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Accelerating Full and Fast Simulation of the CMS Experiment

Monte Carlo Simulation data for the CMS experiment can be produced using two software tools. The first, the Full Simulation, is a more precise tool based on Geant4 detector simulation. The second, the Fast Simulation, provides a faster but still reliable tool and is based on parametric particle-material interactions. Full Simulation for the LHC Run-3 shows significant computing performance improvements compared to LHC Run-2 using the current Geant4 version (10.7.2), the new software package DD4hep for geometry description and the Vector Geometry run time library. A further optimization is achieved by the change of the computing platform operating system from CentOS 7 to Alma Linux 8. The challenging CMS detector upgrade plan for HL (High Luminosity)-LHC requires extra efforts due to the increased luminosity and the new and complex detectors geometry. Full Simulation plans to meet the requirements for HL-LHC with the new Geant4 version (11.1) as well as physics improvement including machine learning techniques to reduce compute capacity needs. Major progresses of Fast Simulation are reached by a more efficient handling of the generator particles in their propagation through the detectors. Recent developments include the implementation of an increasing more accurate shower generation, improved track finding and tuning of physics processes. This contribution reports the current Full and Fast Simulation performance innovations and further plans to fulfill the significant higher Monte Carlo Simulation demands in LHC Run-3 and for HL-LHC.

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