Subject: Re: Tracking: Kalman Task with STT,(electron hypo)
Posted by Alberto Rotondi on Fri, 24 Dec 2010 13:14:52 GMT
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Dear All,
perhaps I can help the discussion by recalling the modifications that we made in GEANE concerning the Energy loss. They are summarized in the enclosed report paper.pdf.
The original GEANE deals correctly the average energy loss for every particle. Electrons and positrons are tracked also taking correctly into account the bremsstrahlung process (see the enclosed report, table 2).

Therefore, no new implementations are necessary for the total energy loss. I recall that, when one studies a detector response, usually only the ionization energy loss is taken into account, whereas, while tracking, it is essential to consider the total energy loss, that is ionization plus bremsstrahlung, which is the main source of dE/dx for high energy electrons. This is considered with electrons, but not for muons (for energies below 10 GeV). Hence, to track an electron as a muon underestimates heavily the current particle energy. Note that the curves (pmc – pGeane)/pmc when electron is tracked as muon, have all the wrong mean and the peak is shifted.

Concerning the errors, we found in the original GEANE only the energy loss straggling by ionization in the Gaussian approximation (eq . 4 of the report). This approximation is absolutely insufficient for a correct error propagation!
Therefore (see the report), we implemented the energy loss by collision straggling with the Urban model and added the bremsstrahlung straggling to electron and positrons. All the formulae implemented by us can be found in the routine ERLAND of GEANE or in the enclosed report.

The bremsstrahlung straggling deals correctly the sigma, but, since the shape is pathological and not Gaussian (see fig.5 of the report), the Kalman algorithm gives biased results. This is well known, and the remedy is to parametrize the bremsstrahlung straggling with a sum of Gaussian, to perform multiple tracking and to weight the results with the area of the Gaussians. The method is called Gaussian Sum Filter (GSF). At present this method is missing in our tracking. However, also with the actual implementations, the pulls of electrons are not so bad.

In the result reported in this discussion I see that the pulls for electrons and the other particles are acceptable when Urban fluctuations by ionization and the present version of bremsstrahlung straggling are on.

When an electron is tracked as a muon, the energy loss is wrong and the tracking error is underestimated. In the Kalman filter, the result is shifted more toward the tracking values than in the case of electrons. The errors used in Kalman is wrong and too small in any case. The results show that the pulls are bad (and this is expected, since the errors are wrong because the bremsstrahlung straggling is missing), and that the absolute differences are sharper. The mean is shifted (and I understand why) and the width is smaller (this is not completely clear to me).
I checked with Lia the code during these days and we did not find bugs.
Merry Christmas and Happy new year to all
Alberto

File Attachments

1) paper.pdf, downloaded 572 times