Test of the Electron-Neutron Detector Array (ENDA) in Laboratory

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The measurement of thermal neutrons generated by cosmic ray extensive air showers (EAS) on the Earth's surface provides a new method for studying the composition and energy spectrum of cosmic rays at the so-called "knee" region. The electron-neutron detector (EN-detector) utilizing a new type scintillator based on a compound alloy of ZnS(Ag) and B2O3 with natural boron is developed. At present 2 clusters (each consists of 16 detectors) are kept at the laboratory in Hebei Normal University (HNU). The performance test of the EN-detector mainly focuses on role of the cone, and the detector noise level.

The structure of the EN-detector is illustrated in figure.1. The main component of the detector is a black polythylene (PE) barrel , with a scintillator at the bottom , and a 4-inch potomulitiplier (PMT) at the top. A reflector cone is used to collect scintillation photons from the scintillator to PMT.

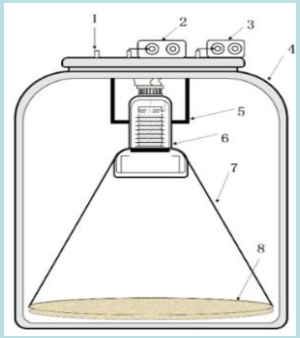

Fig. 1 Schematic of EN-detector. 1- HV input port, 2- d8 preamplifier(DIU), 3- d5 preamplifier (UI),4- black tank,5-PMT fixed holder, 6-PMT, 7- light collecting,cone, 8- scintillator

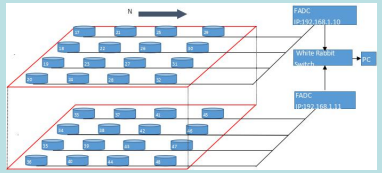

Fig. 2 Configuration of 2 clusters (32 detectors) at the laboratory in Hebei Normal University

The array was arranged in two layers. One cluster on the top called IP12 according to the IP address of the connected FADC, another on the below called IP11. Each cluster has its own FADC. These FADCs transmit data to PC by the White Rabbit Switch (WRS). To quantify the role of the cone, we took out the cone and compared counting rate. We took out the scintillator at detector No.5 in the IP11 cluster to test detector noise level. Detector No.10 in the IP11 array was used to study on role of the cone. Detector No.6 in the IP12 cluster is used as a standard detector. Test process is shown in Table 1. In period.1 the two detectors normal operation and in period.2 we removed the scintillator of detector No.5 and the cone of detector No.10.

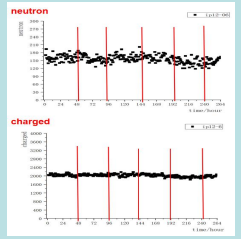

Fig. 3 Variation of counting rate. detector No.06 in cluster IP12

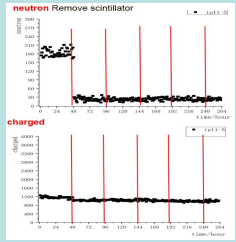

Fig. 4 Variation of counting rate. detector No.05 in cluster IP11

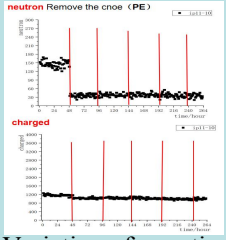

Fig. 5 Variation of counting rate. detector No.10 in cluster IP11

The No. 6 detector is regarded as a standard detector, which is stable in these periods, as shown in figure.3. It indicates the environmental condition of it is stable. After two days of normal operation, the scintillator of detector No.5 and the cone of detector No.10 in cluster IP11 are removed.

Percentage of noise in signal (neutrons and charged particles) counts can be obtained by removing the scintillator. From figure.4 and Table 2, it is obtained that percentage of noise in neutrons and charged particles is 12.9% and 86.8% respectively. Percentage of light collection by the cone in signal counts can be obtained by removing the cone. From figure.5 and Table 2, it is obtained that percentage of light collection by the cone in neutrons and charged particles is 1-25.8%=74.2% and 1-84.5%=15.5% respectively

Conclusion:

During test of EN-detectors in laboratory, percentage of noise in counting rate of neutrons and charged is obtained, and function of the reflector is studied. In the near future, we will keep on test to study for optimization of performance of the detectors.