THE DRIFT CHAMBERS AND THE GAS SUPPLY AT BIG KARL (COSY)*

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The characteristics and the working conditions of the new focal plane drift chambers at the magnetic spectrograph BIG KARL are described. One chamber was tested with an 1 GeV electron beam. The drift time spectrum, the efficiency and the position resolution are discussed. A gas supply system for an argon/ethane gas mixture was used. The composition of the detector was monitored by two proportional counters with a ^{55}Fe X-ray source.

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1. Introduction

For the new proton cooler synchrotron COSY in Jülich the magnetic spectrograph BIG KARL has been upgraded [1]. In the planned experiments the particle trajectories of the reaction products have to be determined near the focal plane of the spectrograph in order to trace them through to the magnetic field back to the target point. These requirements are met by the new focal plane detector, which was built at the University of Cracow [2]. The new focal plane detector is capable of measuring both position and direction of the particle trajectories with high precision.

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2. Layout of the chambers

The drift chambers are of the graded field type and have a sense wire spacing of 40 mm. The cell structure and the voltage distribution is shown in figure 1. The sense wires are made of 20 μm thick tungsten. For the field-shaping wires 50 μm Cu-Be alloy wires are used. A row of drift cells forms a single detection plane. In order to measure both the position and the direction of trajectories twelve planes are used, grouped in two packs. Each pack contains two planes with vertical wires, two with wires inclined by 31° and two with wires inclined by −31°. The planes in each pair are staggered by half a cell width with respect to the other to resolve the right-left ambiguity.

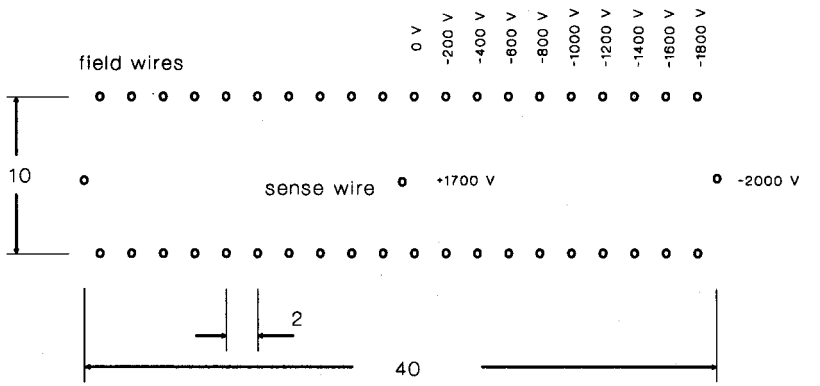

Fig. 1. Cell structure

The outer dimensions of one chamber are 180 cm×60 cm×20 cm and the dimensions of the active window are 140 cm×20 cm. The detection planes with vertical wires contain 32 sense wires. The planes with inclined wires contain 27 sense wires. The distance between the detection planes is 18 mm.

3. Performance tests

The chambers were tested at the 2.5 GeV electron synchrotron of the University of Bonn. By conversion of high energy photons, electrons of about 1 GeV were generated. The transversal dimensions of the beam were defined by two stacked scintillators of 1 cm thickness which were placed behind the chamber. Essentially three parameters determine the working point of the chamber: the composition of the gas mixture, the drift field strength and the sense wire voltage.

We started with a gas mixture of 50% argon and 50% ethane. The drift velocity of electrons in this gas mixture saturates for a drift field strength

in the neighbourhood of 1000 V/cm [3]. Thereby a linear drift velocity was obtained that increased the stability of the chamber operation. The field shaping wires were set to potentials as shown in figure 1. During the test the gas mixture was changed to 30% argon and 70% ethane.

The efficiency of drift chambers is less then 100%, hence not always a detection plane fires when a particle passes through. The detection efficiencies are given in Table I as a function of the sense wire voltage.

TABLE I

Detection efficiency in one plane in percent

Argon/Ethane	sense wire voltage						
in %	1.7 kV	1.8 kV	1.9 kV	2.0 kV	2.1 kV	2.2 kV	2.3 kV
30/70	0.1	0.3	77.0	95.0	98.6	98.9	98.8
50/50	99.1	98.6	97.5				

In our tests we get a good detection efficiency for both gas mixtures. The drift time spectrum from all sense wires is shown in figure 2 for 50% argon/50% ethane and a 1700 V sense wire voltage.

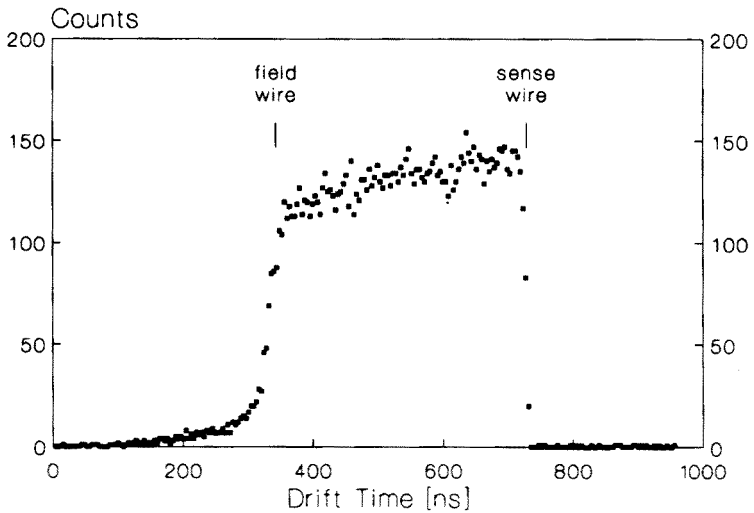

Fig. 2. Drift time spectrum

The width of the drift time distribution is about 400 ns which corresponds to the maximum drift distance of 2 cm. The rapid rise at the position of the sense wire indicates a good time resolution (of the order of 1 ns) and the equality of all delays in the different electronic channels. The deduced position resolution of the whole chamber is 220 μm FWHM [2].

3. The gas monitoring system

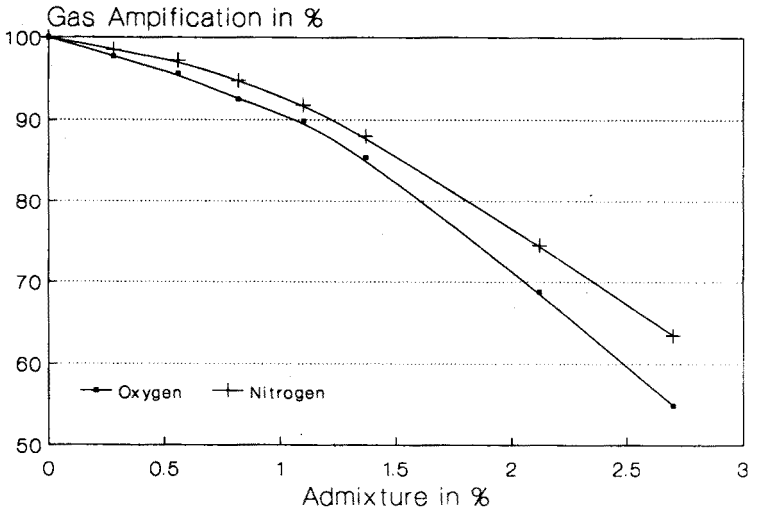

Fig. 3. Change of gas amplification with small admixture of nitrogen and oxygen

The gas supply produces a 50% argon/50% ethane mixture to fill the chambers. With two proportional counters, one between the gas system and the drift chamber and one behind the chamber we measure the gas amplification of the mixture and compare it with the chamber gas amplification. The proportional counters take ^{55}Fe-spectra and we observe the 5.9 keV X-ray peak.

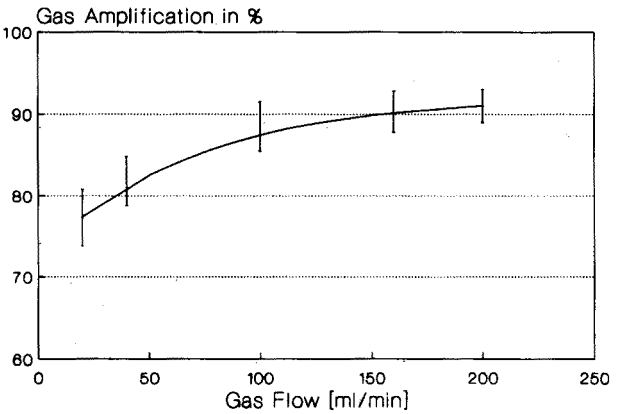

Fig. 4. Dependence of the gas amplification in the chamber from the gas flow

By adding small amounts of nitrogen and oxygen to the mixture we were able to investigate the influence of these main components of air. Figure 3 shows the gas amplification vs admixture.

The gas amplification of the pure argon/ethane mixtures is normalized to 100%. The gas amplification decreases with higher contaminations of nitrogen and oxygen. This results in the high electronegativity of oxygen (3.44) and nitrogen (3.04) [5]. This effect is used to monitor the purity of the gas flowing through the drift chambers.

An example of the efficiency of our monitoring system is demonstrated in figure 4. It shows the dependence of the gas amplification from the gas flow through the chamber. The amplification increases with higher gas flow, but 100% could not be reached. According to our results with admixtures of oxygen and nitrogen, there was still 1% air at the highest gas flow of 200 ml/min in the chamber, corresponding to a leak of 0.01 mbar · l/s [4].

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REFERENCES

[1] K. Kilian *et al.*, KFA-Report 1988, p. 149.
[2] B. Gugulski *et al.*, KFA-IKP(I)-1992-3.
[3] B. Jean-Marie *et al.*, NIM **159**, 9 (1979).
[4] K. Scho, Diploma Thesis, ISKP Bonn (1993).
[5] W. Moore, Physkalische Chemie, 4-th edition, Berlin 1986.