EMR Software

MICE Collaboration Meeting 29, 15-18 February 2011

V. Verguilov University of Geneva
DPNC

UNIVERSITÉ DE GENÈVE
FACULTÉ DES SCIENCES
Département de physique nucléaire et corpusculaire

Outline

Overview
- EMR Parameters

Geometry
- G4MICE Geometry
  - EMR Bar
  - EMR Layer

Simulation

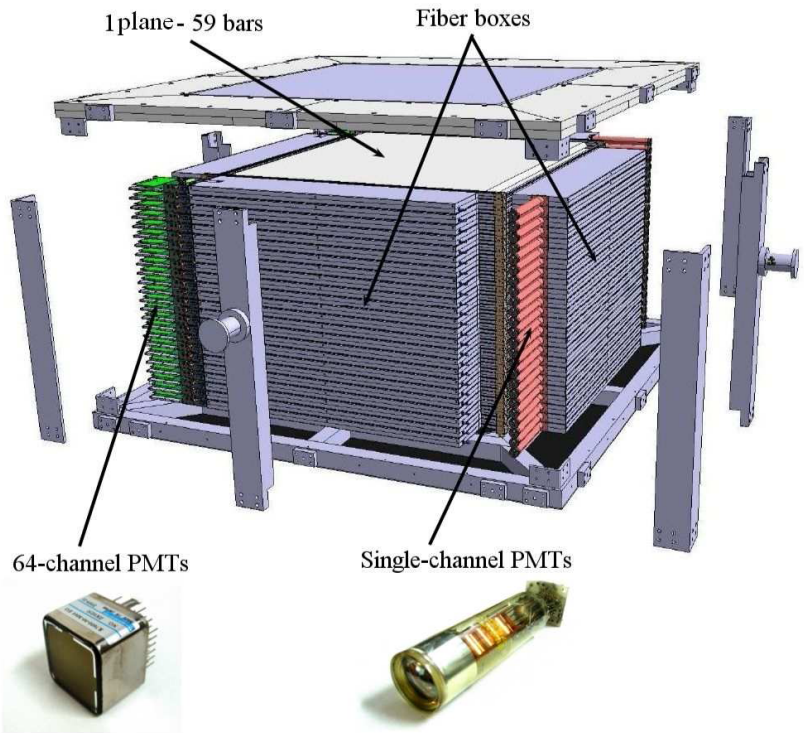
Digitization

Reconstruction
- Clusterization
- Tracking

Conclusions

UNIVERSITÉ DE GENÈVE
FACULTÉ DES SCIENCES
Département de physique nucléaire et corpusculaire

EMR Parameters



Parameters

- 24 X-Y modules, each containing 2 layers
- 48 layers
- 59 extruded scintilator bars per layer

UNIVERSITÉ DE GENÈVE
FACULTÉ DES SCIENCES
Département de physique nucléaire et corpusculaire

Geometry Formats in G4MICE

Two geometry formats are supported in G4MICE:

G4MICE Text Format Text files (.dat) describing the parameters of the beamline and detectors (not only for geometry)

GDML CERN XML based format for detector description used by Geant4 and ROOT(materials, position, rotation)

G4MICE format geometry is generated by a python script, GDML geometry is generated by a ROOT macro. Both can export EMR-like detector with custom geometry which can be used in other simulations.

UNIVERSITÉ DE GENÈVE
FACULTÉ DES SCIENCES
Département de physique nucléaire et corpusculaire

Trapezoid

Support for trapezoid geometry in G4MICE was added. Already used (for the wedges) but not fully functional.

How to generate trapezoid in G4MICE?

- **Volume Trapezoid**
- **Dimensions <X1 Half Length> <X2 Half Length> <Y1 Half Length> <Y2 Half Length> <Z> <units>**

UNIVERSITÉ DE GENÈVE
FACULTÉ DES SCIENCES
Département de physique nucléaire et corpusculaire

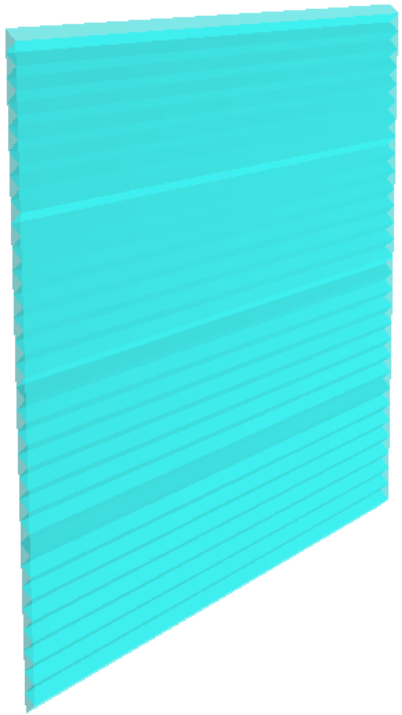
EMR Bar

Bars are represented by 2 files - one for the logical volume bar and one for the scintilator

```
Module EMRLayer0Bar1
{
  Volume Trapezoid
  Dimensions 55.00 55.00 0.00 1.65 0.85 cm
  PropertyInt Layer 0
  PropertyInt Cell 1
  PropertyInt numPMTs 2
  PropertyDouble BlueColour 1.0
  Module EMR/EMRLayer0Bar1Sci.dat
  {
    Position 0.0 0.0 0.0 mm
    Rotation 0.0 0.0 0.0 degree
  }
}
```

UNIVERSITÉ DE GENÈVE
FACULTÉ DES SCIENCES
Département de physique nucléaire et corpusculaire

EMR Layer Geometry



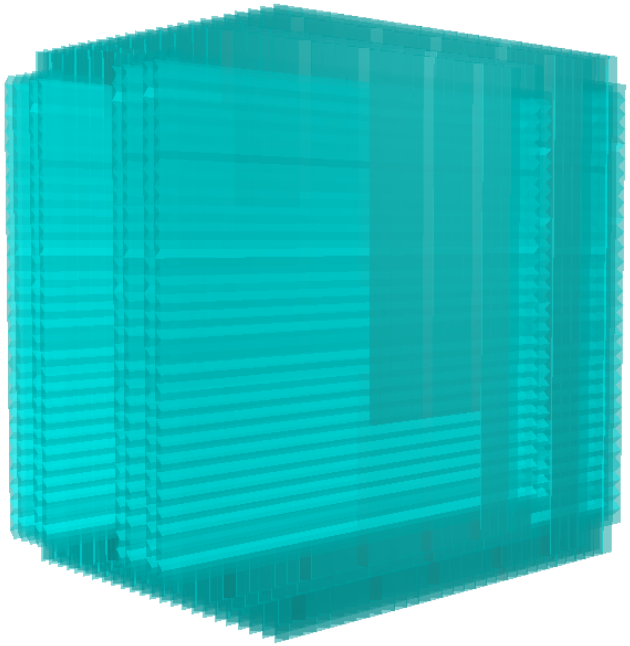
```
Module EMRLayer0
    {
      Volume Trapezoid
     Dimensions  55.00 55.00 47.85 49.50 0.85 cm

      PropertyString Material Galactic

      PropertyInt Layer 0
      PropertyInt numBars 59
      PropertyBool Invisible 1
    Module EMR/EMRLayer0Bar0.dat
      {
        Position 0.00 -47.85 0.00 cm
        Rotation 0.00 0.00 0.00 degree
      }
      Module EMR/EMRLayer0Bar1.dat
      {
        Position 0.00 -46.20 0.00 cm
        Rotation 0.00 180.00 0.00 degree
      }
...
```

UNIVERSITÉ DE GENÈVE
FACULTÉ DES SCIENCES
Département de physique nucléaire et corpusculaire

The Whole Picture

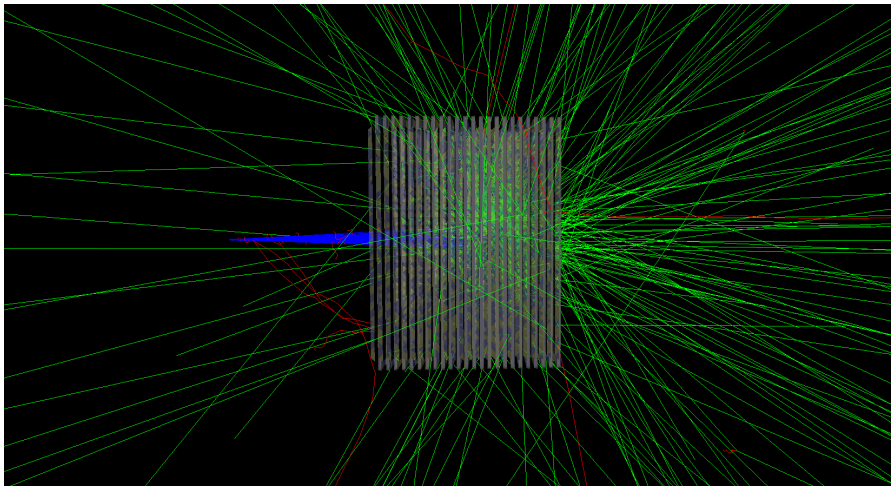


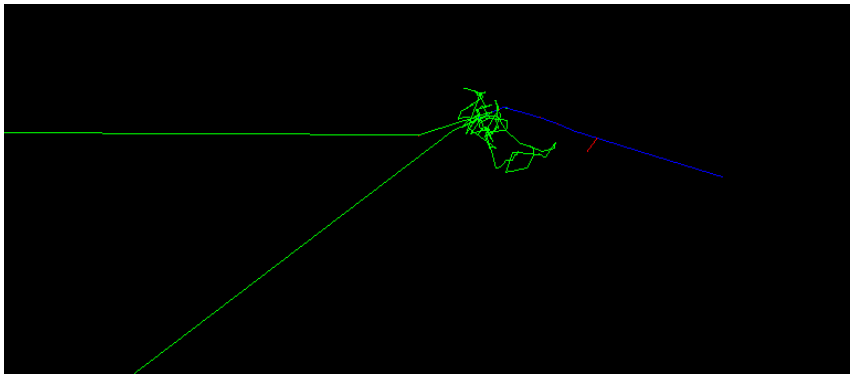
EMR Geometry Status: Done.

UNIVERSITÉ DE GENÈVE
FACULTÉ DES SCIENCES
Département de physique nucléaire et corpusculaire

Simulated events

For developing/testing purpose the EMR is simulated without the upstream beamline and detectors.
250 MeV muon is shot just before the detector.

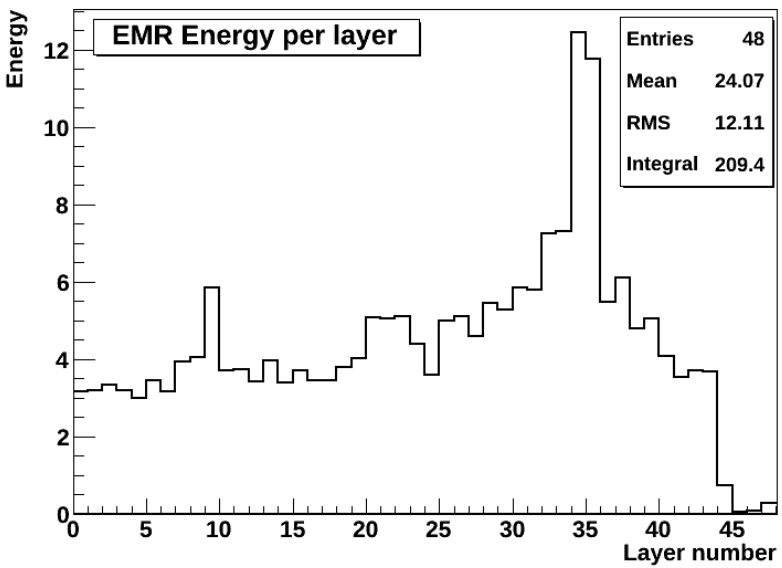


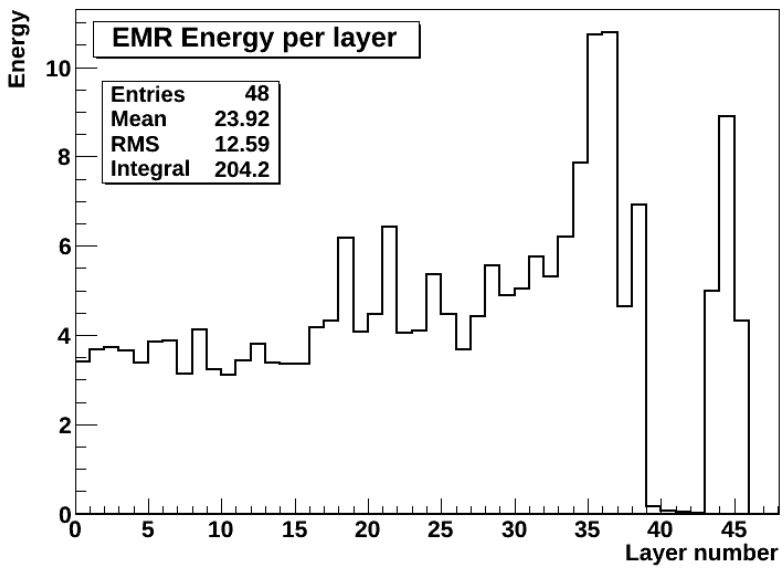


Green lines are neutral particles, blue are positive, red - negative; red dots represent hits in the EMR

UNIVERSITÉ DE GENÈVE
FACULTÉ DES SCIENCES
Département de physique nucléaire et corpusculaire

Simulation





For more information about the EMR simulation, see my talk tomorrow.

EMR Simulation Status: Done.

UNIVERSITÉ DE GENÈVE
FACULTÉ DES SCIENCES
Département de physique nucléaire et corpusculaire

Electronics Output Simulation

Digitization - simulation of analog to digital signal conversion.
3 signals from EMR: Leading Edge, Traling Edge and Energy.

Leading Edge(LE)/Trailing Edge(TE) Time **(per bar)**

$$TE = LE + PulseWidth + Latency$$

Deposited Energy per Layer **(per layer)**

$$E_{layer} = \sum_{i}^{N_{bars}} Edep_i$$

EMR Digitization Status: In progress.

UNIVERSITÉ DE GENÈVE
FACULTÉ DES SCIENCES
Département de physique nucléaire et corpusculaire

EMR Reconstruction

Reconstruction Steps:

Cell Making Module Cells (space points) are created out of bar hits in every module. 1-4 digits are needed to create a cell.

Clusterization Make clusters of cell hits for each module

Tracking Make tracks from the clustered hits

UNIVERSITÉ DE GENÈVE
FACULTÉ DES SCIENCES
Département de physique nucléaire et corpusculaire

Cluster Finding Algorithm

Clusterization is a process of combinig detector hits according to some property. There are different approaches depending on the properties selected and detector types. In the case of the EMR, bar hits are clustered by their Leading Edge time.

1. Sort all cell hits according to their LE time
2. Peek the earliest hit (first one) and assign it as cluster center
3. Cluster neighbour hits with time difference less then T_1 for the closest neighbours and T_2 for ones further away
4. Remove cell hits contributing to the cluster from the list
5. Do the same for the remaining hits
6. Cluster splitting/merging - energy sharing

EMR Clusterization Status: In progress.

UNIVERSITÉ DE GENÈVE
FACULTÉ DES SCIENCES
Département de physique nucléaire et corpusculaire

Tracking

EMR Tracks will be made from the clusters. The algorithm is not choosen yet.

UNIVERSITÉ DE GENÈVE
FACULTÉ DES SCIENCES
Département de physique nucléaire et corpusculaire

EMR Tracking Status: None.

Some Notes

- G4MICE process of
  Simulation $\rightarrow$ Digitization $\rightarrow$ Reconstruction
  is still based on MICEEvent. EMR events are spill-based, so EMR readout and reconstruction of real data cannot be tested(yet).
- Simulation now creates more then 4000 objects, which takes a lot of time and computing resources. It is possible to create geometry with only layers and then spawn the bar hits during the Digitization process, which will be a little bit faster but less precise.

UNIVERSITÉ
DE GENÈVE
FACULTÉ DES SCIENCES
Département de physique
nucléaire et corpusculaire

Future

TODO:(before July 2011)

- Implement simple/faster geometry (???)
- Finish the digitization process
- Clusterization is almost done
- Tracking. Algorithm(s) to be selected.
- Real data readout

I will pass the EMR software torch to Yordan and Ruslan after end of June.

UNIVERSITÉ DE GENÈVE
FACULTÉ DES SCIENCES
Département de physique nucléaire et corpusculaire