Summary of SLAC workshop on Fast Simulation

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- Overview
- Common Infrastructure
- Tuning of parametrisation
- Frozen Showers
- Deliverables

Scope of the Workshop

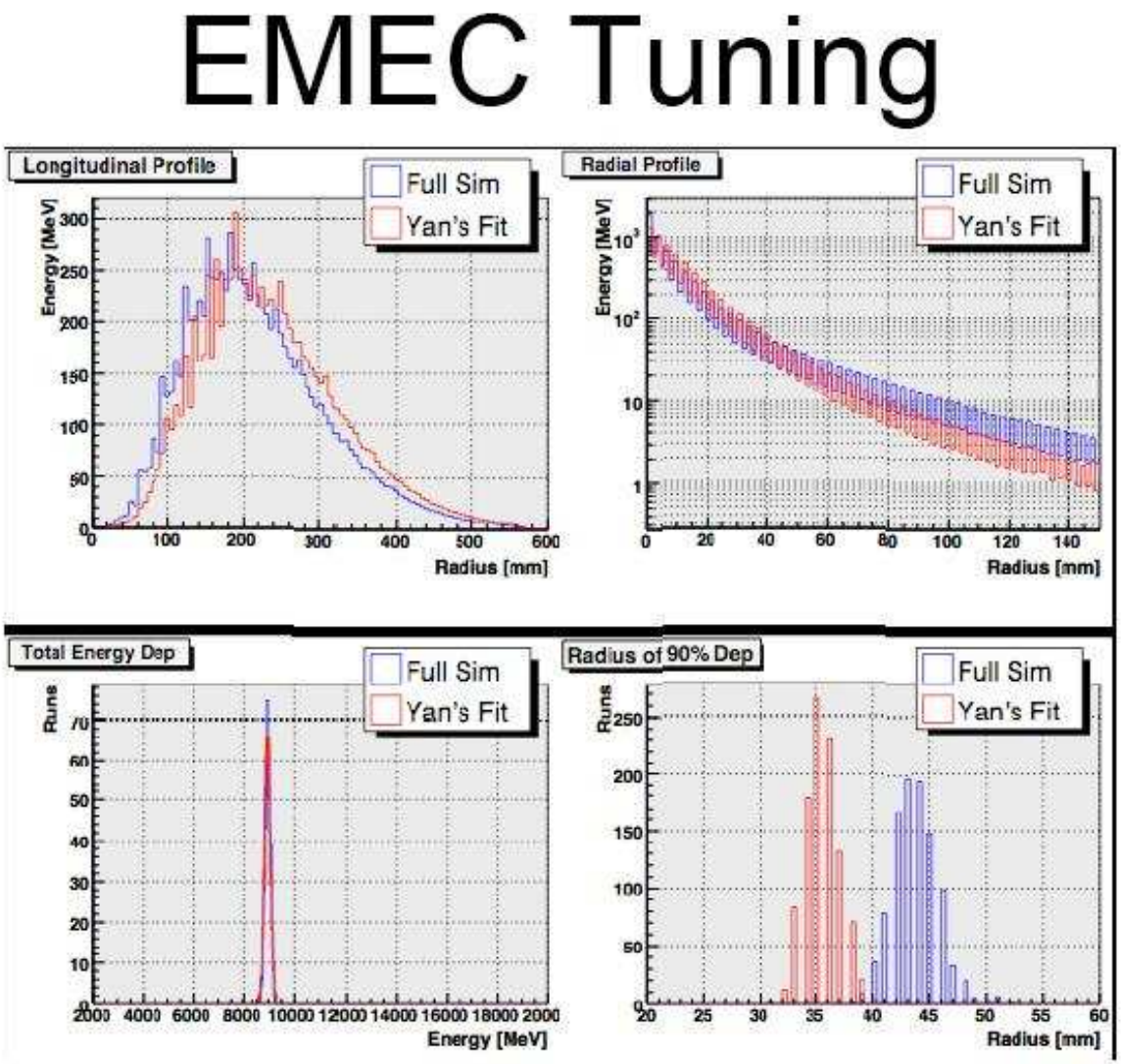
- Meet collegues in person for first time
- Improve infrastructure
- Parametrisation tuning (EMB, EMEC, FCAL)
- Frozen Showers deployment
- Fix list of deliverables for release 13
- AOB

Scope of the Workshop

Infrastructure Improvements

- Most of the code moved to LArG4FastSimulation
- Improved inheritance structure
- Many parameters can be changed using python/JO
- Tuning parameters moved to database
- Added dedicated sensitive detector for easier hit deposition

Tuning of parametrisation



Good progress was made on understanding how to tune the parametrisation. Usually longitudinal profile is easy but radial is more of a problem.

The expert was around and many problems are understood.

Parameters are stored in a database.

Status:
EMB split in to parts ($\eta < 0.8$)
EMEC almost done
FCAL1 almost done
Next: FCAL2/3, HEC, Tile, ...

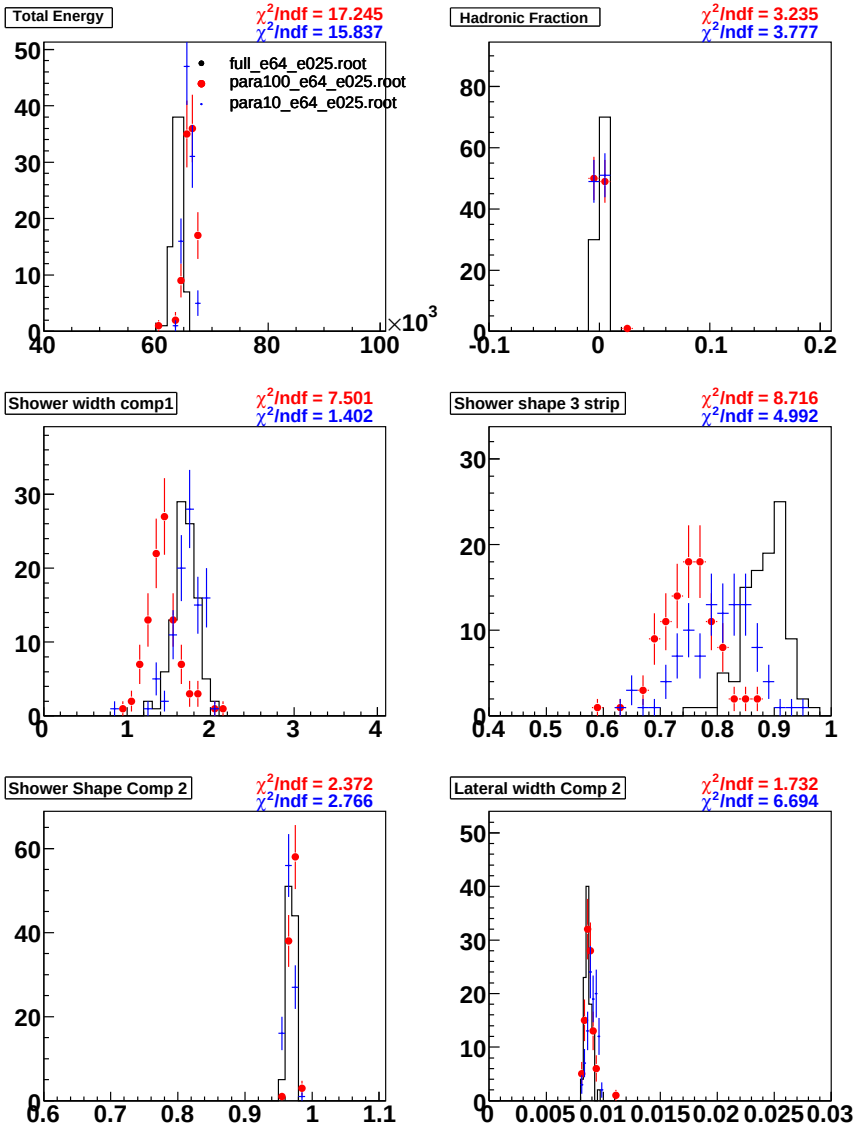
Frozen Showers aka Shower Library

A lot of time of the workshop went into understanding problems and solving them.

Recent improvements are:

- Moved from LArHits to G4 hits (better granularity)
- Using only hits in sensitive detectors (includes already sampling, resolution, charge collection, ...)
- Added some hit clustering to reduse size of showers
- Added frozen showers to FastSimulation (tagged)
- Added dedicated sensitive detector for easy hit deposition

Reference samples



Parameterization+kill at 10

3.6 sec

Parameterization+kill at 100

1.6 sec

Direct GEANT showers

Use UserAction code to access GEANT hits directly.

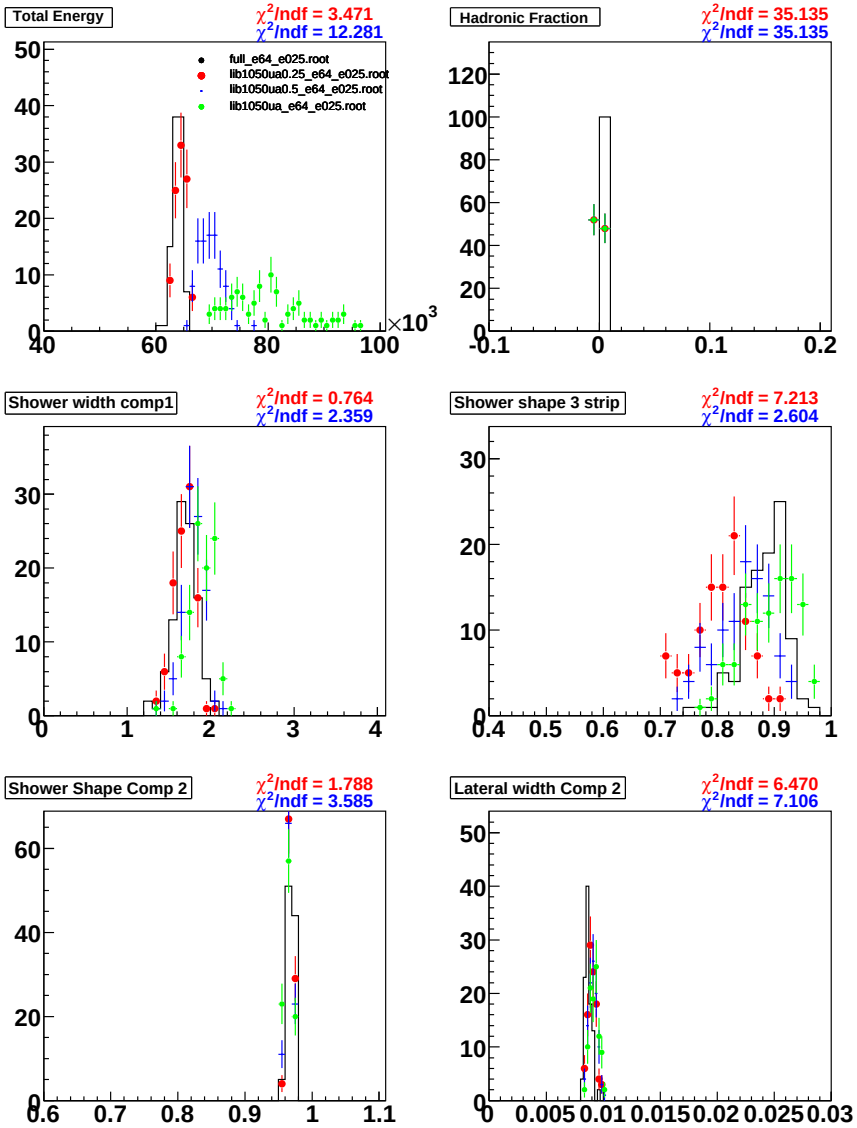
To speedup development, write shower library in a text format. Need to have `lib.dat` file in the execution directory. Move to COOL database for production.

Tune overall energy scale with which the frozen shower is overlayed.

Shower library with $10, 20, 50, 100, 200, 500$ MeV energy bins, ~ 100 showers for each bin.

Works **Ok** for scale factor ~ 0.25 (up to some remaining problems for energy resolution).

Direct GEANT step frozen showers



Effect of different energy scale factors (ratio of dead to sensitive detectors):

1.0 - green

0.5 - blue

0.25 - red

Average time per event:

2.8 sec

(vs 1.6 and 3.6)

Reduction of the shower size

Employ 2 algorithms to reduces shower size:

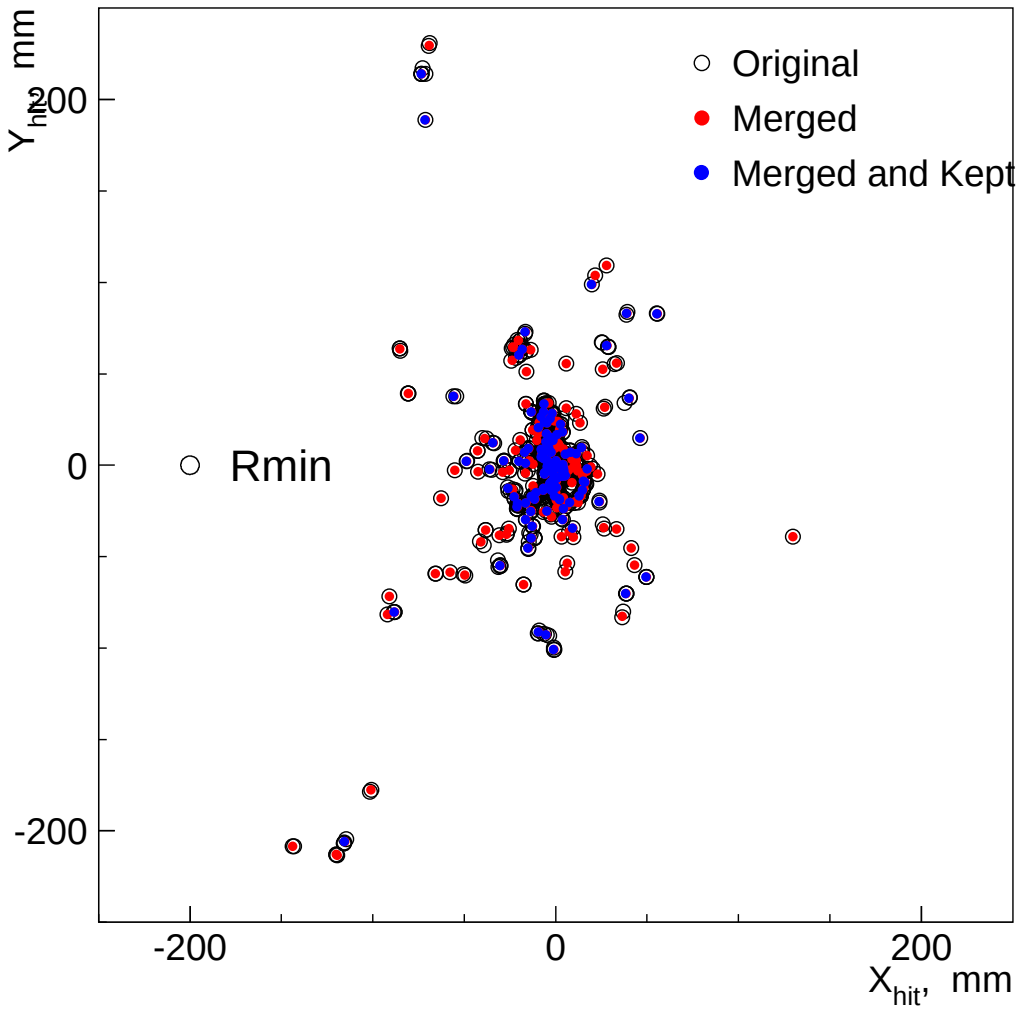
Clustering:
- Find a pair of energy deposits with the smalles spacial separation R
- If $R < R_{min}$, replace the pair by one point at the center of energy
- Repeat first step.

Truncation:
- Sort deposits following the energy.
- Calculated running sum, keep deposits corresponding to fraction f of the total energy.

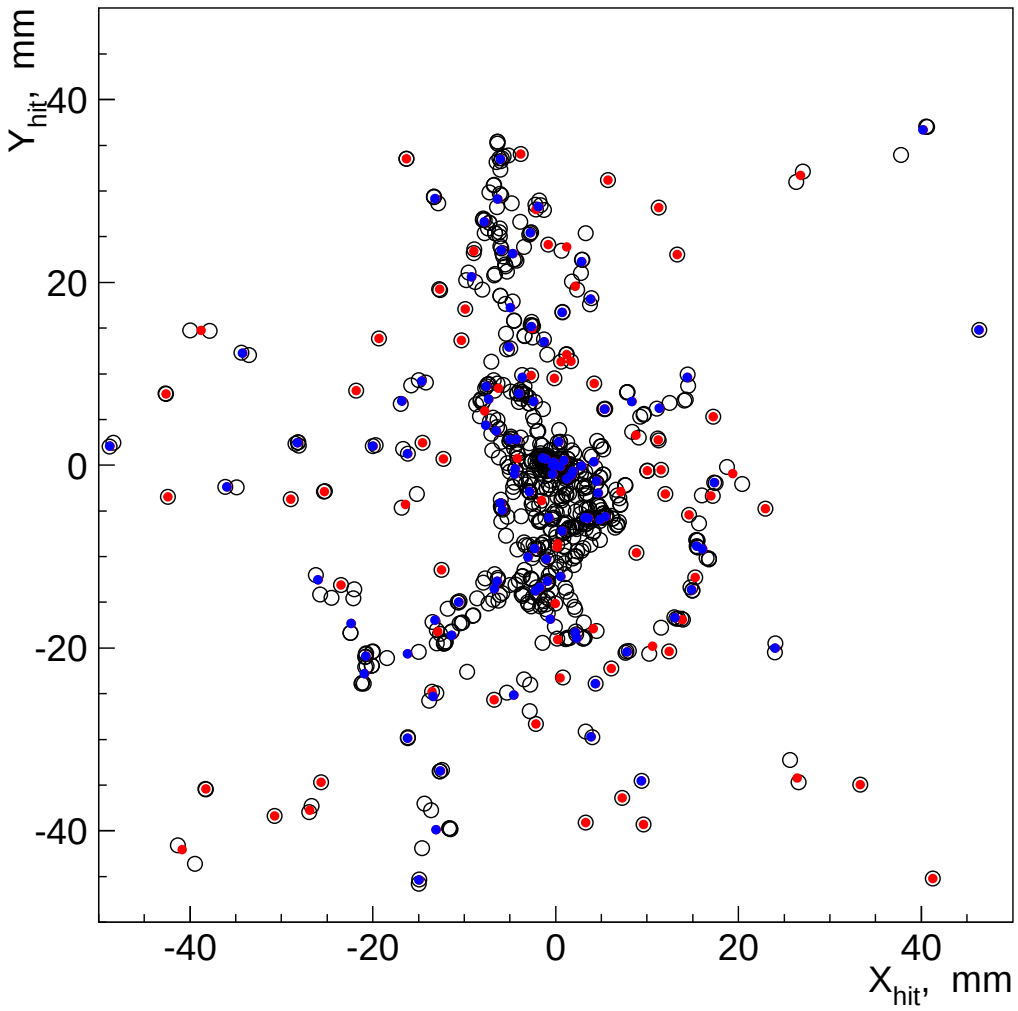
Rescaling: Rescale $X_i - X_{ave}, Y_i - Y_{ave}$ for the remaining hits such that the second momentum of the original shower is preserved.

Use $R_{min} = 5$ mm and $f = 95\%$

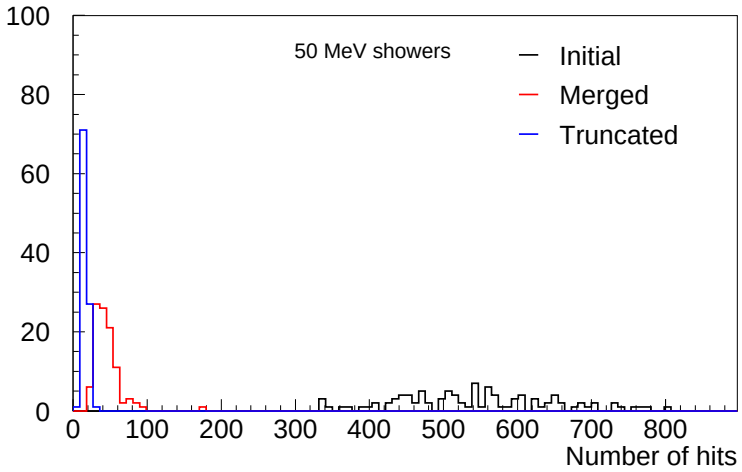
500 MeV Event in LAr

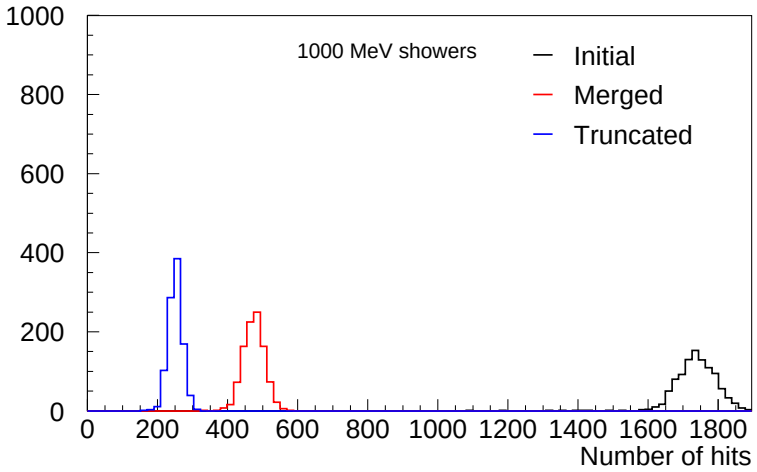


Same Event: zoom



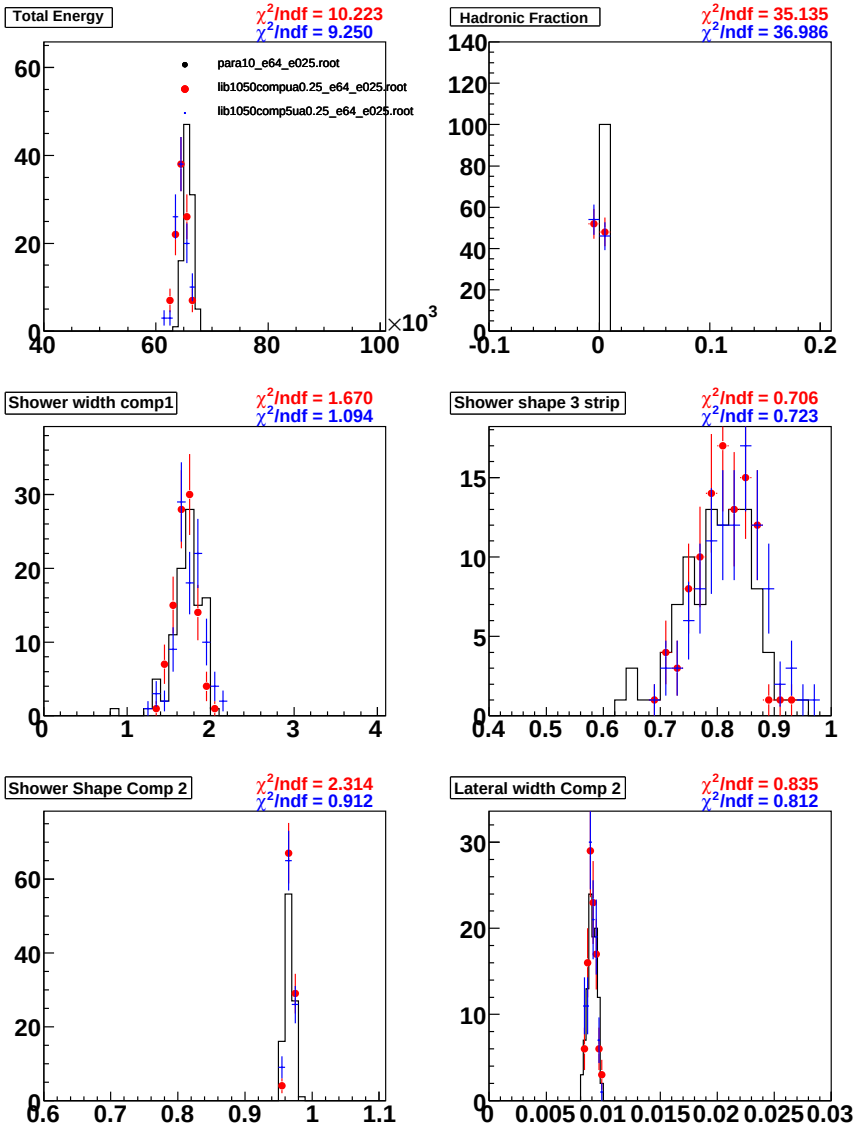
Size Reduction





Significant reduction of the shower size, more than factor of 10 for low energy showers.

Shower shapes after compression



Average time per event:
2.0 sec $(10 - 100$ MeV$)$,
1.7 sec $(10 - 500$ MeV$)$
(vs 1.6 and 3.6)

Scan of the upper validity range

Create shower library bins for
$E = 1000, 2000, 5000$ MeV.

Generate events with Frozen Showers used in
$10 - 2000$ MeV or $10 - 5000$ MeV range and
parameterization above the upper limit.

Significant speedup without distortion of the shower shapes (in fact some improvement)

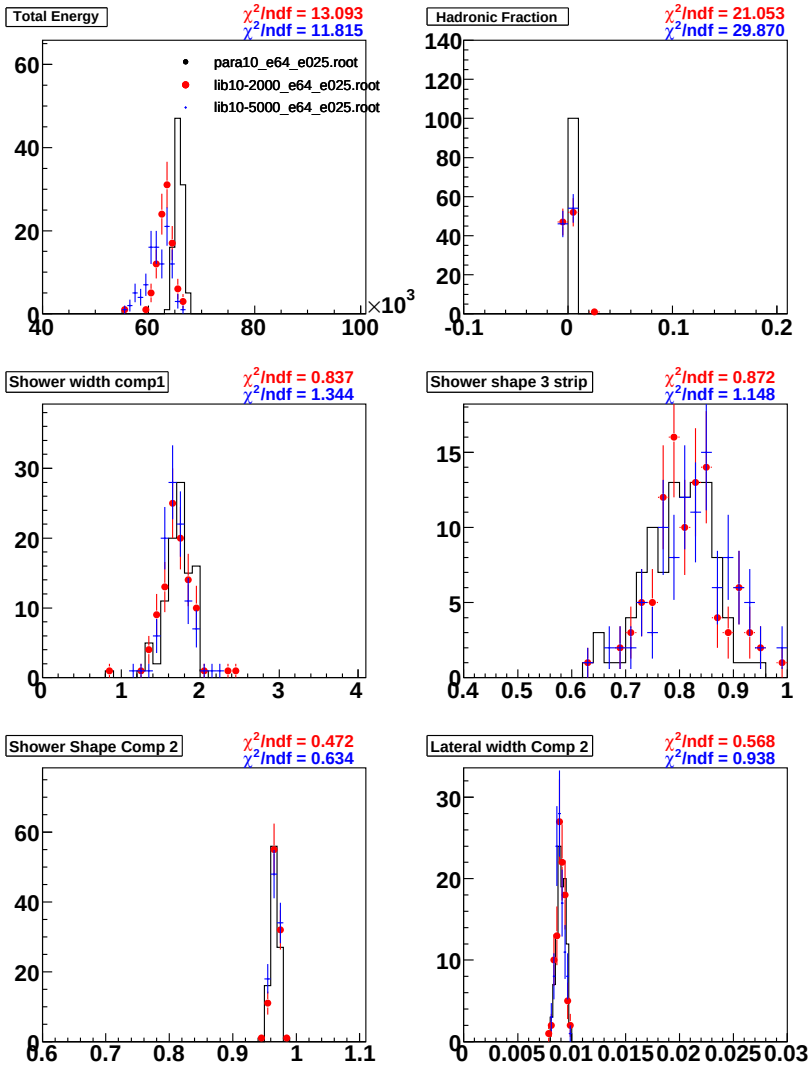
$10 - 2000$ MeV range 1.2 sec

$10 - 5000$ MeV range 0.9 sec

compared to 1.6 sec

But ...

Frozen Showers for $E_{max} = 2$ GeV and 5 GeV



Large energy resolution problem.

This is tracked down to the problem of applying some sampling steps/corrections twice: at shower lib generation and usage.

Solution:

- apply sampling, correction, ... at library generation
- use dedicated sensitive detector for hit making (avoiding a lot of checks)

→ get even more speed up

Deliverables - Next Steps

We are aiming for release 13 (early, middle or late January 2007) with a significant time improvement and resonbable good shower description.

Hard Goals:

- Working tuning of EMB, EMEC, FCAL1
- Frozen showers for EMB, EMEC
- Tuning of shower library parameters
- Optimised cuts of different parametrisations (kill, Frozen Showers, Parametrisation)

Soft Goals:

- Tuning of FCAL2/3
- Frozen showers for FCAL1

Summary

We had a very good and productive workshop.