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Validation of Electromagnetic Physics Models for Parallel Computing Architectures in the GeantV project

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High-energy particle physics (HEP) has advanced greatly over recent years and current plans for the future foresee even more ambitious targets and challenges that have to be coped with. Amongst the many computer technology R&D areas, simulation of particle detectors stands out as the most time consuming part of HEP computing. An intensive R&D and programming effort is required to exploit the new opportunities offered by technological developments in order to support the scientific progress and the corresponding increasing demand of computing power necessary for future experimental HEP programs. The GeantV project aims at narrowing the gap between the performance of the existing HEP detector simulation software and the ideal performance achievable, exploiting the latest advances in computer technology. The project has developed a particle detector simulation prototype capable of transporting in parallel particles in complex geometries profiting by instruction level parallelism (SIMD and SIMT) and task-level parallelism (multithreading), following both the multi-core and the many-core opportunities. We present preliminary validation results concerning the electromagnetic (EM) physics models developed for parallel computing architectures within the GeantV project. In order to exploit the potential of vectorization and accelerators and to make the physics model effectively parallelizable, alternative sampling techniques have been implemented and tested. Some of these techniques introduce intervals and discrete tables. We identify artefacts that are introduced by different discrete sampling techniques and determine the energy range in which these methods provide acceptable approximation. We introduce a set of automated statistical analysis in order to verify the vectorized models by checking their consistency with the corresponding Geant4 models and to validate them against experimental data. The validation presented here is part of a larger effort, involving Cern, Fermilab and SLAC, for a common development of new physics validation framework designed for various particle physics detector simulation software and is focused on the extension for GeantV.

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