Introduction to GEANT4

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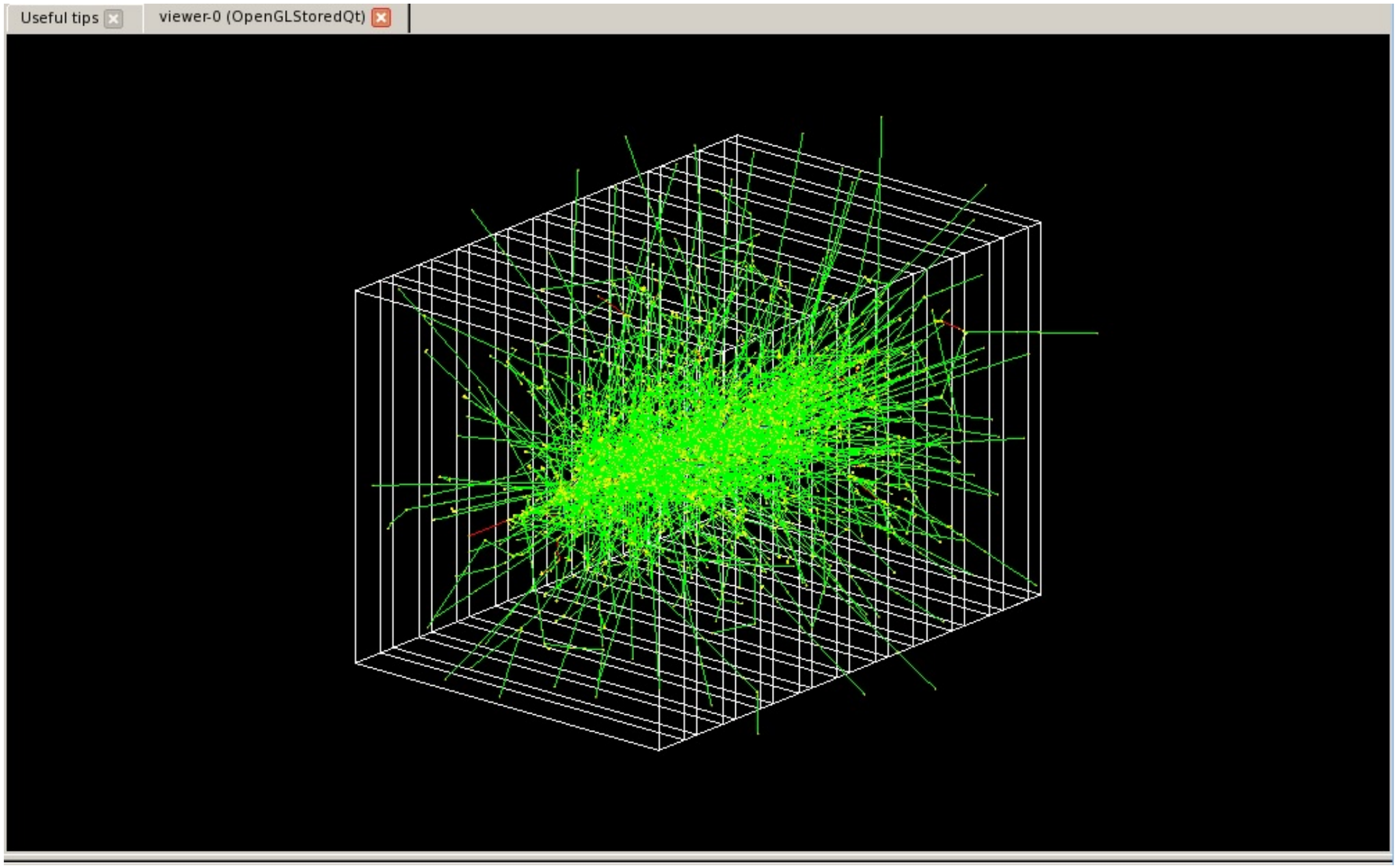
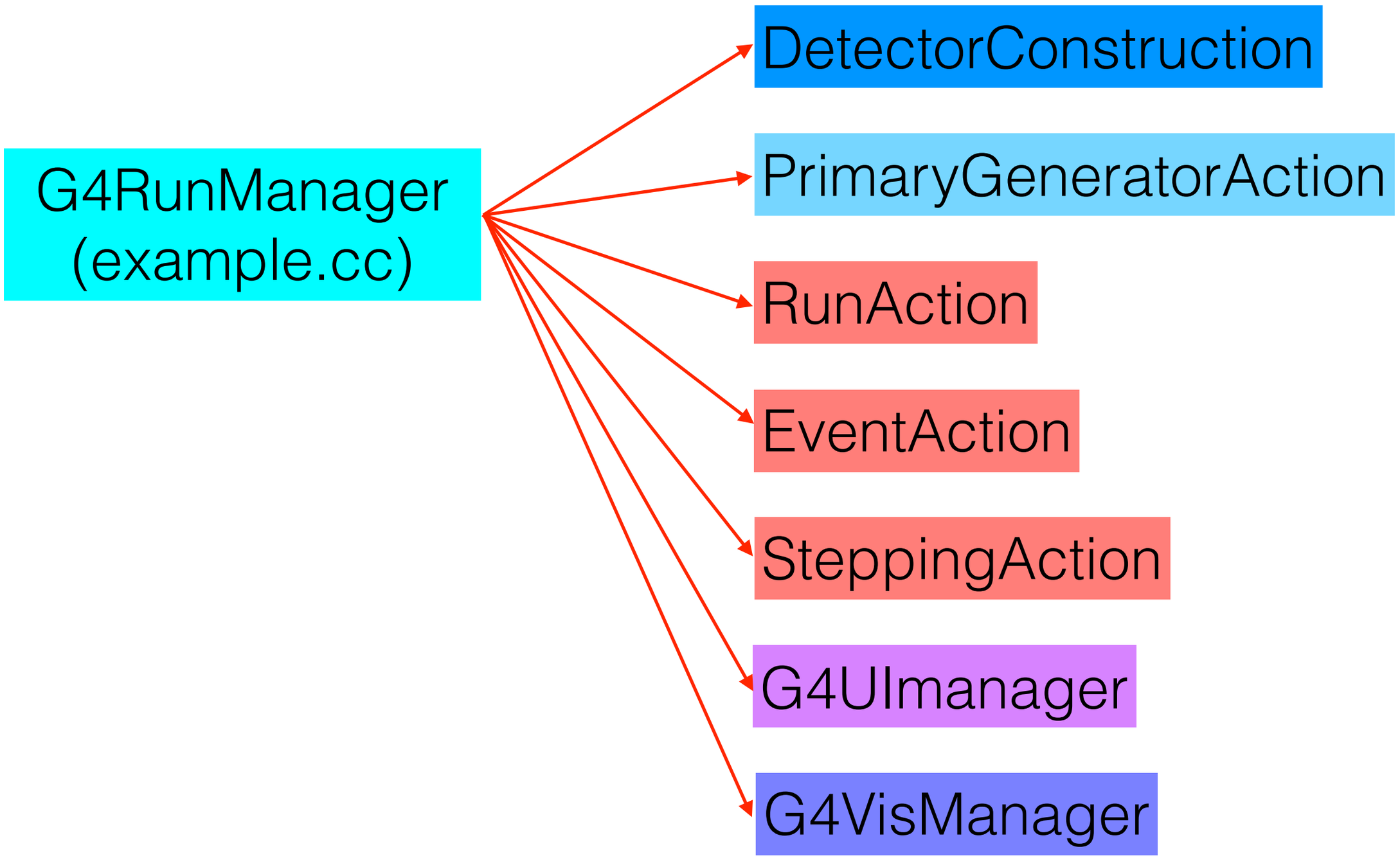
(SPDAK 2019)

Sampling Calorimeter



Structure of GEANT4



basic/B4/B4a

DetectorConstruction : define the detector geometry and materials

PrimaryGeneratorAction : define a particle gun (particle, momentum direction, energy, gun position)

RunAction : called every run, booking histogram and ntuple, summary each run

EventAction : called every event, fill histogram and ntuple, summary each event

SteppingAction : called every step, obtain step length, energy deposit in a volume

G4UImanager :QT, GAG, tcsh, csh

G4VisManager :OpenGL, VRML, G4HepRep

Definition of Materials

- G4Isotope and G4Element describe the properties of the atoms:
  - Atomic number, number of nucleons, mass of a mole, shell energies
- G4Material describes the macroscopic properties of the matter:
  - temperature, pressure, state, density
  - Radiation length, absorption length, etc.

Element & Isotope

- Isotopes can be assembled into elements
  - G4Isotope (const G4String& name,

    G4int z, // atomic number

    G4int n, // number of nucleons

    G4double a); // mass of mole

- building elements as follows:
  - G4Element (const G4String& name,

    const G4String& symbol, // element symbol

    G4int nIso); // # of isotopes

  - G4Element::AddIsotope(G4Isotope* iso, // isotope

    G4double relAbund); // fraction of atom per volume

Element & Isotope

```
//

// define an Element from isotopes, by relative abundance

//

G4Isotope* U5 = new G4Isotope(name="U235", iz=92, n=235, a=235.01*g/mole);

G4Isotope* U8 = new G4Isotope(name="U238", iz=92, n=238, a=238.03*g/mole);


G4Element* elU  = new G4Element(name="enriched Uranium", symbol="U",
ncomponents=2);

elU->AddIsotope(U5, abundance= 90.*perCent);

elU->AddIsotope(U8, abundance= 10.*perCent);
```

Material of One Element

- Single element material

```
G4double density = 1.390*g/cm3;

G4double a = 39.95*g/mole;

G4Material* lAr =

   new G4Material(“liquidArgon",z=18.,a,density);
```

Material: Molecule

- A Molecule is made of several elements (composition by number of atoms):

```
a = 1.01*g/mole;
G4Element* elH  =
                        new G4Element("Hydrogen",symbol="H",z=1.,a);
a = 16.00*g/mole;
G4Element* elO  =
                        new G4Element("Oxygen",symbol="O",z=8.,a);
density = 1.000*g/cm3;
G4Material* H2O =
                        new G4Material(“Water", density, ncomp=2);
H2O->AddElement(elH, natoms=2);
H2O->AddElement(elO, natoms=1);
```

Material: Compound

- Compound: composition by fraction of mass

```
a = 14.01*g/mole;
G4Element* elN  =
                    new G4Element(name="Nitrogen",symbol="N",z= 7.,a);
a = 16.00*g/mole;
G4Element* elO  =
                     new G4Element(name="Oxygen",symbol="O",z= 8.,a);
density = 1.290*mg/cm3;
G4Material* Air =
                     new G4Material(name="Air",density,ncomponents=2);
Air->AddElement(elN, 70.0*perCent);
Air->AddElement(elO, 30.0*perCent);
```

Material: Mixture

- Composition of compound materials

```
G4Element* elC  = ...;   // define “carbon” element

G4Material* SiO2 = ...;  // define “quartz” material

G4Material* H2O = ...;   // define “water” material

density = 0.200*g/cm3;

G4Material* Aerog =

                              new G4Material("Aerogel",density,ncomponents=3);

Aerog->AddMaterial(SiO2,fractionmass=62.5*perCent);

Aerog->AddMaterial(H2O ,fractionmass=37.4*perCent);

Aerog->AddElement (elC ,fractionmass= 0.1*perCent);
```