Measurement of efficiency and time resolution of PPAC

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Introduction-

Parallel plate avalanche counters (PPACs) [1] have been widely used for the detection of heavy ions in nuclear reaction experiments for many years. They have good resolution in time and compared with other detectors PPACs have reduced radiation damage and large sensitive area. These detectors are mainly required to carry on our research activities on the study of fusion fission dynamics with the major accelerator facilities available in our country. PPAC with active area 25 cm^2 has been design and developed at VECC for detection of heavy charged particles [2]. it provides fast timing signal that are used as the "START" time for 'time of flight'(TOF) measurement to know the masses of the fragments generated in nuclear reactions. In the present work we have measured the efficiency and time resolution of PPAC using ^{252}Cf source.

Measurement of efficiency of PPAC for fission fragments.

The efficiency of PPAC for fission fragments has been measured with respect to Si detector using ^{252}Cf source of strength 60.5µCi. The measurement was performed in square scattering chamber of VECC and vacuum of the order ~10^2 mbar was obtained during measurement. The typical bias voltages given to different electrodes of PPAC were +284V and -176V respectively. Isobutene gas was selected as circulating gas in PPAC due to its large gas amplification. The gas pressure inside PPAC was ~3 torr and it was operated in continuous flow mode. During the measurement of decay rate source was kept at 31.4 cm away from detector collimator. Figure 1.a and 1.b shows energy spectrum of fission fragments with Si detector and PPAC

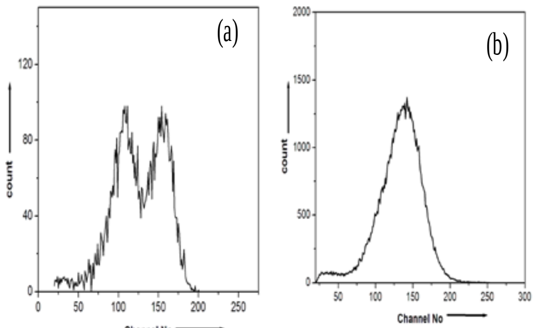

Fig. 1(a) Energy spectrum of fission fragments from Si detector **(b)** spectrum of fission fragments with PPAC.

respectively. In figure 1.a two distinct peaks of fission fragments of unequal masses are clearly separated whereas in figure 1.b fission fragment peaks of ^{252}Cf are merges due to its poor energy resolution. The efficiency of PPAC has been obtained by the comparison of decay rate recorded by the gas-detector with that of Si-detector in 4π solid angle and it was found that its detection efficiency for fission fragments was ~100%.

Measurement of time resolution.

The time resolution of PPAC has been measured using time of flight technique. The source was kept at 30 cm away from PPAC and the distance between the PPAC and neutron detector was 3 meter during the measurement. Block diagram of detector setup is shown in figure. 2. We have taken start timing with PPAC which detects the fission fragments, the gamma that passed through it stopped in the neutron detector.

Photons will reach the neutron detector at the same time so the time of flight was constant for each gamma particle. When the fission fragments from the ^{252}Cf source are detected by the PPAC, the START pulse was triggered. The gamma rays and neutrons emitted along with the fission fragments reaches the neutron detector causes triggering of the STOP pulse at the TDC. This stops the counting by the TDC, the time-interval was measured and its digital value was fed to the computer, by the TDC.

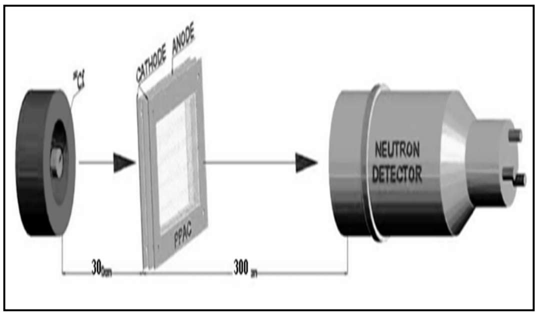

Fig.2 Schematic diagram of experimental setup.

This gives us the time-of-flight (TOF) of the γ rays. Figure. 3(a) shows the time of flight spectra taken by neutron detector. In TOF spectra gammas and neutrons are well separated.

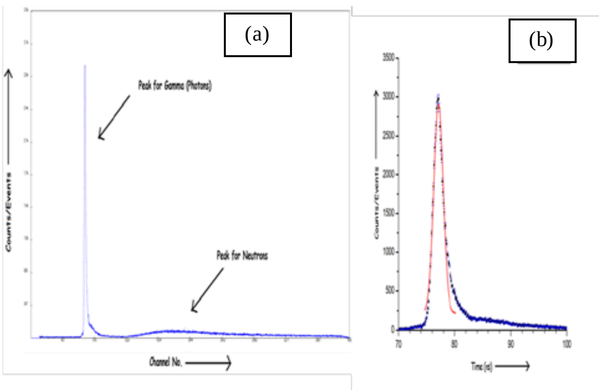

Fig.3 (a) Time of flight spectrum by neutron detectror (b) Gaussian fit of gamma peak.

The data of gamma peak was fitted into Gaussian distribution and from the fitted graph we have taken the value of σ. A time calibrator was used to calibrate the channels. Figure 3 (b) shows the best Gaussian fit for gamma peak. The calculated value of time resolution of PPAC was ~0.5 ns. From the same detector setup we have measured the efficiency of our neutron detector for neutron energy ~1MeV. It was found that its efficiency for neutrons was ~40%.

References

[1] D. Swan et.al, Nuclear instruments and methods. A 348, 314 (1994)
[2] R. Pandey et.al, DAE Symp. On Nucl.Phys. 2012, 57 (2012).