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# High performance Geant4 simulations of electromagnetic processes in oriented crystals

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Electromagnetic processes of charged particles interaction with oriented crystals provide a wide variety of innovative applications in high-energy frontier physics, accelerator physics, detector physics, nuclear physics and radiation therapy. A small piece of crystal material could be used as
-an intense source of X- and gamma-ray radiation for nuclear physics and cancer treatment,
-a positron source for future collider projects, i.e. both linear and circular e+e- colliders (ILC, FCC-ee) as well as for muon colliders,
-a beam manipulation instrument for particle detector R&D at tens of existing electron synchrotrons as well as for ultra-high energy fixed-target experiments at existing and future collider projects (LHC, FCC-ee) to measure, CP-violation processes and physics beyond Standard Model
-a compact crystalline electromagnetic calorimeter and
-a compact plasma wakefield accelerator as well.

The design of every of these applications require simulations. Simulations of these processes imply a very detailed charged particle trajectory calculation and a lot of computational power as well. Geant4 simulation toolkit [1] is perfect for the development of these applications, since it allows one to carry out detailed simulations of a complete experimental setup. It is a Monte Carlo code written on C++, simply parallelizable, including intrinsic multithreading parallelization and MPI parallelization as well. It also includes a rich collection of physical models of particles interaction with matter, wide capabilities to implement a complicated geometry of materials and a number of scoring methods as well.

We present a new simulation model of electromagnetic processes in oriented crystals "ChannelingFastSimModel" implemented into Geant4 using so called Fast Simulation Interface. It allows one to create a model by means of the inheritance G4VFastSimulationModel Geant4 class, and in particular the following functions:
-IsApplicable, a condition if a particle corresponds to the list of particles applicable for this model (electrons and positrons for ChannelingFastSimModel)
-ModelTrigger, a specific condition to launch the model (the particle energy and the angle to be within ChannelingFastSimModel limits)
-DoIt, the main function of the model executing if the IsApplicable and ModelTrigger conditions are fulfilled.

The key advantage of Fast Simulation Interface is automatic switching off of all the standard Geant4 processes on the step when ChannelingFastSimModel is executing. This allows one to avoid its conflict with Geant4 physical processes as well as makes the ChannelingFastSimModel independent of the standard Geant4 physics lists. This model is simply addable to the Geant4 examples already existing, which makes it very simple to use for different applications. In addition, it supports standard Geant4 parallelization methods.

We perform simulations with ChannelingFastSimModel on supercomputers of KISTI and CINECA supercomputing centers. We validate the model with the experimental data. We compare the simulation performance on different architectures and optimize the simulation code.

[1] J.Allison et al., NIM A 835, 186-225 (2016).

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