Contribution ID: **30**

Type: **Oral**

Crystalline effects for electromagnetic processes in Geant4

Wednesday 24 April 2019 15:10 (20 minutes)

Crystals have an internally ordered structure resulting in anisotropy of electromagnetic interaction of charged particles with crystals. When particles move along crystal axes or planes, they can oscillate in their electric field.
For ultra-relativistic particles, i.e. ten or hundred GeV electrons and positrons the electric field of axes or planes is comparable to the Schwinger critical field of QED in the reference system of particles. In this case the electrons and positrons motion is characterized by synchrotron-like radiation with intense emission of hard photons. Therefore, the cross-section of photons emission as well as electron-positron pair production considerably increases.
Nowadays Geant4 treats any substance as the amorphous one and doesn't take into account the crystalline effects of radiation. Though this effects can be simulated well using a Monte-Carlo code based on a method direct integration of the Baier-Katkov (BK) formula [1], such kind of simulations require a considerable computational time problem.
We propose a method to modify standard electromagnetic physical processes in Geant4 to take into account the crystalline effects by fast simulations [2]. In particular, the cross-sections of bremsstrahlung for electrons and positrons and electron-positron pair production for gamma-quanta were multiplied by the correction coefficients. These coefficients were calculated by using full Monte-Carlo code based on BK quasi-classical method.
The electromagnetic (e.m.) shower for primary high energy electrons, positrons and gamma-quanta was simulated for oriented lead tungstate (PWO) (modified Geant4). In comparison with standard Geant4, the maximum of deposited energy shifts to the enter surface. Therefore, one can reduce the calorimeter thickness to contain the e.m. shower because the length of shower decreases significantly, starting from 10 GeV of primary particle energy. Moreover, this effect becomes more pronounced at higher energies, which leads to the opportunity to develop a compact calorimeter for TeV scale.

[1] L.Bandiera, V. V. Tikhomirov, M. Romagnoni, N. Argiolas, E. Bagli, G. Ballerini, A. Berra, C. Brizzolari, R. Camattari, D. D. Salvador, V. Haurylavets, V. Mascagna, A. Mazzolari, M. Prest, M. Soldani, A. Sytov, and E. Vallazza, Phys. Rev. Lett. 121, 021603 (2018)
[2] V. G. Baryshevsky, V. V. Haurylavets, M. V. Korjik, A. S. Lobko, V. Mechinsky, A. Sytov, V. V. Tikhomirov, and V. V. Uglov, Nucl. Instr. Meth. B. 402, 35 (2017)

Author: HAURYLAVETS, Viktar (Institut for Nuclear Problems, Belarusian State University)

Co-authors: BANDIERA, Laura (Universita e INFN, Ferrara (IT)); SYTOV, Alexei (Universita e INFN, Ferrara (IT)); TIKHOMIROV, Victor (BSU); LOBKO, Alexander (Byelorussian State University (BY)); LEVKOVICH, Alesya (Institut for Nuclear Problems, Belarusian State University)

Presenter: HAURYLAVETS, Viktar (Institut for Nuclear Problems, Belarusian State University)

Session Classification: Detector simulation

Track Classification: Detector simulation