Stack management

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Geant4 Tutorial Course

Track stacks in Geant4

- By default, Geant4 has three track stacks.
  - "Urgent", "Waiting" and "PostponeToNextEvent"
  - Each stack is a simple "last-in-first-out" stack.
  - User can arbitrarily increase the number of stacks.
- ClassifyNewTrack() method of UserStackingAction decides which stack each newly storing track to be stacked (or to be killed).
  - By default, all tracks go to Urgent stack.
- A Track is popped up only from Urgent stack.
- Once Urgent stack becomes empty, all tracks in Waiting stack are transferred to Urgent stack.
  - And NewStage() method of UsetStackingAction is invoked.
- Utilizing more than one stacks, user can control the priorities of processing tracks without paying the overhead of "scanning the highest priority track".
  - Proper selection/abortion of tracks/events with well designed stack management provides significant efficiency increase of the entire simulation.

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G4UserStackingAction

- User has to implement three methods.
- G4ClassificationOfNewTrack ClassifyNewTrack(const G4Track*)
  - Invoked every time a new track is pushed to G4StackManager.
  - Classification
    - fUrgent - pushed into Urgent stack
    - fWaiting - pushed into Waiting stack
    - fPostpone - pushed into PostponeToNextEvent stack
    - fKill - killed
- void NewStage()
  - Invoked when Urgent stack becomes empty and all tracks in Waiting stack are transferred to Urgent stack.
  - All tracks which have been transferred from Waiting stack to Urgent stack can be reclassified by invoking stackManager->ReClassify()
- void PrepareNewEvent()
  - Invoked at the beginning of each event for resetting the classification scheme.

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Tips of stacking manipulations

- Classify all secondaries as fWaiting until Reclassify() method is invoked.

  - You can simulate all primaries before any secondaries.

- Classify secondary tracks below a certain energy as fWaiting until Reclassify() method is invoked.

  - You can roughly simulate the event before being bothered by low energy EM showers.

- Suspend a track on its fly. Then this track and all of already generated secondaries are pushed to the stack.

  - Given a stack is "last-in-first-out", secondaries are popped out prior to the original suspended track.

  - Quite effective for Cherenkov lights

- Suspend all tracks that are leaving from a region, and classify these suspended tracks as fWaiting until Reclassify() method is invoked.

  - You can simulate all tracks in this region prior to other regions.

  - Note that some back splash tracks may come back into this region later.

Set the track status

- In UserSteppingAction, user can change the status of a track.

```cpp
void MySteppingAction::UserSteppingAction
                            (const G4Step * theStep)
{
  G4Track* theTrack = theStep->GetTrack();
  if(…) theTrack->SetTrackStatus(fSuspend);
}
```

- If a track is killed in UserSteppingAction, physics quantities of the track (energy, charge, etc.) are not conserved but completely lost.
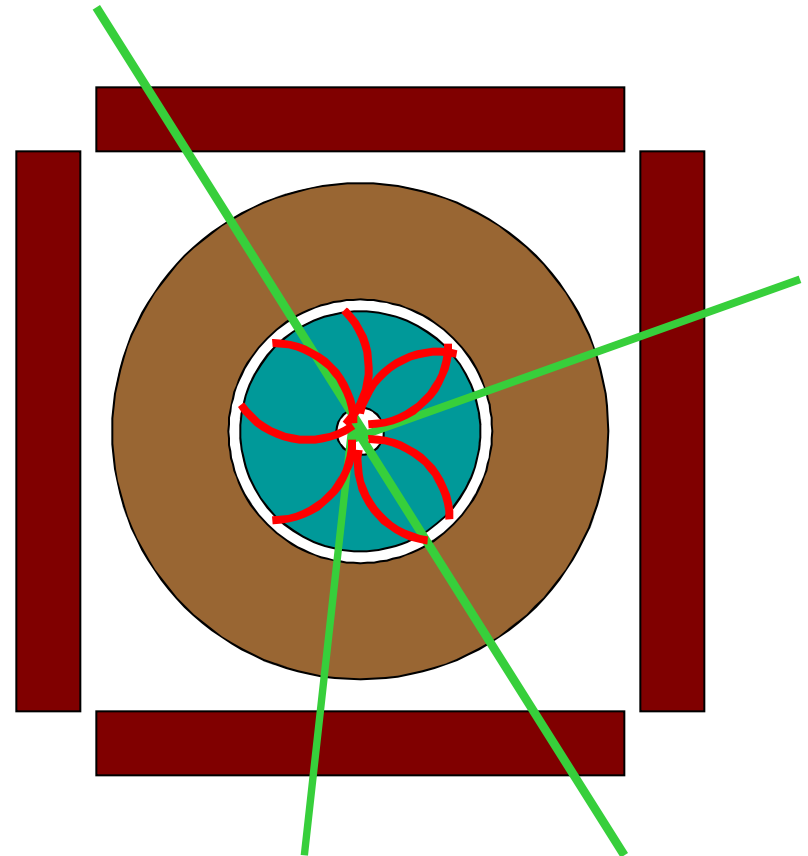
ExN04StackingAction

- ExampleN04 has simplified collider detector geometry and event samples of Higgs decays into four muons.

- Stage 0

  - Only primary muons are pushed into Urgent stack and all other primaries and secondaries are pushed into Waiting stack.

  - All of four muons are tracked without being bothered by EM showers caused by delta-rays.

  - Once Urgent stack becomes empty (i.e. end of stage 0), number of hits in muon counters are examined.

  - Proceed to next stage only if sufficient number of muons passed through muon counters. Otherwise the event is aborted.
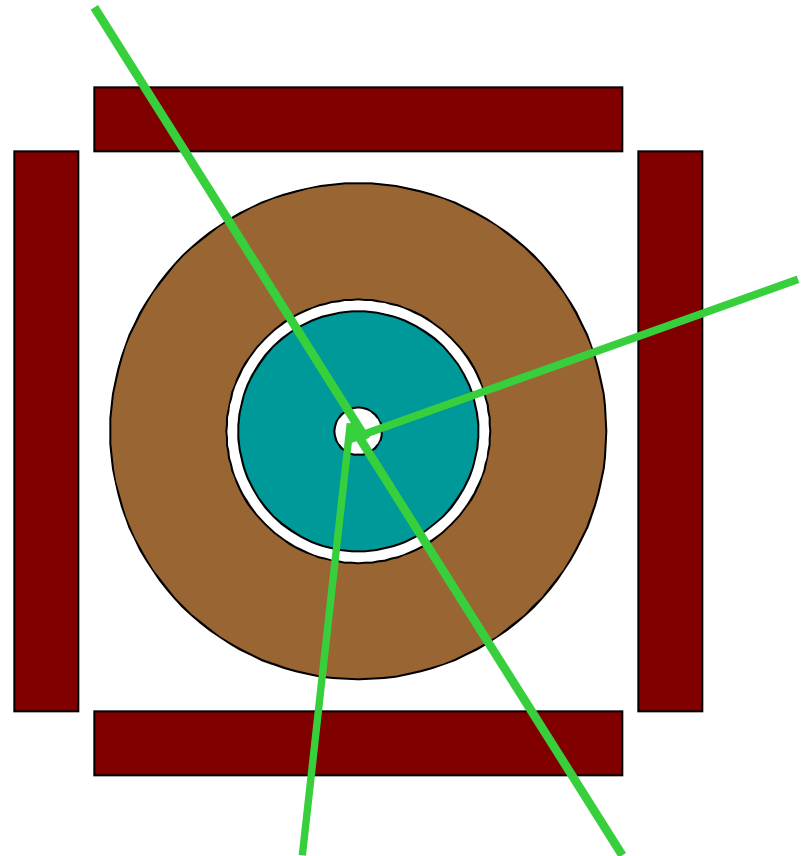
ExN04StackingAction

- Stage 1

  - Only primary charged particles are pushed into Urgent stack and all other primaries and secondaries are pushed into Waiting stack.

  - All of primary charged particles are tracked until they reach to the surface of calorimeter. Tracks reached to the calorimeter surface are suspended and pushed back to Waiting stack.

  - All charged primaries are tracked in the tracking region without being bothered by the showers in calorimeter.

  - At the end of stage 1, isolation of muon tracks is examined.

ExN04StackingAction

- Stage 2

    - Only tracks in "region of interest" are pushed into Urgent stack and all other tracks are killed.

    - Showers are calculated only inside of "region of interest".