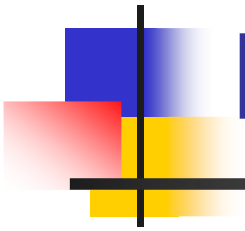
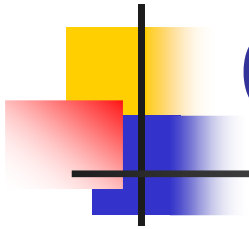


Hands On #1



Overview

Part 1 : Starting and familiarizing

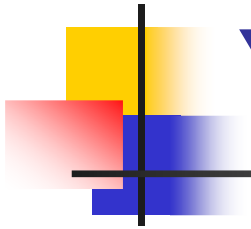
- Where is your installation ?
- Getting the example programs
- Running novice examples : N01, N03, N02 …

Part 2 : Looking into Geant4, trying it out with exercises

- Examine cross sections
- Simulate depth dose curve
- Compute and plot Bragg curve

Addenda : other examples, histogramming

See Wednesday's hands on



Your Geant4 installation

- **VMware Player users under Windows or Mac OS**
  - all files downloaded from
    http://geant4.in2p3.fr/cenbg/vmware.html
  - in principle, no installation needed
  - all your peripherals should be operational (WiFi, disks,…)
- **Installation from beginning**
  - CERN link

    http://geant4.web.cern.ch/geant4/support/download.shtml
  - SLAC link

    http://geant4.slac.stanford.edu/installation/
  - User forum

    http://geant4-hn.slac.stanford.edu:5090/HyperNews/public/get/installconfig.html
  - Installation guide

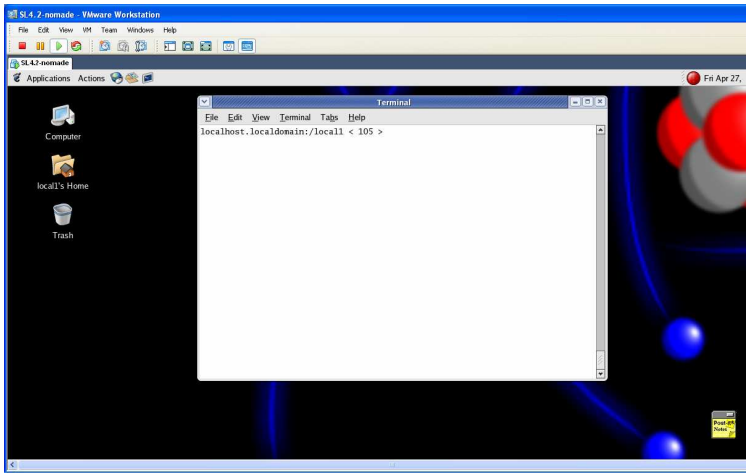
    http://geant4.web.cern.ch/geant4/UserDocumentation/UsersGuides/InstallationGuide/html/index.html

This Hands On will help you check your installation of Geant4 is correct

If not, we can try to help during this Hands On…

Access your Geant4 installation for VMware users

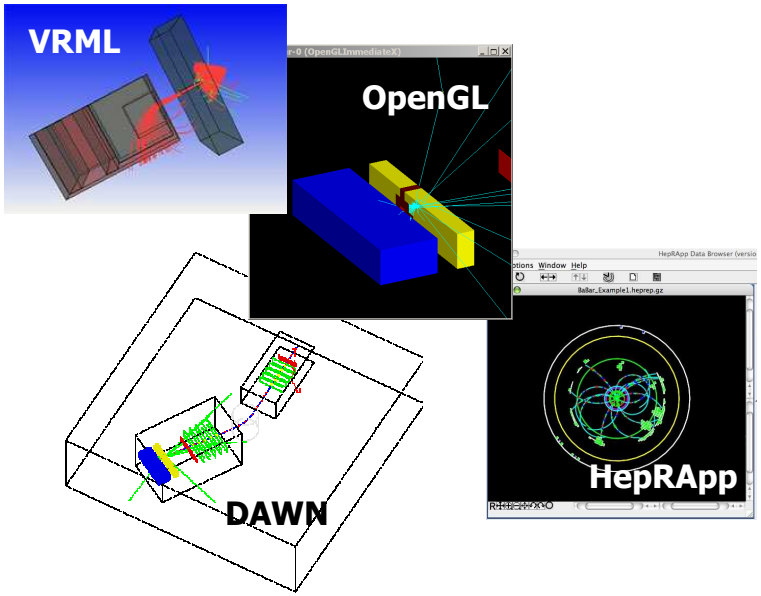
- Start the **VMware player** software
- Start your VMware machine
- Log onto the VMware machine
- Username: **local1**, password: **local1**
- Open a terminal
  (right click on desktop with mouse)
- You are now working under **Scientific Linux 4.2** with gcc 3.4.4
- By default on your Windows PC, the directory **`/mnt/hgfs/echanges`** is a link to **C:**



Tips for VMware users (1/2)

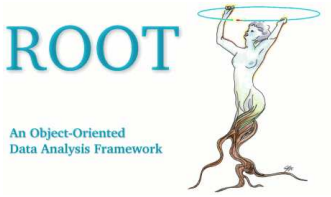
- Geant4 8.3 installation path :
  - `/usr/local/geant4`
  - you need root privileges for modification (logon as **root**, password is **scilinux4.2**)
  - environment defined in `/usr/local/env/Cshrc`

- Visualization
  - OpenGL driver installed
  - HepRApp viewer : `HepRApp`
  - DAWN viewer : `dawn`
  - VRML viewer : `vrmlview`

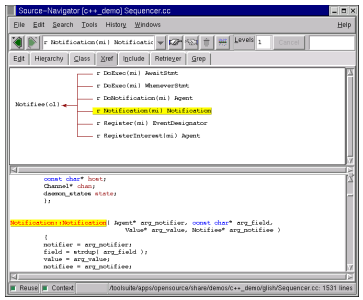


Tips for VMware users (2/2)

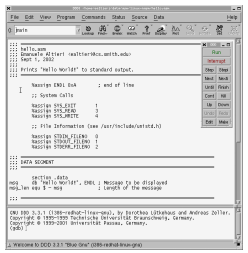
- Data analysis
  - ROOT (5.12) : **`root`**
  - PAW / PAW++ : **`paw`** or **`paw++`**
  - OpenScientist package for histograms



- Code management with Source Navigator **`snavigator`**



- Data Display Debugger : **`ddd`**



- Other : CERNLIB 2003, Gimp, Lyx, xemacs, OpenOffice : **`soffice`**

Troubles with VMware ?

- If you have troubles when **uncompressing** your zip files :
  - **Windows** users may download the 7-Zip utility for Windows. You may also try the PowerArchiver software.
  - **Macintosh** users may download the p7zip utility, doing as follows in terminal mode (thanks to Pierre François Honoré, CEA) :

    fink install p7zip
    7z x .../Home.zip
    7z x .../Softs.zip
    7z x .../SL4.zip

  Under Windows, you may also encounter problems if the disks where you uncompress your files have been formatted in the FAT32 format. Use **NTFS formatted** disks only.

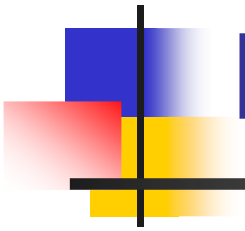
- During the first installation, you may be asked to create a new unique **identifier UUID** (a dedicated window will pop up). Simply choose **Create**.

- During the first startup, a hardware configuration page (DOS like) may appear regarding your **network card adapter**. Do the following :
  - Select with the Enter key the **Remove Configuration** button
  - Select the **Configure** button with the Enter key
  - Choose **use dynamic IP configuration** with the space bar
  - Go to the **OK** button with the arrow keys and Select **OK** with the Enter key

- If your **OpenGL visualization windows do not refresh** properly when running your Geant4 application, connect as super user, edit the **/etc/X11/xorg.conf** file and add the line: **Option "backingstore"** in **Section Screen**

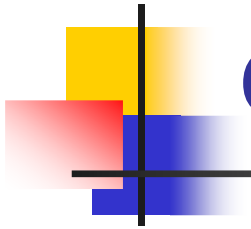
- With the last version of VMware player (download above), you may define an **exchange directory between Windows and Linux** ; assuming you want to setup C:\ as the exchange directory, do as follows :
  - Make sure your Linux machine is shut down and your VMware Player application is closed
  - Open the downloaded ***.vmx** file with WordPad
  - Check the path of the exchange directory ("**C:**") and its linux name ("**share**") and modify it as you want (in the shared folder section)
  - Save this file as a text file
  - Open the VMware player application
  - Go to the VMware Player menu, select Shared Folders…, you should see the name of your directory appear, select Always enabled then OK
  - Start your Linux machine
  - Under your linux session, your exchange directory is located at **/mnt/hgfs/share**

http://geant4.in2p3.fr/cenbg/vmware.htm



Let’s start…

Copy selected Geant4 examples



- The Geant4 system (source and libraries) is already installed on your computer
  Find it at **$G4INSTALL** which locates the head of your copy of Geant4
  (**echo $G4INSTALL** will return **/usr/local/geant4/v8.3/geant4.8.3**)

  You must logon with root priviledges if you want to modify this installation…

- Set up a work directory on your local1 account

```
mkdir mytestdir
cd mytestdir
```

- Copy there several novie examples

```
cp –r $G4INSTALL/examples/novice/N01 .
cp –r $G4INSTALL/examples/novice/N02 .
cp –r $G4INSTALL/examples/novice/N03 .
```

- Check that the following environment variables are set properly
  $G4WORKDIR should define the work directory (by default, **/home/local1/geant4/work**)
  $G4SYSTEM should define the system name (for Linux it is **Linux-g++**)

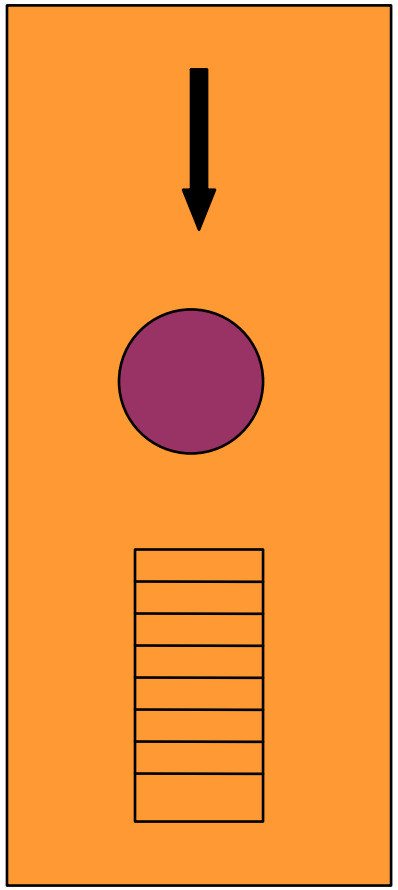
- One of the visualization drivers that you built into the toolkit must be chosen.

  In this tests we will choose the OPENGL visualization driver

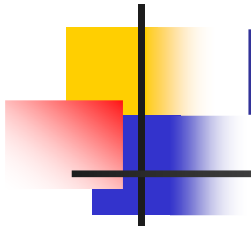
  $G4VIS_USE_OPENGLX should be set to **1**

Novice example N01

- Fixed geometry: Ar gas mother volume with Al cylinder and Pb block with Al slices
- Incident particle is a geantino – no physics interactions
- No magnetic field and only the transportation process is enabled
- Hard coded batch job and verbosity



Compile and run first novice Example N01



- Compile and run N01 (in batch mode)

  ```
  cd N01
  more README
  gmake
  ```

  - compile and link – create the executable called 'exampleN01' in `$G4WORKDIR/bin/$G4SYSTEM`
  - uses the recipe how to do this in GNUmakefile

  ```
  $G4WORKDIR/bin/$G4SYSTEM/exampleN01
  ```

  - runs Geant4 for simple setup, gives you some output : a tracker tube and a sandwich calorimeter made of boxes, it shoots a geantino per event (does not interact)

- Type `exit` at the Idle prompt to quit

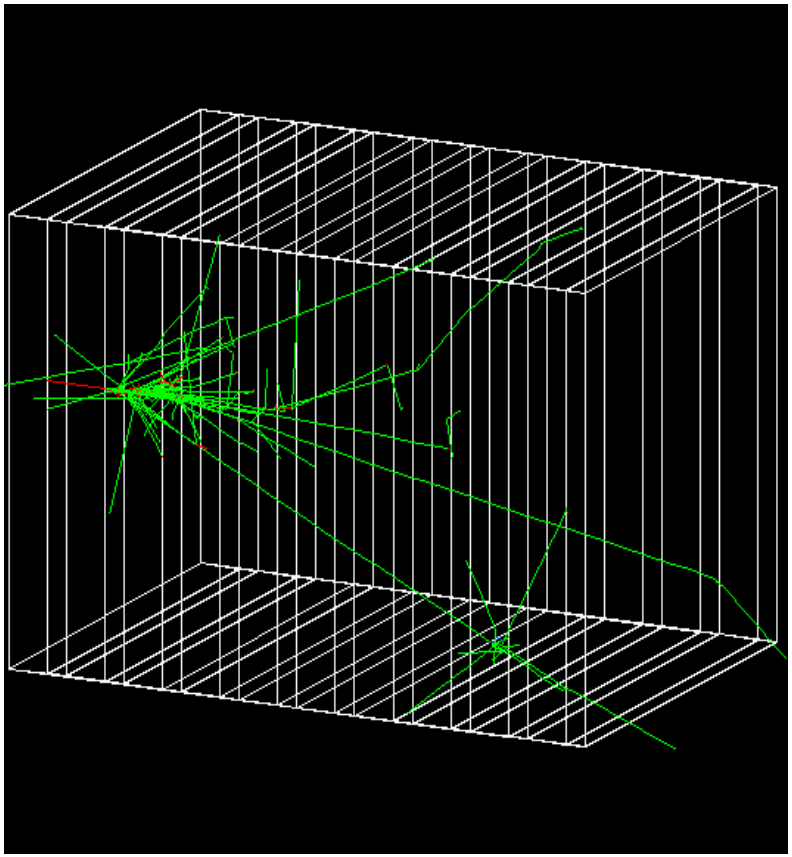
- When you are done

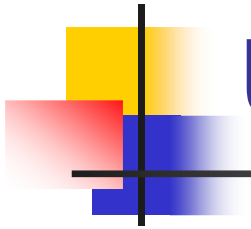
  ```
  gmake clean
  ```

  - this deletes the executable, as exampleN01 is very limited

Novice Example N03

- Sampling calorimeter with layers of Pb absorber and liquid Ar detection gaps (replicas)
- Exhaustive material definitions
- Command interface
- Randomization of incident beam
- All EM processes + decay, with separate production cuts for γ, e+, e- (use for shower studies)
- Detector response: E deposit, track length in absorber and gap
- Visualization tutorial
- Random number seed handling





User Classes

- First, examine N03
  `cd ../N03`
  `nedit README &` (in particular, how to start section)
  `nedit exampleN03.cc &`

- main()
  - the Geant4 toolkit does not provide main()
  - there are more 70 examples

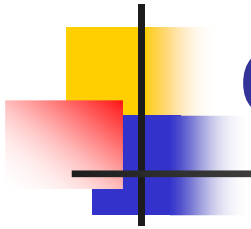
- **Initialization classes**
  - Detector Construction
  - Physics List

- **Action classes** : are invoked during an event loop
  - Primary Generator Action
  - Run Action
  - Event Action
  - Tracking Action
  - Stepping Action
  - Stacking Action

- you can define VisManager, (G)UI session, optional user action classes, and/or your persistency manager in your main()

Note : classes written in red are mandatory !

Compile and run novice example N03



```
cd ../N03
gmake
```

- **execute N03 in batch mode**

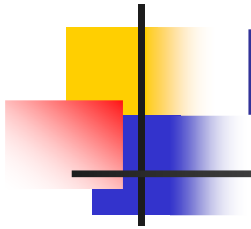
```
nedit run1.mac &
$G4WORKDIR/bin/$G4SYSTEM/exampleN03 run1.mac
```

- **execute N03 in interactive mode**

```
$G4WORKDIR/bin/$G4SYSTEM/exampleN03
```

  - try to enter at the « Idle » prompt
    `/vis/viewer/set/viewpointThetaPhi 30 30 deg` and return
    next enter `/run/beamOn 1` and return
  - run the macro run1.mac
    `control/execute run1.mac`
  - To quit
    `exit`

When you are done, `gmake clean`



N03 : run1.mac

all comments start with #

```
/control/verbose 2
/control/saveHistory
```

- set the verbose level of commands in macro (0, 1, 2)
- store command history to a file

```
/run/verbose 2
/event/verbose 0
/tracking/verbose 1
```

- set the verbose level of run, event, tracking manager

```
/gun/particle mu+
/gun/energy 300 MeV
/run/beamOn 3
```

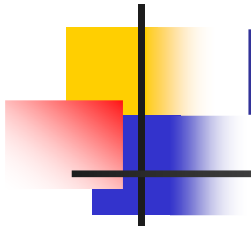
- set particle type, energy, and number of particles to shoot

access all this information by typing `Idle>help`

N03 : run2.mac

```
/control/verbose 2
#
# electron 30 MeV to the direction
   (1.,0.,0.)
# 1 event
#
/run/beamOn 1
#
# shoot randomly 20 events
#
/N03/event/printModulo 5
/N03/gun/rndm on
/run/beamOn 20
#
# activate/inactivate physic
   processes
#
/process/list
/process/inactivate eBrem
#
/run/beamOn 20
```

- user command : print events modulo n
- user command : shoot randomly the incident particle
- list of Physics processes
- inactivation of e-Bremsstrahlung



N03 : exo1.mac

```
/N03/det/setNbOfLayers 1
#
/N03/det/setAbsMat Aluminium
/N03/det/setAbsThick 10 cm
#
/N03/det/setGapMat Air
/N03/det/setGapThick  0 cm
#
/N03/det/setSizeYZ   10 cm
#
/N03/det/update
#
/vis/viewer/zoom 1.3
#
/process/list
/process/inactivate msc
/process/inactivate eBrem
/process/inactivate compt
/process/inactivate conv
#
/run/particle/setCut 10 cm
/run/initialize
#
/gun/particle e+
/gun/energy 30 MeV
```

geometry change

update geometry

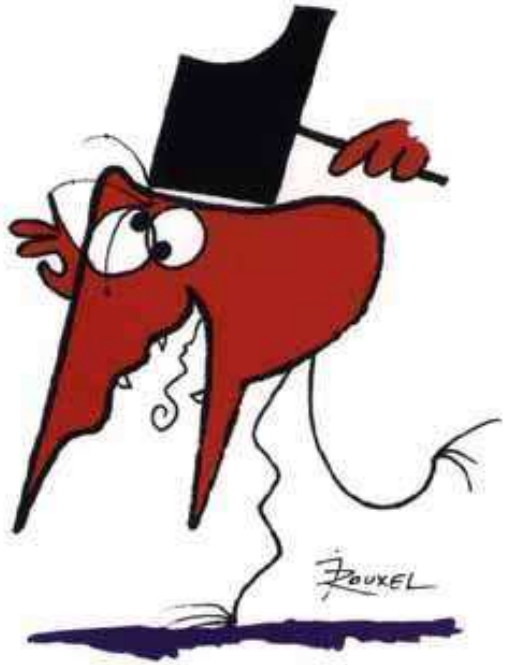
set range cut value :
no secondary generated
below

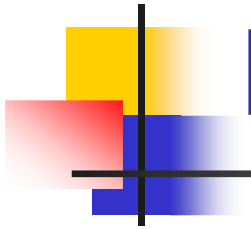
N03 : exercice !

- Copy **`exo1.mac`** to **`myexoA.mac`**
- Try to modify **`myexoA.mac`** in order to :
  - inactivate photo electric effect instead of Compton
  - shoot 10 MeV gamma particles

N03 : answer

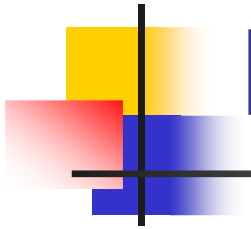
```
/N03/det/setNbOfLayers 1
#
/N03/det/setAbsMat Aluminium
/N03/det/setAbsThick 10 cm
#
/N03/det/setGapMat Air
/N03/det/setGapThick  0 cm
#
/N03/det/setSizeYZ   10 cm
#
/N03/det/update
#
/vis/viewer/zoom 1.3
#
/process/list
/process/inactivate msc
/process/inactivate eBrem
/process/inactivate phot
/process/inactivate conv
#
/run/particle/setCut 10 cm
/run/initialize
#
/gun/particle gamma
/gun/energy 10 MeV
```





N03 : exercice !

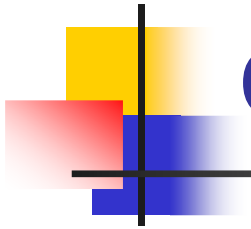
- Copy **`exo1.mac`** to **`myexoB.mac`**
- Try to modify **`myexoB.mac`** in order to :
  - set absorber material as water with a thickness of 40 cm
    - hint : Water is a defined material in N03
  - set a detector transverse size of 40 cm
  - set a magnetic field of 3 T…
    - hint : use help…



N03 : answer

```
/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
#
/vis/viewer/zoom 1.3
```

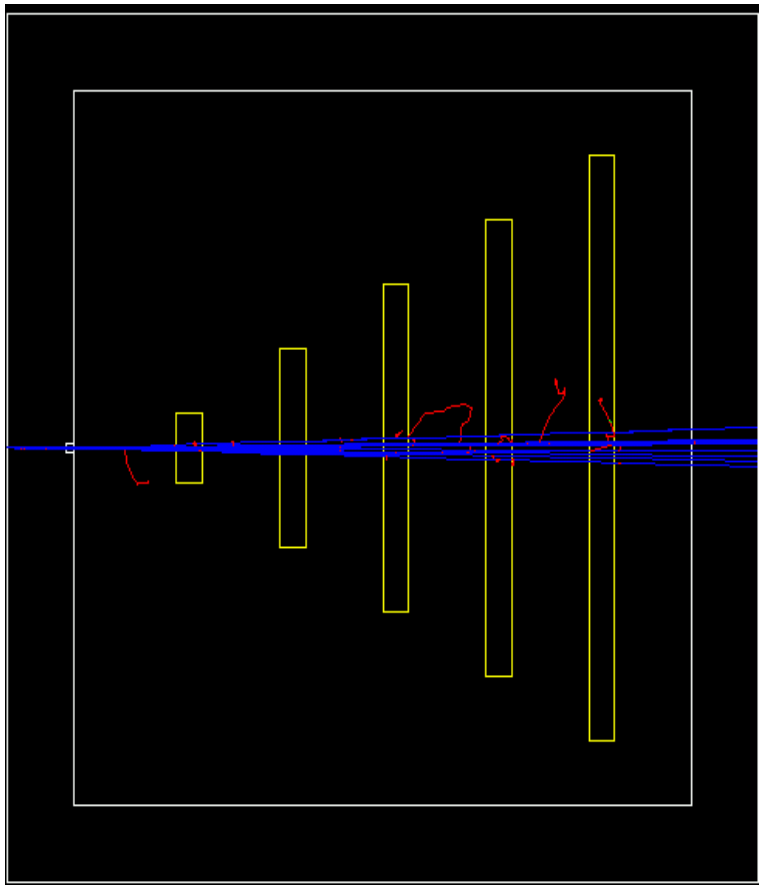
Trying different visualization outputs with N03

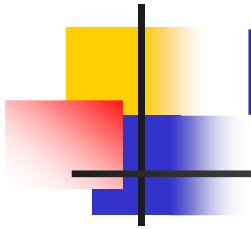


- OpenGL
  - `$G4WORKDIR/bin/$G4SYSTEM/exampleN03`
- DAWN
  - `nedit vis.mac &`
  - comment the line `/vis/open OGLIX`,
  - uncomment the line `/run/beamOn 1`
  - save and close
  - `$G4WORKDIR/bin/$G4SYSTEM/exampleN03 vis.mac`
  - create **g4_01.prim** file
  - you can visualize the file with `dawn g4_01.prim`
- WIRED3/HepRApp
  - `$G4WORKDIR/bin/$G4SYSTEM/exampleN03 visTut/heprep.mac`
  - create the **scene-0.heprep.zip** file
  - `unzip scene-0.heprep.zip`
  - you can visualize the file with `HepRApp &`

Novie Example N02

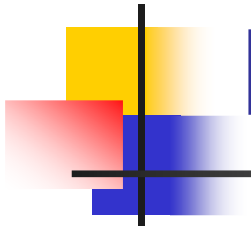
- Pb target, Xe gas chambers (parameterized volumes)
- All EM processes + decay included for γ, charged leptons and charged hadrons
- Detector response
  - Trajectories and chamber hit collections may be stored
- Visualization of detector and event
- Command interface introduced
  - Can change target, chamber materials, magnetic field, incident particle type, momentum, etc. at run time





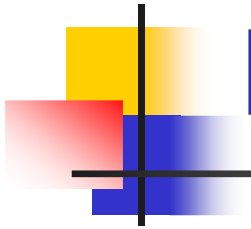
N02 : exercice

- The default particle is a 3 GeV proton
- Write a macro file in order to :
  - shoot one event with detailed printing of tracking (level 1)
  - then, shoot 3 negative muons of 300 MeV with silent tracking



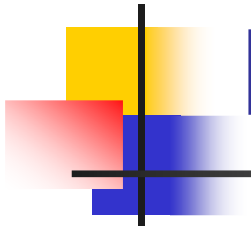
N02 : answer

```
/run/verbose 2
/event/verbose 0
#
# proton 3 GeV to the direction (0.,0.,1.)  (default kinematic)
# 1 event with detailled printing
#
/tracking/verbose 1
/run/beamOn 1
#
# muon 300 MeV to the direction (0.,0.,1.)
# 3 events (no printing)
#
/gun/particle mu-
/gun/energy 300 MeV
/tracking/verbose 0
/run/beamOn 3
```



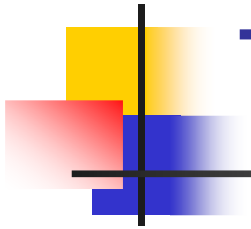
N02 : exercice

- The default particle is a 3 GeV proton
- Write a macro file in order to :
  - shoot one event with detailed printing (1)
  - then, add a 2 T magnetic field and shoot one event with silent tracking
  - try to print the hits (1)



N02 : answer

```
/run/verbose 2
/event/verbose 0
#
# proton 3 GeV to the direction (0.,0.,1.)  (default kinematic)
# 1 event with detailled printing
#
/tracking/verbose 1
/run/beamOn 1
#
# set a magnetic field
# 1 events; print the hits
#
/N02/det/setField 2 tesla
/tracking/verbose 0
/hits/verbose 1
/run/beamOn 1
```

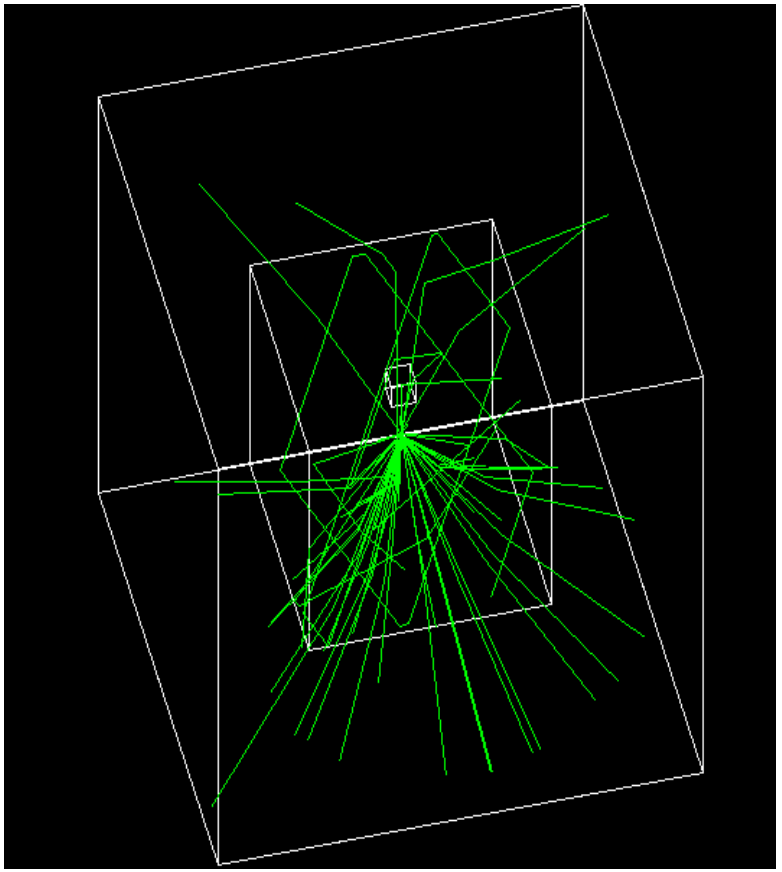


To be continued…

- Wednesday during Hands ON 3
- 16:00 – 17:30
- by Michel, Vladimir, Gunter, Aathos…

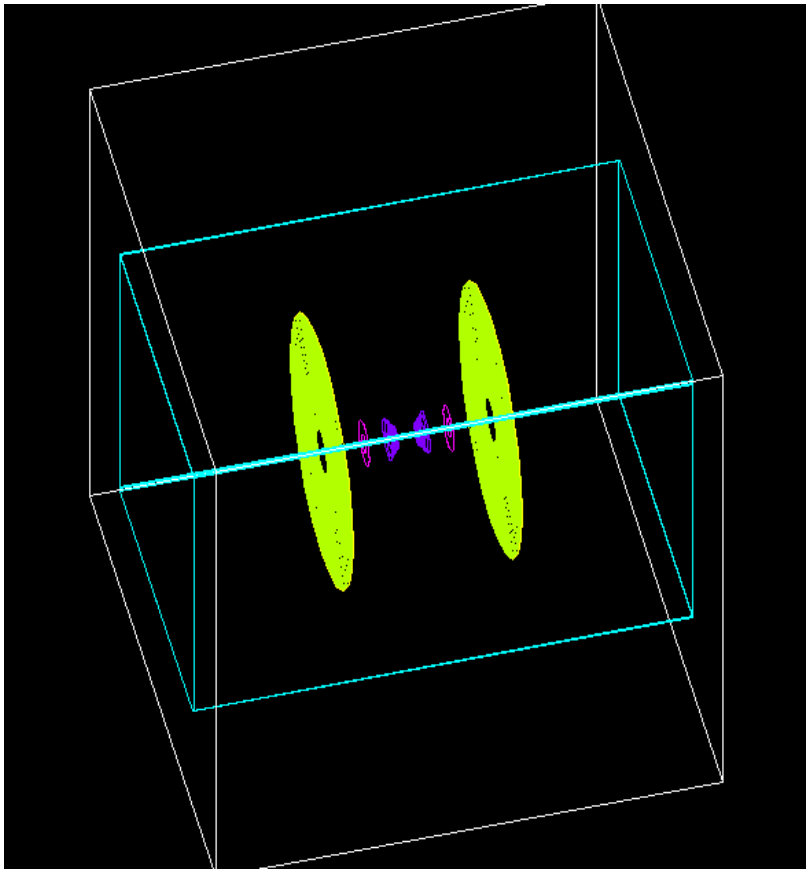
Novice Example N06

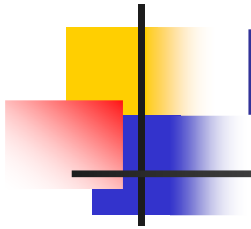
- Water Cerenkov detector with air "bubble"
- Materials
  - Specification of optical properties
  - Specification of scintillation spectra
- Physics
  - Optical processes
  - Generation of Cerenkov radiation, energy loss collected to produce scintillation



Novie Example N04

- Simplified collider detector
  - all kinds of volume definitions
- Magnetic field
- PYTHIA primary event generator
  - Higgs decay by Z0, lepton pairs
- Full set of EM + hadronic processes
  - Should use updated hadronic physics lists
- Event filtering by using stacking mechanism



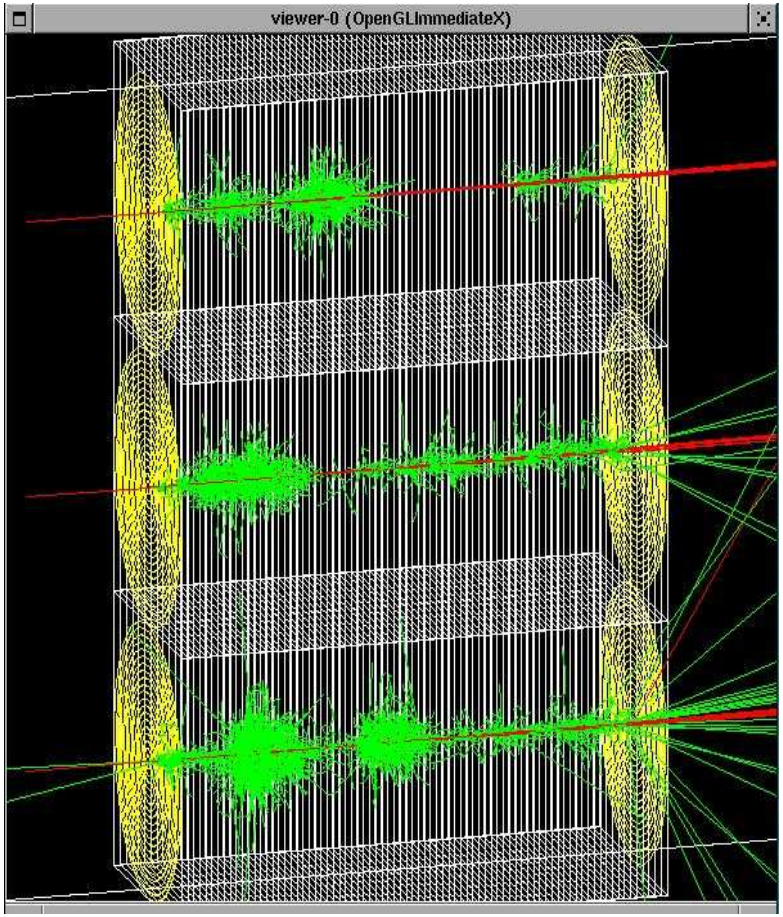


Novice Example N05

- Fast simulation with parameterized showers
  - EM showers (derived from G4VFastSimulationModel)
  - Pion showers (for illustration only – not used)
- EM physics only
  - Use of G4FastSimulationManagerProcess
- Simplified collider detector geometry
  - Drift chamber
  - EM, hadronic calorimeter
  - Ghost volume

Novice Example N07

- 3 simplified sandwich calorimeters (Pb, Al, Ar)
- Cylindrical ghost volume for scoring
- Run-based (as opposed to event-based) hit accumulation
- Changing geometries without rebuilding world
- Setting different secondary production cuts for each calorimeter using G4Region



Histogramming with Extended exemple AnaEx01

cd ..

cp –r $G4INSTALL/examples/extended/analysis/AnaEx01 .

nedit src/AnaEx01AnalysisManager.cc &

Replace

```
std::string opts = "compress=no";
fTree = treeFactory->create("AnaEx01.aida","xml",false,true,opts);
// std::string opts = "export=root";
// fTree = treeFactory->create("AnaEx01.root","ROOT",false,true,opts);
```

by

```
// std::string opts = "compress=no";
// fTree = treeFactory->create("AnaEx01.aida","xml",false,true,opts);
std::string opts = "export=root";
fTree = treeFactory->create("AnaEx01.root","ROOT",false,true,opts);
```

cp analysis/jas/run.mac .

gmake

$G4WORKDIR/bin/$G4SYSTEM/AnaEx01 run.mac

At the end, the ROOT file AnaEx01.root is created. You can browse it with

root

- **TBrowser g**