Subject: EMC resolution
Posted by binsong on Fri, 11 Oct 2013 12:05:28 GMT
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hi,
i find some problems with the EMC energy resolution. Maybe there are some bugs.

I do the simulations for electron and photon with box generator with the latest trunk at both barrel region (80deg--100deg) and forward region (12deg--20deg).

i get the reconstructed energy(E_rec) by using GetEmcRawEnergy(),

then i plot (E_mc-E_rec)/E_mc for each simulation.

but i find the resolution sigma/E much smaller then the result in TDR:

electron_barrel: 1.18%
electron_forward: 1.58%
photon_barrel: 1.07%
photon_forward: 1.39%

and in TDR, the resolution for photon at 1GeV is more than 2%.

you can find all the four plots in attachment.

does someone know this problem?

Binsong

File Attachments
1) electron_barrel_1GeV.eps, downloaded 387 times
2) electron_forward_1GeV.eps, downloaded 348 times
3) photon_barrel_1GeV.eps, downloaded 340 times
4) photon_forward_1GeV.eps, downloaded 337 times

Subject: Re: EMC resolution
Posted by Dima Melnychuk on Mon, 14 Oct 2013 12:47:47 GMT
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Hi,

Some additional comments from my side on EMC resolution.

I have more or less the same numbers as Binsong and I tried to look what are main constributions to these numbers.

By the way I used apr13 release of pandaroot for these studies and did simulation for barrel in 30-130 degree range.

So first of all I made a comparison of resolution which includes and does not include digitization.

The resolution without digitization can be obtained if PndEmcMakeDigi class is used for digitization and in emc.par
UseDigiEffectiveSmearing:Int_t 0

In this case the resolution is only due to energy leakage below threshold. With single crystal threshold 3 MeV the resolution is 1.08 %

The resolution in my case is obtained from Novosibirsk fit
(root/pandaroot/trunk/macro/emc/dedicated/fit_resolution.C)

When digitization is included two additional constributions to resolution are photostatistics and electronics noise. With current parameters in emc.par/all.par photostatistics for case of barrel for 1 GeV photon should give 0.43 % (94 p.e. per MeV and 1.7 excess noise factor). 1.5 MeV noise gives 0.15% contribution accordingly.
Adding these three contrubution quadratically
sqrt(1.08^2+0.15^2+0.43^2)=1.17 %

Simulation of 50 k photons with digitization included gives 1.20 % resolution which is in agreement with simple estimation.

If we want to compare the results of simulation with prototype measurements the non-uniformity of ligh yield should be included in simulation and it will give a sizeble effect.

But otherwise it seems that electronics noise and photon statistics are treated reasonably well and I can only imagine that the energy leakage could be underestimated.

Dima

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Subject: Re: EMC resolution
Posted by StefanoSpataro on Mon, 14 Oct 2013 15:29:36 GMT
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If I remember well, after Hossein update, we switched off the non uniformity because there were some problems, but I do not remember which ones.

---

Subject: Re: EMC resolution
Posted by binsong on Wed, 30 Oct 2013 09:50:05 GMT
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Hi,

I try to re-put the nonuniformity to 1.

But there is no difference for the resolution.

it is always the same, 1.15%

Binsong

## File Attachments

1) ele_barrel_nonuniformity_1.eps, downloaded 235 times

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Subject: Re: EMC resolution
Posted by StefanoSpataro on Wed, 30 Oct 2013 13:57:18 GMT
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I notived Dima has done some modifications to have the old digitization. Could you please update emc folder and try again?

---

Subject: Re: EMC resolution
Posted by Dima Melnychuk on Wed, 30 Oct 2013 14:23:31 GMT
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Some additional results on emc resolution from my side.

First of all after Jifeng put a latest version of digitization by default, (based on code for EMC feature extraction developed at KVI) the energy resolution is different.

I did study for barrel 30-130 degree range, 10 k events, 1 GeV photons.

For new digitization sigma=1.6%

For previous digitization sigma=1.2%

There are two options for non-uniformity, first is based on measurements and implemented by Christian Hammann, sigma=2.6%

And second one (linear non-uniformity) is based on fit to reproduce prototype data and implemented by Hossein Moeini, sigma=2.5%, so both options are very close.

You can use this option with

```
PndEmcHitProducer* emcHitProd = new PndEmcHitProducer();
TString nonuniformityFile=gSystem->Getenv("VMCWORKDIR");
nonuniformityFile+="/macro/params/EmcDigiNoniformityPars2.root";
emcHitProd->SetNonuniformityFile(nonuniformityFile.Data());
```

So non-uniformity definitely affect the result as well as newer digitization.

But you can see if you use non-uniform response the peak position is shifted and calibrartion/energy correction is necessary. And shift is in different direction for two implementations of non-uniformity. Hossein provided correction for his case but it was for older digitization and newer digitization shift a peak position itself a little bit. So it should be redone.

So I plan to redo energy correction for new digitization with both non-uniformity options and I hope rather soon.

2.6% resolution for 1 GeV photon is what Christian Hammann quoted before as a result in agreement with prototype data.

So when energy correction will be ready the question can be closed.

Dima

## File Attachments

1) energy1.png, downloaded 573 times
2) energy2.png, downloaded 558 times
3) energy3.png, downloaded 491 times
4) energy4.png, downloaded 612 times

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Subject: Re: EMC resolution
Posted by Ronald Kunne on Wed, 06 Nov 2013 10:13:11 GMT
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Some remarks on the EMC resolution problem.

1) the present EMC PID is two years old, release 14213.

2) I think what should be available in PandaRoot ideally is two versions for the cluster energy Eraw et Ecorrected, where Eraw is the cluster energy as close to the value as we will measure it in the experiment, and Ecorrected a software corrected value to be used for gamma tracks and Binsong's electron correction

3) At present there are three values Eraw (non-uniformity off), an Eraw(non-uniformity on) et an Ecalibrated (which is probably wrong, if it uses Eraw). Of these: Eraw(non-uniformity on) represents the best the data as will be measured in the experiment

4) I checked the resolutions using the tuples made recently by Gosia. Eraw and Ecalibrated give resolutions that practically identical and both are too low.

Description of the plot added.
Upper raw: data using Eraw
Lower raw: data using Ecalibrated

1st column: pMC versus (Eemc-pMC)/pMC in %
2st column: profile plot of pMC versus (Eemc-pMC)/pMC in %

3st column: resolution obtained by fitting Gaussians to slices of the 2D histos.

Greetings,
Ronald Kunne

---

Subject: Re: EMC resolution
Posted by Dima Melnychuk on Wed, 06 Nov 2013 11:35:29 GMT
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Hi,

I have just update emc energy correction parameters for the case of non-uniformity switched on with the latest version of digitization.

I also switched on the use of non-uniformity by default in all.par

The files with correction are in /macro/params/
emc_correction_hist_gamma_2.root
emc_correction_hist_gamma_3.root
emc_correction_hist_gamma_4.root
emc_correction_par_gamma_2.root
emc_correction_par_gamma_3.root
emc_correction_par_gamma_4.root

You use correction like

PndEmcAbsClusterCalibrator * calibrator1=
PndEmcClusterCalibrator::MakeEmcClusterCalibrator(1, 3);

And then obtain calibrated energy like
cluster_energy_calibrated=calibrator1->Energy(cluster);

And here first number stands for the method applied (1 - correction from histogram, 2 - correction from parametrization)

Second number stands for version and here
1 - previous version of digitization, no non-uniformity (deprecated)
2 - current version of digitization, no non-uniformity
3 - current version of digitization, with non-uniformity
(should be used by default)
4 - current version of digitization, with non-uniformity calculated by Hossein (linear non-uniformity 1.5%, set from the file /macro/params/EmcDigiNoniformityPars2.root)

By the way the macro which produces the last non-uniformity file is
/macro/emc/dedicated/fill_nonuniformity_param.C

Here some plots which demonstrate how applying non-uniformity change reconstructed emc

energy. I do not know if it's by accident or by intention of Christian Hammann who provided non-uniformity parameters from measured data in case of barrel EMC correction is almost not needed, i.e. 1 GeV energy peak is centred around 1 GeV. But for endcaps correction is still needed anyway.

For energies in range 0-10 GeV energy versus polar angle

Reconstructed energy of 1 GeV photons

Reconstructed pi0 invariant mass

In this last case the corrected energy gives even slightly worse results.

In PndPidCorrelator.cxx
fEmcCalibrator= PndEmcClusterCalibrator::MakeEmcClusterCalibrator(2, 1);

should be modified to

fEmcCalibrator= PndEmcClusterCalibrator::MakeEmcClusterCalibrator(2, 3);

Dima

## File Attachments

1) e_vs_theta.png, downloaded 632 times
2) energy_1GeV.png, downloaded 596 times
3) mpi0.png, downloaded 587 times

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Subject: Re: EMC resolution
Posted by StefanoSpataro on Wed, 06 Nov 2013 16:11:25 GMT
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I have just updated the PndPidCorrelator.
Can somebody check the output of the simulation now, to be sure that everything is fine and coherent?
Thanks.

---

Subject: Re: EMC resolution
Posted by binsong on Fri, 15 Nov 2013 14:10:00 GMT
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hi,

I have checked with the new correlator for electron and photon at 1 GeV/c at Barrel region.

The calibrate energy in EMC seems a little strange, I plot the (E_MC-E_Cal)/E_MC, there is a

gap in the peak. (see the figures)

Binsong

File Attachments
1) photon_cal.eps, downloaded 211 times
2) electron_cal.eps, downloaded 217 times

Subject: Re: EMC resolution
Posted by Dima Melnychuk on Fri, 15 Nov 2013 14:24:23 GMT
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Hi Binsong,

Could you make the same plot not with calibrated but with raw energy?
It would help to understand at what point the gap in the energy distribution appear.

Dima

Subject: Re: EMC resolution
Posted by binsong on Fri, 15 Nov 2013 14:30:40 GMT
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yes, this is the same plots with raw energy.

Binsong

File Attachments
1) electron_raw.eps, downloaded 211 times
2) photon_raw.eps, downloaded 184 times

Subject: Re: EMC resolution
Posted by Dima Melnychuk on Fri, 15 Nov 2013 14:39:22 GMT
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One more clarification.
For which polar angle range in barrel are these plots,
the whole barrel or more narrow angle range?

Dima

Subject: Re: EMC resolution
Posted by binsong on Fri, 15 Nov 2013 14:49:56 GMT
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the theta is from 30deg to 130deg, and phi is from 0 to 360.

Subject: Re: EMC resolution
Posted by StefanoSpataro on Fri, 15 Nov 2013 15:23:14 GMT
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Are you selecting all the clusters or only the ones coming from the primary particles?

Subject: Re: EMC resolution
Posted by binsong on Fri, 15 Nov 2013 15:30:42 GMT
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only the one from primary track

Subject: Re: EMC resolution
Posted by StefanoSpataro on Fri, 15 Nov 2013 15:35:38 GMT
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Could you please do a 2D plot as a function of theta?

Subject: Re: EMC resolution
Posted by binsong on Thu, 13 Feb 2014 14:16:08 GMT
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Dear all,

now the problem is clear. it is due to the nonuniformity.

To obtain a realistic resolution (validated by the PROTO60 results),
simulations must be done using following parameters in all.par:

Use_nonuniformity:1
Use-Shaped_noise 0

The first flag needs to be set to 1 to take into account the observed non linearity of the light yield
in the barrel EMC crystals as a function of the interaction depth. The effect is an increase of the sigma of a Nivosibirsk fit from
1.6 (Use_nonuniformity:0 ) to 2.5 % (with Use_nonuniformity:1) for photons at 1 GeV with a flat distribution in theta from 30 to
130 deg.

With the second flag set to 0, a more precise description of the electronic noise is obtained, while faster but less accurate results are
obtained with the flag set to 1. The effect is an increase of the

sigma of a Novosibirsk fit from
2.2 (Use-Shaped_noise 1) to 2.5 % (Use-Shaped_noise 0) for a photon at 1 GeV

Before end of november 2013, the standard parameters were "Use_nonuniformity 0" and "Use-Shaped_noise 1", leading to a too optimistic resolution, by about a factor 2. Now, the standard setting is "Use_nonuniformity 1" and "Use-Shaped_noise 0")

The raw energy includes both effects of the non-uniformity and of the electronic noise. The cluster calibrated energy is deduced using calibration
parameters adjusted as a function of theta and energy to reproduce the pi0 mass.
By default, the calibration parameter file is the one corresponding to Use_nonuniformity:1 and "Use-Shaped_noise 0".

The two attached figures are the results for photon with the new version of pandaroot.

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Subject: Re: EMC resolution
Posted by binsong on Thu, 13 Feb 2014 14:17:44 GMT
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here is another figure for the cal energy

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