

# Lesson from CALICE software

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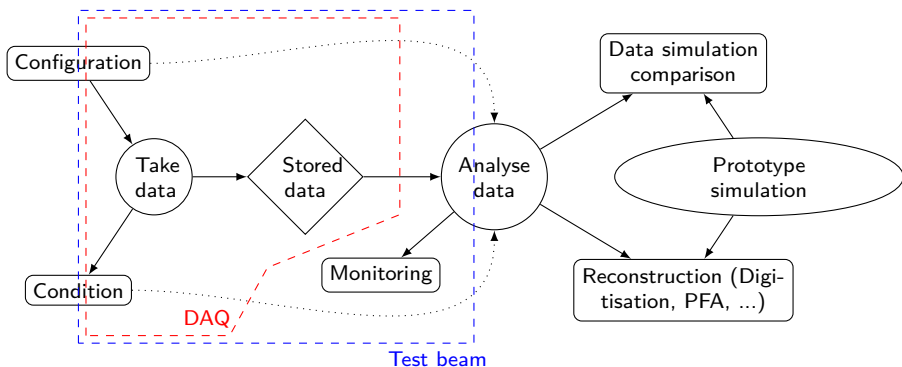
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département  
**Physique**

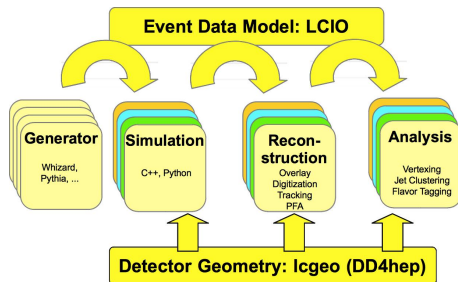
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## Software tasks



- DAQ : priority take data, mix SW and HW, CALICE used EUDAQ, ZDAQ, ...
- Test beam software : lightweight, self-sufficient, able to operate disconnected from internet.

- CALICE software partially based on iLCSoft.
- iLCSoft is the common software framework for Linear Collider detector studies.
- key4HEP replaces iLCSoft.
- iLCSoft has become larger and heavier with time.
- The full key4HEP stack is too much for test beam.



- Hierarchical : LCEvent contains LCCollection of various LCObject.
- CALICE data : LCGenericObject for raw data buffer and RawCalorimeterHit.

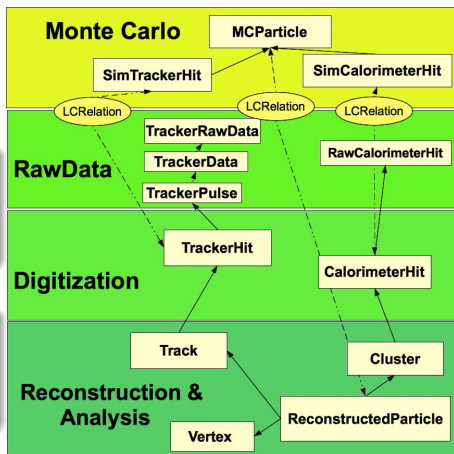
## RawCalorimeterHit

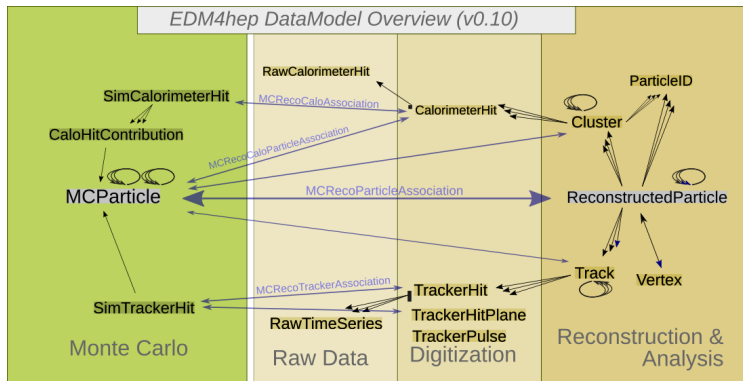
- ▶ 4 int\_32 : cellID0, ( cellID1 ), amplitude, timestamp.
- ▶ CALICE sole user.

## LCCollection

- ▶ has a name to retrieve it.
- ▶ has parameters, cellID bit description, slow control information, ...

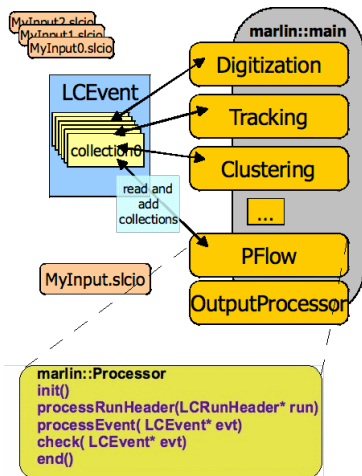
- Simulated data : SimCalorimeterHit



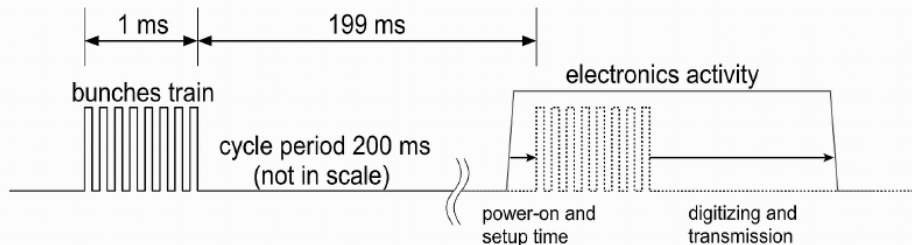


- Strongly inspired by LCIO.
- `RawCalorimeterHit` like LCIO ones.
- Generated by the PODIO EDM toolkit.
- CALICE has started to redefine LCIO `RawCalorimeterHit`, DRD 6 might use PODIO to design specific `RawCalorimeterHit` (but keep Raw-Reco hit association).

- Application framework used throughout iLCSoft.
- Every task is implemented in a Processor.
- Configured via XML files.
- Designed as an offline tool.
- Digitisers (from SimCalorimeterHit to CalorimeterHit) implemented as Marlin Processors : from prototype simulation to full detector simulation.



## Readout events and shower events



- CALICE detectors developed for ILC.
- Electronic registers many (up to 127 for SDHCAL) events.
- A DAQ readout can contain multiple shower events.
- Raw DAQ buffer is (in any order)
  - ▶ stored in LCIO file,
  - ▶ converted to `LCIO::RawCalorimeterHit`,
  - ▶ split in "shower" events.
- Out of "shower" events used to characterize noise.
- Raw DAQ buffer more compact than "readout events" collection of `RawCalorimeterHit`.

## Prototype simulation

- 1 Use standard iLCSoft simulation tools with your prototype geometry.

Same active layer in prototype simulations and in full detector simulations and your prototype geometry part of iLCSoft.

- 2 Use standard full ILD detector simulation in a ad hoc configuration (e.g. HCAL prototype is ILD endcap without ECAL).

Same active layer in prototype simulations and in full detector simulations.

- 3 Use standalone G4 application that saves simulated data in LCIO files.

More control and more flexible, can output more than sim hits (leakage, EM fraction, ...).

## Digitisation

- part of ILD reconstruction, in iLCSoft,
- technology dependant,
- tuned with prototype data.
- Generic algorithm available for simple case.

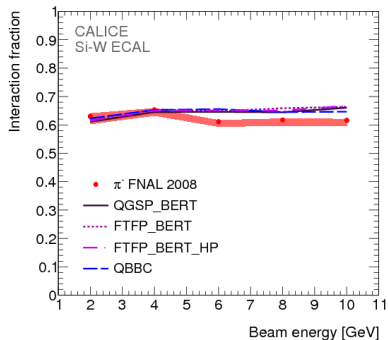
### Advice for more complex cases

keep core algorithm out of Marlin::Processor or Gaudi Algorithm.  
wrote it in EDM4hep.

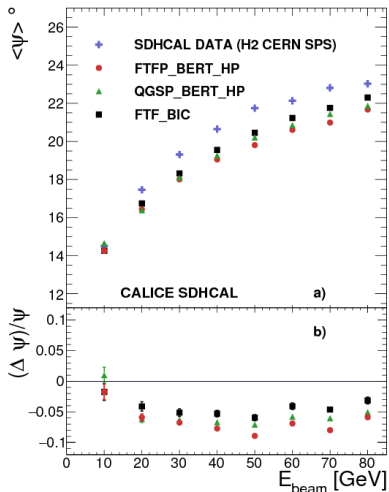


# Data simulation comparison

Accurate simulations and advanced reconstruction techniques allow test of G4. (See Lorenzo's talk)

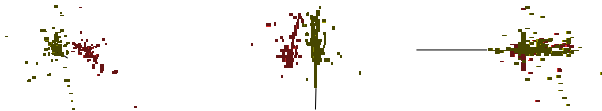


Fraction of pion interacting in SiW ECAL.

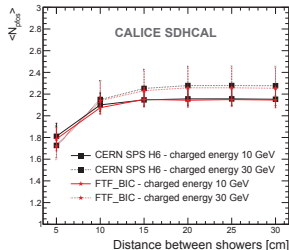


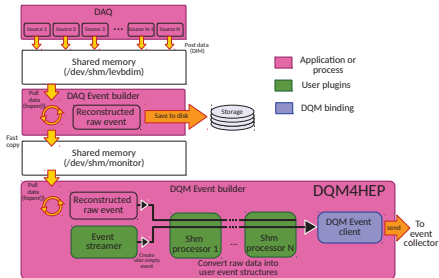
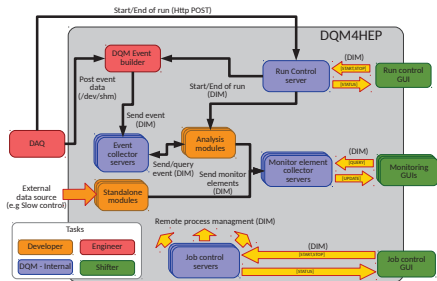
Opening angle of Hough transform tracks inside pion shower in SDHCAL.

- PFA is high level reco, part of full detector simulation, so in iLCSoft, key4hep.
- Test PFA with real data : procedure to overlay 2 testbeam shower.



Overlay of a 10 GeV  $\pi^+$  without its track and a 30 GeV  $\pi^+$  (color are reconstructed PFO)





An example of a monitoring system developed for CALICE.

- CALICE has developed software for lots of prototype calorimeter needs.
- Some developments are reusable.
- Some of the soft have been developed for ILC detectors (e.g. PFA)

### DRD 6

- Test beam software should be kept lightweight, full key4hep stack not needed.
- Store raw data as you want but at the end, exchange it in PODIO/EDM4hep format.
- Use key4hep for high level reconstruction.
- Configuration and condition records should be thought of.
- Experimental data management needs to be considered early on (bookkeeping, preservation, storage, access, ... ).