Fast Parametrisation of electromagnetic showers in LAr Calorimeter: Frozen Showers

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DESY - ATLAS

- Introduction to Frozen Showers (FS)

- Energy response of FS in different ATLAS LAr calorimeters (r13.0.40)

- Summary

Introduction to Frozen Showers (FS)

The time needed to simulate EM shower in LAr calorimeter may be significantly reduced using fast shower parametrisation techiques (e.g. Frozen Showers) thus reducing overall simulation time
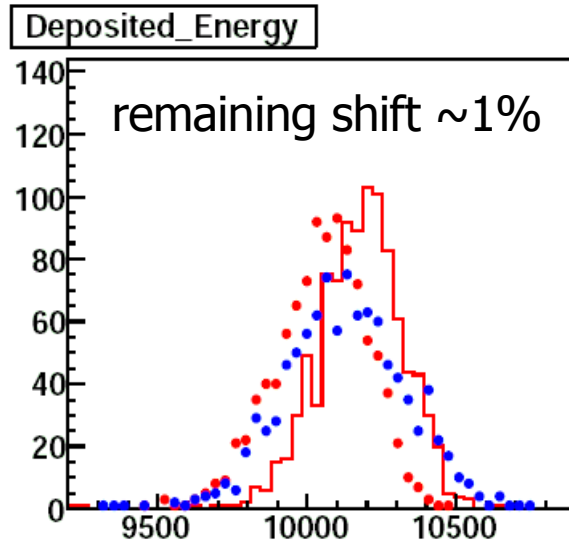
Frozen Shower Library (FS):
➜ full simulation down to 1 GeV cut-off
➜ pre-stored shower library of compressed GEANT hits

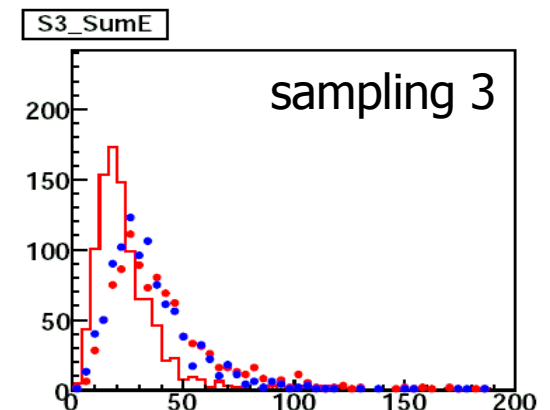➜ shower shape description should have good agreement with full simulation
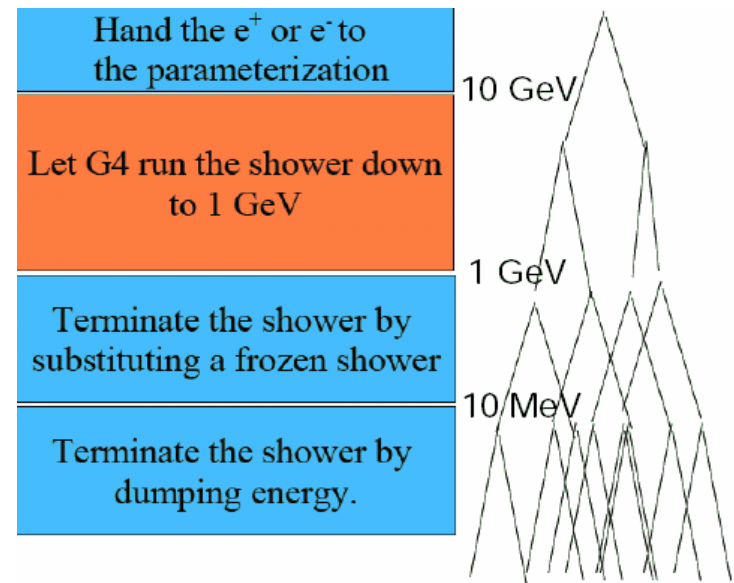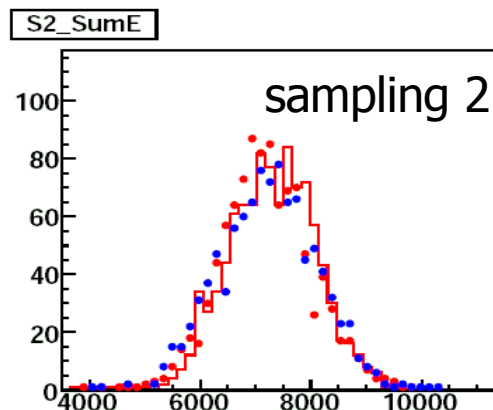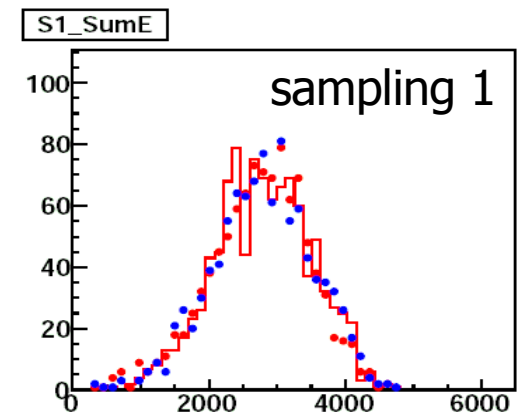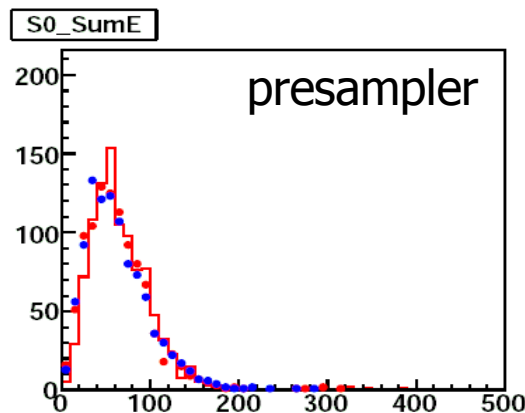

FS libraries are implemented for EMB, EMEC, FCAL1 calorimeters

Deposited_Energy

remaining shift ~1%

— full simulation (e of 64 GeV)
- FS < 1 GeV < full simulation
- FS < 1 GeV < full sim < 12 GeV < parametrisation

S0_SumE — presampler

S1_SumE — sampling 1

S2_SumE — sampling 2

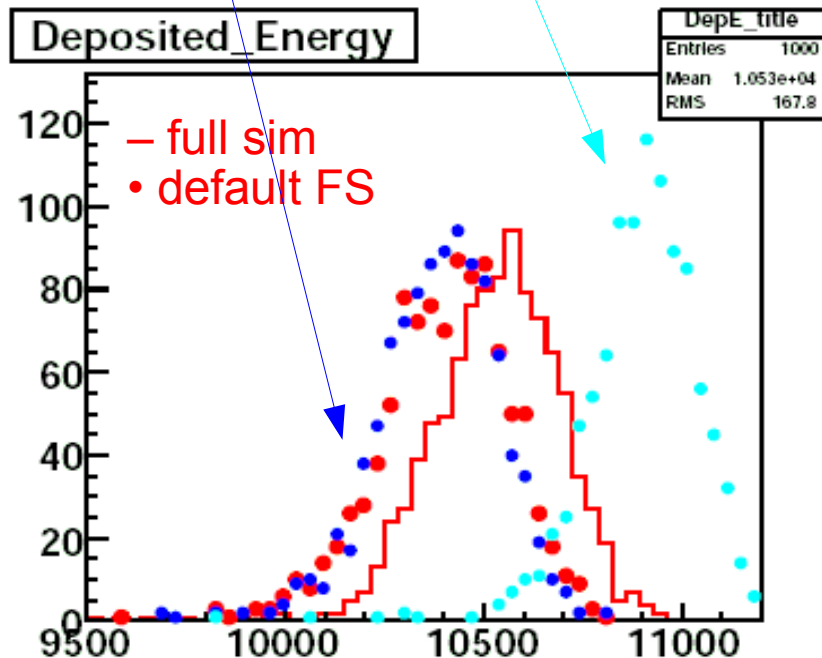**S3_SumE** — sampling 3

average time per event:

full sim	16.0 s
FS	0.9 s
FS+param	0.8 s

Energy shift in Frozen Showers vs Phi
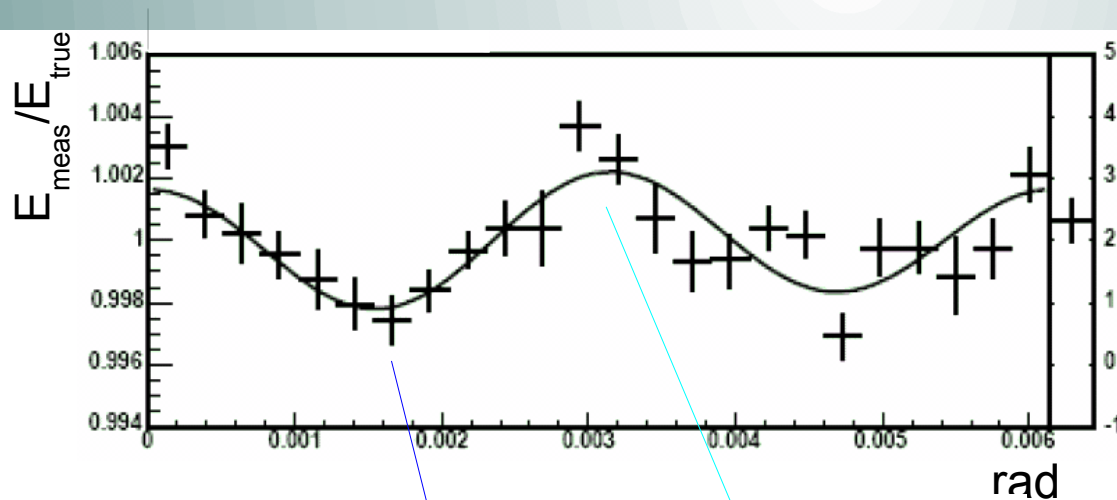
after generating
FS libs at min/max...

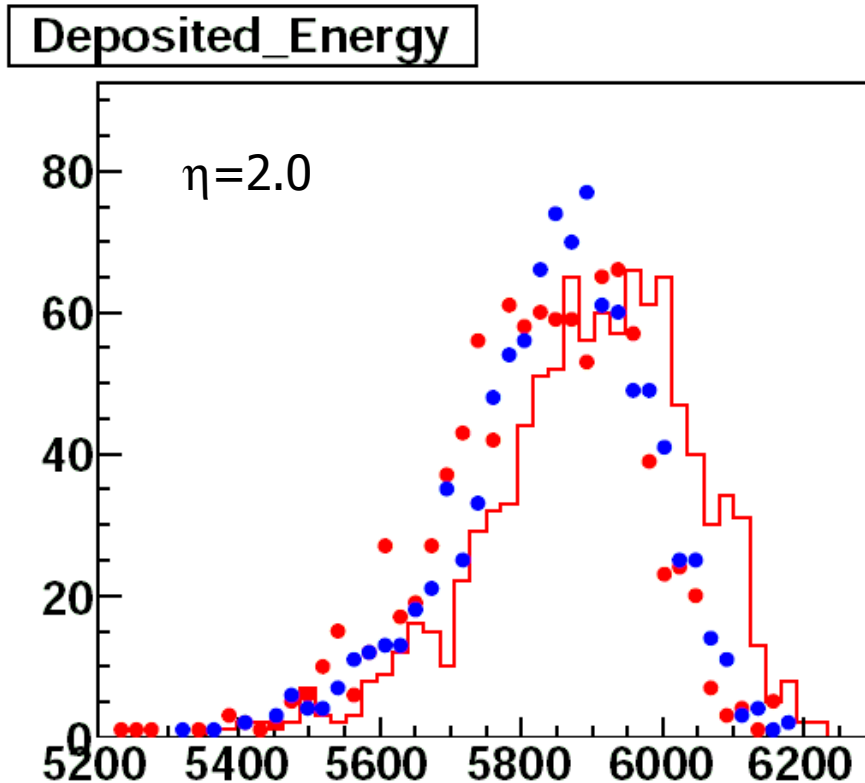... max change
in energy ~5%

In the lower plot:
– full sim
• default FS

Deposited_Energy

DepE_title
Entries 1000
Mean 1.053e+04
RMS 167.8

Frozen Showers generated with average Phi: EMB

full sim
(10529.5)

FS(e)
(10400.4)

FS(e) with av φ
(10527.5)

DepE_title	
Entries	1000
Mean	1.053e+04
RMS	167.8
χ^2 / ndf	19.42 / 28
Constant	102.6 ± 4.0
Mean	1.054e+04 ± 5
Sigma	151.8 ± 3.5

DepE_title	
Entries	1000
Mean	1.04e+04
RMS	163.9
χ^2 / ndf	40.31 / 24
Constant	100.1 ± 4.1
Mean	1.04e+04 ± 5
Sigma	152.8 ± 4.0

DepE_title	
Entries	1000
Mean	1.053e+04
RMS	156.4
χ^2 / ndf	50.63 / 25
Constant	108.3 ± 4.7
Mean	1.054e+04 ± 5
Sigma	139.8 ± 4.1

- Full sim and new FS have the same mean

- new FS distribution width is more narrow than full sim (was larger)

Frozen Showers generated with average Phi: EMEC

full sim
(5898.5)

FS(e)
(5820.7)

FS(e) with av φ
(5845.7)

Deposited_Energy

$\eta=2.0$

Deposited_Energy

$\eta=1.5\text{-}3.3$

E_vs_Eta

- full sim
• FS(e)
• FS(e) with av φ

Needs better understanding of the
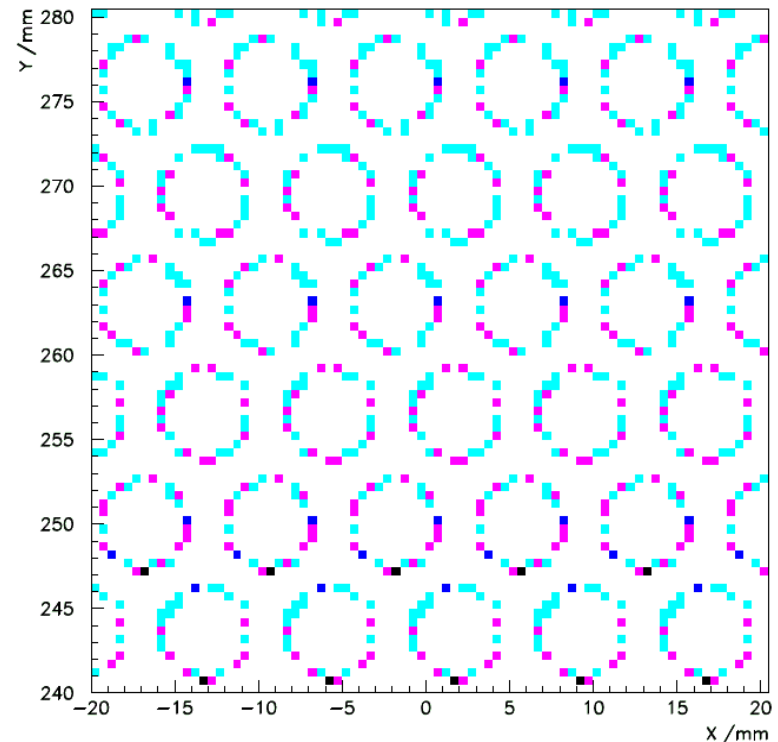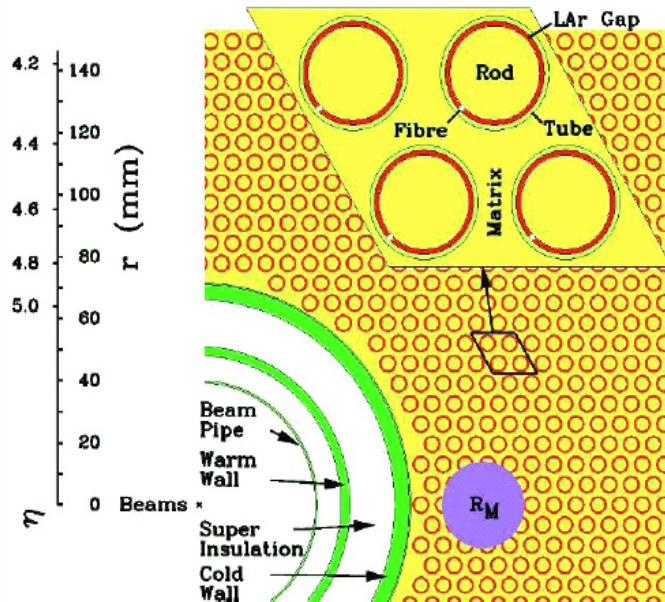shower response in the crack region
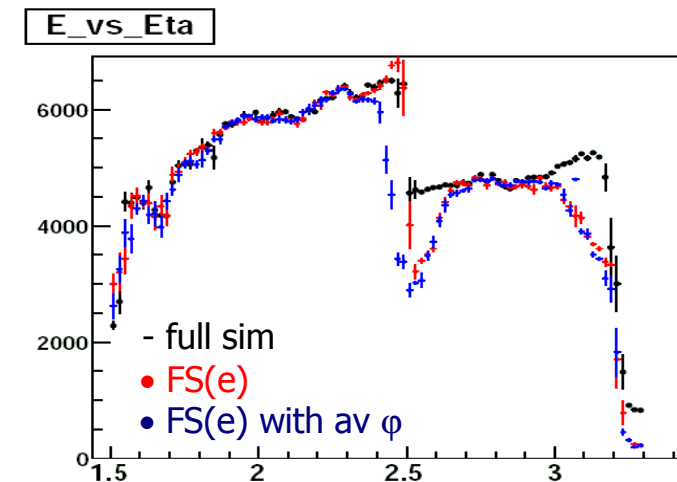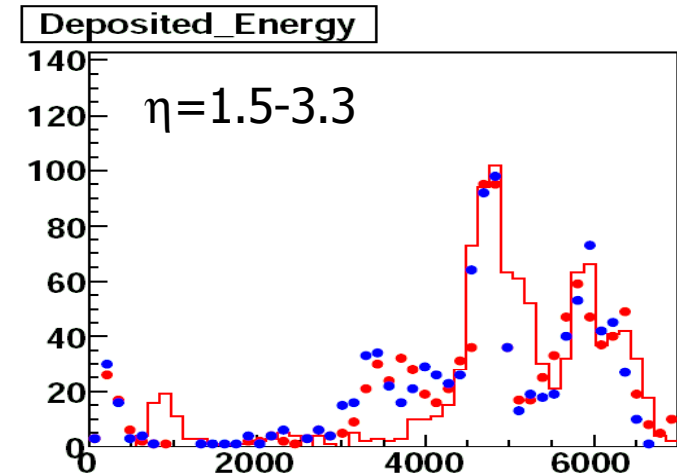
Frozen Showers for FCAL1

- EMB and EMEC frozen libraries has energy and eta binning
- FCAL response has little eta dependence BUT low energy showers are strongly depend from the LAr gap (position dependence)
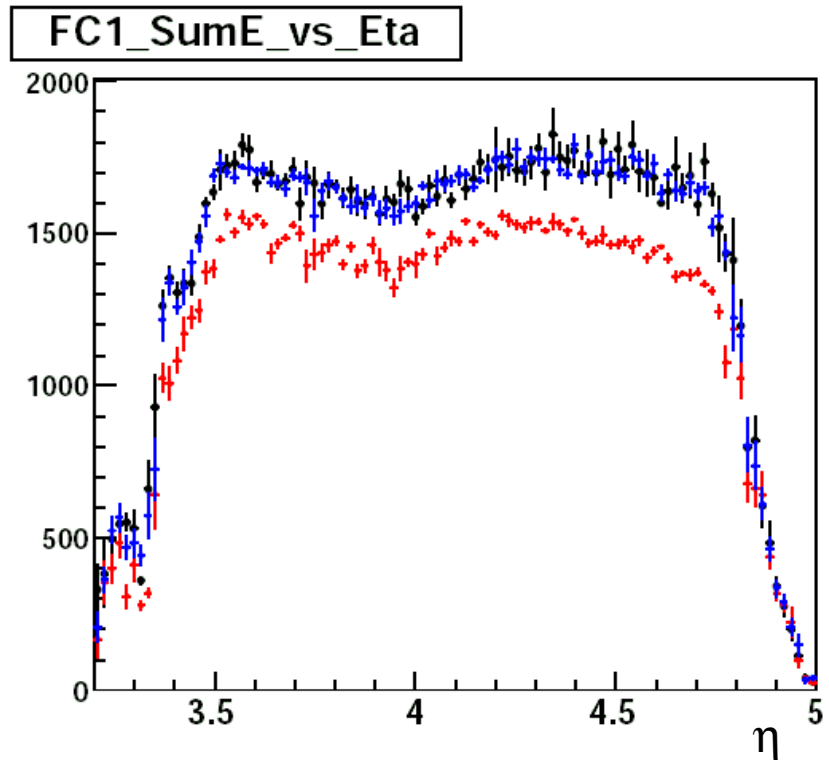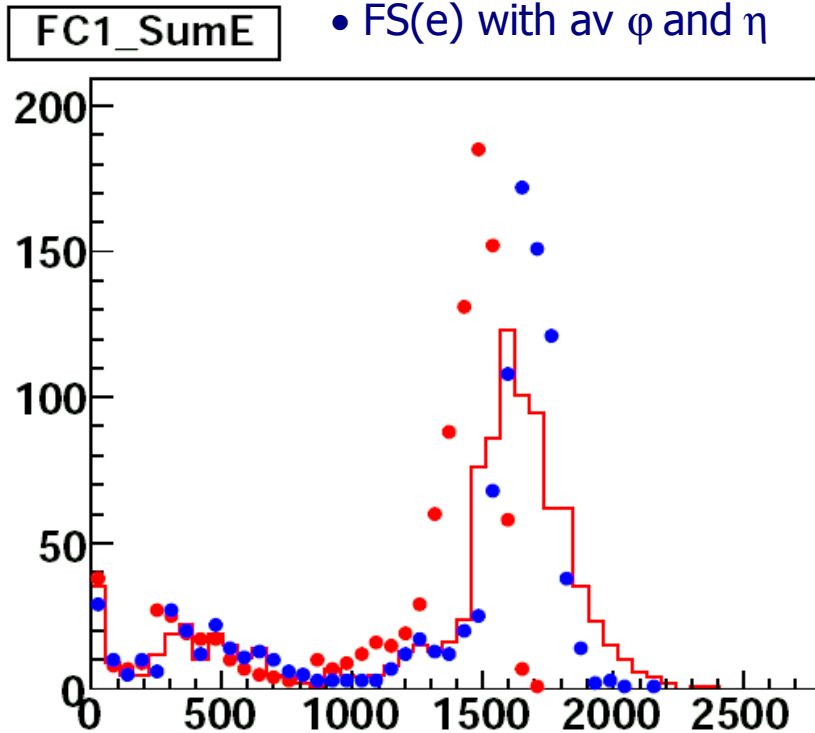
FCAL1:

hexagonal array of cooper tubes/rods

LAr gaps in between

- Now eta bins are replaced with the distance from the center of the closest rod (two bins: in and outside the gap)

- full sim (e of 64 GeV)
- FS(e)
- FS(e) with av φ and η

- much better energy description (still more narrow with respect to the full simulation)

Open issues

- Storage of the shower libraries: database instead of text files

- Separate instance of the service for different calorimeters (difference of FCAL binning)

- Tuning of EMEC (crack region and phi boundaries)

- Understanding of resolution difference/adding extra smearing

Summary

Frozen Shower performance is good in EMB, EMEC, FCAL1 calorimeters
(here only energy response of Frozen Showers has been presented)
with
the improvement in time of ~10 times
(~2 of the whole simulation time)

some additional work is required to improve further