A Comparative Assessment of Monte-Carlo Codes and Nuclear Data Libraries for SiC Neutron Detector Simulations at 14.1 MeV

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Abstract. This work presents a theoretical assessment of Monte-Carlo transport simulations for neutron interactions in SiC solid-state detectors at 14.1 MeV, with a focus on the impact of modeling assumptions and evaluated nuclear data on the predicted detector response. The objective is to quantify their influence on energy deposition and to assess the consistency of simulation outcomes. Experimental data were collected by exposing a SiC detector to a quasi-monoenergetic 14.1 MeV neutron field generated by a neutron generator in the DANAIDES irradiation casemate of the TOTEM facility at CEA Cadarache. An initial comparison among four widely adopted Monte-Carlo codes (MCNP, PHITS, FLUKA, and GEANT4) is performed to identify a suitable computational framework. Once the reference code is selected, a detailed model of the entire experimental setup is implemented within the chosen code. A systematic analysis of different evaluated nuclear data libraries for neutron-induced reactions on silicon and carbon atoms (namely JENDL-4.0, JEFF-3.3, ENDF/B-VIII.0, and CENDL-3.2) is then carried out. The detector response is characterized through energy deposition spectra, which represent the primary observable for neutron spectroscopy applications based on solid-state sensors. The comparison with experimental measurements is performed exclusively for the results obtained using the different nuclear data libraries within the selected Monte-Carlo model. The analysis reveals non-negligible discrepancies affecting the shape of the deposited energy distribution, mainly attributed to differences in the underlying cross-section evaluations. Overall, this study highlights the importance of nuclear data selection and high-fidelity modeling in Monte-Carlo simulations, as well as the role of experimental benchmarking in supporting the development of SiC-based neutron detection and spectroscopy methodologies.