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Conceptual design of a neutron detector for (alpha, n) cross section measurement

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Polyethylene-moderated 3He neutron detectors are widely used in the neutron flux monitor, fission neutron multiplicity measurement, (alpha, n), (gamma, n), and (n, xn) reaction cross-section measurements. However, this kind of detector faces a problem that their detection efficiency strongly depends on neutron emission angle and neutron energy when neutron energy rises above 1 MeV. Therefore, we proposed a novel conceptual design of the neutron detector to address these problems that basically consists of a large spherical heavy water tank, a layer of "3He+CF4"gas, and surrounding photo-multiplier tubes. We used the MCNPX code to calculate detection efficiency dependencies with the neutron energy and neutron emission angle under different configurations, and obtained an optimal configuration (6 cm 11B + 0.2 cm Be + 70 cm D2O) that can offer a high detection efficiency (75%) and relatively good efficiency flatness (1.02) in the interest energy region. To reduce costs, the present study also proposed two new configurations (10 cm natCu + 0.6 cm Be + 50 cm D2O, 10 cm natCu + 1 cm Be + 65 cm C), both of which can have fairly flat detection efficiencies when the neutron energy exceeds 1 MeV. The newly designed neutron detector maybe can substitute the conventional polyethylene-moderated 3He detector and solve the long-standing problems of efficiency energy and angular dependence.

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