Study of a cylindrical single wire gas ionization detector

Sreelakshmi. J[1], C. Basu[2*], S. Adhikari[3], A. K. Mitra[2], J. Panja[2]
[1]*National Institute of Technology Calicut, Calicut-673601, INDIA*
[2]*Saha Institute of Nuclear Physics, 1/AF Bidhan Nagar, Kolkata-700064, INDIA*
[3]*Physics Department, Techno India University, EM 4, Sector-V, SaltLake, Kolkata-700091, INDIA*
** email: chinmay.basu@saha.ac.in*

Introduction

The cylindrical single wire gas detector with a radial electric field is used as a proportional counter routinely in nuclear particle and X-ray detection [1]. The anode wire runs along the axis of the cylindrical chamber and the detector body acts as the cathode. In the proportional mode, normally P10 is used as the detector gas to introduce the quenching effect.

In this work, we study a new electric field configuration for a cylindrical detector. The anode wire is placed perpendicular to the axis of the cylinder and the field is not purely radial. The detector gas is Xenon which is normally used for X-ray detection due to high Z. The detector is optimized for heavy ions and alpha particles.

Detector design and fabrication

The detector body was made of alumunium and is cylindrical in shape. The detector has two parts. The height of the upper and lower parts are 19 mm and 36 mm respectively. The radius of the cylinder is 50 mm. In the lower part perpendicular to the axis two fittings are attached. One of the fittings is T-shaped and made of alumunium is used for attaching with the vacuum pump and inlet for gas charging. The alumunium fitting is welded with the detector body. The other fittings made of brass is used for mounting the anode wire. The fitting is fixed to the detector body by a neoprene O-ring. A teflon bush is fitted into the brass fitting again using a neoprene O-ring. The teflon bush is drilled to insert the thin anode wire made of copper. Araldite is used to fix the wire inside the drilled hole in the teflon bush. Several such fitments are made for wires of different radii. The adhesive is allowed to dry overnight. The wire is positioned about 23 mm from the bottom of the detector surface. The wire is soldered with a BNC panel connector that is crewed with the detector body. A photograph of the detector is shown in Fig.1.

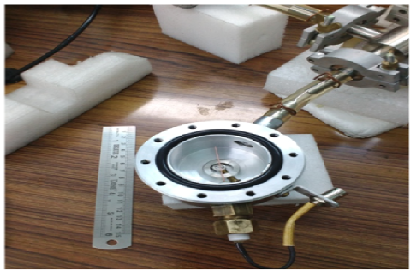

Fig.1 Photograph of the detector

Experimental details

The detector was evacuated by a turbomolecular pump, Pfeiffer model TC310. One arm of the T-shaped alumunium fitting in the detector is attached to the pump through a valve. The other arm is attached to the gas cylinder with another valve. A 10μCi ^{252}Cf spontaneous fission source is placed inside the detector volume. Thus the motion of the nuclear particles are approximately perpendicular to the direction of the thin anode wire. The radius of the wire for which the present measurement is reported is 100 μm. The detector is biased using a Ortec 142A Preamplifier. The signal is also obtained from the energy output of the same preamplifier.

The inital noise level of the detctor signal after the preamplifier was found to be high i.e about 500 mV. The main component of this noise was found to be derived from the brass coupling. This could be reduced considerably to a level of 30mV by wrapping the brass fitting with alumunium foil.

The detector was initially evacuated by the turbopump to a pressure of about 5 to 8×10^{-5} mm Hg. Xenon gas was charged into the detector chamber and the pressure was monitored by an analog manometer. The detector was operated under gas pressures of 100, 200, 480, 560 and 680 mm Hg. At each gas pressure, anode voltage was varied to record the spectra. At first the gain of the amplifier was adjusted to obtain the fission fragment spectrum. After the operating parameters were optimized for fission, the gain of the amplifier was changed to obtain the signal due to low ionizing particles.

Results and discussions

Fig 2-6 shows the acquired spectra using the detector fabricated in this work. The fission humps [2] are most clearly separated at pressures in the range of 200-500 Torr. At higher pressure i.e 680 Torr, the spectrum resolution worsens. A two Gauss fit (green and red lines in fig, 3 and 4) is used to obtain the spectrum parameters and they are in good agreement with systematics.

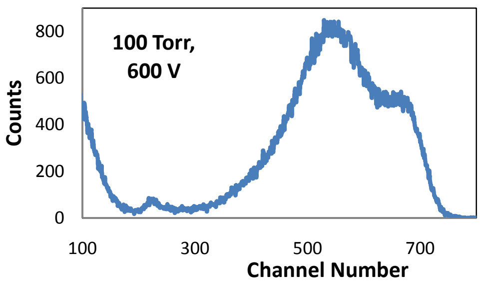

Fig. 2 ^{252}**Cf** Fission spectrum (blue symbol)

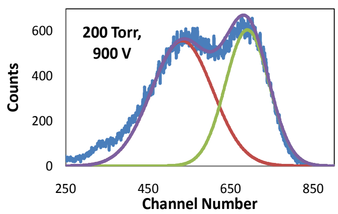

Fig. 3 Same as fig,2 except P=200 Torr and double Gauss fit.

As gas pressure is increased, optimum bias increases and also requires higher shaping times. The alpha spectrum is also seen (fig.6) but on a background that needs to be understood. This background can be also from the internal conversion electrons.

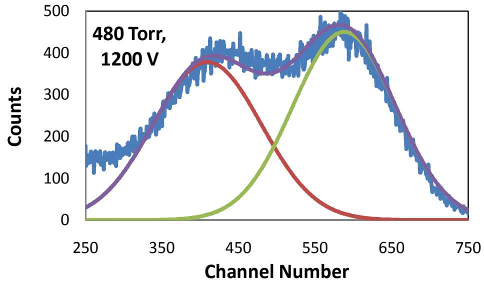

Fig. 4 Same as fig.3 except P=480 Torr.

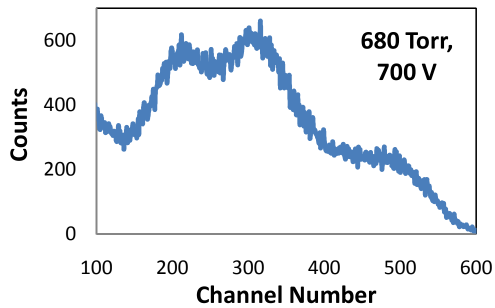

Fig. 5 Same as fig.1except P=680 Torr

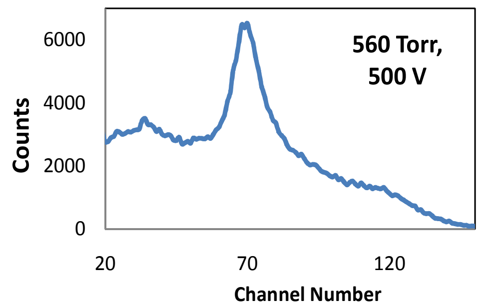

Fig. 6 ^{252}Cf alpha particle spectrum.

We study a cylindrical gas detector with an unusual non radial electric field. The detector do not operate in the proportional region but provides a good separation for the fission fragments and detects the alpha particles and possibly the conversion electrons.

References

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