Fast LAr Shower Simulation

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Introduction

→ Idea of Frozen Showers

→ Implementation and performance

→ Usage

→ Summary

Frozen Showers (FS)

→ Full simulation of typical QCD event in ATLAS LAr calorimeter takes ~15 min

→ large part of this time is electromagnetic shower simulation

Solutions:

→ Parameterisation of the shower (Grindhammer)

→ "Frozen shower library":

– full simulation down to 1 GeV cut-off

– pre-stored shower library of compressed GEANT hits

→ speed up MC events simulation

→ shower shapes should be well described compared to full simulation

Implementation of Frozen Showers

- → Separately simulate and record (once) GEANT hits, store compressed information (LArG4GenShowerLib)
- → Retrieve hits instead of shower parametrisation, binning, transition, rotation, … (LArG4ShowerLibSvc)
- → Do fast simulation (LArG4FastSimulation)
- → LArG4ShowerLib contains the library and shower classes

Implementation of Frozen Showers

done in:

→ η bins (takes into account changing LAr structure)

→ linear extrapolation at the calorimeter surface is done for tracks between two η bins: $|\eta_1| < |\eta| < |\eta_2|$

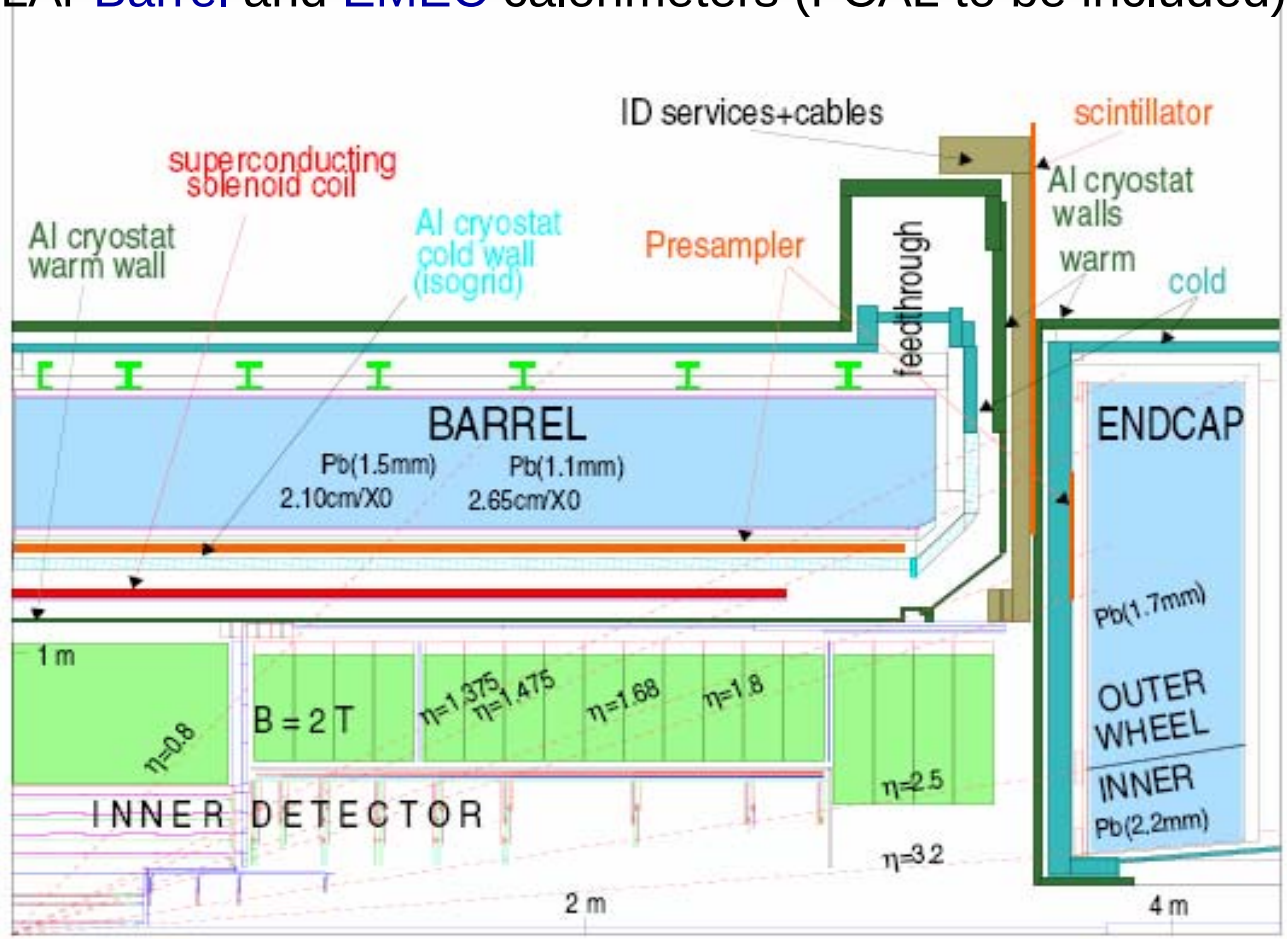
→ probability to take bin_1: $P = |\eta_2| - |\eta| \ / \ |\eta_2| - |\eta_1|$

→ E bins covers large range of particle energies (from 10 up to 1000 MeV)

→ In each E bin typically 1000 showers are stored with a list of hits together with their position (X,Y,Z) and E

Implementation of Frozen Showers

→ Presently Frozen Showers are implemented and working for LAr Barrel and EMEC calorimeters (FCAL to be included)



Implementation of Frozen Showers

→ Barrel:

η binning (7):

0.1 0.3 0.5 0.81 0.83 1.1 1.3

E binning: 10 20 50 100 200 500 1000

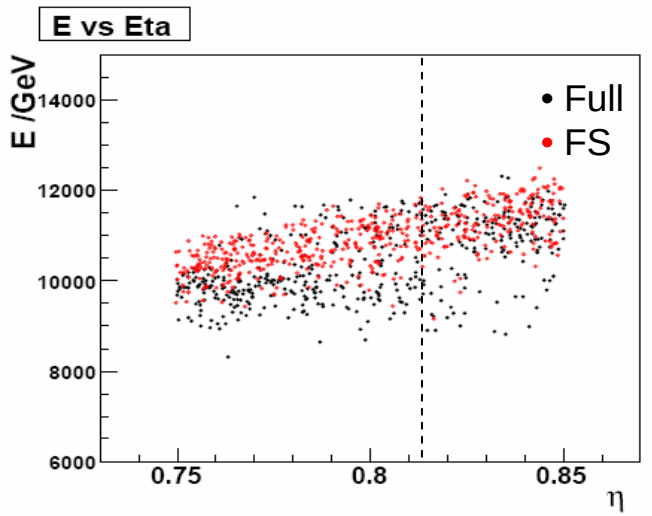
(1000 events per bin)

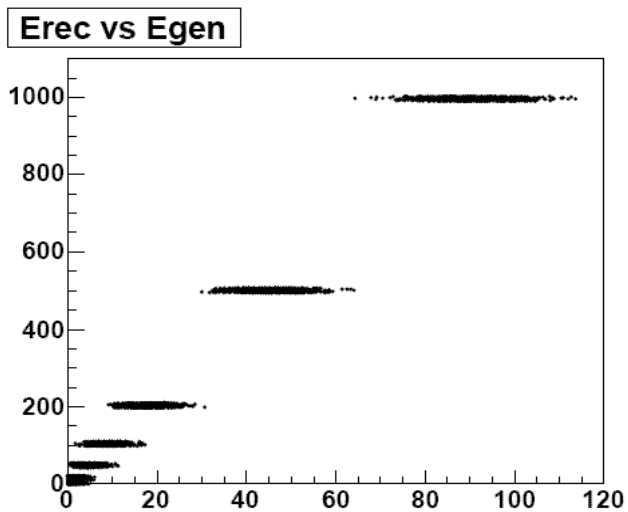
→ EMEC:

η binning (5): 1.6 2.0 2.4 2.6 3.0

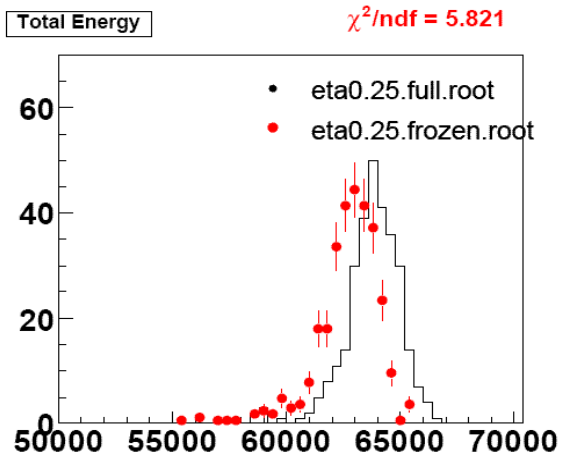
E binning: 10 20 50 100 200 500 1000

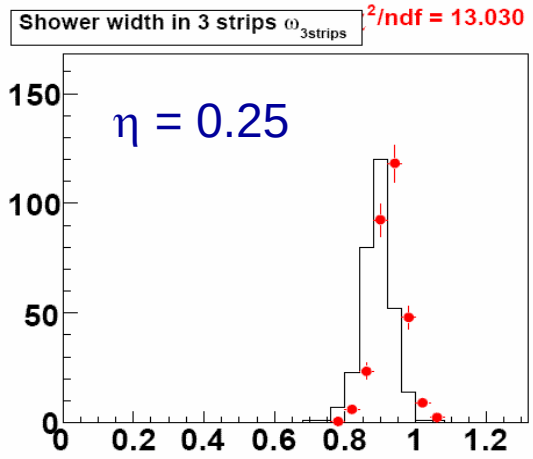
(1000 events per bin)

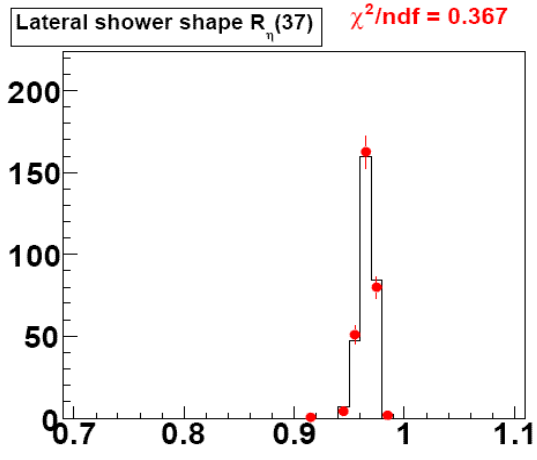


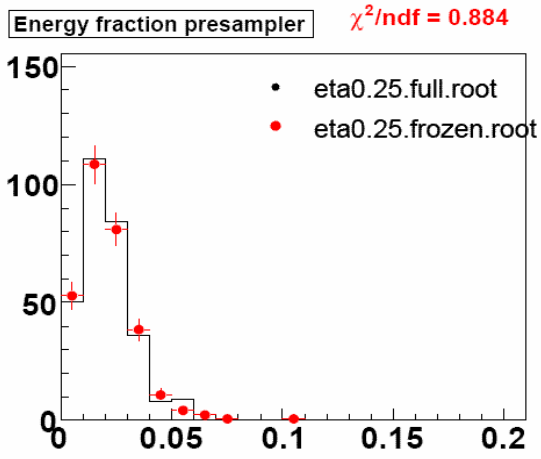


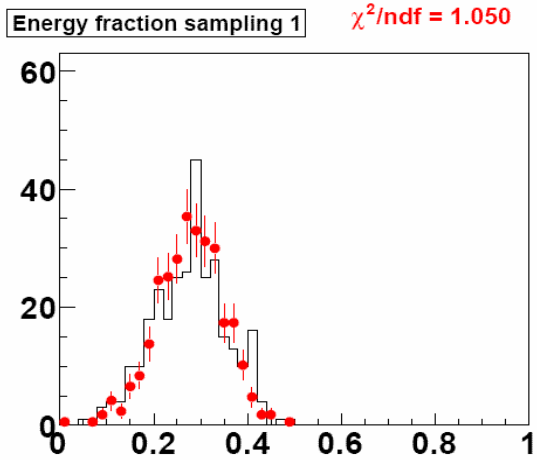
Performance of Frozen Showers: Shower Shapes in EMB

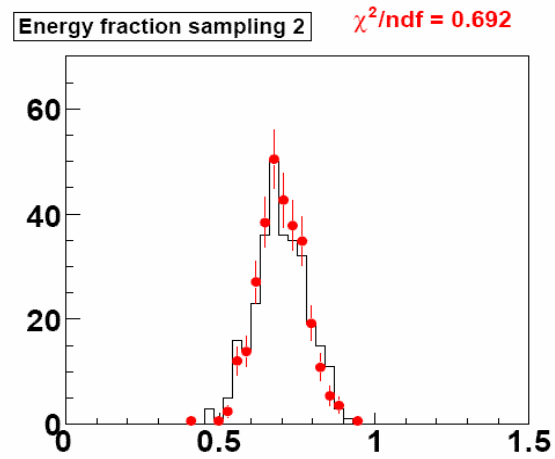




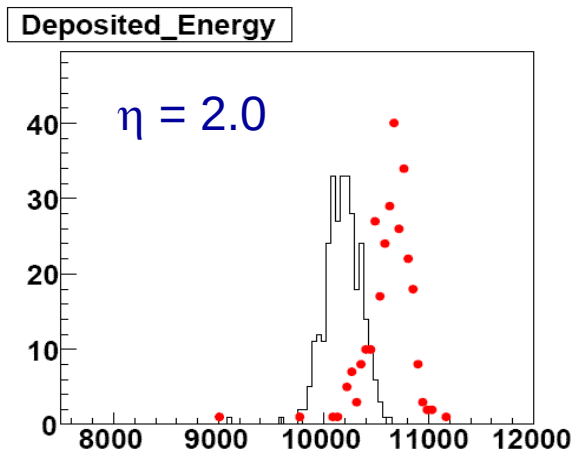


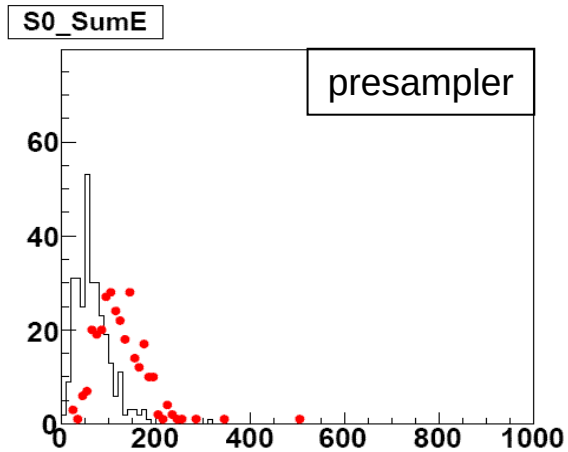


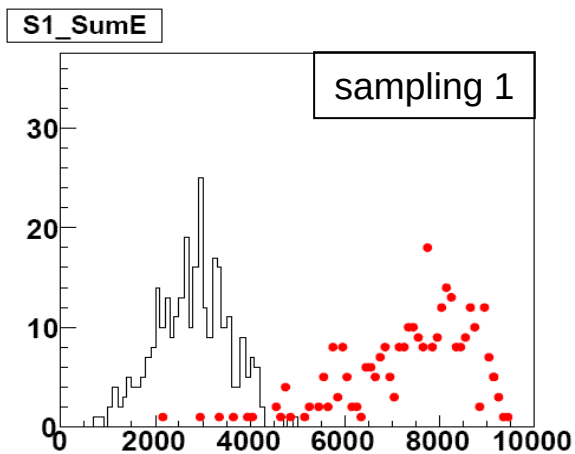


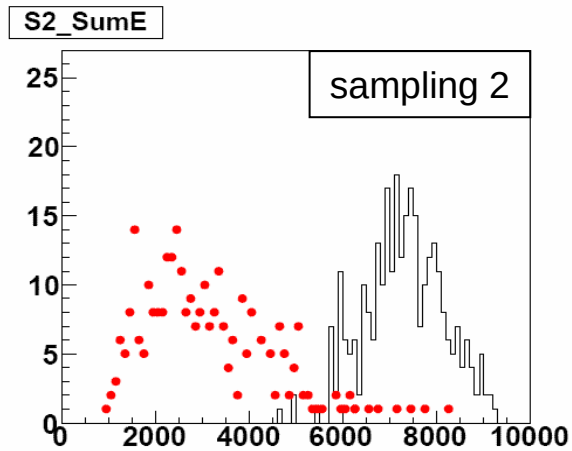


Performance of Frozen Showers: Shower Shapes in EMEC







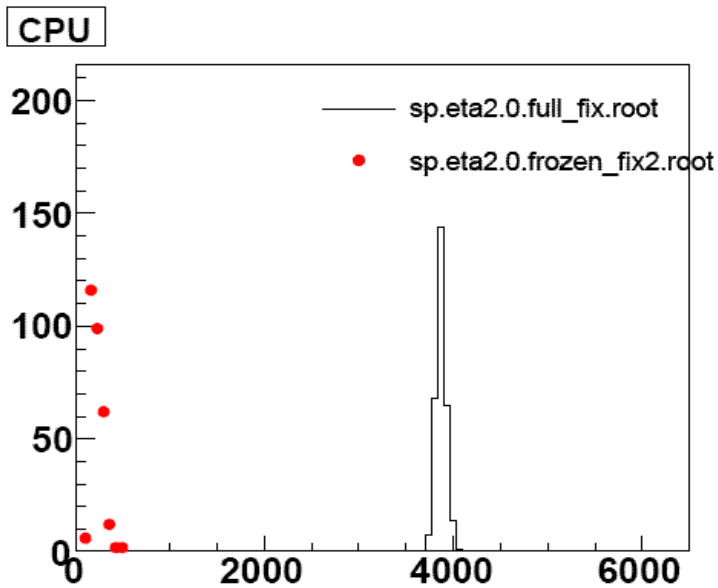


→ some problems (i.e. energy sharing in different compartments) to be solved

Performance of Frozen Showers: Timing

Average time required to simulate an electron from interaction point with E = 64 GeV

	η	time, s	
		full	FS
EMB	0.25	~ 20	1.2
EMEC	2.0	~ 39	2.3



Usage of Frozen Showers

To achieve the best timing and shower description following methods could be combined:

→ full simulation

→ parametrisation

→ Frozen Showers

1. FS library < 1 GeV < Full simulation
2. FS library < 1 GeV < Parametrisation
3. FS library < 1 GeV < Full simulation < 10 GeV < Parametrisation
4. **...**

→ there is no final strategy yet …

Summary

→ Frozen Showers are implemented and working for EMB and EMEC calorimeters
  → show good performance and excellent timing

→ Still some work to be done:
  → needs more testing (EMEC) and tuning of existing FS
  → understanding FCAL and implementing FS

→ Final strategy to be discussed with collaborators and PWG … (something for coming ATLAS LAr week)