First SDHCAL steps in opening the Pandora black box

Gérald Grenier
IPN Lyon, Université Lyon 1

ILD optimisation meeting, February 9th 2011

- Up to now SDHCAL Pandora studies have used Pandora as a black box.
- First attempt to open the Pandora black box to adapt it to SDHCAL
- 2 potential differences :
  - Geometry (outer HCAL is circular rather than 16-sides polygon)
  - Hits are semi-digital

First steps

First : try to run Pandora on SDHCAL Videau geometry Mokka file (single klong)

- Take PandoraPFA and MarlinPandora Trunk version of January 31st
- Build them against ilcsoft v01-10
- Use StandardConfig/v02-02/current/bbudsc_3evt_stdreco.xml as Marlin xml file
  - Change input file
  - Remove flavour tagging processors
- Use MarlinPandora/scripts/PandoraSettings.xml for Pandora
- Then run

Problem : Marlin crashes in Pandora with following error messages :
[ERROR "MyMarlinPandora"] Failed to initialize marlin pandora: gear exception
gear::UnknownParameterException: Hcal_outer_polygon_phi0
terminate called after throwing an instance of 'gear::Exception'

Gear variables causing troubles

- Hcal_outer_polygon_phi0
- Hcal_outer_symmetry_order
- Hcal_stave_gaps

Modify MarlinPandora code to get it running on SDHCAL Videau geometry without crashing.

Looking deeper into the geometry

The Hcal_outer_symmetry_order and hcal_outer_polygon_phi0
have no real concrete meaning for Videau geometry.

These are not only MarlinPandora issues, but are found deep inside Pandora code :

PandoraApi::GeometryParameters::SubDetectorParameters
has variables to store these 2 parameters.

Following GEAR recommendation, I'll set these to 0 for Videau geometry.

These parameters are only used at the moment in the ConcentricGap class.

For the Videau geometry, we'll need a second version of the ConcentricGap to handle a concentric gap that is octogon at the inside and circular at the outside.

For the moment, SDHCAL Videau geometry in Pandora has no gaps.

Second check : making it digital

Have just started a thorough exploration of the PandoraSettings.xml file to understand what Pandora is doing and try to check were the semi-digital nature of SDHCAL hits might be a problem.

First observation, MarlinPandora currently hardcodes the fact that HCAL hits are not digital (CaloHitCreator class).

To figure how to set the energy of the Digital CalorimeterHit, look into the various kind of energy of a Pandora CaloHit :

- inputEnergy : this is the energy of the lcio CalorimeterHit
- mipEquivalentEnergy : this is inputEnergy*HCalToMip*absorberCorrection
- electromagneticEnergy : this is inputEnergy*HCalToEMGeV
- hadronicEnergy : this is inputEnergy*HCalToHadGeV

In blue, are Pandora input parameters.

Couple of Pandora parameters settings are a trap for Semi-Digital hits :

- maxHCalHitHadronicEnergy : should be set so that
  Higher Energy Semi Digital hit * HCalToHadGev < maxHCalHitHadronicEnergy
- hcalMipThreshold : should be set so that
  Lower Energy Semi Digital hit *HCalToMip*absorbercorrection > hcalMipThreshold

For (Semi-)Digital hits, the concept of MIP equivalent energy is meaningless.

Pandora Plugins

Hadronic Energy Correction functions :

CleanClusters : correct cluster energy by searching for constituent calo hits with anomalously high energy. Corrections are made by examining the energy in adjacent layers of the cluster.

No meaning for digital HCAL : not to be used

ScaleHotHadrons : Correct cluster energy by searching for clusters with anomalously high mip energies per constituent calo hit. Corrections are made by scaling back the mean number of mips per calo hit.

No meaning for digital HCAL : not to be used

MuonCoilCorrection : Correct energy of clusters containing muon hits, by addressing issue of energy loss in the coil.

OK even for digital : might need calibration of parameters

ParticleId plugin : found no particular issue linked to digital HCAL.

HCAL hits are analog

Quickly going through each algorithm that is in the PandoraSettings.xml file to spot potential issues for SDHCAL.

Have reached ShowerMipMerging4 .
Found a problem with BackscatteredTracks2 :

First observation, MarlinPandora currently hardcodes the fact that HCAL hits are not digital (CaloHitCreator class).

This will be a problem for the correct assignment of the CaloHit PossibleMipFlag by CaloHitHelper::CalculateCaloHitProperties.

This wrong assignment will make the search of the shower start in a cluster by ClusterHelper::GetShowerStartLayer to be misleading.

Fix needs to modify MarlinPandora's CaloHitCreator class.
Probably by adding a setting parameter to the CaloHitCreator
so that HCAL digital/analog switch can be made in the Marlin xml steering file.

Conclusion

Work has just started to open the PandoraPFA black box for SDHCAL

2 distinctive issues :

- **The Videau geometry (hcal_outer_symmetry_order=0)**
  - Needed code updates to avoid crash.
  - Pandora seems relatively independent of this at the moment.
  - Only exception is concentricGap that can't deal with circular barrel outer side.
  - Haven't yet check how the Pandora pseudolayers fits with Videau geometry.

- **The Digital nature of the hits :**
  - Some hadronic energy corrections have to be removed.
  - Few traps related to digital nature hits identified in CaloHitCreator settings.
  - CaloHitCreator needs to be modified to have digital Pandora CaloHit for HCAL.
  - MIP equivalent energy has no defined meaning for digital hits.
  - Ordering of hits in terms of energy density might be a problem.

The 2 issues could be adressed separately since we can now simulate Digital GRPC with AHCAL geometry.

Next step : keep going with exploration of the Pandora Algorithms.