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A Two-dimensional Transmission Counter with a Backgammon-Drift Read-Out Technique

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Abstract
A new type of two-dimensional position sensitive gas counter for transmission counter with a backgammon-shaped flat electrode has been developed. The two dimensional position read-out can be achieved with the combination of the backgammon-shaped flat electrode read-out as horizontal position and the drift time measurement read-out as vertical position. The gas counter is designed as a transmission trajectory counter that can be used to determined angle of incident charged particle in the charged particle detecting system. To check the characteristics of this gas counter, test experiments are performed with a coincidence plastic scintillation counter and p - ray source of ^{90}Sr.

1. Introduction

Our group is developing an NaI(Tl) crystal spectrometer for medium energy charged particle to use in experiments with a new ring Cyclotron at RCNP Research Center for Nuclear Physics), Osaka University [1]. For pre-test of the instrument system, it needs a medium energy radiation that passes through the full detector volume and than we use cosmic-ray [2]. In order to investigate the response function of the spectrometer for incidence of charged particle in part of the sensitive area of the detector, two-dimensional position sensitive gas counter is needed.

A number of two-dimensional position sensitive gas counter with backgammon-shaped electrodes technique have been constructed in several laboratories. However, transmission type counter with a backgammon-shaped flat electrode read-out have not been realized [3,4,5]. For example, in our laboratory, a new type of two-dimensional position sensitive gas counter with a backgammon-shaped flat electrode has been developing. The two-dimensional position read-out can be achieved with the combination of a backgammon read-out and drift time measurement read-out for horizontal position and vertical position, respectively.

The gas counter is designed as a transmission counter so that it can be used to determined angle of incident charged particles when several such counters are used in charged particle detecting system.

2. Gas Counter

A. Structure of the Gas Counter

The structure of gas counter is shown in Fig.1. It consists of a detector body, a drift space body and two covering plates. The detector body holds the drift space body and both sides of the detector body are covered by the covering plates. The detector body holds the drift space body and both sides of the detector body are covered by the covering plates.

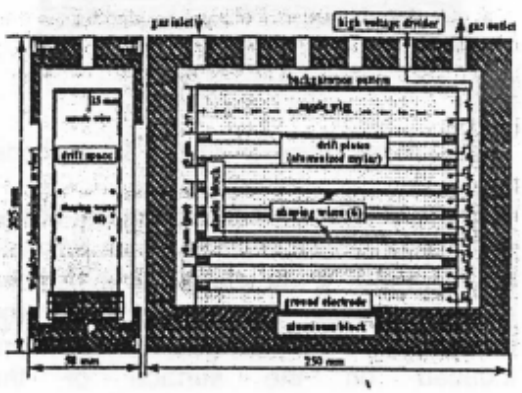

Fig.1. The structure of two dimensional transmission counter with a backgammon-drift read-out technique

The drift space body consist of anode wire, 6 field shaping wire and 18 drift plates including a backgammon electrode and ground electrode. The anode wire

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and shaping wire are nichrome (Ni-Cr) wire of 50 μm in diameter. The anode wire is fixed 15 mm and parallel with a backgammon-shaped flat electrode. The drift plates are fabricated from an aluminized mylar sheet, except a backgammon-shaped electrode and a ground electrode. The distance between a drift plats is 6 mm, respectively.

The high voltage divider circuit that is used as distributor of high voltage for drift plates and shaping wire is soldered on the drift space body.

B. Backgammon-shaped Electrode Pattern

The backgammon-shaped flat electrode is a thin conductive layer divided into two regions, R-side and L-side, like a saw-teeth with a narrow insulating gap [3]. The backgammon-shaped flat electrode pattern was manufactured by the photo-etching of the thin gold layer laminated onto an epoxy glass plate. The width of the insulating gap is 0.5 mm and the sensitive area of the backgammon-shaped electrode pattern is a 120x40 mm^2.

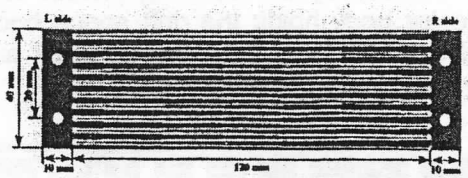

Fig.2. The backgammon-shaped flat electrode

The principle of a backgammon-shape electrode read-out technique can illustrate as following, if an electrode avalanche develops near the anode wire the ionization of counter gas, charges are induced on the surface of the backgammon electrode and then the induced charges are divided into two parts by the backgammon electrode and move to both sides, R (right side) and L (left side) of the electrode

C. Equipotensial Lines Calculation

The second dimension read-out is achieved by the drift time measurement in a uniform electric field. A uniform electric field is formed by a set of electric potential on the electrodes as drift plates and shaping wire, which are determined by the result of the field calculation with a computer as code "The equipotential lines calculation" [6] for various arrangements and potential value of those electrodes. The optimum result of the field calculation is shown in Fig.3.

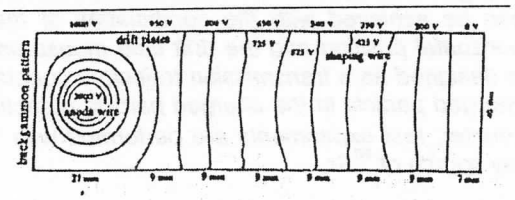

Fig.3. The equipotential lines calculation with 1 anode wire, 6 shaping wires and 18 drift plates.

3. Experimental and Result

A. Test with β -rays

The experimental arrangement for test of gas counter as a transmission counter is shown in Fig.4. Two detectors, the gas counter and a plastic scintillation counter, are used in this experiment with 1 mm collimated β-ray source of ^{90}Sr as radiation source. A β-ray source ^{90}Sr as a radiation source is placed 1 mm in front of the gas counter and between the gas counter and the plastic scintillator a 1mm aluminum slit was set on the plastic scintillator

The plastic scintillation counter is placed behind of the gas counter that is used to obtain the strat signal of the drift time measurement.

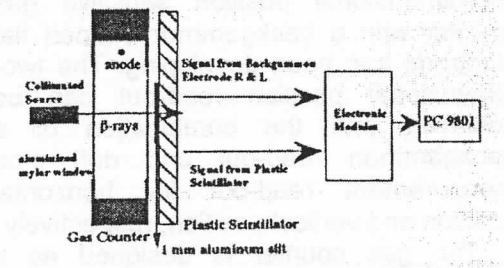

Fig.4. The experimental arrangement of gas counter as a transmission counter

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The sum of the signals from both sides of a backgammon-shaped electrode, right side (R)and left side (L), is used as the stop signal. To obtain two dimensional position information,

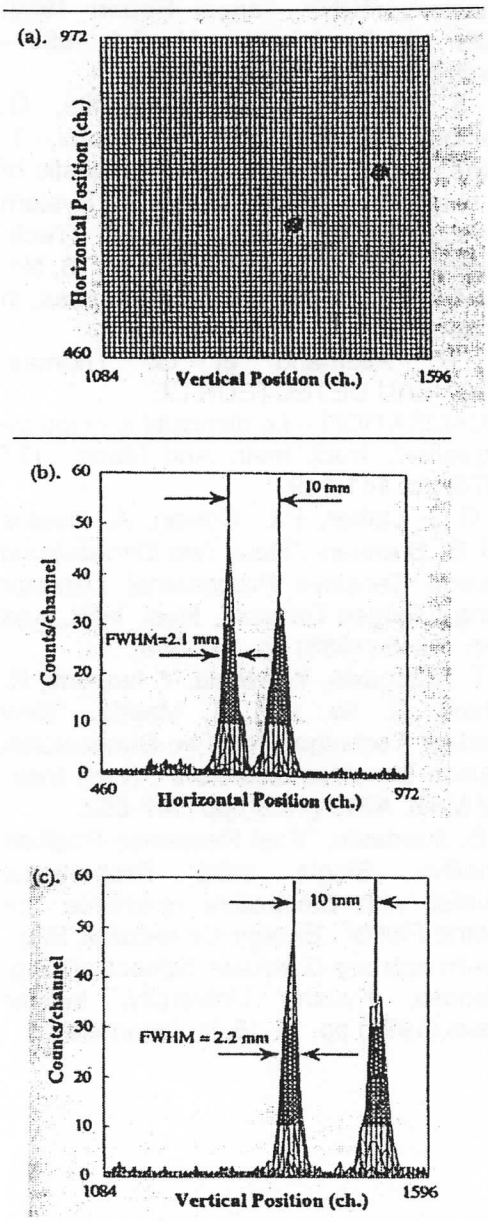

Fig.5. The result of the measurement by using β-rays.
(a). Two dimensional position sensing
(b). A backgammon-shaped electrode read-out as horizontal position read-out.
(c). The drift time measurement as vertical position read-out.

The backgammon-shaped electrode read-out and the drift time measurement read-out are performed simultaneously.
Figure 5 shows a two dimensional position sensing result of the measurement by using β-ray.

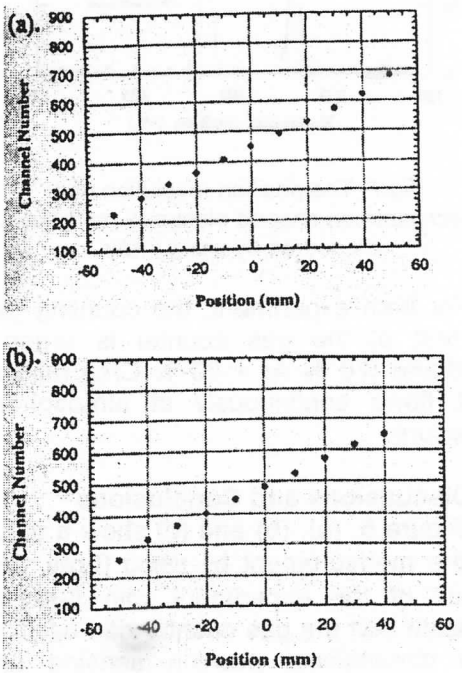

Fig.6. A plot of the linearity of both read-out methods.
(a). A backgammon-shaped electrode read-out
(b). The drift time measurement read-out.

A β-ray also was used for test of the linearity of both read-out techniques. The result of measurements are shown in Fig.6 (a) and (b) for a backgammon-shaped electrode read-out for s drift time measurement read-out, respectively.

B. Test with X-rays

The optimum position resolution of a gas counter, especially for a backgammon-shaped electrode read-out is occurred by using x-ray from the x-ray generator. A pulse from the x-ray generator and signal from a gas counter are used for stop and starts pulse, respectively. The result of measurement is shown in Fig.7.

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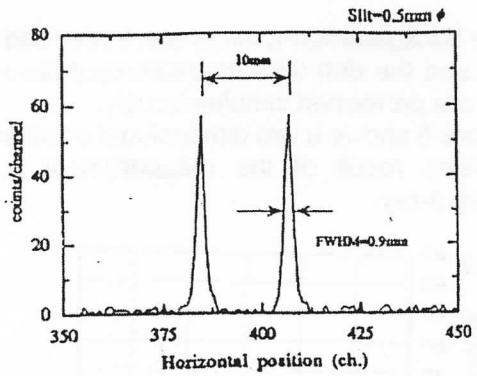

Fig.7. The position resolution of a backgammon-shaped electrode read-out is measured by using x-ray.

For both experiment, the counting gas of test of the gas counter is argon : methane (70 % Ar + 30 % CH_4) mixture that flows continuously at atmospheric pressure.

4. Discussions and Conclusions

Figure 5. (a), (b) and (c) show a result of the measurement by using β-ray. The result of the experiment with β-ray is indicate that the gas counter can used as two dimensional position sensing and applicable for used as transmission type counter. Beside that, the position resolution of a backgammon-shaped electrode read-out and the drift time measurement read-out methods are about 2.1 mm and 2.2 mm in Full Width at Half Maximum (FWHM), respectively and there are shown similar for both read-out technique. The optimum position of gas counter for a backgammon-shaped electrode read-out is 0.9 mm in FWHM that is measured by x-ray, as shown in Fig. 7.

Figure 6. (a) and (b) is a plot of the linearity of both read-out methods. From the linearity measurement, it is shown that this gas counter has a sensitive area at least 70x70 mm^2 for a two dimensional read-out.

We are now planning to apply this counter for a determination of the incident angles of charged particles that are emitted from neutron induced reaction in order to measure the double differential cross section.

5. References

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