

Geant 4

Primary Particle Generation

<http://cern.ch/geant4>

The full set of lecture notes of this Geant4 Course is available at <http://www.ge.infn.it/geant4/events/nss2003/geant4course.html>

Contents

- Primary vertex and primary particle
- Primary generator
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Primary vertices and particles

- Primary vertices and primary particles should be stored in G4Event before processing an event.
 - **G4PrimaryVertex** and **G4PrimaryParticle** classes
 - These classes don't have any dependency to G4ParticleDefinition nor G4Track.
 - Capability of bookkeeping decay chains
 - Primary particles may **not** necessarily be particles which can be tracked by Geant4.
- Geant4 provides some concrete implementations of **G4VPrimaryGenerator**.
 - G4HEPEvtInterface
 - G4HEPMCInterface
 - G4GeneralParticleSource
 - G4ParticleGun

Interfaces to HEPEvt and HepMC

- Concrete implementations of G4VPrimaryGenerator
 - A good example for experiment-specific primary generator implementation
- G4HEPEvtInterface
 - Suitable to /HEPEVT/ common block, which many of (FORTRAN) HEP physics generators are compliant to.
 - ASCII file input
- G4HepMCInterface
 - An interface to HepMC class, which a few new (C++) HEP physics generators are compliant to.
 - ASCII file input or direct linking to a generator through HepMC.

G4GeneralParticleSource

- A concrete implementation of G4VPrimaryGenerator
- Primary vertex is randomly chosen on the surface of a certain (radioactive) volume.
- Capability of event biasing (variance reduction).
 - By enhancing particle type, distribution of vertex point, energy and/or direction
- Suitable especially to space applications

G4ParticleGun

- Concrete implementations of G4VPrimaryGenerator
 - A good example for experiment-specific primary generator implementation
- It shoots one primary particle of a certain energy from a certain point at a certain time to a certain direction.
 - Various set methods are available
 - Intercoms commands are also available

G4VUserPrimaryGeneratorAction

- This class is one of mandatory user action classes to control the generation of primaries.
 - This class itself should NOT generate primaries but invoke `GeneratePrimaryVertex()` method of primary generator(s).
 - One of most frequently asked questions is :
 - I want “particle shotgun”, “particle machinegun”, etc.
 - Instead of implementing such a fancy weapon, you can
 - Shoot random numbers in arbitrary distribution
 - Use set methods of `G4ParticleGun`
 - Use `G4ParticleGun` as many times as you want
 - Use any other primary generators as many times as you want

G4VUserPrimaryGeneratorAction

- **Constructor**
 - Instantiate primary generator(s)
 - Set default values to it(them)
- **GeneratePrimaries() method**
 - Randomize particle-by-particle value(s)
 - Set them to primary generator(s)
 - Invoke `GeneratePrimaryVertex()` method of primary generator(s)
 - Never use hard-coded UI commands

G4VUserPrimaryGeneratorAction

```
void T01PrimaryGeneratorAction::
    GeneratePrimaries(G4Event* anEvent)
{
    G4ParticleDefinition* particle;
    G4int i = (int)(5.*G4UniformRand());
    switch(i)
    {
        case 0: particle = positron; break;
        ...
    }
    particleGun->SetParticleDefinition(particle);
    G4double pp =
        momentum+(G4UniformRand()-0.5)*sigmaMomentum;
    G4double mass = particle->GetPDGMass();
    G4double Ekin = sqrt(pp*pp+mass*mass)-mass;
    particleGun->SetParticleEnergy(Ekin);
}
```

```
G4double angle =  
    (G4UniformRand()-0.5)*sigmaAngle;  
particleGun->SetParticleMomentumDirection  
    (G4ThreeVector(sin(angle),0.,cos(angle)));  
  
particleGun->GeneratePrimaryVertex(anEvent);  
}
```

- You can repeat this for generating more than one primary particles.