ISTITUTO NAZIONALE DI FISICA NUCLEARE

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MEASUREMENT OF THE SECOND COORDINATE IN A DRIFT CHAMBER USING THE CHARGE DIVISION METHOD.

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1.-INTRODUCTION

In the design of a sophisticated apparatus to be used in colliding beams experiments the amount of material on the path of emerging particles has to be kept as little as possible, in order to reduce multiple scattering of charged products and conversion of neutral ones.

As in recent experiments[(1)], in the ALA/MDA project[(2)] it has been proposed to determine the position along the sense wires of a set of cylindrical drift chambers using the charge division method, which allows the measurement of both coordinates without the insertion of additional material on the path of the particles.

In this paper we report the results obtained using this method.

2.-MECHANICS

A plane chamber, with a total lenght of 87 cm and a simple cell structure without field shaping[(3)] has been used for this test. (Fig. 1).

We used 25 μm stainless steel sense wires and 100 μm CuBe field wires stretched to 40 gr and 100 gr respectively.

Two adiacent sense wires were connected at one end to form a U-shape.

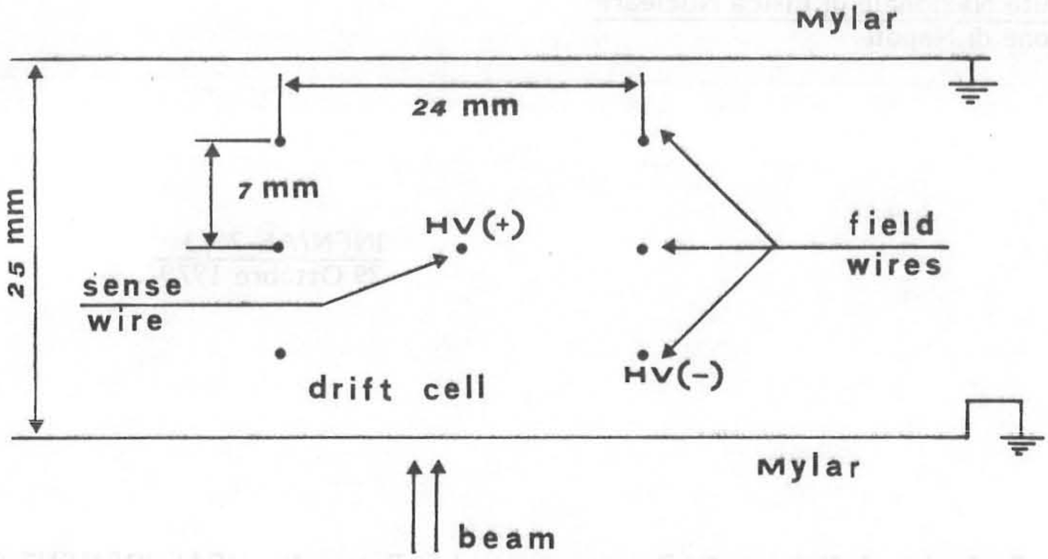

FIG. 1 - Cell drift geometry.

3.-DESIGN CONSIDERATIONS

Position along the sense wire is determined collecting at the two ends the charge which divides according to the ratio of resistences and indipendently of the resistence value.

The method is very simple but great care has to be taken in designing the read out electronics if good linearity and low noise are desired[3].

In this test we used sense wires with a resistivity ϱ of about 18.4 Ω/cm. The characteristic impedence $Z_o = \sqrt{L/C}$ and the distributed capacitance of the sense wire are $\sim$ 200 Ω and $\sim$ 20(pF/m). These values are in good agreement with the relation $R = \varrho \ell = 2\pi Z_o$ which has to be satisfied to get the shortest charge distribution time.

Amplifiers with an input impedence low with respect to the wire's resistence have to be used to achieved good sensitivity in position measurement. The scheme, using a common base input stage is shown in Fig. 2.

To minimize the base-collector capacitance which determines the rise time of the output signal, important for timing, we used a RCA 3046 monolithic transitors array with external resistors. The measured value for this configuration is C_{cb} = 0.58 pF, a factor 4 ÷ 5 better than a fast transitor. The corresponding rise time is 35 nsec giving a time uncertainty of $\sim$ 2 nsec and a position indetermination of 0.1 mm.

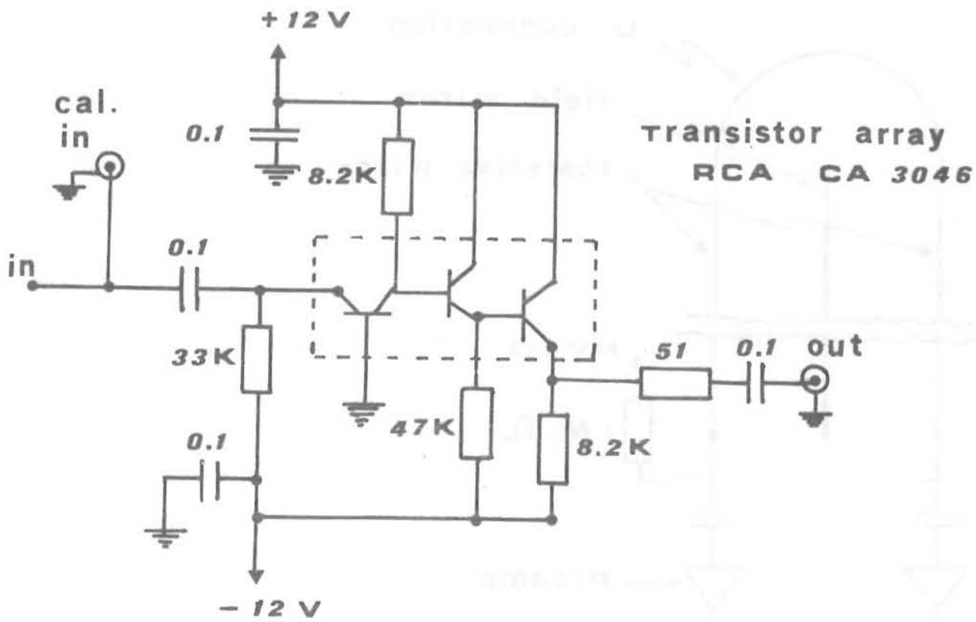

FIG. 2 - Circuit diagram of the amplifier.

4.-READ OUT AND RESULTS

Measurements have been performed using a ^{90}Sr collimated source and a scintillation counters telescope which gives a beam definition of 1 mm and a cosmic rays background less than 1%. The chamber was operating with a 60% Argon and 40% Isobutane mixture. The total resistance of two sense wires connected in a U-shape was 3155 Ω.

The amplifiers were connected to both ends of the U-shape wires and the output pulses were sent via 50 Ω coaxial cables to the digitizing electronics. For charge measurements commercial 10 bit ADCs were used. The data were transmitted via CAMAC to an on-line NOVA computer. (Fig. 3).

The chamber efficiency was close to 97% with the chamber operating between 2.3 and 2.7 KV.

In the analysis we calculated the position along the wire from the relation

$$x/\ell = A/A+B$$

where A, B are the charges collected by the ADC's and ℓ is the wire lenght.

The resolution of the position measurement and the collected charge are shown in Fig. 4, as a function of the operating voltage. Fig. 5 shows the calculated distributions of A/(A+B) when the beam was placed in 5 different positions along the wire.

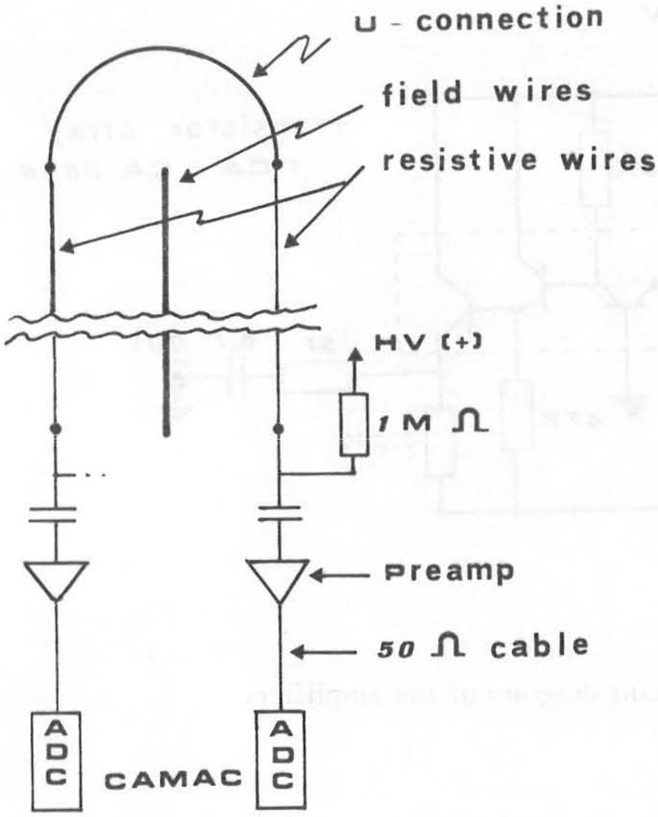

FIG. 3 - Schematic diagram of the read-out system.

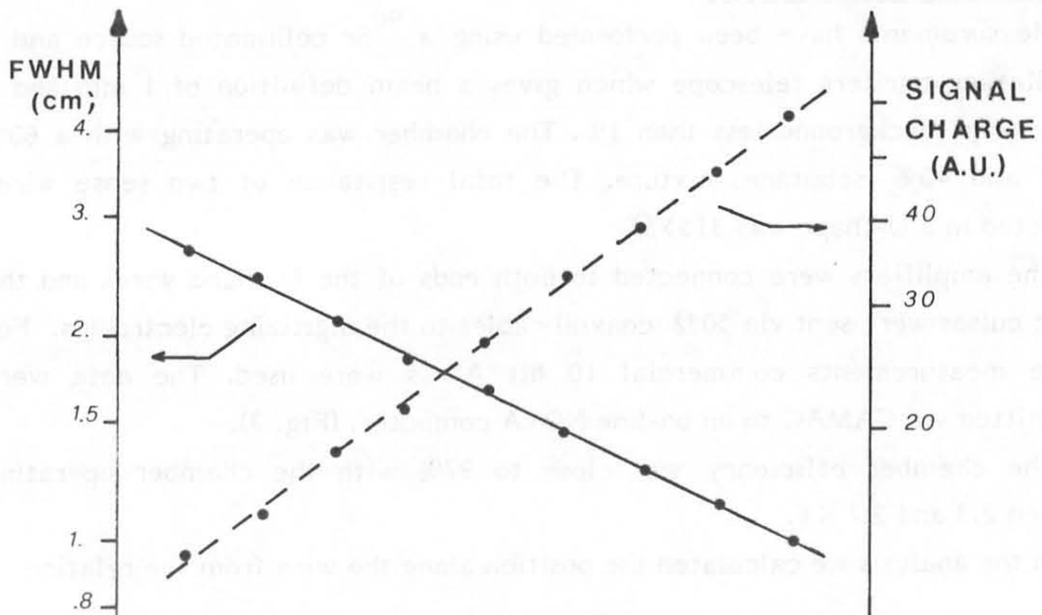

FIG. 4 - Position resolution as a function of the signal charge and the sense wire voltage.

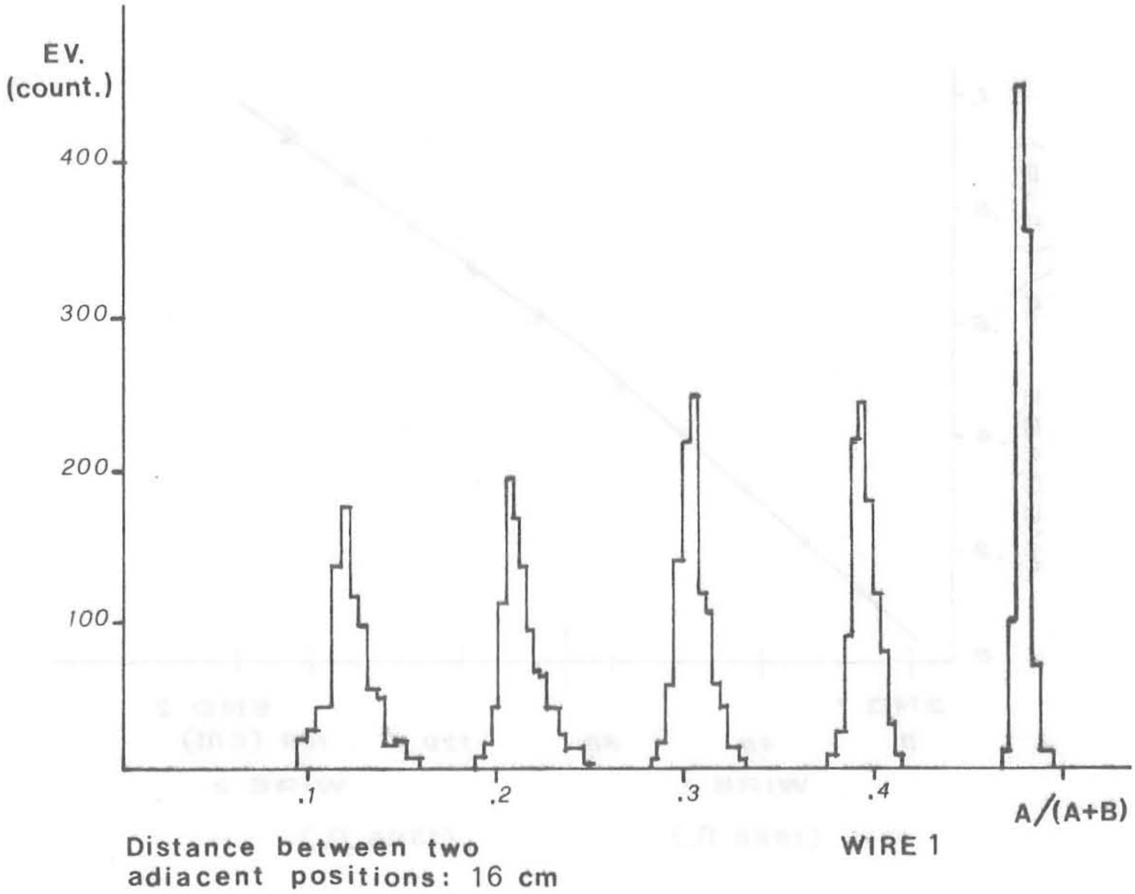

FIG. 5 - A/(A+B) distribution in 5 different positions along the sense wire.

Non linearity in the position measurement on each wire is less than 0.5%. The little difference in the two wire's resistances determines the change of slope at the U center (Fig. 6).

The measurement resolution (FWHM) is shown in Fig. 7 and ranges from 14 mm = 0.8% of the total wire lenght at the center of the wire to 34 mm =2% of the total wire lenght to the ends.

We wish to thank the technicians L. Caiazzo, P. Salmas and V. Marzullo for the electronic and mechanical support given during the test.

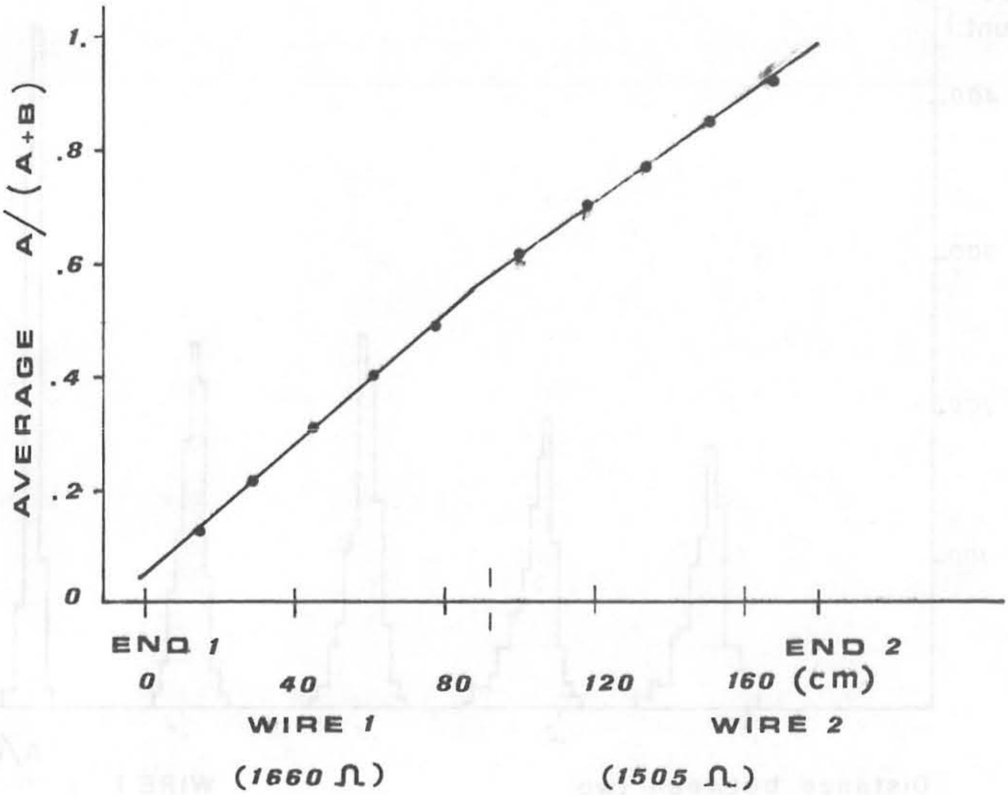

FIG. 6 - Charge ratio as a function of the source position.

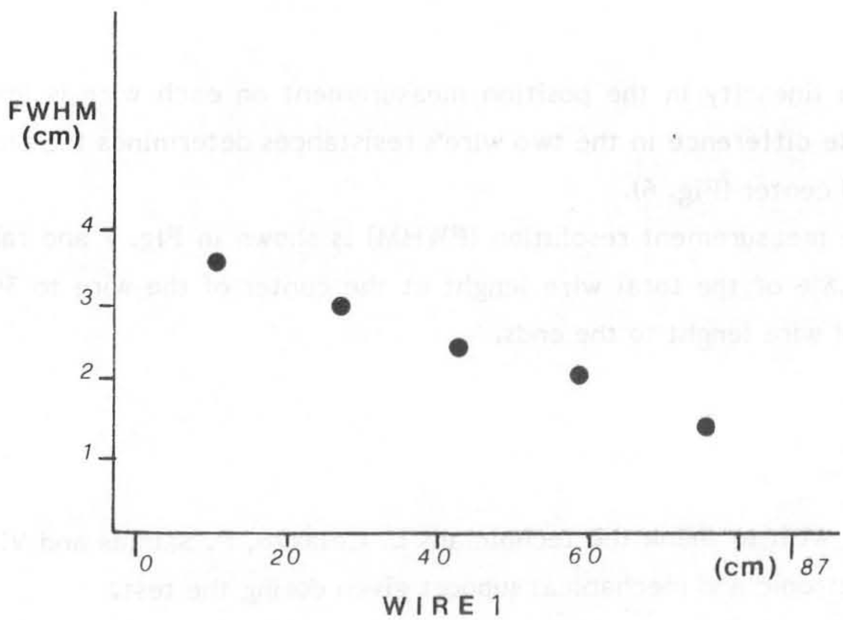

FIG. 7 - Resolution (FWHM) measured in 5 different position along the sense wire.

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