Response of a bi-dimensional pixel cathode strip gas detector for fission fragments

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Introduction

Gas detectors are widely used for the detection of fission fragments in nuclear physics experiments. We have developed a bi-dimensional cathode strip gas detector for fission fragments which gives good energy as well as position resolution. This type of detector can also have a wide range of applications ranging from x-ray imaging to tracking of ionizing particles (e.g. light charged particles to fission fragments) in heavy ion induced reactions which could only be possible due to inclusion 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 pixel cathode strip plane as given below in Fig 1.

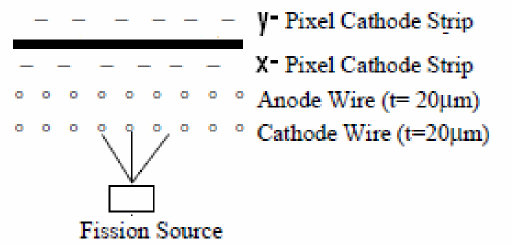

Fig.1 : Schematic Diagram of detector

Bi-dimensional Pixel Cathode Strip plane is the main heart of this detector which is realized on a 0.2mm thick double sided copper clad PCB and has 17 strips on X-plane and 25 strips on Y-plane, each strip of both the planes has been made in pixel form and the size of each pixel is 3 mm x 3 mm. The complete work of design and fabrication is done at our Gas Detector Lab. Fig 2 is a schematic diagram to explain the design of the pixel cathode strip in the cathode planes. X pixels are located on the front plane of the PCB (shown in grey colour) while Y pixels are realized on the back plane of the same PCB (shown in black colour). X-pixels and Y-pixels are shorted through a very fine copper track of thickness 0.1 mm in a manner as shown in the diagram. The main idea behind this is to minimize the capacitive coupling between X and Y strips at their crossing points. Since this PCB is very thin (0.2 mm thick) and is not self supporting hence after its fabrication it was pasted on a 1.6 mm thick G-10 board and connections for X and Y positions were taken through H-connectors to 17-tap and 25-tap high impedance SMD LC delay lines having a delay of ~ 10 ns/tap designed and fabricated by us [1,2].

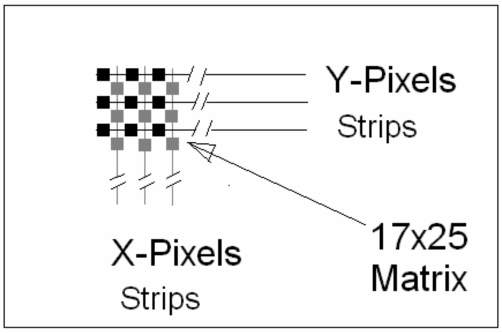

Fig. 2 : Schematic Diagram of Pixel Cathode Strip

Anode wire plane is made of gold coated tungsten wires at a pitch of 2 mm. Pixel cathode strip plane and anode wire plane are at a distance of 2.4 mm. Cathode Wire plane is also made of gold coated tungsten wire at a pitch of 1 mm. The separation between anode wire plane and cathode wire plane is 4.8 mm. The active area of the detector is 16 cm (H) x 10 cm (W).

Performance test of the detector

The detector and ^{252}Cf fission source are put inside bell jar vacuum chamber and fully evacuated. The detector is filled with P-10 gas at 30mbar (absolute) pressure and operated in proportional region. A thin copper clad PCB mask (mask to source distance was ~ 6 cm) was put between detector and source. The mask was drilled from a 2 mm drill bit to make Letters 'FPS NPD', acronym of Fission Physics Section, Nuclear Physics Division in a 7x5 dot matrix format. Center to center distance between two adjacent holes is 5 mm. Anode wire plane and Cathode wire plane are applied bias of +380 V and -310 V respectively through separate charge sensitive pre-amplifiers. The energy output of anode and cathode pre-amplifiers are shaped through shaping amplifier. The timing output of anode pre-amplifier is amplified and filtered through TFA and fed to CFD and output of CFD becomes the start pulse for TAC as well as used for generating master gate pulse for PC based Data Acquisition System through GDG. Delay-line outputs of X and Y position are amplified through a charge sensitive pre-amplifier and are called position sensitive timing output. X and Y position timing outputs are filtered through TFAs and fed to CFDs and output of CFDs are suitably delayed through a delay unit and become the stop pulses for X and Y TACs. The pulse height of the both TAC outputs are proportional to delay that translate position of the impinging fission fragments on the detector in X and Y plane. All the signals viz. anode energy, cathode energy, X-position and Y-positions are acquired on a PC based multi-parameter Data Acquisition System and spectra were generated through LINUX based LAMPS software.

Fig 3 (a) & (b) show the energy spectrum obtained from anode and cathode respectively. Fig 4 shows the text 'FPS NPD' formed nicely. It is seen that the detector is able to clearly pin-point the adjacent 2 dots formed by 2 mm dia. hole having center to center distance of 5 mm. This detector will be useful for nuclear physics experiment where one requires position measurement in two dimensions for the detection of fission fragments.

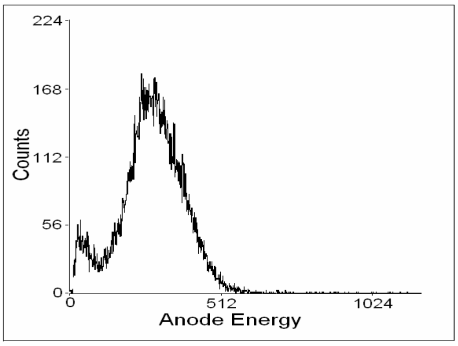

Fig 3 (a): Anode energy (channel no) v/s counts

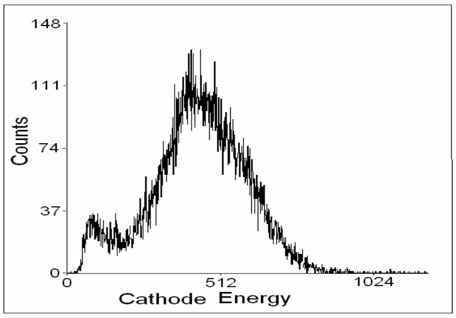

Fig 3 (b) : Cathode energy (channel no) v/s counts

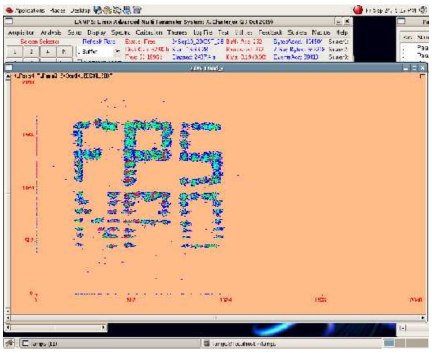

Fig 4 : Image of mask 'FPS NPD'

References

[1] R.P. Vind et al. DAE Symp. On Nucl.Phys. V**45B** (2002) page 460-461.

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