

Recent Geant4 Developments (non-physics)

I.Hrivnacova, IPN Orsay

for Geant4 Collaboration

Geant4 Users and Collaboration Workshop
LNS INFN, Catania,
October 15 - 22 2009

Outline

- Developments in the last year
 - Restricted to geometry and kernel domains
 - Releases 9.2. + patches p01, p02; 9.3.beta and development tags (up to 09-02-ref09)
- Several contributions
 - From collaborators and developers in the users community
 - No explicit mention of authors in this presentation
- Brief look to supported platforms

Geometry & Field

New Features - Geometry

- New **locator classes** and options for transportation in field
 - Identification of the intersection point with a boundary of a charged particle in a field
 - Simple Brent, and Multi level (default) locators
 - Allow the user to investigate tradeoffs between increased accuracy and CPU speed according to the use case
- Refined treatment of **geometrical safety** in G4Navigator
 - Avoid side effects of call to the navigator (by MSC processes and other cases)
- Implementation of generic **divisions** along Z for G4Polyhedra and G4Polycone solids

9.2.[p01]

9.3.beta

Major Fixes – Geometry (1)

- Code revision for **G4Tubs, G4Cons, G4Sphere** 9.2.[p01]
 - Boosted performance up to 20% for phi-sections and up to 7% 9.3.beta in all other configurations in pure tracking
- Fixes in solids
 - **G4Tubs, G4Cons, G4Sphere** - PR #977, #1022
 - **G4Ellipsoid** - PR #1022, #1050, #1076
 - **Faceted specific solids** - PR #1062
 - **Curved solids** - work around for applying of distance splitting for long distances in DistanceToIn(p,v)
 - Fixing issue of precision loss on 64-bits systems
 - **Fixed treatment of surface normal** for rotated cases
 - Affects optical processes

Major Fixes – Geometry (2)

- Fix in [G4PathFinder](#) for treatment of steps at boundary 9.2.p02
 - Relevant for use in parallel geometries (eg. for cavern studies)
- Fixed implementation of TotalVolumeEntities() in [G4LogicalVolume](#) 09-02-ref09
 - Addressing problem report #1082
- Fix in CheckOverlaps() in [G4PVPParameterised](#):
 - Avoid modifying daughter volume transformation matrix
 - Addresses problem report #1078.

New Features – Persistency (1)

- Fully featured **GDML** plugin module 9.2.[p01]
 - Replaces fully the old external GDML module
 - Geometry can be now also exported to a file
 - GDML schema upgraded to support missing solids and parametrization (GDML 3_0_0)
- Implemented virtual layer 9.3.beta
 - Enabled user to customize writer to add own schema(s)
- Implemented ability to write **surface properties** associated to volumes and **material properties**
- Added support for '**assembly**' tag 09-02-ref09
 - Implementing assemblies of simple placements through G4AssemblyVolume
- General code cleanup

New Features – Persistency (2)

- New module for importing detector descriptions in **ASCII** text format
 - Can be used as an alternative to GDML or other persistency techniques

9.2.[p01]

```
// Define a parameter for later use
:P POSZ 5.

// Define materials
:ELEM Hydrogen H 1. 1.
:ELEM Oxygen O 8 16.
:ELEM Nitrogen N 7 14.
:MIXT Air 1.214E-03 2
      Nitrogen 0.75
      Oxygen   0.25

// Define rotation matrix
:ROTM R00 90. 0. 90. 90. 0. 0. // unit matrix

// Define volumes and place them
:VOLU world BOX 30. 30. 30. Air

:VOLU "my tube" TUBS 0. 10. 20. 0. 360. G4_WATER
:PLACE "my tube" 1 world R00 0. 0. $POSZ

:VOLU sphere ORB 5. G4_AIR
:PLACE sphere 1 "my tube" R00 0. 1. 10.
```

Major fixes - GDML

- Fix in G4GDMLMatrix
 - Avoid cases of memory corruption
- Fix for handling of materials and solids tags
 - Allow for definition of quantities in tag scope, foreseen by schema
- Corrected handling of loops for treatment of multiple placements
 - Restricted usage to placements of volumes
- Enhanced treatment of Boolean structures
 - Handling nested structures with displaced solids applied to both operands (ATLAS use case)

9.2.p02

9.3.beta

Kernel

New Features – Materials

- Implemented migration of **ICRU-73 stopping power classes** for materials to the G4VIonDEDXTable interface 9.3.beta
 - New utility class **G4ExtDEDXTable** to handle external electronic stopping power tables for ions
- Improved implementation of **UI commands** in G4NistManager/Messenger and G4NistElementBuilder 09-02-ref09
- Added method **GetNbOfShellElectrons()** in G4Element returning the number of electrons on a shell.

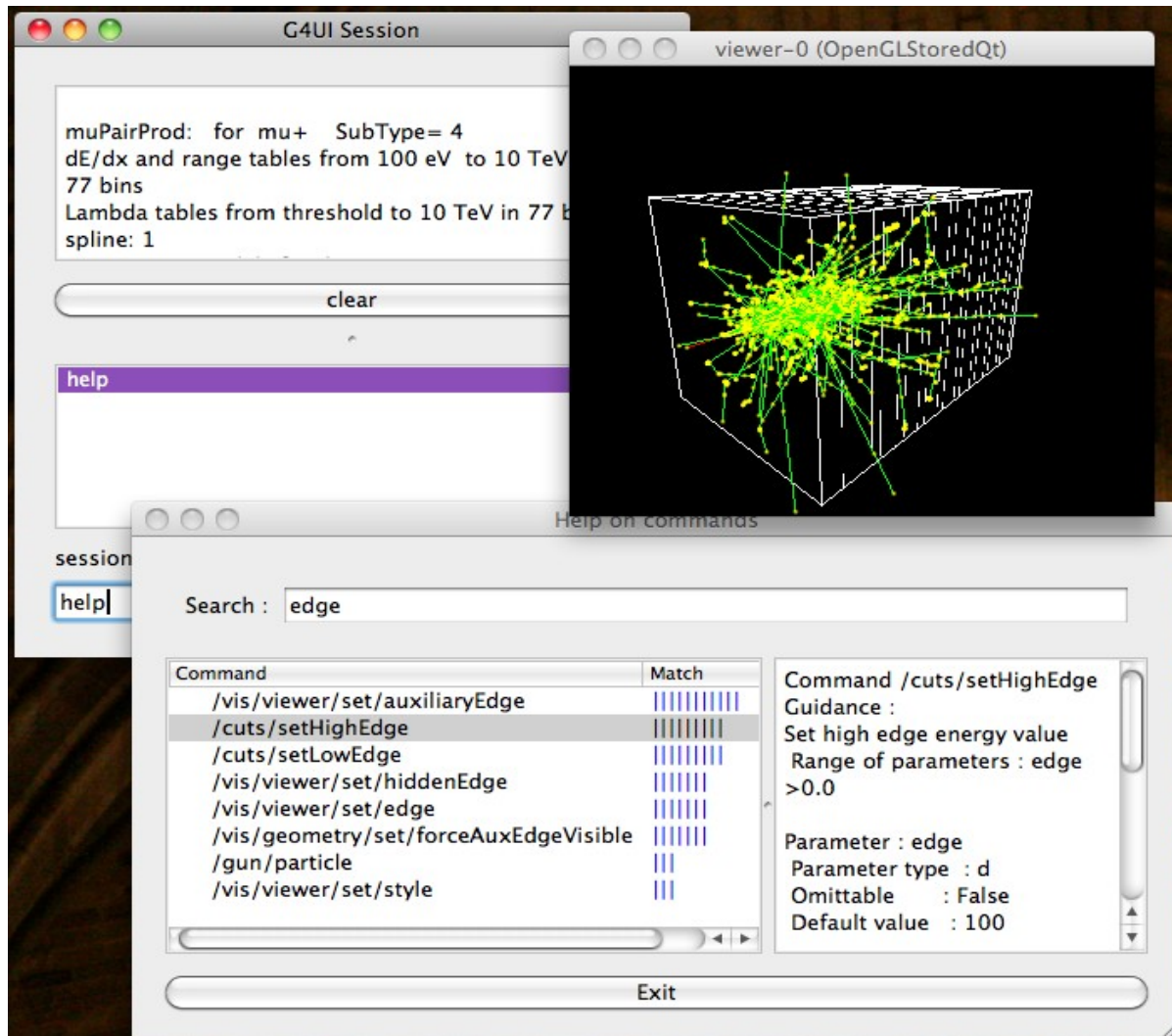
New Features - Particles

- Updated masses and widths of particles to PDG-2008 9.2.[p01]
- Requires new CLHEP version: 2.0.4.2
- Added UI command for setting verbosity level in particle-table
- Removed class **G4NucleiPropertiesTable** as obsolete 09-02-ref08
 - Now using G4NucleiPropertiesTableAME03 instead based on the Ame2003 atomic mass evaluation (II), the old class was based on the data published by same authors in 1995
- Developments in **G4IonTable**:
 - Added method G4IonTable::CreateAllIon() and **/particle/createAllIon** command
 - Use std::map in G4IonTable to get better performance to search an ion in the table

New Features - Event

- New **G4SmartTrackStack** class. 09-02-ref08
- Instead of popping the last track stored in the urgent stack, the track of same particle type as the previous one is popped (if such track is present)
- This mechanism is expected to improve the performance for ultra-large scale simulation such as LHC, by increasing the cache hit rate of the physics tables.
- The use of G4SmartTrackStack is temporarily optional. To use it, uncomment the "#define" line in include/evmandefs.hh.

New Features - Interfaces & Visualization (1)



- New drivers based on **Qt graphics** 9.2.[p01]
 - Compatible with either Qt-3 and Qt-4 packages
- Updated **G4py** Python interface
- Enhancements to **9.3.beta** **G4VBasicShell** for better command completion in command line

New Features - Interfaces & Visualization (2)

- New class **G4UIExecutive** for automatic instantiation of user interactive sessions. 9.3.beta

```
#if defined(G4UI_USE_TCSH)
#include "G4Uiterminal.hh"
#include "G4Uitcsh.hh"
#elif defined(G4UI_USE_XM)
#include "G4UIXm.hh"
#elif defined(G4UI_USE_WIN32)
#include "G4UIWin32.hh"
#elif defined(G4UI_USE_QT)
#include "G4UIQt.hh"
#include "G4Qt.hh"
#else
#include "G4Uiterminal.hh"
#endif
```

OLD

```
G4UISession* session = 0;
#if defined(G4UI_USE_TCSH)
    session = new G4Uiterminal(new G4Uitcsh);
#elif defined(G4UI_USE_XM)
    session = new G4UIXm(argc,argv);
#elif defined(G4UI_USE_WIN32)
    session = new G4UIWin32();
#elif defined(G4UI_USE_QT)
    session = new G4UIQt(argc,argv);
#else
    session = new G4Uiterminal();
#endif
session->SessionStart();
```

```
#include "G4UIExecutive.hh"
```

NEW

```
G4UIExecutive* session
    = new G4UIExecutive(argc, argv);

session->SessionStart();
```

- Simplification of user code
- New UIs automatically available

New Features – Physics Lists

- New utility, [G4PhysicsListFactory](#) 9.2.[p01]
 - Allowing any reference physics list to be built
- New [option3](#) physics constructor for [EM physics](#)
 - Can be used for simulation requiring spatial precision $\ll 1\text{mm}$
- Checking particles in [G4VUserPhysicsList](#)
 - Calling added method [CheckParticleList\(\)](#) to probe consistency of list of particles before constructing processes 09-02-ref07
 - Just before invoking [G4VUserPhysicsList::SetCuts\(\)](#) (by [G4RunManagerKernel](#)) 09-02-ref08
 - Performing check to confirm no particle is registered when [G4RunManagerKernel](#) is instantiated 09-02-ref09
 - Added [DisableCheckParticleList\(\)](#) method as well to avoid problem when ions are created in the Pre-Init state.

New Features – Data Sets

- **G4NDL.3.13**

9.2.[p01]

- Added isotopes in neutron files and updated Elastic and Inelastic x-sections from “JENDL-HE 2007”

- **G4EMLOW.6.2 - 6.7**

09-02-ref08

- New DNA tables (6.2)
- New directory and data files needed by ionization cross section models for PIXE (6.6)
- Extended high energy coverage of proton excitation and ionization (6.7)
- Improved precision of e- ionization Born model (6.7)

New Features – More ...

- Scoring
 - Beta release of cylindrical scoring meshes
- Error Propagation
 - Inclusion of π^+ , π^- and proton in physics list
 - Added possibility to account for error deflation for 'smoothing'
- New and updated examples

9.2.[p01]

9.3.beta

Fixes & Improvements – Kernel (1)

- Global
 - Improved implementation of G4String and G4SubString 9.2.p02
 - to reduce generation of temporaries
 - Reviewed implementation of physics vectors 9.3.beta
 - Providing CPU improvement at initialization
- Cuts 09-02-ref09
 - A new scheme of range to energy cuts conversion has been introduced (in G4VRangeToEnergyConverter)
 - Measured a factor 2 to 3 improvement in initialization speed when building physics tables
 - Significant speed up especially for users who define hundreds of materials like LHC experiments

Fixes & Improvements – Kernel (2)

- Particles

09-02-ref09

- Fixed bug in `G4IonTable::Createlon()`; removed deletion of `G4IsotopeProperty` pointed object
- Added check on application state in the constructor of `G4ParticleDefinition`.

- Configuration

9.2.p02

- Fixed configuration issues on Windows platforms for clashes in CygWin with MatLab installations
- Fixes for detection of Qt libraries in Configure
- Ported code on gcc-4.4.x compiler series
- Review and fixes to advanced examples set

Supported Platforms

Platforms supported for 9.3

- Linux SLC5, gcc-4.1.2, gcc-4.3.X, 32/64 bits
- Linux SLC4, gcc-3.4.6, 32/64 bits
- MacOSX 10.5, gcc-4.0.1
- MacOSX 10.6, gcc-4.2.1
- Windows/XP and CygWin Tools
 - Compiler Visual C++ 9.0 (Visual Studio 2008)
- Also tested: gcc-4.4.X, icc-11.X

Backup

Major Fixes in Solids

- Code revision for **G4Tubs**, **G4Cons** and **G4Sphere**
 - Boosted performance up to 20% for phi-sections and up to 7% in all other configurations in pure tracking
 - Several fixes in these solids
 - Addressed problem report #977, #1022
- Fixes in **G4Ellipsoid** treatment of tolerance for points on surface in `Inside(p)` and `DistanceToIn(p,v)`
 - Addressing problem reports #1022, #1050, #1076
- Corrected typo in `GetSurfaceArea()` for **faceted specific solids**, which gave wrong results
 - Addressing problem report #1062

9.2.[p01]

9.3.beta

09-02-ref08

9.2.[p01]

09-02-ref09

9.2.p02