Simulation for CALICE testbeams

- Introduction
- Test beam configurations @ DESY and @ CERN
- Status of geant3- and geant4-based simulations
- Production for testbeam analysis
- Reconstruction
- Conclusion

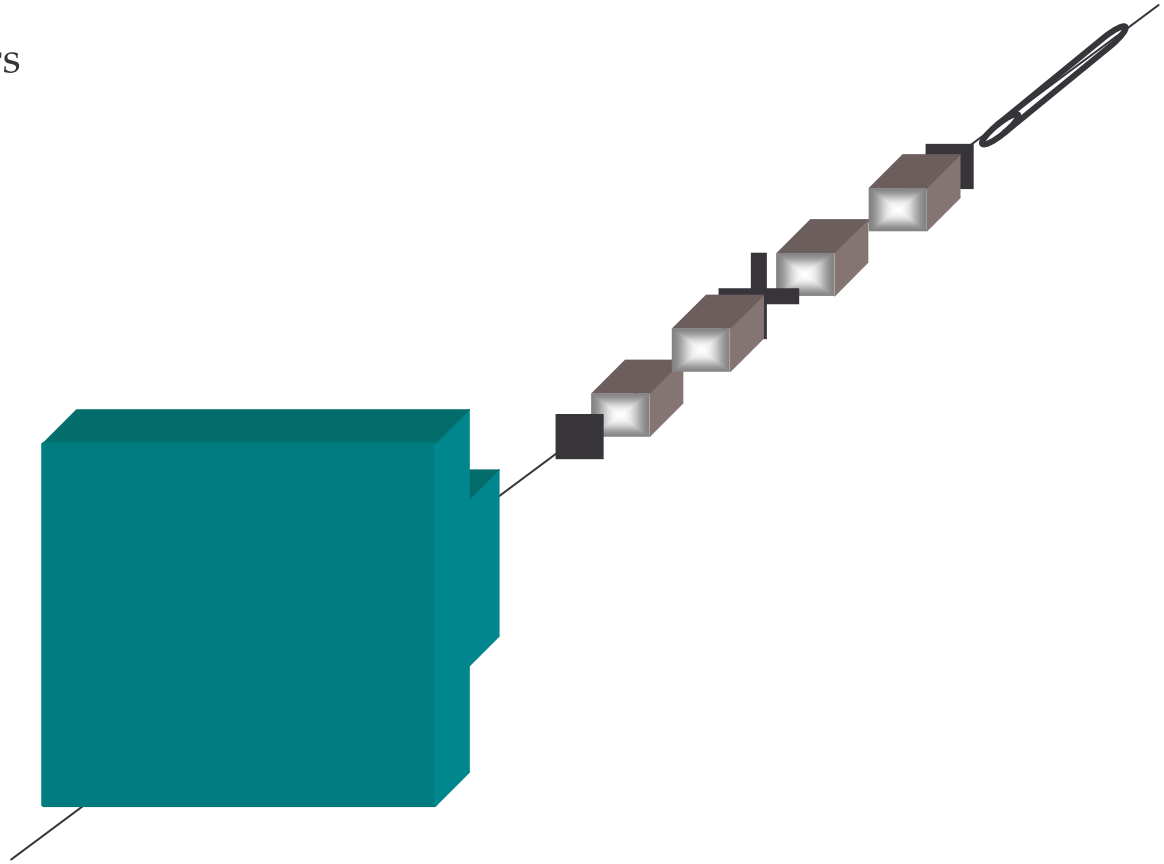
Introduction

- Test Beam Era is already on-going !
- Calendar :
  - Feb 2005 : ~ 200 GB of data on disk, 14 layers, ECAL only
  - May 2006 : **next week**, everything already in place to take data with **ECAL+AHCAL combined**, **5 new slabs**, DESY electron's beam energy : 1 to 6 GeV.
  - 27th July – 8th August 2006 : CERN hadron's beam **ECAL alone**
  - 24th August – 3rd Sept 06 : CERN hadron's beam **AHCAL alone**
  - 12th – 24th October 06 : CERN hadron's beam **COMBINED**
  - Test beam webpage : http://polywww.in2p3.fr/~gaycken/Calice/TestBeam/
    Login & password : consult your emails !!

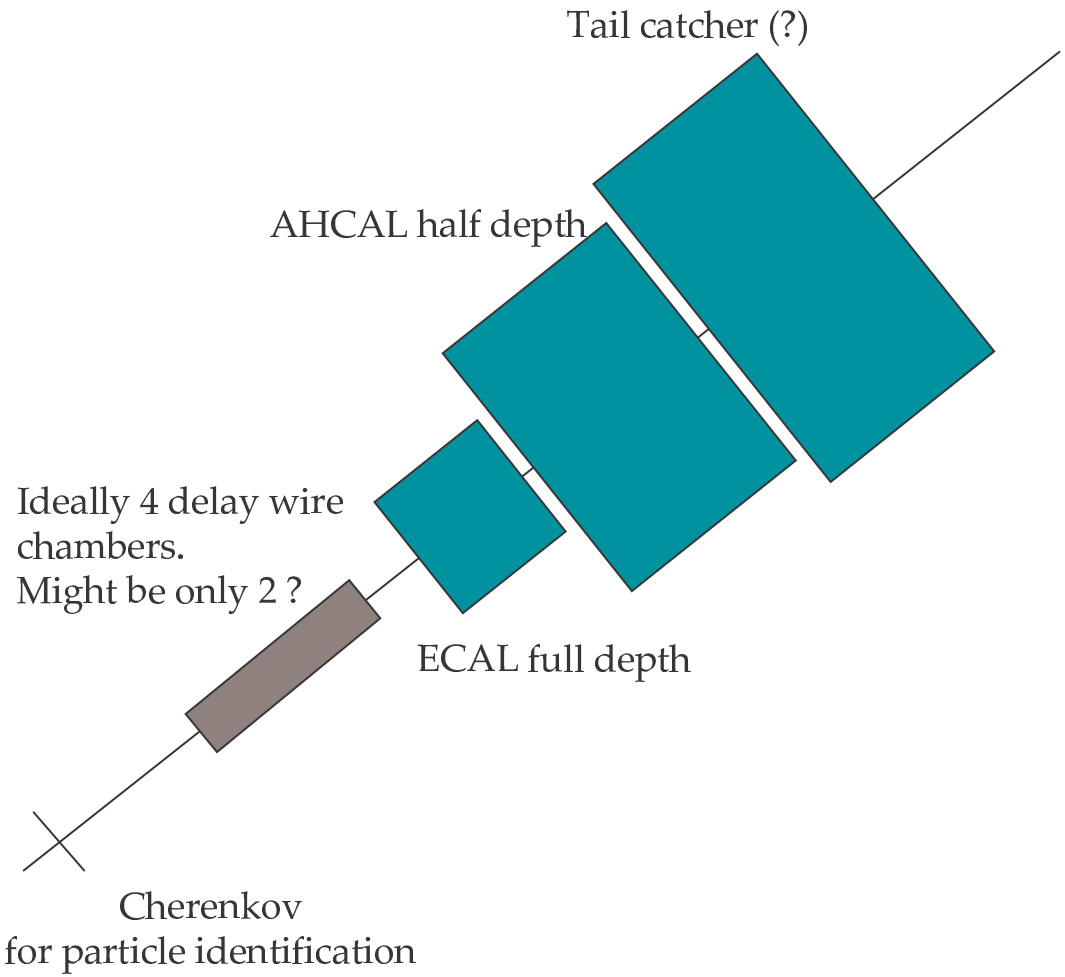
Test Beam Configuration @ DESY

- 4 drift chambers
- 2 scintillator's plans
- 2 scintillator's fingers
- 8+4 slabs for ECAL
- 4 layers for AHCAL

Desy beam : electron or positron.
Synchrotron radiation with 3 to 7 GeV spectra.
γ conversion plan + magnet : selection of 1 to 6 GeV electrons (positron)



Test Beam Configuration @ CERN



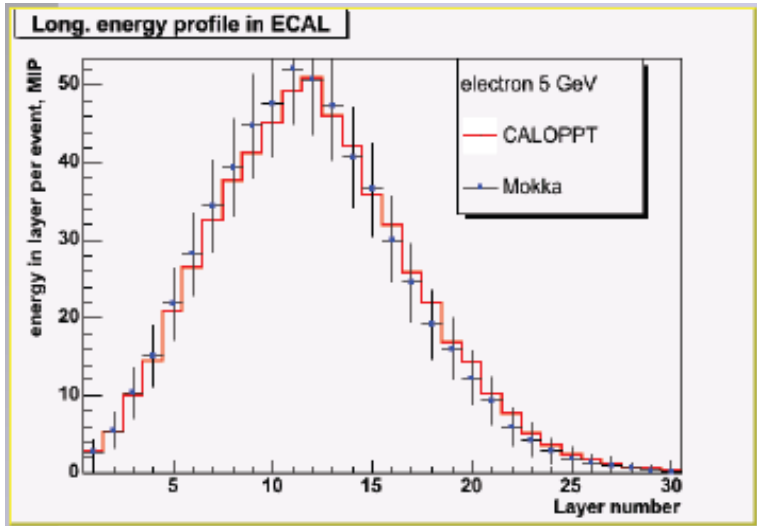
- SPS's proton beam : 400 GeV
- Charged pion beam
- Electron+pion beam, up to 180 GeV. Purity : ~50% ?!?
- Muon beam.

More details on Friday, Felix Sefkow's talk.

G3-based simulation : caloPPT

Alexei Raspereza
http://www.desy.de/%7Erasp/caloppt/caloppt.html

- Closely follows official drawings of Ecal, tile/RPC Hcal and TC
  - ✔Implemented geometry is **similar** to that used in Mokka
  - ✔Non-zero layer tilt (configuration) angle option is included
  - ✔Results of simulation are stored in the **LCIO format**
  - ✔All these features enable straightforward comparison between Mokka and CALOPPT simulation and test-beam data



- If we want to keep the possibility to compare with the well known G3 simulation, need somebody to update the geometry hardcoded files !!

Simulation's chain overview

CURRENT VERSIONS & official software

CLHEP v1.9.2.1 (v2.xx)

Geant v4.8.p01

Mokka v06.00, model TB07
4 DC + scintillators
ECAL "truth" entry point
ECAL 30 layers
HCAL 38 layers
tail catcher

LCIO v01-07

MySQL

Condition's database

Output : LCIO file containing SimCalorimeterHit objects.

Marlin framework v09-04-00
digisim package

Output : LCIO file containing (Raw)CalorimeterHit objects

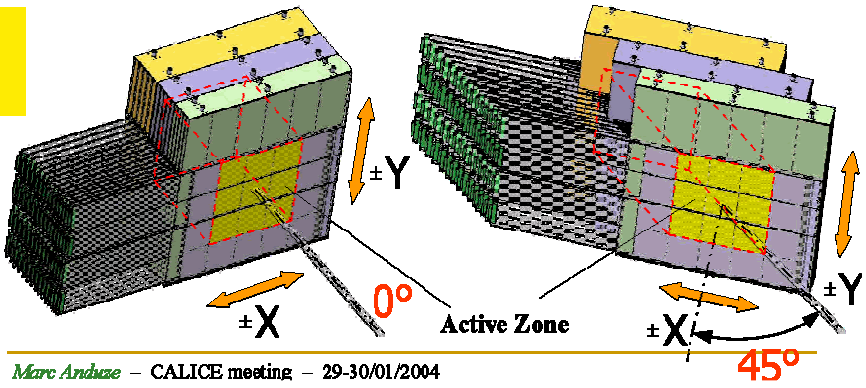
DATA/MC comparison
MC analysis

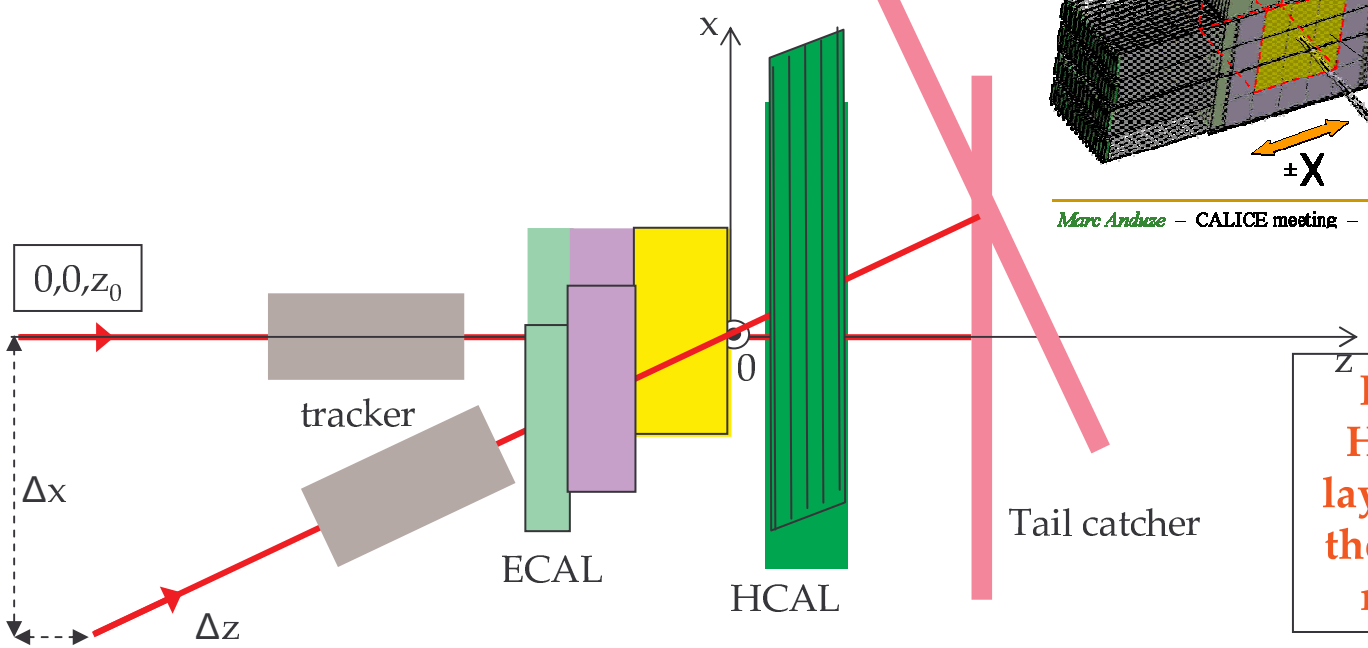
Analysis fwk : root, ...

Coordinate system adopted

http://polywww.in2p3.fr/~musat/Proto/Ecal.html

The Z = 0 plane is the ECAL module 3 (4.2 mm Tungsten) carbon fiber exit face.



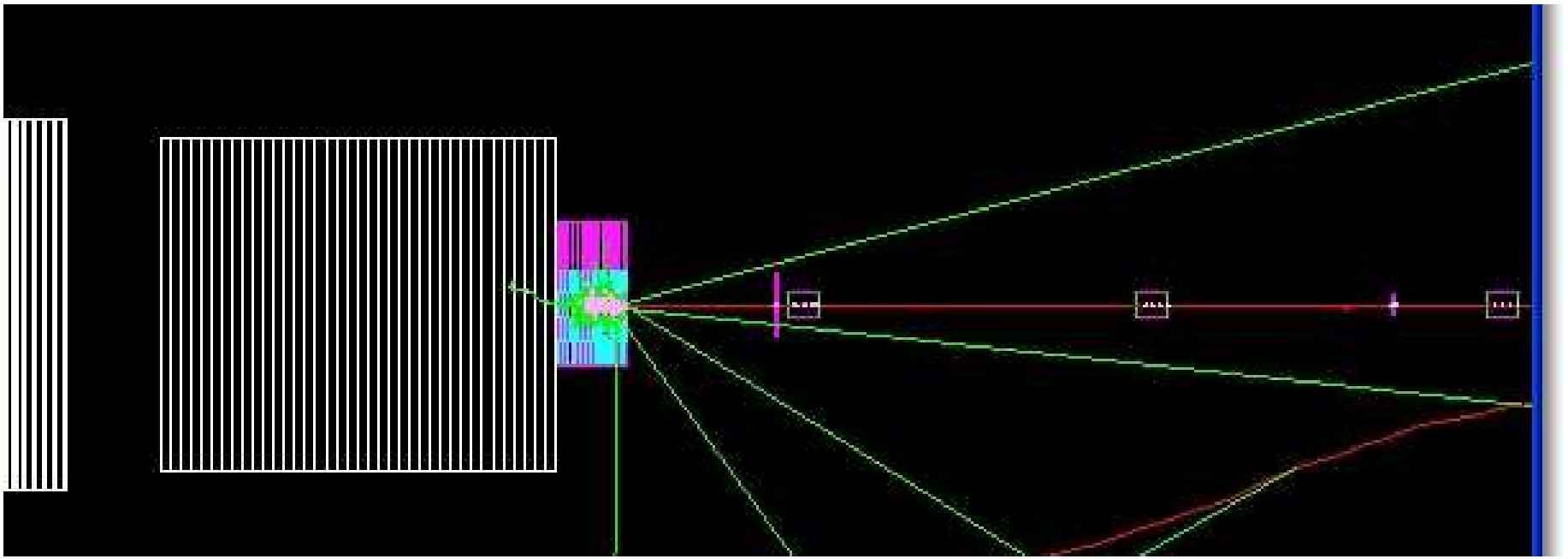


In reality, ECAL and HCAL are rotated+the layers are shifted so that the beam remains in the middle of each plan.

In the simulation :
Rotation of the beam ó rotation of tracker + tail catcher

Model for ECAL shifted : /Mokka/init/detectorSetup TB00 or TB10 or TB20 or TB30 or TB40

Status of Mokka simulation



Apart from the CERN's configuration to be implemented as soon as it's known, everything is fine on the Mokka side !!

CERN : tracking system will probably be delay wire chambers.

Ł Implementation: Fabrizio Salvatore from RHU London

TO BE ADDRESSED : Cherenkov simulation as well !

MC production (1)

- Has to be centralised : Nigel's task list

T13 Production MC simulation. Systematic mokka production of standard MC samples of 100k events for each angle/energy/stage position and detector configuration, based on initial schedule of measurements to be made with beam. Output LCIO files available to collaboration.	Fabrizio Salvatore David Bailey

- As GRID files : apply NOW for your CALICE VO
- What kind of particles do we need ?
  - DESY: electrons
  - CERN: electrons, pions, protons, muons

MC production for DESY

- How big the samples have to be ?
  - data acquisition rate at DESY : ~ 30 or 40 Hz.
    - 140,000 events per hour.
    - 1 M events / configuration seems reasonable.
    - 1,2,3,4,5,6 GeV and 0,10,20,30,40° for incidence angles.
    - 30 M events = 9 full days of data taking.
    - MC simulation, @ RAL : 100,000 evts in 17 hours 1M in 7 days for 1 GeV electrons.
    - Total need of CPU (ex. @RAL) : 735 days.

MC production for CERN

– Data acquisition rate at CERN : ~ 60 Hz.

Spill ~ 5s, spill-to-spill 12s, DAQ rate ~ 1 kHz trigger rate.

Ł 1000/17 ~ 60 Hz of effective data taking rate

(pessimistic 30 Hz, optimistic 100 Hz. See Paul Dauncey's talk on Friday).

Ł 200,000 events per hour.

Ł 1M events / configuration ? Will give ~ 50% of good events.

Ł 13 days = 2/3 data taking Ł 50 M events

Ł HCAL plans : 100,000 in 8 configurations with 5 energies : 10, 18, 25, 50, 100 GeV, and 3 particles : e, π+ and π- Ł ~ 5 days, in order to make sure we understand the beam. Then : detailed studies with more statistics and more points : 5, 6, 8, 10, 15, 18, 25, 35, 50, 75, 100, 150 and 200 GeV.

Ł Be prepared to generate quickly small samples, and then large samples.

Ł Do we need also to generate muons and protons ?

!!See session5 on Friday !!

MC reconstruction

- Centralised as well, and GRID files as well
- Nigel's task list :

T10	Digitisation of tracking hits. Drift chambers currently record all individual energy deposits, need to remove low energy simulated hits at appropriate level, store as tracker hits	Fabrizio Salvatore
T12	Digitisation of ECAL. Add noise (channel-by-channel), threshold, time-dependence due to preamp shaper, crosstalk, coherent noise. This should be implemented as a Marlin processor, build on existing work.	Anne-Marie Magnan, Chris Targett-Adams
T14	Production MC reconstruction. Systematic event reconstruction, application of any default digitisation, and making samples publically available. Output LCIO files with reconstructed objects available to collaboration.	Fabrizio Salvatore, David Bailey
T19	Comparision and tuning of simulation to data.	Chris Targett-Adams, David Ward

T10 : digitisation of tracking hits

Fabrizio Salvatore from RHU London

- First : we are just seriously starting on the subject. No result yet. Need to uniformize the way of doing (thanks to digisim) for tracker, ECAL and HCAL.

- <u>with digisim:</u>
  - Quick way : just smear the MC hit position thanks to detector resolution measurements + apply threshold

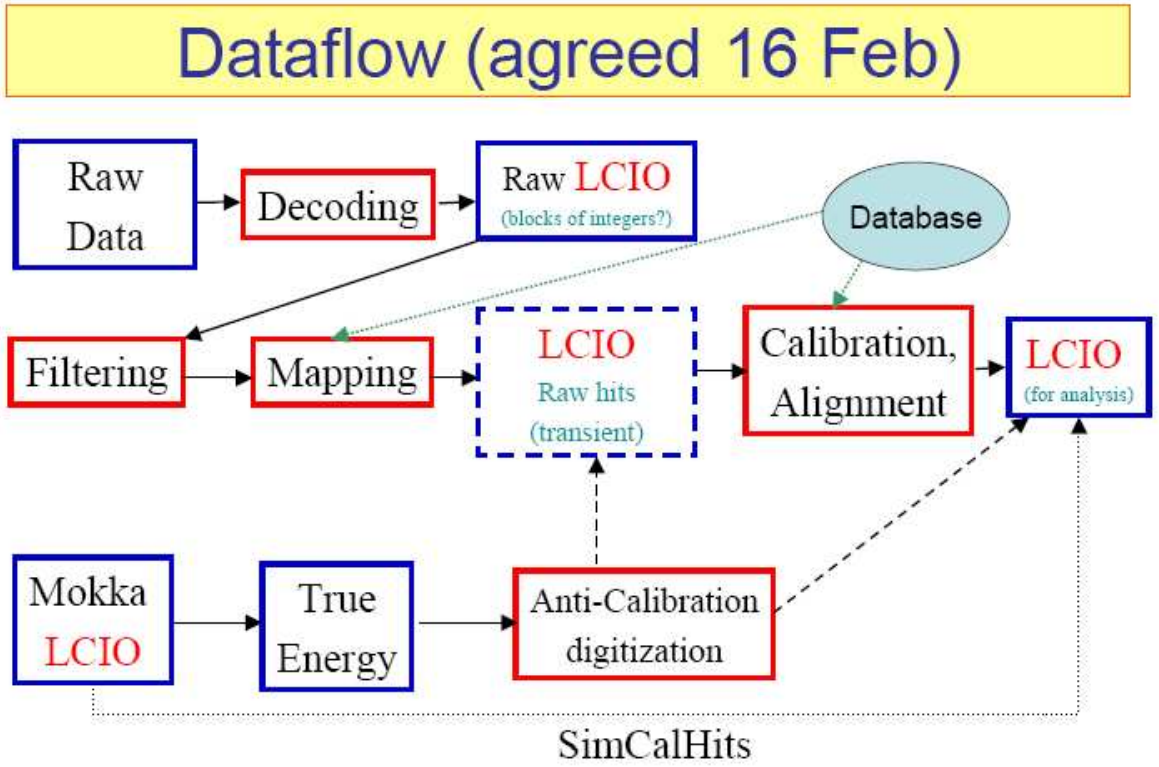
    Output : TrackerHit.
  - Right way : convert to TrackerData : drift time + charge,

    and then apply same reconstruction's code to data and MC.

T12 : digitisation of ECAL hits

AMM, ICL; Chris Targett-Adams, UCL

- Discussion already started one year ago :



Digitisation : time to decide!

- Time to take a decision NOW :

  this will influence ECAL as well as tracker and HCAL

  Ł do we decide to have the comparison between MC and real data as soon as possible : COMMON RECONSTRUCTION SOFTWARE AS SOON AS POSSIBLE.

  Ł or do we prefer to keep things simple, based on our experience and on the current implementation in real data.

- Keep in mind : be prepared for deep studies if needed!
- Digisim offers a nice framework : we definitely should benefit from existing code.

See talk from Guilherme Lima

Digitisation procedure : proposal

- In agreement with current digisim implementation:

data	MC
Raw data format	SimCalorimeterHit (SimTrackerHit)
Pedestal substraction (use the pedestal samples taken before an after each beam data period ?) First "safe" treshold : remove < 5 ADC counts cells (MIP signal ~ 50 ADC, noise ~ 6 ADC Ł Worse case : signal - 5σ = 20 ADC counts) Safely removes 85% of hits.	Anti-calibration : MIP=1 and conversion in ADC counts. (drift time...) Add average noise, coherent noise, crosstalk, ... ++: Simulate non-easy measurable effects (like gain variation,...) to see the overall effect. Digitisation Same "safe" threshold.
Common data-MC format : RawCalorimeterHit. (TrackerData) ONLY SAVED ON DEMAND ++: nice to have a sample properly pedestal substracted available for further studies.	
Remove dead channels	
Calibration	
Threshold cut	
Saved format : CalorimeterHit (TrackerHit)	

I.M.H.O.

- Arguments against a "too early" (RawCalorimeterHit) comparison between data and MC:
  - No need to decalibrate if we recalibrate just after : can compare in MIP signal @ CalorimeterHit level.
  - Rounding effect is negligeable (0.5/50 ADC count compared to noise 6/50)
- I.M.H.O:
  - No E to ADC conversion in MC : does not allow for example gain studies in MC, and possibly other unknown tricky effects. Why do not get prepared NOW for deep studies ?
  - For publication : need to study small effects anyway !
  - We need a properly pedestal substracted sample at some point, and in the same format as MC.
  - We need to be able to compare MC and data before the threshold cut to check what digisim is doing.
  - Not really more CPU consuming if we just translate the LCIO conversion to one step before : the processor which will do the RawCalorimeterHit->CalorimeterHit common DATA/MC step should be really fast.
  - The final output file used by everyone is still the same, containing CalorimeterHit objects !
  - We would save the RawCalorimeterHit only in a few runs dedicated to digitisation studies.

T14: MC Reconstruction

Fabrizio Salvatore, RHUL David Bailey, Manchester

- As well as production, poduction of reconstructed samples for testbeam analysis in a Grid file format.

- About gridifying the current simulation software : Mokka jobs have already been run by DESY people.

  Gidon Moont (from ICL) has setup a web GridPortal that can be easely used to send jobs and retrieve outputs.

- I havn't yet personnally experiment all the chain, but coming soon and pretty confident : people (mostly @DESY) have already worked hard to make that easely available to everyone.

Conclusion

- Desy data will soon be here : we need to analyse them before CERN end of july !!!
- First data at CERN will be needed to understand the beam, the tracker, etc.... Optimise time!
- Simulation side : apart from the digitisation (but DESY data will be needed for this step), in a pretty good shape !! Important issues have already mostly been addressed.
- Production and reconstruction will be needed and hopefully available on the GRID for the entire collaboration as soon as possible !

Summary of remaining issues

- What kind of particle and energy spectra @ CERN ?
- Size of the samples ?
- Only 2 people on the task list for the whole MC production and reconstruction ... Sufficient ?
- Digitisation : need to decide NOW the way of doing.