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HIGH ACCURACY PARALLEL FOIL DRIFT CHAMBER

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SUMMARY

A 50 x 50 cm^2 area 1 cm drift spacing High Accuracy Parallel Foil Drift Chamber[1] was built and successfully operated. This chamber produces an overall average spatial resolution σ = 80μm in the entire drift space. This type of drift chamber has excellent field uniformity in the electron drift region, high count rate capability and relatively small memory time, 192 nsec.

INTRODUCTION

Various types of drift chambers have been built elsewhere[2-5] with drift spacings varying from 1 cm to 50 cm with spatial resolutions typically 0.12 mm to 0.35 mm. Most of these detectors have relatively long memory times, 0.5μsec for 2.5 cm drift spacing and over 10μsec for 50 cm spacing. The PFDC allows us to have small drift spacing with good electric field uniformity in the drift region. This results in higher resolutions with short memory times. This may be important when such chambers are used for high rates.

CONSTRUCTION

The construction of the PFDC was briefly given in an earlier report. Fig. 1 shows a cross sectional view of three neighboring cells. The 25μm diameter gold-plated tungsten wires were soldered to their positions with a precision within 10μm and the 25μm thick aluminum foils were glued to the positions within 30μm. The field shaping wires (70μm thick Cu) were wound on separate frames and then aligned with the main frame having the foils and the signal wires. Tensions applied to the signal wires, aluminum foils and field shaping wires are 80 gm, 80 gm and 100 gm respectively. The chamber has an active area of 50 x 50 cm^2 which contains 25 signal wires. It was placed in an aluminum shielding box having thin windows in the region of the PFDC's active area. This shielding box has greatly reduced the high frequency noise pickup enabling us to operate at low discriminator levels.

Equipotentials and field lines are shown in Fig. 2. The potentials applied to the field shaping wires and the foil are computed to provide uniform drift fields across the drift space. Fig. 3 shows the electric field in the mid-plane as a function of the distance from the wire.

EXPERIMENTAL SET-UP

Drift time to drift distance linearity and spatial resolution of the PFDC were measured by using high resolution high pressure proportional wire chambers[6] and 100 GeV/c π^- beam at the Fermilab as shown in Fig. 4. The proportional wire chambers with 0.4 mm wire (5μm thick tungsten) spacing and 5 cm^2 active area operated at 3 atm pressure of magic gas. A pair of the chambers are staggered at each location to improve the resolution. The drift time is measured with a time-to-amplitude converter (TAC) and an ADC in CAMAC. The signal obtained from the plastic scintillators started the TAC and the PFDC pulse stopped the TAC. The amplitude measured in the ADC and the wire addresses of the PWC's which had the hits are read into a PDP-15 computer.

The pulses from the PFDC were amplified with a circuit designed by C. Kerns. This circuit has an input threshold sensitivity of 0.5 mV across a 500Ω input resistor.

RESULTS

The charged particle detection efficiency of the chamber as a function of the applied voltage is shown in Fig. 5, while $Ar/C_2H_2/CH_4$ gas mixture is flowed through the chamber. The gas is flow mixed with flow ratios of 22% C_2H_2 and 78% of $Ar-CH_4$ (90% Ar-10% CH_4 premixed).

Figure 6 shows the drift time in the PFDC cell as a function of the distance of the trajectory from the signal wire. The position of the trajectory is measured by the high pressure PWC's with an error of about 70μm. The error bars on the data points represent the measured standard deviations of the individual drift times from the average corresponding to a given PWC cell. When the PWC resolution is unfolded from the data the resulting resolution averages 80μm.

This test was performed with the aid of the experimental apparatus of our small-angle hadron elastic scattering experiment. We are grateful for the cooperation of our collaborators on that experiment, Drs. R. Brown, S. Ecklund, L. Fajardo, P. Gollon, J. Lach, J. Mac Lachlan, R. Majka, J. Marx, J. Slaughter, and J. Sandweiss. The authors also express their appreciation to Dr. M. Awschalom for various discussions on the subject.

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6. High Pressure Chambers were constructed by Dr. J. Sandweiss, et al., (Yale University).

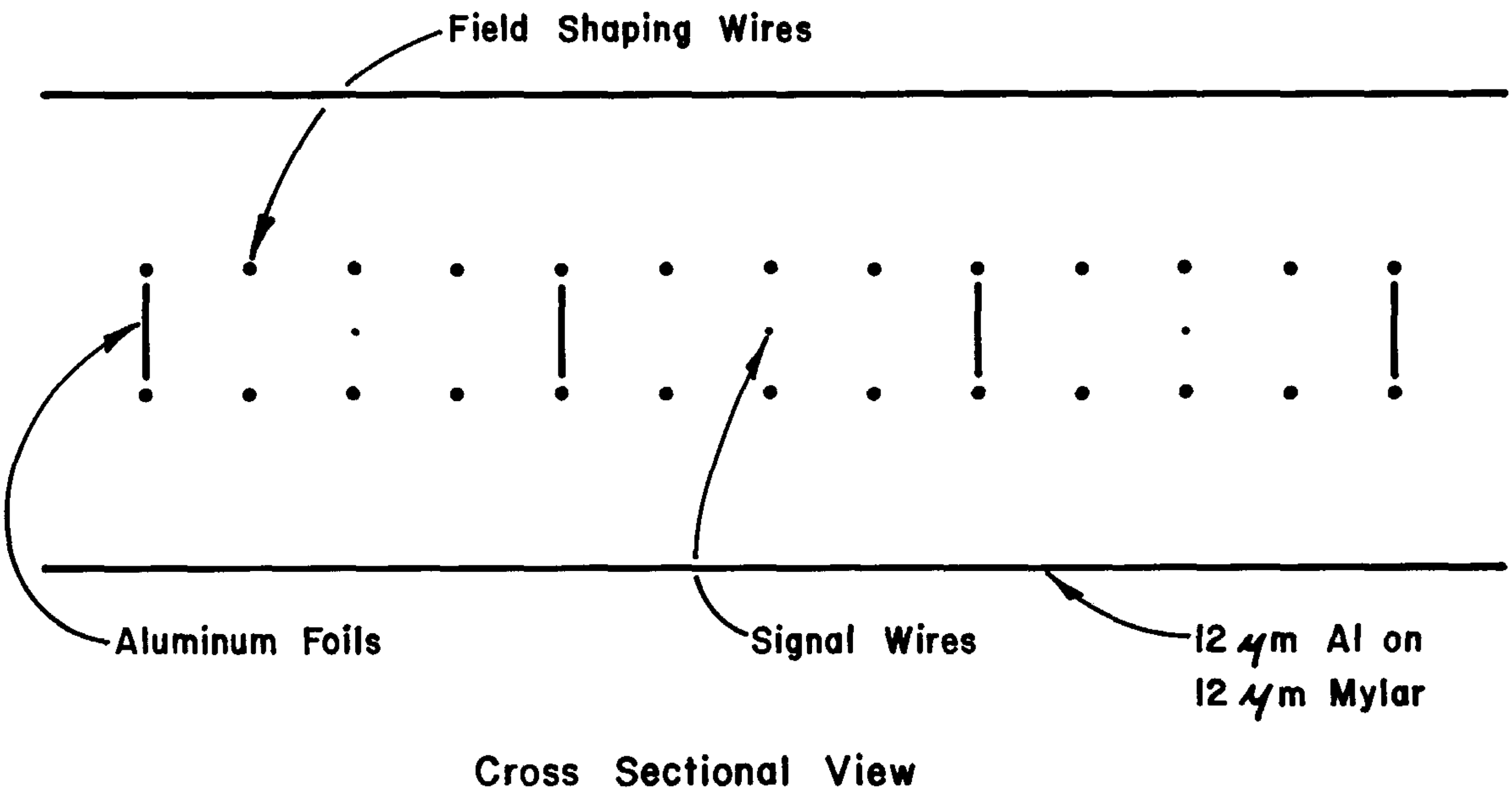

Fig. 1. A cross-sectional view of the Parallel Foil Drift Chamber (PFDC). There are a total number of 25 cells in the chamber.

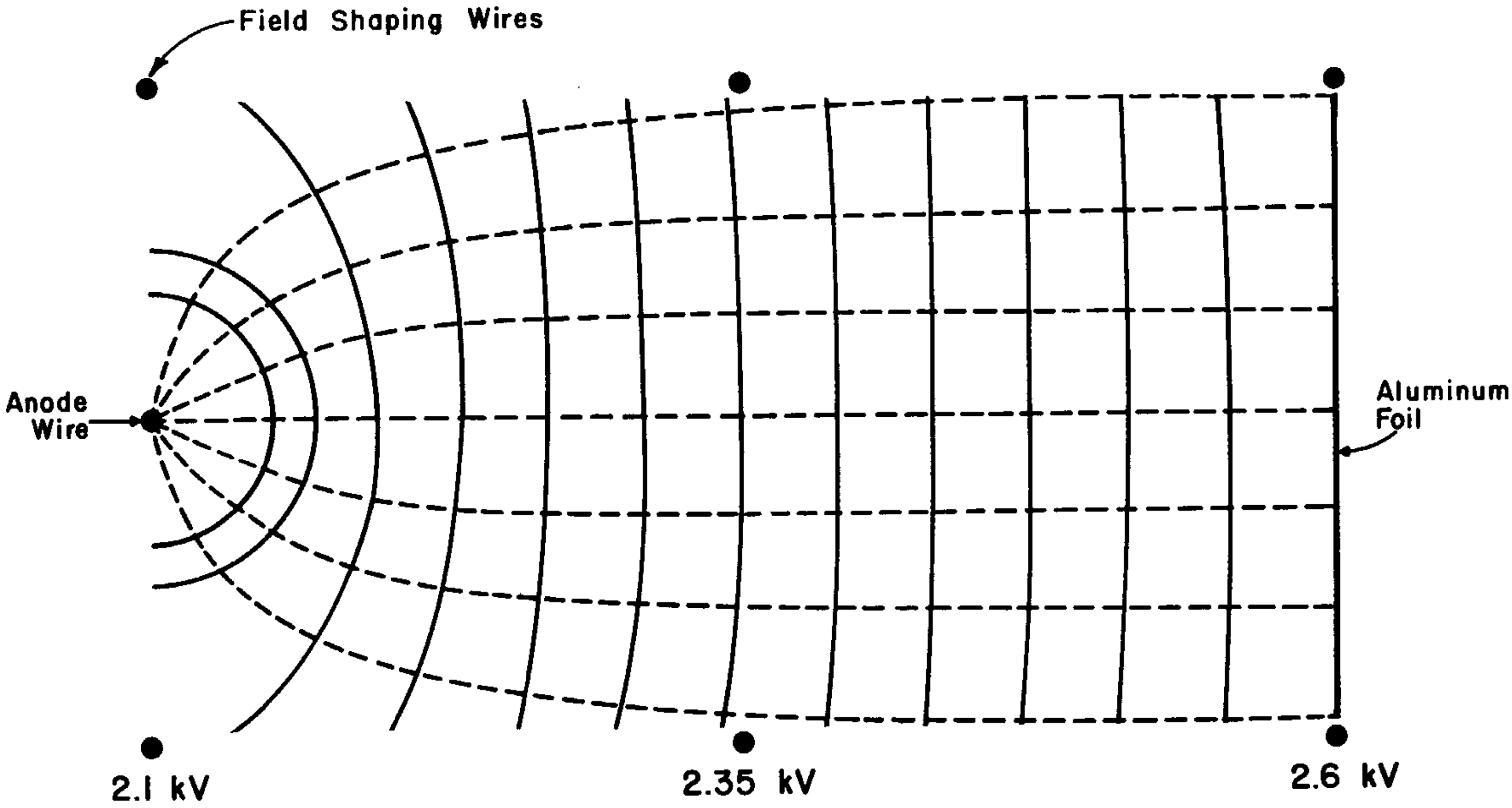

Fig. 2. The uniformly spaced equipotential lines and the field lines in a half cell.

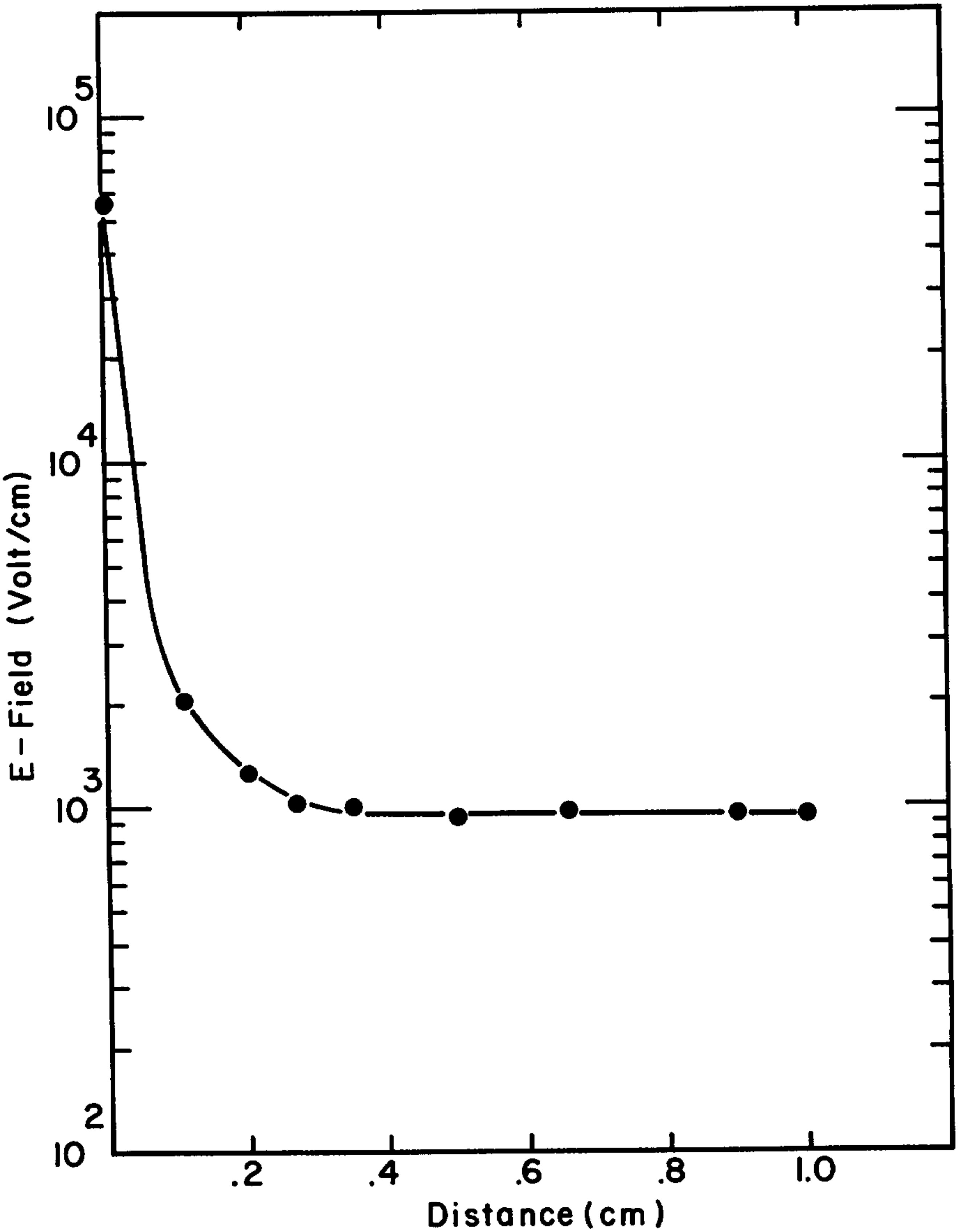

Fig. 3. The electric field as a function of the drift distance at the mid-plane of a half cell.

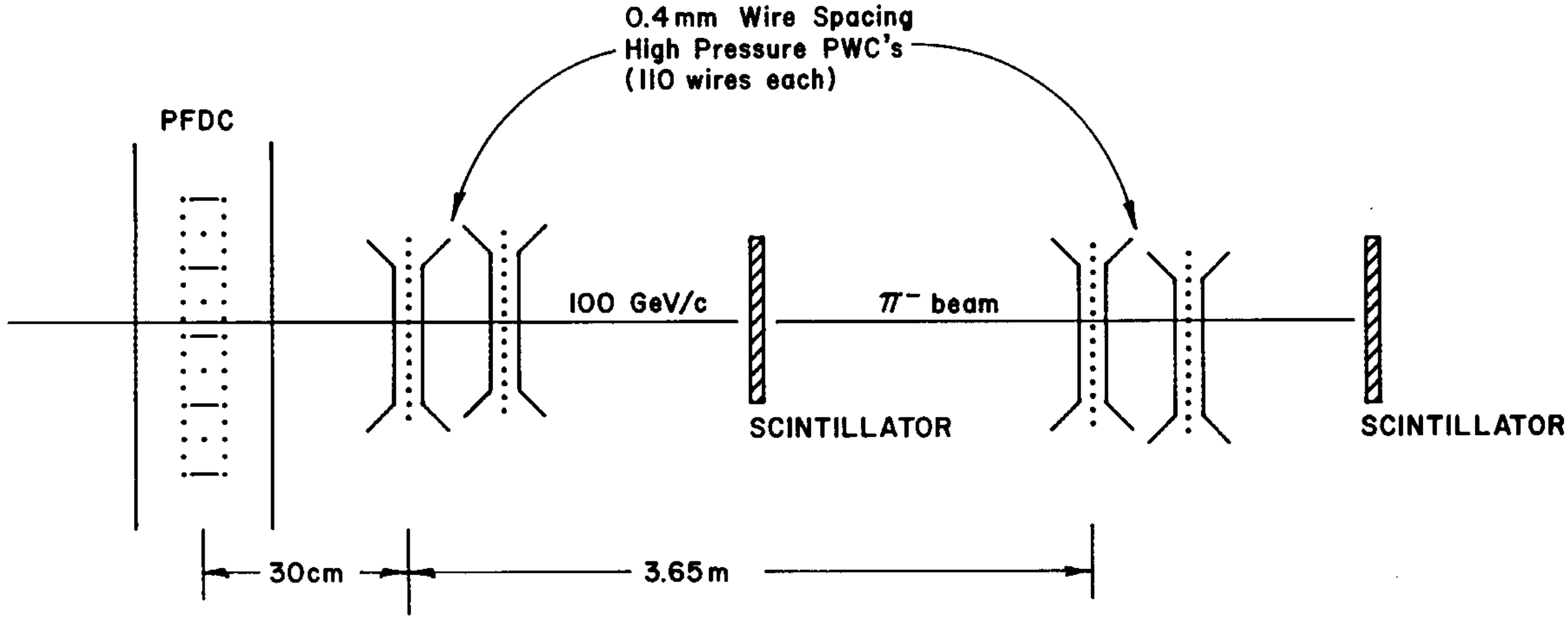

Fig. 4. A schematic view of the test setup.

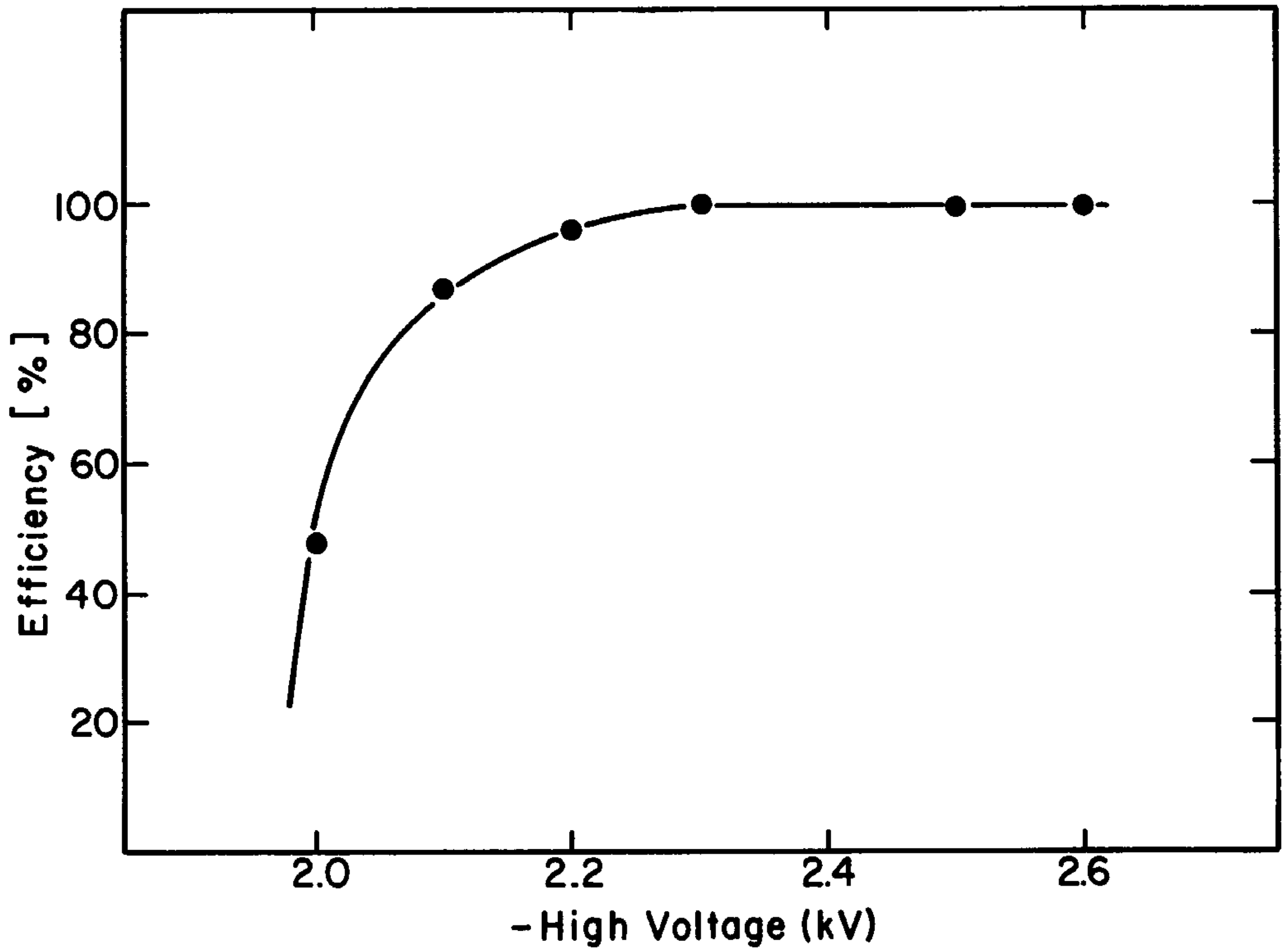

Fig. 5. The detection efficiency as a function of the applied voltage.

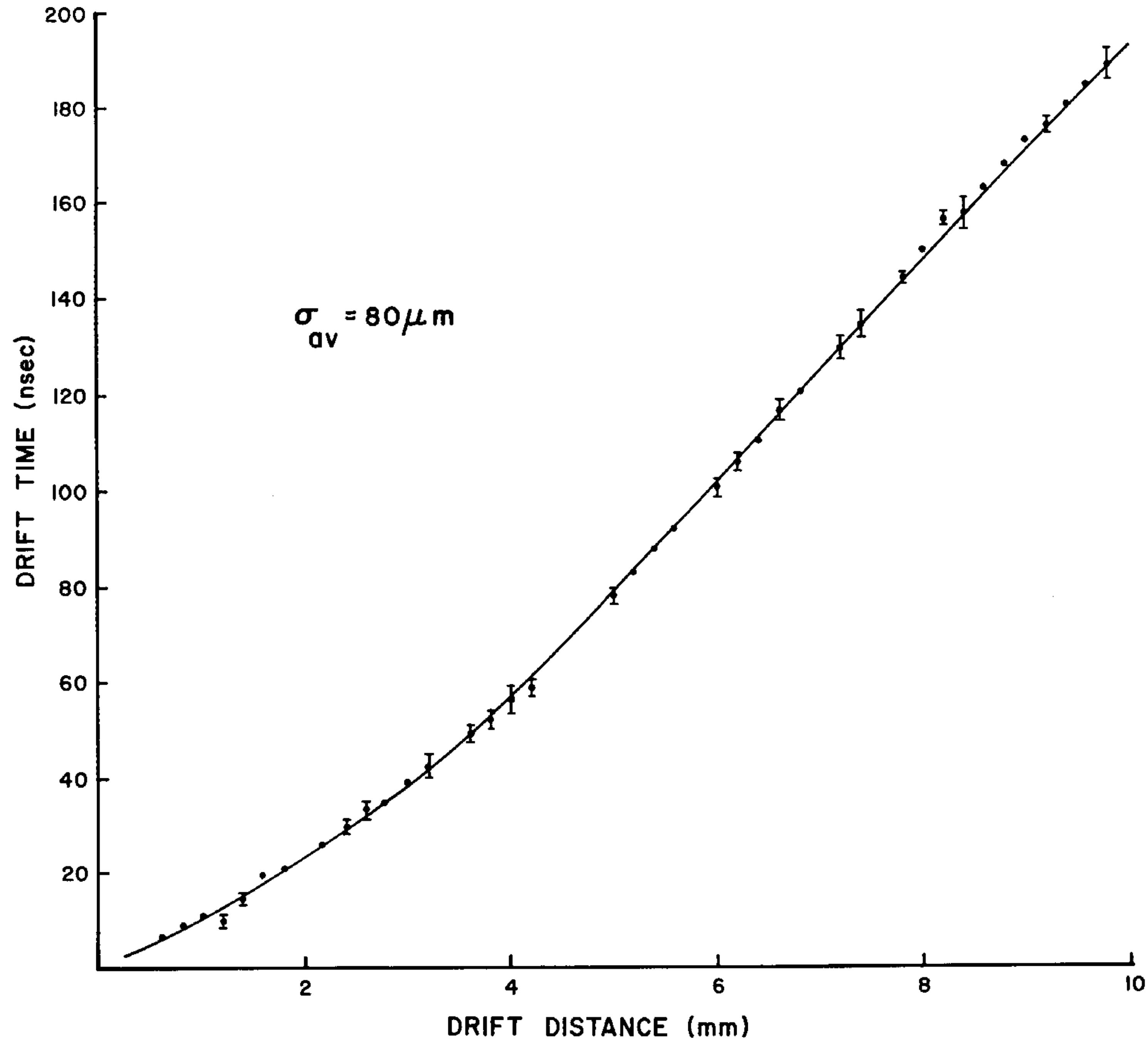

Fig. 6. Drift time in the PFDC cell as a function of the distance of the trajectory from the signal wire.