

# Geant 4

*Fast Simulation*

A shortcut to the tracking

*Author: Marc Verderi*

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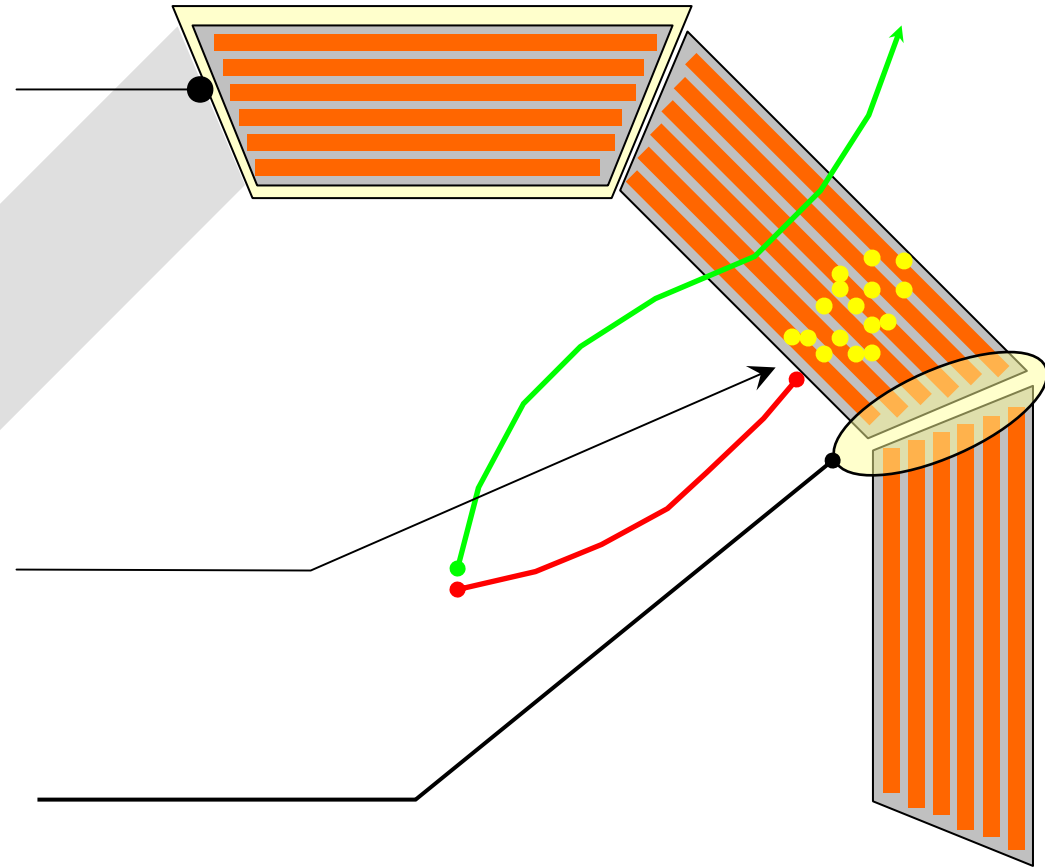
# I. Introduction

# Generalities

- ❑ Fast Simulation, also called parameterisation, is a shortcut to the tracking.
- ❑ Fast Simulation allows you to take over the tracking to implement your own fast physics and detector response.
- ❑ The classical use case of fast simulation is the shower parameterisation where the typical several thousand steps per GeV computed by the tracking are replaced by a few ten of deposits per GeV.
- ❑ Parameterisations are generally experiment dependent.

# Parameterisation features

- ❑ Parameterisations take place in an envelope. This is typically the mother volume of a sub-system or of a large module of such a sub-system.
- ❑ Parameterisations are often particle type dependent and/or may apply only to some.
- ❑ They are often not applied in complicated regions.



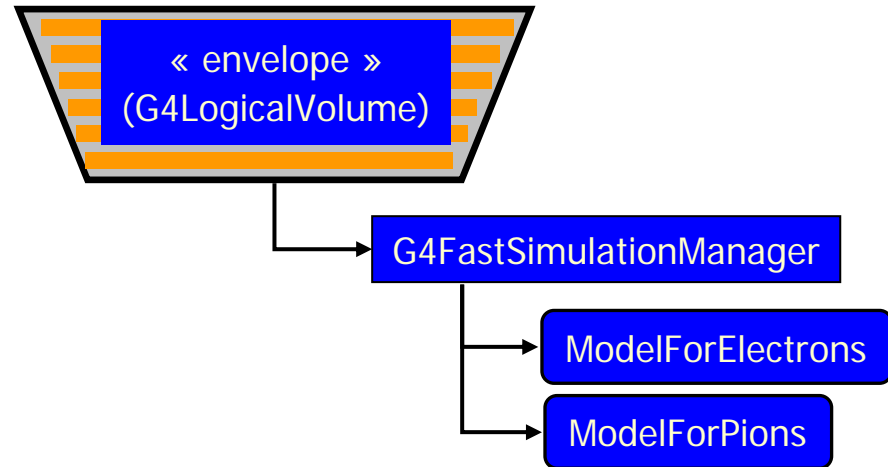
## II. Fast Simulation Components of GEANT4

# G4VFastSimulationModel

- ❑ This is the base class allowing to implement concrete parameterisation models.
- ❑ It has three pure virtual methods to be overridden :
  - G4bool IsApplicable(const G4ParticleDefinition \*)
    - Which specify for which particles the model is valid
  - G4bool ModelTrigger(const G4FastTrack &)
    - Which allow to decide or not to trigger the model at the current point, in order to avoid to trigger in a « complicated region ».
  - void DoIt(const G4FastTrack &, G4FastStep &)
    - Which is the parameterisation properly said, invoked when the model has triggered.
- ❑ The G4FastTrack provides input informations to the model (G4Track, envelope informations, ...).
- ❑ The G4FastStep allows to return back to the tracking the state of the G4Track after parameterisation (alive/killed, position, ...) and what are the eventual secondaries created.

# Binding concrete models to an envelope

- ❑ Concrete models are bound to the envelope through a G4FastSimulationManager object.
- ❑ This allows several models to be bound to a same envelope.
- ❑ The « envelope » is simply a G4LogicalVolume which has received a G4FastSimulationManager.
- ❑ All its [grand[...]]daughters will be sensitive to the parameterisations.



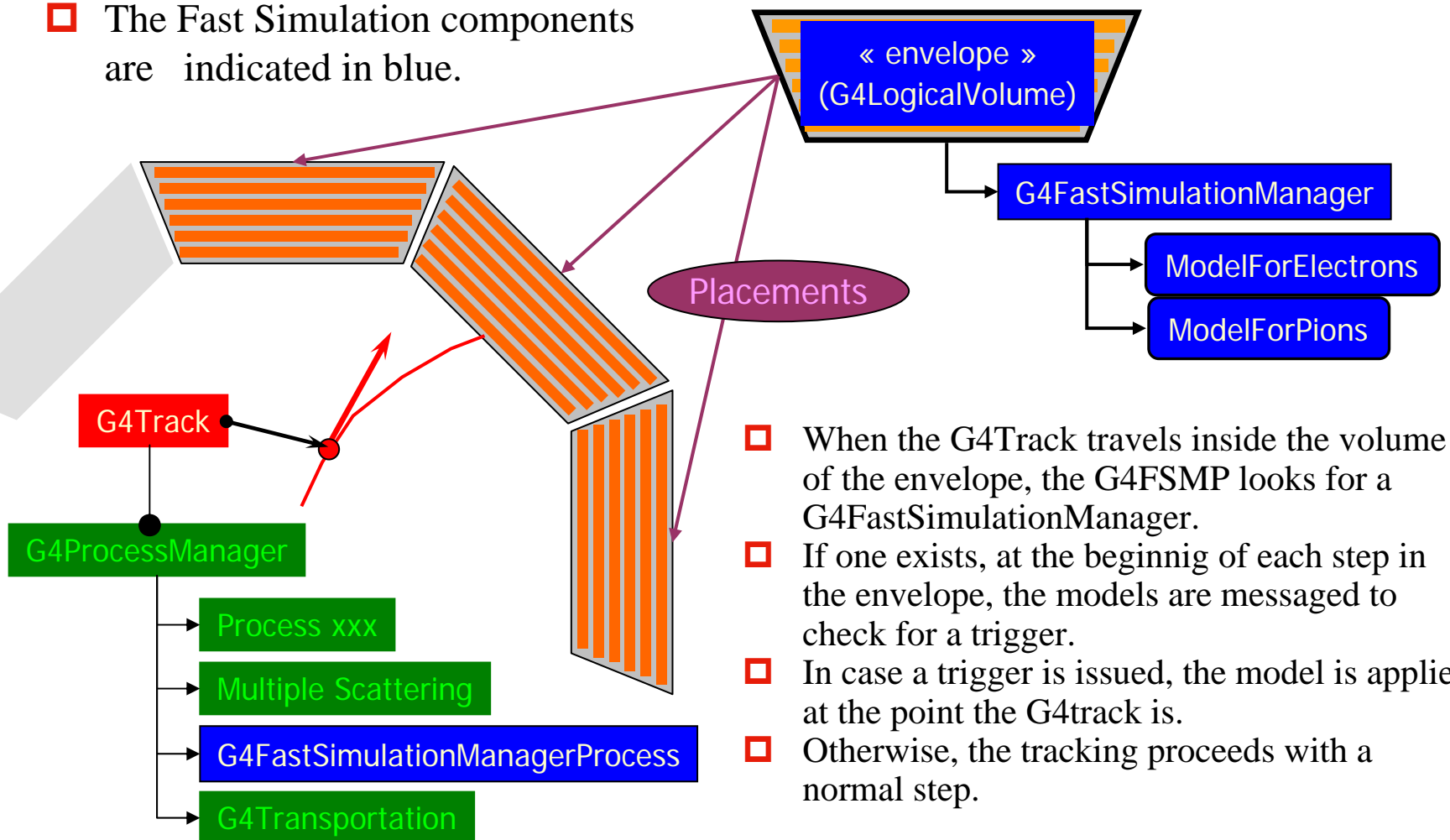


# G4FastSimulationManagerProcess

- ❑ The G4FastSimulationManagerProcess is a process providing the interface between the tracking and the fast simulation.
- ❑ It has to be set to the particles to be parameterised:
  - The process ordering is the following:
    - [n-3] ...
    - [n-2] Multiple Scattering
    - [n-1] G4FastSimulationManagerProcess
    - [ n ] G4Transportation
  - It can be set as a discrete process or it must be set as a continuous & discrete process if using ghost volumes (treated later on in this unit).

# Summary Picture of Fast Simulation Mechanism

- The Fast Simulation components are indicated in blue.



- When the G4Track travels inside the volume of the envelope, the G4FSMP looks for a G4FastSimulationManager.
- If one exists, at the beginning of each step in the envelope, the models are messaged to check for a trigger.
- In case a trigger is issued, the model is applied at the point the G4track is.
- Otherwise, the tracking proceeds with a normal step.

# III. Fast Simulation using Ghost Volumes

# Ghost Volumes (1)

- ❑ Ghost volumes allow to define envelopes independently of the volumes of the tracking geometry.
- ❑ This allows to group together the electromagnetic and hadronic calorimeters for pion parameterisation for example or to define envelopes for geometries coming out of a CAD system which don't have a hierarchical structure.
- ❑ In addition Ghost volumes are sensitive to particle flavor, allowing to define in a completely independent way envelopes for electrons, envelopes for pion etc...

# Ghost Volumes (2)

- ❑ Ghost Volumes of a given particle flavour are placed in a clone of the world volume for tracking.
- ❑ This is done automatically by a singleton class: the `G4GlobalFastSimulationManager`.
- ❑ The `G4FastSimulationManagerProcess` provides the additional navigation inside this « parallel » geometry.
- ❑ This navigation is done transparently to the user.
- ❑ As before, when a parameterisation model attached to a ghost volume issues a trigger, the parameterisation is applied, taking over the tracking.

## IV. Example

- Example of use of Fast Simulation can be found in [example/novice/N05](#)
- This includes examples with non-ghost and ghost envelopes