Design of a portable and wide energy-range neutron detector based on 4H-SiC detector

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The long neutron counter is widely used as neutron flux monitor because of its flat response. However, the traditional long neutron counter has some defects such as large volume, poor portability and slow response time, which makes it difficult to meet the requirements of the measurement of strong neutron radiation field. In order to overcome the above defects, a dual detector compensation design based on 4H-SiC detector is proposed, which can be applied to the neutron flux monitoring in strong neutron radiation fields such as accelerators, fission reactors and fusion test equipment. The neutron detector consists of two 4H-SiC detectors: a 4H-SiC detector covered with a ^{6}LiF thermal neutron sensitive layer (named as D1), which is embedded in the center of the cylindrical polyethylene moderator, so that the detector can obtain relatively flat response characteristics in the energy range of 1eV ~ 1MeV, so as to realize the measurement of neutron flux in the lower energy region. However, the response value of the detector drops sharply when the neutron energy is above 1MeV. To this end, another 4H-SiC detector covered with a polyethylene film (named as D2) is placed on the front end of the cylinder moderator to compensate for the lack of detection capability of thermal neutron detectors in the range of 1MeV to 20MeV.By adjusting the position, size and transfer layer thickness of the 4H-SiC detectors, the summed response of the two 4H-SiC detectors has a flat energy response characteristic. Optimization of the neutron detector carried out using GEANT4 Monte Carlo code. The results show that the optimized neutron detector has a relatively flat response in a wide energy range up to 20 MeV, with an average flux response of 3.5×10^{-3}cm^{2}. In addition, we also proposed a method to evaluate the neutron energy according to the count ratio of the detector D2 to D1, which will allow various new applications taking advantage of the ability to measure neutron fluence and energy at the same time.

Keywords: Compact Neutron Detector; 4H-SiC detector; Geant4 Code; Flat Response;

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