Parallel Session 2B

REPORT

Geant4 Condensed Matter Package

From the SuperCDMS Detector Monte Carlo Group

- Mike Kelsey and Rob Agnese's work.

What is G4CMP?

- Library built on top of Geant4 to add support for low energy condensed matter physics.

Some Features:

- Awareness of various crystal symmetries (and amorphous solids)
- Transport and interactions of (acoustic) phonons
- Transport and interactions of charge carriers (electrons and holes)
- Support for local electric fields from 3D potential maps.
- Seamlessly transition from "normal" Geant4 energy deposits to G4CMP particle physics.

Released

- https://github.com/ragnese/g4cmp

What's new in 2016?

- Support for crystal symmetries other than simple cubic
- Support for sensitive electrode patterns at boundaries (G4CMPVElectrodePattern)
- Charges recombine and release bandgap energy at rest
- Phonons reflect (optionally) diffusely from surfaces
- Kaplan quasi-particle downconversion for phonons that absorb in a superconductor
- Utilize Geant4 track biasing by weight
- User configurable minimum cutoff energies
- Lindhard partitioning of energy deposits to create primaries/secondaries

Future development:

- Add more materials
- Add support for optical phonon modes
- Convert Luke phonon emission to a continuous process
- Use more experimental data to validate/tune various parameters (e.g., recombination phonon distribution)
- Create Bogoliubov quasiparticle type for tracking through superconductors

Modelling scattering of low-energy neutrons in poly- and single-crystals

From ESS & DTU

- Xiao Xiao Cai & Thomas Kittelmann's work

What is NCrystal?

- Geant4 extension to manage neutron-crystal physics for neutron instruments

Some features:

- Support to poly- and single-crystals
- Support for all the crystal space-groups (sginfo)
- Inclusion of detailed Bragg diffraction and simple empirical inelastic scattering models
- Detailed inelastic scattering models (optimization phase)

Future development:

- Development of a proper consistent modelling of the inelastic scattering component (just a simplistic empirical approximation for now).
- Document and publish NCrystal
- Work on integration into Geant4 upstream

Channeling in bent crystal

From INFN & SLAC & IN2P3

- M. Asai, E.Bagli, A Dotti & M. Verderi's work

What is Channeling?

- Geant4 extension to manage charged particle-bent crystal coherent interactions at high-energy

Some features:

- Support to single-crystals
- Channeling & Volume reflection processes of high-energy particles
- Modification of process cross-section wrt particle trajectories

What's new in 2016?

- Particle trajectory integration to allow for the production of coherent radiation
- Support for axial channeling

Future development:

- Migrate to the new crystal classes
- Migrate from custom biasing function to standard biasing.
- Production of coherent radiation (coherent bremsstrahlung, channeling radiation, …)

Crystalline materials

Some developments have required to extend the concept of materials. Indeed, the G4Material is meant to describe amorphous/gaseous material and not to take into consideration the microscopic structure of the material itself

Some examples of these extensions are:

- G4DNA
- G4CMP (Phonon & charge carrier propagation)
- Channeling
- NCrystal (Neutron diffraction)

Implementation scheme

- G4ExtentedMaterial will be a derived class of G4Material
- G4ExtentedMaterial collects a map of G4MaterialExtensions*
- G4CrystalMaterial will be a derived class of G4ExtentedMaterial

Advantage:

- No performance change for who does not use the extended material
- More than one extension can be added to one extended material
- Data for processes/models are stored in independent containers (G4MaterialExtensions)