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Optimization study on neutron spectrum unfolding based on the least-squares method

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Neutron energy spectrum has a wide significance in the region of radiation protection, reactor physics, and neutron detection technology. In the measurement of neutron spectrum, a method of the recoiled proton is considered to be the most effective and common way due to its simplicity in operation and relatively low cost. The main weakness of this method is that a transformation needs to be performed from the recoiled proton spectrum, namely unfolding. In high energy physics, the unfolding technique has been used in a variety of regions, such as the measurement of a differential cross section, energy spectrum and decay time. Earlier researchers have developed many programs such as RooUnfold, UMG, ANNS based on different principles including iterative method, maxed entropy, SVD, and stochastic method. Although input variables for unfolding are essentially the same, slight variations of these parameters may produce a distinctive result, especially in a spectrum with many peaks close to each other. Unfolding results are sensitive to the layout of the response matrix and the selection of parameters, which needs to be further studied. This work ascertained the influence on the results brought by varying channel width, energy interval, counts, and energy range of the response functions. In this work, the response functions and the corresponding matrix of 2 inch X 2 inch BC501A detector have been constructed with the utilization of the Geant4 simulation tool. The simulation has been done with signification variations in response matrix layouts, including counts, energy intervals, channel width, and energy range. It shows that the accuracy of unfolding results based on the least-square method would be improved with higher counts, wider energy range, proper energy interval and channel width of the response matrix. Previous conclusions have been applied to three energy different simulation spectrum, with the results showing good consistency.

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