

ILD Software and Analysis Meeting

PFA and plugins for SDHCAL

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Context

- Working on SDHCAL calibration for ILD option 2 to prepare for APRIL PFA implementation
 - Detector model : ILD_12_v02 with Videau geometry and SDHCAL
 - Files on the grid at :
`/ilc/user/g/ggrenier/prod/v02-02-03/`
- Used calibration procedure described in CalibrationPandoraAnalysisExplained.tex here : [▶ LCPandoraAnalysis](#)
 - ECAL : Single γ , Calibration OK
 - SDHCAL : Single K_0^L , calibrated but lacks corrections
- Theta and phi angle correction needed $\rightarrow E_{rec}$ too low

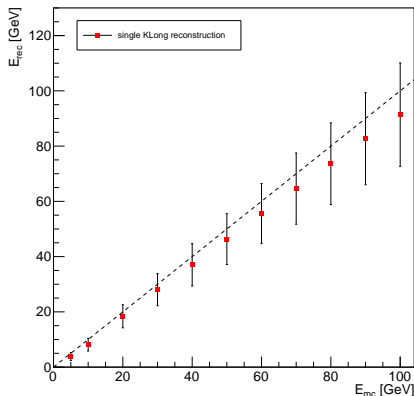
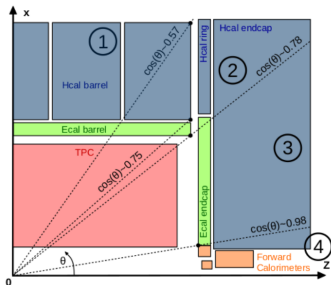
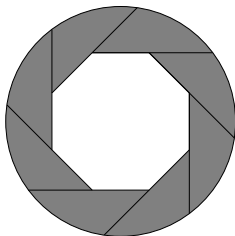


Figure: E_{rec} before correction

Angle corrections

- **Goal** : implement angle corrections
- Purely geometric corrections
 - $N_{\text{hit}}^{\text{new}} = N_{\text{hit}} \times \text{Effect}$
 - Effect $\frac{1}{\cos \theta}$ for endcap
 - Effect $\frac{1}{\sin \theta}$ for barrel
 - Effect $\frac{1}{\cos \varphi}$ for barrel only
 - Videau geometry taken in consideration
- Created SDHCALContent for all SDHCAL related plugins [▶ Git repo](#)
- Separating detector (SDHCAL, ILD option 2) from PFA (APRIL).



Corrections results

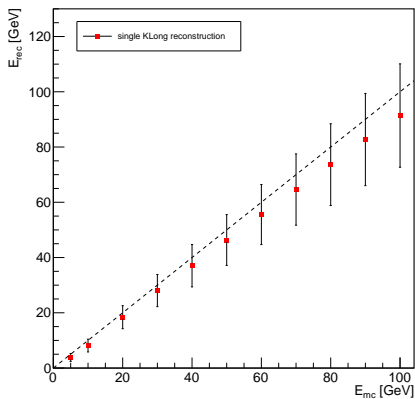


Figure: E_{rec} before correction

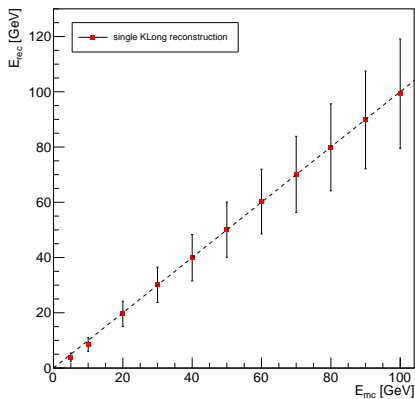


Figure: E_{rec} after correction

To do

- Corrected energy is currently computed linearly with the 3 SDHCAL thresholds' energy factors : $E_{reco} = N_1 E_1 + N_2 E_2 + N_3 E_3$
 - N_1, N_2, N_3 the number of SDHCAL hits for each threshold
 - **Goal** : Reconstruct the energy with the quadratic parameters α, β, γ :

$$E_{reco} = \alpha N_1 + \beta N_2 + \gamma N_3$$
 - α, β and γ are parameterized as functions of the total number of hits and are not constant over a large energy range \rightarrow second-degree polynomial fits
 - Need to recompute α, β and γ to improve the reconstruction at low energy
- Corrections are for now treated separately \rightarrow Regroup them in a single plugin
- Corrections due to gap between modules are done on the energy \rightarrow Do them with N_{hit}

Run the plugins and APRIL PFA

Not really user-friendly for now

- For SDHCALContent :
 - Need to add SDHCALContent to the CMakeLists.txt of a local DDMarlinPandora to get the libraries
 - Include the header file SDHCALContent.h to DDPandoraPFANewProcessor.cc by hand
 - Register the plugins in the RegisterUserComponents by hand
- For APRILContent :
 - Same as for SDHCALContent plus ...
 - Need update to DDCaloHitCreator to create either Pandora::CaloHit or APRIL::CaloHit using a reference to the right Pandora CaloHitFactory.
 - Add dependance to APRILContent and mlpack

Proposed strategy

Short term

- Update DDMarlinPandora with preprocessor tag (`#ifdef`) to include new content easily switchable at compilation time.
- Add SDHCALContent to iLCSoft.
- When ready, add APRILContent to iLCSoft

Medium term

- Adding a new “PandoraContent” (plugins or PFA) in DDMarlinPandora increases the DDMarlinPackage dependencies for each addition.
- Not workable, even more “PandoraContent” likely to come (TimingPFA).
- Needs a rewrite of DDMarlinPandora to be able to plug new “PandoraContent” like we can add a new MarlinProcessor to Marlin.
- Such a rewrite, likely drop Marlin for Key4Hep Gaudi.

Summary and outlook

SDHCAL corrections

- Theta and phi angle corrections are finished and work
- SDHCALContent created for SDHCAL and ILD option 2 plugins (semi-digital energy, angle correction, ...)
- Still some work to do to improve at low energy (semi digital calibration to be done)
- Add more options to the plugins (module gap ...)

Inclusion in DDMarlinPandora

- Our strategy for the moment is to modify DDMarlinPandora to run the SDHCAL plugins and APRIL PFA
- How to include new “PandoraContent” in current iLCSoft ?