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A STUDY OF MICROSTRIP GAS CHAMBER PARAMETERS

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Исследование параметров газового микрострипового детектора

Проведено исследование газового микрострипового детектора на основе микростриповой платы ILL-6C. Максимальный коэффициент газового усиления составил $2 \cdot 10^4$, энергетическое разрешение — 18%. Получено пространственное разрешение ~500 мкм (FWHM) с использованием линии задержки для считывания информации со второй координаты.

Работа выполнена в Лаборатории высоких энергий ОИЯИ.

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A Study of Microstrip Gas Chamber Parameters

A microstrip gas chamber built on the microstrip plate ILL-6C has been studied. A maximum gas gain of $2 \cdot 10^4$ and an energy resolution of 18% (FWHM) at 6 keV have been measured with an Ar-CH_4 gas mixture at atmospheric pressure. A spatial resolution about 500 mkm (FWHM) has been obtained using a delay line for the second coordinate readout.

The investigation has been performed at the Laboratory of High Energies, JINR.

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1. Introduction

The microstrip gas chamber, proposed for the first time in [1], is a variant of gas proportional counter. The basic element of this detector is a microstrip plate in the form of an isolated substrate, with alternating anode and cathode metal strips placed on its surface. A potential difference between adjacent strips produces an electric field, in which, in the vicinity of anode strips, an avalanche multiplication of the electrons arriving from a drift gap to the microstrip plate surface takes place. The photolithography used for making strips allows the strip structure with an accuracy of some 0.1-0.2 mkm to be produced. As compared to other gas counters, the microstrip gas chamber provides a good homogeneity of gas gain resulting in a high energy resolution [2] and high maximum counting rates [3] under rather low working voltage.

2. Detector design

The detector design is presented in Fig.1. The metallized capton 25 mkm thick has been used as the material of the detector entrance window. The drift gap has been composed by this window, with a negative voltage applied to it, and the microstrip

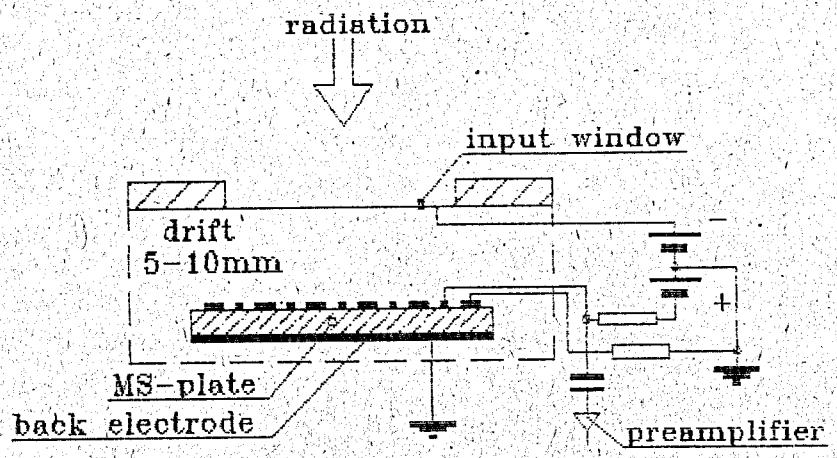

Fig.1 Layout of the detector

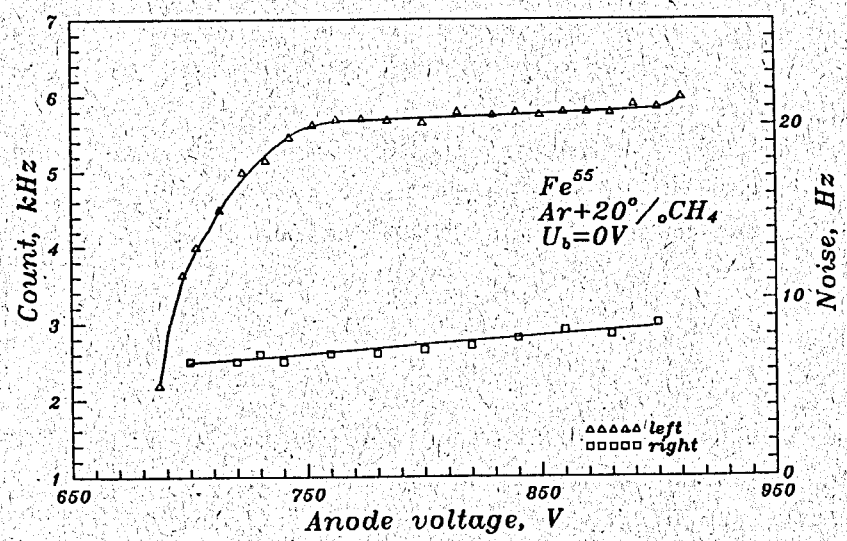

Fig.2 Detector counting plateau

plate ILL-6C placed at a distance of 5-10 mm from it. The sensitive plate area has amounted to 40x40 mm^2. The anode and cathode chromium strips 8 and 400 mkm wide, respectively, have been placed on a borosilicate glass substrate with $\rho = 3 \cdot 10^6$ Ohm·cm. The pitch of anode strips has been 1 mm. All anode as well as all cathode strips have been interconnected. An additional electrode has been placed on the microstrip back plane.

3. Studies of detector characteristics

Detector parameters have been studied by means of ^{55}Fe and copper anode X-ray tube radiation sources with X-ray of 5.9 and 8.0 keV energies, respectively. The Ar + 20%CH_4 gas mixture has been used as a working one.

Fig.2 shows the dependence of counting rate on the potential between anode and cathode strips at fixed values of the voltages at drift electode, U_d = -1000 V and at back plane, U_b = 0 V. The counting rate plateau amounts to 170 V. The noise level has not exceeded 10 Hz per whole detector area.

The dependence of gas gain on cathode strip voltage is demonstrated in Fig.3 . The maximum gas gain with no damages inflicted on the microstrip plate is $2 \cdot 10^4$. Near the counting plateau end the signal-to-noise ratio amounts to about 50. A 50 V

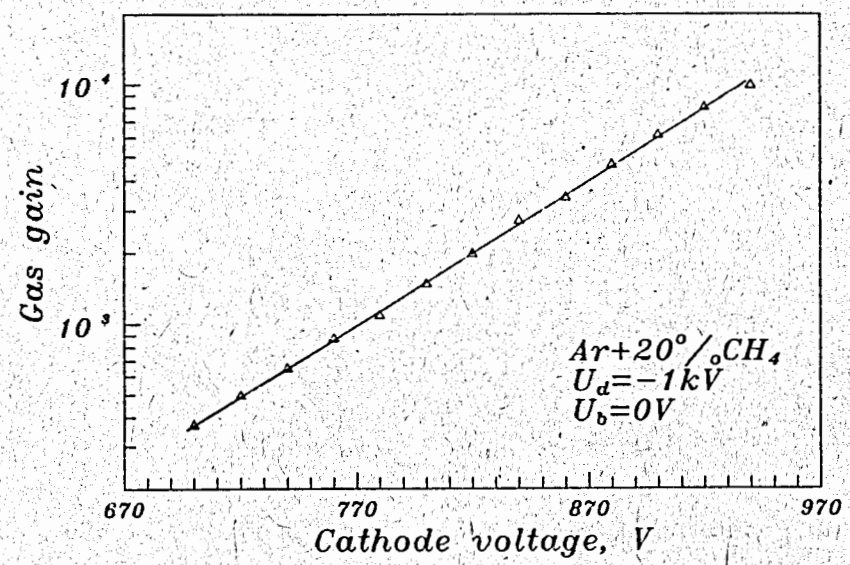

Fig.3 Dependence of gas gain on the voltage between anode and cathode strips

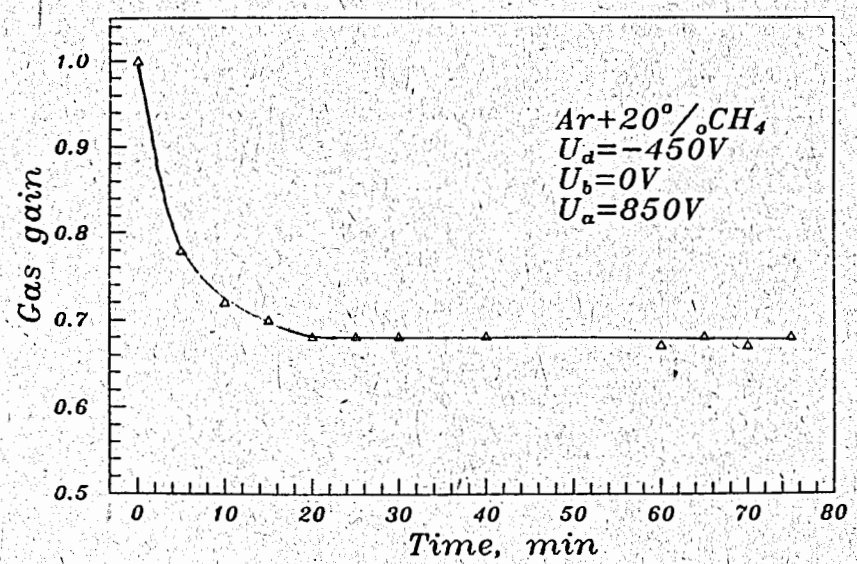

Fig.4 Time dependence of changes in gas gain

change in the voltage between anode and cathode strips results in a doubled signal amplitude. A comparison of signals from anode and cathode strips has shown signal apmlitudes to be equal, with rise time of about 20 ns. The back electrode signal has an amplitude of 65% of that for anode signal.

Since the substrate is made of a glass with the ionic conductivity type, a charge accumulation on the substrate surface results in changing the electric field to be accompanied by a change in gas gain. Fig.4 shows the gas gain change in time. The amplification is seen to fall down by 30% during 20 min after a voltage switch-off and then to go on the plateau.

The energy resolution has been 18% (FWHM) with 5.9 keV.

The counting rate capability has been tested by means of an X-ray tube providing intense radiation beams with an energy about 8 keV. The beam diameter is 3 mm. The beam intensity dependence of the signal amplitude normalized over a low intensity signal amplitude is presented in Fig. 5. Here for the beam intensity up to $2.2 \cdot 10^6$ cm^{-2} s^{-1} provided by our X-ray tube we have observed no change in the signal amplitude. The counting rate response of a conventional multiwire chamber has been given in the same figure for the purpose of comparison.

The delay line technique has been used to readout coordinate information. The readout

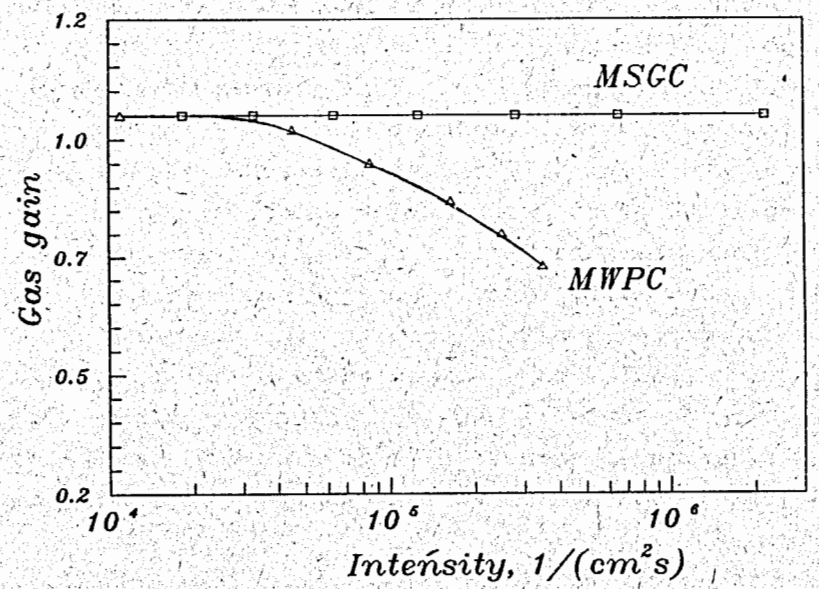

Fig.5 Counting rate response of microstrip gas detector (MSGD) and multiwire proportional chamber (MWPC)

electronics and data acquisition schemeis presented in Fig.6 . A cathode plane wound by a 90 mkm wire with a 0.5 mm pitch has been placed over the microstrip plate at a distance of 0.9 mm. The cathode wires have been oriented perpendicular to the anode ones and have been connected into two wire groups. Each group has been soldered to the delay line with an 1 mm pitch. The delay lines have an impedance of about 300 Ohm and a specific delay time of 1.65 ns/mm. Both wire cathode and delay line have been at a ground potential.

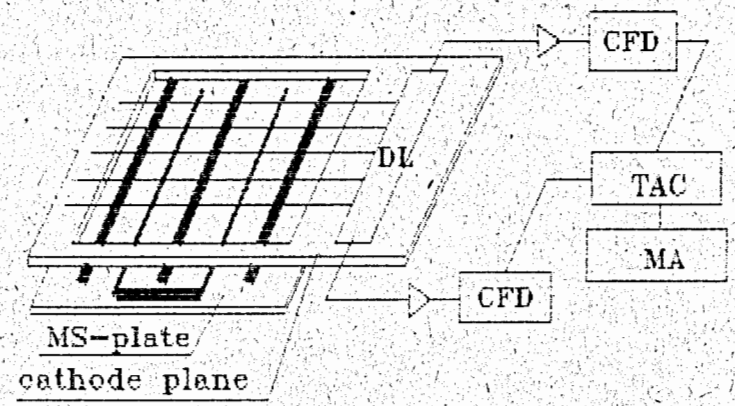

Fig.6 Readout and data acquisition electronics used for investigation of the detector:
DL - delay line,
CFD - constant fraction discriminator,
TAC - time-to-amplitude converter,
MA - multichannel analyzer

The signal amplitude from a wire cathode has amounted to 10% of that from cathode strips. The signal-to-noise ratio for the delay line signals has been about 10. A spatial resolution ~ 500 mkm (FWHM) has been obtained for 5.9 keV X-ray.

4. Conclusions

The performed studies of detector characteristics have demonstrated the detector based on a microstrip plate ILL-6C to possess a

sufficiently high operating reliability. The information readout from the second detector coordinate can be performed in a rather simple way.

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