DREAM collaboration meeting - October 30, 2007

Geant4 simulation of $PbWO_4$/BGO crystals and $PbWO_4$ matrix

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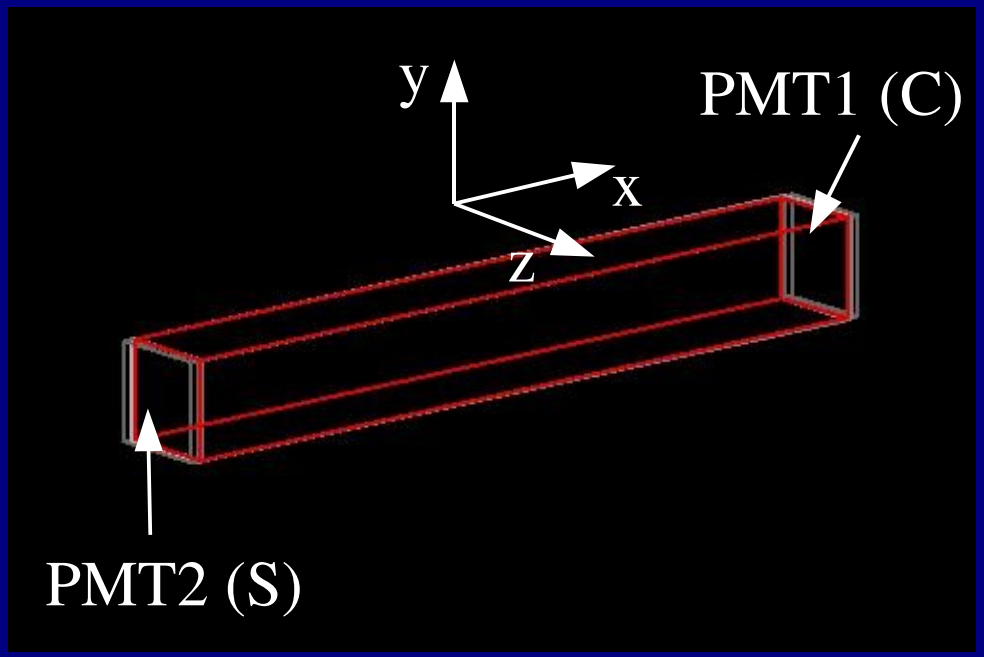
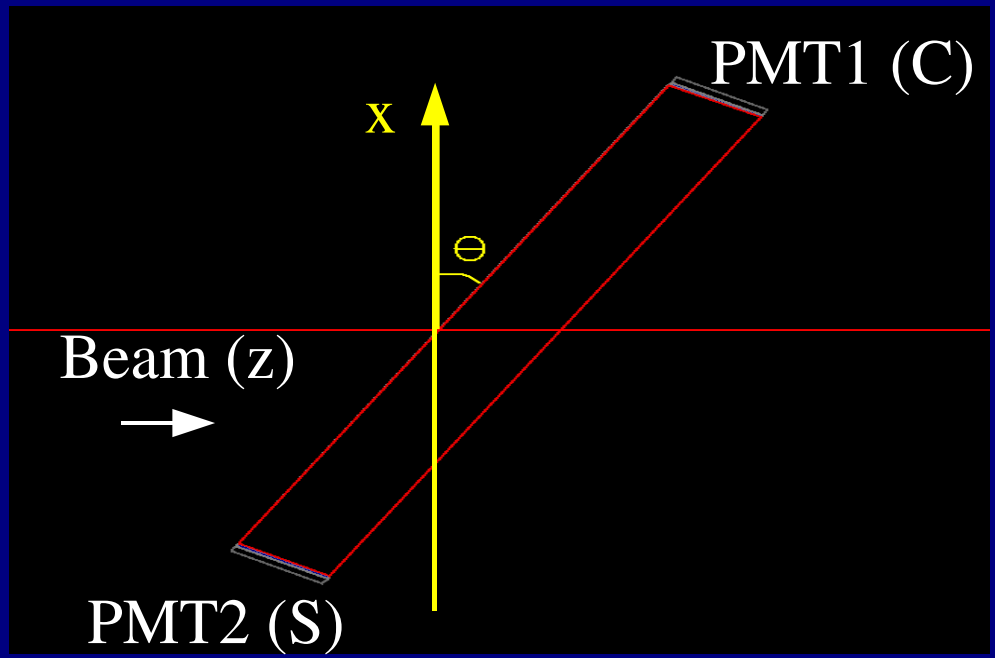
Outline

- simulation of electromagnetic processes: energy deposited in the BGO/$PbWO_4$ crystals and in the $PbWO_4$ matrix
- simulation of optical processes: attempt to estimate the Cerenkov light detection in the BGO crystal
- conclusions

Geometry and materials (1)

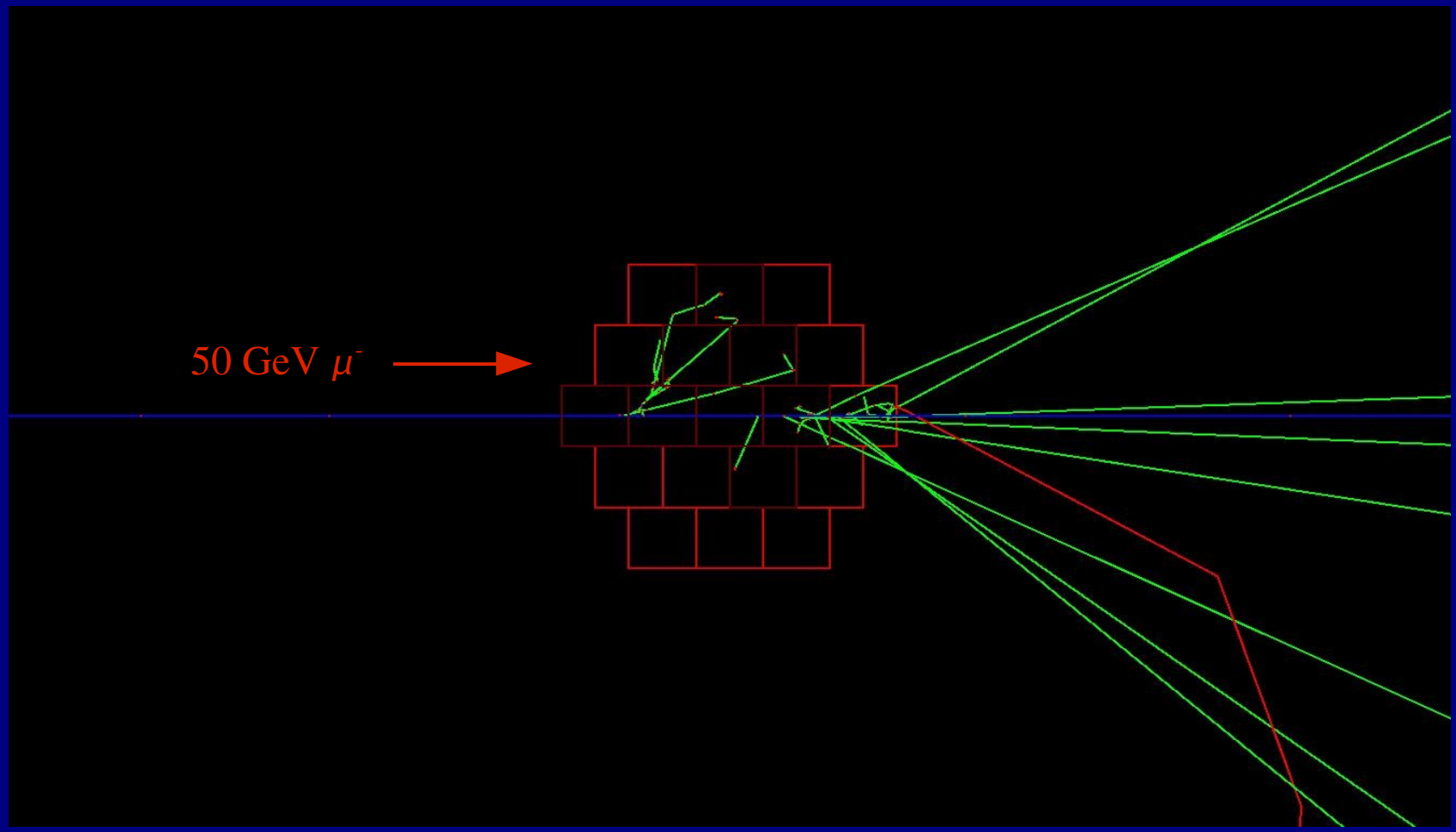
- $PbWO_4$ (BGO) single crystal
  - refractive index n=2.16 (2.15)
- PMTs are coupled with the crystal through silicone (n=1.43) cookies
- crystals are facing with air (n=1.0)





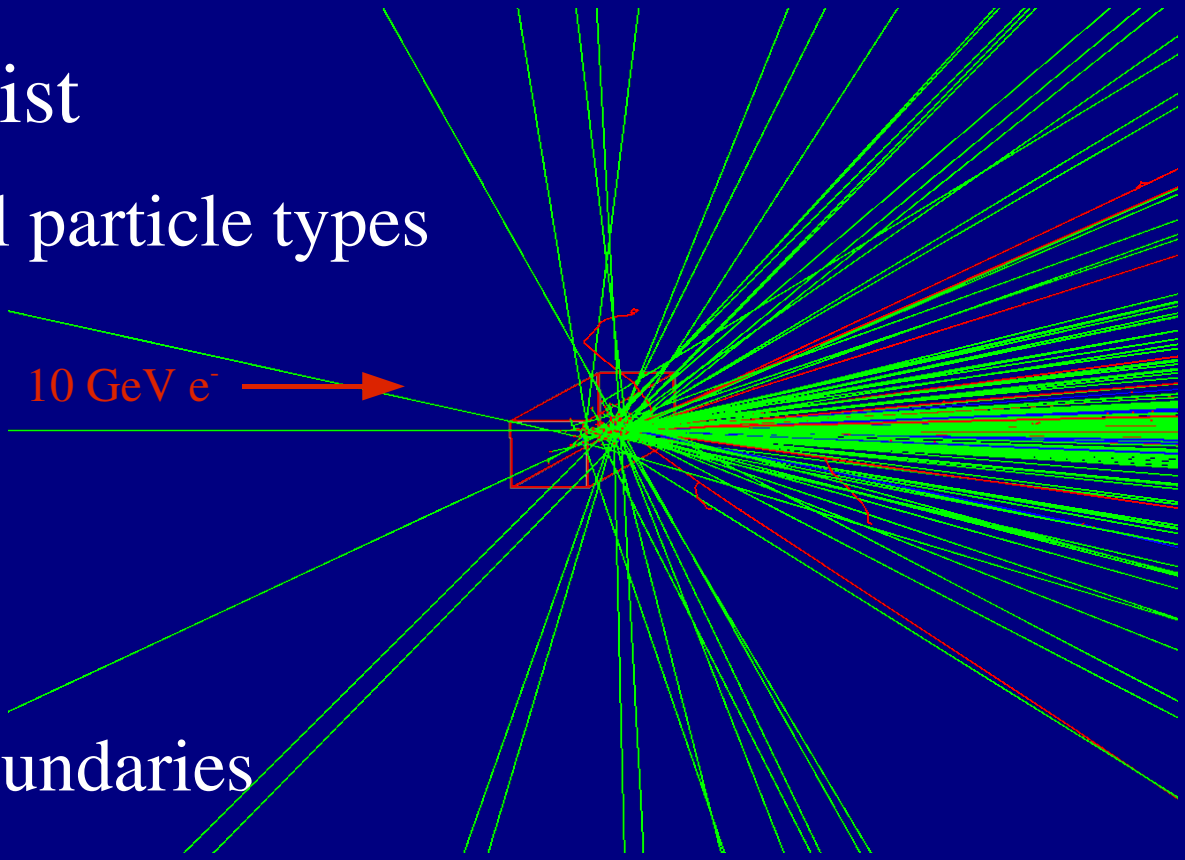
Geometry and materials (2)

- $PbWO_4$ matrix



Physics list

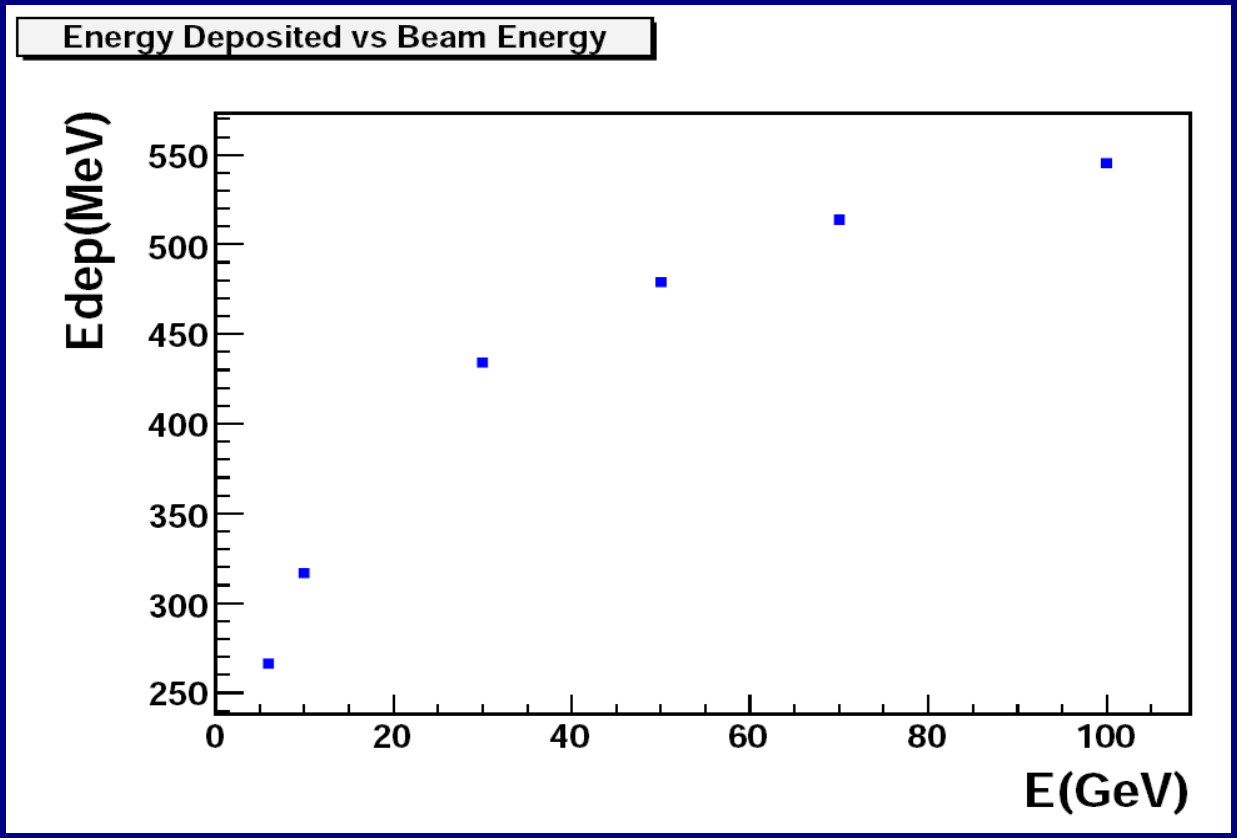
- standard EM Physics list
  - default 1mm cut for all particle types
- optical processes
  - photon production
    - scintillation
    - Cerenkov
  - photon processes at boundaries



Energy deposited in $PbWO_4$ crystal

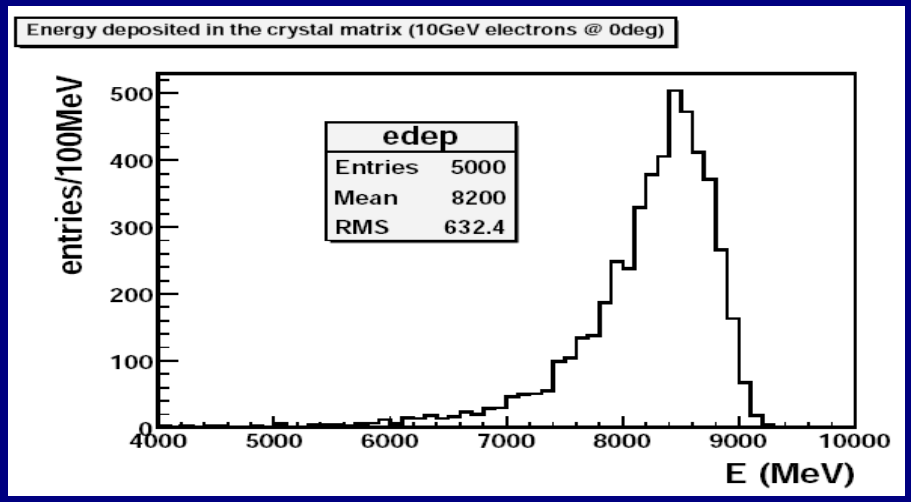
- energy deposited by electrons: ALICE request

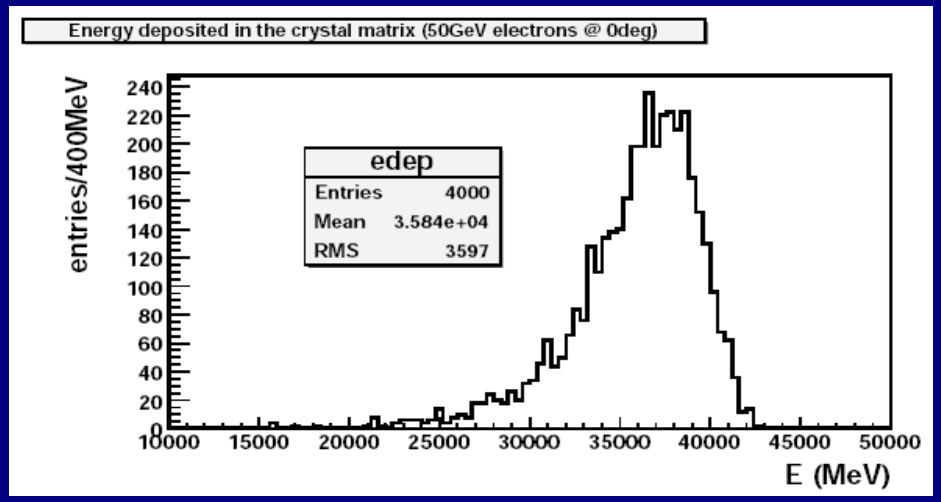
e^- energy(GeV)	energy deposited(MeV)
6	266.3
10	316.7
30	434.0
50	479.0
70	513.8
100	545.3

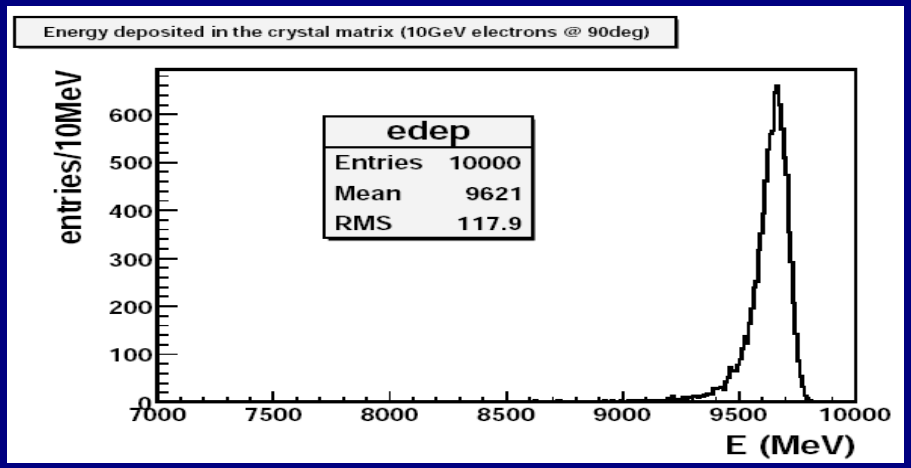


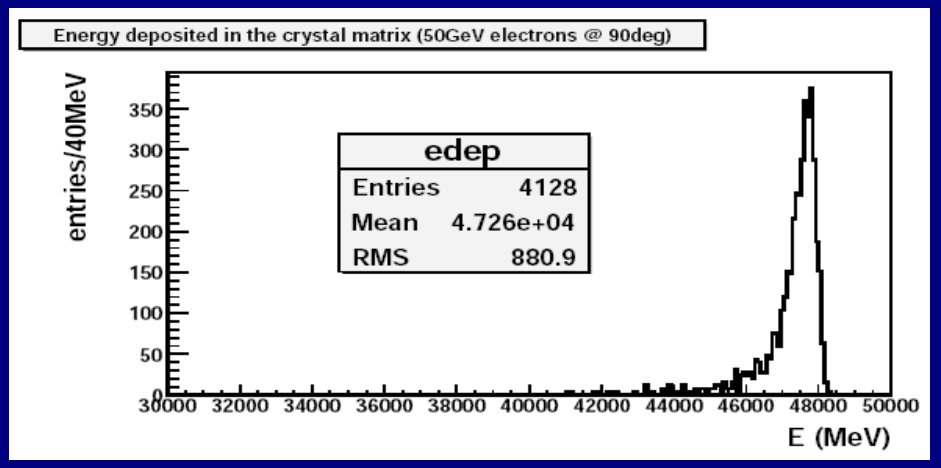
Energy deposited in $PbWO_4$ matrix

- energy deposited by electrons: to know the energy equivalent of the calibration signals



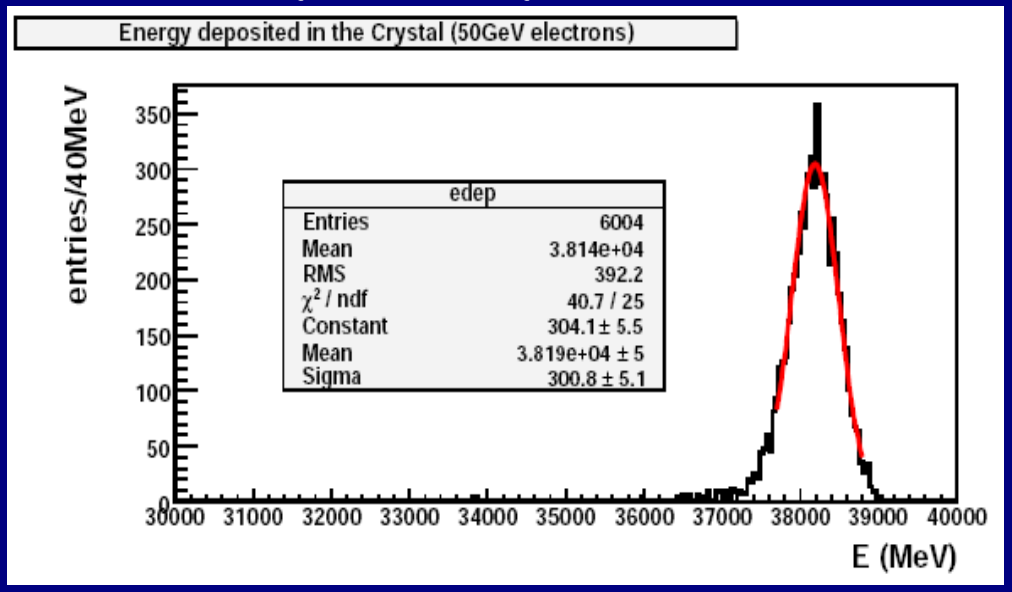


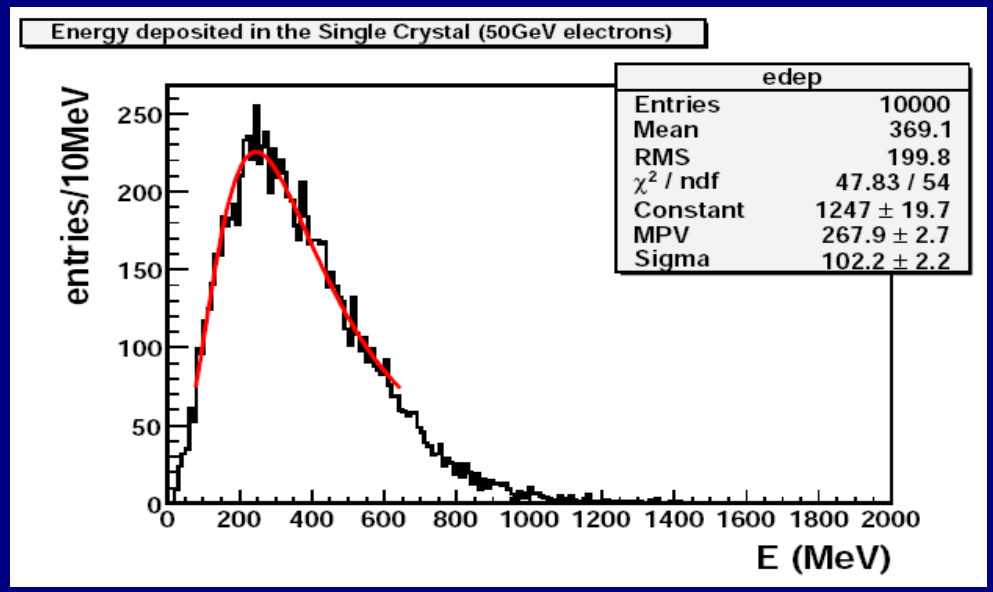




Energy deposited in BGO crystal

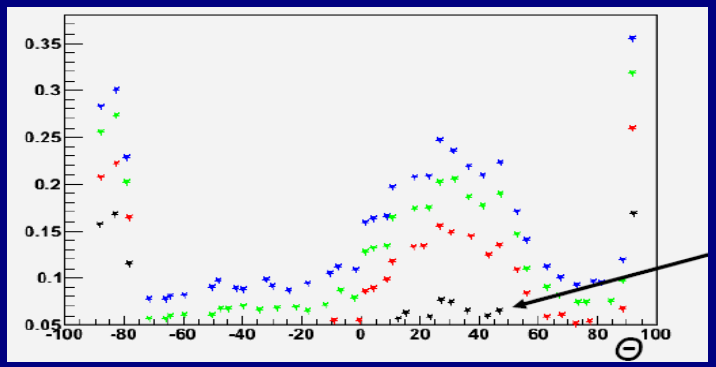
- energy deposited by 50 GeV electrons: to know the energy equivalent of the calibration signals
- oriented longitudinally (in conjunction with the DREAM calorimeter): the leakage is mostly sideways
- oriented perpendicularly

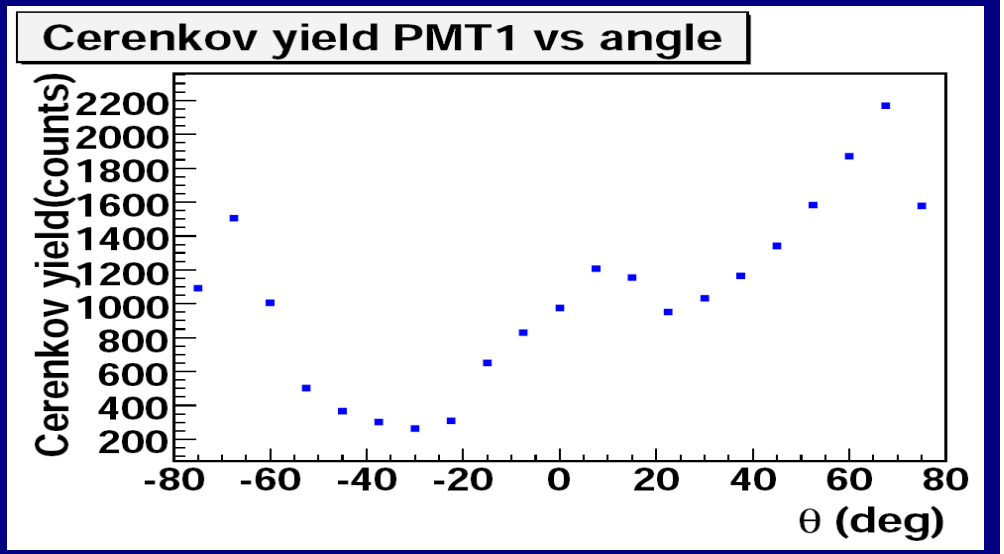


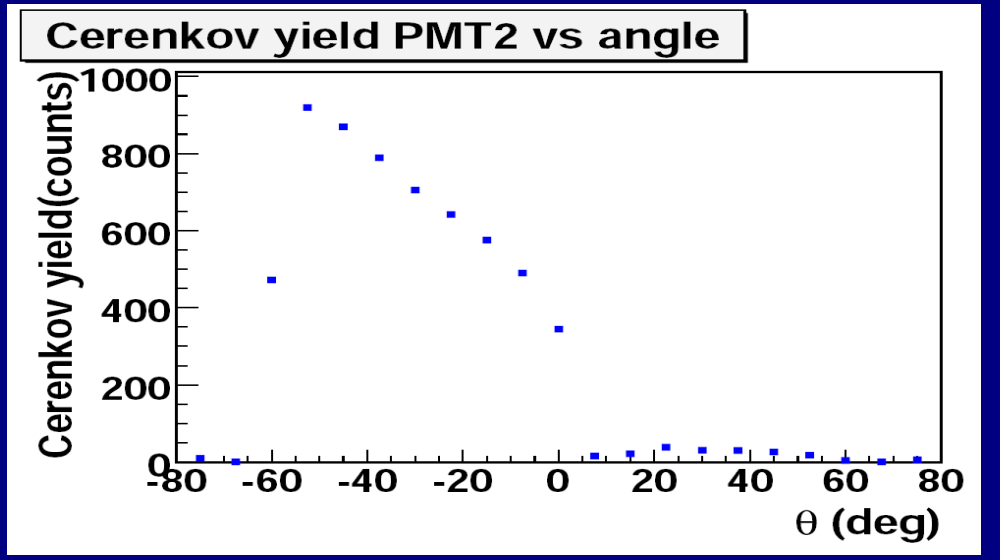


Cerenkov light detection: BGO crystal (1)

- 50 GeV muon beam
- only Cerenkov effect has been activated
- in the most intuitive configuration the BGO crystal is facing with air: dielectric-dielectric transition simply specifying the two refractive indexes
- the Cerenkov light yield seen by the two PMTs is not similar to the "expected" one (see e.g. Cecilia talk)





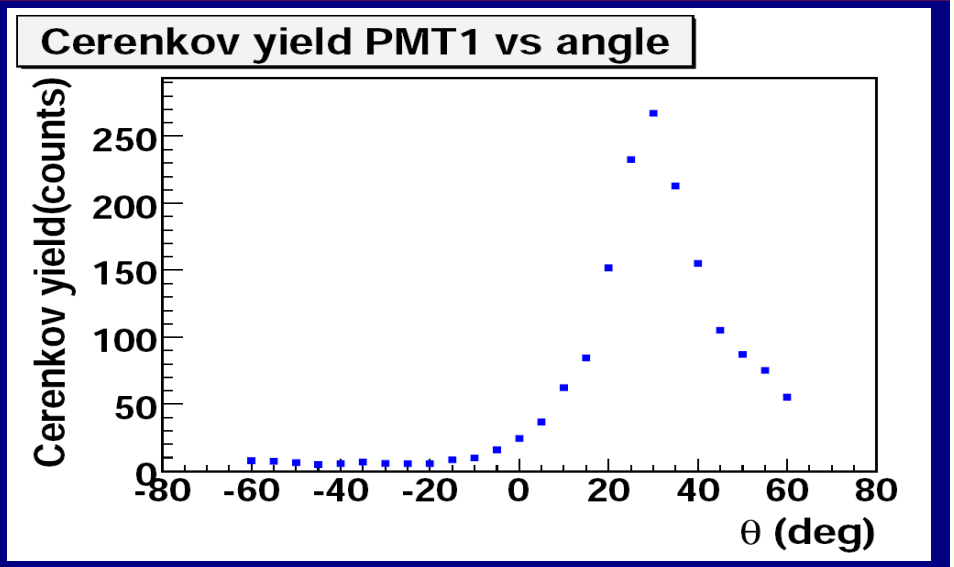


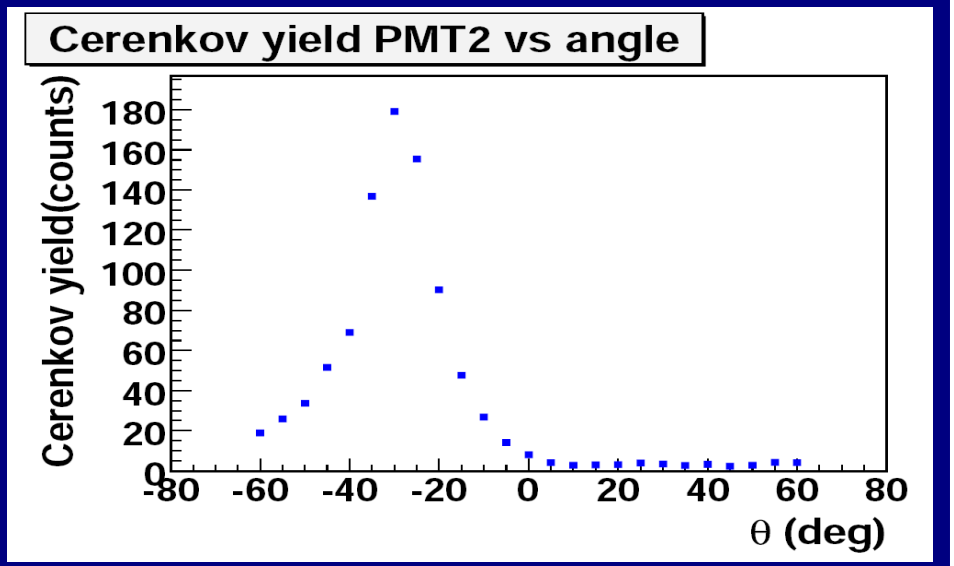
Cerenkov light detection: BGO crystal (2)

- the Cerenkov light detection strongly depends on the crystal/air surface properties
- after various attempts a good configuration as been found: dielectric-dielectric surface with:

```
OpBGOAirSurface->SetFinish(polished);
//G4double ScintillatorSurfaceSpecularLobe[nEntries] = { 1., 1., 1., 1., 1., 1., 1., 1. };
//G4double ScintillatorSurfaceSpecularSpike[nEntries] =  { 0., 0., 0., 0., 0., 0., 0., 0.};
//G4double ScintillatorSurfaceBackScatter[nEntries] =  { 0., 0., 0., 0., 0., 0., 0., 0. };
G4double efficiency[nEntries] =  { 0.7, 0.7, 0.7, 0.7, 0.7, 0.7, 0.7, 0.7 } ;
G4double reflectivity[nEntries] = {0.3, 0.3, 0.3, 0.3, 0.3, 0.3, 0.3, 0.3 } ;
```

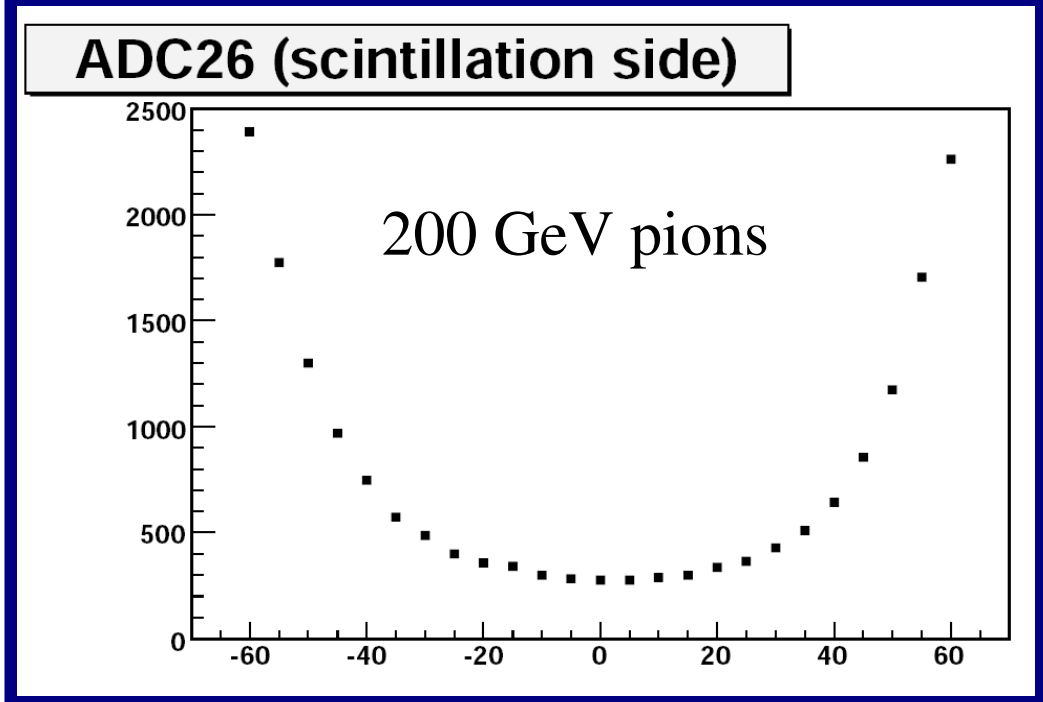
- this configuration leads to results in qualitative agreement with the "expected" ones
- but there are 5 parameters related to the surface that can be fixed!

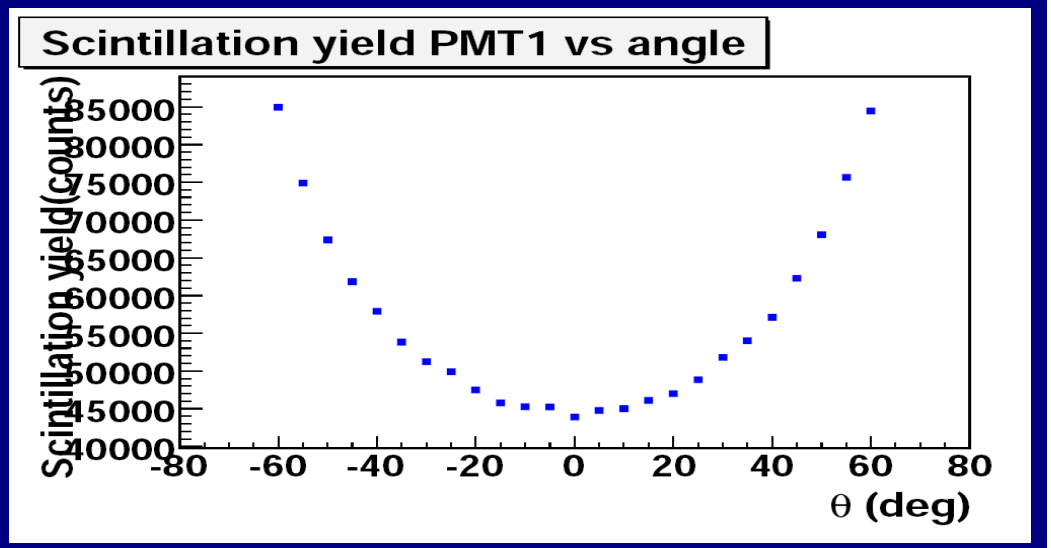


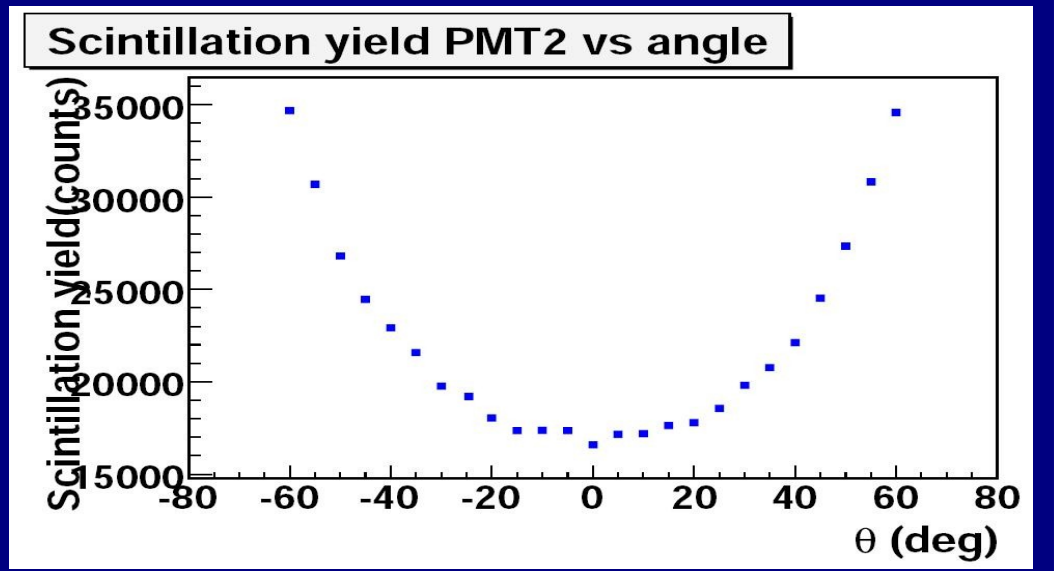


Scintillation light detection: BGO crystal

- the scintillation LY needs to be know "a priori": 8000gamma/MeV for BGO at room temperature
- a more quantitative comparison would be done







Conclusions

- the MC simulation of the single crystal and the matrix is of course a useful tool: we are working to have a public release (with documentation)
- the electromagnetic physics simulation in G4 is a very know matter: it has been used to compute the energy deposited in the crystals
- simulation of optical processes needs some reflections:
  - the scintillation characteristics of a give material and the properties of its contact surface with a different material should be known with high accuracy
  - if this, MonteCarlo results can be used to have a qualitative indication about the performances of a optical system