



Version 11.0

Overview

John Apostolakis (CERN)
Geant4 Advanced Course



- Geant4 is a **toolkit**: it provides all capabilities required for particle transport simulation
 - Defines beams (or sources)
 - Enables user to defined the setup/model of material, geometry, field
 - Includes a complete set of physics models for all interactions (many times with options for speed or precision)
 - Tracks particles through the geometry setup/model
 - Records information in general ways (scoring) and in fully customisable ways (hits)
 - Provides tools to configure, visualize and store outputs scoring and hits
- Geant4 provides template for simple applications, ranging from
 - Full ('advanced') applications for key, targeted topics (e.g. hadrontherapy, ..)
 - Extended examples which demonstrate important capabilities
 - Basic examples that are a starting place, and potential starting points for others;
- Geant4 can be used to build applications (tools) for a set of problems and a community, e.g.
 - Accelerator modelling (interactions with collimators, beampipes, ..)
 - Medical imaging and/or radiotherapy

- This course expects that you already
 - know the overall structure of Geant4,
 - have written (at least parts) of a Geant4 application,
 - have a minimum working knowledge of C++, including knowledge of key modern C++11/14 features (auto, ..)
- The course will go in depth each area of Geant4, and seeks to cover
 - the overall picture of capabilities or physics models,
 - the key aspects which a user should know or control
 - inform and guide you to avoid some pitfalls
 - but not a ‘total’ coverage of all capabilities, corner cases etc.
- But we hope and expect that you will ask questions frequently, e.g.
 - about anything that is unclear
 - to understand how to choose capabilities, and whether they are applicable,
 - about the differences between different options offered.
-

The topics of each day

- Day 1 – Physics (processes & models, EM physics, hadronic physics)
- Day 2 – Geometry and EM Field
- Day 3 – Multithreading, recording information (scoring) and other ‘user’ classes
- Day 4 – More about physics (optical, physics lists, hadronic physics)
- Day 5 – How to get faster results (event biasing, fast simulation)

Day 1

- Processes & models
- EM physics
- Hadronic physics

- Day 4

- Optical photons
- Physics lists
- More hadronic physics

- Geometry
 - What shapes (solids) are available to describe individual volumes?
 - How can you describe a complicated hierarchy of volumes ?
 - How to check for errors (overlaps) in your geometry model
- External ElectroMagnetic Fields
 - How to define a magnetic field for the whole detector/setup or part of it
 - What methods are available to integrate the path of charged particles in an (electro)magnetic field ?
 - Does Geant4 offer ‘perfect’ accuracy for integration of tracks and the intersection with surface boundaries?
 - What you need to know about the approximations that must be made – and how to control them.
 - If the default method is not giving the speed or accuracy, are there alternatives?

- Multithreading (MT)
 - How does Geant4 Multi-threading work ?
 - What do I need to do to adapt my application to work with MT ?
 - How to write out
- Recording information (scoring)
- Other 'user' classes

- Methods to get faster results:
 - event biasing chooses to focus the simulation time/computation on ‘important’ parts of the
 - fast simulation

- Analysis
 - Geant4 offers an embedded analysis module (portable between OSes) – adapted to MT
 - You can use the analysis package that you are familiar with already (e.g. Root) instead
- Visualization
 - There are multiple visualisation options (Qt, OpenGL, OpenInventor, dawn);
 - Some capabilities are specific to certain drivers;
 - Basic capabilities are demonstrated in the beginner course(s);
 - The common capabilities of drivers have greatly increased over the last years;
 - It can be used to verify a setup, understand behaviour of tracks or to produce ‘pretty pictures’
 - It is less used in large HEP experiments, which have other ‘event display’ visualisation;
 - Due to time/effort constraints, currently it is beyond the scope of this course.