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Geant4 simulations of the n_TOF lead spallation target: a benchmark study

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Monte Carlo (MC) simulations are a key tool to study the fundamental features of a neutron beam, such as the neutron flux or the γ-ray background, in the design and optimization of experimental facilities. Traditionally, the most widely used MC codes in this field had been MCNPX and FLUKA. However, the Geant4 toolkit has also become a competitive code for the transport of neutrons after the development of the Neutron High Precision Package (G4NeutronHP, later included in G4ParticleHP), that uses evaluated neutron libraries (ENDF-B, JEFF, and JENDL) to simulate the transport of neutrons below 20 MeV.
This work aimed at validating the intra-nuclear cascade models implemented in the Geant4 toolkit using, as benchmark, the flux and energy distribution of the neutron beam measured at the two experimental areas (EAR1 and EAR2) of the n_TOF facility at CERN. To simulate the neutron production and transport in the lead spallation target of the n_TOF facility, the geometry of the spallation source and the properties of the 20 GeV/c proton beam were accurately modelled following the technical details. The simulations were performed using different officially released Physics Lists, including the aforementioned G4NeutronHP package and considering thermal scattering of neutrons below 4 eV.
The results show a remarkable agreement with the experimental data and the MC calculations using FLUKA and MCNP, and reflect the impact of the choice of hadronic model in the integral neutron production.

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