Gsim4 Manual

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1 What is gsim4?

The gsim4 is a framework library for a interface of Geant4 with ROOT. The particle transportation and detector simulation are performed with Geant4 and the data is stored with ROOT framework. Its aim is to simpify such process and make it easir and faster. Its characteristics are

- A simplified volume model (detector class).
  All the volumes are called as "detector" and they are classified into two. One is a simple detector and the other is a sensitive detector which can be created by adding sensitivity to the simple detector.

- ROOT class I/O
  For the sensitive detecor, information of hits or digitizations are automaticaly stored into a ROOT file with the ROOT class I/O, where the class structures of the data are kept.

- Command line user interface and macro file.
  Almost all the configurations are set with the Geant4 command line interface. Such commands can be used in a macro file. We can check the configuration of a simulation by just looking at the macro files.

- Extendability
  Some basic classes are designed with the factory pattern, where user can easilly implement their own classes in the framework.

2 How to use gsim4 framework

An example program using the gsim4 framework is "gsim4test", which is placed at a directory, e14/examples/gsim4test/. It can be used easily with a macro file as follows.

```
./bin/gsim4test [macro file name] [output file name] \
    [number of events] [seed] [run number base]
```

The "seed" is a random seed for Mersenne Twister. Multiple runs can be processed in a macro file and the run number is assinged as "run number base"+0, "run number base"+1,···. Each command line argument can be omitted. If all the arguments are

omitted, an interactive mode of the gsim4test will be started, where each command inside the macro file can be typed one by one interacttively. Powerful help, history, and completion functions are supplied there.

The commands are structured like a directory tree. A command, "ls", shows commands in the directory.

```
cd e14/examples/gsim4test/↵
./bin/gsim4test↵
Gsim(PreInit)[/]
Gsim(PreInit)[/]ls↵
Command directory path : /
Sub-directories :
/control/ UI control commands.
/units/ Available units.
...
/GsimPhysicsListFactory/ ...Title not available...
...
Commands :
```

Tab is used for command completion. No space is allowed before the Tab. If there are some choices for the completion , just a beep is returned. Then press Tab again and the choices will be shown.

```
Gsim(PreInit)[/] /GsimP Tab  Tab
/GsimPhysicsListFactory/ /GsimPrimaryGeneratorActionFactory/
Gsim(PreInit)[/] /GsimPh Tab
Gsim(PreInit)[/] /GsimPhysicsListFactory/
Gsim(PreInit)[/] /GsimPhysicsListFactory/QGSP/b Tab
Gsim(PreInit)[/] /GsimPhysicsListFactory/QGSP/buildAndRegister
Gsim(PreInit)[/] /GsimPhysicsListFactory/QGSP/buildAndRegister↵
...
Gsim(Idle)[/]
```

Ctr+p or ↑ can be used for ascending history and Ctr+n or ↓ for decending history. Ctr+r is especially useful searching backward in the history. All the command history is stored in a file, /.g4hist at the exit of the gsim4test and the history will be loaed at the start of the gsim4test. You can also use similar command-line editing to the bash environment, Ctr+a, Ctr+k, Ctr+y,····.

```
Gsim(Idle)[/]  Ctr +p
Gsim(Idle)[/] /GsimPhysicsListFactory/QGSP/buildAndRegister
Gsim(Idle)[/] /GsimPhysicsListFactory/QGSP/buildAndRegister Ctr +a
Gsim(Idle)[/]  Ctr +k
Gsim(Idle)[/]  Ctr +y
Gsim(Idle)[/]  Ctr +r
```

A command, "help", shows help message.

```
Gsim(Idle)[/] help /GsimPhysicsListFactory/QGSP/buildAndRegister ↵

Command /GsimPhysicsListFactory/QGSP/buildAndRegister
Guidance :
Build and register this PhysicsList.
```

Tab is also used for file-name or directory-name completion with a space before the Tab.

```
Gsim(Idle)[/] /control/execute Space Tab
Makefile oglini.mac test13.mac
REQUIREMENTS oglsini.mac test13.root
...
beamline.mac shape.mac test2.mac
...
Gsim(Idle)[/] /control/execute sh Tab
Gsim(Idle)[/] /control/execute shape.mac
```

3 Overview

3.1 Macro

Aliases (variables) and loop control are supported as follows.

```
/control/alias sci_num  61
/control/alias loop_num 60
/control/loop cell.mac id 1 {loop_num}
```

`/control/alias` is used for defining an alias and defined alias can be used with {}. A loop is realized with `/control/loop ...`, where new alias (loop counter) is defined and used inside.

Calculations is supported for commands implemented in gsim4, where unit is added as `1*m`. Supported variables are pi (3.14159265358979323846), e (2.7182818284590452354), gamma (0.577215664901532861), radian (1.0), rad (1.0), degree (3.14159265358979323846/180.), and deg (3.14159265358979323846/180.). Supported functions are abs, min, max, sqrt,

pow, sin, cos, tan, asin, acos, atan, atan2, sinh, cosh, tanh, exp, log, and log10. Calculation is not supported for genuine geant4 commands, where unit is assigned at the last of the command.

3.2   Material

Standard atoms (G4Element) can be prepared in the Geant4 with G4NistElementBuilder. Some materials are also prepared with G4NistMaterialBuilder, which are shown in Appendix. **??**. Thier density is given in g/cm^3. and they are prepared under the standard temperature (273.15[K]) and pressure (1[atmomosphere]). Such materials can be used in gsim4 freely. You can add new material as follows.

3.2.1   Macro

```
/GsimMaterialManager/mixElementByWeight myHe  \
  1.*2./(0.082*300)/1000.*g/cm3  1*atmosphere 300*kelvin \
  He 0.999 N 0.001
/GsimMaterialManager/mixElementByNumber myCsI  \
4.53*g/cm3  1*atmosphere 300*kelvin Cs 1 I 1
```

It should be done before the material is used for some volumes.

3.2.2   Optical

```
/GsimMaterialFactory/GsimOpticalMaterial/build
```

You can call it at the first line of your macro file.

3.2.3   class

You can make a material class inheriting from
$E14_TOP_DIR/sources/sim/gsim4/Gsimkernel/GsimKernel/GsimMaterial.h
An example of such class is
$E14_TOP_DIR/sources/sim/gsim4/GsimMaterial/GsimMaterial/GsimOpticalMaterial.h

3.2.4   Special case

Some physics lists require material definition should be done before the physics lists are defined. Such physics lists are QGSP_HP, LHEP_BERT_HP and $\cdots$_HP which include neutron HP(high precision) simulation model. The LBE and GsimLowEnergyEMOp physics list also requires prior material definition. For such physicslist, you have to declare materials to be used beofre building the physics lists as follows.

```
/GsimMaterialManager/useNistMaterial G4_Ar G4_Xe G4_Al
```

The following material builder can also be used prior to building the physics lists.

```
   /GsimMaterialManager/mixElementByWeight myHe  \
     1.*2./(0.082*300)/1000.*g/cm3  1*atmosphere 300*kelvin \
     He 0.999 N 0.001
   /GsimMaterialManager/mixElementByNumber myCsI  \
   4.53*g/cm3  1*atmosphere 300*kelvin Cs 1 I 1
```

3.3 Physics list

A physics list shoud be selected at first.

```
   /GsimPhysicsListFactory/QGSP/buildAndRegister
```

or

```
   /GsimPhysicsListFactory/LHEP/buildAndRegister
```

Just one physics list should be selected and it can't be changed in one gsim4test process. All the physicslists prepared in geant4 can be used, which are shown in Appendix. **??**.

The QGSP_HP, LHEP_BERT_HP and $\cdots$_HP include neutron HP(high precision) simulation model. When such physics lists are used, you have to declare materials to be used as follows.

```
   /GsimMaterialManager/useNistMaterial G4_Ar G4_Xe G4_Al
```

The LBE and GsimLowEnergyEMOp physics list also requires prior material definition.

3.4 Particles (K_L)

The PDG code is used to identify particles. `http://pdg.lbl.gov/2006/mcdata/mc_particle_id_conte`
Ions can be expressed with Z and A as follows

alpha	1000020040
deuteron	1000010020
He3	1000020030
Triton	1000010030
$\cdots$	$\cdots$

Geant4 has K_L with mass, 0.497672[GeV], lifetime, 51.6[ns], and 4 main decay modes ($K\pi^3$, charged $K\pi^3$, $Ke3$, $K\mu3$) as shown in Table. **??**.

Table 1: K_L in Geant4.

name	PID	decay mode	branch
kaon0L	130	$K_L \to \pi^0\pi^0\pi^0$	19.83%
		$K_L \to \pi^+\pi^-\pi^0$	12.47%
		$K_L \to \pi^-e^+\nu_e$	20.20%
		$K_L \to \pi^+e^-\bar{\nu}_e$	20.20%
		$K_L \to \pi^-\mu^+\nu_\mu$	13.48%
		$K_L \to \pi^+\mu^-\bar{\nu}_\mu$	13.48%

Some K_L with specific decay modes are added in gsim4 as shown in Table. **??**.

Table 2: K_L added in gsim4.

name	PID	decay mode
KLpi0nunu	10000130	$K_L \to \pi^0\nu\bar{\nu}$
KLpienu	100130	$K_L \to \pi^-e^+\nu_e$ and $C.C.$
KLpimunu	200130	$K_L \to \pi^-\mu^+\nu_\mu$ and $C.C.$
KL3pi0	300130	$K_L \to \pi^0\pi^0\pi^0$
KLpipipi0	400130	$K_L \to \pi^+\pi^-\pi^0$
KLpipi	500130	$K_L \to \pi^+\pi^-$
KLpi0pi0	600130	$K_L \to \pi^0\pi^0$
KLpienugamma	700130	$K_L \to \pi^-e^+\nu_e\gamma$ and $C.C.$
KLpimunugamma	800130	$K_L \to \pi^-\mu^+\nu_e\gamma$ and $C.C.$
KL2gamma	900130	$K_L \to \gamma\gamma$
KLbeta	1000130	$K_L \to K^-e+\nu_e$
KLpi02gamma	2000130	$K_L \to \pi^0\gamma\gamma$
KLpi0pi0nunu	11000130	$K_L \to \pi^0\pi^0\nu\bar{\nu}$
KL2pi0gamma	12000130	$K_L \to \pi^0\pi^0\gamma$
KLpi0pi0Agamma	13000130	$K_L \to \pi^0\pi^0A\gamma$
KLpi0gamma	14000130	$K_L \to \pi^0\gamma$
KLpipigamma	15000130	$K_L \to \pi^+\pi^-\gamma$
KLeegamma	16000130	$K_L \to e^+e^-\gamma$
KLmumugamma	17000130	$K_L \to \mu^+\mu^-\gamma$
KLpi0gammaA	18000130	$K_L \to \pi^0\gamma A$
KLpipi0enu	19000130	$K_L \to \pi^\pm pi^0 e^\mp \nu$

Please ignore warnings such as `illegal code for meson PDG code=900130`.

If you want to know a particle name corresponding to some PDG code, `/particle/find` can be used as follows.

```
Gsim(PreInit)[/] /particle/find 130
kaon0L

— G4ParticleDefinition —
Particle Name : kaon0L
PDG particle code : 130 [PDG anti-particle code: 130]
Mass [GeV/c2] : 0.497672 Width : 1.287e-17
Lifetime [nsec] : 51.6
Charge [e]: 0
Spin : 0/2
Parity : -1
Charge conjugation : 0
Isospin : (I,Iz): (1/2 , 0/2 )
GParity : 0
Quark contents (d,u,s,c,b,t) : 1, 0, 0, 0, 0, 0
AntiQuark contents : 0, 0, 1, 0, 0, 0
Lepton number : 0 Baryon number : 0
Particle type : meson [kaon]
G4DecayTable: kaon0L
0: BR: 0.202 [KL3 Decay] : pi- e+ nu_e
1: BR: 0.202 [KL3 Decay] : pi+ e- anti_nu_e
2: BR: 0.1983 [Phase Space] : pi0 pi0 pi0
3: BR: 0.1348 [KL3 Decay] : pi- mu+ nu_mu
4: BR: 0.1348 [KL3 Decay] : pi+ mu- anti_nu_mu
5: BR: 0.1247 [Phase Space] : pi0 pi+ pi-
```

Another method is to use `/particle/select`.

```
Gsim(PreInit)[/] /particle/select kaon0L
Gsim(PreInit)[/] /particle/property/dump
```

3.5 Particle gun

A particle gun, GeneralParticleSource, is prepared in Geant4, which can be used in gsim4 as follows.

```
/GsimPrimaryGeneratorActionFactory/GsimGeneralParticleSource/\
buildAndRegister gps
/gps/particle pi+
/gps/energy 1 GeV
/gps/direction 0 0 1
```

Some gps features are as follows.

```
/gps/ang/type beam2d
/gps/ang/sigma_x 0.001 rad
/gps/ang/sigma_y 0.0023 rad

/gps/ang/rot1 -1 0 0
/gps/ang/rot2 0 1 0

/gps/pos/type Beam
/gps/pos/sigma_x 1.3 mm
/gps/pos/sigma_y 1.3 mm
```

- `/gps/ang/type beam2d,sigma_x,sigma_y`
  Beam angle distribution is 2d Gaussian.

- `/gps/ang/rot1 -1 0 0`
  The x'-axis is $(-1, 0, 0)$ in xyz-cordinate system, where x'y'z'-axes are the rotated cordinate system. The angle distribution is measured from (1,0,0) in x'y'z'-corrdinate system.

- `/gps/ang/rot2 0 1 0`
  The y'-axis is $(0, 1, 0)$ in xyz-cordinate system, where x'y'z'-axes are the rotated cordinate system. The angle distribution is measured from (0,0,1) in x'y'z'-corrdinate system.

- `/gps/pos/type Beam,sigma_x,sigma_y`
  The beam position distribution is 2d Gaussian.

3.6 Particle spectrum

Vertex or momentum spectrum can be added to the particle gun. This modify vertex or momentum for the gun at the last stage. Following variables can be used to set the spectrum and ROOT TF1 formula can be used for the spectrum, where thier unit is mm, MeV, or rad.

- VX : vertex x.

- VY : vettex y.

- VZ : vertex z.

- VR : vertex r.

- VTheta : vertex theta.

- VCosTheta : vertex cosTheta.

- VPhi : vertex phi.

- PAbs : absolute momentum.

- Energy : kinetic energy.

- PTheta : momentum theta.

- PCosTheta : momentum cosTheta.

- PPhi : momentum phi

It is possible to set multiple spectrum for a gun but only one variable can be used per one formula.

```
/GsimSpectrumFactory/GsimSpectrum/buildAndRegister
/GsimSpectrum/GsimSpectrum/addSpectrum TMath::Gaus(PAbs,3,1) 0 10
/GsimSpectrum/GsimSpectrum/addSpectrum TMath::Gaus(VX,0,1) -5 5
```

Some special vertex and momentum spectra are prepared for E391 and E14.

```
/GsimSpectrumFactory/GsimE391Spectrum/buildAndRegister
/GsimSpectrum/GsimE391Spectrum/addSpectrum Special
```

```
/GsimSpectrumFactory/GsimE391HalonSpectrum/buildAndRegister
/GsimSpectrum/GsimE391HalonSpectrum/addSpectrum Special
```

```
/GsimSpectrumFactory/GsimE391CorenSpectrum/buildAndRegister
/GsimSpectrum/GsimE391CorenSpectrum/addSpectrum Special
```

```
/GsimSpectrumFactory/GsimE14Spectrum/buildAndRegister
/GsimSpectrum/GsimE14Spectrum/addSpectrum Special
```

```
/GsimSpectrumFactory/GsimE14HalonSpectrum/buildAndRegister
/GsimSpectrum/GsimE14HalonSpectrum/addSpectrum Special
```

For E14 Halon Spectrum, you can specify the spectgrum seed file with E14_HALO_N_SPECTRUM_DATA E391_HALO_N_SPECTRUM_DATA or E391_CORE_N_SPECTRUM_DATA can be used too.

You can implement your own spectrum in the same way.

3.7 Detector

A detector has a name and full path. The world has a name,'world' and full path,'/world', which is automatically created box by the gsim4. If a detector with its name of 'A' is placed inside the world, the detector has a name, 'A' and full path, '/world/A'. The detector placement is treated as a directory tree.

```
/GsimPhysicsListFactory/QGSP/buildAndRegister
/GsimPrimaryGeneratorActionFactory/GsimGeneralParticleSource/\
buildAndRegister gps
/gps/particle pi+
/gps/energy 1 GeV
/gps/direction 0 0 1
/control/execute oglini.mac
/GsimDetector/world/setParameters 30*cm 30*cm 30*cm
/GsimDetectorFactory/GsimBox/buildAndRegister box /world 0 0 0 0 0 0
/GsimDetector/world/box/setParameters 10*cm 10*cm 10*cm
/GsimDetectorFactory/GsimBox/buildAndRegister box2 /world/box \
                 1*cm 1*cm 0 30*deg 30*deg 0
/GsimDetector/world/box/box2/setParameters 3*cm 3*cm 3*cm
/GsimEventAction/setVisualizationMode 1
/GsimDetectorManager/update
/vis/scene/add/axes 0 0 0 10 cm
```
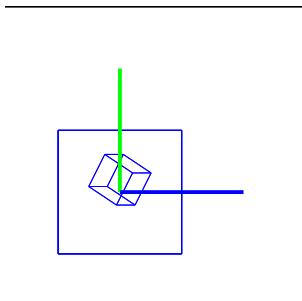

Figure 1: The placement and rotation in the gsim4. The red, green, blue axes are x, y, z axes, respectively. The length of the axis line is 10 cm.

`/control/execute oglini.mac` is just for OpenGL visualization. The world is a box which has 3 paramters, full length of x, y, and z. Such parameters can be set with `/GsimDetector/world/setParameters 30*cm 30*cm 30*cm`. Then, a new detector (box shaep), box, is created and placed at (0,0,0) with a rotation vector (0,0,0). Another box detector, box2, is created inside the "box" at (1*cm,1*cm,0) with a rotation vector (30*deg 30*deg 0) with respect to the cordinate system of "box".

Such rotation vector is the object rotation vector (not frame rotation vector). It means to rotate around x-axis with x component of the rotation vector, then rotate around y-axis with y component of the rotation vector, and finally rotate around z-axis with z component of the rotation vector.

Actual volume creation, placement and rotation are performed after `/GsimDetectorManager/update` is called.

3.7.1   Shapes

Several primitive shapes of detectors are prepared as follows.
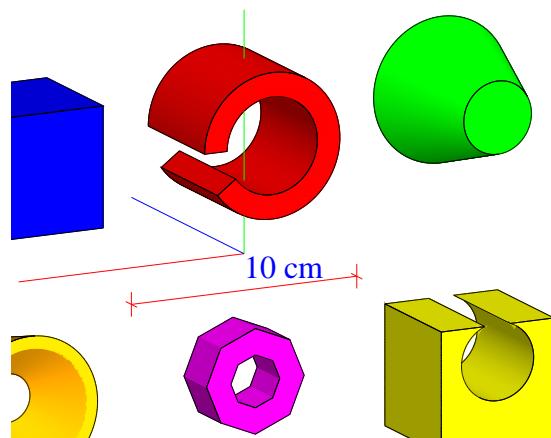
Figure 2: The primitive shapes used in the gsim4. The red, green, blue axes are x, y, z axes, respectively.

```
/control/alias pos 5*cm

/GsimPhysicsListFactory/QGSP/buildAndRegister
/GsimPrimaryGeneratorActionFactory/GsimGeneralParticleSource/buildAndRegister gps
/GsimDetector/world/setOuterVisibility false

/GsimDetectorFactory/GsimBox/buildAndRegister box /world 2*{pos} {pos} 0
/GsimDetector/world/box/setParameters 5*cm 5*cm 5*cm
/GsimDetector/world/box/setOuterColor blue

/GsimDetectorFactory/GsimTube/buildAndRegister tube /world 0 {pos}  0
/GsimDetector/world/tube/setParameters 2*cm 3*cm 5*cm 0*rad 0.9*2.*pi*rad
/GsimDetector/world/tube/setOuterColor red

/GsimDetectorFactory/GsimCone/buildAndRegister cone /world -2*{pos} {pos} 0
/GsimDetector/world/cone/setParameters 1.5*cm 3*cm 5*cm
/GsimDetector/world/cone/setOuterColor green

/GsimDetectorFactory/GsimPolycone2/buildAndRegister pc2 /world 2*{pos} -{pos} 0
/GsimDetector/world/pc2/setParameters 0*deg 360*deg 20*mm 25*mm 30*mm 10*mm 25*mm
/GsimDetector/world/pc2/setOuterColor orange

/GsimDetectorFactory/GsimPolyhedra2/buildAndRegister ph2 /world 0 -{pos} 0
/GsimDetector/world/ph2/setParameters 0*deg 360*deg 8 20*mm 10*mm 20*mm
/GsimDetector/world/ph2/setOuterColor magenta

/GsimDetectorFactory/GsimBoxWithAHole/buildAndRegister boxh /world -2*{pos} -{pos} 0
/GsimDetector/world/boxh/setParameters 5*cm 5*cm 5*cm 0*cm 1*cm 1.6*cm
/GsimDetector/world/boxh/setOuterColor yellow

/GsimEventAction/setVisualizationMode 1
/control/execute oglsini.mac
#/control/execute dawnini.mac

/vis/viewer/set/viewpointThetaPhi 150 30
/vis/viewer/set/style s
/vis/scene/add/axes 0 0 0 10 cm
/vis/scene/add/scale 10 cm x 1 0 0 manual 0 -1.5 0 cm
/GsimDetectorManager/update
```

The commands correspondig to such basic shapes are as follows. The shape parameters can be set with `/GsimDetector/world/setParameters` with parameters. The number of such paramaeters must be the same as that required for the corresponding shape.

- /GsimDetectorFactory/GsimDetector/buildAndRegister
  This detector has no physical volume but just has logical structure, which can be used for grouping subdetectors. The number of dimensional parameters is 0.

- /GsimDetectorFactory/GsimBox/buildAndRegister
  The box shape. The number of dimensional parameters is 3.
  full length in x
  full length in y
  full length in z

- /GsimDetectorFactory/GsimBoxWithAHole/buildAndRegister
  The box shape with a hole inside. The number of dimensional parameters is 6.
  full length in x for the box
  full length in y for the box
  full length in z for the box
  x position of the center of the circle
  y position of the center of the circle

radius of the circle

- /GsimDetectorFactory/GsimCone/buildAndRegister
  The cone shape. The number of dimensional parameters is 3.
  inner radius
  outer radius
  full length in z

- /GsimDetectorFactory/GsimPolycone2/buildAndRegister
  The polycone shape with 2 circler plains. The number of dimensional parameters is 7.
  start of the phi angle.
  opening ange for the phi
  full length in z
  inner radius for smaller z
  outer radius for smaller z
  inner radius for larger z
  outer radius for larger z

- /GsimDetectorFactory/GsimPolyhedra2/buildAndRegister
  The polyhedra shape with 2 rectangular plains. The number of dimensional parameters is 6. start of the phi angle.
  opening ange for the phi
  number of sides
  full length in z
  inner radius
  outer radius

- /GsimDetectorFactory/GsimTrap/buildAndRegister
  The trapezoidal shape. The number of dimensional parameters is 11.
  full length in z
  polar angle of the line joining the centres of the z faces
  azimuthal angle of the line joing the centre of the z faces
  full length along y on the plain of smaller z
  full length along x of the side at smaller y on the plain of smaller z
  full length along x of the side at larger y on the plain of smaller z
  angle of line joining the centres of the y sides w.r.t. the y axis on the plain of smaller z
  full length along y on the plain of larger z
  full length along x of the side at smaller y on the plain of larger z
  full length along x of the side at larger y on the plain of larger z
  angle of line joining the centres of the y sides w.r.t. the y axis on the plain of larger z

- /GsimDetectorFactory/GsimTube/buildAndRegister
  The tube shape. The number of dimensional parameters is 5.
  inner radius
  outer radius
  full length in z

start of the phi angle.
opening ange for the phi

3.7.2 Volume material

Most outer volume for the detector can be modified. New material is assigned as follows.

```
/GsimDetector/world/box/setOuterMaterial G4_Fe
```

All defined materials can be used including materials defined in G4NistMaterialBuilder, which are shown in Appendix. **??**.

3.7.3 Magnetic field

Magnetic field can be applied as follows.

```
/GsimDetector/world/box/setThisMagneticField 2*T 0 0
```

The arguments means x, y, and z components of the magnetic field.

3.7.4 Clone

All the physical detector is created with G4PVPlacement. "Clone" method is implemented to make another G4PVPlacement with the same G4Logical volume, which means also the same G4Solid.

3.8 Sensitivity

The detector sensitivity can be applied as follows.

```
/GsimDetector/world/e391/tube/setSensitiveDetectorWithName tube 0
```

Here, most outer volume for the tube get sensitivity with module ID, 0. Its SDname is tube.

3.9 Data storage

The data stored event by event are track information, hits information, and, digi information. Hits corresponds to all the steps with energy deposition. Digi corresponds to the sum of the hits per sensitive detector channnel. To store data or not can be controlled as follows. The hits information may become very huge, so it is not stored by default. Some fast simulation require hits information. Other data are stored by default.

```
/GsimTrackingAction/setBriefTrackStore false
/GsimDetector/world/e14/cv/setHitsStore true
/GsimDetector/world/setThisAndDaughterHitsStore true
/GsimDetector/world/e14/cv/setDigiStore true
/GsimDetector/world/setThisAndDaughterDigiStore true
```

Some commands to control the data storage are as follows.

- **/GsimTrackingAction/setForceStorePrimary true**
  Store primary information even if setBriefTrackStore is false.

- **/GsimTrackingAction/setTrackHistory true**
  Track history is filled or not.

- **/GsimTrackingAction/addPIDToMonitor pid**
  This pid is also monitored for the brief track.

- **/GsimTrackingAction/clearPIDToMonitor**
  Such monitor is canceled.

- **/GsimTrackingAction/addPIDToTrigger pid**
  If particles with the pid are generated, the event is triggered for storage.

- **/GsimTrackingAction/clearPIDToTrigger**
  Such trigger is canceled.

- **/GsimTrackingAction/addPIDToKill pid**
  If a track with the pid is generated, the track is killed immediately. The information of the track is stored in the GsimGenParticleData if the pid is added for the monitoring.

- **/GsimTrackingAction/clearPIDToKill**
  Clear such pids to be killed.

- **/GsimTrackingAction/setStoreAllTracks true**
  All the tracks are sotred in GsimGenParticleData.

- **/GsimEventAction/setSkipEmptyData false**
  Skip if no data is filled in the sensitive detectors.

3.10   Fast simulation

There are five kinds of fast simulation. One and two are to set fast simulation level at detector, third is to set online threshold at detector, and fourth is to use ordering of track stacking, and fifth is to trigger with the end point of the primary track.

3.10.1   Fast simulation level at detector

Fast simulations can be done by assigning a fast simulation level to detectors as follows.

```
/GsimDetector/world/e391/tube/setFastSimulationLevel 5
```

It effects all detectors inside the detector. The meaning of the fast simulation levels are

- setFastSimulationLevel 6
  This level is used for E14/E391 fast simulation. Some unsensitive volumes are changed to be sensitive and some support-structure voluems are moved to far upstream and become invisible. Particles are stopped at the volume surface of the

detector. Such particle is treated as a hit, so "setHitsStore true" is probably used together.

- setFastSimulationLevel 5
  Particles are stopped at the volume surface of the detector. Such particle is treated as a hit, so "setHitsStore true" is probably used together.

- setFastSimulationLevel 4
  Particles are stopped at one step inside the volume of the detector.

- setFastSimulationLevel 3
  Stop particles generated through "conv", "eBrem", and, "annihil". (Stop shower-origin particles.)

- setFastSimulationLevel 2
  Postpone a track process if the track pass the boundary of brief detector.

3.10.2 Online threshold at detector

The detecor online veto threshold is emulated. If the energy deposition at the sensitive detector exceeds the threshold, the event will be aborted immediately.

```
/GsimSensitiveDetector/FBAR/setOnlineVetoThreshold 0.05*GeV
```

3.10.3 Stacking ordering

All the tracks are once stored in a stack, then which track in the stack will be processed first is decided with the stacking ordering.

```
/GsimStackingAction/setBriefDtectorOrder BHCV CV BCV CC04\cdots
```

3.10.4 Trigger with the end point of the primary track.

This set the trigger z region for the the end point of the primary track. If the end point of the primary track is located outside the region, the event will be aborted immediately.

```
/GsimStackingAction/triggerPrimaryEndZ -10*m 10*m\cdots
```

3.11 Visualization

Some visualization control.

- /GsimEventAction/setVisualizationMode 1
  Tracks are displayd if some event display is prepared.

- /GsimEventAction/setAccumulationNumber num
  Set number of events overplayed in some event display.

- /GsimSteppingAction/setParticleColor pid colorName
  Set color of tracks.

3.12 Debug

- /GsimTrackingAction/setTrackDump true
  Dump of all tracks.

- /GsimEventAction/setVerboseLevel 0..4

  - 0 : verbosity off

  - 1 : error

  - 2 : warning

  - 3 : info

  - 4 : debug

- /GsimEventAction/setDumpMode 0..3

  - 0 : no dump
  - 1 : dump first 10 events
  - 2 : dump all events
  - 3 : dump all events with timing

- /GsimEventAction/writeDictionary true
  Write a text-file dicitonary.

4 Optical photon Simulation

$E14_TOP_DIR/examples/gsim4test/test15.mac

$E14_TOP_DIR/examples/gsim4test/test16.mac

5 E14 Fast Simulation

There are three steps.

1. Fast simulation (particle decay and transportation)
   The same geomery as the full simulation is used. The gsim4test with the fastSimulationLevel, 6, is used.

2. Detector fast simulation
   Some smearing on the energy and angle is applied. Fusion in CsI is treated. Veto weights are calculated according to the models of the detector ineffieicnecy. Finally events are classified with the number of clusters in the CsI.

3. Two gamma analysis is applied for the $K_L \rightarrow \pi^0 \nu\nu$ analysis.

6 Developement

6.1 Adding Branch or Histogram

Some member functions of GsimPersistencyManager can be used. The GsimPersistencyManager class is a singleton class, which can be used at anywhere with "GsimPersistencyManager::getPersistencyManager()".

```
void GsimPersistencyManager::setBranchOf(std::string treeName,
                  std::string title,
                  std::string className,
                  void* address);

void GsimPersistencyManager::setBranchOf(std::string treeName,
                  std::string title,
                  void* address,
                  std::string format);
```

The "treeName" can be "runTree","eventTree",⋯. "format" can be "num/I", "val/D" as used in "ROOT".

```
TH1D* GsimPersistencyManager::createHistogram(char* name,char* title,
                        int nbin,double xmin,double xmax);
void  GsimPersistencyManager::fillHistogram(char* name,double value);

TH2D* GsimPersistencyManager::createHistogram(char* name,char* title,
                        int nbinx,double xmin,double xmax,
                        int nbiny,double ymin,double ymax);
void  fillHistogram(char* name,double xvalue,double yvalue);
```

The useage is as follows. You can find some example in
$E14TOPDIR/sources/sim/gsim4/GsimE14Spectrum/src/GsimE14HalonSpectrum.cc.

```
GsimPersistencyManager::getPersistencyManager()
    ->createHistogram("hE14HalonMome","hE14HalonMome [GeV/c]",
                    150,0,15);
GsimPersistencyManager::getPersistencyManager()
    ->fillHistogram("hE14Mome",p.mag());
```

6.2 Your own detector class

7 Analysis

8 Description about the stored data structure

The Data is stored in ROOT TTree in TFile.

```
root↵
 std::string dir=std::getenv("E14_TOP_DIR");
dir+="/lib/so/libGsimData.so");
gSystem->Load(dir.c_str());
TFile* tf = new TFile(''tmp.root''); tf->ls(); TFile** tmp.root
TFile* tmp.root
KEY: TTree detectorTree00;1 detectorTree00
KEY: TTree physicalVolumeTree00;1 physicalVolumeTree00
KEY: TTree processTree00;1 processTree00
KEY: TTree eventTree00;1 eventTree00
KEY: TTree eventSeedTree00;1 eventSeedTree00
KEY: TTree commandTree;1 commandTree
KEY: TTree runTree;1 runTree
```
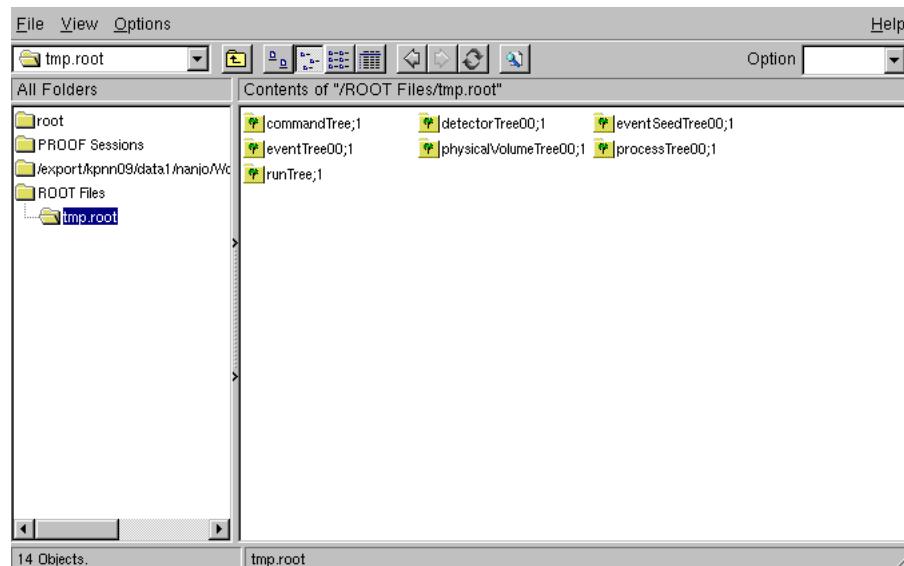

Figure 3: Top.

- commandTree
  Each command typed or in macro file.

- runTree

- detectorTree00

- physicalVolumeTree00

- processTree00

- eventTree00

- eventSeedTree00

8.1   commandTree

Each command typed or executed in macro file is sotred.
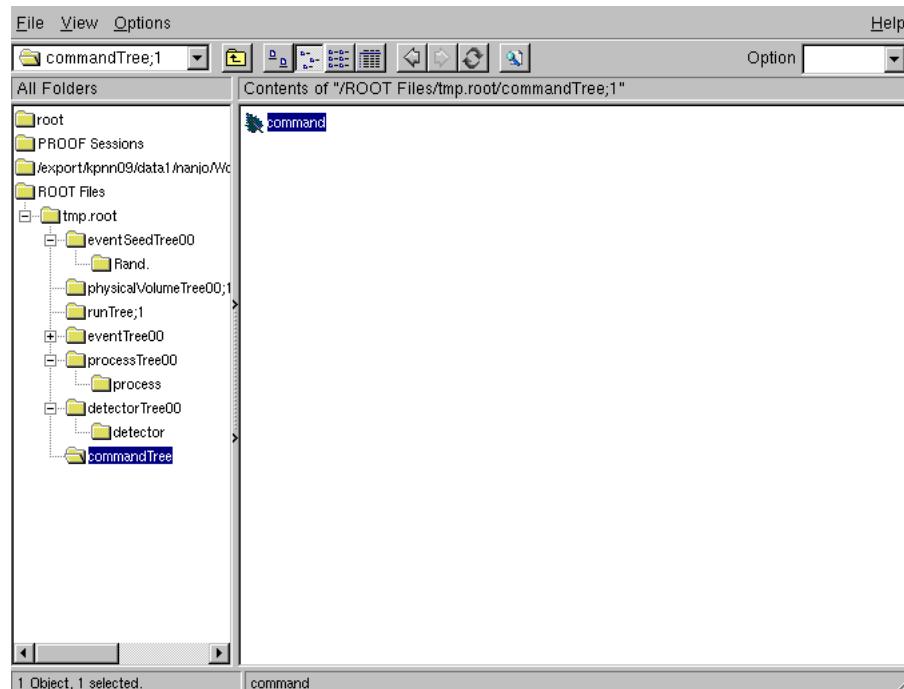
Figure 4: commandTree.

8.2 runTree
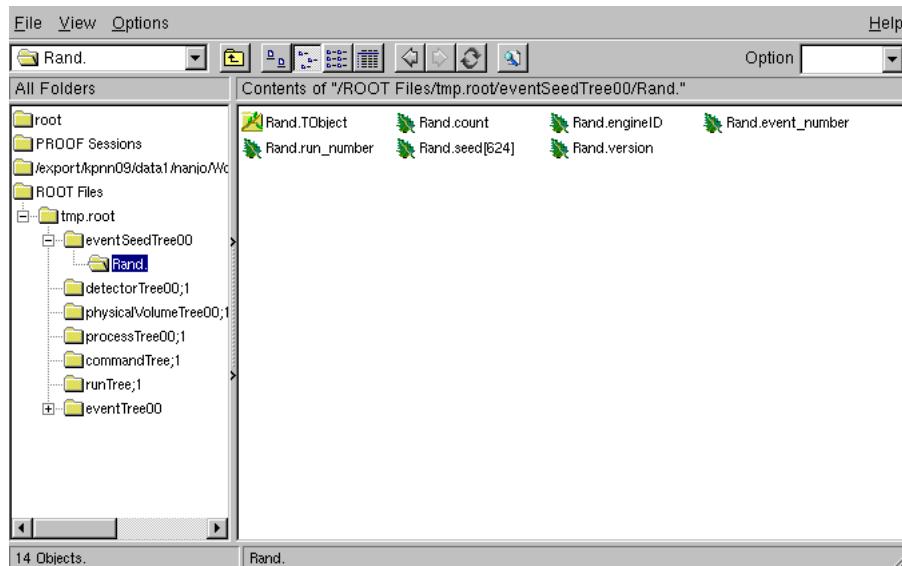
Figure 5: runTree.

- runNumber

- runID

- nEventsRequested

- nEventsProcessed

- nEventsStored

- version

8.3   processTree
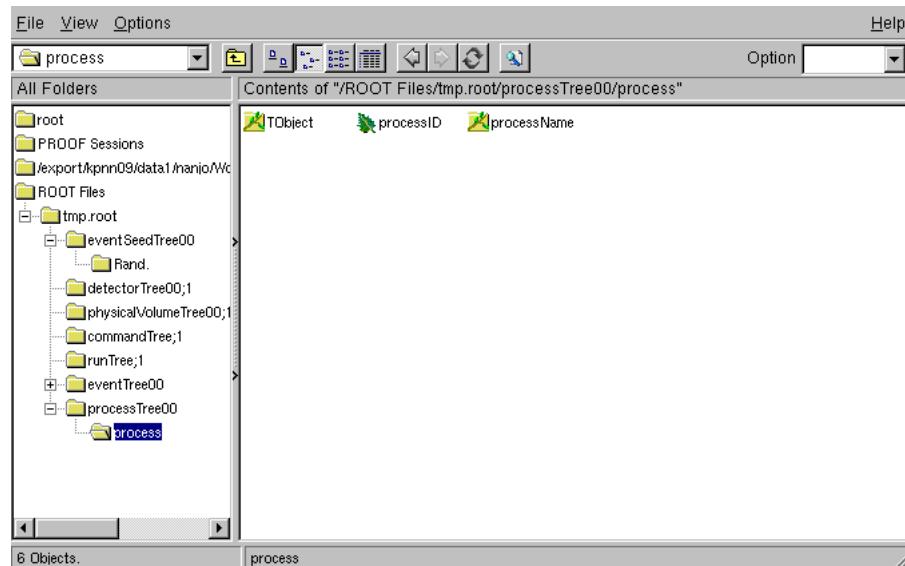
Figure 6: processTree

- processID

- processName

8.4   physicalVolumeTree
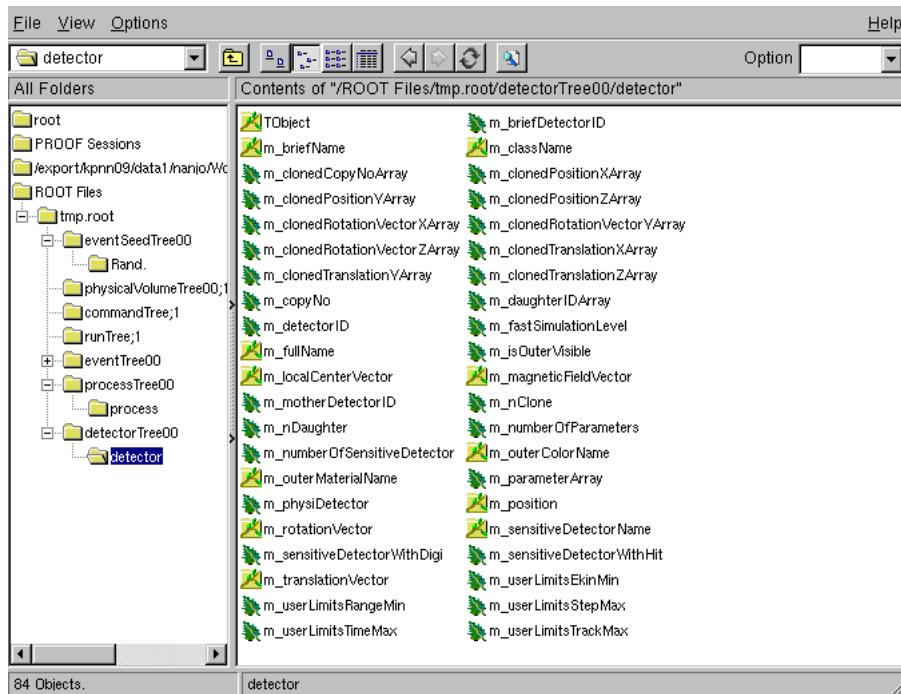
Figure 7: pysicalVolumeTree.

- pvName

- pvopyNo

- detID

- detFullName

- detBriefName

- sdFlag

- sdName

- sdID

- sdNch

- sdChID[sdNch]

- sdClIDl[sdNch]

8.5 detectorTree
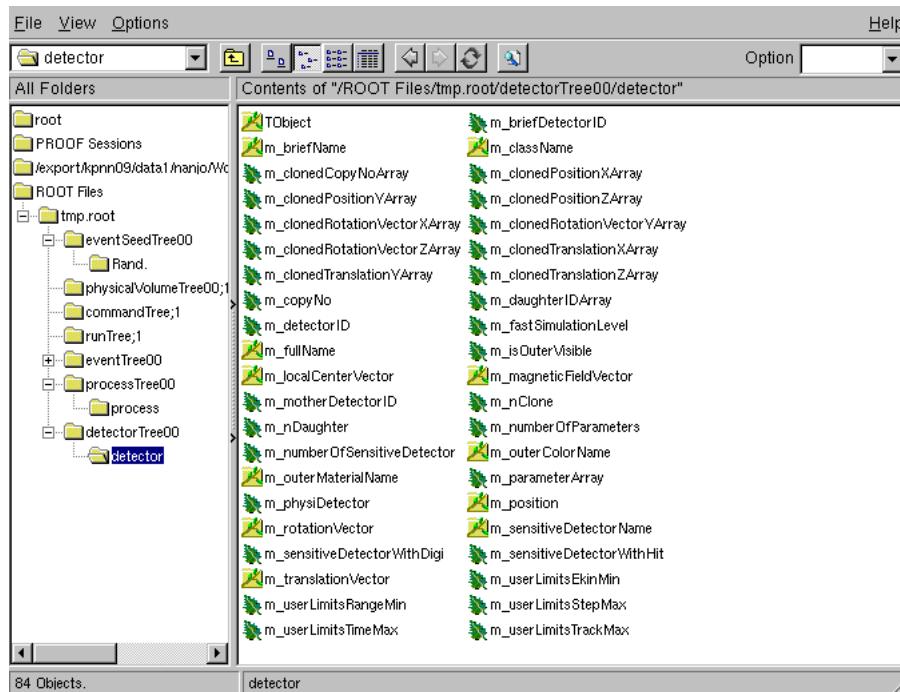
Figure 8: detectorTree.

8.6 eventSeedTree
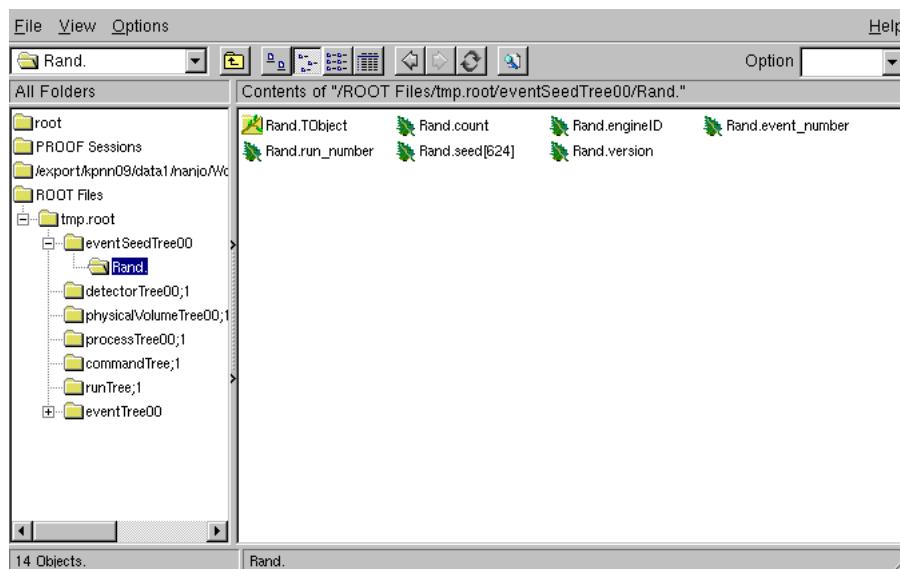
Figure 9: eventSeedTree.

- run_number

- event_number

- engineID

- seed[624]

- count

- version

8.7 eventTree

Digi/hits information is stored in corresponding sensitive detector.
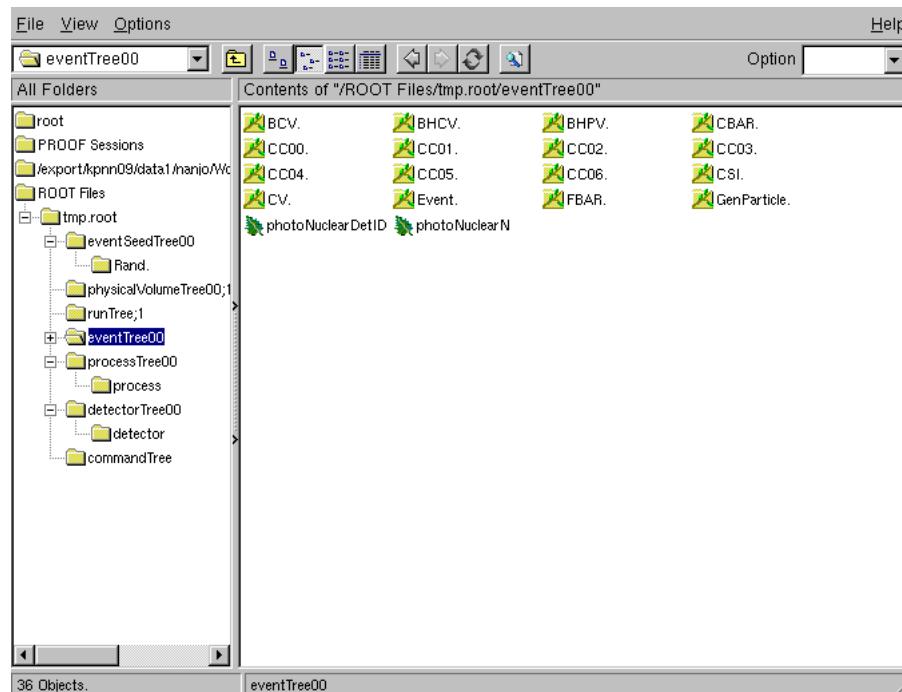
Figure 10: eventTree.

8.7.1 GenParticle

GenParticle is ROOT "TClonesArray" for GsimBriefTrack.
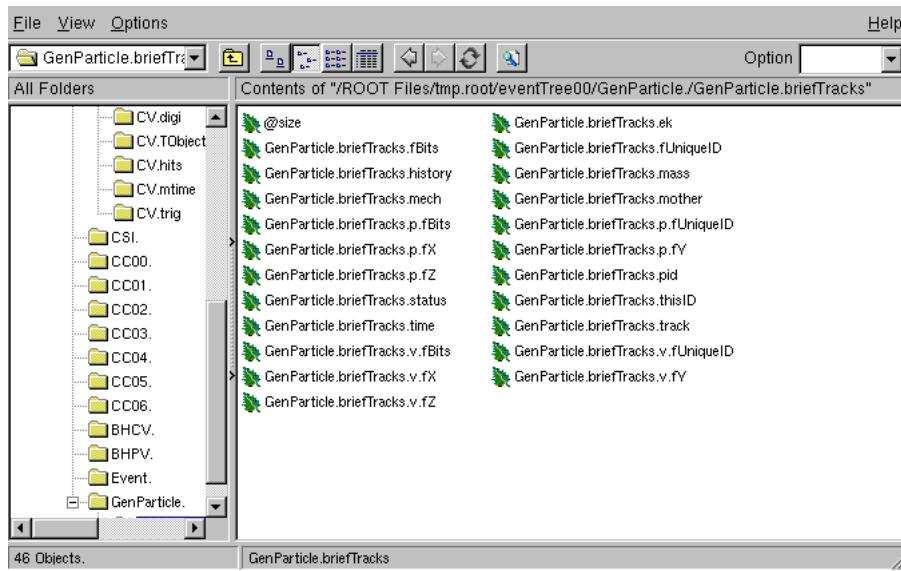
Figure 11: briefTracks.

- GenParticle.briefTracks
  The TClonesArray for GsimTrackDaa.

- GenParticle.briefTracks.track
  The track ID (assinged by Geant4).

- GenParticle.briefTracks.mother
  The track ID for the mother track, which is stored as breif tracks.

- GenParticle.briefTracks.pid
  The particle ID.

- GenParticle.briefTracks.p
  TVector3 momentum.

- GenParticle.briefTracks.ek
  Kinetic energy.

- GenParticle.briefTracks.mass
  Mass.

- GenParticle.briefTracks.time
  The time the particle is created.

- GenParticle.briefTracks.v
  The vertex position where the particle is created.

- GenParticle.briefTracks.mech
  The id of the creation mechanism for the track.

- GenParticle.briefTracks.status
  The track status.

- GenParticle.briefTracks.thisID
  ID assigned by gsim4.

- GenParticle.briefTracks.history
  The volume history.

- GenParticle.version
  The version of this data structre.

8.7.2   Sensitive detector

Digi, hits, etc are for each sensitive detector are stored..
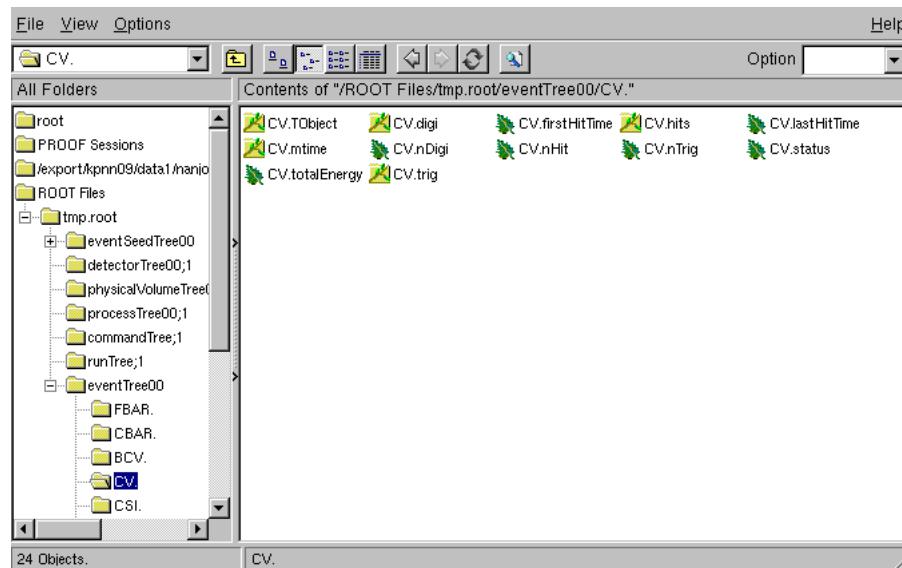
Figure 12: Sensitive detector, for example CV.
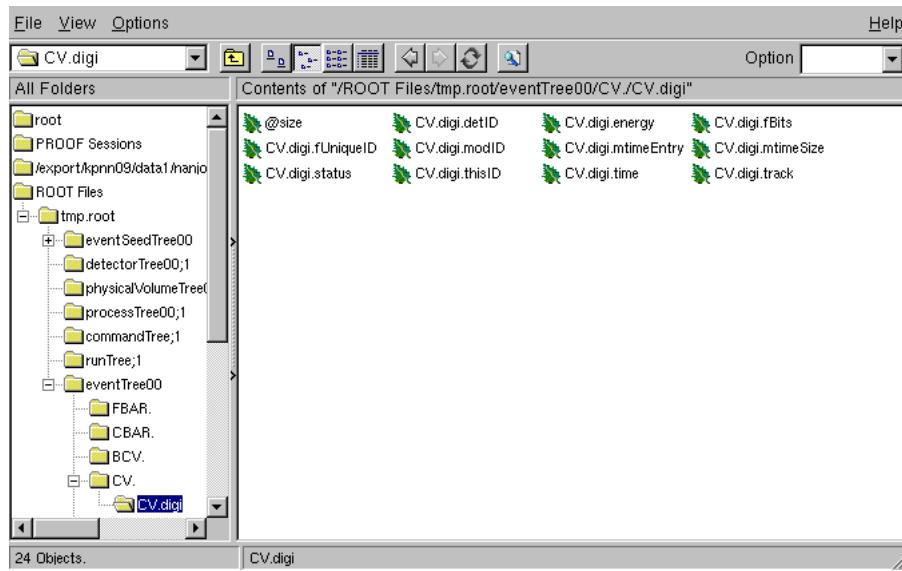
Figure 13: digi for example, CV.

- CV.digi.detID
  detector ID.

- CV.digi.modID
  module ID (channel assignment).

- CV.digi.energy
  total energy deposition at the module.

- CV.digi.time
  First hit timing (threshold/pileup effects are treated).

- CV.digi.thisID
  ID for TClonesArray of GsimDigiData.

- CV.digi.status (stop+10*fastSimulationLevel)
  fAlive:Continue the tracking
  fStopButAlive:Invoke active rest physics processes and kill the current track afterward
  fStopAndKill: Kill the current track
  fKillTrackAndSecondaries: Kill the current track and also associated secondaries.
  fSuspend:Suspend the current track
  fPostponeToNextEvent: Postpones the tracking of thecurrent track to the next event.

- CV.digi.track
  Stored track ID

- CV.digi.mtimeEntry
  Digi is created form bounch of hits along time. Suc hits are stored in mtime. mtimeEntry point to that.

- CV.digi.mtimeSize
  number of mtime entry.
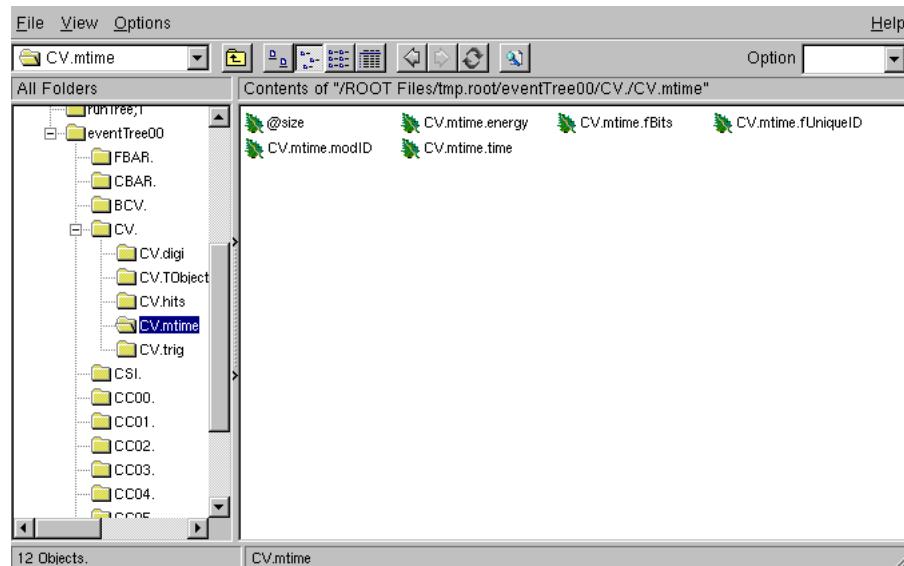
Figure 14: mtime.

- CV.mtime.modID
  module ID.

- CV.mtime.energy
  multi hit time energy.

- CV.mtime.time
  multi hit time.
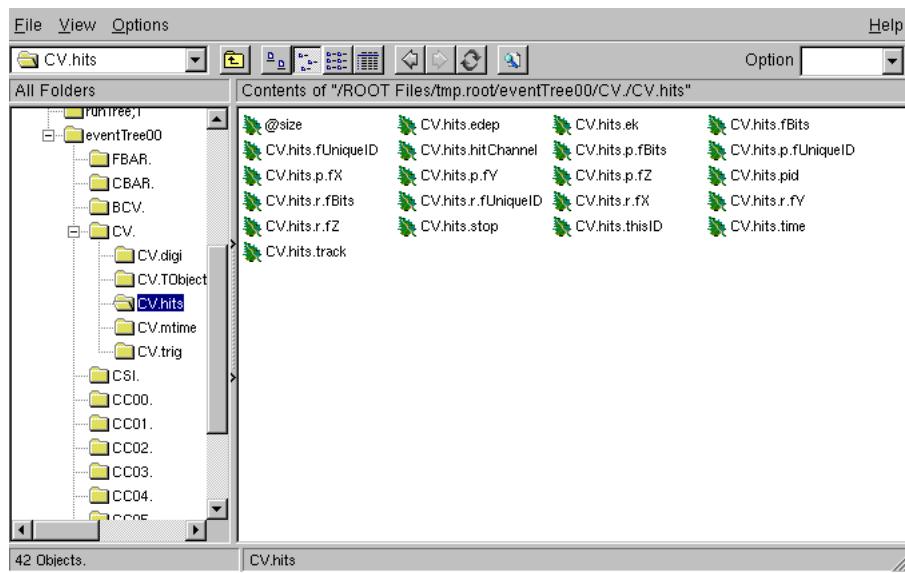
Figure 15:

- CV.hits.thisID

- CV.hits.track
  track ID

- CV.hits.stop
  stop flag

- CV.hits.hitChannel
  hit channel

- CV.hits.time
  hit time

- CV.hits.edep
  edep.

- CV.hits.pid
  pid.

- CV.hits.r
  position

- CV.hits.ek
  kinetic energy

- CV.hits.p
  momentum
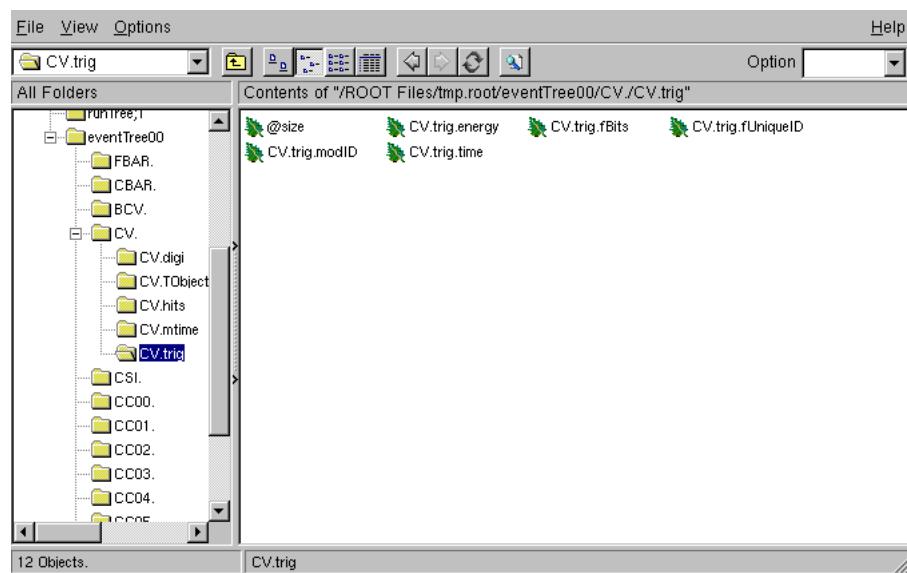
Figure 16: trig.

- CV.trig.modID
  triggered moduleID

- CV.trig.energy
  triggered module energy

- CV.trig.time
  triggered time.

A Materials prepared in Geant4

```
AddMaterial("G4_H" , 8.37480e-5,  1,  19.2, 1, kStateGas);
AddMaterial("G4_He", 1.66322e-4,  2,  41.8, 1, kStateGas);
AddMaterial("G4_Li", 0.534      ,  3,  40. );
AddMaterial("G4_Be", 1.848      ,  4,  63.7);
AddMaterial("G4_B" , 2.37       ,  5,  76. );
AddMaterial("G4_C" , 2.         ,  6,  81. );
AddMaterial("G4_N" , 1.16520e-3,  7,  82. , 1, kStateGas);
AddMaterial("G4_O" , 1.33151e-3,  8,  95. , 1, kStateGas);
AddMaterial("G4_F" , 1.58029e-3,  9, 115. , 1, kStateGas);
AddMaterial("G4_Ne", 8.38505e-4, 10, 137. , 1, kStateGas);
AddMaterial("G4_Na", 0.971      , 11, 149. );
AddMaterial("G4_Mg", 1.74       , 12, 156. );
AddMaterial("G4_Al", 2.699      , 13, 166. );
AddMaterial("G4_Si", 2.33       , 14, 173. );
AddMaterial("G4_P" , 2.2        , 15, 173. );
AddMaterial("G4_S" , 2.0        , 16, 180. );
AddMaterial("G4_Cl", 2.99473e-3, 17, 174. , 1, kStateGas);
AddMaterial("G4_Ar", 1.66201e-3, 18, 188.0, 1, kStateGas);
AddMaterial("G4_K" , 0.862      , 19, 190. );
AddMaterial("G4_Ca", 1.55       , 20, 191. );
AddMaterial("G4_Sc", 2.989      , 21, 216. );
AddMaterial("G4_Ti", 4.54       , 22, 233. );
AddMaterial("G4_V" , 6.11       , 23, 245. );
AddMaterial("G4_Cr", 7.18       , 24, 257. );
AddMaterial("G4_Mn", 7.44       , 25, 272. );
AddMaterial("G4_Fe", 7.874      , 26, 286. );
AddMaterial("G4_Co", 8.9        , 27, 297. );
AddMaterial("G4_Ni", 8.902      , 28, 311. );
AddMaterial("G4_Cu", 8.96       , 29, 322. );
AddMaterial("G4_Zn", 7.133      , 30, 330. );
AddMaterial("G4_Ga", 5.904      , 31, 334. );
AddMaterial("G4_Ge", 5.323      , 32, 350. );
AddMaterial("G4_As", 5.73       , 33, 347. );
AddMaterial("G4_Se", 4.5        , 34, 348. );
AddMaterial("G4_Br", 7.07210e-3, 35, 343. , 1, kStateGas);
AddMaterial("G4_Kr", 3.47832e-3, 36, 352. , 1, kStateGas);
AddMaterial("G4_Rb", 1.532      , 37, 363. );
AddMaterial("G4_Sr", 2.54       , 38, 366. );
AddMaterial("G4_Y" , 4.469      , 39, 379. );
AddMaterial("G4_Zr", 6.506      , 40, 393. );
AddMaterial("G4_Nb", 8.57       , 41, 417. );
AddMaterial("G4_Mo", 10.22      , 42, 424. );
AddMaterial("G4_Tc", 11.50      , 43, 428. );
AddMaterial("G4_Ru", 12.41      , 44, 441. );
AddMaterial("G4_Rh", 12.41      , 45, 449. );
```

```
AddMaterial("G4_Pd", 12.02        , 46, 470. );
AddMaterial("G4_Ag", 10.5         , 47, 470. );
AddMaterial("G4_Cd",  8.65        , 48, 469. );
AddMaterial("G4_In",  7.31        , 49, 488. );
AddMaterial("G4_Sn",  7.31        , 50, 488. );
AddMaterial("G4_Sb",  6.691       , 51, 487. );
AddMaterial("G4_Te",  6.24        , 52, 485. );
AddMaterial("G4_I" ,  4.93        , 53, 491. );
AddMaterial("G4_Xe",  5.48536e-3, 54, 482. , 1, kStateGas);
AddMaterial("G4_Cs",  1.873       , 55, 488. );
AddMaterial("G4_Ba",  3.5         , 56, 491. );
AddMaterial("G4_La",  6.154       , 57, 501. );
AddMaterial("G4_Ce",  6.657       , 58, 523. );
AddMaterial("G4_Pr",  6.71        , 59, 535. );
AddMaterial("G4_Nd",  6.9         , 60, 546. );
AddMaterial("G4_Pm",  7.22        , 61, 560. );
AddMaterial("G4_Sm",  7.46        , 62, 574. );
AddMaterial("G4_Eu",  5.243       , 63, 580. );
AddMaterial("G4_Gd",  7.9004      , 64, 591. );
AddMaterial("G4_Tb",  8.229       , 65, 614. );
AddMaterial("G4_Dy",  8.55        , 66, 628. );
AddMaterial("G4_Ho",  8.795       , 67, 650. );
AddMaterial("G4_Er",  9.066       , 68, 658. );
AddMaterial("G4_Tm",  9.321       , 69, 674. );
AddMaterial("G4_Yb",  6.73        , 70, 684. );
AddMaterial("G4_Lu",  9.84        , 71, 694. );
AddMaterial("G4_Hf", 13.31        , 72, 705. );
AddMaterial("G4_Ta", 16.654       , 73, 718. );
AddMaterial("G4_W" , 19.30        , 74, 727. );
AddMaterial("G4_Re", 21.02        , 75, 736. );
AddMaterial("G4_Os", 22.57        , 76, 746. );
AddMaterial("G4_Ir", 22.42        , 77, 757. );
AddMaterial("G4_Pt", 21.45        , 78, 790. );
AddMaterial("G4_Au", 19.32        , 79, 790. );
AddMaterial("G4_Hg", 13.546       , 80, 800. );
AddMaterial("G4_Tl", 11.72        , 81, 810. );
AddMaterial("G4_Pb", 11.35        , 82, 823. );
AddMaterial("G4_Bi",  9.747       , 83, 823. );
AddMaterial("G4_Po",  9.32        , 84, 830. );
AddMaterial("G4_At",  9.32        , 85, 825. );
AddMaterial("G4_Rn",  9.00662e-3, 86, 794. , 1, kStateGas);
AddMaterial("G4_Fr",  1.00        , 87, 827. );
AddMaterial("G4_Ra",  5.00        , 88, 826. );
AddMaterial("G4_Ac", 10.07        , 89, 841. );
AddMaterial("G4_Th", 11.72        , 90, 847. );
AddMaterial("G4_Pa", 15.37        , 91, 878. );
AddMaterial("G4_U" , 18.95        , 92, 890. );
```

```
AddMaterial("G4_Np", 20.25      , 93, 902. );
AddMaterial("G4_Pu", 19.84      , 94, 921. );
AddMaterial("G4_Am", 13.67      , 95, 934. );
AddMaterial("G4_Cm", 13.51      , 96, 939. );
AddMaterial("G4_Bk", 14.00      , 97, 952. );
AddMaterial("G4_Cf", 10.00      , 98, 966. );


AddMaterial("G4_A-150_TISSUE", 1.127, 0, 65.1, 6);
AddMaterial("G4_ACETONE", 0.7899, 0, 64.2, 3);
AddMaterial("G4_ACETYLENE", 0.0010967, 0, 58.2, 2, kStateGas);
AddMaterial("G4_ADENINE", 1.35, 0, 71.4, 3);
AddMaterial("G4_ADIPOSE_TISSUE_ICRP", 0.92, 0, 63.2, 13);
AddMaterial("G4_AIR", 0.00120479, 0, 85.7, 4, kStateGas);
AddMaterial("G4_ALANINE", 1.42, 0, 71.9, 4);
AddMaterial("G4_ALUMINUM_OXIDE", 3.97, 0, 145.2, 2);
AddMaterial("G4_AMBER", 1.1, 0, 63.2, 3);
AddMaterial("G4_AMMONIA", 0.000826019, 0, 53.7, 2, kStateGas);
AddMaterial("G4_ANILINE", 1.0235, 0, 66.2, 3);
AddMaterial("G4_ANTHRACENE", 1.283, 0, 69.5, 2);
AddMaterial("G4_B-100_BONE", 1.45, 0, 85.9, 6);
AddMaterial("G4_BAKELITE", 1.25, 0, 72.4, 3);
AddMaterial("G4_BARIUM_FLUORIDE", 4.89 ,0, 375.9, 2);
AddMaterial("G4_BARIUM_SULFATE", 4.5, 0, 285.7, 3);
AddMaterial("G4_BENZENE", 0.87865, 0, 63.4, 2);
AddMaterial("G4_BERYLLIUM_OXIDE", 3.01, 0, 93.2, 2);
AddMaterial("G4_BGO", 7.13, 0, 534.1, 3);
AddMaterial("G4_BLOOD_ICRP", 1.06, 0, 75.2, 14);
AddMaterial("G4_BONE_COMPACT_ICRU", 1.85, 0, 91.9, 8);
AddMaterial("G4_BONE_CORTICAL_ICRP", 1.85, 0, 106.4, 9);
AddMaterial("G4_BORON_CARBIDE", 2.52, 0, 84.7, 2);
AddMaterial("G4_BORON_OXIDE", 1.812, 0, 99.6, 2);
AddMaterial("G4_BRAIN_ICRP", 1.03, 0, 73.3, 13);
AddMaterial("G4_BUTANE", 0.00249343, 0, 48.3, 2, kStateGas);
AddMaterial("G4_N-BUTYL_ALCOHOL", 0.8098, 0, 59.9, 3);
AddMaterial("G4_C-552", 1.76, 0, 86.8, 5);
AddMaterial("G4_CADMIUM_TELLURIDE", 6.2, 0, 539.3, 2);
AddMaterial("G4_CADMIUM_TUNGSTATE", 7.9, 0, 468.3, 3);
AddMaterial("G4_CALCIUM_CARBONATE", 2.8, 0, 136.4, 3);
AddMaterial("G4_CALCIUM_FLUORIDE", 3.18, 0, 166., 2);
AddMaterial("G4_CALCIUM_OXIDE", 3.3, 0, 176.1, 2);
AddMaterial("G4_CALCIUM_SULFATE", 2.96, 0, 152.3, 3);
AddMaterial("G4_CALCIUM_TUNGSTATE", 6.062, 0, 395., 3);
AddMaterial("G4_CARBON_DIOXIDE", 0.00184212, 0, 85., 2, kStateGas);
AddMaterial("G4_CARBON_TETRACHLORIDE", 1.594, 0, 166.3, 2);
AddMaterial("G4_CELLULOSE_CELLOPHANE", 1.42, 0, 77.6, 3);
AddMaterial("G4_CELLULOSE_BUTYRATE", 1.2, 0, 74.6, 3);
AddMaterial("G4_CELLULOSE_NITRATE", 1.49, 0, 87., 4);
```

```
AddMaterial("G4_CERIC_SULFATE", 1.03, 0, 76.7, 5);
AddMaterial("G4_CESIUM_FLUORIDE", 4.115, 0, 440.7, 2);
AddMaterial("G4_CESIUM_IODIDE", 4.51, 0, 553.1, 2);
AddMaterial("G4_CHLOROBENZENE", 1.1058, 0, 89.1, 3);
AddMaterial("G4_CHLOROFORM", 1.4832, 0, 156., 3);
AddMaterial("G4_CONCRETE", 2.3, 0, 135.2, 10);
AddMaterial("G4_CYCLOHEXANE", 0.779, 0, 56.4, 2);
AddMaterial("G4_1,2-DICHLOROBENZENE", 1.3048, 0, 106.5, 3);
AddMaterial("G4_DICHLORODIETHYL_ETHER", 1.2199, 0, 103.3, 4);
AddMaterial("G4_1,2-DICHLOROETHANE", 1.2351, 0, 111.9, 3);
AddMaterial("G4_DIETHYL_ETHER", 0.71378, 0, 60., 3);
AddMaterial("G4_N,N-DIMETHYL_FORMAMIDE", 0.9487, 0, 66.6, 4);
AddMaterial("G4_DIMETHYL_SULFOXIDE", 1.1014, 0, 98.6, 4);
AddMaterial("G4_ETHANE", 0.00125324, 0, 45.4, 2, kStateGas);
AddMaterial("G4_ETHYL_ALCOHOL", 0.7893, 0, 62.9, 3);
AddMaterial("G4_ETHYL_CELLULOSE", 1.13, 0, 69.3, 3);
AddMaterial("G4_ETHYLENE", 0.00117497, 0, 50.7, 2, kStateGas);
AddMaterial("G4_EYE_LENS_ICRP", 1.1, 0, 73.3, 4);
AddMaterial("G4_FERRIC_OXIDE", 5.2, 0, 227.3, 2);
AddMaterial("G4_FERROBORIDE", 7.15, 0, 261., 2);
AddMaterial("G4_FERROUS_OXIDE", 5.7, 0, 248.6, 2);
AddMaterial("G4_FERROUS_SULFATE", 1.024, 0, 76.4, 7);
AddMaterial("G4_FREON-12", 1.12, 0, 143., 3);
AddMaterial("G4_FREON-12B2", 1.8, 0, 284.9, 3);
AddMaterial("G4_FREON-13", 0.95, 0, 126.6, 3);
AddMaterial("G4_FREON-13B1", 1.5, 0, 210.5, 3);
AddMaterial("G4_FREON-13I1", 1.8, 0, 293.5, 3)
AddMaterial("G4_GADOLINIUM_OXYSULFIDE", 7.44, 0, 493.3, 3);
AddMaterial("G4_GALLIUM_ARSENIDE", 5.31, 0, 384.9, 2);
AddMaterial("G4_GEL_PHOTO_EMULSION", 1.2914, 0, 74.8, 5);
AddMaterial("G4_Pyrex_Glass", 2.23, 0, 134., 6);
AddMaterial("G4_GLASS_LEAD", 6.22, 0, 526.4, 5);
AddMaterial("G4_GLASS_PLATE", 2.4, 0, 145.4, 4);
AddMaterial("G4_GLUCOSE", 1.54, 0, 77.2, 3);
AddMaterial("G4_GLUTAMINE", 1.46, 0, 73.3, 4);
AddMaterial("G4_GLYCEROL", 1.2613, 0, 72.6, 3);
AddMaterial("G4_GUANINE", 1.58, 0, 75. ,4);
AddMaterial("G4_GYPSUM", 2.32, 0, 129.7, 4);
AddMaterial("G4_N-HEPTANE", 0.68376, 0, 54.4, 2);
AddMaterial("G4_N-HEXANE", 0.6603, 0, 54., 2);
AddMaterial("G4_KAPTON", 1.42, 0, 79.6, 4);
AddMaterial("G4_LANTHANUM_OXYBROMIDE", 6.28, 0, 439.7, 3);
AddMaterial("G4_LANTHANUM_OXYSULFIDE", 5.86, 0, 421.2, 3);
AddMaterial("G4_LEAD_OXIDE", 9.53, 0, 766.7, 2);
AddMaterial("G4_LITHIUM_AMIDE", 1.178, 0, 55.5, 3);
AddMaterial("G4_LITHIUM_CARBONATE", 2.11, 0, 87.9, 3);
AddMaterial("G4_LITHIUM_FLUORIDE", 2.635, 0, 94., 2);
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AddMaterial("G4_LITHIUM_HYDRIDE", 0.82, 0, 36.5, 2);
AddMaterial("G4_LITHIUM_IODIDE", 3.494, 0, 485.1, 2);
AddMaterial("G4_LITHIUM_OXIDE", 2.013, 0, 73.6, 2);
AddMaterial("G4_LITHIUM_TETRABORATE", 2.44, 0, 94.6, 3);
AddMaterial("G4_LUNG_ICRP", 1.05, 0, 75.3, 13);
AddMaterial("G4_M3_WAX", 1.05, 0, 67.9, 5);
AddMaterial("G4_MAGNESIUM_CARBONATE", 2.958, 0, 118., 3);
AddMaterial("G4_MAGNESIUM_FLUORIDE", 3.0, 0, 134.3, 2);
AddMaterial("G4_MAGNESIUM_OXIDE", 3.58, 0, 143.8, 2);
AddMaterial("G4_MAGNESIUM_TETRABORATE", 2.53, 0, 108.3, 3);
AddMaterial("G4_MERCURIC_IODIDE", 6.36, 0, 684.5, 2);
AddMaterial("G4_METHANE", 0.000667151, 0, 41.7, 2, kStateGas);
AddMaterial("G4_METHANOL", 0.7914, 0, 67.6, 3);
AddMaterial("G4_MIX_D_WAX", 0.99, 0, 60.9, 5);
AddMaterial("G4_MS20_TISSUE", 1.0, 0, 75.1, 6);
AddMaterial("G4_MUSCLE_SKELETAL_ICRP", 1.04, 0, 75.3, 13);
AddMaterial("G4_MUSCLE_STRIATED_ICRU", 1.04, 0, 74.7, 9);
AddMaterial("G4_MUSCLE_WITH_SUCROSE", 1.11, 0, 74.3, 4);
AddMaterial("G4_MUSCLE_WITHOUT_SUCROSE", 1.07, 0, 74.2, 4);
AddMaterial("G4_NAPHTHALENE", 1.145, 0, 68.4, 2);
AddMaterial("G4_NITROBENZENE", 1.19867, 0, 75.8, 4);
AddMaterial("G4_NITROUS_OXIDE", 0.00183094, 0, 84.9, 2, kStateGas);
AddMaterial("G4_NYLON-8062", 1.08, 0, 64.3, 4);
AddMaterial("G4_NYLON-6/6", 1.14, 0, 63.9, 4);
AddMaterial("G4_NYLON-6/10", 1.14, 0, 63.2, 4);
AddMaterial("G4_NYLON-11_RILSAN", 1.425, 0, 61.6, 4);
AddMaterial("G4_OCTANE", 0.7026, 0, 54.7, 2);
AddMaterial("G4_PARAFFIN", 0.93, 0, 55.9, 2);
AddMaterial("G4_N-PENTANE", 0.6262, 0, 53.6, 2);
AddMaterial("G4_PHOTO_EMULSION", 3.815, 0, 331., 8);
AddMaterial("G4_PLASTIC_SC_VINYLTOLUENE", 1.032, 0, 64.7, 2);
AddMaterial("G4_PLUTONIUM_DIOXIDE", 11.46, 0, 746.5, 2);
AddMaterial("G4_POLYACRYLONITRILE", 1.17, 0, 69.6, 3);
AddMaterial("G4_POLYCARBONATE", 1.2, 0, 73.1, 3);
AddMaterial("G4_POLYCHLOROSTYRENE", 1.3, 0, 81.7, 3);
AddMaterial("G4_POLYETHYLENE", 0.94, 0, 57.4, 2);
AddMaterial("G4_MYLAR", 1.4, 0, 78.7, 3);
AddMaterial("G4_PLEXIGLASS", 1.19, 0, 74., 3);
AddMaterial("G4_POLYOXYMETHYLENE", 1.425 ,0, 77.4, 3);
AddMaterial("G4_POLYPROPYLENE", 0.9, 0, 56.5, 2);
AddMaterial("G4_POLYSTYRENE", 1.06, 0, 68.7, 2);
AddMaterial("G4_TEFLON", 2.2, 0, 99.1, 2);
AddMaterial("G4_POLYTRIFLUOROCHLOROETHYLENE", 2.1, 0, 120.7, 3);
AddMaterial("G4_POLYVINYL_ACETATE", 1.19, 0, 73.7, 3);
AddMaterial("G4_POLYVINYL_ALCOHOL", 1.3, 0, 69.7, 3);
AddMaterial("G4_POLYVINYL_BUTYRAL", 1.12, 0, 67.2, 3);
AddMaterial("G4_POLYVINYL_CHLORIDE", 1.3, 0, 108.2, 3);
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AddMaterial("G4_POLYVINYLIDENE_CHLORIDE", 1.7, 0, 134.3, 3);
AddMaterial("G4_POLYVINYLIDENE_FLUORIDE", 1.76, 0, 88.8, 3);
AddMaterial("G4_POLYVINYL_PYRROLIDONE", 1.25, 0, 67.7, 4);
AddMaterial("G4_POTASSIUM_IODIDE", 3.13, 0, 431.9, 2);
AddMaterial("G4_POTASSIUM_OXIDE", 2.32, 0, 189.9, 2);
AddMaterial("G4_PROPANE", 0.00187939, 0, 47.1, 2, kStateGas);
AddMaterial("G4_lPROPANE", 0.43, 0, 52., 2);
AddMaterial("G4_N-PROPYL_ALCOHOL", 0.8035, 0, 61.1, 3);
AddMaterial("G4_PYRIDINE", 0.9819, 0, 66.2, 3);
AddMaterial("G4_RUBBER_BUTYL", 0.92, 0, 56.5, 2);
AddMaterial("G4_RUBBER_NATURAL", 0.92, 0, 59.8, 2);
AddMaterial("G4_RUBBER_NEOPRENE", 1.23, 0, 93., 3);
AddMaterial("G4_SILICON_DIOXIDE", 2.32, 0, 139.2, 2);
AddMaterial("G4_SILVER_BROMIDE", 6.473, 0, 486.6, 2);
AddMaterial("G4_SILVER_CHLORIDE", 5.56, 0, 398.4, 2);
AddMaterial("G4_SILVER_HALIDES", 6.47, 0, 487.1, 3);
AddMaterial("G4_SILVER_IODIDE", 6.01, 0, 543.5, 2);
AddMaterial("G4_SKIN_ICRP", 1.1, 0, 72.7, 13);
AddMaterial("G4_SODIUM_CARBONATE", 2.532, 0, 125., 3);
AddMaterial("G4_SODIUM_IODIDE", 3.667, 0, 452., 2);
AddMaterial("G4_SODIUM_MONOXIDE", 2.27, 0, 148.8, 2);
AddMaterial("G4_SODIUM_NITRATE", 2.261, 0, 114.6, 3);
AddMaterial("G4_STILBENE", 0.9707, 0, 67.7, 2);
AddMaterial("G4_SUCROSE", 1.5805, 0, 77.5, 3);
AddMaterial("G4_TERPHENYL", 1.234, 0, 71.7, 2);
AddMaterial("G4_TESTES_ICRP", 1.04, 0, 75., 13);
AddMaterial("G4_TETRACHLOROETHYLENE", 1.625, 0, 159.2, 2);
AddMaterial("G4_THALLIUM_CHLORIDE", 7.004, 0, 690.3, 2);
AddMaterial("G4_TISSUE_SOFT_ICRP", 1.0, 0, 72.3, 13);
AddMaterial("G4_TISSUE_SOFT_ICRU-4", 1.0, 0, 74.9, 4);
AddMaterial("G4_TISSUE-METHANE", 0.00106409, 0, 61.2, 4, kStateGas);
AddMaterial("G4_TISSUE-PROPANE", 0.00182628, 0, 59.5, 4, kStateGas);
AddMaterial("G4_TITANIUM_DIOXIDE", 4.26, 0, 179.5, 2);
AddMaterial("G4_TOLUENE", 0.8669, 0, 62.5, 2);
AddMaterial("G4_TRICHLOROETHYLENE", 1.46, 0, 148.1, 3);
AddMaterial("G4_TRIETHYL_PHOSPHATE", 1.07, 0, 81.2, 4);
AddMaterial("G4_TUNGSTEN_HEXAFLUORIDE", 2.4, 0, 354.4, 2);
AddMaterial("G4_URANIUM_DICARBIDE", 11.28, 0, 752., 2);
AddMaterial("G4_URANIUM_MONOCARBIDE", 13.63, 0, 862., 2);
AddMaterial("G4_URANIUM_OXIDE", 10.96, 0, 720.6, 2);
AddMaterial("G4_UREA", 1.323, 0, 72.8, 4);
AddMaterial("G4_VALINE", 1.23, 0, 67.7, 4);
AddMaterial("G4_VITON", 1.8, 0, 98.6, 3);
AddMaterial("G4_WATER", 1.0,0, 75., 2);
AddMaterial("G4_WATER_VAPOR", 0.000756182, 0, 71.6, 2, kStateGas);
AddMaterial("G4_XYLENE", 0.87, 0, 61.8, 2);
AddMaterial("G4_GRAPHITE", 1.7, 6, 78.);
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AddMaterial("G4_lH2", 0.0708,  1,  21.8, 1, kStateLiquid);
AddMaterial("G4_lAr", 1.396 , 18, 188. , 1, kStateLiquid);
AddMaterial("G4_lKr", 2.418 , 36, 352. , 1, kStateLiquid);
AddMaterial("G4_lXe", 2.953 , 54, 482. , 1, kStateLiquid);
AddMaterial("G4_PbWO4", 8.28, 0, 0.0, 3);
AddMaterial("G4_Galactic", density, 1, 21.8, 1, kStateGas);
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B Particles in gsim4

```
Gsim(Idle)[/] /particle/list
```

B+,	B-,	B0,	Bs0
D+,	D-,	D0,	Ds+
Ds-,	GenericIon,	He3,	J/psi
KL2gamma,	KL3pi0,	KLpi0nunu,	KLpi0pi0
KLpienu,	KLpienugamma,	KLpimunu,	KLpimunugamma
KLpipi,	KLpipipi0,	N(1440)+,	N(1440)0
N(1520)+,	N(1520)0,	N(1535)+,	N(1535)0
N(1650)+,	N(1650)0,	N(1675)+,	N(1675)0
N(1680)+,	N(1680)0,	N(1700)+,	N(1700)0
N(1710)+,	N(1710)0,	N(1720)+,	N(1720)0
N(1900)+,	N(1900)0,	N(1990)+,	N(1990)0
N(2090)+,	N(2090)0,	N(2190)+,	N(2190)0
N(2220)+,	N(2220)0,	N(2250)+,	N(2250)0
a0(1450)+,	a0(1450)-,	a0(1450)0,	a0(980)+
a0(980)-,	a0(980)0,	a1(1260)+,	a1(1260)-
a1(1260)0,	a2(1320)+,	a2(1320)-,	a2(1320)0
alpha,	anti_B0,	anti_Bs0,	anti_D0
anti_N(1440)+,	anti_N(1440)0,	anti_N(1520)+,	anti_N(1520)0
anti_N(1535)+,	anti_N(1535)0,	anti_N(1650)+,	anti_N(1650)0
anti_N(1675)+,	anti_N(1675)0,	anti_N(1680)+,	anti_N(1680)0
anti_N(1700)+,	anti_N(1700)0,	anti_N(1710)+,	anti_N(1710)0
anti_N(1720)+,	anti_N(1720)0,	anti_N(1900)+,	anti_N(1900)0
anti_N(1990)+,	anti_N(1990)0,	anti_N(2090)+,	anti_N(2090)0
anti_N(2190)+,	anti_N(2190)0,	anti_N(2220)+,	anti_N(2220)0
anti_N(2250)+,	anti_N(2250)0,	anti_b_quark,	anti_c_quark
anti_d_quark,	anti_dd1_diquark,	anti_delta(1600)+,	anti_delta(1600)++
anti_delta(1600)-,	anti_delta(1600)0,	anti_delta(1620)+,	anti_delta(1620)++
anti_delta(1620)-,	anti_delta(1620)0,	anti_delta(1700)+,	anti_delta(1700)++
anti_delta(1700)-,	anti_delta(1700)0,	anti_delta(1900)+,	anti_delta(1900)++
anti_delta(1900)-,	anti_delta(1900)0,	anti_delta(1905)+,	anti_delta(1905)++
anti_delta(1905)-,	anti_delta(1905)0,	anti_delta(1910)+,	anti_delta(1910)++
anti_delta(1910)-,	anti_delta(1910)0,	anti_delta(1920)+,	anti_delta(1920)++
anti_delta(1920)-,	anti_delta(1920)0,	anti_delta(1930)+,	anti_delta(1930)++
anti_delta(1930)-,	anti_delta(1930)0,	anti_delta(1950)+,	anti_delta(1950)++
anti_delta(1950)-,	anti_delta(1950)0,	anti_delta+,	anti_delta++
anti_delta-,	anti_delta0,	anti_k(1460)0,	anti_k0_star(1430)0
anti_k1(1270)0,	anti_k1(1400)0,	anti_k2(1770)0,	anti_k2_star(1430)0
anti_k2_star(1980)0,	anti_k3_star(1780)0,	anti_k_star(1410)0,	anti_k_star(1680)0
anti_k_star0,	anti_kaon0,	anti_lambda,	anti_lambda(1405)
anti_lambda(1520),	anti_lambda(1600),	anti_lambda(1670),	anti_lambda(1690)
anti_lambda(1800),	anti_lambda(1810),	anti_lambda(1820),	anti_lambda(1830)
anti_lambda(1890),	anti_lambda(2100),	anti_lambda(2110),	anti_lambda_c+
anti_neutron,	anti_nu_e,	anti_nu_mu,	anti_nu_tau
anti_omega-,	anti_omega_c0,	anti_proton,	anti_s_quark

anti_sd0_diquark,   anti_sd1_diquark,   anti_sigma(1385)+,   anti_sigma(1385)-
anti_sigma(1385)0,   anti_sigma(1660)+,   anti_sigma(1660)-,   anti_sigma(1660)0
anti_sigma(1670)+,   anti_sigma(1670)-,   anti_sigma(1670)0,   anti_sigma(1750)+
anti_sigma(1750)-,   anti_sigma(1750)0,   anti_sigma(1775)+,   anti_sigma(1775)-
anti_sigma(1775)0,   anti_sigma(1915)+,   anti_sigma(1915)-,   anti_sigma(1915)0
anti_sigma(1940)+,   anti_sigma(1940)-,   anti_sigma(1940)0,   anti_sigma(2030)+
anti_sigma(2030)-,   anti_sigma(2030)0,   anti_sigma+,   anti_sigma-
anti_sigma0,   anti_sigma_c+,   anti_sigma_c++,   anti_sigma_c0
anti_ss1_diquark,   anti_su0_diquark,   anti_su1_diquark,   anti_t_quark
anti_u_quark,   anti_ud0_diquark,   anti_ud1_diquark,   anti_uu1_diquark
anti_xi(1530)-,   anti_xi(1530)0,   anti_xi(1690)-,   anti_xi(1690)0
anti_xi(1820)-,   anti_xi(1820)0,   anti_xi(1950)-,   anti_xi(1950)0
anti_xi(2030)-,   anti_xi(2030)0,   anti_xi-,   anti_xi0
anti_xi_c+,   anti_xi_c0,   b1(1235)+,   b1(1235)-
b1(1235)0,   b_quark,   c_quark,   chargedgeantino
d_quark,   dd1_diquark,   delta(1600)+,   delta(1600)++
delta(1600)-,   delta(1600)0,   delta(1620)+,   delta(1620)++
delta(1620)-,   delta(1620)0,   delta(1700)+,   delta(1700)++
delta(1700)-,   delta(1700)0,   delta(1900)+,   delta(1900)++
delta(1900)-,   delta(1900)0,   delta(1905)+,   delta(1905)++
delta(1905)-,   delta(1905)0,   delta(1910)+,   delta(1910)++
delta(1910)-,   delta(1910)0,   delta(1920)+,   delta(1920)++
delta(1920)-,   delta(1920)0,   delta(1930)+,   delta(1930)++
delta(1930)-,   delta(1930)0,   delta(1950)+,   delta(1950)++
delta(1950)-,   delta(1950)0,   delta+,   delta++
delta-,   delta0,   deuteron,   e+
e-,   eta,   eta(1295),   eta(1405)
eta(1475),   eta2(1645),   eta2(1870),   eta_prime
f0(1370),   f0(1500),   f0(1710),   f0(600)
f0(980),   f1(1285),   f1(1420),   f2(1270)
f2(1810),   f2(2010),   f2_prime(1525),   gamma
geantino,   gluon,   h1(1170),   h1(1380)
k(1460)+,   k(1460)-,   k(1460)0,   k0_star(1430)+
k0_star(1430)-,   k0_star(1430)0,   k1(1270)+,   k1(1270)-
k1(1270)0,   k1(1400)+,   k1(1400)-,   k1(1400)0
k2(1770)+,   k2(1770)-,   k2(1770)0,   k2_star(1430)+
k2_star(1430)-,   k2_star(1430)0,   k2_star(1980)+,   k2_star(1980)-
k2_star(1980)0,   k3_star(1780)+,   k3_star(1780)-,   k3_star(1780)0
k_star(1410)+,   k_star(1410)-,   k_star(1410)0,   k_star(1680)+
k_star(1680)-,   k_star(1680)0,   k_star+,   k_star-
k_star0,   kaon+,   kaon-,   kaon0
kaon0L,   kaon0S,   lambda,   lambda(1405)
lambda(1520),   lambda(1600),   lambda(1670),   lambda(1690)
lambda(1800),   lambda(1810),   lambda(1820),   lambda(1830)
lambda(1890),   lambda(2100),   lambda(2110),   lambda_c+
mu+,   mu-,   neutron,   nu_e
nu_mu,   nu_tau,   omega,   omega(1420)

omega(1650),	omega-,	omega3(1670),	omega_c0
opticalphoton,	phi,	phi(1680),	phi3(1850)
pi(1300)+,	pi(1300)-,	pi(1300)0,	pi+
pi-,	pi0,	pi2(1670)+,	pi2(1670)-
pi2(1670)0,	proton,	rho(1450)+,	rho(1450)-
rho(1450)0,	rho(1700)+,	rho(1700)-,	rho(1700)0
rho+,	rho-,	rho0,	rho3(1690)+
rho3(1690)-,	rho3(1690)0,	s_quark,	sd0_diquark
sd1_diquark,	sigma(1385)+,	sigma(1385)-,	sigma(1385)0
sigma(1660)+,	sigma(1660)-,	sigma(1660)0,	sigma(1670)+
sigma(1670)-,	sigma(1670)0,	sigma(1750)+,	sigma(1750)-
sigma(1750)0,	sigma(1775)+,	sigma(1775)-,	sigma(1775)0
sigma(1915)+,	sigma(1915)-,	sigma(1915)0,	sigma(1940)+
sigma(1940)-,	sigma(1940)0,	sigma(2030)+,	sigma(2030)-
sigma(2030)0,	sigma+,	sigma-,	sigma0
sigma_c+,	sigma_c++,	sigma_c0,	ss1_diquark
su0_diquark,	su1_diquark,	t_quark,	tau+
tau-,	triton,	u_quark,	ud0_diquark
ud1_diquark,	uu1_diquark,	xi(1530)-,	xi(1530)0
xi(1690)-,	xi(1690)0,	xi(1820)-,	xi(1820)0
xi(1950)-,	xi(1950)0,	xi(2030)-,	xi(2030)0
xi-,	xi0,	xi_c+,	xi_c0

C   PDG code

1	d	110	rho_diff0	1103	dd_1	10111	a_00
2	u	111	pi0	1114	Delta-	10113	b_10
3	s	113	rho0	2101	ud_0	10211	a_0+
4	c	115	a_20	2103	ud_1	10213	b_1+
5	b	130	K_L0	2110	n_diffr0	10221	f_0
6	t	210	pi_diffr+	2112	neutron	10223	h_1
7	b'	211	pi+	2114	Delta0	10311	K*_00
8	t'	213	rho+	2203	uu_1	10313	K_10
11	e-	215	a_2+	2210	p_diffr+	10321	K*_0+
12	nu_e	220	omega_di	2212	proton	10323	K_1+
13	mu-	221	eta	2214	Delta+	10331	f'_0
14	nu_mu	223	omega	2224	Delta++	10333	h'_1
15	tau-	225	f_2	3101	sd_0		
16	nu_tau	310	K_S0	3103	sd_1		
17	tau'-	311	K0	3112	Sigma-		
18	nu'_tau	313	K*0	3114	Sigma*-		
21	g	315	K*_20	3122	Lambda0		
22	gamma	321	K+	3201	su_0		
23	Z0	323	K*+	3203	su_1		
24	W+	325	K*_2+	3212	Sigma0		
		330	phi_diff	3214	Sigma*0		
		331	eta'	3222	Sigma+		
		333	phi	3224	Sigma*+		
		335	f'_2	3303	ss_1		
				3312	Xi-		
				3314	Xi*-		
				3322	Xi0		
				3324	Xi*0		
				3334	Omega-		

411	D+	4101	cd_0	5101	bd_0	10411	D*_0+
413	D*+	4103	cd_1	5103	bd_1	10413	D_1+
415	D*_2+	4112	Sigma_c0	5112	Sigma_b-	10421	D*_00
421	D0	4114	Sigma*_c0	5114	Sigma*_b-	10423	D_10
423	D*0	4122	Lambda_c+	5122	Lambda_b0	10431	D*_0s+
425	D*_20	4132	Xi_c0	5132	Xi_b-	10433	D_1s+
431	D_s+	4201	cu_0	5142	Xi_bc0	10441	chi_0c
433	D*_s+	4203	cu_1	5201	bu_0	10443	h_1c
435	D*_2s+	4212	Sigma_c+	5203	bu_1	10511	B*_00
440	J/psi_di	4214	Sigma*_c+	5212	Sigma_b0	10513	B_10
441	eta_c	4222	Sigma_c++	5214	Sigma*_b0	10521	B*_0+
443	J/psi	4224	Sigma*_c++	5222	Sigma_b+	10523	B_1+
445	chi_2c	4232	Xi_c+	5224	Sigma*_b+	10531	B*_0s0
511	B0	4301	cs_0	5232	Xi_b0	10533	B_1s0
513	B*0	4303	cs_1	5242	Xi_bc+	10541	B*_0c+
515	B*_20	4312	Xi'_c0	5301	bs_0	10543	B_1c+
521	B+	4314	Xi*_c0	5303	bs_1	10551	chi_0b
523	B*+	4322	Xi'_c+	5312	Xi'_b-	10553	h_1b
525	B*_2+	4324	Xi*_c+	5314	Xi*_b-	20113	a_10
531	B_s0	4332	Omega_c0	5322	Xi'_b0	20213	a_1+
533	B*_s0	4334	Omega*_c0	5324	Xi*_b0	20223	f_1
535	B*_2s0	4403	cc_1	5332	Omega_b-	20313	K*_10
541	B_c+	4412	Xi_cc+	5334	Omega*_b-	20323	K*_1+
543	B*_c+	4414	Xi*_cc+	5342	Omega_bc0	20333	f'_1
545	B*_2c+	4422	Xi_cc++	5401	bc_0	20413	D*_1+
551	eta_b	4424	Xi*_cc++	5403	bc_1	20423	D*_10
553	Upsilon	4432	Omega_cc+	5412	Xi'_bc0	20433	D*_1s+
555	chi_2b	4434	Omega*_cc+	5414	Xi*_bc0	20443	chi_1c
		4444	Omega*_ccc++	5422	Xi'_bc+	20513	B*_10
				5424	Xi*_bc+	20523	B*_1+
				5432	Omega'_bc0	20533	B*_1s0
				5434	Omega*_bc0	20543	B*_1c+
				5442	Omega_bcc+	20553	chi_1b
				5444	Omega*_bcc+	100443	psi'
				5503	bb_1	100553	Upsilon'
				5512	Xi_bb-		
				5514	Xi*_bb-		
				5522	Xi_bb0		
				5524	Xi*_bb0		
				5532	Omega_bb-		
				5534	Omega*_bb-		
				5542	Omega_bbc0		
				5544	Omega*_bbc0		
				5554	Omega*_bbb-		

D   Physicslists prepared in Geant4

- FTFC

- FTFP

- FTFP_EMV

- LBE

- LHEP

- LHEP_BERT

- LHEP_BERT_HP

- LHEP_EMV

- LHEP_PRECO_HP

- QBBC

- QGSC

- QGSC_EFLOW

- QGSC_EMV

- QGSP

- QGSP_BERT

- QGSP_BERT_EMV

- QGSP_BERT_HP

- QGSP_BERT_NQE

- QGSP_BIC

- QGSP_BIC_HP

- QGSP_EMV

- QGSP_EMV_NQE

- QGSP_EMX

- QGSP_NQE

- QGSP_QEL

G4VERSION_NUMBER == 830 or G4VERSION_NUMBER == 831

- LHEP_BIC

- LHEP_BIC_HP

- LHEP_HP

- LHEP_LEAD

- LHEP_LEAD_HP

- LHEP_PRECO

- QGSC_LEAD

- QGSC_LEAD_HP

- QGSP_HP

G4VERSION_NUMBER == 900 or G4VERSION_NUMBER == 901

- QGSP_BERT_TRV