Simulation of nuclear collisions using GEANT4

I. N. C. Pinto, K. C. C. Pires, O. C. B. dos Santos

Departamento de Física Nuclear, Instituto de Física,
Universidade de São Paulo, 05508-090 São Paulo, Brasil

August 2, 2026

Abstract

This work aimed to develop nuclear reaction simulations using the GEANT4 toolkit [1], which enables high-precision modeling of particle interactions with matter. For this purpose, the geometry of the scattering chamber to be installed at the experimental beamline 15B of the Laboratório Aberto de Física Nuclear e Aplicações (LAFNA), Institute of Physics, University of São Paulo, currently undergoing reactivation, was implemented. The chamber was reproduced in the simulation environment based on its actual dimensions and material composition. In addition, the Telescope (Surface Barrier), DSSD (*Double-Sided Silicon Strip Detector*), and PAD (*Position-Sensitive Anode Detector*) detectors were modeled, enabling the simulation of data acquisition. With all components implemented, benchmark simulations were performed using different Physics Lists to identify those that best reproduce experimental data reported in the literature [2, 3, 4]. Since GEANT4 does not natively account for target nuclear recoil, this effect was implemented in the simulation framework. The inclusion of target nuclear recoil represents an important advancement in the simulation of the experimental setup, providing a more realistic kinematic description of the scattered particles. The simulation results will be presented and discussed, demonstrating the potential of GEANT4 simulations as a valuable tool for experimental planning, supporting detector positioning optimization and improving the efficiency of future experimental studies.

References

[1] S. Agostinelli and *et al.* Nucl. Instrum. Methods Phys. Res. A 506 (2003), 250-303.
[2] U. U. Silva and *et al* Physical Review C. 109 (2024).
[3] P. F. F. Carnelli and *et al.* Nuclear Physics A 969 (2018), 94-113.
[4] C. Signorini and *et al.* European Physical Journal A 10 (2001), 249 – 253.