GEMC Overview

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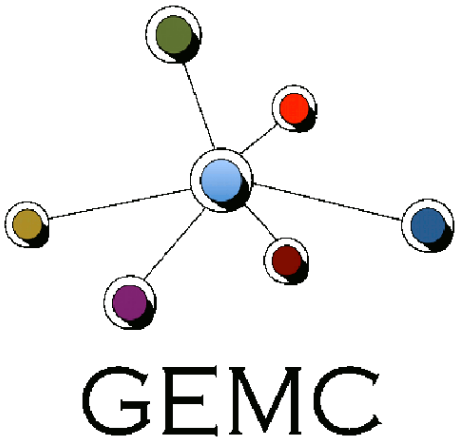
GEMC (GEant4 MonteCarlo)

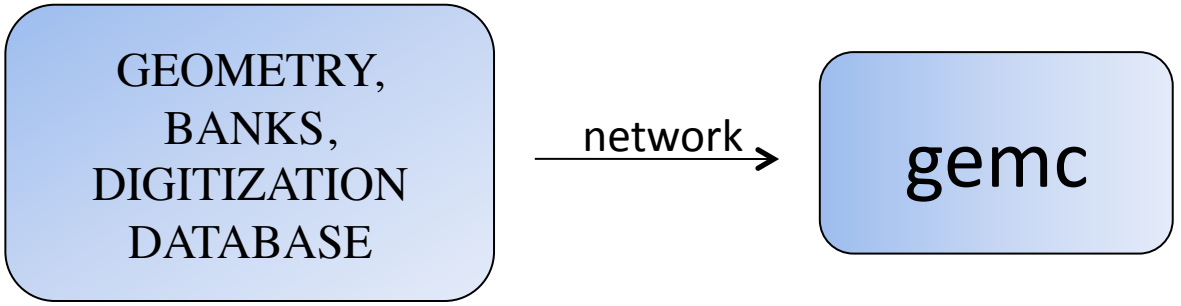
gemc is a C++ program that simulates particles through matter using the geant4 libraries.



> Detectors Information are stored at the JLAB mysql server. Configuration changes are immediately available to the users without need to recompile the code

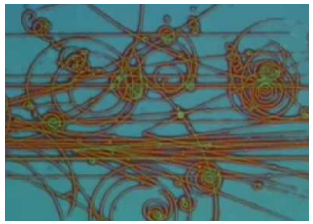
> Hit Process Factory: associate detectors with external digitization routines at run time

> Developers interact with database, do not need to know C++ or Geant4 to build detector and run the simulation

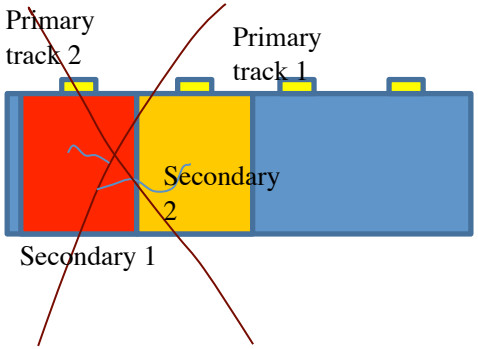


Hit Types Databases

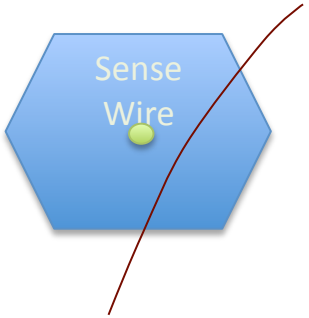
1) "FLUX" type: every track has its own hit. Good for counting purposes (i.e. how many protons pass through a detector, etc)



2) Time Window ADC: all hits (separate tracks too) in the same time window for a particular detector will be added to a single hit



3) Time Window TDC: the *first* signal within the detector time window will give the TDC.



Physics Processes Databases

LHEP Physics Lists

The LHEP Physics lists are based on a parameterised modeling for all hadronic interactions for all particles. Based on Geisha model.
Example:
LHEP_BERT (Bertini Cascade)

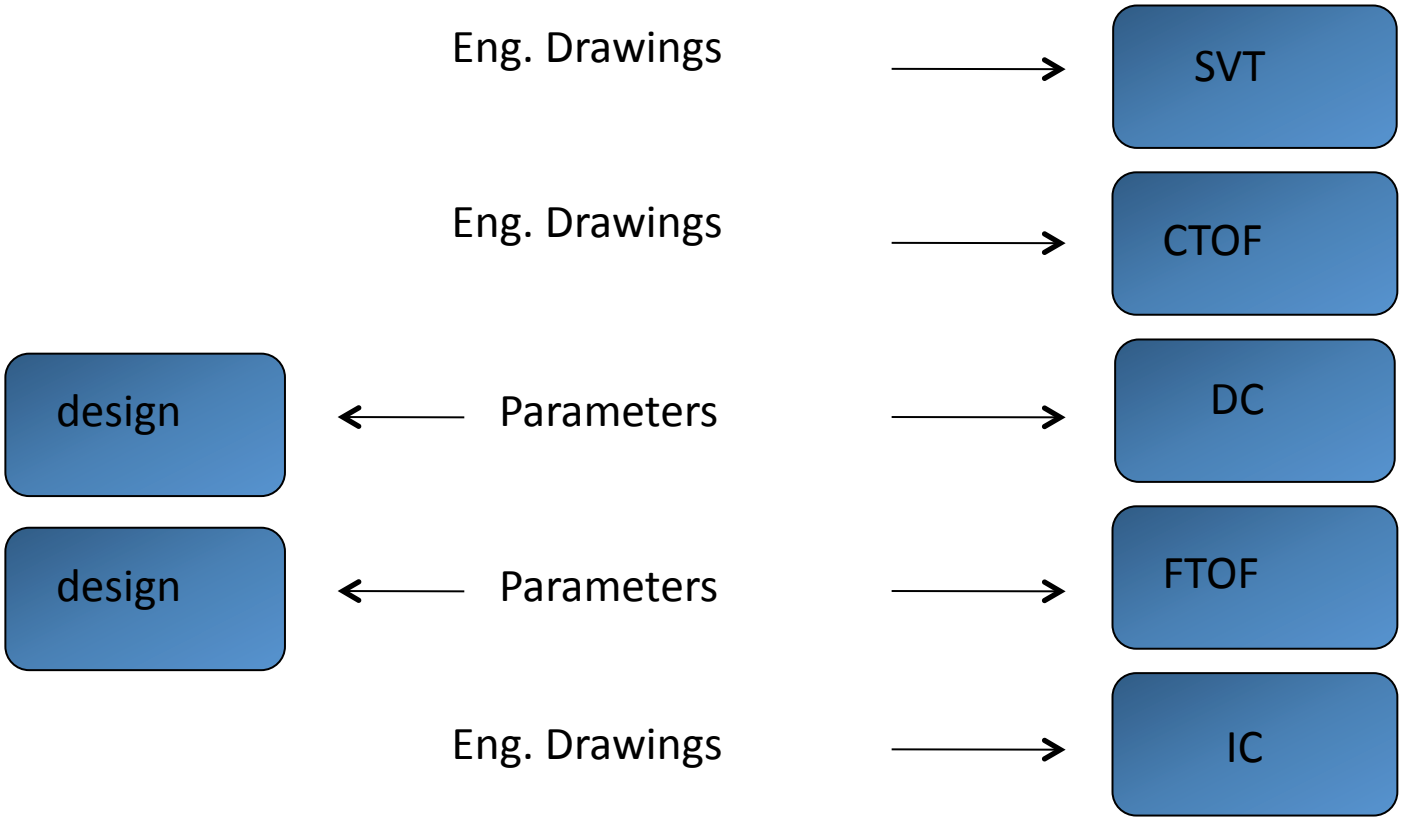
String model based physics lists

These Physics lists apply a string models for the modeling of interactions of high energy hadrons, i.e. for protons, neutrons, pions and Kaons above ~(5-25) GeV. Examples:

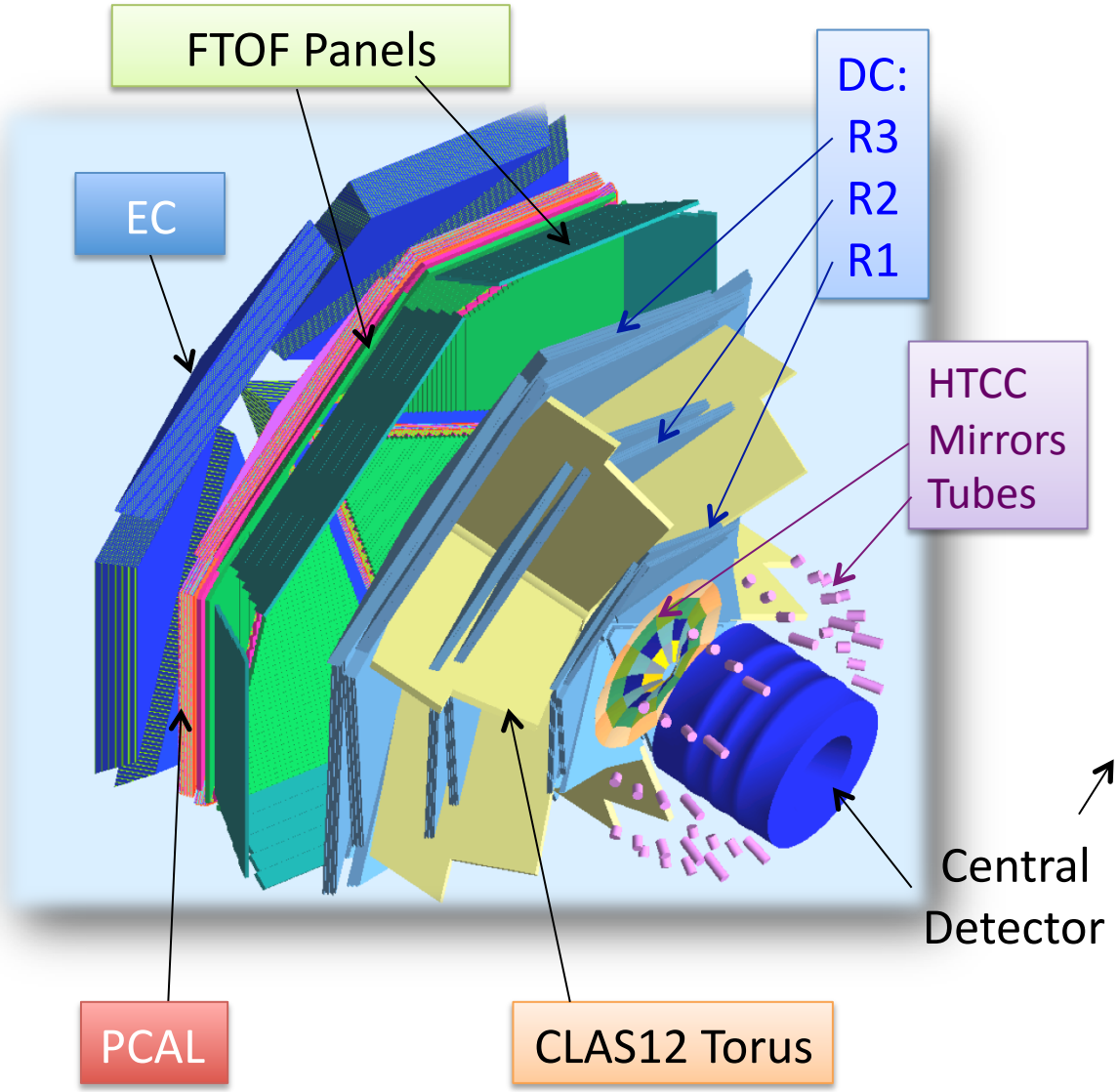
QGSP: quark gluon string model
QGSC: CHIPS modeling for the nuclear de-excitation
QGSC_BERT: Bertini cascade for primary protons, neutrons, pions and Kaons below ~10GeV. (recommended for CLAS12)

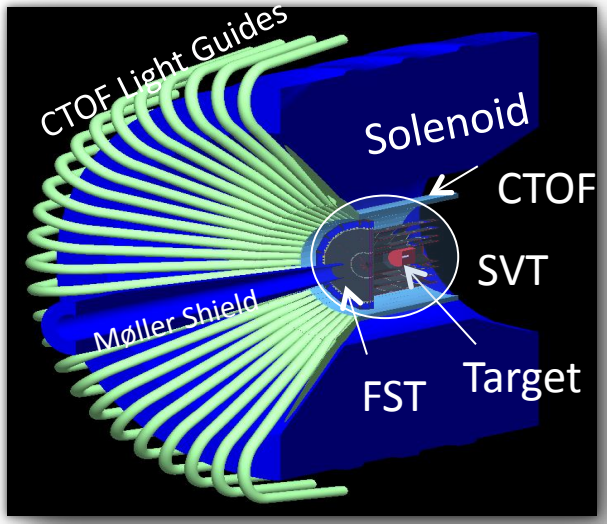
Geometry Database

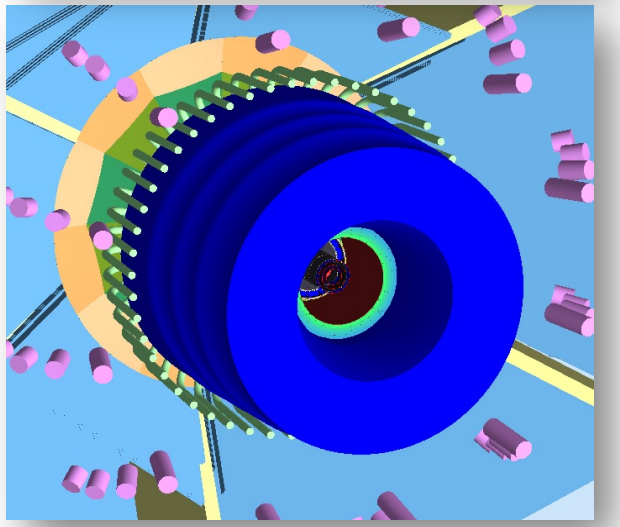
Wanted: same DB for design/montecarlo/reconstruction



Current Status for CLAS12







How To: new detector, hits

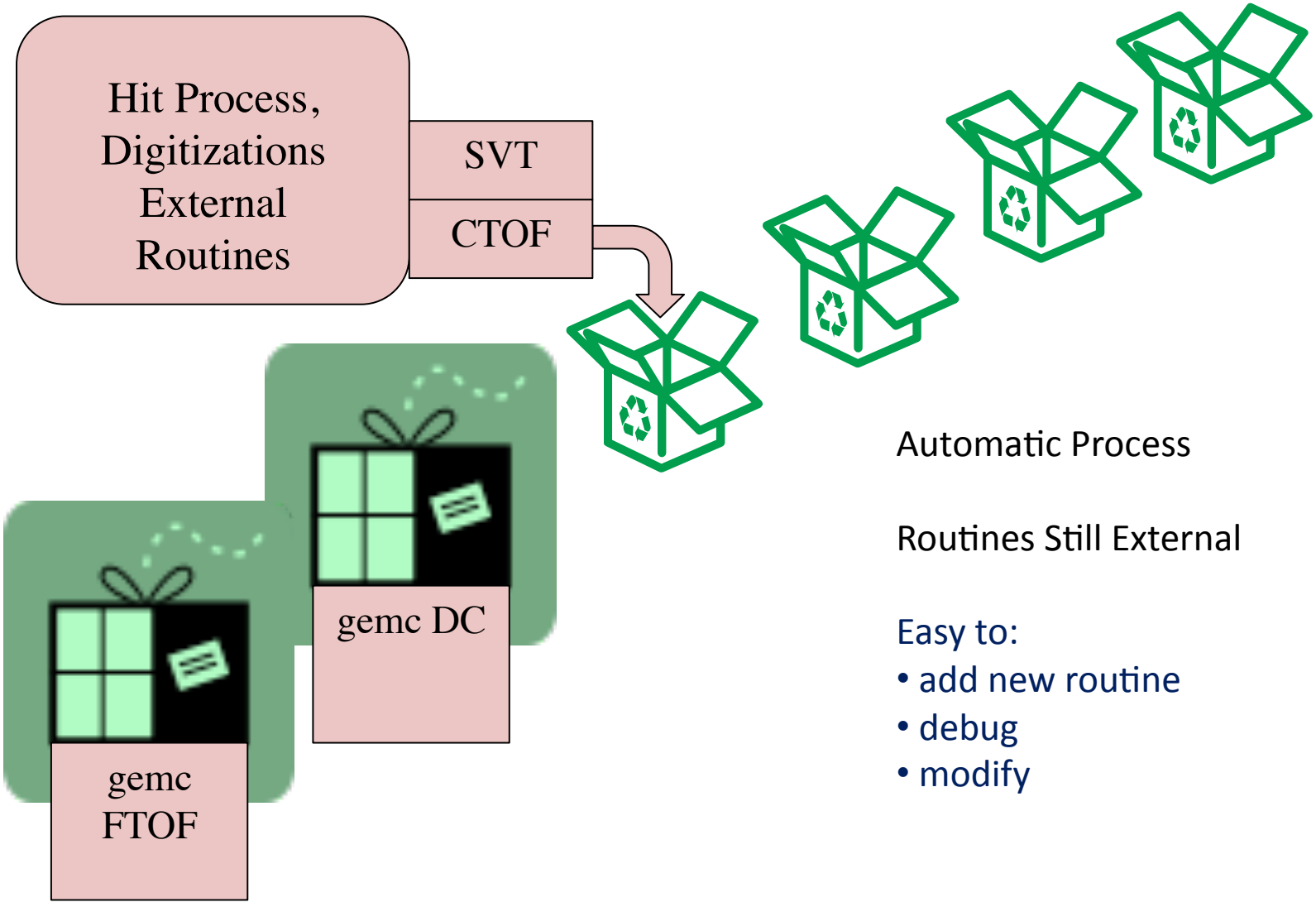
```
$detector{"pos"}         = "10*cm 20*cm 305*mm";
$detector{"rotation"}    = "90*deg 25*deg 0*deg";
$detector{"color"}       = "66bbff";
$detector{"type"}        = "Trd";
$detector{"dimensions"}  = "1*cm 2*cm 3*cm 4*cm 5*cm";
$detector{"material"}    = "Scintillator";
$detector{"mfield"}      = "no";
$detector{"ncopy"}       = 12;
$detector{"pMany"}       = 1;
$detector{"exist"}       = 1;
$detector{"visible"}     = 1;
$detector{"style"}       = 1;
$detector{"sensitivity"} = "CTOF";
$detector{"hit_type"}    = "CTOF";
$detector{"identifiers"} = "paddle manual 2";
```

16th: Bank

17th: Digitization Routine

In general, 1 bank ←→ 1 digitization routine… but not necessary

Factory Method for Hit Processes



Automatic Process

Routines Still External

Easy to:
- add new routine
- debug
- modify

Output

TXT output:

-OUTPUT=“txt, data.txt”

EVIO OUTPUT:

-OUTPUT=“evio, data.ev”

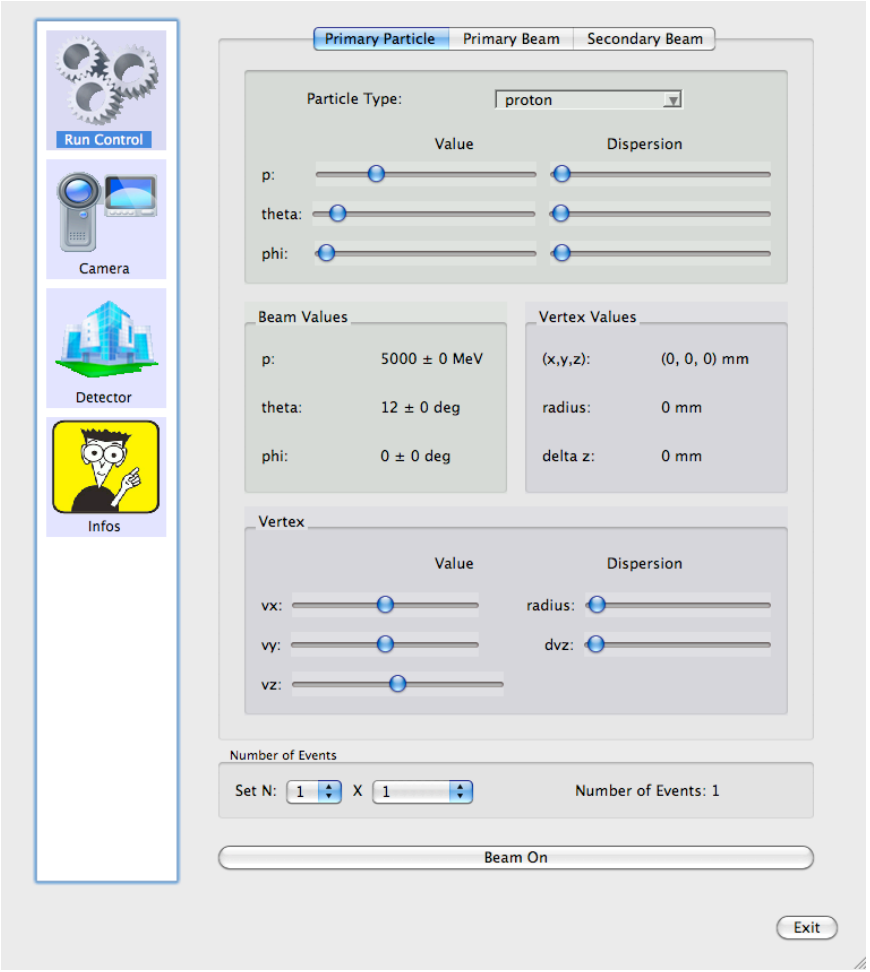
Event Generation

1) With gemc internal generator (later)
2) LUND Format for physics events:

```
8 34406 0  0.  0.  0.  0.  0.  0.  0.
      1  0  1    2212   0   0      0.000    0.000    0.000    0.938    0.938    0.000    0.000    0.000
      2  0  1      11   0   0      0.401   -0.605    5.517    5.565    0.001    0.000    0.000    0.000
      3  0  1     211   0   0     -0.305    0.296    3.417    3.446    0.140    0.000    0.000    0.000
      4  0  1    2112   0   0     -0.379   -0.062    1.627    1.918    0.940    0.000    0.000    0.000
      5  0  1    -211   0   0     -0.015    0.114    0.098    0.205    0.140    0.000    0.000    0.000
      6  0  1     211   0   0      0.137    0.406    0.306    0.545    0.140    0.000    0.000    0.000
      7  0  1      22   0   0      0.162   -0.070    0.041    0.181    0.000    0.000    0.000    0.000
      8  0  1      22   0   0     -0.001   -0.078   -0.006    0.079    0.000    0.000    0.000    0.000
9 34407 0  0.  0.  0.  0.  0.  0.  0.
      1  0  1    2212   0   0      0.000    0.000    0.000    0.938    0.938    0.000    0.000    0.000
      2  0  1      11   0   0      0.340    0.384    2.811    2.857    0.001    0.000    0.000    0.000
      3  0  1    -211   0   0     -0.114    0.357    3.700    3.721    0.140    0.000    0.000    0.000
      4  0  1    2212   0   0     -0.002   -0.776    1.742    2.126    0.938    0.000    0.000    0.000
      5  0  1     211   0   0      0.336   -0.200    0.941    1.029    0.140    0.000    0.000    0.000
      6  0  1      22   0   0     -0.141    0.107    0.033    0.180    0.000    0.000    0.000    0.000
      7  0  1      22   0   0     -0.044    0.118   -0.067    0.143    0.000    0.000    0.000    0.000
      8  0  1      22   0   0     -0.150    0.021    0.455    0.480    0.000    0.000    0.000    0.000
      9  0  1      22   0   0     -0.225   -0.010    1.384    1.402    0.000    0.000    0.000    0.000
```

To all these “primary” particles, a luminosity beam can be added (later)

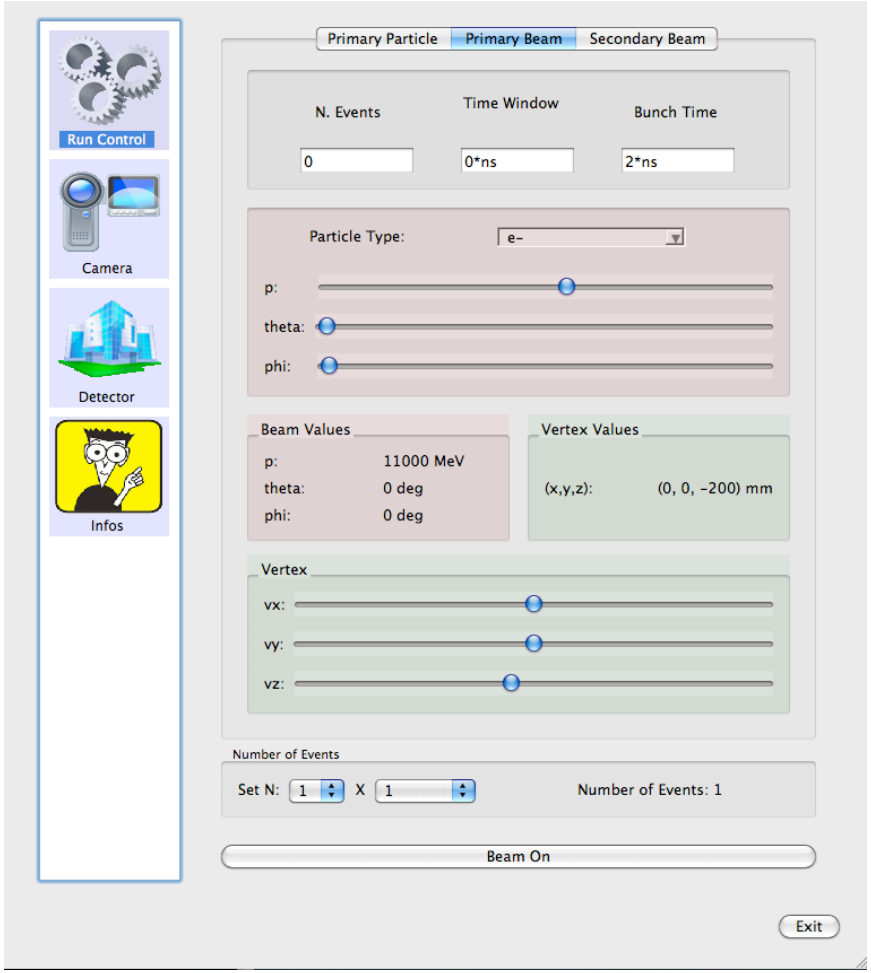
Current Status



RUN Control

Select Primary Particle
Momentum, Vertex ranges

Current Status

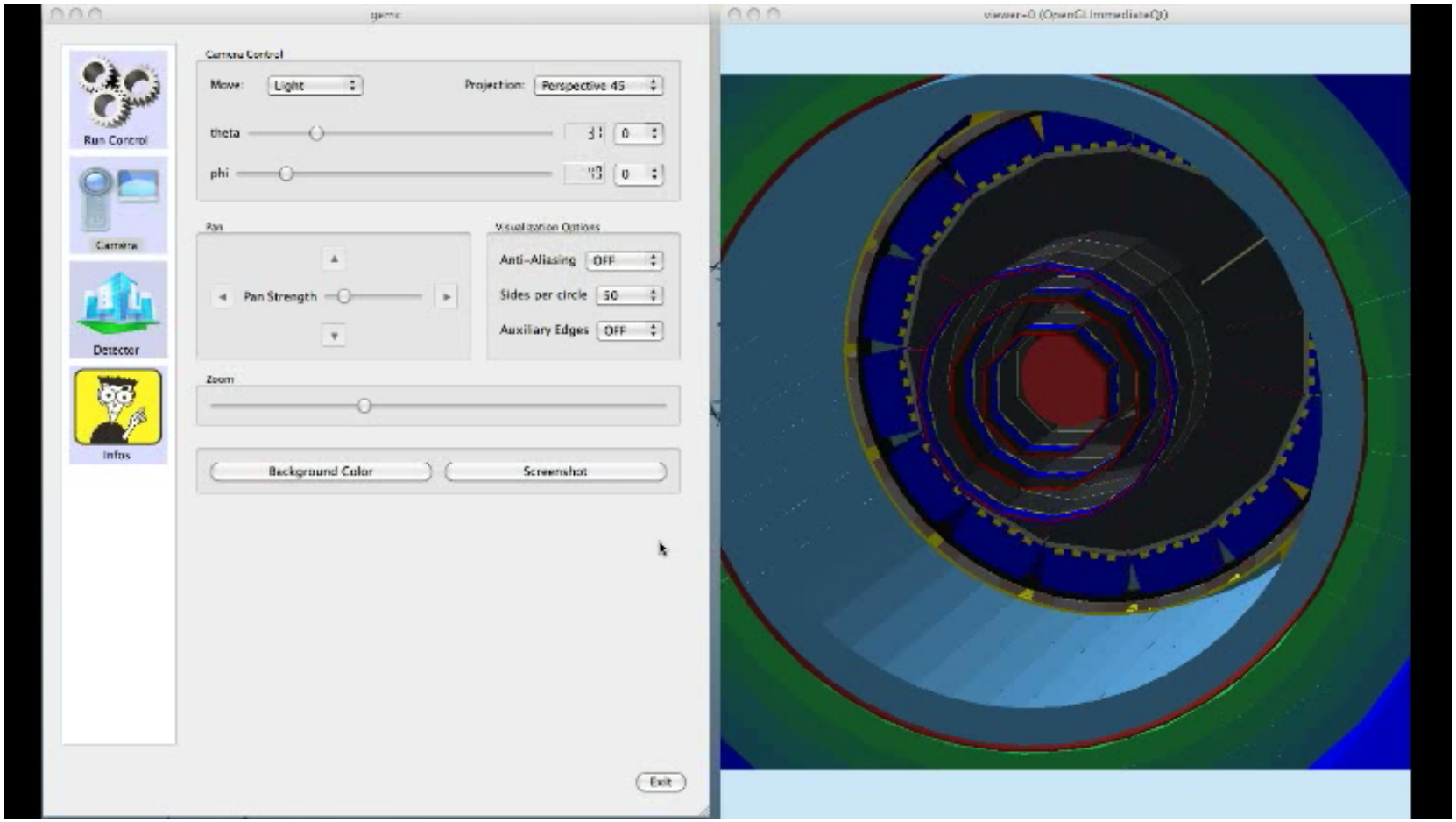


RUN Control

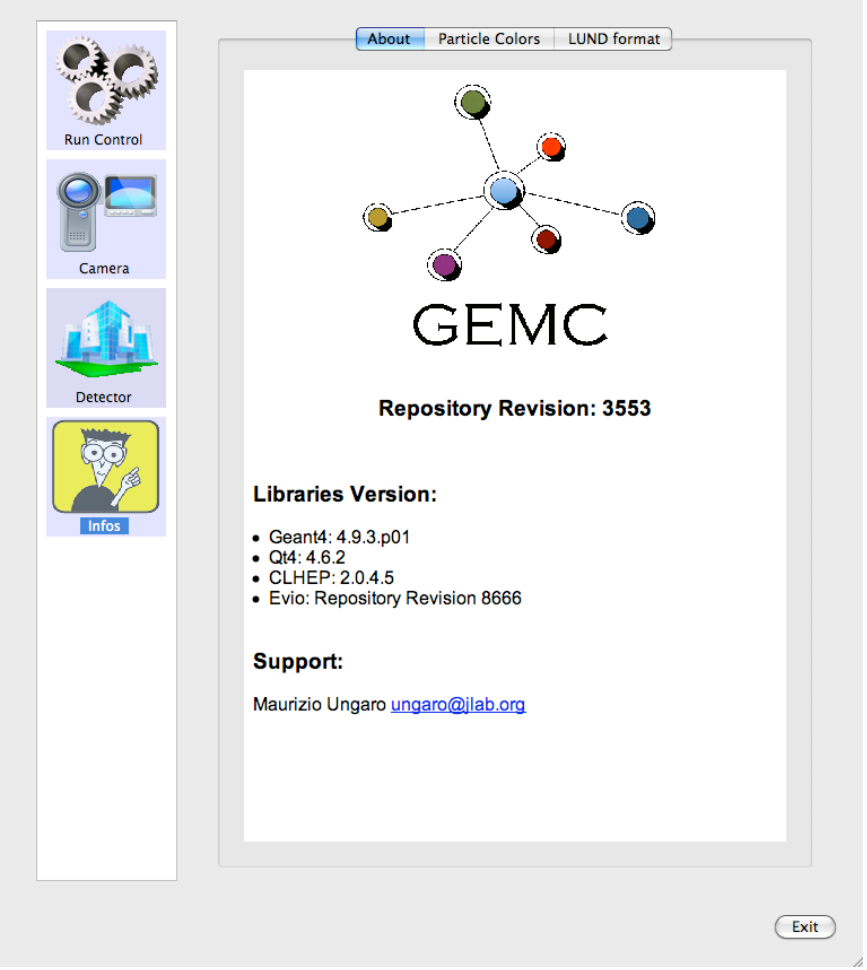
Select Primary Particle
Momentum, Vertex ranges

Primary and Secondary Beam
Time Window, Beam Bunch Time
Beams Momentum and Vertex

Current Status



Current Status



Infos

GEMC version
Libraries Versions

Current Status

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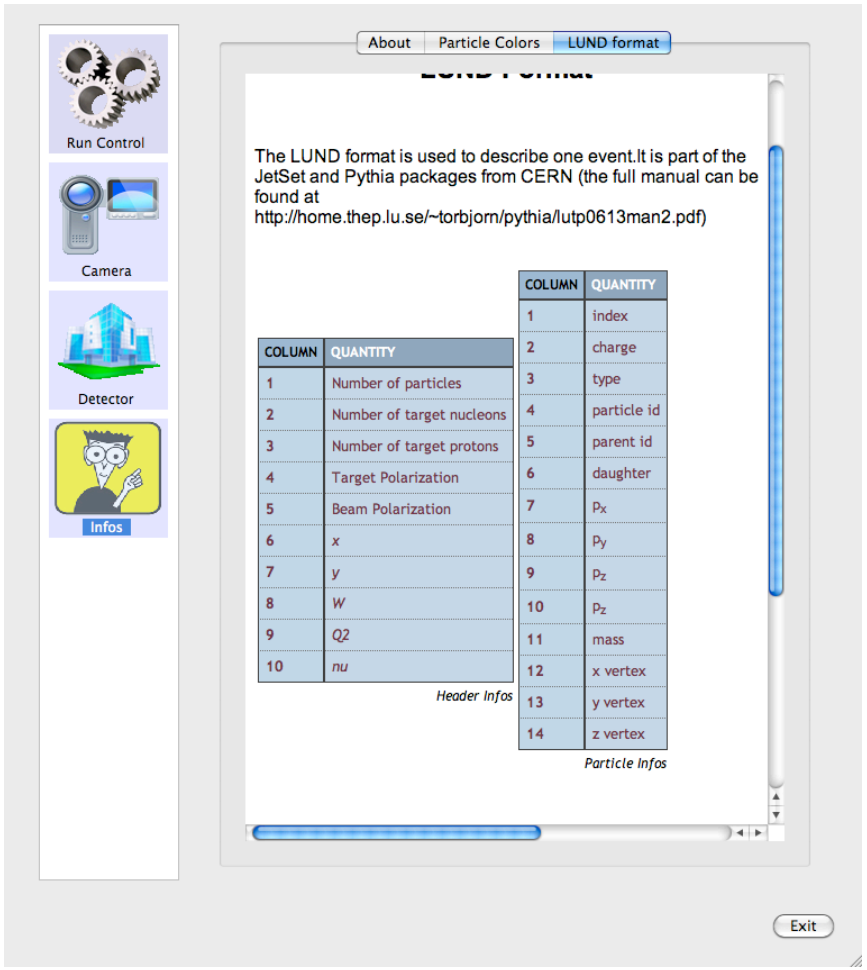
GEMC version
Libraries Versions

Tracks Color Codes

Current Status



Infos

GEMC version
Libraries Versions

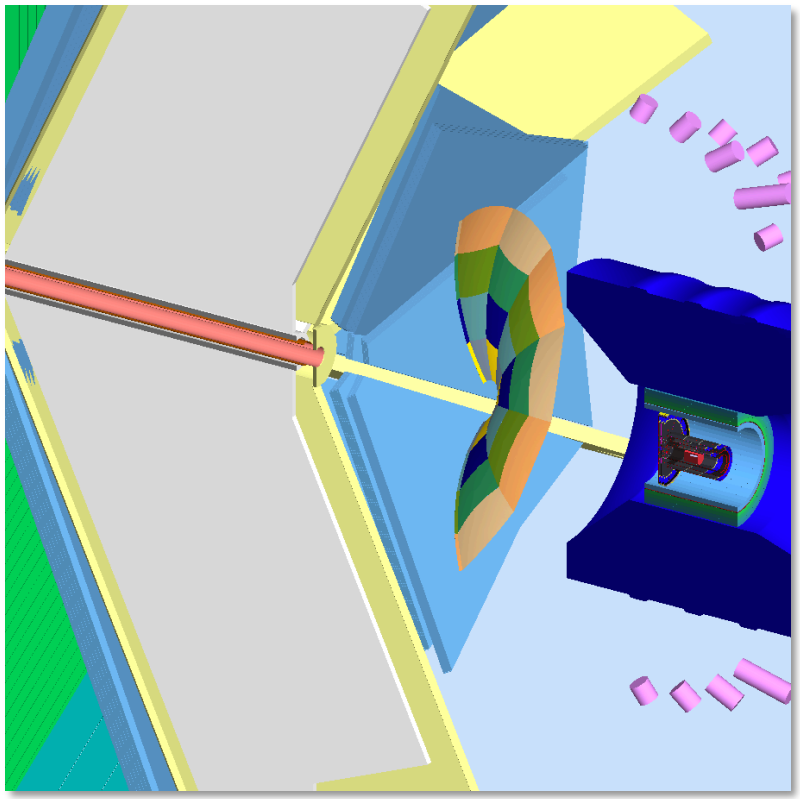
Tracks Color Codes

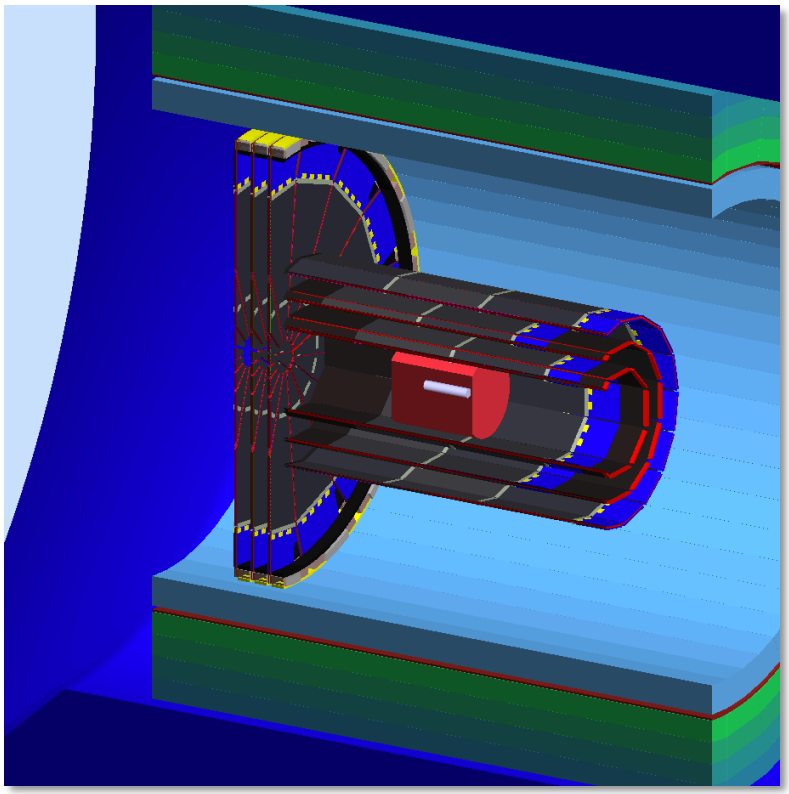
LUND Format Input HOWTO

Good place to add documentation,
Support for HTML and PDF docs.

Future

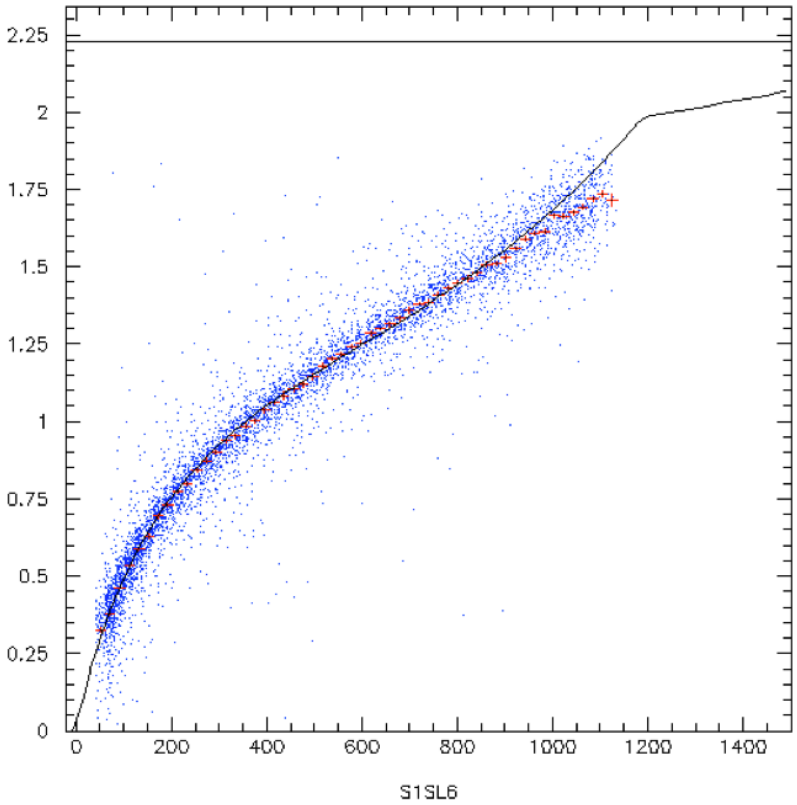
- Add “slice” buttons

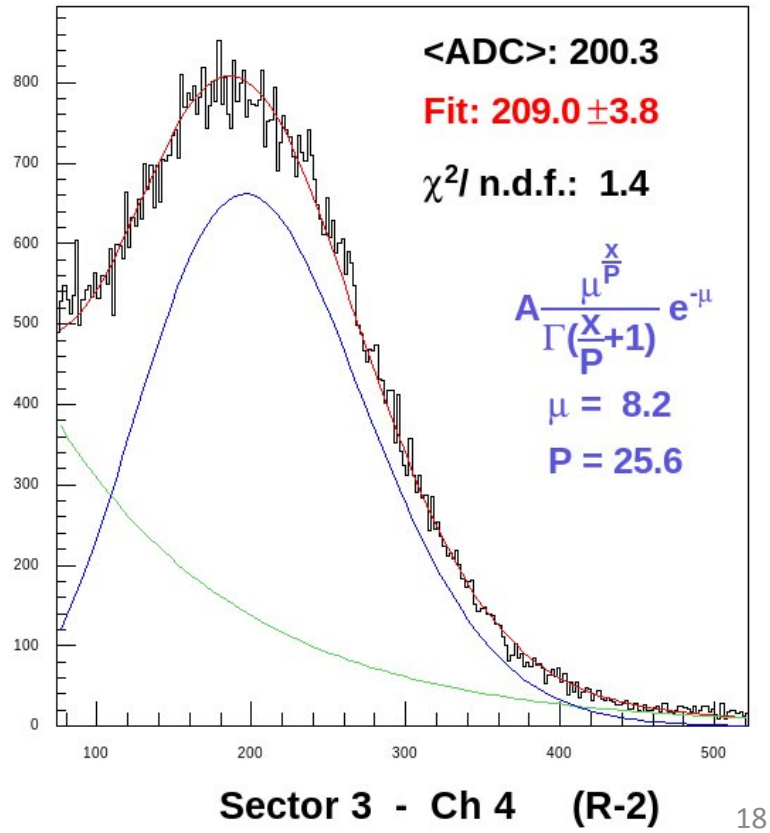




Future

- Calibration constants directly in the simulation





Future

- Database i/o: run indexes
  - Right now: clas12_geometry and user_geometry… enough geometry developers to cause interferences if many people are working on the same detector
  - One main run index, writeable by officials only
  - Copies of Run Indexes: JLAB users can make private copies with a web form (and they decide their own accessibility)

Optical Processes, Optical “Hits”

- Concept of “optical Photon” in G4

$$\lambda >> \text{atomic spacing}$$

  - Cerenkov Process
  - Scintillation Process
  - Transition Radiation

Optical Processes, Optical "Hits"

Boundaries:

- **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

Optical Processes, Optical “Hits”

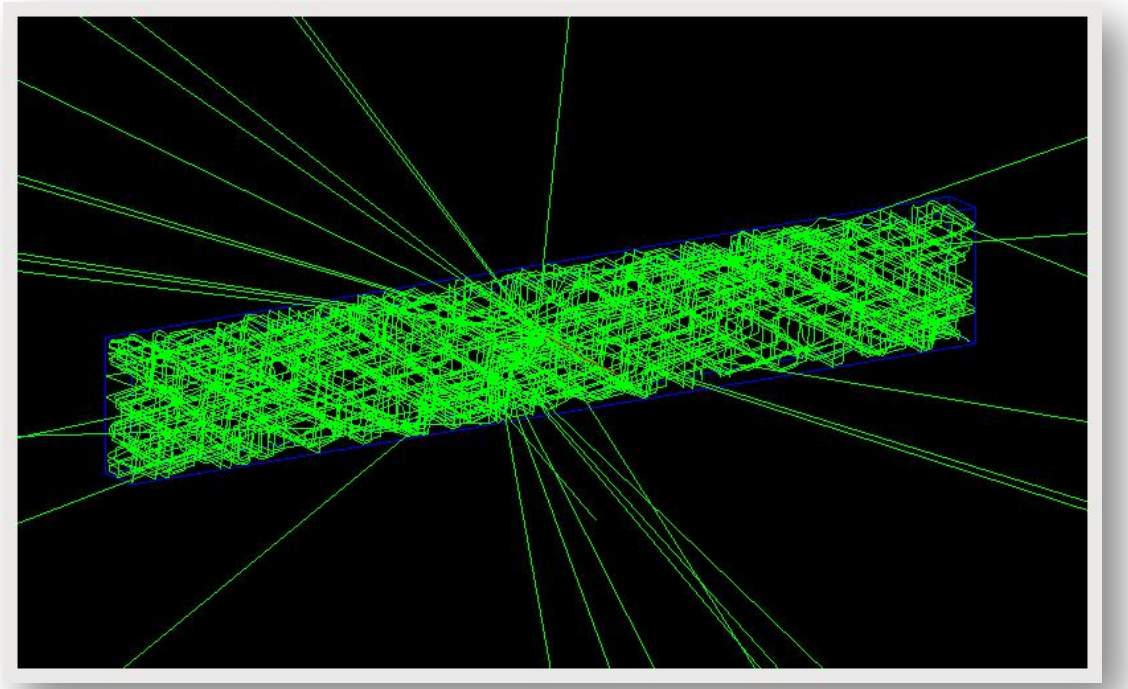
Scintillation:

CTOF LG design,
CTOF response function

In Progress:

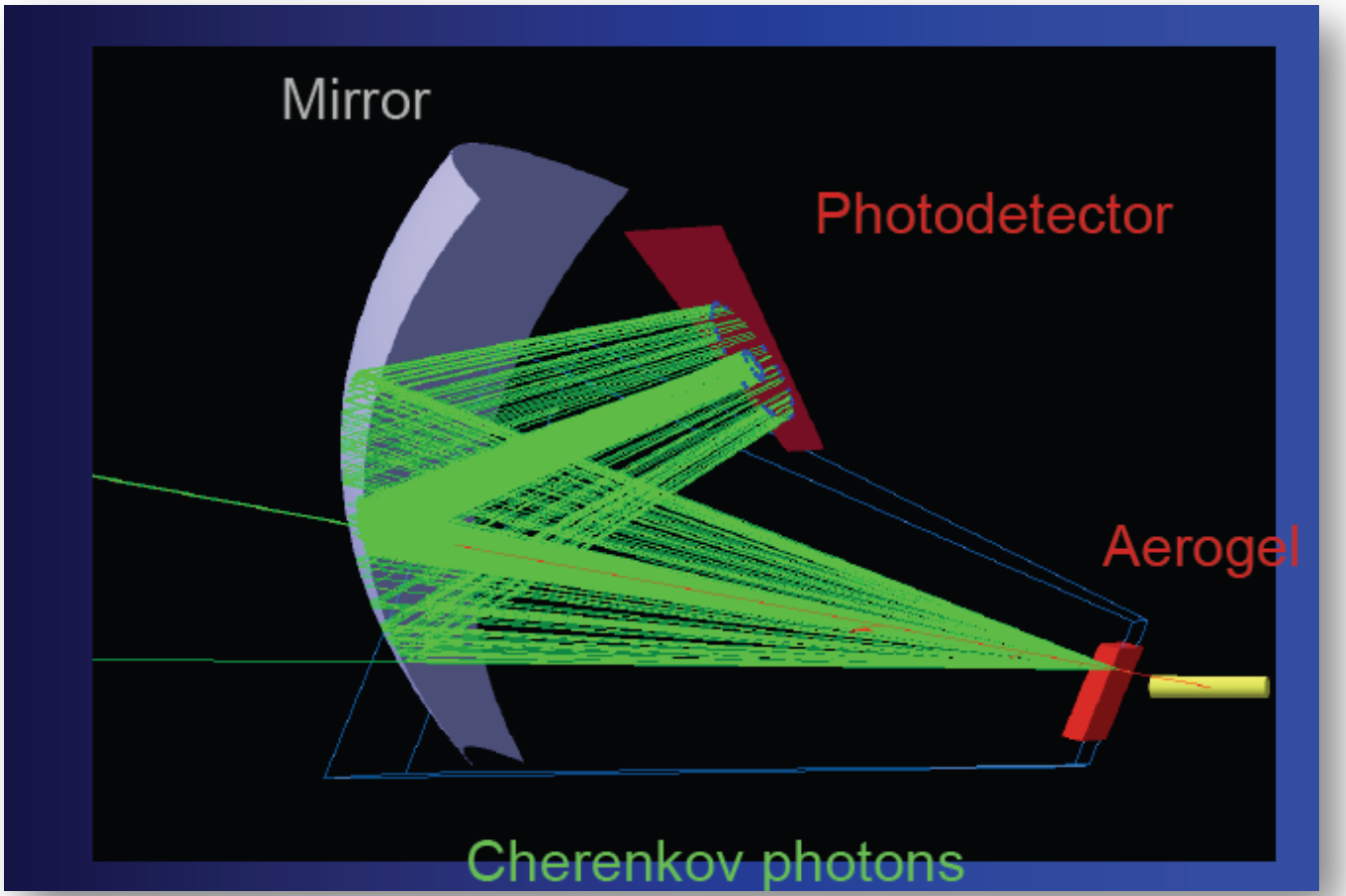
Geometry.

Refractive index, Transmittance are function of wavelenght



Optical Processes, Optical “Hits”

RICH
Simple
Prototype



What's needed to get started:

Mid/End of January: new I/O interface with DB.

Gemc is available on all CUE machines. It's also available as RPM (can be installed with YUM)

Geometry, Magnetic Fields to start play with it

(but wait January for serious work)