Simulations: VMC tracking cuts

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July 2016

1 Introduction

While trying to find the efficiency for gammas, (p,pn) and (p,2p) reactions, I found that the values were not compatible with the previous ones when using the R3BRoot last dev version. These values shown an efficiency too larger (or exceedingly large) with respect to previous simulations and difficult to believe in Crystal Ball. After some research, it was found that in a commit from the 17th of November 2015 the function SetSpecialPhysicsCuts() for the Crystal Ball detector was included. For all the particles, a cut of 0.01 GeV was introduced, so 10 MeV. The meaning of this cut is the following: every time a particle should be created as a secondary, it is only created and propagated if its energy is above 10 MeV; otherwise the corresponding energy is deposited locally. In this case, it is pretty obvious that this cut is too high and that the efficiency values that we will get will be overestimated because the energy won't go to the neighbor crystals. The purpose was then to find out which would be a good cut.

2 The tracking cut

The tracking cut is applied in the following way:

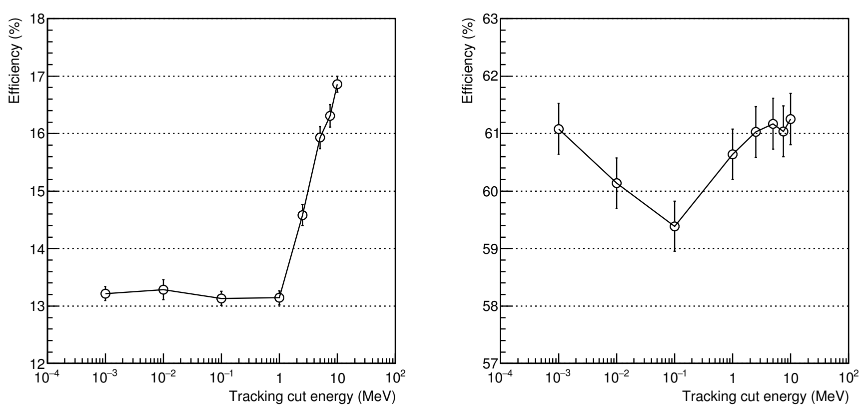
```
// Setting Energy-CutOff for Si Only
Double_t cutE = 0.01; // GeV-> 1 keV

// Si
gMC->Gstpar(pSi->GetId(), "CUTGAM", cutE); /** gammas (GeV)*/
gMC->Gstpar(pSi->GetId(), "CUTELE", cutE); /** electrons (GeV)*/
gMC->Gstpar(pSi->GetId(), "CUTNEU", cutE); /** neutral hadrons (GeV)*/
gMC->Gstpar(pSi->GetId(), "CUTHAD", cutE); /** charged hadrons (GeV)*/
gMC->Gstpar(pSi->GetId(), "CUTMUO", cutE); /** muons (GeV)*/
gMC->Gstpar(pSi->GetId(), "BCUTE", cutE);  /** electron bremsstrahlung (GeV)*/
gMC->Gstpar(pSi->GetId(), "BCUTM", cutE);  /** muon and hadron bremsstrahlung(GeV)*/
gMC->Gstpar(pSi->GetId(), "DCUTE", cutE);  /** delta-rays by electrons (GeV)*/
gMC->Gstpar(pSi->GetId(), "DCUTM", cutE);  /** delta-rays by muons (GeV)*/
gMC->Gstpar(pSi->GetId(), "PPCUTM", -1.);  /** direct pair production by muons (GeV)*/
```

3 Finding a good value for the tracking cut

If we understand how the tracking cut is working, if we decrease the cut at some point there would be stability in the results but the computing time would increase quite much. So, one should try to lower the cut within a reasonable computing time. Studies of the different variables at the output tree from R3BRoot have been performed for the following cuts: 1MeV, 7.5 MeV, 5 MeV, 2.5 MeV, 1 MeV, 100 keV, 10 keV and 1 KeV. The energy spectra from Crystal Ball, the crystal multiplicity, the photo-peak efficiency for gammas and the total efficiency for the (p,pn) and (p,2p) reactions using one Physics list (emStandard for gammas and QGSP_BERT_HP for hadrons) have been studied as a function of the energy of the tracking cut.

For gammas, it was pretty straight forward, as higher is the energy of the cut more Compton is suppressed, and more energy is recovered. So, taking into account the spectra studied a cut below 100 keV should be used.

The most relevant graphs for (p,pn) and (p,2p) to decide which was the best cut for them were the evolution of the total efficiency for detecting two nucleons, p and p or p and n, above 20 MeV as a function of the energy of the tracking cut. In figure 3 are shown the efficiencies for (p,pn) on the left and for (p,2p) on the right. The (p,pn) efficiency is decreasing up to 1MeV, then it is stable within the error bars. The (p,p2) efficiency has a slightly different behavior; all the points are in good agreement within the error bars except for the 100 keV and 10 KeV.



4 Conclusions

According to the tests I made, a cut below 1 MeV should be fine.