Task 12.5: Particle Flow Reconstruction

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on behalf of the Task 12.5 institutes

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Overview

Particle Flow Algorithms (PFAs)

State-of-the-art reconstruction for HEP calorimeters and neutrino detectors

Research Groups (main contacts)

- Dual Readout Calorimeters: No Update
  - I. Vivarelli (Sussex), B. Di Micco (INFN Roma-3), S. Vallecorsa (CERN)

- **APRIL**, **A**lgorithm for **P**article **R**econstruction @ **ILC**:
  - G. Grenier (CNRS-IP2I), V. Boudry (CNRS-LLR)

- DUNE Near Detector reconstruction:
  - J. Marshall* & J. Back* (Warwick), M. Uchida & S. Dennis (Cambridge)

    * WP12.5 co-conveners

AIDAinnova WP12 General Meeting

APRIL inclusion in DDMarlinPandora

Tanguy Pasquier, Gérald Grenier

IP2I/Univ Lyon 1

July 3, 2024

Context

Development split in 3 packages

SDHCALContent for ILD option 2/SDHCAL calibration, corrections, ..., Git repo

APRILContent for APRIL PFA algorithms, Git repo.

DDMarlinPandora Created new version of DDMarlinPandora Git repo.

Contents

SDHCALContent

- Have computed new sets of calibration constants for standard SDHCAL semi-digital energy reconstruction.
- New formulas to reconstruct energy with SDHCAL are explored.
- A M1 internship has looked into corrections for ILD option 2 barrel inter-module gaps.

APRILContent

- Have renamed needed APRIL components to avoid duplicate names between APRILContent and Pandora LCContent.
- Design of the APRIL split-cluster procedure has started.

SDHCALContent in DDMarlinPandora

- Compilation options : `cmake -C $ILCSOFT/ILCSoft.cmake -DPANDORA_MONITORING=ON -DUSE_SDHCALCONTENT=ON -DSDHCALContent_DIR=/absolute/path/to/SDHCALContent ..`
- Using preprocessor tag (#ifdef) to include `SDHCALContent.h` header and register SDHCALContent plugins in `DDPandoraPFANewProcessor`
- Allows user to use the SDHCAL related plugins and corrections with PandoraPFA or APRIL PFA

APRIL in DDMarlinPandora

- Compilation options : `cmake -C $ILCSOFT/ILCSoft.cmake -DPANDORA_MONITORING=ON -DUSE_APRILCONTENT=ON -DAPRILContent_DIR=/absolute/path/to/APRILContent -Dmlpack_DIR=/absolute/path/to/mlpack/INSTALL ..`
- APRILContent uses mlpack nearest neighbours algorithms
- Using preprocessor tag (#ifdef) to include `APRILContent.h` header and register APRIL algorithms in `DDPandoraPFANewProcessor`
- Created a `DDCaloHitCreator::ChooseFactory()` to run APRIL with the right hit factory
- Added a processor xml bool parameter "UseAPRIL" (false by default).
- Copied a bit of Pandora LCContent into a `DDPandoraPFANewProcessor::PandoraHack` method.

Issue with LCContent and APRILContent

- Solved with the `PandoraHack` method.
- The Pandora `LCContent::RegisterBasicPlugins` method registers
  - AHCAL energy corrections,
  - PID plugins,
  - PseudoLayerPlugin and ShowerProfilePlugin.
- PseudoLayerPlugin and ShowerProfilePlugin can only be set once preventing APRIL to use AHCAL energy corrections or Pandora PIDs.
- Split the `LCContent::RegisterBasicPlugins` method into two methods in `DDPandoraPFANewProcessor`.
- Ideal would be to split the LCContent basic plugins registrations in LCContent.

Summary and outlook

DDMarlinPandora update

- DDPandoraPFANewProcessor can run Pandora and APRIL.
- APRILContent and SDHCALContent run in our DDMarlinPandora version
- Possibility to combine APRIL + LCContent plugins or Pandora + SDHCALContent plugins
- SDHCAL DDMarlinPandora ready to be propagated to ilcSoft/key4hep (pull request very soon).

SDHCAL Calibration

- Calibration in `ILD_12_v02` better than before
- Still some work to do to perfect it

Other activities

- Rewrite some ILDConfig xml configuration to rerun PFA.
- Talk given at CEPC european workshop 2024 ▸ Git repo

Reconstruction for the DUNE Near Detector (ND)

- ND LAr = 7x5 array of 1x1x3 m^3 modules, LAr TPCs, **3D pixel** readout

- Pandora LArRecoND package for ND reconstruction
  - V01-00-01 contains 3D development & deep learning vertex algorithms

- 2x2 Demonstrator (4 ND LAr modules)
  - Installation at MINOS (Main Injector Neutrino Oscillation Search) at Fermilab
  - Planning to take data during Summer '24 (NuMI beam ν events)
  - Use Pandora & LArRecoND to reconstruct events

- Quantifying 2x2 reco performance using "MiniRun5" simulation
  - Comparing validation QA plots with new hierarchy tools
  - Hierarchy tools needed for events with multiple neutrinos
  - Validation QA (developed for MicroBooNE) can only handle 1-neutrino events

- Planning for LArRecoND poster/talk presentation later in the year