

Geant4 electromagnetic physics status and prospects

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Background: The Geant4 toolkit [1-3] is the main Monte Carlo simulation engine for high energy physics (HEP) for simulation of experiments at The Large Hadron Collider. It is also established for many other applications domains including space science and radiation medicine. Electromagnetic (EM) physics sub-packages of Geant4 [4-6] are used practically in all user applications defining quality of simulation predictions and CPU performance. In this work we report on status of the recent versions of EM sub-packages and prospects for the new Geant4 version 11.1, which release is expected at the end of 2022.

Material and Methods: Developments for EM sub-packages is continuing in the following directions: addition of new physics models, providing improved handles to configure EM physics, and code optimization. In December 2020, the Geant4 version 10.7 was released and developments on the new series 11.X was started. A lot of technical improvements and modifications were introduced in the toolkit, but main user interfaces remain unchanged. The new data sets EPICS2017 for gamma processes and ICRU90 for protons, alpha, and ions are introduced. The default regime of Geant4 become multithreaded. The most part of data used in EM sub-packages are now shared between threads. Optimization of data access and handling is implemented. Special attention was to run time methods used frequently, which were reviewed, and ineffective C++ implementations were substituted by more advanced algorithms. More flexible interface to physics configuration is provided. Tracking parameters for protons and ions may be defined independently of parameters for electrons and positrons.

Preliminary results: Geant4 11.0 is few percent faster than Geant4 10.7, Geant4 11.1 is expected to be few more percent faster. The exact value of speed-up depends on the geometry of an application and beam energy. It also depends on choice of physics configuration (Physics List). Geant4 provides several variants of EM physics configurations. The default is optimized for HEP, for medical users EM physics option4 is recommended. The are new options to configure EM sub-packages depending on a concrete user application requirement.

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