Subject: Geant3 tracking cuts for the EMC
Posted by Christian Hammann on Fri, 16 Oct 2009 11:58:36 GMT
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Hi

I have noticed that the tracking thresholds for Geant3 are set to 1MeV by default, wich is probably to high. Also they are set globally, so it seems to me they are not tuned in any reasonable way for the EMC.

These cuts are set in gconfig/SetCuts.C. If I decrease the cut values to 100keV I get significant changes in the distribution of the energy in the cluster. For a 657 MeV photon the energy in the central crytal decreases from 542MeV for the 1MeV cut to 512MeV with the 100keV cut. The number of crystals in the cluster also increases from 13.9 to 16.8.

Of course the filesize and computing time increase with the lower cuts (about a factor 2 or so).

Are there some tuned cuts available? Do I have to load an additional file to set proper cut values?

Best regards

Christian

Subject: Re: Geant3 tracking cuts for the EMC
Posted by Bertram Kopf on Fri, 16 Oct 2009 12:40:06 GMT
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Hi Christian,

Christian Hammann wrote on Fri, 16 October 2009 13:58
I have noticed that the tracking thresholds for Geant3 are set to 1MeV by default, which is probably to high. Also they are set globally, so it seems to me they are not tuned in any reasonable way for the EMC.

...

Are there some tuned cuts available? Do I have to load an additional file to set proper cut values?

in my point of view the 1MeV threshold cut is definitely too high. To get a rough estimate for reasonable thresholds, here are the numbers which we have used for our Physics Book studies (G4 simulation):

minimum energy for all particles: 0. keV
energy cut for ion killing: 5. keV
energy cut for neutron killing: 0.01 keV

These cuts have been taken over from BaBar and are therefore tuned for this experiment. Since PANDA will measure in similar energy ranges, I think that such thresholds are at least good starting points for our simulations.

Best regards,
Bertram.

Subject: Re: Geant3 tracking cuts for the EMC
Posted by Bertram Kopf on Fri, 16 Oct 2009 13:06:44 GMT
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Hi Christian,

sorry for the last posting. What I wrote there was not correct. G4 makes use of range cuts and not of fixed energy thresholds. This means that the energy thresholds are depending on the particle typ and also on the material. We have used a 1 mm cut which corresponds to the energy threshold for PWO:

gammas 84 keV
e+- 1 MeV

Cheers,
Bertram.

Subject: Re: Geant3 tracking cuts for the EMC
Posted by StefanoSpataro on Fri, 16 Oct 2009 13:10:07 GMT
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Hello,
I am not surprised about the energy difference, but I am much more surprised about the crystal multiplicity. I mean, after digitization and the cut in energy of each single crystal, the numbers should converge.

About the "tuned cuts" , one needs real experimental data to understand what is good for simulation... still too early, we cannot do yet geant validation (or at least, not from the data sets I have seen, and without passive materials).

Maybe you could try to see the difference between G4 without cuts, G4 with 1 MeV cut and G3 with cut, to evaluate the systematic error within simulation. However, this should affect only shower shape analysis (and pi0 recognition for different digi mult), not the energy response (hopefully).

Subject: Re: Geant3 tracking cuts for the EMC
Posted by Bertram Kopf on Fri, 16 Oct 2009 13:25:06 GMT

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Hi again,
due to this discussion I would like to ask the VMC experts if there is a possibility to use to range cuts instead of fixed energy cuts (at least for G4). I think that such cuts are more reasonable and more convenient for tuning the parameters with real data in the future.

Cheers,
Bertram.

Subject: Re: Geant3 tracking cuts for the EMC
Posted by StefanoSpataro on Fri, 16 Oct 2009 13:30:27 GMT
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In gconfig/g4Config.C one should delete the words "stepLimiter+specialCuts+specialControls" from TG4RunConfiguration, and then you will have the 1mm range cut.

The same is not possible under Geant3.

Subject: Re: Geant3 tracking cuts for the EMC
Posted by Bertram Kopf on Fri, 16 Oct 2009 14:29:17 GMT
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Hi Christian,

to be more precise, here is the complete list with the individual range cuts and the equivalent energy thresholds for the PB simulations:

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Cuts in range (mm)

Material	gamma	e-	e+
Air	1	1	1
Carbon	1	1	1
Aluminum	1	1	1
Silicon	1	1	1
Stt_AlBe	1	1	1
Mylar	1	1	1
Stt_Ar_CO2_90_10	1	1	1
CarbonFiber	1	1	1
DCgas	1	1	1
Gem_G10	1	1	1
Gem_ArCO2	1	1	1
Plastic	1	1	1
quartz	1	1	1
Argon	1	1	1
Iron	1	1	1

Vacuum	1	1	1
Stainless steel	1	1	1
Al+Be	1	1	1
Aluminium	1	1	1
Copper	1	1	1
E_PWO	1	1	1
E_CarbonFibre	0.01	0.01	0.01
Fsc_Lead	0.1	0.1	0.1
Fsc_Scintillator	0.1	0.1	0.1

Cuts in energy (MeV)

Material	gamma	e-	e+
Air	0.00099	0.00099	0.00099
Carbon	0.00329462	0.568011	0.554196
Aluminum	0.00688731	0.59668	0.568011
Silicon	0.00688731	0.540718	0.521113
Stt_AlBe	0.00452342	0.46646	0.449547
Mylar	0.00297898	0.417539	0.4024
Stt_Ar_CO2_90_10	0.00099	0.00120121	0.00118651
CarbonFiber	0.00236543	0.547416	0.527568
DCgas	0.00099	0.00099	0.00099
Gem_G10	0.00413892	0.478087	0.46646
Gem_ArCO2	0.00099	0.00099	0.00099
Plastic	0.00236895	0.355791	0.347138
quartz	0.00551637	0.534102	0.514737
Argon	0.00099	0.00099	0.00099
Iron	0.0208323	1.28002	1.21851
Vacuum	0.00099	0.00099	0.00099
Stainless steel	0.0208323	1.31192	1.23361
Al+Be	0.00336548	0.502219	0.484009
Aluminium	0.00688731	0.59668	0.568011
Copper	0.0246072	1.39521	1.31192
E_PWO	0.0847768	1.13176	1.06419
E_CarbonFibre	0.00099	0.0330634	0.0326589
Fsc_Lead	0.0293406	0.239945	0.231245
Fsc_Scintillator	0.000995281	0.0853134	0.0842696

As you can see there, the standard cut is 1mm. For thin materials like carbon fibres or the scintillators/absorbers within the forward spectrometer 1-2 orders of magnitude lower range cuts have been used.

Cheers,
Bertram.

Subject: Re: Geant3 tracking cuts for the EMC
Posted by Jens Sören Lange on Fri, 16 Oct 2009 15:36:09 GMT
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Bertram Kopf wrote on Fri, 16 October 2009 15:25
... range cuts instead of fixed energy cuts (at least for G4). I think that such cuts are more reasonable and more convenient for tuning the parameters with real data in the future.

Cheers,
Bertram.

Hi Bertram,
here I have a different opinion.
I think experimentally (for "real data") it is really much easier to set threshold (e.g. discriminator) to energy (e.g. 1 MeV) and not to a particle range (e.g. 1 mm). In fact, so far we were (e.g. for the EMC) always talking about 1 MeV threshold or 3 MeV threshold or whatever value, but never about "threshold of 5 mm for a e-, but 3mm for a pi+ (in the same crystal)".

I also think that "1 mm range cut" gives just one possible result (e.g. for cluster energy), but nobody can say if it gives the correct result or not. Only the comparison to G3 or prototypes (and getting consistent results) can tell us which is the correct result. There was quite some discussion about this when we found the singificant differences between G3 and G4. See e.g.

http://panda-wiki.gsi.de/cgi-bin/view/Computing/Minutes06May2008
http://panda-wiki.gsi.de/cgi-bin/view/Computing/Minutes13May2008

cheers, Soeren

P.S. the equivalent energy threshold values in your table are order of 0.1 eV or even finer, which is most probably too fine for tuning anyway.

Subject: Re: Geant3 tracking cuts for the EMC
Posted by Christian Hammann on Mon, 19 Oct 2009 10:00:44 GMT
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Hi Soeren

Jens Soeren Lange wrote on Fri, 16 October 2009 17:36
I think experimentally (for "real data") it is really much easier to set threshold (e.g. discriminator) to energy (e.g. 1 MeV) and not to a particle range (e.g. 1 mm). In fact, so far we were (e.g. for the EMC) always talking about 1 MeV threshold or 3 MeV threshold or whatever value, but never about "threshold of 5 mm for a e-, but 3mm for a pi+ (in the same crystal)".

I think I have to agree with Bertram that the 1mm cut in geant 4 is more convienient for the EMC.
The energy cut in geant3 does not in any way correspond to the threshold which is set in the discriminator (in the case of the EMC). The cut applies to the individual particles in the shower, which are tracked or not depending on their energy. In the EMC only the sum of their energies is measured, no threshold can be set for individual shower particles. Thus this cut is more like a range cut, as with lower cut values more particles are propagated and more energy can be transported to the edge of the shower.

This can be seen in the example I gave above, by lowering the cut value the energy in the central crystal decreased by 30MeV!

The range cut in geant4 simply says you don't care whether the energy is deposited here or in 1mm distance. That's the case for the EMC: one doesn't care where in the crystal you have the energydeposition as long its in this crystal. That simply means the cut distance has to be much smaller than the size of the crystal (of course this has to be tuned).

Best regards
Christian

Subject: Re: Geant3 tracking cuts for the EMC
Posted by Christian Hammann on Mon, 19 Oct 2009 10:10:15 GMT
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Thank you very much for the cut values, they will be a much better starting point.

Can someone tell me how to set the cuts on a per material basis?

I will also try if I can use geant4, if this was used for the physiksbook that might be an even better starting point.

Cheers
Christian

Subject: Re: Geant3 tracking cuts for the EMC
Posted by Mohammad Al-Turany on Mon, 19 Oct 2009 13:29:33 GMT
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Hi,

One should differentiate between production cuts (Geant3) and tracking cuts in G4! So you cannot simply compare the two! Anyway Geant4 uses the mm cuts, and in the VMC the energy cuts are translated to mm cuts internally but they are applied as tracking cuts, i.e. particle loses energy by generation of secondaries down to an energy corresponding to the range cut, then the particle is tracked down to zero energy using continuous energy loss. To summarize, the range cut-off represents the accuracy of the stopping position. It does not mean that the track is killed at that energy like in Geant3. (see Geant4 Physics Reference Manual)

And if you look at the output in a G4 simulation session you will see the cuts applied in mm for all particles, by default this is 1 mm, one can also change this but this is not the subject of the discussion.

In fact the 1 MeV cut in PandaRoot is too high for the calorimeter, and one should go down with the energy cuts for sure, but this should be done on the EMC level and not globally otherwise the simulation will take ages. To do this one should implement (over-write) the

method FairDetector::SetSpecialPhysicsCuts() in the EMC, in this method you have to set:

```
//for electrons
    gMC->Gstpar(MediumId,"CUTGAM",cutE);
    gMC->Gstpar(MediumId,"CUTELE",cutE);
    gMC->Gstpar(MediumId,"BCUTE" ,cutE);
    gMC->Gstpar(MediumId,"BCUTM" ,cutE);
// for hadrons
    gMC->Gstpar(MediumId,"CUTNEU",cutH);
    gMC->Gstpar(MediumId,"CUTHAD",cutH);
    gMC->Gstpar(MediumId,"CUTMUO",cutH);
    gMC->Gstpar(MediumId,"PPCUTM",cutH);
```

MediumId is the medium Id for the material you want to set its property, this you can get usually by:

MediumID = gGeoManager->GetMedium("YourMediumName")->GetId();

cutE and cutH are your favorite cuts.

These are the parameters which one usually uses for calorimeter simulation in G3, and thanks to the VMC this is also valid for G4.

Just a final remark, even though it is possible to use range cuts in native G4 format I would not encourage at all. Because it will be valid only for G4, and it will be hard to convert to energy! On the other hand the energy cuts are valid and more logical for all! G3/G4 and fluka.

Hope this will help!

P.S.

In the newest G4 it is possible to use energy cuts instead of the range cuts, even without the VMC!

Mohammad
