

## Calculation of high-energy neutron spectra with different Monte Carlo transport codes and comparison to experimental data obtained at the CERF facility

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### Abstract:

Energy spectra of neutrons behind shielding of the CERN-EU High Energy Reference Field (CERF) facility were calculated with the FLUKA, MARS and PHITS codes for different measurement locations. At CERF a 120GeV/c mixed hadron beam interacts with a copper target creating a stray radiation field which is then attenuated by a lateral shield of either 80cm or 160cm thick concrete or 40cm thick iron. The measurement locations cover an angular range with respect to the beam axis between 13 and 110 degrees. Results are compared to each other and to measurements performed with a NE213 liquid scintillator detector. The benchmark study focuses on the energy range between several tens to several hundreds of MeV which determines the particle environment and dose equivalent outside shielding of a high-energy accelerator. For many locations the measured neutron fluence is between the FLUKA/PHITS and MARS results with the uncertainties covering all three calculated neutron spectra. Comparing the predictions of the three codes to each other it is observed that FLUKA and PHITS predict similar fluences, while the energy spectra obtained with MARS are generally lower by up to a factor of two. Taking into account the complexity of a high energy neutron measurement the agreement, especially between MARS predictions and experimental data, can be considered as remarkable. However, the benchmark study also underlines the uncertainties in the predictions obtained with different codes in this energy region. Further measurements are needed to draw clear conclusions concerning the quality of different codes and models for shielding calculations at high-energy accelerators.