During the present investigation, a low background gas flow beta counter and an alpha counter with Zn(Ag) as scintillator were used for the estimation of beta and alpha activities associated with experimental samples. A high resolution Hyper Pure Germanium (HPGe) gamma ray spectrometer was used for the determination of $^{238}\text{U}$ and $^{232}\text{Th}$ in river sediments and a calibrated portable gamma scintillometer (ECIL SM 141 D) was used for measuring the terrestrial gamma radiation levels.

**Beta Counting System**

The low background beta counting system employs the 'coincidence - anticoincidence' technique for achieving background reduction. The detectors used were gas flow type G.M counters using argon bubbled through isopropyl alcohol kept at constant temperature, the former being the counting gas and the latter, the organic quenching agent. The dimension and geometrical configuration of the 'main' counter and 'guard' counter were so designed as to ensure maximum reduction of background, in conjunction with a 15 cm thick lead shielding surrounding the detector. The gas flow was adjusted to around 10 bubbles per second. The background of the counter was 1.5 - 2.0 cpm with a counting efficiency of 40 % for $^{40}\text{K}$ β energy (1.31 Mev). The schematic sketch of the beta counter is shown in Fig. 8.
Alpha Counting System

The alpha counting system employs a scintillation principle of detection, using ZnS (Ag) powder as the phosphor, which was uniformly applied on one face of the clear circular perspex disc of 2 mm thick and 5 cm diameter. The uncoated surface of the disc was optically coupled to a 5 cm diameter photomultiplier. The whole counting detector assembly (SP 647A) was housed in a mild steel housing provided with a sliding type sample loading arrangement. The ancillary electronics consists of a scaler, timer, pulse amplifier and E H.T unit, all integrated to form a compact desk-top unit (RCS 4027A). With a $^{239}$Pu alpha standard source (5.15 MeV), counting efficiency of the order of 25%-28% was obtained, while background count rate was in the range of 0.1 - 0.2 cpm (Fig. 9).

A slight modification was called for in the above alpha counting system while measuring radon and daughters in the determination of $^{226}$Ra by emanometry. The measurement step consist of collecting radon from the bubbler in a Lucas scintillation cell, which after allowing storage for build-up of radon daughters, was coupled to a photomultiplier and connected to the above counting system (RCS 4027A). Cell background of less than 1.0 cpm was observed. The efficiency of counting radon daughters was on the average ~ 80%.

HPGe Gamma Ray Spectrometer

A high resolution Hyper Pure Germanium gamma ray spectrometer was used in the present study to determine the concentration of primordial radionuclides in river sediments. The block diagram of the detector system is...
shown in Fig. 10. This detector operates at near liquid nitrogen temperature in order to lower the leakage current and hence the noise of the system. Each photon detector system consists of a semiconductor detector element, a cryostat which maintains the detector element in a vacuum and cryogenic temperature, a liquid nitrogen dewar, and electronics consisting of a low noise charge sensitive preamplifier, high voltage filter, linear amplifier, pulse height analyser, analog to digital converter (ADC) and Multichannel Analyser (MCA) (Health Physics Division, Bhabha Atomic Research Centre, Kalpakkam).
Fig. 8. Beta Counting System (Schematic)