Particle Physics Simulation

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Introduction

- What? Why? How?
- Hands-on introduction to Geant4
- Hands-on introduction to Garfield++

What is Particle Physics Simulation?

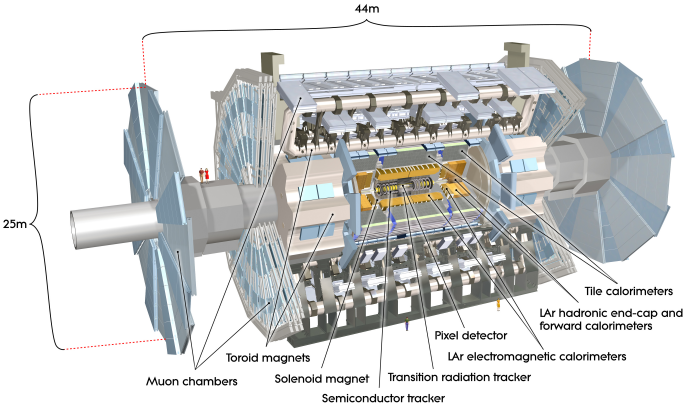
Emerge as the times require:

- Computer technology
- Computational algorithms
- Modern physics

Why We Need Particle Physics Simulation?

Performance of detectors:

- Complex geometry
- Complex material composition
- Efficiency, accuracy and range

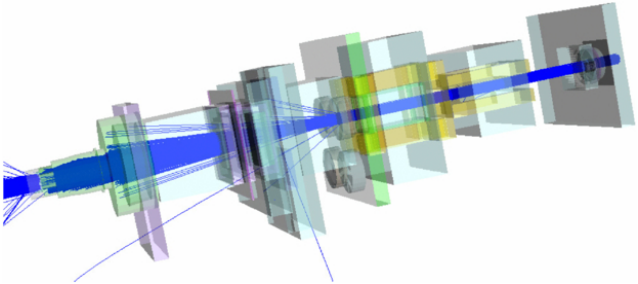


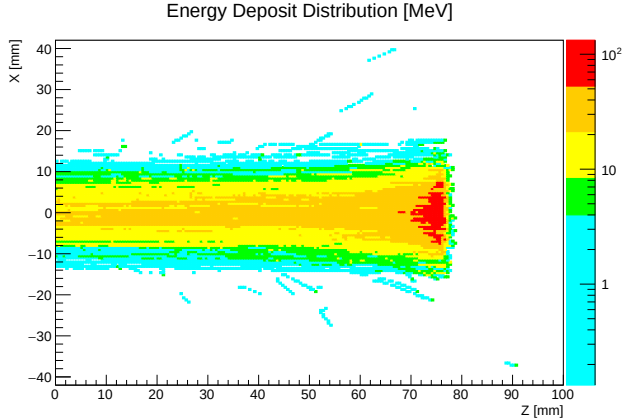
Schematic layout of the ATLAS experiment.

Why We Need Particle Physics Simulation?

Usage of Particle Physics Simulation:

- Collider experiment
- Nuclear reactor simulation
- Medical physics, and so on ...





Geant4:

- The interaction between particle and matter.
- The particle's movement in electromagnetic field.

Garfield++:

- The simulation of electromagnetic field.
- Detailed simulation of gas detectors.

Particle Physics Simulation, from freshman to expert.

Geant4: How to install Geant4 (in Linux)

Get Pre-compiled Libraries:

- Download the libraries
- tar -xvf Linux-g++4.8.5-CC7.tar.gz
- source Geant4-10.X.X-Linux/share/Geant4-10.3.2/geant4make/geant4make.sh
- export GEANT4INCLUDE=Geant4-10.X.X-Linux/include/Geant4

Get Source Files:

- Download the source files
- tar -xvf geant4.10.X.X.tar.gz
- export G4INSTALL=geant4.10.X.X.tar.gz

Get Data Files:

- Download the data files
- Unzip them at pre-compiled libraries:
  Geant4-10.X.X-Linux/share/Geant4-10.3.2/data

Geant4: How to install Geant4 (in Maneframe II)

Load Geant4 module in Maneframe II:

- module load gcc-6.3
- module load geant4/10.X.X

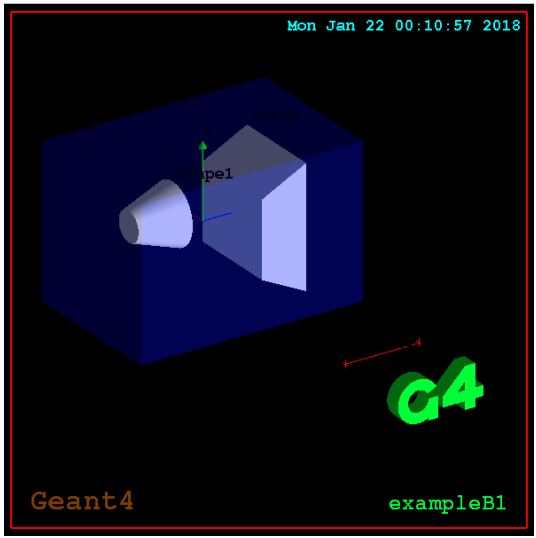
Geant4 configuration:

- geant4-config –libs
- geant4-config –cflags

Geant4: Run First Example

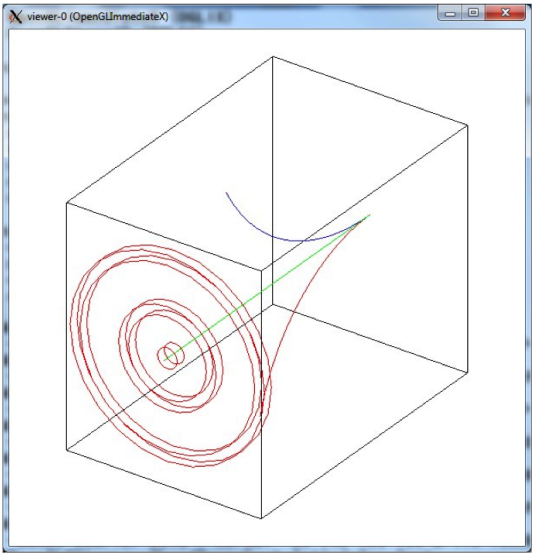
There are several examples in source files:

- Location:
  geant4.10.X.X/examples/basic/B1
- Run: use command “exampleB1” after you built the makefile



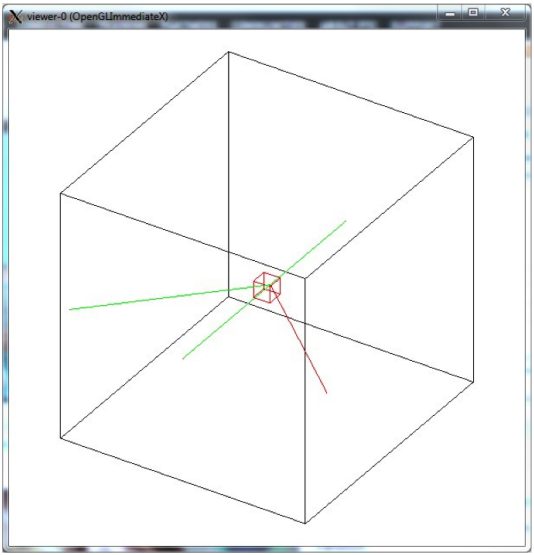
Different particles' trajectory in magnetic field:

- Particle Gun:
  - FirstGun → SetParticle("alpha")
  - SecondGun → SetParticle("electron")
  - ThirdGun → SetParticle("gamma")
- Uniform Magnetic Field:
  - $\vec{B} = 2$ tesla $\hat{x} + 0.0\ \hat{y} + 0.0\ \hat{z}$



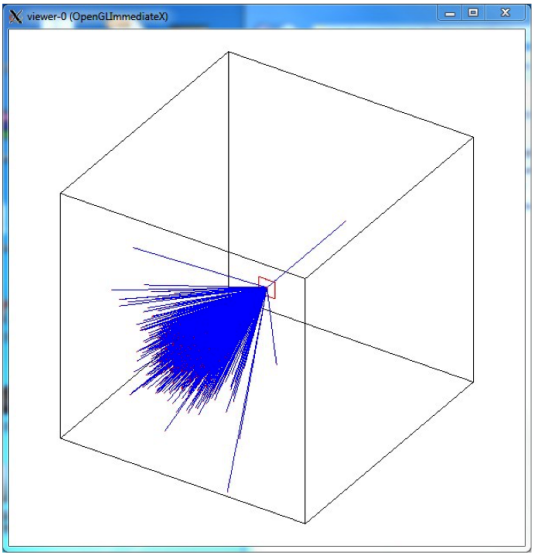
Compoton scattering:

- Particle Gun:
  - Gun → SetParticle("gamma")
  - Particle Initial State: SetParticleEnergy(0.66 MeV)
- Matter:
  - Graphite
  - Thickness: 1 cm
- Runs:
  - 15 events
  - Transport process, Compoton Scattering process.



Rutherford scattering:

- Particle Gun:
  - Gun → SetParticle("alpha")
  - Particle Initial State: SetParticleEnergy(5.155 MeV)
- Matter:
  - Platinum
  - Thickness: 8 μm
- Runs:
  - 1000 events
  - Transport process, Coulomb Scattering process.



- **to be continued**