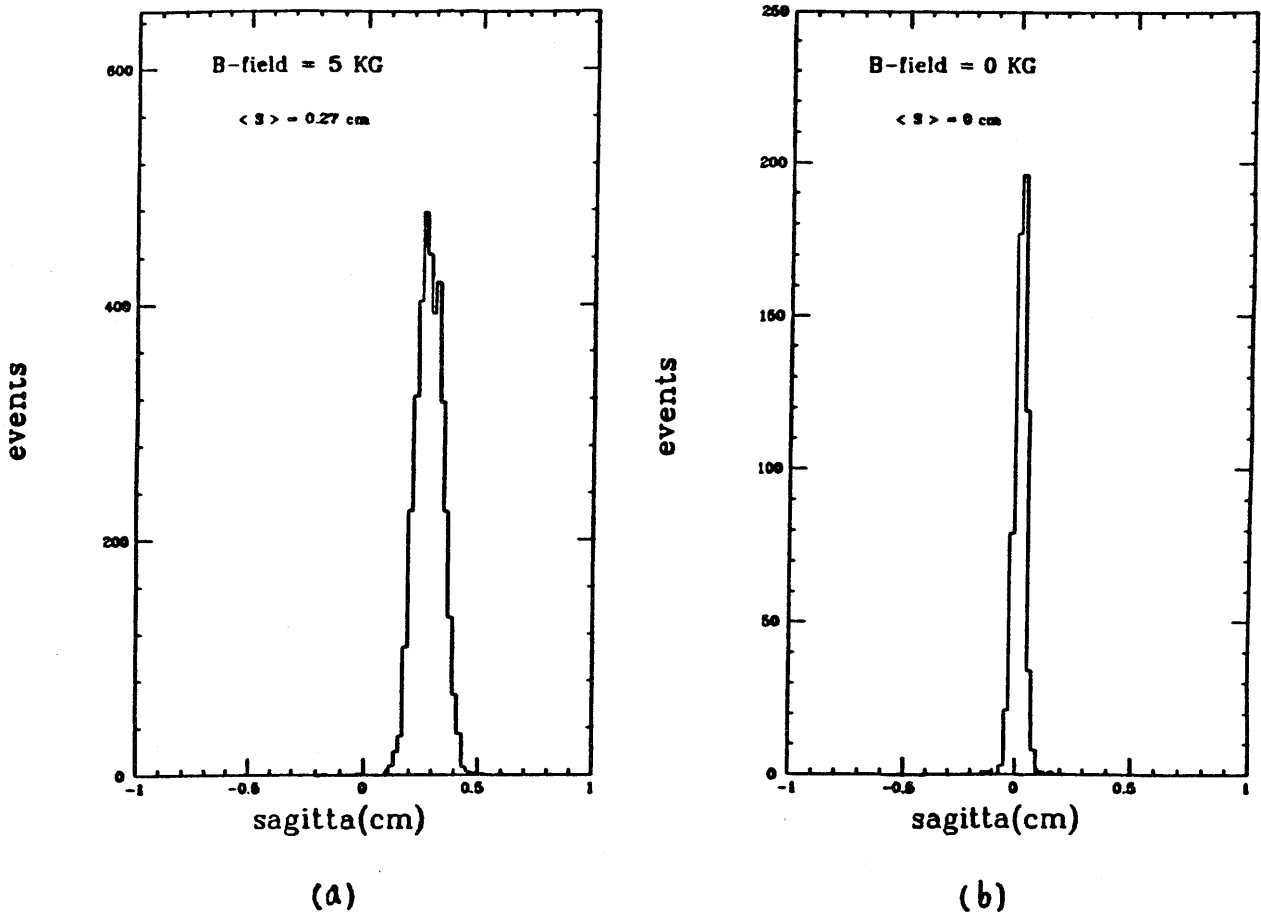


Figure 3. Sagitta measurement. (a) Track bending sagitta distribution with B-field=5 kG; from the sign of sagitta we can determine the sign of charge. (b) Sagitta distribution with B-field=0.

2. Particle identification. Figure 4 shows the proton and deuteron mass spectra, obtained by reconstructing the trajectory of the particle in the drift tubes inside the B-field, and combining TOF data. (Figure 2 shows a deuteron track "D" in the drift tubes).
3. Resolution. Figure 5a shows a track fitting residuals distribution (B-field = 0). The $\text{FWHM} = 0.018 \text{ dm}$, corresponding to a standard deviation of $88 \mu\text{m}$. This is an excellent result for a nonpressurized drift tube. Figure 5b shows the proton mass resolution, $dm/m \sim 15\%$, which is consistent with our 250 psec TOF time resolution.

In conclusion, at IUCF we detected protons and rarer deuterons. We commissioned the superconducting magnetic spectrometer that we subsequently used for the detection of antiprotons in Prince Albert.

MASS MEASUREMENT

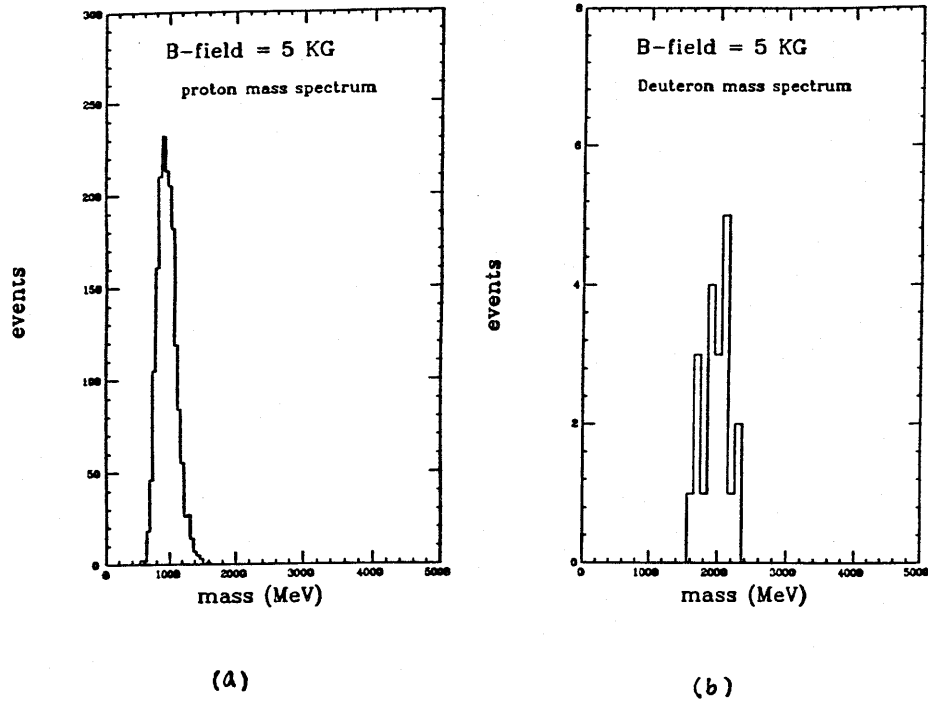


Figure 4. Mass spectra obtained from the track reconstruction combining the TOF data. (a) Mass spectrum of protons. (b) Mass spectrum of deuterons.

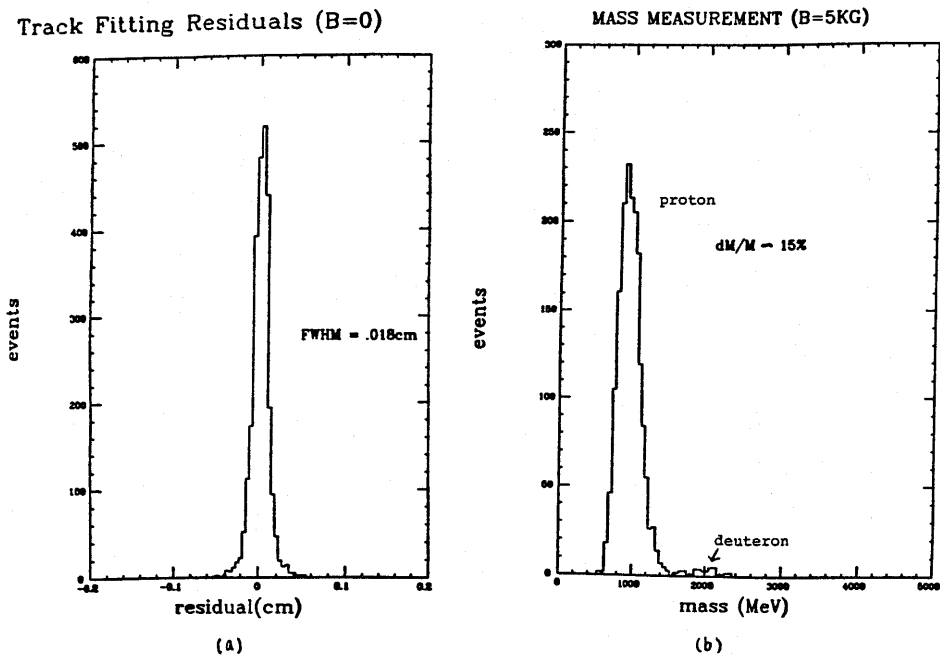


Figure 5. (a) Test beam track fitting residuals distribution with B-field=0, from which we obtain a resolution of $88 \mu\text{m}$ for low energy protons ($\langle E_T \rangle \sim 130 \text{ MeV}$).