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Simulating neutron transport in long neutron beamlines at a spallation neutron source using Geant4

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The transport of neutrons in long neutron beamlines at spallation neutrons sources presents a unique challenge for Monte-Carlo transport calculations. This is due to the need to accurately model the deep-penetration of high-energy neutrons through meters of thick dense shields close to the source and at the same time to model the transport of low-energy neutrons across distances which can be up to around 150 m in length.

Typically, such types of calculations may be carried out with MCNP-based codes or alternatively PHITS. However, in recent years there has been an increased interested in the suitability of Geant4 for such types of calculations. Therefore, we have implemented both supermirror physics and the duct-source variance reduction technique for low-energy neutron transport from the PHITS Monte-Carlo code into Geant4. Additionally, we have also extended the usage of the duct-source technique for neutron deep-penetration calculations.

In the current work, we present a series of benchmarks of these extensions with the PHITS software and also show some example neutron beamline calculations.

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