Geant4 release 9.6+P02

LINUX & YOUR FIRST GEANT4 EXAMPLE

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Outline

- Basics commands for Linux installed on your virtual machine

- Novice example N03
  - Without macro file
  - With macro file

Introduction

- Geant4 can be installed under several OSs
  - Scientific Linux 5 & 6 with gcc compiler
  - MacOS X with gcc compiler
  - Windows 7 with Microsoft Visual Studio 10

- In this tutorial we work with Scientific Linux 5.8, which has become a standard OS for scientific computing
  - constantly updated, freely available

- Scientific Linux 5.8, Geant4 and other utilities are already installed on your virtual machine

Start your Linux machine

- Start you virtual machine
  - you are directly logged in
- If you need to log in again, use:
  - username: local1
  - password: local1
- A mouse right-click on the Desktop allows you to open a terminal where you are going to use Linux commands
- You can exchange files between the Linux virtual machine and Windows…

The shells

- They are the command interpreters

`/bin/sh`	**POSIX shell, standard, for scripts**
`/bin/ksh`	**Korn shell, improved interactivity**
`/bin/csh`	**C-shell, uses a syntax close to C**
`bash`	**Standard shell under Linux, « Bourne Again » shell**
`tcsh`	**Improved C-shell**

How to navigate in directories ?

`pwd`	**Display current directory**
`cd myDir`	**Go to directory 'myDir'**
`cd`	**Go back to home directory (~)**
`cd ..`	**Go back to parent directory**
`ls`	**List files**
`ls -a`	**List files including hidden files**

Move, copy, create, delete…

`mv source target`	Move and/or rename file
`cp source target`	Copy a file
`cp -R source target`	Copie a directory
`mkdir directory`	Create a directory
`rmdir directory`	Delete an **EMPTY** directory
`du -ks directory`	Display the size of a directory in Ko
`rm file`	Delete a file
`rm -f file`	Delete a write protected file
`rm -R directory`	Delete a directory

Other useful commands

`diff file1 file2`	**Display differences between two files**
`wc file`	**Count the number of lines, words, octets in a file**
`more file`	**Display the file content page by page (space for next page, enter for next ligne, u to reach beginning)**
`echo envVariable`	**Display the value of the environment variable envVariable**

Useful installed tools

- **`nedit`** : text file editor
- **`snavigator`** : C++ project manager (Integrated Development Environment)
- **`cmake`** & **`make`** : compile your application
- **`root`** : to start the ROOT software
- Add **`&`** after command name to keep hand

Environment variables

- They are already set when you when you log in using the virtual machine
- Variables are defined using the command **`setenv VARIABLE value`**
- You can check the value of the variable using **`echo $VARIABLE`**
- For Geant4
  - $G4INSTALL
    - Directory where Geant4 is installed
  - $G4SYSTEM
    - Operating system
    - Value is Linux-g++
  - and many other
    - and also for your virtual machine such as $G4SRC for source files

Geant4 examples

- A number of ready-to-use examples are available in Geant4
- Located in `$G4INSTALL/share/Geant4-9.6.2/examples`
- Four categories
  - novice : basic functionalities of Geant4
  - basic : will replace novice examples in the future
  - extended : specific functionalities
    - specific Physics processes, medical, biasing, EM fields…
  - advanced : full simulation of realistic use cases
    - medical physics, space, calorimetry…

Let's try example N03

- Copy N03 to your home and create a build directory

```
cd
cp -R $G4INSTALL/share/Geant4-9.6.2/examples/novice/N03 .
mkdir N03build
cd N03build
```

- Read the README file : simulation of a simple sampling calorimeter…

- Compile & link the example

```
cmake -DGeant4_DIR=$G4DIR ../N03
make -j2
```

- Warning :
  - environment variables must always be set before compiling & running an executable file
  - In your virtual machine, $G4DIR is `/usr/local/geant4.9.6.p02/lib64/Geant4-9.6.2`

Running without macros

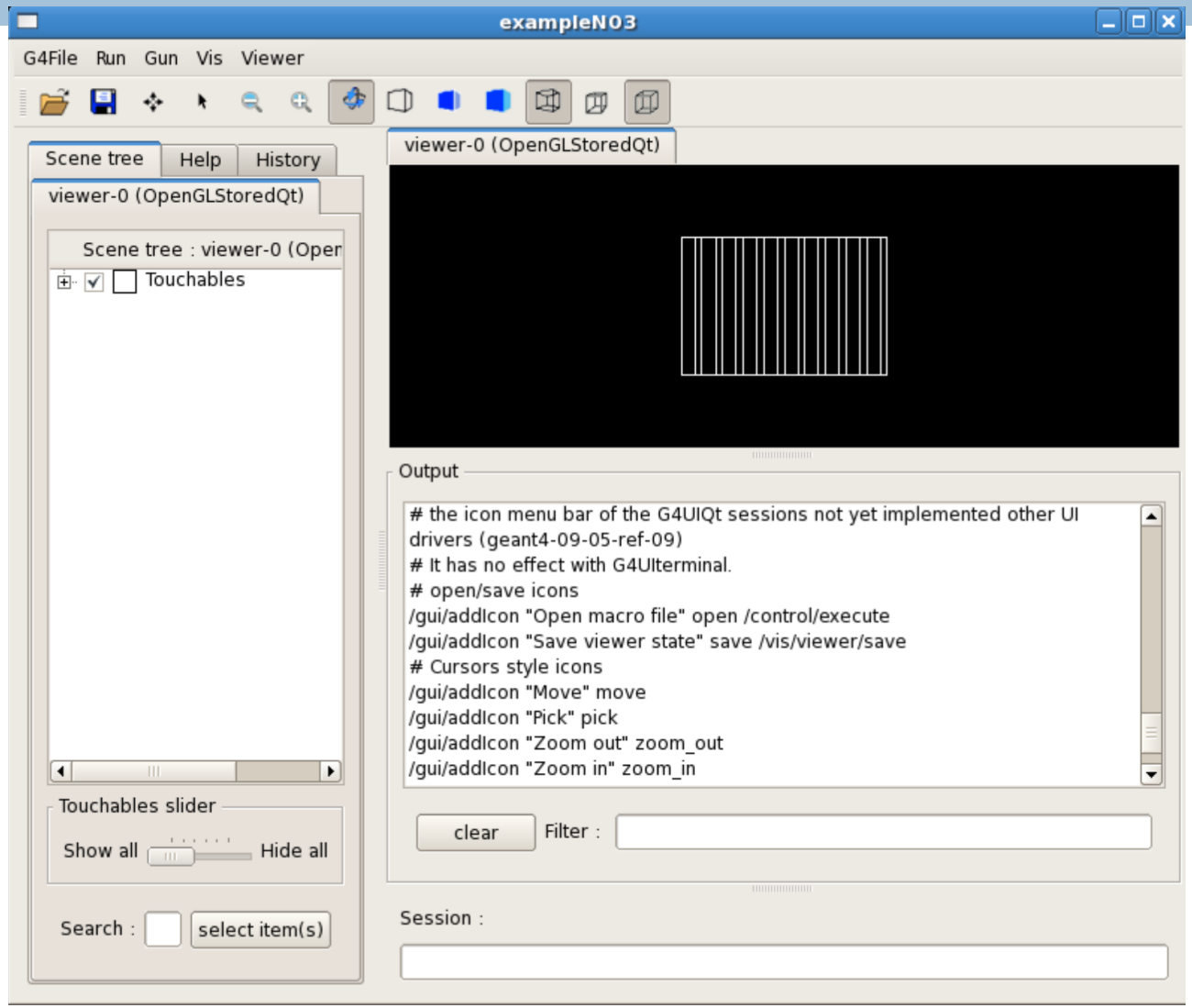
- Once compiled and linked, in your build directory, you can run the executable using simply :

```
./exampleN03
```

Use your Tab key for faster recognition of existing directories & files

- You get the following screen output

Running without macros



Running without macros

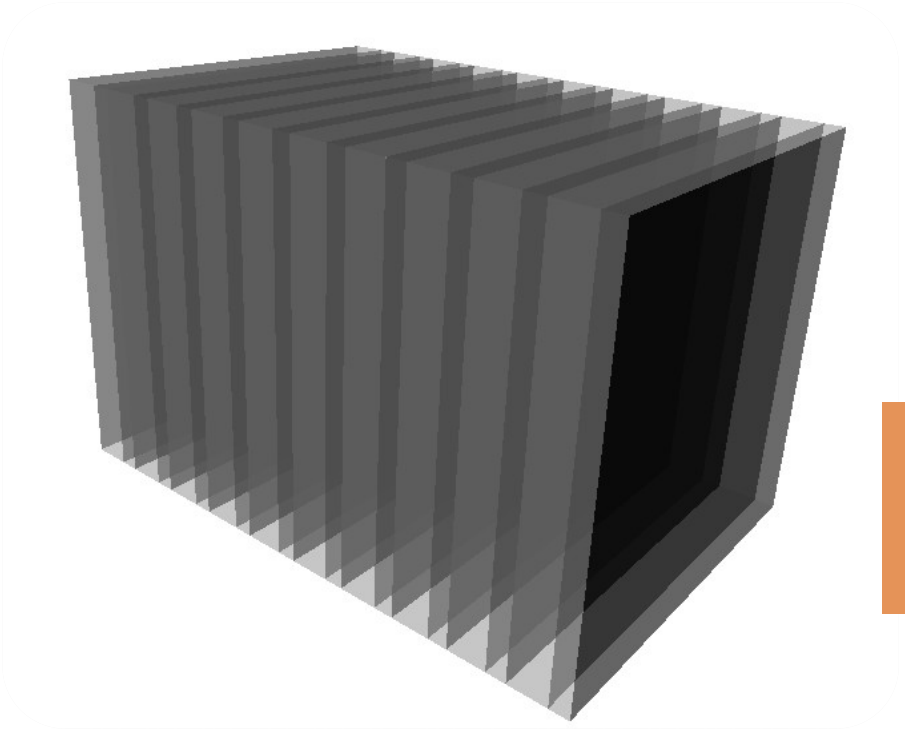
What happened ?

1. the run has been initialized
   1. definition of materials,
   2. build of geometry
   3. set physics processes
   4. set production cuts
   5. ...

2. a macro file vis.mac is automatically read to register the visualization drivers and the set-up is shown on a graphic window (Qt interface)

3. You can enter commands interactively in the "Session" area
   - e.g. change geometry, decide which particle to shoot, which energy, execute another macro, shoot a particle, ..

The default geometry



What you get with the VRMLFILE visualization driver

- 10 layers : 10 mm Lead + 5 mm Liquid Argon
- no magnetic field

Running without macros

Let's try to shoot a particle:

```
/run/beamOn 1
```

By default, a 50 MeV e^- is shot impinging perpendicularly on the calorimeter

```
phot:   for  gamma     SubType= 12
LambdaPrime table from 200 keV to 10 TeV in 54 bins
===== EM models for the G4Region  DefaultRegionForTheWorld ======
PhotoElectric :  Emin=        0 eV    Emax=       10 TeV   AngularGenSauterGavrila
[...]
Index : 1     used in the geometry : Yes     recalculation needed : No
Material : Lead
Range cuts        :  gamma  1 mm     e-  1 mm     e+  1 mm  proton 1 mm
Energy thresholds :  gamma  101.843 keV    e-  1.36749 MeV    e+  1.27862 MeV proton 100 keV
Region(s) which use this couple :
DefaultRegionForTheWorld
```

Initialization of physics tables

Calculation of energy cuts

Running without macros

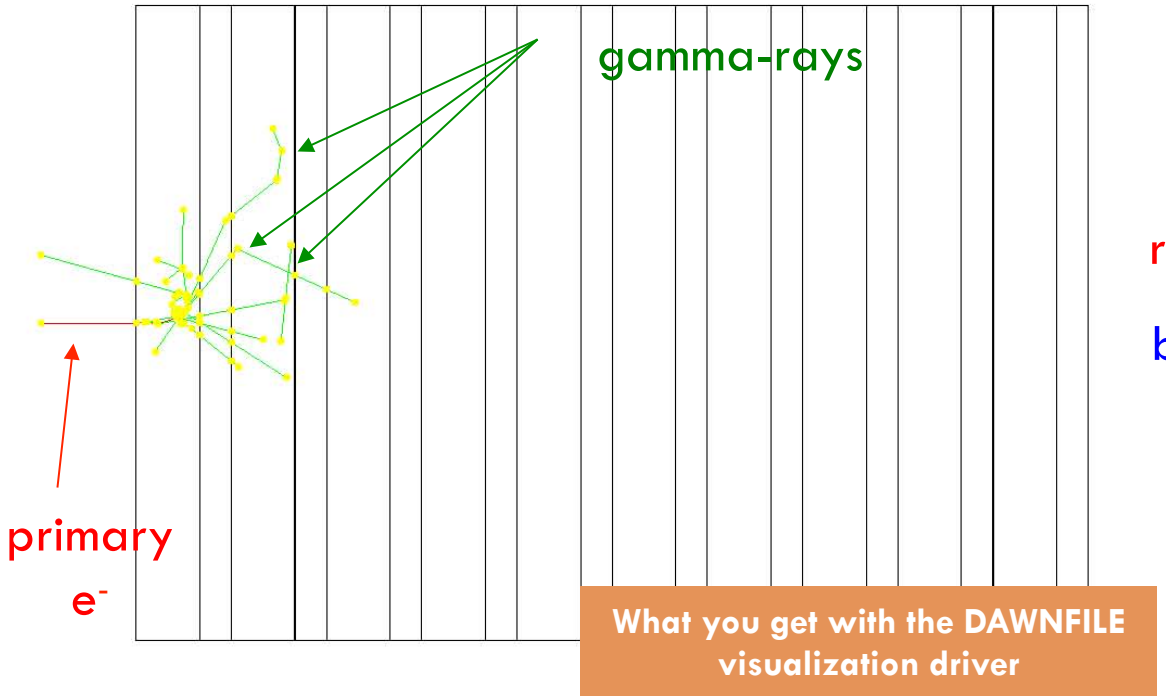

```
---> Begin of event: 0
---> End of event: 0
Absorber: total energy: 40.0567 MeV       total track length:  2.9093 cm
Gap: total energy: 5.52904 MeV       total track length: 2.63017 cm
Run terminated.
Run Summary
Number of events processed : 1
User=0.01s Real=0.12s Sys=0.02s
--------------------End of Run------------------------------

 mean Energy in Absorber : 40.0567 MeV +- 0 eV
 mean Energy in Gap      : 5.52904 MeV +- 0 eV
 mean trackLength in Absorber : 2.9093 cm  +- 0 fm
 mean trackLength in Gap      : 2.63017 cm  +- 0 fm
------------------------------------------------------------
```

Event summary

Run summary

Running without macros

You also get a visualization of the event you have just shot (50 MeV e^-)



What you get with the DAWNFILE visualization driver

Default color code:

red = negative charge

blue = positive charge

green = neutral

Running WITH macros

The argument following the executable name is taken as a macro name, e.g. run1.mac

```
./exampleN03 run1.mac
```

Geant4 macros are ASCII files containing a sequence of Geant4 commands:

```
#
/run/verbose 2
/event/verbose 0
/tracking/verbose 1
#
/gun/particle mu+
/gun/energy 300 MeV
/run/beamOn 3
```

} Shoot 3 mu^+ of energy 300 MeV

Running with macros


```
---> End of event: 2
   Absorber: total energy: 123.976 MeV       total track length:   10.44 cm
        Gap: total energy: 10.7747 MeV       total track length: 5.16631 cm
Run terminated.
Run Summary
  Number of events processed : 3
  User=0.01s Real=0.02s Sys=0.01s

------------------End of Run------------------------------

 mean Energy in Absorber : 125.191 MeV +- 2.67303 MeV
 mean Energy in Gap      : 9.94337 MeV +- 596.048 keV

 mean trackLength in Absorber : 10.5231 cm  +- 1.14618 mm
 mean trackLength in Gap      : 5.09232 cm  +- 524.76 um
------------------------------------------------------------
```

Summary of event #2 (the 3rd one!)

Summary of the full run

Running with macros

Note that

```
./exampleN03 run1.mac
```

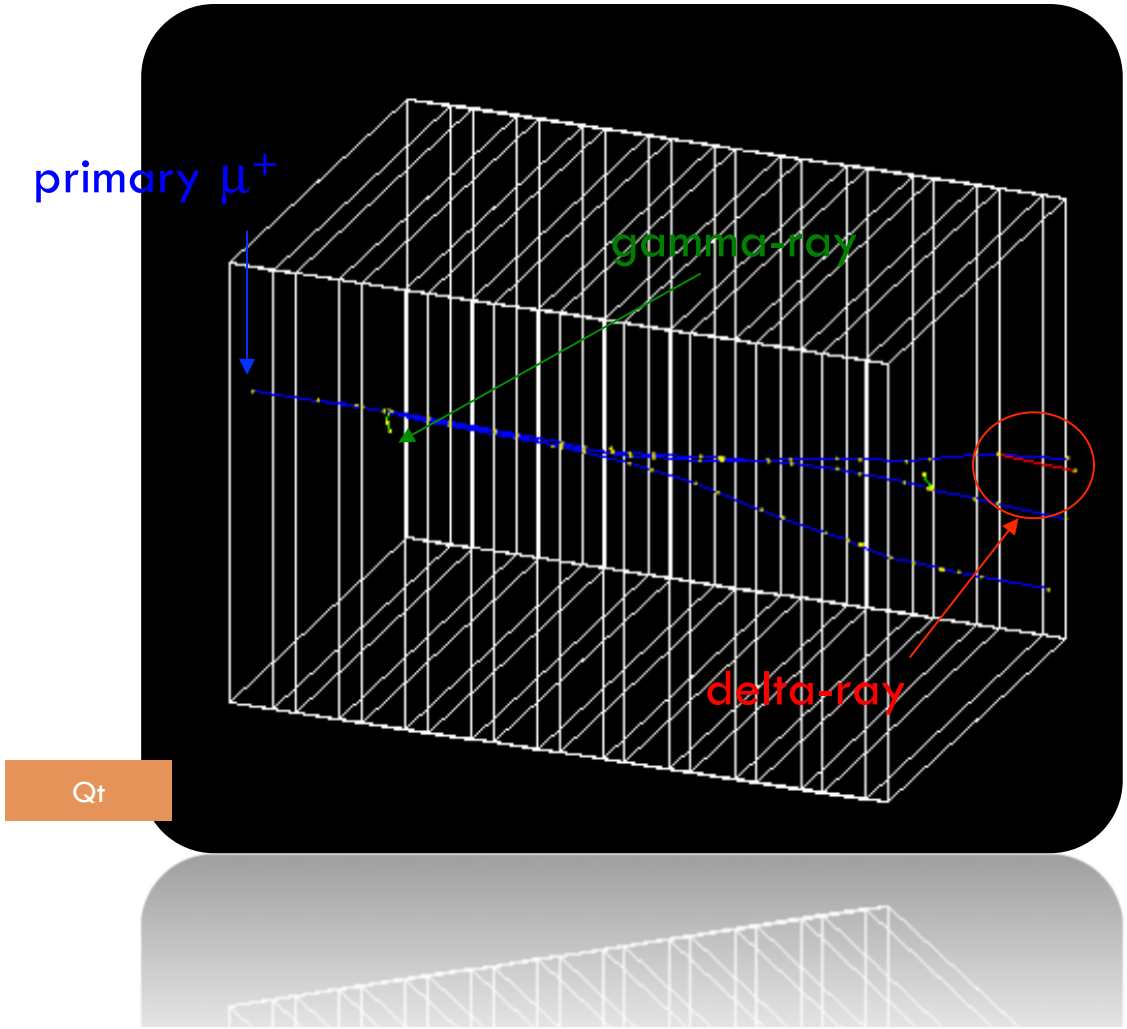
is equivalent to

```
./exampleN03
```

and in the “Session” window of the Qt interface:

command to execute an external macro

Running with macros



Change geometry on-the-fly


```
/control/execute newgeom.mac
/control/execute run1.mac
```

1) First macro changes geometry:

- only one layer of absorber (40 cm of water), no gap (thickness = 0 cm)
→ practically **a solid block of water**

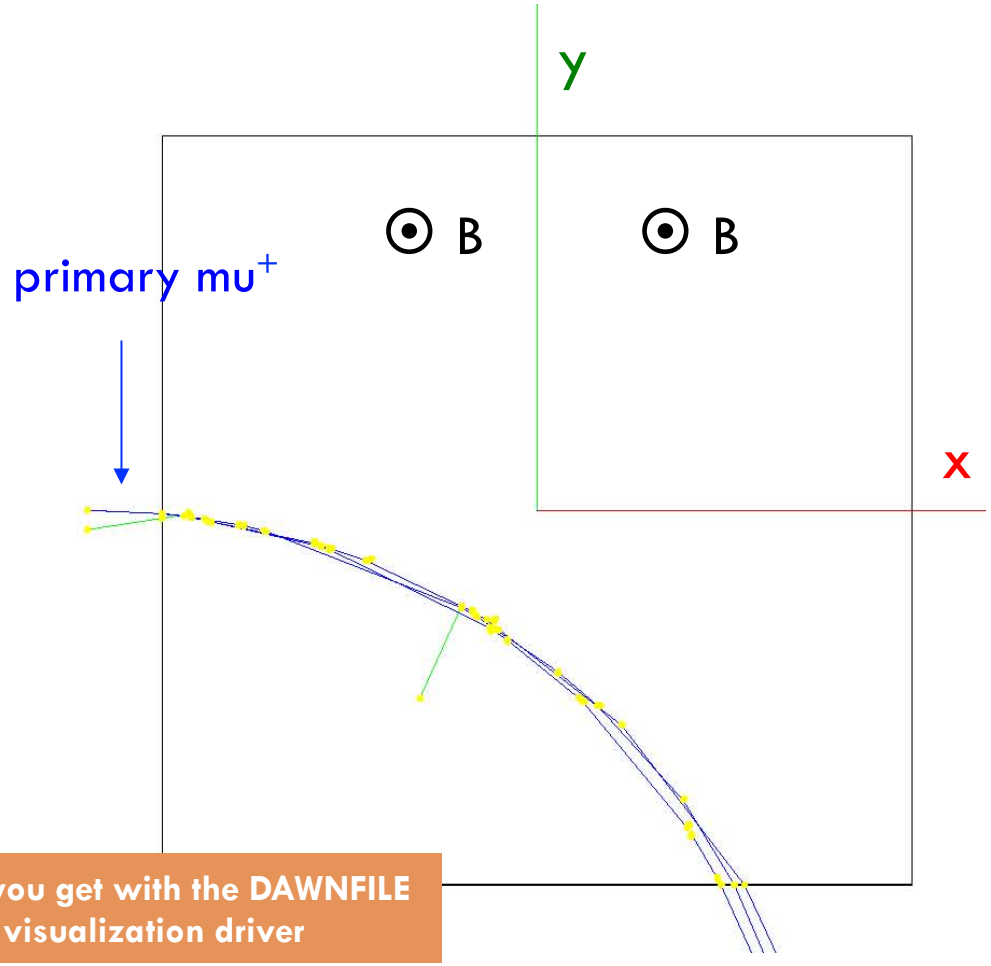
- change transverse dimensions

- set a **3 T magnetic field**

```
/N03/det/setNbOfLayers 1
/N03/det/setAbsMat Water
/N03/det/setAbsThick 40 cm
/N03/det/setGapMat Air
/N03/det/setGapThick  0 cm
/N03/det/setSizeYZ   40 cm
/N03/det/setField 3 tesla
/N03/det/update
```

2) Second macro shoots the 3 300-MeV mu^+, as before

Change geometry on-the-fly



What you get with the DAWNFILE visualization driver

Geometry, materials, magnetic field and primary particles can be tuned by ASCII macros, without recompiling the code !

Summary

- Linux is a convenient environment to work with for the use of Geant4.
  - Virtual machine use avoids the burden of Geant4 installation
- Geant4 provides several examples to show basic and advanced functionalities (basic/extended) and full-scale realistic applications (advanced).
- Environment variables should be properly set to compile and run Geant4 applications.
- Geant4 applications can be run interactively (namely, giving commands by keyboard) or by macros. A few macros are distributed with the examples.
- Simulation parameters (geometry, visualization, primary particles, materials) can be tuned without recompiling the code.