A multi-wire cathode strip gas detector for fission fragments

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Introduction

Gas detectors are extensively used in various configurations for studies of the mass, charge, energy and angular distributions of heavy ion reaction products. Gas filled detectors have several advantages over solid state and scintillation detectors in respect of versatility of construction, large area coverage, immunity to radiation damage and less pulse height defect etc.[1]. We have developed a multi-wire cathode strip gas detector for fission fragments which gives good energy as well as position resolution which could only be possible due to addition of a cathode wire plane in addition to anode wire plane. By doing so we are able to reduce the operating voltage of the detector without compromising on the position resolution.

Description of the detector

The detector consists of two wire planes and a cathode strip plane as given below in Fig 1.

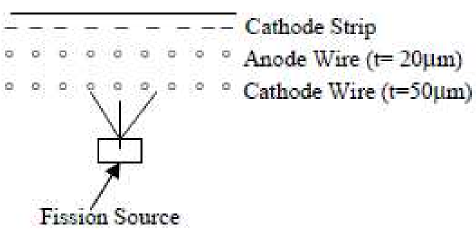

Fig.1 : Schematic Diagram of detector

Cathode Strip plane is realized on a 1.6 mm thick PCB and has 51 strips, each strip having a width of 2.54 mm and separation between adjacent strip is 0.1 mm. Anode wire plane made of 9 gold coated tungsten wires at a pitch of 3 mm. Cathode strip plane and anode wire plane are at a distance of 1.6 mm. Cathode Wire plane is made of 9 gold coated Copper Beryllium wire at a pitch of 3 mm. The separation between anode wire plane and cathode wire plane is 3.2 mm. The electrode planes are glued to the back of a stainless steel frame with high quality vacuum sealant. The face of SS frame is sealed with a G-10 board with a 1.5 micron Mylar foil window of size 15 cm x 3 cm. The position of incident particle is sensed through a 51-tap high impedance delay line read out system developed by us [2] consisting of SMD LC circuits, giving a delay of 10 ns/tap, is mounted on a PCB which then connected to cathode strips through H-connectors. The delay-line read out method has also been used for extracting energy as well as position signal from silicon strip detector [3].

Performance test of the detector

The detector is filled with P-10 gas at 30 mbar (absolute) pressure and operated in proportional region. The detector is tested with ^{252}Cf fission source. An aluminum mask of 12 slots was put between detector and source. Left most 2 slots are having a gap of 2 mm and rest (from 3rd to 12th) slots are having a separation of 6 mm. Each slot has opening width of 2 mm except the 12th one which was having an opening of ~0.2 mm. Anode wire plane and Cathode wire plane are applied bias of +430 V and +310 V respectively through separate charge sensitive pre-amplifiers. The energy output of anode and cathode pre-amplifiers are shaped to ~ 2 µs through shaping amplifier and given to LINUX based Data Acquisition system using LAMPS software. The timing output of anode pre-amplifier is amplified and filtered through TFA and fed to CFD. The output of CFD becomes the start pulse for TAC as well as used for generating master gate pulse for the Data Acquisition System through GDG. Delay-line output is amplified through a charge sensitive pre-amplifier and is called position sensitive timing output. This position timing output is filtered through TFA and fed to CFD and output of CFD is suitably delayed through a delay unit and becomes the stop pulse for TAC. The pulse height of the TAC output is proportional to delay that translates position of the impinging fission fragments on the detector.

Fig. 2 (a) & (b) show the energy spectrum for anode and cathode respectively. From the figure we see two peaks corresponding to heavy and light fission fragment groups emitted from spontaneous fission of ^{252}Cf. The two dimensional position spectrum obtained by putting a mask is shown in Fig 3 (a). The one dimensional position spectrum is obtained after taking the projection as shown in Fig 3 (b). The position resolution is found to be 2.20 mm (FWHM) and after correction for the slit size, it becomes 0.91 mm.

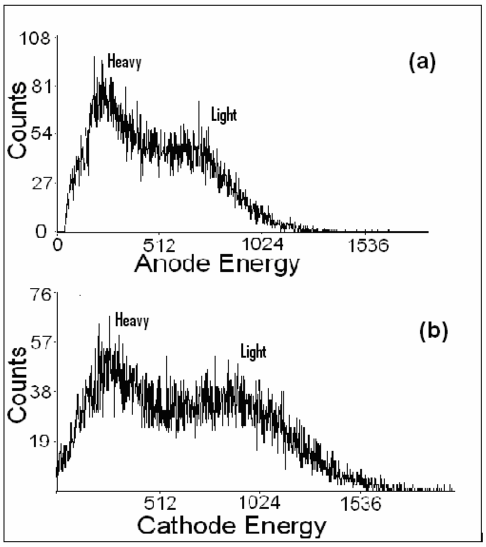

Fig 2 (a): Anode energy (channel no) v/s counts (b): Cathode energy (channel no) v/s counts

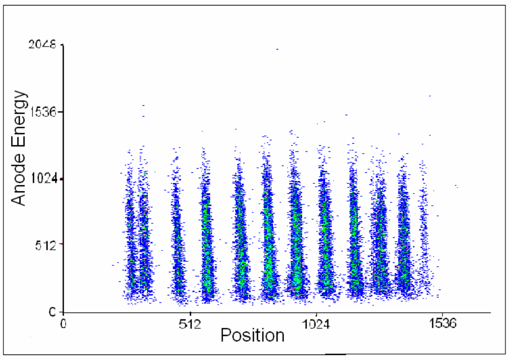

Fig 3 (a) : Position (channel no) v/s anode energy

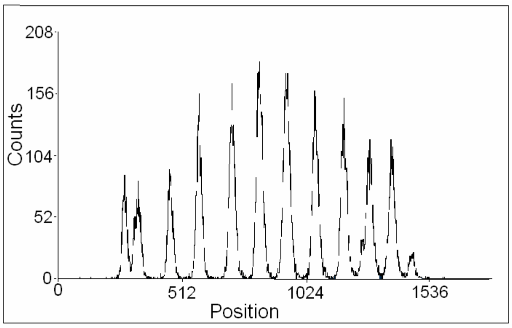

Fig 3 (b) : Position (channel no) v/s counts

Conclusion:

We have developed a position sensitive gas detector for the detection of fission fragments. The position resolution is found to be better than 1mm. This detector will be useful for the detection of fission fragments produced in heavy ion induced reactions.

References

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[3] R.P. Vind et al. , Nucl. Instr. Meth. A 580 (2007) 1435.