Virtual Monte Carlo

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http://root.cern.ch/root/vmc/VirtualMC.html

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Outline

- Introduction
- Packages
- Interfaces
- Available MCs
- Examples
- Distribution
- Future

Introduction

- The concept of Virtual Monte Carlo has been gradually developed by the ALICE Software project
- Class TGeant3 providing access to GEANT3 data structures (commons) and functions
  - Enabled to move user code from FORTRAN to C++
- Interface to MC as generalization of TGeant3
  - Started development for Geant4
  - However the implementations of MC interface depend on the ALICE software
- Interfaces to a user MC application
  - Enabled to remove the dependence on the ALICE software

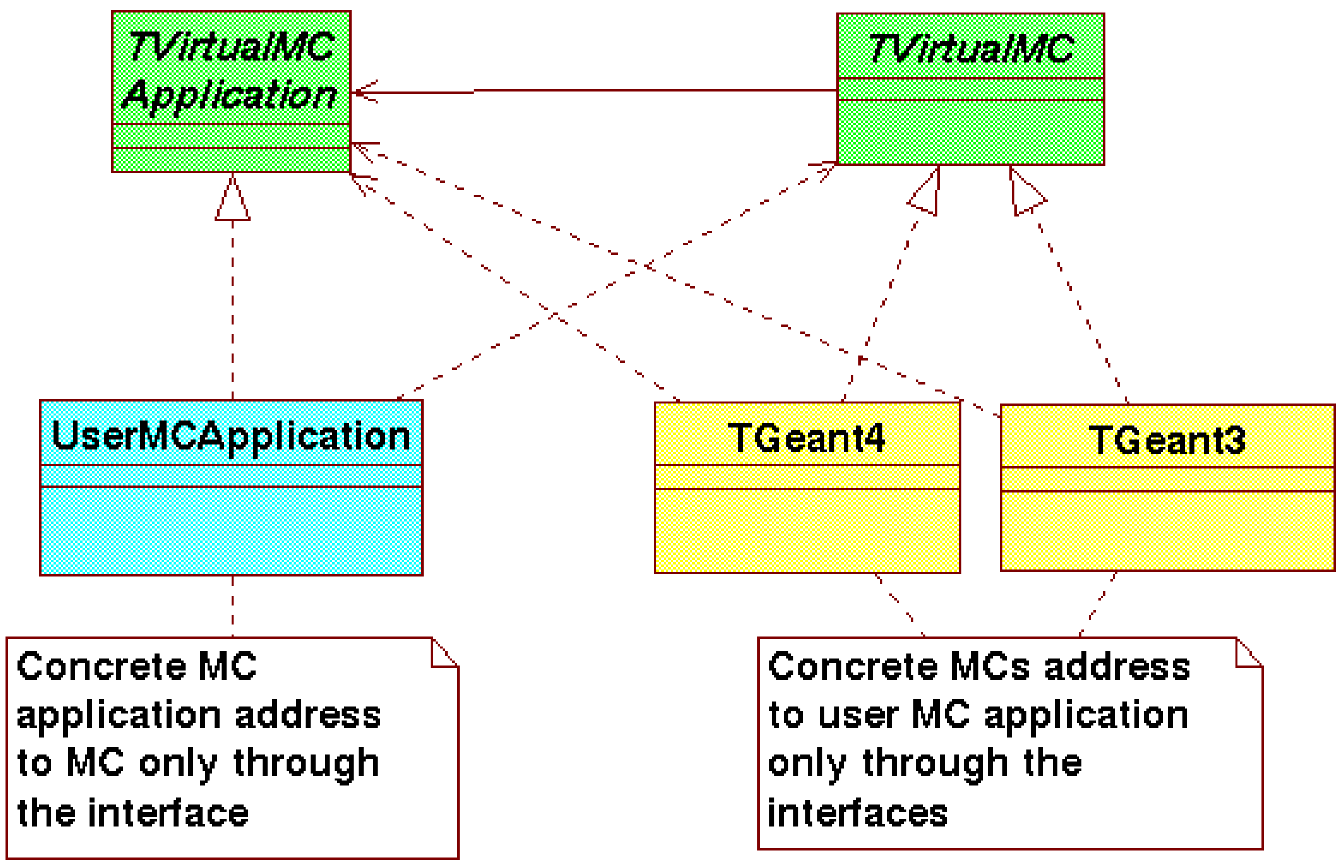
Packages

- MC
  - The core package; provided within Root
  - Directory: root/mc; Library: libMC.so
  - Interfaces
- Geant321 + VMC
- Geant4 VMC
- Examples
  - Provided within Geant4 VMC

Interfaces

- Why interfaces?
- To decouple the dependence of a user code on a concrete MC
  - Enable to run the same user application with all supported Monte Carlo programs
- Authors:
  - R.Brun, F.Carminati, I. Hrivnacova, A. Morsch

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 MC

- Methods For Building & Accessing Geometry
- Methods For Building & Accessing Materials
- Methods For Setting Physics
- Methods For Accessing Tracked Particle During Stepping
- Methods For Drawing
- Methods For Run Control

Interfaces (2)

- TVirtualMCApplication
  - Interface to a user application
  - Mandatory
  - Implementation has to be done by a user

Virtual MC Application

ConstructGeometry
InitGeometry
GeneratePrimaries

BeginEvent
BeginPrimary
PreTrack
Stepping
PostTrack
FinishPrimary
FinishEvent

Interfaces (3)

- TVirtualMCStack
  - Interface to a user defined particles stack
  - Mandatory
  - User can use the concrete stack classes provided in the examples or implement his own stack class

Virtual MC Stack

SetTrack
GetNextTrack : TParticle*
GetPrimaryForTracking
: TParticle*

SetCurrentTrack
GetNTrack
GetNPrimary
CurrentTrack

Interfaces (4)

- TVirtualMCDecayer
  - Interface to an external decayer
  - Eg. Pythia6
  - Not mandatory

Virtual MC Decayer

Init
Decay
ImportParticles

SetForceDecay
ForceDecay
GetPartialBranchingRatio
GetLifetime
ReadDecayTable

Available MCs

- Implementation for 2 MCs available:
  - Geant3, Geant4
  - Implementation for Fluka is in development by the ALICE collaboration

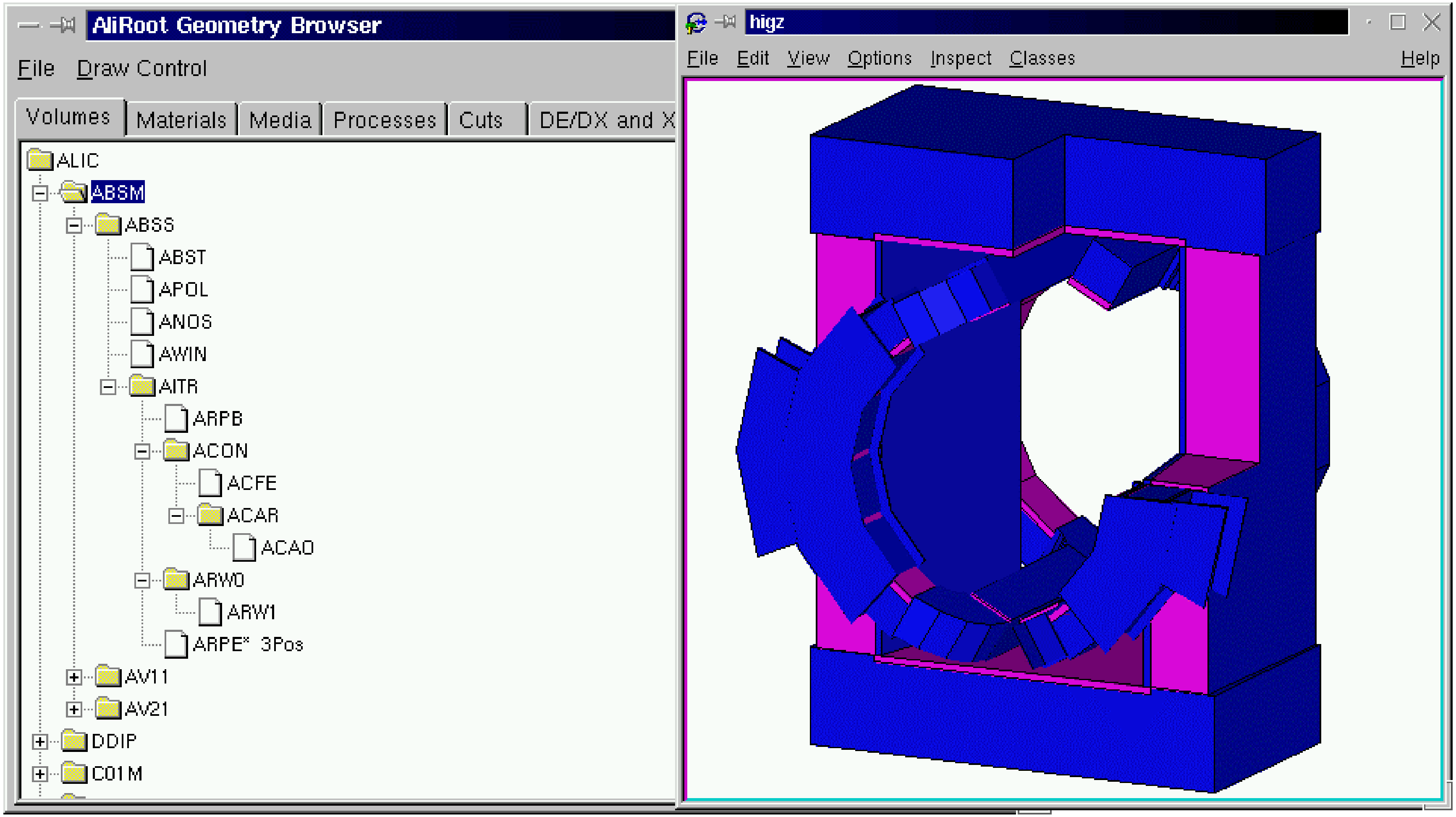
Available MCs

Geant3 VMC

- Provided within a single package together with Geant321 (Fortran)
- File structure
  - geant321/*, TGeant3, minicern – source code
  - Makefile
  - config – platform dependent makefiles
  - lib – created at compilation time
- Geant3 Geometry Browser
  - Provided within TGeant3
  - http://alisoft.cern.ch/ people/morsch/Geant3GUI.html
- Authors:
  - R.Brun, F.Carminati, A. Morsch

Geant3 VMC

Geant3 Geometry Browser



Available MCs

Geant4 VMC (1)

- Provided within a package **geant4_vmc**
  - Requires Geant4 installation
- File structure
  - README, history, source, config
  - lib, tmp – created at compilation time
  - examples – not dependent on Geant4
- Access to Geant4
  - Geant4 classes are not processed by CINT – G4 objects are not accessible from Root UI
  - Switching between Root UI and Geant4 UI is available

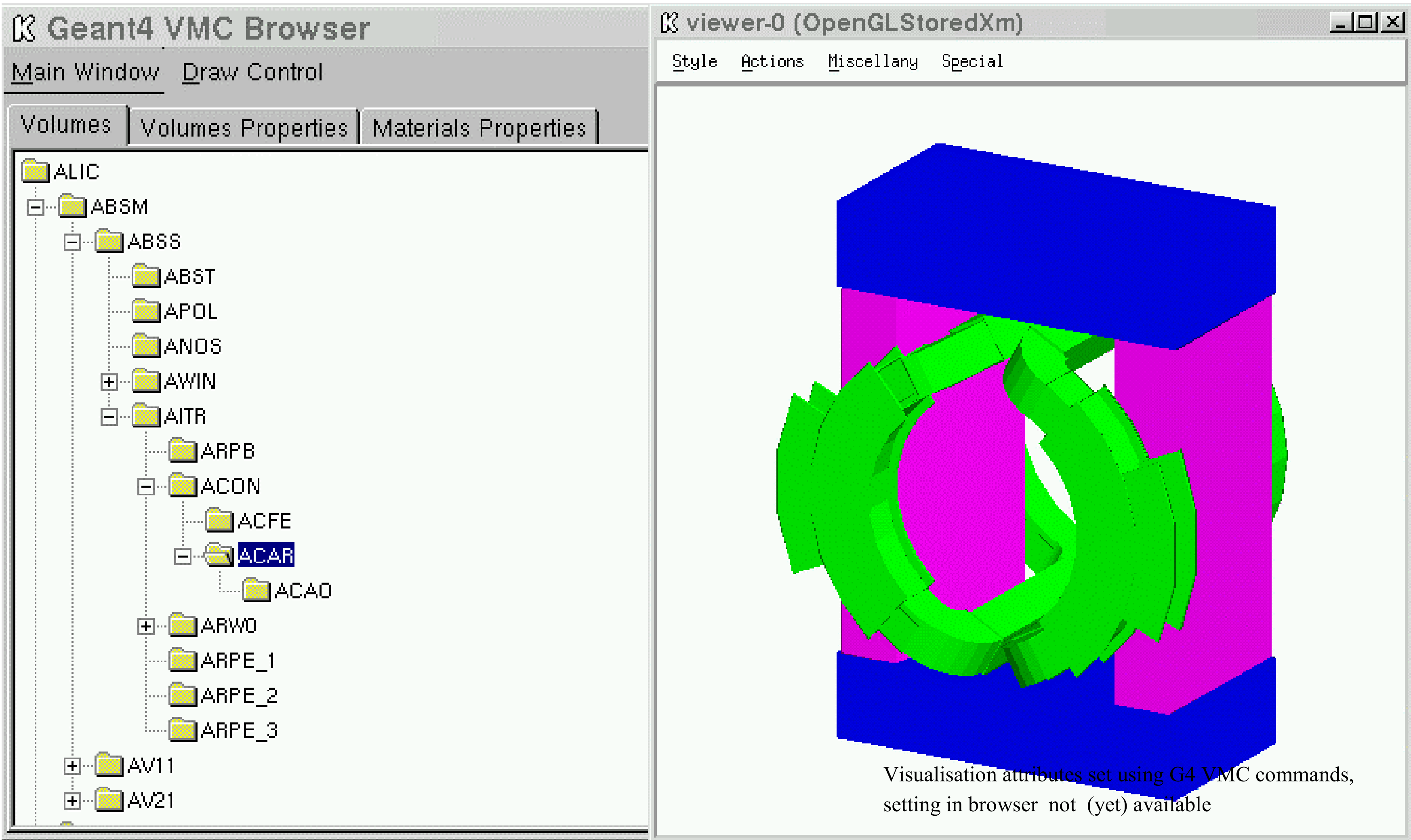
Available MCs

Geant4 VMC (2)

- Geant4 VMC extensions:
  - Geant4 VMC Geometry Browser
    - Analogy to Geant3 Geometry browser
  - Geometry XML Convertor
    - Enables to export Geant4 geometry to XML and then to browse and visualize using GraXML
      - GraXML = Tool for handling HEP experiment Detector Description & Event data in Java 3D (developed for Atlas by J. Hrivnac)
- Authors:
  - D. Adamova, V. Berejnoi, A. Gheata, I. Hrivnacova

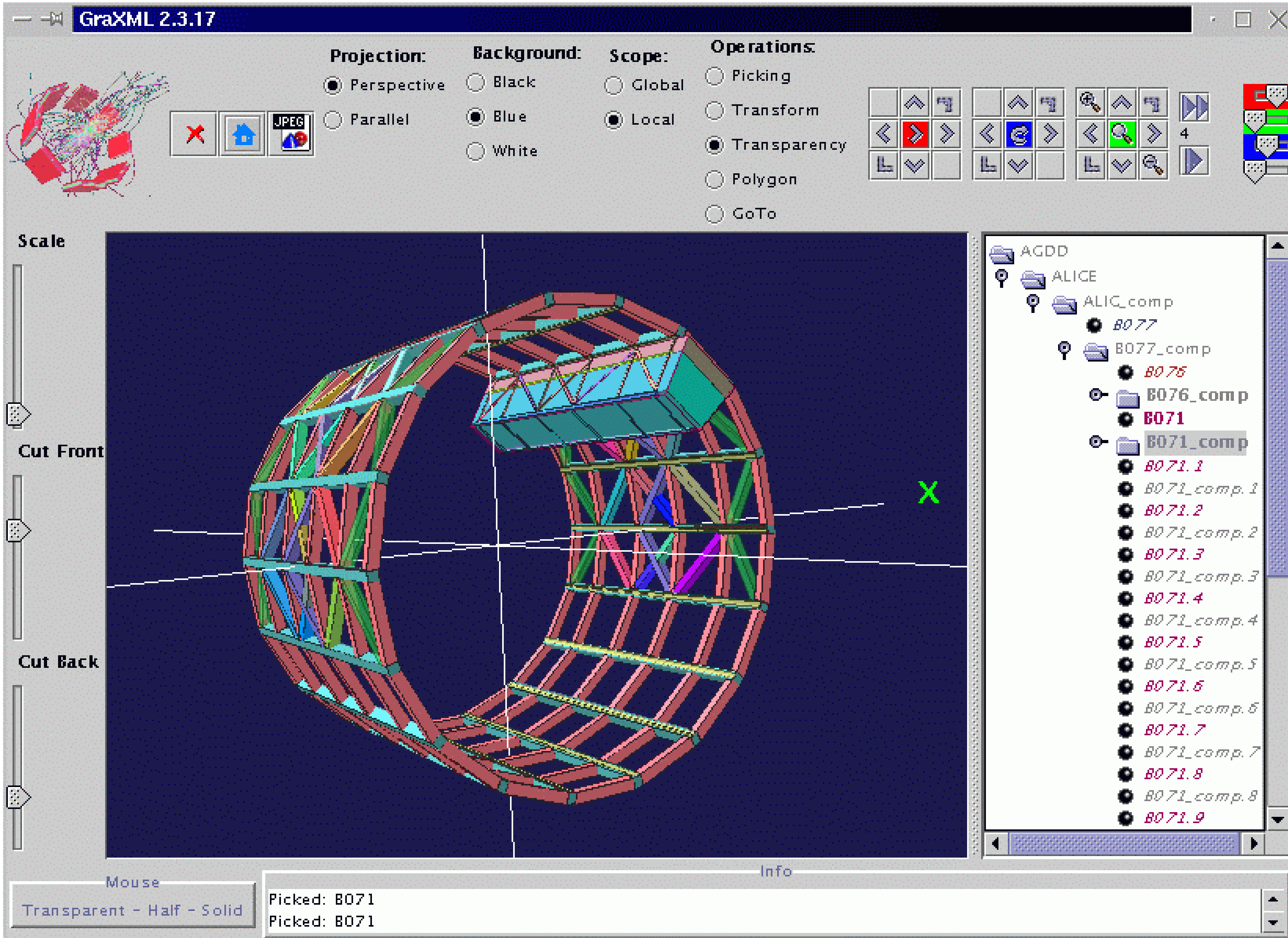
Geant4 VMC

Geant4 Geometry Browser



Visualisation attributes set using G4 VMC commands, setting in browser not (yet) available

Geant4 VMC - Geant4 Geometry in GraXML



Geant4 VMC

Limitations

- TVirtualMC has been inspired by Geant3
  - lead to certain difficulties and left Geant4 VMC with some limitations
- Geant4 VMC geometry is based on G3toG4 tool
  - G3toG4 limitations
  - They have been minimized with Geant4 4.0:
    - Support for reflections
    - Limited support for "MANY" volumes positions
- A few more minor limitations
  - None of them a real obstacle for using the VMC
  - More details can be found on VMC web page

Examples

- 2 examples provided in geant4_vmc
  - In spite of being provided within Geant4 VMC, they are built independently and do not require Geant4 installation in case a user wants to run them with Geant3 only
- Geant4 novice examples N01 and N02 rewritten with usage of Virtual Monte Carlo
- Implement MC Application and MC Stack
- Both examples are executed in the same way:
  - cd geant4_vmc/examples/E01 or E02
  - root
  - root[0] .x run_g3.C or run_g4.C

Examples
E01

- Rewritten Geant4 novice example N01
- Builds simple geometry, tracks geantino and prints info at each step
- Classes:
  - Ex01MCApplication, Ex01MCStack, Ex01Particle

```
// … skipped
//___________________________________________
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
}
```

E01

run_g3.C

run_g4.C

```
{
  // Load basic libraries
  gROOT->LoadMacro("../macro/basiclibs.C");
  basiclibs();

// Load Geant3 libraries
 gROOT->LoadMacro("../macro/g3libs.C");
 g3libs();

// Load Geant4 libraries
 gROOT->LoadMacro("../macro/g4libs.C");
 g4libs();

  // Load this example library
  gSystem->Load("libexample01");

  // MC application
  Ex01MCApplication* appl
    = new Ex01MCApplication("Example01", "The example01 MC application");

appl->InitMC("g3Config.C");

appl->InitMC("g4Config.C");

  appl->RunMC(1);
}
```

E01
g3Config.C
g4Config.C

```
void Config()
{
new  TGeant3("C++ Interface to Geant3");
}
```

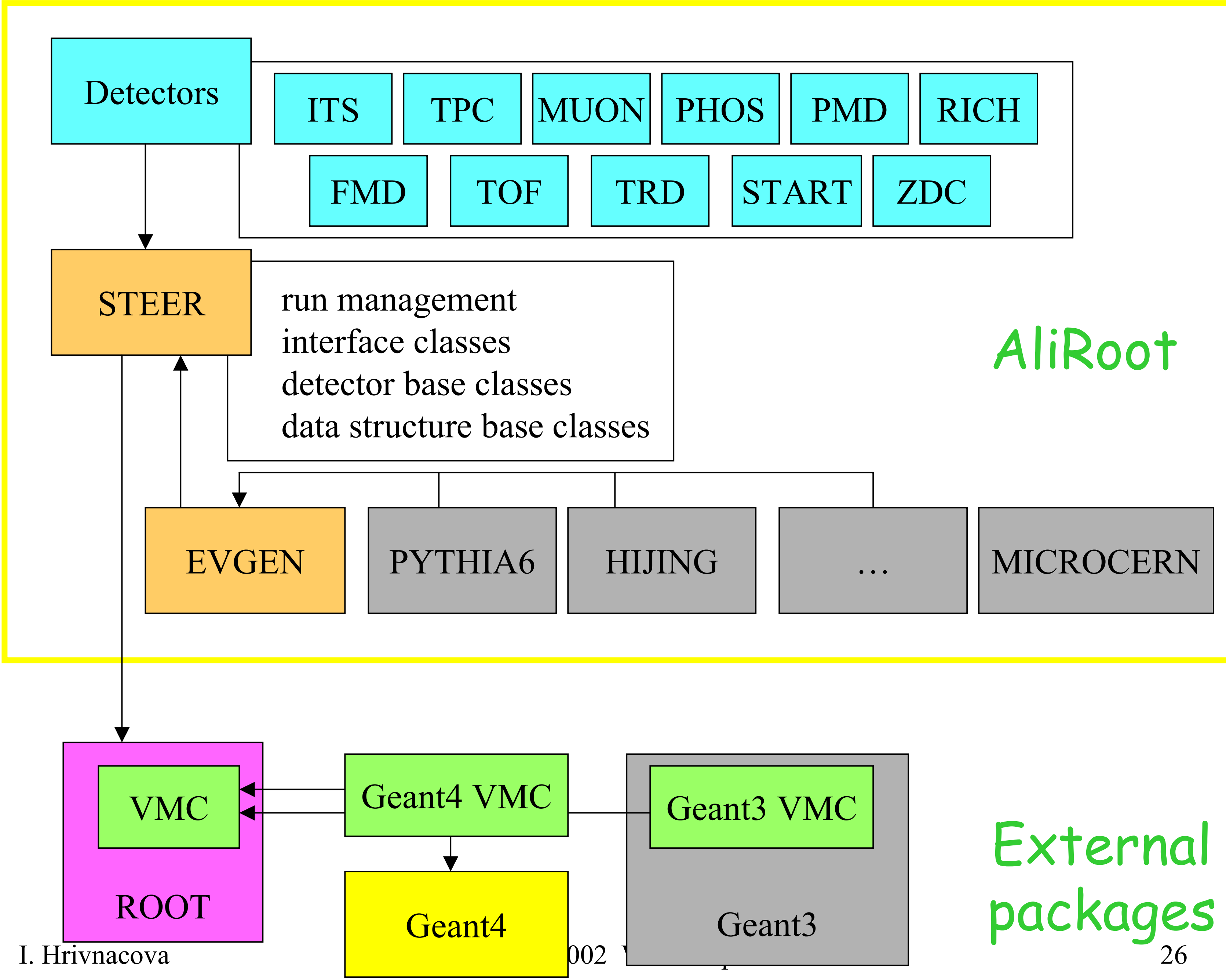
```
void Config()  {

    // RunConfiguration for Geant4
    TG4RunConfiguration* runConfiguration  = new TG4RunConfiguration();

    // TGeant4
    new TGeant4("TGeant4", "The Geant4 Monte Carlo", runConfiguration);
}
```

Examples
E02

- Rewritten Geant4 novice example N02
- Builds parameterised geometry with magnetic field, draws geometry, tracks proton, registers hits in a tracker and saves hits and kinematics in a Root file
  - Persistence only in VMC (not in the Geant4 example)
- Classes:
  - Ex02MCApplication, Ex02MCStack, Ex02Particle, Ex02DetectorConstruction, Ex02ChamberParameterisation, Ex02MagneticField, Ex02TrackerSD, Ex02TrackerHit, Ex02RootManager

Examples
AliRoot

- AliRoot Framework
  - Integrates simulation, reconstruction and analysis ALICE software
- Simulation based on Virtual Monte Carlo
  - A complex "example" of VMC usage
  - Users stay with Geant3
- Each detector subsystem has one single package (one directory, one library)
  - Dependence only on STEER
  - No MC specific code


Detectors
ITS
TPC
MUON
PHOS
PMD
RICH
FMD
TOF
TRD
START
ZDC
STEER
run management
interface classes
detector base classes
data structure base classes
AliRoot
EVGEN
PYTHIA6
HIJING
…
MICROCERN
VMC
ROOT
Geant4 VMC
Geant4
Geant3 VMC
Geant3
External packages

Examples

AliRoot 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("Config.C"); G3 simulation
  - root [0] gAlice->Init("g4Config.C"); G4 simulation
    - Application is initialized with either G3 or G4 configuration file that instantiates either G3 or G4
  - root [1] gAlice->Run();
    - Simulation run with selected MC

Distribution

- ROOT CVS server
  - mc – in root
  - geant3, geant4_vmc
    - 2 new independent modules (parallel with root):
      - cvs -d :pserver:cvs@root.cern.ch:/user/cvs co geant3
      - cvs -d :pserver:cvs@root.cern.ch:/user/cvs co geant4_vmc
- ROOT Web
  - http://root.cern.ch/root/vmc/VirtualMC.html
  - Distribution of sources:
    - geant321+_vmc.0.1.tar.gz
    - geant4_vmc.0.1.tar.gz

Future

- Fluka VMC
  - In development by ALICE Software Project
  - A. Fasso, E. Futo, I. Gonzalez, F. Carminati, A. Morsch
- TGeo + VMC
  - It is foreseen to enable VMC geometry definition using the new geometrical modeller in Root
  - R.Brun, A. & M. Gheata

Summary

- VMC allows to run different simulation Monte Carlo from the same user code
  - On the menu today: Geant3, Geant4
  - In preparation: Fluka
- The first release of VMC, Geant3+VMC, Geant4 VMC and examples available:
  - http://root.cern.ch/root/vmc/VirtualMC.html