Status of EUTelescope

Antonio Bulgheroni (INFN)
on behalf of JRA1 software/analysis group

EUDET Annual Meeting – Paris – 8/10 October 2007

Introduction

Main goals of the tracking software

- Providing the users a set of relevant high level objects (like tracks or space points) to characterize the DUT along with histograms of important figures of merit.
- Complementing the hardware part in improving the test beam infrastructure.
- Collaborating in the development of a common software framework in view of the future International Linear Collider experiment.

Very solid starting point...

... trying not to reinvent the wheel!

- Gain as much as possible from past experience and already available and tested software tools:
  - Single sensor analysis → sucimaPix (INFN)
  - Eta function correction → MAF (IPHC - there are several other things we can and should borrow)
  - Track fitting → Analytical track fitting (A. F. Zarnecki taking care of MS) and straight line fitting (T. Klimkovich)
  - Simple alignment → Minuit based (copied and improved from other codes)
  - Framework → ILC Core software = Marlin + LCIO + GEAR + (R)AIDA + CED (+ LCCD).

A collaborative approach...
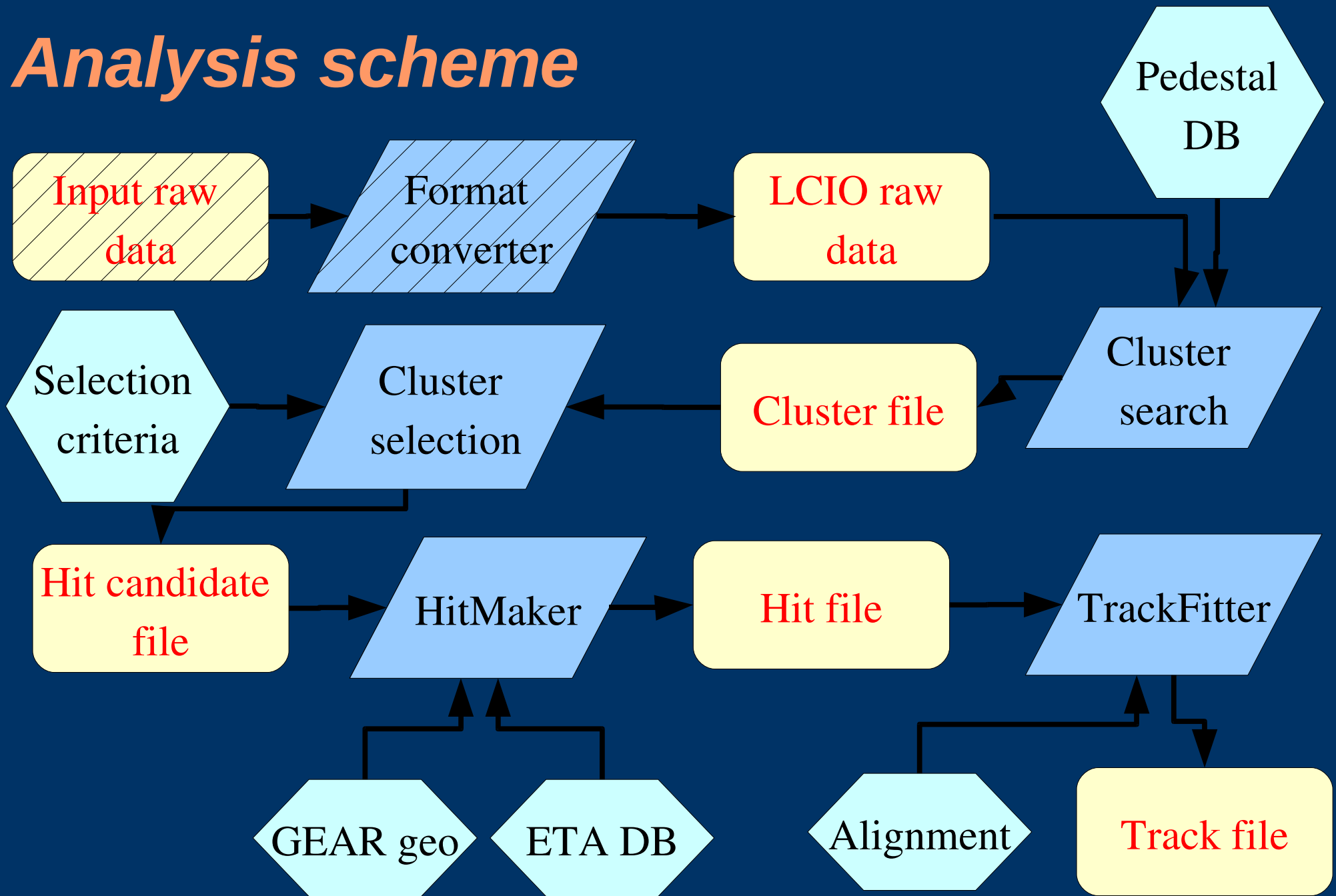
... a virtuous circle!

- In the last months, the ILC software framework has been adapted to our needs:
  - Added the capability to re-loop over the input events
  - Added the possibility to re-implement the output processor
  - Added a new logging mechanism
- At the same time, our team was helping the main developers to implement missing features:
  - Telescope-like GEAR description (T. Klimkovich)
  - Telescope-like graphical event display (A. B.)
  - Alignment using Millepede (work in progress by P. Roloff)

The analysis strategy

... going step by step

- Each analysis module is implemented into a Marlin processor and consequently we can execute all of them together, or stop after every single step to verify the output.
- This is offering several advantages
  - Once the telescope behavior will be well understood, several steps can be merged together but for the time being it is allowing the debug of both hardware and software
  - Some analysis (like efficiency and purity) requires to replay the same analysis step with different selection criteria. Storing intermediate results can reduce long reprocessing time.

Analysis scheme

Input raw data → Format converter → LCIO raw data

Pedestal DB

LCIO raw data → Cluster search

Pedestal DB → Cluster search

Selection criteria → Cluster selection ← Cluster file ← Cluster search

Cluster selection → Hit candidate file

Hit candidate file → HitMaker → Hit file → TrackFitter

GEAR geo → HitMaker

ETA DB → HitMaker

Alignment → TrackFitter

TrackFitter → Track file

Achievements

It's WORKING

- EUTelescope has been successfully used during the last three test beam periods.
- One major bug was discovered in the data conversion soon after the end of the first data taking period and immediately fixed.
- All the results of the beam tests have been obtained using EUTelescope!

It's on the GRID

- Nearly all the analysis steps are performed on the GRID reducing the processing time by at least one order of magnitude

EUTelescope in ILCSOFT

- EUTelescope is available to the ILC community as a Marlin package
  - This is making the installation of EUTelescope very easy using ilcinstall.
  - The integration with all the other software tool is trivial

```
# Marlin Packages
ilcsoft.install( MarlinUtil(  "v00-04" ))
ilcsoft.install( CEDViewer(   "v00-03" ))
ilcsoft.install( Eutelescope( "v00-00-05" ) )

# Eutelescope specific
ilcsoft.module("Eutelescope").download.type="ccvssh"
ilcsoft.module("Eutelescope").download.username="bulgheroni"
ilcsoft.module("Eutelescope").buildWith(["GEAR", "RAIDA",
                        "MarlinUtil", "GSL", "LCCD", "EUDAQ", "ROOT" ])
ilcsoft.module("Eutelescope").env["EUDAQ"]="/home/toto/ilc/eudaq"
ilcsoft.module("Eutelescope").env["ROOT_HOME"]="/cern/root"
```
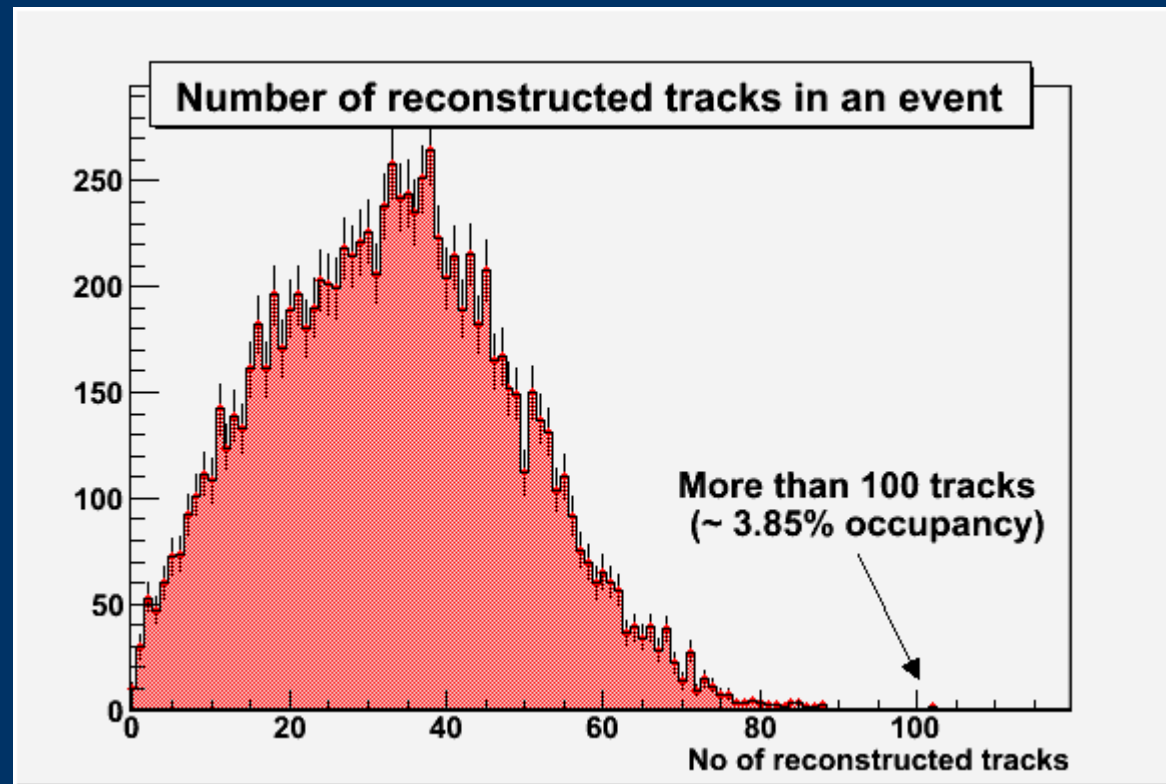
Results...

- Two talks during this annual meeting (1 in JRA1 parallel session and 1 in the plenary)
- Test beam results will be presented also at IEEE – NSS (Hawaii) in less than one month.
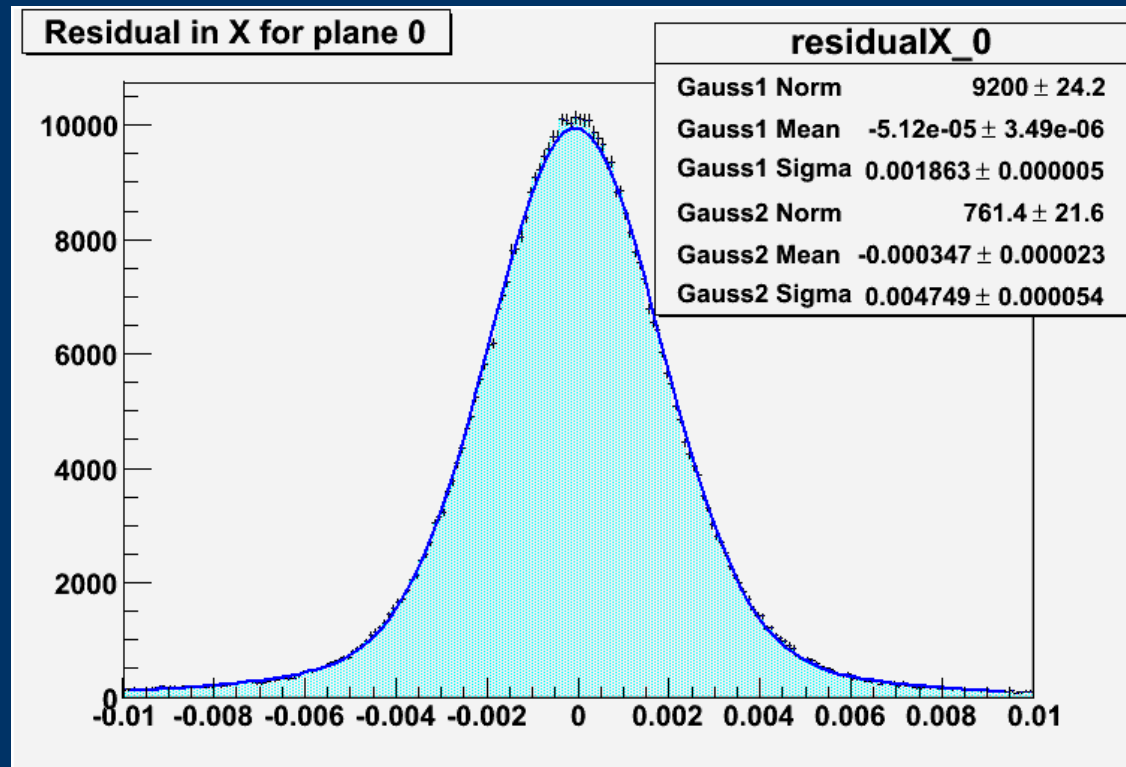
Performances...

- This impressive plot is showing the pretty mature development stage of the tracking software.

CERN large multiplicity data taken two weeks ago

Future plans

Getting closer to the DAQ / 1

- Remove the format conversion step... getting LCIO files directly from the DAQ
  - So far used the native data format only for debug. Now time has come to test the LCIO output.
  - The native format will be used among the DAQ components and the LCIO file will be produced by the DataCollector to minimize the changes.
  - In principle not too difficult, but requires lots of tests because we cannot loose information at this stage.
  - Requires some changes to the LCIO library because compression (zlib) can be too heavy during data taking.

Getting closer to the DAQ / 2

- Improve the interaction between the DAQ and EUTelescope.
  - EUDAQ and EUTelescope should log to the same conditions DB
  - EUTelescope should immediately process pedestal run and upload the new thresholds to the DAQ system when working in ZS mode.

Improve the alignment procedure

- Currently using a simple alignment processor
  - Minimizing the residual on one plane with respect to one or to several other planes.
  - It requires some iterations to align the full telescope.
  - Based on Minuit and currently requiring to link against ROOT.

- Include Millepede in MarlinUtil package and use it within EUTelescope (P. Roloff)
  - The full telescope is aligned in one single iteration.
  - It has been tested already in the simulation but without rotations (T. Klimkovich)

Improve the event display

- Taking part on the development of a common event display for EUDET.
- So far using CED to display hits.
- Still not able to display tracks because the current available parametrization is for helix only.
- Along with 3D visualization also 2D projections can be useful.
- Possibility to display histograms for online DQM.

Better integration with DUT data

- So far only one test beam with DUT.
- Telescope and DUT data streams were saved into two different files using the TLU to tag the event number.
- Now we need to overlay the two streams.
  - The overlay processor available in Marlin is not suitable because it doesn't take care of the event number.
  - Several adhoc processors can be developed but a general solution would be better.
  - Parallel input files instead of serial (?)
- What to do when the DUT data stream is inside the telescope one?

Montecarlo input

- We are considering the possibility to develop some Montecarlo processors in order to feed the analysis chain with simulated data.
- Continuing and improving the work of T. Klimkovich in Mokka
- Include in a Marlin processor the studies done by Lukasz Maczewski on charge sharing in MAPS sensor.

Conclusion

- EUTelescope is working.
- The results obtained from the three data taking periods are proving that it is well behaving...
- A lot of work has been done and the milestone foreseen for the end of 2008 will be easily achieved.
- Other possible improvements are envisaged.

- CVS Server:
  http://www-zeuthen.desy.de/lc-cgi-bin/cvsweb.cgi/Eutelescope/?cvsroot=eutelescope
- DOC Server:
  http://www.roma3.infn.it/~bulgheroni/Eutelescope/head/index.html

Thanks!