GEMC FAQ


ANY QUESTIONS YOU HAVE SHOULD BE COVERED BY THE FAQ ON OUR WEBSITE.
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Q: How can I use gemc on the ifarm?

Q: How can I use gemc on the ifarm?

A:

You can ssh ifarm

setenv JLAB_ROOT /site/12gev_phys
setenv JLAB_VERSION production
source $JLAB_ROOT/ce/releases/$JLAB_VERSION/jlab.csh

Q: How can I use gemc on the ifarm?

A:

```
> Common Environment Version: <production>  (Tue, 25 Feb 2014)
> Running as ungaro on ifarm1101
> OS Release:    Linux_CentOS6.2-x86_64-gcc4.4.6
> JLAB_ROOT set to:     /site/12gev_phys
> JLAB_SOFTWARE set to: /site/12gev_phys/Linux_CentOS6.2-x86_64-gcc4.4.6

> CLHEP   version: 2.1.3.1
> Geant4  version: 4.9.6.p02
> QTDIR   version: 4.8.5
> XERCES  version: 3.1.1
> ROOT    version: 5.34.13
> GEMC    version: 1.8
> JANA    version: 0.7.1
> Build   version: 1.0
> EVIO    version: 4.0
> Banks   version: 0.9
```

Q: How can I use gemc on the ifarm?

A:

Production Version as of 2/27/2014: 1.0

devel	
clhep:	2.1.3.1
qt:	4.8.5
xercesc:	3.1.1
geant4:	4.9.6.p02
gemc:	devel
jana:	0.7.1
root:	5.34.13
banks:	devel
scons_bm:	devel
evio:	4.0

production	
clhep:	2.1.3.1
qt:	4.8.5
xercesc:	3.1.1
geant4:	4.9.6.p02
gemc:	1.8
jana:	0.7.1
root:	5.34.13
banks:	0.9
scons_bm:	1.0
evio:	4.0

Q: How can I use gemc on my laptop

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A1 (mac):

You're in luck, a gemc app is available on the website

Q: How can I use gemc on my laptop

A2 (linux):

Out of luck (for now). You need to build gemc from scratch.

Note: building gemc is easy and fast. However gemc depends on qt4, geant4. These take long time, can burn laptops, decrease life expectancy.

Q: How do I build gemc on my own computer from scratch?

Q: How do I build gemc on my own computer from scratch?

A:

There are a step-by-step instructions,
constantly improved, on the gemc documentation page

Step by Step Instructions

1. Choose a place on your disk where to install everything. Typically:

   /opt/jlab_software

   Point the JLAB_ROOT environment to that directory.

2. Choose a software distribution version. Available versions can be found here
   Point the JLAB_VERSION to that version. Example:

   setenv JLAB_VERSION devel

3. Get and untar the install.tar installation scripts:

   wget http://www.jlab.org/12gev_phys/packages/sources/install.tar
   tar xpvf install.tar

4. Run "go_ce" from the untarred sourcebuild directory. This will install the JLAB software environment. For convenience, you can add the following line in your login file (.cshrc):

   setenv JLAB_VERSION <yourchoiceofversion>
   setenv JLAB_ROOT /opt/jlab_software
   source $JLAB_ROOT/ce/jlab.csh

   At this point start a new shell - or logout and log back in.
   This will ensure the environment is correct.

   You should now see many messages on screen warning
   that packages are not installed. Good! You can now install them in the following order:

5. In the sourcebuild directory, run in sequence the following scripts:

   go_clhep
   go_qt4
   go_xercesc
   go_geant4
   go_sconsscript
   go_evio
   go_gemc
   go_root
   go_banks

Q: How do I run gemc?

Q: How do I run gemc?

A:

gemc can be run with command-line options or with a gcard.

Every command line option can be in gcard entry and viceversa

Q: How do I run gemc?

A:

hps.gcard

```
<gcard>
  <detector name="beamline" factory="TEXT" variation="original"/>
  <option name="BEAM_V" value="(0, 0, -300)cm"/>
  <option name="BEAM_P" value="e-, 2.2*GeV, 20*deg, 30*deg"/>
</gcard>
```

gemc –gcard=hps.gcard

gemc hps.gcard

Mac: drag and drop the gcard file onto the gemc app

Q: How do I run gemc?

A:

hps.gcard

```
<gcard>
  <detector name="beamline" factory="TEXT" variation="original"/>
  <option name="BEAM_V" value="(0, 0, -300)cm"/>
  <option name="BEAM_P" value="e-, 2.2*GeV, 20*deg, 30*deg"/>
</gcard>
```

gemc hps.gcard -BEAM_P=“proton, 1.5*GeV, 20*deg, 20*deg”

Q: Can I run gemc w/o network?

Q: Can I run gemc w/o network?

A:

Yes. Make sure all detectors are loaded with the “TEXT” factory

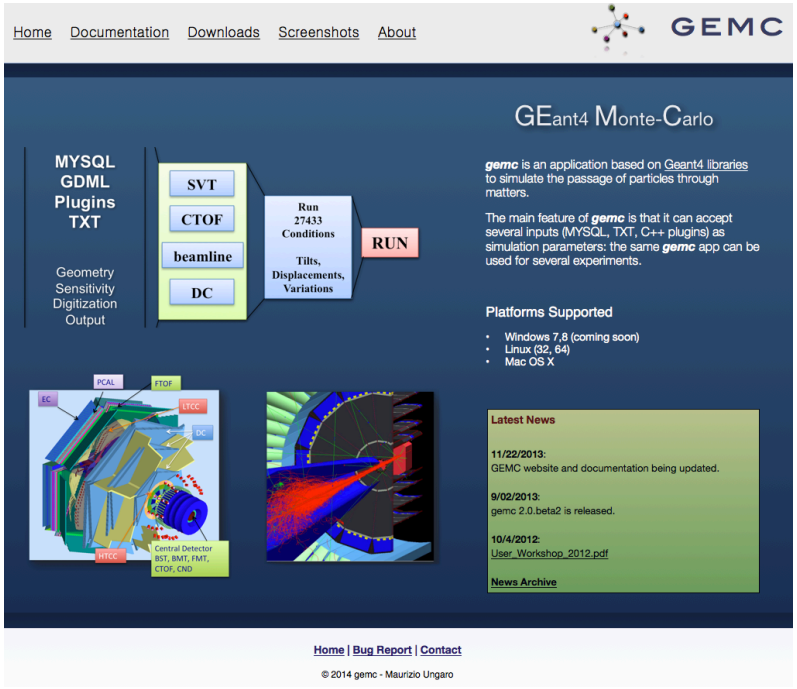
```
<gcard>
  <detector name="beamline" factory="TEXT" variation="original"/>
  <option name="BEAM_V" value="(0, 0, -300)cm"/>
  <option name="BEAM_P" value="e-, 2.2*GeV, 20*deg, 30*deg"/>
</gcard>
```

Q: Where is the help?

Q: Where is the help?

A:

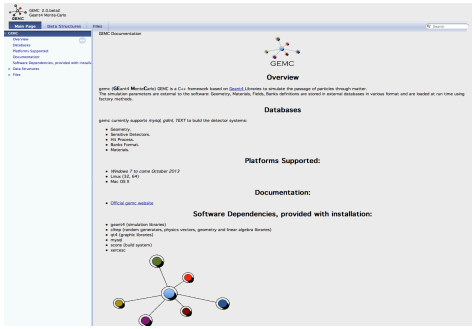
gemc website



Nightly doxygen
for all versions

Doxygen Documentation

GEMC Versions (most recent first)
2.0.beta2
2.0.beta1



Command line –help

Mantis (need fixing)

Email (@Maurik, @Zhiwen, @Mauri)

Q: How do I find out what options are available?

Q: How do I find out what options are available?

A:

There are 78 options to gemc, to see them all: gemc –help-all

```
 Help Options:

>  -help-all:  all available options.

>  -help-control            control options.
>  -help-general            general options.
>  -help-generator          generator options.
>  -help-luminosity         luminosity options.
>  -help-mysql              mysql options.
>  -help-output             output options.
>  -help-physics            physics options.
>  -help-verbosity          verbosity options.
```

Q: How do use the gemc options?

A:

Command line:

-OPTION="value" -BEAM_P="proton, 1.5*GeV, 20*deg, 20*deg"

Gcard:

```
<option name="option" value="value"/>

<option name="BEAM_P" value="e-, 2.2*GeV, 20*deg, 30*deg"/>
```

Q: How do I turn on/off Mag Field(s)?

Q: How do I turn on/off Mag Field(s)?

A:

-NO_FIELD="field name" ← Can be repeated

-NO_FIELD="solenoid"

-NO_FIELD="all"

Q: How do I scale Mag Field?

Q: How do I scale Mag Field?

A:

Command line:

-SCALE_FIELD="srr-solenoid, 0.5" ← Can be repeated

Gcard:

```
<option name="SCALE_FIELD" value ="hps_frascati_magnet_field1_394A, 1.1”/>
<option name="SCALE_FIELD" value ="hps_frascati_magnet_field2_394A, 1.1”/>
<option name="SCALE_FIELD" value ="hps_pair_spectrometer, 1.1”/>
```

Q: How do I reverse field polarity?

A:

-SCALE_FIELD=”torus, -1"

Can be repeated

Q: How do I check the field values?

Q: How do I check the field values?

A:

Can use the FIELD_VERBOSITY option.
For each track, at every step inside a field, it will print:

```
Phi-Simmetric Field: Cart. and Cyl. coordinates (cm), table indexes, magnetic field values (gauss):
x=-0.000893433   y=0.00121572   z=2.60162   r=0.00150871   z=2.60162  phi=126.312   IT=0   IL=605
Bx=-0  By=0  Bz=49997.4
Total Field: coordinates (cm), magnetic field values (gauss):
x=-0.000893433   y=0.00121572   z=2.60162   Bx=0  By=0  Bz=49997.4
```

Q: How do I check the field values?

A:

-FIELD_VERBOSITY=99

Will print this log only once, so can put the track vertex at the desired location

```
Phi-Simmetric Field: Cart. and Cyl. coordinates (cm), table indexes, magnetic field values (gauss):
x=-0.000893433   y=0.00121572   z=2.60162   r=0.00150871   z=2.60162  phi=126.312   IT=0   IL=605
Bx=-0  By=0  Bz=49997.4
Total Field: coordinates (cm), magnetic field values (gauss):
x=-0.000893433   y=0.00121572   z=2.60162   Bx=0  By=0  Bz=49997.4
```

Q: How do I define a new field?

A:

Q: How do I define a new field?

It's a .txt or .dat file.
Write one, point to its location with FIELD_DIR.

Example of uniform field:

```
<mfield>
    <description name="uniform" factory="ASCII" comment="Uniform 10 T Magnetic Field
                                                         along x-axis"/>
    <symmetry type="uniform" format="simple"/>
    <dimension bx="10" by="0" bz="0" units="T"/>
</mfield>
```

Q: How do I define a new field?

It's a .txt or .dat file.
Write one, point to its location with FIELD_DIR.

```
<mfield>
       <description name="hps_frascati_magnet_field1_394A" factory="ASCII" comment="Frascati Magnet for HPS configuration"/>
       <symmetry type="dipole-y" format="map" integration="RungeKutta" minStep="1*mm"/>
       <map>
              <coordinate>
                     <first  name="longitudinal"  npoints="87"  min="-546.1" max="546.1" units="mm"/>
                     <second name="transverse"    npoints="1"   min="0"     max="0"     units="mm"/>
              </coordinate>
              <field unit="T"/>
              <interpolation type="none"/>
              <shift z="-195.58" units="cm"/>
       </map>
</mfield>
-546.1  0       0.0015717
-533.4  0       0.0020661
-520.7  0       0.0025677
-508    0       0.0031922
-495.3  0       0.0037587
```

Q: Does the field move with the volume?

Q: Does the field move with the volume?

A:

No. Coordinates are absolutes.

However can shift the field (independently from the detectors) in the map definition.

```
<shift z="-195.58" units="cm"/>
```

Q: What is the standard configuration gcard of clas12?

Q: What is the standard configuration gcard of clas12?

A:

https://gemc.jlab.org/work/clas12.gcard

https://gemc.jlab.org/work/clas12.gcard

A:

```
<sqltable name="LH2target"/>
<sqltable name="BST"/>
<sqltable name="BMT"/>

<sqltable name="CTOF"/>
<sqltable name="CND"/>

<!-- Forward Detectors:
 These are inside SECTOR, that is copied 5 times around
 CLAS phi to create 6 sectors
 -->
<sqltable name="SECTOR"/>
<sqltable name="DC12"/>
<sqltable name="FTOF"/>
<sqltable name="EC"/>
<sqltable name="PCAL"/>

<!-- Beam Line:
 This is the NO Forward Tagger Configuration -->
<sqltable name="downstream_shielding"/>
<sqltable name="noft_shielding"/>
```

https://gemc.jlab.org/work/clas12.gcard

A:

```
<!--
This will run gemc in batch mode. Change to "1" or
overwrite at command line to run it interactively
Also, use -N=1000 to simulate some number of events
For background events, I suggest you set PRINT_EVENT to 1
-->
<option name="USE_QT"          value="0" />
<option name="USE_PHYSICSL"    value="QGSP_BERT" />
<option name="PRINT_EVENT"     value="10" />



<!--
Internal Generator:
This can generate events flat in momentum, theta and phi
-->
<option name="BEAM_P"        value="e-, 3.0*GeV, 20*deg, 0*deg" />
<option name="SPREAD_P"       value="0.1*GeV, 5*deg, 180*deg" />
<option name="BEAM_V"         value="(0.,0.,0.)cm" />
<option name="SPREAD_V"       value="(0.0015, 2.5)cm" />
```

Q: How do I turn on/off different components of CLAS12?

Q: How do I turn on/off different components of CLAS12?

A:

```
<detector name="BMT_SL_1">
   <existence exist="no" />
</detector>
```

- Applies to all daughter
- Applies at any level

Q: How do I put in shifts and rotations from surveys?

Q: How do I put in shifts and rotations from surveys?

A:

```
<detector name="BST">
    <position x="0*cm"  y="0*cm"  z="6.63*cm"  />
 </detector>
```

```
<detector name="BST">
    <rotation x=”0"  y=”1*deg"  z=“0"  />
 </detector>
```

Q: How many targets are available?

Q: How many targets are available?

A:

Target, SEMI lengths, density

LH2	2.500cm	0.0708g/cm^3
LD2	1.470cm	0.0169g/cm^3
NH3	0.080cm	0.0708g/cm^3
Carbon	0.080cm	2.2100g/cm^3
Iron	0.022cm	7.8740g/cm^3
Lead	0.016cm	11.3500g/cm^3

Q: How do I choose/move target?

A:

```
<sqltable name="LH2target"/>
```

```
<detector name="LH2target">
    <position x="0"  y="0"  z="-10*cm"  />
 </detector>
```

Q: How many generators are available?

Q: How many generators are available?

A:

1. Gemc internal generator, can generate up to 3 independent particles.

2. LUND format (FSGEN, Pythia)

3. StdHep format (used by SLAC, HPS experiment)

Q: How to choose/use generator?

A:

GEMC Primary Particle:

```
<option name="BEAM_P"        value="e-, 3.0*GeV, 20*deg, 0*deg" />
<option name="SPREAD_P"      value="0.1*GeV, 5*deg, 180*deg" />
<option name="BEAM_V"        value="(0.,0.,0.)cm" />
<option name="SPREAD_V"      value="(0.0015, 2.5)cm" />
```

Q: How to choose/use generator?

A:

LUND Format:

```
<option name="INPUT_GEN_FILE"  value="LUND, input.dat" />
```

Q: How to choose/use generator?

A:

LUND Format:

Header Infos

Column	Quantity
1	**Number of particles**
2	**Number of target nucleons**
3	**Number of target protons**
4	**Target Polarization**
5	**Beam Polarization**
6	*x*
7	*y*
8	*W*
9	*Q2*
10	*nu*

Particle Infos

Column	Quantity
1	index
2	charge
3	**type**(=1 is active)
4	**particle id**
5	parent id (decay bookkeeping)
6	daughter (decay bookkeeping)
7	$\mathbf{p_x}$ [GeV]
8	$\mathbf{p_y}$ [GeV]
9	$\mathbf{p_z}$ [GeV]
10	E [GeV]
11	mass (not used)
12	**x vertex** [cm]
13	**y vertex** [cm]
14	**z vertex** [cm]

Q: How do I add background events?

Q: How do I add background events?

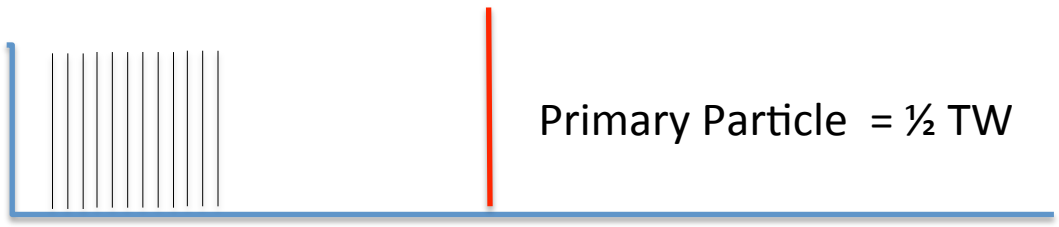
A:

```
This will simulate the beam on target
At CLAS12 luminosity on LH2 for example, there are 62K electrons
in a 130 ns window, bunched every 2ns


<option name="LUMI_EVENT"     value="62000, 130*ns, 2*ns" />
<option name="LUMI_P"         value="e-, 11*GeV, 0*deg, 0*deg" />
<option name="LUMI_V"         value="(0.,0.,-10.)cm" />
<option name="LUMI_SPREAD_V"  value="(0.01, 0.01)cm" />
```

Q: How do I add background events?

A:

```
This will simulate the beam on target
At CLAS12 luminosity on LH2 for example, there are 62K electrons
in a 130 ns window, bunched every 2ns


<option name="LUMI_EVENT"     value="62000, 130*ns, 2*ns" />
<option name="LUMI_P"         value="e-, 11*GeV, 0*deg, 0*deg" />
<option name="LUMI_V"         value="(0.,0.,-10.)cm" />
<option name="LUMI_SPREAD_V"  value="(0.01, 0.01)cm" />
```



Q: Can I apply Energy Cuts to speed up the simulation?

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A:

A general production cut for all materials can be applied.
Units are MeV.

-ENERGY_CUT=10

Q: Can I apply Energy Cuts to speed up the simulation?

A:

Cuts can be applied to sensitive detectors too (see hit definition).

Cuts cannot be applied to “EC” in general for example.
But we should have this capability.

Q: Can I get gemc output in root format?

Q: Can I get gemc output in root format?

A:

1.8: yes. Use gemc_evio2root.
This will create ntuple that are copies of the gemc banks.

2.0: not yet. Almost there. But! Mechanism is a lot more robust.

Q: Can gemc give me the hit position and momentum at each step?

Q: Can gemc give me the hit position and momentum at each step?

A:

In the hit process routine: Yes:

```
vector<G4ThreeVector> pos  = aHit->GetPos();
vector<G4ThreeVector> Lpos  = aHit->GetPos();
vector<G4ThreeVector> mom = aHit->GetMoms ();
```

```
for(unsigned int s=0; s<nsteps; s++)
{
        if(attlen>0)
        {
                double xlocal = Lpos[s].x();
                double ylocal = Lpos[s].y();
                if(view==1) latt=xlocal+(pDx2/(2.*pDy1))*(ylocal+pDy1);
                if(view==2) latt=BA*(pDy1-ylocal)/2./pDy1;
                if(view==3) latt=BA*(ylocal+pDy1-xlocal*2*pDy1/pDx2)/4/pDy1;
                Etota = Etota + Edep[s]*exp(-latt/attlen);
        }
        else
        {
                Etota = Etota + Edep[s];
        }
}
```

Q: Can gemc give me the hit position and momentum at each step?

A:

2.0:

All true information, step by step, will be in the output.
(right now, integrated raw)

Q: How do I distinguish between primary particles and secondary ones? For example, can I follow the primary electron from step-to-step?

Q: How do I distinguish between primary particles and secondary ones? For example, can I follow the primary electron from step-to-step?

A:

Not right now.

This should be possible.

Q: Is GEMC multithreaded?

Q: Is GEMC multithreaded?

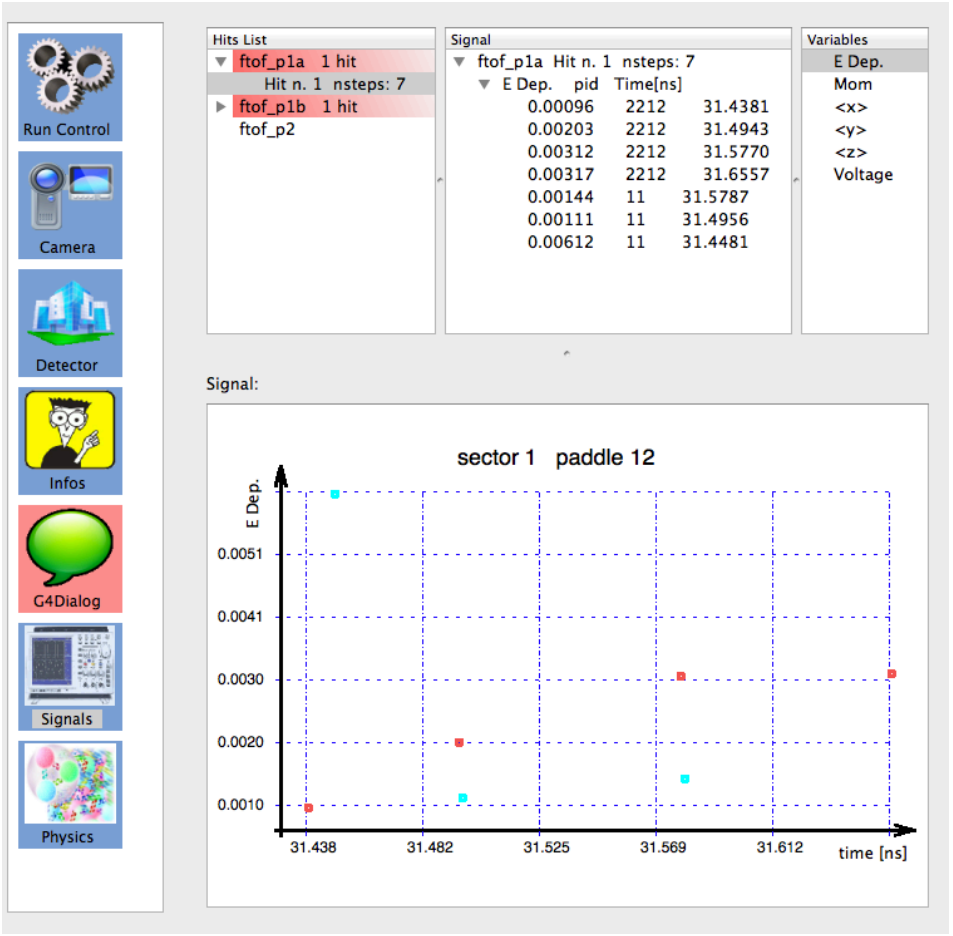
A:

No. But it will be cause G4 10 is.

Q: Can I look at Edep, other infos interactively?

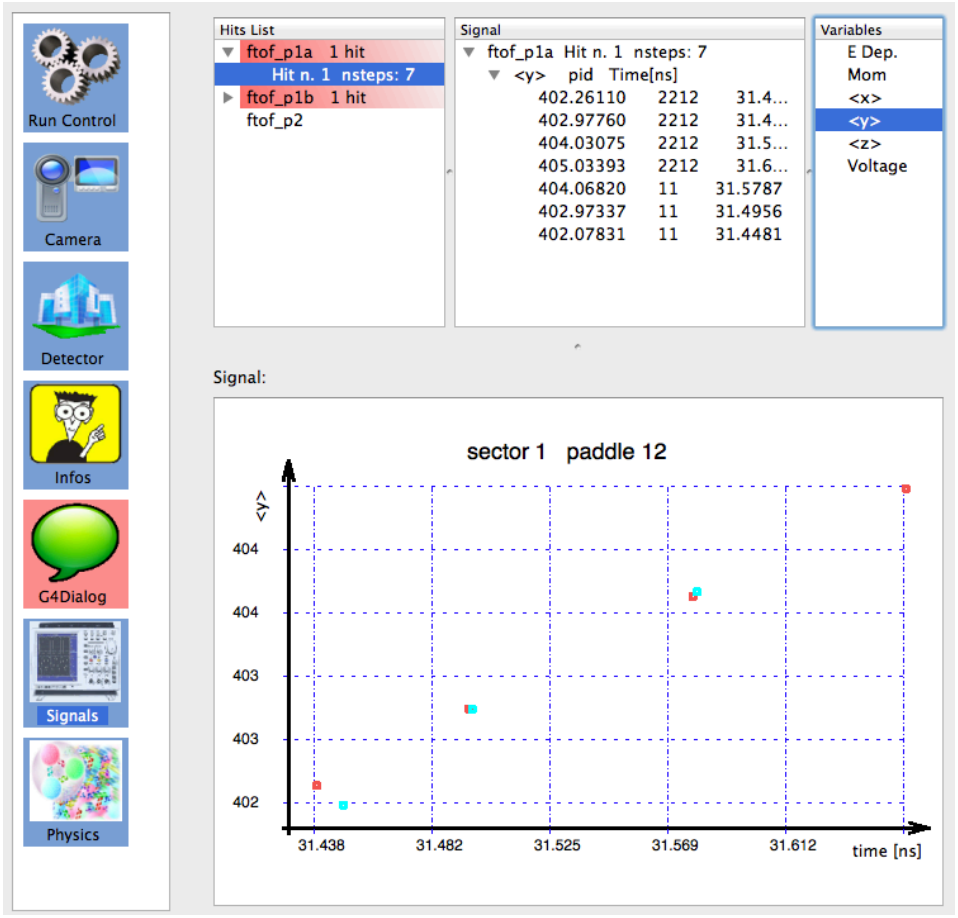
Q: Can I look at Edep, other infos interactively?

A:



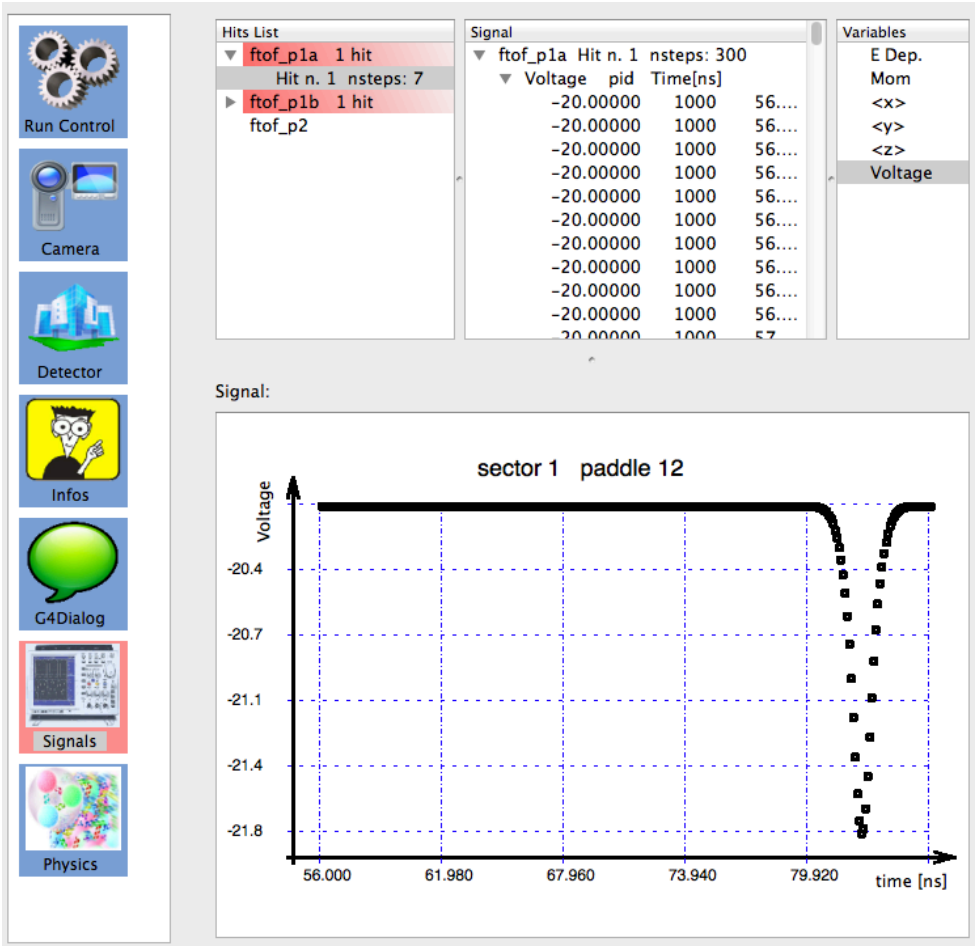
Q: Can I look at Edep, other infos interactively?

A:



Q: Can I look at Edep, other infos interactively?

A:



Q: What is a physics list and how do I choose Physics List?

A physics list is a set of models/cross sections and their energy range of applicability.

Example: High energy is string model + cascade model.
FTFP_BERT

Example: Low energy down to thermal energies:
QGSP_BERT_HP

Q: What is a physics list and how do I choose Physics List?

Gcard or command line option:

-PHYSICS="<HADRONIC> + <EM> + <HP> + <OPTICAL>"

Hadronic can be:

- CHIPS
- FTFP_BERT
- FTFP_BERT_TRV
- FTFP_BERT_HP
- FTF_BIC
- LHEP
- QGSC_BERT
- QGSP
- QGSP_BERT
- QGSP_BERT_CHIPS
- QGSP_BERT_HP
- QGSP_BIC
- QGSP_BIC_HP
- QGSP_FTFP_BERT
- QGS_BIC
- QGSP_INCLXX

EM can be

- STD
- EMV
- EMX
- EMY
- EMZ
- LIV
- PEN

`HP`: High Precision cross sections (e.g. thermal neutron, very low energy processes, etc)

`Optical`: Activate optical processes

Q: Can I profile gemc to study its performance?

Q: Can I profile gemc to study its performance?

A:

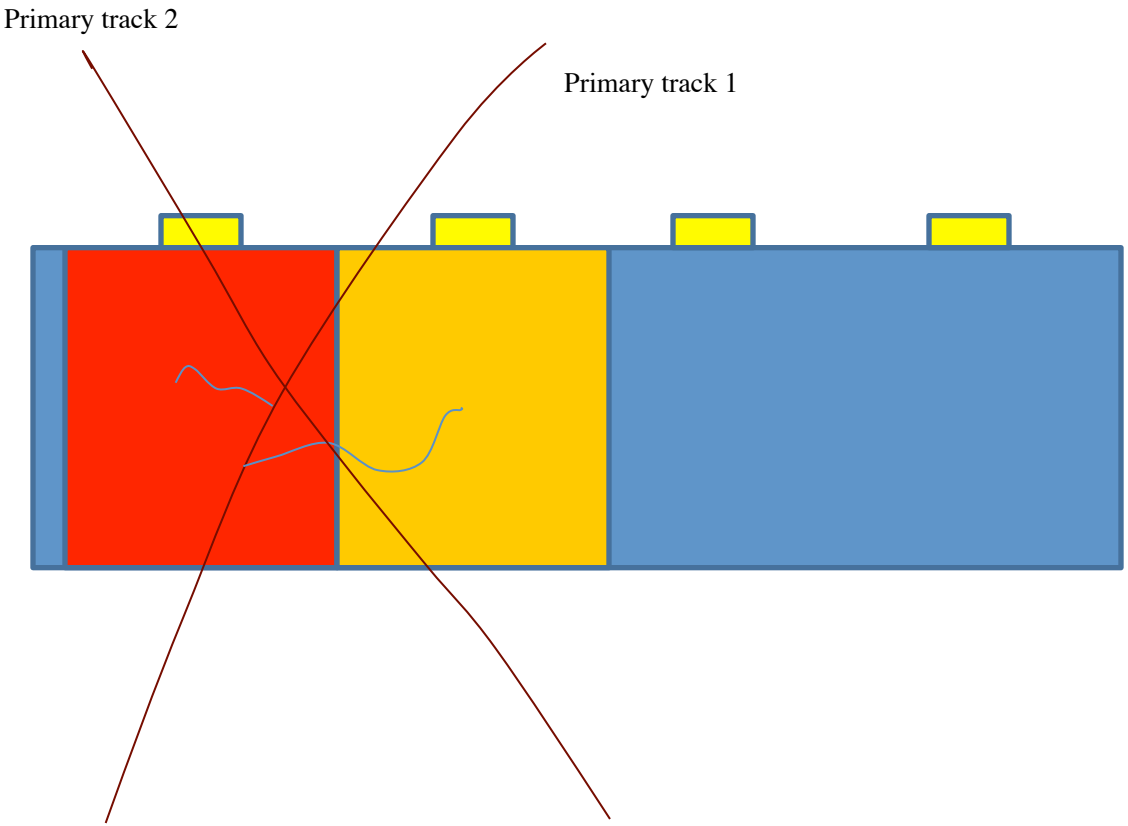
Use valgrind:

```
valgrind --leak-check=yes  --show-reachable=no \
--tool=memcheck -v --log-file=valgrind.log  \
 <gemc command>
```

Q: What is a hit?

Q: What is a hit?

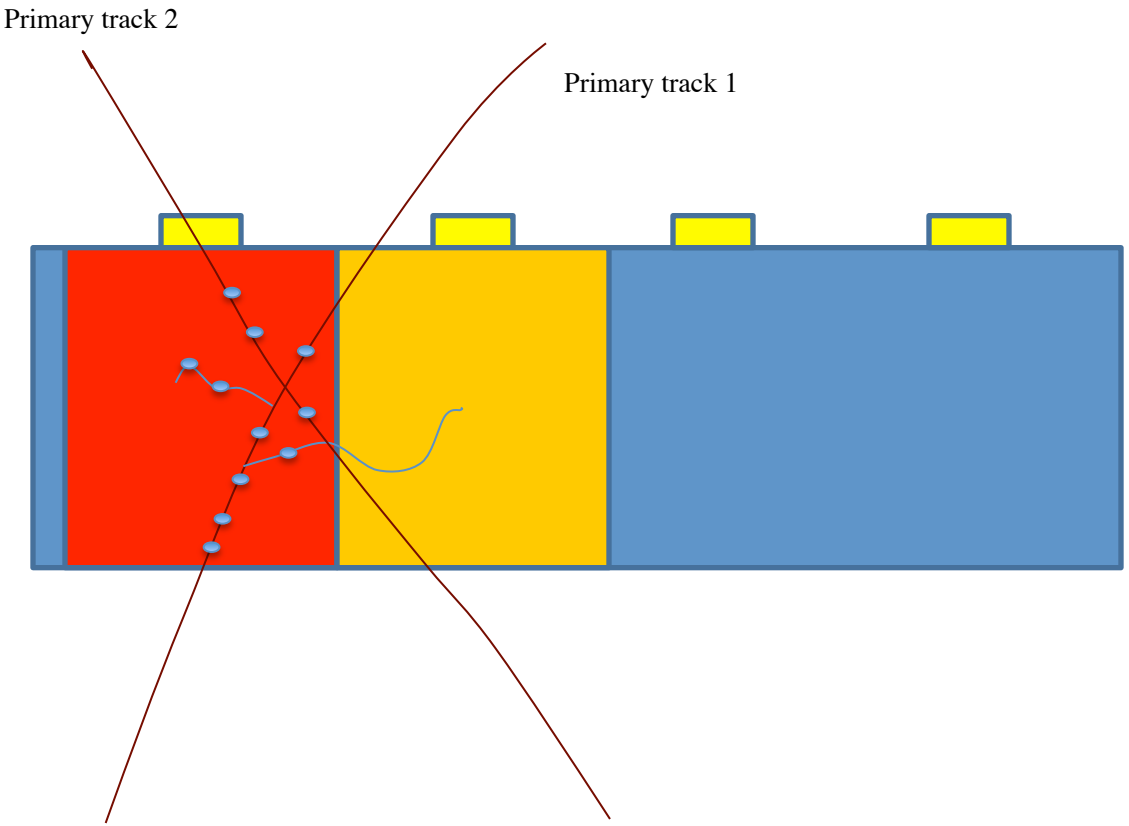
A:



All steps within the cell Time Window constitute a hit

Q: What is a hit?

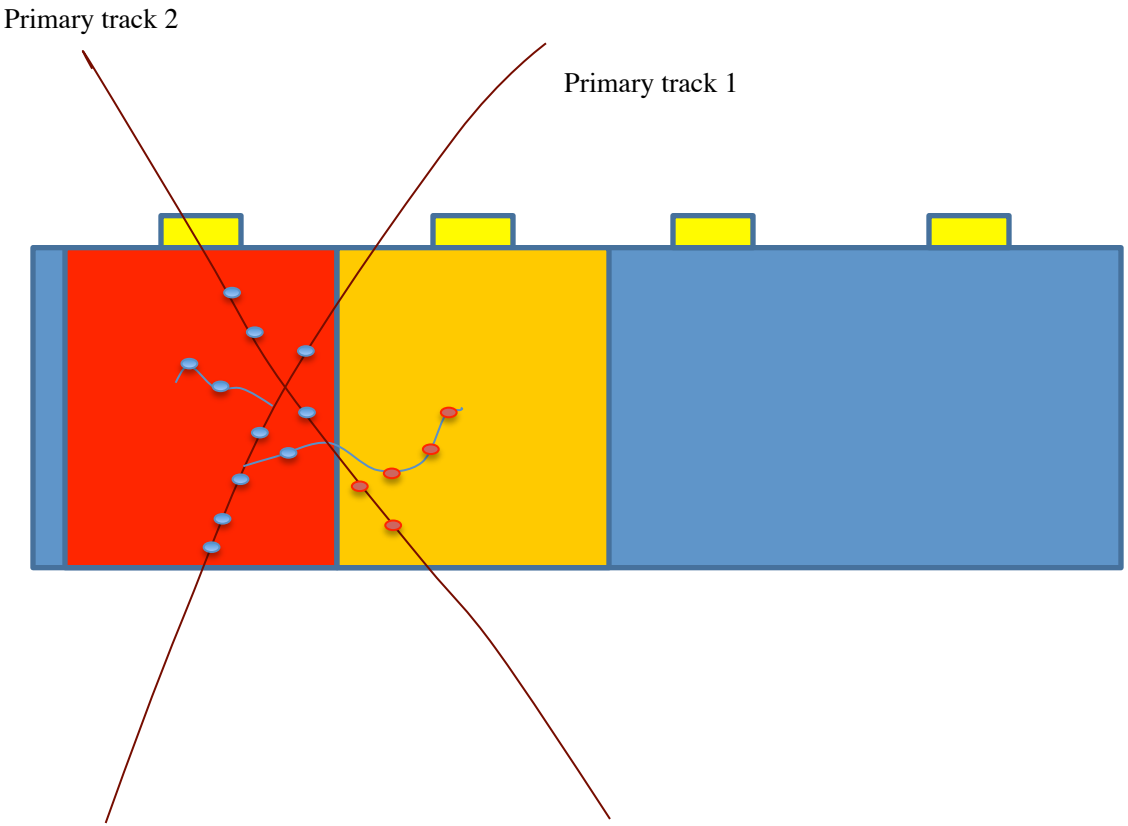
A:



All steps within the cell Time Window constitute a hit

Q: What is a hit?

A:



All steps within the cell Time Window constitute a hit

Q: What information is in a hit?

Q: What information is in a hit?

A:

a) “true” info, automatic:

Edep, mom, E, pos, lpos, time, vertex, mother infos.

b) Digitized: decided by the user

c) Voltage: automatic

Integrated over the time window or step-by-step

Q: How do I define a Hit?

Q: How do I define a Hit?

A:

Can use the gemc API

```
sub define_p1a_hit
{
      # uploading the hit definition
      my %hit = init_hit();

      $hit{"name"}            = "ftof_p1a";
      $hit{"description"}     = "ftof hit definitions for panel 1A";
      $hit{"identifiers"}     = "sector paddle";
      $hit{"signalThreshold"} = "0.5*MeV";
      $hit{"timeWindow"}      = "5*ns";
      $hit{"prodThreshold"}   = "1*mm";
      $hit{"maxStep"}         = "1*cm";
      $hit{"delay"}           = "50*ns";
      $hit{"riseTime"}        = "1*ns";
      $hit{"fallTime"}        = "2*ns";
      $hit{"mvToMeV"}         = 100;
      $hit{"pedestal"}        = -20;

      print_hit(\%configuration, \%hit);
}
```

Q: How well we will simulate the Cherenkov radiation?

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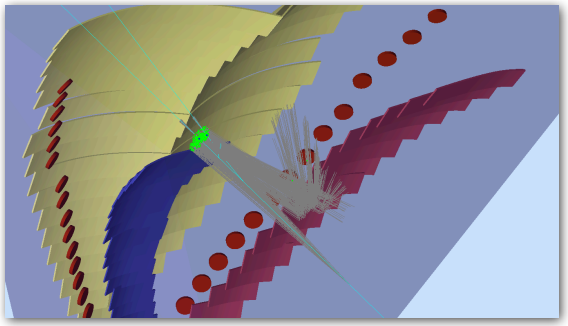
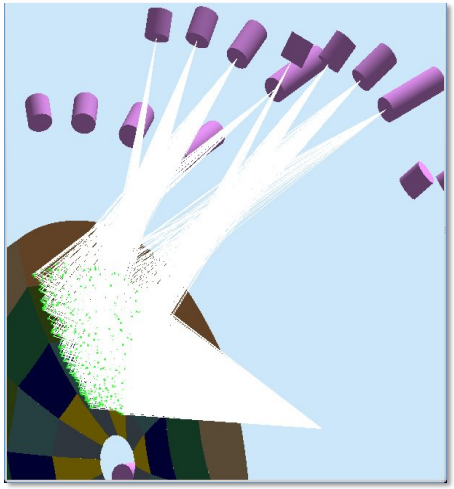
A:

As good as geant4 allows.
This includes:

- Cerenkov Process
- Scintillation Process
- Transition Radiation

Fresnel equations
Reflectivity, Refractive index,
Transmittance
As a function of wavelength





Q: How well we will simulate the Cherenkov radiation?

A:

- Dielectric - Dielectric

  Depending on the photon's wave length, angle of incidence, (linear) polarization, and refractive index on both sides of the boundary:

  (a) total internal reflected

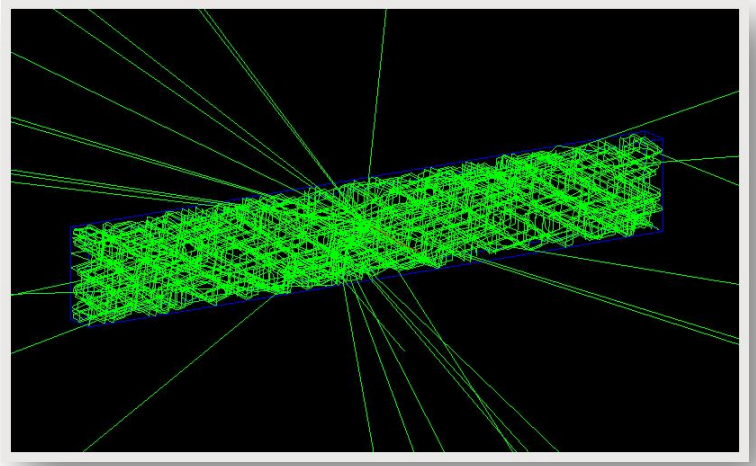
  (b) Fresnel refracted

  (c) Fresnel reflected

- Dielectric - Metal

  (a) absorbed (detected)

  (b) reflected



Q: I would like to study the drift chamber occupancy versus different shield designs. How do I output DC occupancy?

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A:

```
<detector name="DC12" factory="CLARA" variation="shield1" run_number="1"/>
<option name="OUTPUT"         value="evio, shield1.ev" />
```


```
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```

Q: I would like to study the drift chamber occupancy versus different shield designs. How do I output DC occupancy?

A:

Use evio2root, and the ntuple will have the dcT tree with:

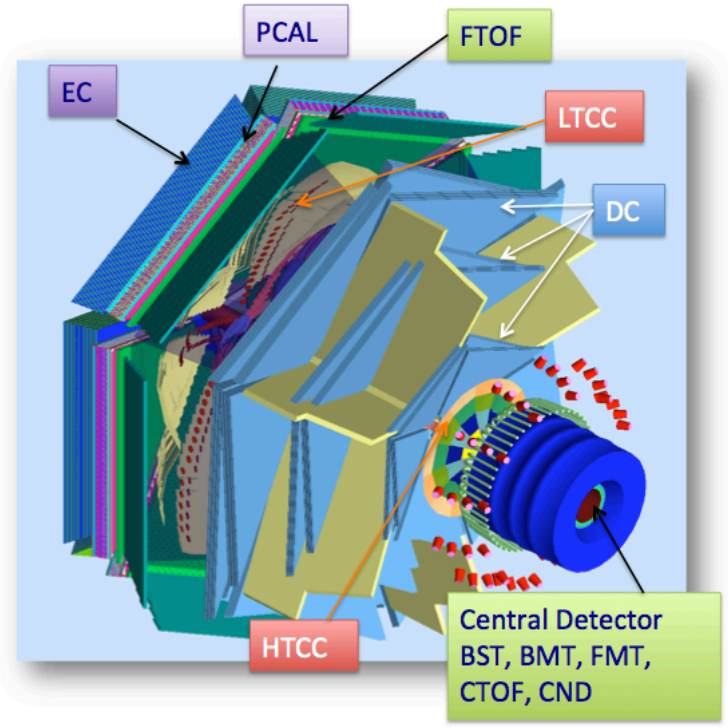
Sector, Superlayer, layer, wire, Edep, etc

Root:

dcT->(“(superlayer-1)*6+layer):wire”, “sector==1”)

gemc versions

1.8



2.0 (beta)

- Automatic “true info”
- Automatic V(T) signal
- Simplified digitization
- FADC ready
- New banks, banks IO, automatic ROOT
- New magnetic field field definitions
- Factory of factories
- Modular Physics List
- Lot of code optimization, Object-Oriented improvements.

Produce 1000 events (farm)

ssh ifarm

setenv JLAB_ROOT /site/12gev_phys
setenv JLAB_VERSION production
source $JLAB_ROOT/ce/releases/$JLAB_VERSION/jlab.csh

cp /work/clas/clas12/ungaro/clas12.gcard .

gemc –gcard=clas12.gcard –N=1000