Glast Code Review: 24 April 2002

An Introduction to G4Generator

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Contents

The work on G4Generator has been carried on by many people with direct contributions (code) and indirect ones (comments, critics, bugs finding etc.); among them (in no particular order)

Toby, Francesco, Tracy, Joanne, Alessandro, Leon, Marco, Sasha, Richard, Heather

These slides have been typeset in ConTEXt.

Introduction

- Lets start with a simple fact: the package `G4Generator` is not a finished, closed, we-are-all-happy-of-it piece of software
- It will become that (we hope) in the ***very near*** future
- To some extent it is already quite **stable** and **usable**
- Netherveless it is still in an evolving phase, due principally to the nature of the problem, i.e. merging together two evolving piece of software (a toolkit and a framework) that have been designed in two completely different ways: ***Geant4*** and **Gaudi**
- First of all I want to briefly introduce these main actors, their interaction problems and how we solved them
- Then I'll show how it works in some detail

Geant4

- It is a toolkit
  - a collection of abstract classes that the user has to concretely implement
  - a manager mechanism to register these classes
  - a central engine hidden from the user
- It has a lot of features and functionalities, more than a normal Monte Carlo library (graphics, persistency, data structure, geometry databasing etc etc)
- It is designed as a stand alone application
- It is quite well supported (two main releases in a year)
- Tune group has shown how ***Geant4*** can be used as a standalone application for ***GLAST*** simulations (Balloon)
- They have also contributed to physics validation (together with Francesco and Alessandro), showing that ***Geant4*** is reliable at least for what concern em processes

- The user must provide a certain number of classes derived by ***Geant4*** abstract ones; at least
  - A concrete implementation of a `G4VUserDetectorConstruction` class for geometry construction; in particular the implementation of the virtual method `G4VPhysicalVolume* Construct()` that must return a pointer to the world volume, i.e. the root of volumes hierarchy (note that also materials must be defined in this class)
  - A concrete implementation of a `G4VPhysicsList` class for physics processes management; in particular the implementation of the virtual methods `void ConstructParticle()`, `void ConstructProcess()` and `void SetCuts()` (as we will see we adopted a more modular implementation)
  - A concrete implementation of a `G4VUserPrimaryGeneratorAction` class for primary particles generation; in particular the implementation of the virtual method `void GeneratePrimaries (G4Event *)` that generates the primary particle in the simulation
- These classes are registered with a manager (`G4RunManager`) that runs the main event loop

Gaudi

- ⋆ It is a framework
- ⋆ Algorithms work on data objects in data stores, both in and out
- ⋆ Services provide functionalities useful to algorithms through abstract interfaces
- ⋆ The main event loop is controlled by the framework

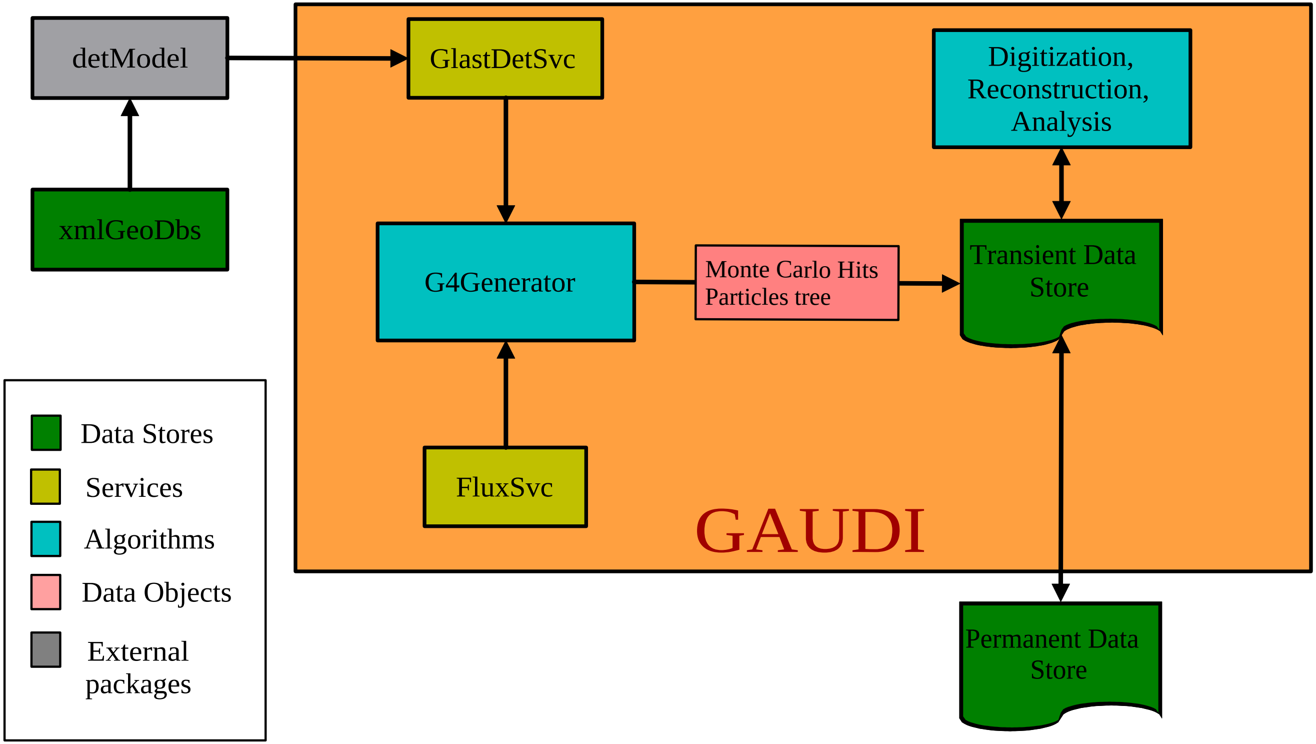
Early problems and solution

- Both ***Geant4*** and Gaudi want to manage the event loop
- ***Geant4*** provides a lot of functionalities that are already provided by Gaudi Services (like graphics, persistency, event data structure, geometry databasing, digitization); we don't need them
- ***Geant4*** is composed of many classes and it can be hard to find out what we need
- The main central engine of ***Geant4*** is managed by the `G4RunManager` that is not an abstract class of the toolkit

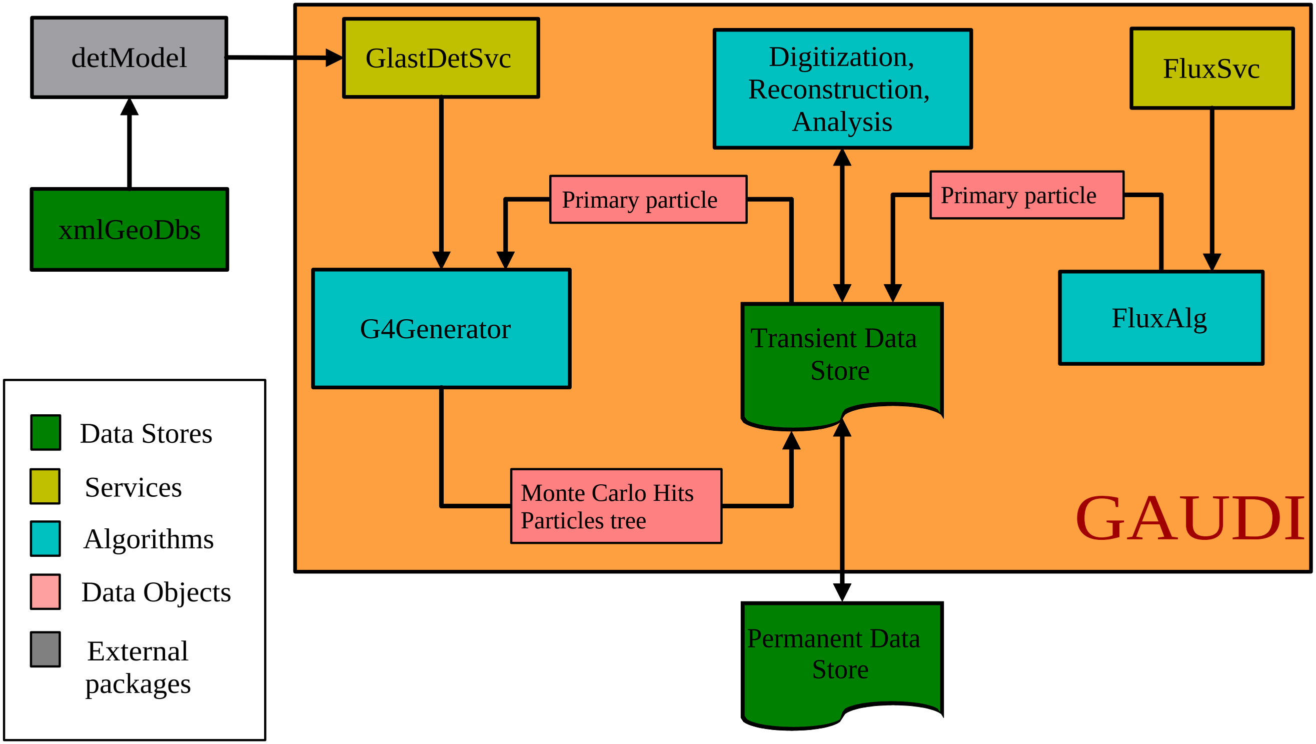
GLAST recipe:

- A local installed ***Geant4*** distribution (we are using v.3.2 binary distribution in the external libraries directory of ***GLAST***)
- A CMT package that wraps the installation of ***Geant4*** for makefiles generation and dependencies handling (it is called `Geant4`)
- A GAUDI algorithm, that is `G4Generator`, that uses ***Geant4*** to produce hits in the detectors and store them in the TDS, followed by other algorithms to produce digits and reconstructed quantities
- Provide a ***GLAST*** specific RunManager for that algorithm such that:
  - It uses only a subset of ***Geant4*** functionalities, the ones we need really
  - It leaves control of the event loop to Gaudi
- Can be dangerous for future ***Geant4*** compatibility: we will take care of it ...
- Some properties and parameters can be passed at run-time with a standard GAUDI **jobOptions** file

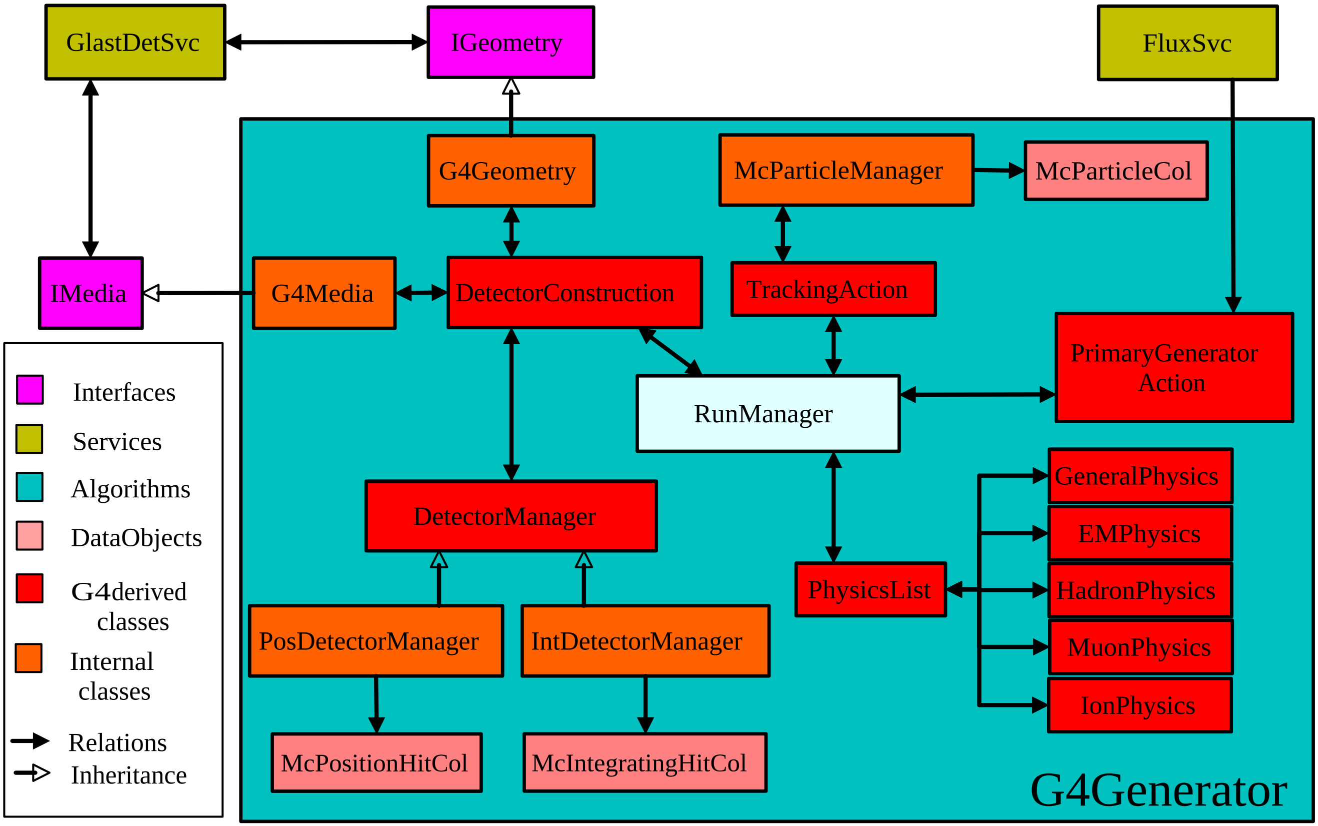
The external interactions of G4Generator



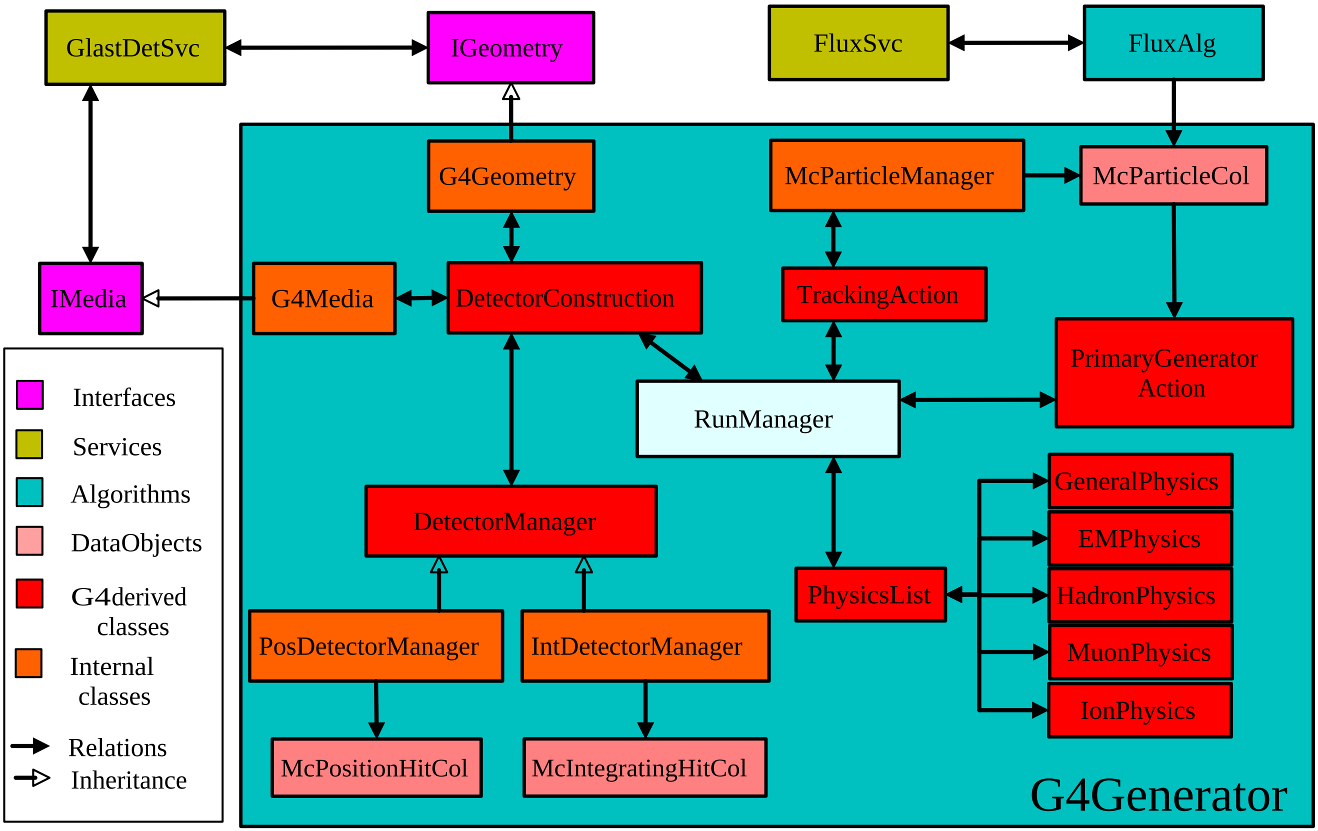
The external interactions of G4Generator (new design)



The internal structure of G4Generator



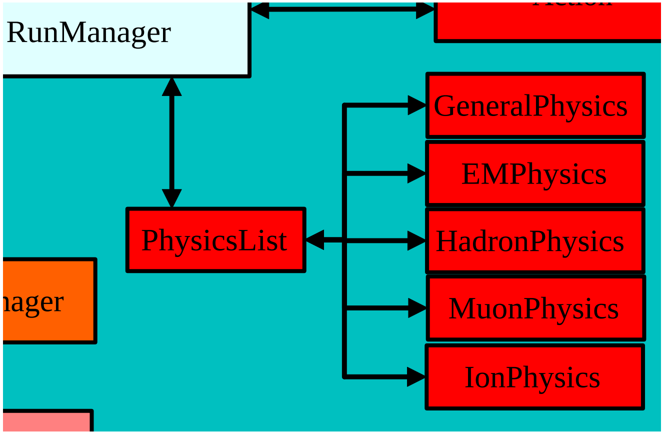
The internal structure of G4Generator (new design)



To summarize (and take a breath)

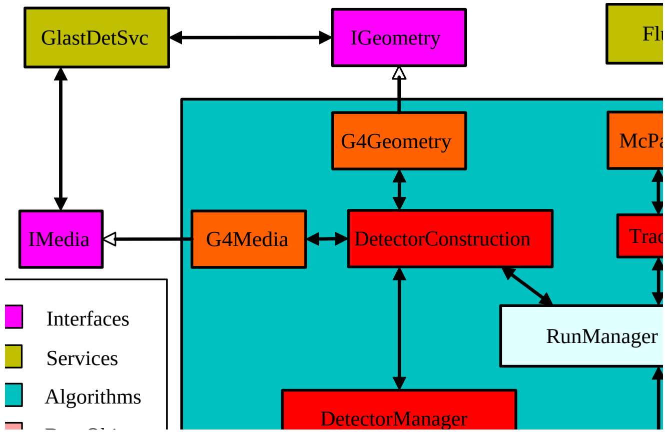
- G4Generator is a GAUDI algorithm
- It produces collections of data objects in the TDS
  - A vector of McPositionHit in /Event/MC/PositionHitsCol
  - A vector of McIntegratingHit in /Event/MC/IntegratingHitsCol
  - A vector of McParticle in /Event/MC/McParticleCol
- It builds the geometry with the help of GlastDetSvc
- It retrieves primary particles from the FluxSvc (directly or indirectly)
- Let's see some details

Physics



- The physics design from Francesco is now in `G4Generator`
- `PhysicsList` is the main class that is registered to the RunManager and hinerits from `G4VModularPhysicsList`
- This class uses 5 other classes to instantiate both particles and physics processes belonging to different physics domains
- For this, each class implements the two methods `ConstructParticle` and `ConstructProcess`

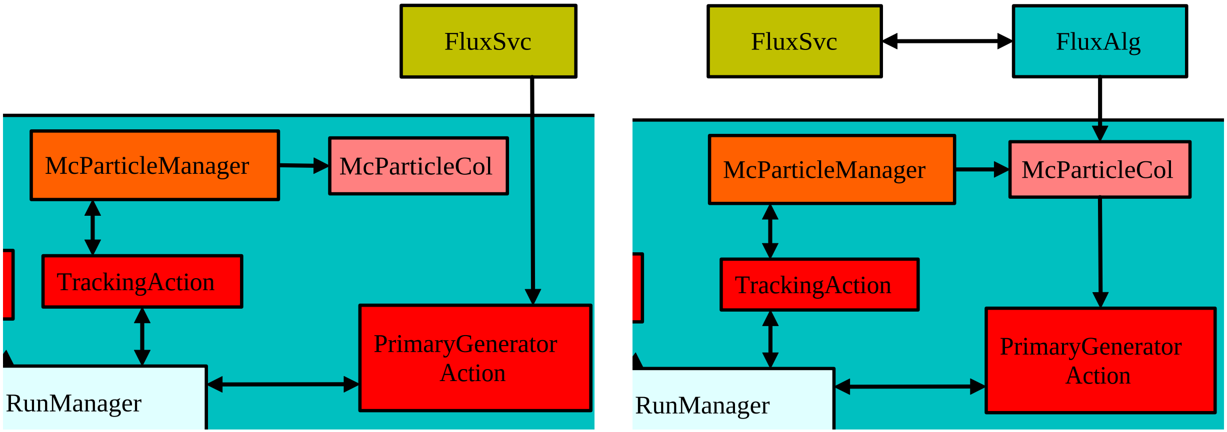
Geometry



- DetectorConstruction is derived from G4VDetectorConstruction and implements the virtual method Construct that returns a pointer to the world volume, i.e. to the root of the volumes hierarchy

- To build such a hierarchy it uses GlastDetSvc with the help of two classes
  - G4Geometry implements the abstract interface IGeometry; it is responsible for navigating the detModel hierarchy and building the ***Geant4*** geometry
  - G4Media implements the abstract interface IMedia; it is responsible for building the ***Geant4*** materials table from the detModel model.

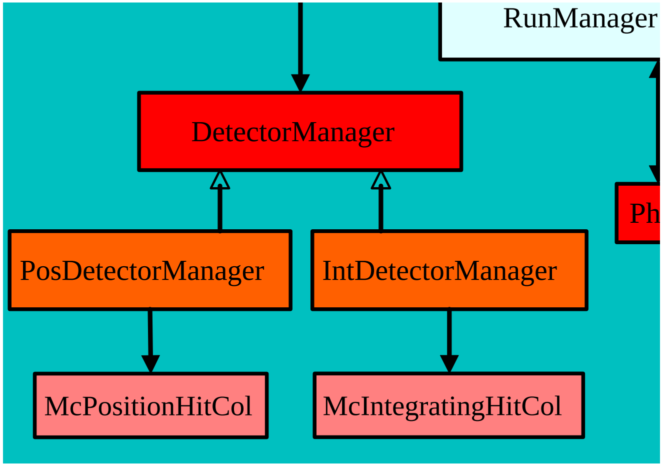
Particles



We are in the middle of a transition to a new design: `G4Generator` will not be related directly to FluxSvc, but will retrieve the primary particle as the root of an McParticle tree in the TDS

- `McParticleManager` is a singleton that manages insertion, retrieval and saving of the `McParticle` collection in the TDS; this is used by the DetectorManager classes to associate `McParticle` to hit objects
- `TrackingAction` is derived from `G4UserTrackingAction` and is used to add new `McParticle` when they are created by ***Geant4***

Hits



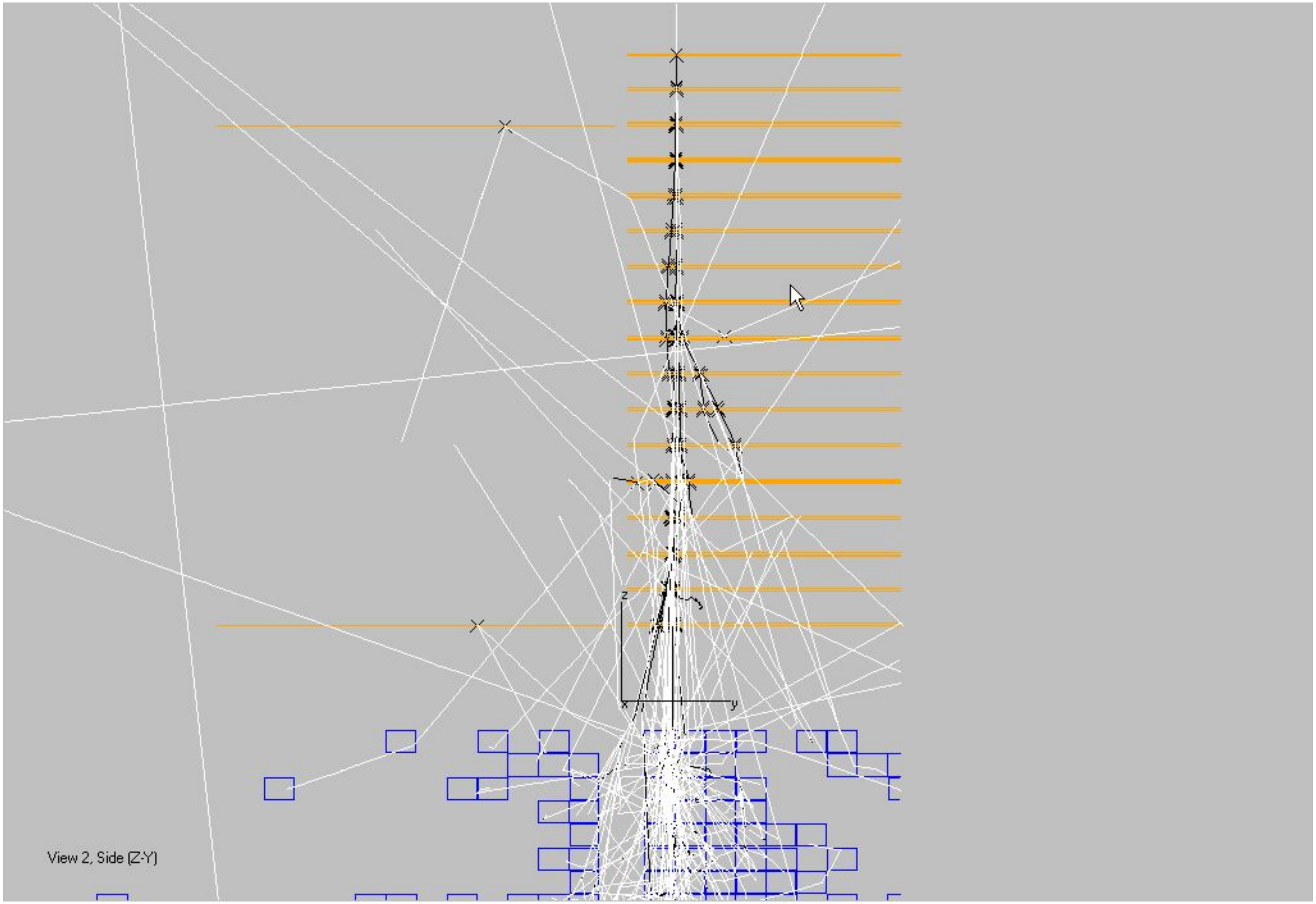
- `DetectorManager` derives from a `G4VSensitiveDetector`; it is automatically called by ***Geant4*** every time an hit occurs in a volume registered with this class (in the `DetectorConstruction`)
- ***Geant4*** calls the method `ProcessHits`; in our case this method is NOT implemented in the `DetectorManager` so that it is also an abstract class

- `PosDetectorManager` is a concrete implementation of the `DetectorManager`; it is used to manage volumes in which hits must be saved as `McPositionHit` (mainly the silicon TKR planes)
- `IntDetectorManager` is a concrete implementation of the `DetectorManager`; it is used to manage volumes in which hits must be saved as `McIntegratingHit` (mainly the ACD tiles and the CAL cells)

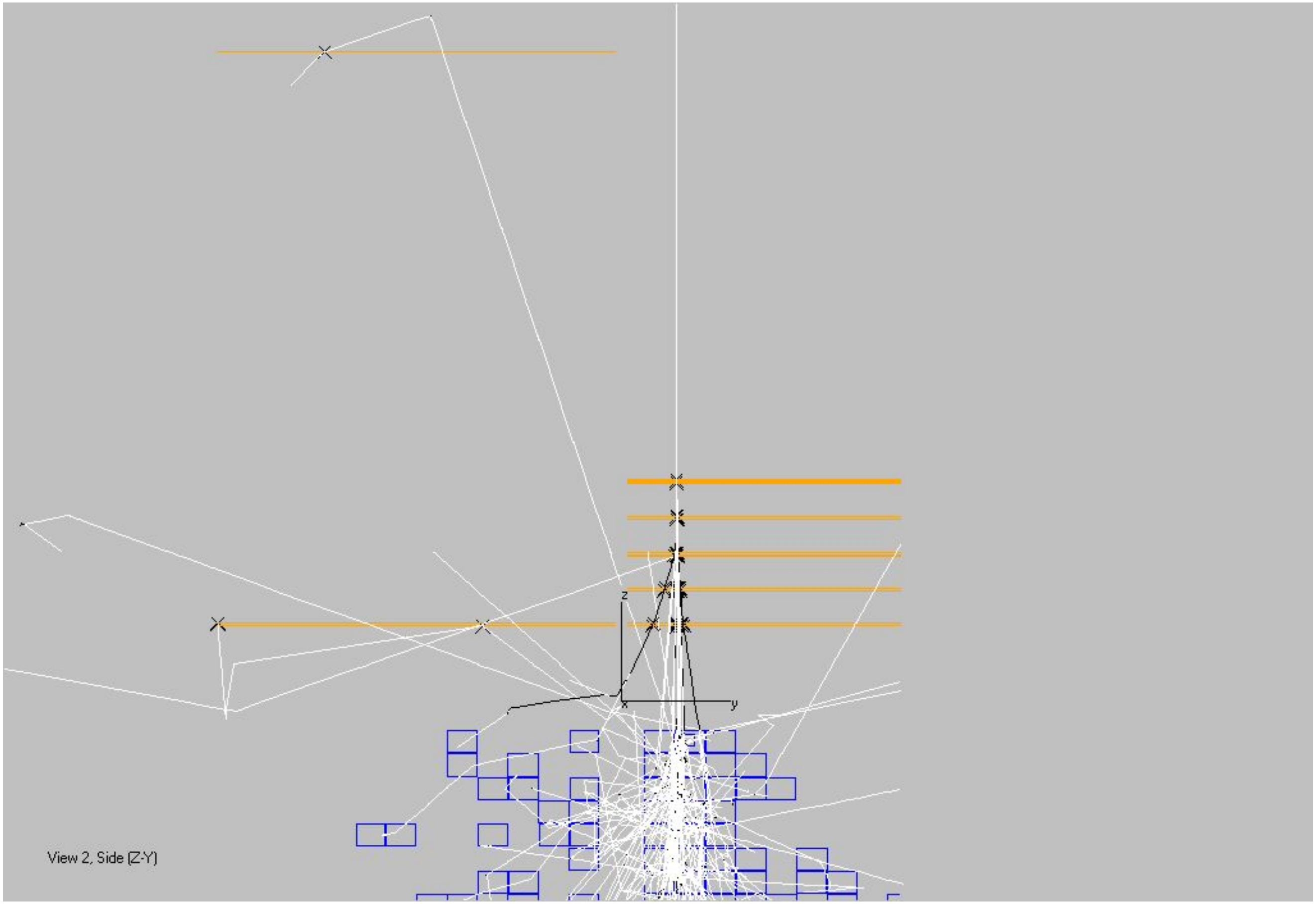
User guide

The user of G4Generator can set the following properties in the `jobObtions.txt` file

- `source_name` to set the source in the `FluxSvc`. This will be obsolete in the new design; this property will belong to the `FluxAlg`
- `UIcommands` to set an array of ***Geant4*** commands to pass to the `RunManager`; these can be used to activate verbosity, trajectories storing or other G4 relevant activities.
- `geometryMode` to set the level of details of the geometry from the xml files. For the range of possible values see the `xmlGeoDbs` package



View 2, Side (Z-Y)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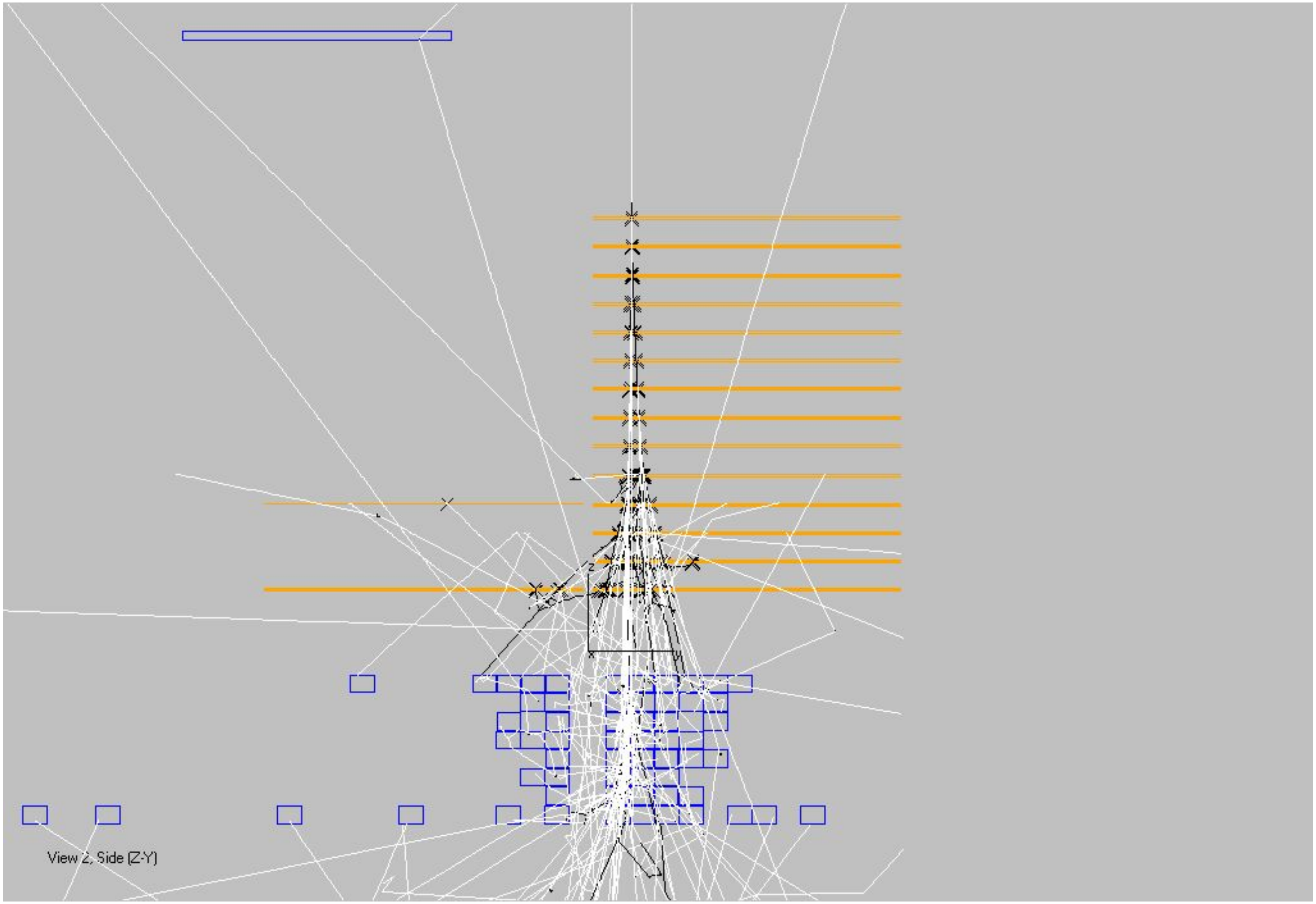
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Conclusions

- So it is possible to run ***Geant4*** simulations from Gaudi (yippee)
- It seems also to be possible to do it in a well integrated way with other ***GLAST*** specific packages (**FluxSvc**, **GuiSvc**, **GlastEvent**, **xmlGeoDbs** and **detModel**) and the **TDS**
- Although some more iterations are needed (see next slides on status) `G4Generator` seems to be now usable
- The ***Geant4*** toolkit is now quite stable and it should be not a big issue to step to new versions (but the use of a customized `RunManager` means careful evaluation)
- Last words will come from the users of `G4Generator`: is it usable? Stable? Easy? Fast enough? Fun?