Hits

Geant4 CERN Tutorial

Wednesday, 17 February 2010

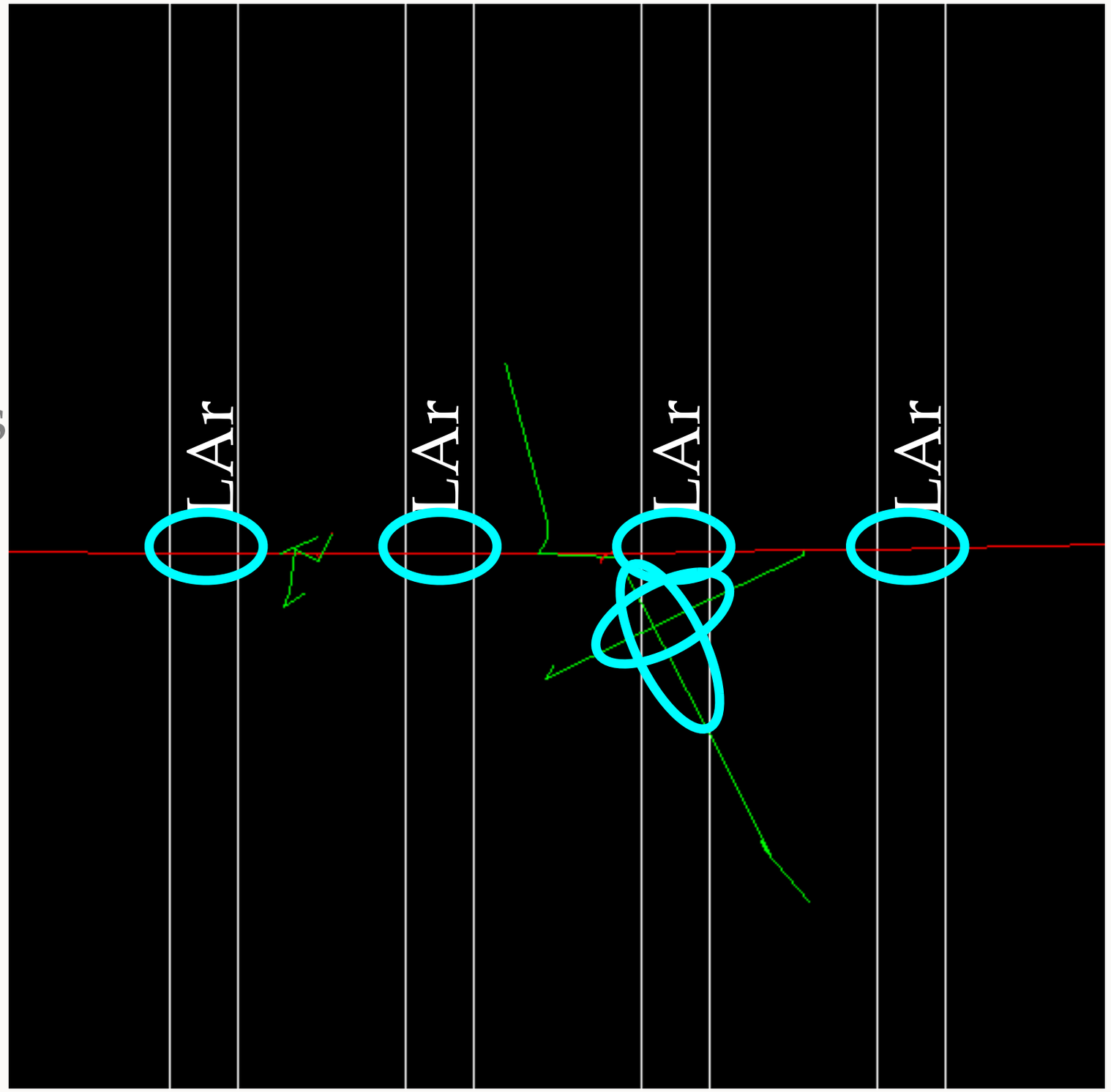
In This Lecture

- What is G4Hit?
- How to use hits

Important: this material refers to this morning lecture: Sensitive Detector

Reminder: G4Step

For all these G4Steps ::ProcessHits(...) will be called



What Hits Are

- Hits are created in Sensitive Detector to store user quantities
- Hits are collected in a container and "registered" in Geant4
  - Hits become available to all components of the application
- A tracker detector typically generates a hit for every single step of every single (charged) track.
  - A tracker hit typically contains: Position and time, Energy deposition of the step, Track ID
- A calorimeter detector typically generates a hit for every "cell", and accumulates energy deposition in each cell for all steps of all tracks.
  - A calorimeter hit typically contains: Sum of deposited energy , Cell ID
- Hits should be identified: they have an id that uniquely identifies them

Hits

- You need to write your own Hit class: inherits from G4VHit
- Hits must be stored in a collection of hits instantiated from G4THitsCollection template class

```
#include "G4VHit.hh"
#include "G4Allocator.hh"
#include "G4THitsCollection.hh"
```

← Headers files

```
class HadCaloHit : public G4VHit {
public:
  HadCaloHit(const G4int layer);
 ~HadCaloHit();
  void Print();
  void          AddEdep(const double e){ eDep += e; }

  G4double      GetEdep()        const { return eDep;}
  G4int         GetLayerNumber() const { return layerNumber; }
private:
  const G4int   layerNumber;
  G4double      eDep;
};

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Base class

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Create a new Hit: the ID is the layer index

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Hit interface: print on screen

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Our specific hit interface

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The Hit container, just add this line

Warning: more advanced code (memory management optimization) not shown here, optional but highly recommended

How To Declare Hits

- A hits collection has a name, this name must be declared in SensitiveDetector constructor
- SD has a data member: collectionName, add your name to this vector of names

  - A SD can declare more than one hits collection!

```
HadCaloSensitiveDetector::HadCaloSensitiveDetector(G4String SDname)
  : G4VSensitiveDetector(SDname)
{
    G4cout<<"Creating SD with name: "<<SDname<<G4endl;
  // 'collectionName' is a protected data member of base class G4VSensitiveDetector.
  // Here we declare the name of the collection we will be using.
  collectionName.insert("HadCaloHitCollection");

  // Note that we may add as many collection names we wou  ish: ie
  // a sensitive detector can have many collections.
}
```

Our hits collection name!

How To Create A HC (Hits Container)

- Every event a new hit collection (HC) has to be created and added to current event collection of hits
- Every HC has two names: the SD name that created it and the name of collection. This pair is unique
  - Geant4 uses also an identifier (a number) to uniquely identify your collection, you need to use this ID to register/retrieve the collection

```
void HadCaloSensitiveDetector::Initialize(G4HCofThisEvent* HCE)
{
   hitCollection = new HadCaloHitCollection(GetName(), collectionName[0]);
   static G4int HCID = -1;
   if (HCID<0) HCID = GetCollectionID(0); // <<-- this is to get an ID for collectionName[0]
   HCE->AddHitsCollection(HCID, hitCollection);
```

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Create a Hit Collection: GetName() returns SD name (“/HadCalo”) , collectionName is a vector: [0] is the first (and only in our case) element (“HadCaloHitCollection”)

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}
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GetCollectionID(0) is an heavy operation, you should avoid to do it every event!
GetCollectionID(0) returns the unique ID associated to the hit collection!

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Register the hits collection object in the Hits Collections of This Event (G4HCofThisEvent)

How To Create And Fill Hits

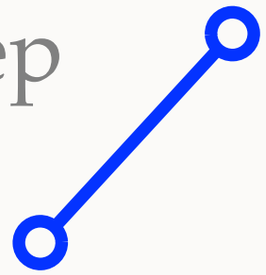
- Every time ProcessHits is called you can (if needed) create a hit and add it to the hits collection

```
G4bool HadCaloSensitiveDetector::ProcessHits(G4Step *step, G4TouchableHistory *)
{
      HadCaloHit* aHit = new HadCaloHit(layerIndex);
     hitCollection->insert(aHit);
     aHit->AddEdep( edep );
     return true;
}
```

- Note: our calorimetric hits accumulate energy on layers, thus hits must be created only the first time a G4Step is in layer "n". You need a way to "remember" if hit has been already created (not shown here)
  - A possible solution is shown in the code of exercise. Not discussed here (use C++ std::map). You are free to use what you want, but try to optimize the code! These part of the code will be called several times during execution.

Summary

G4Step



Summary

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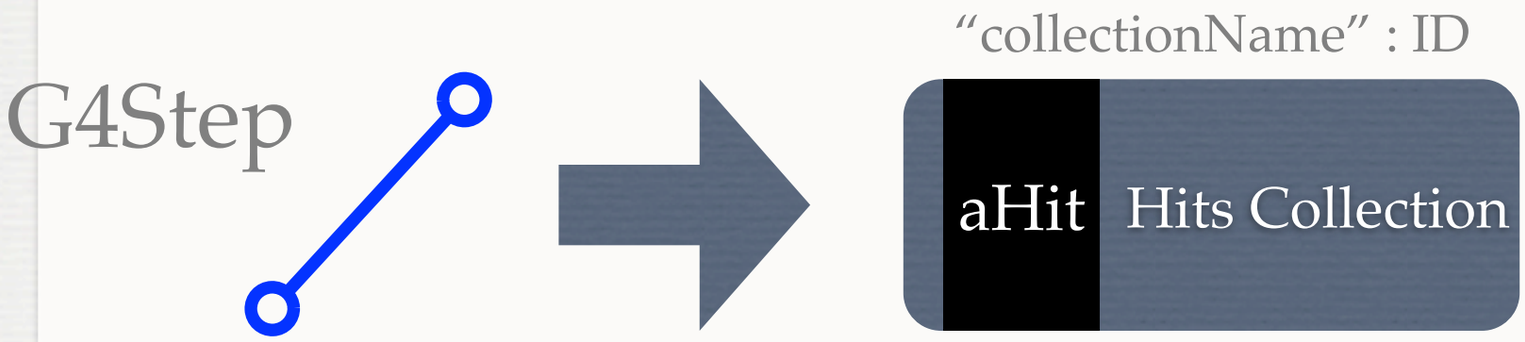

Repeat for each step in the event

Summary

End of the event

Exercise

- task4c
  - Modify current Hit class (add print on screen)
  - Create a Hits collection and register it
  - (optional) Extend Hit class
- cd g4course2010/task4/task4c

A Note

- The code of task2a contains example of a “tracker type” hits:
  - Creates a hit for each track passes in a Si module
- It also contain the “digitization” (not discussed here): the process of simulating the electronic read-out of the detector
  - SiDigitizer class: gaussian noise, cross-talk