Use of Geant4 in experiment interactive frameworks

AliRoot

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Outline

- AliRoot architecture
- Virtual Monte Carlo
- Interactivity
- Present status of AliRoot
AliRoot Architecture

- **AliRoot Framework**
  - Based on ROOT
  - User code in C++
  - Usage of FORTRAN libraries
    - Geant3, event generators, “microcernlib”

- Integrates simulation, reconstruction and analysis ALICE software

- Each detector subsystem has one single package (one directory, one library)
AliRoot

Detectors:
- ITS
- TPC
- MUON
- PHOS
- PMD
- RICH
- FMD
- TOF
- TRD
- START
- ZDC

STEER:
- run management interface classes
- detector base classes
- data structure base classes

EVGEN:
- PYTHIA6
- HIJING
- ...

VMC

ROOT

External packages:

Geant4 VMC
Geant3 VMC

Geant4

Geant3
Virtual Monte Carlo

- Provides interface to Monte Carlo programs
- Decouples dependence of a user code on a concrete MC
  - Ensures to run the same user application with all supported Monte Carlo programs
- Implementation for 2 MCs available:
  - Geant3, Geant4
  - ALICE effort is now concentrated on Fluka
Virtual Monte Carlo Interfaces (1)

- **TVirtualMC**
  - Interface to Monte Carlo program
  - Generalization of Geant3 functions for definition of simulation task
    - Provides methods for definition geometry and physics setup, for access to tracked particle properties during stepping, visualization
  - Implementations: TGeant3, TGeant4
    - Are provided to a user
Virtual Monte Carlo Interfaces (2)

- **TVirtualMCApplication**
  - Interface to a user application
  - Implementation has to be done by a user
  - **Methods:**
    - ConstructGeometry()
    - InitGeometry()
    - GeneratePrimaries()
    - BeginEvent()
    - BeginPrimary()
    - PreTrack()
    - Stepping()
    - …
    - FinishEvent()
Virtual Monte Carlo

TVirtualMC Application

UserMCAplication

Concrete MC application address to MC only through the interface

TVirtualMC

TGeant4

Concrete MCs address to user MC application only through the interfaces

TGeant3
// ________________________________
void Ex01MCApplication::Construct Geometry()
{
    //------------------------------- experimental hall (world)
    Double_t expHall[3];
    expHall[0] = 300.;
    expHall[1] = 100.;
    expHall[2] = 100.;
    gMC->Gsvolu("EXPH","BOX", fImedAr, expHall, 3);

    //------------------------------- a tracker tube
    Double_t trackerTube[3];
    trackerTube[0] = 0.;
    trackerTube[1] = 60.;
    trackerTube[2] = 50.;
    gMC->Gsvolu("TRTU","TUBE", fImedAl, trackerTube, 3);

    Double_t posX = -100.;
    Double_t posY = 0.;
    Double_t posZ = 0.;
    gMC->Gspos("TRTU", 1,"EXPH",
                posX, posY, posZ, 0, "ONLY");

    // … etc
}

Run With Virtual MC

- Concrete Monte Carlo is selected and loaded dynamically at run time

- Steps:
  - aliroot
    - The main program creates the application object gAlice
  - root [0] gAlice->Init("g4Config.C");
    - Application is initialized with G4 configuration file that instantiates G4 VMC and Geant4
  - root [1] gAlice->Run();
    - Simulation run with Geant4
**Geant4 VMC Limitations**

- **Geant4 VMC (geometry part) is based on G3toG4**
  - G3toG4 limitations (reflections, MANY) have been minimized with Geant4 4.0
  - Limited support for “MANY” volumes positions
    - Overlapping volumes have to be specified explicitly (via G4Gsbool function)

- **A few more minor limitations**
  - None of them a real obstacle for using the VMC
Interactivity (UI)

- AliRoot UI = Root UI
- Root provides access to all objects which have been processed by CINT:
  - root [0] MyObject myObject;
  - root [0] myObject.MyFunction ();
- Geant4 classes are not processed by CINT
  - G4 objects are not accessible from AliRoot UI
- Switching between Root UI and Geant4 UI is available
Interactivity (UI)

- **Switch UI**
  - `root [0] geant4->StartGeantUI();`
  - `Idle> /mcControl/root`

- **Execute a macro**
  - `root [0] geant4->ProcessGeantMacro("myMacro.mac");`
  - `Idle> /mcControl/rootMacro myMacro`

- **Execute a command**
  - `root [0] geant4->ProcessGeantCommand("/tracking/verbose 1");`
  - `Idle> /mcControl/rootCmd TBrowser b;`
Present Status Of AliRoot Hits Production

• The ALICE background event
  - HIJING parameterization event generator
  - 5000 primary particles (5.8 % of full background event)
  - Modular physics list according to the physics list in G4 example N04 (electromagnetic and hadronic physics)
  - Included 11 detectors and all structures
    • ITS coarse geometry (due not resolved MANY)
  - The kinetic energy cuts equivalent to those in G3 were applied in G4 using a special process and user limits objects
  - Standard AliRoot magnetic field 0.2 Tesla

• Finished successfully
  - Protection against looping particles
Present Status Of AliRoot
Hits Production

- Hits for 9 (from 11) detectors
  - Missing:
    - ITS (coarse version does not produce hits)
    - RICH (requires adding own particles to the stack - not yet investigated)
- Comparisons of hits x, z distribution
- No detailed analysis
  - Need to involve detector developers
Summary

- **AliRoot simulation is based on VMC**
  - The same user code for Geant3 and Geant4 MC
  - PPR Production with Geant3
- **VMC has been defined as generalization of Geant3 functions**
  - Geant4 VMC - G3toG4 limitations
- **5000 primaries event**
  - Finishes with a success
  - Missing hits from two detectors (ITS, RICH)
- **No detailed analysis of simulated data**
  - Low interest of ALICE collaboration in Geant4
- **Effort concentrated on Fluka VMC**