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## Benchmark experiment of neutron penetration through iron and concrete shields using 138, 243 and 387 MeV quasi-monoenergetic neutrons part-II: Measurements of neutron energy spectra

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The neutron energy spectra penetrating 10 to 100 cm thick iron and 25 to 200 cm thick concrete shields have been measured using 138, 243 and 387 MeV quasi-monoenergetic neutron sources at the Research Center for Nuclear Physics (RCNP) facility, Osaka University, Japan. The source neutrons were produced from a 1 cm thick lithium target bombarded with 140, 245 and 388 MeV protons. Two types of NE213 liquid organic scintillators (12.7-cm-diam x 12.7-cm-length and 25.4-cm-diam x 25.4-cm-length) and Bonner ball neutron spectrometers were used for the neutron energy spectrum measurement. The response function and the neutron detection efficiency for an NE213 have already been measured. The TOF and unfolding methods were applied to estimate the energy spectra behind the shield in the peak energy region and continuous energy region, respectively. We have also measured the neutron energy spectra and angular distribution of the source neutron above 1 MeV in the angular range from 0 to 30 degrees with the TOF method. All measured data were compared with the PHITS Monte Carlo calculations.

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