A two-dimensional cathode strip gas detector for fission fragments

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Introduction

Large area gas detectors play very crucial role in heavy-ion experiments to study mass, charge, energy, and angular distributions of the reaction products. The main advantages of gas detectors over silicon and scintillation detectors are following: versatility of construction, large area coverage, immunity to radiation damage, less pulse height defect etc [1, 2]. We have earlier developed a one-dimensional multi-wire Cathode Strip Gas Detector (CSGD) for fission fragments, which exhibits good energy as well as position resolution [3]. The break through success of this detector development is due to an additional cathode wire plane along with anode wire plane. This detector has been used successfully for fission fragment detection in ^{6,7}Li+^{232}Th reaction at deep sub-barrier and above barrier energies [4].

In many experiments it is desirable to have position information in two dimensions. In the present paper we report the performance characteristics of a two-dimensional multi-wire cathode strip gas detector for fission fragment measurement.

Description of the detector

The detector consists of two wire planes and a cathode strip plane as shown in Fig. 1. The cathode strip plane (X-plane) is fabricated on a 1.6 mm thick PCB and has 51 strips of width 2.54 mm and separation between adjacent strips is 0.1 mm. Anode wire plane is made of 17 gold coated tungsten wires of pitch length 3 mm. The distance between cathode strip and anode wire planes is 1.6 mm. Split cathode wire plane (Y-plane) is made of 17 gold coated copper beryllium wires with

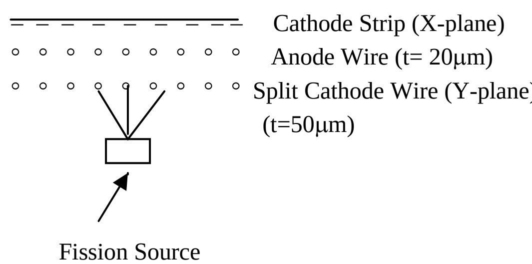

Fig.1 : Schematic diagram of the detector.

pitch-length of 3 mm. One end of each split cathode wire is connected to the tap of high impedance discrete delay line read out system through a high voltage rated isolation capacitor while the other end is connected to the high voltage through a high resistance. The separation between anode wire and cathode wire planes 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 12.5 cm × 4.5 cm. The X-position of incident particle is sensed through a 51-tap high impedance delay line read out system and Y-position through a 17-tap high impedance delay line read out system. The delay line read out system developed earlier [5] consisting of discrete SMD LC circuits of delay ~10 ns/tap, are mounted on a PCBs which are then connected to cathode strips and split cathode wire plane strips through H-connectors. The detector is filled with P-10 gas at a suitable pressure (P=20 to 30 mbar) and operated in proportional region.

Performance test of the detector

A bias voltage of +425 V is applied to anode wire plane through a charge sensitive pre-amplifier. The energy output of anode is shaped through shaping amplifier and fed to the data acquisition system. The timing output of anode pre-amplifier is amplified and filtered through TFA and fed to CFD. Output of CFD becomes the start pulse for TACs as well as used through GDG for generating master gate pulse for data Acquisition System. Each of the 17 split cathode wires are connected to a separate resistors of 6.8 mega ohms at one end and the other ends of these resistors are commonly biased with +305 V. Delay-line outputs (X & Y) are amplified through separate charge sensitive pre-amplifiers and are termed as position timing outputs. These position timing outputs are filtered through TFAs and fed to CFDs and outputs of CFDs are suitably delayed through delay units and become the stop pulses for X and Y TACs. The pulse heights of the TACs output are proportional to the delay and thus, translates position of the incident fission fragments on the detector.

The detector is tested with ^{252}Cf fission source. The energy spectrum obtained from the anode is shown in Fig. 2. The position resolution of the detector is found to be 0.9 mm. A thin PCB (0.2 mm) mask of ‘BARC’, an acronym of Bhabha Atomic Research Centre, prepared in 5×4 dot matrix format by drilling small holes (1.4 mm dia), is placed between detector and source. For the formation of each letter of the acronym ‘BARC’, the center to center distance of the holes is kept 5 mm for straight portions and for curved as well as italic portions it is 2.5 mm. The 2D-position spectrum as shown in Fig.3, is a very clear image of the acronym ‘BARC’.

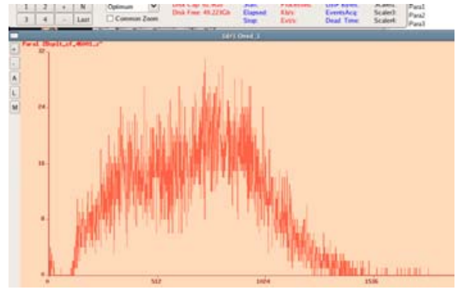

Fig 2: Energy distribution obtained from anode.

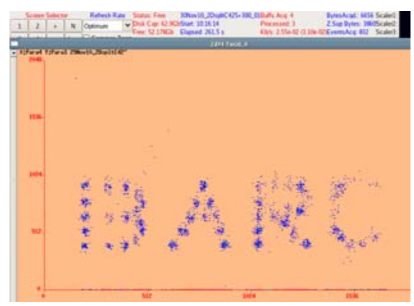

Fig 3: 2-D spectrum of the mask ‘BARC’

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